USE IN LIFE SUPPORT DEVICES OR SYSTEMS MUST BE EXPRESSLY AUTHORIZED

SGS-THOMSON PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF SGS-THOMSON Microelectronics. As used herein:

1. Life support devices or systems are those which (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided with the product, can be reasonably expected to result in significant injury to the user.

2. A critical component is any component of a life support device or system whose failure to perform can reasonably be expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.
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This databook contains datasheets covering the range of discrete devices for small signal consumer, industrial and professional applications, including RF devices.

A selection guide by characteristics and, for RF devices, by application, is provided to enable fast identification of the most suitable devices for your application.

The information on each product has been presented in order that the performance of the product can be readily evaluated within any required equipment design.
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**SGS-THOMSON Microelectronics**

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10
### Transistors for fast and ultra-fast switches in TO-18

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### Transistors for fast and ultra-fast switches in TO-39

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### HIGH VOLTAGE transistors in TO-126

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HANDLING PRECAUTION

PCB Mounting

Frequently lead forming is necessary to allow a suitable fit of a transistor on to a PCB. With or without lead forming these points should be observed.

I) Space the lead holes on the PCB to match the foot print of the transistor

II) Avoid lateral stress or excessive pressure on the ends of the transistor leads.

III) Use a spacer between the transistor and PCB

IV) When lead forming prior to mounting a transistor
   - make the bend at least 3 mm from the transistor body
   - clamp the leads near the transistor body before forming the lead
   - maintain a space between the jig and transistor body
   - follow all the precautions specified in the various standard relating to the transistors

V) When mounting a transistor onto a heat sink:
   - use the correct accessories
   - drill the holes on the heat sink as specified and properly deburr them. Avoid "pitting" the heat sink.
   - use a recommended silicon grease
   - use the correct tightening torque for the mounting screws or use the correct clips for mounting the transistors
   - never use pneumatic screwdrivers to mount transistors

VI) Avoid repeated bending of transistor leads when lead forming.

Soldering

The specified temperatures for soldering transistor leads are 260°C for 10 seconds or 350°C for 3 seconds. Temperature and times in excess of these could adversely effect the transistors.

Use a non corrosive flux

Be sure to
- solder quickly
- avoid applying mechanical stress to the transistor after soldering it, i.e. do not adjust its position
- mount the transistor on its heatsink before soldering the assembly to a PCB
- do not solder the heat radiating metal case, of a metal cased transistor, to a PCB
- use a low leakage soldering iron properly grounded.

Cleaning the PCB

After soldering clean the PCB to remove the flux.
- do not rub identifying marks with a brush or fingers when using a cleaning agent.
- take care using ultrasonic cleaning baths. Under certain circumstances the service life of airtight sealed transistors may be shortened.
- the recommended cleaning method is to adapt steam or jetstream cleaning techniques, where the transistors are mounted on PCB’s.

Static Electricity

Maximum parameter ratings for the transistors should in no case be exceeded. However during handling it is possible that excessive static voltages may be applied directly or indirectly while handling them.
High frequency transistors are particularly prone to damages from static charges.
Proper circuit protection procedures should be observed.
QUALITY ASSURANCE

The average outgoing quality level (AOQ) is ultimately with the results of outgoing inspection which carries out a sampling inspection on each lot according to devices specification. Sampling plan of outgoing inspection (according to MILSTD105D standard).

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Estimator of average outgoing quality level * (see sure 5) AOQ =

\[
\begin{align*}
\text{AOQ} &= \frac{d = c + 1}{\sum \text{Nd} \cdot d} \\
&= \frac{\sum \text{Nd} \cdot n}{d = 0} \\
&= \frac{\text{Total defective units in samples with } d \leq c + 1}{\text{Total inspected units in samples of accepted lots}}
\end{align*}
\]

where:
- \( n \) = sample size
- \( c \) = acceptance criterion
- \( d \) = number of defects in sample
- \( \text{Nd} \) = number of lots with \( d \) defects on sample \( n \)

The value is expressed in:

\[
\text{PPM} = \text{Parts per million } (10^{-6})
\]

(The sums are applied to all inspected lots: 1st, 2nd inspection)
QUALITY

RELIABILITY ASSURANCE
Continuous reliability auditing with accelerated tests are performed on small signal transistor production in 2 stages:
* internal real time control (RTC)

A great emphasis is given to these process oriented reliability tests performed on a weekly basis. High accelerated conditions are used as often as physically possible:
- detection of any slight process shift

- evaluation of the impact of process control continual improvement

* group b and c - long time life tests they are performed on a periodic basis (usually every 3 months) to complete the information given by RTC tests and to define the long term reliability of the product and failure rate evaluation.

The results are cumulated each year - they are available on request.

Reliability Test Conditions

<table>
<thead>
<tr>
<th>Test</th>
<th>Conditions</th>
<th>Typical test Circuit</th>
<th>Standard</th>
</tr>
</thead>
</table>
| HTRB                      | $V_{CC} = 80\% \ V_{CES}$ maximum rating $Ta = 150^\circ C$
  Short term = 168 hours
  Long term = 1000 hours | ![Typical Circuit](image1)                      | MILSTD 750C method 1032 |
| THERMAL CYCLES            | $-65^\circ C$ to $+150^\circ C$
  short term = 100 cycles
  long term = 1000 cycles | ![Typical Circuit](image2)                      | MILSTD750C method 1051 |
| OPERATING LIFE            | $T_j = T_j$ max.
  $PD = \frac{T_j \text{ max.} - T \text{ case}}{R_{th}}$
  long term = 1000 hours | ![Typical Circuit](image3)                      |                      |
| HIGH TEMPERATURE STORAGE  | $Ta = T_j$ max.
  long term = 1000 hours   | ![Typical Circuit](image4)                      |                      |
Note: SPC methods are used for Process Control Assurance and continual quality improvement towards Zero defect target. High values of process control capability (CPK) at each significant step assure reliable results at the end of the process.

TYPICAL WAFER FABRICATION FLOW CHART

LOT FORMING
  
  OXIDATION
    ■ OXIDE INSPECTION
  
  MASKING
    ○ VISUAL CHECK
    ■ INSPECTION
    
    successive diffusion cycles

  ETCHING
    ■ INSPECTION
  
  DIFFUSION DOPING BY DIFFUSION OR BY IMPLANT
    □ STRUCTURE PARAMETER - CHECK
    ■ INSPECTION

OXIDATION, GLASS DEPOSITION
  
  ■ OXIDE and GLASS INSPECTION
  
  MASKING
  ■ INSPECTION
  
  ETCHING
    □ VISUAL and ELECTRICAL CHECK
    ■ INSPECTION

METALIZATION
    □ METALIZATION CHECK
    ■ INSPECTION

FINISHED WAFERS
  
  100% PROBING
    ○ AVERAGE OUTGOING QUALITY EVALUATION

PACKING IN HERMETICALLY SEALED BAGS
  ■ VISUAL INSPECTION

WAFER WAREHOUSE (F.I.F.O. PROCEDURE)

Initialization of "Lot Tracking" procedure (total traceability throughout the process)

End of "Lot Tracking"
QUALITY

Note: SPC methods are used for Process Control Assurance and continual quality improvement towards Zero defect target.
High values of process control capability (CPK) at each significant step assure reliable results at the end of the process.

METAL CASE ASSEMBLY - TYPICAL FLOW CHART

WARES FROM WAREHOUSE

SAWING

VISUAL CHECK

RAW MATERIALS

HEADERS INSPECTION

DIE ATTACHING

DIE ATTACHING INSPECTION

WIRE BONDING

WIRE BOND INSPECTION

PRE-CAP ACCEPTANCE

SEALING

SEALING INSPECTION

LEAD FINISH

LEAD FINISH ACCEPTANCE

INTERNAL WAFER / VAPOR INSPECTION

HIGH IMPACT SHOCK

RAW LINE ACCEPTANCE

SHORT TERM RELIABILITY TEST (RTC)

RAW LINE WAREHOUSE (F.I.F.O. PROCEDURE)

Initialization of Production Route Card (linked to "Lot Tracking" for traceability throughout the process)

End of production route card with raw line acceptance
**Note:** SPC methods are used for Process Control Assurance and continual quality improvement towards Zero defect target. High values of process control capability (CPK) at each significant step assure reliable results at the end of the process.

**FINISHING - TYPICAL FLOW CHART**

1. **RAW LINE STORE**
2. **FIRST TESTING**
3. **FALLOUT ANALYSIS**
4. **FALLOUT RE-TESTING**
5. **ADDITIONAL STEPS ON REQUEST**
6. **SECOND TESTING**
   - [ ] REJECT ANALYSIS (corrective action)
7. **MARKING**
8. **PACKING** (label with lot identification)
9. **FINISHED PRODUCTS WAREHOUSE (F.I.F.O. PROCEDURE)**
   - [ ] AUDITS
10. **SHIPMENT TO CUSTOMERS**

**Initialization of “Lot Identification” linked to other traceability documents**

**End of “Lot Identification”**
Description
The ever growing electronics equipment market is directed towards the shrinking of equipment size, weight and height, while demanding more diversified functions. To meet these requirements Surface Mounting Techniques (SMTs) are being employed.

The miniaturized components such as capacitors, resisitors, inductors, transistors, diodes, ICs, etc. are mounted on the surface of a board rather than having their leads inserted through holes. The use of micropackage devices offers many advantages compared to conventional assembly techniques.

1) The end product can be made more compact with about three times the mounting density as conventional components.
2) Easy handling and automated assembly cut production costs, saving on labour and time.
3) The small size of the packages reduces stray inductance and capacitance and also improves RF performance.
4) The moisture resistance and mechanical ruggedness of the epoxy package ensure high reliability.

Over the last few years SGS-THOMSON has introduced a large number of surface face mounted devices of which the SOT-23 is one of the most popular.

The flat SOT-23 devices are packaged and shipped in super 8 tape & reels. The tapes are made of special conductive vinyl. These reels are designed to hold and protect thousands of surface mountable components—enough to keep robots busy assembling printed circuit boards for hours at a time!

Datasheets are available on request.
TAPE MECHANICAL DATA

<table>
<thead>
<tr>
<th>DIMENSIONS</th>
<th>mm</th>
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<tbody>
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<td>2.65</td>
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<tr>
<td>C</td>
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<tr>
<td>D</td>
<td>1.5</td>
<td>1.6</td>
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<tr>
<td>E</td>
<td>1.95</td>
<td>2.05</td>
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<tr>
<td>G</td>
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<tr>
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<tr>
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<tr>
<td>M</td>
<td>7.8</td>
<td>8.2</td>
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<td>N</td>
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</tr>
<tr>
<td>P</td>
<td>1.3</td>
<td>1.4</td>
</tr>
<tr>
<td>R</td>
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<td>1.8</td>
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Shear force needed to peel back the tape. 0.2 to 1.3 N at 300 mm/min.
SURFACE MOUNTING CASE: SOT 23

REEL MECHANICAL DATA

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<td>C</td>
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<td>176</td>
<td>180</td>
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<tr>
<td>G</td>
<td>1.5</td>
<td>2.5</td>
</tr>
<tr>
<td>H</td>
<td>8.4</td>
<td>9.9</td>
</tr>
<tr>
<td>α</td>
<td>40°</td>
<td></td>
</tr>
<tr>
<td>β</td>
<td>120°</td>
<td></td>
</tr>
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</table>

Quantity per Reel = 3000 pieces
SURFACE MOUNTING CASE: SOT 23

PACKAGE

DIMENSIONS

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<th></th>
<th>mm</th>
<th>inches</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>min</td>
<td>max</td>
</tr>
<tr>
<td>A</td>
<td>0.93</td>
<td>1.04</td>
</tr>
<tr>
<td>B</td>
<td>2.8</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
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<td>1.4</td>
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<tr>
<td>D</td>
<td>2.1</td>
<td>2.5</td>
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<tr>
<td>E</td>
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<td>2.05</td>
</tr>
<tr>
<td>F</td>
<td>0.95</td>
<td>1.05</td>
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<td>G</td>
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<td>0.60</td>
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<tr>
<td>R</td>
<td>0.37</td>
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</table>

pin 1 = EMITTER
pin 2 = BASE
pin 3 = COLLECTOR
DESCRIPTION
The BC107, BC108 and BC109 are silicon planar epitaxial NPN transistors in TO-18 metal case. They are suitable for use in driver stages, low noise input stages and signal processing circuits of television receivers. The complementary PNP types are respectively the BC177, BC178 and BC179.

INTERNAL SCHEMATIC DIAGRAM

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{CBO}</td>
<td>Collector-base Voltage (I_E = 0)</td>
<td>50</td>
<td>30</td>
</tr>
<tr>
<td>V_{CEO}</td>
<td>Collector-emitter Voltage (I_B = 0)</td>
<td>45</td>
<td>20</td>
</tr>
<tr>
<td>V_{EBO}</td>
<td>Emitter-base Voltage (I_C = 0)</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>I_C</td>
<td>Collector Current</td>
<td>100</td>
<td>mA</td>
</tr>
<tr>
<td>P_{tot}</td>
<td>Total Power Dissipation at T_{amb} \leq 25 °C</td>
<td>0.3</td>
<td>W</td>
</tr>
<tr>
<td>at T_{case} \leq 25 °C</td>
<td>0.75</td>
<td>W</td>
<td></td>
</tr>
<tr>
<td>T_{stg}</td>
<td>Storage Temperature</td>
<td>-55 to 175</td>
<td>°C</td>
</tr>
<tr>
<td>T_j</td>
<td>Junction Temperature</td>
<td>175</td>
<td>°C</td>
</tr>
</tbody>
</table>
### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter Description</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&lt;sub&gt;th&lt;/sub&gt;j-case</td>
<td>Thermal Resistance Junction-case</td>
<td></td>
<td></td>
<td></td>
<td>200</td>
<td>°C/W</td>
</tr>
<tr>
<td>R&lt;sub&gt;th&lt;/sub&gt;j-amb</td>
<td>Thermal Resistance Junction-ambient</td>
<td></td>
<td></td>
<td></td>
<td>500</td>
<td>°C/W</td>
</tr>
</tbody>
</table>

### ELECTRICAL CHARACTERISTICS (T<sub>amb</sub> = 25 °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter Description</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>I&lt;sub&gt;CBO&lt;/sub&gt;</td>
<td>Collector Cutoff</td>
<td>for BC107</td>
<td></td>
<td></td>
<td>15</td>
<td>nA</td>
</tr>
<tr>
<td></td>
<td>Current (I&lt;sub&gt;E&lt;/sub&gt; = 0)</td>
<td>V&lt;sub&gt;CB&lt;/sub&gt; = 40 V</td>
<td></td>
<td></td>
<td>15</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V&lt;sub&gt;CB&lt;/sub&gt; = 40 V</td>
<td></td>
<td></td>
<td>15</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T&lt;sub&gt;amb&lt;/sub&gt; = 150 °C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V&lt;sub&gt;(BR)CBO&lt;/sub&gt;</td>
<td>Collector-base Breakdown Voltage</td>
<td>I&lt;sub&gt;C&lt;/sub&gt; = 10 μA</td>
<td></td>
<td></td>
<td>50</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>(I&lt;sub&gt;E&lt;/sub&gt; = 0)</td>
<td>for BC107</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for BC108</td>
<td></td>
<td></td>
<td>30</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for BC109</td>
<td></td>
<td></td>
<td>30</td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;(BR)CEO&lt;/sub&gt;</td>
<td>Collector-emitter Breakdown Voltage</td>
<td>I&lt;sub&gt;C&lt;/sub&gt; = 10 mA</td>
<td></td>
<td></td>
<td>45</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>(I&lt;sub&gt;B&lt;/sub&gt; = 0)</td>
<td>for BC107</td>
<td></td>
<td></td>
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<td></td>
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<td>for BC108</td>
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<td>20</td>
<td>V</td>
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<tr>
<td></td>
<td></td>
<td>for BC109</td>
<td></td>
<td></td>
<td>20</td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;(BR)EBO&lt;/sub&gt;</td>
<td>Emitter-base Breakdown Voltage</td>
<td>I&lt;sub&gt;E&lt;/sub&gt; = 10 μA</td>
<td></td>
<td></td>
<td>6</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>(I&lt;sub&gt;C&lt;/sub&gt; = 0)</td>
<td>for BC107</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for BC108</td>
<td></td>
<td></td>
<td>5</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for BC109</td>
<td></td>
<td></td>
<td>5</td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;CE(sat)&lt;/sub&gt;</td>
<td>Collector-emitter Saturation Voltage</td>
<td>I&lt;sub&gt;C&lt;/sub&gt; = 10 mA</td>
<td></td>
<td></td>
<td>50</td>
<td>mV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I&lt;sub&gt;C&lt;/sub&gt; = 100 mA</td>
<td></td>
<td></td>
<td></td>
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</tr>
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<td></td>
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<td></td>
<td>750</td>
<td>mV</td>
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<td></td>
<td>I&lt;sub&gt;E&lt;/sub&gt; = 100 mA</td>
<td></td>
<td></td>
<td>900</td>
<td>mV</td>
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<tr>
<td>V&lt;sub&gt;BE&lt;/sub&gt;</td>
<td>Base-emitter Voltage</td>
<td>I&lt;sub&gt;C&lt;/sub&gt; = 2 mA</td>
<td></td>
<td></td>
<td>550</td>
<td>mV</td>
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<tr>
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<td></td>
<td>I&lt;sub&gt;C&lt;/sub&gt; = 10 mA</td>
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<td>V&lt;sub&gt;BE(sat)&lt;/sub&gt;</td>
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<td>I&lt;sub&gt;C&lt;/sub&gt; = 100 mA</td>
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<td>I&lt;sub&gt;B&lt;/sub&gt; = 0.5 mA</td>
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<td>750</td>
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<td>I&lt;sub&gt;B&lt;/sub&gt; = 5 mA</td>
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<td>mV</td>
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<td>h&lt;sub&gt;FE&lt;/sub&gt;</td>
<td>DC Current Gain</td>
<td>I&lt;sub&gt;C&lt;/sub&gt; = 2 mA</td>
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<tr>
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<td>for BC107</td>
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<td></td>
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<td>for BC107 Gr. A</td>
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<tr>
<td></td>
<td></td>
<td>for BC107 Gr. B</td>
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<td>for BC108</td>
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<td>for BC108 Gr. A</td>
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<td>for BC108 Gr. B</td>
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* Pulsed: pulse duration = 300 μs, duty cycle = 1%.
## ELECTRICAL CHARACTERISTICS (continued)

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* Pulsed : pulse duration = 300 μs, duty cycle = 1 %.
### ELECTRICAL CHARACTERISTICS (continued)

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<th>Test Conditions</th>
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<td>μS</td>
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* Pulsed: pulse duration = 300 μs, duty cycle = 1%.

#### DC Normalized Current Gain.

![DC Normalized Current Gain Graph](image)

#### Collector-emitter Saturation Voltage.

![Collector-emitter Saturation Voltage Graph](image)
Collector-base Capacitance.

Noise Figure (for BC 109 only).

Transition Frequency.

Noise Figure (for BC 109 only).

Noise Figure (for BC 109 only).

Power Rating Chart.
DESCRIPTION
The BC119 is a silicon planar epitaxial NPN transistor in a TO-39 metal case. It is suitable for 1 W class "A" and up to 6 W class "B" audio output stages.

ABSOLUTE MAXIMUM RATINGS

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<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
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<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>60</td>
<td>V</td>
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<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
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<td>V</td>
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<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
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<td>V</td>
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<tr>
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<td>5</td>
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<td>W</td>
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## THERMAL DATA

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<th>Thermal Resistance Junction-case</th>
<th>Max</th>
<th>( R_{th\ j\ -\ amb} )</th>
<th>Thermal Resistance Junction-ambient</th>
<th>Max</th>
<th>( ^\circ \text{C/W} )</th>
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## ELECTRICAL CHARACTERISTICS \( (T_{\text{amb}} = 25 \, ^\circ \text{C} \) unless otherwise specified)  

<table>
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<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
</table>
| \( I_{\text{CBO}} \) | Collector Cutoff Current \( (I_E = 0) \) | \( V_{\text{CB}} = 40 \, \text{V} \)  
\( V_{\text{CB}} = 40 \, \text{V} \) \( T_{\text{amb}} = 150 \, ^\circ \text{C} \) | 100 | 20 | nA   |
| \( V_{(BR)\text{CBO}} \) | Collector-base Breakdown Voltage \( (I_E = 0) \) | \( I_C = 100 \, \mu\text{A} \) | 60 |  |  | V   |
| \( V_{(BR)\text{CEO}}^* \) | Collector-emitter Breakdown Voltage \( (I_B = 0) \) | \( I_C = 30 \, \text{mA} \) | 30 |  |  | V   |
| \( V_{(BR)\text{EBO}} \) | Emitter-base Breakdown Voltage \( (I_C = 0) \) | \( I_E = 100 \, \mu\text{A} \) | 5 |  |  | V   |
| \( V_{\text{CE(sat)}}^* \) | Collector-emitter Saturation Voltage | \( I_C = 150 \, \text{mA} \)  
\( I_C = 500 \, \text{mA} \)  
\( I_C = 1 \, \text{A} \)  
\( I_C = 150 \, \text{mA} \) \( V_{\text{CE}} = 10 \, \text{V} \)  
\( I_C = 150 \, \text{mA} \) \( V_{\text{CE}} = 1 \, \text{V} \)  
\( I_C = 1 \, \text{A} \) \( I_B = 100 \, \text{mA} \) \( I_B = 50 \, \text{mA} \) \( I_B = 15 \, \text{mA} \) | 0.15 | 0.35 | V   |
| \( V_{\text{BE}}^* \) | Base-emitter Voltage | \( I_C = 500 \, \text{mA} \)  
\( I_C = 150 \, \text{mA} \) \( V_{\text{CE}} = 10 \, \text{V} \)  
\( I_C = 150 \, \text{mA} \) \( V_{\text{CE}} = 1 \, \text{V} \) | 1 | 1.8 | V   |
| \( V_{\text{BE(sat)}}^* \) | Base-emitter Saturation Voltage | \( I_C = 150 \, \text{mA} \)  
\( I_C = 1 \, \text{A} \) \( I_B = 15 \, \text{mA} \)  
\( I_C = 1 \, \text{A} \) \( I_B = 0.1 \, \text{A} \) | 0.9 | 1.2 | V   |
| \( h_{\text{FE}}^* \) | DC Current Gain | \( I_C = 50 \, \text{mA} \)  
\( I_C = 150 \, \text{mA} \) \( V_{\text{CE}} = 1 \, \text{V} \)  
\( I_C = 150 \, \text{mA} \) \( V_{\text{CE}} = 1 \, \text{V} \)  
\( I_C = 500 \, \text{mA} \) \( V_{\text{CE}} = 10 \, \text{V} \) | 100 | 90 | 120 |
| \( f_T \) | Transition Frequency | \( I_C = 50 \, \text{mA} \) \( V_{\text{CE}} = 10 \, \text{V} \) | 40 |  | MHz  |
| \( C_{\text{CBO}} \) | Collector-base Capacitance | \( I_E = 0 \)  
\( V_{\text{CB}} = 10 \, \text{V} \) | 12 | 25 | pF   |

* Pulsed : pulse duration = 300 \mu\text{s}, duty cycle = 1 %. 
DESCRIPTION
The BC139 is a silicon planar epitaxial PNP transistor in a TO-39 metal case. It is particularly designed for use in audio output and driver stages. The complementary NPN type is the BC119.

INTERNAL SCHEMATIC DIAGRAM

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>$-40$</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>$-40$</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>$-5$</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>$-0.5$</td>
<td>A</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 , ^\circ C$ at $T_{case} \leq 25 , ^\circ C$</td>
<td>$0.7$</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$3$</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}$</td>
<td>Storage Temperature</td>
<td>$-55$ to $200$</td>
<td>°C</td>
</tr>
<tr>
<td>$T_j$</td>
<td>Junction Temperature</td>
<td>$200$</td>
<td>°C</td>
</tr>
</tbody>
</table>
**THERMAL DATA**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>°C/W</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>58</td>
<td>58</td>
<td>58</td>
<td></td>
</tr>
<tr>
<td>$R_{th j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>250</td>
<td>250</td>
<td>250</td>
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</table>

**ELECTRICAL CHARACTERISTICS**  
($T_{\text{amb}} = 25$ °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = -30$ V, $T_{\text{amb}} = 75$ °C</td>
<td></td>
<td>$-100$</td>
<td>$-50$</td>
<td>nA</td>
</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = -10$ $\mu$A</td>
<td>$-40$</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CEO}$*</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = -10$ mA</td>
<td>$-40$</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = -10$ $\mu$A</td>
<td>$-5$</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE(sat)}$*</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = -300$ mA, $I_B = -30$ mA, $I_C = -500$ mA, $I_B = -50$ mA</td>
<td>$-0.45$</td>
<td>$-0.8$</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE}$*</td>
<td>Base-emitter Voltage</td>
<td>$I_C = -10$ mA, $V_{CE} = -10$ V, $I_C = -100$ mA, $V_{CE} = -10$ V, $I_C = -300$ mA, $V_{CE} = -1$ V</td>
<td>$-0.7$</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$h_{FE}$*</td>
<td>DC Current Gain</td>
<td>$I_C = -10$ mA, $V_{CE} = -10$ V, $I_C = -100$ mA, $V_{CE} = -10$ V, $I_C = -150$ mA, $V_{CE} = -1$ V, $I_C = -300$ mA, $V_{CE} = -1$ V</td>
<td>40</td>
<td>90</td>
<td>45</td>
<td>35</td>
</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = -50$ mA, $V_{CE} = -10$ V</td>
<td>$200$</td>
<td>MHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$, $f = 1$ MHz</td>
<td>$6$</td>
<td>pF</td>
<td></td>
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</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 $\mu$s, duty cycle = 1 %.

2/3
Base-emitter Voltage.

Collector-emitter Saturation Voltage.

DC Normalized Current Gain.

Power Rating Chart.
GENERAL PURPOSE TRANSISTORS

DESCRIPTION
The BC140 and BC141 are silicon planar epitaxial NPN transistors in TO-39 metal case. They are particularly designed for audio amplifiers and switching applications up to 1 A. The complementary PNP types are the BC160 and BC161.

INTERNAL SCHEMATIC DIAGRAM

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_CBO</td>
<td>Collector-base Voltage (I_E = 0)</td>
<td>80</td>
<td>V</td>
</tr>
<tr>
<td>V_CEO</td>
<td>Collector-emitter Voltage (I_B = 0)</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>V_EBO</td>
<td>Emitter-base Voltage (I_C = 0)</td>
<td>7</td>
<td>V</td>
</tr>
<tr>
<td>I_C</td>
<td>Collector Current</td>
<td>1</td>
<td>A</td>
</tr>
<tr>
<td>I_B</td>
<td>Base Current</td>
<td>0.1</td>
<td>A</td>
</tr>
<tr>
<td>P_{101}</td>
<td>Total Power Dissipation at T_{amb} ≤ 45 °C</td>
<td>0.65</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at T_{case} ≤ 45 °C</td>
<td>3.7</td>
<td>W</td>
</tr>
<tr>
<td>T_{STG}</td>
<td>Storage Temperature</td>
<td>-55 to 175</td>
<td>°C</td>
</tr>
<tr>
<td>T_J</td>
<td>Junction Temperature</td>
<td>175</td>
<td>°C</td>
</tr>
</tbody>
</table>

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**THERMAL DATA**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th,j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td></td>
<td></td>
<td></td>
<td>35</td>
<td>°C/W</td>
</tr>
<tr>
<td>$R_{th,j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td></td>
<td></td>
<td></td>
<td>200</td>
<td>°C/W</td>
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</table>

**ELECTRICAL CHARACTERISTICS** ($T_{amb} = 25 \, ^\circ \text{C}$ unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CES}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CES} = 60 , \text{V}$</td>
<td>100</td>
<td>100</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CES} = 60 , \text{V}$</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$T_{amb} = 150 , ^\circ \text{C}$</td>
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</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = 100 , \mu\text{A}$</td>
<td>80</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for BC140</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>for BC141</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CEO*}$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = 30 , \text{mA}$</td>
<td>40</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for BC140</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>for BC141</td>
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</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_E = 100 , \mu\text{A}$</td>
<td>7</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{CE(sat)*}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = 100 , \text{mA}$</td>
<td>0.1</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_B = 10 , \text{mA}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>$I_C = 500 , \text{mA}$</td>
<td>0.35</td>
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<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_B = 50 , \text{mA}$</td>
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<tr>
<td></td>
<td></td>
<td>$I_C = 1 , \text{A}$</td>
<td>0.6</td>
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<td>V</td>
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<tr>
<td></td>
<td></td>
<td>$I_B = 0.1 , \text{A}$</td>
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<tr>
<td>$V_{BE*}$</td>
<td>Base-emitter Voltage</td>
<td>$I_C = 1 , \text{A}$</td>
<td>1.25</td>
<td></td>
<td>V</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>$V_{CE} = 1 , \text{V}$</td>
<td>1.8</td>
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<tr>
<td>$h_{FE*}$</td>
<td>DC Current Gain</td>
<td>$I_C = 100 , \mu\text{A}$</td>
<td>75</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = 1 , \text{V}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for BC140-141</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>for BC140-141 Gr. 6</td>
<td>28</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>for BC140-141 Gr. 10</td>
<td>40</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>for BC140-141 Gr. 16</td>
<td>90</td>
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<tr>
<td></td>
<td></td>
<td>$I_C = 100 , \text{mA}$</td>
<td>40</td>
<td>140</td>
<td>250</td>
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<tr>
<td></td>
<td></td>
<td>$V_{CE} = 1 , \text{V}$</td>
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<tr>
<td></td>
<td></td>
<td>for BC140-141</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for BC140-141 Gr. 6</td>
<td>40</td>
<td>63</td>
<td>100</td>
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<tr>
<td></td>
<td></td>
<td>for BC140-141 Gr. 10</td>
<td>63</td>
<td>100</td>
<td>160</td>
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<tr>
<td></td>
<td></td>
<td>for BC140-141 Gr.16</td>
<td>100</td>
<td>160</td>
<td>250</td>
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<tr>
<td></td>
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<td>$I_C = 1 , \text{A}$</td>
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<td>$V_{CE} = 1 , \text{V}$</td>
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<tr>
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<td>for BC140-141</td>
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<tr>
<td></td>
<td></td>
<td>for BC140-141 Gr. 6</td>
<td></td>
<td>15</td>
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<td>for BC140-141 Gr. 10</td>
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<td>20</td>
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<tr>
<td></td>
<td></td>
<td>for BC140-141 Gr.16</td>
<td></td>
<td>30</td>
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</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = 50 , \text{mA}$</td>
<td>50</td>
<td></td>
<td>MHz</td>
<td></td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$</td>
<td>12</td>
<td>25</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CB} = 10 , \text{V}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{on}$</td>
<td>Turn-on Time</td>
<td>$I_C = 100 , \text{mA}$</td>
<td>250</td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{B1} = 5 , \text{mA}$</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>$t_{off}$</td>
<td>Turn-off Time</td>
<td>$I_C = 100 , \text{mA}$</td>
<td>850</td>
<td></td>
<td>ns</td>
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<tr>
<td></td>
<td></td>
<td>$I_{B1} = I_{B2} = 5 , \text{mA}$</td>
<td></td>
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</tr>
</tbody>
</table>

* Pused: pulse duration = 300 µs, duty cycle = 1 %.
Collector-emitter Saturation Voltage.

Base-emitter Voltage.

DC Current Gain.

Transition Frequency.
DESCRIPTION
The BC142 is a silicon planar epitaxial NPN transistor in a TO-39 metal case specially intended for use as driver in high power audio amplifier.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>80</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>60</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>7</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>1</td>
<td>A</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 , ^\circ C$ at $T_{case} \leq 25 , ^\circ C$</td>
<td>0.75</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}, T_j$</td>
<td>Storage and Junction Temperature</td>
<td>- 55 to 175</td>
<td>°C</td>
</tr>
</tbody>
</table>

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BC142

THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
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<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>Rth j-case</td>
<td>Thermal Resistance Junction-case</td>
<td></td>
<td></td>
<td></td>
<td>37</td>
<td>°C/W</td>
</tr>
<tr>
<td>Rth j-amb</td>
<td>Thermal Resistance Junction-ambient</td>
<td></td>
<td></td>
<td></td>
<td>200</td>
<td>°C/W</td>
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ELECTRICAL CHARACTERISTICS (T_amb = 25 °C unless otherwise specified)

<table>
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<tr>
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<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>I_{CBO}</td>
<td>Collector Cutoff Current (I_E = 0)</td>
<td>V_CB = 40 V</td>
<td></td>
<td></td>
<td>50</td>
<td>nA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V_CB = 40 V T_amb = 150 °C</td>
<td>50</td>
<td></td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>V_{(BR)CBO}</td>
<td>Collector-base Breakdown Voltage (I_E = 0)</td>
<td>I_C = 100 µA</td>
<td>80</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V_{(BR)CEO}</td>
<td>Collector-emitter Breakdown Voltage (I_B = 0)</td>
<td>I_C = 30 mA</td>
<td>60</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V_{(BR)EBO}</td>
<td>Emitter-base Breakdown Voltage (I_C = 0)</td>
<td>I_E = 100 µA</td>
<td>7</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V_{CE (sat)*}</td>
<td>Collector-emitter Saturation Voltage</td>
<td>I_C = 200 mA I_C = 20 mA</td>
<td>0.15</td>
<td>0.4</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I_B = 500 mA I_B = 50 mA</td>
<td>0.30</td>
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<td>V</td>
</tr>
<tr>
<td>V_{BE (sat)*}</td>
<td>Base-emitter Saturation Voltage</td>
<td>I_C = 200 mA I_B = 20 mA</td>
<td>1.5</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V_{BE*}</td>
<td>Base-emitter Voltage</td>
<td>I_C = 200 mA V_CE = 2 V</td>
<td>0.85</td>
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<td>V</td>
</tr>
<tr>
<td>h_{FE*}</td>
<td>DC Current Gain</td>
<td>I_C = 10 mA V_CE = 10 V</td>
<td>100</td>
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<tr>
<td></td>
<td></td>
<td>I_C = 100 mA V_CE = 10 V</td>
<td>100</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>I_C = 200 mA V_CE = 2 V</td>
<td>60</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>I_C = 500 mA V_CE = 2 V</td>
<td>30</td>
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</tr>
<tr>
<td>f_T</td>
<td>Transition Frequency</td>
<td>I_C = 50 mA f = 20 MHz V_CE = 10 V</td>
<td>80</td>
<td></td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td>C_{CBO}</td>
<td>Collector-base Capacitance</td>
<td>I_E = 0 V_CB = 10 V</td>
<td>12</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
</tbody>
</table>

* Pulsed : pulse duration = 300 µs, duty cycle = 1 %.

DC Current Gain vs. Collector Current.

Base-emitter on Voltage vs. Collector Current.
DESCRIPTION
The BC143 is a silicon planar epitaxial PNP transistor specially designed for use in the driver of high power audio amplifiers.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{CBO}</td>
<td>Collector-base Voltage ( (I_E = 0) )</td>
<td>-60</td>
<td>V</td>
</tr>
<tr>
<td>V_{CEO}</td>
<td>Collector-emitter Voltage ( (I_B = 0) )</td>
<td>-60</td>
<td>V</td>
</tr>
<tr>
<td>V_{EBO}</td>
<td>Emitter-base Voltage ( (I_C = 0) )</td>
<td>-5</td>
<td>V</td>
</tr>
<tr>
<td>I_C</td>
<td>Collector Current</td>
<td>-1</td>
<td>A</td>
</tr>
<tr>
<td>P_{tot}</td>
<td>Total Power Dissipation at ( T_{amb} \leq 25 , ^\circ C )</td>
<td>0.75</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at ( T_{case} \leq 25 , ^\circ C )</td>
<td>4</td>
<td>W</td>
</tr>
<tr>
<td>T_{stg}, T_{j}</td>
<td>Storage and Junction Temperature</td>
<td>-55 to 175</td>
<td>°C</td>
</tr>
</tbody>
</table>

January 1989
**THERMAL DATA**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{thj-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>37</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
<tr>
<td>$R_{thj-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>200</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
</tbody>
</table>

**ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = -30 \text{ V}$</td>
<td>$V_{CB} = -30 \text{ V}$ ($T_{amb} = 150 \text{ °C}$)</td>
<td>$-50$</td>
<td>$-50$</td>
<td>nA</td>
</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = 100 \mu\text{A}$</td>
<td>$-60$</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CEO}^*$</td>
<td>Collector-emitter Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = 10 \text{ mA}$</td>
<td>$-60$</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_E = 10 \mu\text{A}$</td>
<td>$-5$</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE(sat)}^*$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = 500 \text{ mA}$</td>
<td>$I_B = 50 \text{ mA}$</td>
<td>$-0.25$</td>
<td>$-0.5$</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 1 \text{ A}$</td>
<td>$I_B = 100 \text{ mA}$</td>
<td>$-0.7$</td>
<td>$-1$</td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE}^*$</td>
<td>Base-emitter Voltage</td>
<td>$I_C = -500 \text{ mA}$</td>
<td>$V_{CE} = -10 \text{ V}$</td>
<td>$-1.1$</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$h_{FE}^*$</td>
<td>DC Current Gain</td>
<td>$I_C = 10 \text{ mA}$</td>
<td>$V_{CE} = -10 \text{ V}$</td>
<td>$100$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 100 \text{ mA}$</td>
<td>$V_{CE} = -10 \text{ V}$</td>
<td>$100$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -300 \text{ mA}$</td>
<td>$V_{CE} = -1 \text{ V}$</td>
<td>$40$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 500 \text{ mA}$</td>
<td>$V_{CE} = -1 \text{ V}$</td>
<td>$25$</td>
<td></td>
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</tr>
<tr>
<td>$h_{fe}$</td>
<td>High Frequency Current Gain</td>
<td>$I_C = 50 \text{ mA}$</td>
<td>$V_{CE} = -10 \text{ V}$</td>
<td>$1.5$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 100 \text{ MHz}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$</td>
<td>$V_{CB} = -10 \text{ V}$</td>
<td>$13$</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 1 \text{ MHz}$</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1%.

**DC Current Gain vs. Collector Current.**

**Base-emitter on Voltage vs. Collector Current.**
GENERAL PURPOSE TRANSISTORS

DESCRIPTION
The BC160 and BC161 are silicon planar epitaxial PNP transistors in TO-39 metal case. They are particularly designed for audio amplifiers and switching applications up to 1A. The complementary NPN types are the BC140 and BC141.

INTERNAL SCHEMATIC DIAGRAM

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>– 40</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>– 40</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>– 5</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>– 1</td>
<td>A</td>
</tr>
<tr>
<td>$I_B$</td>
<td>Base Current</td>
<td>– 0.1</td>
<td>A</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 45 ^\circ C$ \at $T_{case} \leq 45 ^\circ C$</td>
<td>0.65</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}$</td>
<td>Storage Temperature</td>
<td>– 55 to 175</td>
<td>°C</td>
</tr>
<tr>
<td>$T_j$</td>
<td>Junction Temperature</td>
<td>175</td>
<td>°C</td>
</tr>
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</table>

January 1989
**THERMAL DATA**

<table>
<thead>
<tr>
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<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_{th-j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>35</td>
<td>$^\circ$C/W</td>
<td></td>
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<tr>
<td>$R_{th-j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>200</td>
<td>$^\circ$C/W</td>
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<td></td>
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</tbody>
</table>

**ELECTRICAL CHARACTERISTICS** ($T_{amb} = 25^\circ C$ unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CES}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CES} = 40,V$ for BC160</td>
<td>$-100$</td>
<td>nA</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CES} = 60,V$ for BC161</td>
<td>$-100$</td>
<td>nA</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CES} = 40,V$ for BC160</td>
<td>$-100$</td>
<td>μA</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$T_{amb} = 150^\circ C$</td>
<td></td>
<td></td>
<td>$-100$</td>
<td>μA</td>
</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_C = -100,\mu A$ for BC160</td>
<td>$-40$</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CES} = 60,V$ for BC161</td>
<td>$-60$</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CEO}$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = -10,mA$ for BC160</td>
<td>$-40$</td>
<td>V</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CES} = 60,V$ for BC161</td>
<td>$-60$</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = -100,\mu A$</td>
<td>$-5$</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{CE(sat)}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = -0.1,A$</td>
<td>$-0.1$</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -0.5,A$</td>
<td>$-0.35$</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -1,A$</td>
<td>$-0.6$</td>
<td>V</td>
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<tr>
<td></td>
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<td>$I_B = -10,mA$</td>
<td>$-1$</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_B = -5,mA$</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>$V_{BE}$</td>
<td>Base-emitter Voltage</td>
<td>$I_C = -1,A$</td>
<td>$-1$</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = -1,V$</td>
<td>$-1.7$</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$h_fE$</td>
<td>DC Current Gain</td>
<td>$I_C = -100,\mu A$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = -1,V$ for BC160-161</td>
<td>110</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = -1,V$ for BC160-161 Gr. 6</td>
<td>46</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>$V_{CE} = -1,V$ for BC160-161 Gr. 10</td>
<td>80</td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td>$V_{CE} = -1,V$ for BC160-161 Gr. 16</td>
<td>120</td>
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<tr>
<td></td>
<td></td>
<td>$I_C = -100,mA$</td>
<td>40</td>
<td>140</td>
<td>250</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = -1,V$ for BC160-161 Gr. 6</td>
<td>40</td>
<td>63</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = -1,V$ for BC160-161 Gr. 10</td>
<td>63</td>
<td>100</td>
<td>160</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = -1,V$ for BC160-161 Gr. 16</td>
<td>100</td>
<td>160</td>
<td>250</td>
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</tr>
<tr>
<td>$h_fE$</td>
<td>DC Current Gain</td>
<td>$I_C = -1,A$</td>
<td></td>
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<td>$V_{CE} = -1,V$ for BC160-161</td>
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<td>$V_{CE} = -1,V$ for BC160-161 Gr. 6</td>
<td>15</td>
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<tr>
<td></td>
<td></td>
<td>$V_{CE} = -1,V$ for BC160-161 Gr. 10</td>
<td>20</td>
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<tr>
<td></td>
<td></td>
<td>$V_{CE} = -1,V$ for BC160-161 Gr. 16</td>
<td>30</td>
<td></td>
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<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = -50,mA$</td>
<td>50</td>
<td></td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$</td>
<td>15</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CB} = -20,V$</td>
<td>30</td>
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<td></td>
<td>pF</td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$V_{EB} = -0.5,V$</td>
<td>180</td>
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<td>pF</td>
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<td>$f = 1,MHz$</td>
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<tr>
<td>$t_{on}$</td>
<td>Turn-on Time</td>
<td>$I_C = -100,mA$</td>
<td>500</td>
<td></td>
<td>nS</td>
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<td></td>
<td></td>
<td>$I_B = -5,mA$</td>
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<td></td>
<td>nS</td>
<td></td>
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<tr>
<td>$t_{off}$</td>
<td>Turn-off Time</td>
<td>$I_C = -100,mA$</td>
<td>650</td>
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<td>nS</td>
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<tr>
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<td></td>
<td>$I_B = I_{B2} = -5,mA$</td>
<td></td>
<td></td>
<td>nS</td>
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</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1%.
Collector-emitter Saturation Voltage.

Base-emitter Voltage.

DC Current Gain.

Transition Frequency.
DESCRIPTION
The BC177, BC178 and BC179 are silicon planar epitaxial PNP transistors in TO-18 metal case. They are suitable for use in driver audio stages, low noise input audio stages and as low power, high gain general purpose transistors. The complementary NPN types are respectively the BC107, BC108 and BC109.

INTERNAL SCHEMATIC DIAGRAM

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_CES</td>
<td>Collector-emitter Voltage (V_BE = 0)</td>
<td>– 50</td>
<td>V</td>
</tr>
<tr>
<td>V_CEO</td>
<td>Collector-emitter Voltage (I_B = 0)</td>
<td>– 45</td>
<td>V</td>
</tr>
<tr>
<td>V_EBO</td>
<td>Emitter-base Voltage (I_C = 0)</td>
<td>– 5</td>
<td>V</td>
</tr>
<tr>
<td>I_C</td>
<td>Collector Current</td>
<td>– 100</td>
<td>mA</td>
</tr>
<tr>
<td>I_CM</td>
<td>Collector Peak Current</td>
<td>– 200</td>
<td>mA</td>
</tr>
<tr>
<td>P_tot</td>
<td>Total Power Dissipation at T_amb ≤ 25 °C</td>
<td>300</td>
<td>mW</td>
</tr>
<tr>
<td>T_stg</td>
<td>Storage Temperature</td>
<td>– 65 to 175</td>
<td>°C</td>
</tr>
<tr>
<td>T_j</td>
<td>Junction Temperature</td>
<td>175</td>
<td>°C</td>
</tr>
</tbody>
</table>

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## THERMAL DATA

<table>
<thead>
<tr>
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<th>Max.</th>
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<tr>
<td>$R_{th\text{-case}}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>200</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
<tr>
<td>$R_{th\text{-j-amb}}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>500</td>
<td></td>
<td></td>
<td>°C/W</td>
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</table>

## ELECTRICAL CHARACTERISTICS ($T_{\text{amb}} = 25$ °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$I_{CEs}$</td>
<td>Collector Cutoff Current ($V_{BE} = 0$)</td>
<td>$V_{CE} = 20$ V</td>
<td>-1</td>
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<td></td>
<td></td>
<td>$V_{CE} = 20$ V</td>
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<td>$T_{\text{amb}} = 150$ °C</td>
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<tr>
<td>$V_{(BR)CEO}^*$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = 2$ mA</td>
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<tr>
<td></td>
<td></td>
<td>for BC177</td>
<td></td>
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<tr>
<td></td>
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<td>for BC178</td>
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<td></td>
<td>for BC179</td>
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<tr>
<td>$V_{(BR)CES}$</td>
<td>Collector-emitter Breakdown Voltage ($V_{BE} = 0$)</td>
<td>$I_C = 10$ μA</td>
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<td>for BC179</td>
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<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = 10$ μA</td>
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<td>$V_{CE(sat)}^*$</td>
<td>Collector-emitter Saturation Voltage</td>
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<td>-75</td>
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<td>$I_E = 0.5$ mA</td>
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<td>$I_E = 5$ mA</td>
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<td>$V_{BE}$</td>
<td>Base-emitter Voltage</td>
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<td>$h_{fe}$</td>
<td>Small Signal Current Gain</td>
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<td>125</td>
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<td></td>
<td>for BC177 Gr. B</td>
<td></td>
<td>240</td>
<td>500</td>
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<tr>
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<td></td>
<td>for BC178 Gr. A</td>
<td></td>
<td>125</td>
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<td></td>
<td>for BC178 Gr. B</td>
<td></td>
<td>240</td>
<td>500</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>for BC179 Gr. B</td>
<td></td>
<td>240</td>
<td>500</td>
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*Pulsed: pulsed duration = 300 μs, duty cycle = 1%.*
### ELECTRICAL CHARACTERISTICS (continued)

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<tr>
<th>Symbol</th>
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<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<td>Transition Frequency</td>
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<td>Reverse Voltage Ratio</td>
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<td>$f = 1 kHz$</td>
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<td>for BC177 Gr. A</td>
<td>25</td>
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<td>\mu S</td>
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<td>for BC177 Gr. B</td>
<td>35</td>
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<td>25</td>
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<td>for BC179 Gr. B</td>
<td>35</td>
<td></td>
<td></td>
<td>\mu S</td>
</tr>
</tbody>
</table>

**DC Transconductance.**

**DC Normalized Current Gain.**
Collector-emitter Saturation Voltage.

Normalized h Parameters.

Normalized h Parameters.

Collector-base Capacitance.

Transition Frequency.

Power Rating Chart.
DESCRIPTION
The BC286 is a silicon planar epitaxial NPN transistor in Jedec TO-39 metal case. It is mainly intended for use as audio amplifier.
The complementary PNP type is the BC287.

INTERNAL SCHEMATIC DIAGRAM

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>70</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>60</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>5</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>1</td>
<td>A</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 ^\circ C$</td>
<td>0.75</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 ^\circ C$</td>
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</tr>
<tr>
<td>$T_{stg}$,$T_j$</td>
<td>Storage and Junction Temperature</td>
<td>-55 to 175</td>
<td>°C</td>
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</table>

January 1989
### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter Description</th>
<th>Max</th>
<th>°C/W</th>
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<tbody>
<tr>
<td>$R_{th j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>37</td>
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<tr>
<td>$R_{th j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>200</td>
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### ELECTRICAL CHARACTERISTICS ($T_{amb} = 25$ °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter Description</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = 30$ V</td>
<td>20</td>
<td>nA</td>
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<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = 100$ μA</td>
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<td>V</td>
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<tr>
<td>$V_{(BR)CEO}$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = 30$ mA</td>
<td>60</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CEO}$</td>
<td>Collector-emitter Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = 100$ μA</td>
<td>5</td>
<td>V</td>
<td></td>
<td></td>
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<tr>
<td>$V_{CE(sat)}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = 500$ mA, $I_B = 50$ mA</td>
<td>0.4</td>
<td>V</td>
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<tr>
<td>$V_{BE}$</td>
<td>Base-emitter Voltage</td>
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<td>V</td>
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<tr>
<td>$h_{FE}$</td>
<td>DC Current Gain</td>
<td>$I_C = 100$ mA, $V_{CE} = 2$ V</td>
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<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = 50$ mA, $f = 100$ MHz, $V_{CE} = 5$ V</td>
<td>100</td>
<td>MHz</td>
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<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$, $V_{CB} = 10$ V</td>
<td>12</td>
<td>pF</td>
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* Pulsed: pulse duration = 300 ms, duty cycle = 1 %. 
DESCRIPTION
The BC287 is a silicon planar epitaxial PNP transistor in Jedec TO-39 metal case. It is particularly intended for use as audio amplifier.
The complementary NPN type is the BC286.

INTERNAL SCHEMATIC DIAGRAM

ABSOLUTE MAXIMUM RATINGS

<table>
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<tr>
<th>Symbol</th>
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<th>Value</th>
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</tr>
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<tbody>
<tr>
<td>V_{CBO}</td>
<td>Collector-base Voltage (I_{E} = 0)</td>
<td>- 60</td>
<td>V</td>
</tr>
<tr>
<td>V_{CEO}</td>
<td>Collector-emitter Voltage (I_{B} = 0)</td>
<td>- 60</td>
<td>V</td>
</tr>
<tr>
<td>V_{EBO}</td>
<td>Emitter-base Voltage (I_{C} = 0)</td>
<td>- 5</td>
<td>V</td>
</tr>
<tr>
<td>I_{C}</td>
<td>Collector Current</td>
<td>- 1</td>
<td>A</td>
</tr>
<tr>
<td>P_{tot}</td>
<td>Total Power Dissipation at T_{amb} ≤ 25 °C</td>
<td>0.75</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at T_{case} ≤ 25 °C</td>
<td>4</td>
<td>W</td>
</tr>
<tr>
<td>T_{s,tg}, T_j</td>
<td>Storage and Junction Temperature</td>
<td>- 55 to 175</td>
<td>°C</td>
</tr>
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### THERMAL DATA

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<tr>
<td>$R_{th,j-case}$</td>
<td>Thermal Resistance Junction-case</td>
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<td></td>
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<td>37</td>
<td>°C/W</td>
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<td>$R_{th,j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
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<td>200</td>
<td>°C/W</td>
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### ELECTRICAL CHARACTERISTICS ($T_{amb} = 25$ °C unless otherwise specified)

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<th>Unit</th>
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<tbody>
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<td>$V_{CB} = -30$ V</td>
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<td>nA</td>
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<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = -10$ μA</td>
<td>-60</td>
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<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CEO}$</td>
<td>Collector-emitter Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = -10$ mA</td>
<td>-60</td>
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<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = -10$ μA</td>
<td>-5</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE(sat)}$</td>
<td>Collector-emitter Saturation Voltage ($I_C = 0$)</td>
<td>$I_C = -500$ mA $I_B = -50$ mA</td>
<td>$-0.25$</td>
<td>$-0.7$</td>
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<td>V</td>
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<td>Base-emitter Voltage</td>
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</tr>
<tr>
<td>$h_{FE}$</td>
<td>DC Current Gain</td>
<td>$I_C = -100$ mA $V_{CE} = -2$ V $I_C = -500$ mA $V_{CE} = -2$ V</td>
<td>20</td>
<td>90</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = -50$ mA $V_{CE} = -5$ V $f = 100$ MHz</td>
<td>150</td>
<td></td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance ($I_E = 0$)</td>
<td>$V_{CB} = -10$ V $f = 1$ MHz</td>
<td></td>
<td>13</td>
<td></td>
<td>pF</td>
</tr>
</tbody>
</table>

* Pulsed : pulse duration = 300 μs, duty cycle = 1%.
DESCRIPTION

The BC297 and BC298 are silicon planar epitaxial PNP transistors in TO-18 metal case. They are particularly intended for use in high current high gain applications, in driver stages of hi-fi equipments or in output stages of low power class B amplifiers.

The complementary NPN types are the BC377 and BC378, respectively.

INTERNAL SCHEMATIC DIAGRAM

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CES}$</td>
<td>Collector-emitter Voltage ($VEB = 0$)</td>
<td>$-50$</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($IB = 0$)</td>
<td>$-45$</td>
<td>V</td>
</tr>
<tr>
<td>$VEBO$</td>
<td>Emitter-base Voltage ($IC = 0$)</td>
<td>$-5$</td>
<td>V</td>
</tr>
<tr>
<td>$IC$</td>
<td>Collector Current</td>
<td>$-1$</td>
<td>A</td>
</tr>
<tr>
<td>$IB$</td>
<td>Base Current</td>
<td>$-0.2$</td>
<td>A</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25, ^\circ C$ at $T_{case} \leq 75, ^\circ C$</td>
<td>$375, mW$</td>
<td></td>
</tr>
<tr>
<td>$T_{stg}$</td>
<td>Storage Temperature</td>
<td>$-65$ to $175, ^\circ C$</td>
<td></td>
</tr>
<tr>
<td>$T_{j}$</td>
<td>Junction Temperature</td>
<td>$175, ^\circ C$</td>
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</tr>
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</table>
**THERMAL DATA**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$R_{th j case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>100</td>
<td>°C/W</td>
<td></td>
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</tr>
<tr>
<td>$R_{th j amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>400</td>
<td>°C/W</td>
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**ELECTRICAL CHARACTERISTICS** ($T_{case} = 25\, ^\circ\text{C}$ unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>$I_{CES}$</td>
<td>Collector Cutoff Current ($V_{BE} = 0$)</td>
<td>For BC297 $V_{CE} = -50, \text{V}$ For BC298 $V_{CE} = -30, \text{V}$</td>
<td>$-100$</td>
<td>$-100$</td>
<td>nA</td>
<td>nA</td>
</tr>
<tr>
<td>$V_{(BR)CEO}$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = -10, \text{mA}$ For BC297</td>
<td>$-45$</td>
<td>V</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>For BC298</td>
<td>$-25$</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CEO}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = -10, \mu\text{A}$</td>
<td>$-5$</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE,(sat)}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = -500, \text{mA}$ $I_B = -50, \text{mA}$</td>
<td>$-0.7$</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE,(sat)}$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = -100, \text{mA}$ $V_{CE} = -1, \text{V}$</td>
<td>$-770$</td>
<td>mV</td>
<td>mV</td>
<td>mV</td>
</tr>
<tr>
<td>$h_{FE}$</td>
<td>DC Current Gain</td>
<td>$I_C = -100, \text{mA}$ $V_{CE} = -1, \text{V}$</td>
<td>$75$</td>
<td>$100$</td>
<td>$260$</td>
<td>$260$</td>
</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = -50, \text{mA}$ $V_{CE} = -10, \text{V}$</td>
<td>$250$</td>
<td>MHz</td>
<td>MHz</td>
<td>MHz</td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$ $V_{CB} = -10, \text{V}$</td>
<td>$8$</td>
<td>pF</td>
<td>pF</td>
<td>pF</td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_C = 0$ $V_{EB} = -0.5, \text{V}$</td>
<td>$30$</td>
<td>pF</td>
<td>pF</td>
<td>pF</td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 $\mu$s, duty cycle = 1%.

**DC Normalized Current Gain.**

**Collector-emitter Saturation Voltage.**
Transition Frequency.

Power Rating Chart.
DESCRIPTION
The BC300, BC301 and BC302 are silicon planar epitaxial NPN transistors in TO-39 metal case. They are intended for audio driver stages in commercial and industrial equipments. In addition they are useful as high speed saturated switches and general purpose amplifiers. The PNP types complementary to BC301 and BC302 are respectively the BC303 and BC304.

INTERNAL SCHEMATIC DIAGRAM

ABSOLUTE MAXIMUM RATINGS

<table>
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<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
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<tbody>
<tr>
<td>V_{CBO}</td>
<td>Collector-base Voltage (I_E = 0)</td>
<td>120</td>
<td>V</td>
</tr>
<tr>
<td>V_{CEO}</td>
<td>Collector-emitter Voltage (I_B = 0)</td>
<td>80</td>
<td>V</td>
</tr>
<tr>
<td>V_{EBO}</td>
<td>Emitter-base Voltage (I_C = 0)</td>
<td>7</td>
<td>V</td>
</tr>
<tr>
<td>I_C</td>
<td>Collector Current</td>
<td>0.5</td>
<td>A</td>
</tr>
<tr>
<td>I_{CM}</td>
<td>Collector Peak Current</td>
<td>1</td>
<td>A</td>
</tr>
<tr>
<td>P_{tot}</td>
<td>Total Power Dissipation at T_{amb} ≤ 25 °C at T_{case} ≤ 25 °C</td>
<td>0.85</td>
<td>W</td>
</tr>
<tr>
<td>T_{stg}</td>
<td>Storage Temperature</td>
<td>− 65 to 175</td>
<td>°C</td>
</tr>
<tr>
<td>T_j</td>
<td>Junction Temperature</td>
<td>175</td>
<td>°C</td>
</tr>
</tbody>
</table>

January 1989
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>I_{CBO}</td>
<td>Collector Cutoff Current (I_E = 0)</td>
<td>V_CB = 60 V</td>
<td>5</td>
<td>20</td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td>I_{EBO}</td>
<td>Emitter Cutoff Current (I_C = 0)</td>
<td>V_EB = 5 V</td>
<td></td>
<td></td>
<td>10</td>
<td>nA</td>
</tr>
<tr>
<td>V_{(BR)CEO}^*</td>
<td>Collector-emitter Breakdown Voltage (I_B = 0)</td>
<td>I_C = 30 mA for BC300, 60 for BC301, 45 for BC302</td>
<td>80</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V_{(BR)CBO}</td>
<td>Collector-base Breakdown Voltage (I_E = 0)</td>
<td>I_C = 100 μA for BC300, 90 for BC301, 60 for BC302</td>
<td>120</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V_{CE(sat)^*}</td>
<td>Collector-emitter Saturation Voltage</td>
<td>I_C = 150 mA, I_B = 15 mA</td>
<td>0.2</td>
<td>0.5</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V_{BE}^*</td>
<td>Base-emitter Voltage</td>
<td>I_C = 150 mA, V_CE = 10 V</td>
<td>0.78</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>h_{FE}^*</td>
<td>DC Current Gain Gr. 4, 5, 6</td>
<td>I_C = 150 mA, V_CE = 10 V</td>
<td>40</td>
<td>80</td>
<td>140</td>
<td>kHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I_C = 150 mA, V_CE = 10 V</td>
<td>70</td>
<td></td>
<td>240</td>
<td>kHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I_C = 150 mA, V_CE = 10 V</td>
<td>120</td>
<td></td>
<td></td>
<td>kHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I_C = 0.1 mA, V_CE = 10 V</td>
<td>20</td>
<td></td>
<td></td>
<td>kHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I_C = 500 mA, V_CE = 10 V</td>
<td>20</td>
<td></td>
<td></td>
<td>kHz</td>
</tr>
<tr>
<td>f_T</td>
<td>Transition Frequency</td>
<td>I_C = 10 mA, V_CE = 10 V</td>
<td>100</td>
<td></td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td>C_{CBO}</td>
<td>Collector-base Capacitance</td>
<td>I_E = 0, V_CB = 10 V</td>
<td>12</td>
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<td></td>
<td>pF</td>
</tr>
<tr>
<td>h_{ie}</td>
<td>Input Impedance</td>
<td>I_C = 5 mA, f = 1 kHz V_CE = 10 V</td>
<td>1.1</td>
<td></td>
<td></td>
<td>kΩ</td>
</tr>
<tr>
<td>h_{re}</td>
<td>Reverse Voltage Ratio</td>
<td>I_C = 5 mA, f = 1 kHz V_CE = 10 V</td>
<td>1.7 x 10^{-4}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h_{fe}</td>
<td>Small Signal Current Gain</td>
<td>I_C = 5 mA, f = 1 kHz V_CE = 10 V</td>
<td>140</td>
<td></td>
<td></td>
<td>μS</td>
</tr>
<tr>
<td>h_{oe}</td>
<td>Output Admittance</td>
<td>I_C = 5 mA, f = 1 kHz V_CE = 10 V</td>
<td>14</td>
<td></td>
<td></td>
<td>μS</td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1%.
DC Normalized Current Gain.

Collector-emitter Saturation Voltage.

Transition Frequency.

Power Rating Chart.
DESCRIPTION
The BC303 and BC304 are silicon planar epitaxial PNP transistors in TO-39 metal case. They are intended particularly as audio driver stages in commercial and professional equipments. In addition they are useful as high speed saturated switches and general purpose amplifiers. The complementary NPN types are respectively the BC301 and BC302.

ABSOLUTE MAXIMUM RATINGS

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<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>$- 60$</td>
<td>$- 45$</td>
</tr>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>$- 85$</td>
<td>$- 60$</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>$- 6$</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>$- 0.5$</td>
<td>A</td>
</tr>
<tr>
<td>$I_{CM}$</td>
<td>Collector Peak Current</td>
<td>$- 1$</td>
<td>A</td>
</tr>
<tr>
<td>$I_{BM}$</td>
<td>Base Peak Current</td>
<td>$- 0.5$</td>
<td>A</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 , ^\circ C$</td>
<td>$0.85$</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}$</td>
<td>Storage Temperature</td>
<td>$- 65$ to $175$</td>
<td>°C</td>
</tr>
<tr>
<td>$T_j$</td>
<td>Junction Temperature</td>
<td>$175$</td>
<td>°C</td>
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</table>

December 1988
THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>°C/W</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th,j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td></td>
<td></td>
<td></td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>$R_{th,j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td></td>
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<td></td>
<td>175</td>
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ELECTRICAL CHARACTERISTICS ($T_{case} = 25^\circ C$ unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
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<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = -60 V$</td>
<td>-5</td>
<td>-20</td>
<td>nA</td>
<td></td>
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<tr>
<td>$I_{EBO}$</td>
<td>Emitter Cutoff Current ($I_C = 0$)</td>
<td>$V_{EB} = -5 V$</td>
<td></td>
<td></td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CEO}^*$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = -10 mA$</td>
<td></td>
<td>For BC303</td>
<td>-60</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For BC304</td>
<td>45</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{CE, (sat)}^*$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = -150 mA$</td>
<td>-0.25</td>
<td>-0.65</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{BE,*}$</td>
<td>Base-emitter Voltage</td>
<td>$I_C = -150 mA$</td>
<td>0.78</td>
<td>-</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$h_{FE,*}$</td>
<td>DC Current Gain</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gr.4</td>
<td>$I_C = -150 mA$</td>
<td>$V_{CE} = -10 V$</td>
<td>40</td>
<td>80</td>
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</tr>
<tr>
<td>Gr.5</td>
<td>$I_C = -150 mA$</td>
<td>$V_{CE} = -10 V$</td>
<td>70</td>
<td>140</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gr.6</td>
<td>$I_C = -150 mA$</td>
<td>$V_{CE} = -10 V$</td>
<td>120</td>
<td>240</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$I_C = -0.1 mA$</td>
<td>$V_{CE} = -10 V$</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$I_C = -500 mA$</td>
<td>$V_{CE} = -10 V$</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$f_T$</td>
<td>Transition frequency</td>
<td>$I_C = -50 mA$</td>
<td>100</td>
<td></td>
<td>MHz</td>
<td></td>
</tr>
<tr>
<td>$V_{CE} = -10 V$</td>
<td>$f = 100 MHz$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$</td>
<td>15</td>
<td></td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>$h_{ie}$</td>
<td>Input Impedance</td>
<td>$I_C = -5 mA$</td>
<td>0.9</td>
<td></td>
<td>kΩ</td>
<td></td>
</tr>
<tr>
<td>$f = 1 kHz$</td>
<td>$V_{CE} = -10 V$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$h_{re}$</td>
<td>Reverse Voltage Ratio</td>
<td>$I_C = -5 mA$</td>
<td>1.7x10^-4</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>$f = 1 kHz$</td>
<td>$V_{CE} = -10 V$</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>$h_{fe}$</td>
<td>Small Signal Current Gain</td>
<td>$I_C = -5 mA$</td>
<td>140</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>$f = 1 kHz$</td>
<td>$V_{CE} = -10 V$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$h_{oe}$</td>
<td>Output Admittance</td>
<td>$I_C = -5 mA$</td>
<td>45</td>
<td></td>
<td>μs</td>
<td></td>
</tr>
<tr>
<td>$f = 1 kHz$</td>
<td>$V_{CE} = -10 V$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Pulsed: pulse duration = 300μs, duty cycle = 1%.

DC Normalized Current Gain.

Collector-emitter saturation voltage.
Collector Cutoff Current.

Transition Frequency.
DESCRIPTION
The BC377 and BC378 are silicon planar epitaxial NPN transistors in TO-18 metal case. They are particularly intended for use in high current, high gain applications, in driver stages of hi-fi equipments or in output stages of low power class B amplifiers. The complementary PNP types are the BC297 and BC298 respectively.

INTERNAL SCHEMATIC DIAGRAM

ABSOLUTE MAXIMUM RATINGS

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<tr>
<th>Symbol</th>
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<tr>
<td>$V_{CES}$</td>
<td>Collector-emitter Voltage ($V_{EB} = 0$)</td>
<td>50</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>6</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>1</td>
<td>A</td>
</tr>
<tr>
<td>$I_B$</td>
<td>Base Current</td>
<td>0.2</td>
<td>A</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 , ^\circ C$</td>
<td>375</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 75 , ^\circ C$</td>
<td>1</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}$</td>
<td>Storage Temperature</td>
<td>-65 to 175</td>
<td>°C</td>
</tr>
<tr>
<td>$T_j$</td>
<td>Junction Temperature</td>
<td>175</td>
<td>°C</td>
</tr>
</tbody>
</table>

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### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Thermal Resistance Junction-case</th>
<th>Thermal Resistance Junction-ambient</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{\text{th j-case}}$</td>
<td>Max 100 °C/W</td>
<td>Max 400 °C/W</td>
</tr>
<tr>
<td>$R_{\text{th j-amb}}$</td>
<td></td>
<td></td>
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</table>

### ELECTRICAL CHARACTERISTICS ($T_{\text{case}} = 25$ °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter Description</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{\text{CES}}$</td>
<td>Collector Cutoff Current ($V_{BE} = 0$)</td>
<td>For BC377 $V_{CE} = 50$ V For BC378 $V_{CE} = 30$ V</td>
<td>15</td>
<td>15</td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td>$V_{(BR)\text{EBO}}$</td>
<td>Emitter-base Breakdown Voltage ($I_{C} = 0$)</td>
<td>$I_{E} = 10$ µA</td>
<td>6</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)\text{CEO}}$ *</td>
<td>Collector-emitter Breakdown Voltage ($I_{B} = 0$)</td>
<td>$I_{C} = 2$ mA For BC377 $V_{CE} = 50$ V For BC378 $V_{CE} = 30$ V</td>
<td>40</td>
<td>25</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{\text{CE (sat)}}$ *</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_{C} = 500$ mA $I_{B} = 50$ mA</td>
<td></td>
<td></td>
<td>0.7</td>
<td>V</td>
</tr>
<tr>
<td>$V_{\text{BE}}$ *</td>
<td>Base-emitter Voltage</td>
<td>$I_{C} = 100$ mA $V_{CE} = 1$ V</td>
<td>740</td>
<td></td>
<td></td>
<td>mV</td>
</tr>
<tr>
<td>$V_{\text{BE (sat)}}$ *</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_{C} = 100$ mA $V_{CE} = 1$ V</td>
<td></td>
<td>1.2</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$h_{FE}$ *</td>
<td>DC Current Gain</td>
<td>For BC377 $I_{C} = 100$ mA $V_{CE} = 1$ V</td>
<td>75</td>
<td>125</td>
<td>35</td>
<td>pF</td>
</tr>
<tr>
<td>$f_{T}$</td>
<td>Transition Frequency</td>
<td>$I_{C} = 50$ mA $V_{CE} = 10$ V</td>
<td>100</td>
<td></td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td>$C_{\text{CBO}}$</td>
<td>Collector-base Capacitance</td>
<td>$I_{E} = 0$ $V_{CB} = 10$ V</td>
<td>10</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$C_{\text{EBO}}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_{C} = 0$ $V_{EB} = 0.5$ V</td>
<td>30</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 µs, duty cycle = 1 %.

**DC Normalized Current Gain.**

**Collector-emitter Saturation Voltage.**
DESCRIPTION
The BC393 is a silicon planar epitaxial PNP transistor in Jedec TO-18 metal case, designed for general purpose high-voltage and video amplifier applications.
The complementary NPN type is the BC394.

INTERNAL SCHEMATIC DIAGRAM

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>– 180</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>– 180</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>– 6</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>– 100</td>
<td>mA</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 $^\circ$C</td>
<td>0.4</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 $^\circ$C</td>
<td>1.4</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}$</td>
<td>Storage Temperature</td>
<td>– 55 to 200</td>
<td>$^\circ$C</td>
</tr>
<tr>
<td>$T_J$</td>
<td>Junction Temperature</td>
<td>200</td>
<td>$^\circ$C</td>
</tr>
</tbody>
</table>
### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter Description</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>R\text{th}</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>125</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
<tr>
<td>R\text{th}</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>440</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
</tbody>
</table>

### ELECTRICAL CHARACTERISTICS (\(T_{\text{amb}} = 25\, ^\circ\text{C}\) unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter Description</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>I\text{CBO}</td>
<td>Collector Cutoff Current ((I_E = 0))</td>
<td>(V_{CB} = -100, V) (T_{\text{amb}} = 150, ^\circ\text{C})</td>
<td>50</td>
<td>50</td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td>V\text{(BR) CBO}</td>
<td>Collector-base Breakdown voltage ((I_E = 0))</td>
<td>(I_C = -10, \mu\text{A}) (T_{\text{amb}} = 125, ^\circ\text{C})</td>
<td>-180</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V\text{(BR) CEO}</td>
<td>Collector-emitter Breakdown voltage ((I_B = 0))</td>
<td>(I_C = -2, mA) (T_{\text{amb}} = 125, ^\circ\text{C})</td>
<td>-180</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V\text{(BR) EBO}</td>
<td>Emitter-base Breakdown voltage ((I_C = 0))</td>
<td>(I_E = -10, \mu\text{A}) (T_{\text{amb}} = 125, ^\circ\text{C})</td>
<td>-6</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V\text{CE (sat)}</td>
<td>Collector-emitter Saturation voltage</td>
<td>(I_C = -10, mA) (I_B = -1, mA) (T_{\text{amb}} = 125, ^\circ\text{C})</td>
<td>-100</td>
<td>-300</td>
<td></td>
<td>mV</td>
</tr>
<tr>
<td>V\text{BE (sat)}</td>
<td>Base-emitter Saturation voltage</td>
<td>(I_C = -10, mA) (I_B = -1, mA) (T_{\text{amb}} = 125, ^\circ\text{C})</td>
<td>-750</td>
<td>-900</td>
<td></td>
<td>mV</td>
</tr>
<tr>
<td>h\text{FE}</td>
<td>DC Current Gain</td>
<td>(I_C = -1, mA) (V_{CE} = -10, V) (T_{\text{amb}} = 125, ^\circ\text{C})</td>
<td>85</td>
<td></td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td>f\text{T}</td>
<td>Transition frequency</td>
<td>(I_C = -10, mA) (V_{CE} = -10, V) (T_{\text{amb}} = 125, ^\circ\text{C})</td>
<td>50</td>
<td>95</td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td>C\text{CBO}</td>
<td>Collector-base Capacitance</td>
<td>(I_E = 0) (f = 1, MHz) (V_{CB} = -10, V) (T_{\text{amb}} = 125, ^\circ\text{C})</td>
<td>4</td>
<td>7</td>
<td></td>
<td>pF</td>
</tr>
</tbody>
</table>

* Pulsed : pulse duration = 300 \(\mu\text{s}\), duty cycle = 1 %.

#### DC Current Gain

![DC Current Gain Graph](image1)

#### Collector-emitter Saturation Voltage

![Collector-emitter Saturation Voltage Graph](image2)
Base-emitter Saturation Voltage.

Transition Frequency.

\[ V_{BE(sat)} \]

- \[ T_{amb} = 55^\circ \text{C} \]
- \[ 25^\circ \text{C} \]
- \[ 125^\circ \text{C} \]

- \[ I_C = 10 \text{mA} \]

\[ f_T \]

- \[ V_{CE} = -10 \text{V} \]
- \[ f = 20 \text{MHz} \]
DESCRIPTION
The BC394 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case, designed for general purpose high-voltage and video amplifier applications.

The complementary PNP type is the BC393.

INTERNAL SCHEMATIC DIAGRAM

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{CBO}</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>180</td>
<td>V</td>
</tr>
<tr>
<td>V_{CEO}</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>180</td>
<td>V</td>
</tr>
<tr>
<td>V_{EBO}</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>6</td>
<td>V</td>
</tr>
<tr>
<td>I_C</td>
<td>Collector Current</td>
<td>100</td>
<td>mA</td>
</tr>
<tr>
<td>P_{tot}</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 \degree C$ at $T_{case} \leq 25 \degree C$</td>
<td>0.4 \hspace{1em} 1.4</td>
<td>W</td>
</tr>
<tr>
<td>T_{stg}</td>
<td>Storage Temperature</td>
<td>-55 to 200</td>
<td>°C</td>
</tr>
<tr>
<td>T_j</td>
<td>Junction Temperature</td>
<td>200</td>
<td>°C</td>
</tr>
</tbody>
</table>
THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rth JC-case</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>125</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
<tr>
<td>Rth J-amb</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>440</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
</tbody>
</table>

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25$ °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
</table>
| I_{CBO}| Collector Cutoff Current  
                          ($I_E = 0$) | $V_{CB} = 100 \text{ V}$ 
                          $V_{CB} = 100 \text{ V}$ 
                          $T_{amb} = 150$ °C | 50   | 50   |      | nA   |
| $V_{(BR)\text{ CBO}}$ | Collector-base Breakdown 
                        Voltage ($I_E = 0$) | $I_C = 100 \mu \text{A}$ | 180  |      |      | V    |
| $V_{(BR)\text{ CEO}}$ | Collector-emitter Breakdown 
                        Voltage ($I_B = 0$) | $I_C = 10 \text{ mA}$ | 180  |      |      | V    |
| $V_{(BR)\text{ EBO}}$ | Emitter-base Breakdown 
                        Voltage ($I_C = 0$) | $I_E = 100 \mu \text{A}$ | 6    |      |      | V    |
| $V_{CE \text{ (sat)}}$ | Collector-emitter Saturation 
                        Voltage | $I_C = 10 \text{ mA}$ 
                        $I_C = 50 \text{ mA}$ 
                        $I_B = 1 \text{ mA}$ 
                        $I_B = 5 \text{ mA}$ | 200  | 400  | 300  | mV   |
| $V_{BE \text{ (sat)}}$ | Base-emitter Saturation 
                        Voltage | $I_C = 10 \text{ mA}$ 
                        $I_C = 50 \text{ mA}$ 
                        $I_B = 1 \text{ mA}$ 
                        $I_B = 5 \text{ mA}$ | 750  | 850  | 900  | mV   |
| $h_{FE}$ | DC Current Gain 
                        | $I_C = 1 \text{ mA}$ 
                        $V_{CE} = 10 \text{ V}$ | 85   |      |      | mV   |
| $f_T$ | Transition frequency | $I_C = 10 \text{ mA}$ 
                        $V_{CE} = 10 \text{ V}$ | 50   | 95   |      | MHz  |
| $C_{CBO}$ | Collector-base 
                        Capacitance | $I_E = 0$ 
                        $f = 1 \text{ MHz}$ 
                        $V_{CB} = 10 \text{ V}$ | 5    |      |      | pF   |

* Pulsed: pulse duration = 300 µs, duty cycle = 1 %.

DC Current.

Collector-emitter Saturation Voltage.
Base-emitter Saturation Voltage.

Transition Frequency.

$V_{BE(sat)}$ (V)

$V_{CE} = 10V$

$1f = 20MHz$
DESCRIPTION
The BC440 and BC441 are silicon planar epitaxial NPN transistors in TO-39 metal case. They are intended for general purpose applications, especially for driver stages.

The complementary PNP types are respectively the BC460 and BC461.

INTERNAL SCHEMATIC DIAGRAM

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>BC440</td>
<td>BC441</td>
</tr>
<tr>
<td>V_{CBO}</td>
<td>Collector-base Voltage (I_E = 0)</td>
<td>50</td>
<td>70</td>
</tr>
<tr>
<td>V_{CEO(sUS)}</td>
<td>Collector-emitter Voltage (I_B = 0)</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>V_{CER}</td>
<td>Collector-emitter Voltage (R_{BE} ≤ 100 Ω)</td>
<td>50</td>
<td>70</td>
</tr>
<tr>
<td>V_{EBO}</td>
<td>Emitter-base Voltage (I_C = 0)</td>
<td>5</td>
<td>V</td>
</tr>
<tr>
<td>I_{CM}</td>
<td>Collector Peak Current</td>
<td>2</td>
<td>A</td>
</tr>
<tr>
<td>P_{tot}</td>
<td>Total Power Dissipation at T_{amb} ≤ 25 °C</td>
<td>1</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at T_{case} ≤ 25 °C</td>
<td>10</td>
<td>W</td>
</tr>
<tr>
<td>T_{stg}</td>
<td>Storage Temperature</td>
<td>-65 to 200</td>
<td>°C</td>
</tr>
<tr>
<td>T_{j}</td>
<td>Junction Temperature</td>
<td>200</td>
<td>°C</td>
</tr>
</tbody>
</table>

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THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>R_{th} j-case</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>17.5</td>
<td></td>
<td></td>
<td>°C/W</td>
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<tr>
<td>R_{th} j-amb</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>175</td>
<td></td>
<td></td>
<td>°C/W</td>
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</table>

ELECTRICAL CHARACTERISTICS (T_{case} = 25 °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
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<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>I_{CEO}</td>
<td>Collector Cutoff Current</td>
<td>V_{CB} = 40 V</td>
<td>100</td>
<td></td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td>I_{CER}</td>
<td>Collector Cutoff Current                     (R_{BE} = 100 Ω)</td>
<td>For BC440  V_{CE} = 50 V</td>
<td>10</td>
<td></td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For BC441  V_{CE} = 70 V</td>
<td>10</td>
<td></td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td>V_{(BR) EBO}</td>
<td>Emitter Base Breakdown Voltage (I_{C} = 0)</td>
<td>I_{E} = 100 μA</td>
<td>5</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V_{(BR) CEO}</td>
<td>Collector-emitter Breakdown Voltage (I_{B} = 0)</td>
<td>I_{C} = 10 mA</td>
<td>For BC440  V_{CE} = 40 V</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>For BC441  V_{CE} = 60 V</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V_{CE (sat)}</td>
<td>Collector-emitter Saturation Voltage</td>
<td>I_{C} = 1 A I_{B} = 100 mA</td>
<td>1</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V_{BE (sat)}</td>
<td>Base-emitter Saturation Voltage             I_{C} = 1 A I_{B} = 100 mA</td>
<td>1.5</td>
<td></td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>h_{FE}</td>
<td>DC Current Gain Gr. 4</td>
<td>I_{C} = 500 mA V_{CE} = 4 V</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gr. 5</td>
<td>I_{C} = 500 mA V_{CE} = 4 V</td>
<td>60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gr. 6</td>
<td>I_{C} = 500 mA V_{CE} = 4 V</td>
<td>115</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>f_{T}</td>
<td>Transition frequency</td>
<td>I_{C} = 50 mA V_{CE} = 4 V</td>
<td>50</td>
<td></td>
<td></td>
<td>MHz</td>
</tr>
</tbody>
</table>

* Pulsed : pulse duration = 300 μs, duty cycle = 1%.

DC Normalized Current Gain.

Collector-emitter Saturation Voltage.
DESCRIPTION
The BC460 and BC461 are silicon planar epitaxial PNP transistors in TO-39 metal case. They are intended for general purpose applications, especially for driver stages.
The complementary NPN types are respectively the BC440 and BC441.

INTERNAL SCHEMATIC DIAGRAM

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Collector-base Voltage (I_E = 0)</td>
<td>– 50</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>Collector-emitter Voltage (I_B = 0)</td>
<td>– 40</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>Collector-emitter Voltage (R_BE ≤ 100 Ω)</td>
<td>– 50</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>Emitter-base Voltage (I_C = 0)</td>
<td>– 5</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>Collector Peak Current</td>
<td>– 2</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Total Power Dissipation at T_amb ≤ 25 °C</td>
<td></td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at T_case ≤ 25 °C</td>
<td>1</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>Storage Temperature</td>
<td>– 65 to 200</td>
<td>°C</td>
</tr>
<tr>
<td></td>
<td>Junction Temperature</td>
<td>200</td>
<td>°C</td>
</tr>
</tbody>
</table>

October 1988
**THERMAL DATA**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th\ j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td></td>
<td></td>
<td></td>
<td>17.5</td>
<td>°C/W</td>
</tr>
<tr>
<td>$R_{th\ j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td></td>
<td></td>
<td></td>
<td>175</td>
<td>°C/W</td>
</tr>
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</table>

**ELECTRICAL CHARACTERISTICS** ($T_{case} = 25\, ^\circ C$ unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = -40, V$</td>
<td></td>
<td>100</td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td>$I_{CER}$</td>
<td>Collector Cutoff Current ($R_{BE} = 100, \Omega$)</td>
<td>For BC460 $V_{CE} = -50, V$</td>
<td>-10</td>
<td></td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For BC461 $V_{CE} = -70, V$</td>
<td>-10</td>
<td></td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td>$V_{(BR)\ EBO}$</td>
<td>Emitter Base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = -100, \mu A$</td>
<td>-5</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)\ CEO}^*$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = -10, mA$ For BC460</td>
<td>-40</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For BC461 $V_{CE} = -50, V$</td>
<td>-40</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE\ (sat)}^*$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = -1, A$ $I_B = -100, mA$</td>
<td>-1</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE\ (sat)}^*$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = -1, A$ $I_B = -100, mA$</td>
<td>-1.5</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$h_{FE}^*$</td>
<td>DC Current Gain Gr. 4</td>
<td>$I_C = -500, mA$ $V_{CE} = -4, V$</td>
<td>40</td>
<td></td>
<td>70</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -500, mA$ $V_{CE} = -4, V$</td>
<td>60</td>
<td></td>
<td>130</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -500, mA$ $V_{CE} = -4, V$</td>
<td>115</td>
<td></td>
<td>250</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -1, A$ $V_{CE} = -2, V$ (for BC460 only)</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$f_T$</td>
<td>Transition frequency</td>
<td>$I_C = -50, mA$ $V_{CE} = -4, V$</td>
<td>50</td>
<td></td>
<td></td>
<td>MHz</td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1%.

**DC Normalized Current Gain.**

**Collector-emitter Saturation Voltage.**
DESCRIPTION
The BC477, BC478 and BC479 are silicon planar epitaxial PNP transistors in TO-18 metal case. The BC477 is a high voltage type designed for use in audio amplifiers or driver stages, and in the signal processing circuits of TV sets. The BC478 and BC479 are respectively low noise and very low noise types, designed for general preamplifier or amplifier applications.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Collector-emitter Voltage ((V_{BE} = 0))</td>
<td>− 90</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>Collector-emitter Voltage ((I_B = 0))</td>
<td>− 80</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>Emitter-base Voltage ((I_C = 0))</td>
<td>− 6</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>Collector Current</td>
<td>− 150</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td>Total Power Dissipation at (T_{amb} \leq 25 , ^{\circ}C)\n(T_{case} \leq 25 , ^{\circ}C)</td>
<td>0.36</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>Storage Temperature</td>
<td>− 55 to 200</td>
<td>°C</td>
</tr>
<tr>
<td></td>
<td>Junction Temperature</td>
<td>200</td>
<td>°C</td>
</tr>
</tbody>
</table>

January 1989
## ELECTRICAL CHARACTERISTICS (T<sub>amb</sub> = 25 °C unless otherwise specified )

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Minimum</th>
<th>Typical</th>
<th>Maximum</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICEs</td>
<td>Collector Cutoff Current (V&lt;sub&gt;BE&lt;/sub&gt; = 0)</td>
<td>for BC477&lt;br&gt;V&lt;sub&gt;CE&lt;/sub&gt; = -70 V&lt;br&gt;V&lt;sub&gt;CE&lt;/sub&gt; = -70 V&lt;br&gt;T&lt;sub&gt;amb&lt;/sub&gt; = 125 °C for BC479-BC478&lt;br&gt;V&lt;sub&gt;CE&lt;/sub&gt; = -30 V&lt;br&gt;V&lt;sub&gt;CE&lt;/sub&gt; = -30 V&lt;br&gt;T&lt;sub&gt;amb&lt;/sub&gt; = 125 °C</td>
<td>-10</td>
<td>-10</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Emitte-cutoff Current (I&lt;sub&gt;C&lt;/sub&gt; = 0)</td>
<td>V&lt;sub&gt;EB&lt;/sub&gt; = -4 V</td>
<td>-10</td>
<td></td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>V(BR)ces</td>
<td>Collector-emitter Breakdown Voltage (V&lt;sub&gt;BE&lt;/sub&gt; = 0)</td>
<td>I&lt;sub&gt;C&lt;/sub&gt; = -10 μA for BC477&lt;br&gt;for BC478&lt;br&gt;for BC479</td>
<td>-90</td>
<td>-40</td>
<td>-40</td>
<td>V</td>
</tr>
<tr>
<td>V(BR)ceo</td>
<td>Collector-emitter Breakdown Voltage (I&lt;sub&gt;B&lt;/sub&gt; = 0)</td>
<td>I&lt;sub&gt;C&lt;/sub&gt; = -5 mA for BC477&lt;br&gt;for BC478&lt;br&gt;for BC479</td>
<td>-80</td>
<td>-40</td>
<td>-40</td>
<td>V</td>
</tr>
<tr>
<td>V(BR)EBO</td>
<td>Emitter-base Breakdown Voltage (I&lt;sub&gt;C&lt;/sub&gt; = 0)</td>
<td>I&lt;sub&gt;E&lt;/sub&gt; = -10 μA</td>
<td>-6</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;CE&lt;/sub&gt;(sat)&lt;sup&gt;*&lt;/sup&gt;</td>
<td>Collector-emitter Saturation Voltage</td>
<td>I&lt;sub&gt;C&lt;/sub&gt; = -10 mA&lt;br&gt;I&lt;sub&gt;B&lt;/sub&gt; = -0.5 mA&lt;br&gt;I&lt;sub&gt;C&lt;/sub&gt; = -100 mA&lt;br&gt;I&lt;sub&gt;B&lt;/sub&gt; = -5 mA</td>
<td>-0.1</td>
<td>-0.25</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>V&lt;sub&gt;BE&lt;/sub&gt;*</td>
<td>Base-emitter Voltage</td>
<td>I&lt;sub&gt;C&lt;/sub&gt; = 2 mA&lt;br&gt;V&lt;sub&gt;CE&lt;/sub&gt; = -5 V</td>
<td>-0.55</td>
<td>-0.65</td>
<td>-0.75</td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;BE&lt;/sub&gt;(sat)&lt;sup&gt;*&lt;/sup&gt;</td>
<td>Base-emitter Saturation Voltage</td>
<td>I&lt;sub&gt;C&lt;/sub&gt; = -10 mA&lt;br&gt;I&lt;sub&gt;B&lt;/sub&gt; = -0.5 mA&lt;br&gt;I&lt;sub&gt;C&lt;/sub&gt; = -100 mA&lt;br&gt;I&lt;sub&gt;B&lt;/sub&gt; = -5 mA</td>
<td>-0.75</td>
<td>-0.9</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>h&lt;sub&gt;FE&lt;/sub&gt;*</td>
<td>DC Current Gain</td>
<td>I&lt;sub&gt;C&lt;/sub&gt; = -10 μA&lt;br&gt;V&lt;sub&gt;CE&lt;/sub&gt; = -5 V&lt;br&gt;for BC477&lt;br&gt;for BC478&lt;br&gt;for BC479</td>
<td>30</td>
<td>115</td>
<td>100</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I&lt;sub&gt;C&lt;/sub&gt; = -2 mA&lt;br&gt;V&lt;sub&gt;CE&lt;/sub&gt; = -5 V&lt;br&gt;for BC477&lt;br&gt;for BC478&lt;br&gt;for BC479</td>
<td>50</td>
<td>195</td>
<td>110</td>
<td>290</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I&lt;sub&gt;C&lt;/sub&gt; = -10 mA&lt;br&gt;V&lt;sub&gt;CE&lt;/sub&gt; = -5 V&lt;br&gt;for BC477&lt;br&gt;for BC478&lt;br&gt;for BC479</td>
<td>110</td>
<td>250</td>
<td></td>
<td>450</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I&lt;sub&gt;C&lt;/sub&gt; = -10 mA&lt;br&gt;V&lt;sub&gt;CE&lt;/sub&gt; = -5 V&lt;br&gt;for BC477&lt;br&gt;for BC478&lt;br&gt;for BC479</td>
<td>160</td>
<td></td>
<td></td>
<td>350</td>
</tr>
<tr>
<td>h&lt;sub&gt;fe&lt;/sub&gt;</td>
<td>Small Signal Current Gain</td>
<td>I&lt;sub&gt;C&lt;/sub&gt; = -2 mA&lt;br&gt;v = 1 kHz&lt;br&gt;for BC477&lt;br&gt;for BC478&lt;br&gt;for BC479</td>
<td>125</td>
<td>260</td>
<td></td>
<td>500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V&lt;sub&gt;CE&lt;/sub&gt; = -5 V&lt;br&gt;for BC477&lt;br&gt;for BC478&lt;br&gt;for BC479</td>
<td>220</td>
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<tr>
<td></td>
<td></td>
<td>I&lt;sub&gt;C&lt;/sub&gt; = -10 mA&lt;br&gt;V&lt;sub&gt;CE&lt;/sub&gt; = -5 V&lt;br&gt;f = 20 MHz&lt;br&gt;for BC477&lt;br&gt;for BC478&lt;br&gt;for BC479</td>
<td>125</td>
<td>260</td>
<td></td>
<td>500</td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1 %.
### ELECTRICAL CHARACTERISTICS (continued)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>C_{CBO}</td>
<td>Collector-base Capacitance</td>
<td>I_E = 0, V_{CB} = -5 V</td>
<td>4</td>
<td>6</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>C_{EBO}</td>
<td>Emitter-base Capacitance</td>
<td>I_C = 0, V_{EB} = -0.5 V</td>
<td>11</td>
<td>15</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>NF</td>
<td>Noise Figure</td>
<td>I_C = -20\mu A, V_{CE} = -5 V, R_g = 10 k\Omega, f = 10 Hz to 10 kHz, B = 15.7 kHz</td>
<td>0.8</td>
<td>3.5</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>NF</td>
<td>Noise Figure</td>
<td>I_C = -200 \mu A, V_{CE} = -5 V, R_g = 2 k\Omega, f = 1 kHz, B = 200 Hz</td>
<td>1.5</td>
<td>4</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I_C = -200 \mu A, V_{CE} = -5 V, R_g = 2 k\Omega, f = 1 kHz, B = 200 Hz</td>
<td>0.5</td>
<td>2.5</td>
<td></td>
<td>dB</td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 \mu s, duty cycle = 1 %.

**Collector-emitter Saturation Voltage.**

**Collector Cutoff Current.**
Collector-base Capacitance.

Transition Frequency.

Noise Figure (for BC477 only).

Noise Figure (for BC478 only).

Noise Figure (for BC479 only).

Noise Figure (for BC479 only).
Noise Figure vs. Frequency (for BC479 only).

- **NF (dB)**
  - 8
  - 6
  - 4
  - 2
  - 0

- **f (Hz)**
  - $10^2$
  - $10^3$
  - $10^4$
  - $10^5$

- **Notes:**
  - $V_{ce} = -5$ V
  - $R_g = 2 \, k\Omega$
  - $I_c = 200 \, \mu A$

Power Rating Chart.

- **$P_{tot}$ (W)**
  - 1
  - 0.8
  - 0.6
  - 0.4
  - 0.2

- **$T_{amb}$ (°C)**
  - 0
  - 50
  - 100
  - 150
  - 200

- **Lines:**
  - WITH INEL
  - FREE AIR
DESCRIPTION
The BCY58 and BCY59 are silicon planar epitaxial NPN transistors in Jedec TO-18 metal case. They are intended for use in audio input stages, driver stages and low-noise input stages. The complementary PNP types are respectively the BCY78 and BCY79.

INTERNAL SCHEMATIC DIAGRAM

ABSOLUTE MAXIMUM RATINGS

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<tr>
<th>Symbol</th>
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<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CES}$</td>
<td>Collector-emitter Voltage ($V_{BE} = 0$)</td>
<td>32</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>32</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>7</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>200</td>
<td>mA</td>
</tr>
<tr>
<td>$I_B$</td>
<td>Base Current</td>
<td>50</td>
<td>mA</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 , ^\circ C$ at $T_{case} \leq 45 , ^\circ C$</td>
<td>0.39</td>
<td>mW</td>
</tr>
<tr>
<td>$T_{stg}, T_J$</td>
<td>Storage and Junction Temperature</td>
<td>-65 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>
THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
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<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>150</td>
<td>$^\circ$C/W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_{th j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>450</td>
<td>$^\circ$C/W</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25 \, ^\circ\text{C}$ unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CES}$</td>
<td>Collector Cutoff Current ($V_{BE} = 0$)</td>
<td>For BCY58 $V_{CE} = 32 , \text{V}$ $T_{amb} = 150 , ^\circ\text{C}$</td>
<td>0.1</td>
<td>10</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>$I_{CES}$</td>
<td>Collector Cutoff Current ($V_{BE} = 0$)</td>
<td>For BCY59 $V_{CE} = 45 , \text{V}$ $T_{amb} = 150 , ^\circ\text{C}$</td>
<td>0.1</td>
<td>10</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>$I_{CEX}$</td>
<td>Collector Cutoff Current ($V_{BE} = -0.2 , \text{V}$)</td>
<td>For BCY58 $V_{CE} = 32 , \text{V}$ $T_{amb} = 100 , ^\circ\text{C}$</td>
<td>20</td>
<td></td>
<td>$\mu$A</td>
<td></td>
</tr>
<tr>
<td>$I_{CEX}$</td>
<td>Collector Cutoff Current ($V_{BE} = -0.2 , \text{V}$)</td>
<td>For BCY59 $V_{CE} = 45 , \text{V}$ $T_{amb} = 100 , ^\circ\text{C}$</td>
<td>20</td>
<td></td>
<td>$\mu$A</td>
<td></td>
</tr>
<tr>
<td>$I_{EBO}$</td>
<td>Emitter cutoff Current ($I_{C} = 0$)</td>
<td>$V_{EB} = 5 , \text{V}$</td>
<td>10</td>
<td></td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CEO}^*$</td>
<td>Collector-emitter Breakdown Voltage ($I_{B} = 0$)</td>
<td>$I_{C} = 2 , \text{mA}$ For BCY58</td>
<td>32</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CEO}^*$</td>
<td>Collector-emitter Breakdown Voltage ($I_{B} = 0$)</td>
<td>For BCY59</td>
<td>45</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)EBO}^*$</td>
<td>Emitter-base Breakdown Voltage ($I_{C} = 0$)</td>
<td>$I_{E} = 10 , \mu$A</td>
<td>7</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{CE(sat)}^*$</td>
<td>Collector-Emitter Saturation Voltage</td>
<td>$I_{C} = 10 , \text{mA}$</td>
<td>0.12</td>
<td>0.35</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{CE(sat)}^*$</td>
<td>Collector-Emitter Saturation Voltage</td>
<td>$I_{C} = 100 , \text{mA}$</td>
<td>0.4</td>
<td>0.7</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{BE}$</td>
<td>Base-emitter Voltage</td>
<td>$I_{C} = 2 , \text{mA}$ $V_{CE} = 5 , \text{V}$</td>
<td>0.55</td>
<td>0.65</td>
<td>0.7</td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE}$</td>
<td>Base-emitter Voltage</td>
<td>$I_{C} = 100 , \text{mA}$ $V_{CE} = 1 , \text{V}$</td>
<td>0.75</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{BE(sat)}^*$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_{C} = 10 , \text{mA}$</td>
<td>0.6</td>
<td>0.7</td>
<td>0.85</td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE(sat)}^*$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_{C} = 100 , \text{mA}$</td>
<td>0.75</td>
<td>0.9</td>
<td>1.2</td>
<td>V</td>
</tr>
<tr>
<td>$h_{FE}^*$</td>
<td>DC Current Gain</td>
<td>$I_{C} = 10 , \mu$A $V_{CE} = 5 , \text{V}$</td>
<td>195</td>
<td>100</td>
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</tr>
<tr>
<td>$h_{FE}^*$</td>
<td>DC Current Gain</td>
<td>$I_{C} = 2 , \text{mA}$ $V_{CE} = 5 , \text{V}$</td>
<td>120</td>
<td>350</td>
<td>630</td>
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</tr>
<tr>
<td>$h_{FE}^*$</td>
<td>DC Current Gain</td>
<td>$I_{C} = 10 , \text{mA}$ $V_{CE} = 1 , \text{V}$</td>
<td>80</td>
<td>365</td>
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</tr>
<tr>
<td>$h_{FE}^*$</td>
<td>DC Current Gain</td>
<td>$I_{C} = 100 , \text{mA}$ $V_{CE} = 1 , \text{V}$</td>
<td>40</td>
<td>40</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Pulsed : pulse duration = 300 $\mu$s, duty cycle = 1 %.

---

[Image of the page]
## ELECTRICAL CHARACTERISTICS (continued)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$h_{fe}$</td>
<td>Small Signal Current Gain</td>
<td>$I_C = 2 \ mA$, $f = 1 \ kHz$</td>
<td>$V_{CE} = 5 \ V$</td>
<td>Gr.VII</td>
<td>125</td>
<td>250</td>
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<tr>
<td></td>
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<td></td>
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<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = 10 \ mA$, $f = 100 \ MHz$</td>
<td>$V_{CE} = 5 \ V$</td>
<td>200</td>
<td>MHz</td>
<td></td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_C = 0 \ mA$, $f = 1 \ MHz$</td>
<td>$V_{EB} = 0.5 \ V$</td>
<td>11</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0 \ mA$, $f = 1 \ MHz$</td>
<td>$V_{CB} = 10 \ V$</td>
<td>3.5</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>NF</td>
<td>Noise Figure</td>
<td>$I_C = 0.2 \ mA$, $R_g = 2 \ k\Omega$</td>
<td>$V_{CE} = 5 \ V$, $f = 1 \ kHz$</td>
<td>2</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>$t_{on}$</td>
<td>Turn-on Time</td>
<td>$I_C = 10 \ mA$, $I_{B1} = 1 \ mA$, $I_C = 100 \ mA$, $I_{B1} = 10 \ mA$</td>
<td>$V_{CC} = 10 \ V$</td>
<td>85</td>
<td></td>
<td>ns</td>
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<tr>
<td>$t_{off}$</td>
<td>Turn-off Time</td>
<td>$I_C = 10 \ mA$, $I_{B1} = -I_{B2} = 1 \ mA$, $I_C = 100 \ mA$, $I_{B1} = -I_{B2} = 10 \ mA$</td>
<td>$V_{CC} = 10 \ V$</td>
<td>480</td>
<td></td>
<td>ns</td>
</tr>
</tbody>
</table>

*Pulsed: pulse duration = 300 µs, duty cycle = 1%.

### DC Current Gain.

![DC Current Gain Graph](image1)

### Collector-emitter Saturation Voltage.

![Collector-emitter Saturation Voltage Graph](image2)
Transition Frequency.

Noise Figure (f = 100 Hz).

Noise Figure (f = 1 kHz).

Noise Figure (f = 10 kHz).

Noise Figure vs. Frequency.
DESCRIPTION
The BCY70, BCY71 and BCY72 are silicon planar epitaxial PNP transistors in Jedeq TO-18 metal case.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>BCY70</td>
<td>BCY71</td>
</tr>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>-50</td>
<td>-45</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>-40</td>
<td>-45</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>-5</td>
<td></td>
</tr>
<tr>
<td>$I_{CM}$</td>
<td>Collector Peak Current</td>
<td>-200</td>
<td></td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 , ^\circ C$</td>
<td>350</td>
<td></td>
</tr>
<tr>
<td>$T_{stg}, T_j$</td>
<td>Storage and Junction Temperature</td>
<td>-65 to 200</td>
<td></td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1%.
# THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th,j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>150</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
<tr>
<td>$R_{th,j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>500</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
</tbody>
</table>

# ELECTRICAL CHARACTERISTICS (T\(_{\text{amb}}\) = 25 °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
</table>
| $I_{\text{CES}}$ | Collector Cutoff Current  \((V_{\text{BE}} = 0)\) | For BCY70  
\(V_{\text{CE}} = -20\ \text{V}\)  
\(V_{\text{CE}} = -50\ \text{V}\)  
For BCY71  
\(V_{\text{CB}} = -20\ \text{V}\)  
\(V_{\text{CB}} = -45\ \text{V}\)  
For BCY72  
\(V_{\text{CB}} = -20\ \text{V}\)  
\(V_{\text{CB}} = -25\ \text{V}\) | −10  | −500  | −10  | nA   |
|        |                                  |                          |      |      |      | nA   |
|        |                                  |                          |      |      |      | μA   |
| $I_{\text{EBO}}$ | Emitter cutoff Current \((I_{\text{C}} = 0)\) | \(V_{\text{EB}} = -5\ \text{V}\) | −10  |      |      | μA   |
| $V_{\text{CE(sat)}}$ | Collector-emitter Saturation Voltage | \(I_{\text{C}} = -10\ \text{mA}\)  
\(I_{\text{C}} = -50\ \text{mA}\) | −0.25 |      |      | V    |
|        |                                  | \(I_{\text{B}} = -1\ \text{mA}\)  
\(I_{\text{B}} = -5\ \text{mA}\) | −0.5 |      |      | V    |
| $V_{\text{BE(sat)}}$ | Base-Emitter Saturation Voltage | \(I_{\text{C}} = -10\ \text{mA}\)  
\(I_{\text{C}} = -50\ \text{mA}\)  
For BCY70 and BCY71 Only | −0.6 |      |      | V    |
|        |                                  | \(I_{\text{B}} = -1\ \text{mA}\)  
\(I_{\text{B}} = -5\ \text{mA}\) | −0.9 |      |      | V    |
|        |                                  |                          | −1.2 |      |      | V    |
| $h_{\text{FE}}$ | DC Current Gain | For BCY70  
\(I_{\text{C}} = -0.1\ \text{mA}\)  
\(I_{\text{C}} = -1\ \text{mA}\)  
\(I_{\text{C}} = -10\ \text{mA}\)  
\(I_{\text{C}} = -50\ \text{mA}\)  
For BCY71  
\(I_{\text{C}} = -0.01\ \text{mA}\)  
\(I_{\text{C}} = -0.1\ \text{mA}\)  
\(I_{\text{C}} = -1\ \text{mA}\)  
\(I_{\text{C}} = -10\ \text{mA}\)  
\(I_{\text{C}} = -50\ \text{mA}\)  
For BCY72  
\(I_{\text{C}} = -1\ \text{mA}\)  
\(I_{\text{C}} = -10\ \text{mA}\) | 40  |      |      | MHz  |
|        |                                  |                          | 45  |      |      | MHz  |
|        |                                  |                          | 50  |      |      | MHz  |
|        |                                  |                          | 15  |      |      | MHz  |
|        |                                  |                          | 60  |      |      | MHz  |
|        |                                  |                          | 80  |      |      | MHz  |
|        |                                  |                          | 90  |      |      | MHz  |
|        |                                  |                          | 100 |      |      | MHz  |
|        |                                  |                          | 15  |      |      | MHz  |
|        |                                  |                          | 600 |      |      | MHz  |
|        |                                  |                          |      |      |      | MHz  |
|        |                                  |                          |      |      |      | MHz  |
| $h_{\text{fe}}$ | Small Signal Current Gain \(\text{(for BCY71 only)}\) | \(I_{\text{C}} = -1\ \text{mA}\)  
\(f = 1\ \text{kHz}\)  
\(V_{\text{CE}} = -10\ \text{V}\) | 100 |      |      | MHz  |
| $f_{\text{T}}$ | Transition Frequency | \(I_{\text{C}} = -0.1\ \text{mA}\)  
\(f = 10.7\ \text{MHz}\)  
\(V_{\text{CE}} = -20\ \text{V}\)  
\(\text{For BCY71}\)  
\(I_{\text{C}} = -10\ \text{mA}\)  
\(f = 100\ \text{MHz}\)  
\(V_{\text{CE}} = -20\ \text{V}\)  
\(\text{For BCY70 and BCY72}\) | 15  |      |      | MHz  |
|        |                                  |                          | 250 |      |      | MHz  |
|        |                                  |                          | 200 |      |      | MHz  |
| $C_{\text{EBO}}$ | Emitter-base Capacitance | \(I_{\text{C}} = 0\)  
\(f = 1\ \text{MHz}\)  
\(V_{\text{EB}} = -1\ \text{V}\) | 8  |      |      | pF   |
| $C_{\text{CBO}}$ | Collector-base Capacitance | \(I_{\text{E}} = 0\)  
\(f = 1\ \text{MHz}\)  
\(V_{\text{CB}} = -10\ \text{V}\) | 6  |      |      | pF   |

* Pulsed : pulse duration = 300 μs, duty cycle = 1 %. 

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SGS-THOMSON MICROELECTRONICS

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## ELECTRICAL CHARACTERISTICS (continued)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>NF</td>
<td>Noise Figure</td>
<td>$I_C = -0.1 \text{ mA}, \ V_{CE} = -5 \text{ V}$</td>
<td>$R_g = 2 \text{ k}\Omega, f = 10 \text{ to } 10 \text{ kHz}$</td>
<td>6</td>
<td>2</td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For BCY70 and BCY72</td>
<td>For BCY71</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$h_{ie}$</td>
<td>Input Impedance (for BCY71 only)</td>
<td>$I_C = -1 \text{ mA}, \ V_{CE} = -10 \text{ V}$</td>
<td>2</td>
<td>12</td>
<td>k\Omega</td>
<td></td>
</tr>
<tr>
<td>$h_{re}$</td>
<td>Reverse Voltage Ratio (for BCY71 only)</td>
<td>$I_C = -1 \text{ mA}, \ V_{CE} = -10 \text{ V}$</td>
<td>20x10^{-4}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$h_{oe}$</td>
<td>Output Admittance (for BCY71 only)</td>
<td>$I_C = -1 \text{ mA}, \ V_{CE} = -10 \text{ V}$</td>
<td>10</td>
<td>60</td>
<td>\mu S</td>
<td></td>
</tr>
<tr>
<td>$t_d$</td>
<td>Delay Time (for BCY70 and BCY72 only)</td>
<td>$I_C = -10 \text{ mA}, \ V_{EE} = 3 \text{ V}$</td>
<td>23</td>
<td>35</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$t_r$</td>
<td>Rise Time (for BCY70 and BCY72 only)</td>
<td>$I_C = -10 \text{ mA}, \ V_{EE} = 3 \text{ V}$</td>
<td>25</td>
<td>35</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$t_s$</td>
<td>Storage Time (for BCY70 and BCY72 only)</td>
<td>$I_C = -10 \text{ mA}, \ V_{EE} = 3 \text{ V}$</td>
<td>270</td>
<td>350</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$t_f$</td>
<td>Fall Time (for BCY70 and BCY72 only)</td>
<td>$I_C = -10 \text{ mA}, \ V_{EE} = 3 \text{ V}$</td>
<td>50</td>
<td>80</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$t_{on}$</td>
<td>Turn-on Time (for BCY70 and BCY72 only)</td>
<td>$I_C = -10 \text{ mA}, \ V_{EE} = 3 \text{ V}$</td>
<td>48</td>
<td>65</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$t_{off}$</td>
<td>Turn-off Time (for BCY70 and BCY72 only)</td>
<td>$I_C = -10 \text{ mA}, \ V_{EE} = 3 \text{ V}$</td>
<td>320</td>
<td>420</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 \mu s, duty cycle = 1%.

## TEST CIRCUIT

**Test Circuit for Switching Times.**

![Test Circuit Diagram](image)
Collector-emitter Saturation Voltage.

Base-emitter Saturation Voltage.

Collector-base Capacitance.

Equivalent Input Noise Voltage (for BCY71 only).
Equivalent Input Noise Current (for BCY71 only).

Contours of Constant White Noise Figure (for BCY71 only).
DESCRIPTION
The BCY78 and BCY79 are silicon planar epitaxial PNP transistors in Jedic TO-18 metal case. They are designed for use in audio driver and low-noise input stages.
The complementary NPN types are respectively the BCY58 and BCY59.

INTERNAL SCHEMATIC DIAGRAM

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CES}$</td>
<td>Collector-emitter Voltage ($V_{BE} = 0$)</td>
<td>$-32$</td>
<td>$-45$</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>$-32$</td>
<td>$-45$</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>$-5$</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>$-200$</td>
<td>mA</td>
</tr>
<tr>
<td>$I_B$</td>
<td>Base Current</td>
<td>$-20$</td>
<td>mA</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 \degree C$ at $T_{case} \leq 45 \degree C$</td>
<td>$390$</td>
<td>mW</td>
</tr>
<tr>
<td>$T_{stg, T_j}$</td>
<td>Storage and Junction Temperature</td>
<td>$-65$ to $200$</td>
<td>\degree C</td>
</tr>
</tbody>
</table>
## THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
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<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>150</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
<tr>
<td>$R_{th j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>450</td>
<td></td>
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<td>°C/W</td>
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</tbody>
</table>

## ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\,^\circ C$ unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
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<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CES}$</td>
<td>Collector Cutoff Current ($V_{BE} = 0$)</td>
<td>For BCY78</td>
<td>-2</td>
<td>-20</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = -25,V$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = -32,V$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = -25,V$ $T_{amb} = 150,^\circ C$</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>For BCY79</td>
<td>-2</td>
<td>-20</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = -35,V$</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = -35,V$ $T_{amb} = 150,^\circ C$</td>
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</tr>
<tr>
<td>$I_{CEX}$</td>
<td>Collector Cutoff Current ($V_{BE} = 0.2,V$)</td>
<td>For BCY78</td>
<td>-20</td>
<td></td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = -32,V$ $T_{amb} = 100,^\circ C$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{EBO}$</td>
<td>Emitter Cutoff Current ($I_{C} = 0$)</td>
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<tr>
<td>$V_{(BR)CES}$</td>
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<td>$V_{(BR)CEO}$*</td>
<td>Collector-emitter Breakdown Voltage ($I_{B} = 0$)</td>
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<td>$I_{C} = -2,mA$ For BCY79</td>
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<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_{C} = 0$)</td>
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<td>$V_{CE(sat)}$*</td>
<td>Collector-emitter Saturation Voltage</td>
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<td>$V_{BE}$*</td>
<td>Base-emitter Voltage</td>
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<td>$V_{BE(sat)}$*</td>
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<td>-0.7</td>
<td>-0.85</td>
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* Pulsed: pulse duration = 300 µs, duty cycle = 1 %.
### ELECTRICAL CHARACTERISTICS (continued)

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<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
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<th>Max.</th>
<th>Unit</th>
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<td>$h_{FE}$</td>
<td>DC Current Gain</td>
<td>$I_C = -10 \mu A$ $V_{CE} = -5 V$</td>
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<td>$I_C = -2 mA$ $V_{CE} = -5 V$</td>
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<td>$I_C = -10 mA$ $V_{CE} = -5 V$</td>
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<td>$I_C = -100 mA$ $V_{CE} = -1 V$</td>
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<td></td>
<td>$h_{fe}$</td>
<td>Small Signal Current Gain</td>
<td>$I_C = -2 mA$ $V_{CE} = -5 V$ $f = 1 \text{ kHz}$</td>
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<tr>
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<td>$I_C = -2 mA$ $V_{CE} = -5 V$</td>
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<td>$I_C = -100 mA$ $V_{CE} = -1 V$</td>
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<td>$I_C = -2 mA$ $V_{CE} = -5 V$</td>
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<td>$I_C = -10 mA$ $V_{CE} = -1 V$</td>
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<td>$I_C = -100 mA$ $V_{CE} = -1 V$</td>
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<td>$f_T$</td>
<td>Transition Frequency</td>
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<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_C = 0$ $V_{EB} = -0.5 V$ $f = 1 \text{ MHz}$</td>
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<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
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<td>NF</td>
<td>Noise Figure</td>
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<td>$h_{ie}$</td>
<td>Input Impedance</td>
<td>$I_C = -2 mA$ $V_{CE} = -5 V$ $f = 1 \text{ kHz}$</td>
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<td>$I_C = -2 mA$ $V_{CE} = -5 V$</td>
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<td></td>
<td>$I_C = -100 mA$ $V_{CE} = -1 V$</td>
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<tr>
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<td>$I_C = -2 mA$ $V_{CE} = -5 V$ $I_C = -100 mA$ $V_{CE} = -1 V$</td>
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<td>$h_{re}$</td>
<td>Reverse Voltage Ratio</td>
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<td>$I_C = -2 mA$ $V_{CE} = -5 V$</td>
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<tr>
<td></td>
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<td>$I_C = -100 mA$ $V_{CE} = -1 V$</td>
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</table>

*Pulsed: pulse duration = 300 $\mu$s, duty cycle = 1%.*
**ELECTRICAL CHARACTERISTICS (continued)**

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<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<td>$h_{oe}$</td>
<td>Output Admittance</td>
<td>$I_C = -2\ mA$</td>
<td>$V_{CE} = -5\ V$</td>
<td>18</td>
<td>30</td>
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<td>Gr.VIII</td>
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<td>Gr.IX</td>
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<td>For BCY78 Only</td>
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<td>Rise Time</td>
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<td>$I_B_1 = 10\ mA$</td>
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<td>$t_s$</td>
<td>Storage Time</td>
<td>$I_C = -10\ mA$</td>
<td>$V_{CC} = -10\ V$</td>
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<td>$I_C = 100\ mA$</td>
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<td>$t_f$</td>
<td>Fall Time</td>
<td>$I_C = -10\ mA$</td>
<td>$V_{CC} = -10\ V$</td>
<td>80</td>
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<td>ns</td>
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<td>$I_C = 100\ mA$</td>
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<td>$I_B_1 = -I_B_2 = -10\ mA$</td>
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<tr>
<td>$t_{on}$</td>
<td>Turn-on Time</td>
<td>$I_C = -10\ mA$</td>
<td>$V_{CC} = -10\ V$</td>
<td>85</td>
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<td>$I_B_1 = -1\ mA$</td>
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<td>$I_C = 100\ mA$</td>
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<td>$I_B_1 = -10\ mA$</td>
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<td>$t_{off}$</td>
<td>Turn-off Time</td>
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<td>$V_{CC} = -10\ V$</td>
<td>480</td>
<td>800</td>
<td>ns</td>
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<td>$I_B_1 = -I_B_2 = -1\ mA$</td>
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<td>$I_C = 100\ mA$</td>
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<td>$I_B_1 = -I_B_2 = -10\ mA$</td>
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</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1%.

**Collector-emitter Saturation Voltage.**

![Collector-emitter Saturation Voltage](image)

**Base-emitter Saturation Voltage.**

![Base-emitter Saturation Voltage](image)
DC Current Gain.

Normalized h Parameters.

Noise Figure vs. Frequency.

Noise Figure (f = 1 kHz).
DESCRIPTION

The BF257, BF258 and BF259 are silicon planar epitaxial NPN transistors in Jedec TO-39 metal case. They are particularly designed for video output stages in CTV and MTV sets, class A audio output stages and drivers for horizontal deflection circuits.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>BF257</td>
<td>BF258</td>
</tr>
<tr>
<td>V_{CBO}</td>
<td>Collector-base Voltage (I_E = 0)</td>
<td>160</td>
<td>250</td>
</tr>
<tr>
<td>V_{CEO}</td>
<td>Collector-emitter Voltage (I_B = 0)</td>
<td>160</td>
<td>250</td>
</tr>
<tr>
<td>V_{EBO}</td>
<td>Emitter-base Voltage (I_C = 0)</td>
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<td>I_C</td>
<td>Collector Current</td>
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<td>I_{CM}</td>
<td>Collector Peak Current</td>
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<td>P_{tot}</td>
<td>Total Power Dissipation at T_{amb} ≤ 50 °C</td>
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<tr>
<td>T_{stg}</td>
<td>Storage Temperature</td>
<td>-55 to 200</td>
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<tr>
<td>T_j</td>
<td>Junction Temperature</td>
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</table>
BF257-BF258-BF259

THERMAL DATA

<table>
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<th>Parameter Description</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>$R_{th j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>30</td>
<td>°C/W</td>
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<tr>
<td>$R_{th j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>175</td>
<td>°C/W</td>
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</table>

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25^\circ C$ unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter Description</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current</td>
<td>$V_{CB} = 100$ V &amp; $I_E = 0$ for BF257 &amp; BF259, $V_{CB} = 200$ V for BF258</td>
<td>50 nA</td>
<td>50 nA</td>
<td>50 nA</td>
<td>nA</td>
</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage</td>
<td>$I_C = 100$ µA</td>
<td>160 V</td>
<td>250 V</td>
<td>300 V</td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CEO}$</td>
<td>Collector-emitter Breakdown Voltage</td>
<td>$I_C = 10$ mA</td>
<td>160 V</td>
<td>250 V</td>
<td>300 V</td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage</td>
<td>$I_E = 100$ µA for BF257, $I_E = 10$ mA for BF258, $I_E = 0$ for BF259</td>
<td>5 V</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE(sat)}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = 30$ mA, $I_B = 6$ mA</td>
<td>1 V</td>
<td></td>
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</tr>
<tr>
<td>$h_{FE}$</td>
<td>DC Current Gain</td>
<td>$I_C = 30$ mA, $V_{CE} = 10$ V</td>
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<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = 15$ mA, $V_{CE} = 10$ V</td>
<td>90 MHz</td>
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<tr>
<td>$C_{re}$</td>
<td>Reverse Capacitance</td>
<td>$I_C = 0$, $f = 1$ MHz, $V_{CE} = 30$ V</td>
<td>3 pF</td>
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</table>

* Pulsed: pulse duration = 300 µs, duty cycle = 1%.

DC Current Gain.
DESCRIPTION
The BF457, BF458 and BF459 are silicon planar epitaxial NPN transistors in Jedec TO-126 plastic package. They are particularly intended for use as video output stages in colour and black and white TV receivers, class A output stages and drivers for horizontal deflection circuits. These transistors have been studied in order to guarantee the maximum resistance against flash over.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{CBO}</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>160</td>
<td>V</td>
</tr>
<tr>
<td>V_{CEO}</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>160</td>
<td>V</td>
</tr>
<tr>
<td>V_{EBO}</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>5</td>
<td>V</td>
</tr>
<tr>
<td>I_{CM}</td>
<td>Collector Peak Current</td>
<td>300</td>
<td>mA</td>
</tr>
<tr>
<td>I_{BM}</td>
<td>Base Peak Current</td>
<td>50</td>
<td>mA</td>
</tr>
<tr>
<td>P_{tot}</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 , ^\circ C$</td>
<td>1.25</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 , ^\circ C$</td>
<td>12.5</td>
<td>W</td>
</tr>
<tr>
<td>T_{stg}</td>
<td>Storage Temperature</td>
<td>-55 to 150</td>
<td>°C</td>
</tr>
<tr>
<td>T_J</td>
<td>Junction Temperature</td>
<td>150</td>
<td>°C</td>
</tr>
</tbody>
</table>
BF457-BF458-BF459

THERMAL DATA

<table>
<thead>
<tr>
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<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>Rth j-case</td>
<td>Thermal Resistance Junction-case</td>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td>°C/W</td>
</tr>
<tr>
<td>Rth j-amb</td>
<td>Thermal Resistance Junction-ambient</td>
<td></td>
<td></td>
<td></td>
<td>100</td>
<td>°C/W</td>
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ELECTRICAL CHARACTERISTICS ($T_{case} = 25$ °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>Icbo</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>for BF 457 $V_{CB} = 100$ V</td>
<td>50</td>
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<td></td>
<td>nA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for BF 458 $V_{CB} = 200$ V</td>
<td>50</td>
<td></td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for BF 459 $V_{CB} = 250$ V</td>
<td>50</td>
<td></td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td>V_{(BR)CEO}</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>for BF 457 $I_C = 10$ mA</td>
<td>160</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for BF 458 $I_C = 10$ mA</td>
<td>250</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for BF 459 $I_C = 10$ mA</td>
<td>300</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V_{(BR)EBO}</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = 100$ μA</td>
<td>5</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V_{ce(sat)}</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = 50$ mA $I_B = 10$ mA</td>
<td>1</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>h_{FE}</td>
<td>DC Current Gain</td>
<td>$I_C = 30$ mA $V_{CE} = 10$ V</td>
<td>30</td>
<td>80</td>
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<tr>
<td>f_{T}</td>
<td>Transition Frequency</td>
<td>$I_C = 30$ mA $V_{CE} = 10$ V</td>
<td>90</td>
<td></td>
<td></td>
<td>MHz</td>
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<tr>
<td>C_{re}</td>
<td>Reverse Capacitance</td>
<td>$I_C = 0$ $f = 1$ MHz $V_{CE} = 30$ V</td>
<td>4</td>
<td></td>
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<tr>
<td>C_{oe}</td>
<td>Output Capacitance</td>
<td>$I_C = 0$ $f = 1$ MHz $V_{CE} = 30$ V</td>
<td>5</td>
<td></td>
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<td>pF</td>
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</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1%.

DC Current Gain.

Collector-emitter Saturation Voltage.
Transition Frequency.

Output and Reverse Capacitance.
DESCRIPTION
The BF657, BF658 and BF659 are silicon planar epitaxial NPN transistors in Jedec TO-39 metal case.
They are particularly designed for application with precision "IN-LINE" large screen CRT (thermal resistance ≤ 20 °C/W).

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_CBO</td>
<td>Collector-base Voltage (I_E = 0)</td>
<td>BF657 160</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BF658 250</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>BF659 300</td>
<td></td>
</tr>
<tr>
<td>V_CEO</td>
<td>Collector-emitter Voltage (I_B = 0)</td>
<td>BF657 160</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BF658 250</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>BF659 300</td>
<td></td>
</tr>
<tr>
<td>V_EBO</td>
<td>Emitter-base Voltage (I_C = 0)</td>
<td>BF657 5</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BF658 5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>BF659 5</td>
<td></td>
</tr>
<tr>
<td>I_C</td>
<td>Collector Current</td>
<td>BF657 100</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BF658 200</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>BF659 3</td>
<td></td>
</tr>
<tr>
<td>I_CM</td>
<td>Collector Peak Current</td>
<td>BF657 200</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BF658 3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>BF659 3</td>
<td></td>
</tr>
<tr>
<td>P_tot</td>
<td>Total Power Dissipation at T_case ≤ 60 °C</td>
<td>BF657 7</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at T_case ≤ 140 °C</td>
<td>BF658 3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>BF659 3</td>
<td></td>
</tr>
<tr>
<td>T_stg</td>
<td>Storage Temperature</td>
<td>BF657 -55 to 200</td>
<td>°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BF658 -55 to 200</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>BF659 -55 to 200</td>
<td></td>
</tr>
<tr>
<td>T_J</td>
<td>Junction Temperature</td>
<td>BF657 200</td>
<td>°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BF658 200</td>
<td></td>
</tr>
<tr>
<td></td>
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<td>BF659 200</td>
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January 1989
Collector Cutoff Current.

Collector-base and Reverse Capacitances.

Transition Frequency.

Safe Operating Areas.
THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th}$ j-case</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>20</td>
<td>°C/W</td>
<td></td>
<td></td>
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<tr>
<td>$R_{th}$ j-amb</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>175</td>
<td>°C/W</td>
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ELECTRICAL CHARACTERISTICS ($T_{case} = 25$ °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>for BF657 $V_{CB} = 100$ V</td>
<td>50</td>
<td>nA</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for BF658 $V_{CB} = 200$ V</td>
<td>50</td>
<td>nA</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for BF659 $V_{CB} = 250$ V</td>
<td>50</td>
<td>nA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = 100$ μA for BF657</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for BF658</td>
<td>160</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for BF659</td>
<td>250</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 100$ μA for BF658</td>
<td>300</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for BF659</td>
<td>50</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CEO}$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = 10$ mA for BF657</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for BF658</td>
<td>160</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for BF659</td>
<td>250</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 10$ mA for BF658</td>
<td>300</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for BF659</td>
<td>50</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = 100$ μA</td>
<td>5</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{CE(sat)}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = 30$ mA $I_B = 6$ mA</td>
<td>1</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$h_{FE}$</td>
<td>DC Current Gain</td>
<td>$I_C = 30$ mA $V_{CE} = 10$ V</td>
<td>25</td>
<td>MHz</td>
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<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = 15$ mA $V_{CE} = 10$ V</td>
<td>90</td>
<td>MHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{re}$</td>
<td>Reverse Capacitance</td>
<td>$I_C = 0$ $f = 1$ MHz $V_{CE} = 30$ V</td>
<td>3</td>
<td>pF</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1%.

DC Current Gain.

Collector-emitter Saturation Voltage.
LOW-LEVEL, LOW-NOISE, VERY HIGH GAIN AMPLIFIER

DESCRIPTION
The BFR17 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case, designed for use in high performance low level, low noise amplifier applications.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CES}$</td>
<td>Collector–emitter Voltage ($V_{BE} = 0$)</td>
<td>60</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector–emitter Voltage ($I_B = 0$)</td>
<td>60</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter–base Voltage ($I_C = 0$)</td>
<td>8</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>50</td>
<td>mA</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} = 25$ °C</td>
<td>0.36</td>
<td>W</td>
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<tr>
<td></td>
<td>at $T_{case} = 25$ °C</td>
<td>1.2</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}$, $T_J$</td>
<td>Storage and Junction Temperature</td>
<td>– 55 to 200</td>
<td>°C</td>
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</table>

November 1988
### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter Description</th>
<th>Max.</th>
<th>Unit</th>
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<tr>
<td>$R_{\text{th} j-\text{case}}$</td>
<td>Thermal Resistance Junction-case</td>
<td>146</td>
<td>°C/W</td>
</tr>
<tr>
<td>$R_{\text{th} j-\text{amb}}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>486</td>
<td>°C/W</td>
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</table>

### ELECTRICAL CHARACTERISTICS ($T_{\text{amb}} = 25$ °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter Description</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$I_{\text{CES}}$</td>
<td>Collector Cutoff Current ($V_{\text{BE}} = 0$)</td>
<td>$V_{\text{CE}} = 50$ V</td>
<td>0.1</td>
<td>20</td>
<td>nA</td>
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<tr>
<td></td>
<td></td>
<td>$T_{\text{amb}} = 150$ °C</td>
<td>0.1</td>
<td>20</td>
<td>μA</td>
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<tr>
<td>$I_{\text{EBO}}$</td>
<td>Emitter Cutoff Current ($I_{\text{C}} = 0$)</td>
<td>$V_{\text{EB}} = 5$ V</td>
<td>0.1</td>
<td>20</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>$V_{(\text{BR})\text{CEO}}$*</td>
<td>Collector-emitter Breakdown Voltage ($I_{\text{B}} = 0$)</td>
<td>$I_{\text{C}} = 10$ mA</td>
<td>60</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{(\text{BR})\text{CES}}$</td>
<td>Collector-emitter Breakdown Voltage ($V_{\text{BE}} = 0$)</td>
<td>$I_{\text{C}} = 10$ μA</td>
<td>60</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{(\text{BR})\text{EBO}}$</td>
<td>Emitter-base Breakdown Voltage ($I_{\text{C}} = 0$)</td>
<td>$I_{\text{E}} = 10$ μA</td>
<td>8</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{\text{CE}(\text{sat})}$*</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_{\text{C}} = 1$ mA $I_{\text{B}} = 0.1$ mA</td>
<td>0.15</td>
<td>0.35</td>
<td>V</td>
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</tr>
<tr>
<td>$V_{\text{BE}}$*</td>
<td>Base-emitter Voltage</td>
<td>$I_{\text{C}} = 1$ mA $V_{\text{CE}} = 5$ V</td>
<td>0.64</td>
<td>0.58</td>
<td>0.7</td>
<td>V</td>
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<td></td>
<td>$I_{\text{C}} = 100$ μA $V_{\text{CE}} = 5$ V</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$h_{\text{FE}}$*</td>
<td>DC Current Gain</td>
<td>$I_{\text{C}} = 10$ μA $V_{\text{CE}} = 5$ V</td>
<td>130</td>
<td>220</td>
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<td></td>
<td>$I_{\text{C}} = 100$ μA $V_{\text{CE}} = 5$ V</td>
<td>220</td>
<td>300</td>
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<td></td>
<td>$I_{\text{C}} = 1$ mA $V_{\text{CE}} = 5$ V</td>
<td>450</td>
<td>530</td>
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<tr>
<td></td>
<td></td>
<td>$I_{\text{C}} = 10$ mA $V_{\text{CE}} = 5$ V</td>
<td>530</td>
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<td></td>
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<tr>
<td>$h_{\text{ie}}$</td>
<td>Small Signal Current Gain</td>
<td>$I_{\text{C}} = 1$ mA $f = 20$ kHz $V_{\text{CE}} = 5$ V</td>
<td>530</td>
<td></td>
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</tr>
<tr>
<td>$f_{\text{T}}$</td>
<td>Transition Frequency</td>
<td>$I_{\text{C}} = 1$ mA $f = 20$ MHz $V_{\text{CE}} = 5$ V</td>
<td>70</td>
<td>100</td>
<td>MHz</td>
<td></td>
</tr>
<tr>
<td>$C_{\text{CBO}}$</td>
<td>Collector-base Capacitance</td>
<td>$I_{\text{E}} = 0$ $V_{\text{CB}} = 5$ V</td>
<td>3.5</td>
<td>6</td>
<td>pF</td>
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<tr>
<td>$C_{\text{EBO}}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_{\text{C}} = 0$ $V_{\text{EB}} = 5$ V</td>
<td>3.5</td>
<td>6</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>NF</td>
<td>Noise Figure</td>
<td>$I_{\text{C}} = 10$ μA $R_{\text{g}} = 10$ kΩ $V_{\text{CE}} = 5$ V 10 Hz to 10 kHz</td>
<td>1.8</td>
<td>4</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 kHz</td>
<td>1</td>
<td>3</td>
<td>dB</td>
</tr>
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<td>10 kHz</td>
<td>1</td>
<td>3</td>
<td>dB</td>
</tr>
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<td>$h_{\text{ie}}$</td>
<td>Input Impedance</td>
<td>$I_{\text{C}} = 1$ mA $V_{\text{CE}} = 5$ V</td>
<td>10</td>
<td></td>
<td>kΩ</td>
<td></td>
</tr>
<tr>
<td>$h_{\text{oe}}$</td>
<td>Output Admittance</td>
<td>$I_{\text{C}} = 1$ mA $V_{\text{CE}} = 5$ V</td>
<td>20</td>
<td></td>
<td>μS</td>
<td></td>
</tr>
<tr>
<td>$h_{\text{re}}$</td>
<td>Reverse Voltage Ratio</td>
<td></td>
<td>4.5 X 10⁻⁴</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300μs, duty cycle = 1%.
Collector-base Capacitance.

Contours of Constant Noise Figure $f = 10\text{kHz}$.

Noise Figure vs. Source Resistance.

Contours of Constant Noise Figure $f = 1\text{kHz}$. 
DESCRIPTION
The BFR18 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case. This device is designed for amplifier applications over a wide range of voltage and current.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CES}$</td>
<td>Collector–emitter Voltage ($V_{BE} = 0$)</td>
<td>85</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector–emitter Voltage ($I_B = 0$)</td>
<td>55</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter–base Voltage ($I_C = 0$)</td>
<td>7</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>1</td>
<td>A</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25^\circ C$</td>
<td>0.5</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25^\circ C$</td>
<td>1.8</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}, T_J$</td>
<td>Storage and Junction Temperature</td>
<td>-55 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>
### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th j-case}$</td>
<td>Thermal Resistance Junction–case</td>
<td></td>
<td></td>
<td></td>
<td>97</td>
<td>°C/W</td>
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<tr>
<td>$R_{th j-amb}$</td>
<td>Thermal Resistance Junction–ambient</td>
<td></td>
<td></td>
<td></td>
<td>350</td>
<td>°C/W</td>
</tr>
</tbody>
</table>

### ELECTRICAL CHARACTERISTICS ($T_{amb} = 25$ °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CES}$</td>
<td>Collector Cutoff Current ($V_{BE} = 0$)</td>
<td>$V_{CE} = 60$ V $T_{amb} = 150$ °C</td>
<td>0.2</td>
<td>0.2</td>
<td>10</td>
<td>nA</td>
</tr>
<tr>
<td>$I_{EBO}$</td>
<td>Emitter Cutoff Current ($I_{E} = 0$)</td>
<td>$V_{EB} = 5$ V</td>
<td>0.1</td>
<td>10</td>
<td>0.1</td>
<td>nA</td>
</tr>
<tr>
<td>$V_{(BR) CES}$</td>
<td>Collector–emitter Breakdown Voltage ($V_{BE} = 0$)</td>
<td>$I_{C} = 100$ µA</td>
<td>85</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR) CEO*}$</td>
<td>Collector–emitter Breakdown Voltage ($I_{B} = 0$)</td>
<td>$I_{C} = 30$ mA</td>
<td>55</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR) EBO}$</td>
<td>Emitter–base Breakdown Voltage ($I_{C} = 0$)</td>
<td>$I_{E} = 100$ µA</td>
<td>7</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE(sat)*}$</td>
<td>Collector–emitter Saturation Voltage</td>
<td>$I_{C} = 150$ mA $I_{B} = 15$ mA</td>
<td>0.13</td>
<td>0.25</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE*}$</td>
<td>Base–emitter Voltage</td>
<td>$I_{C} = 10$ mA $V_{CE} = 1$ V</td>
<td>0.66</td>
<td>1</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE(sat)*}$</td>
<td>Base–emitter Saturation Voltage</td>
<td>$I_{C} = 150$ mA $I_{B} = 15$ mA</td>
<td>0.85</td>
<td>1</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$h_{FE*}$</td>
<td>DC Current Gain</td>
<td>$I_{C} = 100$ µA $V_{CE} = 1$ V</td>
<td>30</td>
<td>75</td>
<td>180</td>
<td></td>
</tr>
<tr>
<td>$h_{fe}$</td>
<td>Small Signal Current Gain</td>
<td>$I_{C} = 1$ mA $f = 1$ kHz $V_{CE} = 5$ V</td>
<td>120</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$f_{T}$</td>
<td>Transition Frequency</td>
<td>$I_{C} = 50$ mA $f = 20$ MHz $V_{CE} = 10$ V</td>
<td>60</td>
<td>90</td>
<td>180</td>
<td>MHz</td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter–base Capacitance</td>
<td>$I_{C} = 0$ $f = 1$ MHz $V_{EB} = 0.5$ V</td>
<td>50</td>
<td>80</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector–base Capacitance</td>
<td>$I_{E} = 0$ $f = 1$ MHz $V_{CB} = 10$ V</td>
<td>12</td>
<td>20</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$NF$</td>
<td>Noise Figure</td>
<td>$I_{C} = 30$ µA $R_{q} = 1$ kΩ $f = 1$ kHz $V_{CE} = 10$ V</td>
<td>2</td>
<td>8</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>$h_{le}$</td>
<td>Input Impedance</td>
<td>$I_{C} = 1$ mA $f = 1$ kHz $V_{CE} = 5$ V</td>
<td>2.2</td>
<td></td>
<td></td>
<td>kΩ</td>
</tr>
<tr>
<td>$h_{re}$</td>
<td>Reverse Voltage Ratio</td>
<td>$I_{C} = 1$ mA $f = 1$ kHz $V_{CE} = 5$ V</td>
<td>2.4 x 10^-4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$h_{oe}$</td>
<td>Output Admittance</td>
<td>$I_{C} = 1$ mA $f = 1$ kHz $V_{CE} = 5$ V</td>
<td>8.5</td>
<td></td>
<td></td>
<td>µS</td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300µs, duty cycle = 1%.
Collector-emitter Saturation Voltage.

Base-emitter Saturation Voltage.

Collector-base Capacitance.

High Frequency Current Gain.
DESCRIPTION
The BFR36 is a multi-emitter silicon planar epitaxial NPN transistor in Jedec TO-39 metal case. It is designed for CATV-MATV amplifier applications over a wide frequency range (40 to 860MHz). The device features very good intermodulation properties, very low reverse capacitance, high power gain and high power dissipation.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector–base Voltage ($I_E = 0$)</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector–Emitter Voltage ($I_B = 0$)</td>
<td>30</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter–base Voltage ($I_C = 0$)</td>
<td>3</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>200</td>
<td>mA</td>
</tr>
<tr>
<td>$I_{CM}$</td>
<td>Collector Peak Current</td>
<td>400</td>
<td>mA</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 40$ °C</td>
<td>0.8</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 50$ °C</td>
<td>5</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}$, $T_J$</td>
<td>Storage and Junction Temperature</td>
<td>–55 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>
**THERMAL DATA**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th} j$-case</td>
<td>Thermal Resistance Junction–case</td>
<td></td>
<td></td>
<td></td>
<td>30</td>
<td>°C/W</td>
</tr>
<tr>
<td>$R_{th} j$-amb</td>
<td>Thermal Resistance Junction–ambient</td>
<td></td>
<td></td>
<td></td>
<td>200</td>
<td>°C/W</td>
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</table>

**ELECTRICAL CHARACTERISTICS** ($T_{amb} = 25$ °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = 20$ V</td>
<td></td>
<td>150</td>
<td>20</td>
<td>nA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CB} = 20$ V</td>
<td></td>
<td></td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$T_{amb} = 150$ °C</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{[BRI]CBO}$</td>
<td>Collector–base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = 100$ µA</td>
<td>40</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO(sus)}^*$</td>
<td>Collector–emitter Sustaining Voltage ($I_E = 0$)</td>
<td>$I_C = 10$ mA</td>
<td>30</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{[BRI]EBO}$</td>
<td>Emitter–base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = 100$ µA</td>
<td>3</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEK}^*$</td>
<td>Collector–emitter Knee Voltage</td>
<td>$I_C = 100$ mA</td>
<td>700</td>
<td></td>
<td>750</td>
<td>mV</td>
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<tr>
<td>$V_{BE}$</td>
<td>Base–emitter Voltage</td>
<td>$I_C = 70$ mA</td>
<td>$V_{CE} = 5$ V</td>
<td>750</td>
<td></td>
<td>mV</td>
</tr>
<tr>
<td>$h_{FE}^*$</td>
<td>DC Current Gain</td>
<td>$I_C = 70$ mA</td>
<td>$V_{CE} = 5$ V</td>
<td>60</td>
<td></td>
<td>130</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 150$ mA</td>
<td>$V_{CE} = 5$ V</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 70$ mA</td>
<td>$V_{CE} = 15$ V</td>
<td>65</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 150$ mA</td>
<td>$V_{CE} = 15$ V</td>
<td>65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$V_{CE} = 15$ V</td>
<td>$f = 100$ MHz</td>
<td>1</td>
<td>1.4</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 70$ mA</td>
<td>$V_{CE} = 5$ V</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 150$ mA</td>
<td>$V_{CE} = 5$ V</td>
<td>60</td>
<td></td>
<td></td>
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<tr>
<td>$C_{EBO}$</td>
<td>Emitter–base Capacitance</td>
<td>$I_C = 0$</td>
<td>$V_{EB} = 0.4$ V</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector–base Capacitance</td>
<td>$I_E = 0$</td>
<td>$V_{CB} = 15$ V</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{re}$</td>
<td>Reverse Capacitance</td>
<td>$I_C = 0$</td>
<td>$V_{CE} = 15$ V</td>
<td>1.7</td>
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<td>2.2</td>
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<tr>
<td>$f = 1$ MHz</td>
<td></td>
<td>$f = 1$ MHz</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$NF$</td>
<td>Noise Figure</td>
<td>$V_{CE} = 15$ V</td>
<td>$R_g = 50$ Ω</td>
<td>4</td>
<td></td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 200$ MHz</td>
<td>$I_C = 30$ mA</td>
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<tr>
<td></td>
<td></td>
<td>$I_C = 70$ mA</td>
<td></td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>$G_{pe}$</td>
<td>Power Gain (see test circuit)</td>
<td>$I_C = 70$ mA</td>
<td>$V_{CE} = 18$ V</td>
<td>16</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$f = 200$ MHz</td>
<td>$f = 200$ MHz</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$f = 500$ MHz</td>
<td>$f = 500$ MHz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 800$ MHz</td>
<td>$f = 800$ MHz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$P_o$</td>
<td>Output Power (see test circuit)</td>
<td>$I_C = 70$ mA</td>
<td>$V_{CE} = 18$ V</td>
<td>130</td>
<td></td>
<td>150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 200$ MHz</td>
<td>$f = 200$ MHz</td>
<td>70</td>
<td></td>
<td>90</td>
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<td></td>
<td>$f = 800$ MHz</td>
<td>$f = 800$ MHz</td>
<td></td>
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</tr>
</tbody>
</table>

* Pulsed : pulse duration = 300µs, duty cycle = 1%.
* * $I_B = Value$ corresponding to $I_C = 110$ mA and $V_{CE} = 1$ V.
(1) Output VSMR < 2, $d_m = -30$dB @ $f = 2$ (f<sub>q</sub> - f<sub>p</sub>), f<sub>q</sub> = 798MHz and f<sub>p</sub> = 802MHz.
TEST CIRCUIT
RF amplifier circuit for power gain test (f = 200MHz).

Power Gain vs. Collector Current.

High Frequency Current Gain vs. Collector Current.
Reverse Capitance.

Power Rating Chart.

Input Impedance $S_{11e}$ (normalized 50Ω).

Forward Transfer Coefficient $S_{21e}$.

Reverse Transfer Coefficient $S_{12e}$.

Output Impedance $S_{22e}$ (normalized 50Ω).
TYPICAL APPLICATIONS

CATV-extender line amplifier.

Second order distortion at $V_{\text{OUT}} = +46\, \text{dBmV}$:
- $d_{11} + d_2 = -61\, \text{dB}$
- $d_{11} - d_2 = -66\, \text{dB}$
- $f_1 = 159\, \text{MHz}$
- $f_2 = 57\, \text{MHz}$

MATV-200MHz channel amplifier.

Supply Voltage: 24V
VSWR_in < 1.5
VSWR_OUT = 3
PS: 100W at 30dB
Gain Control > 30dB
DESCRIPTION
The BFR99 is a silicon planar epitaxial PNP transistor in Jedec TO-72 metal case, particularly designed for wide band common-emitter linear amplifier applications up to 1GHz. It features high fT, low reverse capacitance, good cross-modulation properties and low noise.

ABSOLUTE MAXIMUM RATINGS

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<th>Symbol</th>
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<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector–base Voltage ($I_E = 0$)</td>
<td>− 25</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector–emitter Voltage ($I_B = 0$)</td>
<td>− 25</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter–base Voltage ($I_C = 0$)</td>
<td>− 3</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>− 50</td>
<td>mA</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 , ^\circ C$</td>
<td>225</td>
<td>mW</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 , ^\circ C$</td>
<td>360</td>
<td>mW</td>
</tr>
<tr>
<td>$T_{stg}, T_j$</td>
<td>Storage and Junction Temperature</td>
<td>− 55 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>

October 1988
THERMAL DATA

<table>
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<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th}$ j-case</td>
<td>Thermal Resistance Junction–case</td>
<td></td>
<td></td>
<td>486</td>
<td>°C/W</td>
</tr>
<tr>
<td>$R_{th}$ j-amb</td>
<td>Thermal Resistance Junction–ambient</td>
<td></td>
<td></td>
<td>777</td>
<td>°C/W</td>
</tr>
</tbody>
</table>

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25$ °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
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<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E=0$)</td>
<td>$V_{CB} = -15$</td>
<td></td>
<td></td>
<td>-100</td>
<td>nA</td>
</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector–base Breakdown Voltage ($I_E=0$)</td>
<td>$I_C = -100$ μA</td>
<td>-25</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO(sus)}$</td>
<td>Collector–emitter Sustaining Voltage ($I_B=0$)</td>
<td>$I_C = -5$ mA</td>
<td>-25</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter–base Breakdown Voltage ($I_C=0$)</td>
<td>$I_E = -10$ μA</td>
<td>-3</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE}$</td>
<td>Base–emitter Voltage</td>
<td>$I_C = -10$ mA $V_{CE} = -10$</td>
<td>-0.75</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$h_{FE}^*$</td>
<td>DC Current Gain</td>
<td>$I_C = -1 mA$ $V_{CE} = -10$</td>
<td>75</td>
<td>80</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>$I_C = -10$ mA $V_{CE} = -10$</td>
<td>25</td>
<td>20</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>$I_C = -20$ mA $V_{CE} = -10$</td>
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</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = -10$ mA $V_{CE} = -15$</td>
<td>2</td>
<td></td>
<td></td>
<td>GHz</td>
</tr>
<tr>
<td>$C_{re}$</td>
<td>Reverse Capacitance</td>
<td>$I_C = 0$ $V_{CE} = -15$</td>
<td>0.4</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$NF$</td>
<td>Noise Figure</td>
<td>$I_C = -3$ mA $V_{CE} = -15$</td>
<td>2.5</td>
<td>3.5</td>
<td>5</td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$R_g = 50$ Ω $f = 200$ MHz $V_{CE} = -15$</td>
<td></td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -10$ mA $V_{CE} = -15$</td>
<td></td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$R_g = 50$ Ω $f = 800$ MHz</td>
<td>3</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
</tbody>
</table>

* Pulsed : pulse duration = 300μs, duty cycle = 1%.
BFR99A
WIDE BAND VHF/UHF AMPLIFIER

- SILICON PLANAR EPITAXIAL TRANSISTOR
- TO-72 METAL CASE
- VERY LOW NOISE

APPLICATIONS:
- TELECOMMUNICATIONS
- WIDE BAND UHF AMPLIFIER
- RADIO COMMUNICATIONS

DESCRIPTION
The BRF99A is a silicon planar epitaxial PNP transistor produced using interdigitated base emitter geometry. It is particularly designed for use in wide band common-emitter linear amplifiers up to 1GHz. It features very high $f_t$, low reverse capacitance, excellent cross modulation properties and very low noise performance. The BFR99A is complementary to the BFY90. Typical applications include telecommunications and radio communication equipment.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>-25</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>-25</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>-3</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>-50</td>
<td>mA</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 , ^\circ C$</td>
<td>225</td>
<td>mW</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 , ^\circ C$</td>
<td>360</td>
<td>mW</td>
</tr>
<tr>
<td>$T_{stg}, T_j$</td>
<td>Storage and Junction Temperature</td>
<td>-55 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>

December 1988
**THERMAL DATA**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$R_{\text{th j-case}}$</td>
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<td></td>
<td></td>
<td>486</td>
<td>°C/W</td>
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<tr>
<td>$R_{\text{th j-amb}}$</td>
<td></td>
<td></td>
<td></td>
<td>777</td>
<td>°C/W</td>
</tr>
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</table>

**ELECTRICAL CHARACTERISTICS** ($T_{\text{amb}} = 25$ °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>$I_{\text{CBO}}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{\text{CB}} = -15$ V</td>
<td></td>
<td></td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td>$V_{(BR)\text{CBO}}$</td>
<td>Collector–base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = -100$ μA</td>
<td></td>
<td></td>
<td>-25</td>
<td>V</td>
</tr>
<tr>
<td>$V_{\text{CEO (sus)}}$</td>
<td>Collector–emitter Sustaining Voltage ($I_B = 0$)</td>
<td>$I_C = 5$ mA</td>
<td></td>
<td></td>
<td>-25</td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)\text{EBO}}$</td>
<td>Emitter–base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = -10$ μA</td>
<td></td>
<td></td>
<td>-3</td>
<td>V</td>
</tr>
<tr>
<td>$V_{\text{CEK}}$</td>
<td>Collector–emitter Knee Voltage</td>
<td>$I_C = -20$ mA</td>
<td></td>
<td></td>
<td>-0.8</td>
<td>V</td>
</tr>
<tr>
<td>$V_{\text{BE}}$</td>
<td>Base–emitter Voltage</td>
<td>$I_C = -10$ mA $V_{\text{CE}} = -10$ V</td>
<td>-0.75</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$h_{\text{FE}}$</td>
<td>DC Current Gain</td>
<td>$I_C = 1$ mA $V_{\text{CE}} = -10$ V</td>
<td>25</td>
<td>75</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 10$ mA $V_{\text{CE}} = -10$ V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 20$ mA $V_{\text{CE}} = -10$ V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$f_{\text{T}}$</td>
<td>Transition Frequency</td>
<td>$I_C = -10$ mA $f = 100$ MHz $V_{\text{CE}} = -15$ V</td>
<td>1.4</td>
<td>2.3</td>
<td></td>
<td>GHz</td>
</tr>
<tr>
<td>$C_{\text{re}}$</td>
<td>Reverse Capacitance</td>
<td>$I_C = 0$ $f = 1$ MHz $V_{\text{CE}} = -15$ V</td>
<td>0.4</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$N_{\text{F}}$</td>
<td>Noise Figure</td>
<td>$I_C = -3$ mA $R_{g} = 50$ Ω $V_{\text{CE}} = -15$ V</td>
<td>2.5</td>
<td>4</td>
<td>5</td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 200$ MHz $V_{\text{CE}} = -15$ V</td>
<td>3.5</td>
<td>5</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 800$ MHz $V_{\text{CE}} = -15$ V</td>
<td>3</td>
<td>4</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>$G_{\text{pe}}$</td>
<td>Power Gain</td>
<td>$I_C = -10$ mA $f = 800$ MHz $V_{\text{CE}} = -15$ V</td>
<td>10</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>$P_{o}$</td>
<td>Output Power</td>
<td>$I_C = -10$ mA $f = 800$ MHz $V_{\text{CE}} = -15$ V</td>
<td>14</td>
<td></td>
<td></td>
<td>mW</td>
</tr>
<tr>
<td>$</td>
<td>S_{\text{21e}}</td>
<td>^{2}$</td>
<td>Transducer Power Gain</td>
<td>$I_C = -10$ mA $R_{g} = R_{L} = 50$ Ω $f = 800$ MHz $V_{\text{CE}} = -15$ V</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300μs, duty cycle = 1%
* $I_{B}$ = value corresponding to $I_C = -22$ mA and $V_{\text{CE}} = -1V$. 
Transition Frequency.

Noise Figure vs. Collector Current.

Noise Figure vs. Ambient Temperature.

Transducer Power Gain.

Reverse Capacitance.

Noise Figure vs. Frequency.
Input Impedance $S_{11e}$ (50Ω normalized).

Forward Transfer Coefficient $S_{21e}$.

Reverse Transfer Coefficient $S_{12e}$.

Output Impedance $S_{22e}$ (50Ω normalized).

Wide Band MATV Amplifier.

$BW = 40 \div 860$ MHz
$G = 16\,\text{dB}$
$NF < 5\,\text{dB}$
$VSWR_{\text{IN}} < 2$
$VSWR_{\text{OUT}} < 2$
$Y_{\text{OUT}} = 100\,\text{mV}$ for 1% Crossmodulation
MATV Channel Amplifier.

BFR99A

BFR 99A

BFR 38

BFR 38

BFR 99A

M.P.

s

BFR 99A

BFR 38

BFR 38

BFR 99A

M.P.

BFR 99A

BFR 38

BFR 38

BFR 99A

M.P.

BFR 99A

BFR 38

BFR 38

BFR 99A

M.P.

BFR 99A

BFR 38

BFR 38

BFR 99A

M.P.

BFR 99A

BFR 38

BFR 38

BFR 99A

M.P.

BFR 99A

BFR 38

BFR 38

BFR 99A

M.P.

BFR 99A

BFR 38

BFR 38

BFR 99A

M.P.

BFR 99A

BFR 38

BFR 38

BFR 99A

M.P.

BFR 99A

BFR 38

BFR 38

BFR 99A

M.P.

BFR 99A

BFR 38

BFR 38

BFR 99A

M.P.

BFR 99A

BFR 38

BFR 38

BFR 99A

M.P.

BFR 99A

BFR 38

BFR 38

BFR 99A

M.P.

BFR 99A

BFR 38

BFR 38

BFR 99A

M.P.

BFR 99A

BFR 38

BFR 38

BFR 99A

M.P.

BFR 99A

BFR 38

BFR 38

BFR 99A

M.P.

BFR 99A

BFR 38

BFR 38

BFR 99A

M.P.

BFR 99A

BFR 38

BFR 38

BFR 99A

M.P.

BFR 99A

BFR 38

BFR 38

BFR 99A

M.P.

BFR 99A

BFR 38

BFR 38

BFR 99A

M.P.

BFR 99A

BFR 38

BFR 38

BFR 99A

M.P.

BFR 99A

BFR 38

BFR 38

BFR 99A

M.P.
DESCRIPTION
The BFW 16A and BFW 17A are multi-emitter silicon planar epitaxial NPN transistors in Jedec TO-39 metal case, with extremely good intermodulation properties and high power gain. They are primarily intended for final and driver stages in channel-and band-aerial amplifiers with high output power from 40 to 860 MHz.

Another possible application is as the final stage of the wide band vertical amplifier in high speed oscilloscopes.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{CBO} )</td>
<td>Collector-base Voltage (( I_E = 0 ))</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>( V_{CER} )</td>
<td>Collector-emitter Voltage (( R_{BE} \leq 50 \Omega ))</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>( V_{DEO} )</td>
<td>Collector-emitter Voltage (( I_B = 0 ))</td>
<td>25</td>
<td>V</td>
</tr>
<tr>
<td>( V_{EBO} )</td>
<td>Emitter-base Voltage (( I_C = 0 ))</td>
<td>3</td>
<td>V</td>
</tr>
<tr>
<td>( I_C )</td>
<td>Collector Current</td>
<td>150</td>
<td>mA</td>
</tr>
<tr>
<td>( I_{CM} )</td>
<td>Collector Peak Current</td>
<td>300</td>
<td>mA</td>
</tr>
<tr>
<td>( P_{tot} )</td>
<td>Total Power Dissipation at ( T_{amb} \leq 25 , ^\circ C )</td>
<td>0.7</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at ( T_{case} \leq 125 , ^\circ C )</td>
<td>1.5</td>
<td>W</td>
</tr>
<tr>
<td>( T_{stg}, T_{j} )</td>
<td>Storage and Junction Temperature</td>
<td>– 65 to 200</td>
<td>( ^\circ C )</td>
</tr>
</tbody>
</table>
**THERMAL DATA**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th \text{-} j\text{-case}}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>50</td>
<td>°C/W</td>
<td></td>
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<tr>
<td>$R_{th \text{-} j\text{-amb}}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>250</td>
<td>°C/W</td>
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</table>

**ELECTRICAL CHARACTERISTICS** ($T_{\text{amb}} = 25$ °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = 20$ V</td>
<td>20</td>
<td>μA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = 100$ μA</td>
<td>3</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{CEK}^{**}$</td>
<td>Collector-emitter Knee Voltage</td>
<td>$I_C = 100$ mA</td>
<td>0.75</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$h_{FE}^{*}$</td>
<td>DC Current Gain</td>
<td>$I_C = 50$ mA</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>$I_C = 150$ mA</td>
<td>25</td>
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<td></td>
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<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = 150$ mA</td>
<td>1.2</td>
<td>GHz</td>
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<td></td>
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<td></td>
<td></td>
<td>$f = 500$ MHz</td>
<td>for BFW 16A</td>
<td>GHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = 15$ V</td>
<td>for BFW 17A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$</td>
<td>4</td>
<td>pF</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 1$ MHz</td>
<td></td>
<td></td>
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<tr>
<td>$C_{re}$</td>
<td>Reverse Capacitance</td>
<td>$I_C = 10$ mA</td>
<td>1.7</td>
<td>pF</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>$f = 1$ MHz</td>
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<tr>
<td>$NF$</td>
<td>Noise Figure</td>
<td>$I_C = 30$ mA</td>
<td>6</td>
<td>dB</td>
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<tr>
<td></td>
<td>(for BFW 16A only)</td>
<td>$V_{CE} = 15$ V</td>
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<td></td>
<td></td>
<td>$R_g = 75$ Ω</td>
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<tr>
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<td>$f = 200$ MHz</td>
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<tr>
<td>$G_{pe}$</td>
<td>Power Gain (not neutralized)</td>
<td>$I_C = 70$ mA</td>
<td>16</td>
<td>dB</td>
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<td></td>
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<td>$V_{CE} = 18$ V</td>
<td>For BFW 16A only</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 200$ MHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 800$ MHz</td>
<td>for BFW 16A</td>
<td>dB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$P_0$</td>
<td>Output Power</td>
<td>$I_C = 70$ mA</td>
<td>130</td>
<td>mW</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Channel 9$^{(1)}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = 18$ V</td>
<td>for BFW 16A</td>
<td>mW</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for BFW 17A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Channel 6$^{(2)}$</td>
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</tr>
<tr>
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<td></td>
<td>For BFW 16A only</td>
<td>70</td>
<td>mW</td>
<td></td>
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</tr>
</tbody>
</table>

* Pulsed : pulse duration = 300 μs, duty cycle = 1 %.

** NF $I_E$ value for which $I_E = 110$ mA at $V_{CE} = 1V$.
(1) $f_p = 202$ MHz, $f_{q} = 205$ MHz, $f_{(q-p)} = 208$ MHz.
(2) $f_p = 798$ MHz, $f_{q} = 802$ MHz, $f_{(q-p)} = 806$ MHz.
TEST CIRCUIT

Test Circuit for Power Gain and Output Power Measurements (f = 200 MHz).

High Frequency Current Gain.

Reverse Capacitance.

Input Impedance $S_{11e}$ (normalized 50 Ω).

Forward Transfer Coefficient $S_{21e}$. 
Reverse Transfer Coefficient $S_{12e}$.  

Output Impedance $S_{22e}$ (normalized 50 Ω).
DESCRIPTION
The BFW43 and BFW44 are silicon planar epitaxial PNP transistors in Jedec TO-18 (BFW43) and Jedec TO-39 (BFW44) metal cases.
Both devices are designed for use in amplifiers where high voltage and high gain are necessary. In particular, they feature a $V_{CEO}$ of 150 V and are specified over a wide range of currents.

ABSOLUTE MAXIMUM RATINGS

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<th>Unit</th>
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<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-Base Voltage ($I_E = 0$)</td>
<td>-150</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-Emitter Voltage ($I_B = 0$)</td>
<td>-150</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-Base Voltage ($I_C = 0$)</td>
<td>-6</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>-100</td>
<td>mA</td>
</tr>
</tbody>
</table>
| $P_{tot}$ | Total Power Dissipation at $T_{amb} \leq 25\, ^\circ C$ | \begin{align*} 
0.4 & \text{ for BFW 43} \\
0.7 & \text{ for BFW 44} \\
1.4 & \text{ at } T_{case} \leq 25\, ^\circ C \\
2.5 & \text{ for BFW 43} \\
& \text{ for BFW 44} 
\end{align*} | W |
| $T_{stg, T_j}$ | Storage and Junction Temperature | -55 to 200 | °C |

October 1988
# THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter Description</th>
<th>BFW43</th>
<th>BFW44</th>
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<tbody>
<tr>
<td>R&lt;sub&gt;th j-case&lt;/sub&gt;</td>
<td>Thermal Resistance Junction-case Max</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R&lt;sub&gt;th j-amb&lt;/sub&gt;</td>
<td>Thermal Resistance Junction-ambient Max</td>
<td>125 °C/W</td>
<td>70 °C/W</td>
</tr>
<tr>
<td></td>
<td></td>
<td>438 °C/W</td>
<td>250 °C/W</td>
</tr>
</tbody>
</table>

# ELECTRICAL CHARACTERISTICS (T<sub>amb</sub> = 25 °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter Description</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>I&lt;sub&gt;CBO&lt;/sub&gt;</td>
<td>Collector Cutoff Current (I&lt;sub&gt;E&lt;/sub&gt; = 0)</td>
<td>V&lt;sub&gt;CB&lt;/sub&gt; = -100 V</td>
<td>-0.2</td>
<td>-0.03</td>
<td>-10</td>
<td>nA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V&lt;sub&gt;CB&lt;/sub&gt; = -100 V</td>
<td>-150</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;(BR)CBO&lt;/sub&gt;</td>
<td>Collector-base Breakdown Voltage (I&lt;sub&gt;E&lt;/sub&gt; = 0)</td>
<td>I&lt;sub&gt;C&lt;/sub&gt; = -10 μA</td>
<td>-2</td>
<td>-0.03</td>
<td>-1</td>
<td>μA</td>
</tr>
<tr>
<td>V&lt;sub&gt;(BR)CEO&lt;/sub&gt;*</td>
<td>Collector-emitter Breakdown Voltage (I&lt;sub&gt;C&lt;/sub&gt; = -10 mA)</td>
<td>V&lt;sub&gt;CE&lt;/sub&gt; = -10 V</td>
<td>40</td>
<td>85</td>
<td>100</td>
<td>MHz</td>
</tr>
<tr>
<td>V&lt;sub&gt;(BR)EBO&lt;/sub&gt;</td>
<td>Emitter-base Breakdown Voltage (I&lt;sub&gt;E&lt;/sub&gt; = 0)</td>
<td>I&lt;sub&gt;B&lt;/sub&gt; = -1 mA</td>
<td>-1</td>
<td>-0.1</td>
<td>-0.5</td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;CE(sat)&lt;/sub&gt;*</td>
<td>Collector-emitter Saturation Voltage</td>
<td>I&lt;sub&gt;C&lt;/sub&gt; = -10 mA</td>
<td>-0.74</td>
<td>-0.9</td>
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<td>pF</td>
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<tr>
<td>V&lt;sub&gt;BE(sat)&lt;/sub&gt;*</td>
<td>Base-emitter Saturation Voltage</td>
<td>I&lt;sub&gt;E&lt;/sub&gt; = 0</td>
<td>5</td>
<td>7</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>h&lt;sub&gt;FE&lt;/sub&gt;*</td>
<td>DC Current Gain</td>
<td>I&lt;sub&gt;C&lt;/sub&gt; = -1 mA</td>
<td>40</td>
<td>85</td>
<td>100</td>
<td>MHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>f = 20 MHz</td>
<td></td>
<td></td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td>f&lt;sub&gt;T&lt;/sub&gt;</td>
<td>Transition Frequency</td>
<td>V&lt;sub&gt;CE&lt;/sub&gt; = -10 V</td>
<td>60</td>
<td>50</td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td>C&lt;sub&gt;EBO&lt;/sub&gt;</td>
<td>Emitter-base Capacitance</td>
<td>I&lt;sub&gt;C&lt;/sub&gt; = 0</td>
<td>20</td>
<td>25</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>C&lt;sub&gt;GBO&lt;/sub&gt;</td>
<td>Collector-base Capacitance</td>
<td>I&lt;sub&gt;E&lt;/sub&gt; = 0</td>
<td>5</td>
<td>7</td>
<td></td>
<td>pF</td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1 %.

DC Current Gain.

[Graph: DC Current Gain]

Collector-emitter Saturation Voltage.

[Graph: Collector-emitter Saturation Voltage]
Base-emitter Saturation Voltage.

Transition Frequency.
DESCRIPTION
The BFX37 is a silicon planar epitaxial PNP transistor in Jedec TO-18 metal case, designed for use in high performance, low-noise amplifiers over a wide frequency range. It features high current gain over the range from 1 µA to 100 mA and excellent NF at low frequency.

INTERNAL SCHEMATIC DIAGRAM

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{CES}</td>
<td>Collector-emitter Voltage (V_{BE} = 0)</td>
<td>– 90</td>
<td>V</td>
</tr>
<tr>
<td>V_{CEO}</td>
<td>Collector-emitter Voltage (I_{B} = 0)</td>
<td>– 80</td>
<td>V</td>
</tr>
<tr>
<td>V_{EBO}</td>
<td>Emitter-base Voltage (I_{C} = 0)</td>
<td>– 6</td>
<td>V</td>
</tr>
<tr>
<td>I_{C}</td>
<td>Collector Current</td>
<td>– 100</td>
<td>mA</td>
</tr>
<tr>
<td>P_{tot}</td>
<td>Total Power Dissipation at T_{amb} ≤ 25 °C</td>
<td>0.36</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at T_{case} ≤ 25 °C</td>
<td>1.2</td>
<td>W</td>
</tr>
<tr>
<td>T_{stg}, T_{j}</td>
<td>Storage and Junction Temperature</td>
<td>– 55 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>

November 1988
### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$R_{th, j\text{-case}}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>146</td>
<td>°C/W</td>
<td></td>
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<tr>
<td>$R_{th, j\text{-amb}}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>486</td>
<td>°C/W</td>
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</table>

### ELECTRICAL CHARACTERISTICS ($\text{T}_{\text{amb}} = 25\,^\circ\text{C}$ unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{\text{CES}}$</td>
<td>Collector Cutoff Current ($V_{\text{BE}} = 0$)</td>
<td>$V_{\text{CE}} = -70,\text{V}$</td>
<td>$-0.1 \pm 10,\text{nA}$</td>
<td>$-0.1 \pm 10,\mu\text{A}$</td>
<td></td>
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</tr>
<tr>
<td>$I_{\text{EBO}}$</td>
<td>Emitter Cutoff Current ($I_{\text{C}} = 0$)</td>
<td>$V_{\text{EB}} = -4,\text{V}$</td>
<td>$-0.1 \pm 10,\text{nA}$</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>$V_{(\text{BR})\text{CES}}$</td>
<td>Collector-emitter Breakdown Voltage ($V_{\text{BE}} = 0$)</td>
<td>$I_{\text{C}} = -10,\mu\text{A}$</td>
<td>$-90,\text{V}$</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>$V_{(\text{BR})\text{CEO}}$</td>
<td>Collector-emitter Breakdown Voltage ($I_{\text{B}} = 0$)</td>
<td>$I_{\text{C}} = -5,\text{mA}$</td>
<td>$-80,\text{V}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(\text{BR})\text{EBO}}$</td>
<td>Emitter-base Breakdown Voltage ($I_{\text{C}} = 0$)</td>
<td>$I_{\text{E}} = -10,\mu\text{A}$</td>
<td>$-6,\text{V}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{\text{CE}\text{(sat)}}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_{\text{C}} = -10,\text{mA}$</td>
<td>$-0.1 \pm 0.25,\text{V}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{\text{CE}\text{(sat)}}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_{\text{C}} = -50,\text{mA}$</td>
<td>$-0.15 \pm 0.4,\text{V}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{\text{BE}}$</td>
<td>Base-emitter Voltage</td>
<td>$I_{\text{C}} = -1,\text{mA}$</td>
<td>$-0.65,\text{V}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$h_{\text{FE}}$</td>
<td>DC Current Gain</td>
<td>$I_{\text{C}} = -1,\mu\text{A}$</td>
<td>70</td>
<td>230</td>
<td></td>
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</tr>
<tr>
<td>$h_{\text{fe}}$</td>
<td>Small Signal Current Gain</td>
<td>$I_{\text{C}} = -1,\text{mA}$</td>
<td>125</td>
<td>280</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$f_{\text{T}}$</td>
<td>Transition Frequency</td>
<td>$I_{\text{C}} = -0.5,\text{mA}$</td>
<td>125</td>
<td>200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{\text{EBO}}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_{\text{C}} = 0$</td>
<td>6.5</td>
<td>k$\Omega$</td>
<td></td>
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</tr>
<tr>
<td>$C_{\text{CBO}}$</td>
<td>Collector-base Capacitance</td>
<td>$I_{\text{E}} = 0$</td>
<td>2.5x10$^{-6}$</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>$N_{\text{F}}$</td>
<td>Noise Figure</td>
<td>$I_{\text{C}} = -20,\mu\text{A}$</td>
<td>0.8</td>
<td>2.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$h_{\text{ib}}$</td>
<td>Input Impedance</td>
<td>$I_{\text{C}} = -1,\text{mA}$</td>
<td>1</td>
<td>3.5</td>
<td></td>
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<tr>
<td>$h_{\text{re}}$</td>
<td>Reverse Voltage Ratio</td>
<td>$I_{\text{C}} = -1,\text{mA}$</td>
<td>2.5x10$^{-4}$</td>
<td></td>
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<tr>
<td>$h_{\text{oe}}$</td>
<td>Output Admittance</td>
<td>$I_{\text{C}} = -1,\text{mA}$</td>
<td>15</td>
<td>µS</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 µs, duty cycle = 1%.
DC Current Gain.

Collector-emitter Saturation Voltage.

Collector-base Capacitance.

Normalized h Parameters.

Transition Frequency.

Noise Figure vs. Source Resistance.
Contours of Constant Noise Figure (f = 100 Hz).

Contours of Constant Noise Figure (f = 1 kHz).

Contours of Constant Noise Figure (f = 10 kHz).

Noise Figure vs. Frequency.
DESCRIPTION
The BFX38, BFX39, BFX40 and BFX41 are silicon planar epitaxial PNP transistors in Jedec TO-39 metal case, designed for a wide variety of applications. They are particularly useful as complementary drivers (BFY56A is a good complement) in output and switching applications where high voltage and high current are required.

INTERNAL SCHEMATIC DIAGRAM

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{CBO}</td>
<td>Collector-base Voltage ((I_E = 0))</td>
<td>-55</td>
<td>V</td>
</tr>
<tr>
<td>V_{CEO}</td>
<td>Collector-emitter Voltage ((I_B = 0))</td>
<td>-55</td>
<td>V</td>
</tr>
<tr>
<td>V_{EBO}</td>
<td>Emitter-base Voltage ((I_C = 0))</td>
<td>-5</td>
<td>V</td>
</tr>
<tr>
<td>I_C</td>
<td>Collector Current</td>
<td>-1</td>
<td>A</td>
</tr>
<tr>
<td>P_{T01}</td>
<td>Total Power Dissipation at (T_{amb} \leq 25 , ^\circ C) (\text{at } T_{case} \leq 25 , ^\circ C)</td>
<td>0.8</td>
<td>W</td>
</tr>
<tr>
<td>T_{stg}, T_j</td>
<td>Storage and Junction Temperature</td>
<td>-55 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>
## THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
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<tbody>
<tr>
<td>$R_{th} j\text{-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>44</td>
<td>4°C/W</td>
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<tr>
<td>$R_{th} j\text{-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>219</td>
<td>4°C/W</td>
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## ELECTRICAL CHARACTERISTICS ($T_{amb} = 25$ °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>for BFX38 – BFX39 $V_{CB} = -40$ V $V_{CB} = -40$ V $T_{amb} = 125$ °C</td>
<td>$-0.2$</td>
<td>$-0.25$</td>
<td>$-0.2$</td>
<td>nA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for BFX40 – BFX41</td>
<td></td>
<td></td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = -10$ µA</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for BFX38 – BFX39</td>
<td></td>
<td></td>
<td>$-55$</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for BFX40 – BFX41</td>
<td></td>
<td></td>
<td>$-75$</td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CEO}^*$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = -10$ mA</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for BFX38 – BFX39</td>
<td></td>
<td></td>
<td>$-55$</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for BFX40 – BFX41</td>
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<td></td>
<td>$-75$</td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = -10$ µA</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE(sat)}^*$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = -150$ mA $I_B = -15$ mA</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -500$ mA $I_B = -50$ mA</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE(sat)}^*$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = -150$ mA $I_B = -15$ mA</td>
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<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -500$ mA $I_B = -50$ mA</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$h_{FE}^*$</td>
<td>DC Current Gain</td>
<td>for BFX38 – BFX40</td>
<td>$I_C = -100$ µA $V_{CE} = -5$ V</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -100$ mA $V_{CE} = -5$ V</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -500$ mA $V_{CE} = -5$ V</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>for BFX39 – BFX41</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -100$ µA $V_{CE} = -5$ V</td>
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<tr>
<td></td>
<td></td>
<td>$I_C = -100$ mA $V_{CE} = -5$ V</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -500$ mA $V_{CE} = -5$ V</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$T_{amb} = -55$ °C</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>for BFX38 – BFX40</td>
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</tr>
<tr>
<td></td>
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<td>for BFX39 – BFX41</td>
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</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = -50$ mA $V_{CE} = -10$ V</td>
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<td>$f = 100$ MHz</td>
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<td></td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_C = 0$ $f = 1$ MHz $V_{EB} = -0.5$ V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>75</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$ $f = 1$ MHz $V_{CB} = -0.5$ V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>15</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$t_{on}^{**}$</td>
<td>Turn-on Time</td>
<td>$I_C = -500$ mA $V_{CC} = -30$ V</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$I_{B1} = -50$ mA</td>
<td>33</td>
<td></td>
<td></td>
<td>ns</td>
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</tbody>
</table>

* Pulsed: pulse duration = 300 µs, duty cycle = 1 %.
** See test circuit.
ELECTRICAL CHARACTERISTICS (continued)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t_s^{**}$</td>
<td>Storage Time</td>
<td>$I_C = -500 \text{ mA}$ $V_{CC} = -30 \text{ V}$ $I_{B_1} = I_{B_2} = -50 \text{ mA}$</td>
<td>160</td>
<td>350</td>
<td>ns</td>
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</tr>
<tr>
<td>$t_f^{**}$</td>
<td>Fall Time</td>
<td>$I_C = -500 \text{ mA}$ $V_{CC} = -30 \text{ V}$ $I_{B_1} = -I_{B_2} = -50 \text{ mA}$</td>
<td>27</td>
<td>50</td>
<td>ns</td>
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</tbody>
</table>

DC Current Gain (for BFX38 and BFX40 only).

Collector-emitter Saturation Voltage.

Base-emitter Saturation Voltage.
Transition Frequency.

Collector-base Capacitance.

Test Circuit for $t_{on}$, $t_s$, and $t_r$.

PULSE GENERATOR:
- $t_r, t_c < 20$ ns
- $PW = 10 \mu s$
- $Z_{IN} = 50 \Omega$
- $DC < 2 \%$

TO OSCILLOSCOPE:
- $t_r = 10$ ns
- $Z_{IN} > 100 \Omega$
DESCRIPTION
The BFX48 is a silicon planar epitaxial PNP transistor in Jedec TO-18 metal case. It is suitable for a wide range of applications including low noise, low current high gain RF and wide band pulse amplifiers.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>– 30</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>– 30</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>– 5</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>– 100</td>
<td>mA</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 \degree C$</td>
<td>0.36</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 \degree C$</td>
<td>1</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}, T_j$</td>
<td>Storage and Junction Temperature</td>
<td>– 65 to 200</td>
<td>°C</td>
</tr>
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</table>
### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Max</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$R_{\text{th j-case}}$</td>
<td>Thermal Resistance Junction-case</td>
<td>175</td>
<td>°C/W</td>
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<tr>
<td>$R_{\text{th j-amb}}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>486</td>
<td>°C/W</td>
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### ELECTRICAL CHARACTERISTICS ($T_{\text{amb}} = 25$ °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter Description</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{\text{CES}}$</td>
<td>Collector Cutoff Current ($V_{BE} = 0$)</td>
<td>$V_{CE} = -20$ V, $V_{CE} = -20$ V, $T_{\text{amb}} = 125$ °C</td>
<td>$-15$ nA</td>
<td>$-15$ μA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = -10$ μA</td>
<td>$30$ V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CEO}$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = -10$ mA</td>
<td>$30$ V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = -10$ μA</td>
<td>$5$ V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{CE(sat)}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = -1$ mA, $I_B = -0.1$ mA</td>
<td>$-0.1$ V</td>
<td>$-0.13$ V</td>
<td>$-0.3$ V</td>
<td>V</td>
</tr>
<tr>
<td>$I_C = -10$ mA, $I_B = -1$ mA</td>
<td>$-0.14$ V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_C = -50$ mA, $I_B = -5$ mA</td>
<td>$-0.1$ V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$T_{\text{amb}} = -55$ °C</td>
<td>$-0.77$ V</td>
<td>$-0.9$ V</td>
<td>$-1.1$ V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{BE(sat)}$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = -1$ mA, $I_B = -0.1$ mA</td>
<td>$-0.1$ V</td>
<td>$-0.13$ V</td>
<td>$-0.3$ V</td>
<td>V</td>
</tr>
<tr>
<td>$I_C = -10$ mA, $I_B = -1$ mA</td>
<td>$-0.14$ V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_C = -50$ mA, $I_B = -5$ mA</td>
<td>$-0.1$ V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$h_{FE}$</td>
<td>DC Current Gain</td>
<td>$I_C = -10$ μA, $V_{CE} = -1$ V, $T_{\text{amb}} = -55$ °C</td>
<td>$40$</td>
<td>$80$</td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td>$I_C = -100$ μA, $V_{CE} = -1$ V</td>
<td>$70$</td>
<td>$130$</td>
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<tr>
<td>$I_C = -10$ mA, $V_{CE} = -1$ V</td>
<td>$90$</td>
<td>$160$</td>
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<tr>
<td>$I_C = -50$ mA, $V_{CE} = -1$ V</td>
<td>$20$</td>
<td>$40$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_C = -10$ mA, $T_{\text{amb}} = -55$ °C</td>
<td>$30$</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = -10$ mA, $V_{CE} = -20$ V</td>
<td>$400$</td>
<td>$550$</td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td>$f = 100$ MHz</td>
<td>$40$</td>
<td>$550$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_C = 0$</td>
<td>$4$</td>
<td>$5.5$</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$f = 1$ MHz, $V_{EB} = -0.5$ V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$</td>
<td>$2.2$</td>
<td>$3.5$</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$f = 1$ MHz, $V_{CB} = -10$ V</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>$NF$</td>
<td>Noise Figure</td>
<td>$I_C = -1$ mA, $V_{CE} = -5$ V, $R_9 = 100$ Ω</td>
<td>$3.5$</td>
<td>$6$</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>$f = 100$ MHz</td>
<td>$3.5$</td>
<td>$6$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{on}$</td>
<td>Turn-on Time</td>
<td>$I_C = -50$ mA</td>
<td>$20$</td>
<td>$50$</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$t_{off}$</td>
<td>Turn-off Time</td>
<td>$I_C = -50$ mA, $I_B = -5$ mA</td>
<td>$95$</td>
<td>$160$</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$r_{bb'Ce'b'c}$</td>
<td>Feedback Time Constant</td>
<td>$I_C = -10$ mA, $f = 80$ MHz, $V_{CE} = -20$ V</td>
<td>$40$</td>
<td></td>
<td></td>
<td>ps</td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1%. 

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168
Collector-emitter Saturation Voltage.

- Collector-emitter Saturation Voltage ($V_{CE(sat)}$)

- $V_{BE(sat)}$...

- $hFE = 10$

- $T_{amb} = 25^\circ C$

- $T_{amb} = 125^\circ C$

- $T_{amb} = 55^\circ C$

---

Base-emitter Saturation Voltage.

- Base-emitter Saturation Voltage ($V_{BE(sat)}$)

- $V_{BE(sat)}$

- $hFE = 10$

- $T_{amb} = 25^\circ C$

- $T_{amb} = 125^\circ C$

- $T_{amb} = 55^\circ C$
The BFX73, 2N918 and 2N3600 are silicon planar epitaxial NPN transistors in Jedec TO-72 metal case. They are designed for low-noise VHF amplifiers, oscillators up to 1 GHz, non-neutralized IF amplifiers and non-saturating circuits with rise and fall times of less than 2.5 ns.

**ABSOLUTE MAXIMUM RATINGS**

<table>
<thead>
<tr>
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<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>30</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>15</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>3</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>50</td>
<td>mA</td>
</tr>
<tr>
<td>$P_{15}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 \degree C$</td>
<td>200</td>
<td>mW</td>
</tr>
<tr>
<td></td>
<td>at $T_{amb} \leq 25 \degree C$</td>
<td>300</td>
<td>mW</td>
</tr>
<tr>
<td>$T_{stg}$, $T_J$</td>
<td>Storage and Junction Temperature</td>
<td>-65 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>
### THERMAL DATA

<table>
<thead>
<tr>
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<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>R_{th j-case}</strong></td>
<td>Thermal Resistance Junction-case</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>R_{th j-amb}</strong></td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>584</td>
<td></td>
<td></td>
<td>°C/W</td>
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<tr>
<td><strong>R_{th j-amb}</strong></td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>875</td>
<td></td>
<td></td>
<td>°C/W</td>
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### ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
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<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>I_{CBO}</td>
<td>Collector Cutoff Current (I_E = 0)</td>
<td>V_{CB} = 15 V</td>
<td>10</td>
<td></td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V_{CB} = 15 V T_{amb} = 150 °C</td>
<td>1</td>
<td></td>
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<td>μA</td>
</tr>
<tr>
<td>V_{(BR)CBO}</td>
<td>Collector-base Breakdown Voltage (I_E = 0)</td>
<td>I_C = 1 μA</td>
<td>30</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V_{CEO (sus)}</td>
<td>Collector-emitter Sustaining Voltage (I_B = 0)</td>
<td>I_C = 3 mA</td>
<td>15</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V_{(BR) EBO}</td>
<td>Emitter-base Breakdown Voltage (I_C = 0)</td>
<td>I_E = 10 μA</td>
<td>3</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V_{CE (sat)}</td>
<td>Collector-emitter Saturation Voltage</td>
<td>I_C = 10 mA I_B = 1 mA</td>
<td>0.4</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V_{BE (sat)}</td>
<td>Base-emitter Saturation Voltage</td>
<td>I_C = 10 mA I_B = 1 mA</td>
<td>1</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>h_{FE}</td>
<td>DC Current Gain</td>
<td>I_C = 3 mA V_{CE} = 1 V</td>
<td>20</td>
<td>50</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for 2N918/BFX73 for 2N3600</td>
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<tr>
<td>f_T</td>
<td>Transition Frequency</td>
<td>for 2N918/BFX73</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>I_C = 4 mA V_{CE} = 10 V</td>
<td>600</td>
<td>900</td>
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<tr>
<td></td>
<td></td>
<td>f = 100 MHz</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for 2N3600</td>
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<tr>
<td></td>
<td></td>
<td>I_C = 5 mA V_{CE} = 6 V</td>
<td>850</td>
<td>1500</td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>f = 100 MHz</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C_{EBO}</td>
<td>Emitter-base Capacitance</td>
<td>I_C = 0 V_{EB} = 0.5 V</td>
<td>1.4</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for 2N918/BFX73 for 2N3600</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>f = 1 MHz</td>
<td>2</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>C_{CBO}</td>
<td>Collector-base Capacitance (for 2N918/BFX73 only)</td>
<td>I_E = 0 V_{CE} = 0 V</td>
<td>1.8</td>
<td>3</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V_{CE} = 10 V</td>
<td>1</td>
<td>1.7</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>C_{re}</td>
<td>Reverse Capacitance (for 2N3600 only)</td>
<td>I_C = 0 V_{CB} = 10 V</td>
<td>1</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>f = 1 MHz</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>NF</td>
<td>Noise Figure</td>
<td>I_C = 1.5 mA V_{CE} = 6 V</td>
<td>4.5</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R_g = 50 Ω f = 200 MHz for 2N3600</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>I_C = 1 mA V_{CE} = 6 V</td>
<td>6</td>
<td></td>
<td></td>
<td>dB</td>
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<tr>
<td></td>
<td></td>
<td>R_g = 400 Ω f = 60 MHz for 2N3600</td>
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<tr>
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<td></td>
<td>I_C = 6 mA V_{CE} = 12 V for 2N918/BFX73</td>
<td>15</td>
<td>21</td>
<td></td>
<td>dB</td>
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<td></td>
<td>I_C = 5 mA V_{CE} = 6 V for 2N3600</td>
<td>17</td>
<td>24</td>
<td></td>
<td>dB</td>
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</table>

*See test circuits.*
### ELECTRICAL CHARACTERISTICS (continued)

<table>
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<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Po*</td>
<td>Output Power</td>
<td>I_C = 12 mA, V_CB = 10 V, f = 500 MHz</td>
<td>30</td>
<td>40</td>
<td></td>
<td>mW</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for 2N918/BFX73</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>for 2N3600</td>
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<tr>
<td>n</td>
<td>Collector Efficiency</td>
<td>I_C = 12 mA, V_CB = 10 V, f = 500 MHz</td>
<td>25</td>
<td></td>
<td></td>
<td>%</td>
</tr>
<tr>
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<tr>
<td>rdb,Cbc</td>
<td>Feedback Time Constant</td>
<td>I_C = 5 mA, V_CB = 6 V, f = 31.9 MHz</td>
<td>4</td>
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<td>ps</td>
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<td>(for 2N3600 only)</td>
<td></td>
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</tbody>
</table>

**DC Current Gain.**

![DC Current Gain](image)

**Transition Frequency.**

![Transition Frequency](image)

**Input Admittance vs. Collector Current.**

![Input Admittance](image)

**Forward Transadmittance vs. Collector Current.**

![Forward Transadmittance](image)
Reverse Transadmittance vs. Collector Current.

Output Admittance vs. Collector Current.

Input Admittance vs. Frequency.

Forward Transadmittance vs. Frequency.

Reverse Transadmittance vs. Frequency.

Output Admittance vs. Frequency.
Figure 1: 500 MHz Oscillator Test Circuit.
BFX89
BFY90

WIDE BAND VHF/UHF AMPLIFIER

- SILICON PLANAR EPITAXIAL TRANSISTORS
- TO-72 METAL CASE
- VERY LOW NOISE

APPLICATIONS:
- TELECOMMUNICATIONS
- WIDE BAND UHF AMPLIFIER
- RADIO COMMUNICATIONS

DESCRIPTION
The BFX89 and BFY90 are silicon planar epitaxial NPN transistors produced using interdigitated base emitter geometry. They are particularly designed for use in wide band common-emitter linear amplifiers up to 1 GHz. They feature very high $f_T$, low reverse capacitance, excellent cross modulation properties and very low noise performance. The BFY90 is complementary to the BFR99A. Typical applications include telecommunication and radio communication equipment.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
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<tbody>
<tr>
<td>V_CBO</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>30 V</td>
<td></td>
</tr>
<tr>
<td>V_CER</td>
<td>Collector-emitter Voltage ($R_{BE} \leq 50 , \Omega$)</td>
<td>30 V</td>
<td></td>
</tr>
<tr>
<td>V_CEO</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>15 V</td>
<td></td>
</tr>
<tr>
<td>V_EBO</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>2.5 V</td>
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</tr>
<tr>
<td>I_C</td>
<td>Collector Current</td>
<td>25 mA</td>
<td></td>
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<tr>
<td>I_CCM</td>
<td>Collector Peak Current ($f \geq 1 , MHz$)</td>
<td>50 mA</td>
<td></td>
</tr>
<tr>
<td>P_TOT</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 , ^\circ C$</td>
<td>200 mW</td>
<td></td>
</tr>
<tr>
<td>T_STG, T_J</td>
<td>Storage and Junction Temperature</td>
<td>-65 to 200 °C</td>
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## THERMAL DATA

<table>
<thead>
<tr>
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<th>Parameter</th>
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<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tr>
<td>$R_{th j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>580</td>
<td>°C/W</td>
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<tr>
<td>$R_{th j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>880</td>
<td>°C/W</td>
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## ELECTRICAL CHARACTERISTICS ($T_{amb} = 25$ °C unless otherwise specified)

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<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = 15$ V</td>
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<td>10</td>
<td>nA</td>
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<td>$V_{CEK}$</td>
<td>Collector-emitter Knee Voltage</td>
<td>$I_C = 20$ mA</td>
<td>$V_{CE} = 1$ V</td>
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<td>0.75</td>
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<td>$h_{FE}$</td>
<td>DC Current Gain</td>
<td>$I_C = 2$ mA</td>
<td>$V_{CE} = 1$ V</td>
<td>20</td>
<td>150</td>
<td>GHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>for BFX89</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>for BFY90</td>
<td>25</td>
<td>150</td>
<td>GHz</td>
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<tr>
<td></td>
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<td>$I_C = 25$ mA</td>
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<td></td>
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</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$V_{CE} = 5$ V</td>
<td>$f = 500$ MHz</td>
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<td>1</td>
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<td>$I_C = 25$ mA</td>
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<td>1.2</td>
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<tr>
<td>$C_{CBO}^{(1)}$</td>
<td>Collector-base Capacitance</td>
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<td>$f = 1$ MHz</td>
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<td>1.7</td>
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<td>$C_{re}^{(2)}$</td>
<td>Reverse Capacitance</td>
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<td></td>
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<td>$f = 1$ MHz</td>
<td>for BFX89</td>
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<td>0.8</td>
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<td>$N_{F}^{(2)}$</td>
<td>Noise Figure</td>
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<td>$R_g = $ Optimized</td>
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<td>$f = 100$ kHz</td>
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<td>$f = 200$ MHz</td>
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<td>$f = 500$ MHz</td>
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<td>$f = 800$ MHz</td>
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<td>$R_g = 50$ Ω</td>
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<td>$f = 800$ MHz</td>
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<tr>
<td></td>
<td></td>
<td>for BFY90</td>
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<td>$R_g = $ Optimized</td>
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<tr>
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<td></td>
<td>for BFX89</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>$f = 800$ MHz</td>
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<tr>
<td></td>
<td></td>
<td>for BFY90</td>
<td></td>
<td></td>
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<tr>
<td>$G_{pe}^{(2)}$</td>
<td>Power Gain (not neutralized)</td>
<td>$I_C = 8$ mA</td>
<td>$V_{CE} = 10$ V</td>
<td></td>
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<td>$f = 200$ MHz</td>
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<td></td>
<td></td>
<td>$f = 800$ MHz</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for BFX90</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 14$ mA</td>
<td>$V_{CE} = 10$ V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 200$ MHz</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 800$ MHz</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

---

* $I_E =$ value lor which $I_C =$ 22 mA at $V_{CE} =$ 1 V
(1) Shield lead not grounded
(2) Shield lead grounded

---

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SGS-THOMSON
MICROELECTRONICS

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### ELECTRICAL CHARACTERISTICS (continued)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>$P_o$</td>
<td>Output Power</td>
<td>for <strong>BFX89</strong> $I_C = 8$ mA, $d_m = -30$ dB, <strong>Channel 9</strong>  $V_{CE} = 10$ V</td>
<td>6</td>
<td>6</td>
<td>10</td>
<td>mW</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for <strong>BFY90</strong> $I_C = 14$ mA, $d_m = -30$ dB, <strong>Channel 62</strong> $V_{CE} = 10$ V</td>
<td>12</td>
<td>12</td>
<td></td>
<td>mW</td>
</tr>
</tbody>
</table>

$* I_b =$ value for which $I_C = 22$ mA at $V_{CE} = 1$ V

(1) Shield lead not grounded
(2) Shield lead grounded

---

### Power Rating Chart.

![Power Rating Chart]

### Transition Frequency.

![Transition Frequency]

### Collector-base Capacitance.

![Collector-base Capacitance]

### Noise Figure vs. Collector Current.

![Noise Figure vs. Collector Current]
Noise Figure vs. Frequency.

Forward Transmission Gain vs. Frequency.
DESCRIPTION
The BFX90 and BFX91 are silicon planar epitaxial PNP transistors in Jedec TO-18 (BFX90) and Jedec TO-39 (BFX91) metal cases.
Both devices feature high voltage, high gain, low noise and excellent current gain linearity from 10 μA to 50 mA.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{CBO}</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>-180</td>
<td>V</td>
</tr>
<tr>
<td>V_{CEO}</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>-180</td>
<td>V</td>
</tr>
<tr>
<td>V_{EBO}</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>-6</td>
<td>V</td>
</tr>
<tr>
<td>I_C</td>
<td>Collector Current</td>
<td>-100</td>
<td>mA</td>
</tr>
<tr>
<td>P_{tot}</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 ^\circ C$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>for BFX90</td>
<td>0.4</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>for BFX91</td>
<td>0.7</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 ^\circ C$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>for BFX90</td>
<td>1.4</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>for BFX91</td>
<td>2.5</td>
<td>W</td>
</tr>
<tr>
<td>T_{stg}, T_j</td>
<td>Storage and Junction Temperature</td>
<td>-55 to 200</td>
<td>°C</td>
</tr>
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</table>
### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter Description</th>
<th>Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>R(_{th}) j-case</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>125</td>
<td>438</td>
<td>70</td>
<td>°C/W</td>
</tr>
<tr>
<td>R(_{th}) j-amb</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>70</td>
<td>250</td>
<td>438</td>
<td>°C/W</td>
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### ELECTRICAL CHARACTERISTICS (\(T_{amb} = 25\) °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter Description</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(I_{CBO})</td>
<td>Collector Cutoff Current ((I_E = 0))</td>
<td>(V_{CB} = -100) V, (T_{amb} = 125) °C</td>
<td>(-10)</td>
<td>(-10)</td>
<td>nA</td>
<td>nA</td>
</tr>
<tr>
<td>(I_{EBO})</td>
<td>Emitter Cutoff Current ((I_C = 0))</td>
<td>(V_{EB} = -4) V</td>
<td>(-10)</td>
<td></td>
<td>nA</td>
<td>nA</td>
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<tr>
<td>(V_{(BR) , CBO})</td>
<td>Collector-base Breakdown Voltage ((I_E = 0))</td>
<td>(I_C = -10) (\mu A)</td>
<td>(-180)</td>
<td></td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>(V_{(BR) , CEO})</td>
<td>Collector-emitter Breakdown Voltage ((I_B = 0))</td>
<td>(I_C = -2) mA</td>
<td>(-180)</td>
<td></td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>(V_{(BR) , EBO})</td>
<td>Emitter-base Breakdown Voltage ((I_C = 0))</td>
<td>(I_E = -10) (\mu A)</td>
<td>(-6)</td>
<td></td>
<td>V</td>
<td>V</td>
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<tr>
<td>(V_{CE, (sat)})</td>
<td>Collector-emitter Saturation Voltage</td>
<td>(I_C = -10m A, I_B = -1m A)</td>
<td>(-0.1)</td>
<td>(-0.25)</td>
<td>V</td>
<td>V</td>
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<tr>
<td>(V_{BE, (sat)})</td>
<td>Base-emitter Saturation Voltage</td>
<td>(I_C = -10m A, I_B = -1m A)</td>
<td>(-0.74)</td>
<td>(-0.9)</td>
<td>V</td>
<td>V</td>
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<td>(h_{FE,*})</td>
<td>DC Current Gain</td>
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<td>60</td>
<td>110</td>
<td>80</td>
<td>170</td>
</tr>
<tr>
<td>(h_{fe})</td>
<td>Small Signal Current Gain</td>
<td>(I_C = -1) mA, (V_{CE} = -10) V, (f = 1) kHz</td>
<td>80</td>
<td>400</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(f_T)</td>
<td>Transition Frequency</td>
<td>(I_C = -1) mA, (f = 20) MHz</td>
<td>40</td>
<td>60</td>
<td>160</td>
<td>MHz</td>
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<tr>
<td>(C_{EBO})</td>
<td>Emitter-base Capacitance</td>
<td>(I_C = 0), (V_{EB} = -0.5) V, (f = 1) MHz</td>
<td>20</td>
<td>25</td>
<td>pF</td>
<td>pF</td>
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<tr>
<td>(C_{CBO})</td>
<td>Collector-base Capacitance</td>
<td>(I_E = 0), (V_{CB} = -5) V, (f = 1) MHz</td>
<td>5</td>
<td>7</td>
<td>pF</td>
<td>pF</td>
</tr>
<tr>
<td>(NF)</td>
<td>Noise Figure</td>
<td>(I_C = -10) (\mu A), (R_g = 10) k(\Omega), (f = 10) kHz</td>
<td>1</td>
<td>3</td>
<td>dB</td>
<td>dB</td>
</tr>
<tr>
<td>(h_{ie})</td>
<td>Input Impedance</td>
<td>(I_C = -1) mA, (V_{CE} = -10) V, (f = 1) kHz</td>
<td>2.5</td>
<td>18</td>
<td>k(\Omega)</td>
<td>k(\Omega)</td>
</tr>
<tr>
<td>(h_{oe})</td>
<td>Output Admittance</td>
<td>(I_C = -1) mA, (V_{CE} = -10) V, (f = 1) kHz</td>
<td>5</td>
<td>25</td>
<td>(\mu S)</td>
<td>(\mu S)</td>
</tr>
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</table>

* Pulsed: pulse duration = 300 \(\mu\)s, duty cycle = 1 %.
DC Current Gain.

Collector-emitter Saturation Voltage.

Base-emitter Saturation Voltage.

Normalized h Parameters vs. Collector Current.

Normalized h Parameters vs. Ambient Temperature.

Emitter-base and Collector-base Capacitances.
Contours of Constant Transition Frequency.

Equivalent Input Noise Voltage.

Contours of Constant Noise Figure (f = 1 kHz).

Contours of Constant Noise Figure (f = 10 kHz).

Contours of Constant Noise Figure (f = 100 Hz).

Equivalente Input Noise Current.
Contours of Constant Wide Band Noise Figure.

Noise Figure vs. Frequency.
DESCRIPTION
The BFY50, BFY51 and BFY52 are silicon planar epitaxial NPN transistors in Jedec TO-39 metal case. They are intended for general purpose linear and switching applications.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>BFY50</th>
<th>BFY51</th>
<th>BFY52</th>
</tr>
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<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>80 V</td>
<td>60 V</td>
<td>40 V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>35 V</td>
<td>30 V</td>
<td>20 V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>6 V</td>
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<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>1 A</td>
<td></td>
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<tr>
<td>$I_{CM}$</td>
<td>Collector Peak Current</td>
<td>1.5 A</td>
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<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 , ^\circ C$</td>
<td>0.8 W</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 , ^\circ C$</td>
<td>5 W</td>
<td></td>
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<tr>
<td>$T_{stg}$, $T_J$</td>
<td>Storage and Junction Temperature</td>
<td></td>
<td>-65 to 200 °C</td>
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January 1989
### THERMAL DATA

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<th>Symbol</th>
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<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$R_{th\ j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td></td>
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<tr>
<td>$R_{th\ j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
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### ELECTRICAL CHARACTERISTICS ($T_{case} = 25^\circ C$ unless otherwise specified)

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<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>for BFY50 $V_{CB} = 60$ V $T_{case} = 100^\circ C$</td>
<td>80</td>
<td>60</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for BFY51 $V_{CB} = 60$ V $T_{case} = 100^\circ C$</td>
<td>50</td>
<td>2.5</td>
<td>nA</td>
<td>µA</td>
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<tr>
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<td>for BFY52 $V_{CB} = 40$ V $T_{case} = 100^\circ C$</td>
<td>50</td>
<td>2.5</td>
<td>nA</td>
<td>µA</td>
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<tr>
<td>$I_{EBO}$</td>
<td>Emitter Cutoff Current ($I_C = 0$)</td>
<td>$V_{EB} = 5$ V $T_{case} = 100^\circ C$</td>
<td>50</td>
<td>2.5</td>
<td>nA</td>
<td>µA</td>
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<tr>
<td>$V(BR)CBO^*$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = 100$ µA</td>
<td>80</td>
<td>60</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
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<td>for BFY50 $V_{CB} = 60$ V $T_{case} = 100^\circ C$</td>
<td>50</td>
<td>2.5</td>
<td>nA</td>
<td>µA</td>
</tr>
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<td>for BFY51 $V_{CB} = 60$ V $T_{case} = 100^\circ C$</td>
<td>50</td>
<td>2.5</td>
<td>nA</td>
<td>µA</td>
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<tr>
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<td>for BFY52 $V_{CB} = 40$ V $T_{case} = 100^\circ C$</td>
<td>50</td>
<td>2.5</td>
<td>nA</td>
<td>µA</td>
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<tr>
<td>$V(BR)CEO^*$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = 30$ mA</td>
<td>35</td>
<td>30</td>
<td>20</td>
<td>V</td>
</tr>
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<td>for BFY50 $V_{CB} = 60$ V $T_{case} = 100^\circ C$</td>
<td>50</td>
<td>2.5</td>
<td>nA</td>
<td>µA</td>
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<td>for BFY51 $V_{CB} = 60$ V $T_{case} = 100^\circ C$</td>
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<td>2.5</td>
<td>nA</td>
<td>µA</td>
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<td>for BFY52 $V_{CB} = 40$ V $T_{case} = 100^\circ C$</td>
<td>50</td>
<td>2.5</td>
<td>nA</td>
<td>µA</td>
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<tr>
<td>$V(BR)EBO$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = 100$ µA</td>
<td>6</td>
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<td>V</td>
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<tr>
<td>$V_{CE(sat)^*}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = 150$ mA $I_B = 15$ mA</td>
<td>0.14</td>
<td>0.14</td>
<td>0.7</td>
<td>V</td>
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<td>for BFY50 $V_{CB} = 60$ V $T_{case} = 100^\circ C$</td>
<td>0.2</td>
<td>0.35</td>
<td>1</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for BFY51 $V_{CB} = 60$ V $T_{case} = 100^\circ C$</td>
<td>0.2</td>
<td>0.35</td>
<td>1</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for BFY52 $V_{CB} = 40$ V $T_{case} = 100^\circ C$</td>
<td>0.2</td>
<td>0.35</td>
<td>1</td>
<td>V</td>
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<td>for BFY51 and BFY52 $V_{CB} = 60$ V $T_{case} = 100^\circ C$</td>
<td>0.7</td>
<td>1</td>
<td>V</td>
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<td>for BFY50 $V_{CB} = 60$ V $T_{case} = 100^\circ C$</td>
<td>0.7</td>
<td>1</td>
<td>V</td>
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<td>for BFY51 and BFY52 $V_{CB} = 60$ V $T_{case} = 100^\circ C$</td>
<td>0.7</td>
<td>1</td>
<td>V</td>
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<tr>
<td>$V_{BE\ (sat)^*}$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = 150$ mA $I_B = 15$ mA</td>
<td>0.95</td>
<td>0.95</td>
<td>1.5</td>
<td>V</td>
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<td>for BFY50 $V_{CB} = 60$ V $T_{case} = 100^\circ C$</td>
<td>1.3</td>
<td>2</td>
<td>V</td>
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<td>for BFY51 $V_{CB} = 60$ V $T_{case} = 100^\circ C$</td>
<td>1.3</td>
<td>2</td>
<td>V</td>
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</tr>
<tr>
<td>$h_{FE}^*$</td>
<td>DC Current Gain</td>
<td>for BFY50 $V_{CE} = 10$ V</td>
<td>20</td>
<td>40</td>
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<td>for BFY51 $V_{CE} = 10$ V</td>
<td>30</td>
<td>55</td>
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<tr>
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<td></td>
<td>for BFY52 $V_{CE} = 10$ V</td>
<td>15</td>
<td>30</td>
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<td>for BFY51 and BFY52 $V_{CE} = 10$ V</td>
<td>15</td>
<td>30</td>
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<td>for BFY50 $V_{CE} = 10$ V</td>
<td>15</td>
<td>30</td>
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<td>for BFY51 $V_{CE} = 10$ V</td>
<td>15</td>
<td>30</td>
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<tr>
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<td>for BFY52 $V_{CE} = 10$ V</td>
<td>15</td>
<td>30</td>
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<td>for BFY50 $V_{CE} = 10$ V</td>
<td>15</td>
<td>30</td>
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<tr>
<td></td>
<td></td>
<td>for BFY51 $V_{CE} = 10$ V</td>
<td>15</td>
<td>30</td>
<td></td>
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</tr>
<tr>
<td></td>
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<td>for BFY52 $V_{CE} = 10$ V</td>
<td>15</td>
<td>30</td>
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</tr>
<tr>
<td>$h_{fe}$</td>
<td>Small Signal Current Gain</td>
<td>$V_{CE} = 6$ V $f = 1$ kHz</td>
<td>25</td>
<td>30</td>
<td>40</td>
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<td></td>
<td>for BFY50 $V_{CE} = 6$ V $f = 1$ kHz</td>
<td>45</td>
<td>60</td>
<td>120</td>
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<tr>
<td></td>
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<td>for BFY51 $V_{CE} = 6$ V $f = 1$ kHz</td>
<td>45</td>
<td>60</td>
<td>120</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>for BFY52 $V_{CE} = 6$ V $f = 1$ kHz</td>
<td>45</td>
<td>60</td>
<td>120</td>
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</tbody>
</table>

* Pulsed : pulse duration = 300 µs, duty cycle = 1 %.

---

SGS-THOMSON MICROWAVE ELECTRONICS

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### ELECTRICAL CHARACTERISTICS (continued)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = 50$ mA $V_{CE} = 10$ V</td>
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<tr>
<td></td>
<td></td>
<td>for BFY50</td>
<td>60</td>
<td>100</td>
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<tr>
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<td>for BFY51</td>
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<td>110</td>
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<td>MHz</td>
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<td>for BFY52</td>
<td>50</td>
<td>120</td>
<td></td>
<td>MHz</td>
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<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$ $V_{CB} = 10$ V</td>
<td>10</td>
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<td>pF</td>
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<td>$h_{ie}$</td>
<td>Input Impedance</td>
<td>$I_C = 10$ mA $f = 1$ kHz</td>
<td>180</td>
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<td>$\Omega$</td>
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<td>for BFY50</td>
<td>180</td>
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<td>$\Omega$</td>
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<td>for BFY51</td>
<td>220</td>
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<td>for BFY52</td>
<td>400</td>
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<td>$\Omega$</td>
</tr>
<tr>
<td>$h_{re}$</td>
<td>Reserve Voltage Ratio</td>
<td>$I_C = 10$ mA $f = 1$ kHz</td>
<td>55x10^{-6}</td>
<td>70x10^{-6}</td>
<td>130x10^{-6}</td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>for BFY51</td>
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<td></td>
<td>for BFY52</td>
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<tr>
<td>$h_{oe}$</td>
<td>Output Admittance</td>
<td>$I_C = 10$ mA $f = 1$ kHz</td>
<td>30</td>
<td></td>
<td></td>
<td>$\mu S$</td>
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<td>for BFY52</td>
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<td>$t_d$</td>
<td>Delay Time</td>
<td>$I_C = 150$ mA $V_{CC} = 10$ V $I_{B1} = 15$ mA $V_{BE} = -2$ V</td>
<td>15</td>
<td></td>
<td></td>
<td>ns</td>
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<td>$t_r$</td>
<td>Rise Time</td>
<td>$I_C = 150$ mA $V_{CC} = 10$ V $I_{B1} = 15$ mA $V_{BE} = -2$ V</td>
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<tr>
<td>$t_s$</td>
<td>Storage Time</td>
<td>$I_C = 150$ mA $V_{CC} = 10$ V $I_{B1} = -I_{B2} = 15$ mA</td>
<td>300</td>
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<td>ns</td>
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<tr>
<td>$t_f$</td>
<td>Fall Time</td>
<td>$I_C = 150$ mA $V_{CC} = 10$ V $I_{B1} = -I_{B2} = 15$ mA</td>
<td>60</td>
<td></td>
<td></td>
<td>ns</td>
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* Pulsed: pulse duration = 300 $\mu$s, duty cycle = 1%.
DESCRIPTION
The BFX56 and BFY56A are silicon planar epitaxial NPN transistors in Jedec TO-39 metal case. They are designed for amplifier and switching applications over a wide range of voltage and current.

ABSOLUTE MAXIMUM RATINGS

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<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>BFY56</th>
<th>BFY56A</th>
<th>Unit</th>
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<tr>
<td>$V_{CES}$</td>
<td>Collector-emitter Voltage ($V_{BE} = 0$)</td>
<td>85</td>
<td>85</td>
<td>V</td>
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<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>45</td>
<td>55</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>7</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>1</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 ^\circ C$</td>
<td>0.8</td>
<td></td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 ^\circ C$</td>
<td>5</td>
<td></td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}$, $T_J$</td>
<td>Storage and Junction Temperature</td>
<td>-55 to 200</td>
<td></td>
<td>°C</td>
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### THERMAL DATA

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<th>Symbol</th>
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<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$R_{th\ j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>35</td>
<td>°C/W</td>
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<tr>
<td>$R_{th\ j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>219</td>
<td>°C/W</td>
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### ELECTRICAL CHARACTERISTICS ($T_{amb} = 25$ °C unless otherwise specified)

<table>
<thead>
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<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$I_{CES}$</td>
<td>Collector Cutoff Current</td>
<td>$V_{CE} = 50$ V</td>
<td>0.2</td>
<td>20</td>
<td>nA</td>
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<td>$V_{CE} = 50$ V, $T_{amb} = 150$ °C</td>
<td>0.2</td>
<td>20</td>
<td>μA</td>
<td></td>
</tr>
<tr>
<td>$I_{EBO}$</td>
<td>Emitter Cutoff Current</td>
<td>$V_{EB} = 5$ V</td>
<td>0.1</td>
<td>20</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CES}$</td>
<td>Collector-emitter Breakdown Voltage ($V_{BE} = 0$)</td>
<td>$I_C = 100$ μA</td>
<td>85</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CEO}^*$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = 30$ mA</td>
<td>for BFY56</td>
<td>45</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>for BFY56A</td>
<td>55</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = 100$ μA</td>
<td>7</td>
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<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{CE(sat)}^*$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>for BFY56</td>
<td>$I_C = 150$ mA</td>
<td>$I_B = 15$ mA</td>
<td>0.13</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$I_C = 1$ A</td>
<td>$I_B = 0.1$ A</td>
<td>0.65</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for BFY56A</td>
<td>$I_C = 10$ mA</td>
<td>$I_B = 1$ mA</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$I_C = 150$ mA</td>
<td>$I_B = 15$ mA</td>
<td>0.13</td>
<td>0.25</td>
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<tr>
<td></td>
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<td>$I_C = 1$ A</td>
<td>$I_B = 0.1$ mA</td>
<td>0.65</td>
<td>1</td>
</tr>
<tr>
<td>$V_{BE(sat)}^*$</td>
<td>Base-emitter Saturation Voltage</td>
<td>for BFY56</td>
<td>$I_C = 150$ mA</td>
<td>$I_B = 15$ mA</td>
<td>0.85</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$I_C = 1$ A</td>
<td>$I_B = 0.1$ A</td>
<td>1.5</td>
<td>2.3</td>
</tr>
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<td></td>
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<td>for BFY56A</td>
<td>$I_C = 10$ mA</td>
<td>$I_B = 1$ mA</td>
<td>0.68</td>
<td>0.8</td>
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<td></td>
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<td>$I_C = 150$ mA</td>
<td>$I_B = 15$ mA</td>
<td>0.85</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$I_C = 1$ A</td>
<td>$I_B = 0.1$ A</td>
<td>1.3</td>
<td>1.6</td>
</tr>
<tr>
<td>$h_{FE}^*$</td>
<td>DC Current Gain</td>
<td>for BFY56</td>
<td>$I_C = 0.1$ mA</td>
<td>$V_{CE} = 10$ V</td>
<td>15</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$I_C = 500$ mA</td>
<td>$V_{CE} = 10$ V</td>
<td>20</td>
<td>55</td>
</tr>
<tr>
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<td></td>
<td>$I_C = 150$ mA</td>
<td>$V_{CE} = 1$ V</td>
<td>30</td>
<td>70</td>
</tr>
<tr>
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<td>for BFY56A</td>
<td>$I_C = 0.1$ mA</td>
<td>$V_{CE} = 1$ V</td>
<td>20</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$I_C = 5$ mA</td>
<td>$V_{CE} = 1$ V</td>
<td>50</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$I_C = 150$ mA</td>
<td>$V_{CE} = 1$ V</td>
<td>40</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$I_C = 500$ mA</td>
<td>$V_{CE} = 10$ V</td>
<td>25</td>
<td>55</td>
</tr>
<tr>
<td>$h_{fe}$</td>
<td>Small Signal Current Gain</td>
<td>$I_C = 1$ mA</td>
<td>$V_{CE} = 5$ V</td>
<td>for BFY56</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>for BFY56A</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = 50$ mA</td>
<td>$V_{CE} = 10$ V</td>
<td>for BFY56</td>
<td>40</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>for BFY56A</td>
<td>60</td>
<td>90</td>
<td>MHz</td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1 %.
ELECTRICAL CHARACTERISTICS (continued)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>C_{EBO}</td>
<td>Emitter-base Capacitance</td>
<td>$I_C = 0$ f = 1 MHz, $V_{EB} = 0.5$ V</td>
<td>50</td>
<td>80</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>C_{CBO}</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$ f = 1 MHz, $V_{CB} = 10$ V</td>
<td>14</td>
<td>25</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$h_{ie}$</td>
<td>Input Impedance</td>
<td>$I_C = 1$ mA f = 1 kHz, $V_{CE} = 5$ V</td>
<td>1.8</td>
<td>2</td>
<td></td>
<td>kΩ</td>
</tr>
<tr>
<td>$h_{re}$</td>
<td>Reverse Voltage Ratio</td>
<td>$I_C = 1$ mA f = 1 kHz, $V_{CE} = 5$ V</td>
<td>$2.1 \times 10^{-4}$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1 %.

DC Current Gain.

Collector-emitter Saturation Voltage.

Base-emitter Saturation Voltage.

Emitter-base and Collector-base Capacitances.
Transition Frequency.

Normalized h Parameters.
**DESCRIPTION**

The BFX64 is a silicon planar epitaxial PNP transistor in Jedeoc TO-39 metal case. It is designed for digital and analog applications at current levels up to 500 mA, line driver, memory applications and in low-noise amplifiers.

**ABSOLUTE MAXIMUM RATINGS**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{CBO}</td>
<td>Collector-base Voltage (I_E = 0)</td>
<td>-40</td>
<td>V</td>
</tr>
<tr>
<td>V_{CEO}</td>
<td>Collector-emitter Voltage (I_B = 0)</td>
<td>-40</td>
<td>V</td>
</tr>
<tr>
<td>V_{EBO}</td>
<td>Emitter-base Voltage (I_C = 0)</td>
<td>-5</td>
<td>V</td>
</tr>
<tr>
<td>I_C</td>
<td>Collector Current</td>
<td>-500</td>
<td>mA</td>
</tr>
<tr>
<td>P_{tot}</td>
<td>Total Power Dissipation at T_{amb} \leq 25 °C at T_{case} \leq 25 °C</td>
<td>0.7</td>
<td>W</td>
</tr>
<tr>
<td>T_{stg, T_j}</td>
<td>Storage and Junction Temperature</td>
<td>-65 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>
### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter Description</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th, j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>58</td>
<td>°C/W</td>
</tr>
<tr>
<td>$R_{th, j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>250</td>
<td>°C/W</td>
</tr>
</tbody>
</table>

### ELECTRICAL CHARACTERISTICS ($T_{amb} = 25$ °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter Description</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CES}$</td>
<td>Collector Cutoff Current ($V_{BE} = 0$)</td>
<td>$V_{CE} = -25$ V</td>
<td></td>
<td></td>
<td>-30 nA</td>
<td>nA</td>
</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = -10 \mu A$</td>
<td>-40</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CEO}^*$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = -10 mA$</td>
<td>-40</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = -10 \mu A$</td>
<td>-5</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE(sat)}^*$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = -50 mA; I_B = -2.5 mA$</td>
<td>-0.08</td>
<td>-0.3</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -150 mA; I_B = -15 mA$</td>
<td>-0.18</td>
<td>-0.5</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -500 mA; I_B = -50 mA$</td>
<td>-0.6</td>
<td>-1.8</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE(sat)}^*$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = -50 mA; I_B = -2.5 mA$</td>
<td>-0.92</td>
<td>-1.1</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -150 mA; I_B = -15 mA$</td>
<td>-1</td>
<td>-1.4</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -500 mA; I_B = -50 mA$</td>
<td>-2.2</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$h_{FE}$</td>
<td>DC Current Gain</td>
<td>$I_C = -10 \mu A; V_{CE} = -10 V$</td>
<td>80</td>
<td></td>
<td>130</td>
<td>MHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -1 mA; V_{CE} = -10 V$</td>
<td></td>
<td>200</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -10 mA; V_{CE} = -10 V$</td>
<td></td>
<td>200</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -50 mA; V_{CE} = -1 V$</td>
<td></td>
<td>150</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -150 mA; V_{CE} = -10 V$</td>
<td></td>
<td>130</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$h_{fe}$</td>
<td>Small Signal Current Gain</td>
<td>$I_C = -10 mA; f = 1 kHz; V_{CE} = -10 V$</td>
<td>200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = -50 mA; f = 100 MHz; V_{CE} = -20 V$</td>
<td>200</td>
<td></td>
<td>250</td>
<td>MHz</td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_E = 0; f = 1 MHz; V_{EB} = -2 V$</td>
<td>15</td>
<td></td>
<td>30</td>
<td>pF</td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0; f = 1 MHz; V_{CB} = -10 V$</td>
<td>6</td>
<td></td>
<td>10</td>
<td>pF</td>
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<tr>
<td>$NF$</td>
<td>Noise Figure</td>
<td>$I_C = -30 \mu A; V_{CE} = -5 V; f = 1 kHz; R_g = 10 \Omega$</td>
<td>1</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>$h_{ie}$</td>
<td>Input Impedance</td>
<td>$I_C = -10 mA; f = 1 kHz; V_{CE} = -10 V$</td>
<td>1</td>
<td></td>
<td></td>
<td>kΩ</td>
</tr>
<tr>
<td>$h_{re}$</td>
<td>Reverse Voltage Ratio</td>
<td>$I_C = -10 mA; f = 1 kHz; V_{CE} = -10 V$</td>
<td>2.4 × 10^{-4}</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>$h_{oe}$</td>
<td>Output Admittance</td>
<td>$I_C = -10 mA; f = 1 kHz; V_{CE} = -10 V$</td>
<td>110</td>
<td></td>
<td></td>
<td>μS</td>
</tr>
<tr>
<td>$t_{on}$</td>
<td>Turn-on Time</td>
<td>$I_C = -300 mA; I_{B1} = -30 mA; V_{CC} = -30 V$</td>
<td>35</td>
<td></td>
<td>50</td>
<td>ns</td>
</tr>
<tr>
<td>$t_{off}$</td>
<td>Turn-off Time</td>
<td>$I_C = -300 mA; I_{B1} = -30 mA; V_{CC} = -30 V; I_{B2} = -30 mA$</td>
<td>70</td>
<td></td>
<td>120</td>
<td>ns</td>
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</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1%.

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SGS-THOMSON MICROELECTRONICS

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DC Current Gain.

Collector-emitter Saturation Voltage.

Base-emitter Saturation Voltage.

Transition Frequency.

Emitter-base and Collector-base Capacitances.

Switching Characteristics.
Switching Characteristics vs. Ambient Temperature.

Countours of Constant Noise Figure.
DESCRIPTION
The BFY76 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case. It is designed for use in high performance, low-level, low-noise amplifier circuits from audio to high frequencies.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{C_E}</td>
<td>Collector-emitter Voltage ((V_{B_E} = 0))</td>
<td>60</td>
<td>V</td>
</tr>
<tr>
<td>V_{C_E0}</td>
<td>Collector-emitter Voltage ((I_B = 0))</td>
<td>60</td>
<td>V</td>
</tr>
<tr>
<td>V_{E_B}</td>
<td>Emitter-base Voltage ((I_C = 0))</td>
<td>8</td>
<td>V</td>
</tr>
<tr>
<td>I_C</td>
<td>Collector Current</td>
<td>50</td>
<td>mA</td>
</tr>
<tr>
<td>P_{tot}</td>
<td>Total Power Dissipation at (T_{amb} \leq 25 , ^\circ C)</td>
<td>0.36</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at (T_{case} \leq 25 , ^\circ C)</td>
<td>1.2</td>
<td>W</td>
</tr>
<tr>
<td>T_{stg}, T_J</td>
<td>Storage and Junction Temperature</td>
<td>-55 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>
### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter Description</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{\text{th},\text{j-case}}$</td>
<td>Thermal Resistance Junction-case</td>
<td>$T_{\text{amb}} = 146 \degree\text{C/W}$</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_{\text{th},\text{j-amb}}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>$T_{\text{amb}} = 486 \degree\text{C/W}$</td>
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### ELECTRICAL CHARACTERISTICS ($T_{\text{amb}} = 25 \degree\text{C}$ unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter Description</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{\text{CES}}$</td>
<td>Collector Cutoff Current ($V_{\text{BE}} = 0$)</td>
<td>$V_{\text{CE}} = 50 \text{ V}$ ($V_{\text{CE}} = 50 \text{ V}$) $T_{\text{amb}} = 150 \degree\text{C}$</td>
<td>20</td>
<td>20</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>$I_{\text{EBO}}$</td>
<td>Emitter Cutoff Current ($I_{\text{C}} = 0$)</td>
<td>$V_{\text{EB}} = 5 \text{ V}$</td>
<td>20</td>
<td></td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>$V_{(\text{BR})\text{CES}}$</td>
<td>Collector-emitter Breakdown Voltage ($V_{\text{BE}} = 0$)</td>
<td>$I_{\text{C}} = 10 \mu\text{A}$</td>
<td>60</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{(\text{BR})\text{CEO}}$</td>
<td>Collector-emitter Breakdown Voltage ($I_{\text{B}} = 0$)</td>
<td>$I_{\text{C}} = 10 \text{ mA}$</td>
<td>60</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{(\text{BRI})\text{EBO}}$</td>
<td>Emitter-base Breakdown Voltage ($I_{\text{C}} = 0$)</td>
<td>$I_{\text{E}} = 10 \mu\text{A}$</td>
<td>8</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{\text{CE}(\text{sat})}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_{\text{C}} = 1 \text{ mA}$ $I_{\text{B}} = 0.1 \text{ mA}$</td>
<td>0.15</td>
<td>0.35</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{\text{BE}}$</td>
<td>Base-emitter Voltage</td>
<td>$I_{\text{C}} = 100 \mu\text{A}$ $V_{\text{CE}} = 5 \text{ V}$</td>
<td>0.5</td>
<td>0.58</td>
<td>0.7</td>
<td>V</td>
</tr>
<tr>
<td>$h_{\text{FE}}$</td>
<td>DC Current Gain</td>
<td></td>
<td>30</td>
<td>70</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>150</td>
<td>190</td>
<td>220</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>150</td>
<td>190</td>
<td>220</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>150</td>
<td>190</td>
<td>220</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>150</td>
<td>190</td>
<td>220</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>150</td>
<td>190</td>
<td>220</td>
<td></td>
</tr>
<tr>
<td>$h_{\text{fe}}$</td>
<td>Small Signal Current Gain</td>
<td>$I_{\text{C}} = 1 \text{ mA} f = 1 \text{ kHz}$</td>
<td>80</td>
<td>220</td>
<td>350</td>
<td></td>
</tr>
<tr>
<td>$f_{\text{T}}$</td>
<td>Transition Frequency</td>
<td>$I_{\text{C}} = 1 \text{ mA} f = 20 \text{ MHz}$</td>
<td>70</td>
<td>100</td>
<td>MHz</td>
<td></td>
</tr>
<tr>
<td>$C_{\text{EBO}}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_{\text{C}} = 0 f = 1 \text{ MHz}$</td>
<td>3.5</td>
<td>6</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>$C_{\text{CBO}}$</td>
<td>Collector-base Capacitance</td>
<td>$I_{\text{C}} = 0 f = 1 \text{ MHz}$</td>
<td>3.5</td>
<td>6</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>$N_{\text{F}}$</td>
<td>Noise Figure</td>
<td>$I_{\text{C}} = 10 \mu\text{A} f = 10 \text{ kHz}$</td>
<td>4</td>
<td>15</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.5</td>
<td>4</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.9</td>
<td>4</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>$h_{\text{ie}}$</td>
<td>Input Impedance</td>
<td>$I_{\text{C}} = 1 \text{ mA} f = 1 \text{ kHz}$</td>
<td>8</td>
<td></td>
<td>kΩ</td>
<td></td>
</tr>
<tr>
<td>$h_{\text{re}}$</td>
<td>Reverse Voltage Ratio</td>
<td>$I_{\text{C}} = 1 \text{ mA} f = 1 \text{ kHz}$</td>
<td>3x10^-4</td>
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<td></td>
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<tr>
<td>$h_{\text{oe}}$</td>
<td>Output Admittance</td>
<td>$I_{\text{C}} = 1 \text{ mA} f = 1 \text{ kHz}$</td>
<td>11</td>
<td></td>
<td>μS</td>
<td></td>
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</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1%.
DC Current Gain.

Collector-emitter Saturation Voltage.

High Frequency Current Gain.

Collector-base capacitance.

Normalized h Parameters.

Contours of Constant Noise Figure (f = 100 kHz).
Contours of Constant Noise Figure (f = 1 kHz).

Contours of Constant Noise Figure (f = 10 kHz).

Noise Figure vs. Source Resistance.

Noise Figure vs. Frequency.
DESCRIPTION
The BSS 26 is a silicon planar epitaxial NPN transistor in Jedeo TO-18 metal case. It is intended for high voltage, high current switching applications.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage $(I_E = 0)$</td>
<td>60</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CES}$</td>
<td>Collector-emitter Voltage $(V_{BE} = 0)$</td>
<td>60</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage $(I_B = 0)$</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage $(I_C = 0)$</td>
<td>6</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>1</td>
<td>A</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 ^\circ C$</td>
<td>0.36</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 ^\circ C$</td>
<td>1.2</td>
<td>W</td>
</tr>
<tr>
<td>$T_{slg}$, $T_j$</td>
<td>Storage and Junction Temperature</td>
<td>− 55 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>
### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter Description</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>146</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
<tr>
<td>$R_{th j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>486</td>
<td></td>
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<td>°C/W</td>
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</table>

### ELECTRICAL CHARACTERISTICS ($T_{amb} = 25$ °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter Description</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff</td>
<td>$V_{CB} = 40$ $V$</td>
<td></td>
<td></td>
<td>1.7</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td>Current ($I_E = 0$)</td>
<td>$V_{CB} = 40$ $V$</td>
<td></td>
<td></td>
<td>120</td>
<td>μA</td>
</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = 10$ $μA$</td>
<td>60</td>
<td>60</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CES}$</td>
<td>Collector-emitter Breakdown Voltage ($V_{BE} = 0$)</td>
<td>$I_C = 10$ $μA$</td>
<td>60</td>
<td>60</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CEO}$*</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = 10$ $mA$</td>
<td>40</td>
<td>40</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = 10$ $μA$</td>
<td>6</td>
<td>6</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE(sat)}^*$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = 100$ $mA$</td>
<td>0.17</td>
<td>0.17</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 500$ $mA$</td>
<td>0.3</td>
<td>0.3</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 1$ $A$</td>
<td>0.5</td>
<td>0.5</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE(sat)}^*$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = 100$ $mA$</td>
<td>0.8</td>
<td>0.8</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 500$ $mA$</td>
<td>0.95</td>
<td>0.95</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 1$ $A$</td>
<td>1.05</td>
<td>1.05</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$h_{FE}^*$</td>
<td>DC Current Gain</td>
<td>$I_C = 10$ $mA$</td>
<td>25</td>
<td>25</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = 1$ $V$</td>
<td>55</td>
<td>55</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 100$ $mA$</td>
<td>40</td>
<td>40</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = 1$ $V$</td>
<td>75</td>
<td>75</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 500$ $mA$</td>
<td>25</td>
<td>25</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = 5$ $V$</td>
<td>45</td>
<td>45</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = 50$ $mA$</td>
<td>250</td>
<td>250</td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 100$ MHz</td>
<td>400</td>
<td>400</td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_C = 0$ $mA$</td>
<td>40</td>
<td>40</td>
<td>55</td>
<td>pF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 1$ MHz</td>
<td>55</td>
<td>55</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$ $mA$</td>
<td>4.8</td>
<td>4.8</td>
<td>12</td>
<td>pF</td>
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<td></td>
<td></td>
<td>$f = 1$ MHz</td>
<td>12</td>
<td>12</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$t_{on}^*$</td>
<td>Turn-on Time</td>
<td>$I_C = 500$ $mA$</td>
<td>15</td>
<td>15</td>
<td>35</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{B1} = 50$ $mA$</td>
<td>35</td>
<td>35</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$t_{off}^*$</td>
<td>Turn-off Time</td>
<td>$I_C = 500$ $mA$</td>
<td>40</td>
<td>40</td>
<td>60</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{B1} = - I_{B2} = 50$ $mA$</td>
<td>60</td>
<td>60</td>
<td></td>
<td>ns</td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1 %

** See test circuit.
DC Current Gain.

Collector-emitter Saturation Voltage.

Base-emitter Saturation Voltage.

High Frequency Current Gain.

Collector-base Capacitance.

Collector Cutoff Current.

\[ V_{CE} = V_{CE(sat)} \]

\[ I_C = 10 \times I_B \]

\[ V_{CE} = 10 \text{V} \]

\[ f = 100 \text{MHz} \]

\[ I_C = 10 \times I_B \]

\[ V_{CE} = V_{CE(sat)} \]

\[ I_C = 10 \times I_B \]

\[ V_{CE} = 40 \text{V} \]

\[ T_{amb} = (\degree \text{C}) \]
Test Circuit for $t_{on}$, $t_{off}$.

- Pulse generator:
  - $t_0, t_{r} \leq 1.0$ ns
  - $\text{PW} = 10$ μs
  - $Z_n = 50 \ \Omega$
  - DC $< 2 \%$

- To oscilloscope:
  - $t_0 < 1.0$ ns
  - $Z_n \geq 100 \ \text{k} \Omega$
DESCRIPTION
The BSS71S is a silicon planar epitaxial NPN transistor in JEC TO-18 metal case. It is designed for high voltage amplifier and switching applications at current levels from 100 µA to 100 mA. The complementary PNP type is the BSS74S.

INTERNAL SCHEMATIC DIAGRAM

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_CBO</td>
<td>Collector-base Voltage</td>
<td>200</td>
<td>V</td>
</tr>
<tr>
<td>V_CEO</td>
<td>Collector-emitter Voltage</td>
<td>200</td>
<td>V</td>
</tr>
<tr>
<td>V_EBO</td>
<td>Emitter-base Voltage</td>
<td>6</td>
<td>V</td>
</tr>
<tr>
<td>I_C</td>
<td>Collector Current</td>
<td>200</td>
<td>mA</td>
</tr>
<tr>
<td>I_B</td>
<td>Base Current</td>
<td>50</td>
<td>mA</td>
</tr>
<tr>
<td>P_tot</td>
<td>Total Device Dissipation at T_amb ≤ 25 °C</td>
<td>0.5</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at T_case ≤ 25 °C</td>
<td>2.5</td>
<td>W</td>
</tr>
<tr>
<td>T_stg, T_j</td>
<td>Storage and Junction Temperature</td>
<td>200</td>
<td>°C</td>
</tr>
</tbody>
</table>

January 1989
### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td></td>
<td></td>
<td></td>
<td>70</td>
<td>°C/W</td>
</tr>
</tbody>
</table>

### ELECTRICAL CHARACTERISTICS ($T_{amb} = 25$ °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = -150$ V</td>
<td></td>
<td></td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td>$I_{CEO}$</td>
<td>Collector Cutoff Current ($I_B = 0$)</td>
<td>$V_{CE} = -150$ V</td>
<td></td>
<td></td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td>$I_{EBO}$</td>
<td>Emitter Cutoff Current ($I_C = 0$)</td>
<td>$V_{BE} = 5$ V</td>
<td></td>
<td></td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-emitter Saturation Voltage ($I_E = 0$)</td>
<td>$I_C = -100$ µA</td>
<td>$-200$</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CEO}$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = -2$ mA</td>
<td>$-200$</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = -100$ µA</td>
<td>$-6$</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE(sat)}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = -10$ mA</td>
<td>$I_B = -1$ mA</td>
<td>$-0.3$</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -30$ mA</td>
<td>$I_B = -3$ mA</td>
<td>$-0.4$</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -50$ mA</td>
<td>$I_B = -5$ mA</td>
<td>$-0.5$</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE(sat)}$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = -10$ mA</td>
<td>$I_B = -1$ mA</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -30$ mA</td>
<td>$I_B = -3$ mA</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -50$ mA</td>
<td>$I_B = -5$ mA</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$h_{FE}$</td>
<td>DC Current Gain</td>
<td>$I_C = -1$ mA</td>
<td>$V_{CE} = -10$ V</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -10$ mA</td>
<td>$V_{CE} = -10$ V</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -30$ mA</td>
<td>$V_{CE} = -10$ V</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = -20$ mA</td>
<td>$V_{CE} = -20$ V</td>
<td>50</td>
<td>200</td>
<td>MHz</td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$</td>
<td>$V_{CB} = -20$ V</td>
<td>3.5</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 1$ MHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_C = 0$</td>
<td>$V_{EB} = -0.5$ V</td>
<td>45</td>
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<td>pF</td>
</tr>
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<td></td>
<td></td>
<td>$f = 1$ MHz</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>$t_{on}$</td>
<td>Turn-on Time</td>
<td>$I_C = -50$ mA</td>
<td>$I_{B1} = -10$ mA</td>
<td>100</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CC} = -100$ V</td>
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<td></td>
</tr>
<tr>
<td>$t_{off}$</td>
<td>Turn-off Time</td>
<td>$I_C = -50$ mA</td>
<td>$I_{B2} = -10$ mA</td>
<td>400</td>
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<td>ns</td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 µs, duty cycle = 1 %.
DESCRIPTION
The BSS72S is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case. It is designed for high voltage amplifier and switching applications at current levels from 100 μA to 100 mA. The complementary PNP type is the BSS75S.

INTERNAL SCHEMATIC DIAGRAM

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_CBO</td>
<td>Collector-base Voltage</td>
<td>200</td>
<td>V</td>
</tr>
<tr>
<td>V_CEO</td>
<td>Collector-emitter Voltage</td>
<td>200</td>
<td>V</td>
</tr>
<tr>
<td>V_EBO</td>
<td>Emitter-base Voltage</td>
<td>6</td>
<td>V</td>
</tr>
<tr>
<td>I_C</td>
<td>Collector Current</td>
<td>200</td>
<td>mA</td>
</tr>
<tr>
<td>I_B</td>
<td>Base Current</td>
<td>50</td>
<td>mA</td>
</tr>
<tr>
<td>P_tot</td>
<td>Total Device Dissipation at T_{amb} ≤ 25°C at T_{case} ≤ 25°C</td>
<td>0.5</td>
<td>W</td>
</tr>
<tr>
<td>T_{stg, T_j}</td>
<td>Storage and Junction Temperature</td>
<td>-65 to 200</td>
<td>°C</td>
</tr>
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</table>
**THERMAL DATA**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>°C/W</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th,j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td></td>
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<td>70</td>
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</table>

**ELECTRICAL CHARACTERISTICS (T\textsubscript{amb} = 25 °C unless otherwise specified)**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = 150$ V</td>
<td>50</td>
<td></td>
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<td>nA</td>
</tr>
<tr>
<td>$I_{CEO}$</td>
<td>Collector Cutoff Current ($I_B = 0$)</td>
<td>$V_{CE} = 150$ V</td>
<td>500</td>
<td></td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td>$I_{EBO}$</td>
<td>Emitter Cutoff Current ($I_C = 0$)</td>
<td>$V_{BE} = 5$ V</td>
<td>50</td>
<td></td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = 100$ μA</td>
<td>200</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CEO}$*</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = 10$ mA</td>
<td>200</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = 100$ μA</td>
<td>6</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE(sat)}$*</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = 10$ mA</td>
<td>$I_B = 1$ mA</td>
<td>0.3</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{BE(sat)}$*</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = 30$ mA</td>
<td>$I_B = 3$ mA</td>
<td>0.4</td>
<td>V</td>
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</tr>
<tr>
<td>$V_{BE(sat)}$*</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = 50$ mA</td>
<td>$I_B = 5$ mA</td>
<td>0.5</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$h_{FE}$*</td>
<td>DC Current Gain</td>
<td>$I_C = 1$ mA</td>
<td>$V_{CE} = 10$ V</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{CE}$*</td>
<td>Transition Frequency</td>
<td>$I_C = 20$ mA</td>
<td>$V_{CE} = 10$ V</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$</td>
<td>$V_{CB} = 20$ V</td>
<td>3.5</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_C = 0$</td>
<td>$V_{EB} = 0.5$ V</td>
<td>45</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>$t_{on}$</td>
<td>Turn-on Time</td>
<td>$I_C = 50$ mA</td>
<td>$I_{B1} = 10$ mA</td>
<td>100</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$t_{off}$</td>
<td>Turn-off Time</td>
<td>$I_C = 50$ mA</td>
<td>$I_{B1} = -I_{B2} = -10$ mA</td>
<td>400</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1 %. 

---

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DESCRIPTION
The BSS74S is a silicon planar epitaxial PNP transistor in JEDC TO-18 metal case. It is designed for high voltage amplifier and switching applications at current levels from 100 µA to 100 mA. The complementary NPN type is the BSS71S.

INTERNAL SCHEMATIC DIAGRAM

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{CBO}</td>
<td>Collector-base Voltage</td>
<td>-200</td>
<td>V</td>
</tr>
<tr>
<td>V_{CEO}</td>
<td>Collector-emitter Voltage</td>
<td>-200</td>
<td>V</td>
</tr>
<tr>
<td>V_{EBO}</td>
<td>Emitter-base Voltage</td>
<td>-6</td>
<td>V</td>
</tr>
<tr>
<td>I_C</td>
<td>Collector Current</td>
<td>-100</td>
<td>mA</td>
</tr>
<tr>
<td>I_B</td>
<td>Base Current</td>
<td>-50</td>
<td>mA</td>
</tr>
<tr>
<td>P_{tot}</td>
<td>Total Device Dissipation at T_{amb} ≤ 25 °C</td>
<td>0.5</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at T_{case} ≤ 25 °C</td>
<td>2.5</td>
<td>W</td>
</tr>
<tr>
<td>T_{stg}, T_{j}</td>
<td>Storage and Junction Temperature</td>
<td>-65 to 200</td>
<td>°C</td>
</tr>
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</table>

January 1989
## THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>( I_{CBO} )</td>
<td>Collector Cutoff Current ((I_E = 0))</td>
<td>( V_{CB} = -150 ) V</td>
<td>-50</td>
<td>nA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( I_{CEO} )</td>
<td>Collector Cutoff Current ((I_B = 0))</td>
<td>( V_{CE} = -150 ) V</td>
<td>-500</td>
<td>nA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( I_{EBO} )</td>
<td>Emitter Cutoff Current ((I_C = 0))</td>
<td>( V_{BE} = 5 ) V</td>
<td>-50</td>
<td>nA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( V_{(BR)CBO} )</td>
<td>Collector-base Breakdown Voltage ((I_E = 0))</td>
<td>( I_C = -100 ) ( \mu A )</td>
<td>-200</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>( V_{(BR)CEO}^* )</td>
<td>Collector-emitter Breakdown Voltage ((I_B = 0))</td>
<td>( I_C = -2 ) mA</td>
<td>-200</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>( V_{(BR)EBO} )</td>
<td>Emitter-base Breakdown Voltage ((I_C = 0))</td>
<td>( I_E = -100 ) ( \mu A )</td>
<td>-6</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>( V_{CE(sat)}^* )</td>
<td>Collector-emitter Saturation Voltage</td>
<td>( I_C = -10 ) mA ( I_B = -1 ) mA</td>
<td>-0.3</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( V_{BE(sat)}^* )</td>
<td>Base-emitter Saturation Voltage</td>
<td>( I_C = -10 ) mA ( I_B = -1 ) mA</td>
<td>-0.8</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( h_{FE}^* )</td>
<td>DC Current Gain</td>
<td>( I_C = -100 ) ( \mu A ) ( V_{CE} = -1 ) V</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( f_T )</td>
<td>Transition Frequency ((f = 20 ) MHz)</td>
<td>( I_C = -20 ) mA ( V_{CE} = -20 ) V</td>
<td>50</td>
<td>200</td>
<td>MHz</td>
<td></td>
</tr>
<tr>
<td>( C_{CBO} )</td>
<td>Collector-base Capacitance ((f = 0 ) MHz)</td>
<td>( I_E = 0 ) ( V_{CB} = -20 ) V</td>
<td>3.5</td>
<td></td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>( C_{EBO} )</td>
<td>Emitter-base Capacitance ((f = 1 ) MHz)</td>
<td>( I_C = 0 ) ( V_{EB} = -0.5 ) V</td>
<td>45</td>
<td></td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>( t_{on} )</td>
<td>Turn-on Time ((f = 1 ) MHz)</td>
<td>( I_C = -50 ) mA ( I_{B1} = -10 ) mA ( V_{CC} = -100 ) V</td>
<td>100</td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>( t_{off} )</td>
<td>Turn-off Time ((f = 1 ) MHz)</td>
<td>( I_C = -500 ) mA ( I_{B1} = -I_{B2} = -10 ) mA ( V_{CC} = -100 ) V</td>
<td>400</td>
<td></td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

*T Pulsed: pulse duration = 300 \( \mu \)s, duty cycle = 1%.
DESCRIPTION
The BSS75S is a silicon planar epitaxial PNP transistor in Jedec TO-18 metal case. It is designed for high voltage amplifier and switching applications at current levels from 100 μA to 100 mA. The complementary NPN type is the BSS72S.

INTERNAL SCHEMATIC DIAGRAM

ABSOLUTE MAXIMUM RATINGS

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<tr>
<th>Symbol</th>
<th>Parameter</th>
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<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage</td>
<td>− 200</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage</td>
<td>− 200</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage</td>
<td>− 6</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>− 100</td>
<td>mA</td>
</tr>
<tr>
<td>$I_B$</td>
<td>Base Current</td>
<td>− 50</td>
<td>mA</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Device Dissipation at $T_{amb} \leq 25 ^\circ C$</td>
<td>0.5</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 ^\circ C$</td>
<td>2.5</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg, T_j}$</td>
<td>Storage and Junction Temperature</td>
<td>− 65 to 200</td>
<td>°C</td>
</tr>
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</table>
**THERMAL DATA**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter Description</th>
<th>Max</th>
<th>°C/W</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

**ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter Description</th>
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<th>Unit</th>
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<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = -150$ V</td>
<td>-50</td>
<td>nA</td>
<td></td>
<td></td>
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<tr>
<td>$I_{CEO}$</td>
<td>Collector Cutoff Current ($I_B = 0$)</td>
<td>$V_{CE} = -150$ V</td>
<td>-500</td>
<td>nA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{EBO}$</td>
<td>Emitter Cutoff Current ($I_C = 0$)</td>
<td>$V_{BE} = 5$ V</td>
<td>-50</td>
<td>nA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-emitter Saturation Voltage ($I_E = 0$)</td>
<td>$I_C = -100$ μA</td>
<td>-200</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CEO}^*$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = -2$ mA</td>
<td>-200</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = -100$ μA</td>
<td>-6</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{CE(sat)}^*$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = -10$ mA $I_B = -1$ mA</td>
<td>-0.3</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -30$ mA $I_B = -3$ mA</td>
<td>-0.4</td>
<td>V</td>
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<tr>
<td></td>
<td></td>
<td>$I_C = -50$ mA $I_B = -5$ mA</td>
<td>-0.5</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{BE(sat)}^*$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = -10$ mA $I_B = -1$ mA</td>
<td>-0.8</td>
<td>V</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>$I_C = -30$ mA $I_B = -3$ mA</td>
<td>-0.9</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -50$ mA $I_B = -5$ mA</td>
<td>-1</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$h_{FE}^*$</td>
<td>DC Current Gain</td>
<td>$I_C = -1$ mA $V_{CE} = -10$ V</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -10$ mA $V_{CE} = -10$ V</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -30$ mA $V_{CE} = -10$ V</td>
<td>40</td>
<td></td>
<td></td>
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<tr>
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</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = -20$ mA $f = 20$ MHz</td>
<td>50</td>
<td></td>
<td>200</td>
<td>MHz</td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$ $f = 1$ MHz</td>
<td>3.5</td>
<td>pF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_C = 0$ $f = 1$ MHz</td>
<td>45</td>
<td>pF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{on}$</td>
<td>Turn-on Time</td>
<td>$I_C = -50$ mA $I_{B1} = -10$ mA $V_{CC} = -100$ V</td>
<td>100</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{off}$</td>
<td>Turn-off Time</td>
<td>$I_C = -50$ mA $I_{B1} = -10$ mA $V_{CC} = -100$ V</td>
<td>400</td>
<td>ns</td>
<td></td>
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</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1%.
DESCRIPTION
The BSV15 and BSV16 are silicon planar epitaxial PNP transistors in Jeder TO-39 metal case, intended for use in medium power general industrial applications.

ABSOLUTE MAXIMUM RATINGS

<table>
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<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>BSV15</td>
<td>BSV16</td>
</tr>
<tr>
<td>V_{CES}</td>
<td>Collector-emitter Voltage (V_{BE} = 0)</td>
<td>- 40</td>
<td>- 60</td>
</tr>
<tr>
<td>V_{CEO}</td>
<td>Collector-emitter Voltage (I_{B} = 0)</td>
<td>- 40</td>
<td>- 60</td>
</tr>
<tr>
<td>V_{EBO}</td>
<td>Emitter-base Voltage (I_{C} = 0)</td>
<td>- 5</td>
<td>V</td>
</tr>
<tr>
<td>I_{C}</td>
<td>Collector Current</td>
<td>- 1</td>
<td>A</td>
</tr>
<tr>
<td>I_{B}</td>
<td>Base Current</td>
<td>- 0.2</td>
<td>A</td>
</tr>
<tr>
<td>P_{tot}</td>
<td>Total Power Dissipation at T_{case} ≤ 25 °C</td>
<td>5</td>
<td>W</td>
</tr>
<tr>
<td>T_{stg}, T_{j}</td>
<td>Storage and Junction Temperature</td>
<td>- 65 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>

October 1988
## THERMAL DATA

<table>
<thead>
<tr>
<th></th>
<th>Thermal Resistance Junction-case</th>
<th>Max</th>
<th>°C/W</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th j-case}$</td>
<td></td>
<td>35</td>
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</tr>
<tr>
<td>$R_{th j-amb}$</td>
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## ELECTRICAL CHARACTERISTICS ($T_{amb} = 25$ °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$I_{CES}$</td>
<td>Collector Cutoff Current ($V_{BE} = 0$)</td>
<td>for BSV 15 $V_{CE} = -40 V$ $T_{amb} = 150$ °C</td>
<td>-0.1</td>
<td>µA</td>
<td>-50</td>
<td>µA</td>
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<td>for BSV 16 $V_{CE} = -60 V$ $T_{amb} = 150$ °C</td>
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<td>µA</td>
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<td>$V_{(BR)CES}$</td>
<td>Collector-emitter Breakdown Voltage ($V_{BE} = 0$)</td>
<td>$I_C = -10$ µA for BSV 15</td>
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<td>-60</td>
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<td>$V_{CEO (sus)}$</td>
<td>Collector-emitter Sustaining Voltage ($I_B = 0$)</td>
<td>$I_C = -10$ mA for BSV 15</td>
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<td>-60</td>
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<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
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<td>$V_{CE (sat)}$</td>
<td>Collector-emitter Saturation Voltage</td>
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<td>$V_{BE}$</td>
<td>Base-emitter Voltage</td>
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<td>$h_{FE}$</td>
<td>DC Current Gain</td>
<td>$I_C = -0.1$ mA $V_{CE} = -1$ V Gr. 6</td>
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* Pulsed : pulse duration = 300 µs, duty cycle = 1 %.
### ELECTRICAL CHARACTERISTICS (continued)

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<th>Symbol</th>
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<th>Typ.</th>
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<td>DC Current Gain</td>
<td>$I_C = -500 \text{ mA}$ $V_{CE} = -1 \text{ V}$</td>
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<td>40</td>
<td>25</td>
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<td>Gr. 6</td>
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<td>Gr. 10</td>
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<td>Gr. 16</td>
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<td>hfe</td>
<td>Small Signal Current Gain</td>
<td>$I_C = -1 \text{ mA}$ $f = 1 \text{ KHz}$ $V_{CE} = -5 \text{ V}$</td>
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<td>fT</td>
<td>Transition Frequency</td>
<td>$I_C = -50 \text{ mA}$ $f = 20 \text{ MHz}$ $V_{CE} = -1 \text{ V}$</td>
<td>50</td>
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<td>C_EBO</td>
<td>Emitter-base Capacitance</td>
<td>$I_C = 0$ $f = 1 \text{ MHz}$ $V_{EB} = -0.5 \text{ V}$</td>
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<td>C_CBO</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$ $f = 1 \text{ MHz}$ $V_{CB} = -10 \text{ V}$</td>
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<td>Storage Time</td>
<td>$I_C = -100 \text{ mA}$ $V_{CC} = -20 \text{ V}$</td>
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<td>t_f **</td>
<td>Fall Time</td>
<td>$I_C = -100 \text{ mA}$ $I_{B1} = -I_{B2} = -5 \text{ mA}$</td>
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<td>t_on **</td>
<td>Turn-on Time</td>
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</table>

** See test circuit.

Test Circuit for $t_s$, $t_f$ and $t_{on}$.

![Test Circuit Diagram]

- **PULSE GENERATOR:**
  - $t_b \geq 10 \mu$s
  - $t \leq 15 \text{ ns}$
  - $t = 15 \text{ ns}$
  - $Z_s = 50 \Omega$

- **TO OSCILLOSCOPE:**
  - $t_r \leq 15 \text{ ns}$
  - $Z_m \geq 100 \text{ K} \Omega$

---

SGS-THOMSON MICROELECTRONICS

3/4
Safe Operating Areas.

Collector-emitter Saturation Voltage.

Base-emitter Saturation Voltage.

Transition Frequency.

DC Current Gain.
DESCRIPTION
The BSX19 and BSX20 are silicon planar epitaxial NPN transistors in Jedec TO-18 metal case. They are primarily intended for very high speed saturated switching applications.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
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<tbody>
<tr>
<td>(V_{CBO})</td>
<td>Collector-base Voltage ((I_E = 0))</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>(V_{CES})</td>
<td>Collector-emitter Voltage ((V_{BE} = 0))</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>(V_{CEO})</td>
<td>Collector-emitter Voltage ((I_B = 0))</td>
<td>15</td>
<td>V</td>
</tr>
<tr>
<td>(V_{EBO})</td>
<td>Emitter-base Voltage ((I_C = 0))</td>
<td>4.5</td>
<td>V</td>
</tr>
<tr>
<td>(I_{CM})</td>
<td>Collector Peak Current ((t = 10 \mu s))</td>
<td>0.5</td>
<td>A</td>
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<tr>
<td>(P_{tot})</td>
<td>Total Power Dissipation at (T_{amb} \leq 25 ^\circ C)</td>
<td>0.36</td>
<td>W</td>
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<tr>
<td>()</td>
<td>at (T_{case} \leq 25 ^\circ C)</td>
<td>1.2</td>
<td>W</td>
</tr>
<tr>
<td>(T_{stg}, T_j)</td>
<td>Storage and Junction Temperature</td>
<td>− 65 to 200</td>
<td>°C</td>
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### THERMAL DATA

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<th>Typ.</th>
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<th>Unit</th>
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<tbody>
<tr>
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<td>Thermal Resistance Junction-case</td>
<td>Max</td>
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<td>Max</td>
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### ELECTRICAL CHARACTERISTICS ($T_{amb} = 25$ °C unless otherwise specified)

<table>
<thead>
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<th>Parameter</th>
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<th>Unit</th>
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<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = 20$ V</td>
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<td>Collector Cutoff Current ($V_{BE} = -3$ V)</td>
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<td>µA</td>
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<tr>
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<td>$V_{CE(sat)}^*$</td>
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<td>$f_T$</td>
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<td>MHz</td>
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<td>MHz</td>
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</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter–base Capacitance</td>
<td>$I_C = 0$</td>
<td>4.5</td>
<td>pF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{BO}$</td>
<td>Collector–base Capacitance</td>
<td>$I_E = 0$</td>
<td>4</td>
<td>pF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_s^{**}$</td>
<td>Storage Time</td>
<td>$I_C = 10$ mA</td>
<td>5</td>
<td>ns</td>
<td>10</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CC} = 10$ V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{B1} = -I_{B2} = 10$ mA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>for BSX19</td>
<td>6</td>
<td></td>
<td>13</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td>for BSX20</td>
<td></td>
<td></td>
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</table>

* Pulsed: pulse duration = 300µs, duty cycle = 1%
** See test circuit.
## ELECTRICAL CHARACTERISTICS (continued)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t_{on}$</td>
<td>Turn-on Time</td>
<td>$I_C = 10 \ mA$, $I_{B1} = 3 \ mA$, $I_C = 100 \ mA$, $I_{B1} = 40 \ mA$, $V_{CC} = 3 \ V$</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CC} = 6 \ V$</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>ns</td>
</tr>
</tbody>
</table>

| $t_{off}$ | Turn-off Time   | $I_C = 10 \ mA$, $I_{B1} = 3 \ mA$, $I_{B2} = -1.5 \ mA$, $I_C = 100 \ mA$, $I_{B1} = 40 \ mA$, $I_{B2} = -20 \ mA$, $V_{CC} = 3 \ V$, $V_{CC} = 6 \ V$ | 15   | 18   | 18   | ns   |
|           |                   | for BSX19, for BSX20 | 18   | 21   | 21   | ns   |

Collector-emitter Saturation Voltage.

![Collector-emitter Saturation Voltage](image1)

Base-emitter Saturation Voltage.

![Base-emitter Saturation Voltage](image2)

DC Current Gain.

![DC Current Gain](image3)

DC Current Gain (for BSX19 only).

![DC Current Gain for BSX19 only](image4)
BSX19-BSX20

DC Current Gain (for BSX20 only).

Transition Frequency.

Test circuit for \( t_s \).
DESCRIPTION
The BSX26 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case. It is designed for switching applications up to 500 mA.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CES}$</td>
<td>Collector-emitter Voltage ($V_{BE} = 0$)</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>15</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>4</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>500</td>
<td>mA</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 , ^\circ C$</td>
<td>0.36</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 , ^\circ C$</td>
<td>1.2</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 100 , ^\circ C$</td>
<td>0.68</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg, T_j}$</td>
<td>Storage and Junction Temperature</td>
<td>−65 to 200</td>
<td>°C</td>
</tr>
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November 1988
### THERMAL DATA

<table>
<thead>
<tr>
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<th>Parameter</th>
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<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>R_{th j-case}</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>146</td>
<td>°C/W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R_{th j-amb}</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>486</td>
<td>°C/W</td>
<td></td>
<td></td>
</tr>
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### ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>I_{CES}</td>
<td>Collector Cutoff Current (V_{BE} = 0)</td>
<td>V_{CE} = 20 V</td>
<td>0.5</td>
<td>μA</td>
<td>15</td>
<td>μA</td>
</tr>
<tr>
<td>V_{(BR)CBO}</td>
<td>Collector-base Breakdown Voltage (I_{E} = 0)</td>
<td>I_{C} = 100 μA</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V_{(BR)CES}</td>
<td>Collector-emitter Breakdown Voltage (V_{BE} = 0)</td>
<td>I_{C} = 100 μA</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V_{(BR)CEO}</td>
<td>Collector-emitter Breakdown Voltage (I_{B} = 0)</td>
<td>I_{C} = 10 mA</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V_{(BR)EBO}</td>
<td>Emitter-base Breakdown Voltage (I_{C} = 0)</td>
<td>I_{E} = 100 μA</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V_{CE(sat)}</td>
<td>Collector-emitter Saturation Voltage</td>
<td>I_{C} = 30 mA</td>
<td>0.16</td>
<td>V</td>
<td>0.18</td>
<td></td>
</tr>
<tr>
<td>V_{BE(sat)}</td>
<td>Base-emitter Saturation Voltage</td>
<td>I_{C} = 30 mA</td>
<td>0.82</td>
<td>V</td>
<td>0.95</td>
<td></td>
</tr>
<tr>
<td>h_{FE}</td>
<td>DC Current Gain</td>
<td>I_{C} = 30 mA</td>
<td>30</td>
<td>120</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f_{T}</td>
<td>Transition Frequency</td>
<td>I_{C} = 30 mA</td>
<td>350</td>
<td>MHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C_{EBO}</td>
<td>Emitter-base Capacitance</td>
<td>I_{E} = 0 f = 1 MHz</td>
<td>6.5</td>
<td>pF</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>C_{CBO}</td>
<td>Collector-base Capacitance</td>
<td>I_{E} = 0 f = 1 MHz</td>
<td>3.3</td>
<td>pF</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>t_{s}</td>
<td>Storage Time</td>
<td>I_{C} = 10 mA</td>
<td>8</td>
<td>ns</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>t_{on}</td>
<td>Turn-on Time</td>
<td>I_{C} = 300 mA</td>
<td>9</td>
<td>ns</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>t_{off}</td>
<td>Turn-off Time</td>
<td>I_{C} = 300 mA</td>
<td>15</td>
<td>ns</td>
<td>25</td>
<td></td>
</tr>
</tbody>
</table>

*Pulsed: pulse duration = 300μs, duty cycle = 1%  
** See test circuit.
DC Current Gain.

Collector-emitter Saturation Voltage.

Base-emitter Saturation Voltage.

Emitter-base and Collector-base Capacitances.

Contours of Constant Transition Frequency.

Switching Characteristics.
Test circuit for $t_{on}, t_{off}$.

PULSE GENERATOR:
- $t_c, t_f < 1.0\,\text{ns}$
- $PW \geq 240\,\text{ns}$
- $Z_{IN} = 50\,\Omega$

TO OSCILLOSCOPE:
- $t_c < 1.0\,\text{ns}$
- $Z_{IN} = 100\,\text{K}\Omega$
DESCRIPTION
The BSX28 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case. It is designed specifically for high speed saturated switching applications.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{CBO}</td>
<td>Collector-base Voltage (I_E = 0)</td>
<td>30</td>
<td>V</td>
</tr>
<tr>
<td>V_{CES}</td>
<td>Collector-emitter Voltage (V_{BE} = 0)</td>
<td>30</td>
<td>V</td>
</tr>
<tr>
<td>V_{CEO}</td>
<td>Collector-emitter Voltage (I_B = 0)</td>
<td>12</td>
<td>V</td>
</tr>
<tr>
<td>V_{EBO}</td>
<td>Emitter-base Voltage (I_C = 0)</td>
<td>4.5</td>
<td>V</td>
</tr>
<tr>
<td>I_C</td>
<td>Collector Current</td>
<td>500</td>
<td>mA</td>
</tr>
<tr>
<td>P_{tot}</td>
<td>Total Power Dissipation at T_{amb} \leq 25 , ^\circ C</td>
<td>0.36</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at T_{case} \leq 25 , ^\circ C</td>
<td>1.2</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at T_{case} \leq 100 , ^\circ C</td>
<td>0.68</td>
<td>W</td>
</tr>
<tr>
<td>T_{stg, T_j}</td>
<td>Storage and Junction Temperature</td>
<td>-65 to 200</td>
<td>^\circ C</td>
</tr>
</tbody>
</table>

November 1988
### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th} \ j$-case</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>146</td>
<td>°C/W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_{th} \ j$-amb</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>486</td>
<td>°C/W</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### ELECTRICAL CHARACTERISTICS (T<sub>amb</sub> = 25 °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CES}$</td>
<td>Collector Cutoff Current ($V_{BE} = 0$)</td>
<td>$V_{CE} = 20, \text{V}$</td>
<td>0.4</td>
<td>μA</td>
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<td></td>
</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_{E} = 0$)</td>
<td>$I_{C} = 10, \mu\text{A}$</td>
<td>30</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CES}$</td>
<td>Collector-emitter Breakdown Voltage ($V_{BE} = 0$)</td>
<td>$I_{C} = 10, \mu\text{A}$</td>
<td>30</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CEO}$</td>
<td>Collector-emitter Breakdown Voltage ($I_{B} = 0$)</td>
<td>$I_{C} = 10, \text{mA}$</td>
<td>12</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_{C} = 0$)</td>
<td>$I_{E} = 100, \mu\text{A}$</td>
<td>4.5</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE(sat)}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_{C} = 10, \text{mA}$</td>
<td>0.15</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE(sat)}$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_{C} = 10, \text{mA}$</td>
<td>0.8</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$h_{FE}$</td>
<td>DC Current Gain</td>
<td>$I_{C} = 10, \text{mA}$</td>
<td>0.72</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$f_{T}$</td>
<td>Transition Frequency</td>
<td>$I_{C} = 20, \text{mA}$</td>
<td>400</td>
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<td>MHz</td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_{E} = 0$</td>
<td>2.3</td>
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<td></td>
<td>pF</td>
</tr>
<tr>
<td>$t_{s}$</td>
<td>Storage Time</td>
<td>$I_{C} = 10, \text{mA}$</td>
<td>6.5</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$t_{on}$</td>
<td>Turn-on Time</td>
<td>$I_{C} = 30, \text{mA}$</td>
<td>9</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$t_{off}$</td>
<td>Turn-off Time</td>
<td>$I_{C} = 30, \text{mA}$</td>
<td>13</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 ms, duty cycle = 1%.
DC Current Gain.

Base-emitter Saturation Voltage.

Contours of Constant Transition Frequency.

Collector-emitter Saturation Voltage.

Emitter-base and Collector-base Capacitances.

Switching Characteristics.
DESCRIPTION
The BSX29 is a silicon planar epitaxial PNP transistor in Jedec TO-18 metal case. It is designed for saturated and nonsaturated switching circuits requiring up to 200mA of collector current.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{CBO}</td>
<td>Collector-base Voltage (I_E = 0)</td>
<td>-12</td>
<td>V</td>
</tr>
<tr>
<td>V_{CES}</td>
<td>Collector-emitter Voltage (V_{BE} = 0)</td>
<td>-12</td>
<td>V</td>
</tr>
<tr>
<td>V_{CEO}</td>
<td>Collector-emitter Voltage (I_B = 0)</td>
<td>-12</td>
<td>V</td>
</tr>
<tr>
<td>V_{EBO}</td>
<td>Emitter-base Voltage (I_C = 0)</td>
<td>-4</td>
<td>V</td>
</tr>
<tr>
<td>I_C</td>
<td>Collector Current</td>
<td>-200</td>
<td>mA</td>
</tr>
<tr>
<td>P_{tot}</td>
<td>Total Power Dissipation at T_{amb} ≤ 25 °C at T_{case} ≤ 25 °C</td>
<td>0.36</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.2</td>
<td>W</td>
</tr>
<tr>
<td>T_{stg}, T_j</td>
<td>Storage and Junction Temperature</td>
<td>-65 to 200</td>
<td>°C</td>
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</tbody>
</table>

December 1988
**THERMAL DATA**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
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<th>Max.</th>
<th>Unit</th>
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<tr>
<td>$R_{th\ j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td></td>
<td>Max</td>
<td>146</td>
<td></td>
<td>°C/W</td>
</tr>
<tr>
<td>$R_{th\ j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td></td>
<td>Max</td>
<td>486</td>
<td></td>
<td>°C/W</td>
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**ELECTRICAL CHARACTERISTICS** \(T_{\text{amb}} = 25\ °\text{C}\) unless otherwise specified

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<tr>
<th>Symbol</th>
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<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{\text{CES}}$</td>
<td>Collector Cutoff Current ((V_{\text{BE}} = 0))</td>
<td>$V_{\text{CE}} = -6\ \text{V}$ (T_{\text{amb}} = 85\ °\text{C})</td>
<td></td>
<td></td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td>$V_{(BR)\text{CBO}}$</td>
<td>Collector-base Breakdown Voltage ((I_E = 0))</td>
<td>$I_C = -10\ \mu\text{A}$</td>
<td>-12</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)\text{CES}}$</td>
<td>Collector-emitter Breakdown Voltage ((V_{\text{BE}} = 0))</td>
<td>$I_C = -10\ \mu\text{A}$</td>
<td>-12</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)\text{CEO}}$</td>
<td>Collector-emitter Breakdown Voltage ((I_B = 0))</td>
<td>$I_C = -10\ \text{mA}$</td>
<td>-12</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)\text{EBO}}$</td>
<td>Emitter-base Breakdown Voltage ((I_C = 0))</td>
<td>$I_E = -100\ \mu\text{A}$</td>
<td>-4</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{\text{CE(sat)}}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{\text{BE(sat)}}$</td>
<td>Base-emitter Saturation Voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$h_{\text{FE}}$</td>
<td>DC Current Gain</td>
<td></td>
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</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td></td>
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<td></td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td>$C_{\text{EBO}}$</td>
<td>Emitter-base Capacitance</td>
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<td></td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$C_{\text{CBO}}$</td>
<td>Collector-base Capacitance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$t_{\text{on}}$</td>
<td>Turn-on Time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$t_{\text{off}}$</td>
<td>Turn-off Time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ns</td>
</tr>
</tbody>
</table>

*Pulsed: pulse duration = 300μs, duty cycle = 1%.

** See test circuit.
DC Current Gain.

Collector-emitter Saturation Voltage.

Base-emitter Saturation Voltage.

Emitter-base and Collector-base Capacitances.

Contours of Constant Transition Frequency.

Switching Characteristics.
TEST CIRCUIT

Test circuit for $t_{on}$, $t_{off}$.

![Circuit Diagram]

PULSE GENERATOR:
- $t_r \leq 1.0\text{ns}$
- $PW = 400\text{ns}$
- $Z_{IN} = 50\Omega$

$t_{on} V_{BB} = +3.0V, V_{IN} = -7.0V$
$t_{off} V_{BB} = -4.0V, V_{IN} = +6.0V$

TO OSCILLOSCOPE:
- $t_r \leq 1.0\text{ns}$
- $Z_{IN} \geq 100K\Omega$
DESCRIPTION
The BSX32 is a silicon planar epitaxial NPN transistor in Jedec TO-39 metal case. It is designed for high voltage, high current switching appli-

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>65</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>6</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>1</td>
<td>mA</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 \ ^\circ C$</td>
<td>0.8</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 \ ^\circ C$</td>
<td>3.5</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}$, $T_J$</td>
<td>Storage and Junction Temperature</td>
<td>-55 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>

October 1988
### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{\text{th},j\text{-case}}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>50</td>
<td>°C/W</td>
<td></td>
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<tr>
<td>$R_{\text{th},j\text{-amb}}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>219</td>
<td>°C/W</td>
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### ELECTRICAL CHARACTERISTICS ($T_{\text{amb}} = 25$ °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
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<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = 50$ V</td>
<td>0.25</td>
<td>4</td>
<td>µA</td>
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</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = 100$ µA</td>
<td>65</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CEO}$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = 10$ mA</td>
<td>40</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = 100$ µA</td>
<td>6</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{CE(sat)}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = 100$ mA $I_B = 10$ mA</td>
<td>0.17</td>
<td>0.25</td>
<td>V</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>$I_C = 500$ mA $I_B = 50$ mA</td>
<td>0.36</td>
<td>0.5</td>
<td>V</td>
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<tr>
<td></td>
<td></td>
<td>$I_C = 1$ A $I_B = 100$ mA</td>
<td>0.6</td>
<td>0.85</td>
<td>V</td>
<td></td>
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<tr>
<td>$V_{BE(sat)}$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = 100$ mA $I_B = 10$ mA</td>
<td>0.8</td>
<td>0.9</td>
<td>V</td>
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<tr>
<td></td>
<td></td>
<td>$I_C = 500$ mA $I_B = 50$ mA</td>
<td>1.5</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 1$ A $I_B = 100$ mA</td>
<td>2</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$h_{FE}$</td>
<td>DC Current Gain</td>
<td>$I_C = 10$ mA $V_{CE} = 1$ V</td>
<td>30</td>
<td>60</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 100$ mA $V_{CE} = 1$ V</td>
<td>60</td>
<td>90</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 500$ mA $V_{CE} = 1$ V</td>
<td>25</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 1$ A $V_{CE} = 5$ V</td>
<td>20</td>
<td>60</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = 1$ V $T_{\text{amb}} = -55$ °C</td>
<td>30</td>
<td>45</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>$I_C = 100$ mA $I_B = 100$ mA</td>
<td>15</td>
<td>35</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 500$ mA $V_{CE} = 10$ V</td>
<td>400</td>
<td></td>
<td>MHz</td>
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<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = 50$ mA $f = 100$ MHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_C = 0$ $V_{EB} = 0.5$ V</td>
<td>40</td>
<td>55</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$ $V_{CB} = 10$ V</td>
<td>6</td>
<td>10</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>$t_{on}$</td>
<td>Turn-on Time</td>
<td>$I_C = 500$ mA $V_{CC} = 30$ V</td>
<td>22</td>
<td>35</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$t_{off}$</td>
<td>Turn-off Time</td>
<td>$I_C = 500$ mA $I_B = 50$ mA $V_{CC} = 30$ V</td>
<td>40</td>
<td>60</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 µs, duty cycle = 1%.
** See test circuit.
DC Current Gain.

Base-emitter Saturation Voltage.

Collector-emitter Saturation Voltage.

Collector-base Capacitance.
Test circuit for $t_{on}$, $t_{off}$.

PULSE GENERATOR:
$t_r, t_f \leq 1.0 \text{ ns}$
$PW = 1.0 \mu\text{s}$
$Z_{IN} = 50 \Omega$
$DC < 2\%$

TO OSCILLOSCOPE:
$t_c < 1.0 \text{ ns}$
$Z_{IN} \geq 100 K\Omega$
DESCRIPTION
The BSX33 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case, designed for high voltage and high current switching applications. It features useful current gain from 100μA to 500mA and a low saturation voltage allowing switching operation at 1A.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>85</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>55</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>7</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>1</td>
<td>A</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 , ^{\circ}C$ at $T_{case} \leq 25 , ^{\circ}C$</td>
<td>0.5</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg, T_j}$</td>
<td>Storage and Junction Temperature</td>
<td>–55 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>
**THERMAL DATA**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>R_{th,j-case}</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>97</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
<tr>
<td>R_{th,i-amb}</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>350</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
</tbody>
</table>

**ELECTRICAL CHARACTERISTICS** \((T_{amb} = 25 \, ^\circ C \text{ unless otherwise specified})\)

<table>
<thead>
<tr>
<th>Symbol</th>
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<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>I_{CBO}</td>
<td>Collector Cutoff Current ((I_E = 0))</td>
<td>(V_{CB} = 60 , V)</td>
<td>10</td>
<td>10</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>I_{EBO}</td>
<td>Emitter Cutoff Current ((I_C = 0))</td>
<td>(V_EB = 5 , V)</td>
<td>10</td>
<td></td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>(V_{(BR)CBO})</td>
<td>Collector-base Breakdown Voltage ((I_C = 0))</td>
<td>(I_C = 100 , \mu A)</td>
<td>85</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>(V_{(BR)CEO}^*)</td>
<td>Collector–emitter Breakdown Voltage ((I_B = 0))</td>
<td>(I_C = 30 , mA)</td>
<td>55</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>(V_{(BR)EBO})</td>
<td>Emitter–base Breakdown Voltage ((I_C = 0))</td>
<td>(I_E = 100 , \mu A)</td>
<td>7</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>(V_{CE(sat)}^*)</td>
<td>Collector-emitter Saturation Voltage</td>
<td>(I_C = 50 , mA) (I_B = 5 , mA)</td>
<td>0.08</td>
<td>0.3</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>(V_{BE(sat)}^*)</td>
<td>Base-emitter Saturation Voltage</td>
<td>(I_C = 50 , mA) (I_B = 5 , mA)</td>
<td>0.76</td>
<td>1.1</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>h_{FE}^*</td>
<td>DC Current Gain</td>
<td>(I_C = 100 , \mu A) (V_{CE} = 1 , V)</td>
<td>20</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>h_{ie}</td>
<td>Small Signal Current Gain</td>
<td>(I_C = 1 , mA) (f = 1 , kHz) (V_{CE} = 5 , V)</td>
<td>85</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f_{T}</td>
<td>Transition Frequency</td>
<td>(I_C = 50 , mA) (f = 20 , MHz) (V_{CE} = 10 , V)</td>
<td>60</td>
<td>90</td>
<td>MHz</td>
<td></td>
</tr>
<tr>
<td>C_{EBO}</td>
<td>Emitter-base Capacitance</td>
<td>(I_C = 0) (f = 1 , MHz) (V_{EB} = 0.5 , V)</td>
<td>50</td>
<td>80</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>C_{CBO}</td>
<td>Collector-base Capacitance</td>
<td>(I_E = 0) (f = 1 , MHz) (V_{CB} = 10 , V)</td>
<td>12</td>
<td>20</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>h_{ie}</td>
<td>Input Impedance</td>
<td>(I_C = 1 , mA) (f = 1 , kHz) (V_{CE} = 5 , V)</td>
<td>2</td>
<td></td>
<td>kΩ</td>
<td></td>
</tr>
<tr>
<td>h_{re}</td>
<td>Reverse Voltage Transfer Ratio</td>
<td>(I_C = 1 , mA) (f = 1 , kHz) (V_{CE} = 5 , V)</td>
<td>2.2 \times 10^4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h_{oe}</td>
<td>Output Admittance</td>
<td>(I_C = 1 , mA) (f = 1 , kHz) (V_{CE} = 5 , V)</td>
<td>8</td>
<td></td>
<td>μs</td>
<td></td>
</tr>
<tr>
<td>t_{on}</td>
<td>Turn-on Time</td>
<td>(I_C = 150 , mA) (I_{B1} = 7.5 , mA) (V_{CC} = 20 , V)</td>
<td>120</td>
<td>200</td>
<td>ns</td>
<td></td>
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<tr>
<td>t_{off}</td>
<td>Turn-off Time</td>
<td>(I_C = 150 , mA) (I_{B1} = - I_{B2} = 7.5 , mA)</td>
<td>350</td>
<td>800</td>
<td>ns</td>
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</tbody>
</table>

* Pulsed : pulse duration = 300μs, duty cycle = 1%.
DC Current Gain.

![DC Current Gain Graph]

Collector-emitter Saturation Voltage.

![Collector-emitter Saturation Voltage Graph]

Base-emitter Saturation Voltage.

![Base-emitter Saturation Voltage Graph]

High Frequency Current Gain.

![High Frequency Current Gain Graph]

Collector-base Capacitance.

![Collector-base Capacitance Graph]

Collector Cutoff Current.

![Collector Cutoff Current Graph]
DESCRIPTION
The BSX39 is a silicon planar epitaxial NPN transistor in Jeder TO-18 metal case. It is designed for very fast switching applications up to 500 mA.

ABSOLUTE MAXIMUM RATINGS

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<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>45</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>20</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>5</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>500</td>
<td>mA</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 ^\circ C$</td>
<td>0.36</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 ^\circ C$</td>
<td>1.2</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 100 ^\circ C$</td>
<td>0.68</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}$, $T_j$</td>
<td>Storage and Junction Temperature</td>
<td>-55 to 200</td>
<td>°C</td>
</tr>
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## THERMAL DATA

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<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tr>
<td>$R_{thj-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>146</td>
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<td>°C/W</td>
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<tr>
<td>$R_{thj-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>486</td>
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<td>°C/W</td>
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## ELECTRICAL CHARACTERISTICS ($T_{amb} = 25$ °C unless otherwise specified)

### Symbol | Parameter                                | Test Conditions | Min. | Typ. | Max. | Unit |
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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>$I_{CES}$</td>
<td>Collector Cutoff Current ($V_{BE} = 0$)</td>
<td>$V_{CE} = 20$ V, $T_{amb} = 125$ °C</td>
<td>0.1</td>
<td>30</td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td>$V_{(BR)CB}$</td>
<td>Collector-base Breakdown Voltage ($I_{E} = 0$)</td>
<td>$I_{C} = 10$ μA</td>
<td>45</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CEO}^*$</td>
<td>Collector-emitter Breakdown Voltage ($I_{B} = 0$)</td>
<td>$I_{C} = 10$ mA</td>
<td>20</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_{C} = 0$)</td>
<td>$I_{E} = 100$ μA</td>
<td>5</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE(sat)}^*$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_{c} = 30$ mA, $I_{B} = 3$ mA</td>
<td>0.15</td>
<td>0.18</td>
<td>0.18</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{c} = 100$ mA, $I_{B} = 10$ mA</td>
<td>0.18</td>
<td>0.28</td>
<td>0.28</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{c} = 300$ mA, $I_{B} = 30$ mA</td>
<td>0.39</td>
<td>0.5</td>
<td>0.5</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{c} = 30$ mA, $I_{B} = 3$ mA</td>
<td>0.17</td>
<td>0.3</td>
<td>0.3</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>$T_{amb} = 85$ °C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE(sat)}^*$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_{c} = 30$ mA, $I_{B} = 3$ mA</td>
<td>0.75</td>
<td>0.8</td>
<td>0.95</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{c} = 100$ mA, $I_{B} = 10$ mA</td>
<td>0.9</td>
<td>1.2</td>
<td>1.2</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{c} = 300$ mA, $I_{B} = 30$ mA</td>
<td>1.1</td>
<td>1.7</td>
<td>1.7</td>
<td>V</td>
</tr>
<tr>
<td>$h_{FE}^*$</td>
<td>DC Current Gain</td>
<td>$V_{CE} = 0.4$ V</td>
<td>40</td>
<td>60</td>
<td>120</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = 0.5$ V</td>
<td>25</td>
<td>55</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = 1$ V</td>
<td>15</td>
<td>40</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = 0.4$ V</td>
<td>12</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$f_{T}$</td>
<td>Transition Frequency</td>
<td>$I_{c} = 30$ mA, $V_{CE} = 10$ V</td>
<td>350</td>
<td>600</td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$V_{EB} = 0.5$ V</td>
<td>7</td>
<td>8</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$V_{CB} = 5$ V</td>
<td>4</td>
<td>5</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$t_{st}$</td>
<td>Storage Time</td>
<td>$V_{CC} = 10$ V</td>
<td>8</td>
<td>18</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$t_{on}^{**}$</td>
<td>Turn-on Time</td>
<td>$V_{CC} = 10$ V</td>
<td>9</td>
<td>15</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$t_{off}^{**}$</td>
<td>Turn-off Time</td>
<td>$V_{CC} = 10$ V</td>
<td>15</td>
<td>25</td>
<td></td>
<td>ns</td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1%.
** See test circuit.
Collector-emitter Saturation Voltage.

Base-emitter Saturation Voltage.

Switching Characteristics.

Switching Characteristics.

CD Current Gain.

High Frequency Current Gain.
Emitter-base and Collector-base Capacitances.

Collector Cut off Current.

Test circuit for $t_{on}, t_{off}$.

Pulse Generator:
- $t_r, t_f < 1.0$ ns
- $PW \geq 240$ ns
- $Z_{IN} = 50 \Omega$

To Oscilloscope:
- $t_r < 1.0$ ns
- $Z_{IN} = 100$ k$\Omega$
DESCRIPTION
The BSX45 and BSX46 are silicon planar epitaxial NPN transistors in Jedece TO-39 metal case, intended for use in medium power general industrial applications.

INTERNAL SCHEMATIC DIAGRAM

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>BSX45</th>
<th>BSX46</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CES}$</td>
<td>Collector-emitter Voltage ($V_{BE} = 0$)</td>
<td>80</td>
<td>100</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_{B} = 0$)</td>
<td>40</td>
<td>60</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_{C} = 0$)</td>
<td>7</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$I_{C}$</td>
<td>Collector Current</td>
<td>1</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>$I_{B}$</td>
<td>Base Current</td>
<td>0.2</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{case} \leq 25 \degree C$</td>
<td>5</td>
<td>W</td>
<td></td>
</tr>
<tr>
<td>$T_{stg}$, $T_{j}$</td>
<td>Storage and Junction Temperature</td>
<td>$-65$ to $200$</td>
<td>°C</td>
<td></td>
</tr>
</tbody>
</table>
## THERMAL DATA

<table>
<thead>
<tr>
<th>$R_{th,j-case}$</th>
<th>Thermal Resistance Junction-case</th>
<th>Max</th>
<th>$°C/W$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th,j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>$°C/W$</td>
</tr>
</tbody>
</table>

## ELECTRICAL CHARACTERISTICS ($T_{amb} = 25 °C$ unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{ces}$</td>
<td>Collector Cutoff Current ($V_{be} = 0$)</td>
<td>$V_{ce} = 60 V$</td>
<td>30</td>
<td>10</td>
<td>nA</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{ce} = 60 V$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$T_{amb} = 150 °C$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{cex}$</td>
<td>Collector Cutoff Current ($V_{be} = -0.2 V$)</td>
<td>$V_{ce} = 60 V$</td>
<td>50</td>
<td></td>
<td>μA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$T_{amb} = 100 °C$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{ebo}$</td>
<td>Emitter Cutoff Current ($I_{c} = 0$)</td>
<td>$V_{eb} = 5 V$</td>
<td>10</td>
<td></td>
<td>nA</td>
<td></td>
</tr>
</tbody>
</table>

| $V_{br}ces$ | Collector-emitter Breakdown Voltage ($V_{be} = 0$) | $I_{c} = 100 \mu A$ | for BSX45 | 80 | V |
|             |                                                     |         | for BSX46 | 100 | V |
| $V_{br}CEO$ * | Collector-emitter Breakdown Voltage ($I_{b} = 0$) | $I_{c} = 30 mA$ | for BSX45 | 40 | V |
|             |                                                     |         | for BSX46 | 60 | V |
| $V_{br}EBO$ | Emitter-base Breakdown Voltage ($I_{c} = 0$) | $I_{e} = 100 \mu A$ | 7 |      | V |     |

| $V_{ CES(sat)}$ * | Collector-emitter Saturation Voltage | $I_{c} = 1 A$ | $I_{b} = 0.1 A$ | 0.7 | 1 | V |

| $V_{BE}$ * | Base-emitter Voltage | $I_{c} = 0.1 A$ | $V_{ce} = 1 V$ | 1 | V |
|            |                     | $I_{c} = 0.5 A$ | $V_{ce} = 1 V$ | 1.5 | V |
|            |                     | $I_{c} = 1 A$ | $V_{ce} = 1 V$ | 2 | V |

| $h_{FE}$ * | DC Current Gain | $I_{c} = 0.1 mA$ | $V_{ce} = 1 V$ | 10 | 28 |
|            |                |                  | Gr. 6 |      |     |
|            |                |                  | Gr. 10 | 15 | 40 |
|            |                |                  | Gr. 16 | 25 | 90 |
|            |                | $I_{c} = 100 mA$ | $V_{ce} = 1 V$ | 40 | 63 | 100 |
|            |                |                  | Gr. 6 |      |     |
|            |                |                  | Gr. 10 | 63 | 160 |
|            |                |                  | Gr. 16 | 100 | 250 |
|            |                | $I_{c} = 500 mA$ | $V_{ce} = 1 V$ | 15 | 25 |
|            |                |                  | Gr. 6 |      |     |
|            |                |                  | Gr. 10 | 25 | 40 |
|            |                |                  | Gr. 16 | 35 | 60 |
|            |                | $I_{c} = 1 A$ | $V_{ce} = 1 V$ | 15 |      |
|            |                |                  | Gr. 6 |      |     |
|            |                |                  | Gr. 10 | 20 |     |
|            |                |                  | Gr. 16 | 30 |     |

| $f_{T}$ | Transition Frequency | $I_{c} = 50 mA$ | $V_{ce} = 10 V$ | 50 | MHz |
|         |                     | $f = 20 MHz$ |      |      |     |

| $C_{EBO}$ | Emitter-base Capacitance | $I_{c} = 0$ | $V_{eb} = 0.5 V$ | 80 | pF |
|           |                           | $f = 1 MHz$ |      |      |     |

* Pulsed: pulse duration = 300μs, duty cycle = 1%.
** See test circuit.
## ELECTRICAL CHARACTERISTICS (continued)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>C_{CBO}</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$ $f = 1$ MHz</td>
<td>for BSX45</td>
<td></td>
<td>25</td>
<td>pF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CB} = 10$ V</td>
<td>for BSX46</td>
<td></td>
<td>20</td>
<td>pF</td>
</tr>
<tr>
<td>NF</td>
<td>Noise Figure</td>
<td>$I_C = 100$ $\mu$A $R_g = 1$ k$\Omega$</td>
<td></td>
<td></td>
<td>3.5</td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = 10$ V $f = 1$ kHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>t\textsubscript{on}</td>
<td>Turn-on Time</td>
<td>$I_C = 100$ mA $I_{B1} = 5$ mA</td>
<td></td>
<td></td>
<td>200</td>
<td>ns</td>
</tr>
<tr>
<td>t\textsubscript{off}</td>
<td>Turn-off Time</td>
<td>$I_C = 100$ mA $I_{B1} = -I_{B2} = 5$ mA $V_{CC} = 20$ V</td>
<td></td>
<td></td>
<td>850</td>
<td>ns</td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300$\mu$s, duty cycle = 1%.

** See test circuit.

### Safe operating areas

#### Collector-emitter Saturation Voltage.

#### Base-emitter Saturation Voltage.

#### DC Current Gain.
Transition Frequency.

Test circuit for $t_{on}$, $t_{off}$.
DESCRIPTION
The BSX88A is a silicon planar epitaxial NPN transistor specially designed as a high speed saturated logic switch. It features 20 Volt \( V_{CEO} \), low saturation voltage and fast switching times from 10 to 300mA.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{CBO} )</td>
<td>Collector-base Voltage ( (I_E = 0) )</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>( V_{CEO} )</td>
<td>Collector-emitter Voltage ( (I_B = 0) )</td>
<td>20</td>
<td>V</td>
</tr>
<tr>
<td>( V_{EBO} )</td>
<td>Emitter-base Voltage ( (I_C = 0) )</td>
<td>5.5</td>
<td>V</td>
</tr>
<tr>
<td>( I_C )</td>
<td>Collector Current</td>
<td>500</td>
<td>mA</td>
</tr>
<tr>
<td>( P_{tot} )</td>
<td>Total Power Dissipation at ( T_{amb} \leq 25 ^\circ C )</td>
<td>0.36</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at ( T_{case} \leq 25 ^\circ C )</td>
<td>1.2</td>
<td>W</td>
</tr>
<tr>
<td>( T_{stg}, T_j )</td>
<td>Storage and Junction Temperature</td>
<td>-55 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>
### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
</tr>
<tr>
<td>$R_{th j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
</tr>
</tbody>
</table>

### ELECTRICAL CHARACTERISTICS ($T_{amb} = 25$ °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CES}$</td>
<td>Collector Cutoff Current ($V_{EB} = 0$)</td>
<td>$V_{CE} = 20$ V</td>
<td>0.3</td>
<td>μA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = 100$ μA</td>
<td>40</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = 100$ μA</td>
<td>5.5</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CEO}^*$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = 10$ mA</td>
<td>20</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{CE(sat)}^*$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = 10$ mA $I_B = 1$ mA</td>
<td>0.18</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{BE(sat)}^*$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = 10$ mA $I_B = 1$ mA</td>
<td>0.39</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$h_{FE}^*$</td>
<td>DC Current Gain</td>
<td>$I_C = 0.5$ mA $V_{CE} = 1$ V</td>
<td>15</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$h_{fe}$</td>
<td>High Frequency Current Gain ($f = 100$ MHz)</td>
<td>$I_C = 30$ mA $V_{CE} = 10$ V</td>
<td>3.5</td>
<td>5.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$ $f = 1$ MHz $V_{CB} = 0.5$ V</td>
<td>3</td>
<td>pF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_C = 0$ $f = 1$ MHz $V_{EB} = 0.5$ V</td>
<td>7</td>
<td>pF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_s$ **</td>
<td>Change Storage Time Constant</td>
<td>$I_C = I_{B1} = I_{B2} = 10$ mA</td>
<td>20</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{on}$ **</td>
<td>Turn-on Time</td>
<td>$I_C = 10$ mA $V_{BE} = -2$ V $I_{B1} = 3$ mA</td>
<td>30</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{off}$ **</td>
<td>Turn-off Time</td>
<td>$I_C = 10$ mA $V_{BE} = -2$ V $I_{B1} = 3$ mA</td>
<td>70</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300μs, duty cycle = 1%.
** See test circuit.

### DC Pulse Current Gain vs. Collector Current.

![DC Pulse Current Gain vs. Collector Current](image1)

### Collector Saturation Voltage vs. Collector Current.

![Collector Saturation Voltage vs. Collector Current](image2)
Base Saturation Voltage vs. Collector Current.

High Frequency Current Gain vs. Collector Current.

Input and Output Capacitance vs. Reverse Bias Voltage.

Switching Times vs. Collector Current.

BSX88A

SGS-THOMSON MICROELECTRONICS
TEST CIRCUITS

Test circuit for $t_{on}$, $t_{off}$.

Test circuit for $t_s$.
HIGH-FREQUENCY SATURATED SWITCH

DESCRIPTION
The BSX93 is a silicon planar epitaxial NPN transistor in Jeder TO-18 metal case. It is designed specifically for high-speed saturated switching applications.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CES}$</td>
<td>Collector-emitter Voltage ($V_{BE} = 0$)</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>15</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>5</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>150</td>
<td>mA</td>
</tr>
<tr>
<td>$I_{CM}$</td>
<td>Collector Peak Current ($t = 10 \mu s$)</td>
<td>500</td>
<td>mA</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 ^\circ C$ at $T_{case} \leq 25 ^\circ C$</td>
<td>0.36</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}, T_j$</td>
<td>Storage and Junction Temperature</td>
<td>– 65 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>

December 1988
### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th,j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td></td>
<td></td>
<td></td>
<td>175</td>
<td>°C/W</td>
</tr>
<tr>
<td>$R_{th,j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td></td>
<td></td>
<td></td>
<td>486</td>
<td>°C/W</td>
</tr>
</tbody>
</table>

### ELECTRICAL CHARACTERISTICS ($T_{amb} = 25 ^\circ C$ unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = 20$ V</td>
<td>0.15</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CB} = 20$ V</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$T_{amb} = 150 ^\circ C$</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = 10$ µA</td>
<td>40</td>
<td></td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CES}^*$</td>
<td>Collector-emitter Breakdown Voltage ($V_{BE} = 0$)</td>
<td>$I_C = 10$ µA</td>
<td>40</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CED}^*$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = 10$ mA</td>
<td>15</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Collector-emitter Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = 10$ µA</td>
<td>5</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE(sat)}^*$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = 10$ mA $I_B = 1$ mA</td>
<td>0.15</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE}^*$</td>
<td>Base-emitter Voltage</td>
<td>$I_C = 10$ mA $V_{CE} = 1$ V</td>
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<tr>
<td>$V_{BE(sat)}^*$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = 10$ mA $I_B = 1$ mA</td>
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<tr>
<td>$h_{FE}^*$</td>
<td>DC Current Gain</td>
<td>$I_C = 10$ mA $V_{CE} = 1$ V</td>
<td>40</td>
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<tr>
<td></td>
<td></td>
<td>$I_C = 100$ mA $V_{CE} = 1$ V</td>
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<tr>
<td></td>
<td></td>
<td>$I_C = 10$ mA $V_{CE} = 1$ V</td>
<td>20</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$T_{amb} = -55 ^\circ C$</td>
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<td></td>
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<td>V</td>
</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = 10$ mA $V_{CE} = 10$ V</td>
<td>400</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$f = 1$ MHz</td>
<td>650</td>
<td></td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_C = 0$ $V_{EB} = 0.5$ V</td>
<td>3.8</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$ $V_{CB} = 5$ V</td>
<td>2.5</td>
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<td>pF</td>
</tr>
<tr>
<td>$t_s$</td>
<td>Storage Time</td>
<td>$I_C = 10$ mA $V_{CC} = 10$ V</td>
<td>6</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>$I_{B1} = -I_{B2} = 10$ mA</td>
<td>13</td>
<td></td>
<td></td>
<td>ns</td>
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<tr>
<td>$t_{on}^{**}$</td>
<td>Turn-on Time</td>
<td>$I_C = 10$ mA $V_{CC} = 3$ V</td>
<td>9</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{B1} = 3$ mA $V_{BB} = -1.5$ mA</td>
<td>12</td>
<td></td>
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<tr>
<td>$t_{off}^{**}$</td>
<td>Turn-off Time</td>
<td>$I_C = 10$ mA $V_{CC} = 3$ V</td>
<td>13</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 µs, duty cycle = 1 %

** See test circuit.
DC Current Gain.

Collector-emitter Saturation Voltage.

Base-emitter Saturation Voltage.

Emitter-base and Collector-base Capacitances.

High Frequency Current Gain.

Switching Characteristics.
TEST CIRCUIT
Test Circuit for $t_{on}$, $t_{off}$.

PULSE GENERATOR
$V_{IN} < 1$ ns
SOURCE IMPEDANCE = 50 $\Omega$
PW $\geq$ 100 ns
DC $< 2$

$V_{BB} = -3$ V
$V_{IN} = +15$ V

TO OSCILLOSCOPE
INPUT IMPEDANCE = 50 $\Omega$
$t_{f} \leq 1$ ns

$V_{BB} = +12$ V
$V_{IN} = -15$ V
DESCRIPTION
The BSY53 and BSY54 are silicon planar epitaxial NPN transistors in Jedec TO-39 metal case, intended for use in general purpose amplifiers.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V&lt;sub&gt;CBO&lt;/sub&gt;</td>
<td>Collector-base Voltage (I&lt;sub&gt;E&lt;/sub&gt; = 0)</td>
<td>75</td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;CEO&lt;/sub&gt;</td>
<td>Collector-emitter Voltage (I&lt;sub&gt;B&lt;/sub&gt; = 0)</td>
<td>30</td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;EBO&lt;/sub&gt;</td>
<td>Emitter-base Voltage (I&lt;sub&gt;E&lt;/sub&gt; = 0)</td>
<td>7</td>
<td>V</td>
</tr>
<tr>
<td>I&lt;sub&gt;C&lt;/sub&gt;</td>
<td>Collector Current</td>
<td>750</td>
<td>mA</td>
</tr>
<tr>
<td>P&lt;sub&gt;tot&lt;/sub&gt;</td>
<td>Total Power Dissipation at T&lt;sub&gt;amb&lt;/sub&gt; ≤ 25 °C at T&lt;sub&gt;case&lt;/sub&gt; ≤ 25 °C</td>
<td>0.8</td>
<td>mW</td>
</tr>
<tr>
<td>T&lt;sub&gt;stg&lt;/sub&gt;, T&lt;sub&gt;j&lt;/sub&gt;</td>
<td>Storage and Junction Temperature</td>
<td>– 65 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>
### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th,j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>58</td>
<td>°C/W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_{th,j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>220</td>
<td>°C/W</td>
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### ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\, °C$ unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = 60, V$ $T_{amb} = 150, °C$</td>
<td>10</td>
<td>10</td>
<td>nA</td>
<td>nA</td>
</tr>
<tr>
<td>$I_{EBO}$</td>
<td>Emitter Cutoff Current ($I_C = 0$)</td>
<td>$V_{EB} = 5, V$</td>
<td>10</td>
<td>10</td>
<td>nA</td>
<td>nA</td>
</tr>
<tr>
<td>$V_{CE,(sat)}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = 150, mA$ $I_B = 15, mA$</td>
<td>0.15</td>
<td>0.6</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{BE,(sat)}$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = 150, mA$ $I_B = 15, mA$</td>
<td>0.95</td>
<td>1.2</td>
<td>V</td>
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<tr>
<td>$h_{FE}$</td>
<td>DC Current Gain</td>
<td>for BSY53</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 0.1, mA$ $V_{CE} = 10, V$</td>
<td>20</td>
<td>40</td>
<td></td>
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<tr>
<td></td>
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<td>$I_C = 1, mA$ $V_{CE} = 10, V$</td>
<td>30</td>
<td>50</td>
<td></td>
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<tr>
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<td>$I_C = 10, mA$ $V_{CE} = 10, V$</td>
<td>36</td>
<td>55</td>
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<tr>
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<td>$I_C = 500, mA$ $V_{CE} = 10, V$</td>
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<td>55</td>
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<td></td>
<td>for BSY54</td>
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</tr>
<tr>
<td></td>
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<td>$I_C = 0.01, mA$ $V_{CE} = 10, V$</td>
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<td>35</td>
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<tr>
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<td>$I_C = 0.1, mA$ $V_{CE} = 10, V$</td>
<td>5</td>
<td>60</td>
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<tr>
<td></td>
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<td>$I_C = 1, mA$ $V_{CE} = 10, V$</td>
<td>9</td>
<td>11</td>
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<tr>
<td></td>
<td></td>
<td>$I_C = 10, mA$ $V_{CE} = 10, V$</td>
<td>74</td>
<td>120</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 500, mA$ $V_{CE} = 10, V$</td>
<td>30</td>
<td>300</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = 50, mA$ $f = 50, MHz$</td>
<td>100</td>
<td></td>
<td>MHz</td>
<td></td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$ $f = 1, MHz$</td>
<td>10</td>
<td></td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_C = 0$ $f = 1, MHz$</td>
<td>23</td>
<td></td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>NF</td>
<td>Noise Figure</td>
<td>$I_C = 0.3, mA$ $R_S = 1.5, k\Omega$ $f = 30, Hz$ to $15, kHz$</td>
<td>3</td>
<td>8</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>$h_{fe}$</td>
<td>Small Signal Current Gain</td>
<td>$I_C = 1, mA$ $V_{CE} = 10, V$ for BSY53 for BSY54</td>
<td>30</td>
<td>150</td>
<td></td>
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</tr>
<tr>
<td></td>
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<td>$f = 1, kHz$</td>
<td>50</td>
<td>250</td>
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</tr>
<tr>
<td>$h_{ie}$</td>
<td>Input Impedance</td>
<td>$I_C = 1, mA$ $V_{CE} = 10, V$ for BSY53 for BSY54</td>
<td>0.8</td>
<td>4.5</td>
<td>kΩ</td>
<td>kΩ</td>
</tr>
<tr>
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<td>$f = 1, kHz$</td>
<td>1.6</td>
<td>9</td>
<td></td>
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<tr>
<td>$h_{re}$</td>
<td>Reverse Voltage Ratio</td>
<td>$I_C = 1, mA$ $V_{CE} = 10, V$ for BSY53 for BSY54</td>
<td>3 X $10^{-4}$</td>
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<tr>
<td>$h_{oe}$</td>
<td>Output Impedance</td>
<td>$I_C = 1, mA$ $V_{CE} = 10, V$ for BSY53 for BSY54</td>
<td>3.5</td>
<td>10</td>
<td>μS</td>
<td>μS</td>
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<td></td>
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<td>$f = 1, kHz$</td>
<td>4.5</td>
<td>12.5</td>
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</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1%
DC Normalized Current Gain (for BSY53 only).

Collector-emitter Saturation Voltage.

Normalized h Parameters.

Power Rating Chart.
DESCRIPTION
The BSY55 and BSY56 are silicon planar epitaxial NPN transistors in Jedec TO-39 metal case, intended for use in high performance amplifier, oscillator and switching circuits.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>120</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>80</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>7</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>500</td>
<td>mA</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 , ^\circ C$</td>
<td>0.8</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 , ^\circ C$</td>
<td>3</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}$, $T_j$</td>
<td>Storage and Junction Temperature</td>
<td>– 65 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>
### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th , j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>58</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
<tr>
<td>$R_{th , j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>220</td>
<td></td>
<td></td>
<td>°C/W</td>
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</table>

### ELECTRICAL CHARACTERISTICS ($T_{\text{amb}} = 25 \, ^\circ \text{C}$ unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = 90 , \text{V}$</td>
<td>10</td>
<td></td>
<td></td>
<td>nA</td>
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<tr>
<td></td>
<td></td>
<td>$V_{CB} = 90 , \text{V}$</td>
<td></td>
<td>10</td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td>$I_{EBO}$</td>
<td>Emitter Cutoff Current ($I_C = 0$)</td>
<td>$V_{EB} = 5 , \text{V}$</td>
<td>10</td>
<td></td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td>$V_{CE (sat)}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = 150 , \text{mA}$</td>
<td>0.2</td>
<td>0.6</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE (sat)}$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = 150 , \text{mA}$</td>
<td>1</td>
<td>1.3</td>
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<td>V</td>
</tr>
<tr>
<td>$h_{FE}$</td>
<td>DC Current Gain</td>
<td>for BSY55</td>
<td>20</td>
<td>50</td>
<td>120</td>
<td></td>
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<tr>
<td></td>
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<td>$I_C = 0.1 , \text{mA}$</td>
<td>35</td>
<td>65</td>
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<tr>
<td></td>
<td></td>
<td>$I_C = 1 , \text{mA}$</td>
<td>40</td>
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<tr>
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<td>$I_C = 10 , \text{mA}$</td>
<td>65</td>
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<tr>
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<td>$I_C = 150 , \text{mA}$</td>
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<tr>
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<td>$I_C = 500 , \text{mA}$</td>
<td>20</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>for BSY56</td>
<td></td>
<td>35</td>
<td>100</td>
<td>300</td>
<td></td>
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<tr>
<td></td>
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<td>$I_C = 0.1 , \text{mA}$</td>
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<td></td>
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<tr>
<td></td>
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<td>$I_C = 1 , \text{mA}$</td>
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<td></td>
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<td>$I_C = 10 , \text{mA}$</td>
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<td>$I_C = 150 , \text{mA}$</td>
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<td>$I_C = 500 , \text{mA}$</td>
<td>300</td>
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<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = 50 , \text{mA}$</td>
<td>100</td>
<td></td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = 10 , \text{V}$</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$</td>
<td>10</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 1 , \text{MHz}$</td>
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</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_C = 0$</td>
<td>23</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 1 , \text{MHz}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$NF$</td>
<td>Noise Figure</td>
<td>$I_C = 0.3 , \text{mA}$</td>
<td>6</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$R_g = 1.5 , \text{k}\Omega$</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = 10 , \text{V}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 30 , \text{Hz}$ to 15 kHz</td>
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<tr>
<td>$h_{re}$</td>
<td>Small Signal Current Gain</td>
<td>$I_C = 1 , \text{mA}$</td>
<td>30</td>
<td>150</td>
<td>250</td>
<td>kΩ</td>
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<tr>
<td></td>
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<td>$f = 1 , \text{kHz}$</td>
<td>60</td>
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<tr>
<td></td>
<td></td>
<td>for BSY55</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = 10 , \text{V}$</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>for BSY56</td>
<td></td>
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<tr>
<td>$h_{le}$</td>
<td>Input Impedance</td>
<td>$I_C = 1 , \text{mA}$</td>
<td>0.8</td>
<td>5</td>
<td>9</td>
<td>kΩ</td>
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<td></td>
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<td>$f = 1 , \text{kHz}$</td>
<td>1.6</td>
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<tr>
<td>$h_{re}$</td>
<td>Reverse Voltage Ratio</td>
<td>$I_C = 1 , \text{mA}$</td>
<td>3 X 10^-4</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$f = 1 , \text{kHz}$</td>
<td></td>
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</tr>
<tr>
<td>$h_{oe}$</td>
<td>Output Admittance</td>
<td>$I_C = 1 , \text{mA}$</td>
<td>2</td>
<td>7</td>
<td>10</td>
<td>μS</td>
</tr>
<tr>
<td></td>
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<td>$f = 1 , \text{kHz}$</td>
<td>3</td>
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</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1%.
DC Normalized Current Gain (for BSY55 only).

Collector-emitter Saturation Voltage.

Base-emitter Saturation Voltage.

Normalized h Parameters.

Power Rating Chart.

Collector-emitter Saturation Voltage.

Base-emitter Saturation Voltage.

Normalized h Parameters.
DESCRIPTION
The 2N708 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case, designed for very fast switching applications.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{CBO}</td>
<td>Collector-base Voltage (I_E = 0)</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>V_{CEO}</td>
<td>Collector-emitter Voltage (I_B = 0)</td>
<td>15</td>
<td>V</td>
</tr>
<tr>
<td>V_{EBO}</td>
<td>Emitter-base Voltage (I_C = 0)</td>
<td>5</td>
<td>V</td>
</tr>
<tr>
<td>I_C</td>
<td>Collector Current</td>
<td>200</td>
<td>mA</td>
</tr>
<tr>
<td>P_{tot}</td>
<td>Total Power Dissipation at T_{amb} ≤ 25 °C at T_{case} ≤ 25 °C</td>
<td>0.36</td>
<td>W</td>
</tr>
<tr>
<td>T_{stg}, T_{g}</td>
<td>Storage and Junction Temperature</td>
<td>–65 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>
### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter Description</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rth j-case</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>146</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
<tr>
<td>Rth j-amb</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>486</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
</tbody>
</table>

### ELECTRICAL CHARACTERISTICS (T<sub>amb</sub> = 25 °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter Description</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
</table>
| I<sub>CBO</sub> | Collector Cutoff Current (I<sub>E</sub> = 0) | V<sub>CB</sub> = 20 V  
V<sub>CB</sub> = 20 V  
T<sub>amb</sub> = 150 °C | 25 nA | 15 µA |      |      |
| V<sub>(BR)CBO</sub> | Collector–base Breakdown Voltage (I<sub>E</sub> = 0) | I<sub>C</sub> = 100 µA | 40   |      |      |      |
| V<sub>(BR)CEO</sub>* | Collector–emitter Breakdown Voltage (I<sub>B</sub> = 0) | I<sub>C</sub> = 10 mA | 15   |      |      |      |
| V<sub>(BR)EBO</sub> | Emitter–base Breakdown Voltage (I<sub>C</sub> = 0) | I<sub>E</sub> = 10 µA | 5    |      |      |      |
| I<sub>EBO</sub> | Emitter Cutoff Current (I<sub>C</sub> = 0) | V<sub>EB</sub> = 4 V  | 100  |      |      | nA   |
| V<sub>CE(sat)</sub>* | Collector–emitter Saturation Voltage (I<sub>C</sub> = 0) | I<sub>C</sub> = 10 mA  
I<sub>B</sub> = 1 mA | 0.4  |      |      | V    |
| V<sub>BE(sat)</sub>* | Base–emitter Saturation Voltage (I<sub>C</sub> = 0) | I<sub>C</sub> = 10 mA  
I<sub>B</sub> = 1 mA | 0.9  |      |      | V    |
| h<sub>FE</sub>* | DC Current Gain | I<sub>C</sub> = 0.5 mA  
I<sub>C</sub> = 10 mA  
T<sub>amb</sub> = -55 °C  
I<sub>C</sub> = 10 mA  
V<sub>CE</sub> = 1 V | 15  | 30  | 120  |      |
| h<sub>fe</sub> | High Frequency Current Gain | I<sub>C</sub> = 10 mA  
f = 100 MHz  
V<sub>CE</sub> = 10 V | 3   |      |      |      |
| C<sub>CBO</sub> | Collector–base Capacitance | I<sub>E</sub> = 0  
f = 1 MHz  
V<sub>CB</sub> = 10 V | 6   |      |      | pF   |
| t<sub>s</sub> | Storage Time | I<sub>C</sub> = 10 mA  
I<sub>B1</sub> = I<sub>B2</sub> | 25  |      |      | ns   |
| t<sub>on</sub> | Turn–on Time | I<sub>C</sub> = 10 mA  
I<sub>B1</sub> = 3 mA | 40  |      |      | ns   |
| t<sub>off</sub> | Turn–off Time | I<sub>C</sub> = 10 mA  
I<sub>B1</sub> = 3 mA  
I<sub>B2</sub> = -1 mA | 75  |      |      | ns   |

* Pulsed: pulse duration = 300 µs, duty cycle = 1%.
DESCRIPTION
The 2N718A and 2N956 are silicon planar epitaxial NPN transistors in Jedec TO-18 metal case, intended for high-speed switching and amplifier applications.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_CBO</td>
<td>Collector-base Voltage (I_E = 0)</td>
<td>75</td>
<td>V</td>
</tr>
<tr>
<td>V_CER</td>
<td>Collector-emitter Voltage (R_BE ≤ 10 Ω)</td>
<td>50</td>
<td>V</td>
</tr>
<tr>
<td>V_EBO</td>
<td>Emitter-base Voltage (I_C = 0)</td>
<td>7</td>
<td>V</td>
</tr>
<tr>
<td>I_C</td>
<td>Collector Current</td>
<td>1</td>
<td>A</td>
</tr>
<tr>
<td>P_tot</td>
<td>Total Power Dissipation at T_amb ≤ 25 °C</td>
<td>0.5</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at T_case ≤ 25 °C</td>
<td>1.8</td>
<td>W</td>
</tr>
<tr>
<td>T_stg, T_j</td>
<td>Storage and Junction Temperature</td>
<td>-65 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>
## THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{\text{th} \ j\text{-case}}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>97</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
<tr>
<td>$R_{\text{th} \ j\text{-amb}}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>350</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
</tbody>
</table>

## ELECTRICAL CHARACTERISTICS

(T$_{\text{amb}}$ = 25 °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{\text{CBO}}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{\text{CB}} = 60 \text{ V}$</td>
<td>10</td>
<td></td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{\text{CB}} = 60 \text{ V}$</td>
<td></td>
<td>10</td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>$I_{\text{EBO}}$</td>
<td>Emitter Cutoff Current ($I_C = 0$)</td>
<td>$V_{\text{EB}} = 5 \text{ V}$</td>
<td></td>
<td>10</td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td>$V_{(\text{BR})\text{CBO}}$</td>
<td>Collector–base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = 100 \mu\text{A}$</td>
<td>75</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(\text{BR})\text{CER}}$</td>
<td>Collector–emitter Breakdown Voltage ($R_{\text{BE}} \leq 10 \Omega$)</td>
<td>$I_C = 10 \text{ mA}$</td>
<td>50</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(\text{BR})\text{EBO}}$</td>
<td>Emitter–base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = 100 \mu\text{A}$</td>
<td>7</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{\text{CE(sat)}}$</td>
<td>Collector–emitter Saturation Voltage</td>
<td>$I_C = 150 \text{ mA}$</td>
<td>0.24</td>
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<td>1.5</td>
<td>V</td>
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<tr>
<td>$V_{\text{BE(sat)}}$</td>
<td>Base–emitter Saturation Voltage</td>
<td>$I_C = 150 \text{ mA}$</td>
<td>1</td>
<td></td>
<td>1.3</td>
<td>V</td>
</tr>
<tr>
<td>$h_{\text{FE}}$</td>
<td>DC Current Gain</td>
<td>for $2N718A$</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$V_{\text{CE}} = 10 \text{ V}$</td>
<td>20</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 0.1 \text{ mA}$</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 10 \text{ mA}$</td>
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<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 150 \text{ mA}$</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 500 \text{ mA}$</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$T_{\text{amb}} = -55 \degree \text{C}$</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for $2N956$</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$V_{\text{CE}} = 10 \text{ V}$</td>
<td>35</td>
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<td>120</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 0.1 \text{ mA}$</td>
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</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 µs, duty cycle = 1%.
### ELECTRICAL CHARACTERISTICS (continued)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$h_{FE}$</td>
<td>DC Current Gain</td>
<td>for 2N956</td>
<td>$I_C = 10 , mA$</td>
<td>$V_{CE} = 10 , V$</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$I_C = 150 , mA$</td>
<td>$V_{CE} = 10 , V$</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$I_C = 500 , mA$</td>
<td>$V_{CE} = 10 , V$</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$I_C = 10 , mA$</td>
<td>$V_{CE} = 10 , V$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$T_{amb} = -55 , ^\circ C$</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>$h_{fe}$</td>
<td>Small Signal Current Gain</td>
<td>for 2N718A</td>
<td>$I_C = 1 , mA$</td>
<td>$V_{CE} = 5 , V$</td>
<td>30</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$I_C = 5 , mA$</td>
<td>$V_{CE} = 10 , V$</td>
<td>35</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for 2N956</td>
<td>$I_C = 1 , mA$</td>
<td>$V_{CE} = 5 , V$</td>
<td>50</td>
<td>300</td>
</tr>
<tr>
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<td></td>
<td>$I_C = 5 , mA$</td>
<td>$V_{CE} = 10 , V$</td>
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<td>300</td>
</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = 50 , mA$</td>
<td>$V_{CE} = 10 , V$</td>
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<td>60</td>
<td>MHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 20 , MHz$</td>
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<td></td>
<td>70</td>
<td>MHz</td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter–base Capacitance</td>
<td>$I_C = 0 , mA$</td>
<td>$V_{EB} = 0.5 , V$</td>
<td></td>
<td>80</td>
<td>pF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 1 , MHz$</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector–base Capacitance</td>
<td>$I_E = 0 , mA$</td>
<td>$V_{CB} = 10 , V$</td>
<td></td>
<td>25</td>
<td>pF</td>
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<tr>
<td></td>
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<td>$f = 1 , MHz$</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>NF</td>
<td>Noise Figure</td>
<td>$I_C = 300 , \mu A$</td>
<td>$V_{CE} = 10 , V$</td>
<td></td>
<td>12</td>
<td>dB</td>
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<td>$f = 1 , kHz$</td>
<td></td>
<td></td>
<td>8</td>
<td>dB</td>
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</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1 %. 

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SGS-THOMSON

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DESCRIPTION
The 2N720A is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case. It is suitable for a wide variety of amplifier and switching applications.

INTERNAL SCHEMATIC DIAGRAM

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>120</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector–emitter Voltage ($I_R = 0$)</td>
<td>80</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter–base Voltage ($I_C = 0$)</td>
<td>7</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>500</td>
<td>mA</td>
</tr>
<tr>
<td>$P_{Tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 , ^\circ C$</td>
<td>0.5</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 , ^\circ C$</td>
<td>1.8</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}$, $T_J$</td>
<td>Storage and Junction Temperature</td>
<td>-65 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>

October 1988
### THERMAL DATA

<table>
<thead>
<tr>
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<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>R_{th j-case}</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>97.2</td>
<td>°C/W</td>
<td></td>
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<tr>
<td>R_{th j-amb}</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>350</td>
<td>°C/W</td>
<td></td>
<td></td>
</tr>
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</table>

### ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>I_{CBO}</td>
<td>Collector Cutoff Current ((I_E = 0))</td>
<td>V_{CB} = 90 V</td>
<td></td>
<td>10</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>V_{(BR)CBO}</td>
<td>Collector–base Breakdown Voltage ((I_E = 0))</td>
<td>I_C = 100 μA</td>
<td></td>
<td>120</td>
<td>V</td>
<td></td>
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<tr>
<td>V_{(BR)CEO}</td>
<td>Collector–emitter Breakdown Voltage ((I_E = 0))</td>
<td>I_C = 30 mA</td>
<td></td>
<td>80</td>
<td>V</td>
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<tr>
<td>V_{(BR)EBO}</td>
<td>Emitter–base Breakdown Voltage ((I_E = 0))</td>
<td>I_E = 100 μA</td>
<td></td>
<td>7</td>
<td>V</td>
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<tr>
<td>I_{EBO}</td>
<td>Emitter Cutoff Current ((I_E = 0))</td>
<td>V_{EB} = 5 V</td>
<td></td>
<td>10</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>V_{CE(sat)}</td>
<td>Collector–emitter Saturation Voltage</td>
<td>I_C = 50 mA</td>
<td>I_B = 5 mA</td>
<td>1.2</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>V_{CE(sat)}</td>
<td>Collector–emitter Saturation Voltage</td>
<td>I_C = 150 mA</td>
<td>I_B = 15 mA</td>
<td>5</td>
<td>V</td>
<td></td>
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<tr>
<td>V_{BE(sat)}</td>
<td>Base–emitter Saturation Voltage</td>
<td>I_C = 50 mA</td>
<td>I_B = 5 mA</td>
<td>0.9</td>
<td>V</td>
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<tr>
<td>V_{BE(sat)}</td>
<td>Base–emitter Saturation Voltage</td>
<td>I_C = 150 mA</td>
<td>I_B = 15 mA</td>
<td>1.3</td>
<td>V</td>
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<tr>
<td>h_{FE}</td>
<td>DC Current Gain</td>
<td>I_C = 100 μA</td>
<td>V_{CE} = 10 V</td>
<td>20</td>
<td>–</td>
<td></td>
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<tr>
<td>h_{FE}</td>
<td>DC Current Gain</td>
<td>I_C = 10 mA</td>
<td>V_{CE} = 10 V</td>
<td>35</td>
<td>–</td>
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<tr>
<td>h_{FE}</td>
<td>DC Current Gain</td>
<td>I_C = 150 mA</td>
<td>V_{CE} = 10 V</td>
<td>40</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>h_{fe}</td>
<td>High Frequency Current Gain</td>
<td>I_C = 50 mA</td>
<td>f = 20 MHz</td>
<td>2.5</td>
<td>–</td>
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</tr>
<tr>
<td>C_{CBO}</td>
<td>Collector–base Capacitance</td>
<td>I_E = 0</td>
<td>V_{CB} = 10 V</td>
<td>15</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>C_{EBO}</td>
<td>Emitter–base Capacitance</td>
<td>I_C = 0</td>
<td>V_{EB} = 0.5 V</td>
<td>85</td>
<td>pF</td>
<td></td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1 %.
DESCRIPTION
The 2N914 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case. It is primarily a universal switch but it is also an excellent high speed, high gain logic and memory driver at collector currents up to 500 mA.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CER}$</td>
<td>Collector-emitter Voltage ($R_{BE} \leq 10 \Omega$)</td>
<td>20</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>15</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>5</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>500</td>
<td>mA</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25^\circ C$</td>
<td>0.36</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25^\circ C$</td>
<td>1.2</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 100^\circ C$</td>
<td>0.68</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}$, $T_J$</td>
<td>Storage and Junction Temperature</td>
<td>–65 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>
## THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>$T_{amb} = 146$ °C/W</td>
<td>146</td>
<td></td>
<td></td>
<td>°C/W</td>
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<tr>
<td>$R_{th j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>$T_{amb} = 486$ °C/W</td>
<td>486</td>
<td></td>
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<td>°C/W</td>
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</table>

## ELECTRICAL CHARACTERISTICS ($T_{amb} = 25$ °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = 20$ V, $T_{amb} = 150$ °C</td>
<td>25</td>
<td>15</td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td>$I_{CEX}$</td>
<td>Collector Cutoff Current ($V_{BE} = -0.25$ V)</td>
<td>$V_{CE} = 20$ V, $T_{amb} = 125$ °C</td>
<td>10</td>
<td></td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>$I_{EBO}$</td>
<td>Emitter Cutoff Current ($I_C = 0$)</td>
<td>$V_{EB} = 4$ V</td>
<td>100</td>
<td></td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector–base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = 1$ µA</td>
<td>40</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CES}$</td>
<td>Collector–emitter Breakdown Voltage ($R_{BE} \leq 10$ Ω)</td>
<td>$I_C = 10$ mA</td>
<td>20</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CEO}$</td>
<td>Collector–emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = 30$ mA</td>
<td>15</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter–base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = 10$ µA</td>
<td>5</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE(sat)}$</td>
<td>Collector–emitter Saturation Voltage</td>
<td>$I_C = 20$ mA, $I_B = 2$ mA</td>
<td>0.2</td>
<td>0.4</td>
<td>0.7</td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE(sat)}$</td>
<td>Base–emitter Saturation Voltage</td>
<td>$I_C = 200$ mA, $I_B = 20$ mA</td>
<td>0.7</td>
<td>0.74</td>
<td>0.8</td>
<td>V</td>
</tr>
<tr>
<td>$h_{FE}$</td>
<td>DC Current Gain</td>
<td>$I_C = 10$ mA, $V_{CE} = 1$ V</td>
<td>30</td>
<td>55</td>
<td>120</td>
<td>–</td>
</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = 500$ mA, $V_{CE} = 5$ V</td>
<td>10</td>
<td>17</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter–base Capacitance</td>
<td>$I_C = 0$ mA, $V_{EB} = 0.5$ V</td>
<td>9</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector–base Capacitance</td>
<td>$I_E = 0$ mA, $V_{CB} = 10$ V</td>
<td>4.5</td>
<td>6</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$t_s$</td>
<td>Storage Time</td>
<td>$I_C = 20$ mA, $V_{CC} = 5$ V</td>
<td>13</td>
<td>20</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$t_{on}$</td>
<td>Turn–on Time</td>
<td>$I_C = 200$ mA, $V_{CC} = 5$ V</td>
<td>25</td>
<td>40</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$t_{off}$</td>
<td>Turn–off Time</td>
<td>$I_C = 200$ mA, $V_{CC} = 5$ V</td>
<td>25</td>
<td>40</td>
<td></td>
<td>ns</td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 µs, duty cycle = 1%.
DC Current Gain.

Collector-base and Emitter-base Capacitances.

Transition Frequency.
DESCRIPTION
The 2N918 is a silicon planar epitaxial NPN transistors in Jedec TO-72 metal case. It is designed for low-noise VHF amplifiers, oscillators up to 1 GHz, non-neutralized IF amplifiers and non-saturating circuits with rise and fall times of less than 2.5 ns.

ABSOLUTE MAXIMUM RATINGS

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<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
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</tr>
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<tbody>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>15</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>3</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>50</td>
<td>mA</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 ^\circ C$</td>
<td>200</td>
<td>mW</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 ^\circ C$</td>
<td>300</td>
<td>mW</td>
</tr>
<tr>
<td>$T_{stg}$, $T_j$</td>
<td>Storage and Junction Temperature</td>
<td>- 65 to 200</td>
<td>°C</td>
</tr>
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</table>
### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
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<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(R_{th,j-case})</td>
<td>Thermal Resistance Junction-case</td>
<td>(V_{CB} = 15\text{ V})</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(R_{th,j-amb})</td>
<td>Thermal Resistance Junction-ambient</td>
<td>(V_{CB} = 15\text{ V})</td>
<td></td>
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</table>

### ELECTRICAL CHARACTERISTICS \(T_{\text{amb}} = 25°C\) unless otherwise specified

<table>
<thead>
<tr>
<th>Symbol</th>
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<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>(I_{CBO})</td>
<td>Collector Cutoff Current ((I_{E} = 0))</td>
<td>(V_{CB} = 15\text{ V})</td>
<td>10</td>
<td>1</td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(V_{CB} = 15\text{ V})</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>(T_{\text{amb}} = 150°C)</td>
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</tr>
<tr>
<td>(V_{(BR)CBO})</td>
<td>Collector–base Breakdown Voltage ((I_{E} = 0))</td>
<td>(I_{C} = 1\mu A)</td>
<td>30</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>(V_{CEO(sus)})</td>
<td>Collector–emitter Sustaining Voltage ((I_{B} = 0))</td>
<td>(I_{C} = 3\text{ mA})</td>
<td>15</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>(V_{(BR)EBO})</td>
<td>Emitter–base Breakdown Voltage ((I_{C} = 0))</td>
<td>(I_{E} = 10\mu A)</td>
<td>3</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>(V_{CE(sat)})</td>
<td>Collector–emitter Saturation Voltage ((I_{C} = 0))</td>
<td>(I_{C} = 10\text{ mA})</td>
<td>0.4</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>(V_{BE(sat)})</td>
<td>Base–emitter Saturation Voltage ((I_{C} = 0))</td>
<td>(I_{C} = 10\text{ mA})</td>
<td>1</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>(h_{FE})</td>
<td>DC Current Gain ((I_{E} = 0))</td>
<td>(I_{C} = 3\text{ mA})</td>
<td>20</td>
<td>50</td>
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<td>–</td>
</tr>
<tr>
<td>(f_{T})</td>
<td>Transition Frequency ((I_{C} = 0))</td>
<td>(I_{C} = 4\text{ mA})</td>
<td>600</td>
<td>900</td>
<td></td>
<td>MHz</td>
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<td></td>
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<td>(f = 100\text{ MHz})</td>
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<tr>
<td></td>
<td></td>
<td>(V_{CE} = 10\text{ V})</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>(C_{EBO})</td>
<td>Emitter–base Capacitance ((I_{C} = 0))</td>
<td>(I_{E} = 0)</td>
<td>2</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td></td>
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<td>(f = 1\text{ MHz})</td>
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<td></td>
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</tr>
<tr>
<td>(C_{CBO})</td>
<td>Collector–base Capacitance ((I_{E} = 0))</td>
<td>(I_{C} = 0)</td>
<td>1.8</td>
<td>3</td>
<td></td>
<td>pF</td>
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<td>(f = 1\text{ MHz})</td>
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<td></td>
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<td>(V_{CE} = 0)</td>
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<td>1</td>
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<td></td>
<td>(V_{CE} = 10\text{ V})</td>
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<td>1.7</td>
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<td>(NF)</td>
<td>Noise Figure ((I_{C} = 0))</td>
<td>(I_{C} = 1\text{ mA})</td>
<td>6</td>
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<td>dB</td>
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<tr>
<td></td>
<td></td>
<td>(R_{g} = 400\text{ \Omega})</td>
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<td></td>
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<td>(V_{CE} = 6\text{ V})</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>(G_{pe})</td>
<td>Power Gain ((I_{C} = 0))</td>
<td>(R_{g} = 50\text{ \Omega})</td>
<td>15</td>
<td>21</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(I_{C} = 6\text{ mA})</td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td>(V_{CE} = 20\text{ MHz})</td>
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<tr>
<td>(P_{o}^*)</td>
<td>Output Power ((I_{C} = 0))</td>
<td>(I_{C} = 12\text{ mA})</td>
<td>30</td>
<td>40</td>
<td></td>
<td>mW</td>
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<tr>
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<td></td>
<td>(f = 500\text{ MHz})</td>
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<tr>
<td>(\eta)</td>
<td>Collector Efficiency ((I_{C} = 0))</td>
<td>(I_{C} = 12\text{ mA})</td>
<td>25</td>
<td></td>
<td></td>
<td>%</td>
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<td></td>
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<td>(f = 500\text{ MHz})</td>
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</tbody>
</table>

* See test circuit.
DC Current Gain.

Transition Frequency.

Input Admittance vs. Collector Current.

Forward Transadmittance vs. Collector Current.

Reverse Transadmittance vs. Collector Current.

Output Admittance vs. Collector Current.
Input Admittance vs. Frequency.

Reverse Transadmittance vs. Frequency.

Forward Transadmittance vs. Frequency.

Output Admittance vs. Frequency.

500 MHz Oscillator Test Circuit.
DESCRIPTION
The 2N930 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case, designed for use in high performance, low-level, low-noise amplifier applications.

ABSOLUTE MAXIMUM RATINGS

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<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>45</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>45</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>5</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>30</td>
<td>mA</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} = 25 , ^\circ C$</td>
<td>0.3</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} = 25 , ^\circ C$</td>
<td>0.6</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}$, $T_J$</td>
<td>Storage and Junction Temperature</td>
<td>–55 to 200</td>
<td>^\circ C</td>
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</table>

October 1988
### THERMAL DATA

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<tr>
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<th>Min.</th>
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<td>Thermal Resistance Junction-case</td>
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### ELECTRICAL CHARACTERISTICS ($T_{amb} = 25$ °C unless otherwise specified)

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<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = 45$ V</td>
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<td>$f = 1$ kHz</td>
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<td>$R_g = 10$ kΩ</td>
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* Pulsed: pulse duration = 300 μs, duty cycle = 1%
DESCRIPTION
The 2N1613 and 2N1711 are silicon planar epitaxial NPN transistors in Jedec TO-39 metal case. They are designed for use in high-performance amplifier, oscillator and switching circuits.

The 2N1711 is also used to advantage in amplifiers where low noise is an important factor.

Products approved to CECC 50002-104 available on request.

ABSOLUTE MAXIMUM RATINGS

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<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
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<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>75</td>
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<tr>
<td>$V_{CER}$</td>
<td>Collector-emitter Voltage ($R_{BE} \leq 10 , \Omega$)</td>
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<td>V</td>
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<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
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<td>V</td>
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<td>$I_C$</td>
<td>Collector Current</td>
<td>500</td>
<td>mA</td>
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<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 , ^\circ C$</td>
<td>0.8</td>
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<td>at $T_{case} \leq 25 , ^\circ C$</td>
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<td>at $T_{case} \leq 100 , ^\circ C$</td>
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<td>Storage and Junction Temperature</td>
<td>−65 to 200</td>
<td>°C</td>
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## THERMAL DATA

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<th>Min.</th>
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<th>Max.</th>
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<td>$R_{th j-case}$</td>
<td>Thermal Resistance Junction-case</td>
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## ELECTRICAL CHARACTERISTICS ($T_{amb} = 25 \degree C$ unless otherwise specified)

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<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = 60 \text{ V}$, $V_{CB} = 60 \text{ V}$, $T_{amb} = 150 \degree C$</td>
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<td>$V_{(BR)~CBO}$</td>
<td>Collector-base Breakdown Voltage</td>
<td>$I_C = 0.1 \text{ mA}$</td>
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<tr>
<td>$V_{CE\text{ (sat)}}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = 150 \text{ mA}$, $I_B = 15 \text{ mA}$</td>
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<td>1.5</td>
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<tr>
<td>$V_{BE\text{ (sat)}}$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = 150 \text{ mA}$, $I_B = 15 \text{ mA}$</td>
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<td>for 2N1613</td>
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* Pulsed: pulse duration = 300 μs, duty cycle = 1 %.
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<th>Min.</th>
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<td>7.3x10^{-4}</td>
<td>μS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = 5 \text{ V}$</td>
<td></td>
<td></td>
<td></td>
<td>μS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for 2N1613</td>
<td></td>
<td></td>
<td></td>
<td>μS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for 2N1711</td>
<td></td>
<td></td>
<td></td>
<td>μS</td>
</tr>
</tbody>
</table>

* Pulsed : pulse duration = 300 μs, duty cycle = 1 %. 
DESCRIPTION
The 2N1893 is a silicon planar epitaxial NPN transistor in JedeTO-39 metal case, designed for use in high-performance amplifier, oscillator and switching circuits.

It provides greater voltage swings in oscillator and amplifier circuits and more protection in inductive switching circuits due to its 120 V collector-to-base voltage rating.

Products approved to CECC 50002-104 available on request.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{CBO} )</td>
<td>Collector-base Voltage ( (I_E = 0) )</td>
<td>120</td>
<td>V</td>
</tr>
<tr>
<td>( V_{CER} )</td>
<td>Collector-emitter Voltage ( (R_{BE} \leq 10 , \Omega) )</td>
<td>100</td>
<td>V</td>
</tr>
<tr>
<td>( V_{CEO} )</td>
<td>Collector-emitter Voltage ( (I_B = 0) )</td>
<td>80</td>
<td>V</td>
</tr>
<tr>
<td>( V_{EBO} )</td>
<td>Emitter-base Voltage ( (I_C = 0) )</td>
<td>7</td>
<td>V</td>
</tr>
<tr>
<td>( I_C )</td>
<td>Collector Current</td>
<td>0.5</td>
<td>A</td>
</tr>
<tr>
<td>( P_{tot} )</td>
<td>Total Power Dissipation at ( T_{amb} \leq 25 , ^\circ\text{C} )</td>
<td>0.8</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at ( T_{case} \leq 25 , ^\circ\text{C} )</td>
<td>3</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at ( T_{case} \leq 100 , ^\circ\text{C} )</td>
<td>1.7</td>
<td>W</td>
</tr>
<tr>
<td>( T_{stg}, T_J )</td>
<td>Storage and Junction Temperature</td>
<td>– 65 to 200</td>
<td>^\circ\text{C}</td>
</tr>
</tbody>
</table>
THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>I_{CBO}</td>
<td>Collector Cutoff Current (I_E = 0)</td>
<td>V_CB = 90 V V_CB = 90 V T_amb = 150 °C</td>
<td>10</td>
<td>15</td>
<td>58</td>
<td>°C/W</td>
</tr>
<tr>
<td>I_{EBO}</td>
<td>Emitter Cutoff Current (I_C = 0)</td>
<td>V_EB = 5 V</td>
<td>10</td>
<td>nA</td>
<td>219</td>
<td>°C/W</td>
</tr>
<tr>
<td>V_{(BR)CBO}</td>
<td>Collector-base Breakdown Voltage (I_E = 0)</td>
<td>I_C = 100 μA</td>
<td>120</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V_{(BR)CER}</td>
<td>Collector-emitter Breakdown Voltage (R_{BE} ≤ 10 Ω)</td>
<td>I_C = 10 mA</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V_{(BR)CEO}</td>
<td>Collector-emitter Breakdown Voltage (I_B = 0)</td>
<td>I_C = 10 mA</td>
<td>80</td>
<td></td>
<td></td>
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<tr>
<td>V_{(BR)EBO}</td>
<td>Emitter-base Breakdown Voltage (I_C = 0)</td>
<td>I_E = 100 μA</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V_{CE (sat)}</td>
<td>Collector-emitter Saturation Voltage</td>
<td>I_C = 50 mA</td>
<td>1.2</td>
<td>V</td>
<td></td>
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</tr>
<tr>
<td>V_{BE (sat)}</td>
<td>Base-emitter Saturation Voltage</td>
<td>I_C = 50 mA</td>
<td>0.82</td>
<td>V</td>
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<tr>
<td>h_{FE}</td>
<td>DC Current Gain</td>
<td>I_C = 0.1 mA</td>
<td>20</td>
<td>50</td>
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<td></td>
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<tr>
<td>h_{fe}</td>
<td>Small Signal Current Gain</td>
<td>I_C = 1 mA</td>
<td>30</td>
<td>70</td>
<td>150</td>
<td></td>
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<tr>
<td>f_{T}</td>
<td>Transition Frequency</td>
<td>I_C = 50 mA</td>
<td>50</td>
<td>70</td>
<td>MHz</td>
<td></td>
</tr>
<tr>
<td>C_{EBO}</td>
<td>Emitter-base Capacitance</td>
<td>I_C = 0 V_EB = 0.5 V</td>
<td>55</td>
<td>85</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>C_{CBO}</td>
<td>Collector-base Capacitance</td>
<td>I_C = 0 V_CB = 10 V</td>
<td>13</td>
<td>15</td>
<td>pF</td>
<td></td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1%.
DC Current Gain.

High-frequency Current Gain.
GENERAL PURPOSE AMPLIFIER AND SWITCH

DESCRIPTION
The 2N2102 is a silicon planar epitaxial NPN transistor in Jedec TO-39 metal case. It is intended for a wide variety of small-signal and medium power applications in military and industrial equipments.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(V_{CBO})</td>
<td>Collector-base Voltage ((I_E = 0))</td>
<td>120</td>
<td>V</td>
</tr>
<tr>
<td>(V_{CEO})</td>
<td>Collector-emitter Voltage ((I_B = 0))</td>
<td>65</td>
<td>V</td>
</tr>
<tr>
<td>(V_{CE})</td>
<td>Collector-emitter Voltage ((R_{BE} \leq 10 \Omega))</td>
<td>80</td>
<td>V</td>
</tr>
<tr>
<td>(V_{EBO})</td>
<td>Emitter-base Voltage ((I_C = 0))</td>
<td>7</td>
<td>V</td>
</tr>
<tr>
<td>(I_C)</td>
<td>Collector Current</td>
<td>1</td>
<td>A</td>
</tr>
<tr>
<td>(P_{tot})</td>
<td>Total Power Dissipation at (T_{amb} \leq 25^\circ C)</td>
<td>1</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at (T_{case} \leq 25^\circ C)</td>
<td>5</td>
<td>W</td>
</tr>
<tr>
<td>(T_{stg}, T_j)</td>
<td>Storage and Junction Temperature</td>
<td>–65 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>

January 1989
### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Thermal Resistance Junction-case</td>
<td></td>
<td></td>
<td></td>
<td>35°C/W</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thermal Resistance Junction-ambient</td>
<td></td>
<td></td>
<td></td>
<td>175°C/W</td>
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</tr>
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</table>

### ELECTRICAL CHARACTERISTICS (T_{amb} = 25°C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICBO</td>
<td>Collector Cutoff Current</td>
<td>V_C = 60 V</td>
<td></td>
<td></td>
<td>2 nA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(I_E = 0)</td>
<td>V_CB = 60 V</td>
<td></td>
<td></td>
<td>2 μA</td>
<td></td>
</tr>
<tr>
<td>IEBO</td>
<td>Emitter Cutoff Current</td>
<td>V_CB = 5 V</td>
<td></td>
<td></td>
<td>5 nA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(I_C = 0)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V_{(BR) CB}</td>
<td>Collector-base Breakdown Voltage</td>
<td>I_C = 100 μA</td>
<td></td>
<td>120</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>(I_E = 0)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>V_{CE (sus)}*</td>
<td>Collector-emitter Sustaining Voltage</td>
<td>I_C = 30 mA</td>
<td></td>
<td>65</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>(I_B = 0)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V_{CE (sat)}*</td>
<td>Collector-emitter Saturation Voltage</td>
<td>I_C = 150 mA</td>
<td>I_B = 15 mA</td>
<td>0.5</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V_{BE (sat)}*</td>
<td>Base-emitter Saturation Voltage</td>
<td>I_C = 150 mA</td>
<td>I_B = 15 mA</td>
<td>1.1</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>hFE*</td>
<td>DC Current Gain</td>
<td>I_C = 10 μA</td>
<td>V_CE = 10 V</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>I_C = 100 μA</td>
<td>V_CE = 10 V</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>I_C = 10 mA</td>
<td>V_CE = 10 V</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>I_C = 150 mA</td>
<td>V_CE = 10 V</td>
<td>40</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>I_C = 500 mA</td>
<td>V_CE = 10 V</td>
<td>25</td>
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<tr>
<td></td>
<td></td>
<td>I_C = 1 A</td>
<td>V_CE = 10 V</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>hfe</td>
<td>High Frequency Current Gain</td>
<td>I_C = 50 mA</td>
<td>V_CE = 10 V</td>
<td>6</td>
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<tr>
<td>NF</td>
<td>Noise Figure</td>
<td>I_C = 300 μA</td>
<td>V_CE = 10 V</td>
<td>8</td>
<td>dB</td>
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<tr>
<td></td>
<td></td>
<td>f = 1 KHz</td>
<td>R_G = 510 Ω</td>
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<td></td>
</tr>
<tr>
<td>C_{CBO}</td>
<td>Collector-base Capacitance</td>
<td>I_E = 0</td>
<td>V_CB = 10 V</td>
<td>15</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>f = 1 MHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C_{EBO}</td>
<td>Emitter-base Capacitance</td>
<td>I_E = 0</td>
<td>V_EB = 0.5 V</td>
<td>80</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>f = 1 MHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1%.
**DESCRIPTION**

The 2N2218, 2N2219, 2N2221 and 2N2222 are silicon planar epitaxial NPN transistors in Jedec TO-39 (for 2N2218 and 2N2219) and in Jedec TO-18 (for 2N2221 and 2N2222) metal cases. They are designed for high-speed switching applications at collector currents up to 500 mA, and feature useful current gain over a wide range of collector current, low leakage currents and low saturation voltages.

2N2218/2N2219 approved to CECC 50002-100, 2N2221/2N2222 approved to CECC 50002-101 available on request.

**INTERNAL SCHEMATIC DIAGRAM**

![Internal Schematic Diagram](image)

**ABSOLUTE MAXIMUM RATINGS**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>60</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>30</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>5</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>0.8</td>
<td>A</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 ^\circ C$</td>
<td>0.8</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>for 2N2218 and 2N2219</td>
<td>0.5</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>for 2N2221 and 2N2222</td>
<td>3</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 ^\circ C$</td>
<td>1.8</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}$</td>
<td>Storage Temperature</td>
<td>-65 to 200</td>
<td>°C</td>
</tr>
<tr>
<td>$T_J$</td>
<td>Junction Temperature</td>
<td>175</td>
<td>°C</td>
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</table>

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## THERMAL DATA

<table>
<thead>
<tr>
<th></th>
<th>2N2218</th>
<th>2N2219</th>
<th>2N2221</th>
<th>2N2222</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{\text{th} \ j\text{-case}}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>50 °C/W</td>
<td>83.3 °C/W</td>
</tr>
<tr>
<td>$R_{\text{th} \ j\text{-amb}}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>187.5 °C/W</td>
<td>300 °C/W</td>
</tr>
</tbody>
</table>

## ELECTRICAL CHARACTERISTICS ($T_{\text{amb}} = 25^\circ\text{C}$ unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{\text{CBO}}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{\text{CB}} = 50 \text{ V}$, $T_{\text{amb}} = 150^\circ\text{C}$</td>
<td>10</td>
<td>nA</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{\text{CB}} = 50 \text{ V}$</td>
<td>10</td>
<td>µA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{\text{EBO}}$</td>
<td>Emitter Cutoff Current ($I_C = 0$)</td>
<td>$V_{\text{EB}} = 3 \text{ V}$</td>
<td>10</td>
<td>nA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{\text{(BR)\text{CBO}}}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = 10 \mu\text{A}$</td>
<td>60</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{\text{(BR)\text{CEO}}}$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = 10 \text{ mA}$</td>
<td>30</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{\text{(BR)\text{EBO}}}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = 10 \mu\text{A}$</td>
<td>5</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{\text{CE (sat)}}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = 150 \text{ mA}$, $I_B = 15 \text{ mA}$</td>
<td>0.4</td>
<td>V</td>
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<td></td>
<td></td>
<td>$I_C = 500 \text{ mA}$, $I_B = 50 \text{ mA}$</td>
<td>1.6</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{\text{BE (sat)}}$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = 150 \text{ mA}$, $I_B = 15 \text{ mA}$</td>
<td>1.3</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 500 \text{ mA}$, $I_B = 50 \text{ mA}$</td>
<td>2.6</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$h_{\text{FE}}^*$</td>
<td>DC Current Gain</td>
<td>for 2N2218 and 2N2222</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 0.1 \text{ mA}$, $V_{\text{CE}} = 10 \text{ V}$</td>
<td>20</td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td>$I_C = 1 \text{ mA}$, $V_{\text{CE}} = 10 \text{ V}$</td>
<td>25</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 10 \text{ mA}$, $V_{\text{CE}} = 10 \text{ V}$</td>
<td>35</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 150 \text{ mA}$, $V_{\text{CE}} = 10 \text{ V}$</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 500 \text{ mA}$, $V_{\text{CE}} = 10 \text{ V}$</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 150 \text{ mA}$, $V_{\text{CE}} = 1 \text{ V}$</td>
<td>20</td>
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<tr>
<td></td>
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<td>for 2N2219 and 2N2222</td>
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<td>$I_C = 0.1 \text{ mA}$, $V_{\text{CE}} = 10 \text{ V}$</td>
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<td>50</td>
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<td>$I_C = 150 \text{ mA}$, $V_{\text{CE}} = 10 \text{ V}$</td>
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<td>$f_T$</td>
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<td>250</td>
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<tr>
<td>$C_{\text{CBO}}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$, $V_{\text{CB}} = 10 \text{ V}$</td>
<td>8</td>
<td>pF</td>
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<tr>
<td>$R_{\text{e(hie)}}$</td>
<td>Real Part of Input Impedance</td>
<td>$I_C = 20 \text{ mA}$, $f = 300 \text{ MHz}$, $V_{\text{CE}} = 20 \text{ V}$</td>
<td>60</td>
<td>Ω</td>
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* Pulsed: pulse duration = 300 µs, duty cycle = 1 %.
DESCRIPTION
The 2N2218A, 2N2219A, 2N2221A and 2N2222A are silicon planar epitaxial NPN transistors in Jedec TO-39 (for 2N2218A and 2N2219A) and in Jedec TO-18 (for 2N2221A and 2N2222A) metal cases. They are designed for high-speed switching applications at collector currents up to 500 mA, and feature useful current gain over a wide range of collector current, low leakage currents and low saturation voltages.

2N2218A/2N2219A approved to CECC 50002-100, 2N2221A/2N2222A approved to CECC 50002-101 available on request.

INTERNAL SCHEMATIC DIAGRAM

ABSOLUTE MAXIMUM RATINGS

<table>
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<tr>
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<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
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<tr>
<td>V_CBO</td>
<td>Collector-base Voltage (I_E = 0)</td>
<td>75</td>
<td>V</td>
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<tr>
<td>V_CEO</td>
<td>Collector-emitter Voltage (I_B = 0)</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>V_EBO</td>
<td>Emitter-base Voltage (I_C = 0)</td>
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<td>I_C</td>
<td>Collector Current</td>
<td>0.8</td>
<td>A</td>
</tr>
<tr>
<td>P_tot</td>
<td>Total Power Dissipation at T_amb ≤ 25 °C</td>
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<td>for 2N2218A and 2N2219A</td>
<td>0.8</td>
<td>W</td>
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<td>0.5</td>
<td>W</td>
</tr>
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<td></td>
<td>at T_case ≤ 25 °C</td>
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<td>3</td>
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<td>1.8</td>
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<td>T_stg</td>
<td>Storage Temperature</td>
<td>−65 to 200</td>
<td>°C</td>
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<tr>
<td>T_j</td>
<td>Junction Temperature</td>
<td>175</td>
<td>°C</td>
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THERMAL DATA

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<th>2N2218A</th>
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<td>Thj-case</td>
<td>Thermal Resistance Junction-case Max</td>
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<td>50 °C/W</td>
<td>83.3 °C/W</td>
<td>187.5 °C/W</td>
<td>300 °C/W</td>
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<td>Thj-amb</td>
<td>Thermal Resistance Junction-ambient Max</td>
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ELECTRICAL CHARACTERISTICS (Tamb = 25 °C unless otherwise specified)

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<tr>
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<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tr>
<td>Icbo</td>
<td>Collector Cutoff Current</td>
<td>Vcb = 60 V Tamb = 150 °C</td>
<td>10</td>
<td>10</td>
<td>nA</td>
<td>μA</td>
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<tr>
<td>Iceex</td>
<td>Collector Cutoff Current</td>
<td>Vce = 60 V</td>
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<tr>
<td>Iebo</td>
<td>Emitter Cutoff Current</td>
<td>Veb = 3 V</td>
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<td>Ibex</td>
<td>Base Cutoff Current</td>
<td>Vce = 60 V</td>
<td>20 nA</td>
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<tr>
<td>Vbr(cbo)</td>
<td>Collector-base Breakdown</td>
<td>Ic = 10 μA</td>
<td>75</td>
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<td></td>
<td>V</td>
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<tr>
<td>Vbr(ceo)</td>
<td>Collector-emitter Breakdown</td>
<td>Ic = 10 mA</td>
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<td>V</td>
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<tr>
<td>Vbr(ebo)</td>
<td>Emitter-base Breakdown</td>
<td>Iv = 10 μA</td>
<td>6</td>
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<tr>
<td>Vce(sat)</td>
<td>Collector-emitter Saturation</td>
<td>Ic = 150 mA Ib = 15 mA</td>
<td>0.3</td>
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<td>V</td>
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<tr>
<td>Vbe(sat)</td>
<td>Base-emitter Saturation</td>
<td>Ic = 150 mA Ib = 15 mA</td>
<td>0.6</td>
<td>1.2</td>
<td>2</td>
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<table>
<thead>
<tr>
<th>Symbol</th>
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<th>Max.</th>
<th>Unit</th>
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<td>DC Current Gain</td>
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<tr>
<td></td>
<td>for 2N2218A and 2N2221A</td>
<td>Ic = 0.1 mA Vce = 10 V</td>
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<tr>
<td></td>
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<td>Ic = 1 mA Vce = 10 V</td>
<td>25</td>
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<tr>
<td></td>
<td></td>
<td>Ic = 10 mA Vce = 10 V</td>
<td>35</td>
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<tr>
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<td>Ic = 150 mA Vce = 10 V</td>
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<tr>
<td></td>
<td></td>
<td>Ic = 500 mA Vce = 10 V</td>
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<td>Ic = 150 mA Vce = 1 V</td>
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<tr>
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<td></td>
<td>Ic = 10 mA Vce = 10 V</td>
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<table>
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<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tr>
<td>Hfe</td>
<td>DC Current Gain</td>
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<td></td>
<td>for 2N2219A and 2N2222A</td>
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<td>Ic = 500 mA Vce = 10 V</td>
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<td>Ic = 150 mA Vce = 1 V</td>
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<td>Ic = 10 mA Vce = 10 V</td>
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* Pulsed: pulse duration = 300 μs, duty cycle = 1%.
## ELECTRICAL CHARACTERISTICS (continued)

<table>
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<td>$h_{ie}$</td>
<td>Small Signal Current Gain</td>
<td>$I_C = 1 , mA$ $V_{CE} = 10 , V$ $f = 1 , kHz$</td>
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<td>150</td>
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<tr>
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<td>300</td>
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<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = 20 , mA$ $V_{CE} = 20 , V$ $f = 100 , MHz$</td>
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<td>MHz</td>
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<tr>
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<td>for 2N2218A and 2N2221A</td>
<td>300</td>
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<td>MHz</td>
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<tr>
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<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_C = 0$ $V_{EB} = 0.5 , V$</td>
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<td>pF</td>
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<tr>
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<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$ $V_{CB} = 10 , V$</td>
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<td>pF</td>
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<td>$f = 100 , kHz$</td>
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<tr>
<td>$R_{e(hie)}$</td>
<td>Real Part of Input Impedance</td>
<td>$I_C = 20 , mA$ $f = 300 , MHz$</td>
<td>60</td>
<td></td>
<td>Ω</td>
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<td>$NF$</td>
<td>Noise Figure</td>
<td>$I_C = 100 , μA$ $R_S = 1 , kΩ$ $f = 1 , kHz$</td>
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<td>dB</td>
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<tr>
<td>$h_{ie}^{**}$</td>
<td>Input Impedance</td>
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<td>1</td>
<td>3.5</td>
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<td>8</td>
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<td>Ω</td>
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<td>$h_{re}^{**}$</td>
<td>Reverse Voltage Ratio</td>
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<tr>
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<td>8×10&lt;sup&gt;-4&lt;/sup&gt;</td>
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<tr>
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<td>for 2N2219A and 2N2222A</td>
<td>2.5×10&lt;sup&gt;-4&lt;/sup&gt;</td>
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<tr>
<td></td>
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<td>for 2N2218A and 2N2221A</td>
<td>4×10&lt;sup&gt;-4&lt;/sup&gt;</td>
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<tr>
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<td>$h_{ce}^{**}$</td>
<td>Output Admittance</td>
<td>$I_C = 1 , mA$ $V_{CE} = 10 , V$</td>
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<td>15</td>
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<td>5</td>
<td>35</td>
<td></td>
<td>μS</td>
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<td>100</td>
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<td>μS</td>
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<tr>
<td></td>
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<td>200</td>
<td></td>
<td>μS</td>
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<tr>
<td>$t_d^{***}$</td>
<td>Delay Time</td>
<td>$I_C = 150 , mA$ $V_{CC} = 30 , V$ $V_B = -0.5 , V$</td>
<td>10</td>
<td></td>
<td>ns</td>
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<tr>
<td></td>
<td></td>
<td>$I_{B1} = 15 , mA$</td>
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<td></td>
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<tr>
<td>$t_r^{***}$</td>
<td>Rise Time</td>
<td>$I_C = 150 , mA$ $V_{CC} = 30 , V$ $V_B = -0.5 , V$</td>
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<td>ns</td>
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<td></td>
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<td>$I_{B1} = 15 , mA$</td>
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<tr>
<td>$t_s^{***}$</td>
<td>Storage Time</td>
<td>$I_C = 150 , mA$ $V_{CC} = 30 , V$ $I_{B1} = -I_{B2} = 15 , mA$</td>
<td>225</td>
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<td>ns</td>
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<tr>
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<td>$I_{B2} = -I_{B1} = 15 , mA$</td>
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<tr>
<td>$t_f^{***}$</td>
<td>Fall Time</td>
<td>$I_C = 150 , mA$ $V_{CC} = 30 , V$ $I_{B1} = -I_{B2} = 15 , mA$</td>
<td>60</td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{B2} = -I_{B1} = 15 , mA$</td>
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<tr>
<td>$r_{bb}C_{o(b,c)}$</td>
<td>Feedback Time Constant</td>
<td>$I_C = 20 , mA$ $f = 31.8 , MHz$ $V_{CE} = 20 , V$</td>
<td>150</td>
<td></td>
<td>ps</td>
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</tbody>
</table>

** $f = 1 \, kHz$

*** see test circuit.
Normalized DC Current Gain.

Collector-emitter Saturation Voltage.

Contours of Constant Narrow Band Noise Figure.

Switching Time vs. Collector Current.
Test Circuit for $t_d, t_r$

![Circuit Diagram](image)

**Pulse Generator:**
- $t_c \leq 20$ ns
- $PW \leq 200$ ns
- $Z_N = 50$ Ω

**TO Oscilloscope:**
- $t_c \leq 5.0$ ns
- $Z_N > 100$ KΩ
- $C_N \leq 12$ pF

---

Test Circuit for $t_d, t_r$

![Circuit Diagram](image)

**Pulse Generator:**
- $PW = 10$ μs
- $Z_N = 50$ Ω
- $T_c \leq 5.0$ ns

**TO Oscilloscope:**
- $t_c < 5.0$ ns
- $Z_N > 100$ KΩ
- $C_N \leq 12$ pF
DESCRIPTION
The 2N2368 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case. It is designed specifically for high-speed saturated switching applications at current levels from 100 μA to 100 mA.

Products approved to CECC 50004-022/023 available on request.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CES}$</td>
<td>Collector-emitter Voltage ($I_{BE} = 0$)</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>15</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>4.5</td>
<td>V</td>
</tr>
<tr>
<td>$I_{CM}$</td>
<td>Collector Peak Current ($t = 10 \mu s$)</td>
<td>0.5</td>
<td>A</td>
</tr>
<tr>
<td>$P_{T01}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 ^\circ C$</td>
<td>0.36</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 ^\circ C$</td>
<td>1.2</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 100 ^\circ C$</td>
<td>0.68</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}$</td>
<td>Storage and Junction Temperature</td>
<td>– 65 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>
**THERMAL DATA**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
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<th>Max.</th>
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</tr>
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<tbody>
<tr>
<td>$R_{thj-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>146</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
<tr>
<td>$R_{thj-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>486</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
</tbody>
</table>

**ELECTRICAL CHARACTERISTICS** ($T_{amb} = 25$ °C unless otherwise specified)

<table>
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<tr>
<th>Symbol</th>
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</tr>
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<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = 20$ V, $T_{amb} = 150$ °C</td>
<td>0.4</td>
<td>30</td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = 10$ μA</td>
<td>40</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CES}$</td>
<td>Collector-emitter Breakdown Voltage ($V_{BE} = 0$)</td>
<td>$I_C = 10$ μA</td>
<td>40</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CEO}$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = 10$ mA</td>
<td>15</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = 10$ μA</td>
<td>4.5</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE (sat) *}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = 10$ mA, $I_B = 1$ mA</td>
<td>0.2</td>
<td>0.25</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE (sat) *}$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = 10$ mA, $I_B = 1$ mA</td>
<td>0.7</td>
<td>0.75</td>
<td>0.85</td>
<td>V</td>
</tr>
<tr>
<td>$h_{FE *}$</td>
<td>DC Current Gain</td>
<td>$I_C = 10$ mA, $V_{CE} = 1$ V</td>
<td>20</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>$I_C = 100$ mA, $V_{CE} = 2$ V</td>
<td>10</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 10$ mA, $V_{CE} = 1$ V, $T_{amb} = -55$ °C</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = 10$ mA, $f = 100$ MHz, $V_{CE} = 10$ V</td>
<td>400</td>
<td>550</td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$, $f = 1$ MHz, $V_{CB} = 5$ V</td>
<td>2.5</td>
<td>4</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$t_s$</td>
<td>Storage Time</td>
<td>$I_C = 10$ mA, $V_{CC} = 10$ V</td>
<td>5</td>
<td>10</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$t_{on}$</td>
<td>Turn-on Time</td>
<td>$I_C = 10$ mA, $I_{B1} = -10$ mA</td>
<td>9</td>
<td>12</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$t_{off}$</td>
<td>Turn-off Time</td>
<td>$I_C = 10$ mA, $V_{CC} = 3$ V</td>
<td>10</td>
<td>15</td>
<td></td>
<td>ns</td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1 %.
DESCRIPTION
The 2N2369 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case. It is designed specifically for high-speed saturated switching applications at current levels from 100 µA to 100 mA.

ABSOLUTE MAXIMUM RATINGS

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<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CES}$</td>
<td>Collector-emitter Voltage ($V_{BE} = 0$)</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>15</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>4.5</td>
<td>V</td>
</tr>
<tr>
<td>$I_{CM}$</td>
<td>Collector Peak Current ($t = 10 \mu s$)</td>
<td>0.5</td>
<td>A</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 ^\circ C$</td>
<td>0.36</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 ^\circ C$</td>
<td>1.2</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 100 ^\circ C$</td>
<td>0.68</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}, T_J$</td>
<td>Storage and Junction Temperature</td>
<td>−65 to 200</td>
<td>°C</td>
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</table>

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### THERMAL DATA

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<tr>
<td>$R_{th j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td></td>
<td>146</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
<tr>
<td>$R_{th j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td></td>
<td>486</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
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</table>

### ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\, ^\circ C$ unless otherwise specified)

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<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = 20, V$</td>
<td>0.4</td>
<td>30</td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CB} = 20, V$</td>
<td></td>
<td></td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$T_{amb} = 150, ^\circ C$</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR) CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = 10, μA$</td>
<td>40</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR) CES}$</td>
<td>Collector-emitter Breakdown Voltage ($V_{BE} = 0$)</td>
<td>$I_C = 10, μA$</td>
<td>40</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR) CEO}$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = 10, mA$</td>
<td>15</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR) EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = 10, mA$</td>
<td>4.5</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE (sat)}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = 10, mA$</td>
<td>0.2</td>
<td>0.25</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE (sat)}$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = 10, mA$</td>
<td>0.7</td>
<td>0.75</td>
<td>0.85</td>
<td>V</td>
</tr>
<tr>
<td>$h_{FE}$</td>
<td>DC Current Gain</td>
<td>$I_C = 10, mA$</td>
<td>40</td>
<td>20</td>
<td>120</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = 1, V$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 100, mA$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = 2, V$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 10, mA$</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$T_{amb} = -55, ^\circ C$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = 10, mA$</td>
<td>500</td>
<td>650</td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = 10, V$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{DBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$</td>
<td>2.5</td>
<td>4</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td></td>
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<td>$f = 1, MHz$</td>
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<tr>
<td></td>
<td></td>
<td>$V_{CB} = 5, V$</td>
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</tr>
<tr>
<td>$t_s$</td>
<td>Storage Time</td>
<td>$I_C = 10, mA$</td>
<td>6</td>
<td>13</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CC} = 10, V$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{B1} = -I_{B2} = 10, mA$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{on}$</td>
<td>Turn-on Time</td>
<td>$I_C = 10, mA$</td>
<td>9</td>
<td>12</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{B1} = 3, mA$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CC} = 3, V$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{off}$</td>
<td>Turn-off Time</td>
<td>$I_C = 10, mA$</td>
<td>13</td>
<td>18</td>
<td></td>
<td>ns</td>
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<tr>
<td></td>
<td></td>
<td>$I_{B1} = 3, mA$</td>
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<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$I_{B2} = -1.5, mA$</td>
<td></td>
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</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1%.
DESCRIPTION
The 2N2369A is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case. It is designed specifically for high-speed saturated switching applications at current levels from 100 μA to 100 mA.

ABSOLUTE MAXIMUM RATINGS

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<td>$V_{CBO}$</td>
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<td>V</td>
</tr>
<tr>
<td>$V_{CES}$</td>
<td>Collector-emitter Voltage ($V_{BE} = 0$)</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>15</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>4.5</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>0.2</td>
<td>A</td>
</tr>
<tr>
<td>$I_{CM}$</td>
<td>Collector Current (10 μs pulse)</td>
<td>0.5</td>
<td>A</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 , ^{\circ}C$</td>
<td>0.36</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 , ^{\circ}C$</td>
<td>1.2</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 100 , ^{\circ}C$</td>
<td>0.68</td>
<td>W</td>
</tr>
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<td>$R_{th \ j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>$T_{amb} = 150 ^\circ C$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_{th \ j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>$T_{amb} =$ Max</td>
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<td></td>
<td></td>
</tr>
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ELECTRICAL CHARACTERISTICS ($T_{amb} = 25 ^\circ C$ unless otherwise specified)

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<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = 20 \text{ V}$ $T_{amb} = 150 ^\circ C$</td>
<td>30</td>
<td></td>
<td></td>
<td>$\mu\text{A}$</td>
</tr>
<tr>
<td>$I_{CES}$</td>
<td>Collector Cutoff Current ($V_{BE} = 0$)</td>
<td>$V_{CE} = 20 \text{ V}$</td>
<td>0.4</td>
<td></td>
<td></td>
<td>$\mu\text{A}$</td>
</tr>
<tr>
<td>$V_{(BR) \ CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = 10 \mu\text{A}$</td>
<td>40</td>
<td></td>
<td></td>
<td>$V$</td>
</tr>
<tr>
<td>$V_{(BR) \ CES}$</td>
<td>Collector-emitter Breakdown Voltage ($V_{BE} = 0$)</td>
<td>$I_C = 10 \mu\text{A}$</td>
<td>40</td>
<td></td>
<td></td>
<td>$V$</td>
</tr>
<tr>
<td>$V_{(BR) \ CEO}^*$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = 10 \text{ mA}$</td>
<td>15</td>
<td></td>
<td></td>
<td>$V$</td>
</tr>
<tr>
<td>$V_{(BR) \ EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = 10 \mu\text{A}$</td>
<td>4.5</td>
<td></td>
<td></td>
<td>$V$</td>
</tr>
<tr>
<td>$V_{CE (sat)}^*$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = 10 \text{ mA}$ $I_B = 1 \text{ mA}$</td>
<td>0.14</td>
<td>0.2</td>
<td></td>
<td>$V$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 30 \text{ mA}$ $I_B = 3 \text{ mA}$</td>
<td>0.17</td>
<td>0.25</td>
<td></td>
<td>$V$</td>
</tr>
<tr>
<td></td>
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<td>$I_C = 100 \text{ mA}$ $I_B = 10 \text{ mA}$</td>
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<tr>
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<td>$I_C = 10 \text{ mA}$ $I_B = 1 \text{ mA}$</td>
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<td>0.3</td>
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<tr>
<td>$V_{BE (sat)}^*$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = 10 \text{ mA}$ $I_B = 1 \text{ mA}$</td>
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<td>$I_C = 30 \text{ mA}$ $I_B = 3 \text{ mA}$</td>
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<tr>
<td></td>
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<td>$I_C = 100 \text{ mA}$ $I_B = 10 \text{ mA}$</td>
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<td>$I_C = 10 \text{ mA}$ $I_B = 1 \text{ mA}$</td>
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<tr>
<td>$h_{FE}^*$</td>
<td>DC Current Gain</td>
<td>$I_C = 10 \text{ mA}$ $V_{CE} = 0.35 \text{ V}$</td>
<td>40</td>
<td>63</td>
<td>120</td>
<td>$\text{V}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 10 \text{ mA}$ $V_{CE} = 1 \text{ V}$</td>
<td>40</td>
<td>66</td>
<td>120</td>
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<tr>
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<td></td>
<td>$I_C = 30 \text{ mA}$ $V_{CE} = 0.4 \text{ V}$</td>
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<td>$\text{V}$</td>
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<td></td>
<td>$I_C = 100 \text{ mA}$ $V_{CE} = 1 \text{ V}$</td>
<td>20</td>
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<td></td>
<td>$\text{V}$</td>
</tr>
<tr>
<td>$h_{FE}^*$</td>
<td>DC Current Gain</td>
<td>$I_C = 10 \text{ mA}$ $T_{amp} = - 55 ^\circ C$ $V_{CE} = 0.35 \text{ V}$</td>
<td>20</td>
<td>50</td>
<td></td>
<td></td>
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<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = 10 \text{ mA}$ $f = 100 \text{ MHz}$ $V_{CE} = 10 \text{ V}$</td>
<td>500</td>
<td>675</td>
<td></td>
<td>$\text{MHz}$</td>
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<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$ $f = 1 \text{ MHz}$ $V_{CB} = 5 \text{ V}$</td>
<td>2.3</td>
<td>4</td>
<td></td>
<td>$\text{pF}$</td>
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<tr>
<td>$t_s$ $^*$</td>
<td>Storage Time</td>
<td>$I_C = 10 \text{ mA}$ $V_{CC} = 10 \text{ V}$</td>
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<td>13</td>
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<tr>
<td></td>
<td></td>
<td>$I_{B1} = - I_{B2} = 10 \text{ mA}$</td>
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<tr>
<td>$t_{on}$ $^*$</td>
<td>Turn-on Time</td>
<td>$I_C = 10 \text{ mA}$ $V_{CC} = 3 \text{ V}$</td>
<td>9</td>
<td>12</td>
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<td>$\text{ns}$</td>
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<td></td>
<td></td>
<td>$I_{B1} = 3 \text{ mA}$</td>
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<td></td>
<td></td>
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<tr>
<td>$t_{off}$ $^*$</td>
<td>Turn-off Time</td>
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<td>18</td>
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<td>$\text{ns}$</td>
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<td></td>
<td></td>
<td>$I_{B1} = 3 \text{ mA}$ $I_{B2} = - 1.5 \text{ mA}$</td>
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</table>

* Pulsed: pulse duration = 300 $\mu$s, duty cycle = 1%.
** See test circuit.
DC Current Gain.

Collector-emitter Saturation Voltage.

Collector-base and Emitter-base capacitances.

Contours of Constant Transition Frequency.

Switching Characteristics.

Switching Characteristics.
Test Circuit for $t_s$

---

Test Circuit for $t_{on}, t_{off}$
DESCRIPTION
The 2N2484 is a silicon planar epitaxial NPN transistor in Jedeo TO-18 metal case. It is designed for use in high-performance, low-noise amplifier circuits from audio to high-frequency.

Products approved to CECC50002-129 available on request.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>60</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>60</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>6</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>50</td>
<td>mA</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 , ^\circ C$</td>
<td>0.36</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 , ^\circ C$</td>
<td>1.2</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 100 , ^\circ C$</td>
<td>0.68</td>
<td>W</td>
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<tr>
<td>$T_{stg}, T_j$</td>
<td>Storage and Junction Temperature</td>
<td>-65 to 200</td>
<td>°C</td>
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October 1988
### THERMAL DATA

<table>
<thead>
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<th>Unit</th>
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<tbody>
<tr>
<td>$R_{th,junction\rightarrow case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>146</td>
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<td>°C/W</td>
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<td>$R_{th,junction\rightarrow ambient}$</td>
<td>Thermal Resistance Junction-ambient</td>
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### ELECTRICAL CHARACTERISTICS ($T_{amb} = 25$ °C unless otherwise specified)

<table>
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<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = 45$ V</td>
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<td>nA</td>
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<td></td>
<td></td>
<td>$V_{CB} = 45$ V</td>
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<td>10</td>
<td>µA</td>
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<tr>
<td>$I_{EBO}$</td>
<td>Emitter Cutoff Current ($I_C = 0$)</td>
<td>$V_{EB} = 5$ V</td>
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<td>10</td>
<td>nA</td>
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<tr>
<td>$V_{(B)}CBO$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = 10$ µA</td>
<td>60</td>
<td></td>
<td></td>
<td>V</td>
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<tr>
<td>$V_{(B)}CEO$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
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<td></td>
<td>V</td>
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<tr>
<td>$V_{(B)}EBO$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = 10$ µA</td>
<td>6</td>
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<td></td>
<td>V</td>
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<tr>
<td>$V_{CE,(sat)}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = 1$ mA $I_B = 0.1$ mA</td>
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<td>0.35</td>
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<td>V</td>
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<td>$V_{BE}$</td>
<td>Base-emitter Voltage</td>
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<td>0.5</td>
<td>0.57</td>
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<td>$h_{FE}$</td>
<td>DC Current Gain</td>
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<td>$I_C = 10$ µA $V_{CE} = 5$ V</td>
<td>100</td>
<td>290</td>
<td>500</td>
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<td>375</td>
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<td>$I_C = 500$ µA $V_{CE} = 5$ V</td>
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<td>430</td>
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<td>450</td>
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<td></td>
<td>$I_C = 10$ mA $V_{CE} = 5$ V</td>
<td>430</td>
<td>800</td>
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<td></td>
<td></td>
<td>$I_C = 100$ µA $V_{CE} = 5$ V</td>
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<tr>
<td>$h_{fe}$</td>
<td>Small Signal Current Gain</td>
<td>$I_C = 1$ mA $V_{CE} = 5$ V</td>
<td>150</td>
<td>400</td>
<td>900</td>
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<tr>
<td></td>
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<td>$f = 1$ kHz</td>
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<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = 1$ µA $V_{CE} = 5$ V</td>
<td>15</td>
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<td>$I_C = 10$ µA $V_{CE} = 5$ V</td>
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<td>$I_C = 500$ µA $V_{CE} = 5$ V</td>
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<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_C = 0$ $V_{EB} = 0.5$ V</td>
<td>3.5</td>
<td>6</td>
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<td>pF</td>
</tr>
<tr>
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<td>$f = 1$ MHz</td>
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<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$ $V_{CB} = 5$ V</td>
<td>3.5</td>
<td>6</td>
<td></td>
<td>pF</td>
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<td></td>
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<td>$f = 1$ MHz</td>
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<td>$NF$</td>
<td>Noise Figure</td>
<td>$I_C = 10$ µA $V_{CE} = 5$ V</td>
<td>4</td>
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<td>dB</td>
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<td></td>
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<td>$R_9 = 10$ kΩ</td>
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<td>$f = 100$ Hz</td>
<td>1.8</td>
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<td>$f = 1$ kHz</td>
<td>0.6</td>
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<tr>
<td></td>
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<td>$f = 10$ kHz</td>
<td>1.8</td>
<td>3</td>
<td></td>
<td>dB</td>
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<td>$f = 10$ to 10000 Hz</td>
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<td>$h_{ie}$</td>
<td>Input Impedance</td>
<td>$I_C = 1$ mA $V_{CE} = 5$ V</td>
<td>3.5</td>
<td>15</td>
<td>24</td>
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<tr>
<td>$h_{re}$</td>
<td>Reverse Voltage Ratio</td>
<td>$I_C = 1$ mA $V_{CE} = 5$ V</td>
<td>4.25</td>
<td>8</td>
<td>$10^{-4}$</td>
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<tr>
<td>$h_{oe}$</td>
<td>Output Admittance</td>
<td>$I_C = 1$ mA $V_{CE} = 5$ V</td>
<td>15</td>
<td>40</td>
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<td>µS</td>
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</table>

* Pulsed: pulse duration = 300 µs, duty cycle = 1 %.
** $f = 1$ kHz.
DC Current Gain.

Collector-base Capacitance.

Noise Figure vs. Source Resistance.

Contours of Constant Noise Figure
f = 100 Hz.

Contours of Constant Noise Figure
f = 1 kHz.

Contours of Constant Noise Figure
f = 10 kHz.
Contours of Constant Noise Figure

$f = 1$ MHz.
DESCRIPTION
The 2N2845 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case. It is intended for high speed switching applications at collector currents up to 500 mA.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>60</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>30</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>5</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>500</td>
<td>mA</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 ,^\circ C$</td>
<td>0.36</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 ,^\circ C$</td>
<td>1.2</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 100 ,^\circ C$</td>
<td>0.68</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}, T_J$</td>
<td>Storage and Junction Temperature</td>
<td>-55 to 200</td>
<td>°C</td>
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THERMAL DATA

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<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$R_{th,j-cases}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>146</td>
<td></td>
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<td>°C/W</td>
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<tr>
<td>$R_{th,j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>486</td>
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<td>°C/W</td>
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ELECTRICAL CHARACTERISTICS ($T_{amb} = 25$ °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current (I_E = 0)</td>
<td>$V_{CB} = 30$ V</td>
<td></td>
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<td>nA</td>
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<td></td>
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<td>$V_{CB} = 30$ V</td>
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<td>µA</td>
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<td>$V_{BR}$</td>
<td>Collector-base Breakdown Voltage (I_E = 0)</td>
<td>I_C = 0.1 mA</td>
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<td>V</td>
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<tr>
<td>$V_{BR}$*</td>
<td>Collector-emitter Breakdown Voltage (I_B = 0)</td>
<td>I_C = 30 mA</td>
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<td>30</td>
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<td>V</td>
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<td>$V_{EBO}$</td>
<td>Emitter-base Breakdown Voltage (I_C = 0)</td>
<td>I_E = 0.1 mA</td>
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<td>5</td>
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<td>V</td>
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<tr>
<td>$V_{CE(sat)}$</td>
<td>Collector-emitter Saturation Voltage</td>
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<td>$V_{BE(sat)}$</td>
<td>Base-emitter Saturation Voltage</td>
<td>I_C = 50 mA</td>
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<td>I_C = 500 mA</td>
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<td></td>
<td></td>
<td>I_B = 5 mA</td>
<td>0.78</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>I_B = 15 mA</td>
<td>0.85</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>I_B = 50 mA</td>
<td>1.12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$h_{FE}$</td>
<td>DC Current Gain</td>
<td>$V_{CE} = 10$ V</td>
<td></td>
<td>60</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = 10$ V</td>
<td></td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = 1$ V</td>
<td>120</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$V_{CE} = 10$ V</td>
<td>250</td>
<td></td>
<td>350</td>
<td>MHz</td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>I_E = 0 V</td>
<td></td>
<td>6</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>f = 1 MHz V</td>
<td></td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{on}$</td>
<td>Turn-on Time</td>
<td>$V_{CC} = 10$ V</td>
<td></td>
<td>18</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$t_{off}$</td>
<td>Turn-off Time</td>
<td>$V_{CC} = 10$ V</td>
<td></td>
<td>25</td>
<td></td>
<td>ns</td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1 %.
DC Current Gain.

Collector-emitter Saturation Voltage.

Base-emitter Saturation Voltage.

Emitter-base and Collector-base Capacitances.

Contours of Constant Transition Frequency.

Switching Characteristics.
DESCRIPTION
The 2N2857 is a silicon planar epitaxial NPN transistors in Jedec TO-72 metal case, intended for amplifier, oscillator and converter applications up to 500 MHz.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{CBO} )</td>
<td>Collector-base Voltage (( I_E = 0 ))</td>
<td>30</td>
<td>V</td>
</tr>
<tr>
<td>( V_{CEO} )</td>
<td>Collector-emitter Voltage (( I_B = 0 ))</td>
<td>15</td>
<td>V</td>
</tr>
<tr>
<td>( V_{EBO} )</td>
<td>Emitter-base Voltage (( I_C = 0 ))</td>
<td>2.5</td>
<td>V</td>
</tr>
<tr>
<td>( I_C )</td>
<td>Collector Current</td>
<td>40</td>
<td>mA</td>
</tr>
<tr>
<td>( P_{tot} )</td>
<td>Total Power Dissipation at ( T_{amb} \leq 25^\circ C )</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| &nbsp;&n...
### Thermal Data

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{thj-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>583</td>
<td>°C/W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_{thj-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>875</td>
<td>°C/W</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Electrical Characteristics ($T_{amb} = 25°C$ unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = 15\ V$ $V_{CB} = 15\ V$ $T_{amb} = 150°C$</td>
<td>10</td>
<td>nA</td>
<td>1</td>
<td>µA</td>
</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = 1\ \mu A$</td>
<td>30</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CEO}$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = 3\ mA$</td>
<td>15</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = 10\ \mu A$</td>
<td>2.5</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$h_{FE}$</td>
<td>DC Current Gain</td>
<td>$I_C = 3\ mA$ $V_{CE} = 1\ V$</td>
<td>30</td>
<td>150</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = 5\ mA$ $f = 100\ MHz$ $V_{CE} = 6\ V$</td>
<td>1</td>
<td>1.9</td>
<td>GHz</td>
<td></td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_C = 0$ $f = 1\ MHz$ $V_{EB} = 0.5\ V$</td>
<td>1.4</td>
<td>pF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{re}$</td>
<td>Reverse Capacitance</td>
<td>$I_C = 0$ $f = 1\ MHz$ $V_{CE} = 10\ V$</td>
<td>0.6</td>
<td>1</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>$NF$</td>
<td>Noise Figure</td>
<td>$I_C = 1.5\ mA$ $f = 450\ MHz$ $R_g = 50\ \Omega$</td>
<td>3.8</td>
<td>4.5</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>$G_{pe}$</td>
<td>Power Gain (neutralized)</td>
<td>$I_C = 1.5\ mA$ $f = 450\ MHz$ $V_{CE} = 6\ V$ $R_g = 50\ \Omega$</td>
<td>12.5</td>
<td>19</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>$P_o$</td>
<td>Oscillator Power Output</td>
<td>$I_C = 12\ mA$ $f = 500\ MHz$ $V_{CB} = 10\ V$</td>
<td>30</td>
<td>mW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$r_{bb'co}$</td>
<td>Feedback Time Constant</td>
<td>$I_C = 2\ mA$ $f = 31.9\ MHz$ $V_{CB} = 6\ V$</td>
<td>4</td>
<td>7</td>
<td>15</td>
<td>ps</td>
</tr>
</tbody>
</table>
DESCRIPTION
The 2N2894, and 2N3209 are silicon planar epi­taxial PNP transistors in Jedec TO-18 metal case, intended for high speed, low saturation switching applications up to 100 mA.

Products approved to CECC 50004-022/023 available on request.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{CBO} )</td>
<td>Collector-base Voltage (( I_E = 0 ))</td>
<td>-12</td>
<td>V</td>
</tr>
<tr>
<td>( V_{CES} )</td>
<td>Collector-emitter Voltage (( V_{BE} = 0 ))</td>
<td>-12</td>
<td>V</td>
</tr>
<tr>
<td>( V_{CEO} )</td>
<td>Collector-emitter Voltage (( I_B = 0 ))</td>
<td>-12</td>
<td>V</td>
</tr>
<tr>
<td>( V_{EBO} )</td>
<td>Emitter-base Voltage (( I_C = 0 ))</td>
<td>-4</td>
<td>V</td>
</tr>
<tr>
<td>( I_C )</td>
<td>Collector Current</td>
<td>-200</td>
<td>mA</td>
</tr>
<tr>
<td>( P_{101} )</td>
<td>Total Power Dissipation at ( T_{amb} \leq 25 ^\circ C ) at ( T_{case} \leq 25 ^\circ C )</td>
<td>0.36</td>
<td>W</td>
</tr>
<tr>
<td>( T_{sig} ), ( T )</td>
<td>Storage and Junction Temperature</td>
<td>-65 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>
# THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th \ j \ case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>146</td>
<td></td>
<td>°C/W</td>
<td></td>
</tr>
<tr>
<td>$R_{th \ j \ amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>486</td>
<td></td>
<td>°C/W</td>
<td></td>
</tr>
</tbody>
</table>

## ELECTRICAL CHARACTERISTICS (T$_{amb}$ = 25 °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>for 2N2894</td>
<td>$V_{CB} = -6$ V $T_{amb} = 125$ °C</td>
<td>-10</td>
<td>μA</td>
<td></td>
</tr>
<tr>
<td>$I_{CES}$</td>
<td>Collector Cutoff Current ($V_{BE} = 0$)</td>
<td>for 2N2894</td>
<td>$V_{CE} = -6$ V $I_{E} = 0$</td>
<td>-80</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for 2N3209</td>
<td>$V_{CE} = -10$ V $T_{amb} = 125$ °C</td>
<td>-80</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for 2N3209</td>
<td>$V_{CE} = -10$ V</td>
<td>-10</td>
<td>μA</td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)\ cbo}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>for 2N2894</td>
<td>$I_C = -10$ μA</td>
<td>-12</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for 2N3209</td>
<td>$I_C = -20$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)\ ces}$</td>
<td>Collector-emitter Breakdown Voltage ($V_{BE} = 0$)</td>
<td>for 2N2894</td>
<td>$I_C = -10$ μA</td>
<td>-12</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for 2N3209</td>
<td>$I_C = -20$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)\ c eo}$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>for 2N2894</td>
<td>$I_C = -10$ mA</td>
<td>-12</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for 2N3209</td>
<td>$I_C = -20$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)\ e bo}$</td>
<td>Emitter-base Breakdown Voltage ($I_E = 0$)</td>
<td>for 2N2894</td>
<td>$I_E = -100$ μA</td>
<td>-4</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{CE\ (sat)}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>for 2N2894</td>
<td>$I_C = -10$ mA $I_B = -1$ mA</td>
<td>-0.15</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for 2N3209</td>
<td>$I_C = -30$ mA $I_B = -3$ mA</td>
<td>-0.2</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for 2N3209</td>
<td>$I_C = -100$ mA $I_B = -10$ mA</td>
<td>-0.5</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$h_{FE}$</td>
<td>DC Current Gain</td>
<td>for 2N2894</td>
<td>$V_{CE} = -0.3$ V</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for 2N3209</td>
<td>$V_{CE} = -0.5$ V</td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for 2N2894</td>
<td>$V_{CE} = -1$ V</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for 2N3209</td>
<td>$V_{CE} = -1$ V</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for 2N3209</td>
<td>$V_{CE} = -0.5$ V $T_{amb} = -55$ °C</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for 2N2894</td>
<td>$V_{CE} = -0.5$ V $T_{amb} = -55$ °C</td>
<td>17</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>for 2N3209</td>
<td>$V_{CE} = -0.5$ V $T_{amb} = -55$ °C</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>for 2N2894</td>
<td>$I_C = -30$ mA $f = 100$ MHz $V_{CE} = -10$ V</td>
<td>400</td>
<td>MHz</td>
<td></td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_C = 0$ $f = 1$ MHz $V_{EB} = -0.5$ V</td>
<td>6</td>
<td>pF</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1%.
ELECTRICAL CHARACTERISTICS (continued)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter Description</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
</table>
| $C_{CEO}$ | Collector-base Capacitance | $I_E = 0$  
$f = 1$ MHz  
for $2N2894$  
for $2N3209$  
$V_{CB} = -5$ V | 6 | 5 | pF | pF |
| $t_{on}$ | Turn-on Time | $I_C = -30$ mA  
$V_{CC} = -2$ V  
$I_{B1} = -1.5$ mA | 60 | ns | |
| $t_{off}$ | Turn-off Time | $I_C = -30$ mA  
$V_{CC} = -2$ V  
$I_{B1} = -I_{B2} = -1.5$ mA | 90 | ns | |

** See test circuit.

Collector-emitter Saturation Voltage.

Emitter-base and Collector-base capacitance.

Contours of Constant Transition Frequency.

Switching Characteristics.
Test Circuit for $t_{on}$, $t_{off}$.

- $V_{BB} = -2.0\text{V}$
- $V_{CC} = -2.0\text{V}$
- $V_{IN} = -7.0\text{V}$ (for $t_{on}$)
- $V_{IN} = +6\text{V}$ (for $t_{off}$)
- $V_{BB} = +3.0\text{V}$, $V_{IN} = -7.0\text{V}$ (Pulse Generator)
- $V_{BB} = -4.0\text{V}$, $V_{IN} = +6\text{V}$ (Pulse Generator)
- Pulse Generator:
  - $t_r \leq 1.0\text{ns}$
  - DC < 2%
  - $PW = 400\text{ns}$
  - $Z_I = 50\text{Ω}$
- Oscilloscope:
  - $t_r < 1.0\text{ns}$
  - $Z_I \geq 100\text{KΩ}$
DESCRIPTION
The 2N2904, 2N2905, 2N2906 and 2N2907 are silicon planar epitaxial PNP transistors in Jedec TO-39 (for 2N2904, 2N2905) and in Jedec TO-18 (for 2N2906 and 2N2907) metal cases. They are designed for high-speed saturated switching and general purpose applications.

2N2904/2N2905 approved to CECC 50002-102, 2N2906/2N2907 approved to CECC 50002-103 available on request.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{CBO}</td>
<td>Collector-base Voltage (I_E = 0)</td>
<td>-60</td>
<td>V</td>
</tr>
<tr>
<td>V_{CEO}</td>
<td>Collector-emitter Voltage (I_B = 0)</td>
<td>-40</td>
<td>V</td>
</tr>
<tr>
<td>V_{EBO}</td>
<td>Emitter-base Voltage (I_C = 0)</td>
<td>-5</td>
<td>V</td>
</tr>
<tr>
<td>I_C</td>
<td>Collector Current</td>
<td>-600</td>
<td>mA</td>
</tr>
<tr>
<td>P_{tot}</td>
<td>Total Power Dissipation at T_{amb} ≤ 25 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>for 2N2904 and 2N2905</td>
<td>0.6</td>
<td>W</td>
</tr>
<tr>
<td>-</td>
<td>for 2N2906 and 2N2907</td>
<td>0.4</td>
<td>W</td>
</tr>
<tr>
<td>-</td>
<td>at T_{case} ≤ 25 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>for 2N2904 and 2N2905</td>
<td>3</td>
<td>W</td>
</tr>
<tr>
<td>-</td>
<td>for 2N2906 and 2N2907</td>
<td>1.8</td>
<td>W</td>
</tr>
<tr>
<td>T_{stg}, T_{J}</td>
<td>Storage and Junction Temperature</td>
<td>-65 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>
## THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th \cdot case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>$T_{amb} = 150 , ^\circ C$</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
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</tr>
<tr>
<td>$R_{th \cdot amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td></td>
<td></td>
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</tbody>
</table>

## ELECTRICAL CHARACTERISTICS ($T_{amb} = 25 \, ^\circ C$ unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>$I_{CBQ}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = -50 , V$</td>
<td>$-20 , nA$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CB} = -50 , V$</td>
<td>$-20 , \mu A$</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>$I_{CEX}$</td>
<td>Collector Cutoff Current ($V_{BE} = 0.5 , V$)</td>
<td>$V_{CE} = -30 , V$</td>
<td></td>
<td></td>
<td>$-50 , nA$</td>
<td></td>
</tr>
<tr>
<td>$I_{BEX}$</td>
<td>Base Cutoff Current ($V_{BE} = 0.5 , V$)</td>
<td>$V_{CE} = -30 , V$</td>
<td></td>
<td></td>
<td>$-50 , nA$</td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = -10 , \mu A$</td>
<td></td>
<td>$-60 , V$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CEO}$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = -10 , mA$</td>
<td></td>
<td>$-40 , V$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR) EBO}$</td>
<td>Emittter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = -10 , \mu A$</td>
<td></td>
<td>$-5 , V$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{CE, (sat)}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = -150 , mA$</td>
<td>$-0.4 , V$</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>$I_C = -500 , mA$</td>
<td>$-1.6 , V$</td>
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<td></td>
</tr>
<tr>
<td>$V_{BE, (sat)}$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = -150 , mA$</td>
<td>$-1.3 , V$</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -500 , mA$</td>
<td>$-2.6 , V$</td>
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</tr>
<tr>
<td>$h_{FE}$</td>
<td>DC Current Gain</td>
<td>for $2N2904$ and $2N2906$</td>
<td>20</td>
<td>25</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td></td>
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<td>200</td>
<td>120</td>
<td>300</td>
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</tr>
<tr>
<td>$h_{FE}$</td>
<td>DC Current Gain</td>
<td>for $2N2905$ and $2N2907$</td>
<td>35</td>
<td>50</td>
<td>75</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>100</td>
<td>100</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = -50 , mA$</td>
<td>200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 100 , MHz$</td>
<td></td>
<td></td>
<td>MHz</td>
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</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_C = 0$</td>
<td>30</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 1 , MHz$</td>
<td></td>
<td></td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 1 , MHz$</td>
<td></td>
<td></td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>$t_d$</td>
<td>Delay Time</td>
<td>$I_C = -150 , mA$</td>
<td>10</td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{B1} = -15 , mA$</td>
<td></td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$t_r$</td>
<td>Rise Time</td>
<td>$I_C = -150 , mA$</td>
<td>40</td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{B1} = -15 , mA$</td>
<td></td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$t_s$</td>
<td>Storage Time</td>
<td>$I_C = -150 , mA$</td>
<td>80</td>
<td></td>
<td>ns</td>
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<td></td>
<td></td>
<td>$I_{B1} = -15 , mA$</td>
<td></td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$t_f$</td>
<td>Fall Time</td>
<td>$I_C = -150 , mA$</td>
<td>30</td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{B1} = -15 , mA$</td>
<td></td>
<td></td>
<td>ns</td>
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</tr>
</tbody>
</table>
DESCRIPTION

The 2N2904A, 2N2905A, 2N2906A and 2N2907A are silicon planar epitaxial PNP transistors in Jedec TO-39 (for 2N2904A and 2N2905A) and in Jedec TO-18 (for 2N2906A and 2N2907A) metal cases. They are designed for high-speed saturated switching and general purpose applications.

2N2904A/2N2905A approved to CECC 50002-100, 2N2906A/2N2907A approved to CECC 50002-103 available on request.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{CBO}</td>
<td>Collector-base Voltage (I_E = 0)</td>
<td>-60</td>
<td>V</td>
</tr>
<tr>
<td>V_{CEO}</td>
<td>Collector-emitter Voltage (I_B = 0)</td>
<td>-60</td>
<td>V</td>
</tr>
<tr>
<td>V_{EBO}</td>
<td>Emitter-base Voltage (I_C = 0)</td>
<td>-5</td>
<td>V</td>
</tr>
<tr>
<td>I_C</td>
<td>Collector Current</td>
<td>-600</td>
<td>mA</td>
</tr>
<tr>
<td>P_{tot}</td>
<td>Total Power Dissipation at T_{amb} ≤ 25 °C</td>
<td>0.6</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>for 2N2904A and 2N2905A</td>
<td>0.4</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>for 2N2906A and 2N2907A</td>
<td>3</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at T_{case} ≤ 25 °C</td>
<td>1.8</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>for 2N2904A and 2N2905A</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>for 2N2906A and 2N2907A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T_{stg}, T_j</td>
<td>Storage and Junction Temperature</td>
<td>-65 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>
## THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(R_{th i-ease})</td>
<td>Junction-case Max</td>
<td>58.3 °C/W</td>
</tr>
<tr>
<td>(R_{th i-amb})</td>
<td>Junction-ambient Max</td>
<td>292 °C/W</td>
</tr>
</tbody>
</table>

## ELECTRICAL CHARACTERISTICS \((T_{amb} = 25 \degree C\) unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(I_{CBO})</td>
<td>Collector Cutoff Current ((I_E = 0))</td>
<td>(V_{CB} = -50 \text{ V})</td>
<td>-10 nA</td>
<td>-10 \mu A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(I_{CEX})</td>
<td>Collector Cutoff Current ((V_{BE} = 0.5 \text{ V}))</td>
<td>(V_{CE} = -30 \text{ V})</td>
<td>-50 nA</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>(I_{BEX})</td>
<td>Base Cutoff Current ((V_{BE} = 0.5 \text{ V}))</td>
<td>(V_{CE} = -30 \text{ V})</td>
<td>-50 nA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(V_{(BR) CBO})</td>
<td>Collector-base Breakdown Voltage ((I_E = 0))</td>
<td>(I_C = -10 \text{ mA})</td>
<td>-60 V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(V_{(BR) CEO})</td>
<td>Collector-emitter Breakdown Voltage ((I_B = 0))</td>
<td>(I_C = -10 \text{ mA})</td>
<td>-60 V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(V_{(BR) EBO})</td>
<td>Emitter-base Breakdown Voltage ((I_C = 0))</td>
<td>(I_E = -10 \text{ \mu A})</td>
<td>-5 V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(V_{CE (sat)})</td>
<td>Collector-emitter Saturation Voltage</td>
<td>(I_C = -150 \text{ mA}) (I_B = -15 \text{ mA})</td>
<td>-0.4 V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(V_{BE (sat)})</td>
<td>Base-emitter Saturation Voltage</td>
<td>(I_C = -150 \text{ mA}) (I_B = -16 \text{ mA})</td>
<td>-1.3 V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(h_{FE})</td>
<td>DC Current Gain</td>
<td>for 2N2904A and 2N2906A</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&amp;</td>
<td>&amp;</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>&amp;</td>
<td>&amp;</td>
<td>120</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>(f_T)</td>
<td>Transition Frequency</td>
<td>(I_C = -50 \text{ mA}) (V_{CE} = -20 \text{ V})</td>
<td>200 MHz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(C_{EBO})</td>
<td>Emitter-base Capacitance</td>
<td>(I_C = 0) (f = 1 \text{ MHz})</td>
<td>30 pF</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(C_{CBO})</td>
<td>Collector-base Capacitance</td>
<td>(I_E = 0) (f = 1 \text{ MHz})</td>
<td>8 pF</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>(t_d)</td>
<td>Delay Time</td>
<td>(I_C = -150 \text{ mA}) (I_B1 = -15 \text{ mA})</td>
<td>10 ns</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(t_r)</td>
<td>Rise Time</td>
<td>(I_C = -150 \text{ mA}) (I_B1 = -15 \text{ mA})</td>
<td>40 ns</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(t_s)</td>
<td>Storage Time</td>
<td>(I_C = -150 \text{ mA}) (I_B1 = -15 \text{ mA})</td>
<td>80 ns</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Pulsed: pulse duration = 300 \mu s, duty cycle = 1.5%.

**See test circuit.
### ELECTRICAL CHARACTERISTICS (continued)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t_f$ **</td>
<td>Fall Time</td>
<td>$I_C = -150$ mA $V_{CC} = -6$ V $I_{B1} = -15$ mA $I_{B2} = -15$ mA</td>
<td>30</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$t_{on}$ **</td>
<td>Turn-on Time</td>
<td>$I_C = -150$ mA $V_{CC} = -30$ V $I_{B1} = -15$ mA $I_{B2} = -15$ mA</td>
<td>45</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$t_{off}$ **</td>
<td>Turn-off Time</td>
<td>$I_C = -150$ mA $V_{CC} = -6$ V $I_{B1} = -15$ mA $I_{B2} = -15$ mA</td>
<td>100</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1.5%.
** see test circuit.

Normalized DC Current Gain.

Collector-emitter Saturation Voltage.

Collector-base and Emitter-base capacitances.

Switching Characteristics.
Test Circuit for $t_{on}$, $t_r$, $t_d$.

PULSE GENERATOR:
- $t_r \leq 2.0 \text{ ms}$
- Frequency = $150 \text{ Hz}$
- $Z_o = 50 \text{ } \Omega$

TO OSCILLOSCOPE:
- $t_r < 5.0 \text{ ns}$
- $Z_{in} > 10 \text{ M}\Omega$

Test Circuit for $t_{off}$, $t_o$, $t_r$.

PULSE GENERATOR:
- $t_r \leq 2.0 \text{ ns}$
- Frequency = $150 \text{ Hz}$
- $Z_o = 50 \text{ } \Omega$

TO OSCILLOSCOPE:
- $t_r < 5.0 \text{ ns}$
- $Z_{in} > 100 \text{ M}\Omega$
DESCRIPTION
The 2N3013 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case intended for high speed low saturation switching application up to 300 mA.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_CBO</td>
<td>Collector-base Voltage (I_E = 0)</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>V_CES</td>
<td>Collector-emitter Voltage (V_BE = 0)</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>V_CEO</td>
<td>Collector-emitter Voltage (I_B = 0)</td>
<td>15</td>
<td>V</td>
</tr>
<tr>
<td>V_EBO</td>
<td>Emitter-base Voltage (I_C = 0)</td>
<td>5</td>
<td>V</td>
</tr>
<tr>
<td>I_C</td>
<td>Collector Current</td>
<td>200</td>
<td>mA</td>
</tr>
<tr>
<td>I_C</td>
<td>Collector Peak Current (t &lt; 10 μs)</td>
<td>500</td>
<td>mA</td>
</tr>
<tr>
<td>P_tot</td>
<td>Total Power Dissipation at T_amb &lt; 25 °C</td>
<td>360</td>
<td>mW</td>
</tr>
<tr>
<td></td>
<td>at T_case &lt; 25 °C</td>
<td>1200</td>
<td>mW</td>
</tr>
<tr>
<td></td>
<td>at T_case &lt; 100 °C</td>
<td>680</td>
<td>mW</td>
</tr>
<tr>
<td>T_stg</td>
<td>Storage Temperature</td>
<td>-55 to 200</td>
<td>°C</td>
</tr>
<tr>
<td>T_j</td>
<td>Max. Operating Junction Temperature</td>
<td>200</td>
<td>°C</td>
</tr>
</tbody>
</table>

January 1989
## THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>$R_{th j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max 146</td>
<td></td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
<tr>
<td>$R_{th j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max 486</td>
<td></td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
</tbody>
</table>

## ELECTRICAL CHARACTERISTICS ($T_{amb} = 25 \, ^\circ C$ unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CES}$</td>
<td>Collector Cutoff Current ($V_{BE} = 0$)</td>
<td>$V_{CE} = 20 , V$ $T_{amb} = 125 , ^\circ C$</td>
<td>300</td>
<td>40</td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage</td>
<td>$I_C = 100 , \mu A$ $I_E = 0$</td>
<td>40</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CEO}^*$</td>
<td>Collector-emitter Breakdown Voltage</td>
<td>$I_C = 10 , mA$ $I_B = 0$</td>
<td>15</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage</td>
<td>$I_E = 100 , \mu A$ $I_C = 0$</td>
<td>5</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$h_{FE}^*$</td>
<td>DC Current Gain</td>
<td>$V_{CE} = 0.4 , V$ $I_C = 30 , mA$</td>
<td>30</td>
<td>25</td>
<td>120</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = 0.5 , V$ $I_C = 100 , mA$</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = 1 , V$ $I_C = 300 , mA$</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE(sat)}^*$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = 30 , mA$ $I_B = 3 , mA$</td>
<td>0.18</td>
<td>0.28</td>
<td>0.50</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 100 , mA$ $I_B = 10 , mA$</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 300 , mA$ $I_B = 30 , mA$</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$T_{amb} = 55 , ^\circ C$</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE(sat)}^*$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = 30 , mA$ $I_B = 3 , mA$</td>
<td>0.75</td>
<td>0.95</td>
<td>1.20</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 100 , mA$ $I_B = 10 , mA$</td>
<td></td>
<td>1.70</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 300 , mA$ $I_B = 30 , mA$</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$T_{amb} = 125 , ^\circ C$</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$V_{CE} = 10 , V$ $f = 100 , MHz$</td>
<td>350</td>
<td></td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$V_{CB} = 5 , V$ $I_E = 0$ $f = 1 , MHz$</td>
<td>5</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$V_{EB} = 0.5 , V$ $I_C = 0$ $f = 1 , MHz$</td>
<td>8</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$t_{on}$</td>
<td>Turn-on Time</td>
<td>$V_{CC} = 15 , V$ $I_C = 300 , mA$</td>
<td>15</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$t_{off}$</td>
<td>Turn-off Time</td>
<td>$V_{CC} = 15 , V$ $I_C = 300 , mA$</td>
<td>25</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$t_s$</td>
<td>Storage Time</td>
<td>$V_{CC} = 10 , V$ $I_C = 10 , mA$</td>
<td>18</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1.5%.
DESCRIPTION
The 2N3014 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case intended for high speed low saturation switching application up to 300 mA.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{CBO}</td>
<td>Collector-base Voltage ( (I_E = 0) )</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>V_{CES}</td>
<td>Collector-emitter Voltage ( (V_{BE} = 0) )</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>V_{CEO}</td>
<td>Collector-emitter Voltage ( (I_B = 0) )</td>
<td>20</td>
<td>V</td>
</tr>
<tr>
<td>V_{EBO}</td>
<td>Emitter-base Voltage ( (I_C = 0) )</td>
<td>5</td>
<td>V</td>
</tr>
<tr>
<td>I_C</td>
<td>Collector Current</td>
<td>200</td>
<td>mA</td>
</tr>
<tr>
<td>I_{Cp}</td>
<td>Collector Peak Current ( (t &lt; 10 \mu s) )</td>
<td>500</td>
<td>mA</td>
</tr>
<tr>
<td>P_{tot}</td>
<td>Total Dissipation at ( T_{amb} &lt; 25 \degree C )</td>
<td>360</td>
<td>mW</td>
</tr>
<tr>
<td></td>
<td>at ( T_{case} &lt; 25 \degree C )</td>
<td>1200</td>
<td>mW</td>
</tr>
<tr>
<td></td>
<td>at ( T_{case} &lt; 100 \degree C )</td>
<td>680</td>
<td>mW</td>
</tr>
<tr>
<td>T_{stg}</td>
<td>Storage Temperature</td>
<td>-55 to 200</td>
<td>\degree C</td>
</tr>
<tr>
<td>T_J</td>
<td>Maximum Operating Junction Temperature</td>
<td>200</td>
<td>\degree C</td>
</tr>
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October 1988
**THERMAL DATA**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$R_{th j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td></td>
<td></td>
<td></td>
<td>146</td>
<td>°C/W</td>
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<tr>
<td>$R_{th j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td></td>
<td></td>
<td></td>
<td>486</td>
<td>°C/W</td>
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</table>

**ELECTRICAL CHARACTERISTICS** ($T_{amb} = 25$ °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CES}$</td>
<td>Collector Cutoff Current ($V_{BE} = 0$)</td>
<td>$V_{CE} = 20$ V $V_{CE} = 20$ V $T_{amb} = 125$ °C</td>
<td>300</td>
<td>40</td>
<td>nA</td>
<td>μA</td>
</tr>
<tr>
<td>$V_{(BR)CEO}$</td>
<td>Collector-base Breakdown Voltage</td>
<td>$I_C = 100$ μA $I_E = 0$</td>
<td>40</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CEO}$</td>
<td>Collector-emitter Breakdown Voltage</td>
<td>$I_C = 10$ A $I_B = 0$</td>
<td>20</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage</td>
<td>$I_E = 100$ μA $I_C = 0$</td>
<td>5</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$h_{FE}$</td>
<td>DC Current Gain</td>
<td>$V_{CE} = 0.4$ V</td>
<td>25</td>
<td></td>
<td>120</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE(sat)}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = 10$ mA $I_B = 1$ mA</td>
<td>0.18</td>
<td>0.18</td>
<td>0.35</td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE(sat)}$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = 30$ mA $I_B = 3$ mA</td>
<td>0.75</td>
<td>0.95</td>
<td>1.20</td>
<td>V</td>
</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$V_{CE} = 10$ V $f = 100$ MHz</td>
<td>350</td>
<td></td>
<td>MHz</td>
<td></td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$V_{CB} = 5$ V $I_E = 0$ $f = 1$ MHz</td>
<td>5</td>
<td></td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$V_{EB} = 0.5$ V $I_C = 0$ $f = 1$ MHz</td>
<td>8</td>
<td></td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>$t_{on}$</td>
<td>Turn-on Time</td>
<td>$V_{CC} = 2$ V $I_{B1} = 3$ mA</td>
<td>16</td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$t_{off}$</td>
<td>Turn-off Time</td>
<td>$V_{CC} = 2$ V $I_C = 30$ mA $I_{B1} = -I_{B2} = 3$ mA</td>
<td>25</td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$t_s$</td>
<td>Storage Time</td>
<td>$V_{CC} = 10$ V $I_C = 10$ mA $I_{B1} = -I_{B2} = 10$ mA</td>
<td>18</td>
<td></td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1.5%.
DESCRIPTION
The 2N3019 and 2N3020 are silicon planar epitaxial NPN transistors in Jedec TO-39 metal case, designed for high-current, high-frequency amplifier applications. They feature high gain and low saturation voltages.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{CBO}</td>
<td>Collector-base Voltage (I_E = 0)</td>
<td>140</td>
<td>V</td>
</tr>
<tr>
<td>V_{CED}</td>
<td>Collector-emitter Voltage (I_B = 0)</td>
<td>80</td>
<td>V</td>
</tr>
<tr>
<td>V_{EBO}</td>
<td>Emitter-base Voltage (I_C = 0)</td>
<td>7</td>
<td>V</td>
</tr>
<tr>
<td>I_C</td>
<td>Collector Current</td>
<td>1</td>
<td>mA</td>
</tr>
<tr>
<td>P_{tot}</td>
<td>Total Power Dissipation at T_{amb} ≤ 25 °C</td>
<td>0.8</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at T_{case} ≤ 25 °C</td>
<td>5</td>
<td>W</td>
</tr>
<tr>
<td>T_{stg}, T_j</td>
<td>Storage and Junction Temperature</td>
<td>-65 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>
**THERMAL DATA**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th,j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>35</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
<tr>
<td>$R_{th,j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>219</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
</tbody>
</table>

**ELECTRICAL CHARACTERISTICS (T$_{amb}$ = 25 °C unless otherwise specified)**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = 90$ V, $T_{amb} = 150$ °C</td>
<td>10</td>
<td></td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>$I_{EBO}$</td>
<td>Emitter Cutoff Current ($I_C = 0$)</td>
<td>$V_{EB} = 5$ V</td>
<td>10</td>
<td></td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>$V(BR)_{CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = 100$ μA</td>
<td>140</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V(BR)_{CEO}$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = 10$ mA</td>
<td>80</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V(BR)_{EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_E = 100$ μA</td>
<td>7</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE(sat)}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = 150$ mA, $I_B = 15$ mA</td>
<td>0.2</td>
<td></td>
<td>V</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>$I_C = 500$ mA, $I_B = 50$ mA</td>
<td>0.5</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{BE(sat)}$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = 150$ mA, $I_B = 15$ mA</td>
<td>1.1</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$h_{FE}$</td>
<td>DC Current Gain</td>
<td>$I_C = 0.1$ mA, $V_{CE} = 10$ V</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 10$ mA, $V_{CE} = 10$ V</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 150$ mA, $V_{CE} = 10$ V</td>
<td>90</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 500$ mA, $V_{CE} = 10$ V</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 1$ A, $V_{CE} = 10$ V</td>
<td>50</td>
<td></td>
<td>100</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 150$ mA, $T_{amb} = -55$ °C, $V_{CE} = 10$ V</td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td>For 2N3019</td>
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</tr>
<tr>
<td>$h_{ie}$</td>
<td>Small Signal Current Gain</td>
<td>$I_C = 1$ mA, $f = 1$ kHz, $V_{CE} = 5$ V</td>
<td>80</td>
<td>400</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>For 2N3019</td>
<td>30</td>
<td></td>
<td>MHz</td>
<td>MHz</td>
</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = 50$ mA, $f = 20$ MHz, $V_{CE} = 10$ V</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>For 2N3019</td>
<td>80</td>
<td></td>
<td>MHz</td>
<td>MHz</td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_C = 0$ mA, $f = 1$ MHz, $V_{EB} = 0.5$ V</td>
<td>60</td>
<td></td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$ mA, $f = 1$ MHz, $V_{CB} = 10$ V</td>
<td>12</td>
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<td>pF</td>
<td></td>
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<td>NF</td>
<td>Noise Figure</td>
<td>$I_C = 100$ μA, $f = 1$ kHz, $R_g = 1$ KΩ, $V_{CE} = 10$ V</td>
<td>4</td>
<td></td>
<td>dB</td>
<td></td>
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<tr>
<td>$r_{bb' Cb'c}$</td>
<td>Feedback Time Constant</td>
<td>$I_C = 10$ mA, $f = 4$ MHz, $V_{CE} = 10$ V</td>
<td>400</td>
<td></td>
<td>ps</td>
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</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1 %.
DESCRIPTION
The 2N3053 is a silicon planar epitaxial NPN transistor in Jedeck TO-39 metal case, intended for medium-current switching and amplifier applications.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>60</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>5</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>700</td>
<td>mA</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{case} \leq 25 \degree C$</td>
<td>5</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}$, $T_j$</td>
<td>Storage and Junction Temperature</td>
<td>-65 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>
### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
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<th>Test Conditions</th>
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<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{thj-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td></td>
<td>Max</td>
<td></td>
<td></td>
<td>$^\circ$C/W</td>
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### ELECTRICAL CHARACTERISTICS ($T_{\text{amb}} = 25 ^\circ \text{C}$ unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
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<th>Test Conditions</th>
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<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CEX}$</td>
<td>Collector Cutoff Current ($V_{BE} = -1.5 \text{ V}$)</td>
<td>$V_{CE} = 60 \text{ V}$</td>
<td></td>
<td></td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = 100 \mu \text{A}$</td>
<td></td>
<td></td>
<td>60</td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CEO}$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = 100 \mu \text{A}$</td>
<td></td>
<td></td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CER*}$</td>
<td>Collector-emitter Breakdown Voltage ($R_{BE} \leq 10 \Omega$)</td>
<td>$I_C = 10 \text{ mA}$</td>
<td></td>
<td></td>
<td>50</td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_E = 100 \mu \text{A}$</td>
<td></td>
<td></td>
<td>5</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE(sat)*}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = 150 \text{ mA}$ $I_B = 15 \text{ mA}$</td>
<td></td>
<td></td>
<td>1.4</td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE*}$</td>
<td>Base-emitter Voltage</td>
<td>$I_C = 150 \text{ mA}$ $V_{CE} = 2.5 \text{ V}$</td>
<td></td>
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<td>1.7</td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE(sat)*}$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = 150 \text{ mA}$ $I_B = 15 \text{ mA}$</td>
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<td>1.7</td>
<td>V</td>
</tr>
<tr>
<td>$h_{FE*}$</td>
<td>DC Current Gain</td>
<td>$I_C = 150 \text{ mA}$ $V_{CE} = 2.5 \text{ V}$ $V_{CE} = 10 \text{ V}$</td>
<td>25</td>
<td>50</td>
<td>250</td>
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<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = 50 \text{ mA}$ $f = 20 \text{ MHz}$</td>
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<td></td>
<td>MHz</td>
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<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_C = 0$ $f = 1 \text{ MHz}$</td>
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<td>pF</td>
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<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$ $f = 1 \text{ MHz}$</td>
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<td>pF</td>
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</table>

* Pulse: pulse duration = 300 $\mu$s, duty cycle = 1 %.

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DESCRIPTION
The 2N3107, 2N3108, 2N3109 and 2N3110 are silicon planar epitaxial NPN transistors in Jedec TO-39 metal case primarily intended for large signal, low noise industrial applications.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>40</td>
<td>60</td>
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<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>7</td>
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<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>1</td>
<td>A</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 , ^{\circ}C$</td>
<td>0.8</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 , ^{\circ}C$</td>
<td></td>
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</tr>
<tr>
<td>$T_{stg, , T_j}$</td>
<td>Storage and Junction Temperature</td>
<td>– 65 to 200</td>
<td>°C</td>
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</table>
## THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$R_{th j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>35</td>
<td>°C/W</td>
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<tr>
<td>$R_{th j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>219</td>
<td>°C/W</td>
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## ELECTRICAL CHARACTERISTICS ($T_{amb} = 25 \, ^\circ C$ unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = 60 , V$ $T_{amb} = 150 , ^\circ C$</td>
<td>10</td>
<td>μA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{CES}$</td>
<td>Collector Cutoff Current ($V_{BE} = 0$)</td>
<td>$V_{CE} = 60 , V$</td>
<td>10</td>
<td>nA</td>
<td></td>
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</tr>
<tr>
<td>$I_{EBO}$</td>
<td>Emitter Cutoff Current ($I_C = 0$)</td>
<td>$V_{EB} = 5 , V$</td>
<td>10</td>
<td>nA</td>
<td></td>
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</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = 100 , \mu A$ For 2N 3109 and 2N 3110</td>
<td>80</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>For 2N 3107 and 2N 3108</td>
<td>100</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CEO}$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = 30 , mA$ For 2N 3109 and 2N 3110</td>
<td>40</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>For 2N 3107 and 2N 3108</td>
<td>60</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = 100 , \mu A$</td>
<td>7</td>
<td>V</td>
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<tr>
<td>$V_{CE(sat)}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = 150 , mA$ $I_B = 15 , mA$</td>
<td>0.25</td>
<td>V</td>
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<td>$I_C = 1 , A$ $I_B = 100 , mA$</td>
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<tr>
<td>$V_{BE(sat)}$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = 150 , mA$ $I_B = 15 , mA$</td>
<td>1.1</td>
<td>V</td>
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<td>$I_C = 1 , A$ $I_B = 100 , mA$</td>
<td>2</td>
<td>V</td>
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<tr>
<td>$h_{FE}$</td>
<td>DC Current Gain</td>
<td>For 2N 3107 and 2N 3109</td>
<td>100</td>
<td>300</td>
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<tr>
<td></td>
<td></td>
<td>$I_C = 150 , mA$ $V_{CE} = 1 , V$</td>
<td>MHz</td>
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<tr>
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<td>$I_C = 0.1 , mA$ $V_{CE} = 10 , V$</td>
<td>MHz</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 500 , mA$ $V_{CE} = 10 , V$</td>
<td>MHz</td>
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<tr>
<td></td>
<td></td>
<td>$T_{amb} = -55 , ^\circ C$</td>
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<tr>
<td></td>
<td></td>
<td>For 2N 3108 and 2N 3110</td>
<td>120</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>$I_C = 150 , mA$ $V_{CE} = 1 , V$</td>
<td>MHz</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 0.1 , mA$ $V_{CE} = 10 , V$</td>
<td>MHz</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>$I_C = 500 , mA$ $V_{CE} = 10 , V$</td>
<td>MHz</td>
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<tr>
<td></td>
<td></td>
<td>$I_C = 150 , mA$ $V_{CE} = 10 , V$</td>
<td>MHz</td>
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<tr>
<td></td>
<td></td>
<td>$T_{amb} = -55 , ^\circ C$</td>
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<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = 50 , mA$ $V_{CE} = 10 , V$</td>
<td>70</td>
<td>MHz</td>
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<td>$f = 20 , MHz$</td>
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<tr>
<td></td>
<td></td>
<td>For 2N 3107 and 2N 3109</td>
<td>MHz</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>For 2N 3108 and 2N 3110</td>
<td>MHz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_C = 0$ $V_{EB} = 0.5 , V$</td>
<td>80</td>
<td>pF</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 1 , MHz$</td>
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<td></td>
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</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$ $V_{CB} = 10 , V$</td>
<td>20</td>
<td>pF</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>$f = 1 , MHz$</td>
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<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>For 2N 3107 and 2N 3109</td>
<td>MHz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>For 2N 3108 and 2N 3110</td>
<td>MHz</td>
<td></td>
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<td></td>
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<tr>
<td>NF</td>
<td>Noise Figure</td>
<td>$I_C = 30 , \mu A$ $V_{CE} = 10 , V$</td>
<td>8</td>
<td>dB</td>
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<tr>
<td></td>
<td></td>
<td>$f = 1 , kHz$ $R_g = 1 , K\Omega$</td>
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<tr>
<td>$t_{on}$</td>
<td>Turn-on Time</td>
<td>$I_C = 150 , mA$ $V_{CC} = 20 , V$</td>
<td>200</td>
<td>ns</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$I_B = 7.5 , mA$</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>$t_{off}$</td>
<td>Turn-off Time</td>
<td>$I_C = 150 , mA$ $V_{CC} = 20 , V$</td>
<td>1000</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_B = -I_{B2} = 7.5 , mA$</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1%.

** See test circuit.
Normalized DC Current Gain.

Contours of Constant Narrow Band Noise Figure.

Test Circuit for $t_{on}$, $t_{off}$.

PULSE GENERATOR:
- $t_1$ of input pulse < 15 ns
- $t_2$ of input pulse < 15 ns

TO OSCILLOSCOPE:
- $t_3 > 15$ ns
- $Z_{in} = 100 \, \Omega$
DESCRIPTION
The 2N3114 is a silicon planar epitaxial NPN transistor in Jedec TO-39 metal case. It is primarily intended for high voltage, medium power applications.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>150</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>150</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>5</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>150</td>
<td>mA</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 , ^{\circ}C$</td>
<td>0.8</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 , ^{\circ}C$</td>
<td>5</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}, T_j$</td>
<td>Storage and Junction Temperature</td>
<td>65 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>

January 1989
### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>35</td>
<td>°C/W</td>
<td></td>
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</tr>
<tr>
<td>$R_{th j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>219</td>
<td>°C/W</td>
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### ELECTRICAL CHARACTERISTICS ($T_{\text{amb}} = 25$ °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = 100$ V</td>
<td>10 nA</td>
<td>10 µA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{EBO}$</td>
<td>Emitter Cutoff Current ($I_C = 0$)</td>
<td>$V_{EB} = 4$ V</td>
<td>100 nA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = 100$ µA</td>
<td>150</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CEO}^*$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = 10$ mA</td>
<td>150</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = 100$ µA</td>
<td>5</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{CE(sat)}^*$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = 50$ mA</td>
<td>1</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{BE(sat)}^*$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = 50$ mA</td>
<td>0.9</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$h_{FE}^*$</td>
<td>DC Current Gain</td>
<td>$I_C = 100$ µA, $V_{CE} = 10$ V, $T_{\text{amb}} = -55$ °C</td>
<td>15</td>
<td>35</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>$h_{fe}$</td>
<td>High Frequency Current Gain</td>
<td>$I_C = 30$ mA, $V_{CE} = 10$ V, $f = 20$ MHz</td>
<td>12</td>
<td>24</td>
<td></td>
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<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$V_{EB} = 0.5$ V, $f = 1$ MHz</td>
<td>80</td>
<td>pF</td>
<td></td>
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<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$V_{CB} = 20$ V, $f = 1$ MHz</td>
<td>9</td>
<td>pF</td>
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* Pulsed: pulse duration = 300 µs, duty cycle = 1%.
DESCRIPTION
The 2N3137 is a silicon planar epitaxial NPN transistor in a TO-39 metal case. It is primarily designed for application as a Class-C, RF power amplifier. In addition to the large signal capabilities, the low noise and high transition frequency of the 2N3137 provide excellent performance in a variety of linear amplifier for telecommunication applications.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>40</td>
<td>V</td>
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<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
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<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>4</td>
<td>V</td>
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<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25^\circ C$</td>
<td>0.6</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25^\circ C$</td>
<td>1</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}, T_J$</td>
<td>Storage and Junction Temperature</td>
<td>$-65$ to $200$</td>
<td>°C</td>
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THERMAL DATA

<table>
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<tr>
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<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$R_{th j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>175</td>
<td>$^\circ$C/W</td>
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<td></td>
</tr>
<tr>
<td>$R_{th j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>292</td>
<td>$^\circ$C/W</td>
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</table>

ELECTRICAL CHARACTERISTICS ($T_{amb}$ = 25 $^\circ$C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = 20$ V $V_{CB} = 20$ V $T_{amb} = 150$ $^\circ$C</td>
<td>0.12</td>
<td>0.1</td>
<td>50</td>
<td>nA</td>
</tr>
<tr>
<td>$V(BR)_{CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = 100$ $\mu$A</td>
<td>40</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO(sus)}^*$</td>
<td>Collector-emitter Sustaining Voltage ($I_B = 0$)</td>
<td>$I_C = 15$ mA</td>
<td>20</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V(BR)_{EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = 100$ $\mu$A</td>
<td>4</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE(sat)}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = 50$ mA $I_B = 5$ mA</td>
<td>0.12</td>
<td>0.3</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$h_{FE}^*$</td>
<td>DC Current Gain</td>
<td>$I_C = 50$ mA $V_{CE} = 5$ V</td>
<td>20</td>
<td>70</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>$G_{pe}$</td>
<td>Power Gain (class-C)</td>
<td>$V_{CE} = 20$ V $f = 250$ MHz $P_I = 100$ mW</td>
<td>6</td>
<td>7</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>$NF$</td>
<td>Noise Figure</td>
<td>$V_{CE} = 10$ V $f = 200$ MHz $I_C = 30$ mA $R_g = 50$ $\Omega$</td>
<td>4</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$V_{CB} = 10$ V $f = 1$ MHz</td>
<td>2.8</td>
<td>3.5</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = 50$ mA $V_{CE} = 10$ V</td>
<td>500</td>
<td>750</td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td>$\eta$</td>
<td>Collector Efficiency</td>
<td>$V_{CE} = 20$ V $f = 250$ MHz $P_I = 100$ mW</td>
<td>40</td>
<td>60</td>
<td></td>
<td>%</td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 $\mu$s, duty cycle = 1%.
**DESCRIPTION**

The 2N3250 and 2N3251 are silicon planar epitaxial PNP transistors in Jedeck TO-18 metal case. They are suited for switching and amplifier applications.

**ABSOLUTE MAXIMUM RATINGS**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>$-50$</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>$-40$</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>$-5$</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>$-200$</td>
<td>mA</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 , ^\circ C$</td>
<td>$0.36$</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 , ^\circ C$</td>
<td>$1.2$</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}, T_J$</td>
<td>Storage and Junction Temperature</td>
<td>$-65$ to $200$</td>
<td>°C</td>
</tr>
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</table>
### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$R_{thj-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>146</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
<tr>
<td>$R_{thj-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>487</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
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</table>

### ELECTRICAL CHARACTERISTICS ($T_{amb} = 25 °C$ unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CEX}$</td>
<td>Collector Cutoff Current ($V_{BE} = 3 V$)</td>
<td>$V_{CE} = -40 V$</td>
<td>-20</td>
<td>nA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{BEX}$</td>
<td>Base Cutoff Current ($V_{BE} = 3 V$)</td>
<td>$V_{CE} = -40 V$</td>
<td>-50</td>
<td>nA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = -10 \mu A$</td>
<td>-50</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CEO}^*$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = -10 mA$</td>
<td>-40</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = -10 \mu A$</td>
<td>-5</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{CE,(sat)}^*$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = -10 mA$</td>
<td>0.25</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{BE,(sat)}^*$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = -10 mA$</td>
<td>0.9</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$h_{FE}^*$</td>
<td>DC Current Gain</td>
<td>for $2N3250$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$h_{re}$</td>
<td>Small Signal Current Gain</td>
<td>$V_{CE} = -10 V$</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$V_{CE} = -20 V$</td>
<td>250</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$V_{EB} = -1 V$</td>
<td>8</td>
<td>pF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$V_{CB} = -10 V$</td>
<td>6</td>
<td>pF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NF</td>
<td>Noise Figure</td>
<td>$V_{CE} = -5 V$</td>
<td>6</td>
<td>dB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$h_{le}$</td>
<td>Input Impedance</td>
<td>$V_{CE} = -10 V$</td>
<td>6</td>
<td>kΩ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$h_{re}$</td>
<td>Reverse Voltage Ratio</td>
<td>$V_{CE} = -10 V$</td>
<td>$10^{-3}$</td>
<td></td>
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</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1 %.
### ELECTRICAL CHARACTERISTICS (continued)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$h_{oe}$</td>
<td>Output Admittance</td>
<td>$I_C = -1\ mA$ $V_{CE} = -10\ V$ for 2N3250 $f = 1\ kHz$ for 2N3251</td>
<td>4</td>
<td>10</td>
<td>40</td>
<td>$\mu S$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CC} = 3\ V$</td>
<td>60</td>
<td></td>
<td></td>
<td>$\mu S$</td>
</tr>
<tr>
<td>$t_d$</td>
<td>Delay Time</td>
<td>$I_C = 10\ mA$ $I_B = 1\ mA$</td>
<td>35</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$t_r$</td>
<td>Delay Time</td>
<td>$I_C = 10\ mA$ $I_B = 1\ mA$</td>
<td>35</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$t_s$</td>
<td>Storage Time</td>
<td>$I_C = 10\ mA$ $V_{CC} = 3\ V$ for 2N3250 $I_B = - I_{B2} = 1\ mA$</td>
<td>200</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$t_f$</td>
<td>Fall Time</td>
<td>$I_C = 10\ mA$ $V_{CC} = 3\ V$ for 2N3250 $I_B = - I_{B2} = 1\ mA$</td>
<td>50</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$r_{BB,C_{b,c}}$</td>
<td>Feedback Time Constant</td>
<td>$I_C = -10\ mA$ $V_{CE} = -20\ V$</td>
<td>250</td>
<td></td>
<td></td>
<td>ps</td>
</tr>
</tbody>
</table>

* Pulsed : pulse duration = 300 $\mu s$, duty cycle = 1 %.
DESCRIPTION
The 2N3301 and 2N3302 are silicon planar epitaxial NPN transistors in Jedec TO-18 metal case. They are designed to cover a wide range of amplifier and switching applications.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>60</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>30</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>5</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>0.5</td>
<td>A</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 , ^\circ C$</td>
<td>0.36</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 , ^\circ C$</td>
<td>1.8</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}, T_j$</td>
<td>Storage and Junction Temperature</td>
<td>-65 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>

January 1989
### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&lt;sub&gt;th&lt;/sub&gt;</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>97.2</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
<tr>
<td>R&lt;sub&gt;th&lt;/sub&gt;</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>486</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
</tbody>
</table>

### ELECTRICAL CHARACTERISTICS \((T_{amb} = 25 \, ^\circ C\) unless otherwise specified\)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICEs</td>
<td>Collector Cutoff Current ((V_{BE} = 0))</td>
<td>(V_{CB} = 50 , V)</td>
<td>10</td>
<td></td>
<td>10</td>
<td>nA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(V_{CB} = 50 , V) (T_{amb} = 150 , ^\circ C)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IEBO</td>
<td>Emitter-cutoff Current ((I_C = 0))</td>
<td>(V_{EB} = 3 , V)</td>
<td>10</td>
<td></td>
<td>10</td>
<td>nA</td>
</tr>
<tr>
<td>V(BR)CBO</td>
<td>Collector-base Breakdown Voltage ((I_E = 0))</td>
<td>(I_C = 10 , \mu A)</td>
<td>60</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V(BR)CEO*</td>
<td>Collector-emitter Breakdown Voltage ((I_B = 0))</td>
<td>(I_C = 10 , mA)</td>
<td>30</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V(BR)EBO</td>
<td>Emitter-base Breakdown Voltage ((I_C = 0))</td>
<td>(I_E = 10 , \mu A)</td>
<td>5</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>VCE (sat)*</td>
<td>Collector-emitter Saturation Voltage</td>
<td>(I_C = 150 , mA)</td>
<td>0.22</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(I_C = 500 , mA)</td>
<td>0.6</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>VBE (sat)*</td>
<td>Base-emitter Saturation Voltage</td>
<td>(I_C = 150 , mA)</td>
<td>1.1</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(I_C = 500 , mA)</td>
<td>1.5</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>hFE*</td>
<td>DC Current Gain</td>
<td>for 2N3301</td>
<td>20</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(I_C = 0.1 , mA)</td>
<td>35</td>
<td>70</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(I_C = 1 , mA)</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(I_C = 10 , mA)</td>
<td>50</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(I_C = 150 , mA)</td>
<td>20</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(I_C = 500 , mA)</td>
<td>20</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>hfe</td>
<td>High Frequency Current Gain</td>
<td>(f = 100 , MHz)</td>
<td>2.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C&lt;sub&gt;EBO&lt;/sub&gt;</td>
<td>Emitter-base Capacitance</td>
<td>(V_{EB} = 2 , V)</td>
<td>20</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(f = 1 , MHz)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C&lt;sub&gt;CBO&lt;/sub&gt;</td>
<td>Collector-base Capacitance</td>
<td>(V_{CB} = 10 , V)</td>
<td>8</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(f = 1 , MHz)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>t&lt;sub&gt;on&lt;/sub&gt;</td>
<td>Turn-on Time</td>
<td>(I_C = 300 , mA)</td>
<td>60</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(I_{B1} = 30 , mA)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>t&lt;sub&gt;off&lt;/sub&gt;</td>
<td>Turn-off Time</td>
<td>(I_C = 300 , mA)</td>
<td>150</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(I_{B1} = -I_{B2} = 30 , mA)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 \, \mu s, duty cycle = 1%.

** See test circuits.
Test Circuit for $t_{on}$.

![Test Circuit for $t_{on}$](image)

PULSE GENERATOR:
- $t_r \leq 1.0$ ns
- $Z_N = 50 \, \Omega$

TO OSCILLOSCOPE:
- $t_r \leq 1.0$ ns
- $ZIN = 100 \, k\Omega$

Test Circuit for $t_{off}$.

![Test Circuit for $t_{off}$](image)

PULSE GENERATOR:
- $t_r \leq 20$ ns
- $Z_N = 50 \, \Omega$

TO OSCILLOSCOPE:
- $t_r \leq 1.0$ ns
- $ZIN = 100 \, k\Omega$
GENERAL PURPOSE AMPLIFIERS AND SWITCHES

DESCRIPTION
The 2N3502, 2N3503, 2N3504 and 2N3505 are silicon planar epitaxial PNP transistors in Jeder TO-39 (2N3502, 2N3503) and in Jeder TO-18 (2N3504, 2N3505) metal cases. They are designed for high-speed saturated switching and general purpose applications.

INTERNAL SCHEMATIC DIAGRAM

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>2N3502 2N3504</td>
<td>2N3503 2N3505</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>- 45</td>
<td>- 60</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>5</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>600</td>
<td>mA</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total power Dissipation at Tamb $\leq 25$ °C</td>
<td>0.4</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>For 2N3504, 2N3505</td>
<td>0.7</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>For 2N3502, 2N3503</td>
<td>1.3</td>
<td>W</td>
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<tr>
<td></td>
<td>at Tcase $\leq 25$ °C</td>
<td>3</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}, T_j$</td>
<td>Storage and Junction Temperature</td>
<td>- 65 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>

October 1988
### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$R_{th}$</td>
<td>$R_{th}$ j-case</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>132 °C/W</td>
<td>58.3 °C/W</td>
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<tr>
<td>$R_{th}$</td>
<td>$R_{th}$ j-amb</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>437 °C/W</td>
<td>250 °C/W</td>
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### ELECTRICAL CHARACTERISTICS ($T_{amb} = 25$ °C unless otherwise specified)

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<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$I_{CES}$</td>
<td>Collector Cutoff Current ($V_{BE} = 0$)</td>
<td>For 2N3503 and 2N3505 $V_{CE} = -50$ V For 2N3502 and 2N3504 $V_{CE} = -30$ V</td>
<td>–10</td>
<td>nA</td>
<td>–10</td>
<td>nA</td>
</tr>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_{E} = 0$)</td>
<td>For 2N3503 and 2N3505 $V_{CE} = -50$ V $T_{amb} = 150$ °C For 2N3502 and 2N3504 $V_{CE} = -30$ V $T_{amb} = 150$ °C</td>
<td>–10</td>
<td>nA</td>
<td>–10</td>
<td>nA</td>
</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_{E} = 0$)</td>
<td>$I_{C} = -10$ μA For 2N3503 and 2N3505</td>
<td>–60</td>
<td>V</td>
<td>–45</td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CEO}$</td>
<td>Collector-emitter Breakdown Voltage ($I_{B} = 0$)</td>
<td>$I_{C} = -10$ mA For 2N3503 and 2N3505</td>
<td>–60</td>
<td>V</td>
<td>–45</td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_{C} = 0$)</td>
<td>$I_{E} = -10$ μA</td>
<td>–5</td>
<td>V</td>
<td>–2</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE(sat)}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_{C} = -50$ mA $I_{B} = -2.5$ mA $I_{C} = -150$ mA $I_{B} = -15$ mA $I_{C} = -500$ mA $I_{B} = -50$ mA</td>
<td>–0.25</td>
<td>V</td>
<td>–1.6</td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE(sat)}$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_{C} = -50$ mA $I_{B} = -2.5$ mA $I_{C} = -150$ mA $I_{B} = -15$ mA $I_{C} = -500$ mA $I_{B} = -50$ mA</td>
<td>–1</td>
<td>V</td>
<td>–2</td>
<td>V</td>
</tr>
<tr>
<td>$h_{FE}$</td>
<td>DC Current Gain</td>
<td>$I_{C} = -0.01$ mA $V_{CE} = -10$ V $I_{C} = -0.1$ mA $V_{CE} = -10$ V $I_{C} = -1$ mA $V_{CE} = -10$ V $I_{C} = -10$ mA $V_{CE} = -10$ V $I_{C} = -150$ mA $V_{CE} = -10$ V $I_{C} = -500$ mA $V_{CE} = -10$ V $T_{amb} = -55$ °C</td>
<td>80</td>
<td></td>
<td>300</td>
<td></td>
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<tr>
<td>$f_{T}$</td>
<td>Transition Frequency</td>
<td>$I_{C} = -50$ mA $V_{CE} = -20$ V $f = 100$ MHz</td>
<td>200</td>
<td>MHz</td>
<td></td>
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</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_{C} = 0$ $V_{EB} = -0.5$ V $f = 100$ kHz</td>
<td>30</td>
<td>pF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_{E} = 0$ $V_{CB} = -10$ V $f = 1$ MHz</td>
<td>8</td>
<td>pF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$NF$</td>
<td>Noise Figure</td>
<td>$I_{C} = -30$ μA $V_{CE} = -5$ V $f = 1$ MHz $R_{G} = 10$ KΩ</td>
<td>4</td>
<td>dB</td>
<td></td>
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</tr>
<tr>
<td>$t_{on}$</td>
<td>Turn-on Time</td>
<td>$I_{C} = -300$ mA $V_{CC} = -30$ V $I_{B1} = -30$ mA</td>
<td>40</td>
<td>ns</td>
<td></td>
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<tr>
<td>$t_{off}$</td>
<td>Turn-off Time</td>
<td>$I_{C} = -300$ mA $V_{CC} = -30$ V $I_{B1} = -I_{B2} = -30$ mA</td>
<td>100</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1.5 %.

---

**Note:** The text appears to be a translation or summary of technical specifications for a transistor model, 2N3052, 2N3503, 2N3504, and 2N3505, detailing thermal and electrical characteristics. The table lists various parameters such as thermal resistance, collector current, voltage breakdowns, current gain, and other electrical properties along with their test conditions and typical values.
DESCRIPTION
The 2N3700 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case, intended for small signal, low noise industrial applications.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{CBO} )</td>
<td>Collector-base Voltage ( (I_E = 0) )</td>
<td>140</td>
<td>V</td>
</tr>
<tr>
<td>( V_{CEO} )</td>
<td>Collector-emitter Voltage ( (I_B = 0) )</td>
<td>80</td>
<td>V</td>
</tr>
<tr>
<td>( V_{EBO} )</td>
<td>Emitter-base Voltage ( (I_C = 0) )</td>
<td>7</td>
<td>V</td>
</tr>
<tr>
<td>( I_C )</td>
<td>Collector Current</td>
<td>1</td>
<td>A</td>
</tr>
<tr>
<td>( P_{tot} )</td>
<td>Total Power Dissipation ( \text{at } T_{amb} \leq 25 , ^\circ C )</td>
<td>0.5</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>( \text{at } T_{case} \leq 25 , ^\circ C )</td>
<td>1.8</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>( \text{at } T_{case} \leq 100 , ^\circ C )</td>
<td>1</td>
<td>W</td>
</tr>
<tr>
<td>( T_{stg, T_J} )</td>
<td>Storage and Junction Temperature</td>
<td>-65 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>
### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
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<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$R_{th,j-case}$</td>
<td>Thermal Resistance Junction-case</td>
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<tr>
<td>$R_{th,j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
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<table>
<thead>
<tr>
<th>Symbol</th>
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<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CE(sat)}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = 150\ mA$</td>
<td>0.2</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_B = 15\ mA$</td>
<td>0.5</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{BE(sat)}$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = 150\ mA$</td>
<td>1.1</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_B = 15\ mA$</td>
<td></td>
<td></td>
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</table>

### ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\ ^\circ C$ unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = 90\ V$</td>
<td>10</td>
<td>nA</td>
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<tr>
<td></td>
<td></td>
<td>$V_{CB} = 90\ V$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>$I_{EBO}$</td>
<td>Emitter Cutoff Current ($I_C = 0$)</td>
<td>$V_{EB} = 5\ V$</td>
<td>10</td>
<td>nA</td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
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</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = 100\ \mu A$</td>
<td>140</td>
<td>V</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
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<tr>
<td>$V_{(BR)CEO}$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = 30\ mA$</td>
<td>80</td>
<td>V</td>
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<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = 100\ \mu A$</td>
<td>7</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = 50\ mA$</td>
<td>100</td>
<td>MHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_C = 0$</td>
<td>60</td>
<td>pF</td>
<td></td>
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<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$</td>
<td>12</td>
<td>pF</td>
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<tr>
<td>$r_{bb'c'}$</td>
<td>Feedback Time Constant</td>
<td>$I_C = 10\ mA$</td>
<td>25</td>
<td>ps</td>
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<td></td>
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</table>

* Pulsed: pulse duration = 300 $\mu$s, duty cycle = 1%.
DESCRIPTION
The 2N3724 is a silicon planar epitaxial transistor in TO-39 metal case. It is a high-current switch used for memory applications requiring breakdown voltages up to 30 V and operating currents to 1 A.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>50</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CES}$</td>
<td>Collector-emitter Voltage ($V_{BE} = 0$)</td>
<td>50</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>30</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>6</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>1</td>
<td>A</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 , ^\circ C$</td>
<td>0.8</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 , ^\circ C$</td>
<td>3.5</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}, T_J$</td>
<td>Storage and Junction Temperature</td>
<td>−65 to 200</td>
<td>°C</td>
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</table>
THERMAL DATA

<table>
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<th>Symbol</th>
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<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$R_{th j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>50</td>
<td>°C/W</td>
<td></td>
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<tr>
<td>$R_{th j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>220</td>
<td>°C/W</td>
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ELECTRICAL CHARACTERISTICS ($T_{amb} = 25$ °C unless otherwise specified)

<table>
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<th>Symbol</th>
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<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$I_{CB0}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = 40$ V</td>
<td>1.7</td>
<td>μA</td>
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<tr>
<td></td>
<td></td>
<td>$V_{CB} = 40$ V</td>
<td>120</td>
<td>μA</td>
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<td></td>
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<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = 10$ μA</td>
<td>50</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CES}$</td>
<td>Collector-emitter Breakdown Voltage ($V_{BE} = 0$)</td>
<td>$I_C = 10$ μA</td>
<td>50</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CEO}$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = 10$ mA</td>
<td>30</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = 10$ μA</td>
<td>6</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{CE(sat)}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = 10$ mA</td>
<td>0.25</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 100$ mA</td>
<td>0.20</td>
<td>V</td>
<td></td>
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<tr>
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<td>$I_C = 300$ mA</td>
<td>0.32</td>
<td>V</td>
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<td>$I_C = 500$ mA</td>
<td>0.42</td>
<td>V</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 800$ mA</td>
<td>0.65</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 1000$ mA</td>
<td>0.75</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{BE(sat)}$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = 10$ mA</td>
<td>0.64</td>
<td>V</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 100$ mA</td>
<td>0.75</td>
<td>V</td>
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<td>$I_C = 300$ mA</td>
<td>0.89</td>
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<td>$I_C = 500$ mA</td>
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<td>$I_C = 800$ mA</td>
<td>1.0</td>
<td>V</td>
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<tr>
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<td>$I_C = 1000$ mA</td>
<td>1.1</td>
<td>V</td>
<td></td>
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</tr>
<tr>
<td>$h_{FE}$</td>
<td>DC Current Gain</td>
<td>$I_C = 10$ mA</td>
<td>30</td>
<td>60</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 100$ mA</td>
<td>60</td>
<td>90</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 300$ mA</td>
<td>40</td>
<td>60</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 800$ mA</td>
<td>30</td>
<td>60</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 500$ mA</td>
<td>25</td>
<td>60</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 1000$ mA</td>
<td>35</td>
<td>60</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td>$h_{fe}$</td>
<td>High Frequency Current Gain</td>
<td>$I_C = 50$ mA</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 100$ MHz</td>
<td>12</td>
<td>pF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{CB0}$</td>
<td>Collector-base Capacitance</td>
<td>$I_C = 0$</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 1$ MHz</td>
<td>12</td>
<td>pF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_C = 0$</td>
<td>55</td>
<td>pF</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 1$ MHz</td>
<td>55</td>
<td>pF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{on}$</td>
<td>Turn-on Time</td>
<td>$I_C = 500$ mA</td>
<td>35</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_B = 50$ mA</td>
<td>35</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{off}$</td>
<td>Turn off Time</td>
<td>$I_C = 500$ mA</td>
<td>60</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_B1 = - I_B2 = 50$ mA</td>
<td>60</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1%.
** See test circuit.
Switching Characteristics.

Test Circuit for $t_{on}$, $t_{off}$:

PULSE GENERATOR:
- $t_r, t_f \leq 1.0 \text{ ns}$
- $PW = 1.0 \text{ ms}$
- $Z_m = 50 \text{ W}$
- $DC < 2\%$

TO OSCILLOSCOPE:
- $t_r < 1.0 \text{ ns}$
- $Z_{in} \geq 100 \text{ KW}$
DESCRIPTION
The 2N3725 is a silicon planar epitaxial transistor in TO-39 metal case. It is a high-voltage, high current switch used for memory applications requiring breakdown voltages up to 50 V and operating currents to 1 A. Fast switching times are assured because of the high minimum $f_T$ (300 MHz) and tight control on storage time.

INTERNAL SCHEMATIC DIAGRAM

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>80</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CES}$</td>
<td>Collector-emitter Voltage ($V_{BE} = 0$)</td>
<td>80</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>50</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>6</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>1</td>
<td>A</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25$ °C</td>
<td>0.8</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25$ °C</td>
<td>3.5</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}, T_j$</td>
<td>Storage and Junction Temperature</td>
<td>– 65 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>
## THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Max</th>
<th>°C/W</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th\ j\ -\ case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>$R_{th\ j\ -\ amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>220</td>
<td></td>
</tr>
</tbody>
</table>

## ELECTRICAL CHARACTERISTICS ($T_{amb} = 25$ °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = 60$ V</td>
<td>1.7 fA</td>
<td>120 fA</td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CB} = 60$ V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$T_{amb} = 100$ °C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V(BR_{CBO})$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = 10$ μA</td>
<td>80</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V(BR_{CES})$</td>
<td>Collector-emitter Breakdown Voltage ($V_{BE} = 0$)</td>
<td>$I_C = 10$ μA</td>
<td>80</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V(BR_{CEO})^*$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = 10$ mA</td>
<td>50</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V(BR_{EBO})$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = 10$ μA</td>
<td>6</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE(sat)}^*$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = 10$ mA</td>
<td>0.19</td>
<td>0.25</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 100$ mA</td>
<td>0.21</td>
<td>0.26</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 300$ mA</td>
<td>0.31</td>
<td>0.4</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 500$ mA</td>
<td>0.4</td>
<td>0.52</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 800$ mA</td>
<td>0.5</td>
<td>0.8</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 1000$ mA</td>
<td>0.6</td>
<td>0.95</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE(sat)}^*$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = 10$ mA</td>
<td>0.64</td>
<td>0.76</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 100$ mA</td>
<td>0.75</td>
<td>0.86</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 300$ mA</td>
<td>0.89</td>
<td>1.1</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 500$ mA</td>
<td>1.2</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 800$ mA</td>
<td>1.0</td>
<td>1.5</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 1000$ mA</td>
<td>1.1</td>
<td>1.7</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$h_{FE}^*$</td>
<td>DC Current Gain</td>
<td>$I_C = 10$ mA</td>
<td>30</td>
<td>60</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 100$ mA</td>
<td>60</td>
<td>90</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 300$ mA</td>
<td>40</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 1000$ mA</td>
<td>25</td>
<td>65</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 800$ mA</td>
<td>20</td>
<td>40</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>$I_C = 500$ mA</td>
<td>35</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$h_{fe}$</td>
<td>High Frequency Current Gain</td>
<td>$I_C = 50$ mA</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 100$ MHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$ mA</td>
<td>10</td>
<td>pF</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 1$ MHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_C = 0$ mA</td>
<td>55</td>
<td>pF</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 1$ MHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{on}^{**}$</td>
<td>Turn-on Time</td>
<td>$I_C = 500$ mA</td>
<td>35</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_B = 50$ mA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{off}^{**}$</td>
<td>Turn off Time</td>
<td>$I_C = 500$ mA</td>
<td>60</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CC} = 30$ V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_B1 = - I_B2 = 50$ mA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1%.
** See test circuit.
DC Current Gain.

Collector-emitter Saturation Voltage.

Base-emitter Saturation Voltage.

Contours of Constant Transition Frequency.

Switching Characteristics.

Switching Characteristics.
Test Circuit for $t_{on}$, $t_{off}$.

- $V_{BB} = -3.8\, \text{V}$
- $V_{CC} = +30\, \text{V}$
- $V_{IN}$
- $V_{OUT}$
- $+9.7\, \text{V}$
- $V_{IN}$
- $62\, \Omega$
- $1\, \mu\text{F}$
- $100\, \Omega$
- $43\, \Omega$
- $15\, \Omega$
- $1.0\, \mu\text{F}$

**PULSE GENERATOR:**
- $t_r, t_f \leq 1.0\, \text{ns}$
- $\text{PW} = 1.0\, \mu\text{s}$
- $Z_N = 50\, \Omega$
- $\text{DC} < 2\%$

**TO OSCILLOSCOPE:**
- $t_r < 1.0\, \text{ns}$
- $Z_N \geq 100\, \text{K}\Omega$
DESCRIPTION
The 2N3866 and BFR97 are silicon planar epitaxial NPN transistor in Jedec TO-39 metal case. They are designed for VHF-UHF class A, B, or C amplifier circuits and oscillator applications.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CES}$</td>
<td>Collector–emitter Voltage ($V_{BE} = 0$)</td>
<td>55</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector–emitter Voltage ($I_B = 0$)</td>
<td>30</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter–base Voltage ($I_C = 0$)</td>
<td>3.5</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>0.5</td>
<td>A</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{case} \leq 25 ^\circ C$</td>
<td>5</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}$, $T_j$</td>
<td>Storage and Junction Temperature</td>
<td>$-65$ to $200$</td>
<td>$^\circ C$</td>
</tr>
</tbody>
</table>
THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter Description</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rth-j-case</td>
<td>Thermal Resistance Junction-case</td>
<td></td>
<td>Max</td>
<td>35</td>
<td></td>
<td>°C/W</td>
</tr>
</tbody>
</table>

ELECTRICAL CHARACTERISTICS (T<sub>amb</sub> = 25 °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter Description</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>I&lt;sub&gt;CEO&lt;/sub&gt;</td>
<td>Collector Cutoff Current (I&lt;sub&gt;B&lt;/sub&gt; = 0)</td>
<td>V&lt;sub&gt;CE&lt;/sub&gt; = 28 V</td>
<td></td>
<td>20</td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td>V(BR)CES</td>
<td>Collector–emitter Breakdown Voltage (V&lt;sub&gt;BE&lt;/sub&gt; = 0)</td>
<td>I&lt;sub&gt;C&lt;/sub&gt; = 0.1 mA</td>
<td></td>
<td>55</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V(CEL)</td>
<td>Collector–emitter Sustaining Voltage (I&lt;sub&gt;B&lt;/sub&gt; = 0)</td>
<td>I&lt;sub&gt;C&lt;/sub&gt; = 5 mA</td>
<td></td>
<td>30</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V(BREBO)</td>
<td>Emitter–base Breakdown Voltage (I&lt;sub&gt;C&lt;/sub&gt; = 0)</td>
<td>I&lt;sub&gt;E&lt;/sub&gt; = 100 μA</td>
<td></td>
<td>3.5</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V(CE)</td>
<td>Collector–emitter Saturation Voltage</td>
<td>I&lt;sub&gt;C&lt;/sub&gt; = 100 mA I&lt;sub&gt;B&lt;/sub&gt; = 20 mA</td>
<td></td>
<td>1</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>h&lt;sub&gt;FE&lt;/sub&gt;</td>
<td>DC Current Gain</td>
<td>I&lt;sub&gt;C&lt;/sub&gt; = 50 mA I&lt;sub&gt;C&lt;/sub&gt; = 360 mA V&lt;sub&gt;CE&lt;/sub&gt; = 5 V V&lt;sub&gt;CE&lt;/sub&gt; = 5 V</td>
<td></td>
<td>10</td>
<td>5</td>
<td>200</td>
</tr>
<tr>
<td>f&lt;sub&gt;T&lt;/sub&gt;</td>
<td>Transition Frequency</td>
<td>I&lt;sub&gt;C&lt;/sub&gt; = 50 mA V&lt;sub&gt;CE&lt;/sub&gt; = 15 V</td>
<td></td>
<td>500</td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td>C&lt;sub&gt;CBO&lt;/sub&gt;</td>
<td>Collector–base Capacitance</td>
<td>I&lt;sub&gt;E&lt;/sub&gt; = 0 V&lt;sub&gt;CB&lt;/sub&gt; = -28 V</td>
<td></td>
<td>3</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>P&lt;sub&gt;o&lt;/sub&gt;</td>
<td>Output Power</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt; = -28 V P&lt;sub&gt;1&lt;/sub&gt; = 100 mW</td>
<td></td>
<td>1</td>
<td></td>
<td>W</td>
</tr>
<tr>
<td>η</td>
<td>Collector Efficiency</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt; = -28 V P&lt;sub&gt;1&lt;/sub&gt; = 1 W</td>
<td></td>
<td>45</td>
<td></td>
<td>%</td>
</tr>
</tbody>
</table>

* Plused : pulse duration = 300 ms, duty cycle = 1 %.
** See test circuit.

Test Circuit for Power Output Measurement (f = 400 MHz).

![Test Circuit Diagram]

C<sub>1</sub>, C<sub>2</sub>, C<sub>4</sub>, C<sub>5</sub> = 3 – 25 pF
C<sub>3</sub> = 7 – 15 pF
R<sub>1</sub> = 5.6 Ω
R<sub>2</sub> = 1 kΩ
L<sub>1</sub>, L<sub>2</sub> = 5 cm Line (2 x 5 mm)
L<sub>3</sub>, L<sub>5</sub>, L<sub>6</sub> = RF choke 0.1 μH
L<sub>4</sub> = Ferrite choke 1 mm
High Frequency Current Drain.

Collector-base Capacitance.

RF Output Power.

Power Rating Chart.
DESCRIPTION
The 2N3930 and 2N3931 are silicon planar epitaxial PNP transistors in Jedec TO-18 (2N3930) and Jedec TO-39 (2N3931) metal cases. Both devices feature high voltage, high gain, low noise and excellent current gain linearity from 10 μA to 50 mA.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>-180</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>-180</td>
<td>V</td>
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<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>-6</td>
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<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>-100</td>
<td>mA</td>
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<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25{^\circ}C$</td>
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<tr>
<td>For 2N3930</td>
<td>0.4</td>
<td>W</td>
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<td>For 2N3931</td>
<td>0.7</td>
<td>W</td>
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<td>at $T_{case} \leq 25{^\circ}C$</td>
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<tr>
<td>For 2N3930</td>
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<td>For 2N3931</td>
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<tr>
<td>$T_{stg, T_j}$</td>
<td>Storage and Junction Temperature</td>
<td>-55 to 200</td>
<td>°C</td>
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## THERMAL DATA

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<td>$R_{n_{j-amb}}$</td>
<td>Max</td>
<td>438 °C/W</td>
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## ELECTRICAL CHARACTERISTICS ($T_{amb} = 25$ °C unless otherwise specified)

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<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = -100$ V</td>
<td>-10</td>
<td>-10</td>
<td>nA</td>
<td>nA</td>
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<td>$V_{CB} = -100$ V</td>
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<td>-10</td>
<td>nA</td>
<td>nA</td>
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<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = -10$ μA</td>
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<tr>
<td>$V_{(BR)CEO}$*</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = -2$ mA</td>
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<td>$V_{(BR)EBO}$</td>
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<td>$I_E = -10$ μA</td>
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<td>V</td>
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<td>$V_{CE(sat)}*$</td>
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<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = -1$ mA</td>
<td>40</td>
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<td>$f = 20$ MHz</td>
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<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$V_{EB} = -0.5$ V</td>
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<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$V_{CB} = -5$ V</td>
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<td>$NF$</td>
<td>Noise Figure</td>
<td>$I_C = -10$ μA</td>
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<td>$V_{CE} = -5$ V</td>
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<td>$R_g = 10$ kΩ</td>
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<td>$B = 2$ kHz</td>
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<td>$f = 100$ Hz</td>
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* Pulsed: pulse duration = 300 μs, duty cycle = 1%.
DC Current Gain.

Collector-emitter Saturation Voltage.

Base-emitter Saturation Voltage.

Emitter-base and collector-base capacitances.

Contours of Constant Transition Frequency.

Contours of Constant Noise Figure (f = 100 Hz).
Contours of Constant Noise Figure (f = 1 kHz).

Contours of Constant Noise Figure (f = 10 kHz).

Contours of Constant Wide Band Noise Figure.

Noise Figure vs. Frequency.
DESCRIPTION
The 2N3962, 2N3963, 2N3964 and 2N3965 are silicon planar epitaxial PNP transistors in Jedec TO-18 metal case particularly intended for use in low noise applications. They features are excellent current gain linearity from 1 μA to 50 mA.

ABSOLUTE MAXIMUM RATINGS

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<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{CBO}</td>
<td>Collector-base Voltage ((I_E = 0))</td>
<td>2N3964</td>
<td>2N3962</td>
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<tr>
<td>V_{CEO}</td>
<td>Collector-emitter Voltage ((I_B = 0))</td>
<td>65</td>
<td>80</td>
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<tr>
<td>V_{EBO}</td>
<td>Emitter-base Voltage ((I_C = 0))</td>
<td>6</td>
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<tr>
<td>I_C</td>
<td>Collector Current</td>
<td>200</td>
<td>mA</td>
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<tr>
<td>P_{tot}</td>
<td>Total Power Dissipation at (T_{amb} \leq 25) °C (\text{at} \ T_{case} \leq 25) °C</td>
<td>0.36</td>
<td>1.2</td>
</tr>
<tr>
<td>T_{stg}, T_j</td>
<td>Storage and Junction Temperature</td>
<td>65 to 200</td>
<td>°C</td>
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October 1988
## THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$R_{th j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
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<td>$R_{th j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
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## ELECTRICAL CHARACTERISTICS ($T_{amb} = 25 \, ^\circ C$ unless otherwise specified)

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<th>Min.</th>
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<th>Max.</th>
<th>Unit</th>
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<tr>
<td>$I_{CES}$</td>
<td>Collector Cutoff Current ($V_{BE} = 0$)</td>
<td>For 2N3964 $V_{CE} = -40 , V$</td>
<td>$-10 , nA$</td>
<td>$-10 , \mu A$</td>
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<tr>
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<td>For 2N3962 and 2N3965 $V_{CE} = -50 , V$</td>
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<td>$-10 , \mu A$</td>
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<td>$V_{CE} = -50 , V \quad T_{amb} = 150 , ^\circ C$</td>
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<td>For 2N3963 $V_{CE} = -70 , V$</td>
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<td>$-10 , \mu A$</td>
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<tr>
<td>$I_{EBO}$</td>
<td>Emitter Cutoff Current ($I_C = 0$)</td>
<td>For 2N3964 $V_{EB} = -4 , V$</td>
<td>$-10 , nA$</td>
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<tr>
<td>$V(BR)CBO$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = -10 , \mu A$</td>
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<td>$V(BR)CES$</td>
<td>Collector-base Breakdown Voltage ($V_{BE} = 0$)</td>
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<td>$-45 , V$</td>
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<td>$V(BR)CEO^*$</td>
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<td>$I_C = -5 , mA$</td>
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<td>$V(BR)EBO$</td>
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<tr>
<td>$V_{CE(sat)}^*$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = -10 , mA \quad I_B = -0.5 , mA$</td>
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<td>$h_{FE}^*$</td>
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* Pulsed : pulse duration = 300 $\mu$s, duty cycle = 1 %.
### ELECTRICAL CHARACTERISTICS (continued)

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<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
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<td>Tamb = -55°C</td>
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<td>For 2N3964 and 2N3965</td>
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<tr>
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<td>Transition Frequency</td>
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<td>MHz</td>
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<td>For 2N3964 and 2N3965</td>
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<tr>
<td>C_{EBO}</td>
<td>Emitter-base Capacitance</td>
<td>Ic = 0 VEB = -0.5 V</td>
<td>f = 1 MHz</td>
<td>15</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>C_{CBO}</td>
<td>Collector-base Capacitance</td>
<td>Ic = 0 VC = -5 V</td>
<td>f = 1 MHz</td>
<td></td>
<td>6</td>
<td>pF</td>
</tr>
<tr>
<td>NF</td>
<td>Noise Figure</td>
<td>Ic = -20 µA VCE = -5 V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>RG = 10 kΩ</td>
<td>f = 10 to 10 000 Hz</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>f = 1 kHz</td>
<td>B = 15 kHz</td>
<td>10</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>f = 10 kHz</td>
<td>B = 1.5 kHz</td>
<td>3</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td>For 2N3964 and 2N3965</td>
<td>f = 10 Hz</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>f = 100 Hz</td>
<td>B = 2 Hz</td>
<td>8</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>f = 1 kHz</td>
<td>B = 15 Hz</td>
<td>4</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>f = 10 kHz</td>
<td>B = 1.5 kHz</td>
<td>2</td>
<td></td>
<td>dB</td>
</tr>
</tbody>
</table>

*Pulsed: pulse duration = 300 µs, duty cycle = 1%.*
DESCRIPTION
The 2N4013 is a silicon planar epitaxial transistor in TO-18 metal case. It is a high-current switch used for memory applications requiring breakdown voltages up to 30 V and operating currents to 1 A.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>50</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CES}$</td>
<td>Collector-emitter Voltage ($V_{BE} = 0$)</td>
<td>50</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>30</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>6</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>1</td>
<td>A</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 \degree C$</td>
<td>0.36</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 \degree C$</td>
<td>1.2</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}$</td>
<td>Storage and Junction Temperature</td>
<td>-65 to 200</td>
<td>\degree C</td>
</tr>
</tbody>
</table>
**THERMAL DATA**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>146</td>
<td></td>
<td>°C/W</td>
<td></td>
</tr>
<tr>
<td>$R_{th j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>486</td>
<td></td>
<td>°C/W</td>
<td></td>
</tr>
</tbody>
</table>

**ELECTRICAL CHARACTERISTICS** \( (T_{amb} = 25 \degree C \text{ unless otherwise specified}) \)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ( (I_E = 0) )</td>
<td>$V_{CB} = 40 \text{ V}$, $V_{CB} = 40 \text{ V}$, $T_{amb} = 100 \degree C$</td>
<td>1.7</td>
<td>120</td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ( (I_E = 0) )</td>
<td>$I_C = 10 \mu A$</td>
<td>50</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CES}$</td>
<td>Collector-emitter Breakdown Voltage ( (V_{BE} = 0) )</td>
<td>$I_C = 10 \mu A$</td>
<td>50</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CEO*}$</td>
<td>Collector-Emitter Breakdown Voltage ( (I_E = 0) )</td>
<td>$I_C = 10 \text{ mA}$</td>
<td>30</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-Base Breakdown Voltage ( (I_C = 0) )</td>
<td>$I_E = 10 \mu A$</td>
<td>6</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE(sat)*}$</td>
<td>Collector-Emitter Saturation Voltage</td>
<td>$I_C = 10 \text{ mA}$, $I_B = 1 \text{ mA}$</td>
<td>0.25</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 100 \text{ mA}$, $I_B = 10 \text{ mA}$</td>
<td>0.20</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
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<td>$I_C = 300 \text{ mA}$, $I_B = 30 \text{ mA}$</td>
<td>0.32</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 500 \text{ mA}$, $I_B = 50 \text{ mA}$</td>
<td>0.42</td>
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<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 800 \text{ mA}$, $I_B = 80 \text{ mA}$</td>
<td>0.65</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 1000 \text{ mA}$, $I_B = 100 \text{ mA}$</td>
<td>0.75</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE(sat)*}$</td>
<td>Base-Emitter Saturation Voltage</td>
<td>$I_C = 10 \text{ mA}$, $I_B = 1 \text{ mA}$</td>
<td>0.64</td>
<td>0.75</td>
<td>0.86</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 100 \text{ mA}$, $I_B = 10 \text{ mA}$</td>
<td>0.75</td>
<td>0.89</td>
<td>1.1</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 300 \text{ mA}$, $I_B = 30 \text{ mA}$</td>
<td>0.75</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 500 \text{ mA}$, $I_B = 50 \text{ mA}$</td>
<td>0.89</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 800 \text{ mA}$, $I_B = 80 \text{ mA}$</td>
<td>1.0</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 1000 \text{ mA}$, $I_B = 100 \text{ mA}$</td>
<td>1.1</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$h_{FE}$ *</td>
<td>DC Current Gain</td>
<td>$I_C = 10 \text{ mA}$, $V_{CE} = 1 \text{ V}$</td>
<td>30</td>
<td></td>
<td></td>
<td>150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 100 \text{ mA}$, $V_{CE} = 1 \text{ V}$</td>
<td>60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 300 \text{ mA}$, $V_{CE} = 1 \text{ V}$</td>
<td>40</td>
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<tr>
<td></td>
<td></td>
<td>$I_C = 1000 \text{ mA}$, $V_{CE} = 5 \text{ V}$</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 800 \text{ mA}$, $V_{CE} = 2 \text{ V}$</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 500 \text{ mA}$, $V_{CE} = 1 \text{ V}$</td>
<td>35</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$h_{re}$</td>
<td>High Frequency Current Gain</td>
<td>$I_C = 50 \text{ mA}$, $f = 100 \text{ MHz}$, $V_{CE} = 10 \text{ V}$</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 50 \text{ mA}$, $f = 1 \text{ MHz}$</td>
<td>12</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$, $V_{CB} = 10 \text{ V}$</td>
<td>55</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_E = 0$</td>
<td>55</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_C = 0$, $V_{EB} = 0.5 \text{ V}$</td>
<td>35</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 50 \text{ mA}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{on}$ **</td>
<td>Turn-on Time</td>
<td>$I_C = 500 \text{ mA}$, $V_{CC} = 30 \text{ V}$</td>
<td>35</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$t_{off}$ **</td>
<td>Turn-off Time</td>
<td>$I_C = 500 \text{ mA}$, $V_{CC} = 30 \text{ V}$</td>
<td>60</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
</tbody>
</table>

* Pulsed : pulse duration = 300 μs, duty cycle = 1 %.

** See test circuit.
Switching Characteristics.

Test Circuit for $t_{on}$, $t_{off}$.

PULSE GENERATOR:
- $t_c, t_r \leq 1.0$ ns
- $PW = 1.0$ μs
- $Z_{IN} = 50 \, \Omega$
- DC < 2 %

TO OSCILLOSCOPE:
- $t_c < 1.0$ ns
- $Z_{IN} \geq 100 \, K\Omega$
DESCRIPTION
The 2N4014 is a silicon planar epitaxial transistor in TO-18 metal case. It is a high-voltage, high current switch used for memory applications requiring breakdown voltages up to 50 V and operating currents to 1 A. Fast switching times are assured because of the high minimum \( I_T \) (300 MHz) and tight control on storage time.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{CBO} )</td>
<td>Collector-base Voltage ( (I_E = 0) )</td>
<td>80</td>
<td>V</td>
</tr>
<tr>
<td>( V_{CES} )</td>
<td>Collector-emitter Voltage ( (V_{BE} = 0) )</td>
<td>80</td>
<td>V</td>
</tr>
<tr>
<td>( V_{CEO} )</td>
<td>Collector-emitter Voltage ( (I_B = 0) )</td>
<td>50</td>
<td>V</td>
</tr>
<tr>
<td>( V_{EBO} )</td>
<td>Emitter-base Voltage ( (I_C = 0) )</td>
<td>6</td>
<td>V</td>
</tr>
<tr>
<td>( I_C )</td>
<td>Collector Current</td>
<td>1</td>
<td>A</td>
</tr>
<tr>
<td>( P_{tot} )</td>
<td>Total Power Dissipation at ( T_{amb} \leq 25 \degree C )</td>
<td>0.36</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at ( T_{case} \leq 25 \degree C )</td>
<td>1.2</td>
<td>W</td>
</tr>
<tr>
<td>( T_{stg, T_j} )</td>
<td>Storage and Junction Temperature</td>
<td>– 65 to 200</td>
<td>\degree C</td>
</tr>
</tbody>
</table>
## THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th \ j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>146</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
<tr>
<td>$R_{th \ j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>486</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
</tbody>
</table>

## ELECTRICAL CHARACTERISTICS ($T_{amb} = 25 ^\circ C$ unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = 60 \text{ V}$ $V_{CB} = 60 \text{ V}$</td>
<td>1.7</td>
<td>120</td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = 10 \mu A$</td>
<td>80</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CES}$</td>
<td>Collector-emitter Breakdown Voltage ($V_{BE} = 0$)</td>
<td>$I_C = 10 \mu A$</td>
<td>80</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CEO}^*$</td>
<td>Collector-Emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = 10 \text{ mA}$</td>
<td>50</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-Base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = 10 \mu A$</td>
<td>6</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE(sat)}^*$</td>
<td>Collector-Emitter Saturation Voltage</td>
<td>$I_C = 10 \text{ mA}$ $I_B = 1 \text{ mA}$</td>
<td>0.19</td>
<td>0.25</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 100 \text{ mA}$ $I_B = 10 \text{ mA}$</td>
<td>0.21</td>
<td>0.26</td>
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<td>V</td>
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<tr>
<td></td>
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<td>$I_C = 300 \text{ mA}$ $I_B = 30 \text{ mA}$</td>
<td>0.31</td>
<td>0.4</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 500 \text{ mA}$ $I_B = 50 \text{ mA}$</td>
<td>0.4</td>
<td>0.52</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 800 \text{ mA}$ $I_B = 80 \text{ mA}$</td>
<td>0.5</td>
<td>0.8</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 1000 \text{ mA}$ $I_B = 100 \text{ mA}$</td>
<td>0.6</td>
<td>0.95</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE(sat)}^*$</td>
<td>Base-Emitter Saturation Voltage</td>
<td>$I_C = 10 \text{ mA}$ $I_B = 1 \text{ mA}$</td>
<td>0.64</td>
<td>0.76</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 100 \text{ mA}$ $I_B = 10 \text{ mA}$</td>
<td>0.75</td>
<td>0.86</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 300 \text{ mA}$ $I_B = 30 \text{ mA}$</td>
<td>0.89</td>
<td>1.1</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 500 \text{ mA}$ $I_B = 50 \text{ mA}$</td>
<td>0.9</td>
<td></td>
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<td>V</td>
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<td></td>
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<td>$I_C = 800 \text{ mA}$ $I_B = 80 \text{ mA}$</td>
<td>1.0</td>
<td>1.5</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 1000 \text{ mA}$ $I_B = 100 \text{ mA}$</td>
<td>1.1</td>
<td>1.7</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$h_{FE}^*$</td>
<td>DC Current Gain</td>
<td>$V_{CE} = 1 \text{ V}$</td>
<td>30</td>
<td>60</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>$h_{fe}$</td>
<td>High Frequency Current Gain</td>
<td>$V_{CE} = 10 \text{ V}$</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$V_{CB} = 10 \text{ V}$</td>
<td>10</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$V_{EB} = 0.5 \text{ V}$</td>
<td>55</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$t_{on}^{**}$</td>
<td>Turn-on Time</td>
<td>$I_C = 500 \text{ mA}$ $I_B = 50 \text{ mA}$</td>
<td>35</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$t_{off}^{**}$</td>
<td>Turn-off Time</td>
<td>$I_C = 500 \text{ mA}$ $V_{CC} = 30 \text{ V}$</td>
<td>60</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 ms, duty cycle = 1%.

** See test circuit.
DC Current Gain.

Collector-emitter Saturation Voltage.

Base-emitter Saturation Voltage.

Contours of Constant Transition Frequency.

Switching Characteristics.

Switching Characteristics.
Test Circuit for $t_{\text{on}}$, $t_{\text{off}}$.

**PULSE GENERATOR:**
- $t_r < 1.0 \text{ ns}$
- $PW = 1.0 \mu\text{s}$
- $Z_N = 50 \Omega$
- $DC < 2\%$

**TO OSCILLOSCOPE:**
- $t_r = 1.0 \text{ ns}$
- $Z_{IN} > 100 K\Omega$
DESCRIPTION
The 2N4030, 2N4031, 2N4032, and 2N4033 are silicon planar epitaxial PNP transistors in Jedec TO-39 metal case primarily intended for large signal, low noise industrial applications.

INTERNAL SCHEMATIC DIAGRAM

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>2N4030</th>
<th>2N4031</th>
<th>2N4032</th>
<th>2N4033</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{CBO}</td>
<td>Collector-base Voltage (I_E = 0)</td>
<td>- 60</td>
<td>- 80</td>
<td>- 60</td>
<td>- 80</td>
<td>V</td>
</tr>
<tr>
<td>V_{CEO}</td>
<td>Collector-emitter Voltage (I_B = 0)</td>
<td>- 60</td>
<td>- 80</td>
<td>- 60</td>
<td>- 80</td>
<td>V</td>
</tr>
<tr>
<td>V_{EBO}</td>
<td>Emitter-base Voltage (I_C = 0)</td>
<td>- 5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>I_C</td>
<td>Collector Current</td>
<td>- 1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>A</td>
</tr>
<tr>
<td>P_{tot}</td>
<td>Total Power Dissipation at T_{amb} ≤ 25 °C</td>
<td>0.8</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at T_{case} ≤ 25 °C</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>W</td>
</tr>
<tr>
<td>T_{stg}, T_j</td>
<td>Storage and Junction Temperature</td>
<td>- 65 to 200</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>°C</td>
</tr>
</tbody>
</table>
THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>For 2N4030 and 2N4032</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>For 2N4031 and 2N4033</td>
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ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>For 2N4030 and 2N4032</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>For 2N4031 and 2N4033</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Pulsed: pulse duration = 300 ms, duty cycle = 1 %.
- **See test circuit.**
ELECTRICAL CHARACTERISTICS (continued)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = -50 \text{ mA}$, $V_{CE} = -10 \text{ V}$, $f = 100 \text{ MHz}$</td>
<td>100</td>
<td>400</td>
<td>150</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For 2N4030 and 2N4031</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>For 2N4032 and 2N4033</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_C = 0$, $V_{EB} = -0.5 \text{ V}$, $f = 1 \text{ MHz}$</td>
<td>100</td>
<td>110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$, $V_{CB} = -10 \text{ V}$, $f = 1 \text{ MHz}$</td>
<td>100</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_s$</td>
<td>Storage Time</td>
<td>$I_C = -500 \text{ mA}$, $V_{CC} = -30 \text{ V}$, $I_B1 = -I_B2 = -50 \text{ mA}$</td>
<td>350</td>
<td>50</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>$t_f$</td>
<td>Fall Time</td>
<td>$I_C = -500 \text{ mA}$, $V_{CC} = -30 \text{ V}$, $I_B1 = -I_B2 = -50 \text{ mA}$</td>
<td>350</td>
<td>50</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>$t_{on}^{**}$</td>
<td>Turn-on Time</td>
<td>$I_C = -500 \text{ mA}$, $V_{CC} = -30 \text{ V}$, $I_B1 = -I_B2 = -50 \text{ mA}$</td>
<td>350</td>
<td>50</td>
<td>100</td>
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</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 ms, duty cycle = 1 %.
** See test circuit.

Collector-emitter Saturation Voltage.

Base-emitter Saturation Voltage.

Transition Frequency.

Collector-base Capacitance.
Test Circuit for $t_{on}$, $t_{s}$, $t_{r}$.

- $V_{BB} = +4.1V$
- $V_{CC} = -30V$

**PULSE GENERATOR:**
- $t_r, t_i < 20$ ns
- $PW = 1.0 \mu s$
- $Z_{IN} = 50 \Omega$
- $DC < 2 \%$

**TO OSCILLOSCOPE:**
- $t_r = 10$ ns
- $Z_{IN} > 100 K\Omega$
DESCRIPTION
The 2N4035 is a silicon planar epitaxial PNP transistors in Jedec TO-18 metal case, primarily intended for small signal, low noise industrial applications.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>-40</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>-40</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>-5</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>-100</td>
<td>mA</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 , ^\circ C$</td>
<td>0.36</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 , ^\circ C$</td>
<td>1</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}, T_j$</td>
<td>Storage and Junction Temperature</td>
<td>-65 to 200</td>
<td>°C</td>
</tr>
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</table>

October 1988
THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th, j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>175</td>
<td></td>
<td></td>
<td>°C/W</td>
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<tr>
<td>$R_{th, j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>486</td>
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<td>°C/W</td>
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</table>

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25 \, ^\circ C$ unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CES}$</td>
<td>Collector Cutoff Current ($V_{BE} = 0$)</td>
<td>$V_{CE} = -30 , V$</td>
<td></td>
<td></td>
<td>$-15$ nA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = -30 , V \quad T_{amb} = 125 , ^\circ C$</td>
<td></td>
<td></td>
<td>$-15$ μA</td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = -10 , \mu A$</td>
<td>$-40$</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CES}$</td>
<td>Collector-emitter Breakdown Voltage ($V_{BE} = 0$)</td>
<td>$I_C = -10 , \mu A$</td>
<td>$-40$</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CEO}^*$</td>
<td>Collector-Emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = -10 , mA$</td>
<td>$-40$</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-Base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = -10 , \mu A$</td>
<td>$-5$</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE(sat)}^*$</td>
<td>Collector-Emitter Saturation Voltage</td>
<td>$I_C = -1 , mA \quad I_B = -0.1 , mA$</td>
<td></td>
<td></td>
<td>$-0.13$ V</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -10 , mA \quad I_B = -1 , mA$</td>
<td></td>
<td></td>
<td>$-0.14$ V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -50 , mA \quad I_B = -5 , mA$</td>
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<td></td>
<td>$-0.3$ V</td>
<td></td>
</tr>
<tr>
<td>$V_{BE(sat)}^*$</td>
<td>Base-Emitter Saturation Voltage</td>
<td>$I_C = -1 , mA \quad I_B = -0.1 , mA$</td>
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<td></td>
<td>$-0.7$ V</td>
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</tr>
<tr>
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<td>$I_C = -10 , mA \quad I_B = -1 , mA$</td>
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<td>$-0.9$ V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -50 , mA \quad I_B = -5 , mA$</td>
<td></td>
<td></td>
<td>$-1.1$ V</td>
<td></td>
</tr>
<tr>
<td>$h_{FE}^*$</td>
<td>DC Current Gain</td>
<td>$I_C = -10 , \mu A \quad V_{CE} = -1 , V$</td>
<td>$70$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -100 , \mu A \quad V_{CE} = -1 , V$</td>
<td>$140$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -1 , mA \quad V_{CE} = -1 , V$</td>
<td>$150$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -10 , mA \quad V_{CE} = -1 , V$</td>
<td>$150$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -50 , mA \quad V_{CE} = -1 , V$</td>
<td>$30$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = -10 , mA \quad V_{CE} = -1 , V$</td>
<td>$300$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$T_{amb} = -55 , ^\circ C$</td>
<td>$70$</td>
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<tr>
<td>$h_{te}$</td>
<td>Small Signal Current Gain</td>
<td>$I_C = -1 , mA \quad V_{CE} = -10 , V$</td>
<td>$150$</td>
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<tr>
<td></td>
<td></td>
<td>$f = 1 , kHz$</td>
<td>$450$</td>
<td></td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = -10 , mA \quad V_{CE} = -20 , V$</td>
<td>$450$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_C = 0 \quad V_{EB} = -0.5 , V$</td>
<td>$5.5$</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0 \quad V_{CB} = -10 , V$</td>
<td>$3.5$</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>NF</td>
<td>Noise Figure</td>
<td>$I_C = -1 , mA \quad V_{CE} = -5 , V$</td>
<td>$6$</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 100 , MHz \quad R_g = 100 , \Omega$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{on}$</td>
<td>Turn-on Time</td>
<td>$I_C = -50 , mA \quad V_{CC} = -30 , V$</td>
<td>$40$</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$t_{off}$</td>
<td>Turn-off Time</td>
<td>$I_C = -50 , mA \quad V_{CC} = -30 , V$</td>
<td>$150$</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$h_{ie}$</td>
<td>Input Impedance</td>
<td>$I_C = -1 , mA \quad V_{CE} = -10 , V$</td>
<td>$4$</td>
<td></td>
<td></td>
<td>kΩ</td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1%.
## ELECTRICAL CHARACTERISTICS (continued)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$h_{re}$</td>
<td>Reverse Voltage Ratio</td>
<td>$I_C = -1 \ mA$ $V_{CE} = -10 \ V$ $f = 1 \ kHz$</td>
<td></td>
<td></td>
<td>$4 \times 10^{-4}$</td>
<td></td>
</tr>
<tr>
<td>$h_{oe}$</td>
<td>Output Admittance</td>
<td>$I_C = -1 \ mA$ $V_{CE} = -10 \ V$ $f = 1 \ kHz$</td>
<td>8</td>
<td></td>
<td>40</td>
<td>$\mu \text{S}$</td>
</tr>
<tr>
<td>$r_{bb' C'B'C}$</td>
<td>Feedback Time Constant</td>
<td>$I_C = -10 \ mA$ $V_{CE} = -20 \ V$ $f = 80 \ MHz$</td>
<td></td>
<td></td>
<td>40</td>
<td>$\text{ps}$</td>
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</table>
DESCRIPTION
The 2N4036 is a silicon planar epitaxial PNP transistor in Jedec TO-39 metal case. It is intended particularly as medium speed saturated switch and general purpose amplifier.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>-90</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEX}$</td>
<td>Collector-emitter Voltage ($V_{BE} = 1.5$ V)</td>
<td>-85</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CER}$</td>
<td>Collector-emitter Voltage ($R_{BE} \leq 200$ $\Omega$)</td>
<td>-85</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>-65</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>-6</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>-1</td>
<td>A</td>
</tr>
<tr>
<td>$I_B$</td>
<td>Base Current</td>
<td>-0.5</td>
<td>A</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25$ °C</td>
<td>1</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25$ °C</td>
<td>7</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}, T_j$</td>
<td>Storage and Junction Temperature</td>
<td>-65 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>
## THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Max</th>
<th>25 °C/W</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_{th j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## ELECTRICAL CHARACTERISTICS ($T_{amb} = 25$ °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = -60$ V</td>
<td>-20</td>
<td>nA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{CEO}$</td>
<td>Collector Cutoff Current ($I_B = 0$)</td>
<td>$V_{CE} = -30$ V</td>
<td>-0.5</td>
<td>μA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{EBO}$</td>
<td>Emitter Cutoff Current ($I_C = 0$)</td>
<td>$V_{EB} = -5$ V</td>
<td>-20</td>
<td>nA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = -100$ μA</td>
<td>-90</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CEX}^*$</td>
<td>Collector-emitter Breakdown Voltage ($V_{BE} = 1.5$ V)</td>
<td>$I_C = -10$ mA</td>
<td>-85</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CER}^*$</td>
<td>Collector-emitter Breakdown Voltage ($R_{BE} = 200$ Ω)</td>
<td>$I_C = -10$ mA</td>
<td>-85</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)CEO}^*$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = -10$ mA</td>
<td>-65</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = -100$ μA</td>
<td>-7</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{CE(sat)}^*$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = -150$ mA $I_B = -15$ mA</td>
<td>-0.65</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{BE}^*$</td>
<td>Base-emitter Voltage</td>
<td>$I_C = -150$ mA $V_{CE} = -10$ V</td>
<td>-1.1</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$h_{FE}^*$</td>
<td>DC Current Gain</td>
<td>$I_C = -0.1$ mA $V_{CE} = -10$ V</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = -50$ mA $f = 20$ MHz $V_{CE} = -10$ V</td>
<td>60</td>
<td>MHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance</td>
<td>$I_C = 0$ $f = 1$ MHz $V_{EB} = -0.5$ V</td>
<td>90</td>
<td>pF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$ $V_{CB} = -10$ V</td>
<td>30</td>
<td>pF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{on}^{**}$</td>
<td>Turn-on Time</td>
<td>$I_C = -150$ mA $V_{CC} = -30$ V $I_{B1} = -15$ mA</td>
<td>110</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{off}^{**}$</td>
<td>Turn-off Time</td>
<td>$I_C = -150$ mA $V_{CC} = -30$ V $I_{B1} = -I_{B2} = -15$ mA</td>
<td>700</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Pulsed : pulse duration = 300 μs, duty cycle = 1 %.
** See test circuit.
Test Circuit for $t_{on}$, $t_{off}$.

$+V_{BB} = 4$ V
Adjust $I_{B1} = I_{B2}$

Output to oscilloscope
$Z = 10^6 \Omega$
$C_{in} = 20 \mu F$
$t_r \leq 15 \text{ns}$
Channel A

Input pulse waveform

-8 V
20 μs

f = 10 KHz
t_r \leq 10 \text{ns}

Output to oscilloscope
$Z = 10^6 \Omega$
$C_{in} = 20 \mu F$
$t_r \leq 15 \text{ns}$
Channel B

-30 V

-0.65 V

Output pulse waveform

S-4631

SGS-THOMSON
MICROELECTRONICS
DESCRIPTION
The 2N4037 is a silicon planar epitaxial PNP transistor in a Jedec TO-39 metal case. It is intended particularly as medium speed saturated switch and general purpose amplifier.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{CBO}</td>
<td>Collector-base Voltage (I_E = 0)</td>
<td>-60</td>
<td>V</td>
</tr>
<tr>
<td>V_{CEO}</td>
<td>Collector-emitter Voltage (I_B = 0)</td>
<td>-40</td>
<td>V</td>
</tr>
<tr>
<td>V_{CER}</td>
<td>Collector-emitter Voltage (R_{BE} ≤ 200 Ω)</td>
<td>-60</td>
<td>V</td>
</tr>
<tr>
<td>V_{CEV}</td>
<td>Collector-emitter Voltage (V_{BE} = 1.5 V)</td>
<td>-60</td>
<td>V</td>
</tr>
<tr>
<td>V_{EBO}</td>
<td>Emitter-base Voltage (I_C = 0)</td>
<td>-6</td>
<td>V</td>
</tr>
<tr>
<td>I_C</td>
<td>Collector Current</td>
<td>-1</td>
<td>A</td>
</tr>
<tr>
<td>I_B</td>
<td>Base Current</td>
<td>-0.5</td>
<td>A</td>
</tr>
<tr>
<td>P_{tot}</td>
<td>Total Power Dissipation at T_amb ≤ 25 °C</td>
<td>7</td>
<td>W</td>
</tr>
<tr>
<td>T_{stg, T_j}</td>
<td>Storage and Junction Temperature</td>
<td>-65 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>
### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>25</td>
<td>°C/W</td>
<td></td>
</tr>
<tr>
<td>$R_{th j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>175</td>
<td>°C/W</td>
<td></td>
</tr>
</tbody>
</table>

### ELECTRICAL CHARACTERISTICS ($T_{amb} = 25 ^\circ C$ unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current $(I_E = 0)$</td>
<td>$V_{CB} = -60 V$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{CEO}$</td>
<td>Collector Cutoff Current $(I_B = 0)$</td>
<td>$V_{CE} = -30 V$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{EBO}$</td>
<td>Emitter Cutoff Current $(I_C = 0)$</td>
<td>$V_{EB} = -5 V$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage</td>
<td>$I_E = -100 \mu A$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage $(I_E = 0)$</td>
<td>$I_C = -100 \mu A$</td>
<td></td>
<td></td>
<td>- 60</td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CEO}^*$</td>
<td>Collector-emitter Breakdown Voltage $(I_B = 0)$</td>
<td>$I_C = -10 mA$</td>
<td></td>
<td></td>
<td>- 40</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE(sat)}^*$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = -150 mA$</td>
<td></td>
<td></td>
<td>- 1.4</td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CEV}^*$</td>
<td>Collector-emitter Breakdown Voltage</td>
<td>$I_C = -10 mA$</td>
<td></td>
<td></td>
<td>- 60</td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CEr}^*$</td>
<td>Collector-emitter Breakdown Voltage</td>
<td>$I_C = -10 mA$</td>
<td></td>
<td></td>
<td>- 60</td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE}^*$</td>
<td>Base-emitter Voltage</td>
<td>$I_C = -150 mA$</td>
<td></td>
<td></td>
<td>- 1.5</td>
<td>V</td>
</tr>
<tr>
<td>$h_{FE}^*$</td>
<td>DC Current Gain</td>
<td>$I_C = -1 mA$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$h_{ie}$</td>
<td>Small Signal Current Gain</td>
<td>$I_C = -50 mA$</td>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance $(I_E = 0)$</td>
<td>$V_{CB} = -10 V$</td>
<td></td>
<td></td>
<td>30</td>
<td>pF</td>
</tr>
<tr>
<td>$C_{EBO}$</td>
<td>Emitter-base Capacitance $(I_E = 0)$</td>
<td>$V_{EB} = -0.5 V$</td>
<td></td>
<td></td>
<td>90</td>
<td>pF</td>
</tr>
</tbody>
</table>

* Pulsed : pulse duration = 300 μs, duty cycle = 1.5 %. 
DESCRIPTION
The 2N4427 and BFR98 are silicon planar epitaxial NPN transistor in Jedecl TO-39 metal case. They are designed for VHF class A, B, or C amplifier and oscillator applications.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>20</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>3.5</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>0.5</td>
<td>A</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{case} \leq 25 ^\circ C$</td>
<td>3.5</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg}$</td>
<td>Storage and Junction Temperature</td>
<td>$-65$ to $200$</td>
<td>°C</td>
</tr>
</tbody>
</table>
### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Max. Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rth i-case</td>
<td>Thermal Resistance Junction-case</td>
<td>50</td>
<td>°C/W</td>
</tr>
</tbody>
</table>

### ELECTRICAL CHARACTERISTICS ($T_{\text{amb}} = 25$ °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CEO}$</td>
<td>Collector Cutoff Current ($I_B = 0$)</td>
<td>$V_{CE} = 12$ V</td>
<td>20</td>
<td>µA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V(BR)_{CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = 100$ µA</td>
<td>40</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{CEO(sus)}$</td>
<td>Collector-emitter Sustaining Voltage ($I_B = 0$)</td>
<td>$I_C = 5$ mA</td>
<td>20</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{CE(sus)}$</td>
<td>Collector-Emitter Sustaining Voltage ($R_{BE} = 10$ Ω)</td>
<td>$I_C = 5$ mA</td>
<td>40</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V(BR)_{EBO}$</td>
<td>Emitter-Base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = 100$ µA</td>
<td>3.5</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{CE(sat)}$</td>
<td>Collector-Emitter Saturation Voltage</td>
<td>$I_C = 100$ mA $I_B = 20$ mA</td>
<td>0.5</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$h_{FE}^*$</td>
<td>DC Current Gain</td>
<td>$I_C = 100$ mA $I_C = 360$ mA $V_{CE} = 5$ V $V_{CE} = 5$ V</td>
<td>10</td>
<td>200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = 50$ mA $f = 200$ MHz $V_{CE} = 15$ V</td>
<td>500</td>
<td>MHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$ $f = 1$ MHz $V_{CB} = 12$ V</td>
<td>4</td>
<td>pF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$P_o^{**}$</td>
<td>Output Power</td>
<td>$V_{CC} = 12$ V $P_I = 100$ mW</td>
<td>1</td>
<td>W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\eta^{**}$</td>
<td>Collector Efficiency</td>
<td>$V_{CC} = 12$ V $f = 175$ MHz $P_o = 1$ W</td>
<td>50</td>
<td>%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 µs, duty cycle = 1%.
** See test circuit.

**RF Output Power.**

**Collector-base Capacitance.**
TEST CIRCUIT

Test Circuit for Power Output Measurement (f = 175 MHz).

C1, C2, C3, C4 = 3 ± 30 pF
C5 = 1000 pF
C6 = 20 kpf
R1 = 10 W

L1 = 2 turns 16 wire, 3/16" ID, 1/4" long
L2 = ferrite choke, Z = 450 W
L3 = 2 turns 16 wire, 1/4" ID, 1/4" long
L4 = 4 turns 16 wire, 3/8" ID, 3/8" long
CATV ULTRA-LINEAR HIGH GAIN TRANSISTOR

The 2N5109 is a multi-emitter silicon planar epitaxial NPN transistor in Jedec TO-39 metal case. It is designed for CATV-MATV amplifier applications over a wide frequency range (40 to 860 MHz).

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE}$</td>
<td>Collector-emitter Voltage ($R_{BE} \leq 10 , \Omega$)</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>20</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>3</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>0.4</td>
<td>A</td>
</tr>
<tr>
<td>$I_B$</td>
<td>Base Current</td>
<td>0.4</td>
<td>A</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 , ^{\circ}C$ at $T_{case} \leq 75 , ^{\circ}C$</td>
<td>1 W</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.5 W</td>
<td></td>
</tr>
<tr>
<td>$T_{stg, T_j}$</td>
<td>Storage and Junction Temperature</td>
<td>- 65 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>

October 1988
**THERMAL DATA**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>R\textsubscript{th,case}</td>
<td>Thermal Resistance Junction-case</td>
<td>Max 175 °C/W</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R\textsubscript{th,amb}</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max 50 °C/W</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

**ELECTRICAL CHARACTERISTICS** \((T\textsubscript{amb} = 25 \, ^{\circ}C\) unless otherwise specified\)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>I\textsubscript{CEX}</td>
<td>Collector Cutoff Current ((V\textsubscript{BE} = - 1.5 , V))</td>
<td>(V\textsubscript{CE} = 35 , V) (V\textsubscript{CE} = 15 , V) (T\textsubscript{amb} = 150 , ^{\circ}C)</td>
<td>5</td>
<td>5</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>I\textsubscript{CEO}</td>
<td>Collector Cutoff Current ((I\textsubscript{B} = 0))</td>
<td>(V\textsubscript{CE} = 15 , V)</td>
<td>20</td>
<td></td>
<td></td>
<td>(\mu A)</td>
</tr>
<tr>
<td>I\textsubscript{EBO}</td>
<td>Emitter Cutoff Current ((I\textsubscript{C} = 0))</td>
<td>(V\textsubscript{EB} = 3 , V)</td>
<td>0.1</td>
<td></td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>(V\textsubscript{BR} \textsubscript{CBO})</td>
<td>Collector-base Breakdown Voltage ((I\textsubscript{E} = 0))</td>
<td>(I\textsubscript{C} = 0.1 , mA)</td>
<td>40</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>(V\textsubscript{CE, (sus)})*</td>
<td>Collector-emitter Sustaining Voltage ((R\textsubscript{BE} = 10 , \Omega))</td>
<td>(I\textsubscript{C} = 5 , mA)</td>
<td>40</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>(V\textsubscript{CEO, (sus)})</td>
<td>Collector-emitter Sustaining Voltage ((I\textsubscript{B} = 0))</td>
<td>(I\textsubscript{C} = 5 , mA)</td>
<td>20</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>(V\textsubscript{CE, (sat)})</td>
<td>Collector-emitter Saturation Voltage</td>
<td>(I\textsubscript{C} = 100 , mA) (I\textsubscript{B} = 10 , mA)</td>
<td>0.5</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>(h\textsubscript{FE})*</td>
<td>DC Current Gain ((I\textsubscript{E} = 0)) (f = 200 , MHz)</td>
<td>(I\textsubscript{C} = 50 , mA) (I\textsubscript{C} = 360 , mA) (V\textsubscript{CE} = 15 , V) (V\textsubscript{CE} = 5 , V)</td>
<td>70</td>
<td>210</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(f\textsubscript{T})</td>
<td>Transition Frequency</td>
<td>(I\textsubscript{C} = 50 , mA) (f = 200 , MHz)</td>
<td>1.2</td>
<td></td>
<td></td>
<td>GHz</td>
</tr>
<tr>
<td>(C\textsubscript{CBO})</td>
<td>Collector-base Capacitance ((I\textsubscript{E} = 0)) (f = 1 , MHz)</td>
<td>(V\textsubscript{CB} = 15 , V)</td>
<td>3.5</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>(NF)</td>
<td>Noise Figure</td>
<td>(I\textsubscript{C} = 10 , mA) (R\textsubscript{g} = 50 , \Omega) (f = 200 , MHz)</td>
<td>3</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>(G\textsubscript{p})</td>
<td>Power Gain ((\text{see test circuit}))</td>
<td>(I\textsubscript{C} = 10 , mA) (V\textsubscript{CE} = 15 , V) (f = 200 , MHz) (P\textsubscript{I} = -10 , dBm)</td>
<td>11</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
</tbody>
</table>

* Pulsed: pulse duration = 300 \, \mu s, duty cycle = 1 %.

**TEST CIRCUIT**

Test Circuit for Power Gain Measurement \((f = 200 \, MHz)\).

![Test Circuit Diagram]
High Frequency Current Gain.

Power Gain vs. Collector Current.

Input Impedance $S_{11e}$ (normalized 50 $\Omega$).

Forward Transfer Coefficient $S_{21e}$.

Reverse Transfer Coefficient $S_{12e}$.

Output Impedance $S_{22e}$ (normalized 50 $\Omega$).
DESCRIPTION
The 2N5179 is a silicon planar epitaxial NPN transistor in JedeC TO-72 metal case, intended for low-noise tuned-amplifier and converter applications up to 500 MHz.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>20</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>12</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>2.5</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>50</td>
<td>mA</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 , ^\circ C$</td>
<td>200</td>
<td>mW</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 , ^\circ C$</td>
<td>300</td>
<td>mW</td>
</tr>
<tr>
<td>$T_{stg, , T_J}$</td>
<td>Storage and Junction Temperature</td>
<td>$-65$ to $200$</td>
<td>°C</td>
</tr>
</tbody>
</table>

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### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Min.</th>
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<th>Unit</th>
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<tbody>
<tr>
<td>$R_{th j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>583</td>
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<td>875</td>
<td>°C/W</td>
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<tr>
<td>$R_{th j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td></td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
</tbody>
</table>

### ELECTRICAL CHARACTERISTICS ($T_{amb} = 25$ °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = 15$ V</td>
<td>20</td>
<td>1</td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-base Breakdown Voltage ($I_E = 0$)</td>
<td>$I_C = 1$ µA</td>
<td></td>
<td></td>
<td>20</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO(sus)}$</td>
<td>Collector-emitter Sustaining Voltage ($I_B = 0$)</td>
<td>$I_C = 3$ mA</td>
<td>12</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = 10$ µA</td>
<td>2.5</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE(sat)}$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = 10$ mA $I_B = 1$ mA</td>
<td>0.4</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE(sat)}$</td>
<td>Base-emitter Saturation Voltage</td>
<td>$I_C = 10$ mA $I_B = 1$ mA</td>
<td>1</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$h_{FE}$</td>
<td>DC Current Gain</td>
<td>$I_C = 3$ mA $V_{CE} = 1$ V</td>
<td>25</td>
<td>70</td>
<td>250</td>
<td></td>
</tr>
<tr>
<td>$h_{fe}$</td>
<td>Small Signal Current Gain</td>
<td>$I_C = 2$ mA $V_{CE} = 6$ V</td>
<td>25</td>
<td>90</td>
<td>300</td>
<td></td>
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<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = 5$ mA $V_{CE} = 6$ V</td>
<td>0.9</td>
<td>1.4</td>
<td>2</td>
<td>GHz</td>
</tr>
<tr>
<td>$C_{re}$</td>
<td>Reverse Capacitance</td>
<td>$I_C = 0$ $f = 1$ MHz $V_{CE} = 6$ V</td>
<td>0.7</td>
<td>1</td>
<td></td>
<td>pF</td>
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<tr>
<td>$NF$</td>
<td>Noise Figure</td>
<td>$I_C = 1.5$ mA $V_{CE} = 6$ V</td>
<td>3</td>
<td>4.5</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>$G_{pe}$</td>
<td>Power Gain (neutralized)</td>
<td>$I_C = 5$ mA $V_{CE} = 12$ V $R_g = 125$ Ω</td>
<td>15</td>
<td>21</td>
<td></td>
<td>dB</td>
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<tr>
<td>$P_o$</td>
<td>Oscillator Power Output</td>
<td>$I_C = 12$ mA $V_{CB} = 10$ V</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$r_{bb'C_0'}$</td>
<td>Feedback Time Constant</td>
<td>$I_C = 2$ mA $V_{CB} = 6$ V</td>
<td>3</td>
<td>7</td>
<td>14</td>
<td>ps</td>
</tr>
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</table>
DESCRIPTION
The 2N5320 and 2N5321 are silicon planar epitaxial NPN transistors in Jedec TO-39 metal case. They are especially intended for high-voltage medium power applications in industrial and commercial equipments. The complementary PNP types are respectively the 2N5322 and 2N5323.

INTERNAL SCHEMATIC DIAGRAM

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>100</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>Collector-emitter Voltage ($V_{BE} = 1.5$ V)</td>
<td>100</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>75</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>6</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>Collector Current</td>
<td>2</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Base Current</td>
<td>1</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Total Power Dissipation at $T_{amb} \leq 25$ °C</td>
<td>1</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25$ °C</td>
<td>10</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>Storage and Junction Temperature</td>
<td>-65 to 200</td>
<td>°C</td>
</tr>
</tbody>
</table>

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### THERMAL DATA

<table>
<thead>
<tr>
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<th>Unit</th>
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<tbody>
<tr>
<td>$R_{\text{th}}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>17.5</td>
<td>°C/W</td>
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<tr>
<td>$R_{\text{th}}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>175</td>
<td>°C/W</td>
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### ELECTRICAL CHARACTERISTICS ($T_{\text{case}} = 25$ °C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{\text{CBO}}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>For 2N5320</td>
<td>0.5</td>
<td>µA</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{\text{CB}} = 80$ V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>For 2N5321</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{\text{CB}} = 60$ V</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>$I_{\text{EBO}}$</td>
<td>Emitter Cutoff Current ($I_C = 0$)</td>
<td>For 2N5320</td>
<td></td>
<td></td>
<td>0.1</td>
<td>µA</td>
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<tr>
<td></td>
<td></td>
<td>$V_{\text{EB}} = 5$ V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>For 2N5321</td>
<td></td>
<td></td>
<td>0.5</td>
<td>µA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{\text{EB}} = 4$ V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)\text{CEV}}$</td>
<td>Collector-emitter Breakdown Voltage ($V_{\text{BE}} = 1.5$ V)</td>
<td>$I_C = 0.1$ mA</td>
<td>100</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For 2N5320</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>For 2N5321</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>$V_{(BR)\text{CEO}}$</td>
<td>Collector-Emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = 10$ mA</td>
<td>75</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For 2N5320</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>For 2N5321</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)\text{EBO}}$</td>
<td>Emitter-Base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = 0.1$ mA</td>
<td>6</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For 2N5320</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>For 2N5321</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{\text{CE(sat)}}$</td>
<td>Collector-Emitter Saturation Voltage</td>
<td>$I_C = 500$ mA</td>
<td>0.5</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_B = 50$ mA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>For 2N5320</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>For 2N5321</td>
<td></td>
<td></td>
<td>0.8</td>
<td>V</td>
</tr>
<tr>
<td>$V_{\text{BE}}$</td>
<td>Base-Emitter Voltage</td>
<td>$I_C = 500$ mA</td>
<td>1.1</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{\text{CE}} = 4$ V</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>For 2N5320</td>
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<td></td>
<td>1.4</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For 2N5321</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>$h_{\text{FE}}$</td>
<td>DC Current Gain</td>
<td>For 2N5320</td>
<td>30</td>
<td></td>
<td>130</td>
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<tr>
<td></td>
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<td>$I_C = 500$ mA</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 1$ A</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>For 2N5321</td>
<td></td>
<td></td>
<td>10</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 500$ mA</td>
<td></td>
<td></td>
<td>250</td>
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</tr>
<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = 50$ mA</td>
<td>50</td>
<td></td>
<td></td>
<td>MHz</td>
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<td></td>
<td></td>
<td>$V_{\text{CE}} = 4$ V</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$f = 10$ MHz</td>
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<tr>
<td>$t_{\text{on}}$</td>
<td>Turn-on Time</td>
<td>$I_C = 500$ mA</td>
<td>80</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{B1} = 50$ mA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{\text{off}}$</td>
<td>Turn-off Time</td>
<td>$I_C = 500$ mA</td>
<td>800</td>
<td></td>
<td></td>
<td>ns</td>
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<tr>
<td></td>
<td></td>
<td>$V_{\text{CC}} = 30$ V</td>
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<tr>
<td></td>
<td></td>
<td>$I_{B1} = - I_{B2} = 50$ mA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Pulsed : pulse duration = 300 µs, duty cycle = 1 %.
**DESCRIPTION**
The 2N5322 and 2N5323 are silicon planar epitaxial PNP transistors in Jedej TO-39 metal case. They are especially intended for high-voltage medium power applications in industrial and commercial equipments.

**INTERNAL SCHEMATIC DIAGRAM**

**ABSOLUTE MAXIMUM RATINGS**

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</tr>
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<tbody>
<tr>
<td></td>
<td>2N5322</td>
<td>2N5323</td>
<td></td>
</tr>
<tr>
<td>VCBO</td>
<td>Collector-base Voltage (IE = 0)</td>
<td>-100</td>
<td>-75</td>
</tr>
<tr>
<td>VCEV</td>
<td>Collector-emitter Voltage (VBE = 1.5 V)</td>
<td>-100</td>
<td>-75</td>
</tr>
<tr>
<td>VCEO</td>
<td>Collector-emitter Voltage (IB = 0)</td>
<td>-75</td>
<td>-50</td>
</tr>
<tr>
<td>VEOB</td>
<td>Emitter-base Voltage (IC = 0)</td>
<td>-6</td>
<td>-5</td>
</tr>
<tr>
<td>IC</td>
<td>Collector Current</td>
<td>-2</td>
<td>A</td>
</tr>
<tr>
<td>IB</td>
<td>Base Current</td>
<td>-1</td>
<td>A</td>
</tr>
<tr>
<td>Ptot</td>
<td>Total Power Dissipation at Tamb ≤ 25 °C</td>
<td>1</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at Tcase ≤ 25 °C</td>
<td>10</td>
<td>W</td>
</tr>
<tr>
<td>Tstg, TJ</td>
<td>Storage and Junction Temperature</td>
<td>-65 to 200</td>
<td>°C</td>
</tr>
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<td>$R_{th,j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>17.5</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
<tr>
<td>$R_{th,j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>175</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
</tbody>
</table>

## ELECTRICAL CHARACTERISTICS ($T_{case} = 25{^\circ}C$ unless otherwise specified)

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<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>For $2N5322$ $V_{CB} = -80$ V $V_{EB} = -5$ V</td>
<td>-0.5</td>
<td></td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For $2N5323$ $V_{CB} = -60$ V $V_{EB} = -4$ V</td>
<td>-5</td>
<td></td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>$I_{EBO}$</td>
<td>Emitter Cutoff Current ($I_C = 0$)</td>
<td>For $2N5322$ $V_{EB} = -5$ V</td>
<td>-0.1</td>
<td></td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For $2N5323$ $V_{EB} = -4$ V</td>
<td>-0.5</td>
<td></td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>$V_{(BR)CEV}$</td>
<td>Collector-emitter Breakdown Voltage ($V_{BE} = 1.5$ V)</td>
<td>$I_C = -0.1$ mA</td>
<td>For $2N5322$ $-100$ V</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For $2N5323$ $-75$ V</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CEO}^*$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = -10$ mA</td>
<td>For $2N5322$ $-75$ V</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For $2N5323$ $-50$ V</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-base Breakdown Voltage ($I_C = 0$)</td>
<td>$I_E = -0.1$ mA</td>
<td>For $2N5322$ $-6$ V</td>
<td></td>
<td>5</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For $2N5323$ $-5$ V</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE(sat)}^*$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = -500$ mA $I_B = -50$ mA</td>
<td>For $2N5322$ $V_{CE} = -4$ V</td>
<td>0.7</td>
<td></td>
<td>V</td>
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<tr>
<td></td>
<td></td>
<td>For $2N5323$ $-1.2$ V</td>
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<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE}^*$</td>
<td>Base-emitter Voltage</td>
<td>$I_C = -500$ mA $V_{CE} = -4$ V</td>
<td>For $2N5322$ $-1.1$ V</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For $2N5323$ $-1.4$ V</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$h_{FE}^*$</td>
<td>DC Current Gain</td>
<td>For $2N5322$ $I_C = -500$ mA $V_{CE} = -4$ V $f = 10$ MHz</td>
<td>30</td>
<td>130</td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For $2N5323$ $I_C = -1$ A $V_{CE} = -2$ V</td>
<td>10</td>
<td></td>
<td></td>
<td>MHz</td>
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<tr>
<td>$f_T$</td>
<td>Transition Frequency</td>
<td>$I_C = -50$ mA $V_{CE} = -4$ V</td>
<td>50</td>
<td></td>
<td></td>
<td>MHz</td>
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<tr>
<td>$t_{on}$</td>
<td>Turn-on Time</td>
<td>$I_C = -500$ mA $V_{CC} = -30$ V</td>
<td>100</td>
<td></td>
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<td>ns</td>
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<tr>
<td>$t_{off}$</td>
<td>Turn-off Time</td>
<td>$I_C = -500$ mA $V_{CC} = -30$ V $I_B1 = -50$ mA $I_B2 = -50$ mA</td>
<td>1000</td>
<td></td>
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</table>

* Pulsed: pulse duration = 300 μs, duty cycle = 1%.
DESCRIPTION
The 2N5415S is a silicon planar epitaxial PNP transistor in Jedec TO-39 metal case, intended for high voltage switching and linear amplifier applications.

ABSOLUTE MAXIMUM RATINGS

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<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>Collector-base Voltage ($I_E = 0$)</td>
<td>$-200$</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>Collector-emitter Voltage ($I_B = 0$)</td>
<td>$-200$</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>Emitter-base Voltage ($I_C = 0$)</td>
<td>$-4$</td>
<td>V</td>
</tr>
<tr>
<td>$I_{CM}$</td>
<td>Collector Peak Current</td>
<td>$-1$</td>
<td>A</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation at $T_{amb} \leq 25 , ^\circ C$</td>
<td>$1$</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>at $T_{case} \leq 25 , ^\circ C$</td>
<td>$10$</td>
<td>W</td>
</tr>
<tr>
<td>$T_{stg, , T_j}$</td>
<td>Storage and Junction Temperature</td>
<td>$-55$ to $200$</td>
<td>°C</td>
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October 1988
### THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tr>
<td>$R_{th j-case}$</td>
<td>Thermal Resistance Junction-case</td>
<td>Max</td>
<td>17.5</td>
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<td></td>
<td>°C/W</td>
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<tr>
<td>$R_{th j-amb}$</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max</td>
<td>175</td>
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<td>°C/W</td>
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### ELECTRICAL CHARACTERISTICS ($T_{amb} = 25$ °C unless otherwise specified)

<table>
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<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tr>
<td>$I_{CBO}$</td>
<td>Collector Cutoff Current ($I_E = 0$)</td>
<td>$V_{CB} = -175$ V</td>
<td></td>
<td></td>
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<td>μA</td>
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<tr>
<td>$I_{CEO}$</td>
<td>Collector Cutoff Current ($I_B = 0$)</td>
<td>$V_{CE} = -150$ V</td>
<td></td>
<td></td>
<td></td>
<td>μA</td>
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<tr>
<td>$I_{EBO}$</td>
<td>Emitter Cutoff Current ($I_C = 0$)</td>
<td>$V_{EB} = -4$ V</td>
<td></td>
<td></td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td>$V_{(BR)CEO}^*$</td>
<td>Collector-emitter Breakdown Voltage ($I_B = 0$)</td>
<td>$I_C = -2$ mA</td>
<td></td>
<td>$-200$</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE(sat)}^*$</td>
<td>Collector-emitter Saturation Voltage</td>
<td>$I_C = -50$ mA $I_B = -5$ mA</td>
<td></td>
<td></td>
<td>$-2.5$</td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE}^*$</td>
<td>Base-Emitter Voltage</td>
<td>$I_C = -50$ mA $V_{CE} = -10$ V</td>
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<td></td>
<td>$-1.5$</td>
<td>V</td>
</tr>
<tr>
<td>$h_{FE}^*$</td>
<td>DC Current Gain</td>
<td>$I_C = -50$ mA $V_{CE} = -10$ V</td>
<td></td>
<td>30</td>
<td>150</td>
<td>MHz</td>
</tr>
<tr>
<td>$f_T^*$</td>
<td>Transition Frequency</td>
<td>$I_C = -10$ mA $f = 5$ MHz $V_{CE} = -10$ V</td>
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<td></td>
<td>15</td>
<td>MHz</td>
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<tr>
<td>$C_{CBO}$</td>
<td>Collector-base Capacitance</td>
<td>$I_E = 0$ $f = 1$ MHz $V_{CB} = -10$ V</td>
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<td></td>
<td></td>
<td>pF</td>
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* Pulsed: pulse duration = 300 μs, duty cycle = 1%. 

---
PACKAGES
MECHANICAL DATA

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<td>0.500</td>
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<td>C</td>
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<td>0.228</td>
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<tr>
<td>D</td>
<td>4.9</td>
<td>0.193</td>
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<tr>
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<tr>
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<td>0.019</td>
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<td>typ. 45°</td>
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<td>L</td>
<td>typ. 2.54</td>
<td>typ. 0.100</td>
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pin 1: Emitter - pin 2: Base
pin 3: Collector - pin 4: Shield
PACKAGES

TO-39

MECHANICAL DATA

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<td>B</td>
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<td>C</td>
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<td>E</td>
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<td>F</td>
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<td>G</td>
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pin 1: Emitter - pin 2: Base - pin 3: Collector
MECHANICAL DATA

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<tr>
<td>B</td>
<td>12.7</td>
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<tr>
<td>C</td>
<td>—</td>
<td>5.8</td>
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<td>D</td>
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<td>E</td>
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<td>—</td>
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<tr>
<td>H</td>
<td>typ. 45°</td>
<td>typ. 45°</td>
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<tr>
<td>L</td>
<td>typ. 2.54</td>
<td>typ. 0.100</td>
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pin 1: Emitter - pin 2: Base - pin 3: Collector
PACKAGES

SOT-32

MINIATURE PACKAGE WITH REVERSED TO-220 PINOUT

MECHANICAL DATA

DIMENSIONS

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<td>min</td>
<td>max</td>
<td>min</td>
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<tr>
<td>A</td>
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<td>B</td>
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<td>10.8</td>
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<tr>
<td>C</td>
<td>2.4</td>
<td>2.7</td>
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<tr>
<td>D</td>
<td>0.7</td>
<td>0.9</td>
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<tr>
<td>E</td>
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<td>2.2 typ.</td>
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<td>F</td>
<td>0.49</td>
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<td>15.7 typ.</td>
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<tr>
<td>M</td>
<td>1.2 typ.</td>
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<td>3.8 typ.</td>
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<tr>
<td>P</td>
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*: WITHIN THIS REGION THE CROSS-SECTION OF THE LEADS IS UNCONTROLLED

pin 1: Emitter - pin 2: Collector - pin 3: Base
MECHANICAL DATA

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<td>0.93 - 1.04</td>
<td>0.036 - 0.041</td>
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<td>B</td>
<td>2.8 - 3</td>
<td>0.110 - 0.118</td>
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<tr>
<td>C</td>
<td>1.2 - 1.4</td>
<td>0.047 - 0.055</td>
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<td>D</td>
<td>2.1 - 2.5</td>
<td>0.082 - 0.098</td>
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<tr>
<td>E</td>
<td>1.9 - 2.05</td>
<td>0.074 - 0.080</td>
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<tr>
<td>F</td>
<td>0.95 - 1.05</td>
<td>0.037 - 0.041</td>
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<td>0.45 - 0.60</td>
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<td>0.15</td>
<td>— - 0.006</td>
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<td>0.065 - 0.115</td>
<td>0.003 - 0.004</td>
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<tr>
<td>M</td>
<td>0.013 - 0.1</td>
<td>0.0005 - 0.004</td>
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<tr>
<td>N</td>
<td>0.06</td>
<td>— - 0.003</td>
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<tr>
<td>P</td>
<td>0.45 - 0.6</td>
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<tr>
<td>R</td>
<td>0.37 - 0.46</td>
<td>0.014 - 0.018</td>
</tr>
</tbody>
</table>

pin 1: Emitter - pin 2: Base - pin 3: Collector
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2730 HERLEV
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