# TRANSISTORS, HIGH POWER, NPN

# BASED ON TYPE 2N5539

# ESCC Detail Specification No. 5203/032

**ISSUE 1**

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# ESA/SCC Detail Specification No. 5203/032

space components
coordination group

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## DOCUMENTATION CHANGE NOTICE

| Rev. Letter | Rev. Date | Reference | CHANGE Item | Approved DCR No. |
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| 'A' | Feb. '92 | P1. Cover page | | None |
| | | P2. DCN | | None |
| | | P5. Para. 1.2 | : Paragraph amended | 21021 |
| | | Para. 2 | : "ESA/SCC Basic Spec. No. 23500" added | 21025 |
| | | P11. Para. 4.2.2 | : Bond Strength and Die Shear Test deviations deleted | 23499 |
| | | | : PIND deviation deleted | 21043 |
| | | Para. 4.2.4 | : Bond Strength and Die Shear Test deviations deleted | 23499 |
| | | P17. Table 3 | : Note 1 deleted, subsequent Note renumbered | 21047 |
| | | This document has been transferred from hardcopy to electronic format. The content is unchanged but minor differences in presentation exist. | | |
| 'B' | Aug. '96 | P1. Cover page | | None |
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| | | P3. Table of Contents | : Para. 1.7 entry added | 21083 |
| | | P5. Para. 1.7 | : Paragraph added | 21083 |

## TABLE OF CONTENTS

## 1. GENERAL

### 1.1 SCOPE

This specification details the ratings, physical and electrical characteristics, test and inspection data for a Transistor, High Power, NPN, based on Type 2N5539.

It shall be read in conjunction with ESA/SCC Generic Specification No. 5000, the requirements of which are supplemented herein.

### 1.2 COMPONENT TYPE VARIANTS

See Table 1(a).

### 1.3 MAXIMUM RATINGS

The maximum ratings, which shall not be exceeded at any time during use or storage, applicable to the transistors specified herein, are scheduled in Table 1(b).

### 1.4 PARAMETER DERATING INFORMATION

The derating information applicable to the transistors specified herein is shown in Figures 1(a) and 1(b).

### 1.5 PHYSICAL DIMENSIONS

The physical dimensions of the transistors specified herein are shown in Figure 2.

### 1.6 FUNCTIONAL DIAGRAM

The functional diagram showing lead identification, of the transistors specified herein, is shown in Figure 3.

### 1.7 HANDLING PRECAUTIONS

For tin-lead plated or solder-dipped lead finish, all tests to be performed at a temperature that exceeds +125°C shall be carried out in a 100% inert atmosphere.

## 2. APPLICABLE DOCUMENTS

The following documents form part of this specification and shall be read in conjunction with it:-

(a) ESA/SCC Generic Specification No. 5000 for Discrete Semiconductor Components.

(b) MIL-STD-750, Test Methods and Procedures for Semiconductor Devices.

(c) ESA/SCC Basic Specification No. 23500, Requirements for Lead Materials and Finishes for Components for Space Application.

## TABLE 1(a) - TYPE VARIANTS

| VARIANT | BASED ON TYPE | FIGURE | LEAD MATERIAL AND FINISH |
|---|---|---|---|
| 01 | 2N5539 | 2 | D2 |
| 02 | 2N5539 | 2 | D3 or D4 |

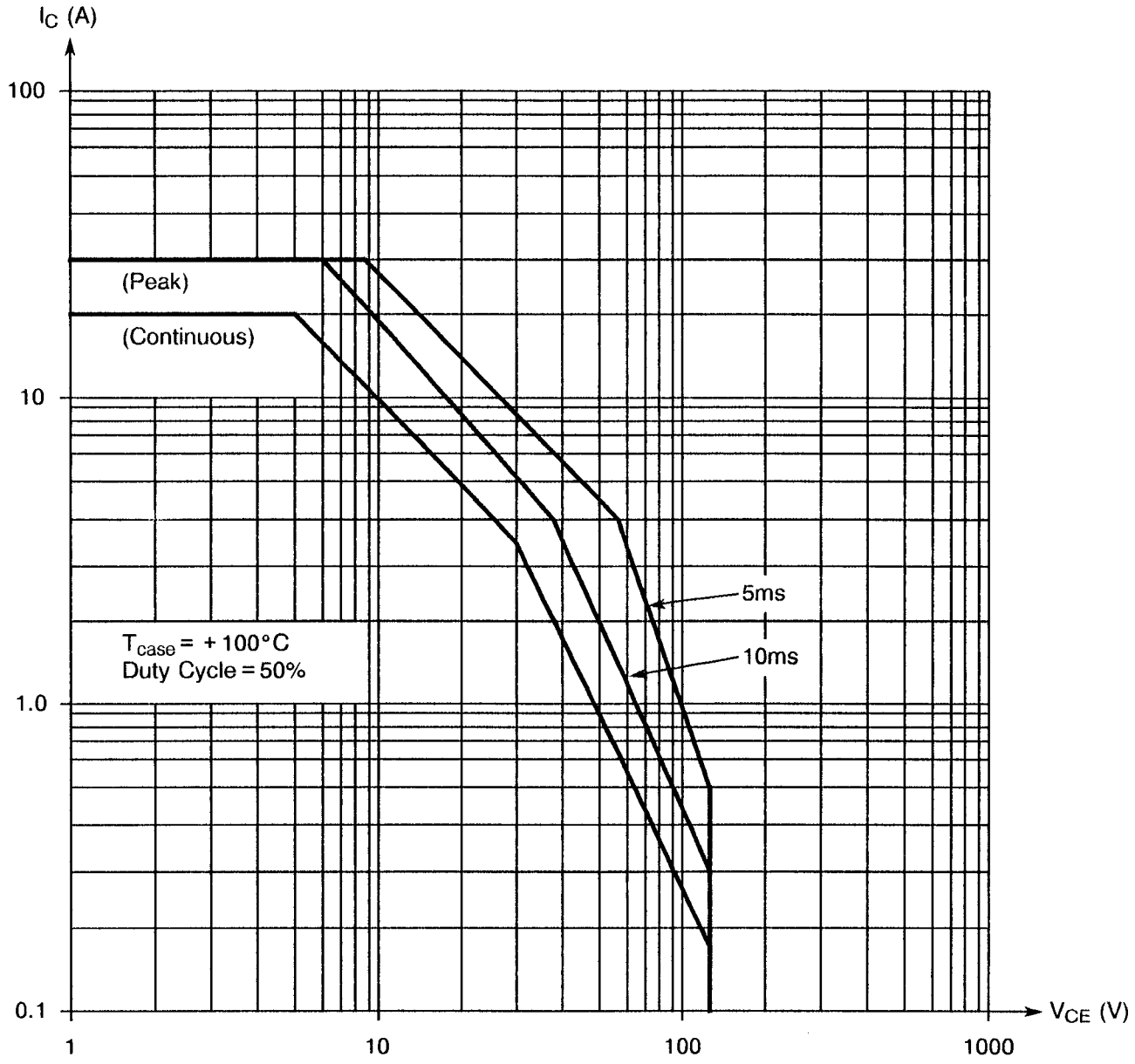
## TABLE 1(b) - MAXIMUM RATINGS

| No. | CHARACTERISTICS | SYMBOL | MAXIMUM RATINGS | UNIT | REMARKS |
|---|---|---|---|---|---|
| 1 | Collector - Base Voltage | $V_{CBO}$ | 175 | V | |
| 2 | Collector - Emitter Voltage | $V_{CEO}$ | 130 | V | Note 1 |
| 3 | Emitter - Base Voltage | $V_{EBO}$ | 7.0 | V | |
| 4 | Collector Current (Continuous) | $I_C$ | 20 | A | |
| 5 | Collector Current (Peak) | $I_C$ | 30 | Apk | |
| 6 | Power Dissipation | $P_{tot}$ | 175 | W | Note 2 |
| 7 | Operating Temperature Range | $T_{op}$ | −65 to +200 | °C | $T_{amb}$ |
| 8 | Storage Temperature Range | $T_{stg}$ | −65 to +200 | °C | |
| 9 | Soldering Temperature | $T_{sol}$ | +300 | °C | Time: ≤10s<br>Distance from case ≥1.5mm |
| 10 | Thermal Resistance (Junction to Case) | $R_{TH(J-C)}$ | 1.0 | °C/W | |

**NOTES**

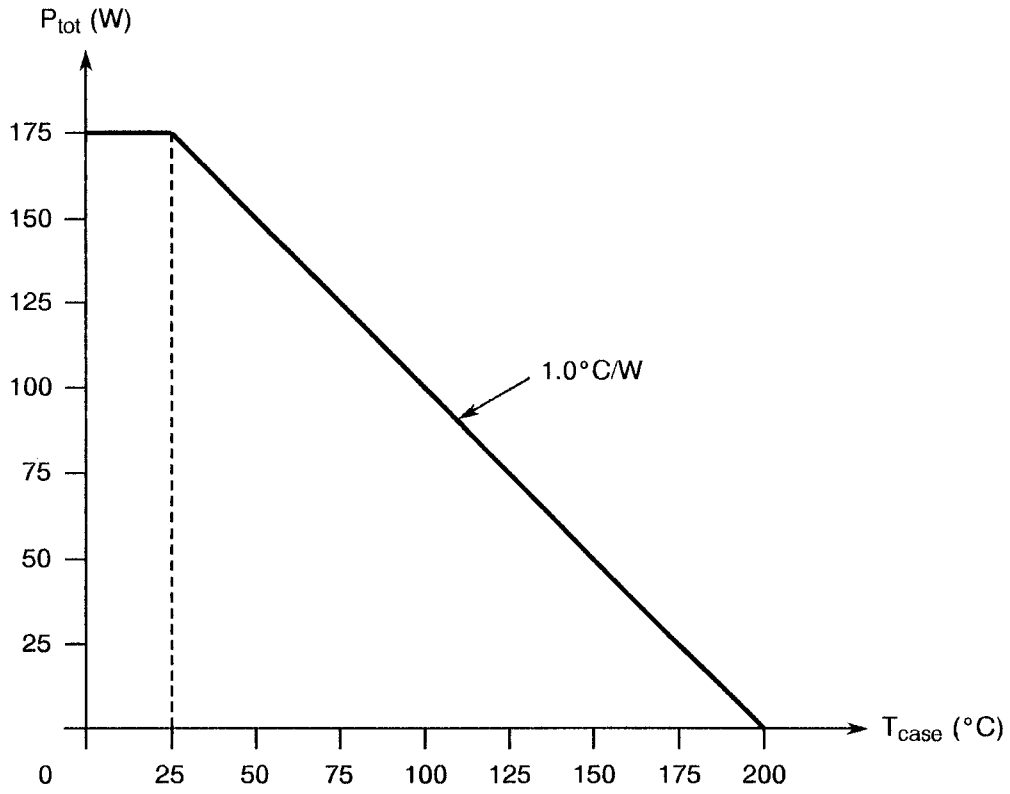
1. For derating of $V_{CE}$ to $V_{CEO}$ Max., see Figure 1(b).
2. At $T_{case} \leq +25°C$. For derating at $T_{case} > +25°C$, see Figure 1(b).

## FIGURE 1 - PARAMETER DERATING INFORMATION



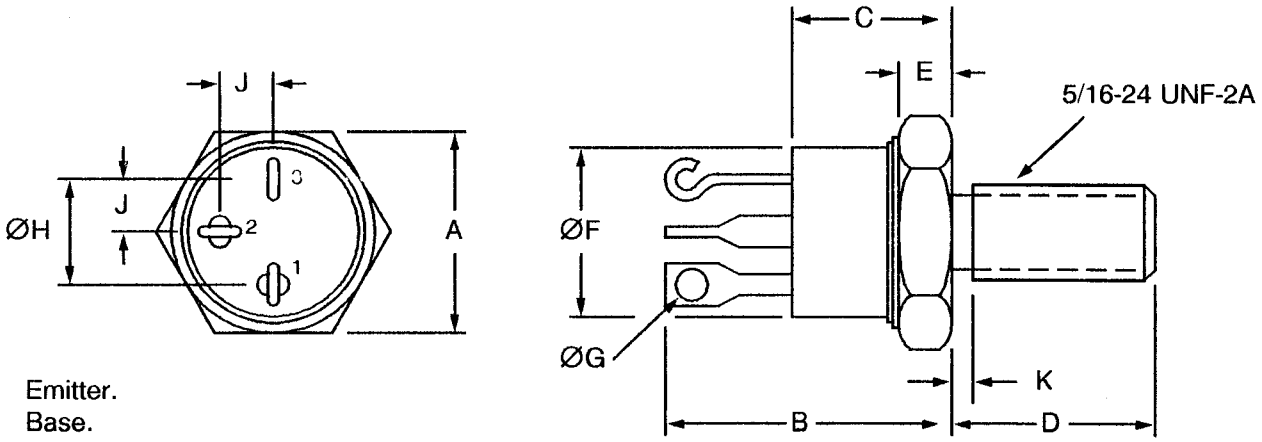

Collector Current versus Collector-Emitter Voltage

**FIGURE 1 - PARAMETER DERATING INFORMATION (CONTINUED)**




Power Dissipation versus Temperature

## FIGURE 2 - PHYSICAL DIMENSIONS



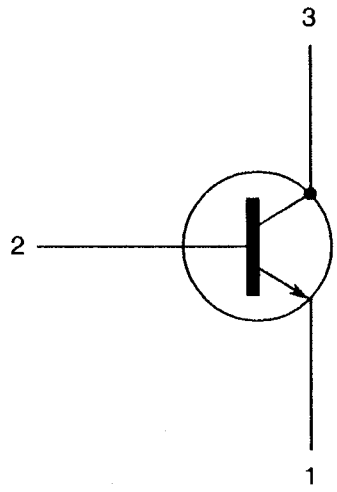

1. Emitter.
2. Base.
3. Collector.

| SYMBOL | MILLIMETRES | | INCHES (NOTE 3) | | NOTES |
|---|---|---|---|---|---|
| | MIN. | MAX. | MIN. | MAX. | |
| A | 21.97 | 22.23 | 0.865 | 0.875 | |
| B | 24.77 | 26.16 | 0.975 | 1.030 | |
| C | 12.70 | 13.59 | 0.500 | 0.535 | |
| D | 11.94 | 12.45 | 0.470 | 0.490 | |
| E | 3.18 | 3.43 | 0.125 | 0.135 | 1 |
| ØF | 19.05 | 19.43 | 0.750 | 0.765 | |
| ØG | 1.52 | 2.67 | 0.060 | 0.105 | |
| ØH | 12.45 | 12.95 | 0.490 | 0.510 | 2 |
| J | 6.22 | 6.48 | 0.245 | 0.255 | 2 |
| K | - | 2.54 | - | 0.100 | |

**NOTES**

1. Chamfer or undercut on one or both ends of hexagonal portion is optional.
2. Position of leads in relation to the hexagon is not controlled.
3. Imperial equivalents (to the nearest 0.001 inch) are given for general information only and are based on 25.4mm = 1.0 inch.

## FIGURE 3 - FUNCTIONAL DIAGRAM




1. Emitter.
2. Base.
3. Collector.

**NOTES**

1. The package is electrically connected to the collector.

## 3. TERMS, DEFINITIONS, ABBREVIATIONS, SYMBOLS AND UNITS

For the purpose of this specification, the terms, definitions, abbreviations, symbols and units specified in ESA/SCC Basic Specification No. 21300 shall apply.

## 4. REQUIREMENTS

### 4.1 GENERAL

The complete requirements for procurement of the transistors specified herein are stated in this specification and ESA/SCC Generic Specification No. 5000. Deviations from the Generic Specification, applicable to this specification only, are listed in Para. 4.2.

Deviations from the applicable Generic Specification and this Detail Specification, formally agreed with specific Manufacturers on the basis that the alternative requirements are equivalent to the ESA/SCC requirements and do not affect the components' reliability, are listed in the appendices attached to this specification.

### 4.2 DEVIATIONS FROM GENERIC SPECIFICATION

#### 4.2.1 Deviations from Special In-process Controls

None.

#### 4.2.2 Deviations from Final Production Tests (Chart II)

None.

#### 4.2.3 Deviations from Burn-in and Electrical Measurements (Chart III)

(a) Para. 9.12, Radiographic Inspection: Shall not be performed if aluminium bond wires are used.

#### 4.2.4 Deviations from Qualification Tests (Chart IV)

None.

4.2.5 Deviations from Lot Acceptance Tests (Chart V)

None.

4.3 MECHANICAL REQUIREMENTS

4.3.1 Dimension Check

The dimensions of the transistors specified herein shall be checked. They shall conform to those shown in Figure 2.

4.3.2 Weight

The maximum weight of the transistors specified herein shall be 28.5 grammes.

4.3.3 Terminal Strength

The requirements for terminal strength testing are specified in Section 9 of ESA/SCC Generic Specification No. 5000. The test conditions shall be as follows:-

Test Condition: 'A' (Tension).
Applied Force: 20N.
Duration: 10 seconds.

4.4 MATERIALS AND FINISHES

The materials and finishes shall be as specified herein. Where a definite material is not specified, a material which will enable the transistors specified herein to meet the performance requirements of this specification shall be used. Acceptance or approval of any constituent material does not guarantee acceptance of the finished product.

4.4.1 Case

Metal case shall be hermetically sealed and have a metal body with hard glass seals and the lid shall be welded, brazed or preform soldered.

4.4.2 Lead Material and Finish

The lead material shall be Type 'D' with either Type '2' or Type '3 or 4' finish in accordance with the requirements of ESA/SCC Basic Specification No. 23500. (See Table 1(a) for Type Variants).

4.5 MARKING

4.5.1 General

The marking of all components delivered to this specification shall be in accordance with the requirements of ESA/SCC Basic Specification No. 21700. Each component shall be marked in respect of:-

(a) Lead Identification.

(b) The SCC Component Number.

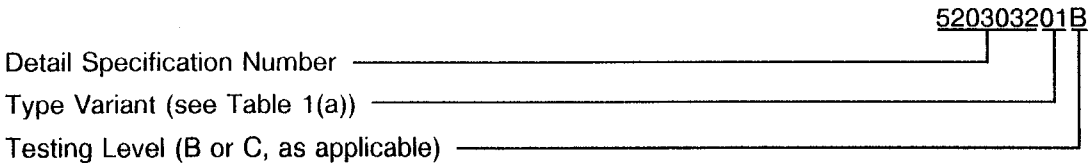
(c) Traceability Information.

4.5.2 Lead Identification

Lead identification shall be as shown in Figures 2 and 3.

4.5.3 The SCC Component Number

Each component shall bear the SCC Component Number which shall be constituted and marked as follows:-




4.5.4 Traceability Information

Each component shall be marked in respect of traceability information in accordance with the requirements of ESA/SCC Basic Specification No. 21700.

4.5.5 Marking of Small Components

When it is considered that the component is too small to accommodate the marking as specified above, as much as space permits shall be marked. The order of precedence shall be as follows:-

(a) Lead Identification.

(b) The SCC Component Number.

(c) Traceability Information.

The marking information in full shall accompany each component in its primary package.

4.6 ELECTRICAL MEASUREMENTS

4.6.1 Electrical Measurements at Room Temperature

The parameters to be measured at room temperature are scheduled in Table 2. Unless otherwise specified, measurements shall be performed at $T_{amb} = +22 \pm 3$ °C.

4.6.2 Electrical Measurements at High and Low Temperatures

The parameters to be measured at high and low temperatures are scheduled in Table 3. The measurements shall be performed at $T_{amb} = -55(+5-0)$ and $+150(+0-5)$ °C respectively.

4.6.3 Circuits for Electrical Measurements

A circuit for use in performing the electrical measurements listed in Table 2 is shown in Figure 4 of this specification.

4.7 BURN-IN TESTS

4.7.1 Parameter Drift Values

The parameter drift values applicable to burn-in are specified in Table 4 of this specification. Unless otherwise stated, measurements shall be performed at $T_{amb} = +22 \pm 3$ °C. The parameter drift values ($\Delta$) applicable to the parameters scheduled shall not be exceeded. In addition to these drift value requirements, the appropriate limit value specified for a given parameter in Table 2 shall not be exceeded.

4.7.2 Conditions for High Temperature Reverse Bias Burn-in

Not applicable.

4.7.3 Conditions for Power Burn-in

The requirements for power burn-in are specified in Section 7 of ESA/SCC Generic Specification No. 5000. The conditions for power burn-in shall be as specified in Table 5 of this specification.

4.7.4 Electrical Circuits for Power Burn-in

Circuits for use in performing the power burn-in tests are shown in Figure 5 of this specification.

## TABLE 2 - ELECTRICAL MEASUREMENTS AT ROOM TEMPERATURE - d.c. PARAMETERS

| No. | CHARACTERISTICS | SYMBOL | MIL-STD-750 TEST METHOD | TEST CONDITIONS | LIMITS | | UNIT |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| 1 | Collector-Base Breakdown Voltage | $V_{(BR)CBO}$ | 3001 | $I_C = 200\mu A$<br>$I_E = 0\mu A$ | 175 | - | V |
| 2 | Collector-Emitter Breakdown Voltage | $V_{(BR)CES}$ | 3011 | $I_C = 100mA$<br>$V_{BE} = 0V$<br>Note 1 | 130 | - | V |
| 3 | Emitter-Base Breakdown Voltage | $V_{(BR)EBO}$ | 3026 | $I_E = 200\mu A$<br>$I_C = 0A$ | 7.0 | - | V |
| 4 | Collector-Emitter Cut-off Current | $I_{CEO}$ | 3041 | $V_{CE} = 100V$<br>$I_B = 0A$ | - | 1.0 | mA |
| 5 | Collector-Base Cut-off Current | $I_{CBO}$ | 3036 | $V_{CB} = 100V$<br>$I_E = 0A$ | - | 0.5 | µA |
| 6 | Emitter-Base Cut-off Current | $I_{EBO}$ | 3061 | $V_{EB} = 4.0V$<br>$I_C = 0A$ | - | 0.5 | µA |
| 7 | D.C. Forward Current Transfer Ratio | $h_{FE1}$ | 3076 | $I_C = 5.0A$<br>$V_{CE} = 5.0V$ | 30 | 120 | - |
| | | $h_{FE2}$ | | $I_C = 10A$<br>$V_{CE} = 5.0V$<br>Note 1 | 25 | 75 | |
| | | $h_{FE3}$ | | $I_C = 15A$<br>$V_{CE} = 5.0V$<br>Note 1 | 15 | 60 | |
| 8 | Collector-Emitter Saturation Voltage | $V_{CE(sat)1}$ | 3071 | $I_C = 10A$<br>$I_B = 1.0A$<br>Note 1 | - | 0.5 | V |
| | | $V_{CE(sat)2}$ | | $I_C = 20A$<br>$I_B = 2.0A$<br>Note 1 | - | 3.0 | |
| 9 | Base-Emitter Saturation Voltage | $V_{BE(sat)}$ | 3066 | $I_C = 10A$<br>$I_B = 1.0A$<br>Note 1 | - | 1.5 | V |

**NOTES:** See Page 16.

## TABLE 2 - ELECTRICAL MEASUREMENTS AT ROOM TEMPERATURE - d.c. PARAMETERS (CONT'D)

| No. | CHARACTERISTICS | SYMBOL | MIL-STD-750 TEST METHOD | TEST CONDITIONS | LIMITS | | UNIT |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| 10 | Secondary Breakdown Voltage | $I_{SB}$ | - | t = 1.0 min<br>$T_{case}$ = + 100°C<br>$V_{CE}$ = 5.0V<br>$V_{CE}$ = 30V<br>$V_{CE}$ = 130V<br>Note 2 | <br><br>20<br>3.5<br>0.18 | <br><br>-<br>-<br>- | A |

**NOTES**

1. Pulse measurement: Pulse Length ≤ 300µs, Duty Cycle ≤ 2.0%.
2. The criteria for passing the $I_{SB}$ test is that no measurable variation (higher than measurement equipment accuracy) is observed between the $I_{CBO}$ values measured before and after the $I_{SB}$ test.

   The $I_{SB}$ test shall be performed only once immediately after the final production tests and prior to burn-in and electrical measurements.

## TABLE 2 - ELECTRICAL MEASUREMENTS AT ROOM TEMPERATURE - a.c. PARAMETERS

| No. | CHARACTERISTICS | SYMBOL | MIL-STD-750 TEST METHOD | TEST FIG. | TEST CONDITIONS (NOTE 1) | LIMITS | | UNIT |
|---|---|---|---|---|---|---|---|---|
| | | | | | | MIN | MAX | |
| 11 | Turn-on Time | $t_{on}$ | - | 4 | $I_C$ = 10A<br>$I_{B1}$ = $I_{B2}$ = 1.0A<br>$V_{CC}$ = 20V | - | 0.5 | µs |
| | Storage Time | $t_{st}$ | | | | - | 1.5 | |
| | Fall Time | $t_{fall}$ | | | | - | 0.5 | |

**NOTES**

1. Shall be performed on a sample basis, LTPD7 or less.

## TABLE 3 - ELECTRICAL MEASUREMENTS AT HIGH AND LOW TEMPERATURES

| No. | CHARACTERISTICS | SYMBOL | MIL-STD-750 TEST METHOD | TEST CONDITIONS | LIMITS | | UNIT |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| 5 | Collector-Base Cut-off Current | $I_{CBO}$ | 3036 | $T_{amb}$ = +150°C<br>$V_{CE}$ = 100V<br>$I_E$ = 0A | - | 200 | µA |
| 8 | D.C. Forward Current Transfer Ratio 2 | $h_{FE2}$ | 3076 | $T_{amb}$ = −55°C<br>$I_C$ = 10A<br>$V_{CE}$ = 5.0V<br>Note 1 | 15 | 60 | - |

**NOTES**

1. Pulsed measurement: Pulse Width ≤300µs, Duty Cycle ≤2.0%.

## TABLE 4 - PARAMETER DRIFT VALUES

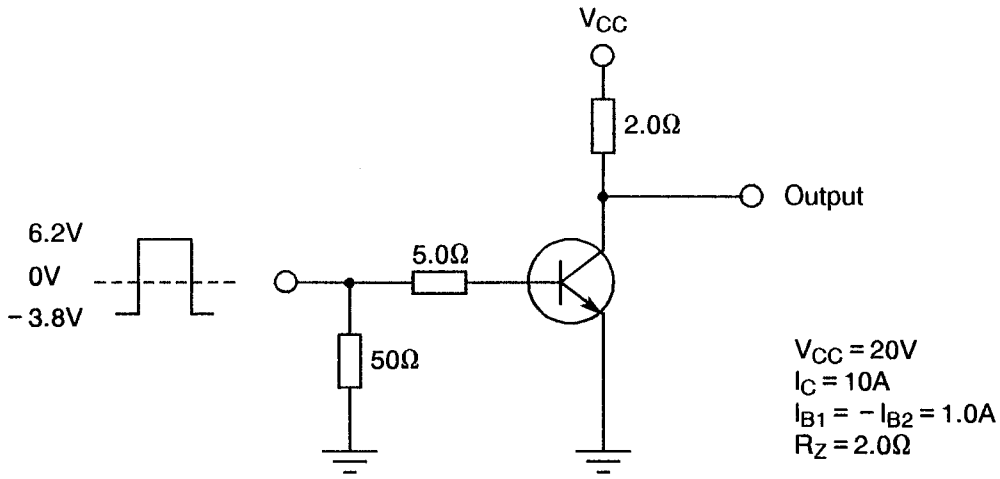
| No. | CHARACTERISTICS | SYMBOL | SPEC. AND/OR TEST METHOD | TEST CONDITIONS | CHANGE LIMITS (Δ) | UNIT |
|---|---|---|---|---|---|---|
| 5 | Collector-Base Cut-off Current | $I_{CBO}$ | As per Table 2 | As per Table 2 | ±50<br>or (1)<br>±100 | nA<br><br>% |
| 7 | D.C. Forward Current Transfer Ratio 1 | $h_{FE1}$ | As per Table 2 | As per Table 2 | +20 −10 | % |
| 8 | Collector-Emitter Saturation Voltage 1 | $V_{CE(sat)1}$ | As per Table 2 | As per Table 2 | +40 | mV |

**NOTES**

1. Whichever is greater, referred to the initial value.

## FIGURE 4 - CIRCUITS FOR ELECTRICAL MEASUREMENTS

SWITCHING TIMES



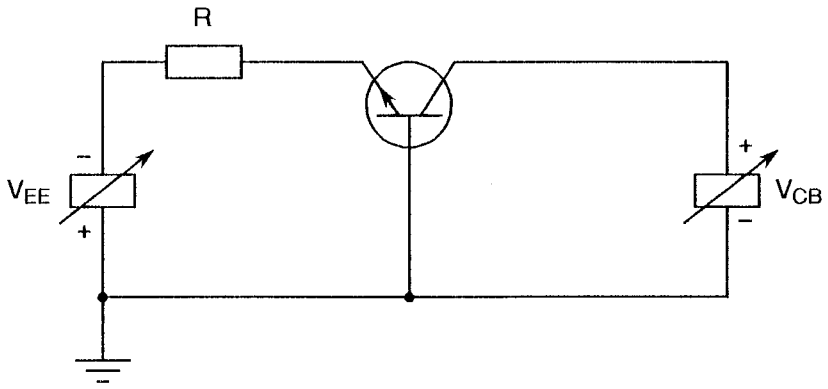

**NOTES**

1. $V_{IN}$ adjusted to $I_{B1}$ and $I_{B2}$ using current probe.

## TABLE 5 - CONDITIONS FOR POWER BURN-IN AND OPERATING LIFE TESTS

| No. | CHARACTERISTICS | SYMBOL | CONDITIONS | UNIT |
|---|---|---|---|---|
| 1 | Case Temperature | $T_{case}$ | +100(+0−3) | °C |
| 2 | Collector-Base Voltage | $V_{CB}$ | 20 | V |
| 3 | Power Dissipation | $P_{tot}$ | 100 | W |

## FIGURE 5 - ELECTRICAL CIRCUIT FOR POWER BURN-IN AND OPERATING LIFE TESTS



4.8 ENVIRONMENTAL AND ENDURANCE TESTS (CHARTS IV AND V OF ESA/SCC GENERIC SPECIFICATION NO. 5000)

4.8.1 Electrical Measurements on Completion of Environmental Tests

The parameters to be measured on completion of environmental tests are scheduled in Table 2. Unless otherwise stated, the measurements shall be performed at $T_{amb} = +22 \pm 3$ °C.

4.8.2 Electrical Measurements at Intermediate Points and on Completion of Endurance Tests

The parameters to be measured at intermediate points and on completion of endurance testing are scheduled in Table 6 of this specification. Unless otherwise stated, the measurements shall be performed at $T_{amb} = +22 \pm 3$ °C.

4.8.3 Conditions for Operating Life Tests (Part of Endurance Testing)

The requirements for operating life testing are specified in Section 9 of ESA/SCC Generic Specification No. 5000. The conditions for operating life testing shall be the same as specified in Table 5 for the burn-in test.

4.8.4 Electrical Circuits for Operating Life Tests

The circuit to be used for performing the operating life test shall be the same as that shown in Figure 5 for burn-in.

4.8.5 Conditions for High Temperature Storage Test (Part of Endurance Testing)

The requirements for the high temperature storage test are specified in ESA/SCC Generic Specification No. 5000. The temperature to be applied shall be the maximum storage temperature specified in Table 1(b) of this specification.

**TABLE 6 - ELECTRICAL MEASUREMENTS AT INTERMEDIATE POINTS AND ON COMPLETION OF ENDURANCE TESTING**

| No. | CHARACTERISTICS | SYMBOL | SPEC. AND/OR TEST METHOD | TEST CONDITIONS | LIMITS | | UNIT |
|---|---|---|---|---|---|---|---|
| | | | | | MIN. | MAX. | |
| 5 | Collector-Base Cut-off Current | $I_{CBO}$ | As per Table 2 | As per Table 2 | - | 0.5 | µA |
| 7 | D.C. Forward Current Transfer Ratio 1 | $h_{FE1}$ | As per Table 2 | As per Table 2 | 30 | 120 | - |
| 8 | Collector-Emitter Saturation Voltage 1 | $V_{CE(sat)1}$ | As per Table 2 | As per Table 2 | - | 0.5 | V |