TRANSISTORS, HIGH POWER, NPN

BASED ON TYPE 2N3999

ESCC Detail Specification No. 5203/033

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BASED ON TYPE 2N3999

ESA/SCC Detail Specification No. 5203/033

space components
coordination group

Issue/Rev.	Date	Approved by	
		SCCG Chairman	ESA Director General or his Deputy
Issue 1	September 1982	-	-
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DOCUMENTATION CHANGE NOTICE

Rev. Letter	Rev. Date	CHANGE Reference / Item	Approved DCR No.
		This Issue incorporates all modifications agreed on the basis of Policy DCR No. 21022 for adaptation to new ESA/SCC Generic Specification Issue 4 April 1982 requirements.	
'A'	Feb. '92	P1. Cover page	None
		P2. DCN	None
		P6. Table 1(a) : "Lead Material and/or Finish" column added	21025
		P9. Para. 2 : MIL-STD-1276B deleted, "ESA/SCC Basic Spec. No. 23500" added	21025
		Para. 4.2.2 : Bond Strength and Die Shear Test deviations deleted	23499
		: PIND deviation deleted	21043
		Para. 4.2.3 : Radiographic Inspection deviation deleted	21049
		Para. 4.2.4 : Bond Strength and Die Shear Test deviations deleted	23499
		P11. Para. 4.4.2 : Paragraph amended	21025
		P16. Table 3 : Sampling Note deleted	21047
		This document has been transferred from hardcopy to electronic format. The content is unchanged but minor differences in presentation exist.	

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 2N3999.

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 Figure 1.

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.

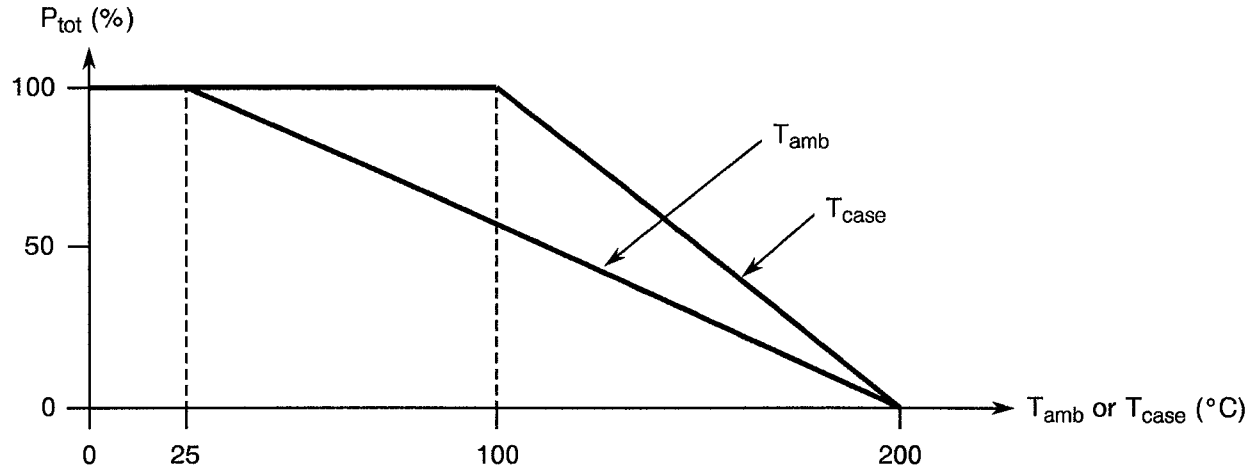
TABLE 1(a) - TYPE VARIANTS

VARIANT	BASED ON TYPE	LEAD MATERIAL AND FINISH
01	2N3999	D2

TABLE 1(b) - MAXIMUM RATINGS

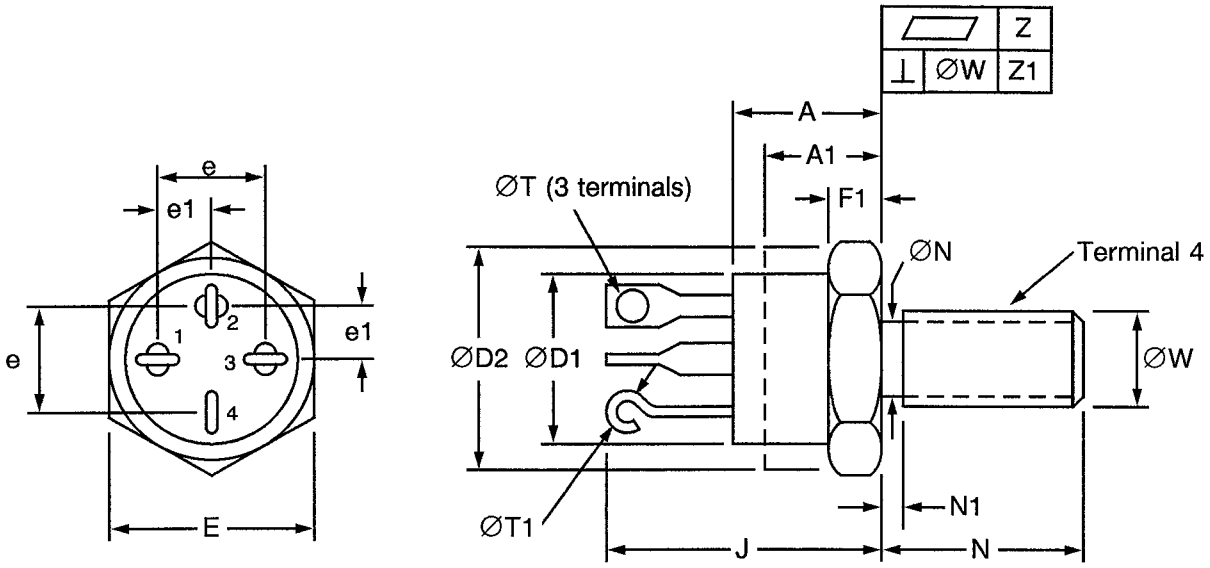
No.	CHARACTERISTICS	SYMBOL	MAXIMUM RATINGS	UNIT	REMARKS
1	Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	100	V	
2	Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	80	V	
3	Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$	8.0	V	
4	Collector Current	I_C	5.0	A	
5	Power Dissipation	P_{tot}	2.0	W	T_{amb} = +25°C
6	Operating Temperature Range	T_{op}	−65 to +200	°C	T_{amb}
7	Storage Temperature Range	T_{stg}	−65 to +200	°C	
8	Soldering Temperature	T_{sol}	+235	°C	Time: ≤10s Distance from case ≥1.5mm
9	Collector Current (Peak)	I_{CM}	10	A	t_p < 1.0ms Duty Cycle <50%
10	Power Dissipation	P_{tot}	30	W	T_{case} = +100°C

FIGURE 1 - PARAMETER DERATING INFORMATION



Power Dissipation versus Temperature

FIGURE 2 - PHYSICAL DIMENSIONS



Similar to JEDEC TO-61

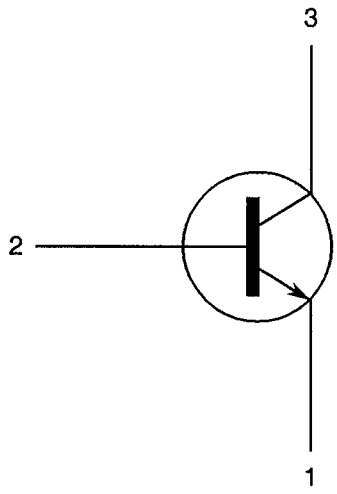
SYMBOL	INCHES		MILLIMETRES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.345	0.400	9.76	10.16	
A1	-	0.250	-	5.35	3
ØD1	0.318	0.380	8.08	9.65	
ØD2	0.370	0.437	7.40	11.10	3
E	0.424	0.437	10.77	11.10	
e	0.180	0.215	4.57	5.46	5
e1	0.080	0.110	2.03	2.79	5
F1	0.090	0.140	2.29	3.56	2, 6
J	0.575	0.675	14.61	17.15	1
ØN	0.155	0.189	3.94	4.80	
N	0.400	0.455	10.16	11.56	
N1	-	0.078	-	1.98	7
ØT	0.040	0.065	1.02	1.65	
ØT1	0.040	0.065	1.02	1.65	4
ØW	0.190-32 UNF-2A				8
Z	-	0.002	-	0.051	
Z1	-	0.006	-	0.152	

FIGURE 2 - PHYSICAL DIMENSIONS (CONTINUED)

NOTES

1. Terminal 1 = emitter, Terminal 2 = base, Terminal 3 = collector, Terminal 4 = case.
2. Chamfer or undercut on one or both ends of hexagonal portion is optional.
3. The outline contour with the exception of the hexagon is optional within cylinder defined by ∅D2 and A1.
4. Terminal 4 can be flattened and pierced or hook type. A visual index is required when the flattened and pierced tab terminal contour (identical to the adjacent terminals) option is used. The case terminal (hook) is mechanically connected to the case. The other three terminals shall be electrically isolated from the case.
5. Angular orientation of terminals with respect to hexagon is optional.
6. F1 dimension does not include sealing flanges.
7. N1 is the length of incomplete or undercut threads.
8. ∅W is the pitch diameter of coated threads.
9. Dimensions are in inches.
10. Metric equivalents are given for general information only and are based on 1.0 inch = 25.4 mm.

FIGURE 3 - FUNCTIONAL DIAGRAM



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

NOTES

1. Package isolated from connections 1, 2 and 3.
2. Terminal 4 is connected to case.

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.

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. 7.1.1, "H.T.R.B.: Shall not be performed".

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 18 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: 'D2' (Stud Torque).
Torque to be applied: 1.7 Nm (15 in./lbs).
Duration: 15 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, hermetically sealed, similar to JEDEC TO-61.

4.4.2 Lead Material and Finish

The lead material shall be Type 'D' with Type '2' 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.

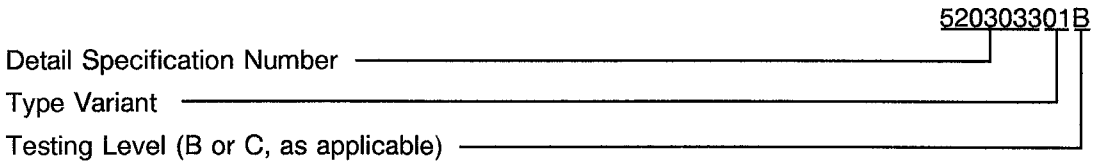
(c) Traceability Information.

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. The 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.

4.6.3 Circuits for Electrical Measurements

Circuits for use in performing the electrical measurements listed in Tables 2 and 3 of this specification are shown in Figure 4.

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 (Δ) 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 Burn-in

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

4.7.5 Electrical Circuits for Burn-in

Circuits for use in performing the 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-Emitter Breakdown Voltage	$V_{(BR)CEO}$	3011	I_C = 50mA I_B = 0A Note 1	80	-	V
2	Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	3001	V_{CC} = 100V I_C = 10µA	100	-	V
3	Collector-Emitter Cut-off Current	I_{CES}	3041	V_{CE} = 80V V_{BE} = 0V	-	200	nA
4	Emitter-Base Cut-off Current	I_{EBO}	3061D	V_{EB} = 5.0V I_C = 0A	-	200	nA
5	D.C. Forward Current Transfer Ratio	h_{FE1}	3076	I_C = 50mA V_{CE} = 2.0V Note 1	60	-	-
		h_{FE2}		I_C = 1.0A V_{CE} = 2.0V Note 1	80	240	
		h_{FE3}		I_C = 5.0A V_{CE} = 5.0V Note 1	20	-	
6	Collector Saturation Voltage	V_{CEsat}	3071	I_C = 1.0A I_B = 0.1A Note 1	-	0.25	V
7	Collector Saturation Voltage	V_{CEsat}	3071	I_C = 5.0A I_B = 0.5A Note 1	-	2.0	V
8	Base Saturation Voltage	V_{BEsat}	3066	I_C = 5.0A I_B = 0.5A Note 1	-	1.6	V
9	Base Saturation Voltage	V_{BEsat}	3066	I_C = 1.0A I_B = 0.1A Note 1	-	1.2	V

NOTES

1. Pulse measurements: Pulse Length ≤ 300µs, Duty Cycle ≤ 2.0%.

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

No.	CHARACTERISTICS	SYMBOL	MIL-STD-750 TEST METHOD	TEST FIG.	TEST CONDITIONS (NOTE 2)	LIMITS		UNIT
						MIN	MAX	
1	A.C. Forward Current Transfer Ratio	h_{fe}	3306	-	$I_C = 1.0A$ $V_{CE} = 5.0V$ $f = 10MHz$	3.0	12	-
2	Output Capacitance	C_{obo}	3236	-	$V_{CB} = 10V$ $I_E = 0A$ $f = 1.0MHz$	-	150	pF
3	Delay Time	t_d	-	4	-	-	100	ns
	Pulse Rise Time	t_r				-	240	ns
	Pulse Storage Time	t_s				-	1.75	µs
	Pulse Fall Time	t_f				-	0.3	µs
	Turn-on Time $(t_d + t_r)$	t_{ON}				-	0.3	µs
	Turn-off Time $(t_s + t_f)$	t_{OFF}				-	2.0	µs

NOTES

1. Pulsed measurement: Pulse Width ≤300µs, Duty Cycle ≤2.0%.
2. Shall be performed on a sample basis, LTPD7.

TABLE 3 - ELECTRICAL MEASUREMENTS AT HIGH AND LOW TEMPERATURES

No.	CHARACTERISTICS	SYMBOL	MIL-STD-750 TEST METHOD	TEST CONDITIONS	LIMITS		UNIT
					MIN	MAX	
1	Collector-Emitter Cut-off Current	I_{CES}	3041	T_{case} = +150°C V_{CE} = 80V V_{BE} = 0V	-	50	µA
2	D.C. Forward Current Transfer Ratio	h_{FE}	3076	T_{case} = −55°C I_C = 1.0A V_{CE} = 2.0V Note 1	20	-	-

NOTES

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

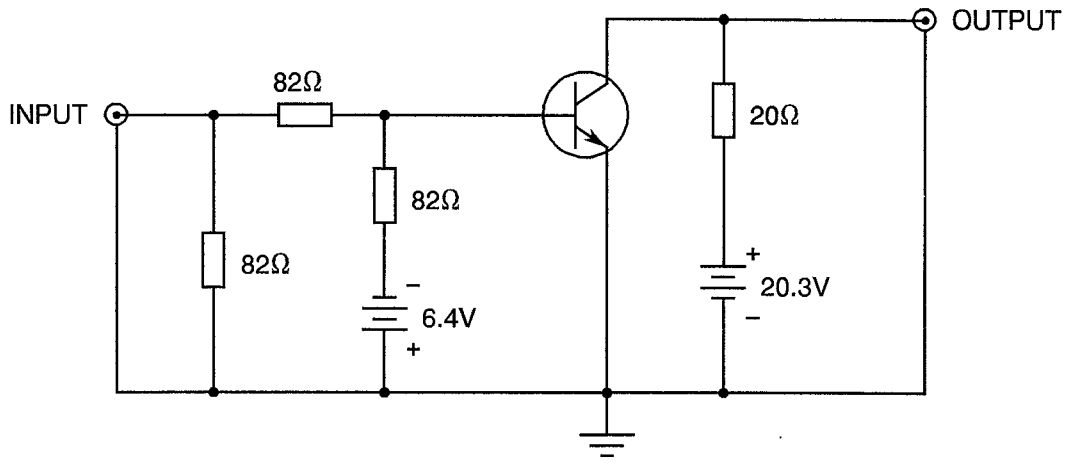
TABLE 4 - PARAMETER DRIFT VALUES

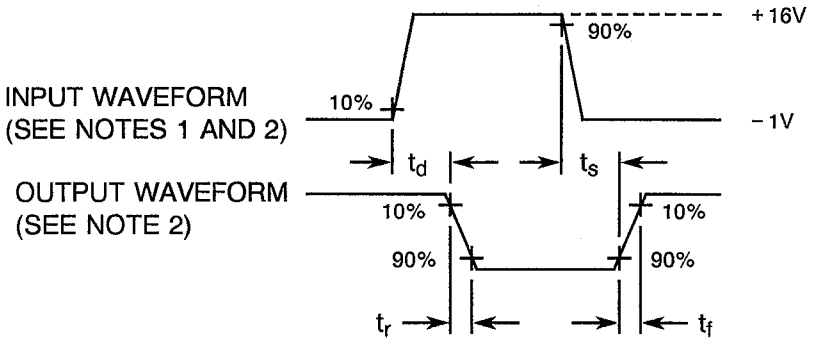
No.	CHARACTERISTICS	SYMBOL	MIL-STD-750 TEST METHOD	TEST CONDITIONS	CHANGE LIMITS (Δ)	UNIT
1	Emitter-Base Cut-off Current	I_{EBO}	3061D	V_{EB} = 5.0V I_C = 0A	±200 or ±100	nA %
2	Collector-Emitter Cut-off Current	I_{CES}	3041	V_{CE} = 80V V_{BE} = 0V	±100 or ±100	nA %
3	D.C. Forward Current Transfer Ratio	h_{FE}	3076A	V_{CE} = 2.0V I_C = 1.0A Note 1	±20	%
4	Collector Saturation Voltage	V_{CEsat}	3071	I_C = 1.0A I_B = 0.1A Note 1	±50	%

NOTES

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

FIGURE 4 - TEST CIRCUIT AND SWITCHING OUTPUT WAVEFORMS





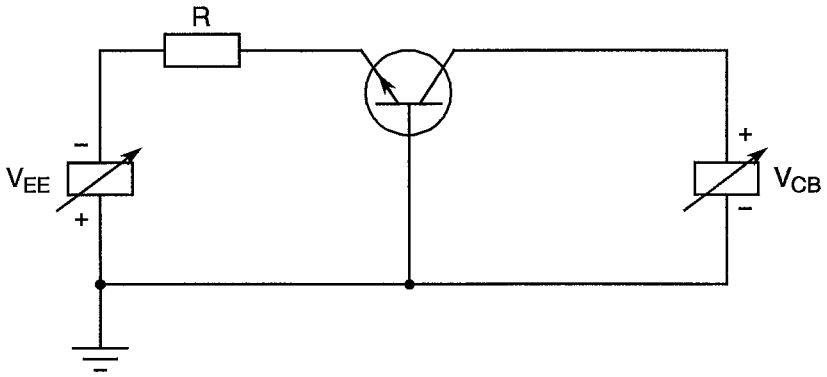
NOTES

1. The input waveform is supplied by a generator with the following characteristics: $t_r \leq 15ns$, $t_f \leq 15ns$, $Z_{out} = 50\Omega$, PW = 2.0µs, Duty Cycle ≤ 2.0%.
2. Waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 15ns$, $R_{in} \geq 10M\Omega$, $C_{in} \leq 11.5pF$.
3. Resistors must be non-inductive types.
4. The d.c. power supplies may require additional bypassing in order to minimise ringing.

TABLE 5 - CONDITIONS FOR BURN-IN

No.	CHARACTERISTICS	SYMBOL	CONDITIONS	UNIT
1	Case Temperature	T_{case}	+100	°C
2	Collector-Emitter Voltage	V_{CE}	25 ± 5	V
3	Power Dissipation	P_{tot}	30	W

FIGURE 5 - ELECTRICAL CIRCUIT FOR BURN-IN



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. 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.

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	MIL-STD-750 TEST METHOD	TEST CONDITIONS	LIMITS		UNIT
					MIN.	MAX.	
1	D.C. Forward Current Transfer Ratio	h_{FE}	3076	$I_C = 1.0A$ $V_{CE} = 2.0V$ Note 1	80	240	-
2	Collector-Emitter Saturation Voltage	V_{CEsat}	3071	$I_C = 1.0A$ $I_B = 0.1A$ Note 1	-	0.25	V
3	Collector-Emitter Cut-off Current	I_{CES}	3041	$I_B = 0A$ $V_{CE} = 80V$	-	200	nA

NOTES

1. Pulse measurement: Pulse Length $\leq 300\mu s$, Duty Cycle $\leq 2.0\%$.