



Pages 1 to 20

**TRANSISTORS, HIGH POWER, PNP,
BASED ON TYPE 2N5153
ESCC Detail Specification No. 5204/002**

**ISSUE 2
September 2004**



Document Custodian: European Space Agency - see <https://escies.org>

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DOCUMENTATION CHANGE NOTICE

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DCR No.	CHANGE DESCRIPTION
80	Specification upissued to incorporate technical and editorial changes per DCR.



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APPENDICES (Applicable to specific Manufacturers only)

None.

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1. GENERAL

1.1 SCOPE

This specification details the ratings, physical and electrical characteristics, test and inspection data for a Transistor, High Power, PNP, based on Type 2N5153.

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

1.2 COMPONENT TYPE VARIANTS

Variants of the basic transistors specified herein, which also covered by this specification, are given in 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.

1.7 HIGH TEMPERATURE TEST 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 100% inert atmosphere.

2. APPLICABLE DOCUMENTS

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

- (a) ESCC Generic Specification No. 5000 for Discrete Semiconductors.
- (b) MIL-STD-750, Test Methods and Procedures for Semiconductor Devices.

3. TERMS, DEFINITIONS, ABBREVIATIONS, SYMBOLS AND UNITS

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

TABLE 1(a) - TYPE VARIANTS

VARIANT	BASED ON TYPE	CASE	FIGURE	LEAD MATERIAL AND FINISH
01	2N5153	TO39	2(a)	D2
02	2N5153	TO39	2(a)	D3 or D4
03	2N5153	TO39	2(a)	D7
04	2N5153	TO257	2(b)	H2
05	2N5153	TO257	2(b)	H4
06	2N5153	SMD.5	2(c)	Q14

TABLE 1(b) - MAXIMUM RATINGS

No.	CHARACTERISTIC	SYMBOL	MAXIMUM RATING	UNIT	REMARKS
1	Collector-Base Voltage	V_{CBO}	-100	V	
2	Collector-Emitter Voltage	V_{CEO}	-80	V	
3	Emitter-Base Voltage	V_{EBO}	-5.5	V	
4	Collector Current (Continuous)	I_C	-5	A	
5	Power Dissipation 1 Variants 01 to 03 Variants 04 to 06	P_{tot1}	1 3.3	W	$T_{amb} = +25^{\circ}C$ See Note 1
6	Power Dissipation 2 Variants 01 to 03 Variants 04 to 06	P_{tot2}	10 35	W	$T_{case} = +25^{\circ}C$ See Note 1
7	Operating Temperature Range	T_{op}	-65 to +200	$^{\circ}C$	T_{amb} or T_{case}
8	Storage Temperature Range	T_{stg}	-65 to +200	$^{\circ}C$	
9	Soldering Temperature Variants 01 to 05 Variant 06	T_{sol}	+260 +245	$^{\circ}C$	Notes 2, 3
10	Thermal Resistance (Junction to Case) Variants 01 to 03 Variants 04 to 06	$R_{TH(J-C)}$	17.5 5	$^{\circ}C/W$	

NOTES

- For derating at T_{amb} or $T_{case} > +25^{\circ}C$, see Figure 1.
- For Variants 01 to 05, duration 10 seconds maximum at a distance of not less than 1.5mm from the device body and the same lead shall not be resoldered until 3 minutes have elapsed.
- For Variant 06, duration 5 seconds maximum and the same package shall not be resoldered until 3 minutes have elapsed.

FIGURE 1 - PARAMETER DERATING INFORMATION

FIGURE 1(a) - POWER DISSIPATION VERSUS TEMPERATURE

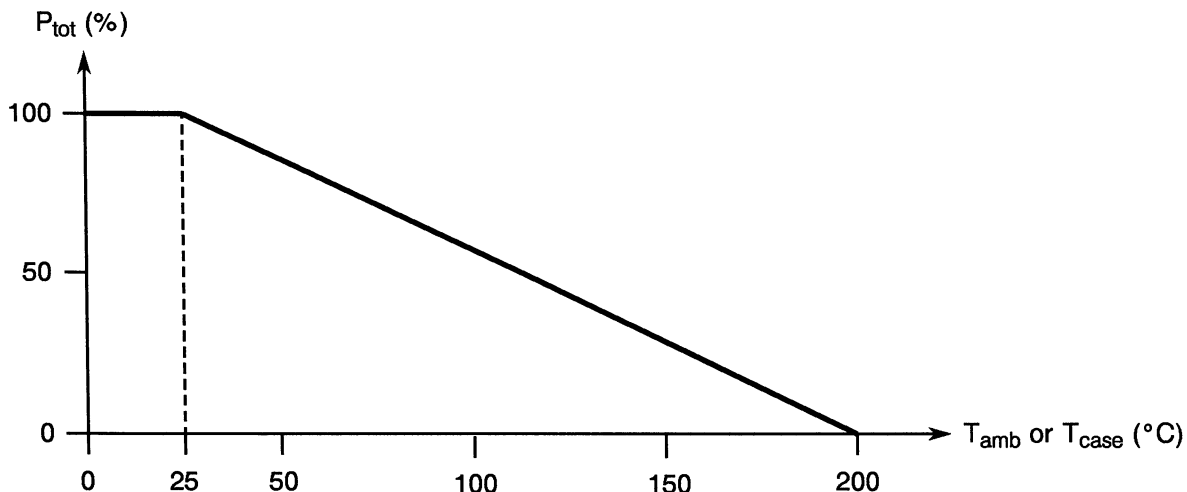
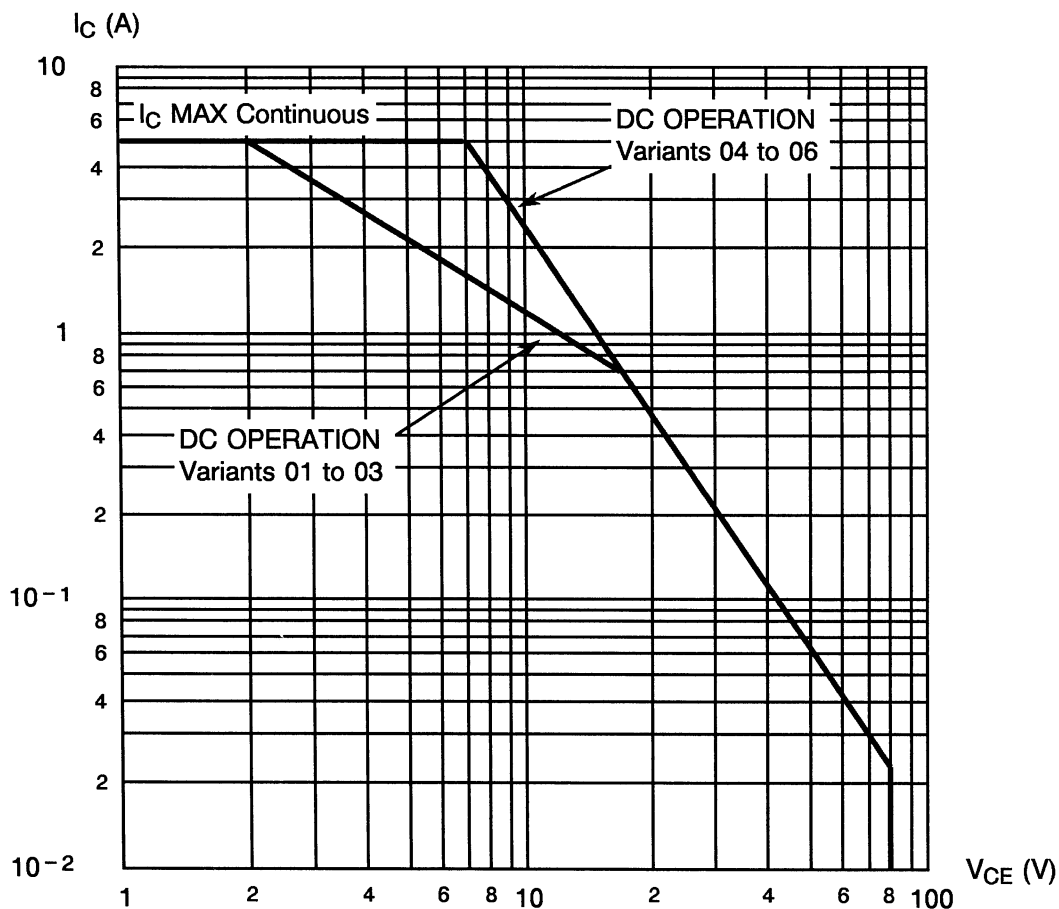


FIGURE 1(b) - FORWARD BIAS SAFE OPERATING AREA (MAXIMUM CONTINUOUS DC)



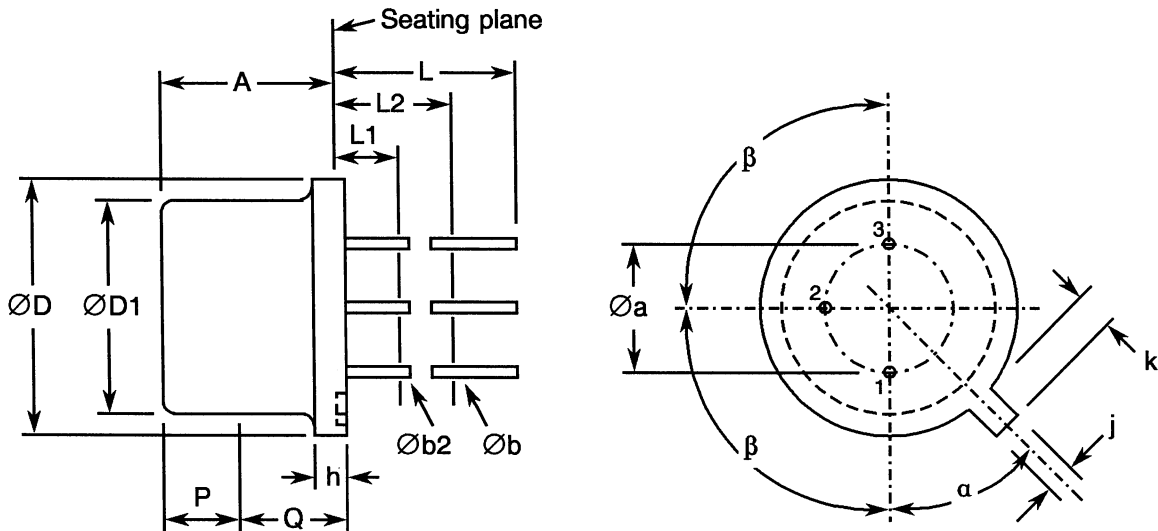
Collector Current versus Collector-Emitter Voltage

NOTES

1. See Para. 4.7.6.

FIGURE 2 - PHYSICAL DIMENSIONS

FIGURE 2(a) - VARIANTS 01 TO 03



SYMBOL	MILLIMETRES		NOTES
	MIN.	MAX.	
$\varnothing a$	4.83	5.33	
A	6.1	6.6	
$\varnothing b$	0.406	0.533	2
$\varnothing b2$	0.406	0.483	2
$\varnothing D$	8.89	9.4	
$\varnothing D1$	8	8.51	
h	0.229	3.18	
j	0.711	0.864	
k	0.737	1.02	3
l	12.7	-	2
l1	-	1.27	2
l2	6.35	-	2
P	2.54	-	1
Q	-	-	4
α	45° NOMINAL		
β	90° NOMINAL		

NOTES

1. This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed 0.254mm.
2. (Three leads) $\varnothing b2$ applies between $l1$ and $l2$. $\varnothing b$ applies between $l2$ and 12.7mm from seating plane. Diameter is uncontrolled in $l1$ and beyond 12.7mm from seating plane.
3. Measured from maximum diameter of the actual device.
4. Details of outline in this zone optional.

FIGURE 2 - PHYSICAL DIMENSIONS (CONT.)

FIGURE 2(b) - VARIANTS 04 AND 05

SYMBOL	MILLIMETRES	
	MIN.	MAX.
A	10.41	10.67
B	10.41	10.67
C	16.51	16.76
D	4.7	5.33
E	0.89	1.14
∅F	3.56	3.81
G	13.39	13.64
H	5.13	5.38
I	0.64	0.89
J	2.92	3.18
K	2.41	2.67
L	15.24	16.51
M	2.29 Typical	
N	-	0.71
R	1.65 Typical	

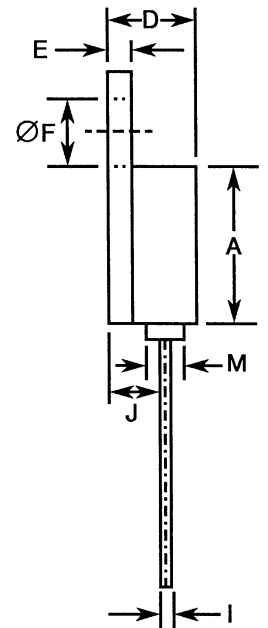
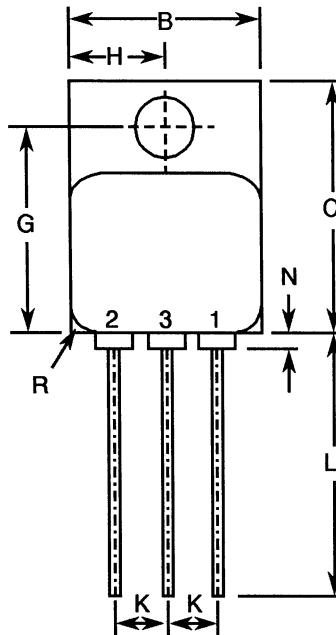
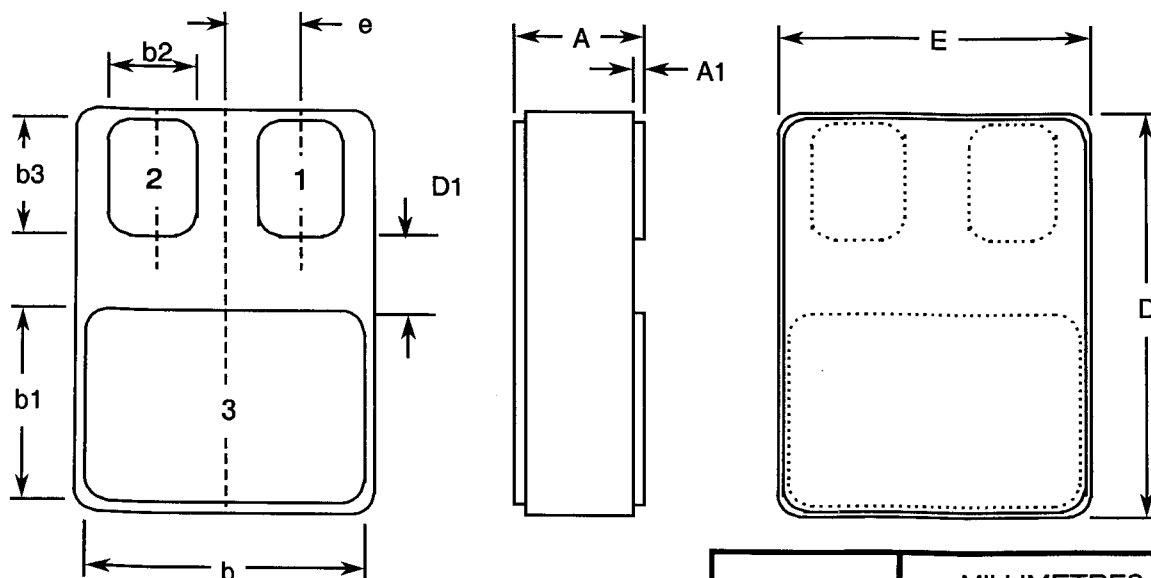


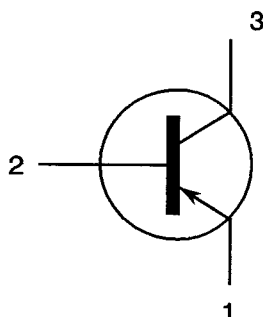
FIGURE 2 - PHYSICAL DIMENSIONS

FIGURE 2(c) - VARIANT 06



SYMBOL	MILLIMETRES	
	MIN.	MAX.
A	2.84	3.15
A1	0.25	0.51
b	7.13	7.39
b1	5.58	5.84
b2	2.28	2.54
b3	2.92	3.18
D	10.03	10.28
D1	0.76	-
E	7.39	7.64
e	1.91 Typical	

FIGURE 3 - FUNCTIONAL DIAGRAM



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

NOTES

1. For Variants 01 to 03, the collector is internally connected to the case.
2. For Variants 04 to 06, the collector is isolated from the case.

4. REQUIREMENTS

4.1 GENERAL

The complete requirements for procurement of the transistors specified herein are stated in this specification and ESCC Generic Specification No. 5000 for Discrete Semiconductors. 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 ESCC 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)

None.

4.2.4 Deviations from Qualification Tests (Chart IV)

Terminal Strength: Not applicable for Variant 06.

4.2.5 Deviations from Lot Acceptance Tests (Chart V)

Terminal Strength: Not applicable for Variant 06.

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 1.5 grammes for Variants 01 to 03, 5 grammes for Variants 04 and 05 and 2 grammes for Variant 06.

4.3.3 Terminal Strength

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

Variants 01 to 03

Test Condition : 'E', Lead Fatigue.

Variants 04 and 05

Test Condition : 'A' (Tension).

Applied Force : 10 N.

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

For Variants 01 to 03, the case shall be hermetically sealed and have a metal body with hard glass seals and the lid shall be welded, brazed, preform soldered or glass frit sealed.

For Variants 04 and 05, the case shall be hermetically sealed and have a metal body, the Fe/Ni copper core pin shall pass through a ceramic eyelet brazed into the frame and the lid shall be welded.

For Variant 06, the case shall be hermetically sealed and have a ceramic body with a Kovar lid.

4.4.2 Lead Material and Finish

For Variants 01 to 03, the lead material shall be Type 'D' with either Type '2', Type '3 or 4' or Type '7' finish in accordance with the requirements of ESCC Basic Specification No. 23500. (See Table 1(a) for Type Variants).

For Variants 04 and 05, the lead material shall be Type 'H' with either Type '2' or Type '4' finish in accordance with the requirements of ESCC Basic Specification No. 23500. (See Table 1(a) for Type Variants).

For Variant 06, the lead material shall be Type 'Q' with Type '14' finish in accordance with the requirements of ESCC Basic Specification No. 23500.

4.5 MARKING

4.5.1 General

The marking of all components delivered to this specification shall be in accordance with the requirements of ESCC Basic Specification No. 21700 and the following paragraphs. When the component is too small to accommodate all of the marking specified, as much as space permits shall be marked and the marking information, in full, shall accompany the component in its primary package.

The information to be marked and the order of precedence, shall be as follows:-

- (a) Lead Identification.
- (b) The ESCC 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 ESCC Component Number

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

Detail Specification Number _____ 520400202B
Type Variant (see Table 1(a)) _____
Testing Level (B or C, as applicable) _____

4.5.4 Traceability Information

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

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 stated, 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 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, the 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 High Temperature Reverse Bias Burn-in

The requirements for high temperature reverse bias burn-in are specified in Section 7 of ESCC Generic Specification No. 5000. The conditions for high temperature reverse bias burn-in shall be as specified in Table 5(a) of this specification.

4.7.3 Conditions for Power Burn-in

The requirements for power burn-in are specified in Section 7 of ESCC Generic Specification No. 5000. The conditions for power burn-in shall be as specified in Table 5(b) of this specification.

4.7.4 Electrical Circuit for High Temperature Reverse Bias.

The circuit required for performing the high temperature reverse bias burn-in test is shown in Figure 5(a) of this specification.

4.7.5 Electrical Circuit for Power Burn-in

The circuit required for performing the power burn-in test is shown in Figure 5(b) of this specification.

4.7.6 Verification of Safe Operating Area

The requirements for the verification of the Safe Operating Area are specified in Section 9 of ESCC Generic Specification No. 5000. The test method shall be as follows:-

Maximum continuous DC in accordance with MIL-STD-750, Method 3052 and Figure 1(b) of this specification, at $T_{case} = +25$ °C and for an operating time of 50ms maximum.

For Variants 01 to 06: $I_C = 500$ mA, $V_{CE} = 18$ V.



TABLE 2 - ELECTRICAL MEASUREMENTS AT ROOM TEMPERATURE - DC PARAMETERS

No.	CHARACTERISTICS	SYMBOL	MIL-STD-750 TEST METHOD	TEST CONDITIONS	LIMITS		UNIT
					MIN	MAX	
1	Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	3011	$I_C = -100mA$ $I_B = 0A$ Note 1	-80	-	V
2	Collector-Emitter Cut-off Current	I_{CES}	3041	$V_{CE} = -60V$ $V_{BE} = 0V$	-	-1	μA
3	Collector-Emitter Cut-off Current	I_{CEO}	3041	$V_{CE} = -40V$ $I_B = 0A$	-	-50	μA
4	Emitter-Base Cut-off Current 1	I_{EBO1}	3061	$V_{EB} = -4V$ $I_C = 0A$	-	-1	μA
5	Emitter-Base Cut-off Current 2	I_{EBO2}	3061	$V_{EB} = -5.5V$ $I_C = 0A$	-	-1	mA
6	DC Forward Current Transfer Ratio 1	h_{FE1}	3076	$V_{CE} = -5V$ $I_C = -50mA$ Note 1	50	-	-
7	DC Forward Current Transfer Ratio 2	h_{FE2}	3076	$V_{CE} = -5V$ $I_C = -2.5A$ Note 1	70	200	-
8	DC Forward Current Transfer Ratio 3	h_{FE3}	3076	$V_{CE} = -5V$ $I_C = -5A$ Note 1	40	-	-
9	Collector-Emitter Saturation Voltage	$V_{CE(SAT)}$	3071	$I_C = -5A$ $I_B = -500mA$ Notes 1 and 2	-	-1.5	V
10	Base-Emitter Saturation Voltage 1	$V_{BE(SAT)1}$	3066	$I_C = -2.5A$ $I_B = -250mA$ Notes 1 and 2	-	-1.45	V
11	Base-Emitter Saturation Voltage 2	$V_{BE(SAT)2}$	3066	$I_C = -5A$ $I_B = -500mA$ Notes 1, 2	-	-2.2	V

NOTES

1. Pulsed measurement: Pulse Length $\leq 300\mu s$, Duty Cycle $\leq 2\%$.
2. Saturation voltages measured 6mm from header.

TABLE 2 - ELECTRICAL MEASUREMENTS AT ROOM TEMPERATURE - AC PARAMETERS

No.	CHARACTERISTICS	SYMBOL	MIL-STD-750 TEST METHOD	TEST FIG.	TEST CONDITIONS (Note 1)	LIMITS		UNIT
						MIN.	MAX.	
12	AC Forward Current Transfer Ratio	h_{fe}	3206	-	$V_{CE} = -5V$ $I_C = -500mA$ $f = 20MHz$	3.5	-	-
13	Output Capacitance	C_{obo}	3236	-	$V_{CB} = -10V$ $I_E = 0A$ $f = 1MHz$	-	250	pF
14	Turn-on Time	t_{on}	-	4	$I_C = -5A$ $I_{B1} = -500mA$ $I_{B2} = 500mA$ $V_{CC} = -30V$ $V_{BB} = 4V$ $V_{IN} \approx -51V$	-	500	ns
15	Turn-off Time	t_{off}	-	4	$I_C = -5A$ $I_{B1} = -500mA$ $I_{B2} = 500mA$ $V_{CC} = -30V$ $V_{BB} = 4V$ $V_{IN} \approx -51V$	-	1.3	μs

NOTES

- Measurements performed on a sample basis, LTPD 7 or less.

TABLE 3 - ELECTRICAL MEASUREMENTS AT HIGH AND LOW TEMPERATURES

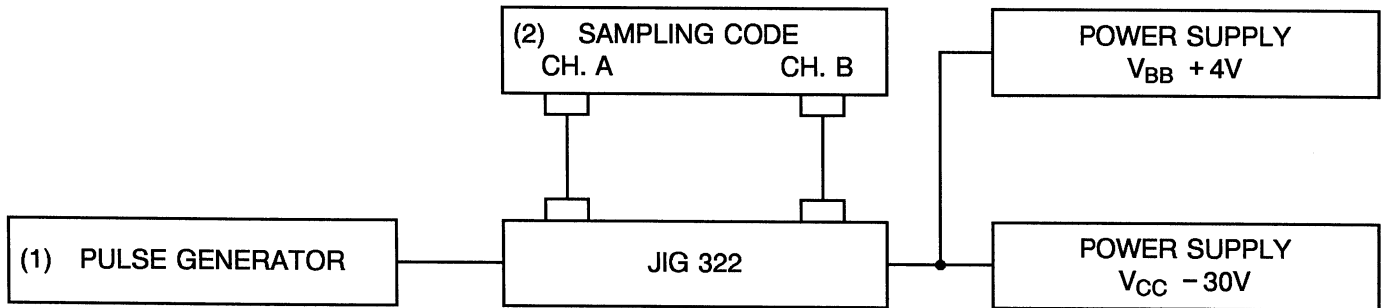
No.	CHARACTERISTICS	SYMBOL	MIL-STD-750 TEST METHOD	TEST CONDITIONS	LIMITS		UNIT
					MIN.	MAX.	
2	Collector-Emitter Cut-off Current	I_{CES}	3041	$V_{CE} = -60V$ $V_{BE} = 0V$ $T_{amb} = +150^{\circ}C$	-	-10	μA
7	DC Forward Current Transfer Ratio 2	h_{FE2}	3076	$V_{CE} = -5V$ $I_C = -2.5A$ $T_{amb} = -55^{\circ}C$ Note 1	35	-	-

NOTES

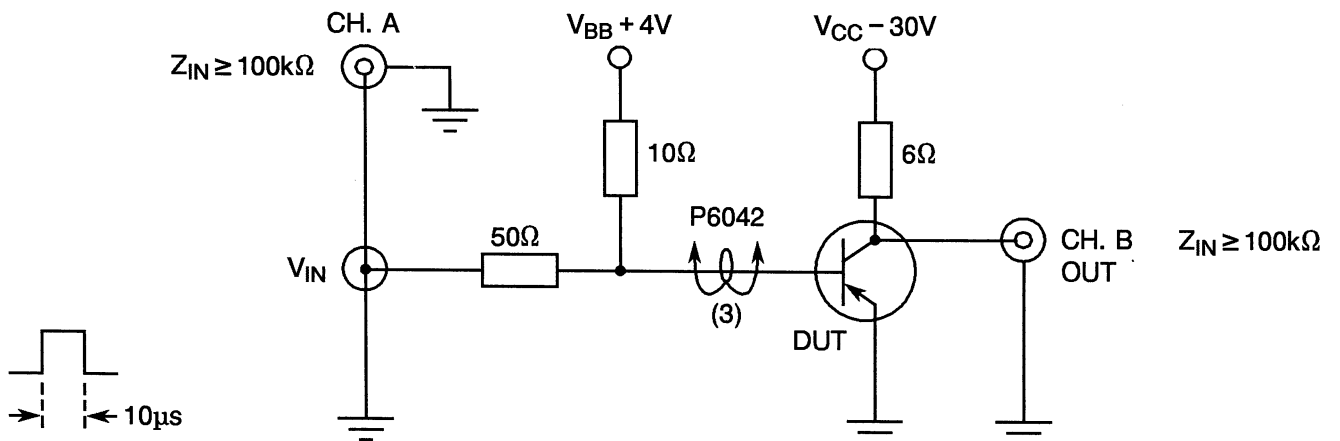
- Pulsed measurement: Pulse Length $\leq 300\mu s$, Duty Cycle $\leq 2\%$.

FIGURE 4 - CIRCUITS FOR ELECTRICAL MEASUREMENTS

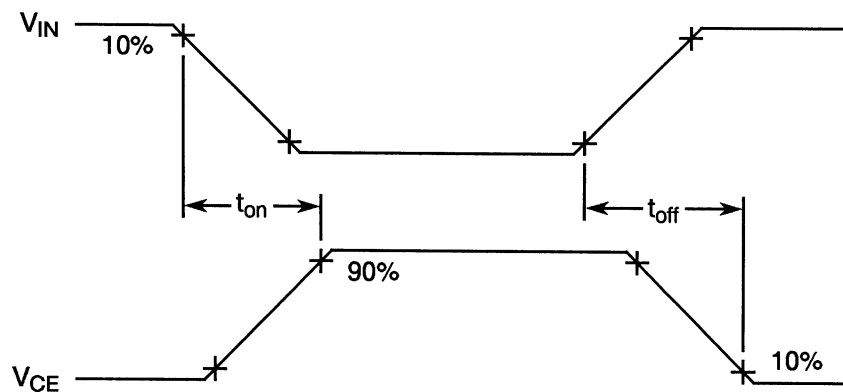
BLOCK DIAGRAM



EQUIVALENT TEST CIRCUIT



VOLTAGE WAVEFORMS



NOTES

1. Pulse generator Type EH132 or equivalent, $t_r \leq 20ns$, $t_p = 10\mu s$, Duty Cycle = 1%.
2. Sampling Scope Tetroniks 568 or equivalent.
3. Adjust $V_{IN} - V_B$ with current probe P6042.

TABLE 4 - PARAMETER DRIFT VALUES

No.	CHARACTERISTICS	SYMBOL	SPEC. AND/OR TEST METHOD	TEST CONDITION	CHANGE LIMITS (Δ)	UNIT
2	Collector-Emitter Cut-off Current	I_{CES}	As per Table 2	As per Table 2	± 100	nA
7	DC Forward Current Transfer Ratio 2	h_{FE2}	As per Table 2	As per Table 2	± 25	%
9	Collector-Emitter Saturation Voltage	$V_{CE(SAT)}$	As per Table 2	As per Table 2	± 100	mV

TABLE 5(a) - CONDITIONS FOR HIGH TEMPERATURE REVERSE BIAS BURN-IN

No.	CHARACTERISTIC	SYMBOL	CONDITION	UNIT
1	Ambient Temperature	T_{amb}	+ 150	$^{\circ}C$
2	Collector-Base Voltage	V_{CB}	- 60	V
3	Emitter-Base Voltage	V_{EB}	- 4.5	V
4	Duration	t	48	Hours

TABLE 5(b) - CONDITIONS FOR POWER BURN-IN AND OPERATING LIFE TESTS

VARIANTS 01 TO 03

No.	CHARACTERISTIC	SYMBOL	CONDITION	UNIT
1	Ambient Temperature	T_{amb}	+ 20 to + 50 (1)	$^{\circ}C$
2	Power Dissipation 1	P_{tot1}	Max. rating at T_{amb} according to derating curve (See Figure 1(a))	W
3	Collector-Base Voltage	V_{CB}	- 20	V

NOTES

1. No heat sink nor forced air directly on the device shall be permitted.

TABLE 5(b) - CONDITIONS FOR POWER BURN-IN AND OPERATING LIFE TESTS (CONT.)

VARIANTS 04 TO 06

No.	CHARACTERISTIC	SYMBOL	CONDITION	UNIT
1	Case Temperature	T_{case}	+ 100(+ 0 - 5)	°C
2	Power Dissipation 2	P_{tot2}	Max. rating at T_{case} according to derating curve (See Figure 1(a))	W
3	Collector-Base Voltage	V_{CB}	- 20	V

FIGURE 5(a) - ELECTRICAL CIRCUIT FOR HIGH TEMPERATURE REVERSE BIAS BURN-IN

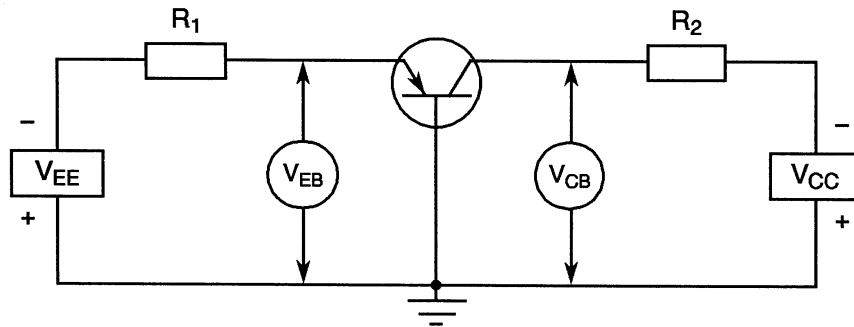
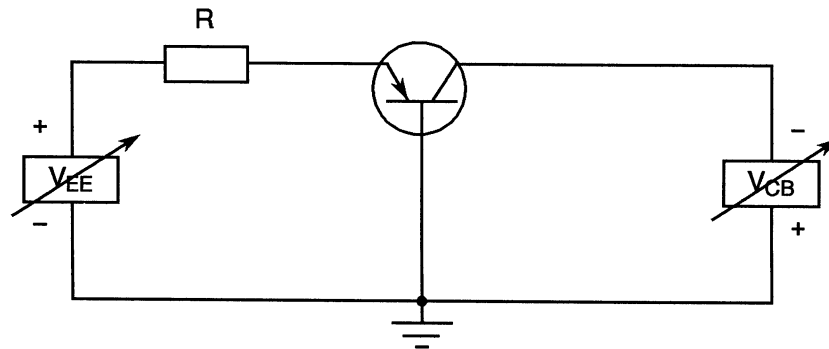


FIGURE 5(b) - ELECTRICAL CIRCUIT FOR POWER BURN-IN AND OPERATING LIFE TESTS





- 4.8 ENVIRONMENTAL AND ENDURANCE TESTS (CHARTS IV AND V OF ESCC 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. Unless otherwise stated, the measurements shall be performed at $T_{amb} = +22 \pm 3$ °C.
- 4.8.3 Conditions for Operating Life Test (Part of Endurance Testing)
The requirements for operating life testing are specified in Section 9 of ESCC Generic Specification No. 5000. The conditions for operating life testing shall be the same as specified in Table 5(b) for the power burn-in test.
- 4.8.4 Electrical Circuit for Operating Life Test
The circuit required for performing the operating life test shall be the same as shown in Figure 5(b) for power 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 ESCC 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 CONDITION	LIMITS		UNIT
					MIN.	MAX.	
2	Collector-Emitter Cut-off Current	I_{CES}	As per Table 2	As per Table 2	-	-1	μA
7	DC Forward Current Transfer Ratio 2	h_{FE2}	As per Table 2	As per Table 2	70	200	-
9	Collector-Emitter Saturation Voltage	$V_{CE(SAT)}$	As per Table 2	As per Table 2	-	-1.5	V