



**TRANSISTORS, MICROWAVE,  
SMALL SIGNAL, SILICON, BIPOLAR  
BASED ON TYPES BFY405, BFY420 AND BFY450**

**ESCC Detail Specification No. 5611/008**

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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, Microwave, Small Signal, Silicon, Bipolar, based on Types BFY405, BFY420 and BFY450. It shall be read in conjunction with ESCC Generic Specification No. 5010, the requirements of which are supplemented herein.

### 1.2 COMPONENT TYPE VARIANTS

Variants of the basic type transistors specified herein, which are 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 transistor specified herein, are as 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 HANDLING PRECAUTIONS

These devices are susceptible to damage by electrostatic discharge. Therefore suitable precautions shall be employed for protection during all phases of manufacture test, packaging, shipping and handling.

These components are categorised as Class 1 with a Minimum Critical Path Failure Voltage of 70V for Variant 01, 100V for Variant 02 and 190V for Variant 03.

## 2 APPLICABLE DOCUMENTS

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

- (a) ESCC Generic Specification No. 5010 for Discrete Microwave Semiconductor Components.
- (b) MIL-STD-750, Test Methods 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. In addition, the following abbreviations are used:

- $R_{TH(J-S)}$  = Thermal Resistance, Junction-Soldering Point.

**TABLE 1(a) - TYPE VARIANTS**

Variant	Type	Case	Figure	Lead material and finish
01	BFY405	MICRO-X	2	D2
02	BFY420	MICRO-X	2	D2
03	BFY450	MICRO-X	2	D2

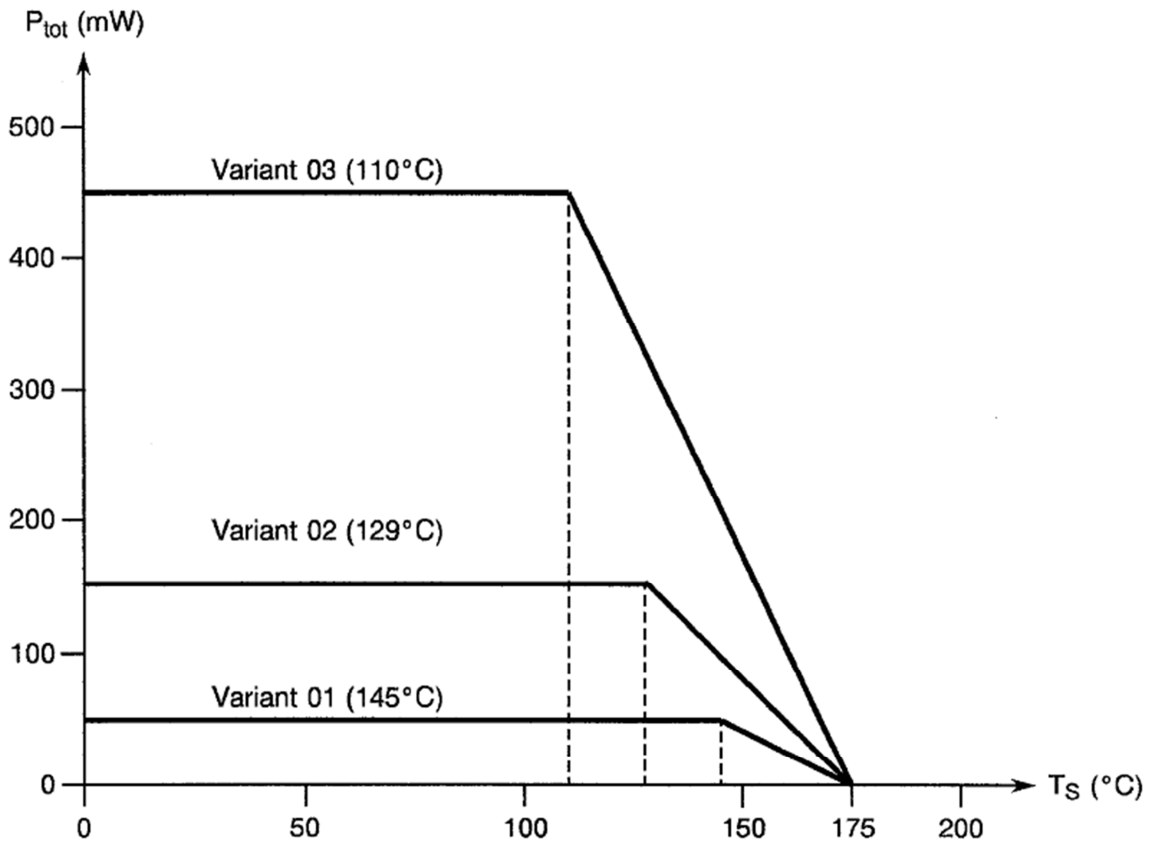
**TABLE 1(b) - MAXIMUM RATINGS**

No.	Characteristics	Symbol	Maximum Ratings (1)	Unit	Remarks
1	Collector-Emitter Voltage	$V_{CEO}$	4.5	V	
2	Collector-Base Voltage	$V_{CBO}$	15	V	
3	Emitter-Base Voltage	$V_{EBO}$	1.5	V	
4	Collector Current Variant 01 Variant 02 Variant 03	$I_C$	12 35 100	mA	
5	Base Current Variant 01 Variant 02 Variant 03	$I_B$	1.0 3 10	mA	
6	Power Dissipation Variant 01 Variant 02 Variant 03	$P_{tot}$	55 ( $T_S \leq 145^\circ\text{C}$ ) 160 ( $T_S \leq 129^\circ\text{C}$ ) 450 ( $T_S \leq 110^\circ\text{C}$ )	mW	Notes 2 and 3
7	Junction Temperature	$T_J$	175	$^\circ\text{C}$	
8	Operating Temperature Range	$T_{op}$	-65 to +175	$^\circ\text{C}$	$T_{amb}$
9	Storage Temperature Range	$T_{stg}$	-65 to +175	$^\circ\text{C}$	
10	Soldering Temperature	$T_{sol}$	+250	$^\circ\text{C}$	Note 4
11	Thermal Resistance (Junction to Soldering Point) Variant 01 Variant 02 Variant 03	$R_{TH(J-S)}$	$\leq 545$ $\leq 285$ $\leq 145$	$^\circ\text{C/W}$	Note 2

**NOTES**

1. Maximum ratings must not be exceeded under any combination of DC ratings and RF voltage/current swings.
2.  $T_S$  is measured on the collector lead at the soldering point to the PCB.
3. At the  $T_S$  specified. For derating at  $T_S >$  than specified, see Figure 1.
4. Duration 5 seconds maximum at a distance of not less than 0.5mm from the device body and the same lead shall not be resoldered until 3 minutes have elapsed.

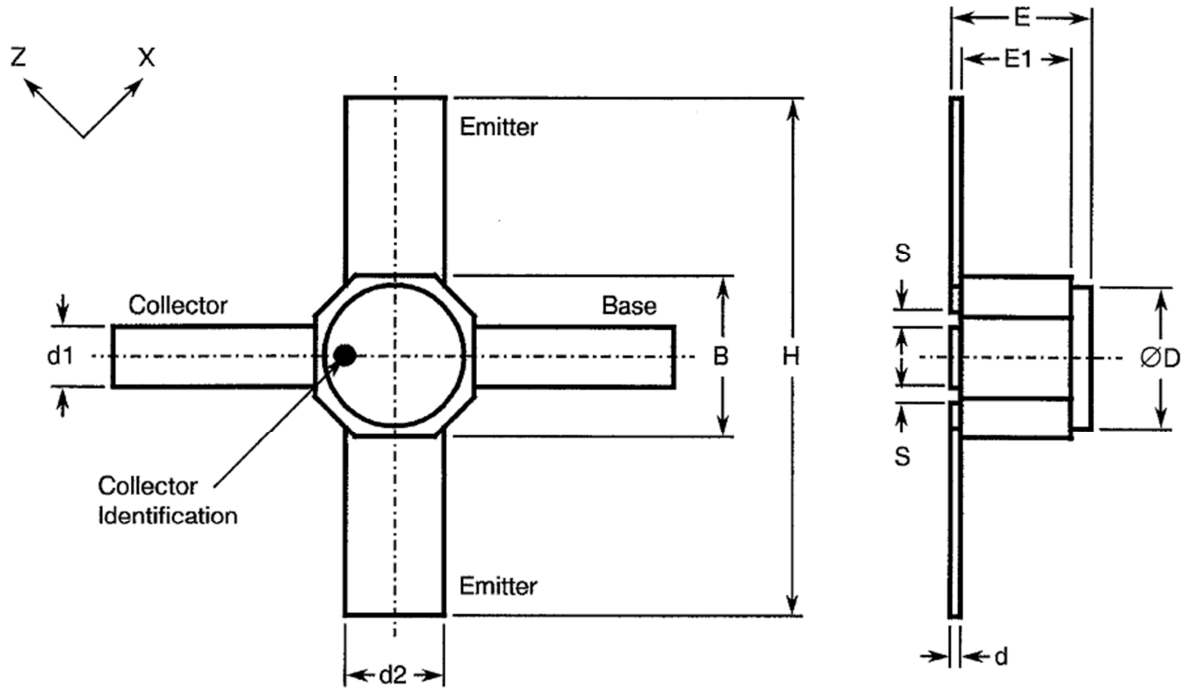
**FIGURE 1 - PARAMETER DERATING INFORMATION**



Power Dissipation versus Solder-Point Temperature

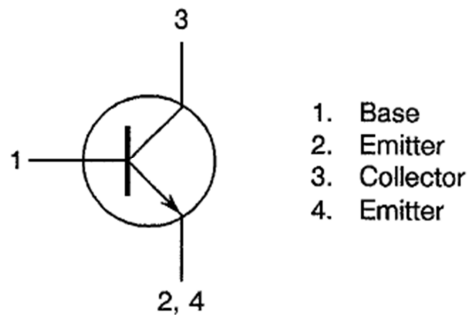


**FIGURE 2 - PHYSICAL DIMENSIONS**



Symbol	Millimetres		Notes
	Min.	Max.	
B	1.68	1.88	
d	0.07	0.15	
d1	0.4	0.6	
d2	0.92	1.12	
ØD	1.55	1.85	
E	0.85	1.25	
E1	0.66	0.86	
H	4	4.4	
S	0.08	0.3	

**FIGURE 3 - FUNCTIONAL DIAGRAM**



**NOTES**

1. The collector is marked with a black dot.

## 4 REQUIREMENTS

### 4.1 GENERAL

The complete requirements for procurement of the transistors specified herein shall be as stated in this specification and ESCC Generic Specification No. 5010 for Discrete Microwave Semiconductor Components. 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

(a) Para. 5.3, Wafer Lot Acceptance: Shall be performed as a SEM Inspection only.

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

(a) Para. 6.2, Pre-burn-in: To be left to Manufacturer's discretion.

(b) Para. 9.6, Constant Acceleration: Shall not be performed.

(c) Para. 9.7, Particle Impact Noise Detection (PIND) test: May be performed at any point after the position indicated in Chart II.

(d) Para. 9.14, Vibration, Variable Frequency: Shall not be performed.

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

(a) Para. 7.1.1(b), Power Burn-in 2 and 3 measurements: Shall be performed if drift after power burn-in 1 exceeds half of the allowed limit in Table 4 (applicable PDA: 5%).  
For Level C, power burn-in 2 shall be performed for 168 hours if pre-burn-in is performed during Chart II.

(b) Para. 9.9.2, may be performed at any stage after power burn-in 2.

(c) Para. 9.9.3, may be performed at any stage after power burn-in 2.

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

(a) Para. 9.13, Shock Test: Shall not be performed.

(b) Para. 9.14, Vibration Test: Shall not be performed.

(c) Para. 9.15, Constant Acceleration: Shall not be performed.

(d) Para. 9.20, Operating Life: Shall be performed at 1 temperature only on 30 pieces.

(e) Para. 9.23, Special Testing: Shall not be performed.

#### 4.2.5 Deviations from Lot Acceptance Tests (Chart V)

(a) Para. 9.13, Shock Test: Shall not be performed.

(b) Para. 9.14, Vibration Test: Shall not be performed.

(c) Para. 9.15, Constant Acceleration: Shall not be performed.

(d) Para. 9.20, Operating Life: Shall be performed at 1 temperature only on 16 pieces.

(e) Para. 9.23, Special Testing: Shall not be performed.

### 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 0.03 grammes.

#### 4.3.3 Terminal Strength

The requirements for terminal strength testing are specified in Section 9 of ESCC Generic Specification No. 5010. The test conditions shall be as follows:

- (a) Condition: 'A' (Tension).
- (b) Force: 2.23N.
- (c) Duration: 5 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

The case shall be hermetically sealed and have a ceramic body.

##### 4.4.2 Lead Material and Finish

The lid, end-cap and lead material shall be Type 'D' with Type '2' finish in accordance with the requirements of ESCC Basic Specification No. 23500.

#### 4.5 MARKING

##### 4.5.1 General

The marking of 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 as 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) Collector Identification.
- (b) The ESCC Component Number.
- (c) Traceability Information.

The primary package shall bear an "ESD Sensitive" label.

##### 4.5.2 Collector Identification

Collector identification shall be as shown in Figures 2 and 3 of this specification.

#### 4.5.3 The ESCC Component Number

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

Example: 561100801B

- Detail Specification Number: 5611008
- Type Variant (see Table 1(a)): 01
- Testing Level (B or C, as applicable): B

#### 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 specified, the measurements shall be performed at  $T_{amb} = +25 \pm 3^{\circ}\text{C}$ .

#### 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. Unless otherwise specified, the measurements shall be performed at  $+150 (+0 -5)^{\circ}\text{C}$  and  $-55 (+5 -0)^{\circ}\text{C}$ .

#### 4.6.3 Circuits for Electrical Measurements

Circuits for use in performing electrical measurements listed in Table 2 of this specification are shown in Figure 4.

### 4.7 BURN-IN TESTS

Burn-in shall be to Chart III(b).

#### 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  $T_{amb} = +25 \pm 3^{\circ}\text{C}$ . The parameter drift values ( $\Delta$ ) applicable to the scheduled parameters 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. 5010. 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. 5010. The conditions for power burn-in shall be as specified in Table 5(b) of this specification.

#### 4.7.4 Electrical Circuits for High Temperature Reverse Bias Burn-in

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

4.7.5 Electrical Circuits for Power Burn-in

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

**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 Cut-off Current	$I_{CBO}$	3036	$V_{CB} = 5.0V, I_E = 0mA$ Variant 01: Variant 02: Variant 03:	- - -	10 30 100	nA
2	Collector-Emitter Cut-off Current	$I_{CEX}$	3041	$V_{CE} = 4.5V$ Variant 01: $I_B = 0.1\mu A$ Variants 02, 03: $I_B = 1.0\mu A$	- -	20 200	$\mu A$
3	Emitter Cut-off Current	$I_{EBO}$	3061	$V_{EB} = 1.5V, I_C = 0mA$ Variant 01: Variant 02: Variant 03:	- - -	5 20 50	$\mu A$
4	DC Forward Current Transfer Ratio	$h_{FE}$	3076	$V_{CE} = 1.0V$ Variant 01: $I_E = 2.0mA$ Variant 02: $I_E = 5.0mA$ Variant 03: $I_E = 20mA$	50	150	-

**TABLE 2 - ELECTRICAL MEASUREMENTS AT ROOM TEMPERATURE - AC PARAMETERS**

No.	Characteristics	Symbol	MIL-STD-750 Test Method	Test Conditions	Limits		Unit
					Min.	Max.	
5	Collector-Base Capacitance	$C_{CB}$	3241	$V_{CB} = 2.0V, V_{BE} = 0V, f = 1.0MHz$ Variant 02 Note 1	-	0.9	pF
6	Emitter-Base Capacitance	$C_{EB}$	3241	$V_{EC} = 0.5V, V_{CB} = 0V, f = 1.0MHz$ Variant 02 Note 2	-	3	pF
7	Collector-Emitter Capacitance	$C_{CE}$	3241	$V_{CE} = 2.0V, V_{BE} = 0V, f = 1.0MHz$ Variant 01: Variant 02: Variant 03: Note 3	- - -	0.48 0.85 2.6	pF
8	Insertion Power Gain	$ S_{21} ^2$	-	$V_{CE} = 2.0V, f = 1.8GHz$ Variant 01: $I_C = 5.0mA$ Variant 02: $I_C = 20mA$ Variant 03: $I_C = 50mA$ Notes 5 and 6	14 14 8	- - -	dB
9	Noise Figure	NF	-	$V_{CE} = 2.0V, f = 1.8GHz$ Variant 01: $I_C = 2.0mA$ Variant 02: $I_C = 5.0mA$ Variant 03: $I_C = 10mA$ Note 4	- - -	1.8 1.7 2	dB

No.	Characteristics	Symbol	MIL-STD-750 Test Method	Test Conditions	Limits		Unit
					Min.	Max.	
10	Transition Frequency	$f_T$	-	$V_{CE} = 3.0V$ Variant 01: $I_C = 10mA, f = 2.0GHz$ Variant 02: $I_C = 30mA, f = 2.0GHz$ Variant 03: $I_C = 90mA, f = 1.0GHz$ Note 5	20 20 18	- - -	GHz

**NOTES**

1. The emitter is connected to the ground terminal.
2. The collector is connected to the ground terminal.
3. The base is connected to the ground terminal.
4. Input tuned for NF min.
5. Measured in a  $50\Omega$  system (S-parameter).
6. Small signal measurement.

**TABLE 3(a) - ELECTRICAL MEASUREMENTS AT HIGH TEMPERATURE**

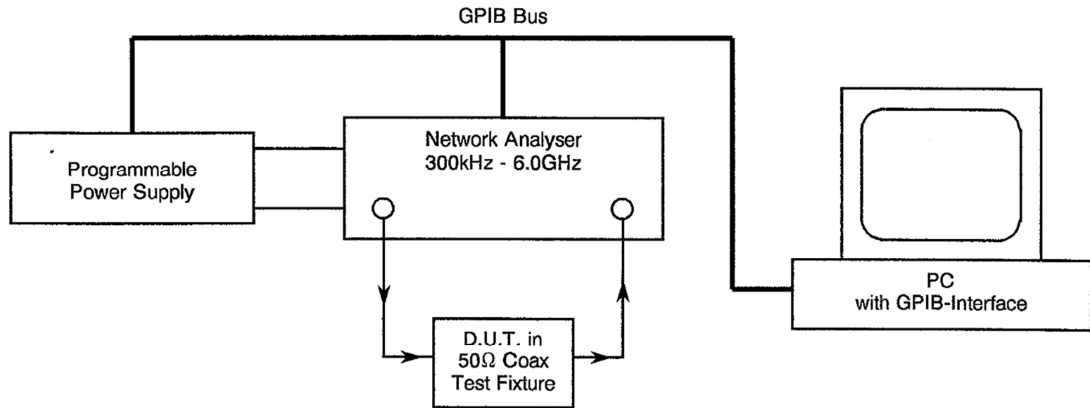
No.	Characteristics	Symbol	MIL-STD-750 Test Method	Test Conditions	Limits		Unit
					Min.	Max.	
1	Collector Cut-off Current	$I_{CBO}$	3036	$V_{CB} = 5.0V, I_E = 0mA$ Variant 01: Variant 02: Variant 03:	- - -	10 30 100	$\mu A$

**TABLE 3(b) - ELECTRICAL MEASUREMENTS AT LOW TEMPERATURE**

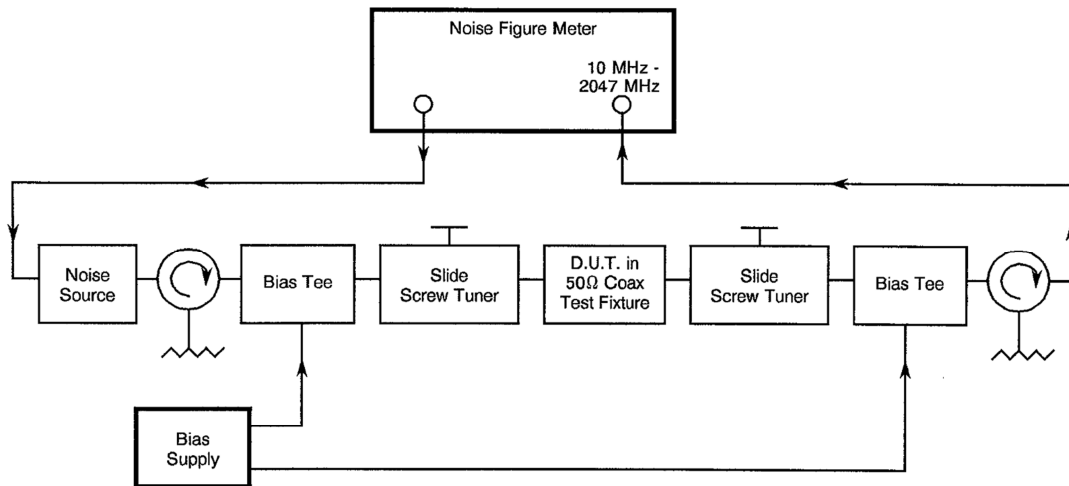
No.	Characteristics	Symbol	MIL-STD-750 Test Method	Test Conditions	Limits		Unit
					Min.	Max.	
4	DC Forward Current Transfer Ratio	$h_{FE}$	3076	$V_{CE} = 1.0V$ Variant 01: $I_C = 2.0mA$ Variant 02: $I_C = 5.0mA$ Variant 03: $I_C = 20mA$	10	-	-

**FIGURE 4 - CIRCUITS FOR ELECTRICAL MEASUREMENTS**

**FIGURE 4(a) - TEST SET-UP FOR S-PARAMETER MEASUREMENT**



**FIGURE 4(b) - TEST SET-UP FOR NOISE FIGURE MEASUREMENT**



**TABLE 4 - PARAMETER DRIFT VALUES**

No.	Characteristics	Symbol	Spec. and/or Test Method	Test Conditions	Change Limits ( $\Delta$ )	Unit
1	Collector Cut-off Current	$I_{CBO}$	As per Table 2	As per Table 2	$\pm 10$ or (2) $\pm 100$	nA %
3	Emitter Cut-off Current	$I_{EBO}$	As per Table 2	As per Table 2 Variant 01: Variant 02: Variant 03:	$\pm 1$ $\pm 5$ $\pm 10$ or (2) $\pm 100$	$\mu A$ $\mu A$ $\mu A$ %
4	DC Forward Current Transfer Ratio	$h_{FE}$	As per Table 2	As per Table 2	$\pm 10$	%

**NOTES**

- $\Delta 1 = \Delta 2 = \Delta 3$ .
- Whichever is greater referred to the initial measurement.

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

No.	Characteristics	Symbol	Conditions	Unit
1	Case Temperature	$T_{case}$	+150 (+0 -5)	$^{\circ}C$
2	Collector-Emitter Voltage	$V_{CES}$	12	V

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

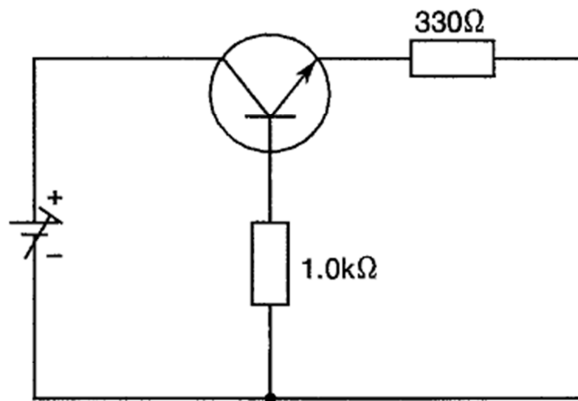
No.	Characteristics	Symbol	Conditions	Unit
1	Ambient Temperature	$T_{amb}$	+125 (+0 -5)	$^{\circ}C$
2	Power Dissipation	$P_{tot}$	Variant 01: 36 Variant 02: 114 Variant 03: 170 (Note 1)	mW
3	Collector-Emitter Voltage	$V_{CE}$	Variants 01, 02: 4.0 Variant 03: 3.5	V

**NOTES**

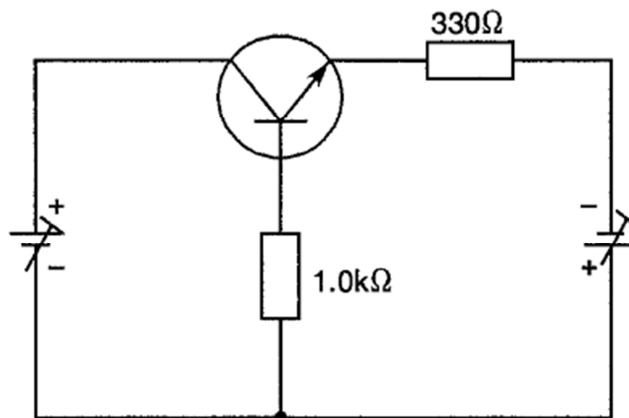
- Because the components are clamped within the Burn-in fixture, in order to achieve  $T_j = +175^{\circ}C$ ,  $R_{TH(S-A)} = 150k/W$  must be considered.



**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. 5010)

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  $T_{amb} = +25 \pm 3^{\circ}\text{C}$ .

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  $T_{amb} = +25 \pm 3^{\circ}\text{C}$ .

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

The requirements for operating life testing are specified in Section 9 of ESCC Generic Specification No. 5010. The conditions for operating life testing are specified in Table 5(b) of this specification.

4.8.4 Electrical Circuits for Operating Life Tests

The circuit for use in performing the operating life test shall be the same as shown in Figure 5(b) for Power Burn-in.

4.9 TOTAL DOSE IRRADIATION TESTING

Not applicable.

4.10 SPECIAL TESTING

Not applicable.

**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.	
1	Collector Cut-off Current	$I_{CBO}$	As per Table 2	As per Table 2	As per Table 2		nA
2	Collector Cut-off Current	$I_{CEX}$	As per Table 2	As per Table 2	As per Table 2		$\mu$ A
3	Emitter Cut-off Current	$I_{EBO}$	As per Table 2	As per Table 2	As per Table 2		$\mu$ A
4	DC Forward Current Transfer Ratio	$h_{FE}$	As per Table 2	As per Table 2	As per Table 2		-

**FIGURE 6 - BIAS CONDITIONS FOR IRRADIATION TESTING**

Not applicable.

**TABLE 7 - ELECTRICAL MEASUREMENTS DURING AND ON COMPLETION OF IRRADIATION TESTING**

Not applicable.

**APPENDIX A**  
**AGREED DEVIATIONS FOR SIEMENS (D)**

Items Affected	Description of Deviations
Para. 4.2.2	Para. 9.4, High Temperature Stabilisation Bake: May be performed at +175 (+0 -3)°C.
Para. 4.2.3	Para. 9.12, Radiographic Inspection: May be replaced by a Visual Inspection for verifying the length, height and shape of the wire bonding.