TRANSISTORS, HIGH POWER, PNP

BASED ON TYPE 2N5153

ESCC Detail Specification No. 5204/002

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TABLE OF CONTENTS

1	GENERAL	5
1.1	SCOPE	5
1.2	APPLICABLE DOCUMENTS	5
1.3	TERMS, DEFINITIONS, ABBREVIATIONS, SYMBOLS AND UNITS	5
1.4	THE ESCC COMPONENT NUMBER AND COMPONENT TYPE VARIANTS	5
1.4.1	The ESCC Component Number	5
1.4.2	Component Type Variants	5
1.5	MAXIMUM RATINGS	6
1.6	HANDLING PRECAUTIONS	7
1.7	PHYSICAL DIMENSIONS AND TERMINAL IDENTIFICATION	8
1.7.1	Metal Flange Mount Package (TO-257) - 3 lead (Variants 04, 05)	8
1.7.2	Surface Mount Package (SMD.5) - 3 terminal (Variants 06, 07, 09, 10)	9
1.7.3	Die (Variant 08)	10
1.8	FUNCTIONAL DIAGRAM	11
1.9	MATERIALS AND FINISHES	11
1.9.1	Materials and Finishes of Packaged Components	11
1.9.2	Materials and Finishes of Die Components	11
2	REQUIREMENTS	12
2.1	GENERAL	12
2.1.1	Deviations from the Generic Specification	12
2.2	MARKING	12
2.3	CASE ISOLATION	12
2.4	TERMINAL STRENGTH	12
2.5	VERIFICATION OF SAFE OPERATING AREA	13
2.6	ELECTRICAL MEASUREMENTS AT ROOM, HIGH AND LOW TEMPERATURES	13
2.6.1	Room Temperature Electrical Measurements	13
2.6.2	High and Low Temperatures Electrical Measurements	15
2.7	PARAMETER DRIFT VALUES	15
2.8	INTERMEDIATE AND END-POINT ELECTRICAL MEASUREMENTS	16
2.9	HIGH TEMPERATURE REVERSE BIAS BURN-IN CONDITIONS	16
2.10	POWER BURN-IN CONDITIONS	16
2.11	OPERATING LIFE CONDITIONS	16
2.12	TOTAL DOSE RADIATION TESTING	17
2.12.1	Bias Conditions and Total Dose Level for Total dose Radiation Testing	17
2.12.2	Electrical Measurements for Radiation Testing	17
APPENDIX A		18

1 GENERAL

1.1 SCOPE

This specification details the ratings, physical and electrical characteristics and test and inspection data for the component type variants and/or the range of components specified below. It supplements the requirements of, and shall be read in conjunction with, the ESCC Generic Specification listed under Applicable Documents.

1.2 APPLICABLE DOCUMENTS

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

(a) ESCC Generic Specification No. 5000

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

1.3 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.

1.4 THE ESCC COMPONENT NUMBER AND COMPONENT TYPE VARIANTS

1.4.1 The ESCC Component Number

The ESCC Component Number shall be constituted as follows:

Example: 520400204R

- Detail Specification Reference: 5204002
- Component Type Variant Number: 04 (as required)
- Total Dose Radiation Level Letter: R (as required)

1.4.2 Component Type Variants

The component type variants applicable to this specification are as follows:

Variant Number	Based on Type	Case	Lead/Terminal Material and Finish (Note 1)	Weight max g	Total Dose Radiation Level Letter (Note 2)
04	2N5153	TO-257	H2	5	R [100kRAD(Si)]
05	2N5153	TO-257	H4	5	R [100kRAD(Si)]
06	2N5153	SMD.5 (Note 3)	Q14	2	R [100kRAD(Si)]
07	2N5153	SMD.5 (Note 3)	Q14	2	R [100kRAD(Si)]
08	2N5153	Die	N/A	N/A	R [100kRAD(Si)]
09	2N5153	SMD.5 (Note 3)	Q4	2	R [100kRAD(Si)]
10	2N5153	SMD.5 (Note 3)	Q4	2	R [100kRAD(Si)]

NOTES:

1. The lead/terminal material and finish shall be in accordance with the requirements of ESCC Basic Specification No. 23500.

2. Total dose radiation level letters are defined in ESCC Basic Specification No. 22900. If an alternative radiation test level is specified in the Purchase Order, the letter shall be changed accordingly.
3. See Para. 1.7.2 for terminal identification.

1.5 MAXIMUM RATINGS

The maximum ratings shall not be exceeded at any time during use or storage.

Maximum ratings shall only be exceeded during testing to the extent specified in this specification and when stipulated in Test Methods and Procedures of the ESCC Generic Specification.

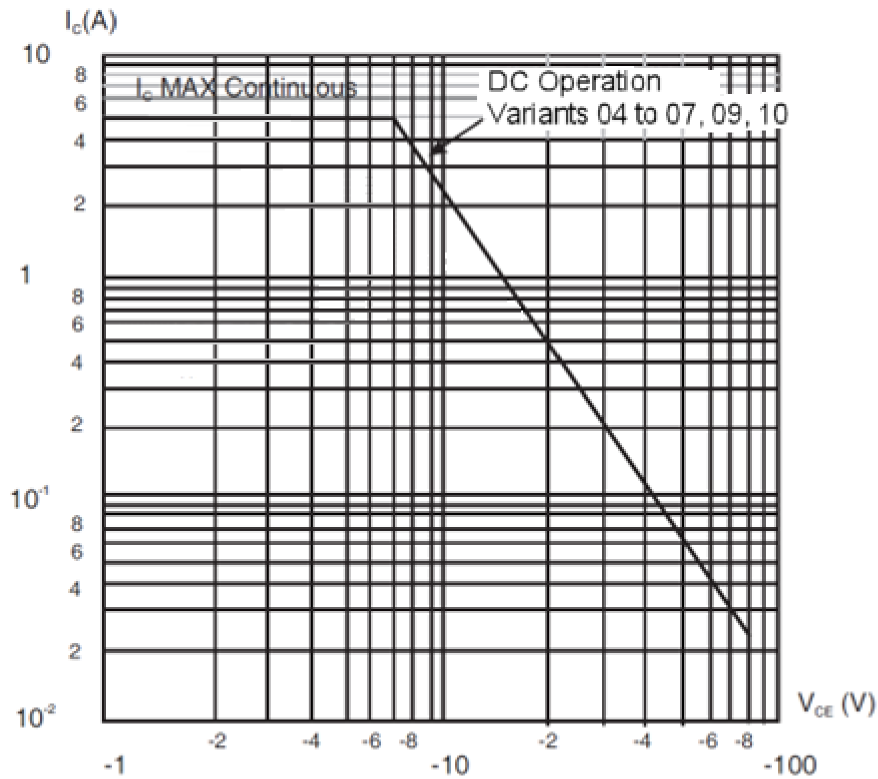
Characteristics	Symbols	Maximum Ratings	Unit	Remarks
Collector-Base Voltage	V_{CBO}	-100	V	Over T_{op}
Collector-Emitter Voltage	V_{CEO}	-80	V	Over T_{op}, Note 5
Emitter-Base Voltage	V_{EBO}	-5.5	V	Over T_{op}
Collector Current	I_C	-5	A	Continuous, Note 5
Power Dissipation	P_{tot1}	3.3	W	At $T_{amb} \leq +25°C$, Note 1
	P_{tot2}	35		At $T_{case} \leq +25°C$, Note 1
Thermal Resistance, Junction-to-Ambient	$R_{th(j-a)}$	53	°C/W	
Thermal Resistance, Junction-to-Case	$R_{th(j-c)}$	5	°C/W	
Operating Temperature Range	T_{op}	-65 to +200	°C	Note 2
Storage Temperature Range	T_{stg}	-65 to +200	°C	Note 2
Soldering Temperature For TO-257 (Variants 04, 05): For SMD.5 (06, 07, 09, 10):	T_{sol}	 +260 +245	°C	 Note 3 Note 4

NOTES:

1. For T_{amb} or T_{case} > +25°C, derate linearly to 0W at +200°C.
2. For Variants 05, 09, 10 with tin-lead plating or hot solder dip lead finish all testing, and any handling, performed at T_{amb} > +125°C shall be carried out in a 100% inert atmosphere.
3. 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.
4. Duration 5 seconds maximum and the same package shall not be resoldered until 3 minutes have elapsed.

5. Safe Operating Area applies as follows:

Maximum Safe Operating Area Graph

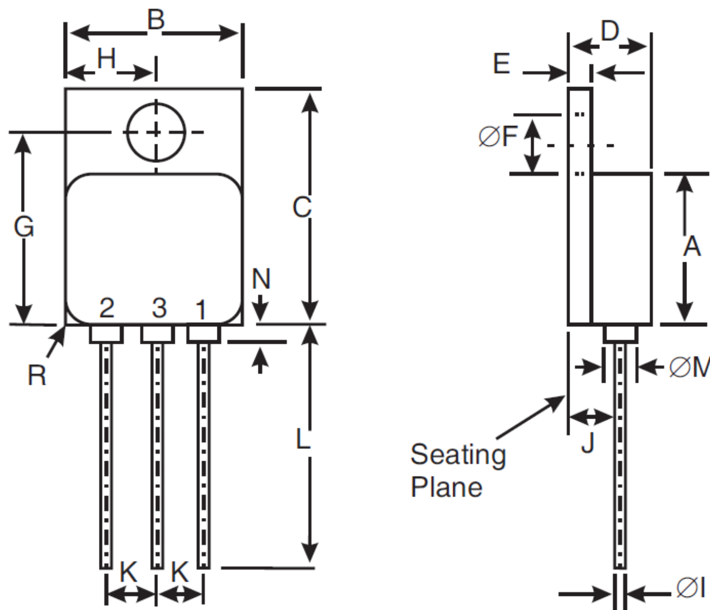


1.6 HANDLING PRECAUTIONS

The TO-257 package (Variants 04, 05) contains Beryllium Oxide (BeO) and therefore it must not be ground, machined, sandblasted or subjected to any mechanical operation which will produce dust. The case must not be subjected to any chemical process (e.g. etching) which will produce fumes.

1.7 PHYSICAL DIMENSIONS AND TERMINAL IDENTIFICATION

1.7.1 Metal Flange Mount Package (TO-257) - 3 lead (Variants 04, 05)

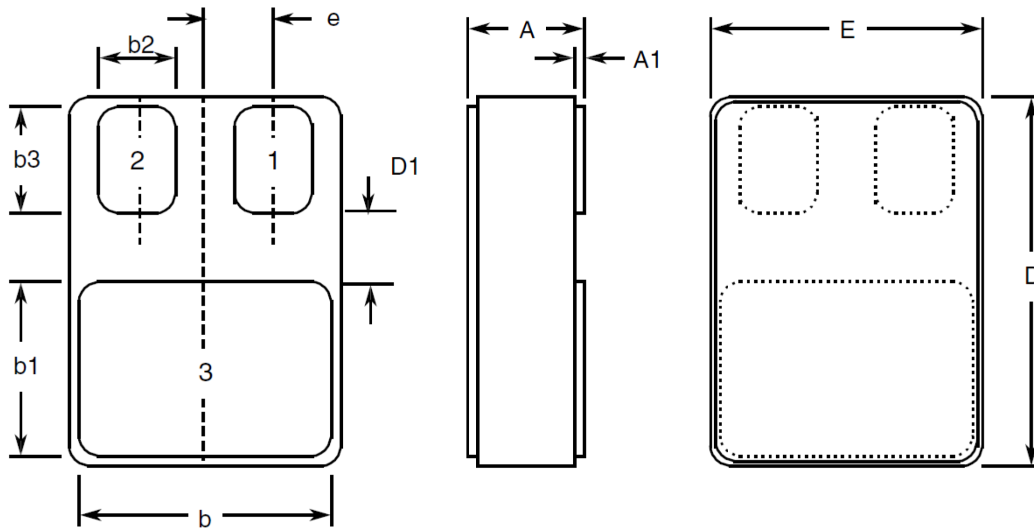


Symbols	Dimensions mm		Notes
	Min	Max	
A	10.41	10.67	
B	10.41	10.67	
C	16.51	16.76	
D	4.7	5.33	
E	0.89	1.14	
ØF	3.56	3.81	
G	13.39	13.64	
H	5.13	5.38	
ØI	0.64	0.89	2
J	2.92	3.18	
K	2.41	2.67	
L	15.24	16.51	
ØM	2.29 Typical		2
N	-	0.71	2
R	1.65 Typical		3

NOTES:

1. Terminal identification is specified by the component's geometry where Lead 1 = emitter, Lead 2 = base, Lead 3 = collector.
2. Applies to all leads.
3. Radius of body corner, 4 places.

1.7.2 Surface Mount Package (SMD.5) - 3 terminal (Variants 06, 07, 09, 10)

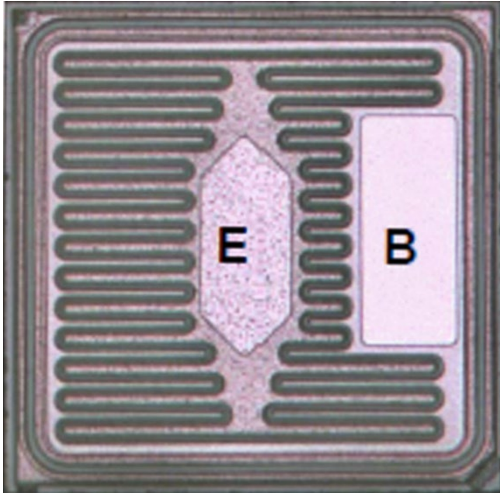


Symbols	Dimensions mm		Notes
	Min	Max	
A	2.84	3.3	
A1	0.25	0.51	
b	7.13	7.39	
b1	5.58	5.84	
b2	2.28	2.54	2
b3	2.92	3.18	2
D	10.03	10.28	
D1	0.76	-	2
E	7.39	7.64	
e	1.91 BSC		2

NOTES:

1. Terminal identification is specified by the component's geometry where:
   - For Variants 06, 09: Terminal 1 = emitter, Terminal 2 = base, Terminal 3 = collector
   - For Variants 07, 10: Terminal 1 = base, Terminal 2 = emitter, Terminal 3 = collector
2. 2 places.

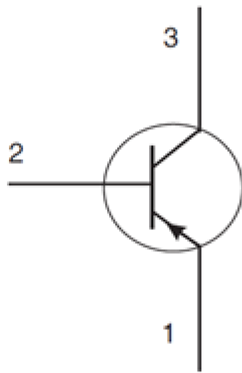
1.7.3 Die (Variant 08)



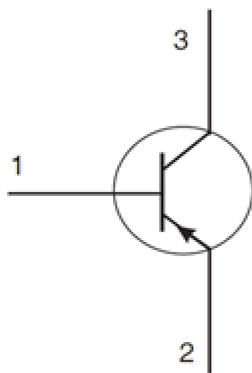
NOTES:

1. Die materials and dimensions:
    - Die substrate: Silicon
    - Die length: 1510 µm
    - Die width: 1500 µm
    - Die thickness: 230 ±20µm
    - Top Glassivation:
        - P-Vapox with thickness: 720 ±80nm and
        - Nitride with thickness 540 ±60nm
    - Top metallisation: Al/Si (1%) with thickness: 2 ±0.2µm (Typ.)
    - Backside metallisation: Au/As with thickness: 1.485 ±0.165µm
    - Emitter pad dimensions: 275 × 707 µm
    - Base pad dimensions: 300 × 540 µm
2. Terminal identification and Bias details: B = base, E = emitter, Backside contact = collector

1.8 FUNCTIONAL DIAGRAM



Variants 04 to 06, 09
1. Emitter.
2. Base.
3. Collector.



Variants 07, 10
1. Base.
2. Emitter.
3. Collector.

NOTES:

1. For TO-257 (Variants 04, 05), the case is not connected to any lead.
2. For SMD.5 (Variants 06, 07, 09, 10), the lid is not connected to any terminal.
3. For Die Components (Variant 08), the terminal numbering is not applicable.

1.9 MATERIALS AND FINISHES

1.9.1 Materials and Finishes of Packaged Components

For Variants 04 to 07, 09, 10 the materials and finishes shall be as follows:

(a) Case

For the metal flange mount package (Variants 04, 05), the case shall be hermetically sealed and have a metal body. The leads pass through ceramic eyelets brazed into the frame and the lid shall be welded.

For the surface mount package (Variants 06, 07, 09, 10), the case shall be hermetically sealed and have a ceramic body with a Kovar lid.

(b) Leads/Terminals

As specified in Para. 1.4.2.

1.9.2 Materials and Finishes of Die Components

For Variant 08, the materials and finishes shall be as specified in Para. 1.7.3.

2 REQUIREMENTS

2.1 GENERAL

The complete requirements for procurement of the components specified herein are as stated in this specification and the ESCC Generic Specification. Permitted deviations from the Generic Specification, applicable to this specification only, are listed below.

Permitted deviations from the Generic Specification and this Detail Specification, formally agreed with specific Manufacturers on the basis that the alternative requirements are equivalent to the ESCC requirement and do not affect the component's reliability, are listed in the appendices attached to this specification.

2.1.1 Deviations from the Generic Specification

None.

2.2 MARKING

The marking shall be in accordance with the requirements of ESCC Basic Specification No. 21700 and as follows.

The information to be marked on the component or its primary package shall be:

(a) The ESCC qualified components symbol (for ESCC qualified components only).
(b) The ESCC Component Number (see Para. 1.4.1).
(c) Traceability information.
(d) Warning sign for Beryllium Oxide (Variants 04, 05 (TO-257) only).

2.3 CASE ISOLATION

For Variants 04, 05 (TO-257), Case Isolation shall be performed as specified in the ESCC Generic Specification and as follows:

- Test Conditions:
  - Test voltage: 500Vdc
  - Duration of application of test voltage: 1s
  - Points of application of test voltage: between case metal tab and all terminals connected together.
  - Maximum leakage current: 10nA

2.4 TERMINAL STRENGTH

The test conditions for terminal strength, tested as specified in the ESCC Generic Specification, shall be as follows:

- For Variants 04, 05 (TO-257), Test Condition: A, tension, with an applied force of 10N for a duration of 10s.

2.5 VERIFICATION OF SAFE OPERATING AREA

The Safe Operating Area shall be verified as specified in the ESCC Generic Specification and Para. 1.5 Maximum Ratings herein. The test conditions shall be:

- Test Method = MIL-STD-750, Method 3051, Continuous DC
- T_{case} = +25°C
- V_{CE} = -18V
- I_C = -500mA
- Operating Time ≤ 50ms

2.6 ELECTRICAL MEASUREMENTS AT ROOM, HIGH AND LOW TEMPERATURES

Electrical measurements shall be performed at room, high and low temperatures.

2.6.1 Room Temperature Electrical Measurements

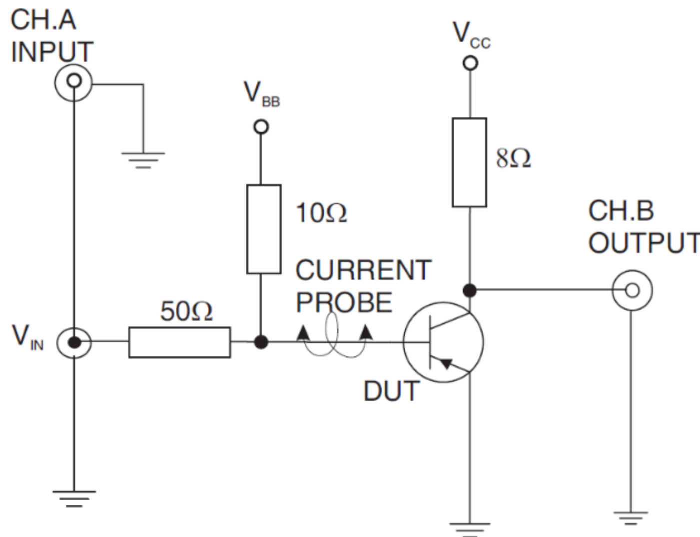
The measurements shall be performed at T_{amb} = +22 ±3°C.

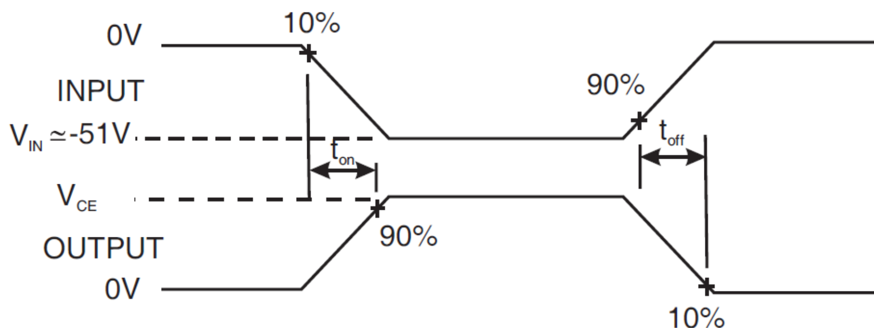
Characteristics	Symbols	MIL-STD-750 Test Method	Test Conditions	Limits		Units
				Min	Max	
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	3011	I_C = -100mA, Bias condition D Note 1	-80	-	V
Collector-Emitter Cut-off Current	I_{CES}	3041	V_{CE} = -60V, Bias condition C	-	-1	μA
	I_{CEO}	3041	V_{CE} = -40V, Bias condition D	-	-50	μA
Emitter-Base Cut-off Current	I_{EBO1}	3061	V_{EB} = -4V, Bias condition D	-	-1	μA
	I_{EBO2}	3061	V_{EB} = -5.5V, Bias condition D	-	-1	mA
Forward-Current Transfer Ratio	h_{FE1}	3076	V_{CE} = -5V; I_C = -50mA Note 1	50	-	-
	h_{FE2}	3076	V_{CE} = -5V; I_C = -2.5A Note 1	70	200	-
	h_{FE3}	3076	V_{CE} = -5V; I_C = -5A Note 1	40	-	-
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	3071	I_C = -5A, I_B = -500mA Note 1	-	-1.5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)1}$	3066	I_C = -2.5A, I_B = -250mA Test condition A Note 1	-	-1.45	V
	$V_{BE(sat)2}$	3066	I_C = -5A, I_B = -500mA Test condition A Note 1	-	-2.2	V
High Frequency Small Signal Current Gain	h_{fe}	3306	V_{CE} = -5V, I_C = -500mA f = 20MHz Notes 2, 3	3.5	-	-
Output Capacitance	C_{obo}	3236	V_{CB} = -10V, I_E = 0A, f = 1MHz Notes 2, 3	-	250	pF
Turn-on Time	t_{on}	-	I_C = -5A, I_{B1} = -500mA I_{B2} = 500mA, V_{CC} = -30V V_{BB} = 4V, V_{IN} ≈ -51V Notes 2, 3, 4	-	500	ns

Characteristics	Symbols	MIL-STD-750 Test Method	Test Conditions	Limits		Units
				Min	Max	
Turn-off Time	t_{off}	-	I_C = -5A, I_{B1} = -500mA I_{B2} = 500mA V_{CC} = -30V, V_{BB} = 4V V_{IN} ≈ -51V Notes 2, 3, 4	-	1.3	μs

NOTES:

1. Pulse measurement: Pulse Width ≤ 300μs, Duty Cycle ≤ 2%
2. For Packaged Components (Variants 04 to 07, 09, 10), all AC characteristics read and record measurements shall be performed on a sample of 32 components with 0 failures allowed. Alternatively, a 100% inspection may be performed.
3. For Die Components (Variant 08), all AC characteristics read and record measurements shall be performed on either a sample of 32 components or 100% of the Packaged Test Sublot, whichever is less, with 0 failures allowed
4. t_{on} and t_{off} shall be measured using the following test circuit. The input waveform shall be supplied by a pulse generator with the following characteristics: t_r ≤ 20ns, Pulse Width = 10μs, Duty Cycle = 1%. The sampling oscilloscope for CH.A and CH.B shall have the characteristics Z_{IN} ≥ 100kΩ, C_{IN} ≤ 12pF and t_r ≤ 5ns. Adjustment of V_{IN} shall be made with a suitable current probe to achieve the specified I_{B1} and I_{B2} test conditions, where I_{B1} is the on-state base current and I_{B2} is the post off-state base current.





2.6.2 High and Low Temperatures Electrical Measurements

Characteristics	Symbols	MIL-STD-750 Test Method	Test Conditions Note 1	Limits		Units
				Min	Max	
Collector-Base Cut-off Current	I_{CES}	3041	T_{amb} = +150 (+0 -5)°C V_{CE} = -60V, Bias Condition C	-	-10	µA
Forward-Current Transfer Ratio 2	h_{FE2}	3076	T_{amb} = -55 (+5 -0)°C V_{CE} = -5V, I_C = -2.5A Note 2	35	-	-

NOTES:
1. Measurements shall be performed on a sample basis as specified in the Generic Specification.
2. Pulsed measurement: Pulse Width ≤ 300µs, Duty Cycle ≤ 2%.

2.7 PARAMETER DRIFT VALUES

Unless otherwise specified, the measurements shall be performed at T_{amb} = +22 ±3°C.

The test methods and test conditions shall be as per the corresponding test defined in Para. 2.6.1, Room Temperature Electrical Measurements.

The drift values (Δ) shall not be exceeded for each characteristic specified. The corresponding absolute limit values for each characteristic shall not be exceeded.

Characteristics	Symbols	Limits			Units
		Drift Value Δ	Absolute		
			Min	Max	
Collector-Emitter Cut-off Current	I_{CES}	±100	-	-1000	nA
Forward-Current Transfer Ratio 2	h_{FE2}	±25%	70	200	-
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	±100	-	-1500	mV

2.8 INTERMEDIATE AND END-POINT ELECTRICAL MEASUREMENTS

Unless otherwise specified, the measurements shall be performed at T_{amb} = +22 ±3°C.

The test methods and test conditions shall be as per the corresponding test defined in Para. 2.6.1, Room Temperature Electrical Measurements.

The limit values for each characteristic shall not be exceeded.

Characteristics	Symbols	Limits		Units
		Min	Max	
Collector-Emitter Cut-off Current	I_{CES}	-	-1	µA
Forward-Current Transfer Ratio 2	h_{FE2}	70	200	-
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	-	-1.5	V

2.9 HIGH TEMPERATURE REVERSE BIAS BURN-IN CONDITIONS

Characteristics	Symbols	Conditions	Units
Ambient Temperature	T_{amb}	+150	°C
Emitter-Base Voltage	V_{EB}	-4.5	V
Collector-Base Voltage	V_{CB}	-60	V
Duration	t	48	hours

2.10 POWER BURN-IN CONDITIONS

Characteristics	Symbols	Conditions	Units
Case Temperature	T_{case}	+100 (+0 -5)	°C
Power Dissipation	P_{tot}	As per Para. 1.5 Maximum Ratings. Derate P_{tot2} at the specified T_{case} using the specified $R_{th(j-c)}$.	W
Collector-Base Voltage	V_{CB}	-20	V

2.11 OPERATING LIFE CONDITIONS

The conditions shall be as specified in Para. 2.10 Power Burn-in Conditions.

2.12 TOTAL DOSE RADIATION TESTING

All lots shall be irradiated in accordance with ESCC Basic Specification No. 22900, low dose rate (window 2: 36 to 360 RAD/h).

2.12.1 Bias Conditions and Total Dose Level for Total dose Radiation Testing

The following bias conditions shall be used for Total Dose Radiation Testing:

Characteristics	Symbols	Test Conditions	Units
Ambient Temperature	T_{amb}	+20 ±5	°C
Bias Condition 1: Collector-Emitter Voltage	V_{CES}	≥ 80% $V_{(BR)CEO}$	V
Bias Condition 2: Collector-Emitter Voltage	V_{CES}	0	V

The total dose level applied shall be as specified in Para. 1.4.2 or in the Purchase Order.

2.12.2 Electrical Measurements for Radiation Testing

Prior to irradiation testing the devices shall have successfully met Room Temperature Electrical Measurements specified in Para. 2.6.1.

Unless otherwise stated the measurements shall be performed at T_{amb} = +22 ±3°C.

Unless otherwise specified the test methods and test conditions shall be as per the corresponding test defined in Para. 2.6.1, Room Temperature Electrical Measurements.

The parameters to be measured during and on completion of irradiation testing are shown below.

Characteristics	Symbols	MIL-STD-750 Test Method	Test Conditions	Limits		Units
				Min	Max	
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	See Para. 2.6.1	See Para. 2.6.1	-80	-	V
Collector-Emitter Cut-off Current	I_{CES}	See Para. 2.6.1	See Para. 2.6.1	-	-1	μA
	I_{CEO}	See Para. 2.6.1	See Para. 2.6.1	-	-50	μA
Emitter-Base Cut-off Current	I_{EBO1}	See Para. 2.6.1	See Para. 2.6.1	-	-1	μA
	I_{EBO2}	See Para. 2.6.1	See Para. 2.6.1	-	-1	mA
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	See Para. 2.6.1	See Para. 2.6.1	-	-1.5	V
Base-Emitter Saturation Voltage	$V_{BE(sat)1}$	See Para. 2.6.1	See Para. 2.6.1	-	-1.45	V
	$V_{BE(sat)2}$	See Para. 2.6.1	See Para. 2.6.1	-	-2.2	V
Forward-Current Transfer Ratio (post irradiation gain calculation) (Note 1)	[h_{FE1}]	3076	V_{CE} = -5V, I_C = -50mA	[25]	-	-
	[h_{FE2}]		V_{CE} = -5V, I_C = -2.5A	[35]	200	-
	[h_{FE3}]		V_{CE} = -5V, I_C = -5A	[20]	-	-

NOTES:

1. The post-irradiation gain calculation of [h_{FE}], made using h_{FE} measurements from prior to and on completion of irradiation testing and after each annealing step if any, shall be as specified in MIL-STD-750 Method 1019.

APPENDIX A

AGREED DEVIATIONS FOR STMICROELECTRONICS (F)

ITEMS AFFECTED	DESCRIPTION OF DEVIATIONS
Para. 2.1.1, Deviations from the Generic Specification: Para. 8, Test Methods and Procedures	For qualification and qualification maintenance, or procurement of qualified or unqualified components, the following replacement test method specifications shall be used instead of the following ESCC Basic Specifications: No. 20400, Internal Visual Inspection: replaced by MIL-STD-750 Test Method 2072. No. 20500, External Visual Inspection: replaced by MIL-STD-750 Test Method 2071. No. 20900, Radiographic Inspection of Electronic Components: replaced by MIL-STD-750 Test Method 2076.
Para. 2.1.1, Deviations from the Generic Specification: Screening Tests - Chart F3	Solderability is not applicable unless specifically stipulated in the Purchase Order.
Para. 2.6.1, Room Temperature Electrical Measurements	All AC characteristics (Para. 2.6.1, Notes 3 and 4) may be considered guaranteed but not tested if successful pilot lot testing has been performed on the wafer lot which includes AC characteristic measurements per the Detail Specification. A summary of the pilot lot testing shall be provided if required by the Purchase Order.
Para. 2.6.2, High and Low Temperatures Electrical Measurements	All characteristics specified may be considered guaranteed but not tested if successful pilot lot testing has been performed on the wafer lot which includes characteristic measurements at high and low temperatures per the Detail Specification. A summary of the pilot lot testing shall be provided if required by the Purchase Order.
Para. 2.10, Power Burn-in Conditions	For TO-257 and SMD.5 packaged Variants (Variants 04 to 07, 09, 10), the following alternate Power Burn-in conditions may be applied: • Ambient Temperature (T_{amb}): +20 to +50°C (Note 1) • Power Dissipation (P_{tot}): As per Para. 1.5 Maximum Ratings. Derate P_{tot1} at the chosen T_{amb} using the specified $R_{th(j-a)}$ (W) • Collector-Base Voltage (V_{CB}): 20 to 40V **NOTE 1:** No heat sink nor forced air directly on the device shall be permitted.