

## Hi-Rel NPN bipolar transistor 80 V, 5 A

Datasheet - production data

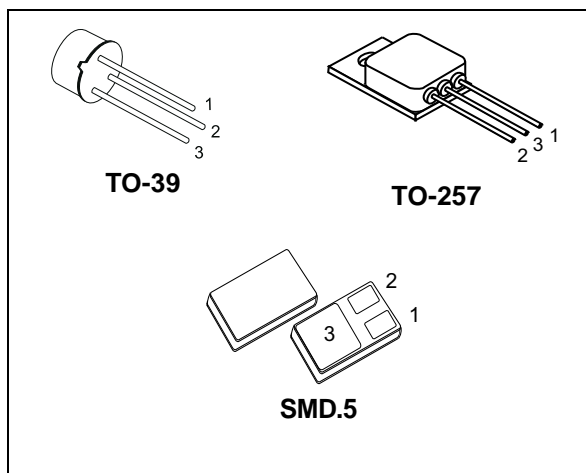
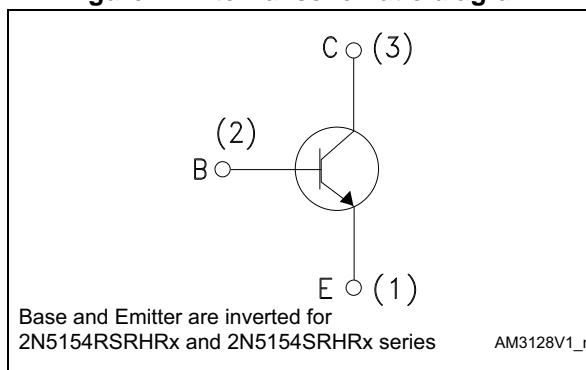


Figure 1. Internal schematic diagram



### Features

$V_{CEO}$	80 V
$I_C$ (max)	5 A
$H_{FE}$ at 10 V, 150 mA	> 70
Operating temperature range	- 65 °C to + 200 °C

- Hi-Rel NPN bipolar transistor
- Linear gain characteristics
- ESCC qualified
- European preferred part list - EPPL
- Radiation level: lot specific total dose contact marketing for specified level

### Description

The 2N5154HR is a silicon planar epitaxial NPN transistor in TO-39, TO-257 and SMD.5 packages. It is specifically designed for aerospace Hi-Rel applications and ESCC qualified according to the 5203/010 specification. In case of conflict between this datasheet and ESCC detailed specification, the latter prevails.

Table 1. Device summary

Order code	Quality level	Agency specification	Package	Other features	EPPL
2N5154HRx	ESCC	5203/010	TO-39	-	Yes
2N5154RHRx				100 krad ESCC LDR	
2N5154ESYHRx			TO-257	-	
2N5154RESYHRx				100 krad ESCC LDR	
2N5154RSRHRx			SMD.5	100 krad LDR, emitter on pin 1	
2N5154SHRx				Emitter on pin 1	
2N5154RSRHRx				100 krad LDR, emitter on pin 2	
2N5154SRHRx				Emitter on pin 2	

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		TO-39	TO-257 SMD.5	
$V_{CBO}$	Collector-base voltage ( $I_E = 0$ A)	100		V
$V_{CEO}$	Collector-emitter voltage ( $I_B = 0$ A)	80		
$V_{EBO}$	Emitter-base voltage ( $I_C = 0$ A)	6		
$I_C$	Collector current	5		A
$P_{TOT}$	Total dissipation at $T_{amb} \leq 25$ °C	1	3.3	W
	Total dissipation at $T_{case} \leq 25$ °C	8.75	35	
$T_{STG}$	Storage temperature range	-65 to 200		°C
$T_J$	Operating junction temperature range			

**Table 3. Thermal data**

Symbol	Parameter	Value		Unit
		TO-39	TO-257 SMD.5	
$R_{thJ-case}$	Thermal resistance junction-case	20	5	°C/W
$R_{thJ-amb}$	Thermal resistance junction-ambient	175	53	

## 2 Electrical characteristics

$T_{\text{case}} = 25\text{ °C}$  unless otherwise specified.

**Table 4. Electrical characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{\text{CES}}$	Collector cut-off current	$V_{\text{CB}} = 60\text{ V}, I_{\text{E}} = 0\text{ A}$		-	1	$\mu\text{A}$
		$V_{\text{CB}} = 60\text{ V}, I_{\text{E}} = 0\text{ A}$ $T_{\text{amb}} = 150\text{ °C}$		-	10	$\mu\text{A}$
$I_{\text{EBO}}$	Emitter cut-off current	$V_{\text{EB}} = 5\text{ V}, I_{\text{C}} = 0\text{ A}$		-	1	$\mu\text{A}$
		$V_{\text{EB}} = 6\text{ V}, I_{\text{C}} = 0\text{ A}$		-	1	$\text{mA}$
$I_{\text{CEO}}$	Collector cut-off current	$V_{\text{CE}} = 40\text{ V}, I_{\text{B}} = 0\text{ A}$		-	50	$\mu\text{A}$
$V_{(\text{BR})\text{CEO}}^{(1)}$	Collector-emitter breakdown voltage	$I_{\text{C}} = 100\text{ mA}, I_{\text{B}} = 0\text{ A}$	80	-		$\text{V}$
$V_{\text{CE}(\text{sat})}^{(1)}$	Collector-emitter saturation voltage	$I_{\text{C}} = 2.5\text{ A}, I_{\text{B}} = 0.25\text{ A}$		-	1.45	$\text{V}$
		$I_{\text{C}} = 5\text{ A}, I_{\text{B}} = 0.5\text{ A}$		-	1.5	
$V_{\text{BE}(\text{sat})}^{(1)}$	Base-emitter saturation voltage	$I_{\text{C}} = 2.5\text{ A}, I_{\text{B}} = 0.25\text{ A}$		-	1.45	$\text{V}$
		$I_{\text{C}} = 5\text{ A}, I_{\text{B}} = 0.5\text{ A}$		-	2.2	
$h_{\text{FE}}^{(1)}$	DC current gain	$I_{\text{C}} = 50\text{ mA}, V_{\text{CE}} = 5\text{ V}$	50	-		
		$I_{\text{C}} = 2.5\text{ A}, V_{\text{CE}} = 5\text{ V}$	70	-	200	
		$I_{\text{C}} = 5\text{ A}, V_{\text{CE}} = 5\text{ V}$	40	-		
		$I_{\text{C}} = 2.5\text{ A}, V_{\text{CE}} = 5\text{ V}$ $T_{\text{amb}} = -55\text{ °C}$	35	-		
$h_{\text{fe}}$	AC forward current transfer ratio	$V_{\text{CE}} = 5\text{ V}, I_{\text{C}} = 500\text{ mA}$ $f = 20\text{ MHz}$	3.5	-		
$C_{\text{OBO}}$	Output capacitance	$I_{\text{E}} = 0\text{ A}, V_{\text{CB}} = 10\text{ V}$ $f = 1\text{ MHz}$		-	250	$\text{pF}$
$t_{\text{on}}$	Turn-on time	$V_{\text{CC}} = 30\text{ V}, V_{\text{BB}} = -4\text{ V}$		-	0.5	$\mu\text{s}$
$t_{\text{off}}$	Turn-off time	$V_{\text{in}} \cong 51\text{ V}, I_{\text{C}} = 5\text{ A}$ $I_{\text{B}1} = -I_{\text{B}2} = 0.5\text{ A}$		-	1.3	$\mu\text{s}$

1. Pulsed duration = 300  $\mu\text{s}$ , duty cycle  $\leq 2\%$

## 2.1 Electrical characteristics (curves)

Figure 2.  $V_{BE(on)}$  @  $V_{CE} = 5\text{ V}$

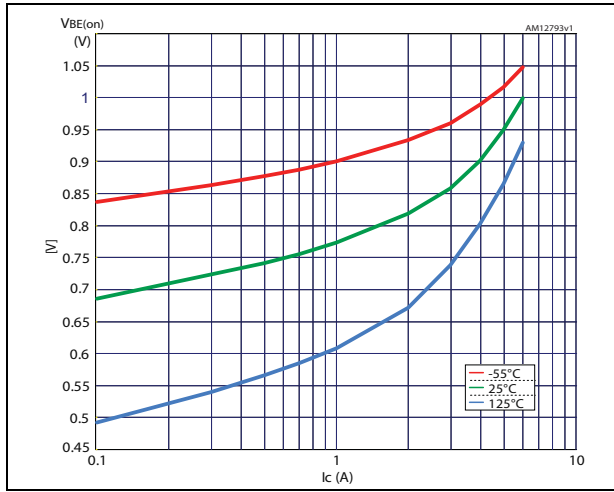


Figure 3.  $h_{FE}$  @  $V_{CE} = 5$

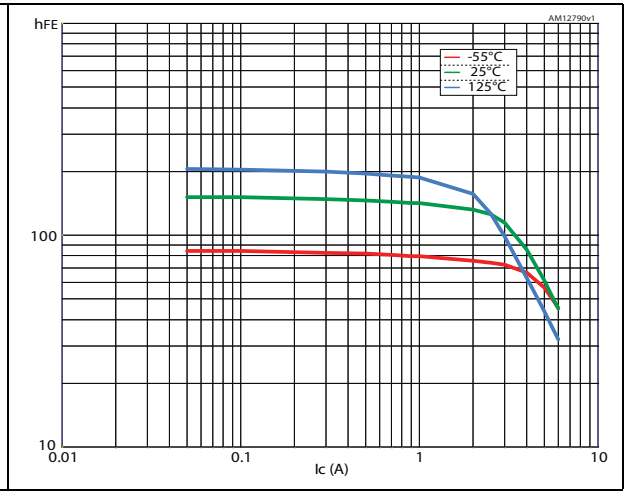


Figure 4.  $V_{CE(sat)}$  @  $h_{FE} = 10$

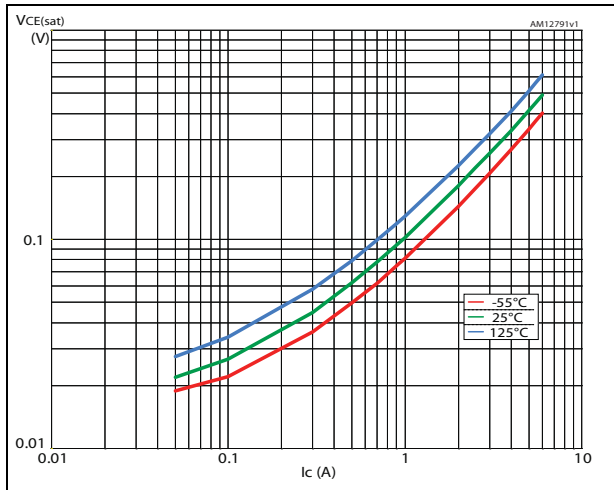
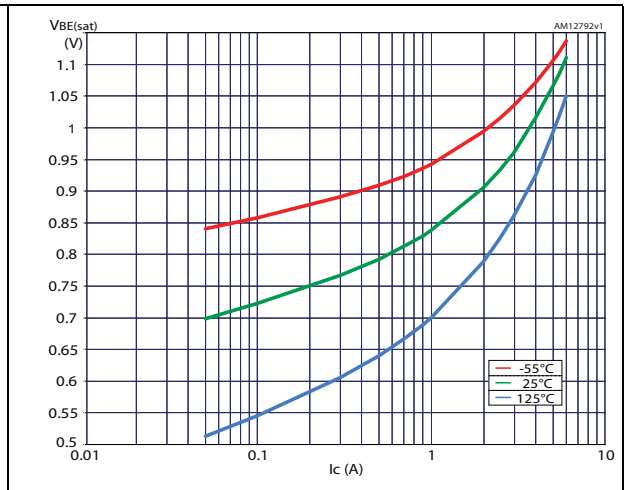
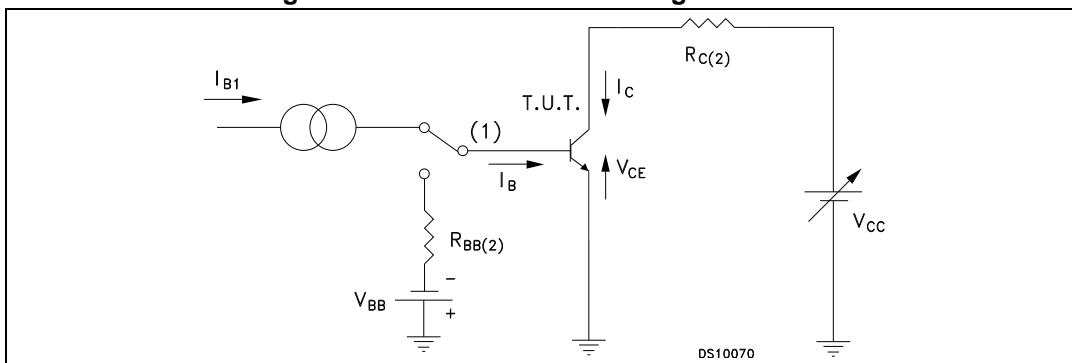


Figure 5.  $V_{BE(sat)}$  @  $h_{FE} = 10$



## 2.2 Test circuit

Figure 6. Resistive load switching test circuit



1. Fast electronic switch
2. Non-inductive resistor

### 3 Radiation hardness assurance

The products guaranteed in radiation within the ESCC system fully comply with the ESCC 5203/010 and ESCC 22900 specifications.

#### ESCC radiation assurance

Each product lot is tested according to the ESCC basic specification 22900, with a minimum of 11 samples per diffusion lot and 5 samples per wafer, one sample being kept as unirradiated sample, all of them being fully compliant with the applicable ESCC generic and/or detailed specification.

ST goes beyond the ESCC specification by performing the following procedure:

- Test of 11 pieces by wafer, 5 biased at least 80% of  $V_{(BR)CEO}$ , 5 unbiased and 1 kept for reference
- Irradiation at 0.1 rad (Si)/s
- Acceptance criteria of each individual wafer if as 100 krad guaranteed if all 10 samples comply with the post radiation electrical characteristics provided in [Table 5](#)
- Delivery together with the parts of the radiation verification test (RVT) report of the particular wafer used to manufacture the products. This RVT includes the value of each parameter at 30, 50, 70 and 100 krad (Si) and after 24 hour annealing at room temperature and after an additional 168 hour annealing at 100°C.

Table 5. ESCC 5203/010 post radiation electrical characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{CES}$	Collector cut-off current	$V_{CB} = 60 \text{ V}, I_E = 0 \text{ A}$		-	1	$\mu\text{A}$
$I_{EBO}$	Emitter cut-off current	$V_{EB} = 5 \text{ V}, I_C = 0 \text{ A}$		-	1	$\mu\text{A}$
		$V_{EB} = 6 \text{ V}, I_C = 0 \text{ A}$		-	1	$\text{mA}$
$I_{CEO}$	Collector cut-off current	$V_{CE} = 40 \text{ V}, I_B = 0 \text{ A}$		-	50	$\mu\text{A}$
$V_{(BR)CEO}^{(1)}$	Collector-emitter breakdown voltage	$I_C = 100 \text{ mA}, I_B = 0 \text{ A}$	80	-		V
$V_{CE(sat)}^{(1)}$	Collector-emitter saturation voltage	$I_C = 2.5 \text{ A}, I_B = 0.25 \text{ A}$		-	1.45	V
		$I_C = 5 \text{ A}, I_B = 0.5 \text{ A}$		-	1.5	
$V_{BE(sat)}^{(1)}$	Base-emitter saturation voltage	$I_C = 2.5 \text{ A}, I_B = 0.25 \text{ A}$		-	1.45	V
		$I_C = 5 \text{ A}, I_B = 0.5 \text{ A}$		-	2.2	
$[h_{FE}]^{(1)}$	Post irradiation gain calculation <sup>(2)</sup>	$I_C = 50 \text{ mA}, V_{CE} = 5 \text{ V}$	[25]	-		
		$I_C = 2.5 \text{ A}, V_{CE} = 5 \text{ V}$	[35]	-	[200]	
		$I_C = 5 \text{ A}, V_{CE} = 5 \text{ V}$	[20]	-		

1. Pulsed duration = 300  $\mu\text{s}$ , duty cycle  $\leq 2\%$

2. 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 MILSTD-750 method 1019.

## 4 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK<sup>®</sup> is an ST trademark.

### 4.1 TO-39 package information

Figure 7. TO-39 package outline

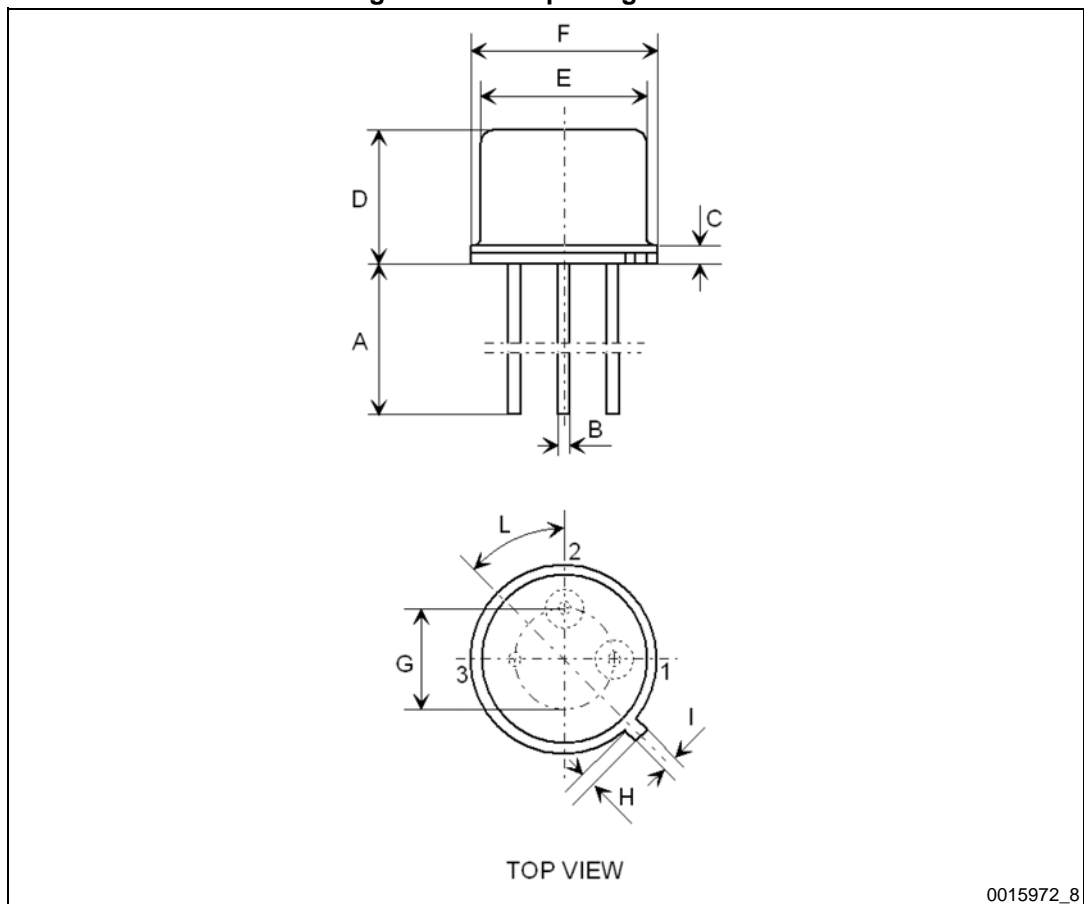


Table 6. TO-39 package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	12.70	13.50	14.30
B	0.40	0.45	0.49
C	0.58		0.74
D	6.00		6.40
E	8.15	8.20	8.25
F	9.10		9.40
G	4.93	5.08	5.23
H	0.86	0.91	0.96
I	0.77	0.80	0.86
L	42 °	45 °	48 °

## 4.2 TO-257 package information

Figure 8. TO-257 package outline

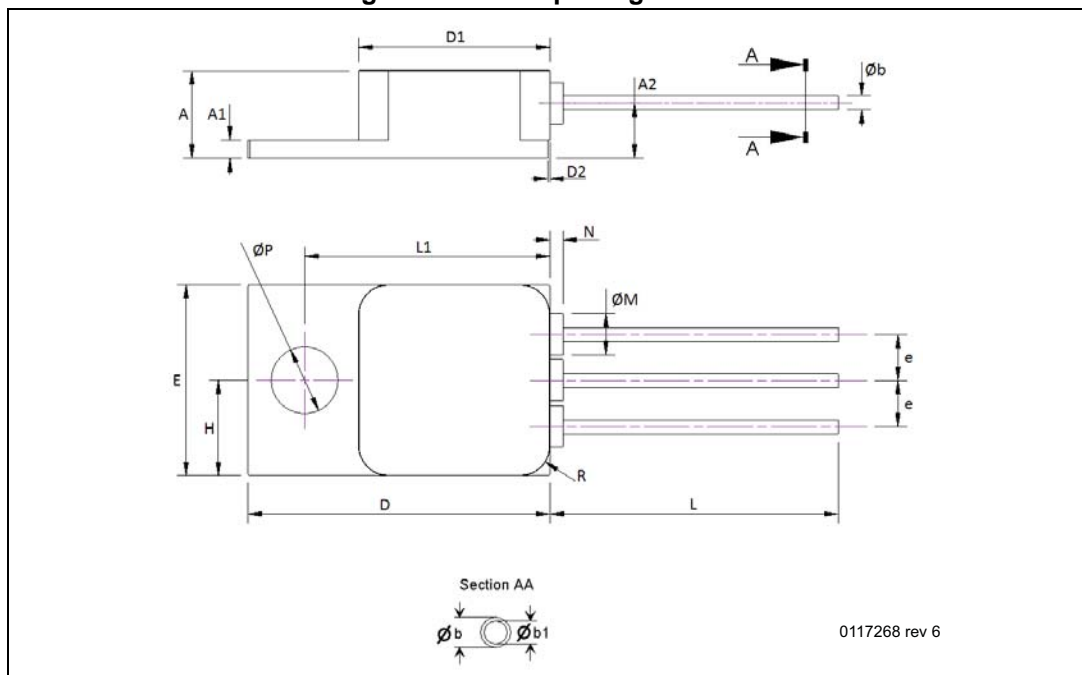


Table 7. TO-257 package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.83	4.95	5.08
A1	0.89	1.02	1.14
A2	2.91	3.05	3.18
b	0.64		1.02
b1	0.64	0.74	0.89
D	16.51	16.64	16.76
D1	10.41	10.54	10.67
D2			0.97
e	2.41	2.54	2.67
E	10.41	10.54	10.67
H	5.13	5.25	5.38
L	15.24	15.88	16.51
L1	13.39	13.51	13.64
M	2.16	2.29	2.41
N			0.71
P	3.56	3.68	3.81
R		1.65	

### 4.3 SMD.5 package information

Figure 9. SMD.5 package outline

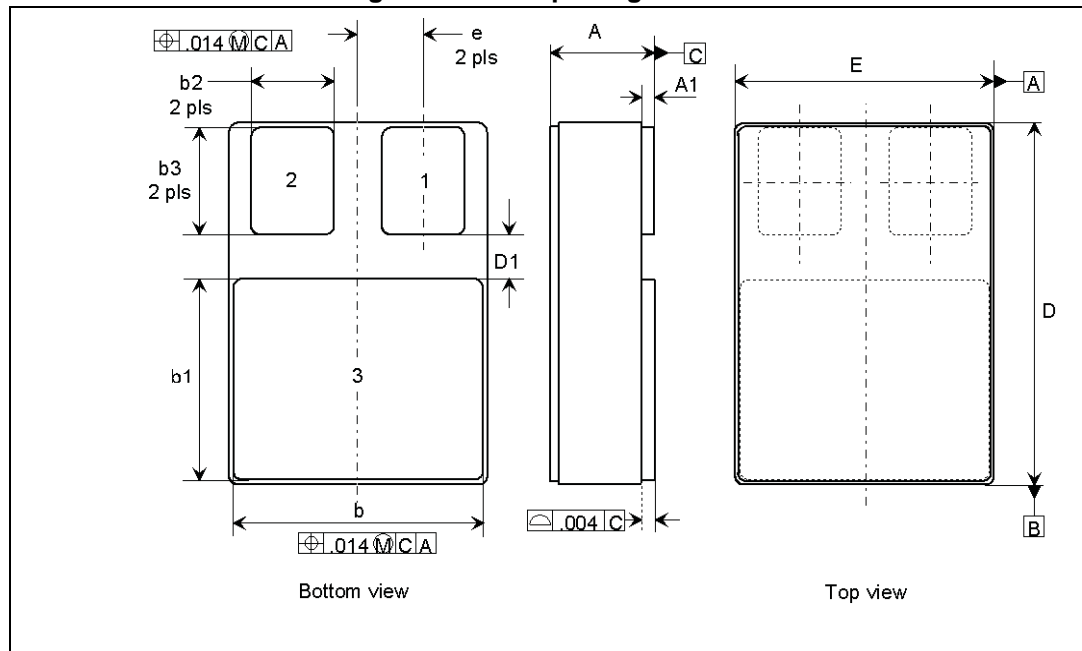


Table 8. SMD.5 package mechanical data

Dim.	mm			Inch		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	2.84	3.00	3.15	0.112	0.118	0.124
A1	0.25	0.38	0.51	0.010	0.015	0.020
b	7.13	7.26	7.39	0.281	0.286	0.291
b1	5.58	5.72	5.84	0.220	0.225	0.230
b2	2.28	2.41	2.54	0.090	0.095	0.100
b3	2.92	3.05	3.18	0.115	0.120	0.125
D	10.03	10.16	10.28	0.935	0.400	0.405
D1	0.76			0.030		
E	7.39	7.52	7.64	0.291	0.296	0.301
e		1.91			0.075	

## 5 Ordering information

Table 9. Order codes

Order code	Agency specification	EPPL	Quality level	Other features	Package	Lead finish	Marking <sup>(1)</sup>	Packing
2N51541	-	-	Engineering model	-	TO-39	Gold	2N51541	Strip pack
2N5154HRG	5203/010/01	Yes	ESCC	-		Gold	520301001	
2N5154HRT	5203/010/02	Yes	ESCC	-		Solder dip	520301002	
2N5154RHRG	5203/010/01R	Yes	ESCC	100 krad ESCC LDR		Gold	520301001R	
2N5154RHRT	5203/010/02R	Yes	ESCC	100 krad ESCC LDR		Solder dip	520301002R	
2N5154ESY1	-	-	Engineering model	-	TO-257	Gold	2N5154ESY1 + BeO	
2N5154ESYHRG	5203/010/04	Yes	ESCC	-		Gold	520301004 + BeO	
2N5154ESYHRT	5203/010/05	Yes	ESCC	-		Solder dip	520301005 + BeO	
2N5154RESYHRG	5203/010/04R	Yes	ESCC	100 krad ESCC LDR		Gold	520301004R + BeO	
2N5154RESYHRT	5203/010/05R	Yes	ESCC	100 krad ESCC LDR		Solder dip	520301005R + BeO	
2N5154S1	-	-	Engineering model	Emitter on pin 1	SMD.5	Gold	2N5154S1	
2N5154RSHRG	5203/010/06R	Yes	ESCC	100 krad LDR, emitter on pin 1			520301006R	
2N5154SHRG	5203/010/06	Yes	ESCC	Emitter on pin 1			520301006	
2N5154SR1	-	-	Engineering model	Emitter on pin 2			2N5154SR1	
2N5154RSRHRG	5203/010/07R	Yes	ESCC	100 krad LDR, emitter on pin 2			520301007R	
2N5154SRHRG	5203/010/07	Yes	ESCC	Emitter on pin 2			520301007	

1. Specific marking only. The full marking includes in addition, for the engineering models: ST logo, date code, country of origin (FR). For ESCC flight parts: ST logo, date code, country of origin (FR), ESA logo, serial number of the part within the assembly lot.

Contact ST sales office for information about the specific conditions for:

- Products in die form
- Tape and reel packing

## 6 Shipping details

### 6.1 Date code

Date code xyywwz is structured as per the table below:

**Table 10. Date code**

Type	x	yy	ww	z
EM (ESCC)	3	Last two digits of the year	Week digits	Lot index within the week
ESCC flight				

### 6.2 Documentation

**Table 11. Documentation provided for each type of product**

Quality level	Radiation level	Documentation
Engineering model		Last two digits of the year
ESCC flight	100 krad	Certificate of conformance
		0.1 rad/s radiation verification test report

## 7 Revision history

**Table 12. Document revision history**

Date	Revision	Changes
08-Jan-2009	1	Initial release
08-Jan-2010	2	Modified Table 1: Device summary
22-Jul-2011	3	Updated marking for the order code 2N5154ESYHRB in Table 1: Device summary
12-Sep-2012	4	Added: Section 2.1: Electrical characteristics (curves) on page 5
29-Jan-2014	5	Added Section 3: Radiation hardness assurance and Section 5: Ordering information Updated Table 1: Device summary.
08-Apr-2014	6	Updated Table 1: Device summary and Table 10: Order codes. Updated Section 4: Package mechanical data. Added Figure 2.: Safe operating area. Minor text changes.
29-Jan-2016	7	Updated Figure 2.: Safe operating area. Minor text changes.
05-Apr-2016	8	Added part number 2N5154RSRHRG. Document updated accordingly. Updated <a href="#">Section 4: Package information</a> .
02-May-2016	9	Updated package silhouette, <a href="#">Figure 1: Internal schematic diagram</a> and <a href="#">Table 1: Device summary</a> in cover page. Updated <a href="#">Section 4: Package information</a> and <a href="#">Section 5: Ordering information</a> . Inserted <a href="#">Section 6: Shipping details</a> . Minor text changes.

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