

### Features

Parameter	ESCC	JANS
$BV_{CEO}$ min	40 V	50 V
$I_C$ (max)	0.8 A	
$h_{FE}$ at 10 V - 150 mA	100	

- Linear gain characteristics
- Hermetic packages
- ESCC and JANS qualified
- European preferred part list EPPL
- Up to 100 krad(Si) low dose rate

### Description

The 2N2222AHR is a silicon planar NPN transistor specifically designed and housed in hermetic packages for aerospace and Hi-Rel applications. It is available in the JAN qualification system (MIL-PRF19500 compliance) and in the ESCC qualification system (ESCC 5000 compliance). In case of discrepancies between this datasheet and the relevant agency specification, the latter takes precedence.

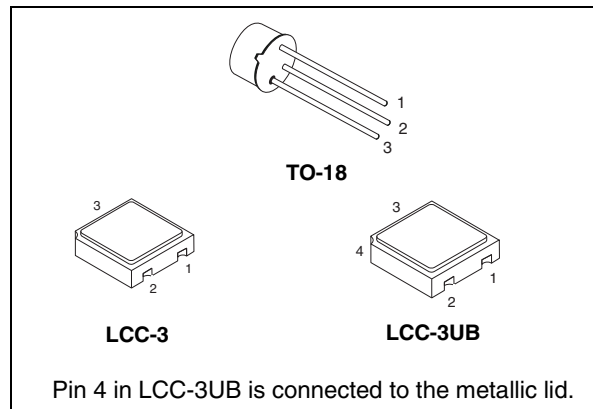


Figure 1. Internal schematic diagram<sup>1</sup>

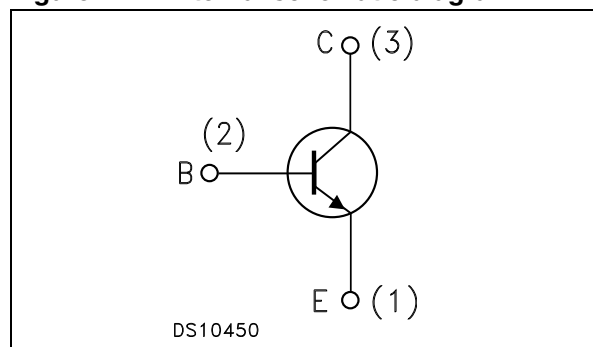


Table 1. Devices summary<sup>(1)</sup>

Device	Qualification	Agency spec.	Package	Radiation level	EPPL
JANS2N2222A	JANS	MIL-PRF-19500/255	LCC-3UB	-	-
JANSR2N2222A				100 krad	-
SOC2222AUB	ESCC	5201/002	LCC-3UB	-	Yes
SOC2222AUBxxSW				100 krad	Yes
SOC2222A			LCC-3	-	Yes
SOC2222AxxSW				100 krad	Yes
2N2222AHR			TO-18	-	-
2N2222ASW				100 krad	-

1. Contact ST sales office for information about the specific conditions for products in die form and other JAN quality levels

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CBO}$	Collector-base voltage ( $I_E = 0$ )	75	V
$V_{CEO}$	Collector-emitter voltage ( $I_B = 0$ ) for JANS devices	50	V
	Collector-emitter voltage ( $I_B = 0$ ) for ESCC devices	40	V
$V_{EBO}$	Emitter-base voltage ( $I_C = 0$ )	6	V
$I_C$	Collector current	0.8	A
$P_{TOT}$	Total dissipation at $T_{amb} \leq 25\text{ °C}$		
	ESCC: TO-18	0.5	W
	LCC-3 and LCC-3UB	0.5	
	LCC-3 and LCC-3UB <sup>(1)</sup>	0.73	
	JANS: LCC-3UB	0.5	
Total dissipation at $T_{case} \leq 25\text{ °C}$			
ESCC: TO-18	1.8		
$P_{TOT}$	Total dissipation at $T_{sp(1S)} = 25\text{ °C}$		
	JANS: LCC-3UB	1	W
$T_{STG}$	Storage temperature	-65 to 200	°C
$T_J$	Max. operating junction temperature	200	°C

1. When mounted on a 15 x 15 x 0.6 mm ceramic substrate.

**Table 3. Thermal data**

Symbol	Parameter	LCC-3 LCC-3UB	TO-18	Unit
$R_{thJC}$	Thermal resistance junction-case (max) for JANS	-	-	°C/W
	Thermal resistance junction-case (max) for ESCC	-	97	
$R_{thJSP(1S)}$	Thermal resistance junction-solder pad (infinite sink) (max) for JANS	90	-	
	Thermal resistance junction-solder pad (infinite sink) (max) for ESCC	-	-	
$R_{thJA}$	Thermal resistance junction-ambient (max) for JANS	325	-	
	Thermal resistance junction-ambient (max) for ESCC	350 240 <sup>(1)</sup>	350	

1. When mounted on a 15 x 15 x 0.6 mm ceramic substrate.

## 2 Electrical characteristics

JANS and ESCC version of the products are assembled and tested in compliance with the agency specification it is qualified in. The electrical characteristics of each version are provided in dedicated tables.

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

### 2.1 JANS electrical characteristics

**Table 4. JANS electrical characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{CBO}$	Collector cut-off current ( $I_E = 0$ )	$V_{CB} = 75\text{ V}$ $V_{CB} = 60\text{ V}$ $V_{CB} = 60\text{ V}$ $T_{amb} = 150\text{ °C}$		-	10 10 10	$\mu\text{A}$ nA $\mu\text{A}$
$I_{CES}$	Collector cut-off current ( $I_E = 0$ )	$V_{CE} = 50\text{ V}$		-	50	nA
$I_{EBO}$	Emitter cut-off current ( $I_C = 0$ )	$V_{EB} = 6\text{ V}$ $V_{EB} = 4\text{ V}$		-	10 10	$\mu\text{A}$ nA
$V_{(BR)CEO}^{(1)}$	Collector-emitter breakdown voltage ( $I_B = 0$ )	$I_C = 10\text{ mA}$	50	-		V
$V_{CE(sat)}^{(1)}$	Collector-emitter saturation voltage	$I_C = 150\text{ mA}$ $I_B = 15\text{ mA}$ $I_C = 500\text{ mA}$ $I_B = 50\text{ mA}$		-	0.3 1	V V
$V_{BE(sat)}^{(1)}$	Base-emitter saturation voltage	$I_C = 150\text{ mA}$ $I_B = 15\text{ mA}$ $I_C = 500\text{ mA}$ $I_B = 50\text{ mA}$	0.6		1.2 2	V
$h_{FE}^{(1)}$	DC current gain	$I_C = 0.1\text{ mA}$ $V_{CE} = 10\text{ V}$ $I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$ $I_C = 10\text{ mA}$ $V_{CE} = 10\text{ V}$ $I_C = 150\text{ mA}$ $V_{CE} = 10\text{ V}$ $I_C = 500\text{ mA}$ $V_{CE} = 10\text{ V}$ $I_C = 10\text{ mA}$ $V_{CE} = 10\text{ V}$ $T_{amb} = -55\text{ °C}$	50 75 100 100 30 35	-	325 300	
$h_{fe}$	Small signal current gain	$V_{CE} = 20\text{ V}$ $I_C = 20\text{ mA}$ $f = 100\text{ MHz}$ $V_{CE} = 10\text{ V}$ $I_C = 1\text{ mA}$ $f = 1\text{ kHz}$	2.5 50	-		
$C_{obo}$	Output capacitance ( $I_E = 0$ )	$V_{CB} = 10\text{ V}$ $100\text{ kHz} \leq f \leq 1\text{ MHz}$		-	8	pF
$C_{ibo}$	Output capacitance ( $I_E = 0$ )	$V_{EB} = 0.5\text{ V}$ $100\text{ kHz} \leq f \leq 1\text{ MHz}$		-	25	pF

Table 4. JANS electrical characteristics (continued)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{on}$	Turn-on time	$V_{CC} = 30\text{ V}$ $I_C = 150\text{ mA}$ $I_{B1} = 15\text{ mA}$		-	35	ns
$t_{off}$	Turn-off time	$V_{CC} = 30\text{ V}$ $I_C = 150\text{ mA}$ $I_{B1} = -I_{B2} = 15\text{ mA}$		-	300	ns

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

## 2.2 ESCC electrical characteristics

Table 5. ESCC electrical characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{CBO}$	Collector cut-off current ( $I_E = 0$ )	$V_{CB} = 60\text{ V}$ $V_{CB} = 60\text{ V}$ $T_{amb} = 150\text{ }^\circ\text{C}$		-	10 10	nA $\mu\text{A}$
$I_{EBO}$	Emitter cut-off current ( $I_C = 0$ )	$V_{EB} = 3\text{ V}$		-	10	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage ( $I_E = 0$ )	$I_C = 100\text{ }\mu\text{A}$	75	-		V
$V_{(BR)CEO}^{(1)}$	Collector-emitter breakdown voltage ( $I_B = 0$ )	$I_C = 30\text{ mA}$	40	-		V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ( $I_C = 0$ )	$I_E = 100\text{ }\mu\text{A}$	6	-		V
$V_{CE(sat)}^{(1)}$	Collector-emitter saturation voltage	$I_C = 150\text{ mA}$ $I_B = 15\text{ mA}$		-	0.3	V
$V_{BE(sat)}^{(1)}$	Base-emitter saturation voltage	$I_C = 150\text{ mA}$ $I_B = 15\text{ mA}$		0.87	1.2	V
$h_{FE}^{(1)}$	DC current gain	$I_C = 0.1\text{ mA}$ $V_{CE} = 10\text{ V}$ $I_C = 10\text{ mA}$ $V_{CE} = 10\text{ V}$ $I_C = 150\text{ mA}$ $V_{CE} = 10\text{ V}$ $I_C = 500\text{ mA}$ $V_{CE} = 10\text{ V}$ $I_C = 10\text{ mA}$ $V_{CE} = 10\text{ V}$ $T_{amb} = -55\text{ }^\circ\text{C}$	35 75 100 40 35	-	300	
$h_{fe}$	Small signal current gain	$V_{CE} = 20\text{ V}$ $I_C = 20\text{ mA}$ $f = 100\text{ MHz}$	3	-	10	
$C_{obo}$	Output capacitance ( $I_E = 0$ )	$V_{CB} = 10\text{ V}$ $100\text{ kHz} \leq f \leq 1\text{ MHz}$		-	8	pF

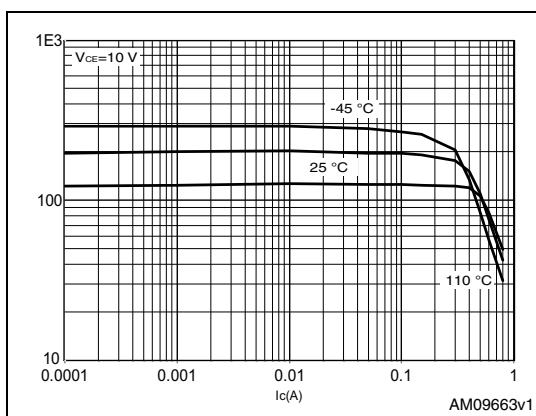
**Table 5. ESCC electrical characteristics (continued)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{on}$	Turn-on time	$V_{CC} = 30\text{ V}$ $I_C = 150\text{ mA}$ $I_{B1} = 15\text{ mA}$		-	35	ns
$t_{off}$	Turn-off time	$V_{CC} = 30\text{ V}$ $I_C = 150\text{ mA}$ $I_{B1} = -I_{B2} = 15\text{ mA}$		-	285	ns

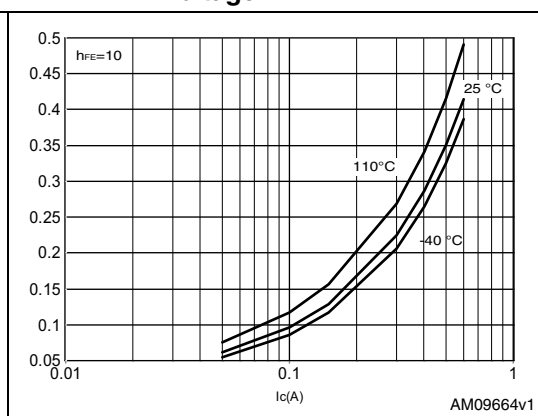
1. Pulsed duration = 300  $\mu\text{s}$ , duty cycle  $\leq 2\%$

### 2.3 Electrical characteristics (curves)

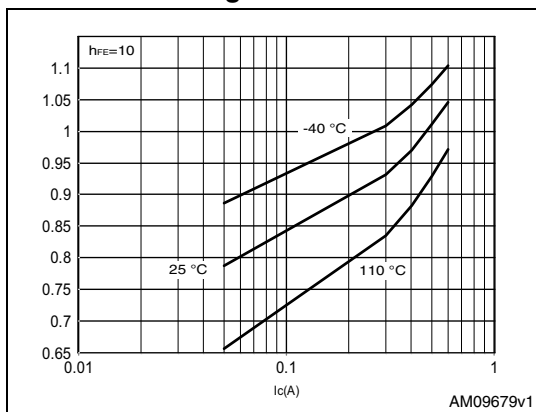
**Figure 2. DC current gain**



**Figure 3. Collector emitter saturation voltage**



**Figure 4. Base emitter saturation voltage**



## 2.4 Test circuits

Figure 5. JANS saturated turn-on switching time test circuit

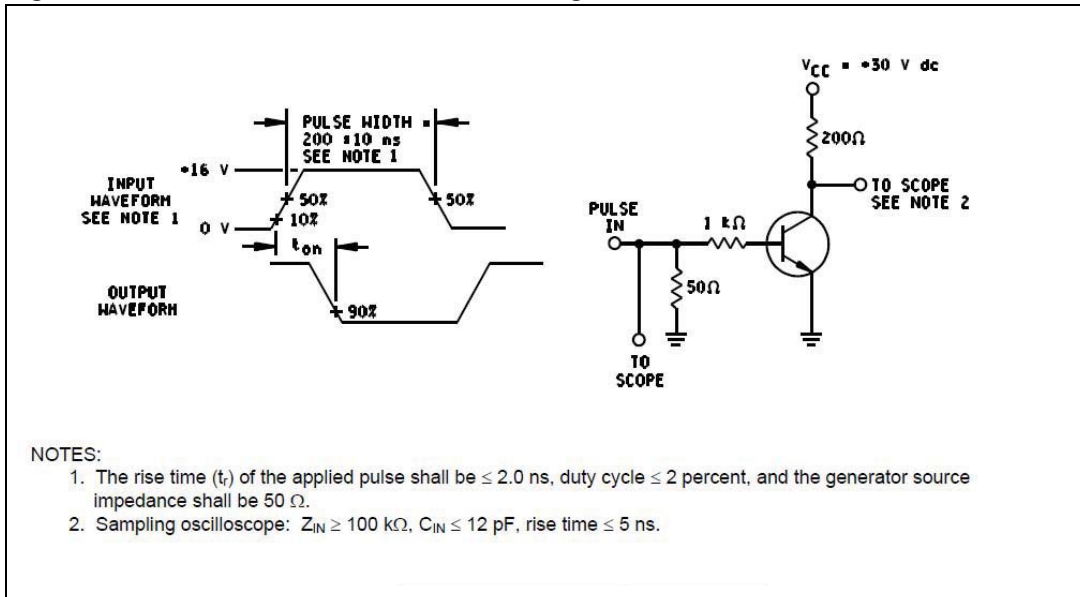


Figure 6. JANS saturated turn-off switching time test circuit

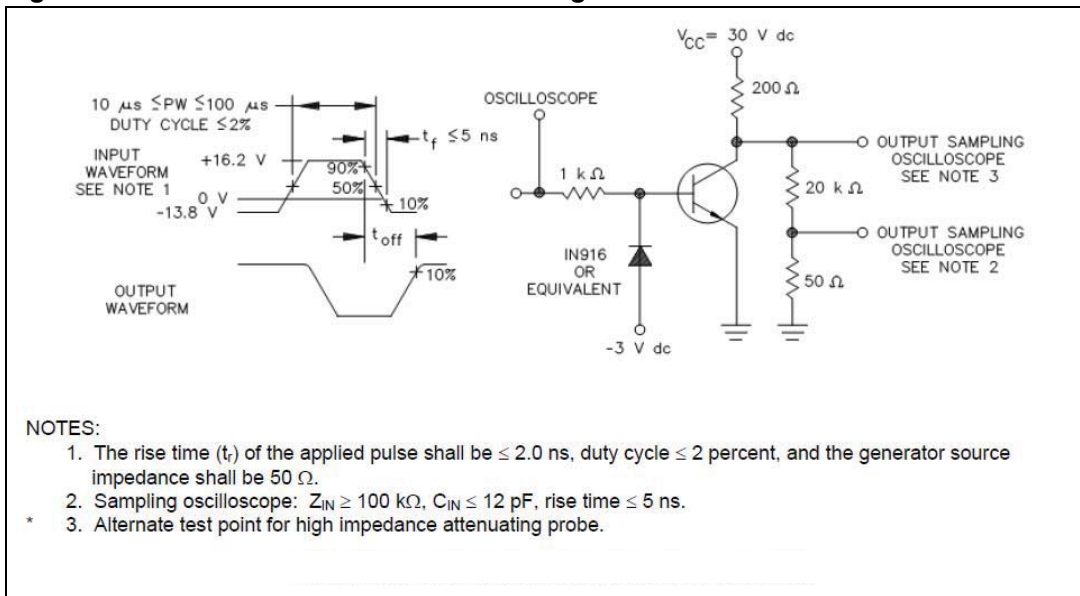
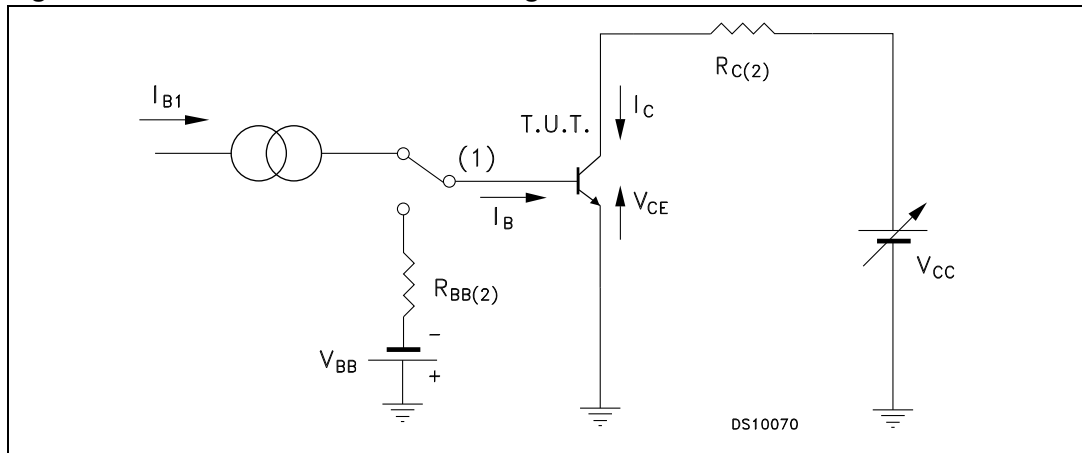


Figure 7. ESCC resistive load switching test circuit



1. Fast electronic switch
2. Non-inductive resistor



### 3 Radiation hardness assurance

The products guaranteed in radiation within the JANS system fully comply with the MIL-PRF-19500/255 specification.

The ESCC detail specifications for bipolar do not include any specification supporting radiation guarantee. ST has therefore developed its own qualification procedure, which is described below:

#### JANS radiation assurance

ST JANS parts guaranteed at 100 krad (Si), tested, in full compliancy with the MIL-PRF-19500 specification, specifically the Group D inspection, between 50 and 300 rad/s. A brief summary is provided below:

- All test are performed in accordance to MIL-PRF-19500 and test method 1019 of MIL-STD-750 for total ionizing dose.
- Each wafer of each lot is tested. The table below provides for each monitored parameters of the test conditions and the acceptance criteria

**Table 6. MIL-PRF-19500 (test method 1019) post radiation electrical characteristics**

Symbol	Parameter	Test conditions	Value		Unit
			Min.	Max.	
$I_{CBO}$	Collector to base cutoff current	$V_{CB} = 75$		20	$\mu A$
		$V_{CB} = 60 V$		20	nA
$I_{EBO}$	Emitter to base cutoff current	$V_{EB} = 6 V$		20	$\mu A$
		$V_{EB} = 4 V$		20	nA
$V_{(BR)CEO}$	Breakdown voltage, collector to emitter	$I_C = 10 mA$	50		V
$I_{CES}$	Collector to emitter cutoff current	$V_{CE} = 50 V$		100	nA
$h_{FE}$	Forward-current transfer ratio	$V_{CE} = 10 V; I_C = 0.1 mA$	[25] <sup>(1)</sup>		
		$V_{CE} = 10 V; I_C = 1.0 mA$	[37.5] <sup>(1)</sup>	325	
		$V_{CE} = 10 V; I_C = 10 mA$	[50] <sup>(1)</sup>		
		$V_{CE} = 10 V; I_C = 150 mA$	[50] <sup>(1)</sup>	300	
		$V_{CE} = 10 V; I_C = 500 mA$	[15] <sup>(1)</sup>		
$V_{CE(sat)}$	Collector-emitter saturation voltage	$I_C = 150 mA; I_B = 15 mA$		0.35	V
		$I_C = 500 mA; I_B = 50 mA$		1.15	
$V_{BE(sat)}$	Base-emitter saturation voltage	$I_C = 150 mA; I_B = 15 mA$	0.6	1.38	V
		$I_C = 500 mA; I_B = 50 mA$		2.3	

1. See method 1019 of MIL-STD-750 for how to determine  $[h_{FE}]$  by first calculating the delta ( $1/h_{FE}$ ) from the pre- and Post-radiation  $h_{FE}$ . Notice the  $[h_{FE}]$  is not the same as  $h_{FE}$  and cannot be measured directly. The  $[h_{FE}]$  value can never exceed the pre-radiation minimum  $h_{FE}$  that it is based upon.

### ST radiation guarantee on ESCC devices

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.

The radiation test is made on biased parts, at  $V_{ces} = 80\% V_{(BR)ceo}$ . They are irradiated between 36 and 360 rad (Si)/h. The key parameters listed in table 7 of each samples are tested when irradiation reaches 30, 50, 70 and 100 krad (Si) after a 24 hour annealing at room temperature and then after a 168 hours annealing at 100°C.

If all tested parameters stay within their pre-radiation specification at all measurements steps, parts compliant with the applicable ESCC generic and/or detailed specification are guaranteed by ST at 100 krad (Si).

**Table 7. ESCC post radiation electrical characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{CBO}$	Collector cut-off current ( $I_E = 0$ )	$V_{CB} = 60 \text{ V}$		-	10	nA
$I_{EBO}$	Emitter cut-off current ( $I_C = 0$ )	$V_{EB} = 3 \text{ V}$		-	10	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage ( $I_E = 0$ )	$I_C = 100 \mu\text{A}$	75	-		V
$V_{(BR)CEO}^{(1)}$	Collector-emitter breakdown voltage ( $I_B = 0$ )	$I_C = 30 \text{ mA}$	40	-		V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ( $I_C = 0$ )	$I_E = 100 \mu\text{A}$	6	-		V
$V_{CE(sat)}^{(1)}$	Collector-emitter saturation voltage	$I_C = 150 \text{ mA}$ $I_B = 15 \text{ mA}$		-	0.3	V
$V_{BE(sat)}^{(1)}$	Base-emitter saturation voltage	$I_C = 150 \text{ mA}$ $I_B = 15 \text{ mA}$			1.2	V
$h_{FE}^{(1)}$	DC current gain	$I_C = 0.1 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $I_C = 10 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $I_C = 150 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $I_C = 500 \text{ mA}$ $V_{CE} = 10 \text{ V}$	35 75 100 40	-	300	

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

## 4 Package mechanical data

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.

**Table 8. Product mass summary**

Package	Mass (g)
LCC-3UB	0.06
LCC-3	0.06
TO-18	0.40

Table 9. LCC-3UB mechanical data

Dim.	mm.		
	Min.	Typ.	Max.
A	1.16		1.42
C	0.46	0.51	0.56
D	0.56	0.76	0.96
E	0.92	1.02	1.12
F	1.95	2.03	2.11
G	2.92	3.05	3.18
I	2.41	2.54	2.67
J	0.42	0.57	0.72
K	1.37	1.52	1.67
L	0.41	0.51	0.61
M	2.46	2.54	2.62
N	1.81	1.91	2.01
r		0.20	
r1		0.30	
r2		0.56	

Figure 8. LCC-3UB drawings

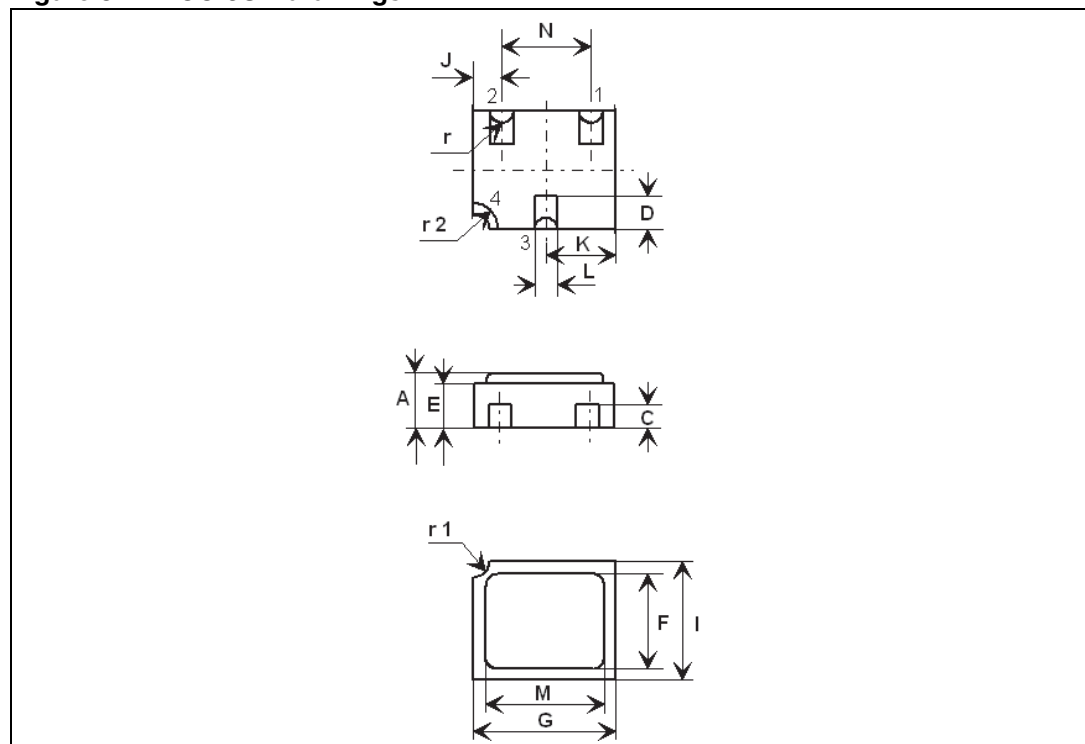


Table 10. LCC-3 mechanical data

Dim.	mm.		
	Min.	Typ.	Max.
A	1.16		1.42
C	0.45	0.50	0.56
D	0.60	0.76	0.91
E	0.91	1.01	1.12
F	1.95	2.03	2.11
G	2.92	3.05	3.17
I	2.41	2.54	2.66
J	0.42	0.57	0.72
K	1.37	1.52	1.67
L	0.40	0.50	0.60
M	2.46	2.54	2.62
N	1.80	1.90	2.00
R		0.30	

Figure 9. LCC-3 drawings

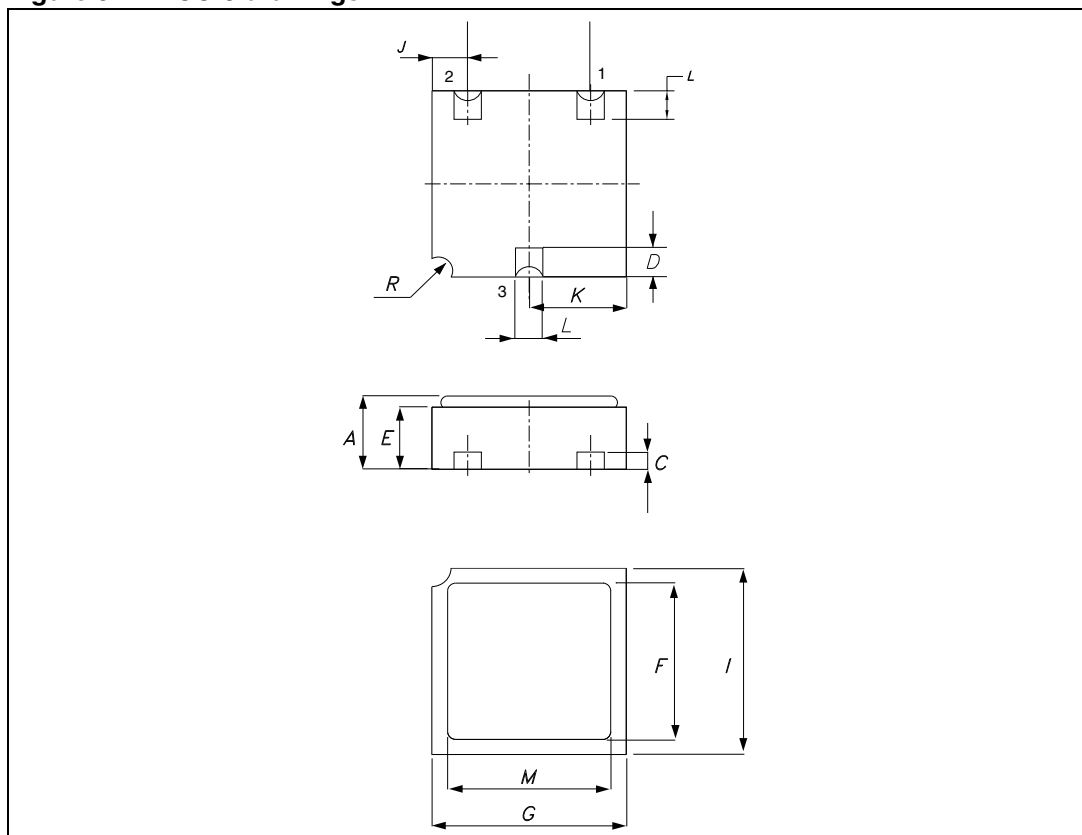
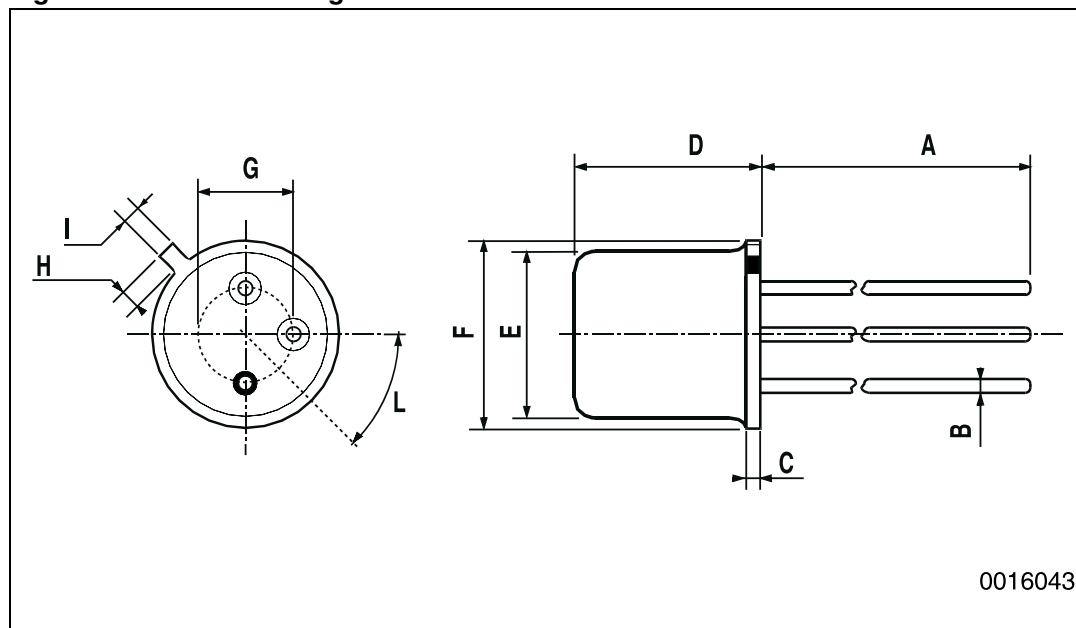


Table 11. TO-18 mechanical data

Dim.	mm.		
	Min.	Typ.	Max.
A		12.7	
B			0.49
D			5.3
E			4.9
F			5.8
G	2.54		
H			1.2
I			1.16
L	45°		

Figure 10. TO-18 drawings





## 5 Order codes

**Table 12. Ordering information**

Part number	Agency specification	EPPL	Quality level	Radiation level	Package	Lead finish	Marking <sup>(1)</sup>	Packing
2N2222AUB1	-	-	Engineering model ESCC	-	LCC-3UB	Gold	U20	Waffle pack
J2N2222AUB1		-	Engineering model JANS		LCC-3UB	Gold	J2N2222A	Waffle pack
SOC2222A	-	-	Engineering model ESCC	-	LCC-3	Gold	N20	Waffle pack
JANS2N2222AUBG	MIL-PRF-19500/255	-	JANS flight	-	LCC-3UB	Gold	JS2222	Waffle pack
JANS2N2222AUBT	MIL-PRF-19500/255	-	JANS flight	-	LCC-3UB	Solder dip	JS2222	Waffle pack
JANSR2N2222AUBG	MIL-PRF-19500/255	-	JANS flight	100 krad	LCC-3UB	Gold	JSR2222	Waffle pack
JANSR2N2222AUBT	MIL-PRF-19500/255	-	JANS flight	100 krad	LCC-3UB	Solder dip	JSR2222	Waffle pack
SOC2222AUB11SW	5201/002/11	Yes	ESCC flight	100 krad	LCC-3UB	Gold	520100211	Waffle pack
SOC2222AUB12SW	5201/002/12	Yes	ESCC flight	100 krad	LCC-3UB	Solder dip	520100212	Waffle pack
SOC2222AUB11	5201/002/11	Yes	ESCC flight	-	LCC-3UB	Gold	520100211	Waffle pack
SOC2222AUB12	5201/002/12	Yes	ESCC flight	-	LCC-3UB	Solder dip	520100212	Waffle pack
SOC2222ASW	5201/002/04 or 05 <sup>(2)</sup>	Yes	ESCC flight	100 krad	LCC-3	Gold or solder dip <sup>(2)</sup>	520100204 or 05 <sup>(2)</sup>	Waffle pack
SOC2222AHRB	5201/002/04 or 05 <sup>(2)</sup>	Yes	ESCC flight	-	LCC-3	Gold or solder dip <sup>(2)</sup>	520100204 or 05 <sup>(2)</sup>	Waffle pack
2N2222AHR	5201/002/01 or 02 <sup>(2)</sup>	-	ESCC flight	-	TO-18	Gold or solder dip <sup>(2)</sup>	520100201 or 02 <sup>(2)</sup>	Waffle pack

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.

For JANS flight parts : ST logo, date code, country of origin (FR), manufacturer code (CSTM), serial number of the part within the assembly lot.

2. Depending ESCC part number mentioned on the purchase order.

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

- Products in die form
- Other JANS quality levels
- Tape and reel packing

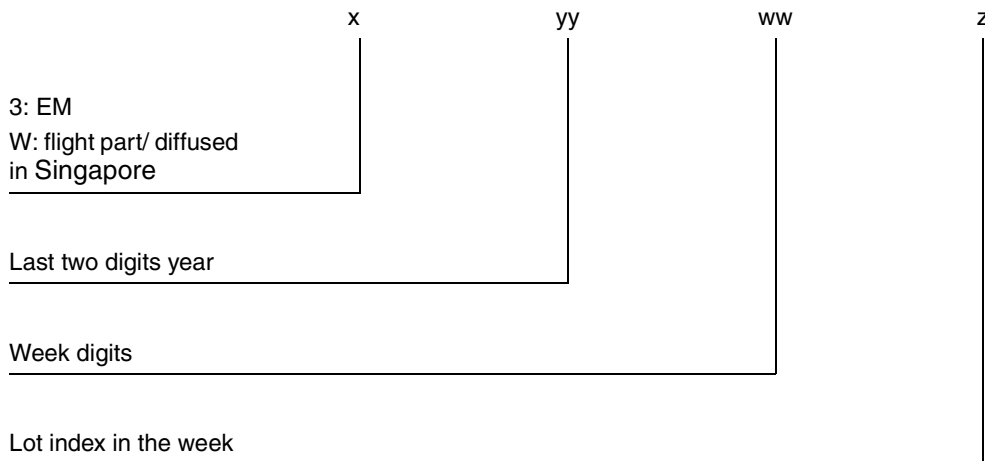
## 6 Shipping details

### 6.1 Data code

Data code is structured as described below:

- EM (ESCC and JANS) xyywwz
- ESCC Flight yywwz
- JANS Flight xyywwz

where:



### 6.2 Documentation

**Table 13. Documentation provided for each type of product**

Quality level	Radiation level	Documentation
Engineering model	-	-
JANS Flight	-	Certificate of conformance
JANSR Flight	100 krad	Certificate of conformance 50 rad/s radiation verification test report
ESCC Flight	-	Certificate of conformance
	100 krad	Certificate of conformance 0.1 rad/s radiation verification test report



## 7 Revision history

**Table 14. Document revision history**

Date	Revision	Changes
04-Jan-2010	1	Initial release
16-Apr-2010	2	Added <a href="#">Table 1 on page 1</a>
09-Jul-2010	3	Modified: <a href="#">Table 1 on page 1</a> and <a href="#">Table 11 on page 14</a>
30-Nov-2011	4	<ul style="list-style-type: none"> <li>– Modified: <a href="#">Table 5 on page 5</a></li> <li>– Added: <a href="#">Section 2.3: Electrical characteristics (curves)</a></li> <li>– Modified: <a href="#">Table 1</a> and <a href="#">2</a></li> <li>– Added: <a href="#">Table 2, 11, 12</a></li> <li>– Minor text changes in the document title and description on the coverpage</li> </ul>
12-Dec-2011	5	Minor text changes to improve readability
17-Apr-2012	6	<p>Updated:</p> <ul style="list-style-type: none"> <li>– Title and description in cover page.</li> <li>– <math>P_{TOT}</math> in <a href="#">Table 2: Absolute maximum ratings</a>.</li> <li>– The entire <a href="#">Section 2: Electrical characteristics</a>.</li> <li>– <a href="#">Table 12: Ordering information</a>.</li> </ul> <p>Added:</p> <ul style="list-style-type: none"> <li>– <a href="#">Table 3: Thermal data</a>, <a href="#">Section 3: Radiation hardness assurance</a> and <a href="#">Table 12: Ordering information</a>.</li> <li>– <a href="#">Figure 5: JANS saturated turn-on switching time test circuit</a> and <a href="#">Figure 6: JANS saturated turn-off switching time test circuit</a>.</li> <li>– <a href="#">Section 6: Shipping details</a>.</li> </ul>
19-Apr-2012	7	Updated titles in <a href="#">Figure 5: JANS saturated turn-on switching time test circuit</a> and <a href="#">Figure 6: JANS saturated turn-off switching time test circuit</a> .
24-Apr-2012	8	Updated $R_{thJA}$ value in <a href="#">Table 3: Thermal data</a> .
14-May-2012	9	Updated <a href="#">Table 12: Ordering information</a> .

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