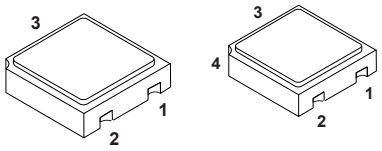
2N2222AHR

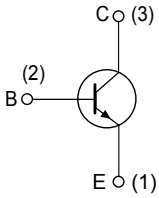
Datasheet

Rad-Hard 50 V, 0.8 A NPN transistor



LCC-3 **UB**

Pin 4 in UB is connected to the metallic lid.



DS10450

Features

V_{ceo}	I_C(max.)	H_{FE} at 10 V, 150 mA	T_j(max.)
50 V	0.8 A	> 100	200 °C

- Hermetic packages
- ESCC qualified
- 100 krad

Description

The 2N2222AHR is a bipolar transistor able to operate under severe environment conditions and radiation exposure providing high immunity to total ionizing dose (TID).

Qualified as per ESCC 5201/002 specification and available in LCC-3 and UB hermetic packages, it is specifically recommended for space and harsh environment applications and suitable for low current and high precision circuits such preamplifiers, oscillators, current mirror configuration.

In case of discrepancies between this datasheet and the relevant agency specification, the latter takes precedence.

Product status link
2N2222AHR

Product summary

Product summary				
Part-number	**Qualification system**	**Agency specification**	**Package**	**Radiation level**
2N2222ARUBx	ESCC Flight	5201/002	UB	100 krad
2N2222AUBx	ESCC Flight	5201/002	UB	-
SOC2222ARHRx	ESCC Flight	5201/002	LCC-3	100 krad
SOC2222AHRx	ESCC Flight	5201/002	LCC-3	-

Note: See Table 7 for ordering information.

1 Electrical ratings

Table 1. 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)		50	V
V_{EBO}	Emitter-base voltage (I_C = 0)		6	V
I_C	Collector current		0.8	A
P_{TOT}	Total dissipation at $T_{amb} \leq 25$ °C	LCC-3 and UB LCC-3 and UB(1)	0.5 0.73	W
T_{OP}	Operating temperature range		-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 2. Thermal data

Symbol	Parameter	LCC-3 and UB Value	Unit
RthJA	Thermal resistance junction-ambient (max) for LCC-3 and UB	350 240(1)	°C/W

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

2 Electrical characteristics

Table 3. **Electrical characteristics (T_{amb} = 25 °C unless otherwise specified)**

Symbol	Parameter	Test conditions	Min.	Max.	Unit
I_{CBO}	Collector-base cut-off current (I_E = 0)	V_{CB} = 60 V		10	nA
		V_{CB} = 60 V, T_{amb} = 150 °C		10	µA
I_{EBO}	Emitter-base cut-off current (I_C = 0)	V_{EB} = 3 V		10	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 100 µA	75		V
$V_{(BR)CEO}$	Collector-emitter breakdown voltage (I_B = 0)	I_C = 10 mA	50		V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_C = 100 µA	6		V
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_C = 150 mA, I_B = 15 mA		0.3	V
$V_{BE(sat)}$	Base-emitter saturation voltage	I_C = 150 mA, I_B = 15 mA		1.2	V
h_{FE}	DC current gain	I_C = 0.1 mA, V_{CE} = 10 V	35		
		I_C = 10 mA, V_{CE} = 10 V	75		
		I_C = 150 mA, V_{CE} = 10 V	100	300	
		I_C = 500 mA, V_{CE} = 10 V	40		
		I_C = 10 mA, T_{amb} = -55 °C, V_{CE} = 10 V	35		
h_{fe}	Small signal current gain	I_C = 20 mA, f = 100 MHz, V_{CE} = 20 V	2.5		
C_{OBO}	Output capacitance (I_E = 0)	100 kHz ≤ f ≤ 1 MHz, V_{CB} = 10 V		8	pF
t_{on}	Turn-on time	I_{CC} = 150 mA, I_{B1} = 15 mA, V_{CC} = 30 V		35	ns
t_{off}	Turn-off time	I_{CC} = 150 mA, I_{B1} = I_{B2} = 15 mA, V_{CC} = 30 V		285	ns

1. *Pulsed duration = 300 µs, duty cycle ≤ 1.5%*

2.1 Radiation assurance

Radiation test are guaranteed in compliance with ESCC 22900 and ESCC 5201/002 specifications.
Each lot is tested in radiation according to the following procedure:

- Radiation condition of 0.1 rad (Si)/s.
- Test of 11 samples by wafer, 5 biased at 80% of V(BR)CEO, 5 unbiased and for reference.
- Acceptance criteria in compliance with the post radiation electrical characteristics as per Table 4.

Table 4. ESCC 5201/002 post radiation electrical characteristics (T_{amb} = 25 °C unless otherwise specified)

Symbol	Parameter	Test conditions	Min.	Max	Unit
I_{CBO}	Collector cut-off current (I_E = 0)	V_{CB}= 60 V		10	nA
I_{EBO}	Emitter cut-off current (I_C= 0)	V_{EB} = 3 V		10	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E= 0)	I_C=100 µA	75		V
$V_{(BR)CEO}$ (1)	Collector-emitter breakdown voltage (I_B = 0)	I_C = 10 mA	50		V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C= 0)	I_E = 100 µA	6		V
$V_{CE(sat)}$ (1)	Collector-emitter saturation voltage	I_C=150 mA, I_B = 15 mA		0.3	V
$V_{BE(sat)}$ (1)	Base-emitter saturation voltage	I_C=150 mA, I_B = 15 mA		1.2	V
$[h_{FE}]$ (1)	Post irradiation gain calculation (2)	I_C= 0.1 mA, V_{CE}= 10 V	[17.5]		
		I_C= 10 mA, V_{CE}= 10 V	[37.5]		
		I_C= 150 mA, V_{CE}= 10 V	[50]	300	
		I_C= 500 mA, V_{CE}= 10 V	[20]		

1. *Pulsed duration = 300 µs, duty cycle ≥ 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.*

2.2 Electrical characteristics (curves)

Figure 1. DC current gain

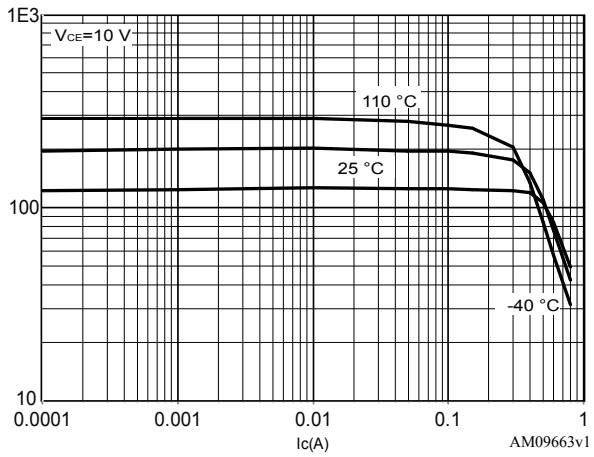


Figure 2. Collector emitter saturation voltage

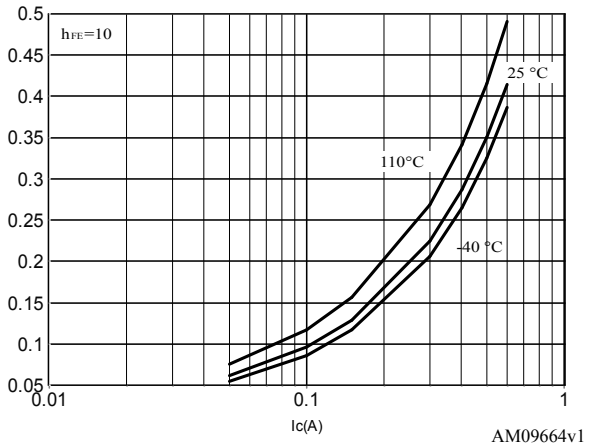
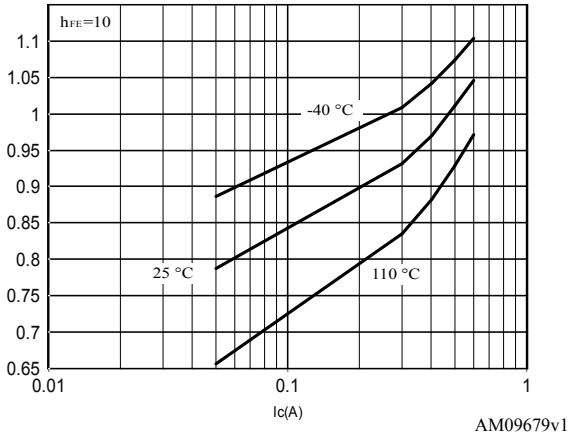
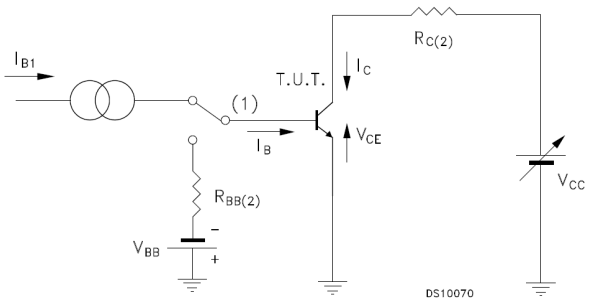


Figure 3. Base emitter saturation voltage



2.3 Test circuits

Figure 4. ESCC resistive load switching test circuit



Note: (1) Fast electronic switch

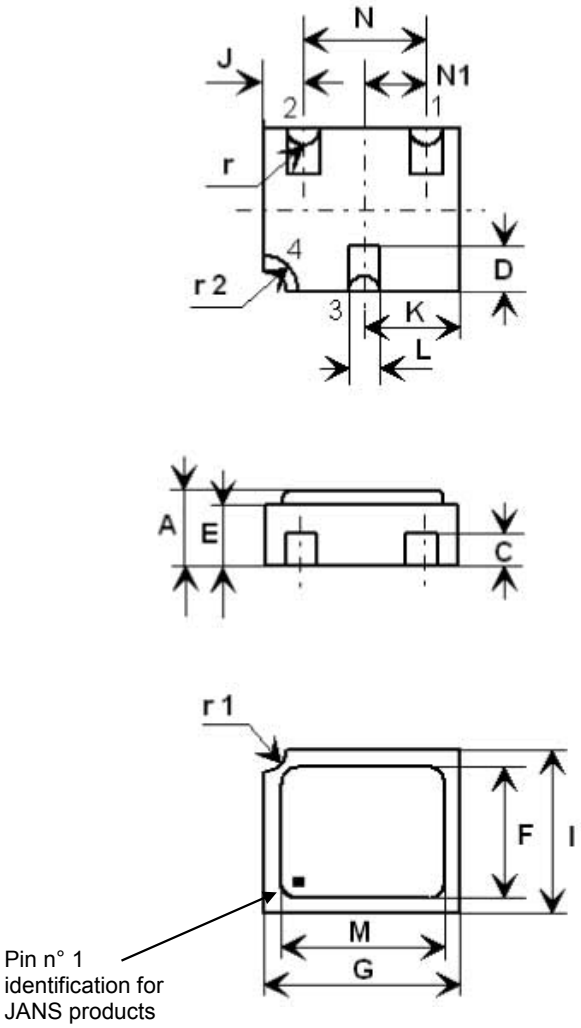
Note: (2) Non-inductive resistor

3 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK packages, depending on their level of environmental compliance. ECOPACK specifications, grade definitions and product status are available at: www.st.com. ECOPACK is an ST trademark.

3.1 UB package information

Figure 5. UB package outline



Pad 1: Emitter

Pad 2: Base

Pad 3: Collector

Pad 4: Shielding connected to the lid

8206487 rev.6

Table 5. **UB package mechanical data**

Symbols	Dimensions in mm			Dimensions in inches (for reference only)		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	1.16		1.42	0.045		0.056
C	0.46	0.51	0.56	0.018	0.020	0.022
D	0.56	0.76	0.96	0.024	0.030	0.036
E	0.92	1.02	1.12	0.036	0.040	0.044
F	1.95	2.03	2.11	0.077	0.080	0.083
G	2.92	3.05	3.18	0.115	0.120	0.125
I	2.41	2.54	2.67	0.095	0.100	0.105
J	0.42	0.57	0.72	0.0165	0.0225	0.0285
K	1.37	1.52	1.67	0.054	0.060	0.066
L	0.41	0.51	0.61	0.016	0.020	0.024
M	2.46	2.54	2.62	0.097	0.100	0.103
N	1.81	1.91	2.01	0.071	0.075	0.079
N1	0.91	0.96	1.02	0.036	0.038	0.040
r		0.20			0.008	
r1		0.30			0.012	
r2		0.56			0.022	

3.2 LCC-3 package information

Figure 6. LCC-3 package outline

Pad 1: emitter
Pad 2: base
Pad 3: collector

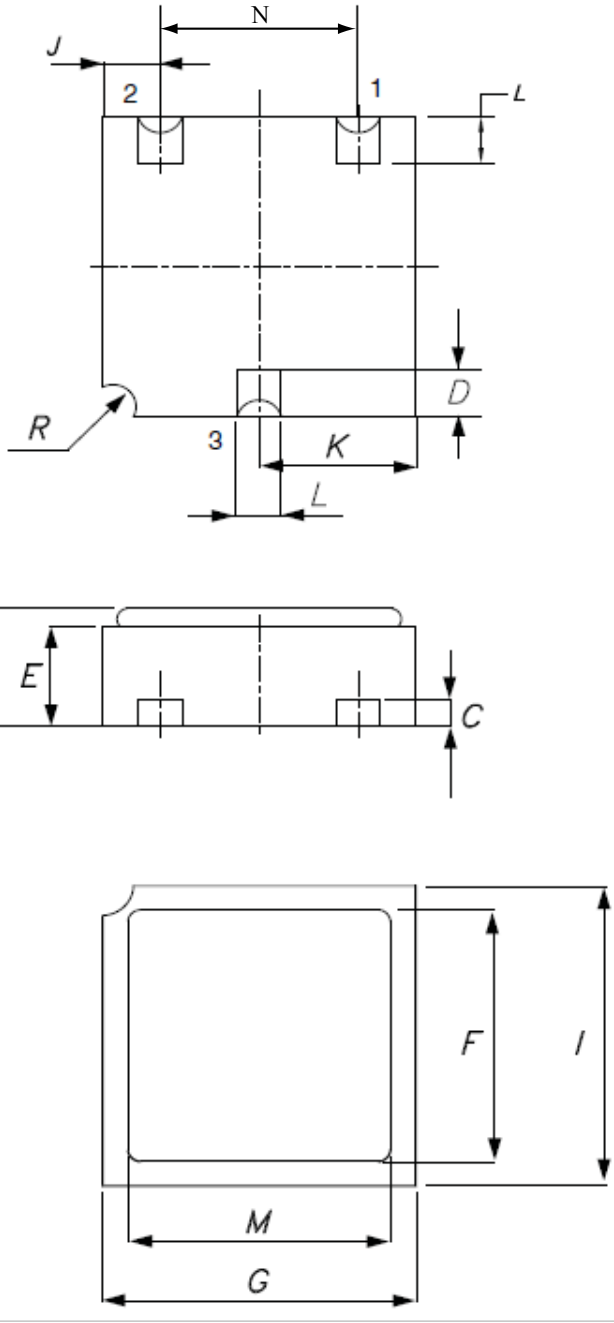


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Table 6. **LCC-3 package mechanical data**

Symbols	Dimensions in mm			Dimensions in inches (for reference only)		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	1.16		1.42	0.046		0.056
C	0.45	0.50	0.56	0.018	0.020	0.022
D	0.60	0.56	0.96	0.024	0.022	0.038
E	0.91	1.01	1.12	0.036	0.040	0.044
F	1.95	2.03	2.11	0.077	0.080	0.083
G	2.92	3.05	3.17	0.115	0.120	0.125
I	2.41	2.54	2.66	0.095	0.100	0.105
J	0.42	0.57	0.72	0.0165	0.0225	0.0285
K	1.37	1.52	1.67	0.054	0.060	0.066
L	0.40	0.50	0.60	0.016	0.020	0.024
M	2.46	2.54	2.62	0.097	0.100	0.103
N	1.80	1.90	2.00	0.071	0.075	0.079
R		0.30			0.012	

4 Ordering information

Table 7. Ordering information

Part number	ESCC specification	Screening option	Radiation level	Package	Mass	Lead finish	Marking[1]	Packing
2N2222AUB1	-	Engineering model	-	UB	0.6 g	Gold	2N2222AUB1	WafflePack
SOC2222A1	-		-	LCC-3			SOC2222A1	
2N2222ARUBG	5201/002/11R	Flight model	100 krad	UB		Gold	520100211R	
2N2222ARUBT	5201/002/12R					Solder Dip	520100212R	
2N2222ARUBTW	5201/002/12R							Tape and reel
2N2222AUBG	5201/002/11		-			Gold	520100211	WafflePack
2N2222AUBT	5201/002/12		-			Solder Dip	520100212	
SOC2222ARHRG	5201/002/04R		100 krad	LCC-3		Gold	520100204R	
SOC2222ARHRT	5201/002/05R					Solder Dip	520100205R	
SOC2222ARHRTW	5201/002/05R					Solder Dip	520100205R	Tape and reel
SOC2222AHRG	5201/002/04		-			Gold	520100204	WafflePack
SOC2222AHRT	5201/002/05		-			Solder Dip	520100205	
SOC2222AHRTW	5201/002/05		-			Solder Dip	520100205	Tape and reel

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 specific conditions for products in die form.

5 Other information

5.1 Traceability information

Table 8. Date codes

Model	Date code
EM	3yywwN
ESCC	yywwN

1. *yy = year, ww = week number, N = lot index in the week.*

5.2 Documentation

Table 9. Documentation provided for each type of product

Quality level	Radiation level	Documentation
Engineering model	-	Certificate of conformance
Flight model	-	Certificate of conformance ESCC qualification maintenance lot reference
Flight model	100 krad	Certificate of conformance ESCC qualification maintenance lot reference Radiation verification test (RVT) report at 25 / 50 / 70 / 100 krad at 0.1 rad / s.

Revision history

Table 10. **Document revision history**

Date	Revision	Changes
04-Jan-2010	1	Initial release.
16-Apr-2010	2	Added Table 1 on page 1.
09-Jul-2010	3	Modified: Table 1 on page 1 and Table 12 on page 18.
30-Nov-2011	4	– Modified: Table 5 on page 5. – Added: Section 2.3: Electrical characteristics (curves). – Modified: Table 1 and 2; – Added: Table 2, 11, 12. – Minor text changes in the document title and description on the cover page.
12-Dec-2011	5	Minor text changes to improve readability;
17-Apr-2012	6	Updated: – Title and description in cover page. – PTOT in Table 2: Absolute maximum ratings. – The entire Section 2: Electrical characteristics. Added: – Table 3: Thermal data, Section 3: Radiation hardness assurance and Table 13: Ordering information. – Figure 7: JANS saturated turn-on switching time test circuit and Figure 8: JANS saturated turn-off switching time test circuit. – Section 6: Shipping details.
19-Apr-2012	7	Updated titles in Figure 7: JANS saturated turn-on switching time test circuit and Figure 8: JANS saturated turn-off switching time test circuit.
24-Apr-2012	8	Updated R_{thJA} value in Table 3: Thermal data.
14-May-2012	9	Updated Table 13: Ordering information.
21-Feb-2013	10	Table 1: Device summary and Table 13: Ordering information have been updated. Updated text in Section 3: Radiation hardness assurance.
04-Apr-2013	11	Inserted Table 7: Radiation summary.
06-Jun-2013	12	Updated package name for UB.
18-Sep-2013	13	Table 1: Device summary and Table 13: Ordering information have been updated.
25-Mar-2014	14	Table 1: Device summary and Table 13: Ordering information have been updated. Updated Section 3: Radiation hardness assurance and Section 4: Package mechanical data. Inserted Figure 2: Safe operating area for LCC-3 and UB and Figure 3: Safe operating area for TO-18.
01-Apr-2014	15	Modified note in package silhouette on cover page.
29-May-2014	16	Updated Table 1: Device summary and Table 13: Ordering information.
17-Feb-2015	17	Updated Table 1.: Device summary. Minor text changes.
27-Feb-2015	18	Minor text changes.
05-May-2015	19	Updated Table 1.: Device summary. Minor text changes.
21-Aug-2015	20	Updated: Section 4.3: TO-18 package information. Minor text changes.
02-Apr-2020	21	Removed TO-18 package information. Minor text changes.
10-Jun-2020	22	Modified title and features table on cover page. Minor text changes.

Date	Revision	Changes
02-Feb-2021	23	Updated functional schematic. Updated Table 1, Table 7 and Section 5.2 . Removed STPOWER logo and Radiation summary table.
11-Oct-2021	24	Updated features, Description, Product summary, Table 1, Table 2, Section 2 Electrical characteristics, Section 2.3 Test circuits, Table 7, Table 8 and Table 9.
18-Jan-2022	25	Updated Features, Description, Section 2.1 Radiation assurance, Table 7 and Table 9. Documentation provided for each type of product.

Contents