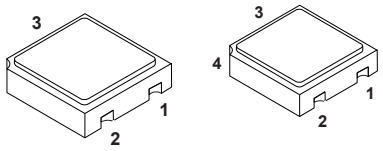
2N2222AHR

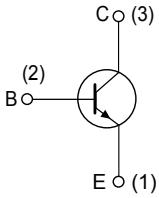
Datasheet

Rad-Hard 50 V, 0.8 A NPN transistor



LCC-3 **UB**

Pin 4 in UB is connected to the metallic lid.



DS10450

Product status link
2N2222AHR

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 and JANS qualified
- 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.

Product summary

Product summary				
Part-number	**Qualification system**	**Agency specification**	**Package**	**Radiation level**
JANSR2N2222AUBx	JANSR	MIL-PRF-19500/255	UB	100 krad
JANS2N2222AUBx	JANS	MIL-PRF-19500/255	UB	-
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 9 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	ESCC LCC-3 and UB LCC-3 and UB(1)	0.5 0.73	W
		JANS: UB	0.5	
	Total dissipation at $T_{SP(IS)}$ = 25 °C	JANS: UB	1	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
$R_{thJSP(IS)}$	Thermal resistance junction-solder pad (infinite sink) (max) for JANS	90	°C/W
RthJA	Thermal resistance junction-ambient (max) for JANS	325	
	Thermal resistance junction-ambient (max) for ESCC	350 240(1)	

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. The electrical characteristics of each version are provided in dedicated tables.

2.1 JANS 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} = 75 V		10	µA
		V_{CB} = 60 V		10	nA
		V_{CB} = 60 V, T_{amb} = 150 °C		10	µA
I_{CES}	Collector-base cut-off current (I_E = 0)	V_{CE} = 50 V		50	nA
I_{EBO}	Emitter-base cut-off current (I_C = 0)	V_{EB} = 6 V		10	µA
		V_{EB} = 4 V		10	nA
$V_{(BR)CEO}$ (1)	Collector-emitter breakdown voltage (I_B = 0)	I_C = 10 mA	50		V
$V_{CE(sat)}$ (1)	Collector-emitter saturation voltage	I_C = 150 mA, I_B = 15 mA		0.3	V
		I_C = 500 mA, I_B = 50 mA		1	V
$V_{BE(sat)}$ (1)	Base-emitter saturation voltage	I_C = 150 mA, I_B = 15 mA	0.6	1.2	V
		I_C = 500 mA, I_B = 50 mA		2	V
h_{FE} (1)	DC current gain	I_C = 0.1 mA, V_{CE} = 10 V	50		
		I_C = 1 mA, V_{CE} = 10 V	75	325	
		I_C = 10 mA, V_{CE} = 10 V	100		
		I_C = 150 mA, V_{CE} = 10 V	100	300	
		I_C = 500 mA, V_{CE} = 10 V	30		
		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		
		I_C = 1 mA, f = 1 kHz, V_{CE} = 10 V	50		
C_{OBO}	Output capacitance, (I_E = 0)	100 kHz ≤ f ≤ 1 MHz, V_{CB} = 10 V		8	pF
C_{IBO}	Input capacitance, (I_C = 0)	100 kHz ≤ f ≤ 1 MHz, V_{EB} = 0.5 V		25	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		300	ns

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

2.2 ESCC electrical characteristics

Table 4. 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
$V_{(BR)CEO}$ (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_C = 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)	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%*

2.3 Electrical characteristics (curves)

Figure 1. DC current gain

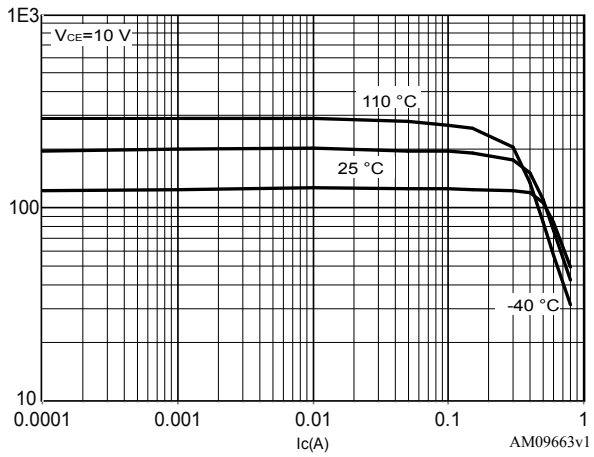


Figure 2. Collector emitter saturation voltage

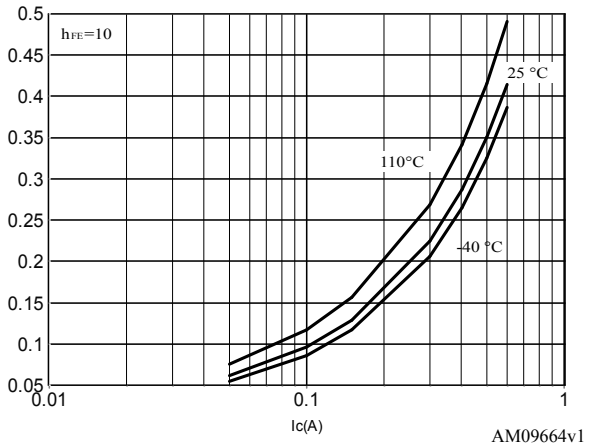
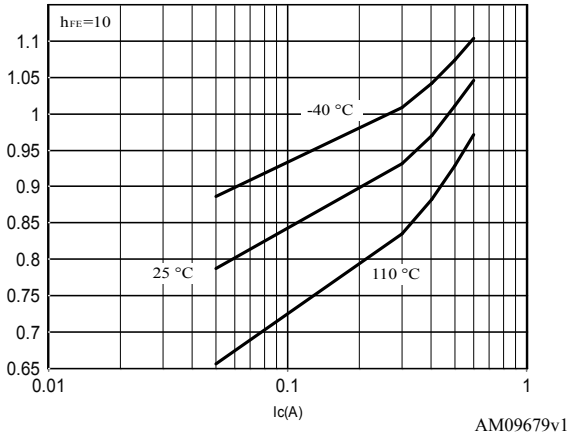
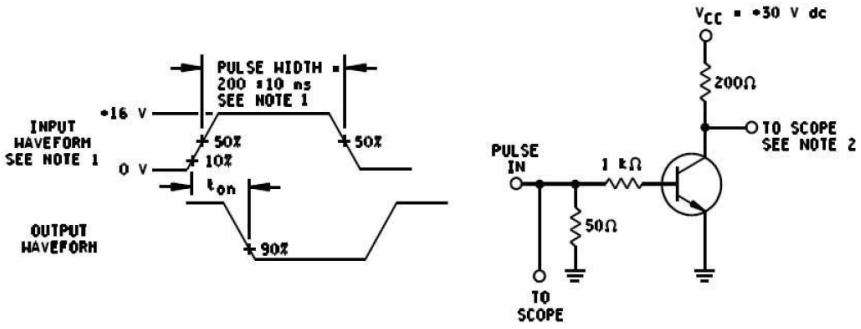


Figure 3. Base emitter saturation voltage



2.4 Test circuits

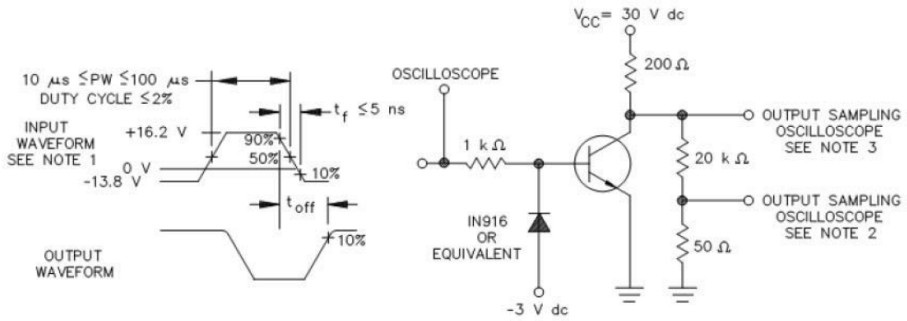
Figure 4. JANS saturated turn-on switching time test circuit



Note: (1) The rise time (t_r) of the applied pulse should be ≤ 2.0 ns, duty cycle ≤ 2 percent, and the generator source impedance shall be50 Ω.

Note: (2) Sampling oscilloscope: Z_{IN} ≥ 100 kΩ, C_{IN} ≤ 12 pF, rise time ≤ 5ns.

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

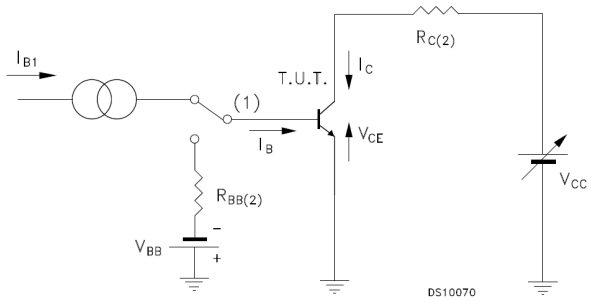


Note: (1) The rise time (t_r) of the applied pulse should be ≤ 2.0 ns, duty cycle ≤ 2 percent, and the generator source impedance shall be50 Ω.

Note: (2) Sampling oscilloscope: Z_{IN} ≥ 100 kΩ, C_{IN} ≤ 12 pF, rise time ≤ 5ns.

Note: (3) Alternate test point for high impedance attenuating probe.

Figure 6. ESCC resistive load switching test circuit



Note: (1) Fast electronic switch

Note: (2) Non-inductive resistor

3 Radiation hardness assurance

3.1 JANS radiation assurance

JANSR2N2222A is guaranteed at 100 krad in compliance with the MIL-PRF-19500, Group D between 50 and 300 rad/s with an additional guarantee at 0.1 rad/s as per ESCC 22900.

Table 5. MIL-PRF-19500 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}= 75 V		20	µA
		V_{CB}= 60 V		20	nA
I_{EBO}	Emitter cut-off current (I_C= 0)	V_{EB} = 6 V		20	µA
		V_{EB} = 4 V		20	µA
$V_{(BR)CEO}$(1)	Collector-emitter breakdown voltage (I_B = 0)	I_C = 10 mA	50		V
I_{CES}	Collector to emitter cut-off current	V_{CE} = 50 V		100	nA
$V_{CE(sat)}$	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	
[h_{FE}]	Post irradiation gain calculation	I_C= 0.1 mA, V_{CE}= 10 V	[25](2)		
		I_C= 1.0 mA, V_{CE}= 10 V	[37.5](2)	325	
		I_C= 10 mA, V_{CE}= 10 V	[50](2)		
		I_C= 150 mA, V_{CE}= 10 V	[50](2)	300	
		I_C= 500 mA, V_{CE}= 10 V	[15](2)		

1. *Pulsed duration = 300 µs, duty cycle ≥ 2 %*
2. *See method 1019 of MIL-STD-750 for how to determine [hFE] by first calculating the delta (1/hFE) from the pre- and Post-radiation hFE. Notice the [hFE] is not the same as hFE and cannot be measured directly. The [hFE] value can never exceed the pre-radiation minimum hFE that it is based upon.*

3.2 ESCC radiation assurance

This products is guaranteed in radiation as per ESCC 22900 and in compliance with ESCC 5201/002 specification.

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 of each wafer at 100 krad if all 10 samples comply with the post radiation electrical characteristics as per Table 6.

RVT includes the value of each parameter at 30, 50, 70 and 100 krad (Si), post annealing at 24 hour / 25 °C and and post annealing at 168 hours / 100°C.

Table 6. 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]		

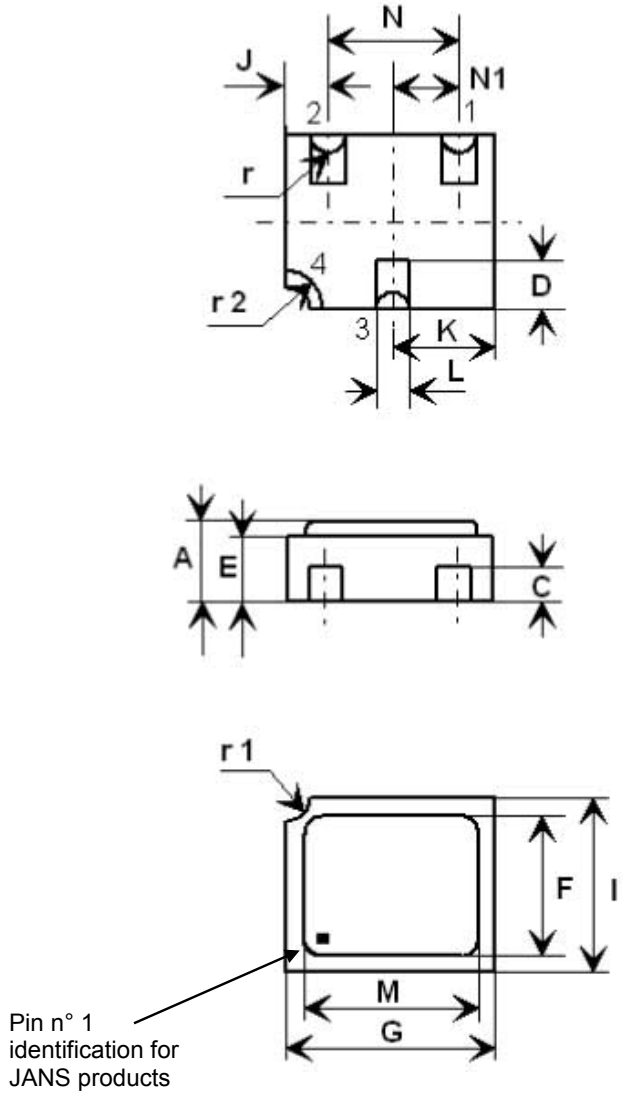
1. *Pulsed duration = 300 µs, duty cycle ≥ 2 %*
2. *The post-irradiation gain calculation of [h_{FE}], made using h_{FE} measurements from prior to and on completion of irradiation testing and after each annealing step if any, shall be as specified in MILSTD-750 method 1019.*

4 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.

4.1 UB package information

Figure 7. UB package outline



Pad 1: Emitter

Pad 2: Base

Pad 3: Collector

Pad 4: Shielding connected to the lid

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Note: For JANS products: the pin out numbering for emitter and base is inverted (base is designated pin 1 and emitter pin 2)

Table 7. 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	

4.2 LCC-3 package information

Figure 8. **LCC-3 package outline**

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

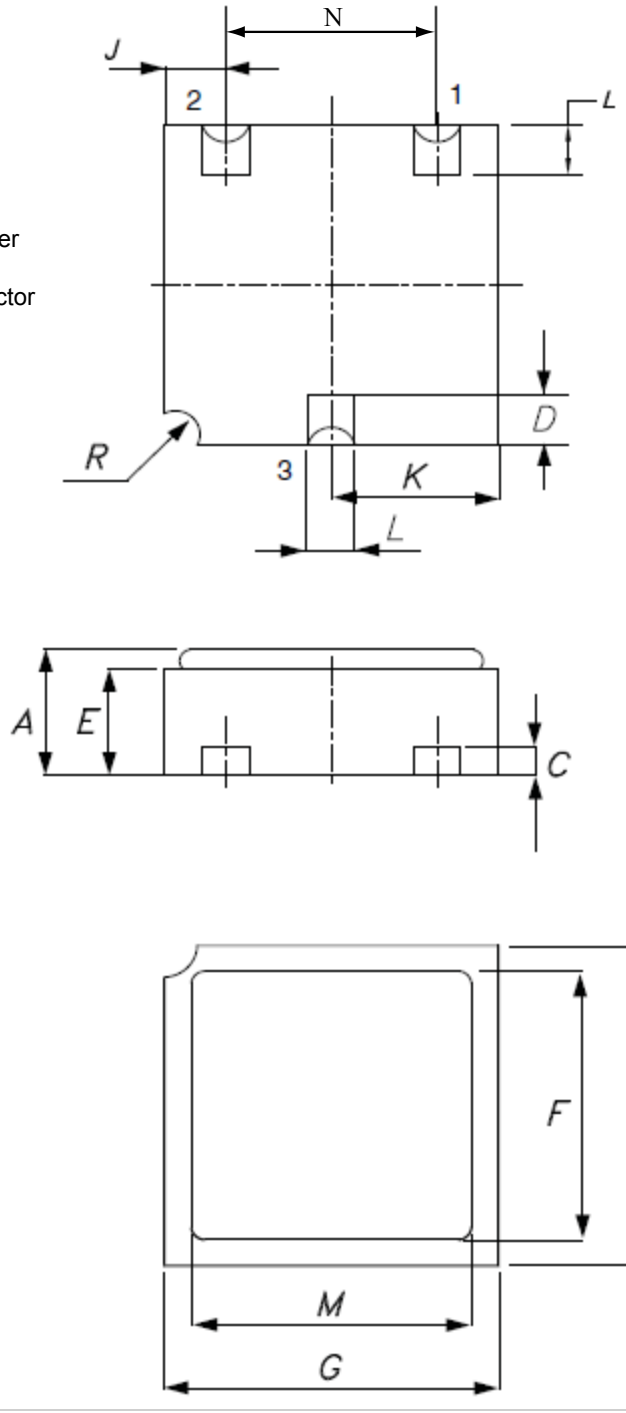

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Table 8. **LCC-3 package mechanical data**

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	

5 Ordering information

Table 9. Ordering information

Part number	Agency specification	Quality level	Radiation level[1]	Package	Mass	Lead finish	Marking[2]	Packing
J2N2222AUB1	-	Engineering model JANS	-	UB	0.6 g	Gold	J2222AUB1	WafflePack
2N2222AUB1	-	Engineering model ESCC	-				2N2222AUB1	
SOC2222A1	-	Engineering model ESCC	-	LCC-3			SOC2222A1	
JANSR2N2222AUBG	MIL-PRF-19500/255	JANSR	100 krad high and low dose rate	UB			JSR2222	
JANSR2N2222AUBT		JANSR				Solder Dip	JSR2222	
JANS2N2222AUBG		JANS	-			Gold	JS2222	
JANS2N2222AUBT		JANS				Solder Dip	JS2222	
2N2222ARUBG	5201/002/11R	ESCC Flight	100 krad - low dose rate			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 - low dose rate	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. *High dose rate as per MIL-PRF-19500 specification group D, subgroup 2 inspection. Low dose rate as per ESCC specification 22900.*
2. *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.

6 Other information

6.1 Traceability information

The date code in formation is structured as described in the table below.

Table 10. Date codes

Model	Date code
EM	3yywwN
ESCC	yywwN
JANS FLIGHT	WyywwN

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

6.2 Documentation

Table 11. Documentation provided for each type of product

Quality level	Radiation level	Documentation
JANS Flight	-	Certificate of conformance
JANSR Flight	100 krad	Certificate of conformance RVT report (50 rad/s and 0.1 rad/s)
Engineering model	-	Certificate of conformance
ESCC	-	Certificate of conformance ESCC qualification maintenance lot reference
ESCC	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 12. **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 9 and Section 6.2 . Removed STPOWER logo and Radiation summary table.

Contents

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