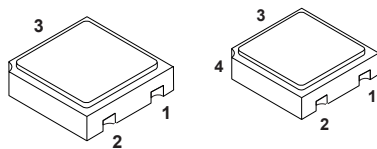


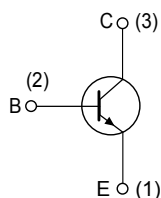
## Rad-Hard 50 V, 0.8 A NPN transistor



**LCC-3**

**UB**

Pin 4 in UB is connected to the metallic lid.



DS10450

### Features

| $V_{CE0}$ | $I_C(\text{max.})$ | $H_{FE}$ at 10 V,<br>150 mA | $T_j(\text{max.})$ |
|-----------|--------------------|-----------------------------|--------------------|
| 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 summary

| Product status link       |
|---------------------------|
| <a href="#">2N2222AHR</a> |

| 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 $T_{amb} \leq 25\text{ °C}$ | LCC-3 and UB                | 0.5        | W    |
|           |                                                  | LCC-3 and UB <sup>(1)</sup> | 0.73       |      |
| $T_{OP}$  | 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 |
|------------|------------------------------------------------------------|--------------------|------|
| $R_{thJA}$ | Thermal resistance junction-ambient (max) for LCC-3 and UB | 350                | °C/W |
|            |                                                            | 240 <sup>(1)</sup> |      |

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

## 2 Electrical characteristics

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

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

1. Pulsed duration = 300  $\mu\text{s}$ , duty cycle  $\leq 1.5\%$

## 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](#).

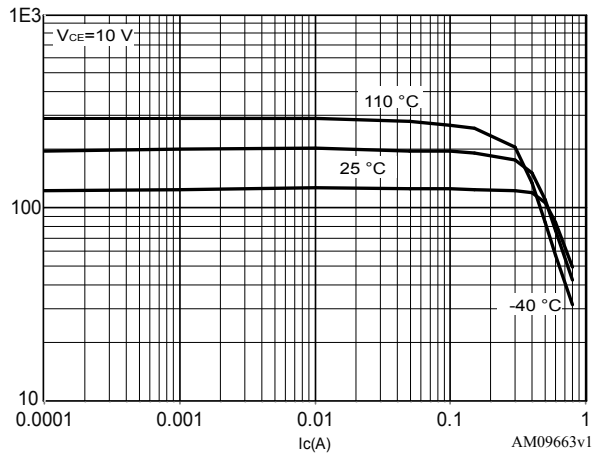
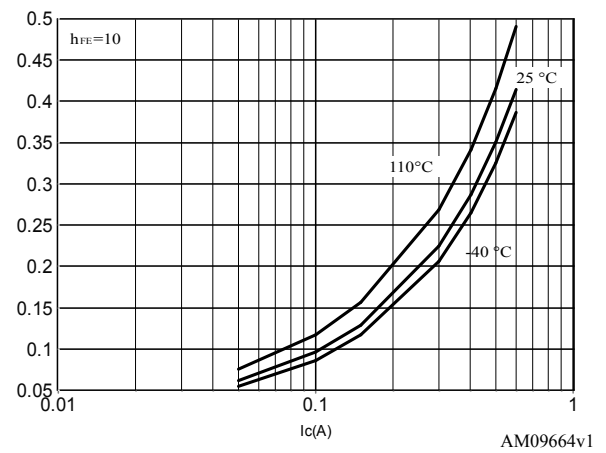
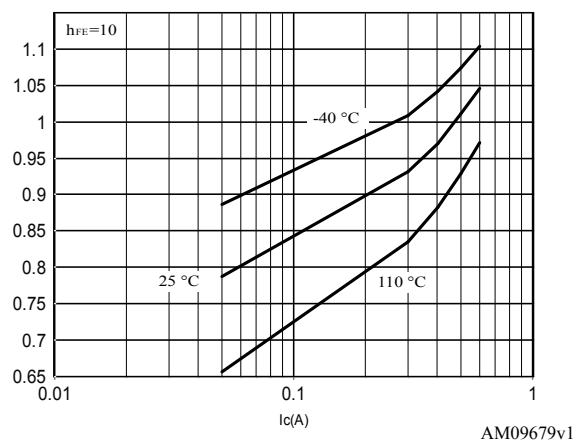
**Table 4. ESCC 5201/002 post radiation electrical characteristics ( $T_{amb} = 25\text{ °C}$  unless otherwise specified)**

| Symbol              | Parameter                                         | Test conditions                                | Min.   | 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 ( $I_E = 0$ )    | $I_C = 100\text{ }\mu\text{A}$                 | 75     |     | V    |
| $V_{(BR)CEO}^{(1)}$ | Collector-emitter breakdown voltage ( $I_B = 0$ ) | $I_C = 10\text{ mA}$                           | 50     |     | 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                   | $I_C = 150\text{ mA}$ , $I_B = 15\text{ mA}$   |        | 1.2 | V    |
| $[h_{FE}]^{(1)}$    | Post irradiation gain calculation <sup>(2)</sup>  | $I_C = 0.1\text{ mA}$ , $V_{CE} = 10\text{ V}$ | [17.5] |     |      |
|                     |                                                   | $I_C = 10\text{ mA}$ , $V_{CE} = 10\text{ V}$  | [37.5] |     |      |
|                     |                                                   | $I_C = 150\text{ mA}$ , $V_{CE} = 10\text{ V}$ | [50]   | 300 |      |
|                     |                                                   | $I_C = 500\text{ mA}$ , $V_{CE} = 10\text{ V}$ | [20]   |     |      |

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

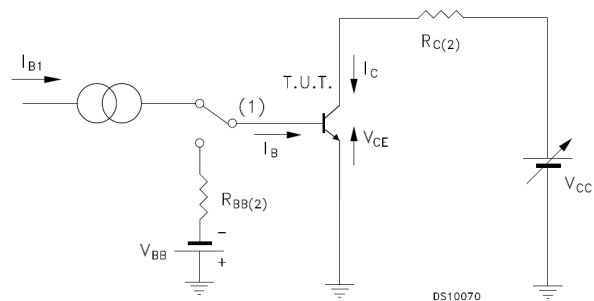
2. The post-irradiation gain calculation of  $[h_{FE}]$ , made using  $h_{FE}$  measurements from prior to and on completion of irradiation testing and after each annealing step if any, shall be as specified in MILSTD-750 method 1019.

## 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

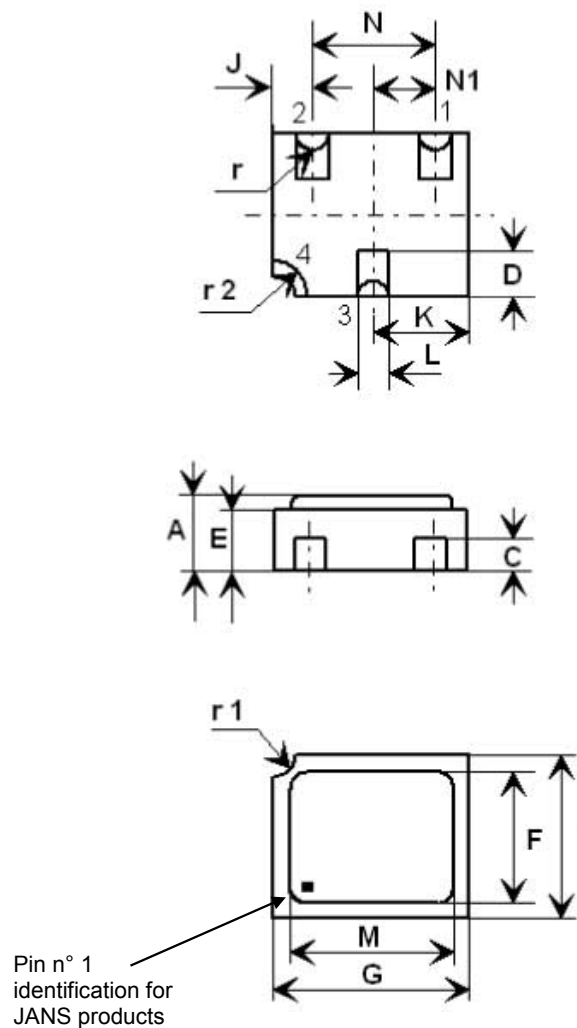
Note: (2) Non-inductive resistor

### 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](http://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

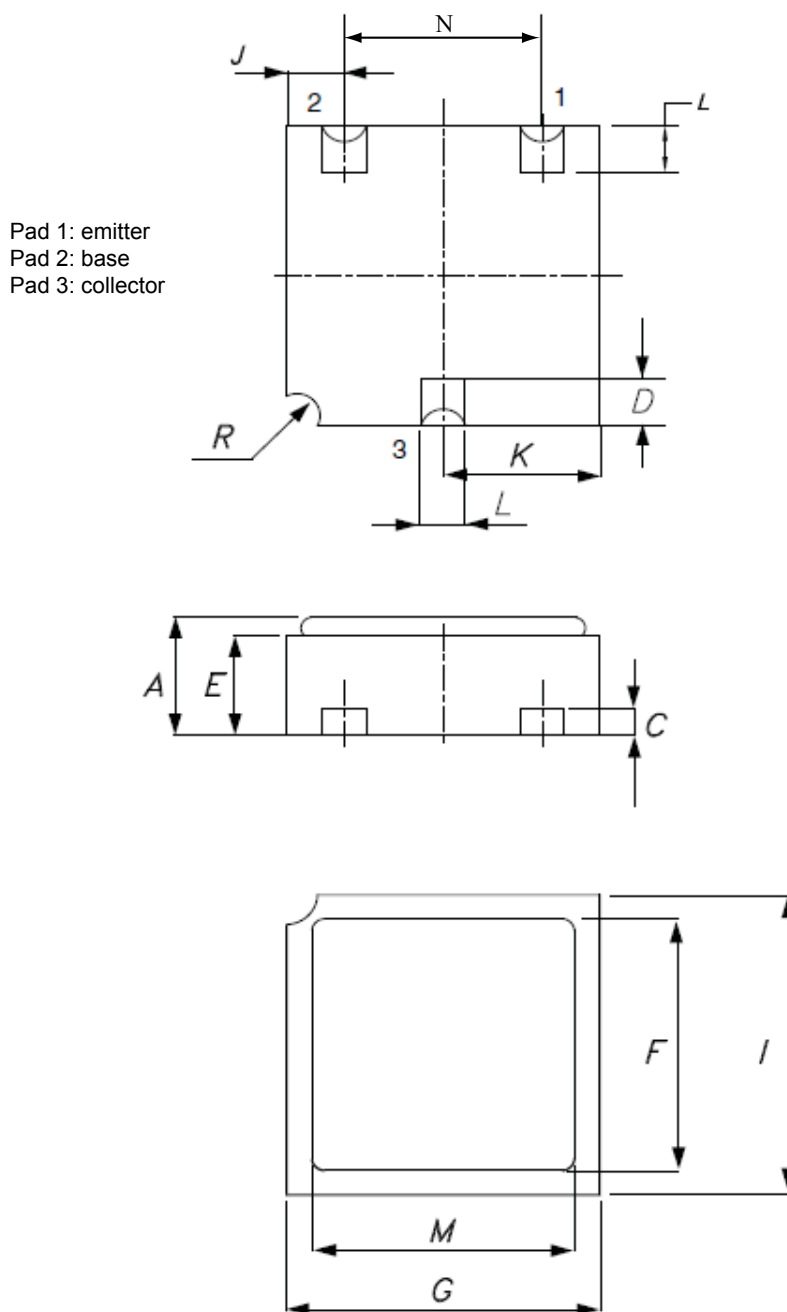
8206487 rev.6

**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



0041211 rev.14

**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 <sup>(1)</sup> | 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             | Tape and reel |               |
| 2N2222ARUBT   | 5201/002/12R       |                   |                 |         |       | Solder Dip  | 520100212R             |               |               |
| 2N2222ARUBTW  | 5201/002/12R       |                   |                 |         |       | Gold        | 520100211              |               |               |
| 2N2222AUBG    | 5201/002/11        |                   | -               |         |       | Solder Dip  | 520100212              | WafflePack    |               |
| 2N2222AUBT    | 5201/002/12        |                   | -               |         |       | Gold        | 520100204R             |               |               |
| SOC2222ARHRG  | 5201/002/04R       |                   | 100 krad        | LCC-3   |       | Solder Dip  | 520100205R             |               |               |
| SOC2222ARHRT  | 5201/002/05R       |                   |                 |         |       | Solder Dip  | 520100205R             | Tape and reel |               |
| SOC2222ARHRTW | 5201/002/05R       |                   |                 |         |       | Gold        | 520100204              | WafflePack    |               |
| SOC2222AHRG   | 5201/002/04        |                   | -               |         |       | Solder Dip  | 520100205              |               |               |
| SOC2222AHRT   | 5201/002/05        |                   | -               |         |       | Solder Dip  | 520100205              |               | Tape and reel |
| SOC2222AHRTW  | 5201/002/05        |                   | -               |         |       |             |                        |               |               |

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<br>ESCC qualification maintenance lot reference                                                                                        |
| Flight model      | 100 krad        | Certificate of conformance<br>ESCC qualification maintenance lot reference<br>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        | <ul style="list-style-type: none"> <li>– Modified: Table 5 on page 5.</li> <li>– Added: Section 2.3: Electrical characteristics (curves).</li> <li>– Modified: Table 1 and 2;</li> <li>– Added: Table 2, 11, 12.</li> <li>– Minor text changes in the document title and description on the cover page.</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>– PTOT in Table 2: Absolute maximum ratings.</li> <li>– The entire Section 2: Electrical characteristics.</li> </ul> <p>Added:</p> <ul style="list-style-type: none"> <li>– Table 3: Thermal data, Section 3: Radiation hardness assurance and Table 13: Ordering information.</li> <li>– Figure 7: JANS saturated turn-on switching time test circuit and Figure 8: JANS saturated turn-off switching time test circuit.</li> <li>– Section 6: Shipping details.</li> </ul> |
| 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.<br>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       | <p>Table 1: Device summary and Table 13: Ordering information have been updated.</p> <p>Updated Section 3: Radiation hardness assurance and Section 4: Package mechanical data.</p> <p>Inserted Figure 2: Safe operating area for LCC-3 and UB and Figure 3: Safe operating area for TO-18.</p>                                                                                                                                                                                                                                                                                     |
| 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 <a href="#">Table 1</a> , <a href="#">Table 7</a> and <a href="#">Section 5.2</a> . Removed STPOWER logo and Radiation summary table.                                                                                                            |
| 11-Oct-2021 | 24       | Updated features, Description, Product summary, <a href="#">Table 1</a> , <a href="#">Table 2</a> , <a href="#">Section 2 Electrical characteristics</a> , <a href="#">Section 2.3 Test circuits</a> , <a href="#">Table 7</a> , <a href="#">Table 8</a> and <a href="#">Table 9</a> . |
| 18-Jan-2022 | 25       | Updated Features, Description, <a href="#">Section 2.1 Radiation assurance</a> , <a href="#">Table 7</a> and <a href="#">Table 9</a> . Documentation provided for each type of product.                                                                                                |

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