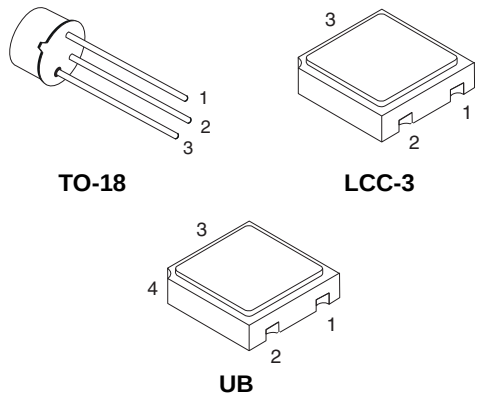
# 2N5551HR

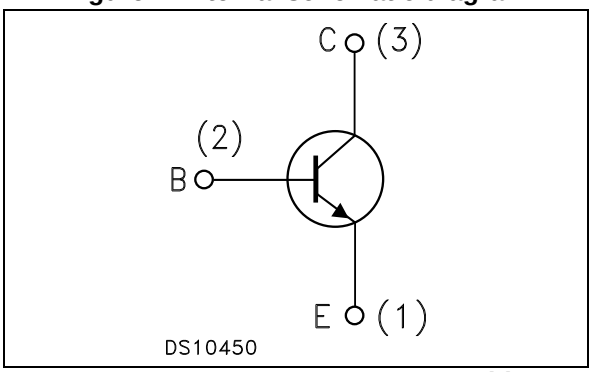
## Hi-Rel NPN bipolar transistor 160 V, 0.5 A

**Datasheet - production data**




Pin 4 in UB is connected to the metallic lid.

**Figure 1. Internal schematic diagram**




## Features

| | |
|---|---|
| $BV_{CEO}$ | 160 V |
| $I_C$ (max) | 0.5 A |
| $H_{FE}$ at 5 V - 10 mA | > 80 |

- Hermetic packages
- ESCC and JANS qualified
- Up to 100 krad(Si) low dose rate

## Description

The 2N5551HR 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.

**Table 1. Device summary**

| Device | Qualification system | Agency specification | Package | Radiation level | EPPL |
|---|---|---|---|---|---|
| JANSR2N5551UBx | JANSR | MIL-PRF-19500/761 | UB | 100 krad high and low dose rate | - |
| JANS2N5551UBx | JANS | MIL-PRF-19500/761 | UB | - | - |
| 2N5551RUBx | ESCC Flight | 5201/019 | UB | 100 krad - low dose rate | Target |
| 2N5551UBx | ESCC Flight | 5201/019 | UB | - | Target |
| SOC5551RHRx | ESCC Flight | 5201/019 | LCC-3 | 100 krad - low dose rate | Yes |
| SOC5551HRx | ESCC Flight | 5201/019 | LCC-3 | - | Yes |
| 2N5551RHRx | ESCC Flight | 5201/019 | TO-18 | 100 krad - low dose rate | - |
| 2N5551HRx | ESCC Flight | 5201/019 | TO-18 | - | - |

# Contents

# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{CBO}$ | Collector-base voltage ($I_E$ = 0) | 180 | V |
| $V_{CEO}$ | Collector-emitter voltage ($I_B$ = 0) | 160 | V |
| $V_{EBO}$ | Emitter-base voltage ($I_C$ = 0) | 6 | V |
| $I_C$ | Collector current<br>for TO-18<br>for LCC-3 and UB | <br>0.6<br>0.5 | <br>A<br>A |
| $P_{TOT}$ | Total dissipation at $T_{amb} \leq 25$ °C<br>for TO-18<br>for LCC-3 and UB<br>for LCC-3 and UB (1)<br>Total dissipation at $T_c \leq 25$ °C<br>for TO-18 | <br>0.36<br>0.36<br>0.58<br><br>1.2 | <br>W<br>W<br>W<br><br>W |
| $T_{STG}$ | Storage temperature | -65 to 200 | °C |
| $T_J$ | Max. operating junction temperature | 200 | °C |

1. When mounted on a 8 x 10 x 0.6 mm ceramic substrate.

**Table 3. Thermal data for through-hole package**

| Symbol | Parameter | | Value | Unit |
|---|---|---|---|---|
| $R_{thJC}$ | Thermal resistance junction-case | max | 146 | °C/W |
| $R_{thJA}$ | Thermal resistance junction-ambient | max | 486 | °C/W |

**Table 4. Thermal data for SMD package**

| Symbol | Parameter | | Value | Unit |
|---|---|---|---|---|
| $R_{thJA}$ | Thermal resistance junction-ambient | max | 486 | °C/W |
| | Thermal resistance junction-ambient (1) | max | 302 | °C/W |

1. When mounted on a 8 x 10 x 0.6 mm ceramic substrate.

# 2 Electrical characteristics

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

**Table 5. Electrical characteristics**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $I_{CBO}$ | Collector-base cut-off current ($I_E$ = 0) | $V_{CB}$ = 120 V<br>$V_{CB}$ = 120 V $T_C$ = 150 °C | | - | 50<br>50 | nA<br>µA |
| $I_{EBO}$ | Emitter-base cut-off current ($I_C$ = 0) | $V_{EB}$ = 4 V | | - | 50 | nA |
| $V_{(BR)CBO}$ | Collector-base breakdown voltage ($I_E$ = 0) | $I_C$ = 100 µA | 180 | - | | V |
| $V_{(BR)CEO}$ (1) | Collector-emitter breakdown voltage ($I_B$ = 0) | $I_C$ = 1 mA | 160 | - | | V |
| $V_{(BR)EBO}$ | Emitter-base breakdown voltage ($I_C$ = 0) | $I_E$ = 10 µA | 6 | - | | V |
| $V_{CE(sat)}$ (1) | Collector-emitter saturation voltage | $I_C$ = 10 mA $I_B$ = 1 mA<br>$I_C$ = 50 mA $I_B$ = 5 mA | | - | 0.15<br>0.2 | V<br>V |
| $V_{BE(sat)}$ (1) | Base-emitter saturation voltage | $I_C$ = 10 mA $I_B$ = 1 mA<br>$I_C$ = 50 mA $I_B$ = 5 mA | | - | 1<br>1 | V<br>V |
| $h_{FE}$ (1) | DC current gain | $I_C$ = 1 mA $V_{CE}$ = 5 V<br>$I_C$ = 10 mA $V_{CE}$ = 5 V<br>$I_C$ = 50 mA $V_{CE}$ = 5 V<br>$I_C$ = 10 mA $V_{CE}$ = 5 V<br>$T_{amb}$ = - 55 °C | 80<br>80<br>30<br>20 | - | 250 | |
| $h_{fe}$ | Small signal current gain | For ESCC<br>$V_{CE}$ = 10 V $I_C$ = 10 mA<br>f > 1 kHz | 50 | - | | |
| | | For JANS<br>$V_{CE}$ = 10 V $I_C$ = 10 mA<br>f > 20 kHz | 2.5 | | | |
| $h_{fe}$ | Small signal current gain | $V_{CE}$ = 10 V $I_C$ = 10 mA<br>f > 100 MHz | 1 | - | | |
| $C_{obo}$ | Output capacitance ($I_E$ = 0) | $V_{CB}$ = 10 V f = 1 MHz | | - | 6 | pF |
| $C_{ebo}$ | Emitter-base capacitance ($I_C$ = 0) | For ESCC<br>$V_{EB}$ = 5 V f = 1 MHz | | - | 20 | pF |
| | | For JANS<br>$V_{EB}$ = 500 mV f = 1 MHz | | | 45 | pF |

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

## 2.1 Electrical characteristics (curves)

Figure 2. $h_{FE}$ @ $V_{CE}$ = 5 V

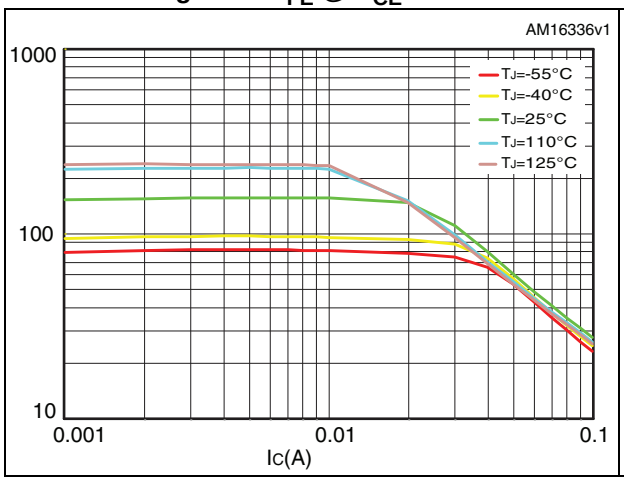



Figure 3. $V_{CE(sat)}$ @ $h_{FE}$ =10

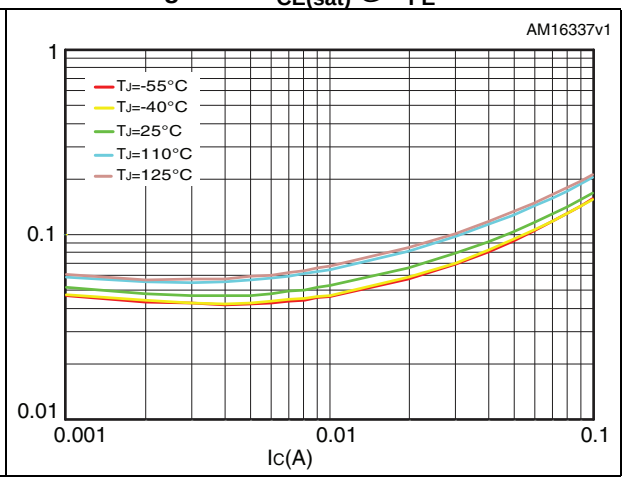
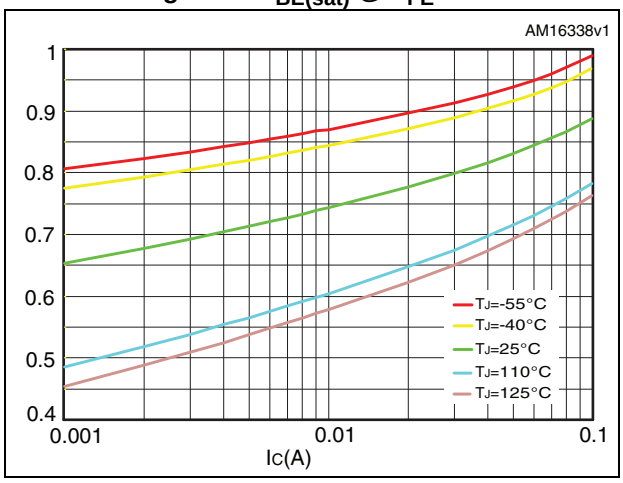



Figure 4. $V_{BE(sat)}$ @ $h_{FE}$ =10



# 3 Radiation hardness assurance

The products guaranteed in radiation within the JANS system fully comply with the MIL-PRF-19500/761 specification.

The products guaranteed in radiation within the ESCC system fully comply with the ESCC 5201/019 and ESCC 22900 specifications.

### 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, subgroup 2 inspection, between 50 and 300 rad/s. On top of the standard JANSR high dose rate by wafer lot guarantee, ST 2N5551HR series include an additional wafer by wafer 100 krad Low dose rate guarantee at 0.1 rad/s, identical to the ESCC 100 krad guarantee. It is supported with the same radiation verification test report provided with each shipment. A brief summary of the standard High Dose Rate by wafer lot JANSR guarantee 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.

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 | $V_{CB}$ = 120 V | | 100 | nA |
| $I_{EBO}$ | Emitter to base cutoff current | $V_{EB}$ = 4 V | | 100 | nA |
| $V_{(BR)CEO}$ | Breakdown voltage, collector to emitter | $I_C$ = 1 mA | 184 | | V |
| $V_{(BR)BCO}$ | Breakdown voltage, base to collector | $I_C$ = 100 µA | 207 | | V |
| $V_{(BR)EBO}$ | Breakdown voltage, emitter to base | $I_{EB}$ = 10 µA | 6.9 | | V |
| $h_{FE}$ | Forward-current transfer ratio | $V_{CE}$ = 5 V; $I_C$ = 1 mA | [40](1) | | |
| | | $V_{CE}$ = 5 V; $I_C$ = 10 mA | [40](1) | 250 | |
| | | $V_{CE}$ = 5 V; $I_C$ = 50 mA | [15](1) | | |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | $I_C$ = 10 mA; $I_B$ = 1 mA | | 0.1725 | V |
| | | $I_C$ = 50 mA; $I_B$ = 5 mA | | 0.23 | |
| $V_{BE(sat)}$ | Base-emitter saturation voltage | $I_C$ = 10 mA; $I_B$ = 1 mA | | 1.15 | V |
| | | $I_C$ = 50 mA; $I_B$ = 5 mA | | 1.15 | |

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.

### 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 7*
- 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 7. ESCC 5201/019 post radiation electrical characteristics**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $I_{CBO}$ | Collector cut-off current ($I_E$ = 0) | $V_{CB}$ = 120 V | | - | 50 | nA |
| $I_{EBO}$ | Emitter cut-off current ($I_C$ = 0) | $V_{EB}$ =4 V | | - | 50 | nA |
| $V_{(BR)CBO}$ | Collector-base breakdown voltage ($I_E$ = 0) | $I_C$ = 100 µA | 180 | - | | V |
| $V_{(BR)CEO}$ (1) | Collector-emitter breakdown voltage ($I_B$ = 0) | $I_C$ = 1 mA | 160 | - | | V |
| $V_{(BR)EBO}$ | Emitter-base breakdown voltage ($I_C$ = 0) | $I_E$ = 10 µA | 6 | - | | V |
| $V_{CE(sat)}$ (1) | Collector-emitter saturation voltage | $I_C$ = 10 mA $I_B$ = 1 mA<br>$I_C$ = 50 mA $I_B$ = 5 mA | | - | 0.2<br>0.2 | V<br>V |
| $V_{BE(sat)}$ (1) | Base-emitter saturation voltage | $I_C$ = 10 mA $I_B$ = 1 mA<br>$I_C$ = 50 mA $I_B$ = 5 mA | | | 1<br>1 | V<br>V |
| $[h_{FE}]$ (1) | Post irradiation gain calculation (2) | $I_C$ = 1 mA $V_{CE}$ = 5 V<br>$I_C$ = 10 mA $V_{CE}$ = 5 V<br>$I_C$ = 50 mA $V_{CE}$ = 5 V | [40]<br>[40]<br>[15] | - | 250 | |

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 mechanical data

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 LCC-3

**Figure 5. LCC-3 drawings**

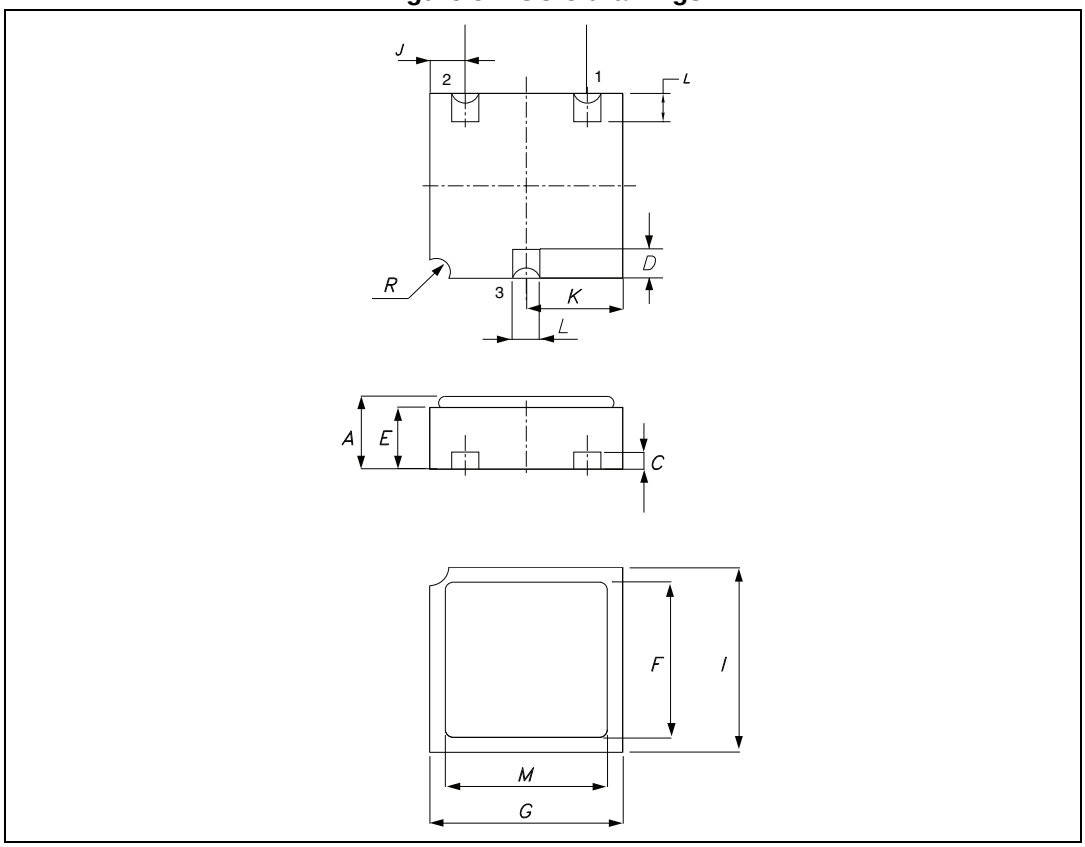


Table 8. LCC-3 mechanical data

| 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 | |

## 4.2 TO-18

Figure 6. TO-18 drawings

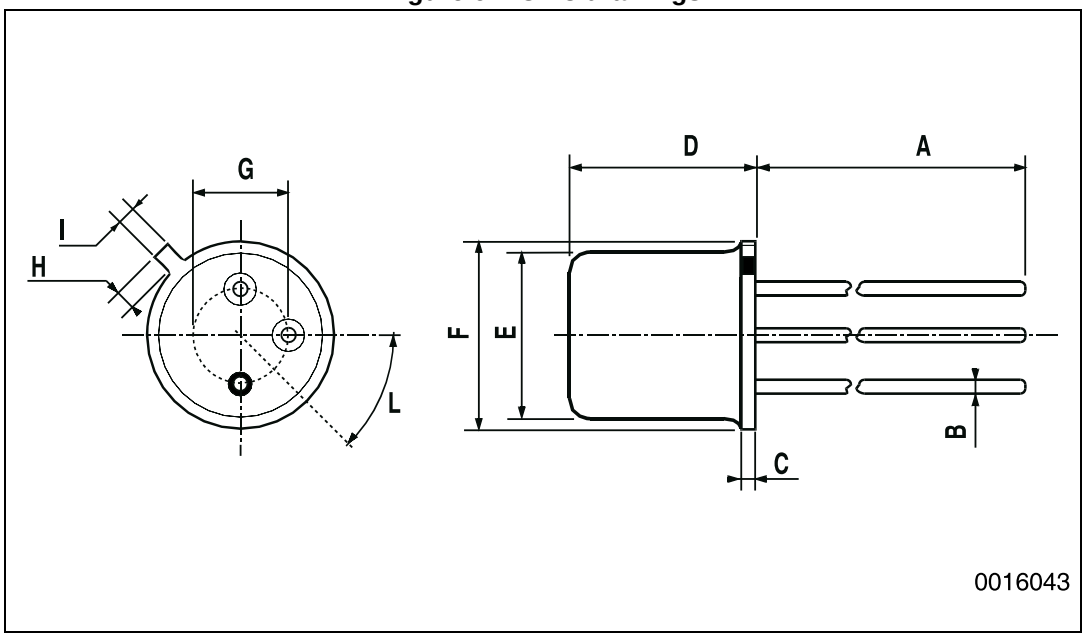


Table 9. TO-18 mechanical data

| 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° | | |

## 4.3 UB

Figure 7. UB drawing

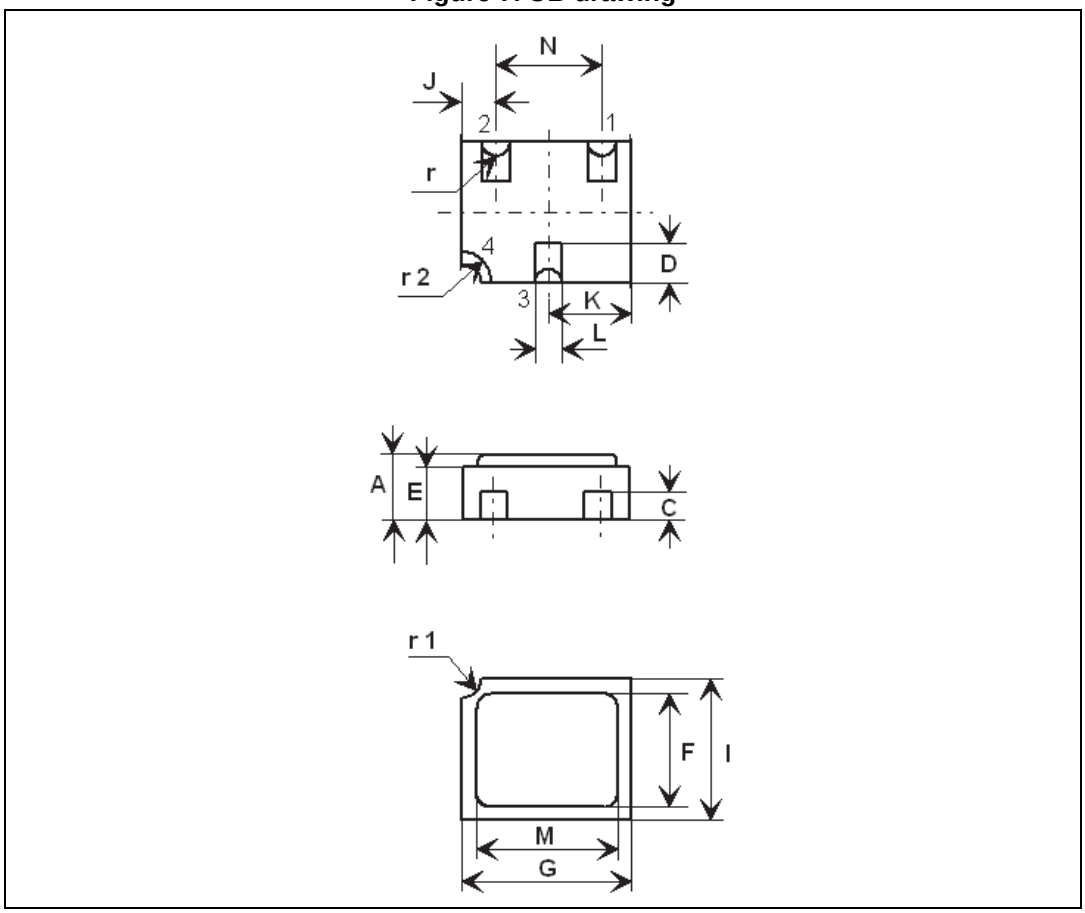


Table 10. UB mechanical data

| Dim. | mm | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | - | 12.70 | 14.20 |
| B | | 0.40 | 0.49 |
| C | | 0.58 | 0.74 |
| D | | 6.00 | 6.40 |
| E | | 8.15 | 8.25 |
| F | | 9.10 | 9.20 |
| G | | 4.93 | 5.23 |
| H | | 0.85 | 0.95 |
| I | | 0.75 | 0.85 |
| L | | 42° | 48° |

# 5 Order codes

**Table 11. Order codes**

| CPN | Agency specification | EPPL | Quality level | Radiation level(1) | Package | Lead finish | Marking(2) | Packing |
|---|---|---|---|---|---|---|---|---|
| J2N5551UB1 | - | - | Engineering model JANS | - | UB | Gold | J5551UB1 | WafflePack |
| 2N5551UB1 | - | - | Engineering model ESCC | - | UB | Gold | 2N55511UB1 | WafflePack |
| SOC55511 | - | - | Engineering model ESCC | - | LCC-3 | Gold | SOC55511 | WafflePack |
| JANSR2N5551UBG | MIL-PRF-19500/761 | - | JANSR | 100 krad high and low dose rate | UB | Gold | JSR5551 | WafflePack |
| JANSR2N5551UBT | MIL-PRF-19500/761 | - | JANSR | 100 krad high and low dose rate | UB | Solder Dip | JSR5551 | WafflePack |
| JANS2N5551UBG | MIL-PRF-19500/761 | - | JANS | - | UB | Gold | JS5551 | WafflePack |
| JANS2N5551UBT | MIL-PRF-19500/761 | - | JANS | - | UB | Solder Dip | JS5551 | WafflePack |
| 2N5551RUBG | 5201/019/08R | Target | ESCC Flight | 100 krad - low dose rate | UB | Gold | 520101908R | WafflePack |
| 2N5551RUBT | 5201/019/09R | Target | ESCC Flight | 100 krad - low dose rate | UB | Solder Dip | 520101909R | WafflePack |
| 2N5551UBG | 5201/019/08 | Target | ESCC Flight | - | UB | Gold | 520101908 | WafflePack |
| 2N5551UBT | 5201/019/09 | Target | ESCC Flight | - | UB | Solder Dip | 520101909 | WafflePack |
| SOC5551RHRG | 5201/019/04R | Yes | ESCC Flight | 100 krad - low dose rate | LCC-3 | Gold | 520101904R | WafflePack |
| SOC5551RHRT | 5201/019/05R | Yes | ESCC Flight | 100 krad - low dose rate | LCC-3 | Solder Dip | 520101905R | WafflePack |
| SOC5551HRG | 5201/019/04 | Yes | ESCC Flight | - | LCC-3 | Gold | 520101904 | WafflePack |

**Table 11. Order codes (continued)**

| CPN | Agency specification | EPPL | Quality level | Radiation level(1) | Package | Lead finish | Marking(2) | Packing |
|---|---|---|---|---|---|---|---|---|
| SOC5551HRT | 5201/019/05 | Yes | ESCC Flight | - | LCC-3 | Solder Dip | 520101905 | WafflePack |
| 2N5551RHRG | 5201/019/01R | - | ESCC Flight | 100 krad - low dose rate | TO-18 | Gold | 520101901R | Strip Pack |
| 2N5551RHRT | 5201/019/02R | - | ESCC Flight | 100 krad - low dose rate | TO-18 | Solder Dip | 520101902R | Strip Pack |
| 2N5551HRG | 5201/019/01 | - | ESCC Flight | - | TO-18 | Gold | 520101901 | Strip Pack |
| 2N5551HRT | 5201/019/02 | - | ESCC Flight | - | TO-18 | Solder Dip | 520101902 | Strip Pack |

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

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 Date code

Date code xyywwz is structured as below table:

**Table 12. Date code**

| | x | yy | ww | z |
|---|---|---|---|---|
| EM (ESCC & JANS) | 3 | last two digits of the year | week digits | lot index in the week |
| ESCC FLIGHT | - | | | |
| JANS FLIGHT (diffused in Singapore) | W | | | |

## 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 | MIL-STD 100 krad | Certificate of conformance<br>50 rad/s radiation verification test report |
| | ST 100 krad | Certificate of conformance<br>0.1 rad/s radiation verification test report on each wafer |
| 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 |
| 17-May-2010 | 2 | Modified: *Table 1: Device summary* and *Table 9 on page 11* |
| 12-Jul-2010 | 3 | Modified: *Table 1: Device summary* and *Table 9 on page 11* |
| 13-Nov-2012 | 4 | Added:*Section 2.1: Electrical characteristics (curves)* |
| 12-Dec-2013 | 5 | Updated *Table 1: Device summary*, *Table 2: Absolute maximum ratings* and *Section 4: Package mechanical data*.<br>Added *Section 5: Order codes* and *Section 6: Shipping details* |
| 27-Mar-2014 | 6 | Updated *Table 1: Device summary*, *Section 3: Radiation hardness assurance*, *Figure 7: UB drawing*, *Section 5: Order codes* and *Table 13: Documentation provided for each type of product*.<br>Minor text changes. |
| 01-Apr-2014 | 7 | Inserted note in package silhouette on cover page. |
| 14-Jul-2014 | 8 | Updated *Table 1: Device summary* and *Table 11: Order codes*. |