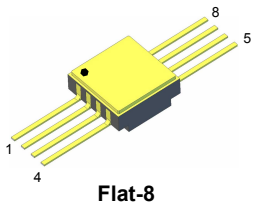
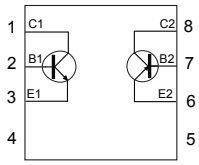
# 2ST3360K

Datasheet

## Rad-Hard 60 V, 0.8 A, NPN and PNP transistors in single package




**Flat-8**




**Flat-8**

Pin 4 and pin 5
are connected together to the seal ring and lid

| Product status link |
|---|
| 2ST3360K |

## Features

| Polarity | $V_{(BR)CEO}$ | IC (max.) | $h_{FE}$ |
|---|---|---|---|
| NPN | 60 V | 0.8 A | 160 |
| PNP | -60 V | -0.8 A | 160 |

*1. at IC = 1 A and $V_{CE}$ = 2 V*

- 100 krad
- Linear gain characteristics
- ESCC qualified

## Description

The 2ST3360K is a dual NPN and PNP bipolar transistor developed from ST's Rad-Hard high current density technology and housed in Flat-8 hermetic package.

Both NPN and PNP transistors offer linear and complementary behavior, fast switching and best in class radiation hardness performance.

Specifically designed for aerospace applications and suitable for power MOSFET driver and high peak output current applications, it is qualified in the ESCC system as per 5207/009 specification.

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

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol | Parameter | Value | | Unit |
|---|---|---|---|---|
| | | NPN | PNP | |
| $V_{CBO}$ | Collector-base voltage ($I_E$ = 0) | 60 | -60 | V |
| $V_{CEO}$ | Collector-emitter voltage ($I_B$ = 0) | 60 | -60 | V |
| $V_{EBO}$ | Emitter-base voltage ($I_C$ = 0) | 6 | -6 | V |
| $I_C$ | Collector current | 0.8 | -0.8 | A |
| $I_{CM}$ | Collector peak current ($t_P$ < 5 ms) | 4 | -4 | A |
| $I_B$ | Base current | 0.2 | -0.2 | A |
| $I_{BM}$ | Base peak current ($t_P$ < 5 ms) | 0.4 | -0.4 | A |
| $P_{TOT}$ | Total dissipation at $T_{amb}$ ≤ 25 °C | 1.4(1) | | W |
| | | 0.8(2) | | |
| | Total dissipation at $T_c$ ≤ 25 °C | 7(1) | | W |
| | | 5(2) | | |
| $T_{STG}$ | Storage temperature range | -65 to 200 | | °C |
| $T_J$ | Operating junction temperature range | | | °C |

1. *Both sections.*
2. *One section.*

**Table 2. Thermal data**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $R_{thJA}$ | Thermal resistance junction-to-ambient max. | 125(1) | °C/W |
| | | 180(2) | |
| $R_{thJC}$ | Thermal resistance junction-to-case max. | 25(1) | |
| | | 35(2) | |

1. *Both sections.*
2. *One section.*

# 2 Electrical characteristics

*Note: For PNP transistor voltage and current polarity is reversed.*

**Table 3. Electrical characteristics for NPN ($T_{amb}$ = 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 | | 100 | nA |
| | | $V_{CB}$ = 60 V, $T_a$ = 150 °C | | 10 | µA |
| $I_{EBO}$ | Emitter-base cut-off current ($I_C$ = 0) | $V_{EB}$ = 6 V | | 100 | nA |
| $V_{(BR)CBO}$ | Collector-base breakdown voltage ($I_E$ = 0) | $I_C$ = 100 µA | 60 | | V |
| $V_{(BR)CEO}$ | Collector-emitter breakdown voltage ($I_B$ = 0) | $I_C$ = 1 mA | 60 | | V |
| $V_{(BR)EBO}$ | Emitter-base breakdown voltage | $I_E$ = 10 µA | 6 | | V |
| $V_{BE(on)}$ | Base-emitter on voltage | $V_{CE}$ = 2 V, $I_C$ = 100 mA | 600 | 720 | mV |
| $V_{CE(sat)}$ (1) | Collector-emitter saturation voltage | $I_C$ = 0.8 A, $I_B$ = 40 mA | | 160 | mV |
| | | $I_C$ = 2 A $I_B$ = 100 mA | | 380 | mV |
| $h_{FE}$ (1) | DC current gain | $I_C$ = 100 mA, $V_{CE}$ = 2 V | 100 | | |
| | | $I_C$ = 100 mA, $V_{CE}$ = 2 V, $T_a$ = -55 °C | 40 | | |
| | | $I_C$ = 1 A, $V_{CE}$ = 2 V | 160 | 400 | |
| $t_{on}$ | Turn on-time | $V_{CC}$ = 10 V, $I_C$ = 0.8 A, $I_{bon}$ = 80 mA, $I_{boff}$ = -80 mA(2) | | 175 | ns |
| $t_{off}$ | Turn off-time | | | 2.5 | µs |
| $C_{OBO}$ | Output capacitance | $V_{CB}$ = 10 V, $I_E$ = 0 A, f = 1 MHz | | 45 | pF |

1. *Pulse test: pulse duration ≤ 300 µs, duty cycle ≤ 2%.*
2. *Resistive load*

**Table 4. Electrical characteristics for PNP ($T_{amb}$ = 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 | | 100 | nA |
| | | $V_{CB}$ = 60 V, $T_a$ = 150 °C | | 10 | µA |
| $I_{EBO}$ | Emitter-base cut-off current ($I_C$ = 0) | $V_{EB}$ = 6 V | | 100 | nA |
| $V_{(BR)CBO}$ | Collector-base breakdown voltage ($I_E$ = 0) | $I_C$ = 100 µA | 60 | | V |
| $V_{(BR)CEO}$ | Collector-emitter breakdown voltage ($I_B$ = 0) | $I_C$ = 1 mA | 60 | | V |
| $V_{(BR)EBO}$ | Emitter-base breakdown voltage | $I_E$ = 10 µA | 6 | | V |
| $V_{BE(on)}$ | Base-emitter on voltage | $V_{CE}$ = 2 V, $I_C$ = 100 mA | 600 | 720 | mV |
| $V_{CE(sat)}$ (1) | Collector-emitter saturation voltage | $I_C$ = 0.8 A, $I_B$ = 40 mA | | 180 | mV |
| | | $I_C$ = 2 A $I_B$ = 100 mA | | 440 | mV |
| $h_{FE}$ (1) | DC current gain | $I_C$ = 100 mA, $V_{CE}$ = 2 V | 100 | | |
| | | $I_C$ = 100 mA, $V_{CE}$ = 2 V, $T_a$ = -55 °C | 40 | | |
| | | $I_C$ = 1 A, $V_{CE}$ = 2 V | 160 | 400 | |
| $t_{on}$ | Turn on-time | $V_{CC}$ = 10 V, $I_C$ = 0.8 A, $I_{bon}$ = 80 mA, $I_{boff}$ = -80 mA(2) | | 150 | ns |
| $t_{off}$ | Turn off-time | | | 1 | µs |
| $C_{OBO}$ | Output capacitance | $V_{CB}$ = 10 V, $I_E$ = 0 A, f = 1 MHz | | 60 | pF |

1. *Pulse test: pulse duration ≤ 300 µs, duty cycle ≤ 2%.*
2. *Resistive load*

## 2.1 Test circuits

Figure 1. **Resistive load switching for NPN**

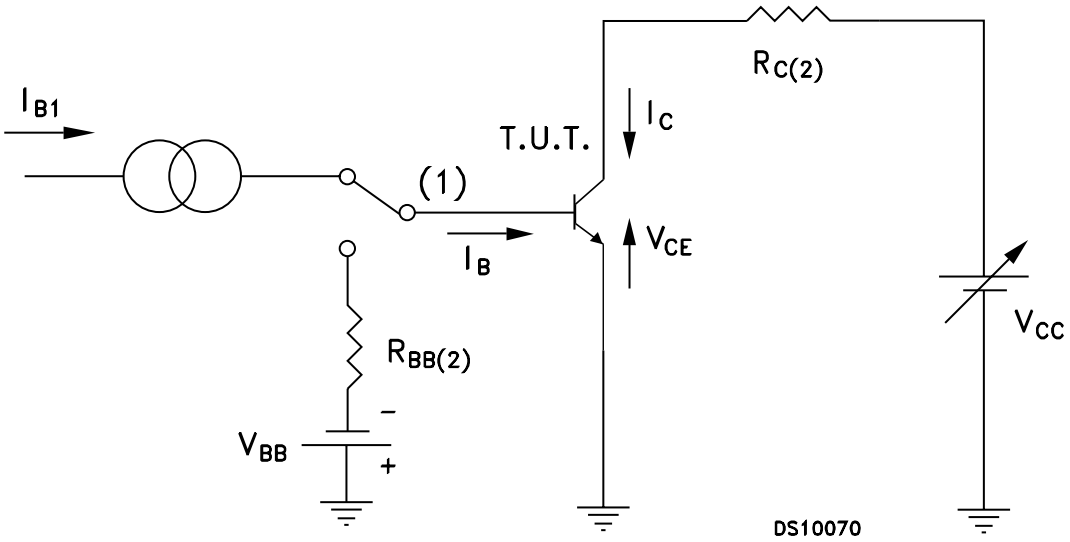
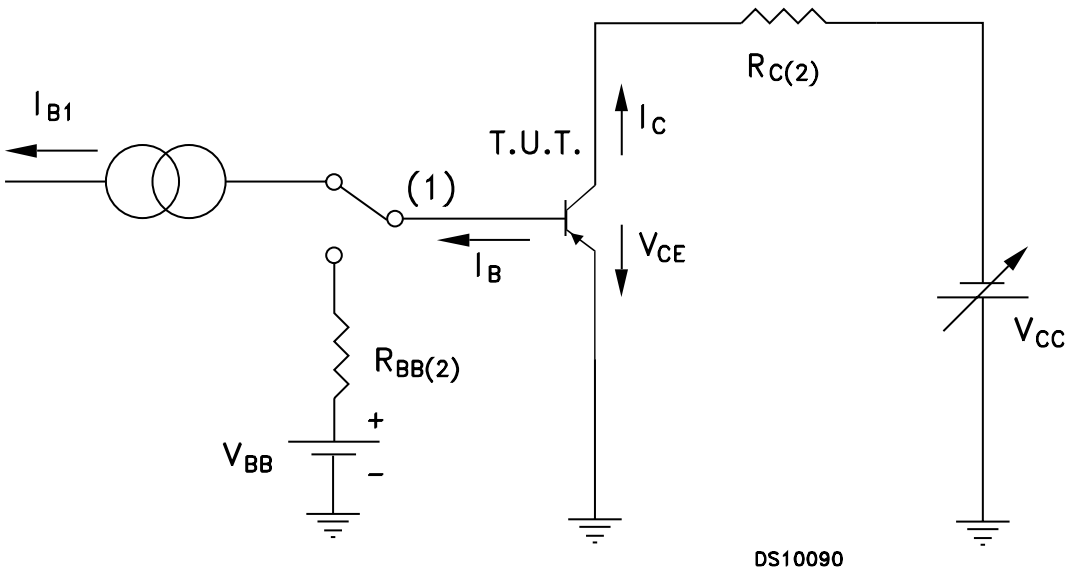



Figure 2. **Resistive load switching for PNP**



# 3 Radiation hardness assurance

This products is guaranteed in radiation as per ESCC 22900 and in compliance with ESCC 5207/009 specification. Each lot is tested in radiation according to the following procedure:

- Irradiation at 0.1 rad (Si)/s
- Test of 11 samples by wafer, 5 biased at least 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 5 and Table 6.

**Table 5. ESCC5207/009 post radiation electrical characteristics for NPN ($T_{amb}$ = 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 | | 200 | nA |
| $I_{EBO}$ | Emitter cut-off current ($I_C$= 0) | $V_{EB}$ = 6 V | | 200 | nA |
| $V_{BE(on)}$ | VBE(on) Base-emitter on voltage | $V_{CE}$ = 2 V, $I_C$ = 100 mA | 600 | 828 | mV |
| $V_{(BR)CBO}$ | Collector-base breakdown voltage ($I_E$= 0) | $I_C$=100 µA | 60 | | V |
| $V_{(BR)CEO}$ | Collector-emitter breakdown voltage ($I_B$ = 0) | $I_C$ = 1 mA | 60 | | 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 | $I_C$=0.8 A, $I_B$ = 40 mA | | 184 | mV |
| | | $I_C$= 2 A, $I_B$ = 100 mA | | 437 | |
| $h_{FE}$(1) | DC current gain | $I_C$= 100 mA, $V_{CE}$= 2 V | [50](2) | | |
| | | $I_C$= 1 A, $V_{CE}$= 2 V | [80](2) | 400 | |

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*

*Note: For PNP transistor voltage and current polarity is reversed.*

**Table 6. ESCC5207/009 post radiation electrical characteristics for PNP ($T_{amb}$ = 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 | | 200 | nA |
| $I_{EBO}$ | Emitter cut-off current ($I_C$= 0) | $V_{EB}$ = 6 V | | 200 | nA |
| $V_{BE(on)}$ | Base-emitter on voltage | $V_{CE}$ = 2 V, $I_C$ = 100 mA | 600 | 828 | mV |
| $V_{(BR)CBO}$ | Collector-base breakdown voltage ($I_E$= 0) | $I_C$= 100 µA | 60 | | V |
| $V_{(BR)CEO}$ | Collector-emitter breakdown voltage ($I_B$ = 0) | $I_C$ = 1 mA | 60 | | 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 | $I_C$=0.8 A, $I_B$ = 40 mA | | 207 | mV |
| | | $I_C$= 2 A, $I_B$ = 100 mA | | 506 | |
| $h_{FE}$[1] | DC current gain | $I_C$= 100 mA, $V_{CE}$= 2 V | [50][2] | | |
| | | $I_C$= 1 A, $V_{CE}$= 2 V | [80][2] | 400 | |

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 Flat-8 package information

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

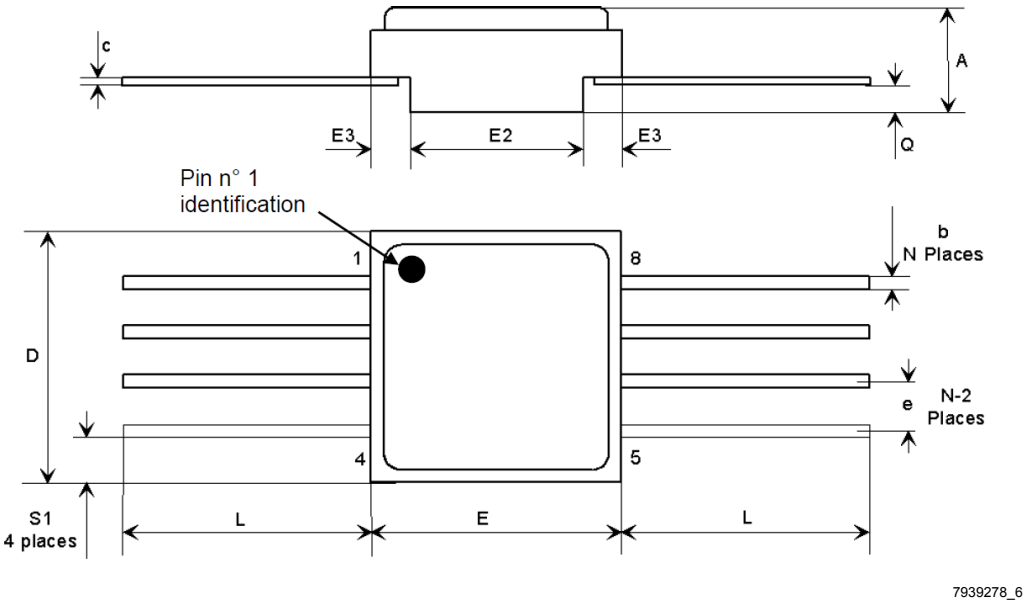



**Table 7. Flat-8 mechanical data**

| Symbol | Milimeters | | | Inches | | |
|---|---|---|---|---|---|---|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | 2.24 | 2.44 | 2.64 | 0.088 | 0.096 | 0.104 |
| b | 0.38 | 0.43 | 0.48 | 0.015 | 0.017 | 0.019 |
| c | 0.10 | 0.13 | 0.16 | 0.004 | 0.005 | 0.006 |
| D | 6.35 | 6.48 | 6.61 | 0.250 | 0.255 | 0.260 |
| E | 6.35 | 6.48 | 6.61 | 0.250 | 0.255 | 0.260 |
| E2 | 4.32 | 4.45 | 4.58 | 0.170 | 0.175 | 0.180 |
| E3 | 0.88 | 1.01 | 1.14 | 0.035 | 0.040 | 0.045 |
| e | | 1.27 | | | 0.050 | |
| L | 6.51 | - | 7.38 | 0.256 | - | 0.291 |
| Q | 0.66 | 0.79 | 0.92 | 0.026 | 0.031 | 0.036 |
| S1 | 0.92 | 1.12 | 1.32 | 0.036 | 0.044 | 0.052 |
| N | 08 | | | 08 | | |

# 5 Ordering information

**Table 8. Ordering information**

| Part number | Agency specification | Quality level | Radiation level | Package | Weight | Lead finish | Marking[1] | Packing |
|---|---|---|---|---|---|---|---|---|
| 2ST3360K1 | | Engineering model | - | Flat-8 | 0.4 g | Gold | 2ST3360K1 | Waffle pack |
| 2ST3360RKG | 5207/009/01R | ESCC flight | 100 krad | | | | 520700901R | |
| 2ST3360RKT | 5207/009/02R | ESCC flight | 100 krad | | | Solder dip | 520700902R | |

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: STlogo, 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 Date code

Date code information is described in Table 9.

**Table 9. Date codes**

| Model | Date code |
|---|---|
| EM | 3yywwN |
| ECC | yywwN |

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

## 6.2 Documentation

Documentation is provided for each product as per below Table 10.

**Table 10. Documentation summary**

| Quality level | Radiation level | Documentation |
|---|---|---|
| Engineering model | - | Certificate of conformance. |
| ESCC | 100 krad | Certificate of conformance.<br>ESCC qualification maintenance lot reference.<br>Radiation data at 25 / 50 / 70 / 100 krad at 0.1 rad / s. |

## Revision history

Table 11. **Document revision history**

| Date | Version | Changes |
|---|---|---|
| 19-May-2021 | 1 | Initial release. |

# Contents