

## High voltage fast-switching NPN power transistor

### Features

- High voltage capability
- Low spread of dynamic parameters
- Minimum lot-to-lot spread for reliable operation
- Very high switching speed

### Applications

- Compact fluorescent lamp (CFL)
- Switch mode power supplies (AC-DC converters)

### Description

The device is manufactured using high voltage multi-epitaxial planar technology for high switching speeds and medium voltage capability. It uses a cellular emitter structure with planar edge termination to enhance switching speeds while maintaining the wide RBSOA.

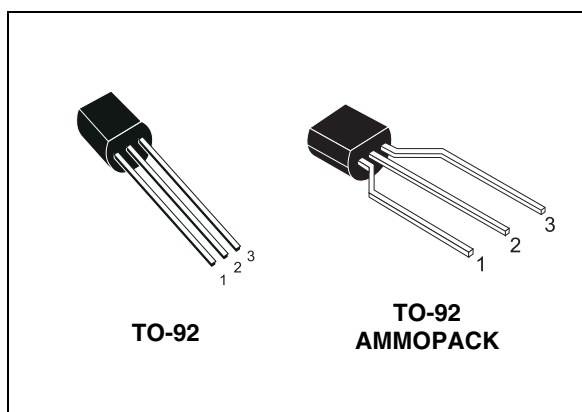


Figure 1. Internal schematic diagram

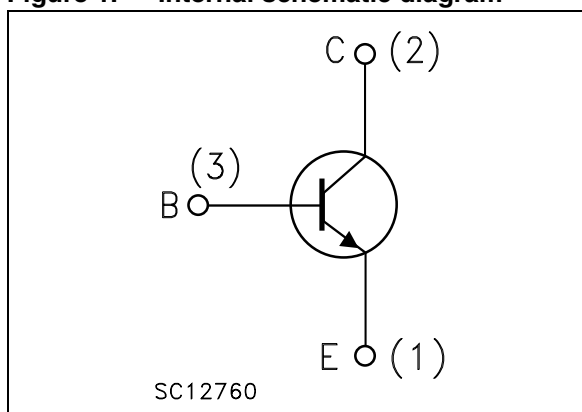


Table 1. Device summary<sup>(1)</sup>

| Order code   | Marking | Package | Packaging |
|--------------|---------|---------|-----------|
| STX13005     | X13005  | TO-92   | Bulk      |
| STX13005G    | X13005G |         |           |
| STX13005-AP  | X13005  |         | Ammopack  |
| STX13005G-AP | X13005G |         |           |

1. The letter "G" in the order code suffix identifies the product as ECOPACK<sup>®</sup>2 grade. Please see [Section 4](#) for details.

# Contents

|          |   |           |
|----------|---|-----------|
| <b>1</b> | <b>Electrical ratings</b> .....               | <b>3</b>  |
| <b>2</b> | <b>Electrical characteristics</b> .....       | <b>4</b>  |
|          | 2.1 Electrical characteristics (curves) ..... | 5         |
| <b>3</b> | <b>Test circuits</b> .....                    | <b>8</b>  |
| <b>4</b> | <b>Package mechanical data</b> .....          | <b>9</b>  |
| <b>5</b> | <b>Revision history</b> .....                 | <b>12</b> |

# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol    | Parameter  | Value         | Unit             |
|-----------|--|---------------|------------------|
| $V_{CES}$ | Collector-emitter voltage ( $V_{BE} = 0$ )                       | 700           | V                |
| $V_{CEO}$ | Collector-emitter voltage ( $I_B = 0$ )                          | 400           | V                |
| $V_{EBO}$ | Emitter-base voltage ( $I_C = 0$ ; $I_B = 1.5$ A; $t_p < 10$ ms) | $V_{(BR)EBO}$ | V                |
| $I_C$     | Collector current  | 3             | A                |
| $I_{CM}$  | Collector peak current ( $t_p < 5$ ms)                           | 6             | A                |
| $I_B$     | Base current   | 1.5           | A                |
| $I_{BM}$  | Base peak current ( $t_p < 5$ ms)                                | 3             | A                |
| $P_{tot}$ | Total dissipation at $T_c = 25^\circ\text{C}$                    | 2.8           | W                |
| $T_{stg}$ | Storage temperature  | -65 to 150    | $^\circ\text{C}$ |
| $T_J$     | Max. operating junction temperature                              | 150           | $^\circ\text{C}$ |

**Table 3. Thermal data**

| Symbol      | Parameter                               | Value | Unit                      |
|-------------|---|-------|---------------------------|
| $R_{thj-c}$ | Thermal resistance junction-case<br>max | 45    | $^\circ\text{C}/\text{W}$ |

## 2 Electrical characteristics

( $T_{case} = 25^{\circ}C$  unless otherwise specified)

**Table 4. Electrical characteristics**

| Symbol               | Parameter  | Test conditions  | Min. | Typ. | Max. | Unit          |
|----------------------|--|--|------|------|------|---------------|
| $I_{CES}$            | Collector cut-off current<br>( $V_{BE} = 0$ )            | $V_{CE} = 700\text{ V}$  |      |      | 1    | mA            |
|                      |  | $V_{CE} = 700\text{ V}$ $T_C = 125^{\circ}C$   |      |      | 5    | mA            |
| $I_{CEO}$            | Collector-cut-off current<br>( $I_B = 0$ )               | $V_{CE} = 400\text{ V}$  |      |      | 1    | mA            |
| $V_{(BR)EBO}$        | Emitter base breakdown<br>voltage<br>( $I_C = 0$ )       | $I_E = 10\text{ mA}$   | 9    |      | 18   | V             |
| $V_{CEO(sus)}^{(1)}$ | Collector-emitter<br>sustaining voltage<br>( $I_B = 0$ ) | $I_C = 10\text{ mA}$   | 400  |      |      | V             |
| $V_{CE(sat)}^{(1)}$  | Collector-emitter<br>saturation voltage                  | $I_C = 1\text{ A}$ $I_B = 200\text{ mA}$   |      |      | 0.5  | V             |
|                      |  | $I_C = 2\text{ A}$ $I_B = 500\text{ mA}$   |      |      | 0.6  | V             |
|                      |  | $I_C = 3\text{ A}$ $I_B = 750\text{ mA}$   |      |      | 5    | V             |
| $V_{BE(sat)}^{(1)}$  | Base-emitter saturation<br>voltage                       | $I_C = 1\text{ A}$ $I_B = 200\text{ mA}$   |      |      | 1.2  | V             |
|                      |  | $I_C = 2\text{ A}$ $I_B = 500\text{ mA}$   |      |      | 1.6  | V             |
| $h_{FE}^{(1)}$       | DC current gain  | $I_C = 1\text{ A}$ $V_{CE} = 5\text{ V}$   | 10   |      | 30   |               |
|                      |  | $I_C = 2\text{ A}$ $V_{CE} = 5\text{ V}$   | 8    |      | 24   |               |
| $t_s$<br>$t_f$       | Resistive load<br>Storage time                           | $I_C = 2\text{ A}$ $V_{CC} = 125\text{ V}$<br>$I_{B1} = -I_{B2} = 400\text{ mA}$<br>$t_p = 30\text{ }\mu\text{s}$                        |      | 1.65 |      | $\mu\text{s}$ |
|                      | Fall time  |  |      | 260  |      | ns            |
| $t_s$<br>$t_f$       | Inductive load<br>Storage time                           | $I_C = 1\text{ A}$ $V_{clamp} = 300\text{ V}$<br>$I_{B1} = 200\text{ mA}$ $V_{BE(off)} = -5\text{ V}$<br>$L = 50\text{ mH}$ $R_{BB} = 0$ |      | 0.8  |      | $\mu\text{s}$ |
|                      | Fall time  |  |      | 150  |      | ns            |

1. Pulse test: pulse duration  $\leq 300\text{ }\mu\text{s}$ , duty cycle  $\leq 2\%$

## 2.1 Electrical characteristics (curves)

Figure 2. Safe operating area @ $T_C = 25^\circ\text{C}$

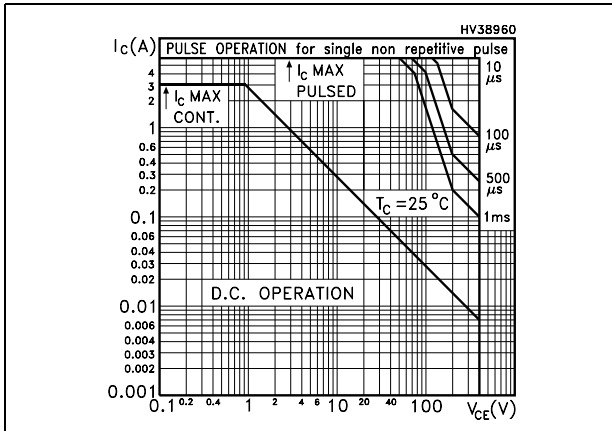


Figure 3. Safe operating area @ $T_C = 135^\circ\text{C}$

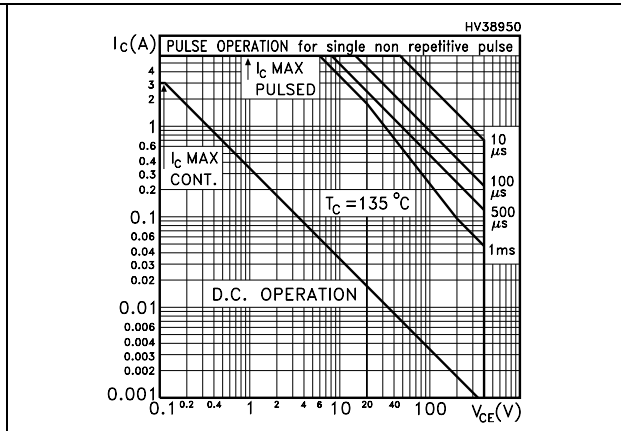


Figure 4. Derating curve

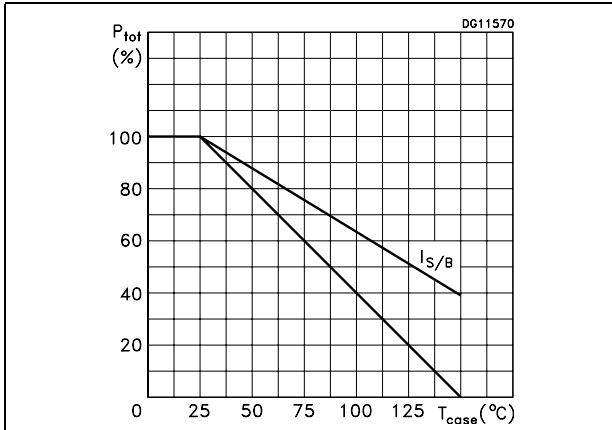


Figure 5. Output characteristics

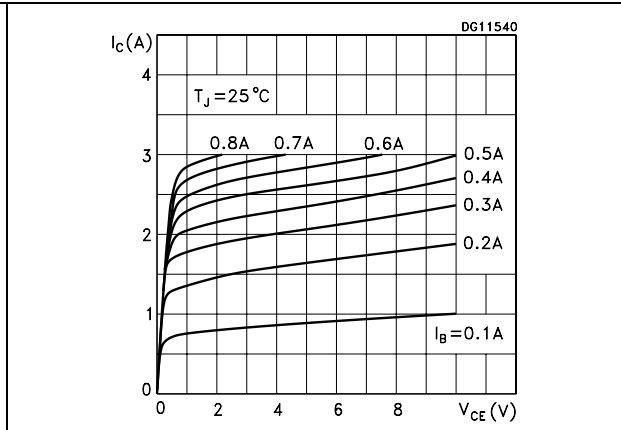


Figure 6. DC current gain @ $V_{CE} = 1\text{ V}$

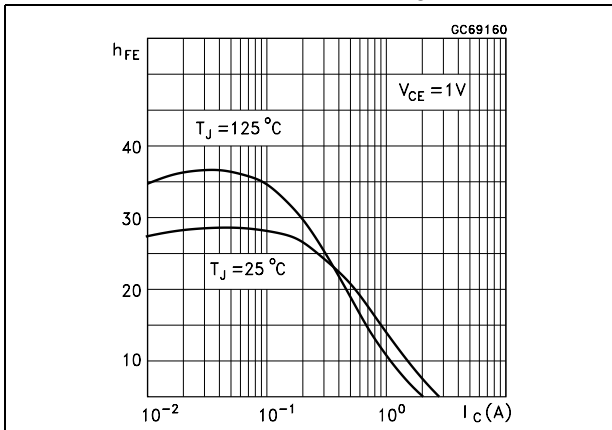


Figure 7. DC current gain @ $V_{CE} = 5\text{ V}$

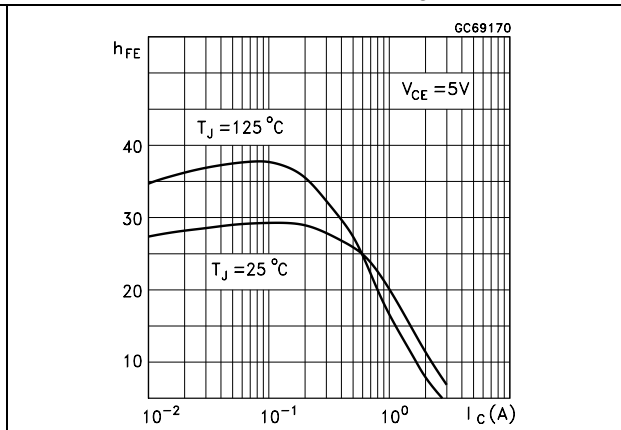


Figure 8. Collector-emitter saturation voltage Figure 9. Base-emitter saturation voltage

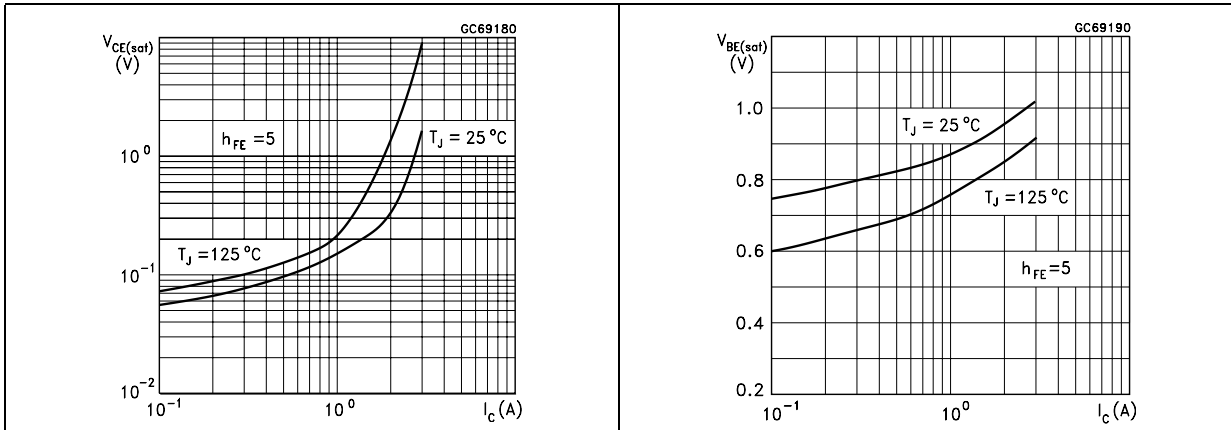


Figure 10. Inductive load fall time Figure 11. Inductive load storage time

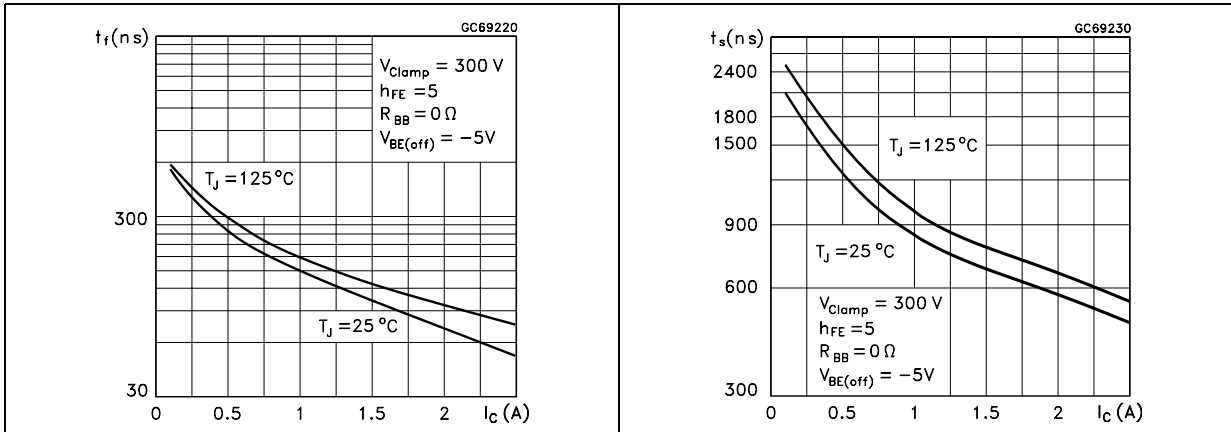


Figure 12. Resistive load fall time Figure 13. Resistive load storage time

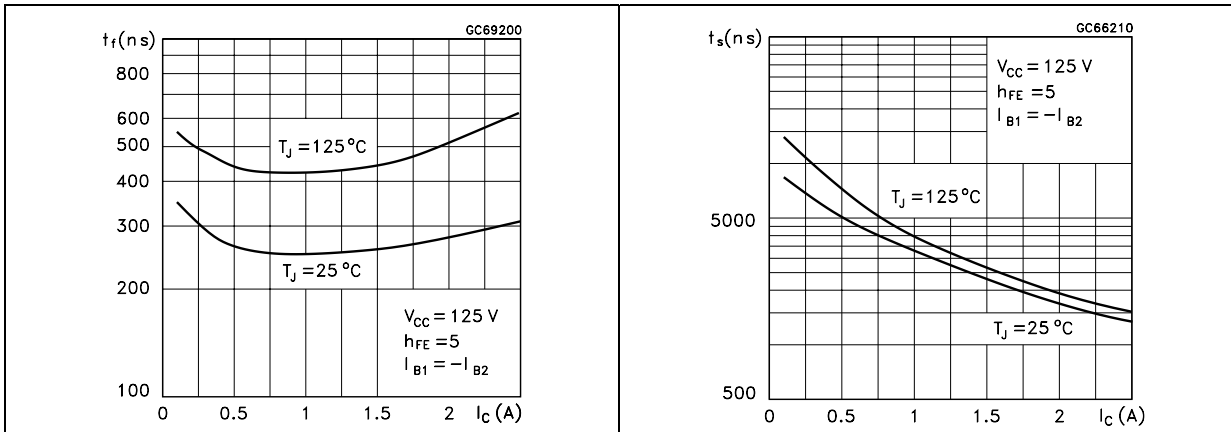
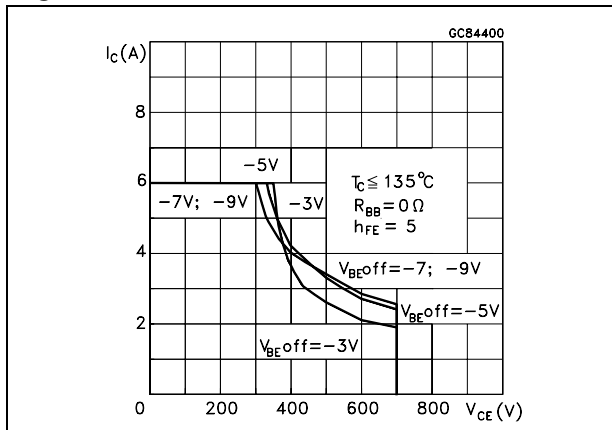
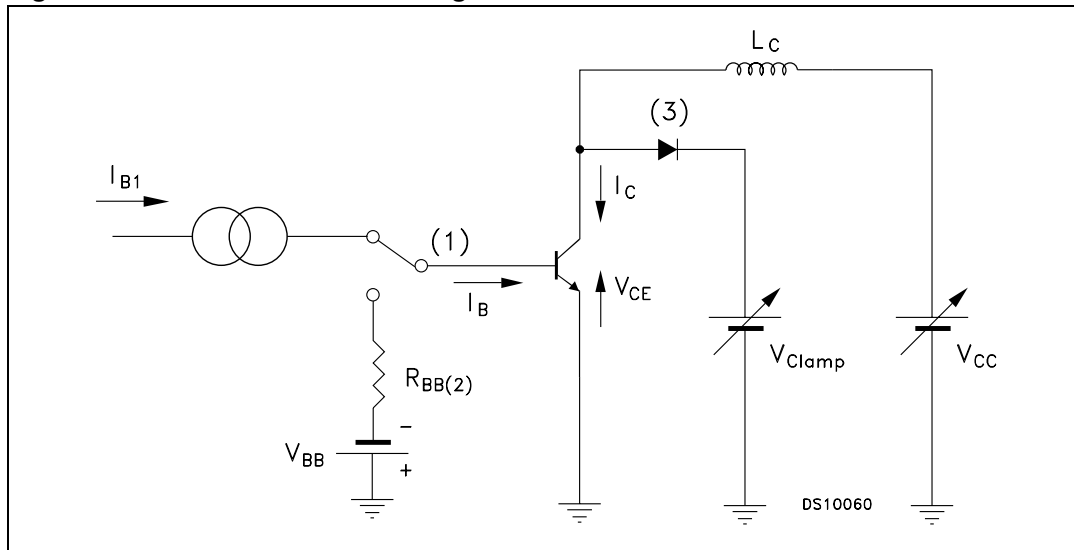


Figure 14. Reverse biased SOA



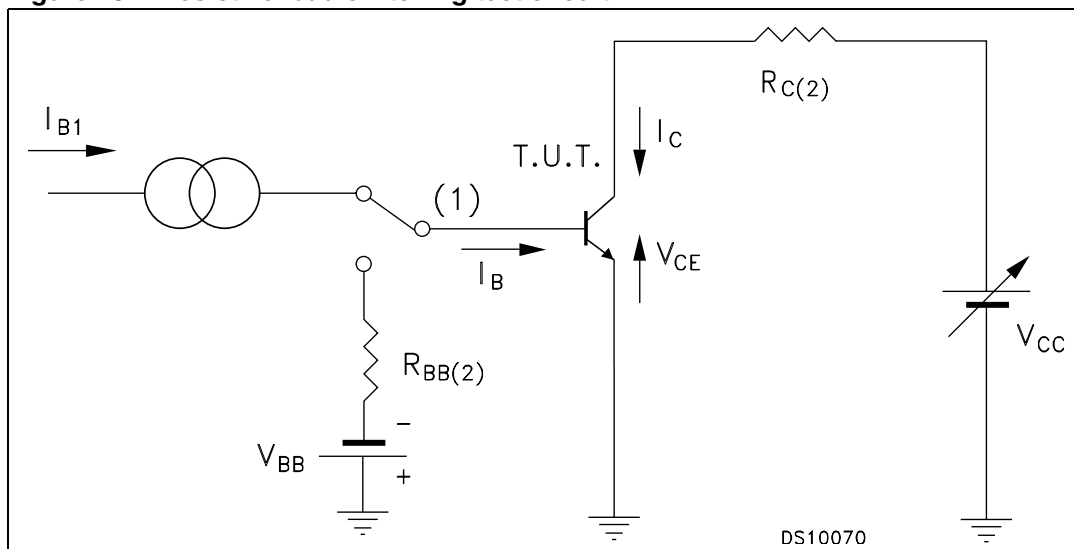
### 3 Test circuits

Figure 15. Inductive load switching test circuit



- 1) Fast electronic switch
- 2) Non-inductive resistor
- 3) Fast recovery rectifier

Figure 16. Resistive load switching test circuit



- 1) Fast electronic switch
- 2) Non-inductive resistor



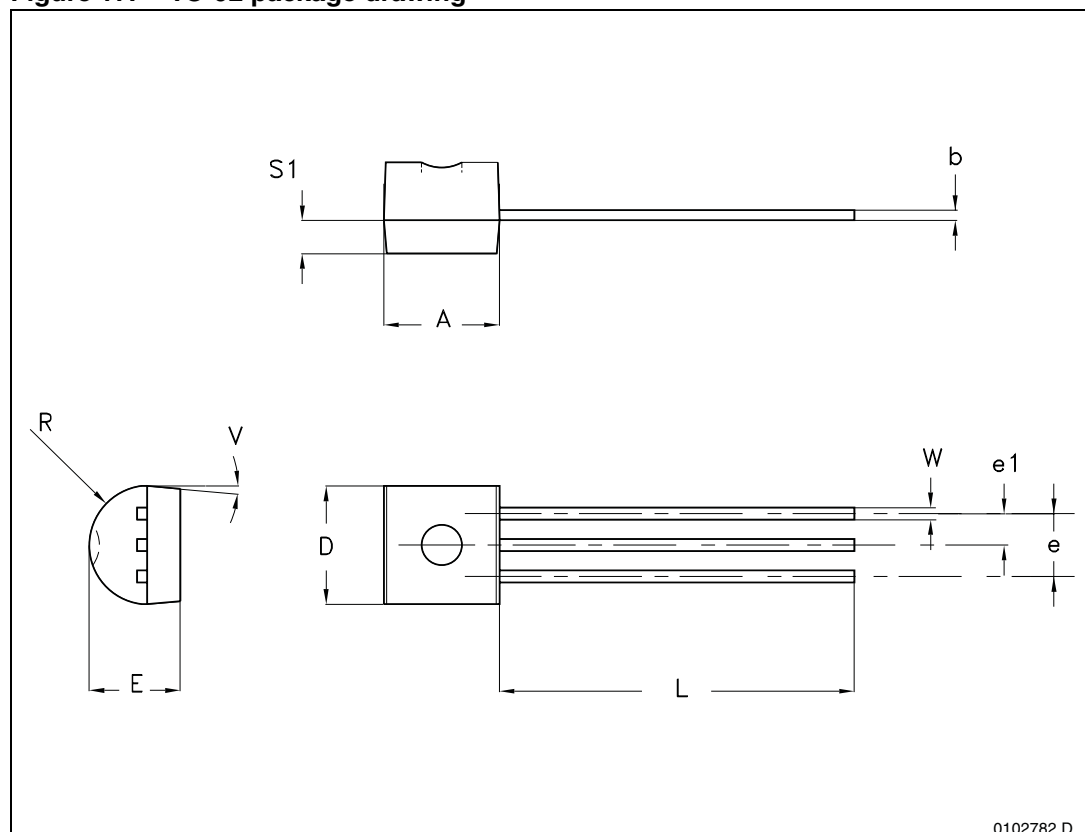
## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK<sup>®</sup> is an ST trademark.

Table 5. TO-92 package mechanical data

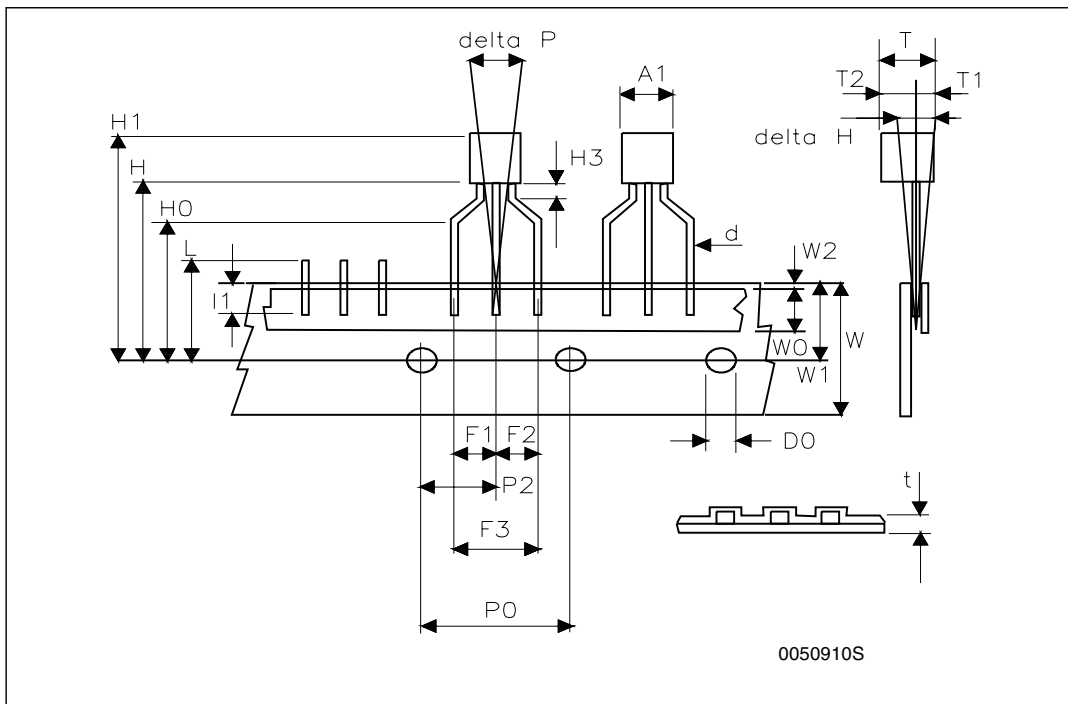
| Dim. | mm    |      |       |
|------|-------|------|-------|
|      | Min.  | Typ. | Max.  |
| A    | 4.32  |      | 4.95  |
| b    | 0.36  |      | 0.51  |
| D    | 4.45  |      | 4.95  |
| E    | 3.30  |      | 3.94  |
| e    | 2.41  |      | 2.67  |
| e1   | 1.14  |      | 1.40  |
| L    | 12.70 |      | 15.49 |
| R    | 2.16  |      | 2.41  |
| S1   | 0.92  |      | 1.52  |
| W    | 0.41  |      | 0.56  |
| V    |       | 5°   |       |

Figure 17. TO-92 package drawing



TO-92 ammpack shipment (suffix"-AP") mechanical data

| Dim.    | mm    |       |       |
|---------|-------|-------|-------|
|         | Min   | Typ   | Max   |
| A1      |       |       | 4.80  |
| T       |       |       | 3.80  |
| T1      |       |       | 1.60  |
| T2      |       |       | 2.30  |
| d       |       |       | 0.48  |
| P0      | 12.50 | 12.70 | 12.90 |
| P2      | 5.65  | 6.35  | 7.05  |
| F1,F2   | 2.44  | 2.54  | 2.94  |
| F3      | 4.98  | 5.08  | 5.48  |
| delta H | -2.00 |       | 2.00  |
| W       | 17.50 | 18.00 | 19.00 |
| W0      | 5.70  | 6.00  | 6.30  |
| W1      | 8.50  | 9.00  | 9.25  |
| W2      |       |       | 0.50  |
| H       | 18.50 |       | 20.50 |
| H3      | 0.5   | 1     | 1.5   |
| H0      | 15.50 | 16.00 | 16.50 |
| H1      |       |       | 25.00 |
| D0      | 3.80  | 4.00  | 4.20  |
| t       |       |       | 0.90  |
| L       |       |       | 11.00 |
| l1      | 3.00  |       |       |
| delta P | -1.00 |       | 1.00  |



## 5 Revision history

**Table 6. Document revision history**

| Date        | Revision | Changes  |
|-------------|----------|--|
| 01-Jul-2004 | 1        | First release.   |
| 11-Feb-2005 | 2        | New table on page 1  |
| 02-Aug-2007 | 3        | New <a href="#">Figure 3</a> and updated <a href="#">Figure 14</a>                     |
| 28-Sep-2007 | 4        | Updated <a href="#">Figure 2</a> and <a href="#">Figure 3</a>                          |
| 16-Dec-2008 | 5        | Added ECOPACK <sup>®</sup> 2 grade products with suffix "G"                            |
| 11-Aug-2009 | 6        | Updated TO-92 mechanical data and <a href="#">Figure 1: Internal schematic diagram</a> |

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