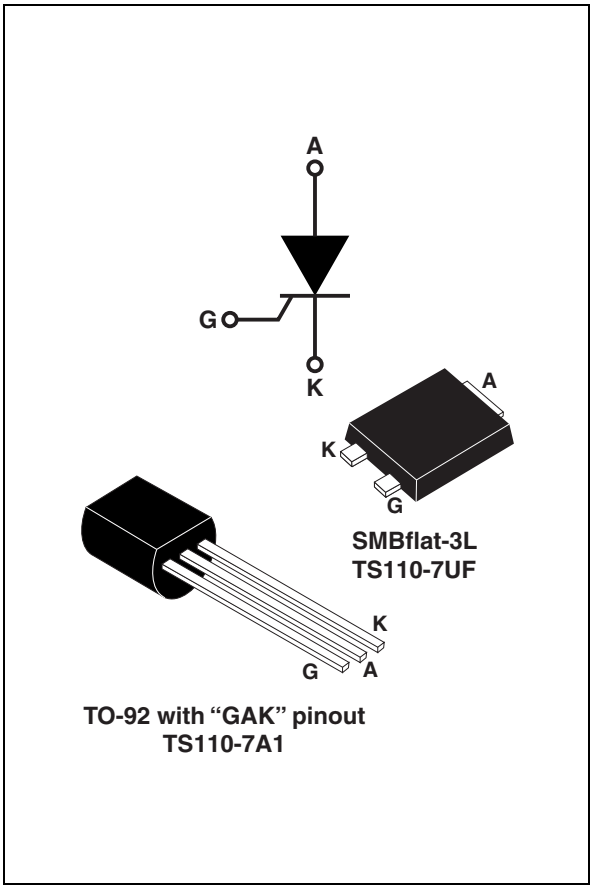
# TS110-7

## High surge voltage 1.25 A SCR for circuit breaker

**Datasheet - production data**




**TO-92 with "GAK" pinout**
**TS110-7A1**

## Features

- On-state rms current, 1.25 A
- Repetitive peak off-state voltage, 700 V
- Non-repetitive direct surge peak off-state voltage, 1250 V
- Non-repetitive reverse surge peak off-state voltage, 850 V
- Triggering gate current, 100 µA

## Description

Thanks to highly sensitive triggering levels, the TS110-7 series is suitable for circuit breaker applications where the available gate current is limited. Such applications include GFCI (ground fault circuit interrupter), AFCI (arc fault circuit interrupter), RCD (residual current device), and RCBO (residual current circuit breaker with overload protection).

The 1250 V surge voltage capability of the TS110-7 enables high robustness of the whole circuit breaker. The low leakage current of the TS110-7 reduces power consumption over the entire lifetime of the circuit breaker.

The TS110-7 is available in through-hole TO-92 package with GAK pinout and in SMBflat-3L.

# 1 Characteristics

**Table 1. Absolute ratings (limiting values)**

| Symbol | Parameter | | | Value | Unit |
|---|---|---|---|---|---|
| $I_{T(RMS)}$ | On-state rms current (180° conduction angle) | TO-92 | $T_l$ = 58 °C | 1.25 | A |
| | | SMBflat-3L | $T_{tab}$ = 110 °C | | |
| $IT_{(AV)}$ | Average on-state current (180° conduction angle) | TO-92 | $T_l$ = 58 °C | 0.8 | A |
| | | SMBflat-3L | $T_{tab}$ = 110 °C | | |
| $I_{TSM}$ | Non repetitive surge peak on-state current | $t_p$ = 8.3 ms | | 27 | A |
| | | $t_p$ = 10 ms | | 25 | |
| | 1st step: one surge every 5 seconds, 25 surges<br>2nd step: one surge every 5 seconds, 25 surges | $t_p$ = 10 ms | $T_{j\ initial}$ = 25 °C | 25 times 12 A,<br>25 times 16 A | |
| $I^2t$ | $I^2t$ Value for fusing | $t_p$ = 10 ms | | 3.1 | $A^2s$ |
| dI/dt | Critical rate of rise of on-state current<br>$I_G$ = 2 x $I_{GT}$, $t_r \leq$ 100 ns | F = 60 Hz | $T_j$ = 125 °C | 100 | A/µs |
| | Critical rate of rise of on-state current<br>Gate open, $V_D = V_{BO}$, $t_r \leq$ 100 ns | | $T_j$ = 25 °C | 100 | |
| $V_{DRM}$, $V_{RRM}$ | Repetitive peak off-state voltage, gate open | | $T_j$ = 125 °C | 700 | V |
| $V_{DSM}$ | Non-repetitive direct surge peak off-state voltage, $R_{GK}$ = 220 Ω | $t_p$ = 50 µs | $T_j$ = 25 °C | 1250 | V |
| $V_{RSM}$ | Non-repetitive reverse surge peak off-state voltage, $R_{GK}$ = 220 Ω | $t_p$ = 50 µs | $T_j$ = 25 °C | 850 | V |
| $I_{GM}$ | Peak gate current | $t_p$ = 20 µs | $T_j$ = 125 °C | 1.2 | A |
| $P_{G(AV)}$ | Average gate power dissipation | | $T_j$ = 125 °C | 0.2 | W |
| $T_{stg}$ | Storage junction temperature range | | | - 40 to + 150 | °C |
| $T_j$ | Operating junction temperature range | | | - 40 to + 125 | |

**Table 2. Electrical characteristics**

| Symbol | Test conditions | | | Value | Unit |
|---|---|---|---|---|---|
| $I_{GT}$ | $V_D$ = 12 V, $R_L$ = 140Ω | $T_j$ = 25 °C | Min. | 1 | µA |
| | | | Max. | 100 | |
| $V_{GT}$ | | | Max. | 0.8 | V |
| $V_{GD}$ | $V_D = V_{DRM}$, $R_L$ = 33 kΩ, $R_{GK}$ = 220 Ω | $T_j$ = 125 °C | Min. | 0.1 | V |
| $V_{RG}$ | $I_{RG}$ = 2 mA | $T_j$ = 25 °C | Min. | 7.5 | V |
| $I_H$ | $I_T$ = 50 mA, $R_{GK}$ = 220 Ω | $T_j$ = 25 °C | Max. | 2 | mA |
| $I_L$ | $I_G$ = 5 mA, $R_{GK}$ = 220 Ω | $T_j$ = 25 °C | Max. | 2 | mA |
| dV/dt | $V_D$ = 67% $V_{DRM}$, $R_{GK}$ = 220 Ω | $T_j$ = 125 °C | Min. | 15 | V/µs |

**Table 3. Static electrical characteristics**

| Symbol | Test conditions | | | Value | Unit |
|---|---|---|---|---|---|
| $V_{TM}$ | $I_{TM}$ = 2.5 A, $t_p$ = 380 µs | $T_j$ = 25 °C | Max. | 1.4 | V |
| $V_{T0}$ | Threshold voltage | $T_j$ = 125 °C | Max. | 0.9 | V |
| $R_D$ | Dynamic resistance | $T_j$ = 125 °C | Max. | 200 | mΩ |
| $I_{DRM}$ $I_{RRM}$ | $V_D$ = $V_{DRM}$ / $V_{RRM}$, $R_{GK}$ = 220 Ω | $T_j$ = 25 °C | Max. | 1 | µA |
| | | $T_j$ = 125 °C | | 100 | µA |

**Table 4. Thermal resistance**

| Symbol | Parameter | | | Value | Unit |
|---|---|---|---|---|---|
| $R_{th(j-l)}$ | Junction to leads (DC) | | TO-92 | 65 | °C/W |
| $R_{th(j-a)}$ | Junction to ambient (DC) | | TO-92 | 160 | |
| | | | SMBflat-3L | 75 | |
| $R_{th(j-c)}$ | Junction to case (DC) | S = 5 $cm^2$ | SMBflat-3L | 14 | |

**Figure 1. Maximum average power dissipation versus average on-state current**

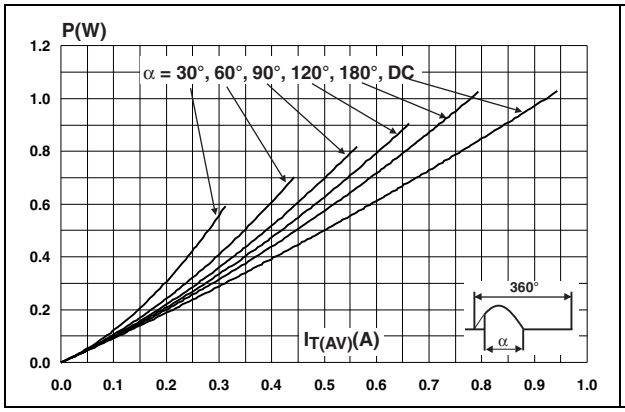



**Figure 2. Average and DC on-state current versus lead temperature (TO-92)**

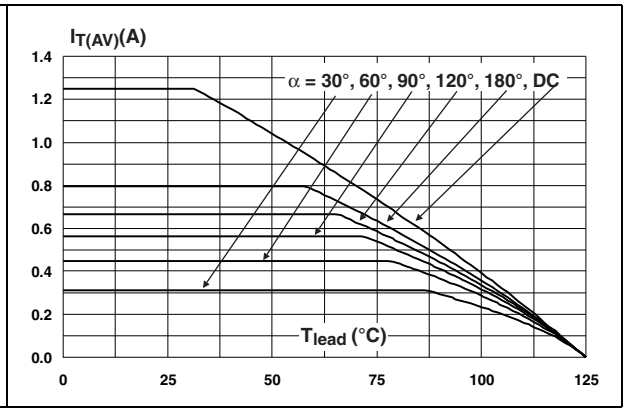



**Figure 3. Average and DC on-state current versus lead temperature (SMBflat-3L)**

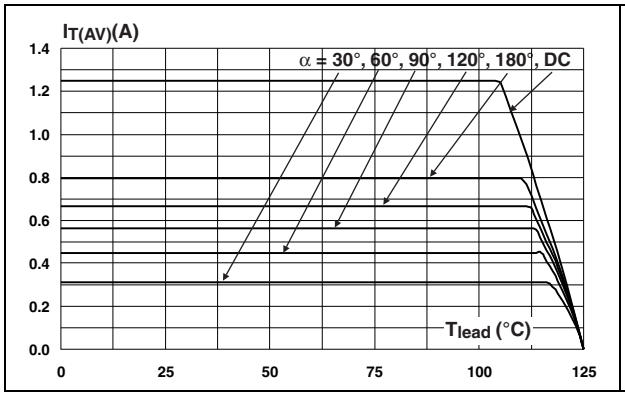



**Figure 4. Average and DC on-state current versus ambient temperature**

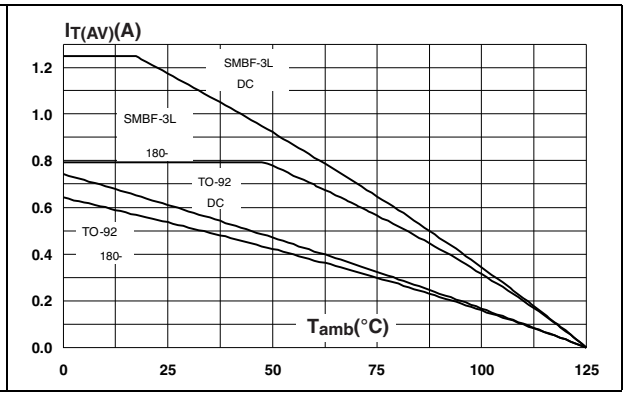


**Figure 5. Relative variation of thermal impedance junction to ambient versus pulse duration**

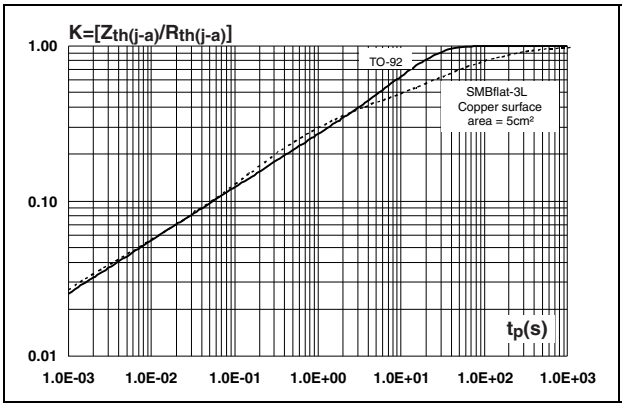



**Figure 6. Relative variation of gate triggering current and voltage, holding and latching current versus $T_j$**

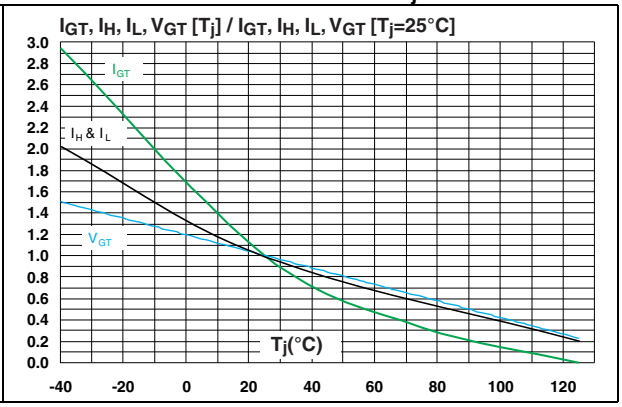



**Figure 7. Relative variation of holding current versus gate-cathode resistance (typical values)**

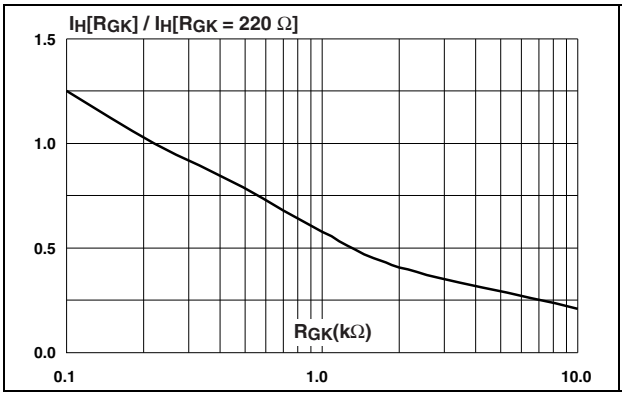



**Figure 8. Relative variation of dV/dt immunity versus gate-cathode resistance (typical values)**

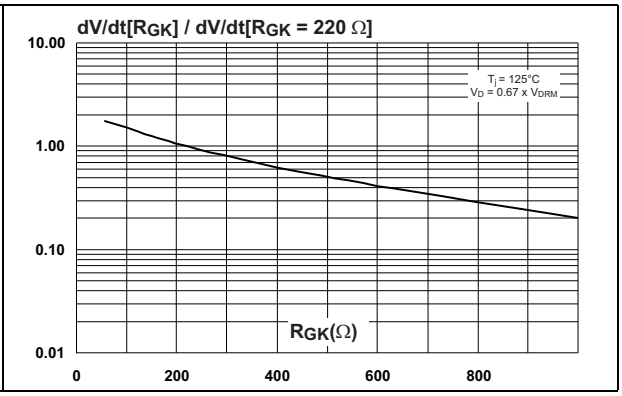



**Figure 9. Relative variation of dV/dt immunity versus gate-cathode capacitance (typical values)**

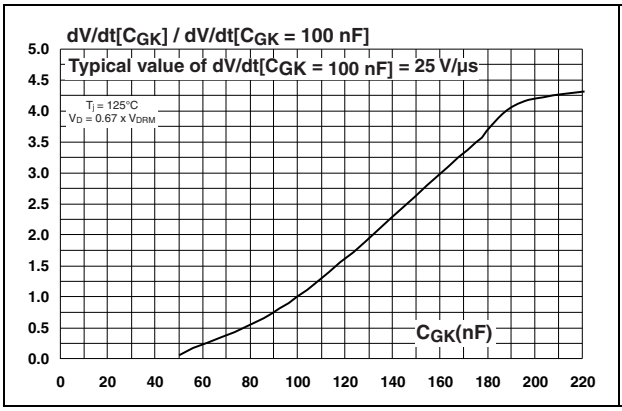



**Figure 10. Relative variation of dV/dt immunity versus junction temperature with $R_{GK}$ = 220 Ω (typical values)**

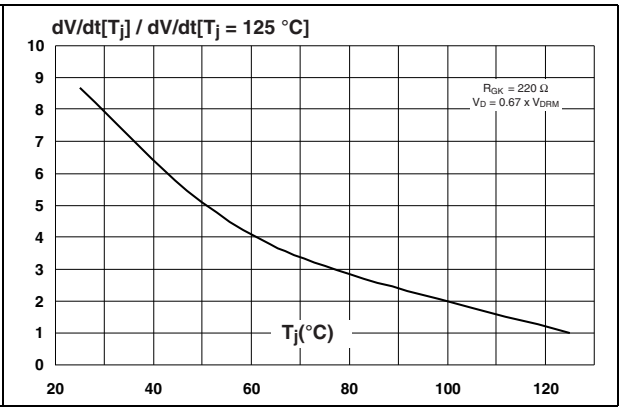


**Figure 11. Surge peak on-state current versus number of cycles**

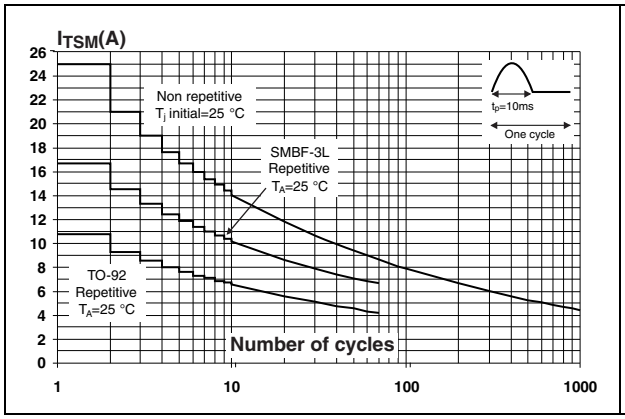



**Figure 12. Non-repetitive surge peak on-state current, and corresponding values of $I^2t$**

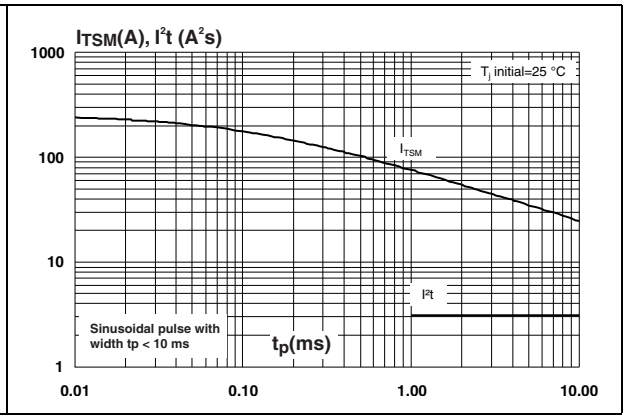



**Figure 13. On-state characteristics (maximum values)**

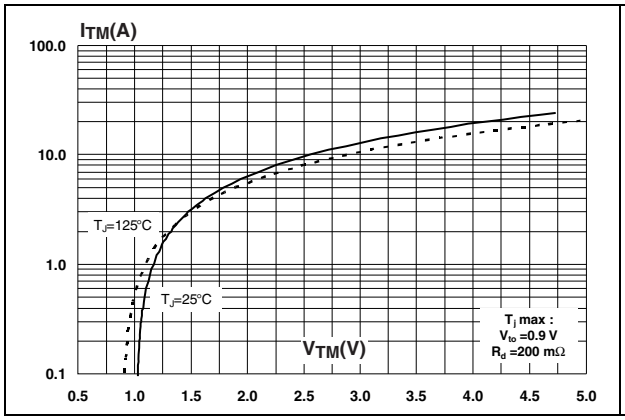
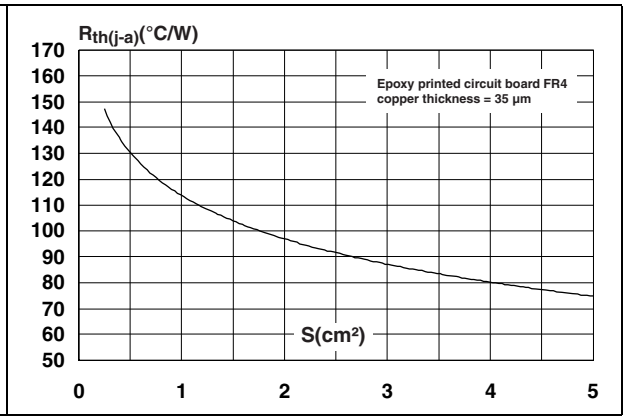



**Figure 14. Thermal resistance junction to ambient versus copper surface under anode (SMBflat-3L)**



# 2 AC line transient voltage ruggedness

In comparison with standard SCRs, the TS110-7 is self-protected against over-voltage. The TS110-7 switch can safely withstand AC line surge voltages by switching to the on state (for less than 10 ms on 50 Hz mains) to dissipate energy shocks through the load. The load limits the current through the TS110-7. The self-protection against over-voltage is based on an overvoltage crowbar technology. This safety feature works even with high turn-on current ramp up.

*Figure 15* represents the TS110-7 in a test environment. It is used to stress the TS110-7 switch according to the IEC 61000-4-5 standard conditions. The TS110-7 folds back safely to the on state as shown in *Figure 16*.

The TS110-7 recovers its blocking voltage capability after the surge and the next zero current crossing. Such a non repetitive test can be done at least 10 times.

**Figure 15. Overvoltage ruggedness test circuit for IEC 61000-4-5 standards**

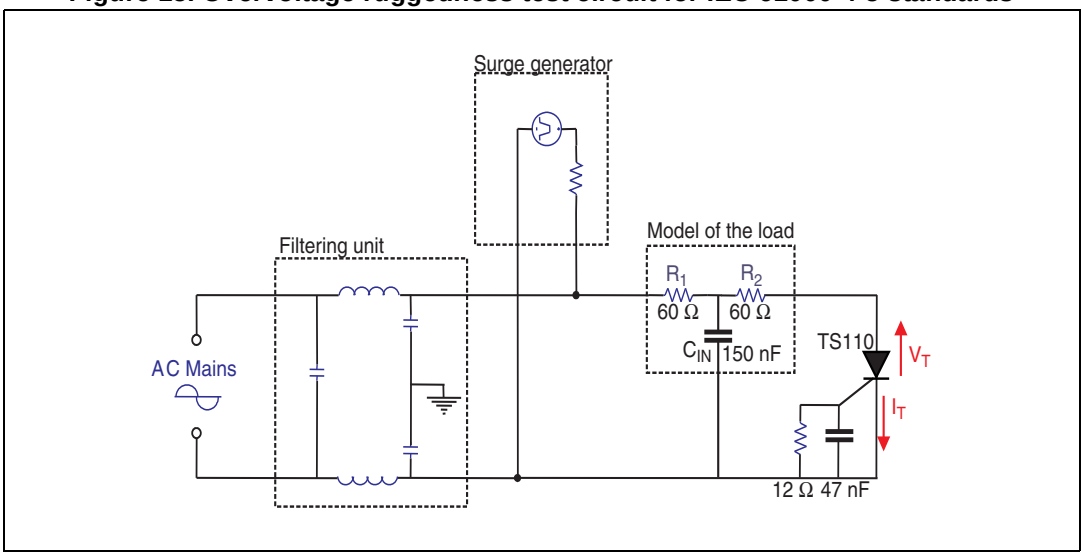
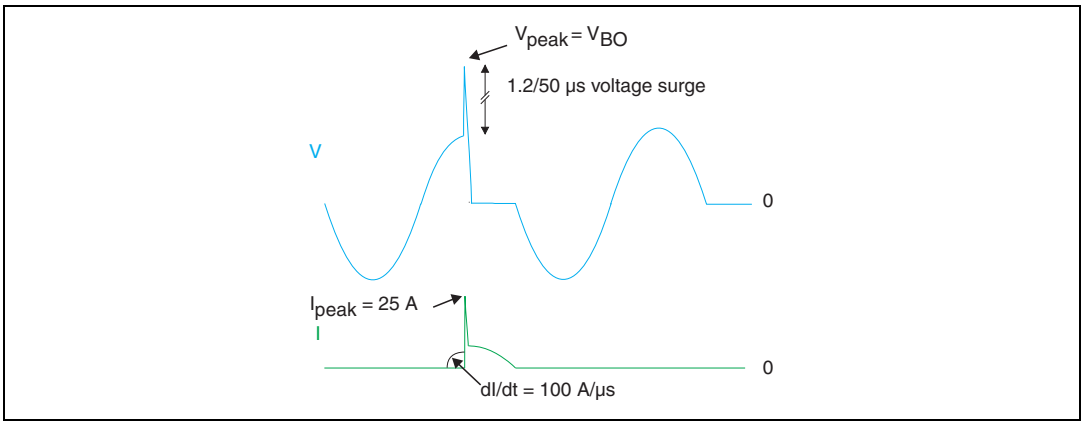



**Figure 16. Typical current and voltage waveforms across the TS110-7 during IEC 61000-4-5 standard test**



# 3 Package information

- Epoxy meets UL94, V0
- Lead-free package

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.

**Figure 17. TO_92 dimensions (definitions)**

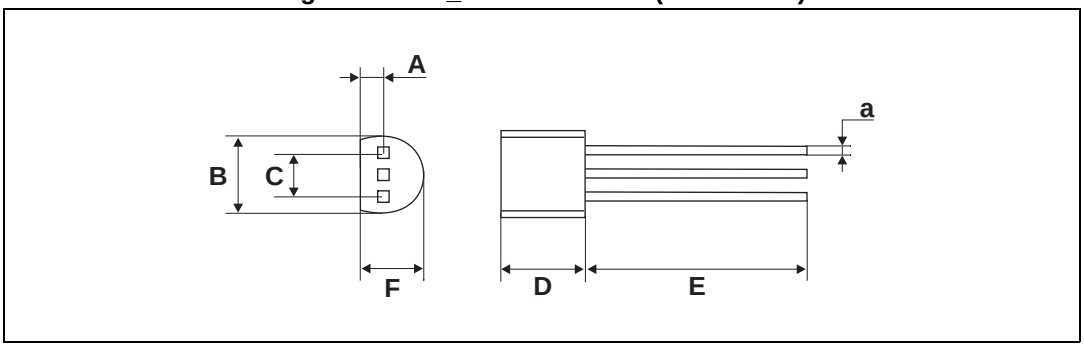



**Table 5. TO-92 dimensions (values)**

| Ref. | Dimensions | | | | | |
|---|---|---|---|---|---|---|
| | Millimeters | | | Inches | | |
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | 1.35 | | | 0.053 | |
| B | | | 4.70 | | | 0.185 |
| C | | 2.54 | | | 0.100 | |
| D | 4.40 | | | 0.173 | | |
| E | 12.70 | | | 0.500 | | |
| F | | | 3.70 | | | 0.146 |
| a | | | 0.5 | | | 0.019 |

For packing information see STMicroelectronics document PD0022 Packing information, “Axial, through hole, surface mount and chip scale packages for IPAD™, protection, rectifiers, thyristors and ACSs™”.

**Figure 18. SMBflat-3L dimensions (definitions)**

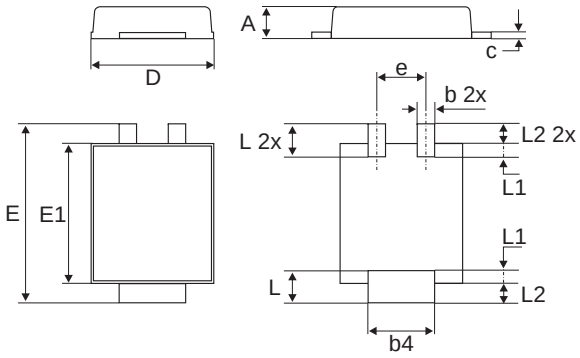
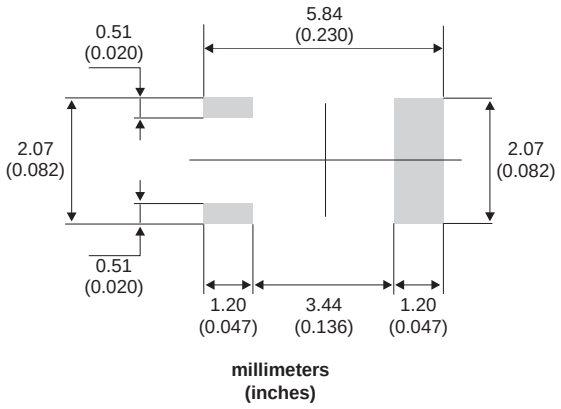



**Table 6. SMBflat-3L dimensions (values)**

| Ref. | Dimensions | | | | | |
|---|---|---|---|---|---|---|
| | Millimeters | | | Inches | | |
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | 0.90 | | 1.10 | 0.035 | | 0.043 |
| b | 0.35 | | 0.65 | 0.014 | | 0.026 |
| b4 | 1.95 | | 2.20 | 0.07 | | 0.087 |
| c | 0.15 | | 0.40 | 0.006 | | 0.016 |
| D | 3.30 | | 3.95 | 0.130 | | 0.156 |
| E | 5.10 | | 5.60 | 0.201 | | 0.220 |
| E1 | 4.05 | | 4.60 | 0.156 | | 0.181 |
| L | 0.75 | | 1.50 | 0.030 | | 0.059 |
| L1 | | 0.40 | | | 0.016 | |
| L2 | | 0.60 | | | 0.024 | |
| e | | 1.60 | | | 0.063 | |

**Figure 19. SMBflat-3L footprint dimensions**



# 4 Ordering information

**Figure 20. Ordering information scheme**

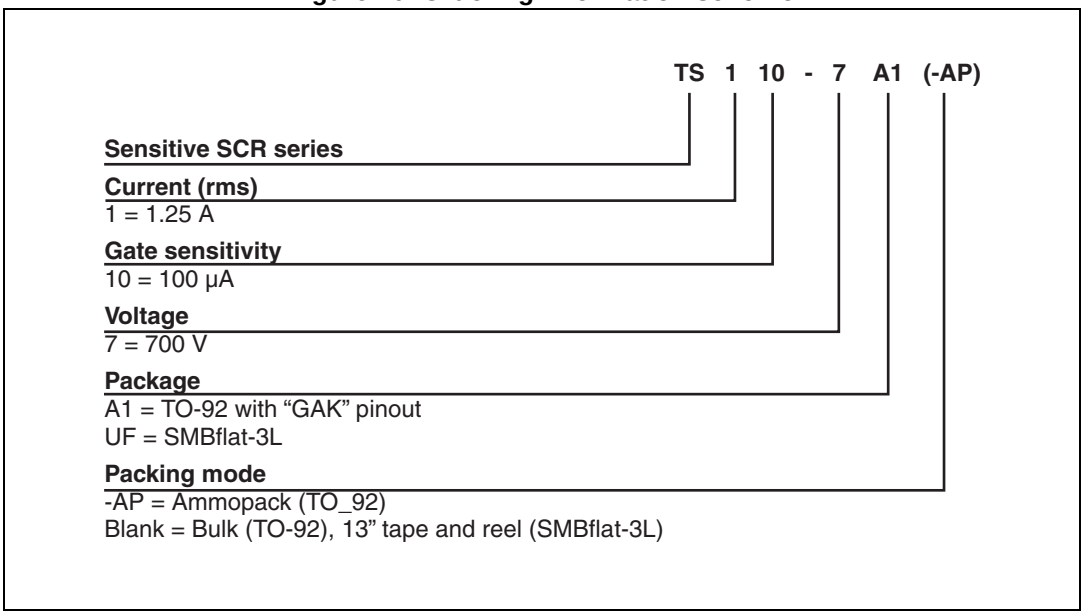



**Table 7. Ordering information**

| Order code | Marking | Package | Weight | Base qty. | Delivery mode |
|---|---|---|---|---|---|
| TS110-7A1 | TS110-7 | T0-92 | 200 mg | 2500 | Bulk |
| TS110-7A1-AP | TS110-7 | | | 2000 | Ammopack |
| TS110-7UF | TS110-7 | SMBflat-3L | 47 mg | 5000 | Tape and reel 13" |

# 5 Revision history

**Table 8. Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 01-Sep-2012 | 1 | Initial release. |
| 11-Sep-2012 | 2 | Added SMBflat-3L package. |
| 17-Oct-2013 | 3 | Corrected typographical error in *Figure 8*. |
| 18-Jun-2014 | 4 | Updated device name. |

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