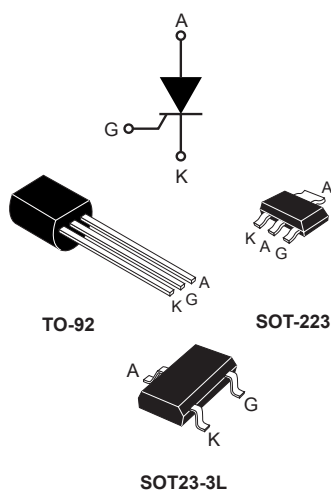


## Up to 0.8 A, up to 600 V sensitive standard SCR thyristor



### Features

- On-state rms current,  $I_{T(RMS)}$  0.8 A
- Repetitive peak off-state voltage up to 600 V
- Triggering gate current from 5 to 200  $\mu A$
- ECOPACK2 compliant

### Applications

- Gate driver for large Thyristors
- Overvoltage crowbar protection
- Ground fault circuit interrupters
- Arc fault circuit interrupter
- Standby mode power supplies
- Residual current detector
- Smoke detectors
- DC 24/48 V proximity sensors
- Capacitive ignition circuit

### Description

Thanks to highly sensitive triggering levels, the P010XX SCR series is suitable for all applications where available gate current is limited, such as ground fault circuit interrupters, pilot circuits in solid state relays, stand-by mode power supplies, smoke and alarm detectors.

Available in through-hole or surface mount packages, the voltage capability of this series has been upgraded since its introduction and is now available up to 600 V.

| Product status link |                       |
|---------------------|-----------------------|
| P010XX              |                       |
| Product summary     |                       |
| $I_{T(RMS)}$        | up to 0.8 A           |
| $V_{DRM}/V_{RRM}$   | up to 600 V           |
| $I_{GT}$            | From 5 to 200 $\mu A$ |
| $T_{jmax.}$         | 125 °C                |

# 1 Characteristics

**Table 1. Absolute maximum ratings (limiting values, P010xxA and P010xxN)**

| Symbol       | Parameters                                                                                      |                       |                          | Value       | Unit             |
|--------------|-------------------------------------------------------------------------------------------------|-----------------------|--------------------------|-------------|------------------|
| $I_{T(RMS)}$ | On-state RMS current (180° conduction angle)                                                    | TO-92                 | $T_L = 55\text{ °C}$     | 0.8         | A                |
|              |                                                                                                 | SOT-223               | $T_{amb} = 70\text{ °C}$ |             |                  |
| $I_{T(AV)}$  | Average on-state current (180° conduction angle)                                                | TO-92                 | $T_L = 55\text{ °C}$     | 0.5         | A                |
|              |                                                                                                 | SOT-223               | $T_{amb} = 70\text{ °C}$ |             |                  |
| $I_{TSM}$    | Non repetitive surge peak on-state current, $T_j$ initial = 25 °C                               | $t_p = 8.3\text{ ms}$ | $T_j = 25\text{ °C}$     | 8           | A                |
|              |                                                                                                 | $t_p = 10\text{ ms}$  |                          | 7           |                  |
| $I^2t$       | $I^2t$ value for fusing                                                                         | $t_p = 10\text{ ms}$  | $T_j = 25\text{ °C}$     | 0.24        | A <sup>2</sup> s |
| dl/dt        | Critical rate of rise of on-state current<br>$I_G = 2 \times I_{GT}$ , $t_r \leq 100\text{ ns}$ | F = 60 Hz             | $T_j = 125\text{ °C}$    | 50          | A/μs             |
| $I_{GM}$     | Peak gate current                                                                               | $t_p = 20\text{ μs}$  | $T_j = 125\text{ °C}$    | 1           | A                |
| $P_{G(AV)}$  | Average gate power dissipation                                                                  |                       | $T_j = 125\text{ °C}$    | 0.1         | W                |
| $T_{stg}$    | Storage junction temperature range                                                              |                       |                          | -40 to +150 | °C               |
| $T_j$        | Operating junction temperature range                                                            |                       |                          | -40 to +125 | °C               |

**Table 2. Absolute maximum ratings (limiting values, P010xxL)**

| Symbol       | Parameters                                                                                      |                       |                          | Value       | Unit             |
|--------------|-------------------------------------------------------------------------------------------------|-----------------------|--------------------------|-------------|------------------|
| $I_{T(RMS)}$ | On-state RMS current (180° conduction angle)                                                    |                       | $T_{amb} = 36\text{ °C}$ | 0.25        | A                |
| $I_{T(AV)}$  | Average on-state current (180° conduction angle)                                                |                       | $T_{amb} = 36\text{ °C}$ | 0.16        | A                |
| $I_{TSM}$    | Non repetitive surge peak on-state current, $T_j$ initial = 25 °C                               | $t_p = 8.3\text{ ms}$ | $T_j = 25\text{ °C}$     | 7           | A                |
|              |                                                                                                 | $t_p = 10\text{ ms}$  |                          | 6           |                  |
| $I^2t$       | $I^2t$ value for fusing                                                                         | $t_p = 10\text{ ms}$  | $T_j = 25\text{ °C}$     | 0.18        | A <sup>2</sup> s |
| dl/dt        | Critical rate of rise of on-state current<br>$I_G = 2 \times I_{GT}$ , $t_r \leq 100\text{ ns}$ | F = 60 Hz             | $T_j = 125\text{ °C}$    | 50          | A/μs             |
| $I_{GM}$     | Peak gate current                                                                               | $t_p = 20\text{ μs}$  | $T_j = 125\text{ °C}$    | 0.5         | A                |
| $P_{G(AV)}$  | Average gate power dissipation                                                                  |                       | $T_j = 125\text{ °C}$    | 0.02        | W                |
| $T_{stg}$    | Storage junction temperature range                                                              |                       |                          | -40 to +150 | °C               |
| $T_j$        | Operating junction temperature range                                                            |                       |                          | -40 to +125 | °C               |

**Table 3. Electrical characteristics ( $T_j = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified, P010xxA and P010xxN)**

| Symbol   | Parameters                                                                                         |      | Value | Unit             |
|----------|----------------------------------------------------------------------------------------------------|------|-------|------------------|
| $I_{GT}$ | $V_D = 12\text{ V}$ , $R_L = 140\text{ }\Omega$                                                    | Max. | 200   | $\mu\text{A}$    |
| $V_{GT}$ |                                                                                                    | Max. | 0.8   | V                |
| $V_{GD}$ | $V_D = V_{DRM}$ , $R_{GK} = 1\text{ k}\Omega$ , $T_j = 125\text{ }^{\circ}\text{C}$                | Min. | 0.1   | V                |
| $V_{RG}$ | $I_{RG} = 10\text{ }\mu\text{A}$                                                                   | Min. | 8     |                  |
| $I_H$    | $I_T = 50\text{ mA}$ , $R_{GK} = 1\text{ k}\Omega$                                                 | Max. | 5     | mA               |
| $I_L$    | $I_G = 1\text{ mA}$ , $R_{GK} = 1\text{ k}\Omega$                                                  | Max. | 6     | mA               |
| dV/dt    | $V_D = 67\text{ }\%$ $V_{DRM}$ , $R_{GK} = 1\text{ k}\Omega$ , $T_j = 125\text{ }^{\circ}\text{C}$ | Min. | 75    | V/ $\mu\text{s}$ |

**Table 4. Static electrical characteristics (P010xxA and P010xxN)**

| Symbol                 | Test conditions                                                  |                               |      | Value | Unit          |
|------------------------|------------------------------------------------------------------|-------------------------------|------|-------|---------------|
| $V_{TM}$               | $I_{TM} = 1.6\text{ A}$ , $t_p = 380\text{ }\mu\text{s}$         | $25\text{ }^{\circ}\text{C}$  | Max. | 1.95  | V             |
| $V_{TO}$               | Threshold on-state voltage                                       | $125\text{ }^{\circ}\text{C}$ | Max. | 0.95  | V             |
| $R_d$                  | Dynamic resistance                                               | $125\text{ }^{\circ}\text{C}$ | Max. | 600   | m $\Omega$    |
| $I_{DRM}$<br>$I_{RRM}$ | $V_{DRM} = V_{RRM} = 400\text{ V}$ , $R_{GK} = 1\text{ k}\Omega$ | $25\text{ }^{\circ}\text{C}$  | Max. | 1     | $\mu\text{A}$ |
|                        | $V_{DRM} = V_{RRM} = 600\text{ V}$ , $R_{GK} = 1\text{ k}\Omega$ |                               |      | 10    |               |
|                        | $V_{DRM} = V_{RRM}$ , $R_{GK} = 1\text{ k}\Omega$                | $125\text{ }^{\circ}\text{C}$ |      | 100   |               |

**Table 5. Electrical characteristics ( $T_j = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified, P010xxL)**

| Symbol   | Parameters                                                                                                       |      | P010<br>2xL | P010<br>9AL | Unit             |
|----------|------------------------------------------------------------------------------------------------------------------|------|-------------|-------------|------------------|
| $I_{GT}$ | $V_D = 12\text{ V}$ , $R_L = 140\text{ }\Omega$                                                                  | Max. | 200         | 1           | $\mu\text{A}$    |
| $V_{GT}$ |                                                                                                                  | Max. | 0.8         |             | V                |
| $V_{GD}$ | $V_D = V_{DRM}$ , $R_L = 3.3\text{ k}\Omega$ , $R_{GK} = 1\text{ k}\Omega$ , $T_j = 125\text{ }^{\circ}\text{C}$ | Min. | 0.1         |             | V                |
| $V_{RG}$ | $I_{RG} = 10\text{ }\mu\text{A}$                                                                                 | Min. | 8           |             | V                |
| $I_H$    | $I_T = 50\text{ mA}$ , $R_{GK} = 1\text{ k}\Omega$                                                               | Max. | 6           |             | mA               |
| $I_L$    | $I_G = 1\text{ mA}$ , $R_{GK} = 1\text{ k}\Omega$                                                                | Max. | 7           |             | mA               |
| dV/dt    | $V_D = 67\text{ }\%$ $V_{DRM}$ , $R_{GK} = 1\text{ k}\Omega$ , $T_j = 125\text{ }^{\circ}\text{C}$               | Min. | 200         | 100         | V/ $\mu\text{s}$ |

**Table 6. Static electrical characteristics (P010xxL)**

| Symbol                 | Test conditions                                                                                  |      | P010<br>2xL | P010<br>9AL | Unit          |
|------------------------|--------------------------------------------------------------------------------------------------|------|-------------|-------------|---------------|
| $V_{TM}$               | $I_{TM} = 0.4 \text{ A}$ , $t_p = 380 \text{ } \mu\text{s}$ , $T_j = 25 \text{ } ^\circ\text{C}$ | Max. | 1.7         |             | V             |
| $V_{TO}$               | Threshold on-state voltage, $T_j = 125 \text{ } ^\circ\text{C}$                                  | Max. | 1.0         |             | V             |
| $R_d$                  | Dynamic resistance, $T_j = 125 \text{ } ^\circ\text{C}$                                          | Max. | 1000        |             | m $\Omega$    |
| $I_{DRM}$<br>$I_{RRM}$ | $V_{DRM} = V_{RRM}$ , $T_j = 25 \text{ } ^\circ\text{C}$                                         | Max. | 1<br>100    |             | $\mu\text{A}$ |

**Table 7. Electrical device summary**

| Order code      | Voltage |       |       |       | Sensitivity       | Package  | Packing mode             |
|-----------------|---------|-------|-------|-------|-------------------|----------|--------------------------|
|                 | 100 V   | 200 V | 400 V | 600 V |                   |          |                          |
| P0102AA<br>1AA3 | X       |       |       |       | 200 $\mu\text{A}$ | TO-92    | Bulk                     |
| P0102AA<br>5AL3 | X       |       |       |       |                   | TO-92    | Tape and reel<br>13 inch |
| P0102AL<br>5AA4 | X       |       |       |       |                   | SOT23-3L | Tape and reel<br>7 inch  |
| P0102BA<br>1AA3 |         | X     |       |       |                   | TO-92    | Bulk                     |
| P0102BL<br>5AA4 |         | X     |       |       |                   | SOT23-3L | Tape and reel<br>7 inch  |
| P0102DN<br>5AA4 | X       |       | X     |       |                   | SOT-223  | Tape and reel<br>7 inch  |
| P0102MA<br>1AA3 |         |       |       | X     |                   | TO-92    | Bulk                     |
| P0102MN<br>5AA4 |         |       |       | X     |                   | SOT-223  | Tape and reel<br>7 inch  |
| P0109AL<br>5AA4 | X       |       |       |       | 1 $\mu\text{A}$   | SOT23-3L | Tape and reel<br>7 inch  |
| P0109DA<br>1AA3 |         |       | X     |       |                   | TO-92    | Bulk                     |
| P0109DA<br>5AL3 |         |       | X     |       |                   | TO-92    | Tape and reel<br>13 inch |

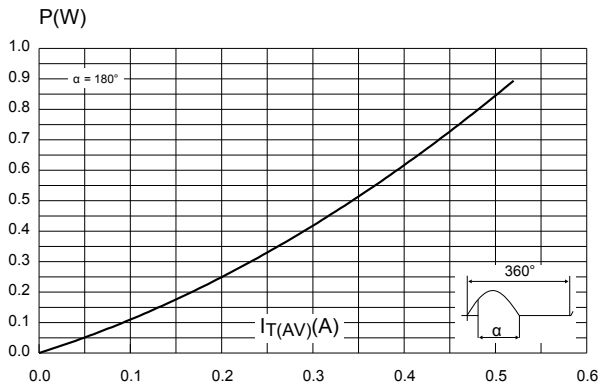
**Table 8. Thermal resistance**

| Symbol        | Parameters                                                                   | Max.<br>value | Unit                 |
|---------------|------------------------------------------------------------------------------|---------------|----------------------|
| $R_{th(j-a)}$ | Junction to case (DC)TO-92                                                   | 80            | $^{\circ}\text{C/W}$ |
| $R_{th(j-t)}$ | Junction to ambient (DC)SOT-223                                              | 30            |                      |
| $R_{th(j-a)}$ | Junction to ambient (DC)TO-92                                                | 150           |                      |
|               | Junction to ambient (DC)<br>$S^{(1)} = 5 \text{ cm}^2$                       | 60            |                      |
| $R_{th(j-a)}$ | Junction to ambient (mounted on FR4 with recommended pad layout)<br>SOT23-3L | 400           |                      |

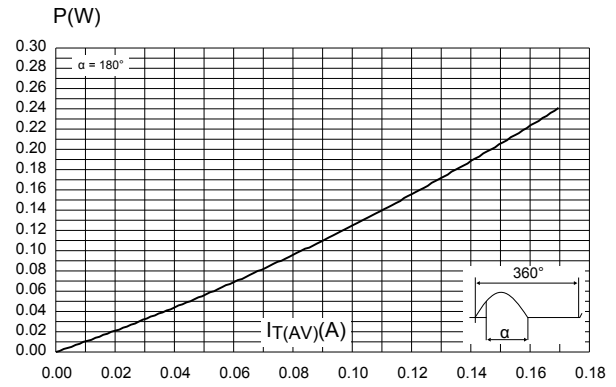
 1.  $S$  = Copper surface under tab.

## 1.1 Characteristics (curves)

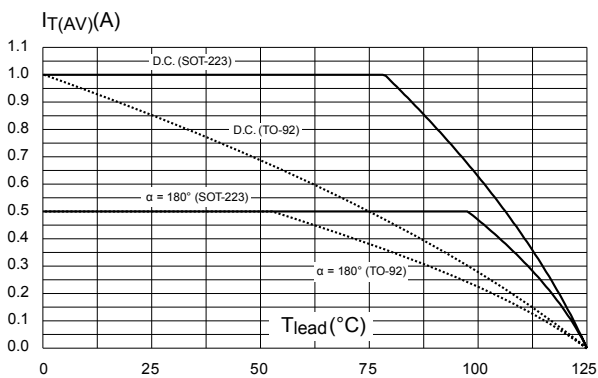
**Figure 1. Maximum power dissipation versus on-state RMS current (full cycle)**



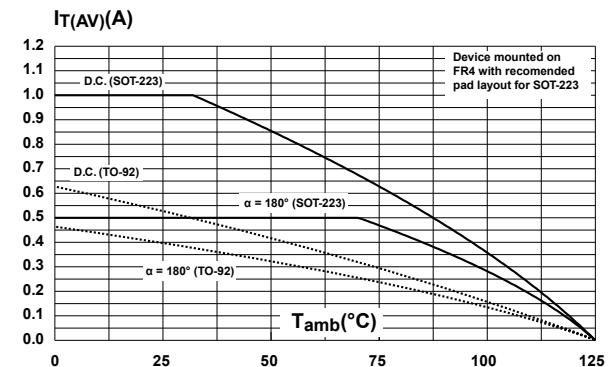
**Figure 2. Maximum average power dissipation versus average on-state current P010xxL**



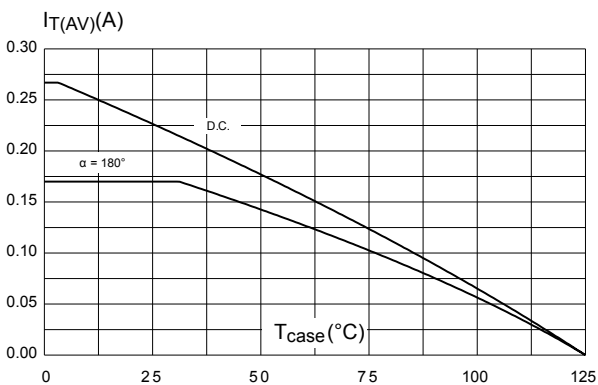
**Figure 3. Average and DC on-state current versus lead temperature P010xxA and P010xxN**



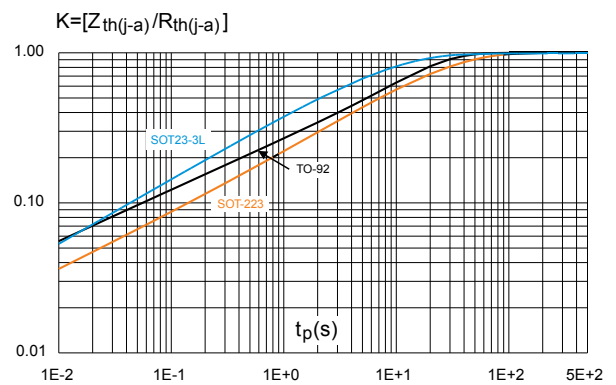
**Figure 4. Average and DC on-state current versus ambient temperature P010xxA and P010xxN**



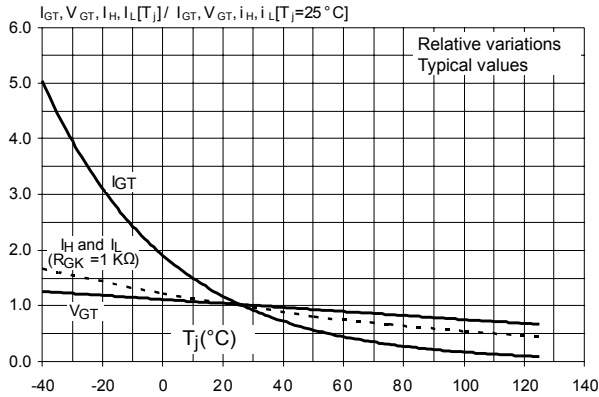
**Figure 5. Average and DC on-state current versus case temperature P010xxL**



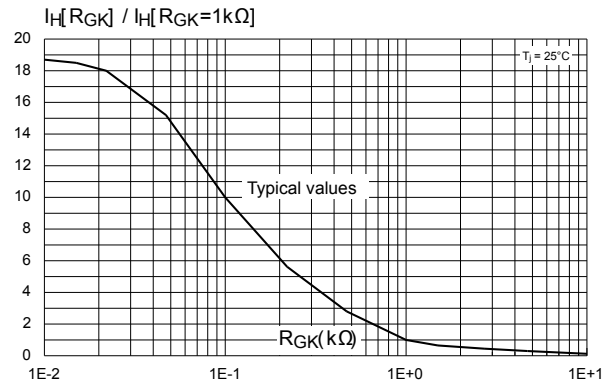
**Figure 6. Relative variation of thermal impedance junction to ambient versus pulse duration**



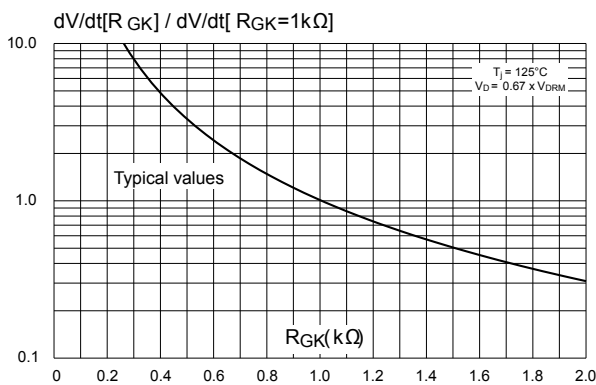
**Figure 7. Gate trigger, holding, and latching currents with gate trigger voltage versus junction temperature**



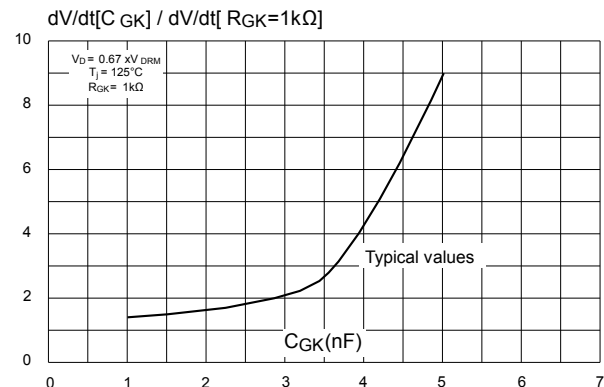
**Figure 8. Relative variation of holding current versus gate-cathode resistance**



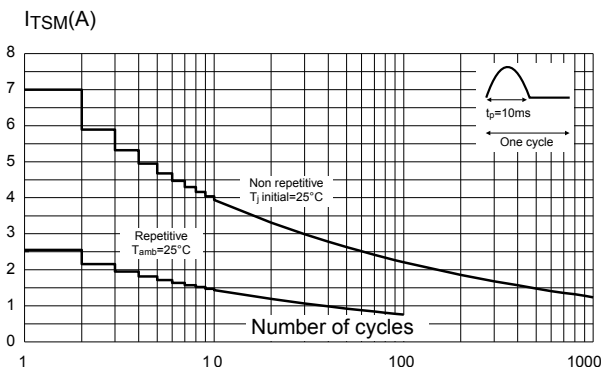
**Figure 9. Relative variation of static dV/dt immunity versus gate-cathode resistance (typical values)**



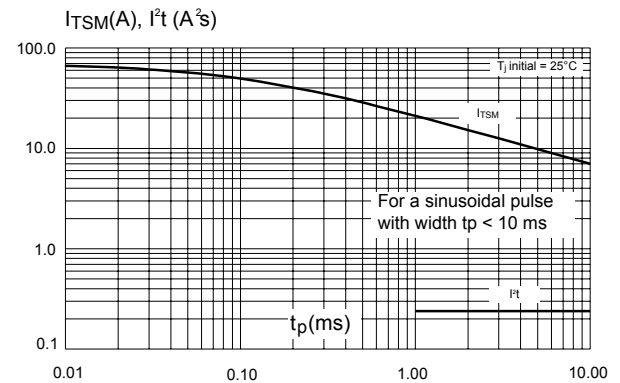
**Figure 10. Relative variation of static dV/dt immunity versus gate-cathode capacitance**



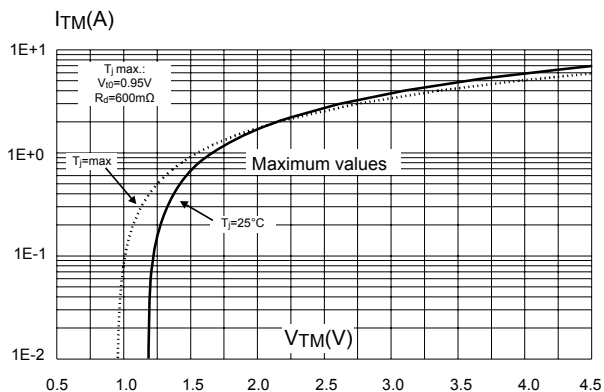
**Figure 11. Surge peak on-state current versus number of cycles**



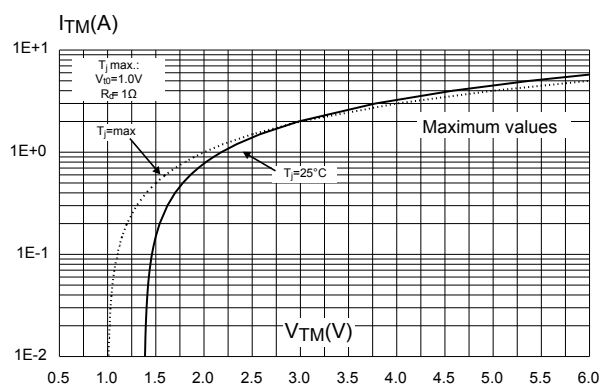
**Figure 12. Non-repetitive surge peak on-state current for sinusoidal pulse ( $t_p < 10$  ms)**



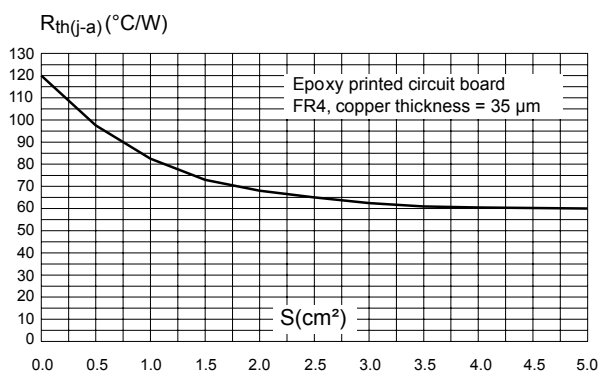
**Figure 13. On-state characteristics P010xxA, P010xxN**



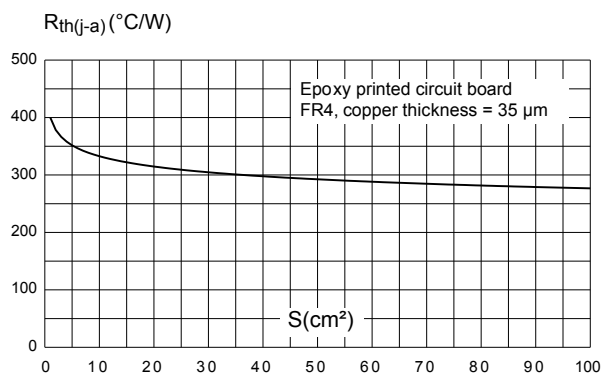
**Figure 14. On-state characteristics P010xxL**



**Figure 15. Thermal resistance junction to ambient versus copper surface under tab P010xxN**



**Figure 16. Thermal resistance junction to ambient versus copper surface under tab P010xxL**



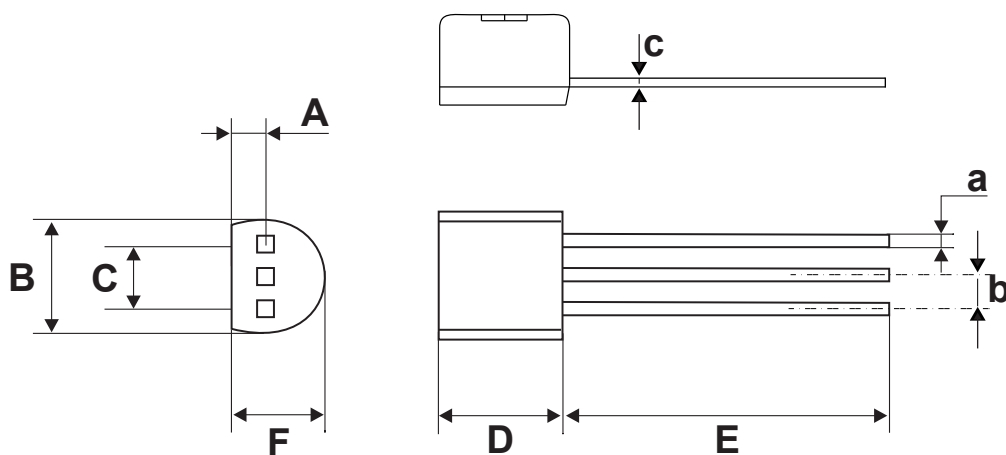
## 2 Package information

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.

### 2.1 TO-92 package information

- Lead free plating + halogen-free molding resin
- Epoxy meets UL94, V0

**Figure 17. TO-92 package outline**



**Table 9. TO-92 package mechanical data**

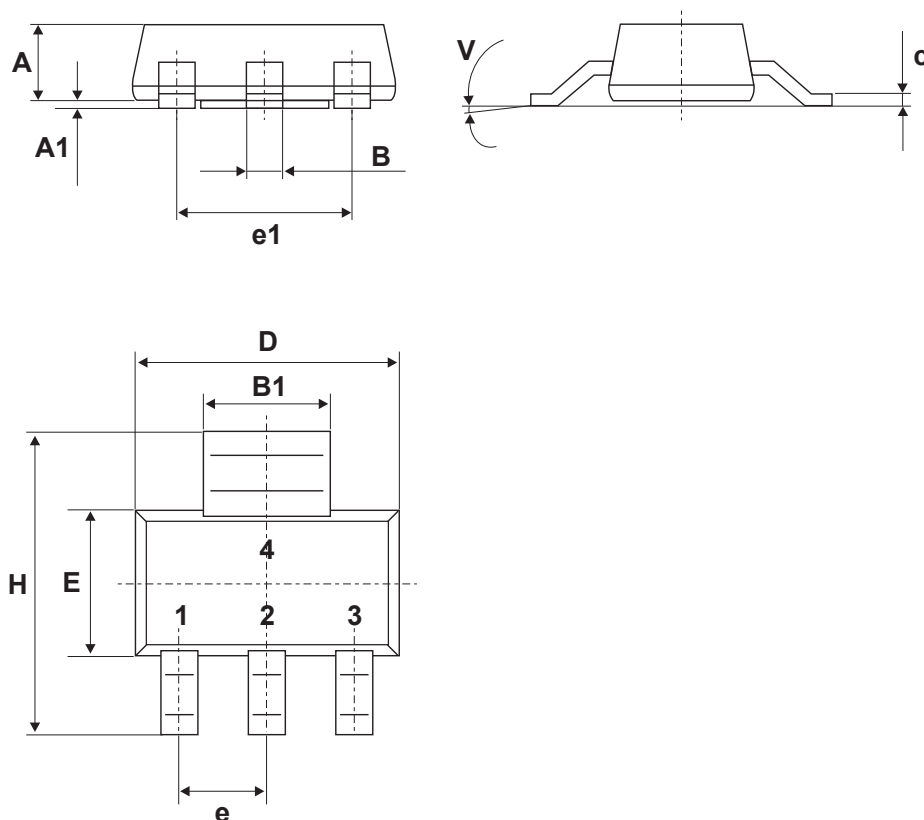
| Ref. | Dimensions  |      |      |                       |        |        |
|------|-------------|------|------|-----------------------|--------|--------|
|      | Millimeters |      |      | Inches <sup>(1)</sup> |        |        |
|      | Min.        | Typ. | Max. | Min.                  | Typ.   | Max.   |
| A    |             | 1.35 |      |                       | 0.0531 |        |
| B    |             |      | 4.70 |                       |        | 0.1850 |
| C    |             | 2.54 |      |                       | 0.1000 |        |
| D    | 4.40        |      |      | 0.1732                |        |        |
| E    | 12.70       |      |      | 0.5000                |        |        |
| F    |             |      | 3.70 |                       |        | 0.1457 |
| a    |             |      | 0.50 |                       |        | 0.0197 |
| b    |             | 1.27 |      |                       | 0.500  |        |
| c    |             |      | 0.48 |                       |        | 0.0189 |

1. Inches dimensions given for information

## 2.2 SOT-223 package information

- Epoxy meets UL94, V0
- Lead free plating + halogen-free molding resin

Figure 18. SOT-223 package outline

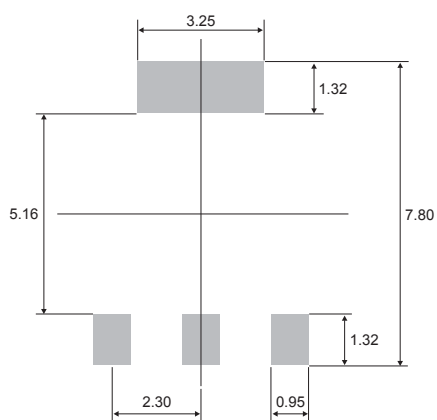


**Table 10. SOT-223 package mechanical data**

| Ref. | Dimensions  |      |      |                       |        |        |
|------|-------------|------|------|-----------------------|--------|--------|
|      | Millimeters |      |      | Inches <sup>(1)</sup> |        |        |
|      | Min.        | Typ. | Max. | Min.                  | Typ.   | Max.   |
| A    |             |      | 1.80 |                       |        | 0.0709 |
| A1   |             | 0.02 | 0.10 |                       | 0.0008 | 0.0039 |
| B    | 0.60        | 0.70 | 0.85 | 0.024                 | 0.0276 | 0.0335 |
| B1   | 2.90        | 3.00 | 3.15 | 0.114                 | 0.1181 | 0.1240 |
| c    | 0.24        | 0.26 | 0.35 | 0.009                 | 0.0102 | 0.0138 |
| D    | 6.30        | 6.50 | 6.70 | 0.248                 | 0.2559 | 0.2638 |
| e    |             | 2.3  |      |                       | 0.0906 |        |
| e1   |             | 4.6  |      |                       | 0.1811 |        |
| E    | 3.30        | 3.50 | 3.70 | 0.130                 | 0.1378 | 0.1457 |
| H    | 6.70        | 7.00 | 7.30 | 0.264                 | 0.2756 | 0.2874 |
| V    | 10° max.    |      |      |                       |        |        |

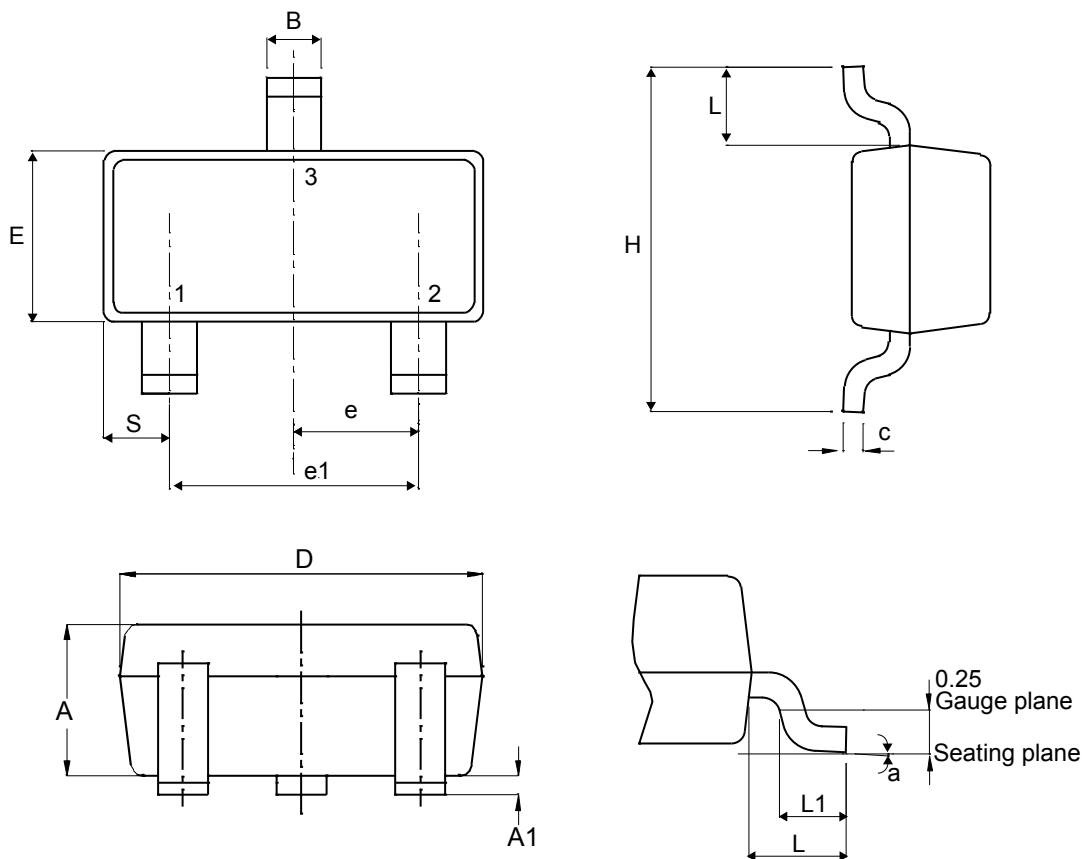
1. Inches only for reference

**Figure 19. SOT-223 footprint (dimensions in mm)**



## 2.3 SOT23-3L package information

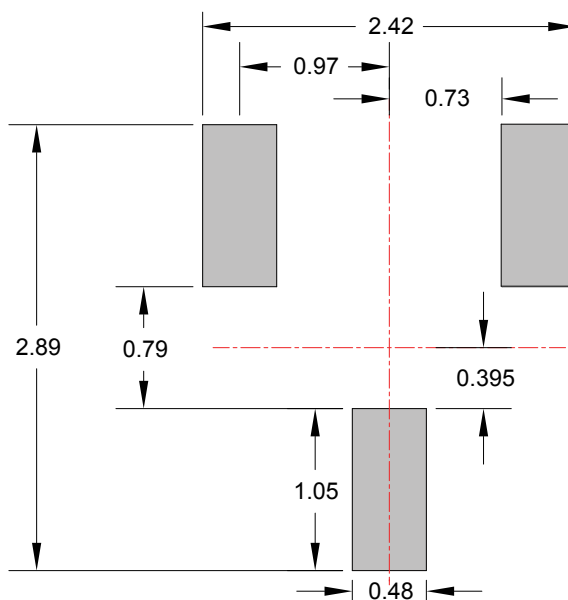
Figure 20. SOT23-3L package outline



**Table 11.** SOT23-3L package mechanical data

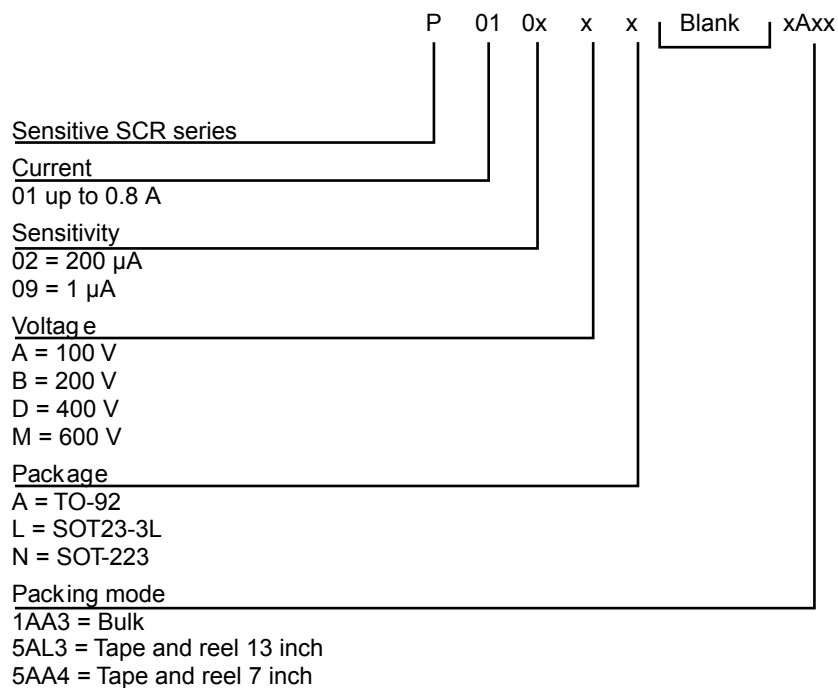
| Ref. | Dimensions  |      |      |                             |        |        |
|------|-------------|------|------|-----------------------------|--------|--------|
|      | Millimeters |      |      | Inches (for reference only) |        |        |
|      | Min.        | Typ. | Max. | Min.                        | Typ.   | Max.   |
| A    | 0.89        |      | 1.40 | 0.0350                      |        | 0.0551 |
| A1   | 0.00        |      | 0.10 | 0.0000                      |        | 0.0039 |
| B    | 0.30        |      | 0.51 | 0.0118                      |        | 0.0201 |
| C    | 0.085       |      | 0.18 | 0.0033                      |        | 0.0071 |
| D    | 2.75        |      | 3.04 | 0.1083                      |        | 0.1197 |
| e    | 0.85        |      | 1.05 | 0.0335                      |        | 0.0413 |
| e1   | 1.70        |      | 2.10 | 0.0669                      |        | 0.0827 |
| E    | 1.20        |      | 1.75 | 0.0472                      |        | 0.0689 |
| H    | 2.10        |      | 3.00 | 0.0827                      |        | 0.1181 |
| L    |             | 0.60 |      |                             | 0.0236 |        |
| S    | 0.35        |      | 0.65 | 0.0138                      |        | 0.256  |
| L1   | 0.25        |      | 0.55 | 0.0098                      |        | 0.0217 |
| a    | 0°          |      | 8°   | 0°                          |        | 8°     |

**Figure 21.** SOT23-3L footprint in mm



### 3 Ordering information

**Figure 22. Ordering information scheme**



**Table 12. Ordering information**

| Order code   | Marking  | Package  | Weight | Base qty. | Delivery mode         |
|--------------|----------|----------|--------|-----------|-----------------------|
| P0102AA 1AA3 | P0102 AA | TO-92    | 0.2 g  | 2500      | Bulk                  |
| P0102AA 5AL3 | P0102 AA | TO-92    | 0.2 g  | 2000      | Tape and reel 13 inch |
| P0102AL 5AA4 | P2A      | SOT23-3L | 0.01 g | 3000      | Tape and reel 7 inch  |
| P0102BA 1AA3 | P0102 BA | TO-92    | 0.2 g  | 1000      | Bulk                  |
| P0102BL 5AA4 | P2B      | SOT23-3L | 0.01 g | 3000      | Tape and reel 7 inch  |
| P0102DN 5AA4 | P2D      | SOT-223  | 0.11 g | 3000      | Tape and reel 7 inch  |
| P0102MA 1AA3 | P0102 MA | TO-92    | 0.2 g  | 2500      | Bulk                  |
| P0102MN 5AA4 | P2M      | SOT-223  | 0.11 g | 2000      | Tape and reel 7 inch  |
| P0109AL 5AA4 | P9A      | SOT23-3L | 0.01 g | 3000      | Tape and reel 7 inch  |
| P0109DA 1AA3 | P0109 DA | TO-92    | 0.2 g  | 2500      | Bulk                  |
| P0109DA 5AL3 | P0109 DA | TO-92    | 0.2 g  | 2000      | Tape and reel 13 inch |

## Revision history

**Table 13. Document revision history**

| Date        | Revision | Changes                                                                                        |
|-------------|----------|------------------------------------------------------------------------------------------------|
| 24-Nov-2008 | 1        | First issue.                                                                                   |
| 01-Apr-2014 | 2        | Added $V_{GT}$ in Figure 7, updated Figure 11 and Table 9 and reformatted to current standard. |
| 23-Sep-2019 | 3        | Removed P0102DA information.                                                                   |

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