

# Sx02xSx EV Series

## EV Series 1.5 Amp Sensitive SCRs

HF RoHS

### Description

This new 1.5A sensitive gate SCR component series offers high static dv/dt and low turn-off time (tq). All SCR junctions are glass-passivated to ensure long term reliability and parametric stability.

### Features

- Surge capability > 15Amps
- Blocking voltage (VDRM/VRRM) capability — up to 600V
- High dv/dt noise immunity
- Improved turn-off time (tq) < 35 µsec.
- Sensitive gate for direct microprocessor interface
- Through-hole and surface mount packages
- RoHS compliant and Halogen-Free

### Additional Information



Resources



Accessories



Samples

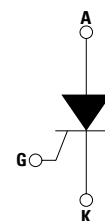
### Applications

The Sx02xSx EV series is specifically designed for solenoid drive often seen in GFCI and similar safety cut-off devices.

### Main Features

| Symbol            | Value      | Unit |
|-------------------|------------|------|
| $I_{T(RMS)}$      | 1.5        | A    |
| $V_{DRM}/V_{RRM}$ | 400 or 600 | V    |
| $I_{GT}$          | 200        | µA   |

### Schematic Symbol



### Absolute Maximum Ratings

| Symbol       | Parameter                                                                                      | Value                                                   | Unit                     |
|--------------|------------------------------------------------------------------------------------------------|---------------------------------------------------------|--------------------------|
| $I_{T(RMS)}$ | RMS on-state current (full sine wave)                                                          | TO-92<br>$T_c = 65^\circ\text{C}$                       | 1.5<br>A                 |
|              |                                                                                                | SOT-89<br>$T_c = 80^\circ\text{C}$                      |                          |
|              |                                                                                                | SOT-223<br>$T_c = 95^\circ\text{C}$                     |                          |
| $I_{T(AV)}$  | Average on-state current                                                                       | TO-92<br>$T_c = 65^\circ\text{C}$                       | 0.95<br>A                |
|              |                                                                                                | SOT-89<br>$T_c = 80^\circ\text{C}$                      |                          |
|              |                                                                                                | SOT-223<br>$T_c = 95^\circ\text{C}$                     |                          |
| $I_{TSM}$    | Non repetitive surge peak on-state current (Single cycle, $T_j$ initial = $25^\circ\text{C}$ ) | TO-92<br>$F = 50\text{ Hz}$                             | 12.5<br>A                |
|              |                                                                                                | SOT-89<br>$F = 60\text{ Hz}$                            |                          |
|              |                                                                                                | SOT-223<br>$F = 60\text{ Hz}$                           |                          |
| $I^2t$       | $I^2t$ Value for fusing                                                                        | $t_p = 10\text{ ms}$<br>$F = 50\text{ Hz}$              | 0.78<br>A <sup>2</sup> s |
|              |                                                                                                | $t_p = 8.3\text{ ms}$<br>$F = 60\text{ Hz}$             |                          |
| di/dt        | Critical rate of rise of on-state current $I_G = 10\text{mA}$                                  | TO-92<br>SOT-89<br>SOT-223<br>$T_j = 125^\circ\text{C}$ | 50<br>A/µs               |
| $I_{GM}$     | Peak gate current                                                                              | $t_p = 10\text{ µs}$<br>$T_j = 125^\circ\text{C}$       | 1.0<br>A                 |
| $P_{G(AV)}$  | Average gate power dissipation                                                                 | $T_j = 125^\circ\text{C}$                               | 0.1<br>W                 |
| $T_{stg}$    | Storage junction temperature range                                                             |                                                         | -40 to 150<br>°C         |
| $T_j$        | Operating junction temperature range                                                           |                                                         | -40 to 125<br>°C         |

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### Electrical Characteristics (T<sub>J</sub> = 25°C, unless otherwise specified)

| Symbol               | Description                                  | Test Conditions                                                                                                                    | Sx02xS |     | Sx02xS1 |     | Sx02xS2 |     | Units |
|----------------------|----------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|--------|-----|---------|-----|---------|-----|-------|
|                      |                                              |                                                                                                                                    | Min    | Max | Min     | Max | Min     | Max |       |
| I <sub>GT</sub>      | DC Gate Trigger Current                      | V <sub>D</sub> = 12V; R <sub>L</sub> = 60 Ω                                                                                        | 15     | 200 | 15      | 100 | 15      | 50  | μA    |
| V <sub>GT</sub>      | DC Gate Trigger Voltage                      | V <sub>D</sub> = 12V; R <sub>L</sub> = 60 Ω                                                                                        | —      | 0.8 | —       | 0.8 | —       | 0.8 | V     |
| V <sub>GRM</sub>     | Peak Reverse Gate Voltage                    | I <sub>RG</sub> = 10μA                                                                                                             | 5      | —   | 5       | —   | 5       | —   | V     |
| I <sub>H</sub>       | Holding Current                              | R <sub>GK</sub> = 1 kΩ                                                                                                             | —      | 5   | —       | 3   | —       | 3   | mA    |
| (dv/dt) <sub>s</sub> | "Critical Rate-of-Rise of Off-State Voltage" | "T <sub>J</sub> = 125°C<br>V <sub>D</sub> = V <sub>DRM</sub> / V <sub>RRM</sub><br>Exponential Waveform<br>R <sub>GK</sub> = 1 kΩ" | 25     | —   | 25      | —   | 25      | —   | V/μs  |
| t <sub>q</sub>       | Turn-Off Time                                | "T <sub>J</sub> = 125°C @ 600 V<br>R <sub>GK</sub> = 1 kΩ"                                                                         | —      | 35  | —       | 35  | —       | 35  | μs    |
| t <sub>gt</sub>      | Turn-On Time                                 | "I <sub>G</sub> = 10mA<br>PW = 15μsec<br>I <sub>T</sub> = 3.0A (pk)"                                                               | —      | 3   | —       | 3   | —       | 3   | μs    |
| V <sub>GD</sub>      | Gate Non-Trigger Voltage                     | "V <sub>D</sub> = V <sub>DRM</sub> , T <sub>J</sub> = 125°C,<br>R <sub>L</sub> = 3.3KΩ"                                            | 0.2    | —   | 0.2     | —   | 0.2     | —   | V     |

x0 = voltage/10

### Static Characteristics (T<sub>J</sub> = 25°C, unless otherwise specified)

| Symbol           | Description                        | Test Conditions                                                                      | Value |      | Unit |
|------------------|------------------------------------|--------------------------------------------------------------------------------------|-------|------|------|
|                  |                                    |                                                                                      | Min   | Max  |      |
| V <sub>TM</sub>  | Peak On-State Voltage              | I <sub>TM</sub> = 3.0A (pk)                                                          | —     | 1.70 | V    |
| I <sub>DRM</sub> | Off-State Current, Peak Repetitive | T <sub>J</sub> = 25°C @ V <sub>D</sub> = V <sub>DRM</sub><br>R <sub>GK</sub> = 1 kΩ  | —     | 5    | μA   |
|                  |                                    | T <sub>J</sub> = 125°C @ V <sub>D</sub> = V <sub>DRM</sub><br>R <sub>GK</sub> = 1 kΩ | —     | 500  | μA   |

### Thermal Resistances

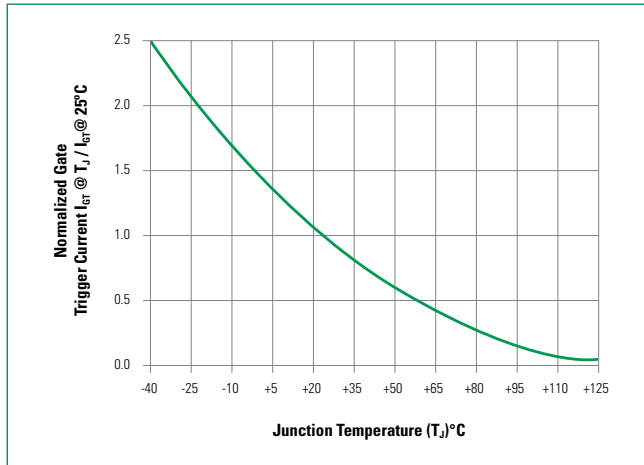
| Symbol              | Parameter             |                                                     |         | Value | Unit |
|---------------------|-----------------------|-----------------------------------------------------|---------|-------|------|
| R <sub>θ(J-C)</sub> | Junction to case (AC) | I <sub>T</sub> = 1.5A <sub>(RMS)</sub> <sup>1</sup> | TO-92   | 50    | °C/W |
|                     |                       |                                                     | SOT-89  | 35    |      |
|                     |                       |                                                     | SOT-223 | 25    |      |
| R <sub>θ(J-A)</sub> | Junction to ambient   | I <sub>T</sub> = 1.5A <sub>(RMS)</sub> <sup>1</sup> | TO-92   | 160   | °C/W |
|                     |                       |                                                     | SOT-89  | 90    |      |
|                     |                       |                                                     | SOT-223 | 60    |      |

<sup>1</sup> 60Hz AC resistive load condition, 100% conduction.

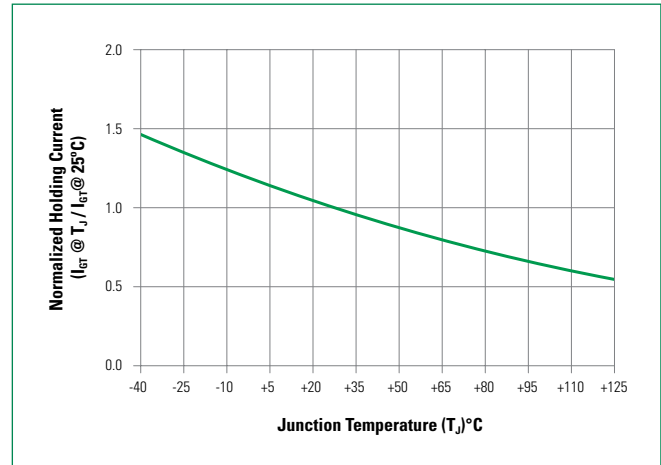
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## EV Series 1.5 Amp Sensitive SCRs

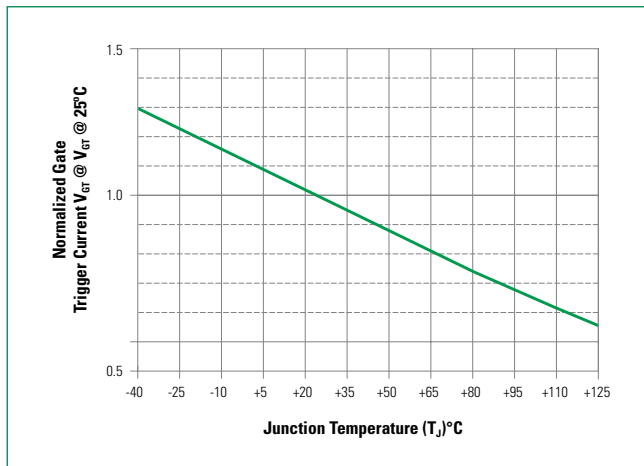
**Figure 1: Normalized DC Gate Trigger Current vs. Junction Temperature**



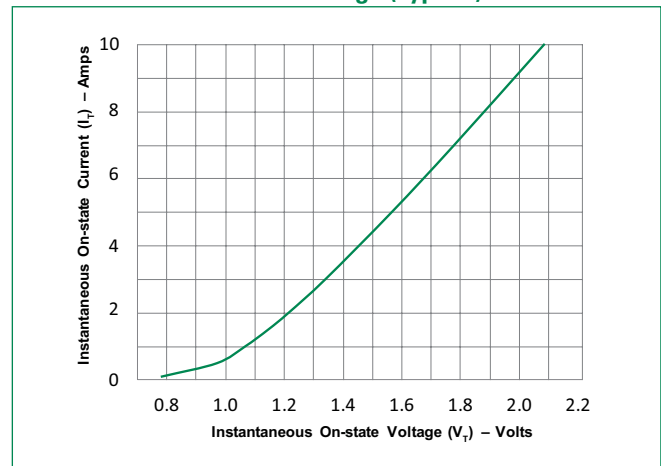
**Figure 2: Normalized DC Holding Current vs. Junction Temperature**



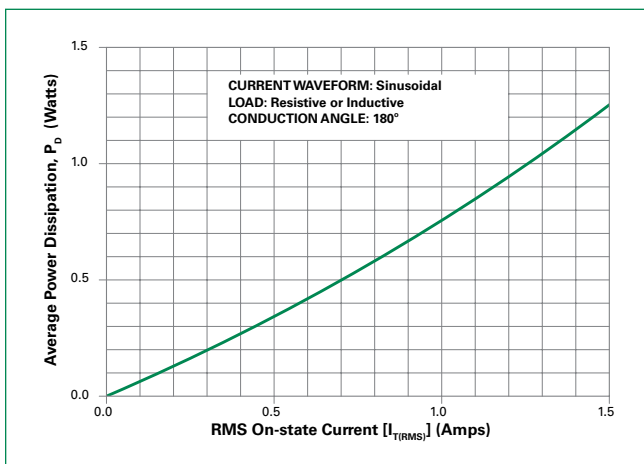
**Figure 3: Normalized DC Gate Trigger Voltage vs. Junction Temperature**



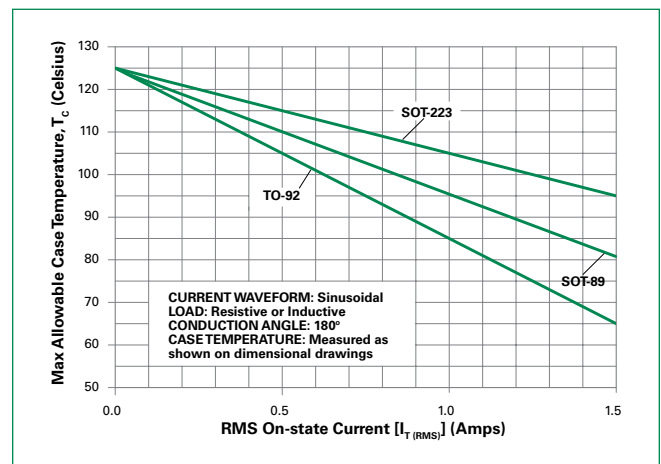
**Figure 4: On-State Current vs. On-State Voltage (Typical)**



**Figure 5: Power Dissipation (Typical) vs. RMS On-State Current**



**Figure 6: Maximum Allowable Case Temperature vs. On-State Current**



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## EV Series 1.5 Amp Sensitive SCRs

Figure 7: Typical DC Gate Trigger Current with  $R_{GK}$  vs. Junction Temperature for Sx02xS

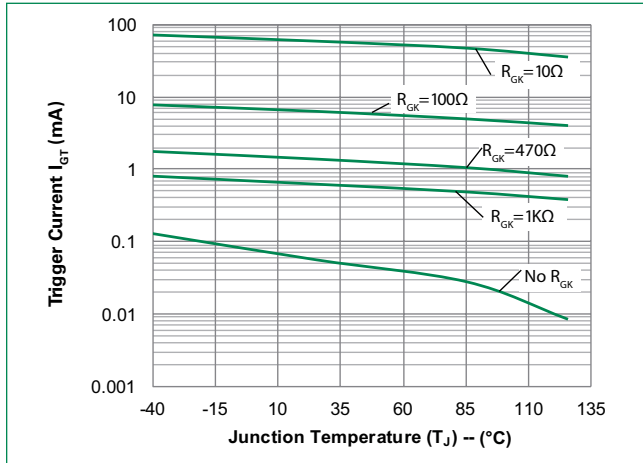


Figure 8: Typical DC Holding Current with  $R_{GK}$  vs. Junction Temperature for Sx02xS

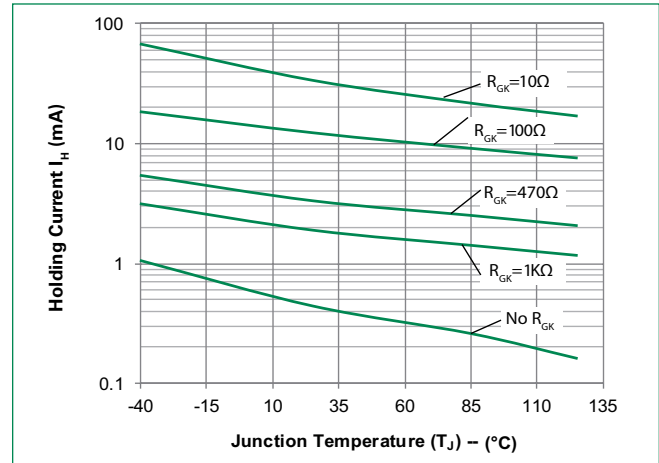


Figure 9: Typical Static dv/dt with  $R_{GK}$  vs. Junction Temperature for Sx02xS

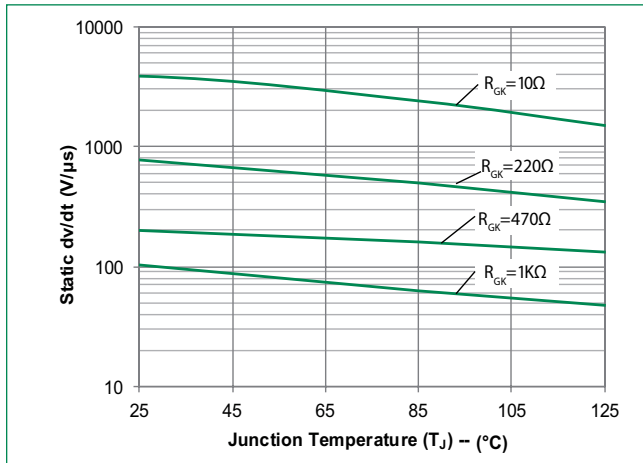


Figure 10: Typical turn off time with  $R_{GK}$  vs. Junction Temperature for Sx02xS

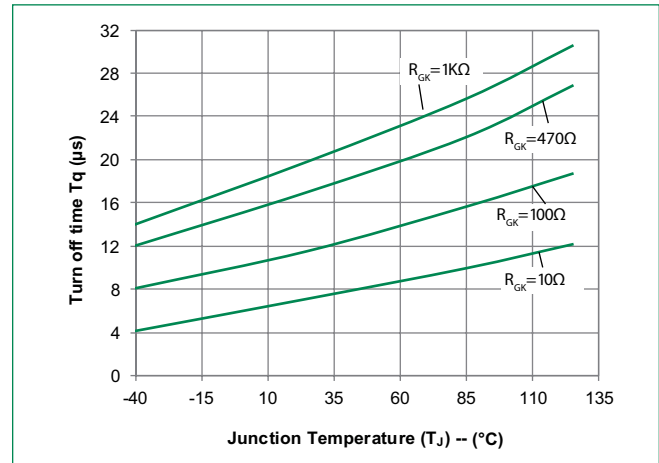
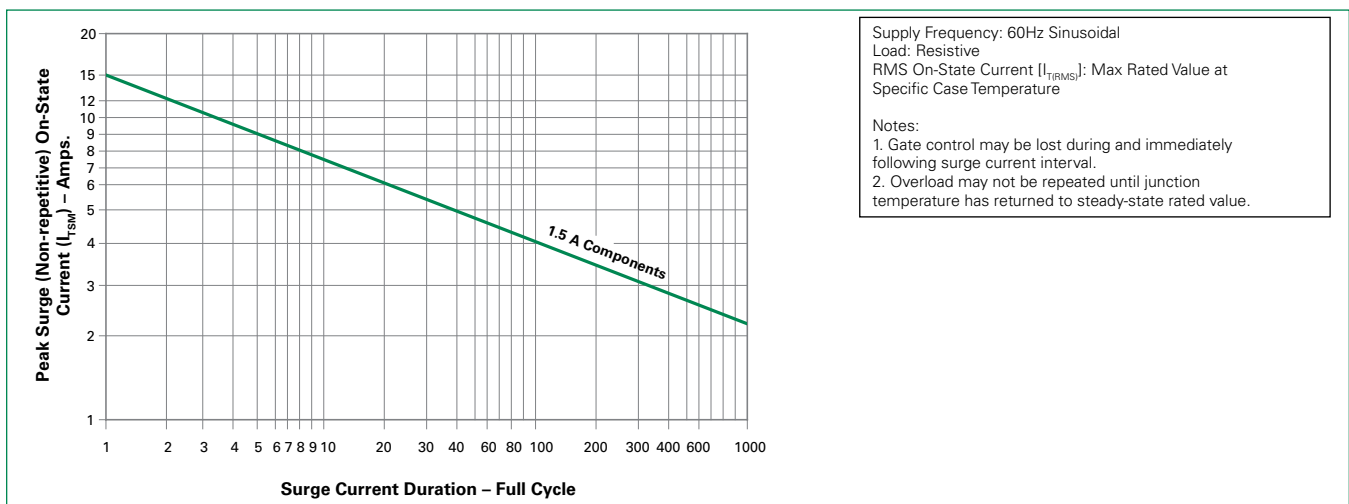


Figure 11: Surge Peak On-State Current vs. Number of Cycles

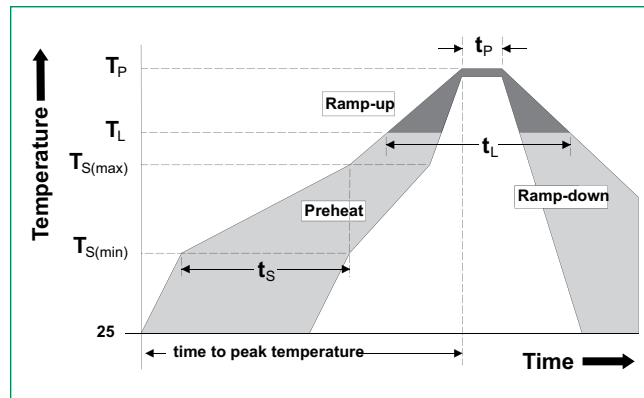


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### Soldering Parameters

|                                                                        |                                    |                         |
|------------------------------------------------------------------------|------------------------------------|-------------------------|
| <b>Reflow Condition</b>                                                |                                    | Pb – Free assembly      |
| <b>Pre Heat</b>                                                        | - Temperature Min ( $T_{s(min)}$ ) | 150°C                   |
|                                                                        | - Temperature Max ( $T_{s(max)}$ ) | 200°C                   |
|                                                                        | - Time (min to max) ( $t_s$ )      | 60 – 120 secs           |
| <b>Average ramp up rate (Liquidus Temp) (<math>T_L</math>) to peak</b> |                                    | 3°C/second max          |
| <b><math>T_{s(max)}</math> to <math>T_L</math> - Ramp-up Rate</b>      |                                    | 5°C/second max          |
| <b>Reflow</b>                                                          | - Temperature ( $T_L$ ) (Liquidus) | 217°C                   |
|                                                                        | - Time (min to max) ( $t_s$ )      | 60 – 150 seconds        |
| <b>Peak Temperature (<math>T_p</math>)</b>                             |                                    | 260 <sup>+0/-5</sup> °C |
| <b>Time within 5°C of actual peak Temperature (<math>t_p</math>)</b>   |                                    | 30 seconds              |
| <b>Ramp-down Rate</b>                                                  |                                    | 6°C/second max          |
| <b>Time 25°C to peak Temperature (<math>T_p</math>)</b>                |                                    | 8 minutes Max.          |
| <b>Do not exceed</b>                                                   |                                    | 260°C                   |



### Physical Specifications

|                        |                                                        |
|------------------------|--------------------------------------------------------|
| <b>Terminal Finish</b> | 100% Matte Tin-plated.                                 |
| <b>Body Material</b>   | UL Recognized compound meeting flammability rating V-0 |
| <b>Lead Material</b>   | Copper Alloy                                           |

### Design Considerations

Careful selection of the correct component for the application's operating parameters and environment will go a long way toward extending the operating life of the Thyristor. Good design practice should limit the maximum continuous current through the main terminals to 75% of the component rating. Other ways to ensure long life for a power discrete semiconductor are proper heat sinking and selection of voltage ratings for worst case conditions. Overheating, overvoltage (including  $dv/dt$ ), and surge currents are the main killers of semiconductors. Correct mounting, soldering, and forming of the leads also help protect against component damage.

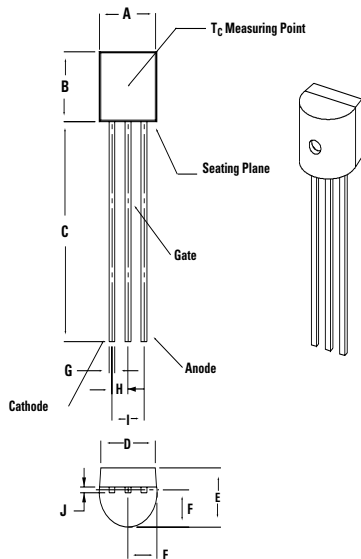
### Environmental Specifications

| Test                             | Specifications and Conditions                                              |
|----------------------------------|----------------------------------------------------------------------------|
| <b>AC Blocking</b>               | MIL-STD-750, M-1040, Cond A Applied Peak AC voltage @ 125°C for 1008 hours |
| <b>Temperature Cycling</b>       | MIL-STD-750, M-1051, 100 cycles; -40°C to +150°C; 15-min dwell-time        |
| <b>Temperature/Humidity</b>      | EIA / JEDEC, JESD22-A101 1008 hours; 160V - DC: 85°C; 85% rel humidity     |
| <b>Resistance to Solder Heat</b> | MIL-STD-750 Method 2031                                                    |
| <b>Solderability</b>             | ANSI/J-STD-002, category 3, Test A                                         |
| <b>Lead Bend</b>                 | MIL-STD-750, M-2036 Cond E                                                 |

# Sx02xSx EV Series

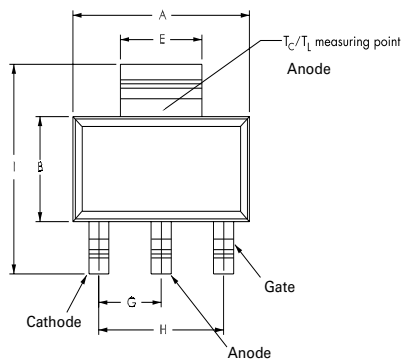
## EV Series 1.5 Amp Sensitive SCRs

### Dimensions — TO-92 (E Package)

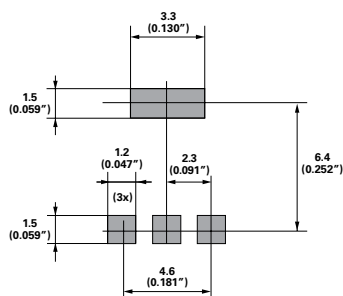


| Dimensions | Inches |       | Millimeters |       |
|------------|--------|-------|-------------|-------|
|            | Min    | Max   | Min         | Max   |
| A          | 0.175  | 0.205 | 4.450       | 5.200 |
| B          | 0.170  | 0.210 | 4.320       | 5.330 |
| C          | 0.500  | —     | 12.700      | —     |
| D          | 0.135  | —     | 3.430       | —     |
| E          | 0.125  | 0.165 | 3.180       | 4.190 |
| F          | 0.080  | 0.105 | 2.040       | 2.660 |
| G          | 0.016  | 0.021 | 0.407       | 0.533 |
| H          | 0.045  | 0.055 | 1.150       | 1.390 |
| I          | 0.095  | 0.105 | 2.420       | 2.660 |
| J          | 0.015  | 0.020 | 0.380       | 0.500 |

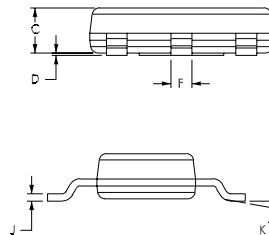
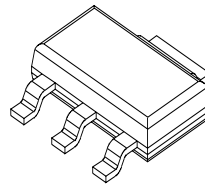
### Dimensions – SOT-223



Pad Layout for SOT-223



Dimensions in Millimeters (Inches)

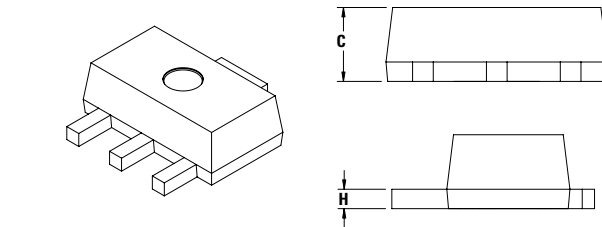
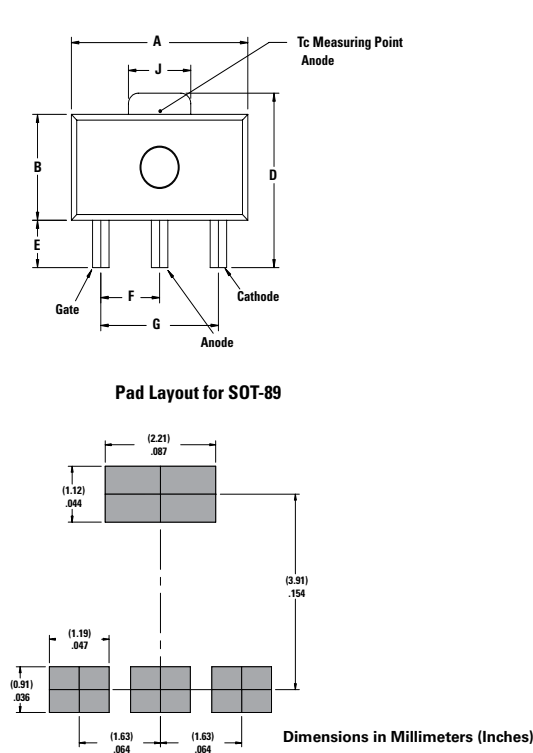


| Dimensions | Inches  |       |       | Millimeters |      |      |
|------------|---------|-------|-------|-------------|------|------|
|            | Min     | Typ   | Max   | Min         | Typ  | Max  |
| A          | 0.248   | 0.256 | 0.264 | 6.30        | 6.50 | 6.71 |
| B          | 0.130   | 0.138 | 0.146 | 3.30        | 3.50 | 3.70 |
| C          | —       | —     | 0.071 | —           | —    | 1.80 |
| D          | 0.001   | —     | 0.005 | 0.02        | —    | 0.13 |
| E          | 0.114   | 0.118 | 0.124 | 2.90        | 3.00 | 3.15 |
| F          | 0.024   | 0.027 | 0.034 | 0.60        | 0.70 | 0.85 |
| G          | —       | 0.090 | —     | —           | 2.30 | —    |
| H          | —       | 0.181 | —     | —           | 4.60 | —    |
| I          | 0.264   | 0.276 | 0.287 | 6.70        | 7.00 | 7.30 |
| J          | 0.009   | 0.010 | 0.014 | 0.23        | 0.26 | 0.35 |
| K          | 10° MAX |       |       |             |      |      |

# Sx02xSx EV Series

## EV Series 1.5 Amp Sensitive SCRs

### Dimensions – SOT-89



| Dimension | Inches |       |       | Millimeters |      |      |
|-----------|--------|-------|-------|-------------|------|------|
|           | Min    | Typ   | Max   | Min         | Typ  | Max  |
| A         | 0.173  | —     | 0.181 | 4.40        | —    | 4.60 |
| B         | 0.090  | —     | 0.102 | 2.29        | —    | 2.60 |
| C         | 0.055  | —     | 0.063 | 1.40        | —    | 1.60 |
| D         | 0.155  | —     | 0.167 | 3.94        | —    | 4.25 |
| E         | 0.032  | —     | 0.047 | 0.81        | —    | 1.20 |
| F         | —      | 0.059 | —     | —           | 1.5  | —    |
| G         | —      | 0.118 | —     | —           | 3    | —    |
| H         | 0.014  | —     | 0.017 | 0.35        | —    | 0.44 |
| I         | 0.014  | —     | 0.019 | 0.36        | —    | 0.48 |
| J         | —      | 0.067 | —     | —           | 1.69 | —    |

### Product Selector

| Part Numbr | Voltage |      | Gate Sensitivity | Package |
|------------|---------|------|------------------|---------|
|            | 400V    | 600V |                  |         |
| Sx02BS     | X       | X    | 200 $\mu$ A      | SOT-89  |
| Sx02ES     | X       | X    | 200 $\mu$ A      | TO-92   |
| Sx02TS     | X       | X    | 200 $\mu$ A      | SOT-223 |
| Sx02BS1    | X       | X    | 100 $\mu$ A      | SOT-89  |
| Sx02ES1    | X       | X    | 100 $\mu$ A      | TO-92   |
| Sx02TS1    | X       | X    | 100 $\mu$ A      | SOT-223 |
| Sx02BS2    | —       | X    | 50 $\mu$ A       | SOT-89  |

Note: x = voltage/100

### Packing Options

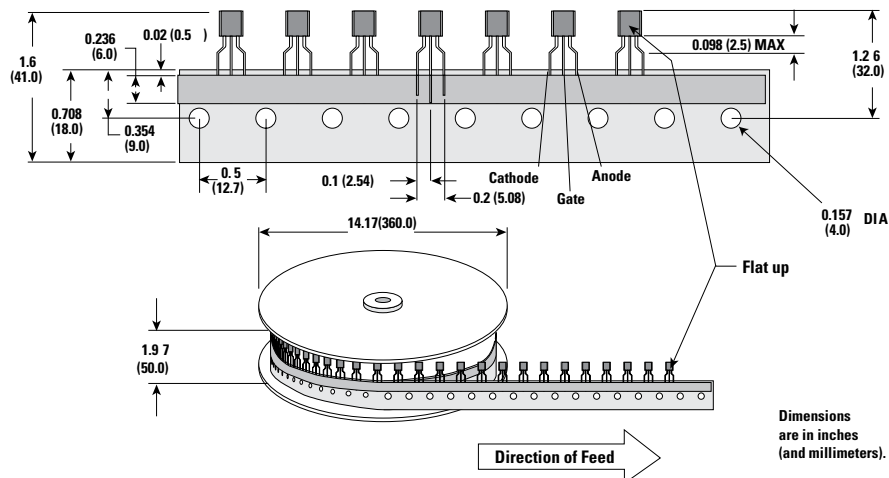
| Part Number | Marking | Weight  | Packing Mode | Base Quantity |
|-------------|---------|---------|--------------|---------------|
| Sx02ESy     | Sx02ESy | 0.217 g | Bulk         | 2500          |
| Sx02ESyAP   | Sx02ESy | 0.217 g | Ammo Pack    | 2000          |
| Sx02ESyRP   | Sx02ESy | 0.217 g | Tape & Reel  | 2000          |
| Sx02TSyRP   | Sx02TSy | 0.120 g | Tape & Reel  | 1000          |
| Sx02BSyRP   | x02y    | 0.053 g | Tape & Reel  | 1000          |
| Sx02BSyRP1  | x02y    | 0.053 g | Tape & Reel  | 1000          |

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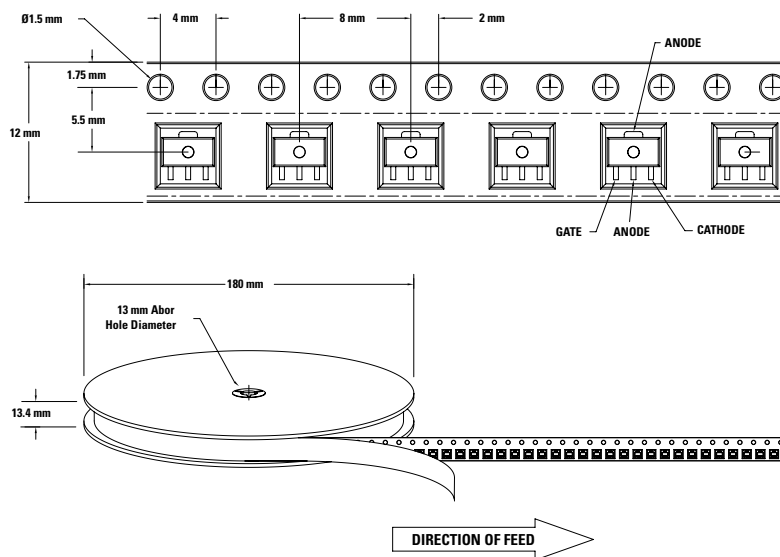
## EV Series 1.5 Amp Sensitive SCRs

### TO-92 (3-lead) Reel Pack (RP) Radial Leaded Specifications

Meets all EIA-468-C Standards



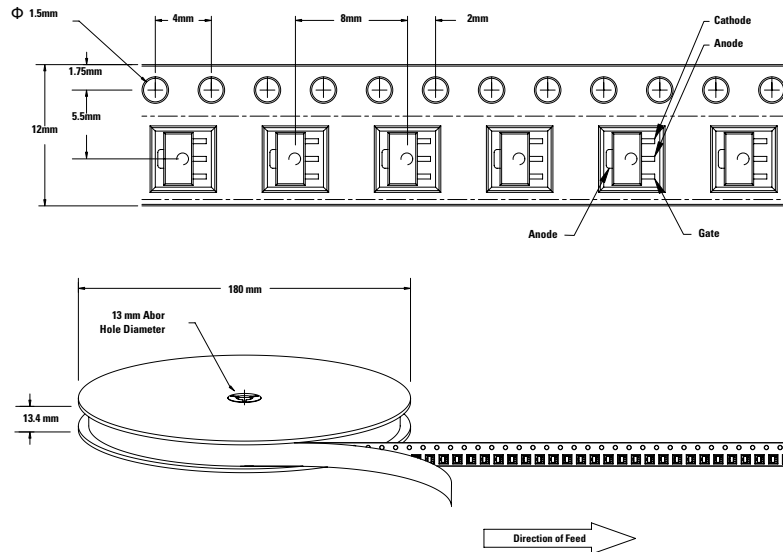
### SOT-89 Reel Pack (RP) Specifications



# Sx02xSx EV Series

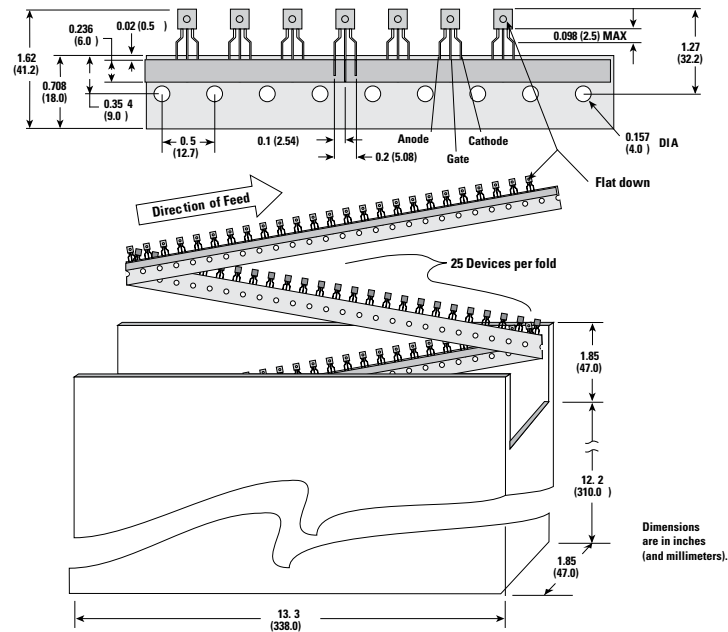
## EV Series 1.5 Amp Sensitive SCRs

### SOT-89 Reel Pack (RP1) Specifications



### TO-92 (3-lead) Ammo Pack (AP) Radial Leaded Specifications

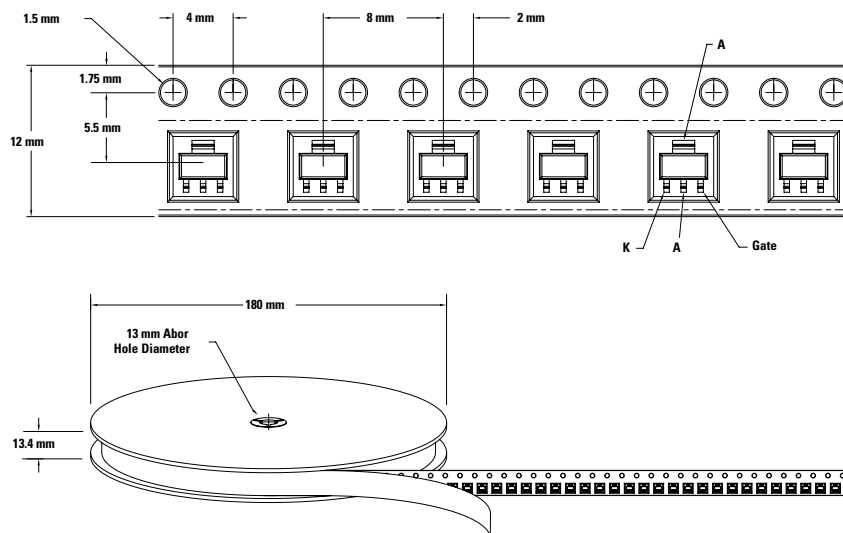
Meets all EIA-468-C Standards



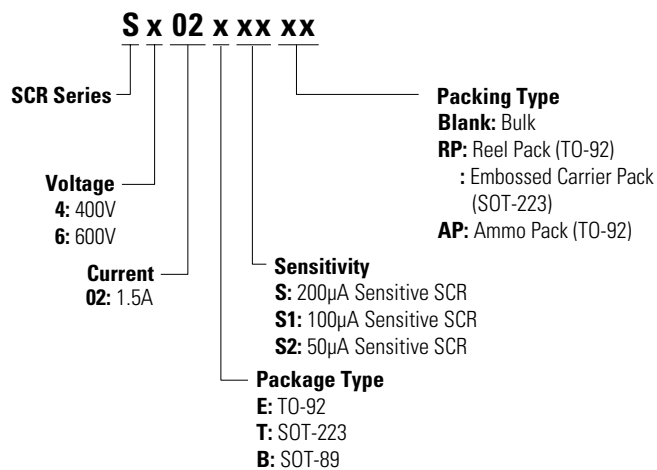
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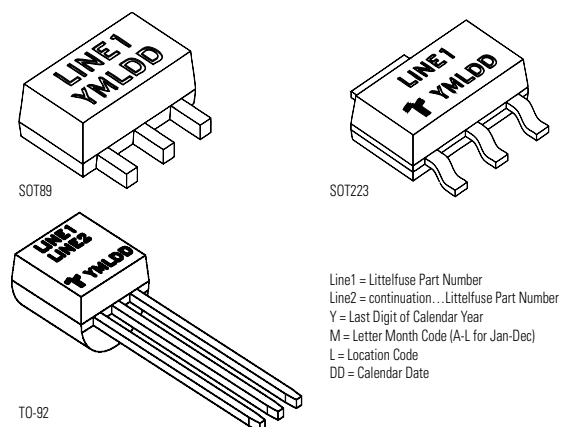
### SOT-223 Reel Pack (RP) Specifications



### Part Numbering System



### Part Marking System



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