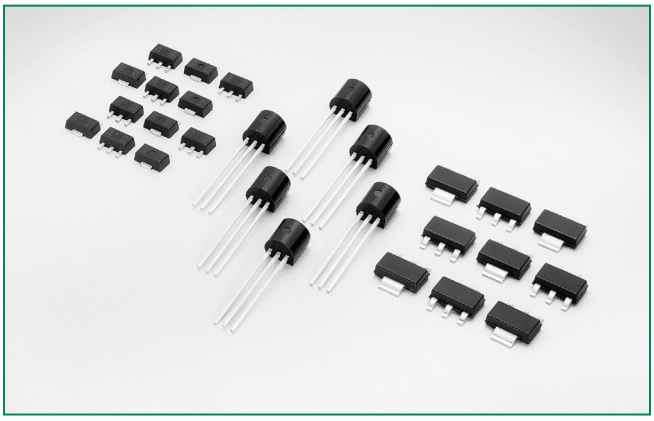
# Sx02xS Series

HF RoHS



## Main Features

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

## Applications

The Sx02xS EV series is specifically designed for solenoid drive often seen in GFCI and similar safety cut-off devices.

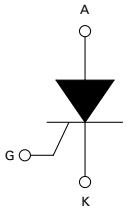
## Description

New 1.5 Amp sensitive gate SCR series offers high static dv/dt with low turn off time (tq) through small die planar construction design. All SCR's junctions are glass-passivated to ensure long term reliability and parametric stability.

## Features

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

## Schematic Symbol




## Absolute Maximum Ratings

| Symbol | Parameter | | | Value | Unit |
|---|---|---|---|---|---|
| $I_{T(RMS)}$ | RMS on-state current (full sine wave) | TO-92 | $T_C$ = 65°C | 1.5 | A |
| | | SOT-89 | $T_C$ = 80°C | | |
| | | SOT-223 | $T_L$ = 95°C | | |
| $I_{T(AV)}$ | Average on-state current | TO-92 | $T_C$ = 65°C | 0.95 | A |
| | | SOT-89 | $T_C$ = 80°C | | |
| | | SOT-223 | $T_C$ = 95°C | | |
| $I_{TSM}$ | Non repetitive surge peak on-state current (Single cycle, $T_J$ initial = 25°C) | TO-92 SOT-89 SOT-223 | F = 50 Hz | 12.5 | A |
| | | | F = 60 Hz | 15.0 | |
| $I^2t$ | $I^2t$ Value for fusing | $t_p$ = 10 ms | F = 50 Hz | 0.78 | $A^2s$ |
| | | $t_p$ = 8.3 ms | F = 60 Hz | 0.93 | |
| di/dt | Critical rate of rise of on-state current IG = 10mA | TO-92 SOT-89 SOT-223 | $T_J$ = 125°C | 50 | A/µs |
| $I_{GM}$ | Peak gate current | $t_p$ = 10 µs | $T_J$ = 125°C | 1.0 | A |
| $P_{G(AV)}$ | Average gate power dissipation | | $T_J$ = 125°C | 0.1 | W |
| $T_{stg}$ | Storage junction temperature range | | | -40 to 150 | °C |
| $T_J$ | Operating junction temperature range | | | -40 to 125 | °C |

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## Electrical Characteristics ($T_J$ = 25°C, unless otherwise specified)

| Symbol | Description | Test Conditions | Sx02xS | | Sx02xS1 | | Unit |
|---|---|---|---|---|---|---|---|
| | | | Min | Max | Min | Max | |
| $I_{GT}$ | DC Gate Trigger Current | $V_D$ = 12V; $R_L$ = 60 Ω | 15 | 200 | 15 | 100 | µA |
| $V_{GT}$ | DC Gate Trigger Voltage | $V_D$ = 12V; $R_L$ = 60 Ω | — | 0.8 | — | 0.8 | V |
| $V_{GRM}$ | Peak Reverse Gate Voltage | $I_{RG}$ = 10µA | 5 | — | 5 | — | V |
| $I_H$ | Holding Current | $R_{GK}$ = 1 kΩ | — | 5 | — | 3 | mA |
| (dv/dt)s | Critical Rate-of-Rise of Off-State Voltage | $T_J$ = 125°C<br>$V_D = V_{DRM}/ V_{RRM}$<br>Exponential Waveform<br>$R_{GK}$ = 1 kΩ | 25 | — | 25 | — | V/µs |
| $t_q$ | Turn-Off Time | $T_J$ = 125°C @ 600 V<br>$R_{GK}$ = 1 kΩ | — | 35 | — | 35 | µs |
| $t_{gt}$ | Turn-On Time | $I_G$ = 10mA<br>PW = 15µsec<br>$I_T$ = 3.0A (pk) | — | 3 | — | 3 | µs |

## Static Characteristics ($T_J$ = 25°C, unless otherwise specified)

| Symbol | Description | Test Conditions | Value | | Unit |
|---|---|---|---|---|---|
| | | | Min | Max | |
| $V_{TM}$ | Peak On-State Voltage | $I_{TM}$ = 3.0A (pk) | — | 1.70 | V |
| $I_{DRM}$ | Off-State Current, Peak Repetitive | $T_J$ = 25°C @ $V_D = V_{DRM}$<br>$R_{GK}$ = 1 kΩ | — | 5 | µA |
| | | $T_J$ = 125°C @ $V_D = V_{DRM}$<br>$R_{GK}$ = 1 kΩ | — | 500 | µA |

## Thermal Resistances

| Symbol | Parameter | | | Value | Unit |
|---|---|---|---|---|---|
| $R_{\theta(J-C)}$ | Junction to case (AC) | $I_T$ = 1.5A (RMS)[1] | TO-92 | 50 | °C/W |
| | | | SOT-89 | 35 | |
| | | | SOT-223 | 25 | |
| $R_{\theta(J-A)}$ | Junction to ambient | $I_T$ = 1.5A (RMS)[1] | TO-92 | 160 | °C/W |
| | | | SOT-89 | 90 | |
| | | | SOT-223 | 60 | |

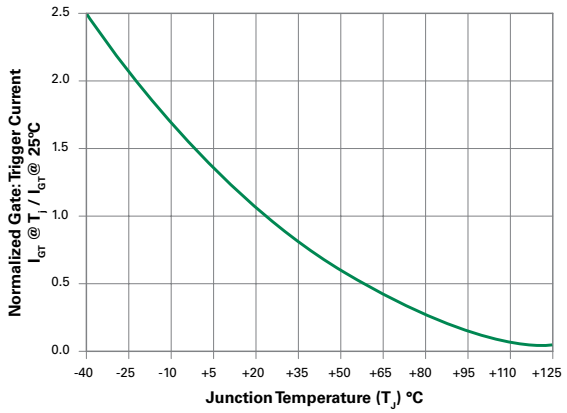
[1] 60Hz AC resistive load condition, 100% conduction.

## Additional Information

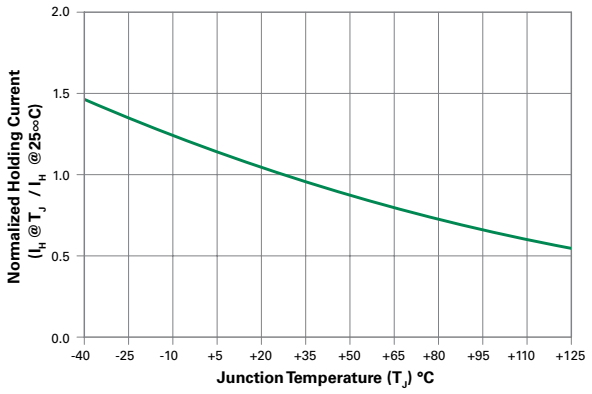
**Datasheet** | **Resources** | **Samples**

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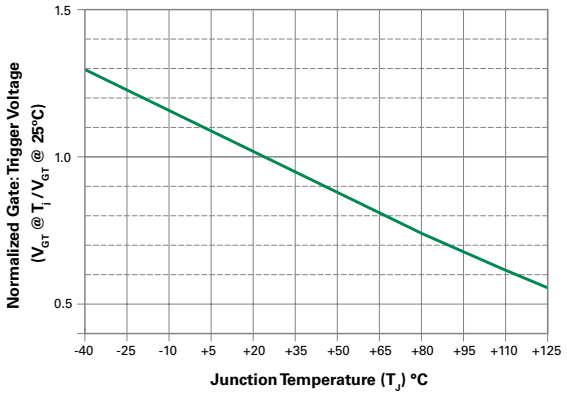
## Figure 1: Normalized DC Gate Trigger Current vs. Junction Temperature



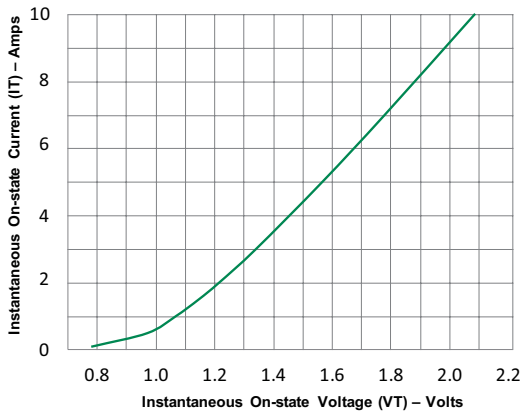

## Figure 2: Normalized DC Holding Current vs. Junction Temperature



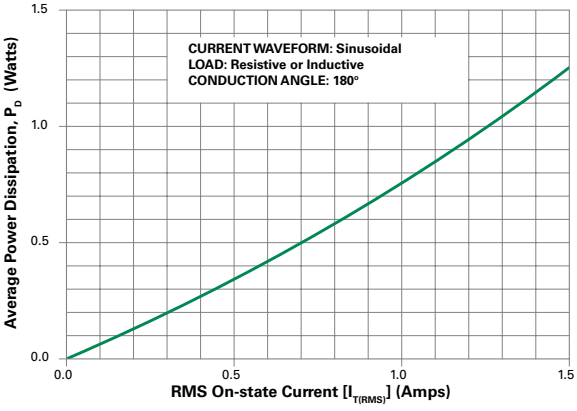

## Figure 3: Normalized DC Gate Trigger Voltage vs. Junction Temperature



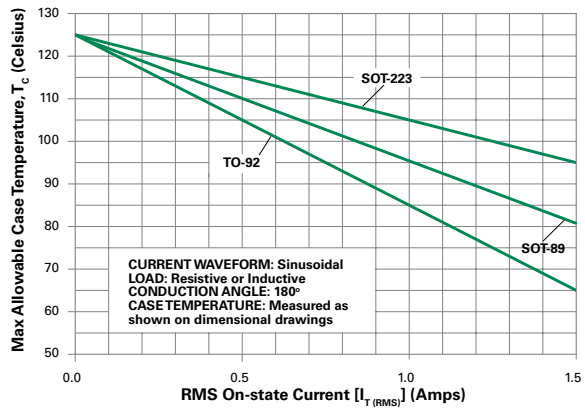

## Figure 4: On-State Current vs. On-State Voltage (Typical)




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

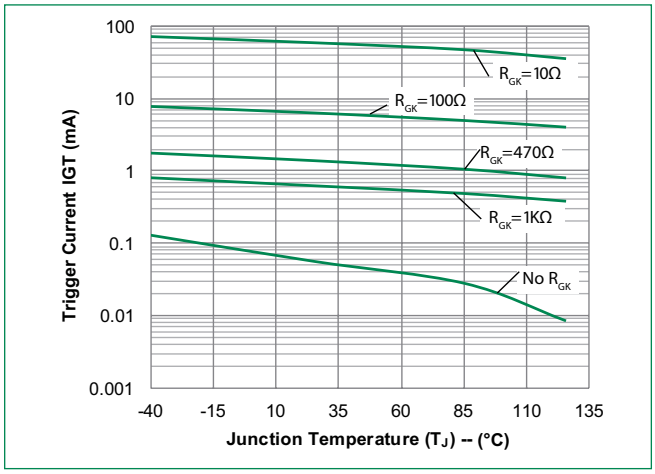



## Figure 6: Maximum Allowable Case Temperature vs. On-State Current

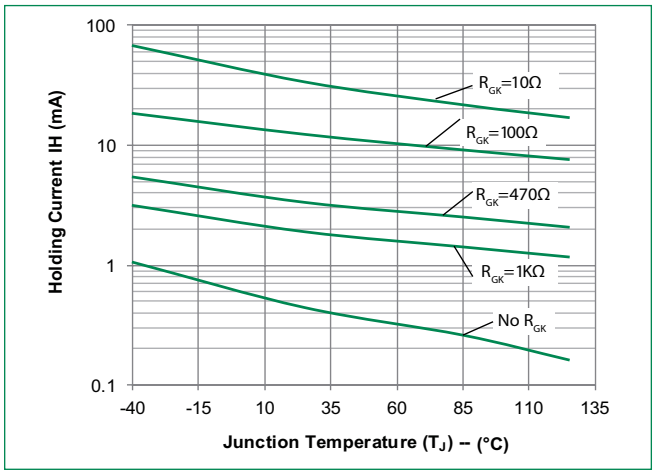



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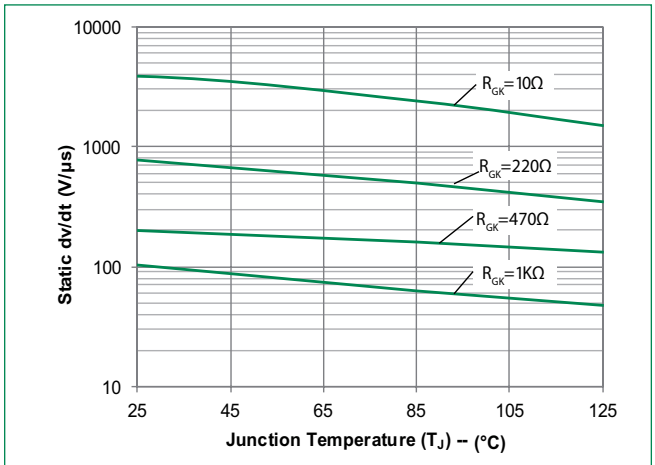
## Figure 7: Typical DC Gate Trigger Current with $R_{GK}$ vs. Junction Temperature for Sx02xS



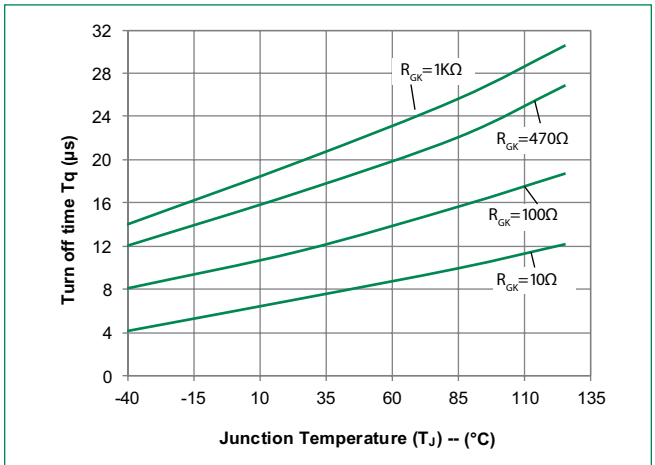

## Figure 8: Typical DC Holding Current with $R_{GK}$ vs. Junction Temperature for Sx02xS



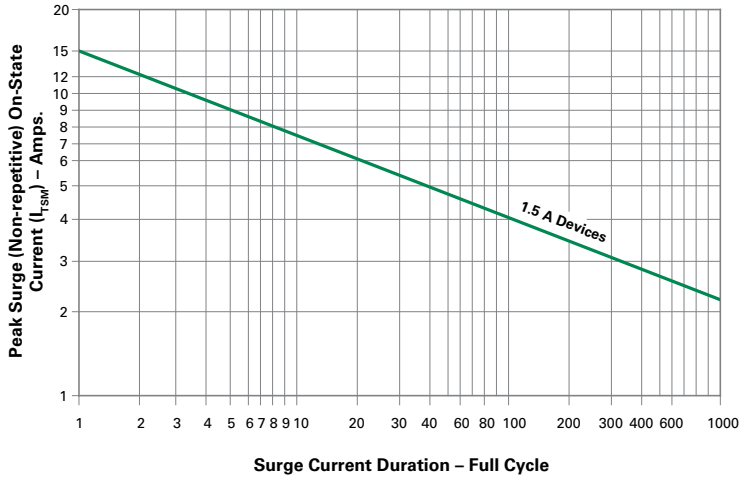

## Figure 9: Typical Static dv/dt with $R_{GK}$ vs. Junction Temperature for Sx02xS




## 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



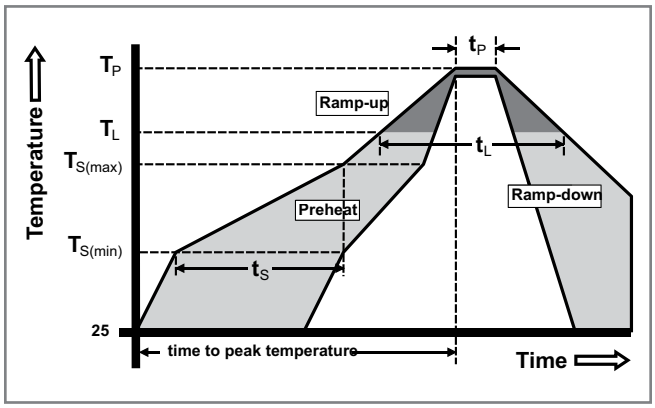

Supply Frequency: 60Hz Sinusoidal
Load: Resistive
RMS On-State Current [$I_{T(RMS)}$]: Max Rated Value at Specific Case Temperature

Notes:
1. Gate control may be lost during and immediately following surge current interval.
2. Overload may not be repeated until junction temperature has returned to steady-state rated value.

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## Soldering Parameters

| | | |
|---|---|---|
| Reflow Condition | | Pb – Free assembly |
| Pre Heat | -Temperature Min ($T_{s(min)}$) | 150°C |
| | -Temperature Max ($T_{s(max)}$) | 200°C |
| | -Time (min to max) ($t_s$) | 60 – 180 secs |
| Average ramp up rate (Liquidus Temp) ($T_L$) to peak | | 5°C/second max |
| $T_{S(max)}$ to $T_L$ - Ramp-up Rate | | 5°C/second max |
| Reflow | -Temperature ($T_L$) (Liquidus) | 217°C |
| | -Time (min to max) ($t_s$) | 60 – 150 seconds |
| Peak Temperature ($T_P$) | | $260^{+0/-5}$ °C |
| Time within 5°C of actual peak Temperature ($t_p$) | | 20 – 40 seconds |
| Ramp-down Rate | | 5°C/second max |
| Time 25°C to peak Temperature ($T_P$) | | 8 minutes Max. |
| Do not exceed | | 280°C |




## Physical Specifications

| | |
|---|---|
| **Terminal Finish** | 100% Matte Tin-plated. |
| **Body Material** | UL recognized epoxy meeting flammability rating V-0. |
| **Lead Material** | Copper Alloy |

## Design Considerations

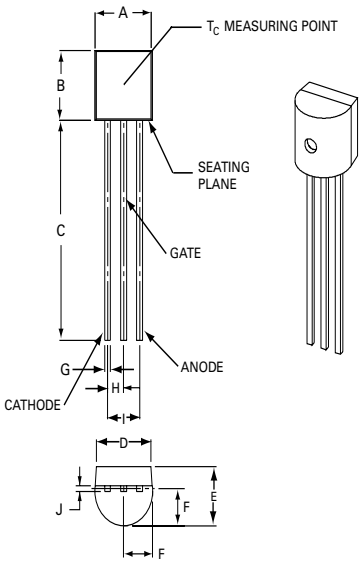
Careful selection of the correct component for the application's operating parameters and environment will go a long way toward extending the operating life of the Thyristor. Good design practice should limit the maximum continuous current through the main terminals to 75% of the component rating. Other 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 |
|---|---|
| **AC Blocking** | MIL-STD-750, M-1040, Cond A Applied Peak AC voltage @ 125°C for 1008 hours |
| **Temperature Cycling** | MIL-STD-750, M-1051, 100 cycles; -40°C to +150°C; 15-min dwell-time |
| **Temperature/ Humidity** | EIA / JEDEC, JESD22-A101 1008 hours; 160V - DC: 85°C; 85% rel humidity |
| **High Temp Storage** | MIL-STD-750, M-1031, 1008 hours; 150°C |
| **Low-Temp Storage** | 1008 hours; -40°C |
| **Resistance to Solder Heat** | MIL-STD-750 Method 2031 |
| **Solderability** | ANSI/J-STD-002, category 3, Test A |
| **Lead Bend** | MIL-STD-750, M-2036 Cond E |

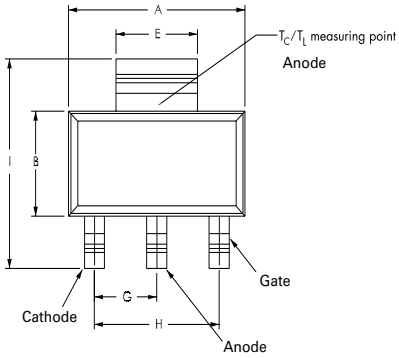
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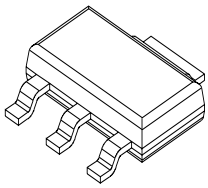
## Dimensions — TO-92 (E Package)

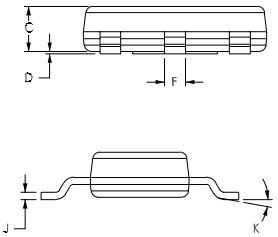



| Dimensions | Inches | | Millimeters | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| A | 0.175 | 0.205 | 4.450 | 5.200 |
| B | 0.170 | 0.210 | 4.320 | 5.330 |
| C | 0.500 | — | 12.700 | — |
| D | 0.135 | — | 3.430 | — |
| E | 0.125 | 0.165 | 3.180 | 4.190 |
| F | 0.080 | 0.105 | 2.040 | 2.660 |
| 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 |

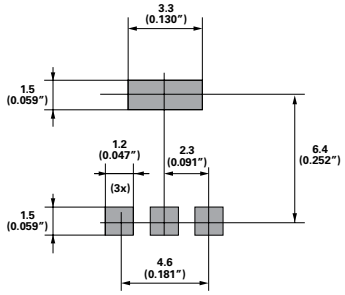
## Dimensions – SOT-223






Pad Layout for SOT-223

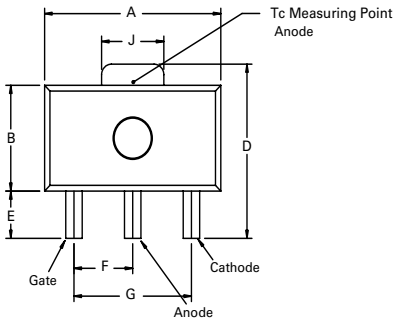


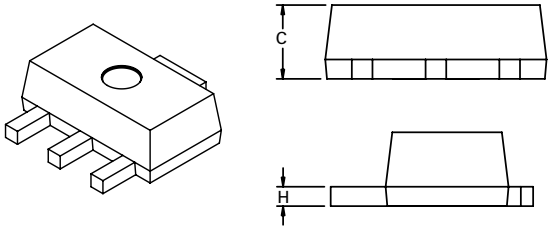

**Dimensions in Millimeters (Inches)**

| Dimensions | Inches | | | Millimeters | | |
|---|---|---|---|---|---|---|
| | Min | Typ | Max | Min | Typ | Max |
| A | 0.248 | 0.256 | 0.264 | 6.30 | 6.50 | 6.70 |
| B | 0.130 | 0.138 | 0.146 | 3.30 | 3.50 | 3.70 |
| C | — | — | 0.071 | — | — | 1.80 |
| D | 0.001 | — | 0.004 | 0.02 | — | 0.10 |
| 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 | 0.24 | 0.26 | 0.35 |
| K | 10° MAX | | | | | |

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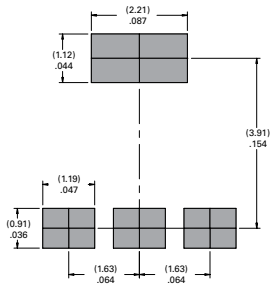
## Dimensions – SOT-89




| 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 | 0.035 | — | 0.047 | 0.89 | — | 1.20 |
| F | 0.056 | — | 0.062 | 1.42 | — | 1.57 |
| G | 0.115 | — | 0.121 | 2.92 | — | 3.07 |
| H | 0.014 | — | 0.017 | 0.35 | — | 0.44 |
| I | 0.014 | — | 0.019 | 0.36 | — | 0.48 |
| J | 0.064 | — | 0.072 | 1.62 | — | 1.83 |

**Pad Layout for SOT-89**




**Dimensions in Millimeters (Inches)**

## Product Selector

| Part Number | Voltage | | Gate Sensitivity | Package |
|---|---|---|---|---|
| | 400V | 600V | | |
| S402ES | X | – | 200µA | TO-92 |
| S602ES | – | X | 200µA | TO-92 |
| S402TS | X | – | 200µA | SOT-223 |
| S602TS | – | X | 200µA | SOT-223 |
| Sx02ES1 | X | X | 100µA | TO-92 |
| Sx02BS1 | X | X | 100µA | SOT-89 |
| Sx02BS | X | X | 200µA | SOT-89 |
| Sx02TS1 | X | X | 100µA | SOT-223 |

Note: x = voltage/10

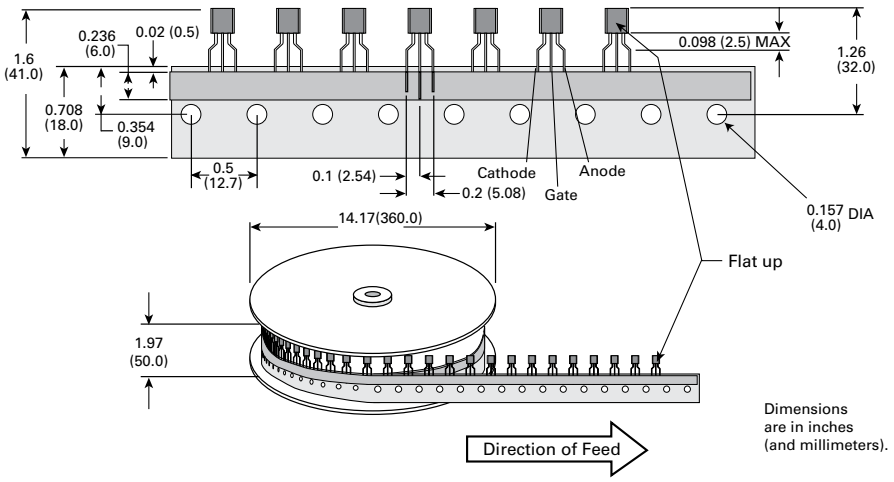
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## Packing Options

| Part Number | Marking | Weight | Packing Mode | Base Quantity |
|---|---|---|---|---|
| Sx02ES | Sx02ES | 0.217 g | Bulk | 2500 |
| Sx02ESAP | Sx02ES | 0.217 g | Ammo Pack | 2000 |
| Sx02ESRP | Sx02ES | 0.217 g | Tape & Reel | 2000 |
| Sx02TSRP | Sx02TS | 0.120 g | Tape & Reel | 1000 |
| Sx02ES1 | Sx02ES | 0.217 g | Bulk | 2500 |
| Sx02ES1AP | Sx02ES1 | 0.217 g | Ammo Pack | 2000 |
| Sx02ES1RP | Sx02ES1 | 0.217 g | Tape & Reel | 2000 |
| Sx02TS1RP | Sx02TS1 | 0.120 g | Tape & Reel | 1000 |
| Sx02BSRP | Sx02BS | 0.053 g | Tape & Reel | 1000 |
| Sx02BS1RP | Sx02BS1 | 0.053 g | Tape & Reel | 1000 |

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

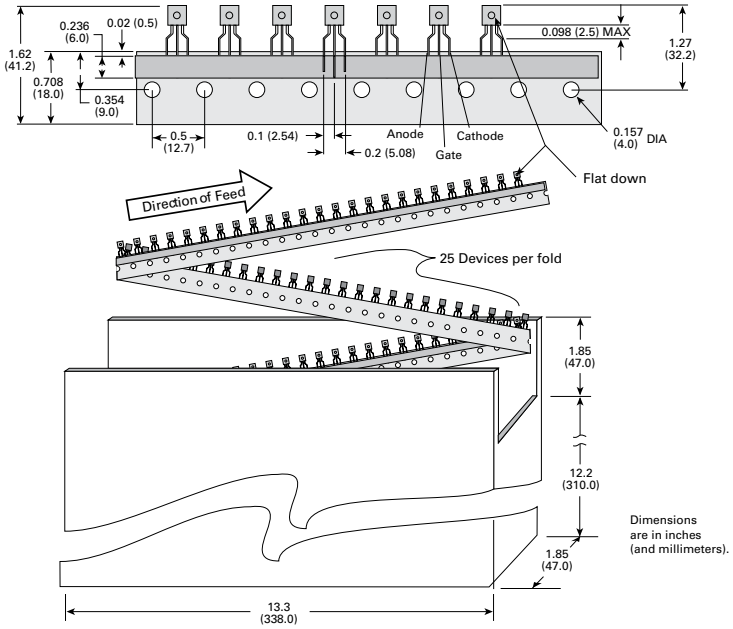
### Meets all EIA-468-C Standards



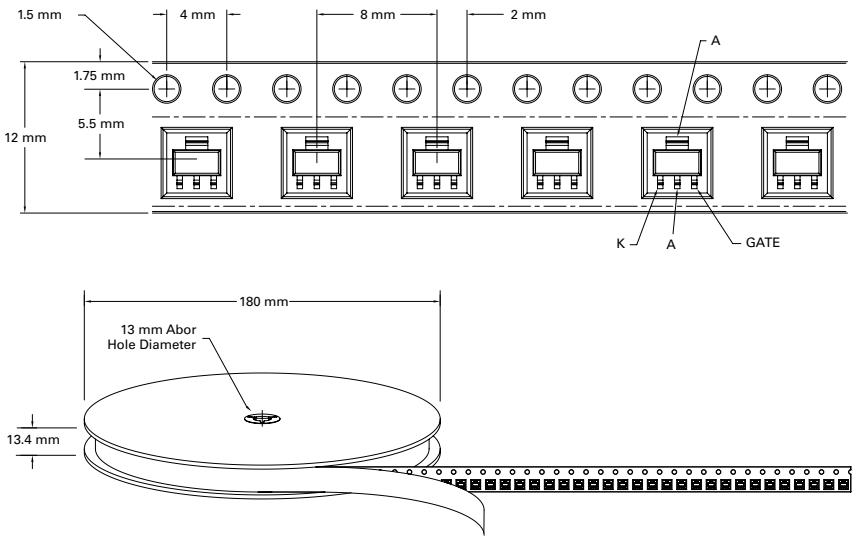

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## TO-92 (3-lead) Ammo Pack (AP) Radial Leaded Specifications

### Meets all EIA-468-C Standards




## SOT-223 Reel Pack (RP) Specifications




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## Part Numbering System

**S x 02 x xx xx**

**SCR SERIES**

**VOLTAGE**
**4:** 400V
**6:** 600V

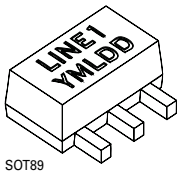
**CURRENT**
**02:** 1.5A

**SENSITIVITY**
**S:** 200µA Sensitive SCR
**S1:** 100µA Sensitive SCR

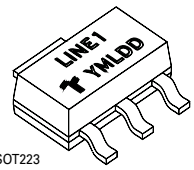
**PACKAGE TYPE**
**E:** TO-92
**T:** SOT-223
**B:** SOT-89

**PACKING TYPE**
**Blank:** Bulk
**RP:** Reel Pack (TO-92)
: Embossed Carrier Pack (SOT-223)
**AP:** Ammo Pack (TO-92)

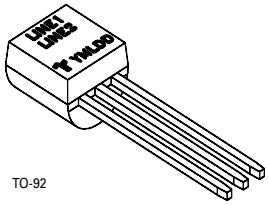
## Part Marking System



SOT89



SOT223



TO-92

Line1 = Littelfuse Part Number
Line2 = continuation...Littelfuse Part Number
Y = Last Digit of Calendar Year
M = Letter Month Code (A-L for Jan-Dec)
L = Location Code
DD = Calendar Date

**Disclaimer Notice - Information furnished is believed to be accurate and reliable. However, users should independently evaluate the suitability of and test each product selected for their own applications. Littelfuse products are not designed for, and may not be used in, all applications. Read complete Disclaimer Notice at www.littelfuse.com/disclaimer-electronics.**

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