

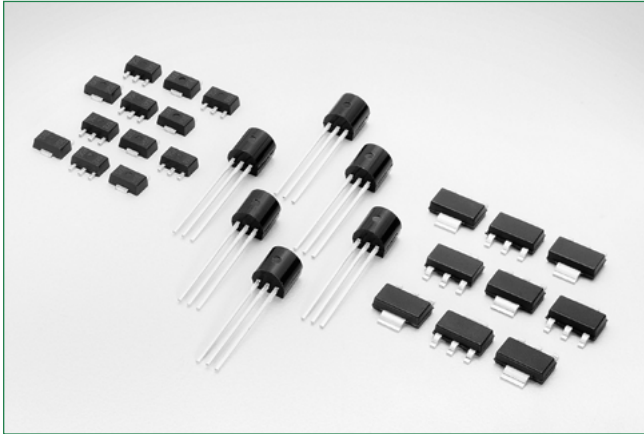


# THE DATASHEET OF S602ES



# Sx02xSx EV Series

## EV Series 1.5 Amp Sensitive SCRs

HF RoHS

### Additional Information



Resources



Accessories



Samples

### Main Features

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

### Description

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

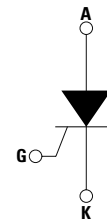
### Features

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

### Applications

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

### Schematic Symbol



### Absolute Maximum Ratings

Symbol	Parameter	Value	Unit	
$I_{T(RMS)}$	RMS on-state current (full sine wave)	TO-92 $T_c = 65^\circ C$	1.5	A
		SOT-89 $T_c = 80^\circ C$		
		SOT-223 $T_c = 95^\circ C$		
$I_{T(AV)}$	Average on-state current	TO-92 $T_c = 65^\circ C$	0.95	A
		SOT-89 $T_c = 80^\circ C$		
		SOT-223 $T_c = 95^\circ C$		
$I_{TSM}$	Non repetitive surge peak on-state current (Single cycle, $T_j$ initial = $25^\circ C$ )	TO-92 $F = 50$ Hz	12.5	A
		SOT-89 $F = 60$ Hz	15.0	
		SOT-223		
$I^2t$	$I^2t$ 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 $I_G = 10mA$	TO-92 SOT-89 SOT-223 $T_j = 125^\circ C$	50	$A/\mu s$
$I_{GM}$	Peak gate current	$t_p = 10$ $\mu s$ $T_j = 125^\circ C$	1.0	A
$P_{G(AV)}$	Average gate power dissipation	$T_j = 125^\circ C$	0.1	W
$T_{stg}$	Storage junction temperature range		-40 to 150	$^\circ C$
$T_j$	Operating junction temperature range		-40 to 125	$^\circ C$

# Sx02xSx EV Series

## EV Series 1.5 Amp Sensitive SCRs

### 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>GRRM</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 V <sub>D</sub> = V <sub>DRM</sub> / V <sub>RRM</sub> Exponential Waveform 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 R <sub>GK</sub> = 1 kΩ"	—	35	—	35	—	35	μs
t <sub>gt</sub>	Turn-On Time	"I <sub>G</sub> = 10mA PW = 15μsec 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, 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> R <sub>GK</sub> = 1 kΩ	—	5	μA
		T <sub>J</sub> = 125°C @ V <sub>D</sub> = V <sub>DRM</sub> R <sub>GK</sub> = 1 kΩ	—	500	μA

### Thermal Resistances

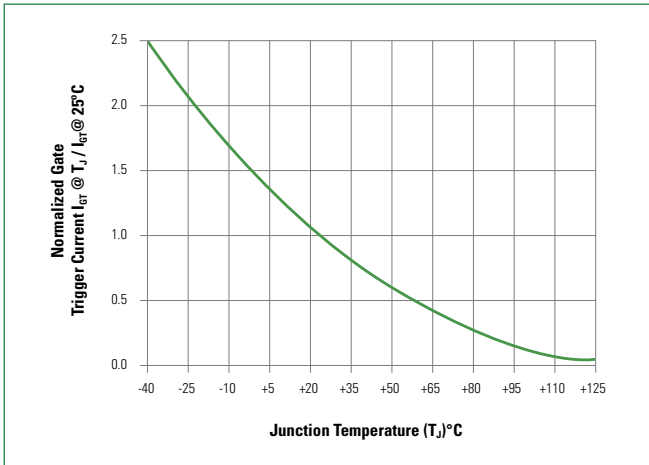
Symbol	Parameter	Test Conditions	Value	Unit	
R <sub>θ(J-C)</sub>	Junction to case (AC)	I <sub>T</sub> = 1.5A <sub>(RMS)</sub> <sup>1</sup>	TO-92	50	°C/W
			SOT-89	35	
			SOT-223	25	
R <sub>θ(J-A)</sub>	Junction to ambient	I <sub>T</sub> = 1.5A <sub>(RMS)</sub> <sup>1</sup>	TO-92	160	°C/W
			SOT-89	90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

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

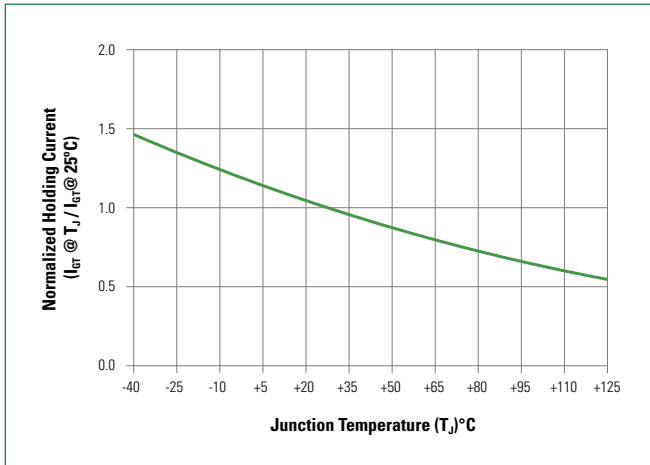
# Sx02xSx EV Series

## EV Series 1.5 Amp Sensitive SCRs

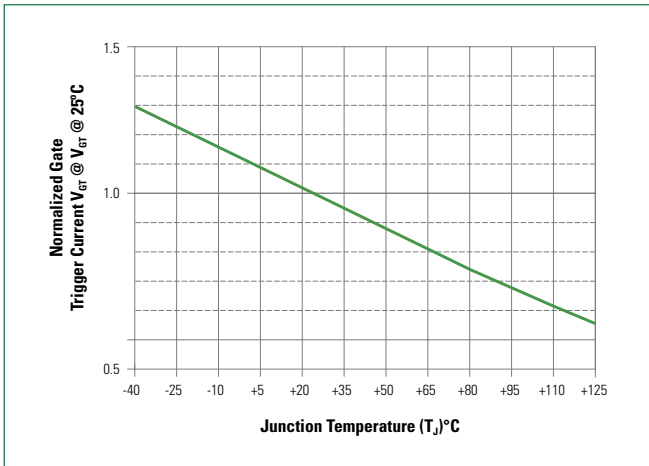
**Figure 1: Normalized DC Gate Trigger Current vs. Junction Temperature**



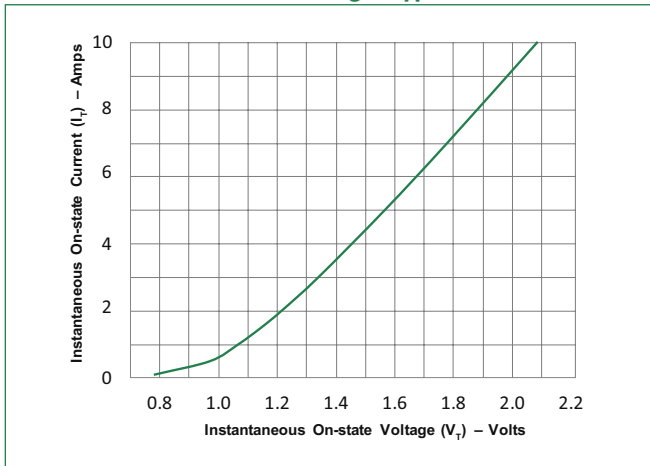
**Figure 2: Normalized DC Holding Current vs. Junction Temperature**



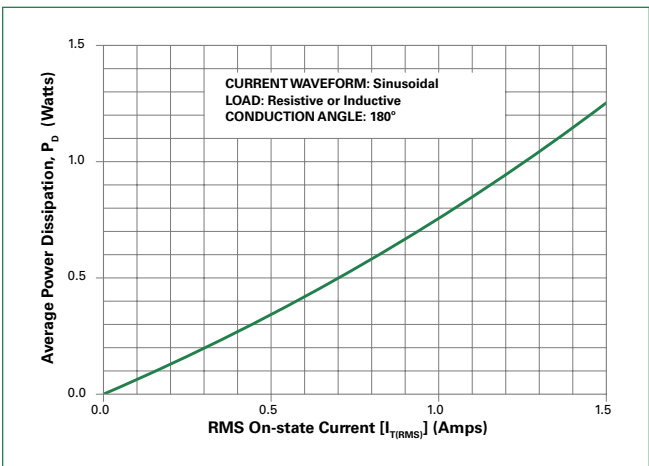
**Figure 3: Normalized DC Gate Trigger Voltage vs. Junction Temperature**



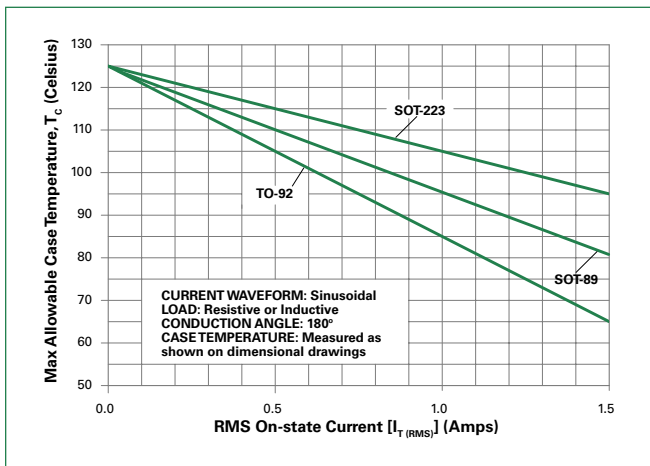
**Figure 4: On-State Current vs. On-State Voltage (Typical)**



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



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



# Sx02xSx EV Series

## EV Series 1.5 Amp Sensitive SCRs

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

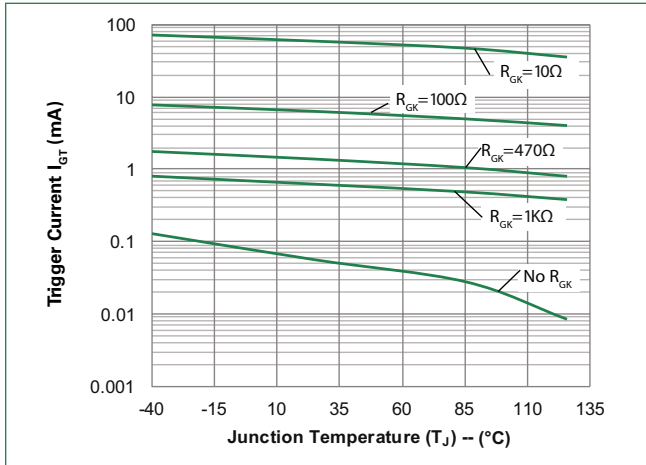


Figure 8: Typical DC Holding Current with  $R_{GK}$  vs. Junction Temperature for Sx02xS

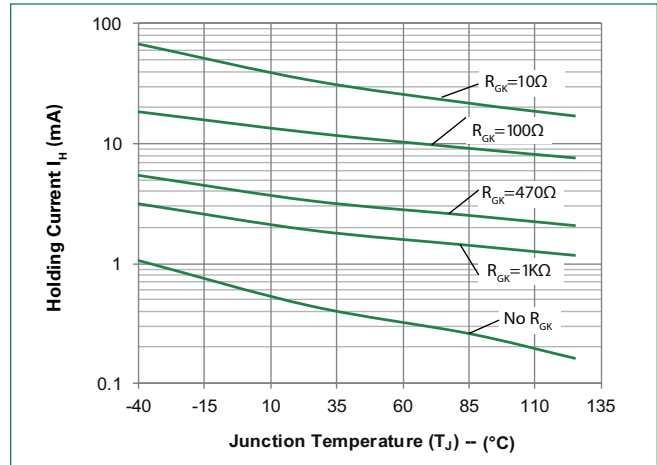


Figure 9: Typical Static dv/dt with  $R_{GK}$  vs. Junction Temperature for Sx02xS

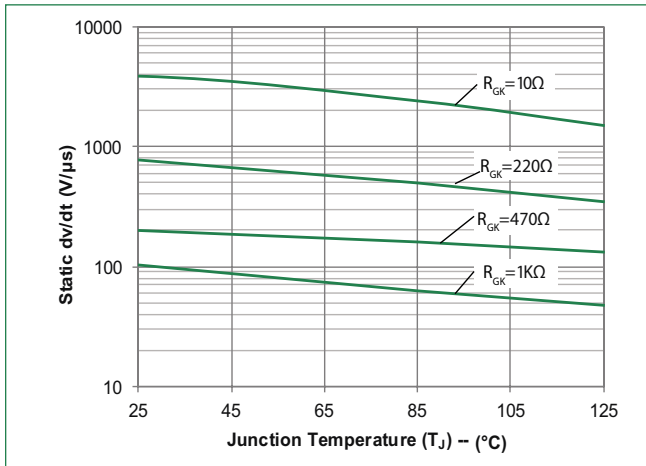


Figure 10: Typical turn off time with  $R_{GK}$  vs. Junction Temperature for Sx02xS

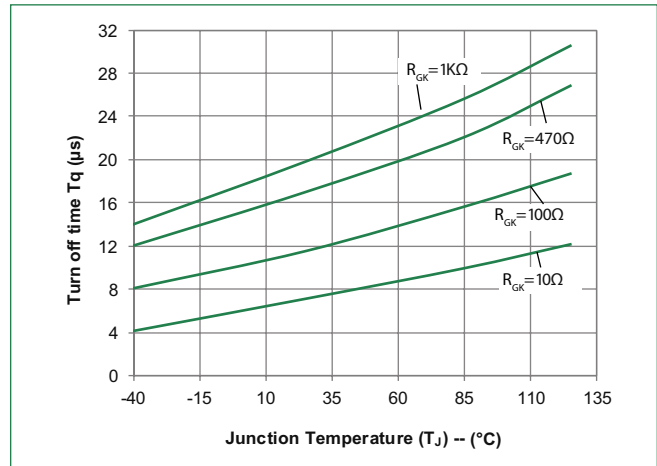
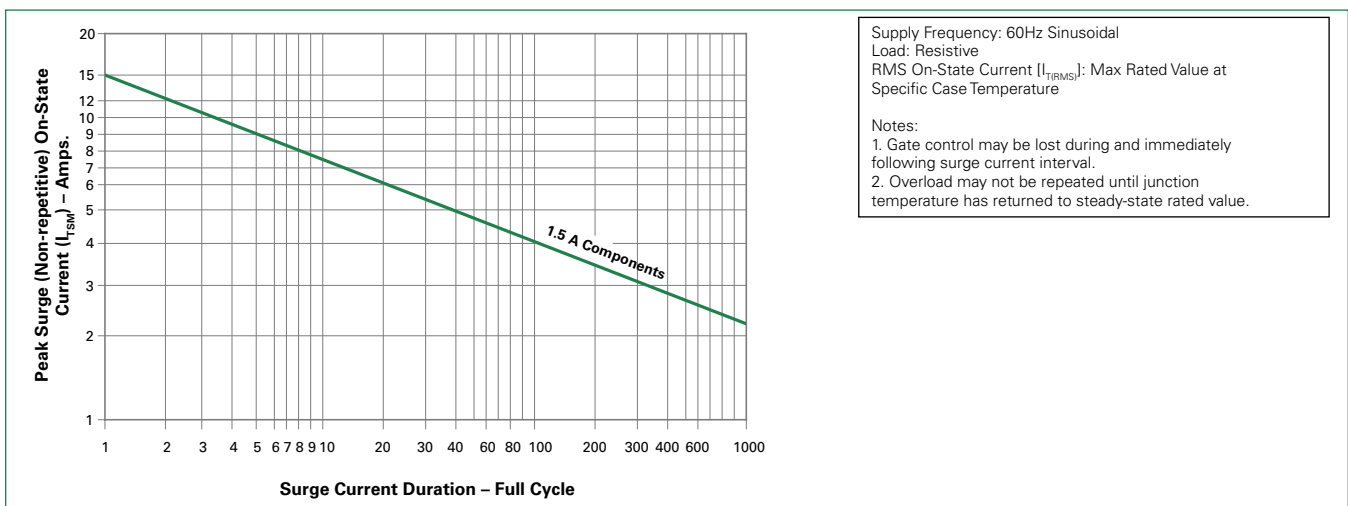


Figure 11: Surge Peak On-State Current vs. Number of Cycles

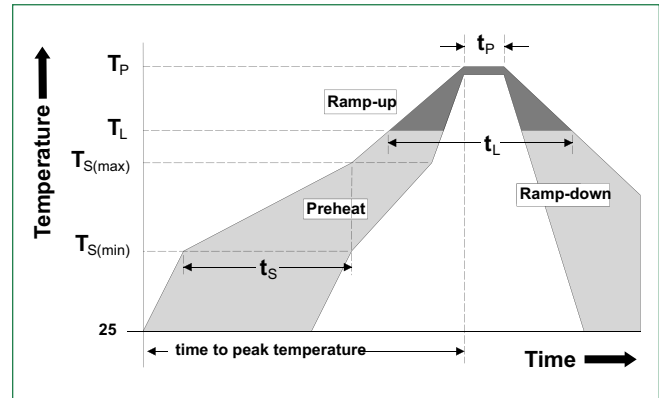


# Sx02xSx EV Series

## EV Series 1.5 Amp Sensitive SCRs

### 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 – 180 secs
<b>Average ramp up rate (Liquidus Temp) (<math>T_L</math>) to peak</b>		5°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>		20 – 40 seconds
<b>Ramp-down Rate</b>		5°C/second max
<b>Time 25°C to peak Temperature (<math>T_p</math>)</b>		8 minutes Max.
<b>Do not exceed</b>		280°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.

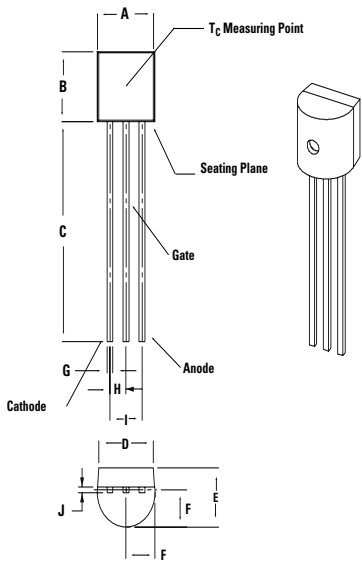
### Environmental Specifications

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

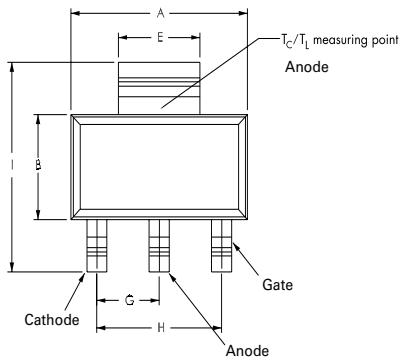
## EV Series 1.5 Amp Sensitive SCRs

### Dimensions – TO-92 (E Package)

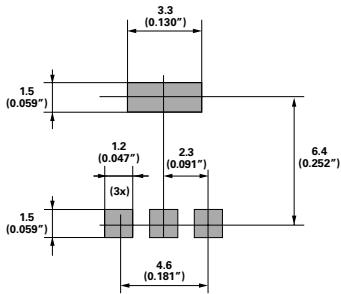


Dimensions	Inches		Millimeters	
	Min	Max	Min	Max
<b>A</b>	0.175	0.205	4.450	5.200
<b>B</b>	0.170	0.210	4.320	5.330
<b>C</b>	0.500	—	12.700	—
<b>D</b>	0.135	—	3.430	—
<b>E</b>	0.125	0.165	3.180	4.190
<b>F</b>	0.080	0.105	2.040	2.660
<b>G</b>	0.016	0.021	0.407	0.533
<b>H</b>	0.045	0.055	1.150	1.390
<b>I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

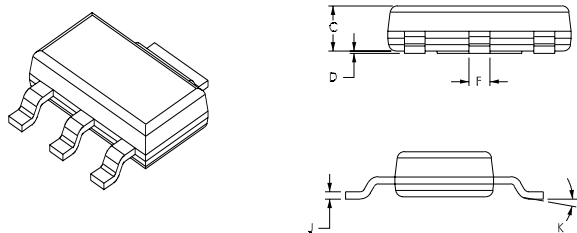
### Dimensions – SOT-223



Pad Layout for SOT-223



Dimensions in Millimeters (Inches)

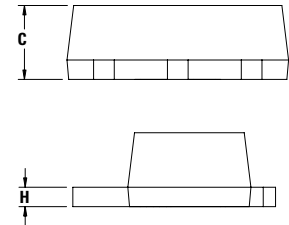
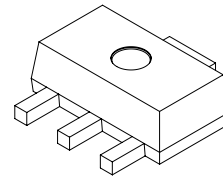
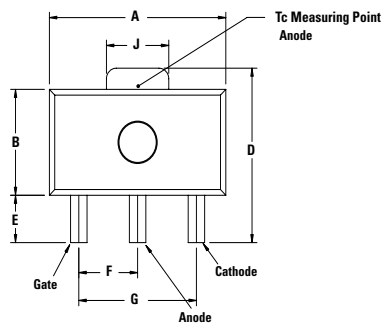


Dimensions	Inches			Millimeters		
	Min	Typ	Max	Min	Typ	Max
<b>A</b>	0.248	0.256	0.264	6.30	6.50	6.70
<b>B</b>	0.130	0.138	0.146	3.30	3.50	3.70
<b>C</b>	—	—	0.071	—	—	1.80
<b>D</b>	0.001	—	0.004	0.02	—	0.10
<b>E</b>	0.114	0.118	0.124	2.90	3.00	3.15
<b>F</b>	0.024	0.027	0.034	0.60	0.70	0.85
<b>G</b>	—	0.090	—	—	2.30	—
<b>H</b>	—	0.181	—	—	4.60	—
<b>I</b>	0.264	0.276	0.287	6.70	7.00	7.30
<b>J</b>	0.009	0.010	0.014	0.24	0.26	0.35
<b>K</b>	10° MAX					

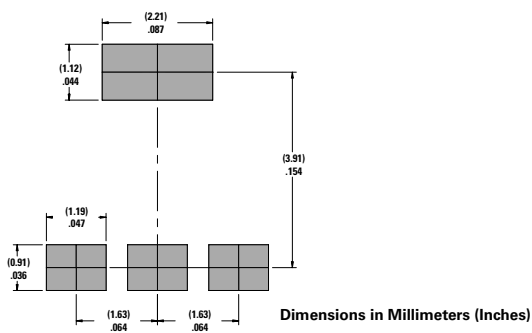
# Sx02xSx EV Series

## EV Series 1.5 Amp Sensitive SCRs

### Dimensions – SOT-89



Pad Layout for 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

### 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

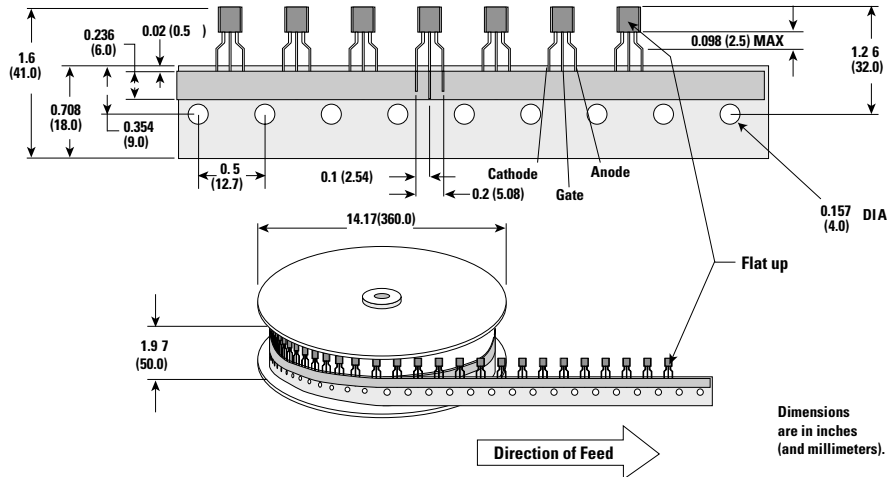
Part Number	Marking	Weight	Packing Mode	Base Quantity
Sx02ESy	Sx02ESy	0.217 g	Bulk	2500
Sx02ESyAP	Sx02ESy	0.217 g	Ammo Pack	2000
Sx02ESyRP	Sx02ESy	0.217 g	Tape & Reel	2000
Sx02TSyRP	Sx02TSy	0.120 g	Tape & Reel	1000
Sx02BSyRP	x02y	0.053 g	Tape & Reel	1000
Sx02BSyRP1	x02y	0.053 g	Tape & Reel	1000

# Sx02xSx EV Series

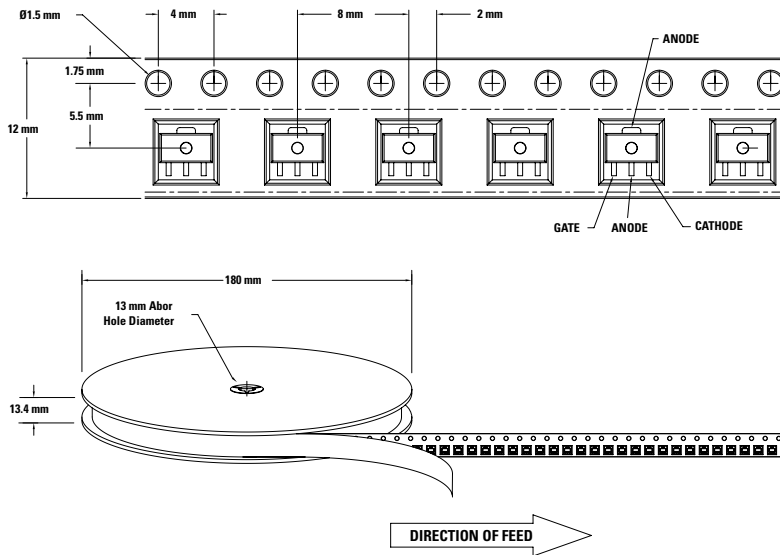
## EV Series 1.5 Amp Sensitive SCRs

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

Meets all EIA-468-C Standards



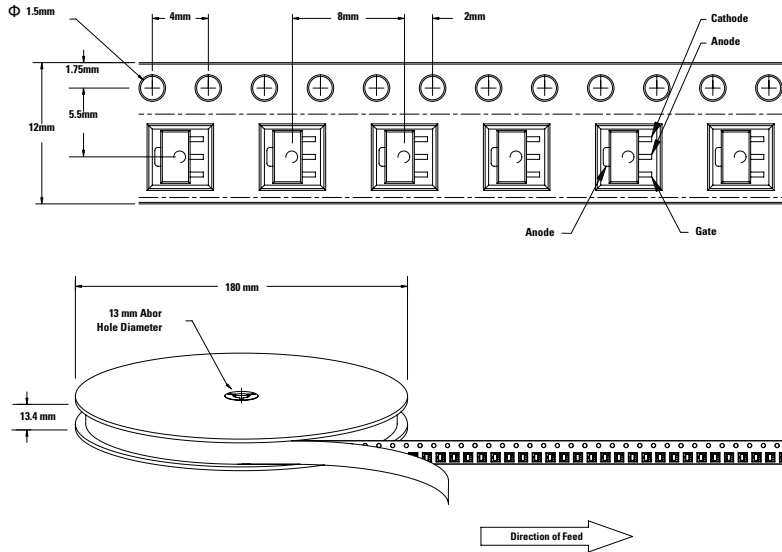
### SOT-89 Reel Pack (RP) Specifications



# Sx02xSx EV Series

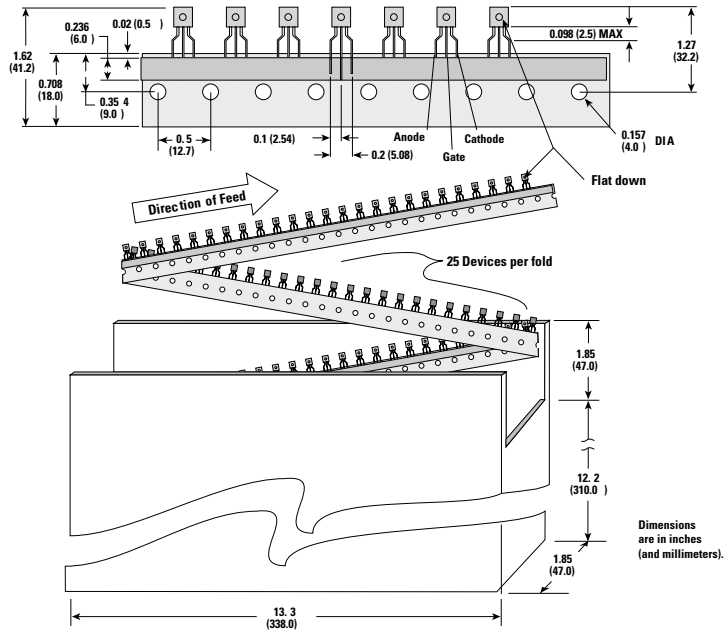
## EV Series 1.5 Amp Sensitive SCRs

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



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

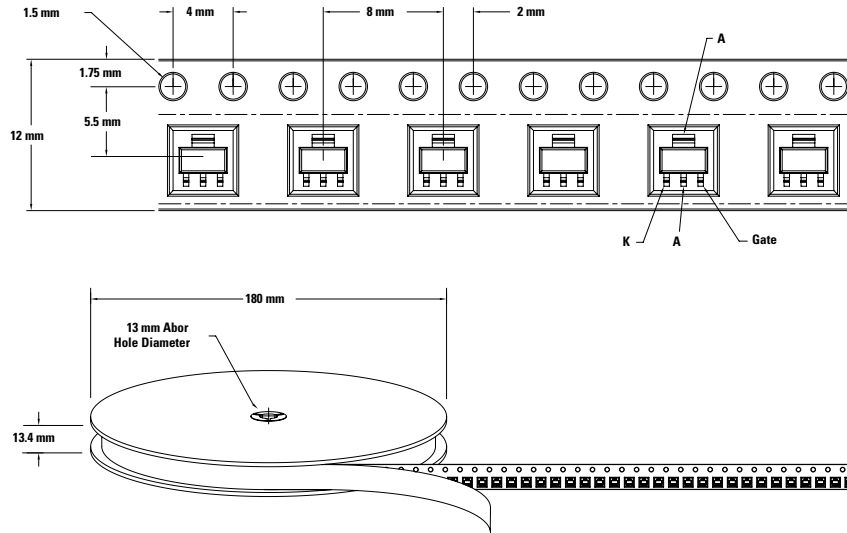
Meets all EIA-468-C Standards



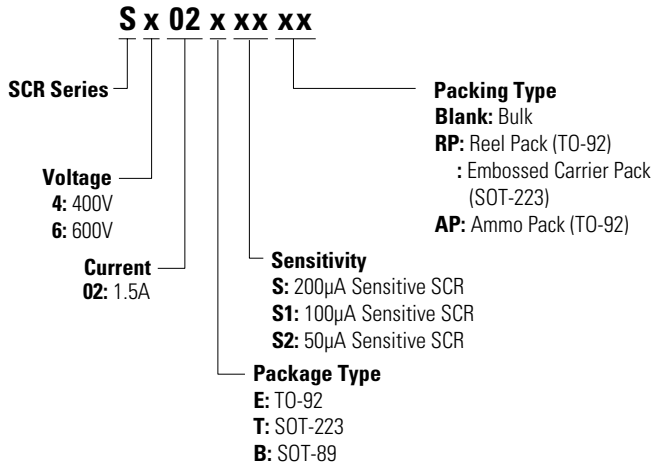
# Sx02xSx EV Series

## EV Series 1.5 Amp Sensitive SCRs

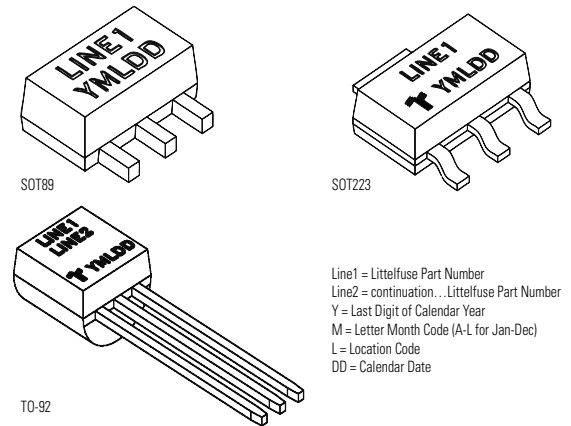
### SOT-223 Reel Pack (RP) Specifications



### Part Numbering System




### Part Marking System



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