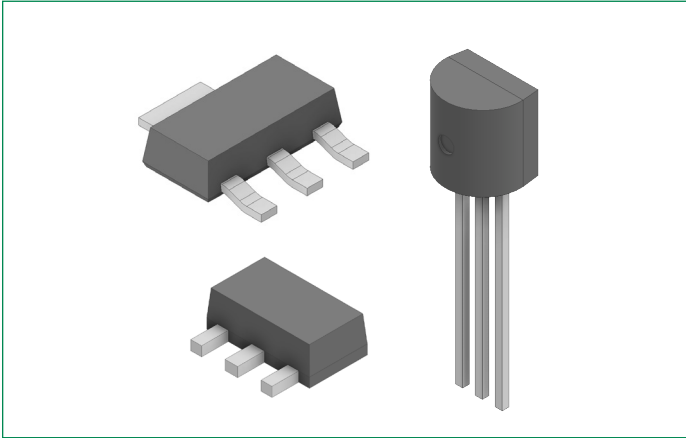


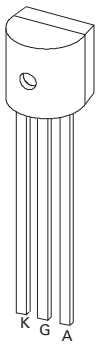
# Sx02xSx EV Series

## 1.5 A Sensitive SCRs

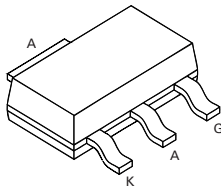
**HF** **RoHS**


### Pinout Diagram

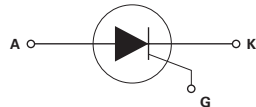
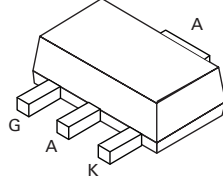
TO-92



SOT-223



SOT-89



**A:** Anode; **K:** Cathode; **G:** Gate

### Description:

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

### Features:

- RoHS compliant and halogen-free
- Through-hole and surface mount packages
- Blocking voltage ( $V_{DRM}$  /  $V_{RRM}$ ) capability up to 600 V
- High  $dv/dt$  noise immunity
- Surge current capability > 15 A
- Improved turn-off time ( $t_q$ ) < 35  $\mu$ s
- Sensitive gate for direct microprocessor interface

### Applications:

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

### Product Summary

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

## Maximum Ratings

Symbol	Characteristics	Conditions		Value	Units	
$I_{T(RMS)}$	On-state RMS Current	Full sine wave	TO-92	$T_C = 65\text{ }^\circ\text{C}$	1.5	A
			SOT-89	$T_C = 80\text{ }^\circ\text{C}$		
			SOT-223	$T_C = 95\text{ }^\circ\text{C}$		
$I_{T(AV)}$	Average On-state Current	TO-92		$T_C = 65\text{ }^\circ\text{C}$	0.95	A
		SOT-89		$T_C = 80\text{ }^\circ\text{C}$		
		SOT-223		$T_L = 95\text{ }^\circ\text{C}$		
$I_{TSM}$	Non-repetitive Surge Peak On-state Current	TO-92 SOT-89 SOT-223	f = 50 Hz	$T_{vj}$ initial = $25\text{ }^\circ\text{C}$ , Single cycle	12.5	A
			f = 60 Hz		15	
$I^2t$	$I^2t$ Value for Fusing	$t_p = 10\text{ ms}$		f = 50 Hz	0.78	A <sup>2</sup> s
		$t_p = 8.3\text{ ms}$		f = 60 Hz	0.93	
di/dt	Critical Rate of Rise of On-state Current	TO-92 SOT-89 SOT-223		$I_G = 10\text{ mA}$ , $T_{vj} = 125\text{ }^\circ\text{C}$	50	A/ $\mu\text{s}$
$I_{GM}$	Peak Gate Current	$t_p = 10\text{ }\mu\text{s}$		$T_{vj} = 125\text{ }^\circ\text{C}$	1	A
$P_{G(AV)}$	Average Gate Power Dissipation	$T_{vj} = 125\text{ }^\circ\text{C}$			0.1	W
$T_{stg}$	Storage Temperature Range	-			-40 to 150	$^\circ\text{C}$
$T_{vj}$	Virtual Junction Temperature Range	-			-40 to 125	$^\circ\text{C}$

## Electrical Characteristics ( $T_{vj} = 25\text{ }^\circ\text{C}$ , unless otherwise specified)

Symbol	Characteristics	Conditions	Sx02xS		Sx02xS1		Sx02xS2		Units
			Min.	Max.	Min.	Max.	Min.	Max.	
$I_{GT}$	DC Gate Trigger Current	$V_D = 12\text{ V}$ , $R_L = 60\text{ }\Omega$	15	200	15	100	15	50	$\mu\text{A}$
$V_{GT}$	DC Gate Trigger Voltage	$V_D = 12\text{ V}$ , $R_L = 60\text{ }\Omega$	-	0.8	-	0.8	-	0.8	V
$V_{GRM}$	Peak Reverse Gate Voltage	$I_{RG} = 10\text{ }\mu\text{A}$	5	-	5	-	5	-	V
$V_{GD}$	Gate Non-trigger Voltage	$V_D = V_{DRM}$ , $T_{vj} = 125\text{ }^\circ\text{C}$ , $R_L = 3.3\text{ k}\Omega$							V
$I_H$	Holding Current	$R_{GK} = 1\text{ k}\Omega$	-	5	-	3	-	3	mA
$(dv/dt)_{cr}$	Critical Rate-of-rise of Off-stage Voltage	$T_{vj} = 125\text{ }^\circ\text{C}$ , $V_D = V_{DRM}/V_{RRM}$ , Exp. Waveform, $R_{GK} = 1\text{ k}\Omega$	25	-	25	-	25	-	V/ $\mu\text{s}$
$t_q$	Turn-off Time	$T_{vj} = 125\text{ }^\circ\text{C}$ @ 600 V, $R_{GK} = 1\text{ k}\Omega$	-	35	-	35	-	35	$\mu\text{s}$
$t_{gt}$	Turn-on Time	$I_G = 10\text{ mA}$ , $P_W = 15\text{ }\mu\text{s}$ , $I_T = 3.0\text{ A}_{pk}$	-	3	-	3	-	3	$\mu\text{s}$

Note: x0 = voltage/10

**Static Characteristics** ( $T_{vj} = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified)

Symbol	Characteristics	Conditions	Value		Units
			Min.	Max.	
$V_{TM}$	Peak On-state Voltage	$I_T = 3.0A_{pk}$	–	1.70	V
$I_{DRM}$	Off-state Current, Peak Repetitive	$T_{vj} = 25\text{ }^{\circ}\text{C} @ V_D = V_{DRM}, R_{GK} = 1\text{ k}\Omega$	–	5	$\mu\text{A}$
		$T_{vj} = 125\text{ }^{\circ}\text{C} @ V_D = V_{DRM}, R_{GK} = 1\text{ k}\Omega$	–	500	

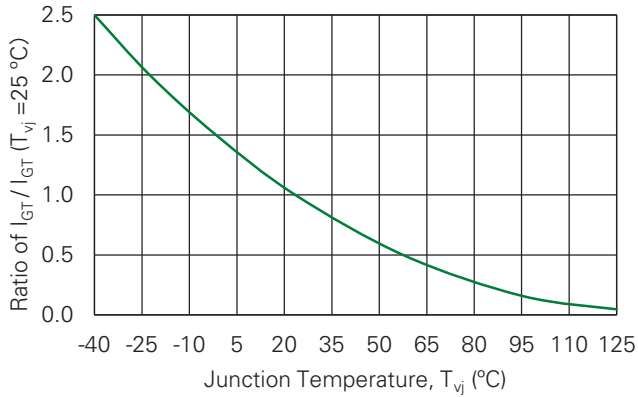
**Thermal Characteristics**

Symbol	Characteristics	Conditions	Value	Units	
$R_{thJC}$	Thermal Resistance, Junction to Case (AC)	$I_T = 1.5 A_{(RMS)}^1$	TO-92	50	K/W
			SOT-89	35	
			SOT-223	25	
$R_{thJA}$	Thermal Resistance, Junction to Ambient	$I_T = 1.5 A_{(RMS)}^1$	TO-92	160	K/W
			SOT-89	90	
			SOT-223	60	

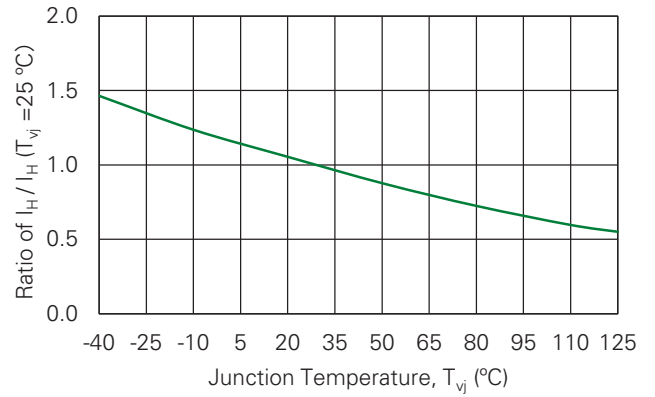
**Note 1:** 60 Hz AC resistive load condition, 100% conduction

**Characteristic Curves**

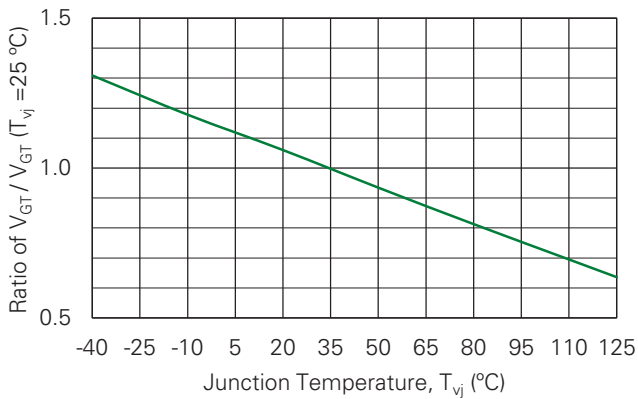
**Fig. 1. Normalized DC Gate Trigger Current vs. Junction Temperature**



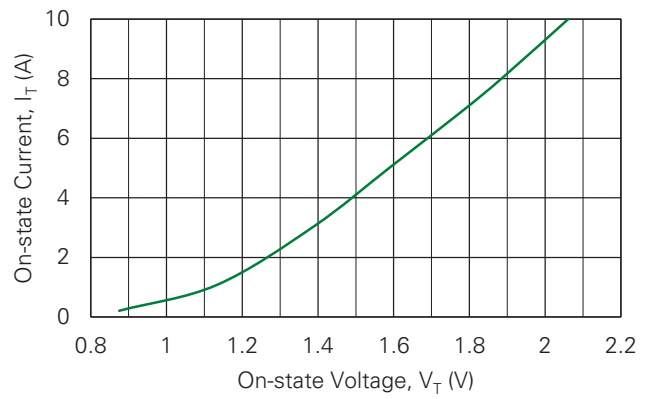
**Fig. 2. Normalized DC Holding Current vs. Junction Temperature**



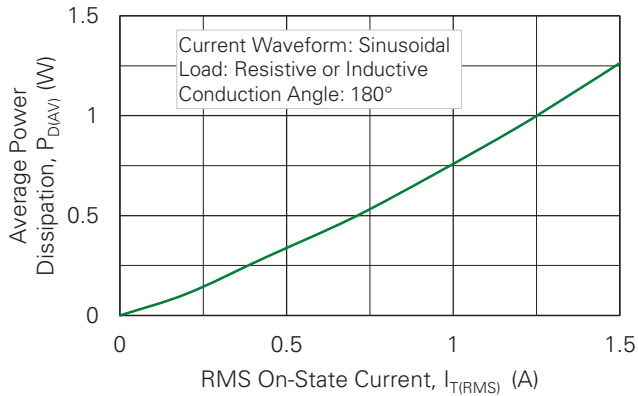
**Fig. 3. Normalized DC Gate Trigger Voltage vs. Junction Temperature**



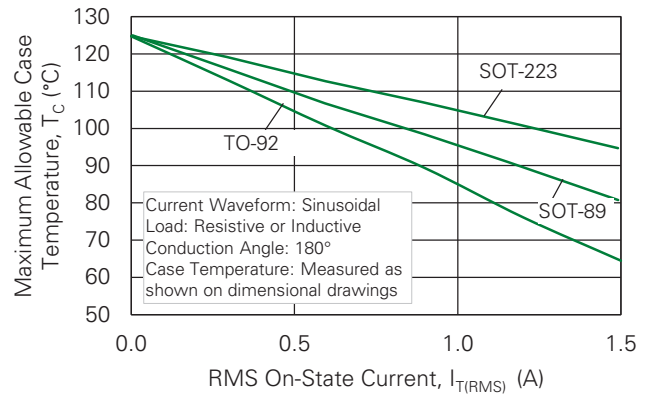
**Fig. 4. Typical On-state Current vs. On-state Voltage**



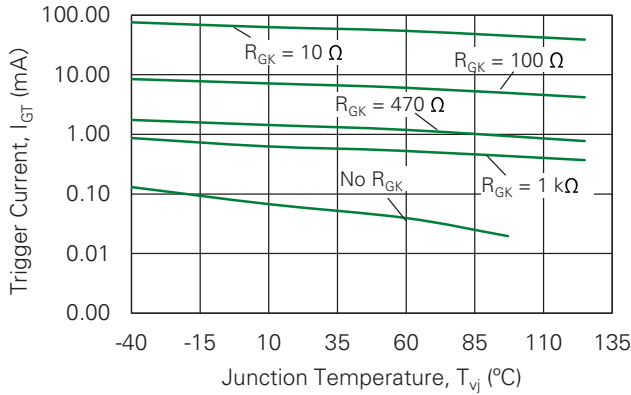
**Fig. 5. Typical Power Dissipation vs. RMS On-state Current**



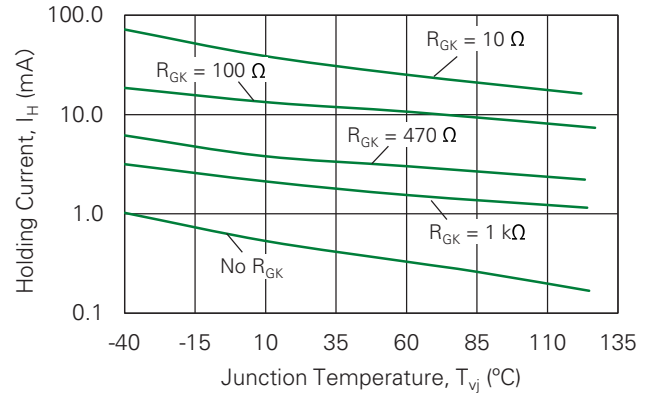
**Fig. 6. Maximum Allowable Case Temperature vs. On-state Current**



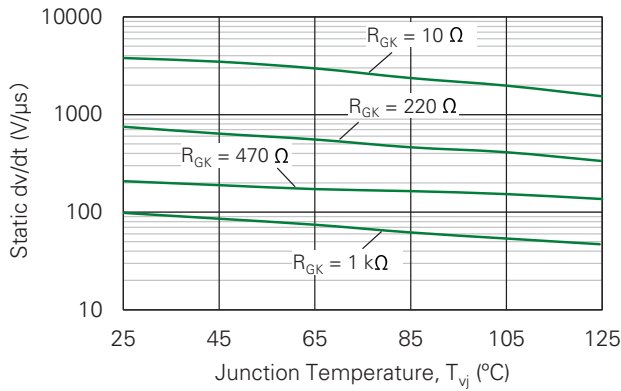
**Fig. 7. Typical DC Gate Trigger Current with  $R_{GK}$  vs. Junction Temperature for Sx02xS**



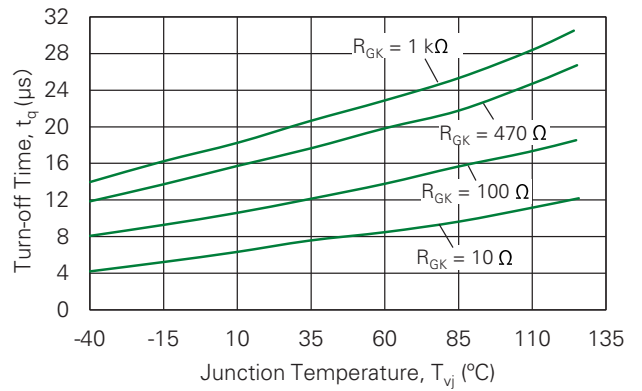
**Fig. 8. Typical DC Holding Current with  $R_{GK}$  vs. Junction Temperature for Sx02xS**



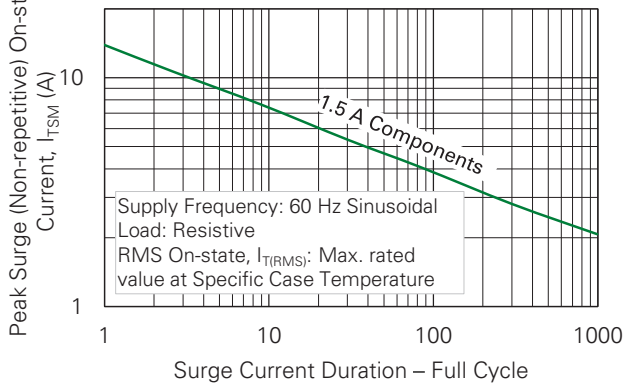
**Fig. 9. Typical Static dv/dt with  $R_{GK}$  vs. Junction Temperature for Sx02xS**



**Fig. 10. Typical Turn-off Time with  $R_{GK}$  vs. Junction Temperature for Sx02xS**



**Fig. 11. Surge Peak On-state Current vs. Number of Cycles**



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.

## Soldering Parameters

Characteristic		Value
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 – 120 secs
Average ramp up rate (Liquidus Temp)( $T_L$ ) to peak		3°C/second max
$T_{s(max)}$ to $T_L$ - Ramp-up Rate		5°C/second max
Reflow	Temperature ( $T_L$ ) (Liquidus)	217°C
	Time ( $t_L$ )	60 – 150 seconds
Peak Temperature ( $T_p$ )		260 <sup>+0/-5</sup> °C
Time within 5°C of actual peak Temperature ( $t_p$ )		30 seconds
Ramp-down Rate		6°C/second max
Time 25°C to peak Temperature ( $T_p$ )		8 minutes max
Do Not Exceed		260°C

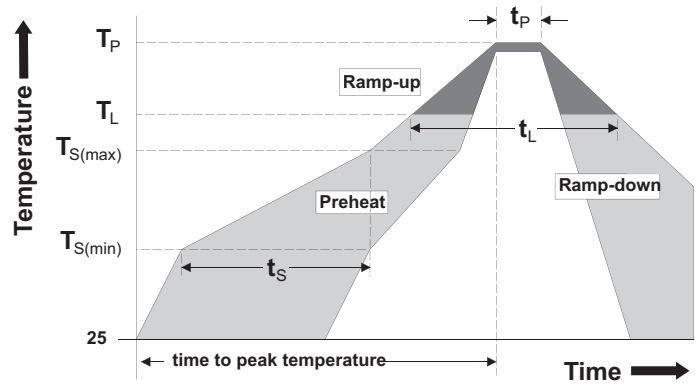
## Environmental Specifications

Test	Specifications and Conditions
AC Blocking	MIL-STD-750, M-1040, Cond A Applied Peak AC voltage @ 125 °C for 1008 hours
Temperature/Humidity	EIA / JEDEC, JESD22-A101, 1008 hours; 160 V - DC: 85 °C; 85 % relative humidity
Temperature Cycling	MIL-STD-750, M-1051, 100 cycles; -40 °C to +150 °C; 15-min dwell-time
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

## Product Selector

Part Number	Voltage		Gate Sensitivity	Package
	400 V	600 V		
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



## Physical Specifications

Characteristic	Value
Terminal Finish	100% Matte Tin-plated
Body Material	UL Recognized compound meeting flammability rating V-0
Lead Material	Copper Alloy

## Design Considerations

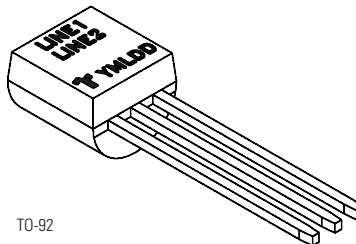
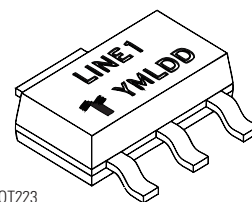
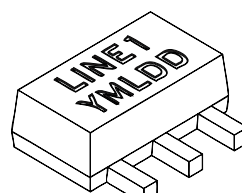
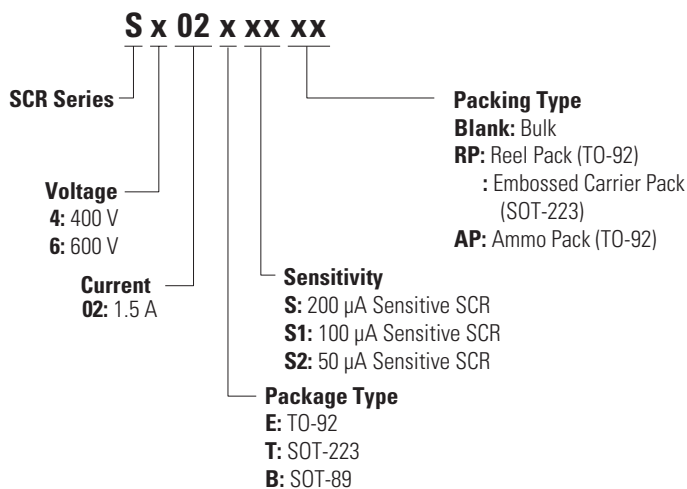
Careful selection of the correct component for the application's operating parameters and environment will go a long way toward extending the operating life of the Thyristor. Good design practice should limit the maximum continuous current through the main terminals to 75% of the component rating. Other 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.

## 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

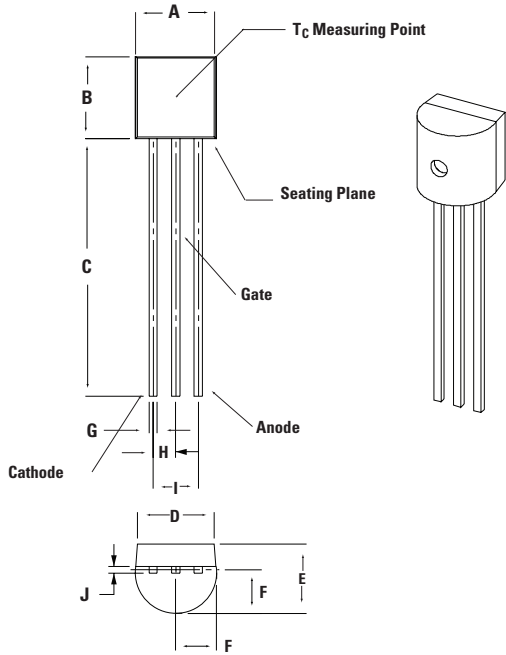
Note: x = voltage/100, y = gate sensitivity

## Part Numbering and Marking



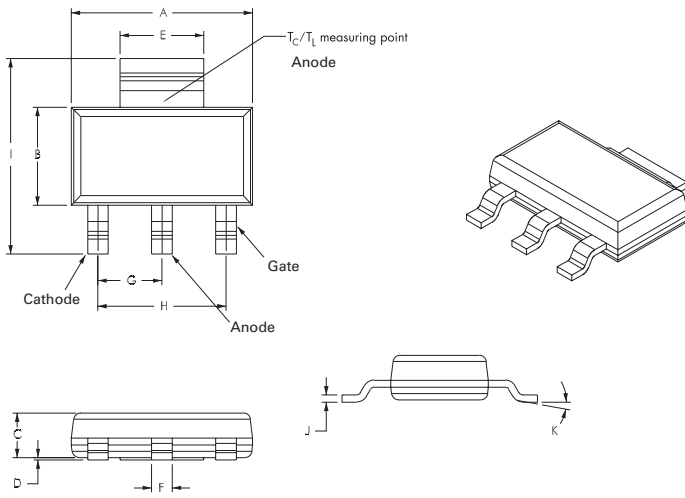
Line1 = Littelfuse Part Number  
 Line2 = continuation... Littelfuse Part Number  
 Y = Last Digit of Calendar Year  
 M = Letter Month Code (A-L for Jan-Dec)  
 L = Location Code  
 DD = Calendar Date

**Package Dimensions** TO-92

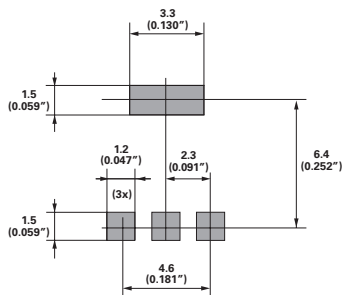


Symbol	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	4.450	5.200	0.175	0.205
B	4.320	5.330	0.170	0.210
C	12.70	–	0.500	–
D	3.430	–	0.135	–
E	3.180	4.190	0.125	0.165
F	2.040	2.660	0.080	0.105
G	0.407	0.533	0.016	0.021
H	1.150	1.390	0.045	0.055
I	2.420	2.660	0.095	0.105
J	0.380	0.500	0.015	0.020

**Package Dimensions** SOT-223



Pad Layout for SOT-223

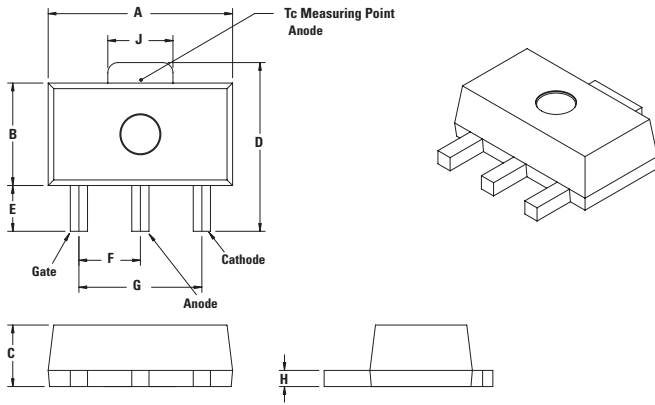


Dimensions in Millimeters (Inches)

Symbol	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	6.30	6.50	6.71	0.248	0.256	0.264
B	3.30	3.50	3.70	0.130	0.138	0.146
C	–	–	1.80	–	–	1.071
D	0.02	–	0.13	0.001	–	0.005
E	2.90	3.00	3.15	0.114	0.118	0.124
F	0.60	0.70	0.85	0.024	0.027	0.034
G	–	2.30	–	–	0.090	–
H	–	4.60	–	–	0.181	–
I	6.70	7.00	7.30	0.264	0.276	0.287
J	0.23	0.26	0.35	0.009	0.010	0.014
K	10° MAX.					

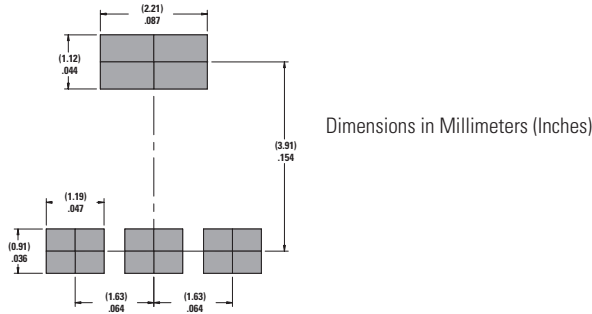


**Package Dimensions** SOT-89



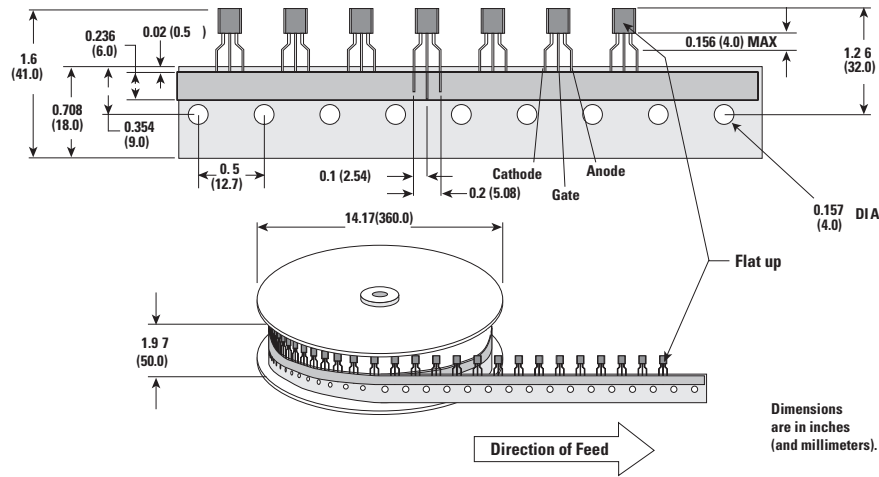
Symbol	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max
A	4.40	–	4.60	0.173	–	0.181
B	2.29	–	2.60	0.090	–	0.102
C	1.40	–	1.60	0.055	–	0.063
D	3.94	–	4.25	0.155	–	0.167
E	0.81	–	1.20	0.032	–	0.047
F	–	1.5	–	–	0.059	–
G	–	3	–	–	0.118	–
H	0.35	–	0.44	0.014	–	0.017
I	0.36	–	0.48	0.014	–	0.019
J	–	1.69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

Pad Layout for SOT-89



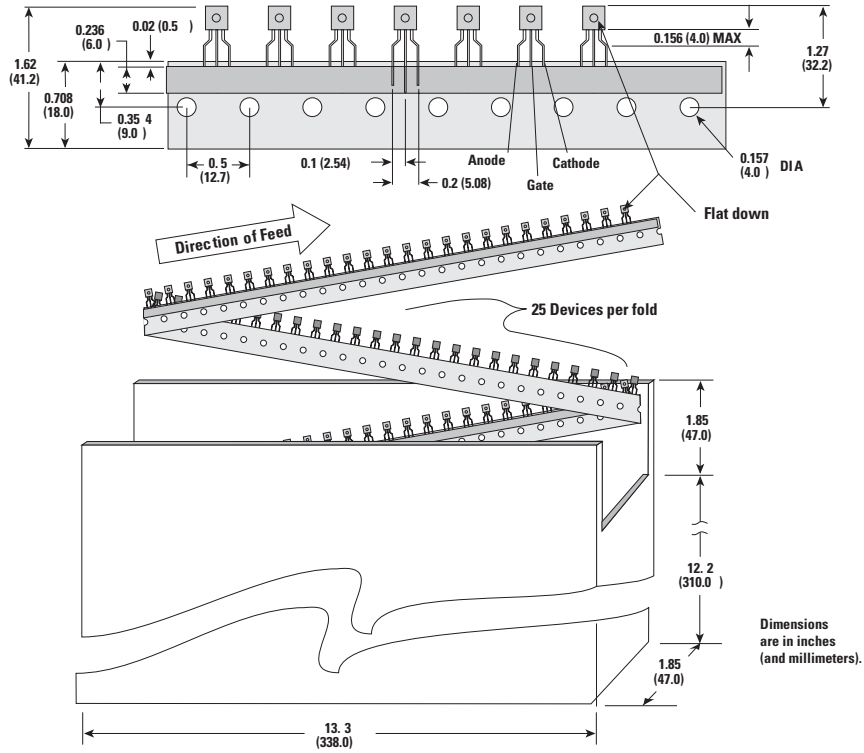
**TO-92 (3-lead) Reel Pack (RP) Radial Leaded Specifications**

Meets all EIA-468-C Standards

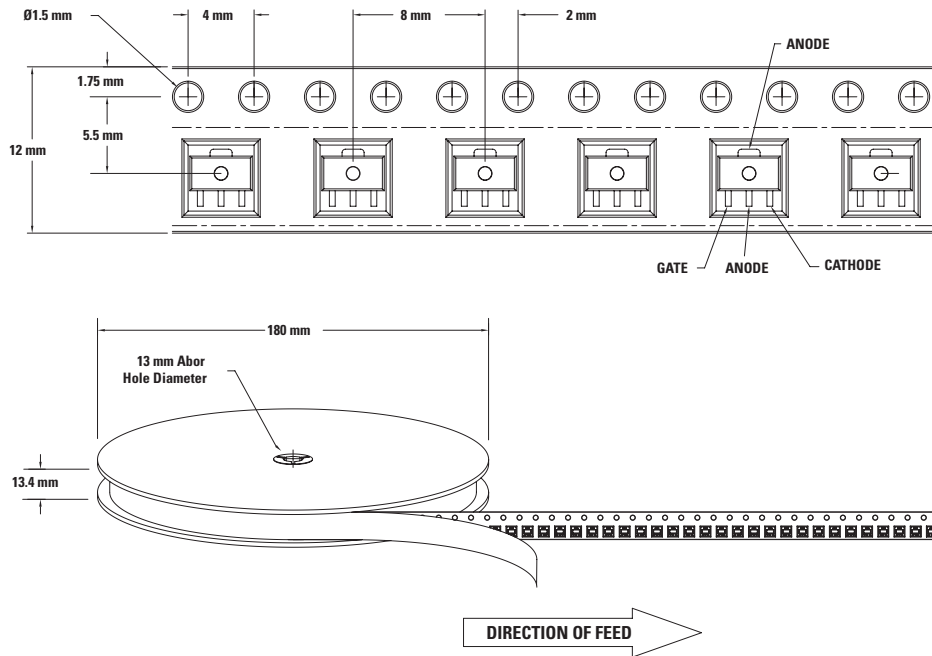


### TO-92 (3-lead) Ammo Pack (AP) Radial Leaded Specifications

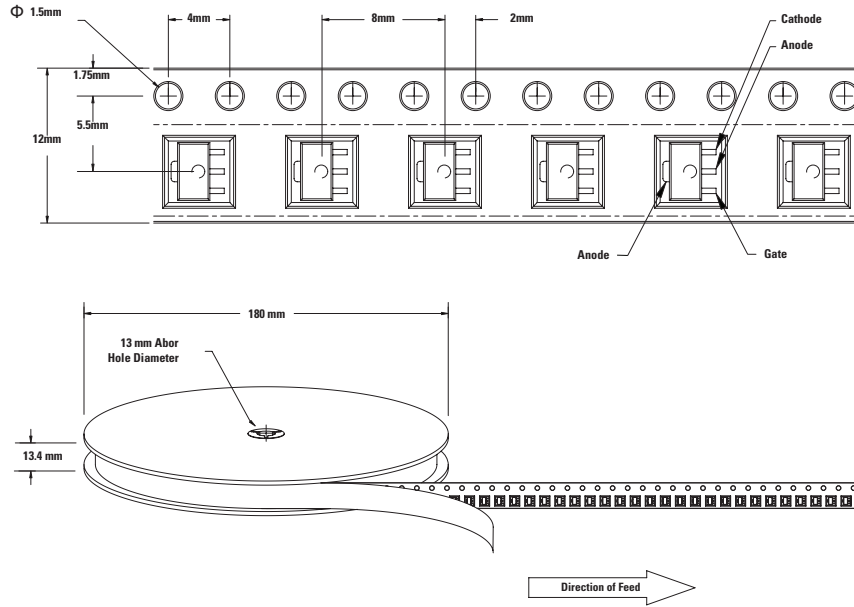
Meets all EIA-468-C Standards



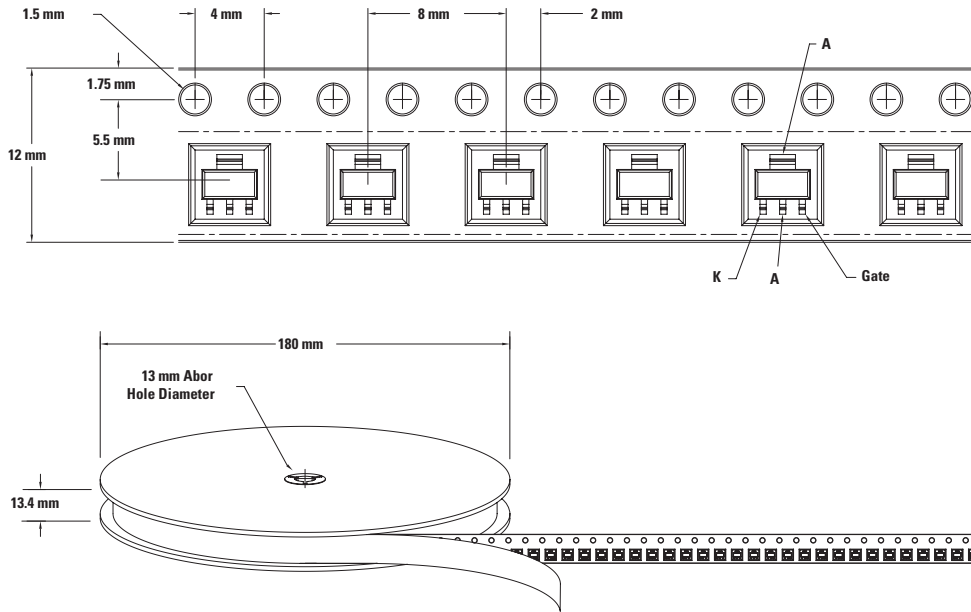
### SOT-89 Reel Pack (RP) Specifications



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



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



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