

**RoHS Sxx15x & Sxx16x Series**



**Description**

Excellent unidirectional switches for phase control applications such as heating and motor speed controls. Standard phase control SCRs are triggered with few milliamperes of current at less than 1.5V potential.

**Features & Benefits**

- RoHS compliant
- Glass – passivated junctions
- Voltage capability up to 1000 V
- Surge capability up to 225 A

**Applications**

Typical applications are capacitive discharge systems for strobe lights, nailers, staplers and gas engine ignition. Also controls for power tools, home/brown goods and white goods appliances.

Internally constructed isolated packages are offered for ease of heat sinking with highest isolation voltage.

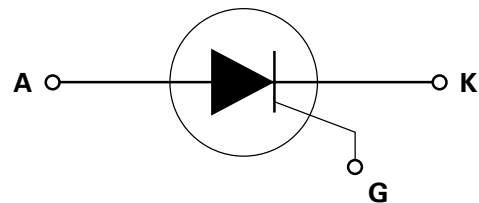
**Agency Approval**

| Agency | Agency File Number |
|--------|--------------------|
|        | L Package: E71639  |

**Main Features**

| Symbol            | Value       | Unit |
|-------------------|-------------|------|
| $I_{T(RMS)}$      | 15 & 16     | A    |
| $V_{DRM}/V_{RRM}$ | 400 to 1000 | V    |
| $I_{GT}$          | 30          | mA   |

**Schematic Symbol**



**Absolute Maximum Ratings – Standard SCRs**

| Symbol       | Parameter                                 | Test Conditions  |                           | Value      | Unit                   |
|--------------|---|--|---------------------------|------------|------------------------|
|              |   | Symbol   | Temperature               |            |                        |
| $I_{T(RMS)}$ | RMS on-state current                      | Sxx15L   | $T_c = 90^\circ\text{C}$  | 15         | A                      |
|              |   | Sxx16R<br>Sxx16N   | $T_c = 110^\circ\text{C}$ | 16         |                        |
| $I_{T(AV)}$  | Average on-state current                  | Sxx15L   | $T_c = 90^\circ\text{C}$  | 9.5        | A                      |
|              |   | Sxx16R<br>Sxx16N   | $T_c = 110^\circ\text{C}$ | 10.0       |                        |
| $I_{TSM}$    | Peak non-repetitive surge current         | single half cycle; $f = 50\text{Hz}$ ;<br>$T_J$ (initial) = $25^\circ\text{C}$ |                           | 188        | A                      |
|              |   | single half cycle; $f = 60\text{Hz}$ ;<br>$T_J$ (initial) = $25^\circ\text{C}$ |                           | 225        |                        |
| $I^2t$       | $I^2t$ Value for fusing                   | $t_p = 8.3 \text{ ms}$   |                           | 210        | $\text{A}^2\text{s}$   |
| $di/dt$      | Critical rate of rise of on-state current | $f = 60 \text{ Hz}; T_J = 125^\circ\text{C}$                                   |                           | 125        | $\text{A}/\mu\text{s}$ |
| $I_{GM}$     | Peak gate current                         | $T_J = 125^\circ\text{C}$  |                           | 3          | A                      |
| $P_{G(AV)}$  | Average gate power dissipation            | $T_J = 125^\circ\text{C}$  |                           | 0.6        | W                      |
| $T_{stg}$    | Storage temperature range                 |  |                           | -40 to 150 | $^\circ\text{C}$       |
| $T_J$        | Operating junction temperature range      |  |                           | -40 to 125 | $^\circ\text{C}$       |

Note: xx = voltage

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

| Symbol          | Test Conditions  | Value  |        | Unit |      |
|-----------------|--|--------|--------|------|------|
|                 |  | Sxx15x | Sxx16x |      |      |
| I <sub>GT</sub> | V <sub>D</sub> = 12V; R <sub>L</sub> = 60 Ω                                      |        | MAX.   | 30   | mA   |
|                 |  |        | MIN.   | 1    |      |
| V <sub>GT</sub> |  |        | MAX.   | 1.5  | V    |
| dv/dt           | V <sub>D</sub> = V <sub>DRM</sub> ; gate open; T <sub>J</sub> = 100°C            | 400V   | MIN.   | 450  | V/μs |
|                 |  | 600V   |        | 425  |      |
|                 |  | 800V   |        | 400  |      |
|                 | 1000V  | 200    |        |      |      |
|                 | V <sub>D</sub> = V <sub>DRM</sub> ; gate open; T <sub>J</sub> = 125°C            | 400V   |        | 350  |      |
|                 |  | 600V   |        | 325  |      |
| 800V            |  | 300    |        |      |      |
| V <sub>GD</sub> | V <sub>D</sub> = V <sub>DRM</sub> R <sub>L</sub> = 3.3 kΩ T <sub>J</sub> = 110°C |        | MIN.   | 0.2  | V    |
| I <sub>H</sub>  | I <sub>T</sub> = 200mA (initial)   |        | MAX.   | 40   | mA   |
| t <sub>q</sub>  | I <sub>T</sub> =2A; t <sub>p</sub> =50μs; dv/dt=5V/μs; di/dt=-30A/μs             |        | MAX.   | 35   | μs   |
| t <sub>gt</sub> | I <sub>G</sub> = 2 × I <sub>GT</sub> PW = 15μs I <sub>T</sub> = 12A              |        | TYP.   | 2    | μs   |

Note: xx = voltage, x = package

(1) I<sub>T</sub>=2A; t<sub>p</sub>=50μs; dv/dt=5V/μs; di/dt=-30A/μs

**Static Characteristics**

| Symbol                              | Test Conditions  |                        | Value       | Unit |      |    |
|-------------------------------------|--|------------------------|-------------|------|------|----|
| V <sub>TM</sub>                     | 15A Device I <sub>T</sub> = 30A; t <sub>p</sub> = 380 μs |                        | MAX.        | 1.6  | V    |    |
|                                     | 16A Device I <sub>T</sub> = 32A; t <sub>p</sub> = 380 μs |                        |             |      |      |    |
| I <sub>DRM</sub> / I <sub>RRM</sub> | V <sub>DRM</sub> = V <sub>RRM</sub>                      | T <sub>J</sub> = 25°C  | 400 - 600V  | MAX. | 10   | μA |
|                                     |  |                        | 800 - 1000V |      | 20   |    |
|                                     |  | T <sub>J</sub> = 100°C | 400 - 600V  |      | 500  |    |
|                                     |  |                        | 800V        |      | 1000 |    |
|                                     |  |                        | 1000V       |      | 3000 |    |
|                                     |  | T <sub>J</sub> = 125°C | 400 - 600V  |      | 1000 |    |
|                                     |  |                        | 800V        |      | 2000 |    |

**Thermal Resistances**

| Symbol              | Parameter             | Value          | Unit |      |
|---------------------|-----------------------|----------------|------|------|
| R <sub>θ(J-C)</sub> | Junction to case (AC) | Sxx16R/ Sxx16N | 1.1  | °C/W |
|                     |                       | Sxx15L         | 2.5  |      |
| R <sub>θ(J-A)</sub> | Junction to ambient   | Sxx16R         | 40   | °C/W |
|                     |                       | Sxx15L         | 50   |      |

Note: xx = voltage

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



**Figure 2: Normalized DC Gate Trigger Voltage vs. Junction Temperature**



**Figure 3: Normalized DC Holding Current 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. RMS On-State Current**



Figure 7: Maximum Allowable Case Temperature vs. Average On-State Current

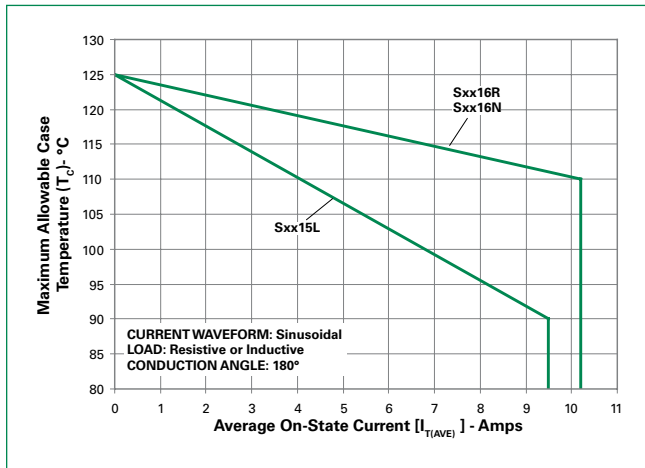
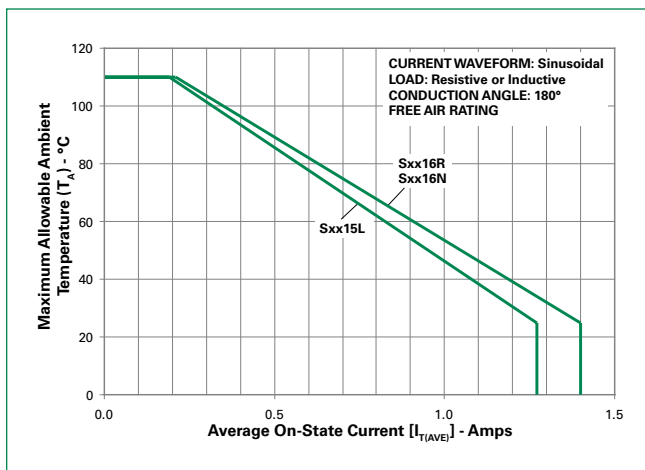


Figure 8: Maximum Allowable Ambient Temperature vs. RMS On-State Current



Figure 9: Maximum Allowable Ambient Temperature vs. Average On-State Current



Note: xx = voltage

Figure 10: Peak Capacitor Discharge Current

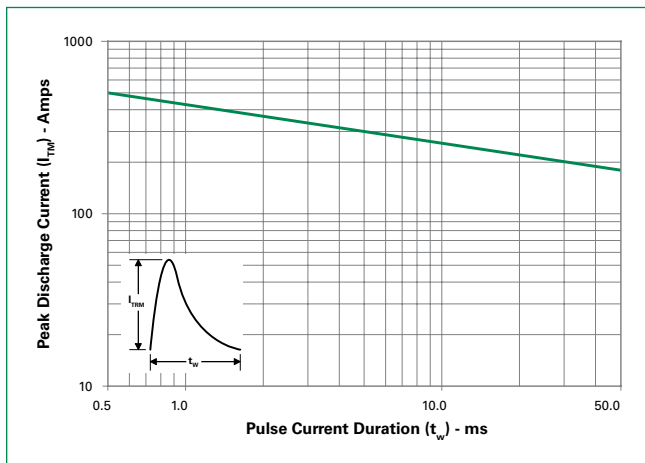
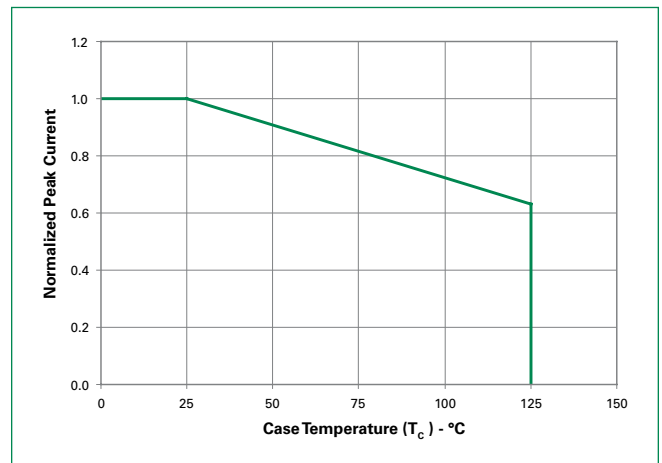


Figure 11: Peak Capacitor Discharge Current Derating



**Figure 12: Surge Peak On-State Current vs. Number of Cycles**



**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                   |
|  | - Temperature ( $t_L$ )            | 60 – 150 seconds        |
| Peak Temperature ( $T_p$ )                             |                                    | 260 <sup>+0/-5</sup> °C |
| Time within 5°C of actual peak Temperature ( $t_p$ )   |                                    | 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

|                        |   |
|------------------------|---|
| <b>Terminal Finish</b> | 100% Matte Tin-plated   |
| <b>Body Material</b>   | UL recognized epoxy meeting flammability classification 94V-0 |
| <b>Lead Material</b>   | Copper Alloy  |

### Design Considerations

Careful selection of the correct device 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 device 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; 320V - DC: 85°C; 85% rel humidity  |
| <b>High Temp Storage</b>         | MIL-STD-750, M-1031, 1008 hours; 150°C  |
| <b>Low-Temp Storage</b>          | 1008 hours; -40°C   |
| <b>Thermal Shock</b>             | MIL-STD-750, M-1056 10 cycles; 0°C to 100°C; 5-min dwell-time at each temperature; 10 sec (max) transfer time between temperature |
| <b>Autoclave</b>                 | EIA / JEDEC, JESD22-A102 168 hours (121°C at 2 ATMs) and 100% R/H   |
| <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  |

### Dimensions — TO-220AB (R-Package) — Non-Isolated Mounting Tab Common with Center Lead



| Dimension | Inches |       | Millimeters |       |
|-----------|--------|-------|-------------|-------|
|           | Min    | Max   | Min         | Max   |
| A         | 0.380  | 0.420 | 9.65        | 10.67 |
| B         | 0.105  | 0.115 | 2.67        | 2.92  |
| C         | 0.230  | 0.250 | 5.84        | 6.35  |
| D         | 0.590  | 0.620 | 14.99       | 15.75 |
| E         | 0.142  | 0.147 | 3.61        | 3.73  |
| F         | 0.110  | 0.130 | 2.79        | 3.30  |
| G         | 0.540  | 0.575 | 13.72       | 14.61 |
| H         | 0.025  | 0.035 | 0.64        | 0.89  |
| J         | 0.195  | 0.205 | 4.95        | 5.21  |
| K         | 0.095  | 0.105 | 2.41        | 2.67  |
| L         | 0.060  | 0.075 | 1.52        | 1.91  |
| M         | 0.085  | 0.095 | 2.16        | 2.41  |
| N         | 0.018  | 0.024 | 0.46        | 0.61  |
| O         | 0.178  | 0.188 | 4.52        | 4.78  |
| P         | 0.045  | 0.060 | 1.14        | 1.52  |
| R         | 0.038  | 0.048 | 0.97        | 1.22  |

**Dimensions — TO-220AB (L-Package) — Isolated Mounting Tab**



| Dimension | Inches |       | Millimeters |       |
|-----------|--------|-------|-------------|-------|
|           | Min    | Max   | Min         | Max   |
| A         | 0.380  | 0.420 | 9.65        | 10.67 |
| B         | 0.105  | 0.115 | 2.67        | 2.92  |
| C         | 0.230  | 0.250 | 5.84        | 6.35  |
| D         | 0.590  | 0.620 | 14.99       | 15.75 |
| E         | 0.142  | 0.147 | 3.61        | 3.73  |
| F         | 0.110  | 0.130 | 2.79        | 3.30  |
| G         | 0.540  | 0.575 | 13.72       | 14.61 |
| H         | 0.025  | 0.035 | 0.64        | 0.89  |
| J         | 0.195  | 0.205 | 4.95        | 5.21  |
| K         | 0.095  | 0.105 | 2.41        | 2.67  |
| L         | 0.060  | 0.075 | 1.52        | 1.91  |
| M         | 0.085  | 0.095 | 2.16        | 2.41  |
| N         | 0.018  | 0.024 | 0.46        | 0.61  |
| O         | 0.178  | 0.188 | 4.52        | 4.78  |
| P         | 0.045  | 0.060 | 1.14        | 1.52  |
| R         | 0.038  | 0.048 | 0.97        | 1.22  |

**Dimensions — TO- 263AA (N-package) — D<sup>2</sup>-Pak Surface Mount**



| Dimension | Inches |       | Millimeters |       |
|-----------|--------|-------|-------------|-------|
|           | Min    | Max   | Min         | Max   |
| A         | 0.360  | 0.370 | 9.14        | 9.40  |
| B         | 0.380  | 0.420 | 9.65        | 10.67 |
| C         | 0.178  | 0.188 | 4.52        | 4.78  |
| D         | 0.025  | 0.035 | 0.64        | 0.89  |
| E         | 0.045  | 0.060 | 1.14        | 1.52  |
| F         | 0.060  | 0.075 | 1.52        | 1.91  |
| G         | 0.095  | 0.105 | 2.41        | 2.67  |
| H         | 0.092  | 0.102 | 2.34        | 2.59  |
| J         | 0.018  | 0.024 | 0.46        | 0.61  |
| K         | 0.090  | 0.110 | 2.29        | 2.79  |
| S         | 0.590  | 0.625 | 14.99       | 15.88 |
| V         | 0.035  | 0.045 | 0.89        | 1.14  |
| U         | 0.002  | 0.010 | 0.05        | 0.25  |
| W         | 0.040  | 0.070 | 1.02        | 1.78  |

### Product Selector

| Part Number | Voltage |      |      |       | Gate Sensitivity | Type         | Package |
|-------------|---------|------|------|-------|------------------|--------------|---------|
|             | 400V    | 600V | 800V | 1000V |                  |              |         |
| Sxx15L      | X       | X    | X    | X     | 30mA             | Standard SCR | TO-220L |
| Sxx16R      | X       | X    | X    | X     | 30mA             | Standard SCR | TO-220R |
| Sxx16N      | X       | X    | X    | X     | 30mA             | Standard SCR | TO-263  |

Note: xx = Voltage

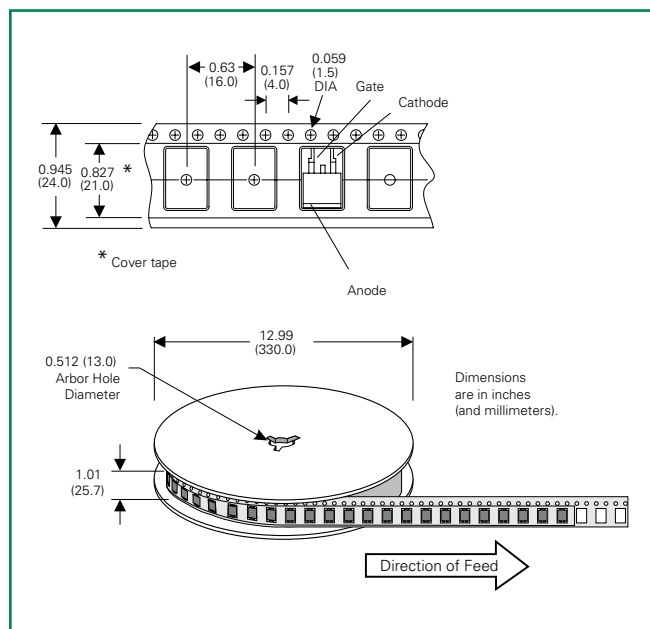
### Packing Options

| Part Number | Marking | Weight | Packing Mode     | Base Quantity     |
|-------------|---------|--------|------------------|-------------------|
| Sxx15L      | Sxx15L  | 2.2 g  | Bulk             | 500               |
| Sxx15LTP    | Sxx15L  | 2.2 g  | Tube             | 500 (50 per tube) |
| Sxx16R      | Sxx16R  | 2.2 g  | Bulk             | 500               |
| Sxx16RTP    | Sxx16R  | 2.2 g  | Tube             | 500 (50 per tube) |
| Sxx16NTP    | Sxx16N  | 1.6 g  | Tube             | 500 (50 per tube) |
| Sxx16NRP    | Sxx16N  | 1.6 g  | Embossed Carrier | 500               |

Note: xx = Voltage

### TO-263 Embossed Carrier Reel Pack (RP) Specs

#### Meets all EIA-481-2 Standards



### Part Marking System



### Part Numbering System







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