

RoHS Sxx10xSx & Sxx10x Series



Description

Excellent unidirectional switches for phase control and general switching applications such as heating and motor speed controls.

Sensitive gate SCRs are easily triggered with microAmps of current as furnished by sense coils, proximity switches, and microprocessors.

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 100 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 |
|--------|--------------------------|
| | TO-220L Package : E71639 |

Main Features

| Symbol | Value | Unit |
|-------------------|-------------|------|
| $I_{T(RMS)}$ | 10 | A |
| V_{DRM}/V_{RRM} | 400 to 1000 | V |
| I_{GT} | 0.2 to 15 | mA |

Schematic Symbol



Absolute Maximum Ratings – Sensitive SCRs

| Symbol | Parameter | Test Conditions | | Value | Unit |
|--------------|---|--|--------------------------|------------|------------------------|
| $I_{T(RMS)}$ | RMS on-state current | Sxx10LSy | $T_c = 80^\circ\text{C}$ | 10 | A |
| | | Sxx10RSy Sxx10DSy Sxx10Vsy | $T_c = 95^\circ\text{C}$ | | |
| $I_{T(AV)}$ | Average on-state current | Sxx10LSy | $T_c = 80^\circ\text{C}$ | 6.4 | A |
| | | Sxx10RSy Sxx10DSy Sxx10Vsy | $T_c = 95^\circ\text{C}$ | | |
| I_{TSM} | Peak non-repetitive surge current | single half cycle; $f = 50\text{Hz}$; T_J (initial) = 25°C | | 83 | A |
| | | single half cycle; $f = 60\text{Hz}$; T_J (initial) = 25°C | | 100 | |
| I^2t | I^2t Value for fusing | $t_p = 8.3 \text{ ms}$ | | 41 | A^2s |
| di/dt | Critical rate of rise of on-state current | $f = 60 \text{ Hz}$; $T_J = 110^\circ\text{C}$ | | 100 | $\text{A}/\mu\text{s}$ |
| I_{GM} | Peak gate current | $T_J = 110^\circ\text{C}$ | | 1 | A |
| $P_{G(AV)}$ | Average gate power dissipation | $T_J = 110^\circ\text{C}$ | | 0.1 | W |
| T_{stg} | Storage temperature range | | | -40 to 150 | $^\circ\text{C}$ |
| T_J | Operating junction temperature range | | | -40 to 110 | $^\circ\text{C}$ |

Note: xx = voltage, y = sensitivity

Absolute Maximum Ratings – Standard SCRs

| Symbol | Parameter | Test Conditions | | Value | Unit |
|--------------|---|--|---------------------------|------------|------------------------|
| $I_{T(RMS)}$ | RMS on-state current | Sxx10L | $T_c = 95^\circ\text{C}$ | 10 | A |
| | | Sxx10R Sxx10D Sxx10V | $T_c = 105^\circ\text{C}$ | | |
| $I_{T(AV)}$ | Average on-state current | Sxx10L | $T_c = 95^\circ\text{C}$ | 6.4 | A |
| | | Sxx10R Sxx10D Sxx10V | $T_c = 105^\circ\text{C}$ | | |
| I_{TSM} | Peak non-repetitive surge current | single half cycle; $f = 50\text{Hz}$; T_J (initial) = 25°C | | 83 | A |
| | | single half cycle; $f = 60\text{Hz}$; T_J (initial) = 25°C | | 100 | |
| I^2t | I^2t Value for fusing | $t_p = 8.3 \text{ ms}$ | | 41 | A^2s |
| di/dt | Critical rate-of-rise of on-state current | $f = 60 \text{ Hz}$; $T_J = 125^\circ\text{C}$ | | 100 | $\text{A}/\mu\text{s}$ |
| I_{GM} | Peak gate current | $T_J = 125^\circ\text{C}$ | | 2 | A |
| $P_{G(AV)}$ | Average gate power dissipation | $T_J = 125^\circ\text{C}$ | | 0.5 | 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 ($T_J = 25^\circ\text{C}$, unless otherwise specified) – Sensitive SCRs

| Symbol | Test Conditions | | Value | | Unit |
|-----------|---|------|----------|----------|------------------|
| | | | Sxx10xS2 | Sxx10xS3 | |
| I_{GT} | $V_D = 6V$ $R_L = 100 \Omega$ | MAX. | 200 | 500 | μA |
| V_{GT} | | MAX. | 0.8 | | V |
| dv/dt | $V_D = V_{DRM}$; $R_{GK} = 1k\Omega$; $T_J = 110^\circ\text{C}$ | TYP. | 8 | | V/ μs |
| V_{GD} | $V_D = V_{DRM}$; $R_L = 3.3 k\Omega$; $T_J = 110^\circ\text{C}$ | MIN. | 0.2 | | V |
| V_{GRM} | $I_{GR} = 10\mu\text{A}$ | MIN. | 6 | | V |
| I_H | $I_T = 20\text{mA}$ (initial) | MAX. | 6 | 8 | mA |
| t_q | (1) | MAX. | 50 | 45 | μs |
| t_{gt} | $I_G = 2 \times I_{GT}$; $PW = 15\mu\text{s}$; $I_T = 12\text{A}$ | TYP. | 4 | 5 | μs |

NOTE: xx = voltage, x = package

(1) $I_T=2\text{A}$; $t_p=50\mu\text{s}$; $dv/dt=5\text{V}/\mu\text{s}$; $di/dt=-30\text{A}/\mu\text{s}$

Electrical Characteristics ($T_J = 25^\circ\text{C}$, unless otherwise specified) – Standard SCRs

| Symbol | Test Conditions | | | Value | Unit |
|----------|---|-------|------|--------|------------------|
| | | | | Sxx10x | |
| I_{GT} | $V_D = 12V$ $R_L = 60 \Omega$ | | MAX. | 15 | mA |
| V_{GT} | | | MAX. | 1.5 | V |
| dv/dt | $V_D = V_{DRM}$; gate open; $T_J = 100^\circ\text{C}$ | 400V | MIN. | 350 | V/ μs |
| | | 600V | | 300 | |
| | | 800V | | 250 | |
| | | 1000V | | 100 | |
| | $V_D = V_{DRM}$; gate open; $T_J = 125^\circ\text{C}$ | 400V | | 250 | |
| | | 600V | | 225 | |
| | | 800V | | 200 | |
| | | | | | |
| V_{GD} | $V_D = V_{DRM}$; $R_L = 3.3 k\Omega$; $T_J = 125^\circ\text{C}$ | | MIN. | 0.2 | V |
| I_H | $I_T = 200\text{mA}$ (initial) | | MAX. | 30 | mA |
| t_q | (1) | | MAX. | 35 | μs |
| t_{gt} | $I_G = 2 \times I_{GT}$; $PW = 15\mu\text{s}$; $I_T = 20\text{A}$ | | TYP. | 2 | μs |

NOTE: xx = voltage, x = package

(1) $I_T=2\text{A}$; $t_p=50\mu\text{s}$; $dv/dt=5\text{V}/\mu\text{s}$; $di/dt=-30\text{A}/\mu\text{s}$

Static Characteristics

| Symbol | Test Conditions | | Value | Unit | |
|---------------------|--|---------------------------|------------|----------|---------------|
| V_{TM} | $I_T = 20\text{A}$; $t_p = 380 \mu\text{s}$ | | MAX. | 1.6 V | |
| I_{DRM} / I_{RRM} | Sxx10xyy | $T_J = 25^\circ\text{C}$ | 400 - 600V | 5 | μA |
| | | $T_J = 110^\circ\text{C}$ | 400 - 600V | 250 | |
| | | $T_J = 25^\circ\text{C}$ | 400 - 800V | 10 | |
| | | | 1000V | 20 | |
| | Sxx10x | $T_J = 100^\circ\text{C}$ | 400 - 800V | 200 | |
| | | | 1000V | 3000 | |
| | | $T_J = 125^\circ\text{C}$ | 400 - 800V | 500 | |
| | | | | | |

Note: xx = voltage, x = package, yy = sensitivity

Thermal Resistances

| Symbol | Parameter | Value | Unit | |
|-------------------|-----------------------|----------|------|------|
| $R_{\theta(J-C)}$ | Junction to case (AC) | Sxx10RSy | 1.6 | °C/W |
| | | Sxx10LSy | 3.0 | |
| | | Sxx10Vsy | 1.7 | |
| | | Sxx10DSy | 1.45 | |
| | | Sxx10R | 1.6 | |
| | | Sxx10L | 3.0 | |
| | | Sxx10V | 1.7 | |
| | | Sxx10D | 1.45 | |
| $R_{\theta(J-A)}$ | Junction to ambient | Sxx10RSy | 40 | °C/W |
| | | Sxx10LSy | 65 | |
| | | Sxx10Vsy | 85 | |
| | | Sxx10R | 40 | |
| | | Sxx10L | 50 | |
| | | Sxx10V | 70 | |

Note: xx = voltage, y = sensitivity

Figure 1: Normalized DC Gate Trigger Current vs. Junction Temperature (Sensitive SCR)



Figure 2: Normalized DC Gate Trigger Current vs. Junction Temperature (Standard SCR)



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



Figure 4: Normalized DC Holding Current vs. Junction Temperature



Figure 5: On-State Current vs. On-State Voltage (Typical)



Figure 6: Power Dissipation (Typical) vs. RMS On-State Current



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



Figure 8: Maximum Allowable Case Temperature vs. Average On-State Current



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



Note: xx = voltage, y = sensitivity

Figure 10: Maximum Allowable Ambient Temperature vs. Average On-State Current

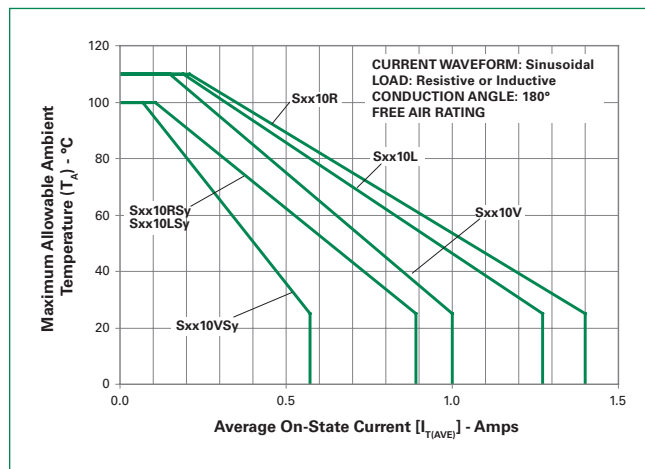


Figure 11: Peak Capacitor Discharge Current



Figure 12: Peak Capacitor Discharge Current Derating

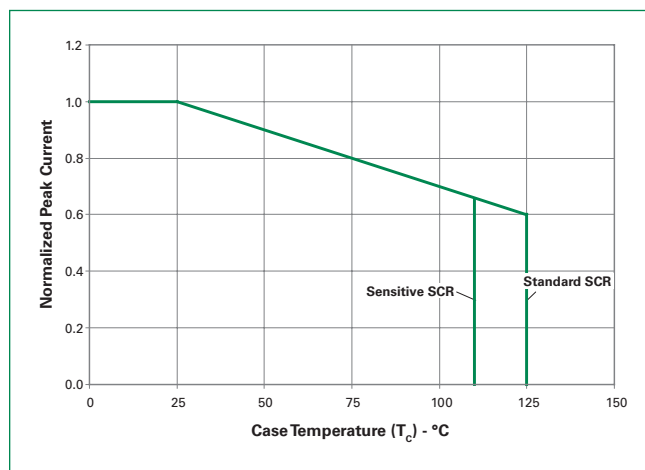
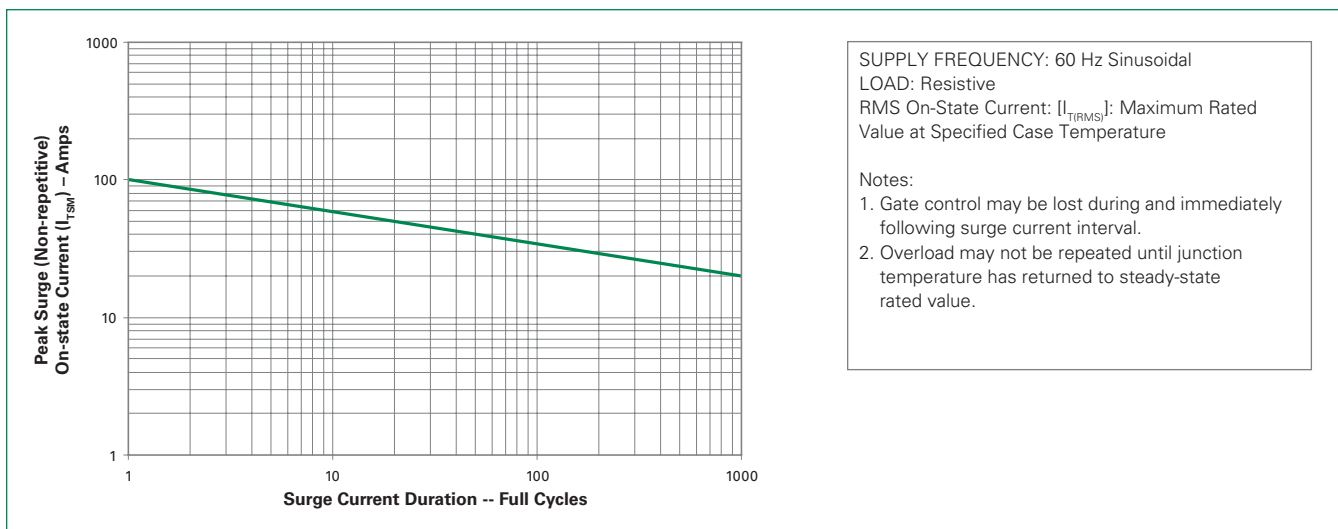


Figure 13: Surge Peak On-State Current vs. Number of Cycles



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 ^{+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 classification 94V-0 |
| Lead Material | 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 |
|----------------------------------|---|
| 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; 320V - 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 |
| Thermal Shock | 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 |
| Autoclave | EIA / JEDEC, JESD22-A102 168 hours (121°C at 2 ATMs) and 100% R/H |
| 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 | Type | Package |
|-------------|---------|------|------|-------|------------------|---------------|---------|
| | 400V | 600V | 800V | 1000V | | | |
| Sxx10RS2 | X | X | | | 0.2mA | Sensitive SCR | TO-220R |
| Sxx10LS2 | X | X | | | 0.2mA | Sensitive SCR | TO-220L |
| Sxx10VS2 | X | X | | | 0.2mA | Sensitive SCR | TO-251 |
| Sxx10DS2 | X | X | | | 0.2mA | Sensitive SCR | TO-252 |
| Sxx10RS3 | X | X | | | 0.5mA | Sensitive SCR | TO-220R |
| Sxx10LS3 | X | X | | | 0.5mA | Sensitive SCR | TO-220L |
| Sxx10VS3 | X | X | | | 0.5mA | Sensitive SCR | TO-251 |
| Sxx10DS3 | X | X | | | 0.5mA | Sensitive SCR | TO-252 |
| Sxx10R | X | X | X | X | 15mA | Standard SCR | TO-220R |
| Sxx10L | X | X | X | X | 15mA | Standard SCR | TO-220L |
| Sxx10V | X | X | X | X | 15mA | Standard SCR | TO-251 |
| Sxx10D | X | X | X | X | 15mA | Standard SCR | TO-252 |

Note: xx = Voltage

Dimensions — TO-251AA (V/I-Package) — V/I-PAK Through Hole



| Dimension | Inches | | | Millimeters | | |
|-----------|--------|-------|-------|-------------|------|------|
| | Min | Typ | Max | Min | Typ | Max |
| A | 0.040 | 0.044 | 0.050 | 1.02 | 1.11 | 1.27 |
| B | 0.235 | 0.242 | 0.245 | 5.97 | 6.15 | 6.22 |
| C | 0.350 | 0.361 | 0.375 | 8.89 | 9.18 | 9.53 |
| D | 0.205 | 0.208 | 0.213 | 5.21 | 5.29 | 5.41 |
| E | 0.255 | 0.262 | 0.265 | 6.48 | 6.66 | 6.73 |
| F | 0.027 | 0.031 | 0.033 | 0.69 | 0.80 | 0.84 |
| G | 0.087 | 0.090 | 0.093 | 2.21 | 2.28 | 2.36 |
| H | 0.085 | 0.092 | 0.095 | 2.16 | 2.34 | 2.41 |
| I | 0.176 | 0.180 | 0.184 | 4.47 | 4.57 | 4.67 |
| J | 0.018 | 0.020 | 0.023 | 0.46 | 0.51 | 0.58 |
| K | 0.038 | 0.040 | 0.044 | 0.97 | 1.01 | 1.12 |
| L | 0.018 | 0.020 | 0.023 | 0.46 | 0.52 | 0.58 |
| P | 0.042 | 0.047 | 0.052 | 1.06 | 1.20 | 1.32 |
| Q | 0.034 | 0.039 | 0.044 | 0.86 | 1.00 | 1.11 |
| R | 0.034 | 0.039 | 0.044 | 0.86 | 1.00 | 1.11 |
| S | 0.074 | 0.079 | 0.084 | 1.86 | 2.00 | 2.11 |

Dimensions — TO-252AA (D-Package) — D-PAK Surface Mount



| Dimension | Inches | | | Millimeters | | |
|-----------|--------|-------|-------|-------------|------|------|
| | Min | Typ | Max | Min | Typ | Max |
| A | 0.040 | 0.043 | 0.050 | 1.02 | 1.09 | 1.27 |
| B | 0.235 | 0.243 | 0.245 | 5.97 | 6.16 | 6.22 |
| C | 0.106 | 0.108 | 0.113 | 2.69 | 2.74 | 2.87 |
| D | 0.205 | 0.208 | 0.213 | 5.21 | 5.29 | 5.41 |
| E | 0.255 | 0.262 | 0.265 | 6.48 | 6.65 | 6.73 |
| F | 0.027 | 0.031 | 0.033 | 0.69 | 0.80 | 0.84 |
| G | 0.087 | 0.090 | 0.093 | 2.21 | 2.28 | 2.36 |
| H | 0.085 | 0.092 | 0.095 | 2.16 | 2.33 | 2.41 |
| I | 0.176 | 0.179 | 0.184 | 4.47 | 4.55 | 4.67 |
| J | 0.018 | 0.020 | 0.023 | 0.46 | 0.51 | 0.58 |
| K | 0.038 | 0.040 | 0.044 | 0.97 | 1.02 | 1.12 |
| L | 0.018 | 0.020 | 0.023 | 0.46 | 0.51 | 0.58 |
| M | 0.000 | 0.000 | 0.004 | 0.00 | 0.00 | 0.10 |
| N | 0.021 | 0.026 | 0.027 | 0.53 | 0.67 | 0.69 |
| O | 0° | 0° | 5° | 0° | 0° | 5° |
| P | 0.042 | 0.047 | 0.052 | 1.06 | 1.20 | 1.32 |
| Q | 0.034 | 0.039 | 0.044 | 0.86 | 1.00 | 1.11 |

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 |

Packing Options

| Part Number | Marking | Weight | Packing Mode | Base Quantity |
|--------------|------------|--------|------------------|-------------------|
| Sxx10L/Ryy | Sxx10L/Ryy | 2.2 g | Bulk | 500 |
| Sxx10L/RyyTP | Sxx10L/Ryy | 2.2 g | Tube | 500 (50 per tube) |
| Sxx10DyyTP | Sxx10Dyy | 0.3 g | Tube | 750 (75 per tube) |
| Sxx10DyyRP | Sxx10Dyy | 0.3 g | Embossed Carrier | 2500 |
| Sxx10VyyTP | Sxx10Vyy | 0.4 g | Tube | 750 (75 per tube) |
| Sxx10L/R | Sxx10L/R | 2.2 g | Bulk | 500 |
| Sxx10L/RTP | Sxx10L/R | 2.2 g | Tube | 500 (50 per tube) |
| Sxx10DTP | Sxx10D | 0.3 g | Tube | 750 (75 per tube) |
| Sxx10DRP | Sxx10D | 0.3 g | Embossed Carrier | 2500 |
| Sxx10VTP | Sxx10V | 0.4 g | Tube | 750 (75 per tube) |

Note: xx = Voltage; yy = Sensitivity

TO-252 Embossed Carrier Reel Pack (RP) Specifications

Meets all EIA-481-2 Standards



Part Numbering System



Part Marking System

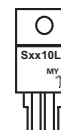
TO-220 AB – (R Package)



TO-251AA – (V Package)
TO-252AA – (D Package)



TO-220 AB – (L Package)



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