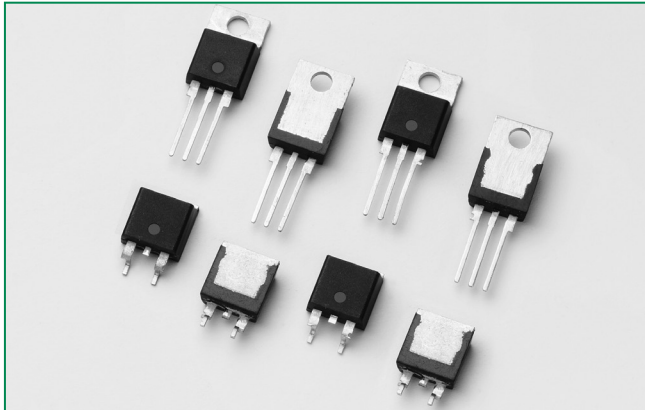


HS4040xAQx Series



Description

The HS4040xAQx series of SCRs offer fast turn-off time (tq) characteristics required for applications such as power inverters, switching regulator, and high frequency pulse circuits.

These fast turn-off time SCRs offer high dv/dt and high di/dt characteristics required in higher frequency (>1000 PPS) switching circuits and a higher temperature environment.

Features & Benefits

- RoHS compliant
- Voltage capability up to 400 V
- Surge capability up to 520 A
- TO-220 and TO-263 packages
- AEC-Q101 Fully compliant
- 150°C maximum junction temperature

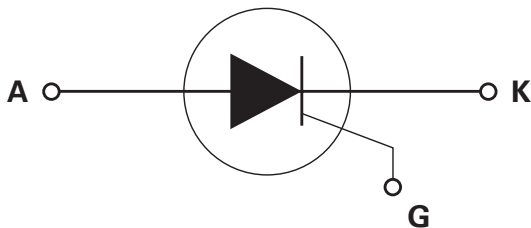
Applications

Fast turn-off time SCRs are ideal for multi phase voltage regulator circuits, DC/AC inverters, and higher frequency pulsing power supplies.

Main Features

| Symbol | Value | Unit |
|-------------------|----------|------|
| $I_{T(RMS)}$ | 40 | A |
| V_{DRM}/V_{RRM} | 400 | V |
| I_{GT} | 15 to 65 | mA |

Schematic Symbol



Absolute Maximum Ratings

| Symbol | Parameter | Test Conditions | Value | Unit |
|-------------------|---|---|------------|------------------|
| $I_{T(RMS)}$ | RMS on-state current | $T_c = 115^\circ\text{C}$ | 40 | A |
| $I_{T(AV)}$ | Average on-state current | $T_c = 115^\circ\text{C}$ | 25.0 | A |
| I_{TSM} | Peak non-repetitive surge current | single half cycle; f = 50Hz; T_j (initial) = 25°C | 430 | A |
| | | single half cycle; f = 60Hz; T_j (initial) = 25°C | 520 | |
| I^2t | I^2t Value for fusing | $t_p = 8.3$ ms | 1122 | A ² s |
| di/dt | Critical rate of rise of on-state current | f = 60Hz; $T_j = 150^\circ\text{C}$ | 175 | A/μs |
| I_{GM} | Peak gate current | $T_j = 150^\circ\text{C}$ | 3.5 | A |
| $P_{G(AV)}$ | Average gate power dissipation | $T_j = 150^\circ\text{C}$ | 0.8 | W |
| T_{stg} | Storage temperature range | | -40 to 150 | °C |
| T_j | Operating junction temperature range | | -40 to 150 | °C |
| V_{DSM}/V_{RSM} | Peak non-repetitive blocking voltage | Pw=100 μs | 500 | V |

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

| Symbol | Test Conditions | | HS4040xAQ | HS4040xAQ2 | HS4040xAQ3 | Unit |
|-----------------|--|------|-----------|------------|------------|------|
| I _{GT} | V _D = 12V; R _L = 30 Ω | MAX. | 35 | 45 | 65 | mA |
| | | MIN. | 15 | 30 | 38 | |
| V _{GT} | | MAX. | 1.5 | | | V |
| I _{GT} | V _D = 12V; R _L = 30Ω; T _J = -40°C | MAX. | 75 | 95 | 160 | mA |
| dv/dt | V _D = V _{DRM'} ; gate open; T _J = 150°C | MIN. | 550 | | | V/μs |
| V _{GD} | V _D = V _{DRM'} ; R _L = 3.3 kΩ; T _J = 150°C | MIN. | 0.2 | | | V |
| I _H | I _T = 400mA (initial) | MAX. | 70 | 120 | 200 | mA |
| t _q | I _T =0.5A; t _p =50μs; dv/dt=5V/μs; di/dt=-30A/μs | MAX. | 15 | 12 | 5 | μs |
| t _{gt} | I _G = 2 x I _{GT} ; PW = 15μs; I _T = 80A | TYP. | 3.0 | | | μs |

Static Characteristics

| Symbol | Test Conditions | | HS4040xAQ | HS4040xAQ2 | HS4040xAQ3 | Unit |
|-------------------------------------|--|------------------------|-----------|------------|------------|------|
| V _{TM} | I _T = 80A; t _p = 380μs | MAX. | 1.6 | | 1.8 | V |
| I _{DRM} / I _{RRM} | V _{DRM} / V _{RRM} | T _J = 25°C | 10 | | | μA |
| | | T _J = 125°C | 2000 | | | |
| | | T _J = 150°C | 4000 | | | |

Thermal Resistances

| Symbol | Parameter | Value | Unit |
|---------------------|-----------------------|-------|------|
| R _{θ(J-C)} | Junction to case (AC) | 0.6 | °C/W |

Figure 1: Normalized DC Holding Current vs. Junction Temperature

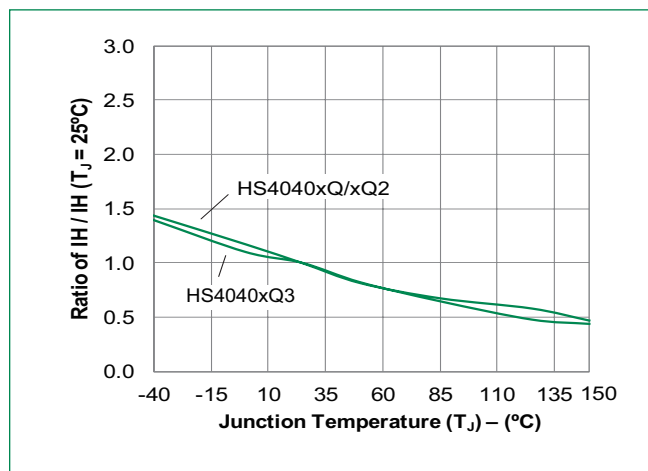


Figure 2: Normalized DC Gate Trigger Current vs. Junction Temperature

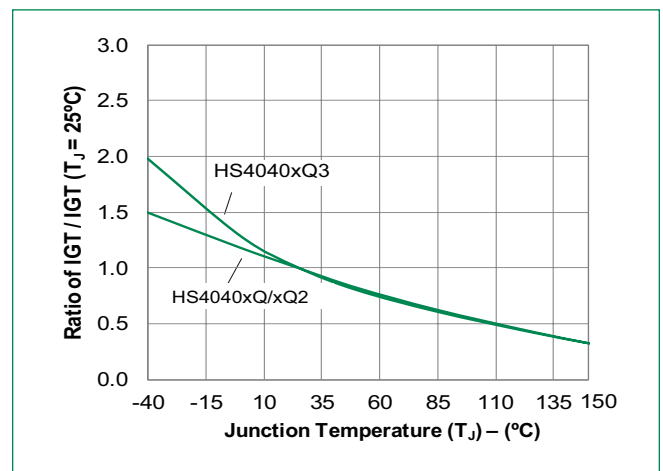


Figure 3: Normalized DC Gate Trigger Voltage vs. Junction Temperature

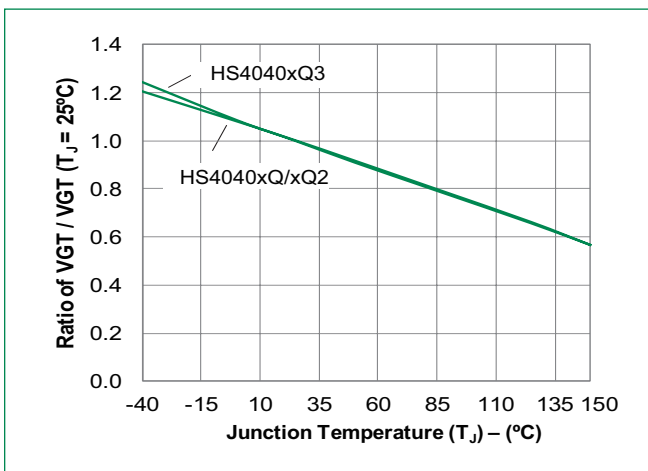


Figure 4: On-State Current vs. On-State Voltage (Typical)

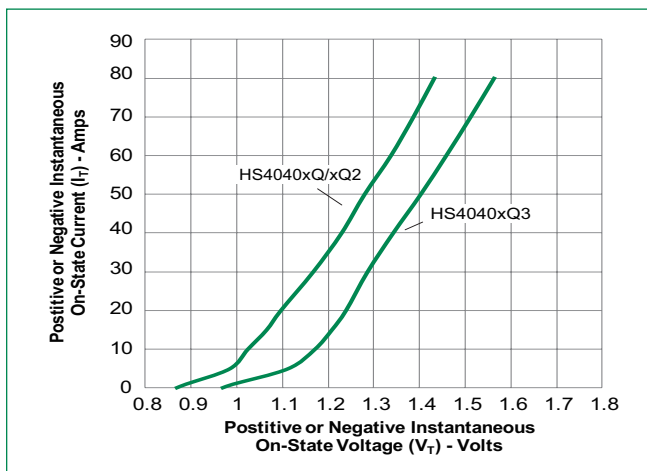


Figure 5: Power Dissipation (Typical) vs. RMS On-State Current

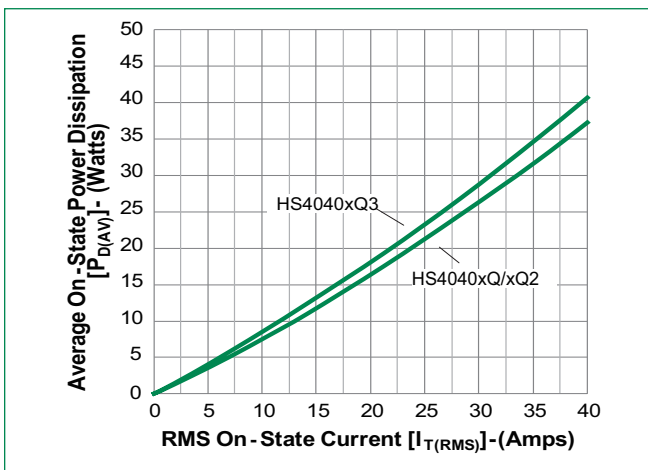


Figure 6: Maximum Allowable Case Temperature vs. RMS On-State Current

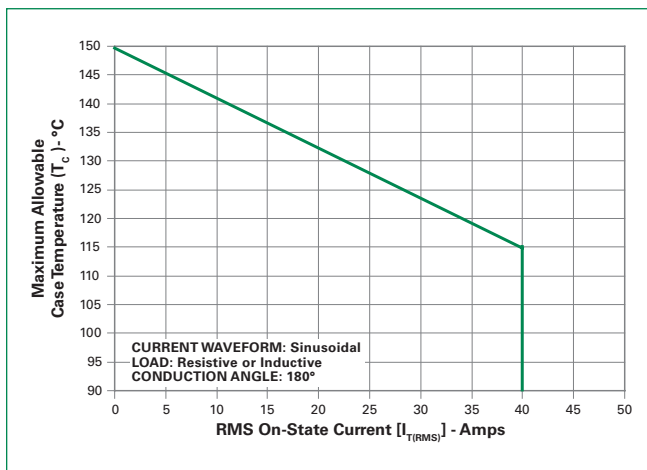


Figure 7: Maximum Allowable Case Temperature vs. Average On-State Current

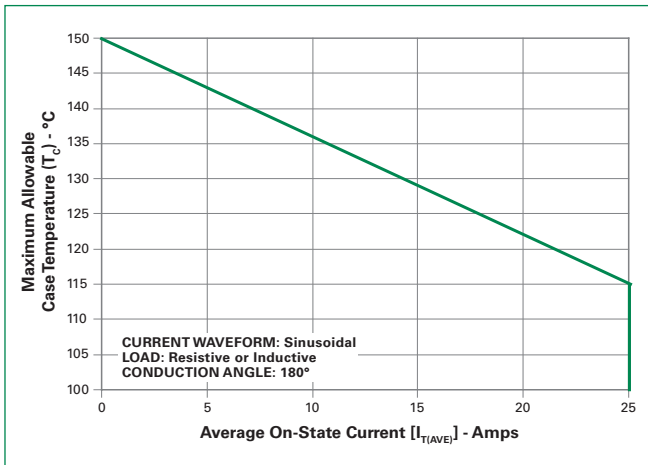


Figure 8: Peak Capacitor Discharge Current

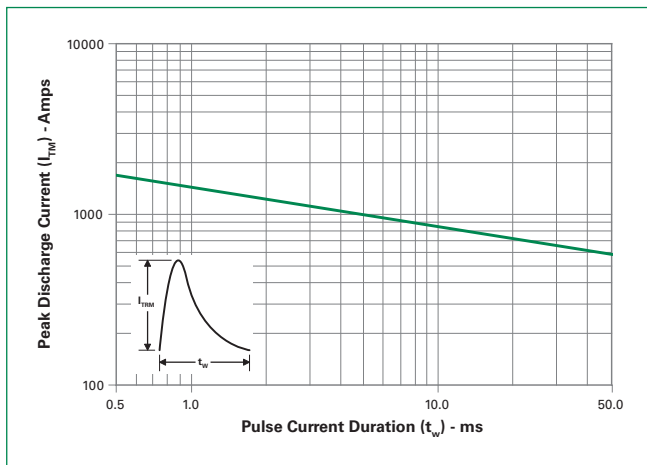


Figure 9: Peak Capacitor Discharge Current Derating

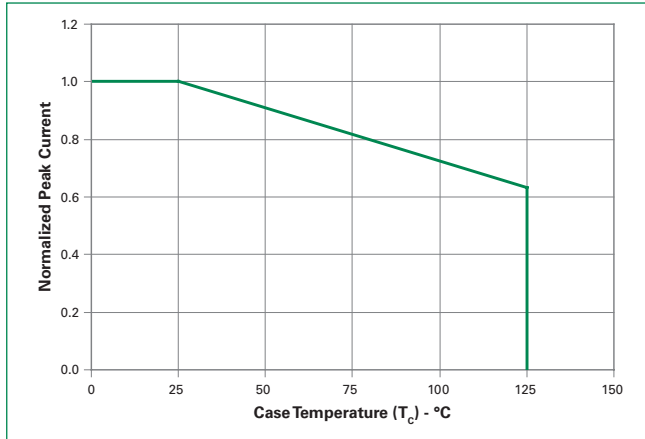
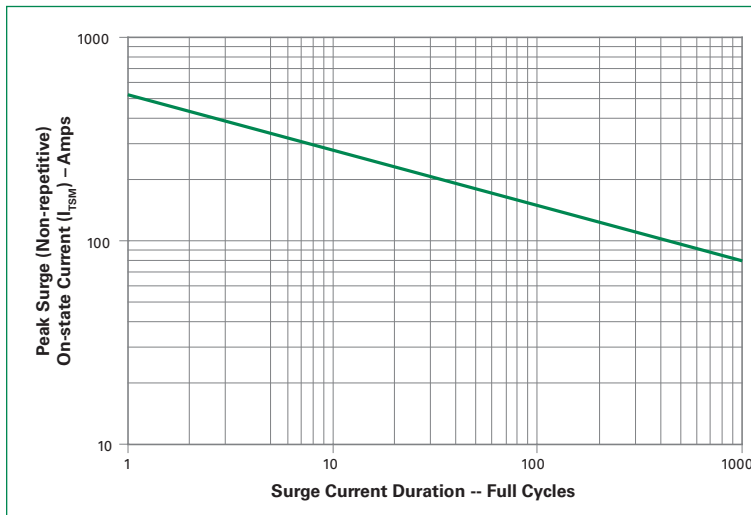


Figure 10: Surge Peak On-State Current vs. Number of Cycles

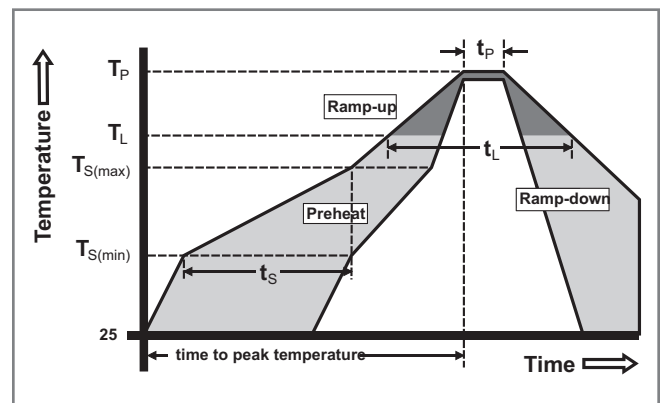


SUPPLY FREQUENCY: 60 Hz Sinusoidal
LOAD: Resistive
RMS On-State Current: [I_{T(RMS)}]: Maximum Rated Value at Specified Case Temperature

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.

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 V-0 |
| Lead Material | Copper Alloy |

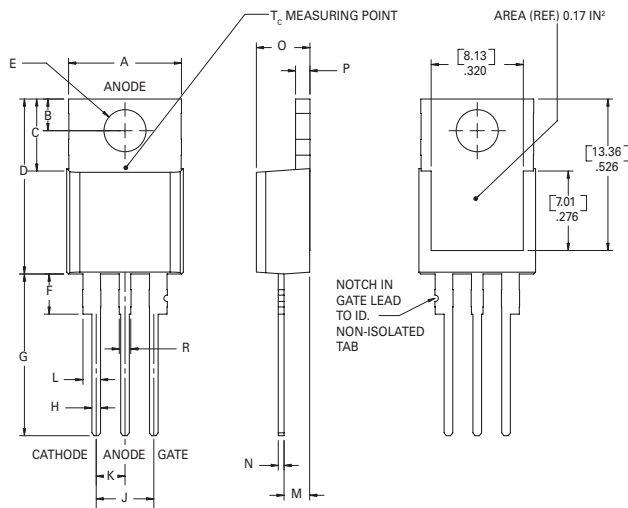
Design Considerations

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 @ 150°C for 1008 hours |
| Biased Temperature & Humidity | EIA / JEDEC, JESD22-A101 1008 hours; 320V - DC: 85°C; 85% rel humidity |
| Temperature Cycling | JESD22 A-104 Appendix 6 -55°C to 150°C, 15-minute dwell, 1000 cycles |
| Intermittent Operational Life | T _A =25C, ΔT _J ≥ 100°C, 1008hrs |
| Autoclave (Pressure Cooker Test) | EIA/JEDEC: JESD22-A102 121°C, 100%RH, 15psig, 96hours |
| Resistance to Solder Heat | JESD22 A-111: 260°C, 10 seconds |
| Solderability | ANSI/J-STD-002, category 3, Test A |

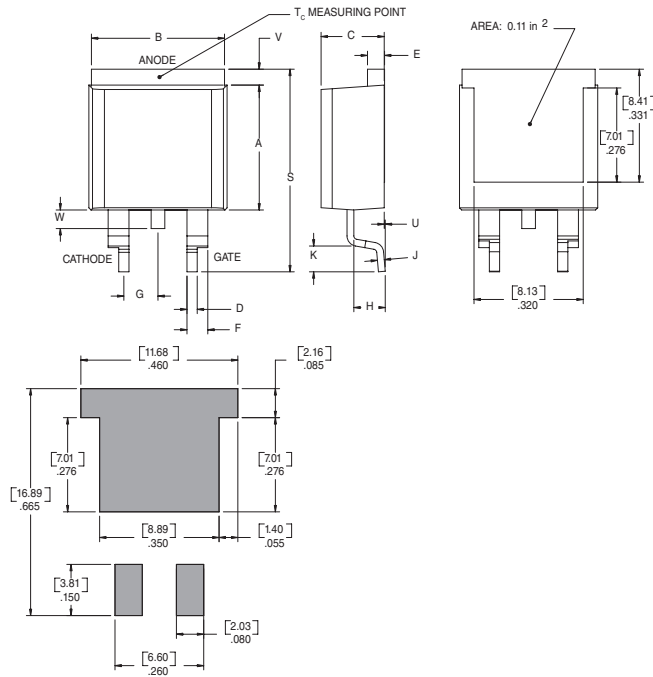
Dimensions — TO-220AB (R-Package) — Non-Isolated Mounting Tab Common with Center Lead



Note: Maximum torque to be applied to mounting tab is 8 in.-lbs. (0.904 Nm).

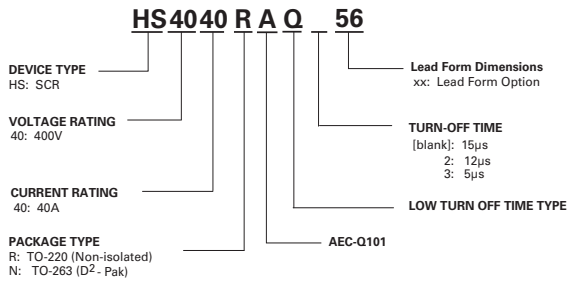
| Dimension | Inches | | Millimeters | |
|-----------|--------|-------|-------------|-------|
| | Min | Max | Min | Max |
| A | 0.380 | 0.420 | 9.65 | 10.67 |
| B | 0.105 | 0.115 | 2.67 | 2.92 |
| C | 0.230 | 0.250 | 5.84 | 6.35 |
| D | 0.590 | 0.620 | 14.99 | 15.75 |
| E | 0.142 | 0.147 | 3.61 | 3.73 |
| 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- 263 (N-package) – D²-Pak Surface Mount



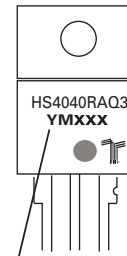
| Dimension | Inches | | Millimeters | |
|-----------|--------|-------|-------------|-------|
| | Min | Max | Min | Max |
| A | 0.360 | 0.370 | 9.14 | 9.40 |
| B | 0.380 | 0.420 | 9.65 | 10.67 |
| C | 0.178 | 0.188 | 4.52 | 4.78 |
| D | 0.025 | 0.035 | 0.63 | 0.89 |
| E | 0.048 | 0.055 | 1.22 | 1.40 |
| F | 0.060 | 0.075 | 1.52 | 1.91 |
| G | 0.095 | 0.105 | 2.41 | 2.67 |
| H | 0.083 | 0.093 | 2.11 | 2.36 |
| 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 | 15.87 |
| 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 |

Part Numbering System



Part Marking System

TO-220 AB - (R Package)
TO-263 (N Package)



Date Code Marking
Y: Year Code
M: Month Code
XXX: Lot Trace Code

Product Selector

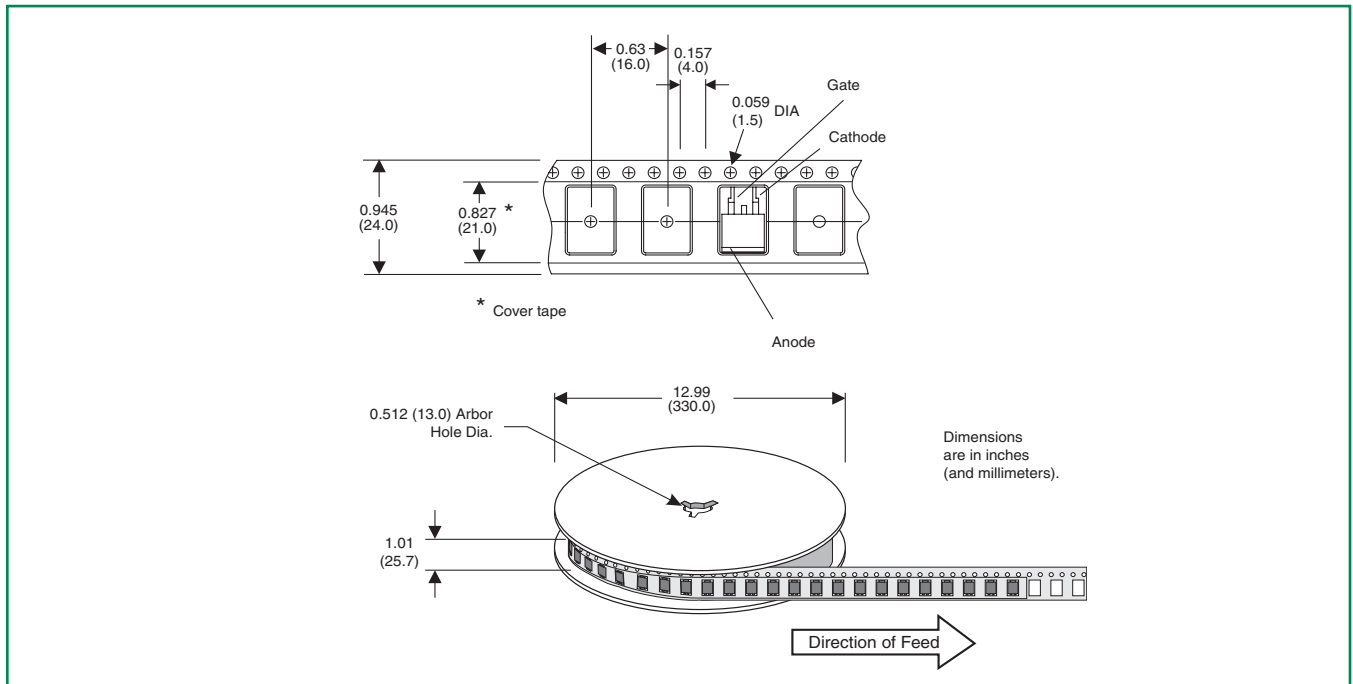
| Part Number | Voltage | Gate Sensitivity | Type | Package |
|-------------|---------|------------------|--------------|----------|
| | 400V | | | |
| HS4040RAQ | X | 15-35 | Standard SCR | TO-220AB |
| HS4040NAQ | X | 15-35 | Standard SCR | TO-263 |
| HS4040RAQ2 | X | 30-45 | Standard SCR | TO-220AB |
| HS4040NAQ2 | X | 30-45 | Standard SCR | TO-263 |
| HS4040RAQ3 | X | 38-65 | Standard SCR | TO-220AB |
| HS4040NAQ3 | X | 38-65 | Standard SCR | TO-263 |

Packing Options

| Part Number | Marking | Weight | Packing Mode | Base Quantity |
|--------------|------------|--------|------------------|-------------------|
| HS4040RAQTP | HS4040RAQ | 2.2g | Tube | 500 (50 per tube) |
| HS4040RAQ2TP | HS4040RAQ2 | 2.2g | Tube | 500 (50 per tube) |
| HS4040RAQ3TP | HS4040RAQ3 | 2.2g | Tube | 500 (50 per tube) |
| HS4040NAQRP | HS4040NAQ | 1.6g | Embossed Carrier | 500 |
| HS4040NAQ2RP | HS4040NAQ2 | 1.6g | Embossed Carrier | 500 |
| HS4040NAQ3RP | HS4040NAQ3 | 1.6g | Embossed Carrier | 500 |

Reel Pack (RP) for TO-263 Embossed Carrier Specifications

Meets all EIA-481-2 Standards



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