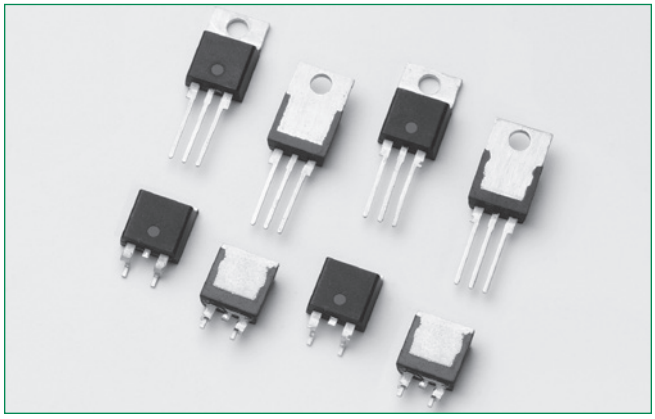
# Thyristors
## 12 Amp Alternistor (High Commutation) Triacs

## Qxx12xHx Series



## Description

This 12 Amp bidirectional solid state switch series is designed for AC switching and phase control applications such as motor speed and temperature modulation controls, lighting controls, and static switching relays.

Standard alternistor triac components operate with in-phase signals in Quadrants I or III and ONLY unipolar negative gate pulses for Quadrant II or III. The alternistor triac will not operate in Quadrant IV. These are used in circuit applications requiring a high dv/dt capability.

## Agency Approval

| Agency | Agency File Number |
|---|---|
| | E71639* |

* - L Package Only

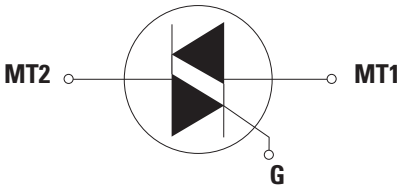
## Main Features

| Symbol | Value | Unit |
|---|---|---|
| $I_{T(RMS)}$ | 12 | A |
| $V_{DRM}/V_{RRM}$ | 400, 600, 800 or 1000 | V |
| $I_{GT (Q1)}$ | 10 or 50 | mA |

## Features & Benefits

- RoHS-compliant
- Glass – passivated junctions
- Voltage capability up to 1000 V
- Surge capability up to 120 A
- The L-package has an isolation rating of 2500$V_{RMS}$
- Solid-state switching eliminates arcing or contact bounce that create voltage transients
- No contacts to wear out from reaction of switching events
- Restricted (or limited) RFI generation, depending on activation point sine wave
- Requires only a small gate activation pulse in each half-cycle
- Recognized to UL 1557 as an Electrically Isolated Semiconductor Device

## Schematic Symbol




## Applications

Excellent for AC switching and phase control applications such as heating, lighting, and motor speed controls.

Typical applications are AC solid-state switches, light dimmers, power tools, lawn care equipment, home/brown goods and white goods appliances.

Alternistor Triacs (no snubber required) are used in applications with extremely inductive loads requiring highest commutation performance.

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

## Additional Information

Datasheet | Resources | Samples

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## Absolute Maximum Ratings — Alternistor (3 Quadrants)

| Symbol | Parameter | | | Value | Unit |
|---|---|---|---|---|---|
| $I_{T(RMS)}$ | RMS on-state current (full sine wave) | Qxx12LHy | $T_C$ = 90°C | 12 | A |
| | | Qxx12RHy<br>Qxx12NHy | $T_C$ = 105°C | | |
| $I_{TSM}$ | Non repetitive surge peak on-state current (full cycle, $T_J$ initial = 25°C) | f = 50 Hz | t = 20 ms | 110 | A |
| | | f = 60 Hz | t = 16.7 ms | 120 | |
| $I^2t$ | $I^2t$ Value for fusing | - | $t_p$ = 8.3 ms | 60 | $A^2s$ |
| di/dt | Critical rate of rise of on-state current | f = 120 Hz | $T_J$ = 125°C | 70 | A/µs |
| $I_{GTM}$ | Peak gate trigger current | $t_p$=20µs | $T_J$ = 125°C | 4 | A |
| $P_{G(AV)}$ | Average gate power dissipation | - | $T_J$ = 125°C | 0.5 | W |
| $T_{stg}$ | Storage temperature range | - | | -40 to 150 | °C |
| $T_J$ | Operating junction temperature range | - | | -40 to 125 | °C |

**Note:** xx = voltage/10, y = sensitivity

## Electrical Characteristics ($T_J$ = 25°C, unless otherwise specified) — Alternistor Triac (3 Quadrants)

| Symbol | Test Conditions | Quadrant | | Qxx12xH2 | Qxx12xH5 | Unit |
|---|---|---|---|---|---|---|
| $I_{GT}$ | $V_D$ = 12V $R_L$ = 60 Ω | I – II – III | MAX. | 10 | 50 | mA |
| $V_{GT}$ | $V_D$ = 12V $R_L$ = 60 Ω | I – II – III | MAX. | 1.3 | 1.3 | V |
| $V_{GD}$ | $V_D = V_{DRM}$ $R_L$ = 3.3 kΩ $T_J$ = 125°C | I – II – III | MIN. | 0.2 | 0.2 | V |
| $I_H$ | $I_T$ = 100mA | | MAX. | 15 | 50 | mA |
| dv/dt | $V_D = V_{DRM}$ Gate Open $T_J$ = 125°C | 400V | MIN. | 300 | 750 | V/µs |
| | | 600V | | 200 | 650 | |
| | | 800V | | 150 | 500 | |
| | $V_D = V_{DRM}$ Gate Open $T_J$ = 100°C | 1000V | | 150 | 300 | |
| (dv/dt)c | (di/dt)c = 6.5 A/ms $T_J$ = 125°C | | MIN. | 2 | 30 | V/µs |
| $t_{gt}$ | $I_G = 2 \times I_{GT}$ PW = 15µs $I_T$ = 17.0 A(pk) | | TYP. | 4 | 4 | µs |

## Static Characteristics

| Symbol | Test Conditions | | | | Value | Unit |
|---|---|---|---|---|---|---|
| $V_{TM}$ | $I_{TM}$ = 17.0A $t_p$ = 380 µs | | | MAX. | 1.60 | V |
| $I_{DRM}$<br>$I_{RRM}$ | $V_D = V_{DRM} / V_{RRM}$ | $T_J$ = 25°C | 400-1000V | MAX. | 10 | µA |
| | | $T_J$ = 125°C | 400-800V | | 2 | mA |
| | | $T_J$ = 100°C | 1000V | | 3 | |

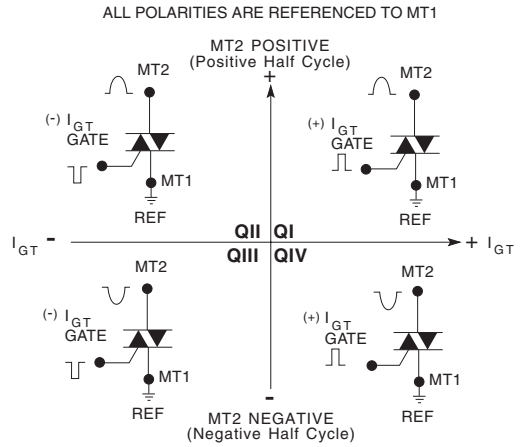
## Thermal Resistances

| Symbol | Parameter | | Value | Unit |
|---|---|---|---|---|
| $R_{\Theta(J-C)}$ | Junction to case (AC) | Qxx12RHy<br>Qxx12NHy | 1.2 | °C/W |
| | | Qxx12LHy | 2.3 | |
| $R_{\Theta(J-A)}$ | Junction to ambient (AC) | Qxx12RHy | 45 | °C/W |
| | | Qxx12LHy | 90 | |

**Note:** xx = voltage/10, y = sensitivity

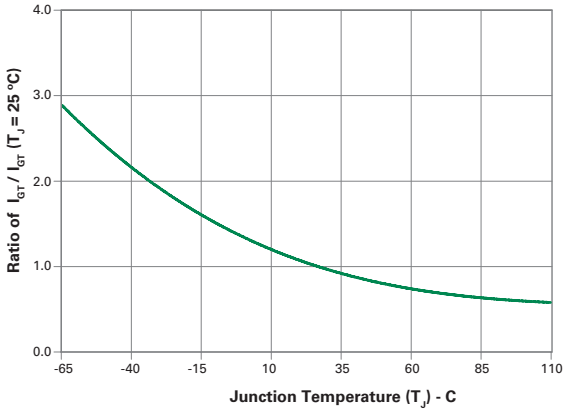
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## Figure 1: Definition of Quadrants

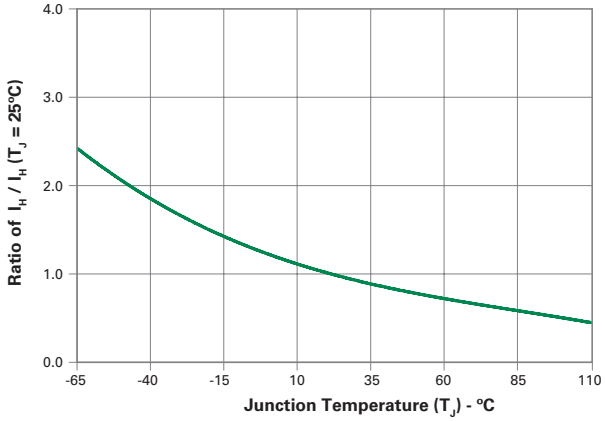



**Note:** Alternistors will not operate in QIV

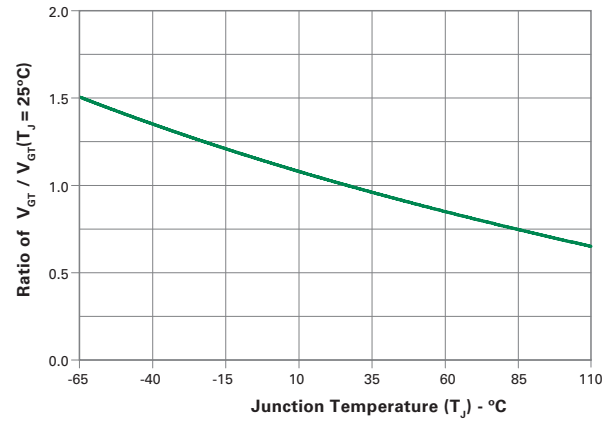
## Figure 2: Normalized DC Gate Trigger Current for All Quadrants vs. Junction Temperature



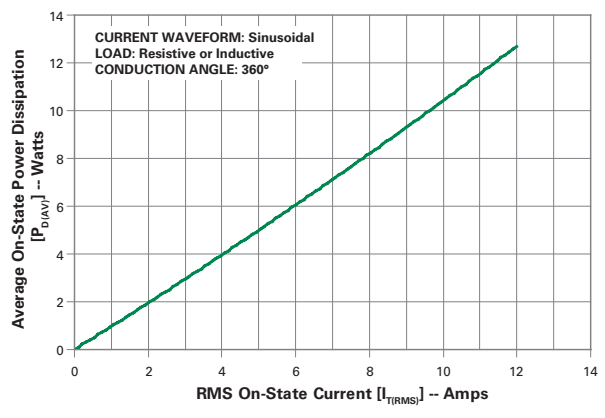

## Figure 3: Normalized DC Holding Current vs. Junction Temperature



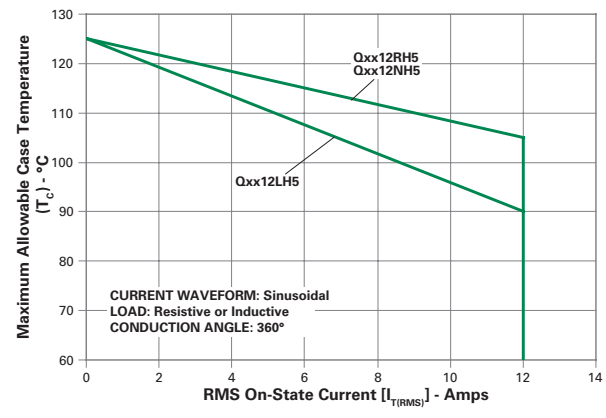

## Figure 4: Normalized DC Gate Trigger Voltage for All Quadrants vs. Junction Temperature




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

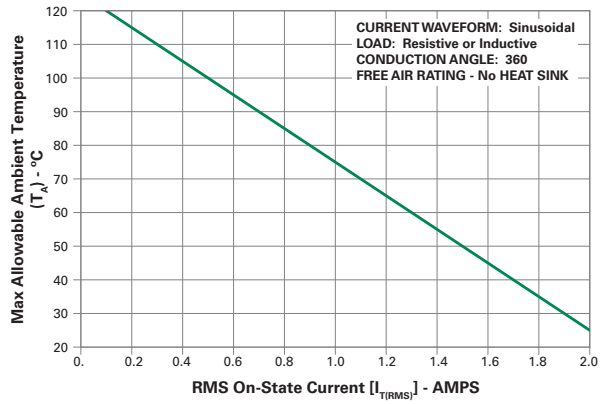



## Figure 6: Maximum Allowable Case Temperature vs. On-State Current

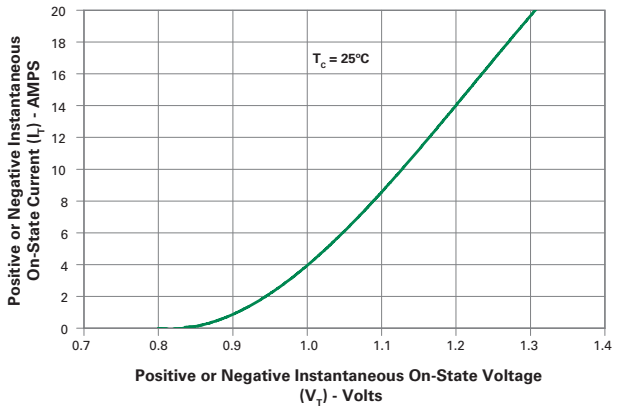



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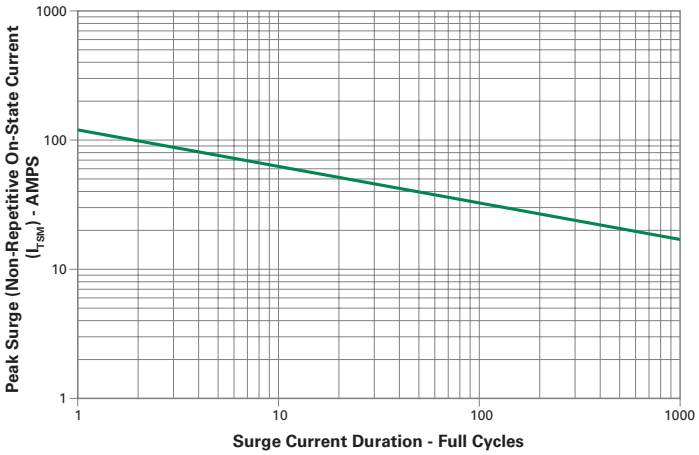
## Figure 7: Maximum Allowable Ambient Temperature vs. On-State Current




## Figure 8: On-State Current vs. On-State Voltage (Typical)




## Figure 9: Surge Peak On-State Current vs. Number of Cycles



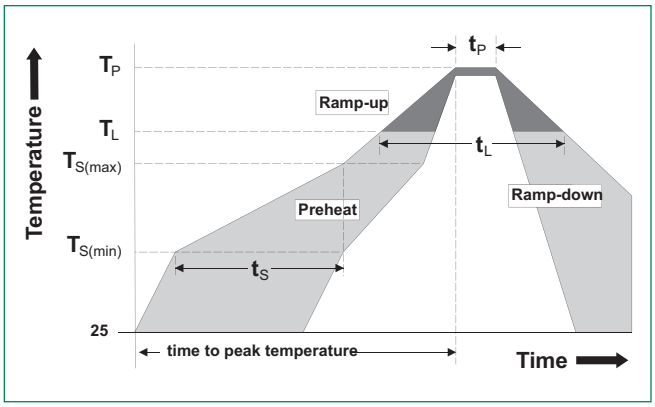

Supply Frequency: 60Hz Sinusoidal
Load: Resistive
RMS On-State Current [$I_{T(RMS)}$ : Maximum]
Rated Value at Specific Case Temperature

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.

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## 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 |
| | **- Time (min to max) ($t_s$)** | 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 compound meeting flammability rating V-0 |
| **Terminal Material** | Copper Alloy |

## Design Considerations

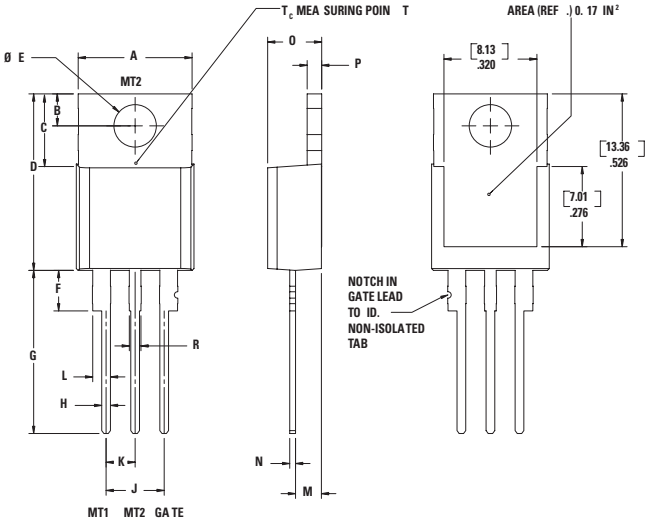
Careful selection of the correct component for the application's operating parameters and environment will go a long way toward extending the operating life of the Thyristor. Good design practice should limit the maximum continuous current through the main terminals to 75% of the component rating. Other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

## 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 |
| **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 |

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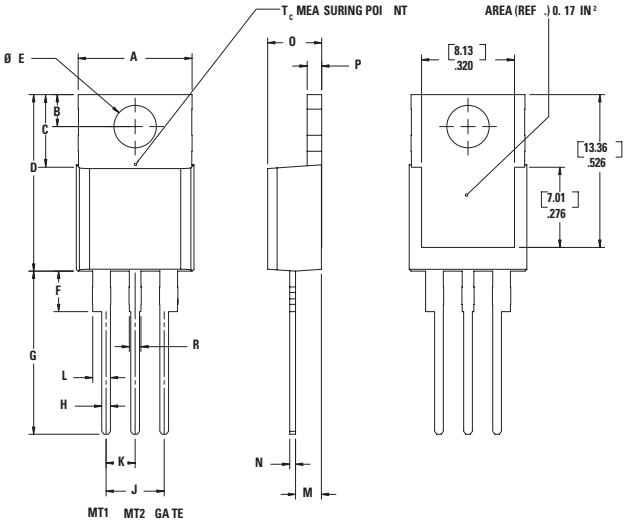
## Dimensions — TO-220AB (R-Package) — Non-Isolated Mounting Tab Common with Center Lead




| 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 |

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

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

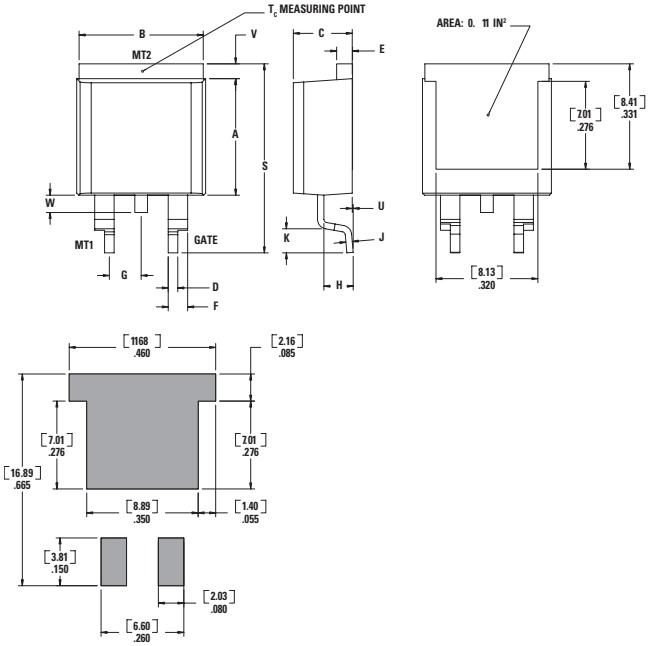



| Dimension | Inches | | Millimeters | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| A | 0.380 | 0.420 | 9.65 | 10.67 |
| B | 0.105 | 0.115 | 2.67 | 2.92 |
| C | 0.230 | 0.250 | 5.84 | 6.35 |
| D | 0.590 | 0.620 | 14.99 | 15.75 |
| E | 0.142 | 0.147 | 3.61 | 3.73 |
| F | 0.110 | 0.130 | 2.79 | 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 |

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

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## Dimensions — TO-263AB (N-Package) — D²Pak 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 Quadrants | Type | Package |
|---|---|---|---|---|---|---|---|
| | 400V | 600V | 800V | 1000V | I – II – III | | |
| Qxx12LH2 | X | X | X | | 10 mA | Alternistor Triac | TO-220L |
| Qxx12RH2 | X | X | X | | 10 mA | Alternistor Triac | TO-220R |
| Qxx12NH2 | X | X | X | | 10 mA | Alternistor Triac | TO-263 D²-PAK |
| Qxx12LH5 | X | X | X | X | 50 mA | Alternistor Triac | TO-220L |
| Qxx12RH5 | X | X | X | X | 50 mA | Alternistor Triac | TO-220R |
| Qxx12NH5 | X | X | X | X | 50 mA | Alternistor Triac | TO-263 D²-PAK |

## Packing Options

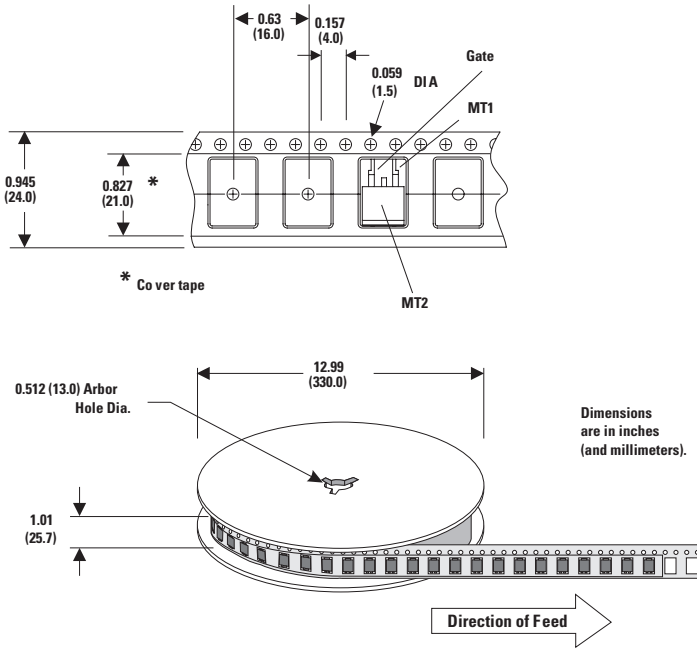
| Part Number | Marking | Weight | Packing Mode | Base Quantity |
|---|---|---|---|---|
| Qxx12L/RHyTP | Qxx12L/RHy | 2.2 g | Tube Pack | 1000 (50 per tube) |
| Qxx12NHyTP | Qxx12NHy | 1.6 g | Tube | 1000 (50 per tube) |
| Qxx12NHyRP | Qxx12NHy | 1.6 g | Embossed Carrier | 500 |

**Note:** xx = Voltage/10; y = Sensitivity

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

### Meets all EIA-481-2 Standards




## Part Numbering System

**Q 60 12 L H5 56**

**Device Type**
Q: Alternistor

**Voltage Rating**
40: 400V
60: 600V
80: 800V
K0: 1000V

**Current Rating**
12: 12A

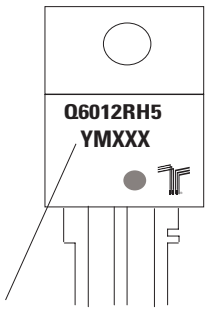
**Package Type**
L : TO-220 Isolated
R : TO-220 Non-Isolated
N : TO-263 ($D^2$Pak)

**Sensitivity & type**
H2: 10mA (QI, II, III)
H5: 50mA (QI, II, III)

**Lead Form Dimensions**
xx: Lead Form Option

## Part Marking System

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




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

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