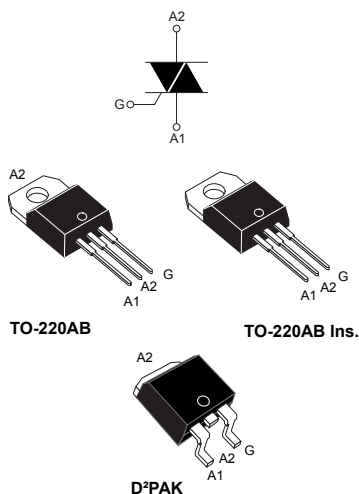


## 16 A - 600 V H-series Snubberless Triac



### Features

- Medium current Triac
- 150 °C max.  $T_j$  turn-off commutation
- Low thermal resistance with clip bonding
- Very high 3 quadrant commutation capabilities
- Packages are RoHS (2002/95/EC) compliant
- UL certified (ref. file E81734)

### Application

The 600 V T1635H and T1650H are especially designed to operate in high power density or universal motor applications such as vacuum cleaner, coffee brewers, and inrush current limiter for inverter based home appliances.

### Description

Available in through-hole or surface mount packages, these Triac series are suitable for general purpose mains power ac switching.

These 20 A Triacs provide a very high switching capability up to junction temperatures of 150 °C.

The heatsink can be reduced, compared to traditional Triacs, according to the high performance at given junction temperatures.

By using an internal ceramic pad, the TO-220AB insulated version provide voltage insulation (rated at 2500  $V_{RMS}$ ).

The surface mount D²PAK package enables compact SMD based designs for automated manufacturing.

#### Product status link

T1635H-6I, T1635H-6T, T1635H-6G,  
T1650H-6I, T1650H-6T, T1650H-6G

#### Product summary

|                   |             |
|-------------------|-------------|
| $I_{T(RMS)}$      | 16 A        |
| $V_{DRM}/V_{RRM}$ | 600 V       |
| $I_{GT}$          | 35 or 50 mA |

# 1 Characteristics

**Table 1. Absolute maximum ratings (limiting values)**

| Symbol            | Parameter                                                                                                           |                                 |                                     | Value                   | Unit               |
|-------------------|---------------------------------------------------------------------------------------------------------------------|---------------------------------|-------------------------------------|-------------------------|--------------------|
| $I_{T(RMS)}$      | RMS on-state current (full sine wave)                                                                               | D <sup>2</sup> PAK,<br>TO-220AB | $T_c = 130\text{ }^{\circ}\text{C}$ | 16                      | A                  |
|                   |                                                                                                                     | TO-220AB Ins.                   | $T_c = 113\text{ }^{\circ}\text{C}$ |                         |                    |
| $I_{TSM}$         | Non repetitive surge peak on-state current (full cycle,<br>$T_j$ initial = $25\text{ }^{\circ}\text{C}$ )           | $f = 50\text{ Hz}$              | $t = 20\text{ ms}$                  | 160                     | A                  |
|                   |                                                                                                                     | $f = 60\text{ Hz}$              | $t = 16.7\text{ ms}$                | 168                     |                    |
| $I^2t$            | $I^2t$ value for fusing                                                                                             |                                 | $t_p = 10\text{ ms}$                | 169                     | A <sup>2</sup> s   |
| $di/dt$           | Critical rate of rise of on-state current, $I_G = 2 \times I_{GT}$ , $t_r \leq 100\text{ ns}$ , $f = 100\text{ Hz}$ | $f = 120\text{ Hz}$             | $T_j = 150\text{ }^{\circ}\text{C}$ | 100                     | A/ $\mu$ s         |
| $V_{DSM}/V_{RSM}$ | Non Repetitive peak off-state voltage                                                                               | $t_p = 10\text{ ms}$            | $T_j = 25\text{ }^{\circ}\text{C}$  | $V_{DRM}/V_{RRM} + 100$ | V                  |
| $I_{GM}$          | Peak gate current                                                                                                   | $t_p = 20\text{ }\mu\text{s}$   | $T_j = 150\text{ }^{\circ}\text{C}$ | 4                       | A                  |
| $P_{G(AV)}$       | Average gate power dissipation                                                                                      |                                 | $T_j = 150\text{ }^{\circ}\text{C}$ | 1                       | W                  |
| $T_{stg}$         | Storage temperature range                                                                                           |                                 |                                     | -40 to +150             | $^{\circ}\text{C}$ |
| $T_j$             | Operating junction temperature range                                                                                |                                 |                                     | -40 to +150             | $^{\circ}\text{C}$ |

**Table 2. Electrical characteristics ( $T_j = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified)**

| Symbol            | Test conditions                                | Quadrants                           |      | Value  |        | Unit       |
|-------------------|------------------------------------------------|-------------------------------------|------|--------|--------|------------|
|                   |                                                |                                     |      | T1635H | T1650H |            |
| $I_{GT}^{(1)}$    | $V_D = 12\text{ V}$ , $R_L = 33\text{ }\Omega$ | I - II - III                        | Max. | 35     | 50     | mA         |
| $V_{GT}$          |                                                |                                     | Max. | 1.0    |        | V          |
| $V_{GD}$          | $V_D = V_{DRM}$ , $R_L = 3.3\text{ k}\Omega$   | I - II - III                        | Min. | 0.15   |        | V          |
| $I_L$             | $I_G = 1.2 \times I_{GT}$                      | I - III                             | Max. | 50     | 90     | mA         |
|                   |                                                | II                                  | Max. | 80     | 110    |            |
| $I_H^{(2)}$       | $I_T = 500\text{ mA}$ , gate open              |                                     | Max. | 35     | 75     | mA         |
| $dV/dt^{(2)}$     | $V_D = 2/3 \times V_{DRM}$ , gate open         | $T_j = 150\text{ }^{\circ}\text{C}$ | Min. | 1000   | 1500   | V/ $\mu$ s |
| $(di/dt)_c^{(2)}$ | Without snubber                                | $T_j = 150\text{ }^{\circ}\text{C}$ | Min. | 21     | 28     | A/ms       |

1. Minimum  $I_{GT}$  is guaranteed at 20% of  $I_{GT}$  max.

2. For both polarities of A2 referenced to A1.

**Table 3. Static characteristics**

| Symbol                        | Test conditions                                         |                                   |      | Value | Unit          |
|-------------------------------|---------------------------------------------------------|-----------------------------------|------|-------|---------------|
| $V_T^{(1)}$                   | $I_{TM} = 23\text{ A}$ , $t_p = 380\text{ }\mu\text{s}$ | $T_j = 25\text{ }^\circ\text{C}$  | Max. | 1.5   | V             |
| $V_{TO}^{(1)}$                | Threshold voltage                                       | $T_j = 150\text{ }^\circ\text{C}$ | Max. | 0.80  | V             |
| $R_D^{(1)}$                   | Dynamic resistance                                      | $T_j = 150\text{ }^\circ\text{C}$ | Max. | 23    | m $\Omega$    |
| $I_{DRM}/$<br>$I_{RRM}^{(2)}$ | $V_{DRM} = V_{RRM}$                                     | $T_j = 25\text{ }^\circ\text{C}$  | Max. | 5     | $\mu\text{A}$ |
|                               |                                                         | $T_j = 150\text{ }^\circ\text{C}$ |      | 4.1   | mA            |
|                               | $V_D = V_R = 400\text{ V}$ , peak voltage               | $T_j = 150\text{ }^\circ\text{C}$ | Max. | 3.5   | mA            |
|                               | $V_D = V_R = 200\text{ V}$ , peak voltage               | $T_j = 150\text{ }^\circ\text{C}$ | Max. | 3.0   |               |

1. For both polarities of A2 referenced to A1.

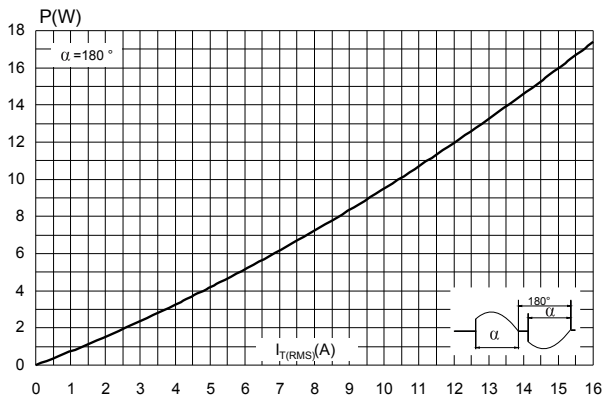
2.  $t_p = 380\text{ }\mu\text{s}$

**Table 4. Thermal resistance**

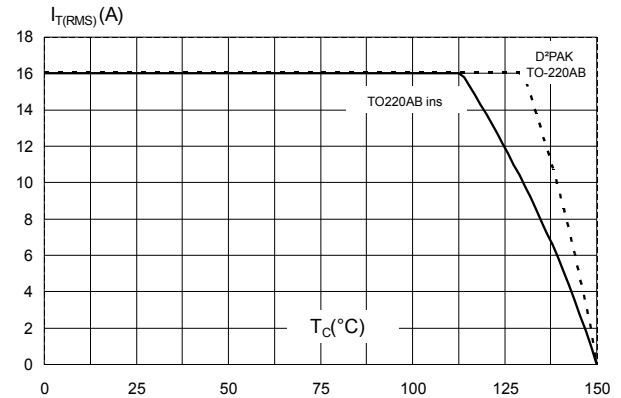
| Symbol        | Parameter                                        |                                 | Value | Unit               |
|---------------|--------------------------------------------------|---------------------------------|-------|--------------------|
| $R_{th(j-c)}$ | Junction to case (AC)                            | D <sup>2</sup> PAK,<br>TO-220AB | 1.15  | $^\circ\text{C/W}$ |
|               |                                                  | TO-220AB Ins.                   | 2.1   |                    |
| $R_{th(j-a)}$ | Junction to ambient ( $S_{cu} = 2\text{ cm}^2$ ) | D <sup>2</sup> PAK,<br>TO-220AB | 45    | $^\circ\text{C/W}$ |
|               | Junction to ambient                              | TO-220AB Ins.                   | 60    |                    |

## 1.1 Characteristics (curves)

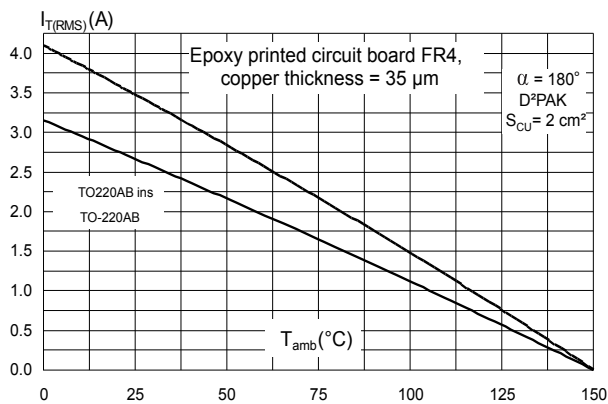
**Figure 1. Maximum power dissipation versus on-state RMS current**



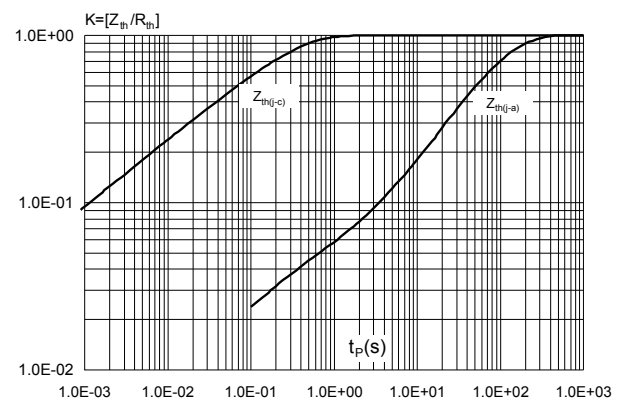
**Figure 2. On-state RMS current versus case temperature**

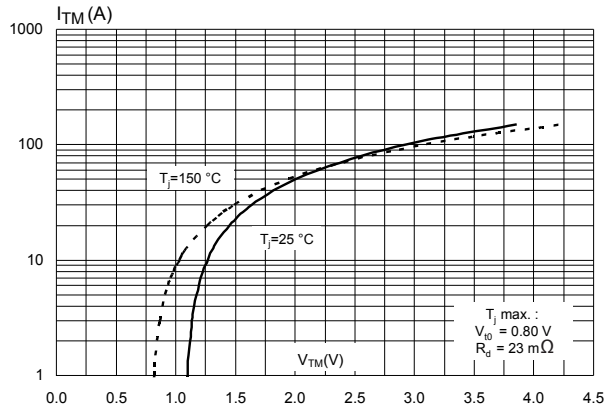
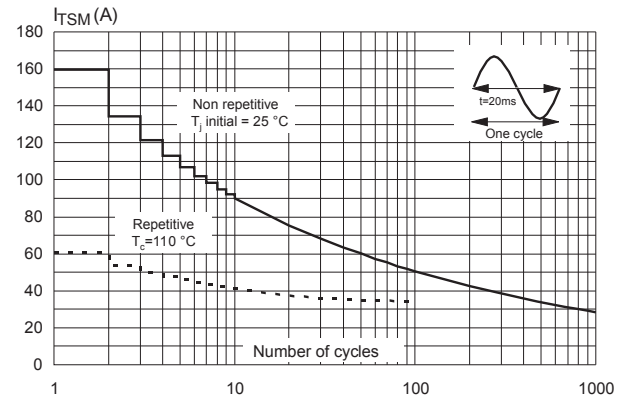
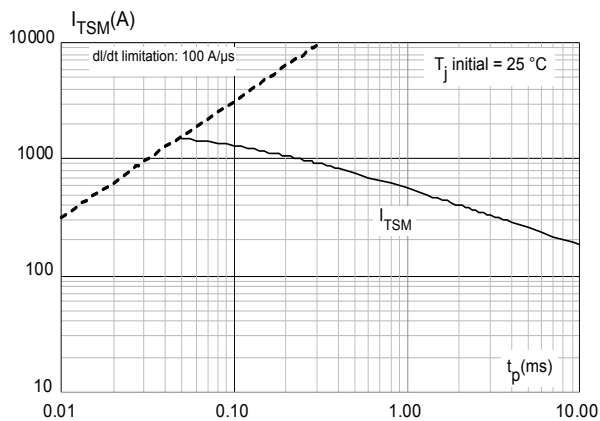
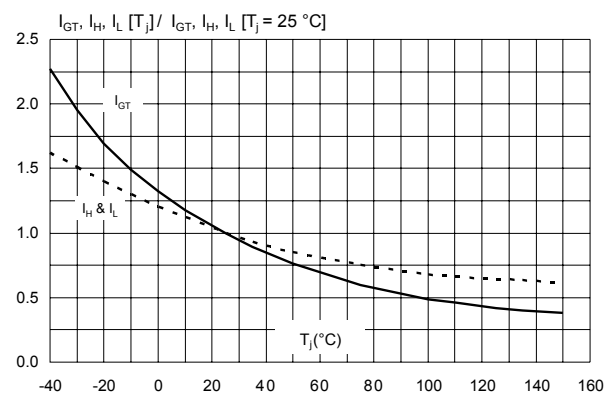
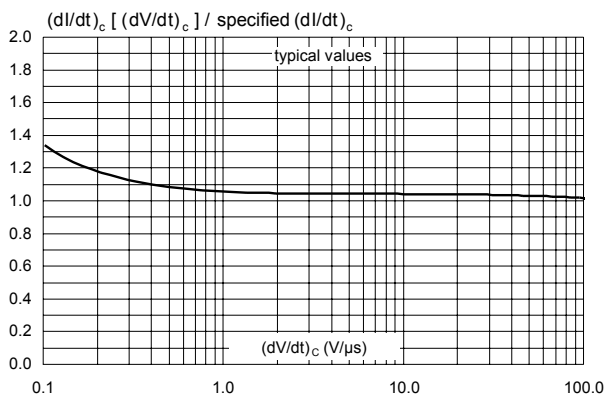
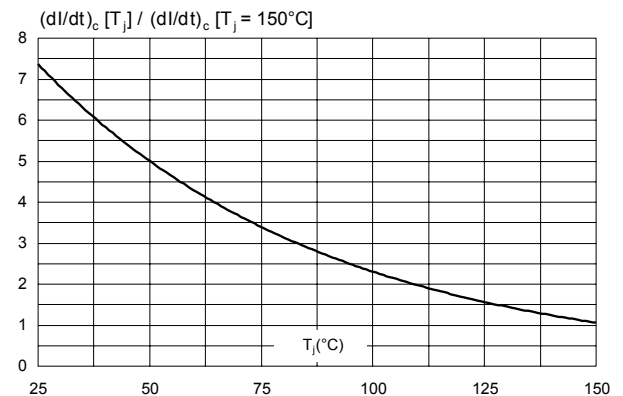


**Figure 3. On-state RMS current versus ambient temperature**

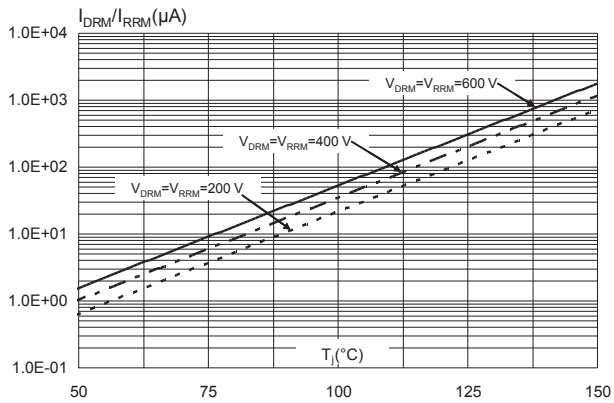


**Figure 4. Variation of thermal impedance versus pulse duration**

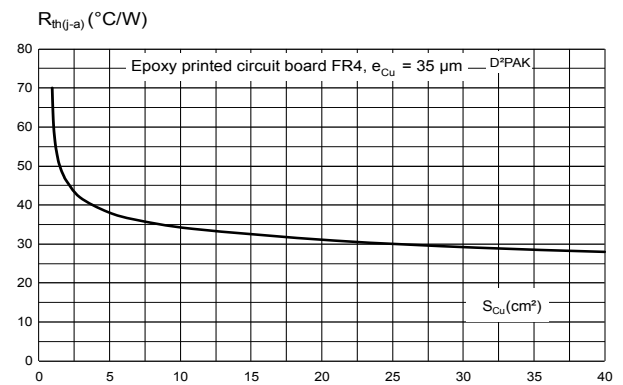


**Figure 5. On-state characteristics (maximum values)**

**Figure 6. Surge peak on-state current versus number of cycles**

**Figure 7. Non repetitive surge peak on-state current for a sinusoidal pulse with width  $t_p < 10$  ms**

**Figure 8. Relative variation of  $I_{GT}$ ,  $I_H$ ,  $I_L$  vs junction temperature (typical values)**

**Figure 9. Relative variation of critical rate of decrease of main current  $(dI/dt)_c$  versus reapplied  $(dV/dt)_c$** 

**Figure 10. Relative variation of critical rate of decrease of main current versus junction temperature**


**Figure 11. Leakage current versus junction temperature for different values of blocking voltage (typical values)**



**Figure 12. Thermal resistance junction to ambient versus copper surface under tab**



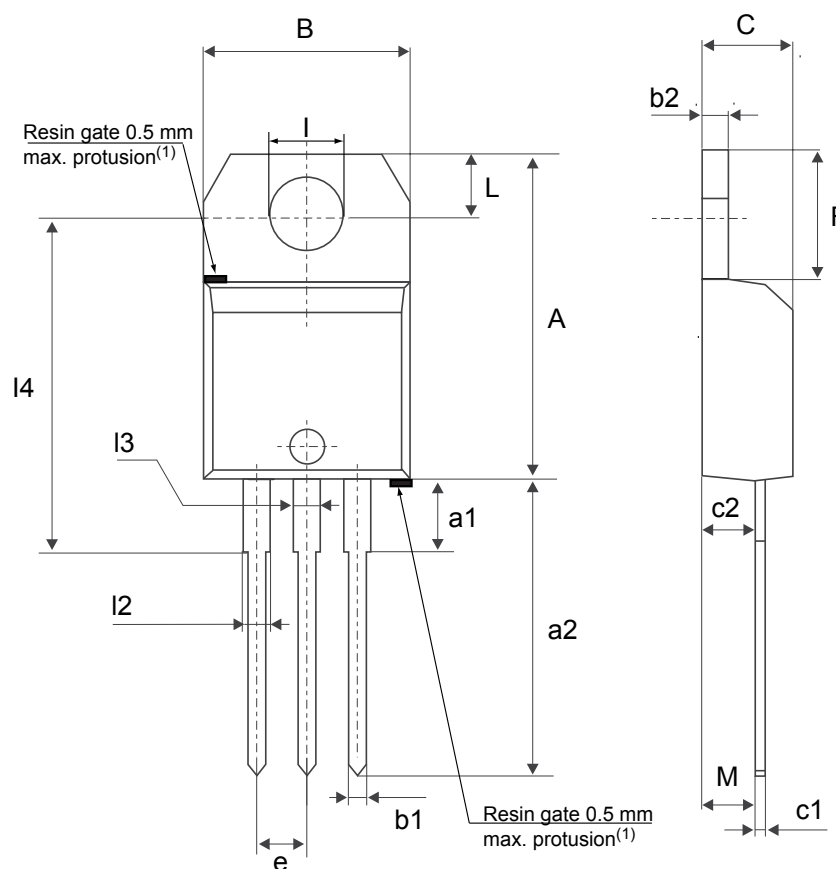
## 2 Package information

In order to meet environmental requirements, ST offers these devices in different grades of **ECOPACK** packages, depending on their level of environmental compliance. ECOPACK specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK is an ST trademark.

### 2.1 TO-220AB package information

- Molding compound resin is halogen-free and meets flammability standard UL94 level 0
- Lead-free package leads finishing
- **ECOPACK2** compliant
- Recommended torque: 0.4 to 0.6 N.m

Figure 13. TO-220AB package outline



(1) Resin gate position accepted in one of the two positions or in the symmetrical opposites.

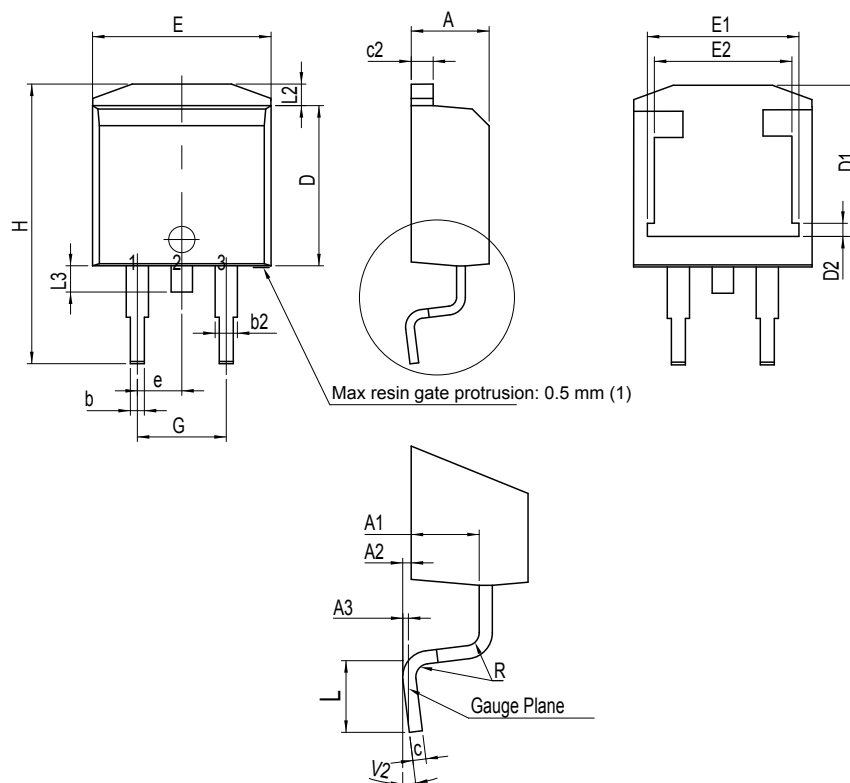
**Table 5. TO-220AB package mechanical data**

| Ref. | Dimensions  |       |       |                       |        |        |
|------|-------------|-------|-------|-----------------------|--------|--------|
|      | Millimeters |       |       | Inches <sup>(1)</sup> |        |        |
|      | Min.        | Typ.  | Max.  | Min.                  | Typ.   | Max.   |
| A    | 15.20       |       | 15.90 | 0.5984                |        | 0.6260 |
| a1   |             | 3.75  |       |                       | 0.1476 |        |
| a2   | 13.00       |       | 14.00 | 0.5118                |        | 0.5512 |
| B    | 10.00       |       | 10.40 | 0.3937                |        | 0.4094 |
| b1   | 0.61        |       | 0.88  | 0.0240                |        | 0.0346 |
| b2   | 1.23        |       | 1.32  | 0.0484                |        | 0.0520 |
| C    | 4.40        |       | 4.60  | 0.1732                |        | 0.1811 |
| c1   | 0.49        |       | 0.70  | 0.0193                |        | 0.0276 |
| c2   | 2.40        |       | 2.72  | 0.0945                |        | 0.1071 |
| e    | 2.40        |       | 2.70  | 0.0945                |        | 0.1063 |
| F    | 6.20        |       | 6.60  | 0.2441                |        | 0.2598 |
| I    | 3.73        |       | 3.88  | 0.1469                |        | 0.1528 |
| L    | 2.65        |       | 2.95  | 0.1043                |        | 0.1161 |
| I2   | 1.14        |       | 1.70  | 0.0449                |        | 0.0669 |
| I3   | 1.14        |       | 1.70  | 0.0449                |        | 0.0669 |
| I4   | 15.80       | 16.40 | 16.80 | 0.6220                | 0.6457 | 0.6614 |
| M    |             | 2.6   |       |                       | 0.1024 |        |

1. Inch dimensions are for reference only.

## 2.2 D<sup>2</sup>PAK package information

Figure 14. D<sup>2</sup>PAK package outline

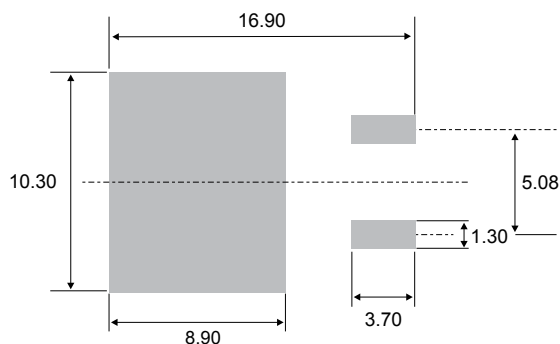


(1) Resin gate is accepted in each of position shown on the drawing, or their symmetrical.

**Table 6. D<sup>2</sup>PAK package mechanical data**

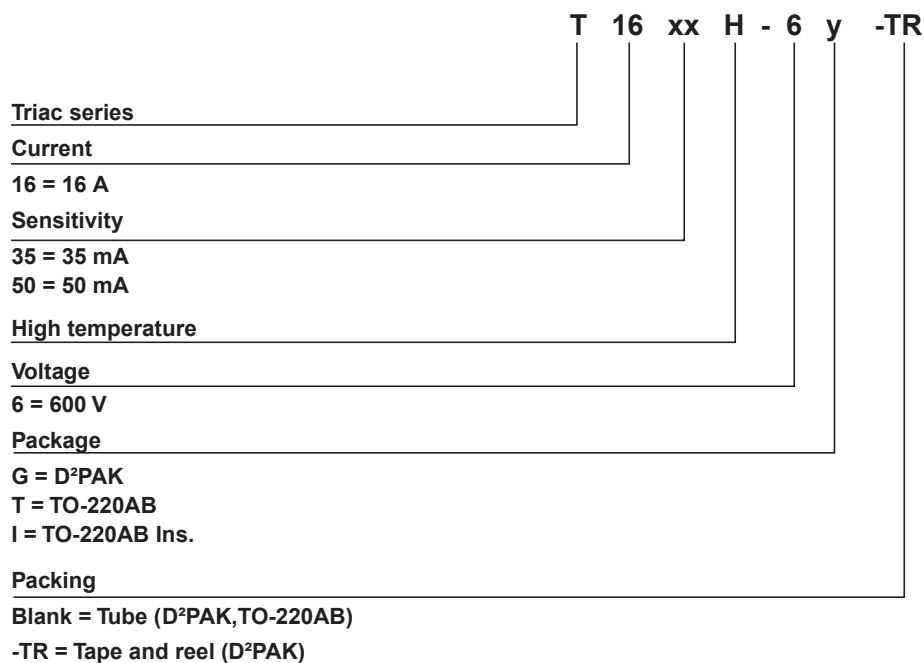
| Ref. | Dimensions  |      |       |                       |        |        |
|------|-------------|------|-------|-----------------------|--------|--------|
|      | Millimeters |      |       | Inches <sup>(1)</sup> |        |        |
|      | Min.        | Typ. | Max.  | Min.                  | Typ.   | Max.   |
| A    | 4.30        |      | 4.60  | 0.1693                |        | 0.1811 |
| A1   | 2.49        |      | 2.69  | 0.0980                |        | 0.1059 |
| A2   | 0.03        |      | 0.23  | 0.0012                |        | 0.0091 |
| A3   |             | 0.25 |       |                       | 0.0098 |        |
| b    | 0.70        |      | 0.93  | 0.0276                |        | 0.0366 |
| b2   | 1.25        |      | 1.7   | 0.0492                |        | 0.0669 |
| c    | 0.45        |      | 0.60  | 0.0177                |        | 0.0236 |
| c2   | 1.21        |      | 1.36  | 0.0476                |        | 0.0535 |
| D    | 8.95        |      | 9.35  | 0.3524                |        | 0.3681 |
| D1   | 7.50        |      | 8.00  | 0.2953                |        | 0.3150 |
| D2   | 1.30        |      | 1.70  | 0.0512                |        | 0.0669 |
| e    | 2.54        |      |       | 0.1                   |        |        |
| E    | 10.00       |      | 10.28 | 0.3937                |        | 0.4047 |
| E1   | 8.30        |      | 8.70  | 0.3268                |        | 0.3425 |
| E2   | 6.85        |      | 7.25  | 0.2697                |        | 0.2854 |
| G    | 4.88        |      | 5.28  | 0.1921                |        | 0.2079 |
| H    | 15          |      | 15.85 | 0.5906                |        | 0.6240 |
| L    | 1.78        |      | 2.28  | 0.0701                |        | 0.0898 |
| L2   | 1.27        |      | 1.40  | 0.0500                |        | 0.0551 |
| L3   | 1.40        |      | 1.75  | 0.0551                |        | 0.0689 |
| R    |             | 0.40 |       |                       | 0.0157 |        |
| V2   | 0°          |      | 8°    | 0°                    |        | 8°     |

1. Dimensions in inches are given for reference only

**Figure 15. D<sup>2</sup>PAK recommended footprint (dimensions are in mm)**


### 3 Ordering information

**Figure 16. Ordering information scheme**



**Table 7. Ordering information**

| Order code   | Marking   | Package            | Weight | Base qty. | Delivery mode     |
|--------------|-----------|--------------------|--------|-----------|-------------------|
| T16xxH-6G    | T16xxH 6G | D <sup>2</sup> PAK | 1.5 g  | 50        | Tube              |
| T16xxH-6G-TR |           |                    |        | 1000      | Tape and reel 13" |
| T16xxH-6T    | T16xxH 6T | TO-220AB           | 2.3 g  | 50        | Tube              |
| T16xxH-6I    | T16xxH 6I | TO-220AB Ins.      | 2.3 g  | 50        | Tube              |

## Revision history

**Table 8. Document revision history**

| Date        | Version | Changes                                                                                                                                                     |
|-------------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 29-May-2007 | 1       | First issue.                                                                                                                                                |
| 20-Sep-2011 | 2       | Updated: Features, Description and Figure 2.                                                                                                                |
| 31-Jan-2014 | 3       | Updated Figure 2, Figure 3, Figure 4, Table 2 and Table 5.                                                                                                  |
| 23-Mar-2020 | 4       | Updated <a href="#">Table 1. Absolute maximum ratings (limiting values)</a> and <a href="#">Figure 3. On-state RMS current versus ambient temperature</a> . |



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