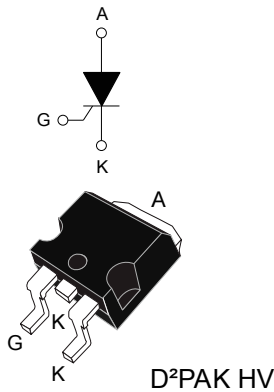



## 40 A 1200 V automotive grade thyristor (SCR)



## Features

- AEC-Q101 qualified 
- High junction temperature: 150 °C
- AC off state voltage: +/- 1200 V
- Nominal on-state RMS current: 40 A<sub>RMS</sub>
- High EFT noise immunity: 1000 V/μs
- Max. gate triggering current: 50 mA
- D²PAK HV creepage distance (anode to cathode):
  - With top coating: 5.38 mm min.
  - Without top coating: 3.48 mm min.
- ECOPACK2 compliant component

## Application

- On board charger
- Capacitor discharge
- Overvoltage crowbar protection
- Power supplies
- AC switches
- Solid state relays

## Product status

TN4050HP-12G2YTR

## Product summary

|                   |               |
|-------------------|---------------|
| $I_{T(RMS)}$      | 40 A          |
| $V_{DRM}/V_{RRM}$ | 1200 V        |
| $V_{DSM}/V_{RSM}$ | 1400 V        |
| $I_{GT}$          | 50 mA         |
| $T_j$             | -40 to 150 °C |

## Description

The **TN4050HP-12G2YTR** is an automotive grade SCR thyristor designed for applications such as automotive on board and stationary battery chargers.

This SCR Thyristor, rated for a 40 A RMS power switching, offers superior performances in peak voltage robustness up to 400 V sine wave pulse. Its key features allow the design of functions such as a 56 A RMS AC switch and a 50 A AC-DC controlled rectifier-bridge.

The **TN4050HP-12G2YTR** is available in D²PAK HV surface mount package, ideal for automatic assembly lines.

D²PAK HV package offers increased creepage distance of 5.38 mm, simplifying design conformity with insulation coordination standards such as IEC60664-1 and UL-840.

# 1 Characteristics

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

| Symbol              | Parameter   |                    | Value          | Unit        |                  |
|---------------------|---|--------------------|----------------|-------------|------------------|
| $I_{T(RMS)}$        | RMS on-state current (180 ° conduction angle)   |                    | 40             | A           |                  |
| $I_{T(AV)}$         | Average on-state current (180 ° conduction angle)   |                    |                |             |                  |
| $I_{TSM}$           | Non repetitive surge peak on-state current, $V_R = 0$ V                                   | $t_p = 8.3$ ms     | 440            | A           |                  |
|                     |   | $t_p = 10$ ms      |                |             |                  |
| $I^2t$              | $I^2t$ value for fusing   | $t_p = 10$ ms      | $T_j = 25$ °C  | 800         | A <sup>2</sup> s |
| $di/dt$             | Critical rate of rise of on-state current,<br>$I_G = 2 \times I_{GT}$ , $t_r \leq 100$ ns | $f = 50$ Hz        | $T_j = 150$ °C | 200         | A/ $\mu$ s       |
| $V_{DRM} / V_{RRM}$ | Repetitive off-state voltage  |                    | $T_j = 150$ °C | 1200        | V                |
| $V_{DSM} / V_{RSM}$ | Non repetitive surge peak off-state voltage   | $t_p = 10$ ms      | $T_j = 25$ °C  | 1400        | V                |
| $V_{GM}$            | Peak forward gate voltage   | $t_p = 20$ $\mu$ s | $T_j = 150$ °C | 10          | V                |
| $I_{GM}$            | Peak forward gate current   | $t_p = 20$ $\mu$ s | $T_j = 150$ °C | 8           | A                |
| $V_{RGM}$           | Maximum peak reverse gate voltage   |                    | $T_j = 25$ °C  | 5           | V                |
| $P_{G(AV)}$         | Average gate power dissipation  |                    | $T_j = 150$ °C | 1           | W                |
| $T_{stg}$           | Storage junction temperature range  |                    |                | -40 to +150 | °C               |
| $T_j$               | Operating junction temperature  |                    |                | -40 to +150 | °C               |

**Table 2. Electrical characteristics ( $T_j = 25$  °C unless otherwise specified)**

| Symbol   | Test Conditions                     |                | Value | Unit |            |
|----------|-------------------------------------|----------------|-------|------|------------|
| $I_{GT}$ | $V_D = 12$ V, $R_L = 33$ $\Omega$   | Min.           | 10    | mA   |            |
|          |                                     | Max.           | 50    |      |            |
| $V_{GT}$ |                                     | Max.           | 1.3   | V    |            |
| $I_{GD}$ | $V_D = 800$ V, $R_L = 3.3$ $\Omega$ | $T_j = 150$ °C | Min.  | 3    | mA         |
| $V_{GD}$ | $V_D = 800$ V, $R_L = 3.3$ $\Omega$ | $T_j = 150$ °C | Min.  | 0.2  | V          |
| $I_H$    | $I_T = 500$ mA, gate open           |                | Max.  | 100  | mA         |
| $I_L$    | $I_G = 1.2 \times I_{GT}$           |                | Max.  | 125  | mA         |
| $dV/dt$  | $V_D = 800$ V, gate open            | $T_j = 150$ °C | Min.  | 1000 | V/ $\mu$ s |

**Table 3. Timing Parameters**

| Symbol   | Test Conditions  |                | Value | Unit |         |
|----------|--|----------------|-------|------|---------|
| $t_{gt}$ | $I_T = 80$ A, $V_D = 800$ V, $I_G = 100$ mA, $dI_G/dt = 0.2$ A/ $\mu$ s  |                | Typ.  | 1    | $\mu$ s |
| $t_q$    | $I_{TM} = 25$ A, $V_D = 800$ V, $dI_T/dt = 10$ A/ $\mu$ s,<br>$V_R = 75$ V, $dV_D/dt = 20$ V/ $\mu$ s, $t_p = 100$ $\mu$ s | $T_j = 150$ °C | Typ.  | 150  | $\mu$ s |

**Table 4. Static Characteristics**

| Symbol   | Test Conditions                      |               | Value | Unit |   |
|----------|--------------------------------------|---------------|-------|------|---|
| $V_{TM}$ | $I_{TM} = 80$ A, $t_p = 380$ $\mu$ s | $T_j = 25$ °C | Max.  | 1.55 | V |

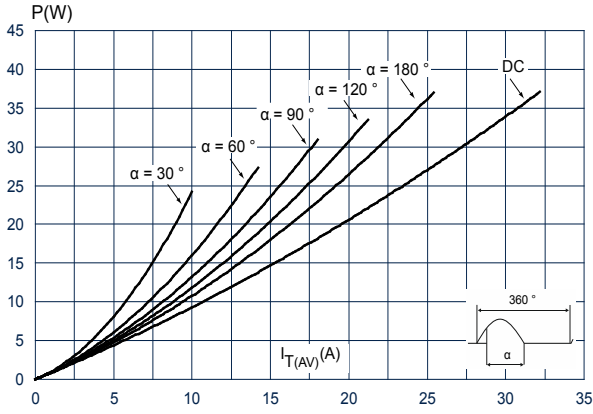
| Symbol            | Test Conditions                |                       |      | Value | Unit |
|-------------------|--------------------------------|-----------------------|------|-------|------|
| $V_{TO}$          | On-state threshold voltage     | $T_j = 150\text{ °C}$ | Max. | 0.83  | V    |
| $R_D$             | On-state dynamic resistance    | $T_j = 150\text{ °C}$ | Max. | 10    | mΩ   |
| $I_{DRM}/I_{RRM}$ | $V_D = V_{DRM}, V_R = V_{RRM}$ | $T_j = 25\text{ °C}$  | Max. | 5     | μA   |
|                   |                                | $T_j = 125\text{ °C}$ |      | 0.9   | mA   |
|                   |                                | $T_j = 150\text{ °C}$ |      | 6     | mA   |
| $I_{DSM}/I_{RSM}$ | $V_D = V_{DSM}, V_R = V_{RSM}$ | $T_j = 25\text{ °C}$  | Max. | 10    | μA   |

**Table 5. Thermal parameters**

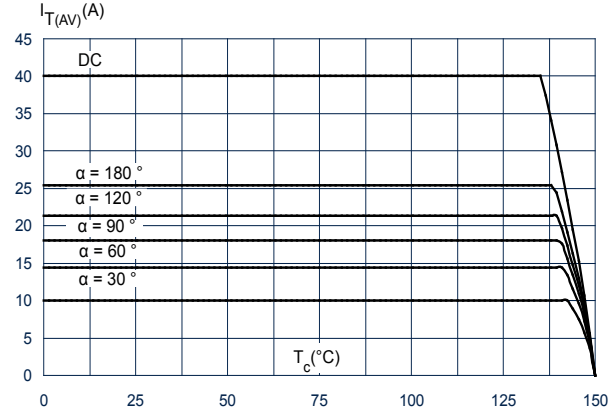
| Symbol        | Parameter   | Value | Unit |
|---------------|---|-------|------|
| $R_{th(j-c)}$ | Junction to case (DC)   | Max.  | 0.4  |
| $R_{th(j-a)}$ | Junction to ambient (DC, $S_{CU} = 2.5\text{ cm}^2$ , $e_{CU} = 70\text{ μm}$ ) | Typ.  | 45   |

## 1.1 Characteristics (curves)

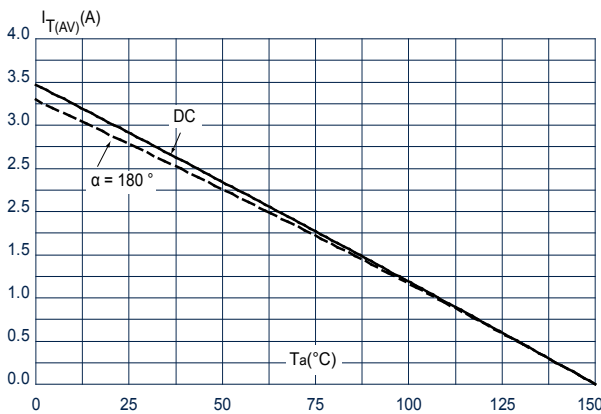
**Figure 1. Maximum average power dissipation versus average on-state current**



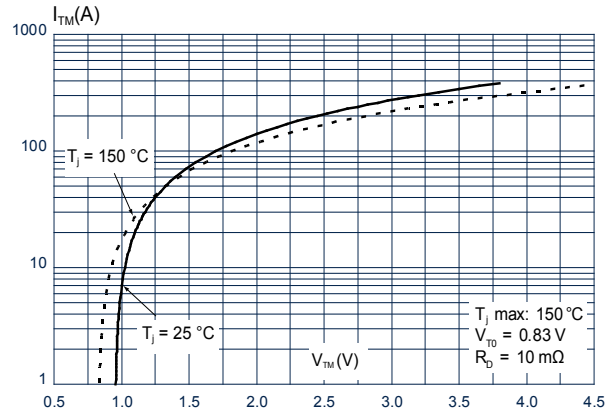
**Figure 2. Average and D.C. on-state current versus case temperature**



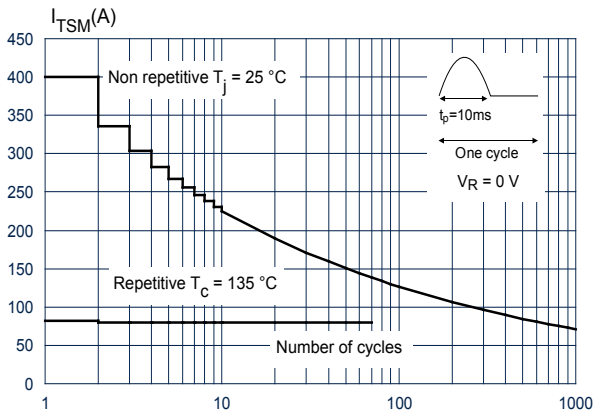
**Figure 3. Average and D.C. on-state current versus ambient temperature**



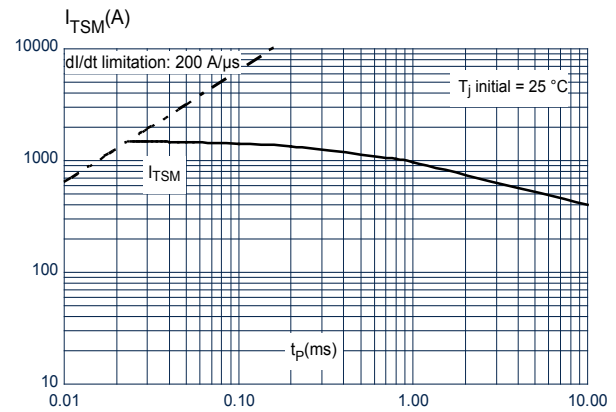
**Figure 4. On-state characteristics (maximum values)**

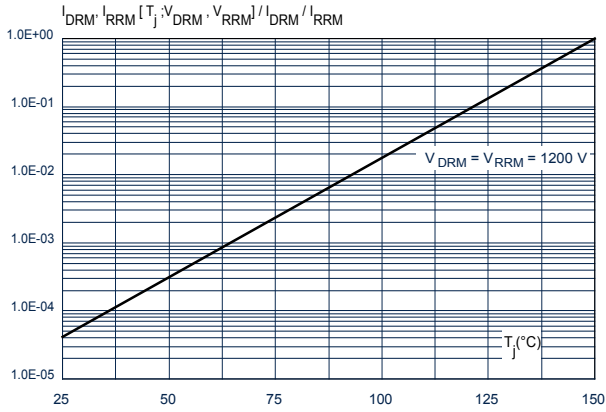
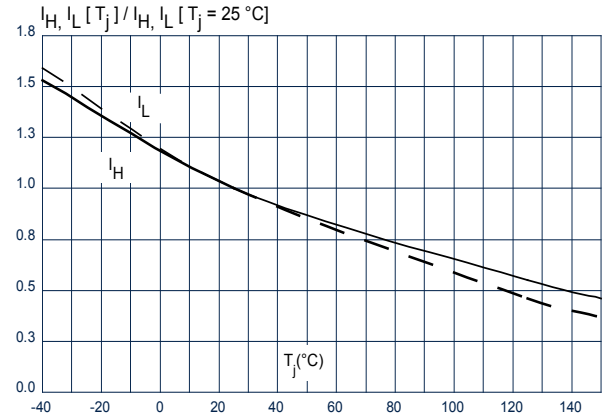
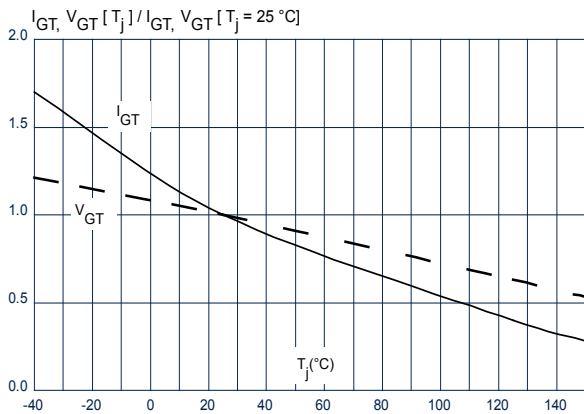
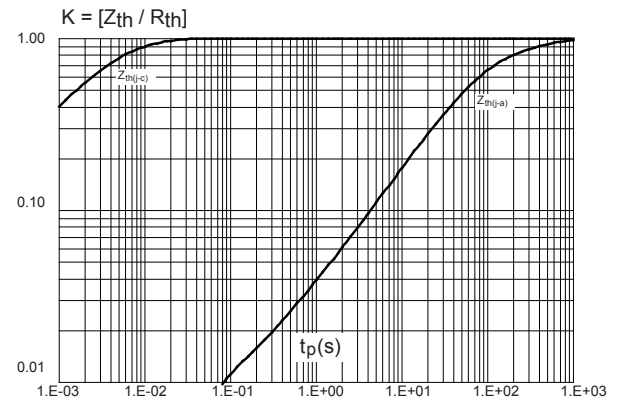
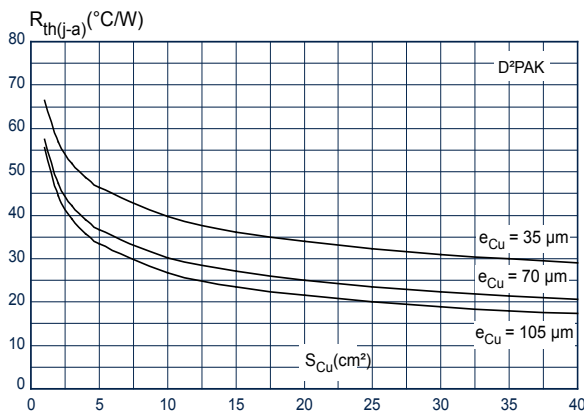
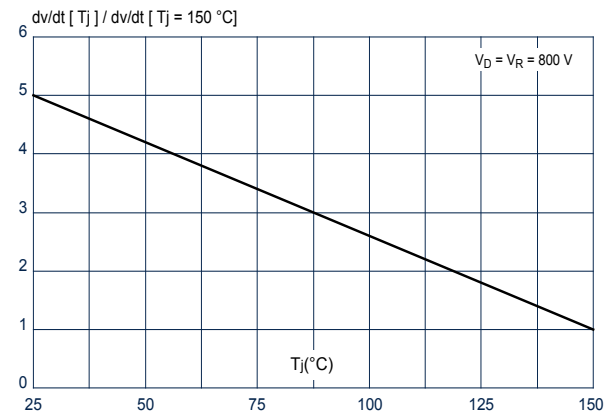


**Figure 5. Surge peak on-state current versus number of cycles**



**Figure 6. Non repetitive surge peak on-state current for a sinusoidal pulse with width  $t_p < 10$  ms**



**Figure 7. Relative variation of leakage current versus junction temperature for different values of blocking voltage (typical values)**

**Figure 8. Relative variation of holding and latching current versus junction temperature (typical values)**

**Figure 9. Relative variation of gate trigger current and gate voltage versus junction temperature (typical values)**

**Figure 10. Relative variation of thermal impedance junction to case and junction to ambient versus pulse duration**

**Figure 11. Thermal resistance junction to ambient versus copper surface under tab (typical values, epoxy printed board FR4) (D<sup>2</sup>PAK)**

**Figure 12. Relative variation of static dV/dt immunity versus junction temperature**


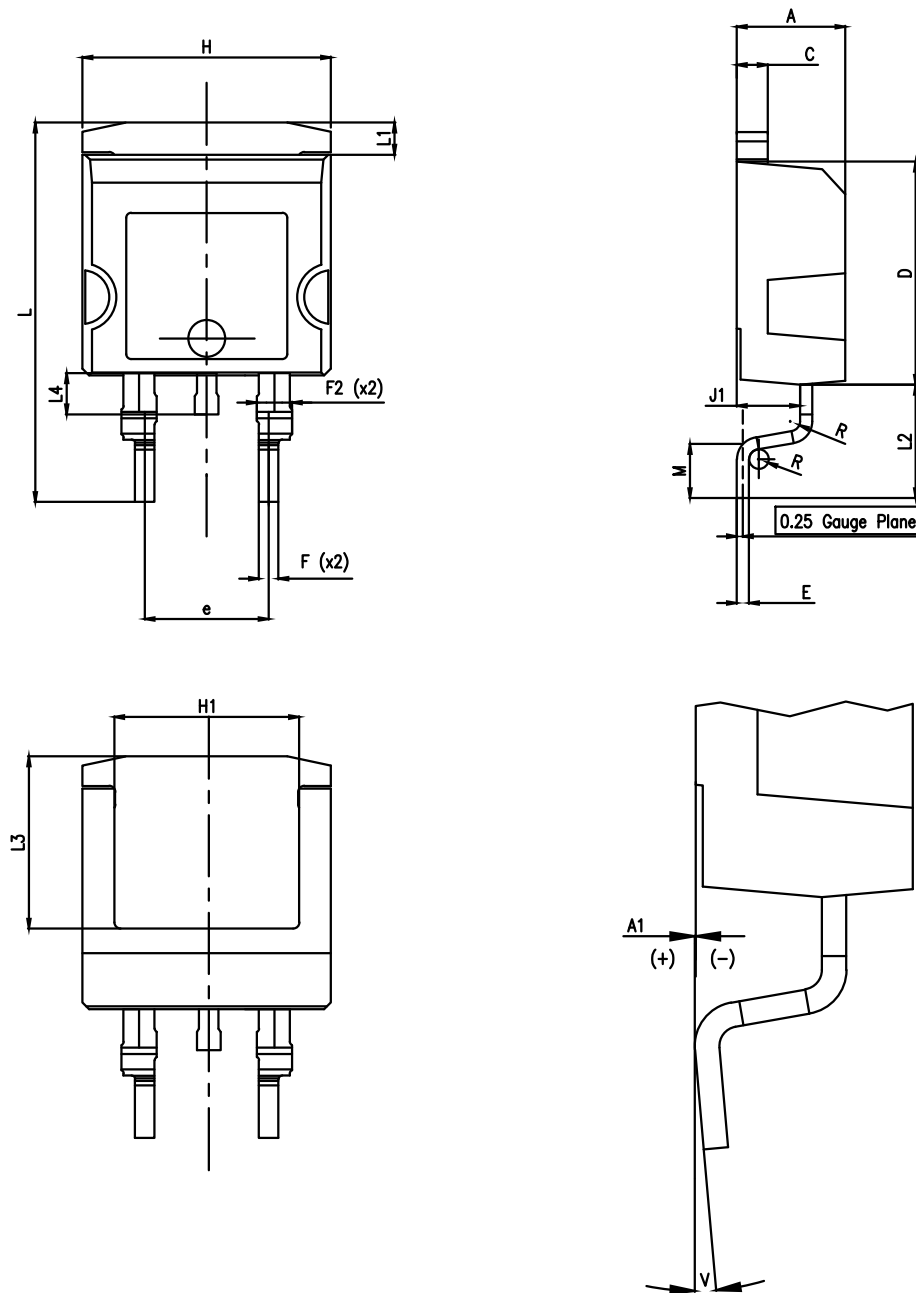
## 2 Package information

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 D<sup>2</sup>PAK high voltage package information

- Epoxy meets UL94, V0

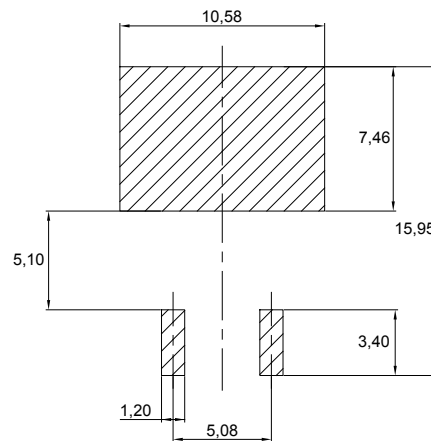
Figure 13. D<sup>2</sup>PAK high voltage package outline



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

| Ref. | Dimensions  |       |        |        |
|------|-------------|-------|--------|--------|
|      | Millimeters |       | Inches |        |
|      | Min.        | Max.  | Min.   | Max.   |
| A    | 4.30        | 4.70  | 0.1692 | 0.1851 |
| A1   | 0.03        | 0.20  | 0.0011 | 0.0079 |
| C    | 1.17        | 1.37  | 0.0460 | 0.0540 |
| D    | 8.95        | 9.35  | 0.3523 | 0.3682 |
| e    | 4.98        | 5.18  | 0.1960 | 0.2040 |
| E    | 0.50        | 0.90  | 0.0196 | 0.0355 |
| F    | 0.78        | 0.85  | 0.0307 | 0.0335 |
| F2   | 1.14        | 1.70  | 0.0448 | 0.0670 |
| H    | 10.00       | 10.40 | 0.3937 | 0.4095 |
| H1   | 7.40        | 7.80  | 0.2913 | 0.3071 |
| J1   | 2.49        | 2.69  | 0.0980 | 0.1060 |
| L    | 15.30       | 15.80 | 0.6023 | 0.6221 |
| L1   | 1.27        | 1.40  | 0.0500 | 0.0552 |
| L2   | 4.93        | 5.23  | 0.1940 | 0.2060 |
| L3   | 6.85        | 7.25  | 0.2696 | 0.2855 |
| L4   | 1.50        | 1.7   | 0.0590 | 0.0670 |
| M    | 2.60        | 2.9   | 0.1023 | 0.1142 |
| R    | 0.20        | 0.60  | 0.0078 | 0.0237 |
| V    | 0°          | 8°    | 0°     | 8°     |

**Figure 14. D<sup>2</sup>PAK high voltage footprint in mm**



*Note: For package and tape orientation, reel and inner box dimensions and tape outline please check TN1173.*

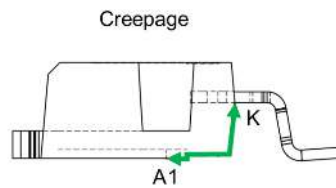
### 2.1.1 Creepage distance between anode and cathode

**Table 7. Creepage distance between anode and cathode**

| Symbol             | Parameter  |                       | Value | Unit |
|--------------------|--|-----------------------|-------|------|
| Cd <sub>K-A1</sub> | Minimum creepage distance between K and A1 (with top coating)    | D <sup>2</sup> PAK HV | 5.38  | mm   |
| Cd <sub>K-A2</sub> | Minimum creepage distance between K and A2 (without top coating) |                       | 3.48  |      |

*Note:* D<sup>2</sup>PAK HV creepage distance (anode to cathode) = 5.38 mm min. (refer to IEC 60664-1)

**Figure 15. Creepage with top coating**



Minimum distance between K & A1 = 5.38 mm (with top coating)

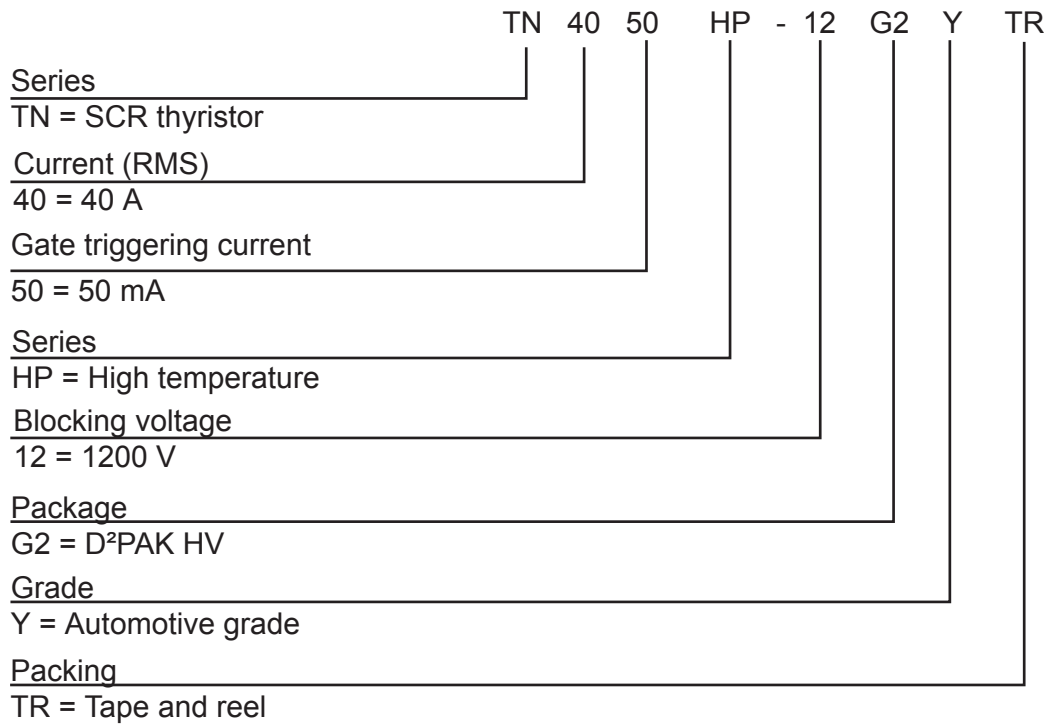
**Figure 16. Creepage without top coating**



Minimum distance between K & A2 = 3.48 mm (without top coating)



### 3 Ordering information

**Figure 17. Ordering information scheme**

**Table 8. Ordering information**

| Order code       | Marking    | Package               | Weight | Base qty. | Delivery mode     |
|------------------|------------|-----------------------|--------|-----------|-------------------|
| TN4050HP-12G2YTR | TN40P12YB2 | D <sup>2</sup> PAK HV | 1.38 g | 1000      | Tape and reel 13" |

## Revision history

**Table 9. Document revision history**

| Date        | Revision | Changes  |
|-------------|----------|--|
| 03-Aug-2021 | 1        | Initial release.   |
| 16-Dec-2021 | 2        | Updated <a href="#">Table 2</a> . Added <a href="#">Figure 6</a> and <a href="#">Figure 11</a> . |

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