

## Overvoltage protected AC switch

Datasheet - production data

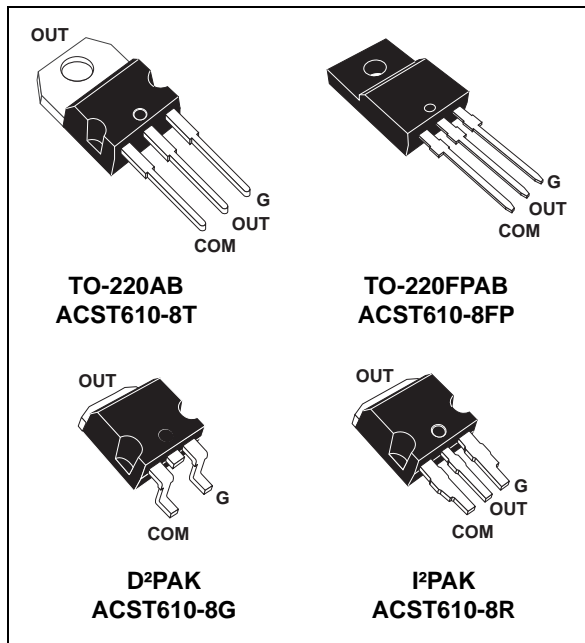
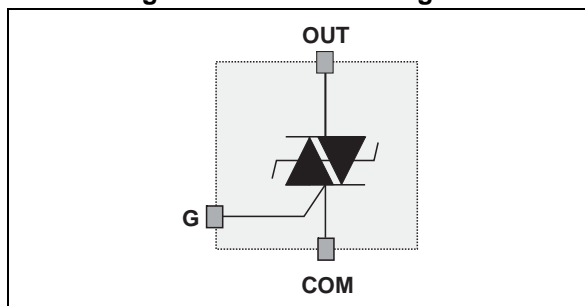


Figure 1. Functional diagram



### Features

- Triac with overvoltage protection
- Low  $I_{GT}$  ( $< 10$  mA)
- TO-220FPAB insulated package:
  - complies with UL standards (file ref: E81734)
  - insulation voltage:  $2000 V_{RMS}$

### Benefits

- Enables equipment to meet IEC 61000-4-5
- High off-state reliability with planar technology
- Needs no external overvoltage protection
- Reduces the power passive component count
- High immunity against fast transients described in IEC 61000-4-4 standards

### Applications

- AC mains static switching in appliance and industrial control systems
- Drive of medium power AC loads such as:
  - Universal motor of washing machine drum
  - Compressor for fridge or air conditioner

### Description

The ACST6 series belongs to the ACS/ACST power switch family built with A.S.D. (application specific discrete) technology. This high performance device is suited to home appliances or industrial systems, and drives loads up to 6 A.

This ACST6 switch embeds a Triac structure and a high voltage clamping device able to absorb the inductive turn-off energy and withstand line transients such as those described in the IEC 61000-4-5 standards. The ACST610 needs only low gate current to be activated ( $I_{GT} < 10$  mA) and still shows a high noise immunity complying with IEC standards such as IEC 61000-4-4 (fast transient burst test).

Table 1. Device summary

| Symbol            | Value | Unit |
|-------------------|-------|------|
| $I_{T(RMS)}$      | 6     | A    |
| $V_{DRM}/V_{RRM}$ | 800   | V    |
| $I_{GT}$          | 10    | mA   |

# 1 Characteristics

**Table 2. Absolute ratings (limiting values)**

| Symbol         | Parameter                                                                                        |                                                      | Value                    | Unit        |                  |
|----------------|--------------------------------------------------------------------------------------------------|------------------------------------------------------|--------------------------|-------------|------------------|
| $I_{T(RMS)}$   | On-state rms current (full sine wave)                                                            | TO-220FPAB                                           | $T_c = 92\text{ °C}$     | 6           | A                |
|                |                                                                                                  | TO-220AB/<br>D <sup>2</sup> PAK / I <sup>2</sup> PAK | $T_c = 106\text{ °C}$    |             |                  |
|                |                                                                                                  | D <sup>2</sup> PAK with<br>1 cm <sup>2</sup> copper  | $T_{amb} = 62\text{ °C}$ | 1.5         |                  |
| $I_{TSM}$      | Non repetitive surge peak on-state current $T_j$<br>initial = 25 °C, ( full cycle sine wave)     | F = 60 Hz                                            | $t_p = 16.7\text{ ms}$   | 47          | A                |
|                |                                                                                                  | F = 50 Hz                                            | $t_p = 20\text{ ms}$     | 45          | A                |
| $I^2t$         | $I^2t$ for fuse selection                                                                        |                                                      | $t_p = 10\text{ ms}$     | 13          | A <sup>2</sup> s |
| dl/dt          | Critical rate of rise on-state current<br>$I_G = 2 \times I_{GT}$ , ( $t_r \leq 100\text{ ns}$ ) | F = 120 Hz                                           | $T_j = 125\text{ °C}$    | 100         | A/ $\mu$ s       |
| $V_{PP}$       | Non repetitive line peak pulse voltage <sup>(1)</sup>                                            |                                                      | $T_j = 25\text{ °C}$     | 2           | kV               |
| $P_{G(AV)}$    | Average gate power dissipation                                                                   |                                                      | $T_j = 125\text{ °C}$    | 0.1         | W                |
| $P_{GM}$       | Peak gate power dissipation ( $t_p = 20\text{ }\mu$ s)                                           |                                                      | $T_j = 125\text{ °C}$    | 10          | W                |
| $I_{GM}$       | Peak gate current ( $t_p = 20\text{ }\mu$ s)                                                     |                                                      | $T_j = 125\text{ °C}$    | 1.6         | A                |
| $T_{stg}$      | Storage temperature range                                                                        |                                                      |                          | -40 to +150 | °C               |
| $T_j$          | Operating junction temperature range                                                             |                                                      |                          | -40 to +125 | °C               |
| $T_l$          | Maximum lead solder temperature during 10 ms (at 3 mm from plastic case)                         |                                                      |                          | 260         | °C               |
| $V_{INS(RMS)}$ | Insulation RMS voltage (60 seconds)                                                              | TO-220FPAB                                           |                          | 2000        | V                |

1. According to test described in IEC 61000-4-5 standard and [Figure 18](#).

**Table 3. Electrical characteristics**

| Symbol            | Test conditions                                    | Quadrant     | $T_j$  |      | Value | Unit       |
|-------------------|----------------------------------------------------|--------------|--------|------|-------|------------|
| $I_{GT}^{(1)}$    | $V_{OUT} = 12\text{ V}$ , $R_L = 33\text{ }\Omega$ | I - II - III | 25 °C  | MAX. | 10    | mA         |
| $V_{GT}$          | $V_{OUT} = 12\text{ V}$ , $R_L = 33\text{ }\Omega$ | I - II - III | 25 °C  | MAX. | 1.0   | V          |
| $V_{GD}$          | $V_{OUT} = V_{DRM}$ , $R_L = 3.3\text{ k}\Omega$   | I - II - III | 125 °C | MIN. | 0.2   | V          |
| $I_H^{(2)}$       | $I_{OUT} = 500\text{ mA}$                          |              | 25 °C  | MAX. | 25    | mA         |
| $I_L$             | $I_G = 1.2 \times I_{GT}$                          | I - III      | 25 °C  | MAX. | 30    | mA         |
| $I_L$             | $I_G = 1.2 \times I_{GT}$                          | II           | 25 °C  | MAX. | 40    | mA         |
| $dV/dt^{(2)}$     | $V_{OUT} = 67\% V_{DRM}$ , gate open               |              | 125 °C | MIN. | 500   | V/ $\mu$ s |
| $(dl/dt)_c^{(2)}$ | $(dV/dt)_c = 15\text{ V}/\mu$ s                    |              | 125 °C | MIN. | 3.5   | A/ms       |
| $V_{CL}$          | $I_{CL} = 0.1\text{ mA}$ , $t_p = 1\text{ ms}$     |              | 25 °C  | MIN. | 850   | V          |

1. Minimum  $I_{GT}$  is guaranteed at 5% of  $I_{GT}$  max
2. For both polarities of OUT pin referenced to COM pin

Table 4. Static characteristics

| Symbol                 | Test conditions                                  |                             | Value | Unit |               |
|------------------------|--------------------------------------------------|-----------------------------|-------|------|---------------|
| $V_{TM}^{(1)}$         | $I_{OUT} = 2.1\text{ A}, t_p = 500\ \mu\text{s}$ | $T_j = 25\ ^\circ\text{C}$  | MAX.  | 1.4  | V             |
|                        | $I_{OUT} = 8.5\text{ A}, t_p = 500\ \mu\text{s}$ |                             |       | 1.7  |               |
| $V_{T0}^{(1)}$         | Threshold voltage                                | $T_j = 125\ ^\circ\text{C}$ | MAX.  | 0.9  | V             |
| $R_d^{(1)}$            | Dynamic resistance                               | $T_j = 125\ ^\circ\text{C}$ | MAX.  | 80   | m $\Omega$    |
| $I_{DRM}$<br>$I_{RRM}$ | $V_{OUT} = V_{DRM}/V_{RRM}$                      | $T_j = 25\ ^\circ\text{C}$  | MAX.  | 20   | $\mu\text{A}$ |
|                        |                                                  | $T_j = 125\ ^\circ\text{C}$ | MAX.  | 500  | $\mu\text{A}$ |

1. For both polarities of OUT pin referenced to COM pin

Table 5. Thermal resistances

| Symbol        | Parameter                                                      |                                                 | Value | Unit               |
|---------------|----------------------------------------------------------------|-------------------------------------------------|-------|--------------------|
| $R_{th(j-a)}$ | Junction to ambient                                            | TO-220AB<br>TO-220FPAB                          | 60    | $^\circ\text{C/W}$ |
|               |                                                                | $I^2\text{PAK}$                                 | 65    |                    |
|               | Junction to ambient (soldered on 1 cm <sup>2</sup> copper pad) | D <sup>2</sup> PAK                              | 45    |                    |
| $R_{th(j-c)}$ | Junction to case for full cycle sine wave conduction           | TO-220FPAB                                      | 4.25  | $^\circ\text{C/W}$ |
|               |                                                                | TO-220AB<br>D <sup>2</sup> PAK, $I^2\text{PAK}$ | 2.5   |                    |

Figure 2. Maximum power dissipation versus RMS on-state current

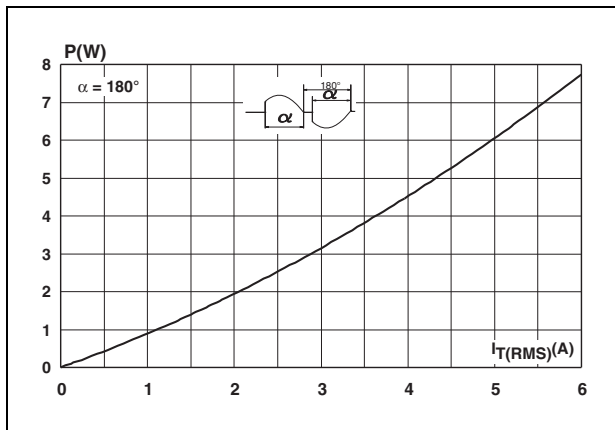
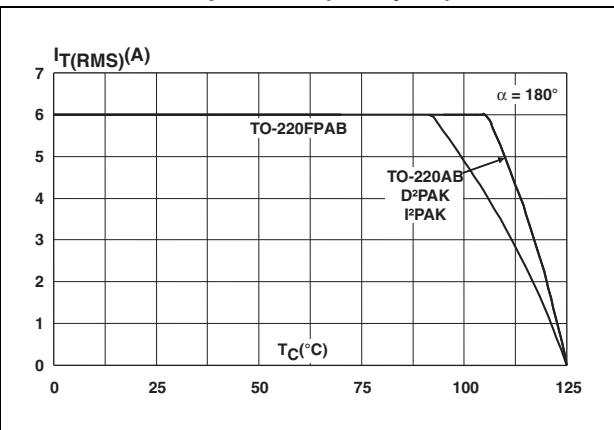
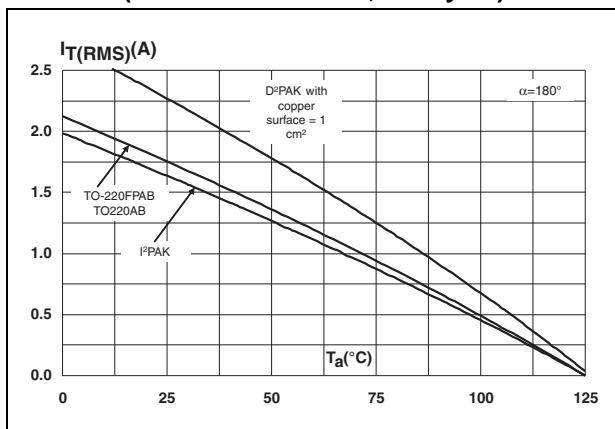


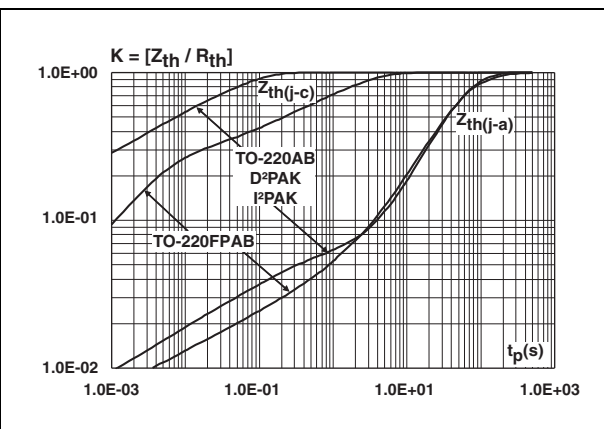
Figure 3. On-state RMS current versus case temperature (full cycle)



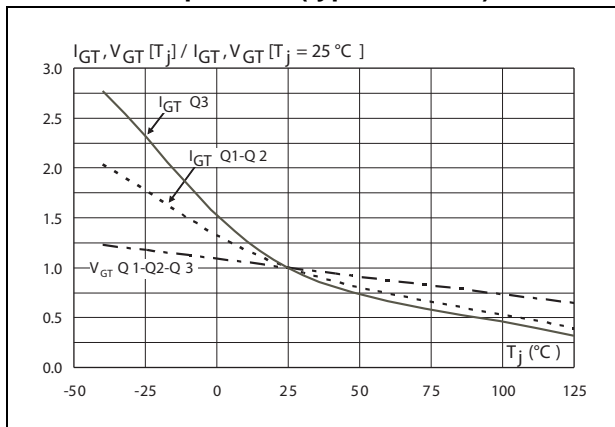
**Figure 4. On-state rms current versus ambient temperature (free air convection, full cycle)**



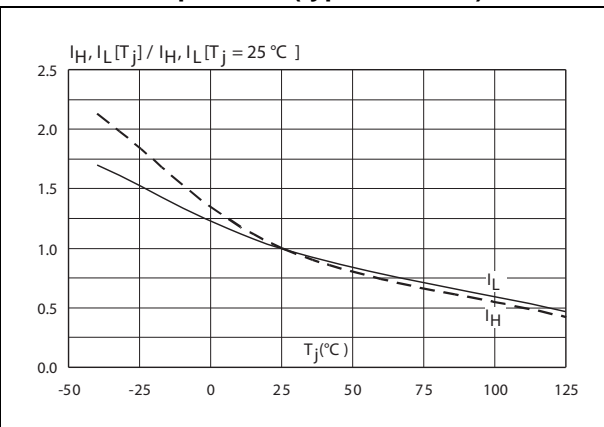
**Figure 5. Relative variation of thermal impedance versus pulse duration**



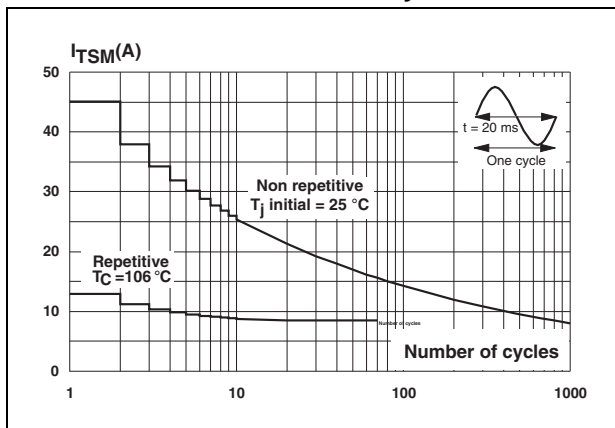
**Figure 6. Relative variation of gate trigger current ( $I_{GT}$ ) and voltage ( $V_{GT}$ ) versus junction temperature (typical values)**



**Figure 7. Relative variation of holding current ( $I_H$ ) and latching current ( $I_L$ ) versus junction temperature (typical values)**



**Figure 8. Surge peak on-state current versus number of cycles**



**Figure 9. Non repetitive surge peak on-state current versus sinusoidal pulse width**

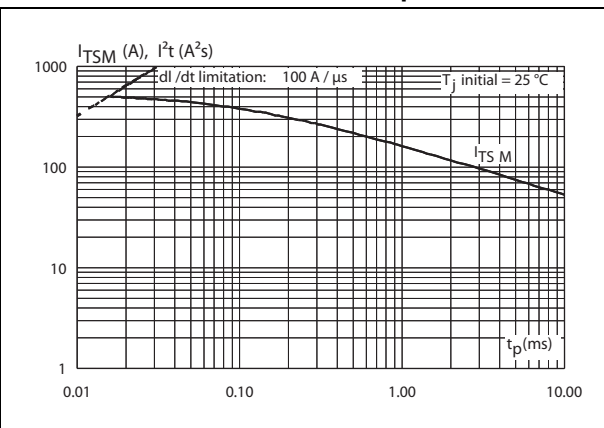


Figure 10. On-state characteristics (maximum values)

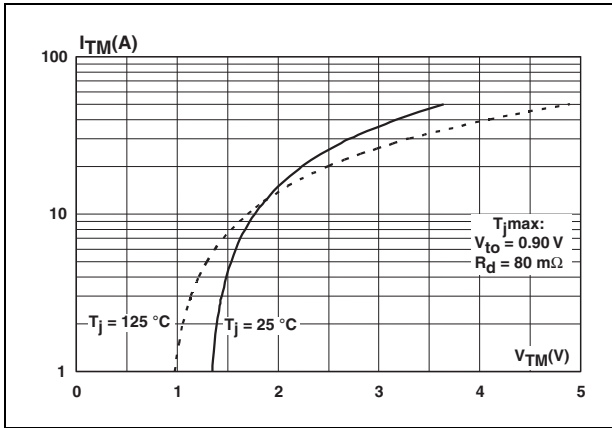


Figure 11. Relative variation of critical rate of decrease of main current  $(di/dt)_c$  versus junction temperature

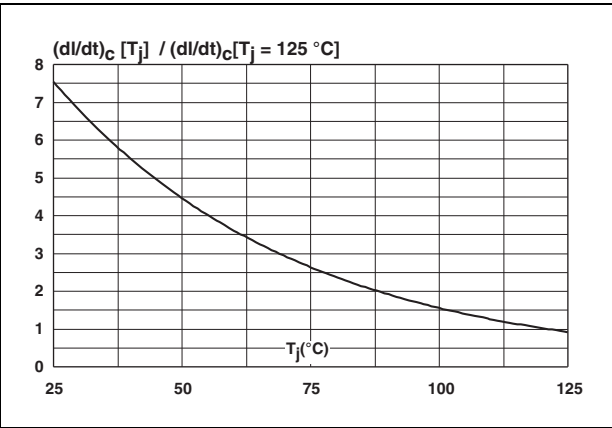


Figure 12. Relative variation of static dV/dt immunity versus junction temperature (gate open)

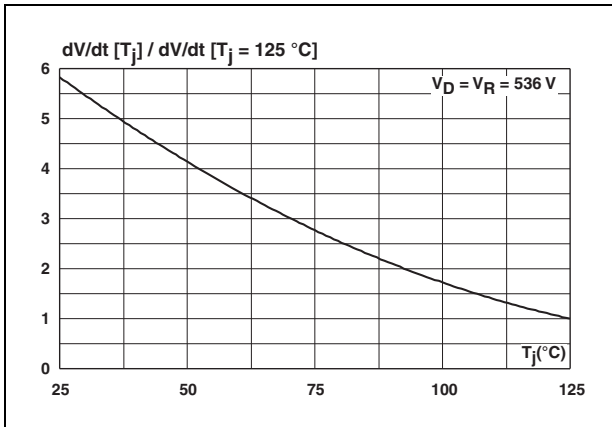


Figure 13. Relative variation of leakage current versus junction temperature

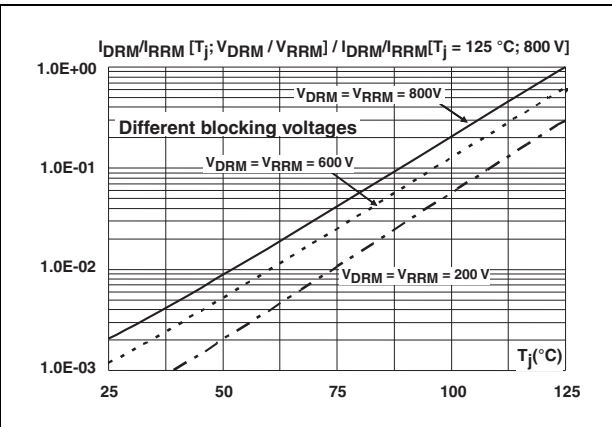


Figure 14. Relative variation of clamping voltage  $(V_{CL})$  versus junction temperature (minimum values)

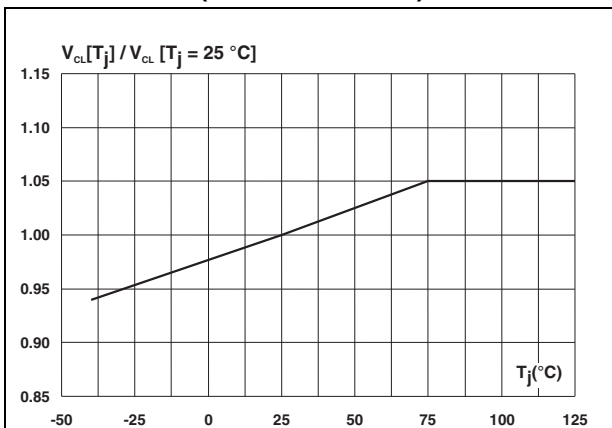
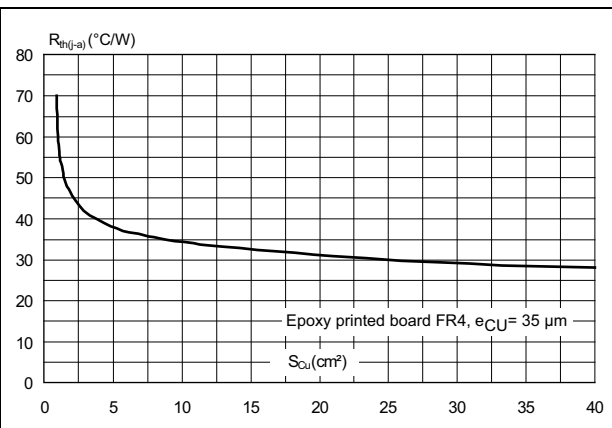


Figure 15. Thermal resistance junction to ambient versus copper surface under tab



## 2 Application information

### 2.1 Typical application description

The ACST6 device has been designed to control medium power load, such as AC motors in home appliances. Thanks to its thermal and turn off commutation performances, the ACST6 switch is able to drive an inductive load up to 6 A with no turn off additional snubber. It also provides high thermal performances in static and transient modes such as the compressor inrush current or high torque operating conditions of an AC motor. Thanks to its low gate triggering current level, the ACST6 can be driven directly by an MCU through a simple gate resistor as shown [Figure 16](#) and [Figure 17](#).

Figure 16. Compressor control – typical diagram

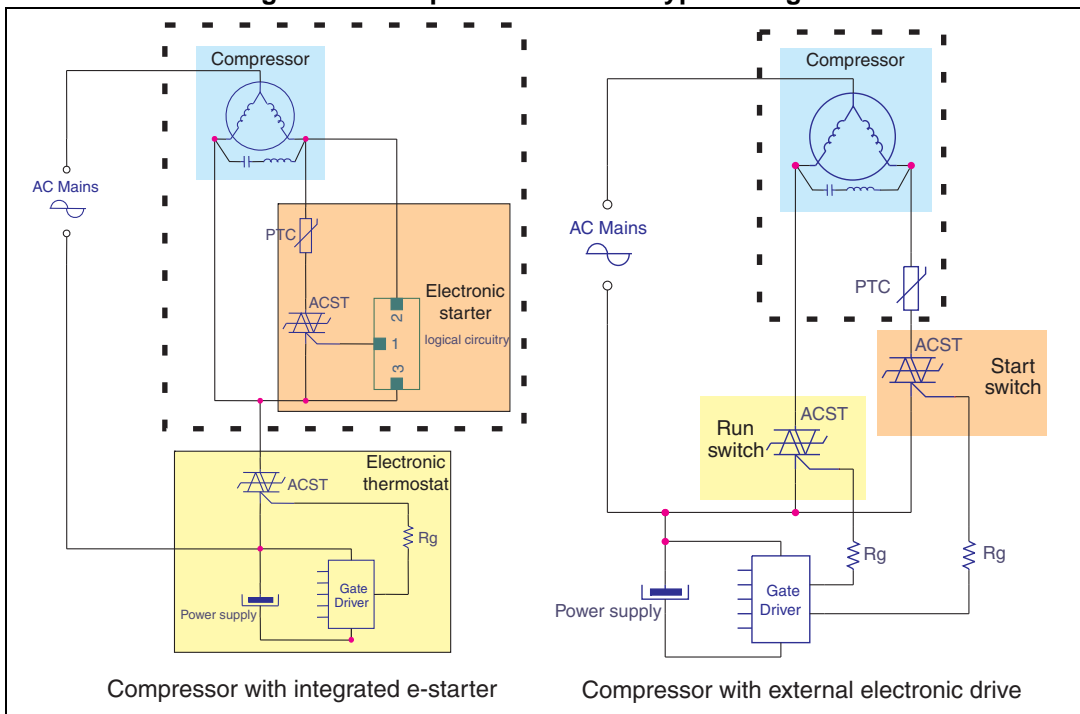
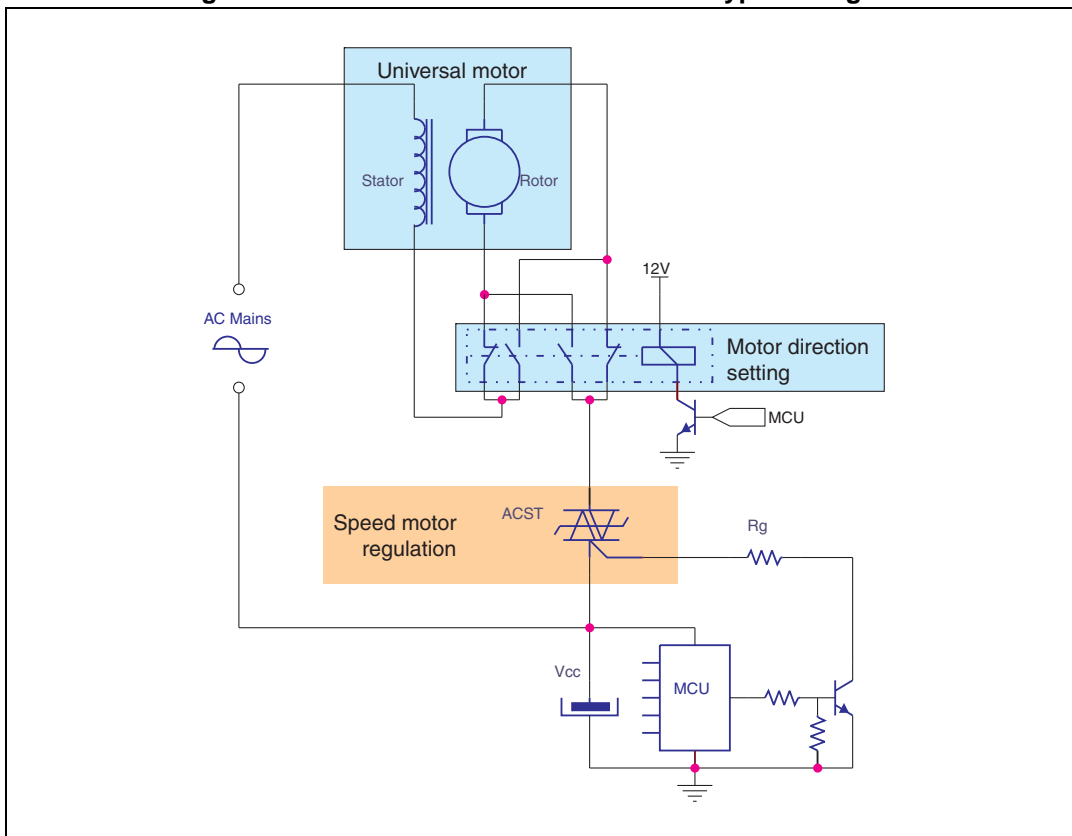


Figure 17. Universal drum motor control – typical diagram

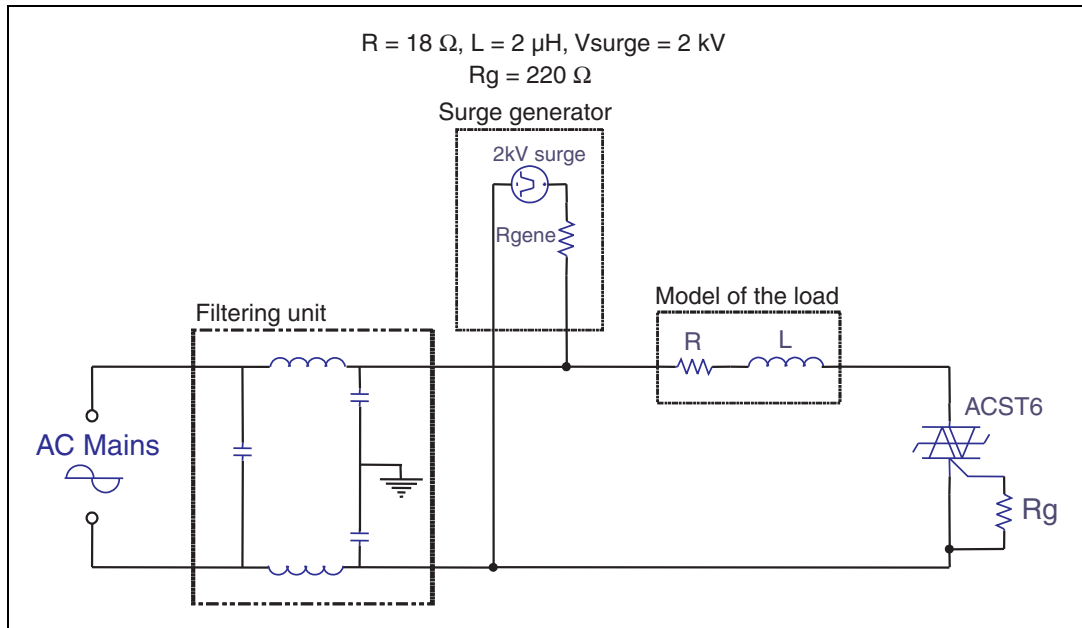


## 2.2 AC line transient voltage ruggedness

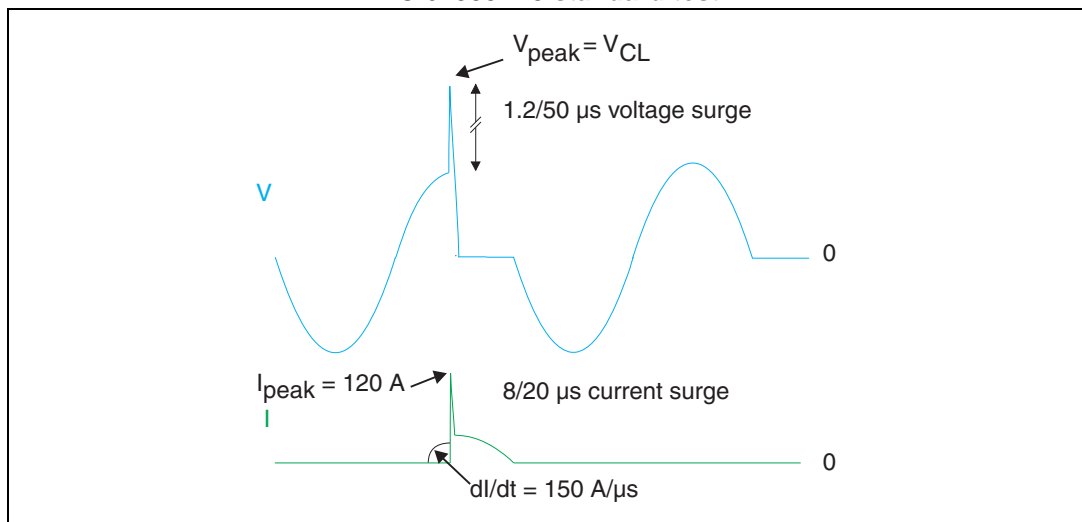
In comparison with standard Triacs, which are not robust against surge voltage, the ACST6 is self-protected against over-voltage, specified by the new parameter  $V_{CL}$ . The ACST6 switch can safely withstand AC line transient voltages either by clamping the low energy spikes, such as inductive spikes at switch off, or by switching to the on state (for less than 10 ms) to dissipate higher energy shocks through the load. This safety feature works even with high turn-on current ramp up.

The test circuit of [Figure 18](#) represents the ACST6 application, and is used to stress the ACST switch according to the IEC 61000-4-5 standard conditions. With the additional effect of the load which is limiting the current, the ACST switch withstands the voltage spikes up to 2 kV on top of the peak line voltage. The protection is based on an overvoltage crowbar technology. The ACST6 folds back safely to the on state as shown in [Figure 19](#). The ACST6 recovers its blocking voltage capability after the surge and the next zero current crossing. Such a non repetitive test can be done at least 10 times on each AC line voltage polarity.

**Figure 18. Overvoltage ruggedness test circuit for resistive and inductive loads for IEC 61000-4-5 standards**



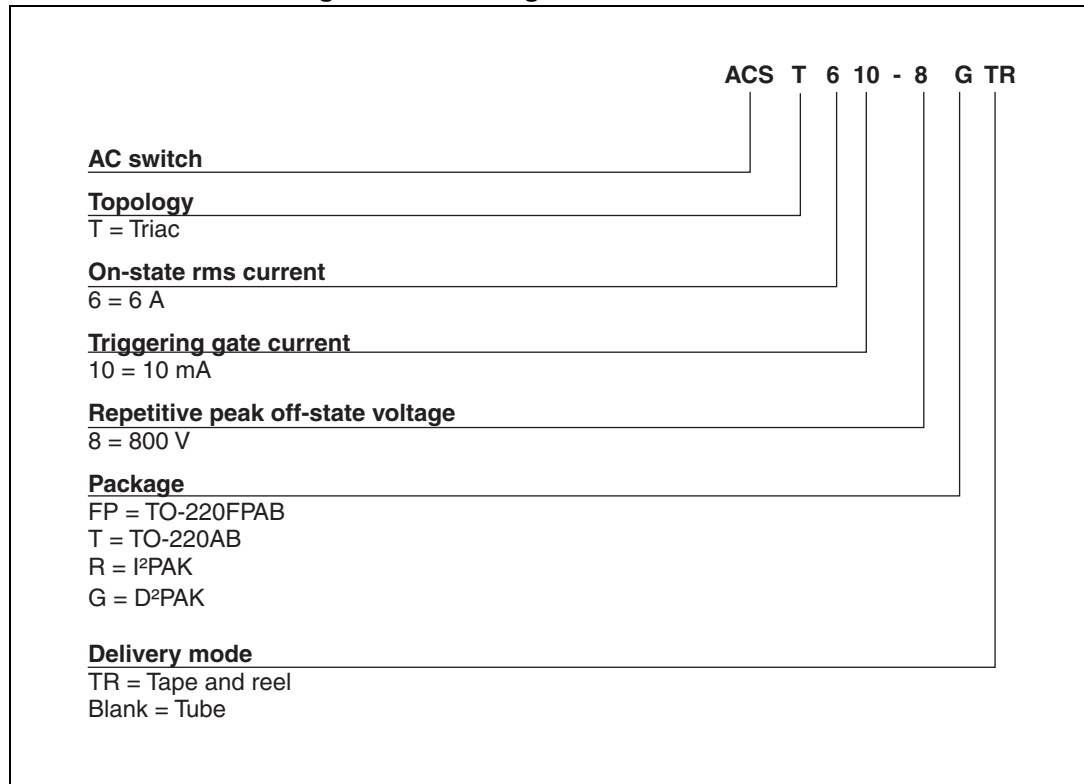
**Figure 19. Typical current and voltage waveforms across the ACST6 during IEC 61000-4-5 standard test**





### 3 Ordering information scheme

Figure 20. Ordering information scheme



## 4 Package information

- Epoxy meets UL94, V0
- Cooling method: by conduction (C)
- Recommended torque value (TO220AB, TO220FPAB): 0.4 to 0.6 N·m

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

## 4.1 TO-220AB package information

Figure 21. TO-220AB package outline

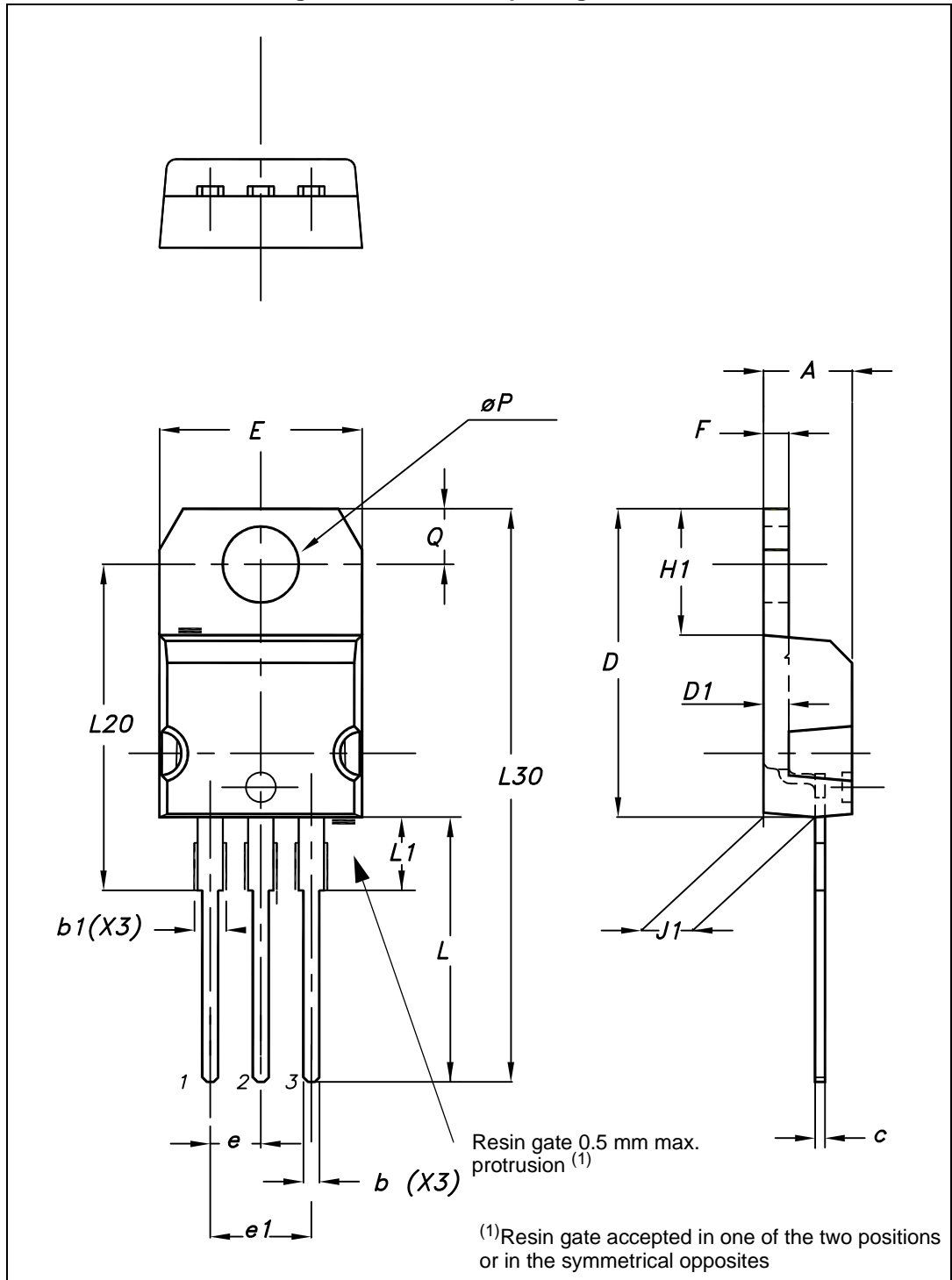


Table 6. TO-220AB package mechanical data

| Ref. | Dimensions  |       |             |        |
|------|-------------|-------|-------------|--------|
|      | Millimeters |       | Inches      |        |
|      | Min.        | Max.  | Min.        | Max.   |
| A    | 4.4         | 4.6   | 0.1732      | 0.1811 |
| b    | 0.61        | 0.88  | 0.024       | 0.0346 |
| b1   | 1.14        | 1.55  | 0.0449      | 0.0610 |
| c    | 0.48        | 0.7   | 0.0189      | 0.0276 |
| D    | 15.25       | 15.75 | 0.6004      | 0.6201 |
| D1   | 1.27 typ.   |       | 0.0500 typ. |        |
| E    | 10          | 10.4  | 0.3937      | 0.4094 |
| e    | 2.4         | 2.7   | 0.0945      | 0.1063 |
| e1   | 4.95        | 5.15  | 0.1949      | 0.2028 |
| F    | 1.23        | 1.32  | 0.0484      | 0.052  |
| H1   | 6.2         | 6.6   | 0.2441      | 0.2598 |
| J1   | 2.4         | 2.72  | 0.0945      | 0.1071 |
| L    | 13          | 14    | 0.5118      | 0.5512 |
| L1   | 3.5         | 3.93  | 0.1378      | 0.1547 |
| L20  | 16.40 typ.  |       | 0.6457 typ. |        |
| L30  | 28.90 typ.  |       | 1.1378 typ. |        |
| θP   | 3.75        | 3.85  | 0.1476      | 0.1516 |
| Q    | 2.65        | 2.95  | 0.1043      | 0.1161 |

## 4.2 TO-220FPAB package information

Figure 22. TO-220FPAB package outline

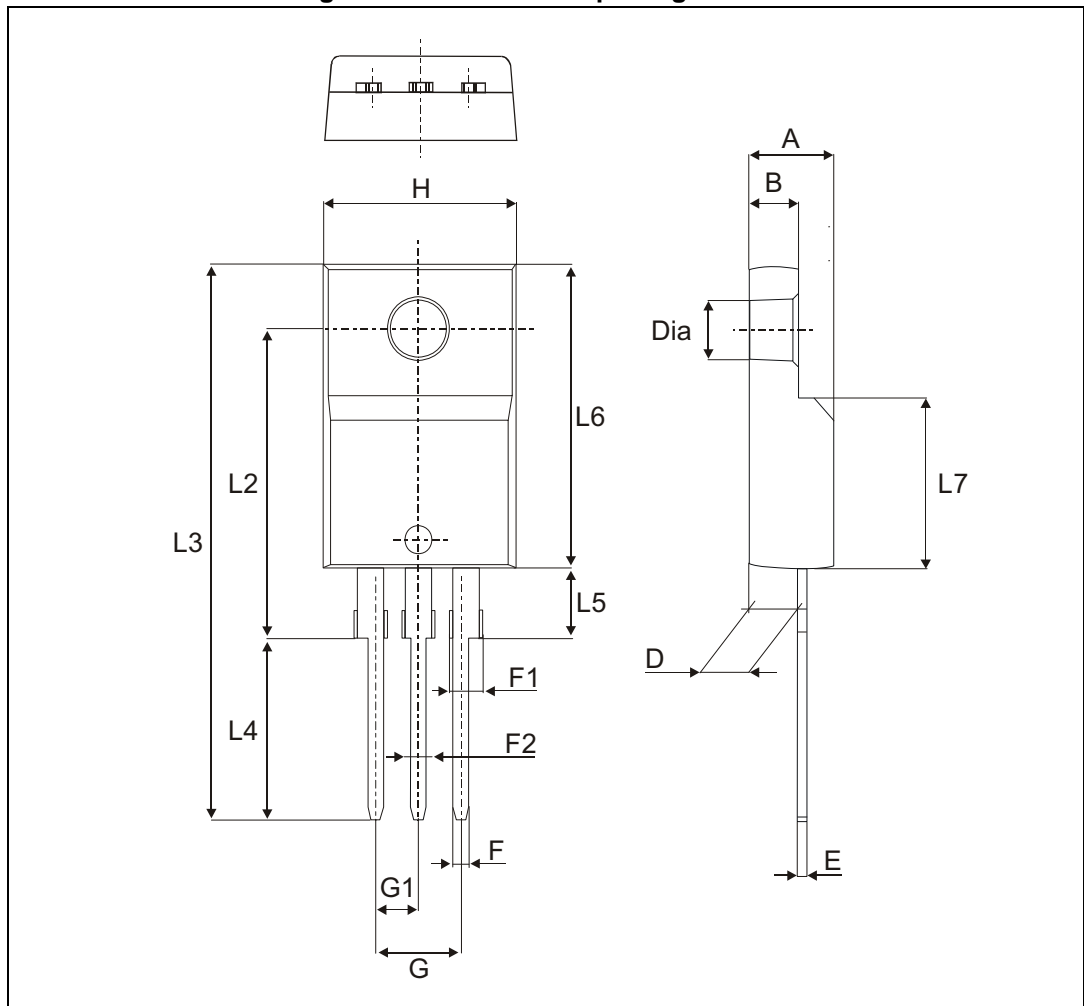


Table 7. TO-220FPAB package mechanical data

| Ref.  | Dimensions  |       |             |        |
|-------|-------------|-------|-------------|--------|
|       | Millimeters |       | Inches      |        |
|       | Min.        | Max.  | Min.        | Max.   |
| A     | 4.40        | 4.60  | 0.1739      | 0.1818 |
| B     | 2.50        | 2.70  | 0.0988      | 0.1067 |
| D     | 2.50        | 2.750 | 0.0988      | 0.1087 |
| E     | 0.45        | 0.70  | 0.0178      | 0.0277 |
| F     | 0.75        | 1.0   | 0.0296      | 0.0395 |
| F1    | 1.15        | 1.70  | 0.0455      | 0.0672 |
| F2    | 1.15        | 1.70  | 0.0455      | 0.0672 |
| G     | 4.95        | 5.20  | 0.1957      | 0.2055 |
| G1    | 2.40        | 2.70  | 0.0949      | 0.1067 |
| H     | 10.0        | 10.4  | 0.3953      | 0.4111 |
| L2    | 16 Typ.     |       | 0.6324 Typ. |        |
| L3    | 28.6        | 30.6  | 1.1304      | 1.2095 |
| L4    | 9.8         | 10.6  | 0.3874      | 0.4190 |
| L5    | 2.9         | 3.6   | 0.1146      | 0.1423 |
| L6    | 15.9        | 16.4  | 0.6285      | 0.6482 |
| L7    | 9.00        | 9.30  | 0.3557      | 0.3676 |
| Diam. | 3.00        | 3.20  | 0.1186      | 0.1265 |

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

Figure 23. D<sup>2</sup>PAK package outline

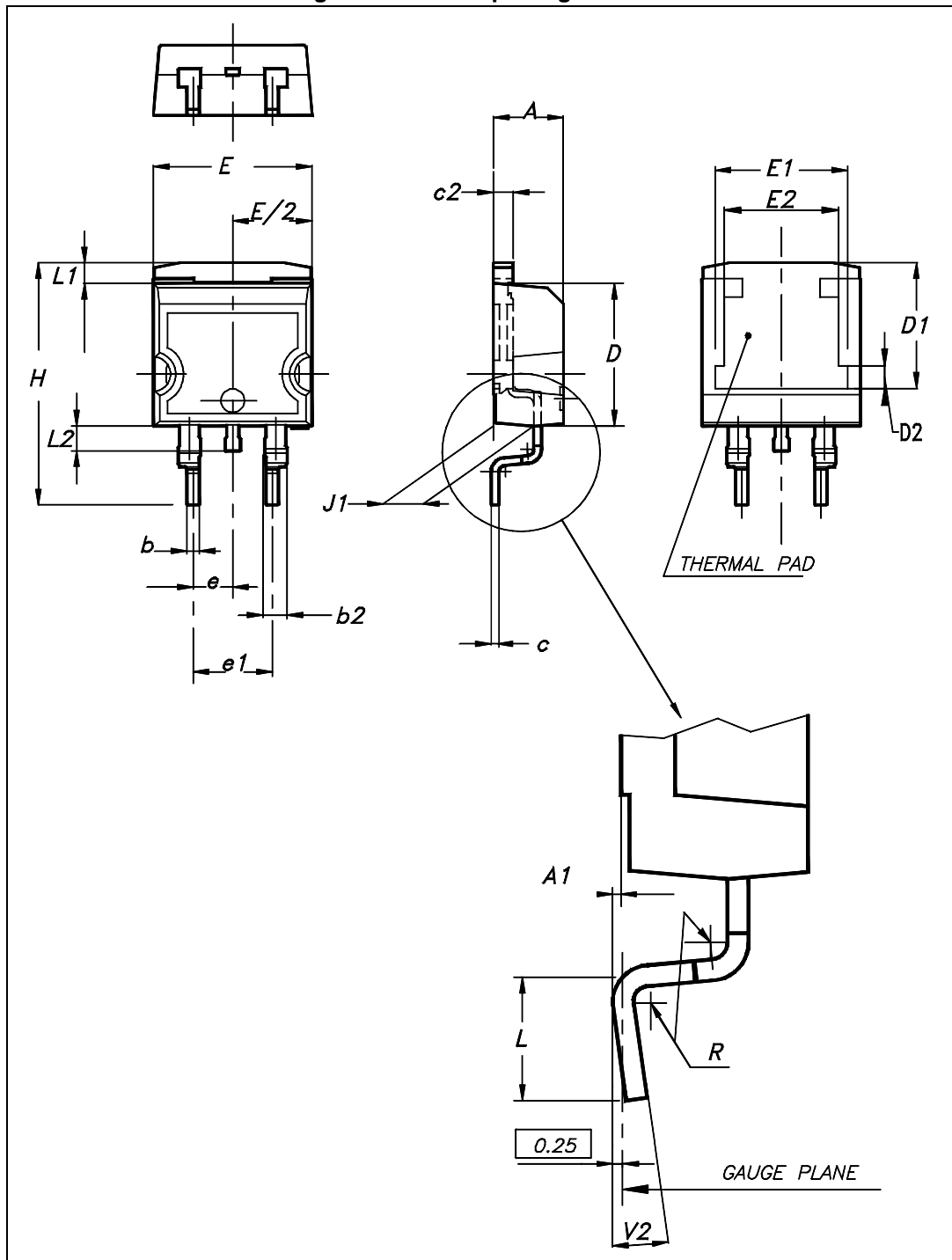
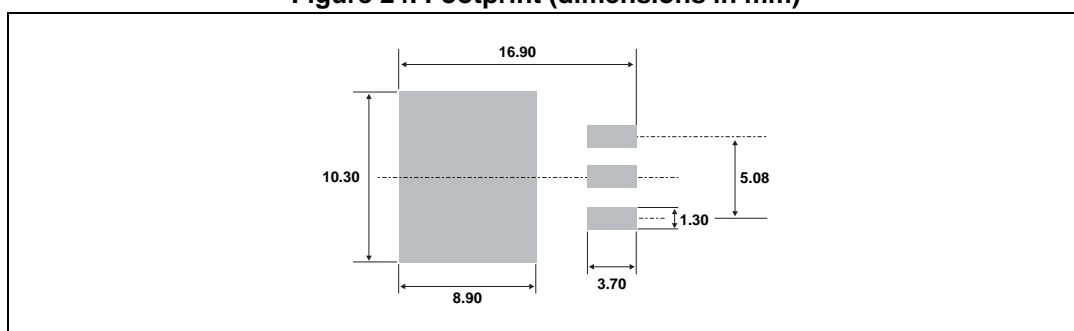


Table 8. D<sup>2</sup>PAK package mechanical data

| Ref. | Dimensions  |       |             |        |
|------|-------------|-------|-------------|--------|
|      | Millimeters |       | Inches      |        |
|      | Min.        | Max.  | Min.        | Max.   |
| A    | 4.40        | 4.60  | 0.1739      | 0.1818 |
| A1   | 2.49        | 2.69  | 0.0984      | 0.1063 |
| A2   | 0.03        | 0.23  | 0.0012      | 0.0091 |
| B    | 0.70        | 0.93  | 0.0277      | 0.0368 |
| B2   | 1.14        | 1.70  | 0.0451      | 0.0672 |
| C    | 0.45        | 0.60  | 0.0178      | 0.0237 |
| C2   | 1.23        | 1.36  | 0.0486      | 0.0538 |
| D    | 8.95        | 9.35  | 0.3538      | 0.3696 |
| E    | 10.00       | 10.40 | 0.3953      | 0.4111 |
| G    | 4.88        | 5.28  | 0.1929      | 0.2087 |
| L    | 15.00       | 15.85 | 0.5929      | 0.6265 |
| L2   | 1.27        | 1.40  | 0.0502      | 0.0553 |
| L3   | 1.40        | 1.75  | 0.0553      | 0.0692 |
| M    | 2.40        | 3.20  | 0.0949      | 0.1265 |
| R    | 0.40 typ.   |       | 0.0158 typ. |        |
| V2   | 0°          | 8°    | 0°          | 8°     |

Figure 24. Footprint (dimensions in mm)





### 4.4 I<sup>2</sup>PAK package information

Figure 25. I<sup>2</sup>PAK package outline

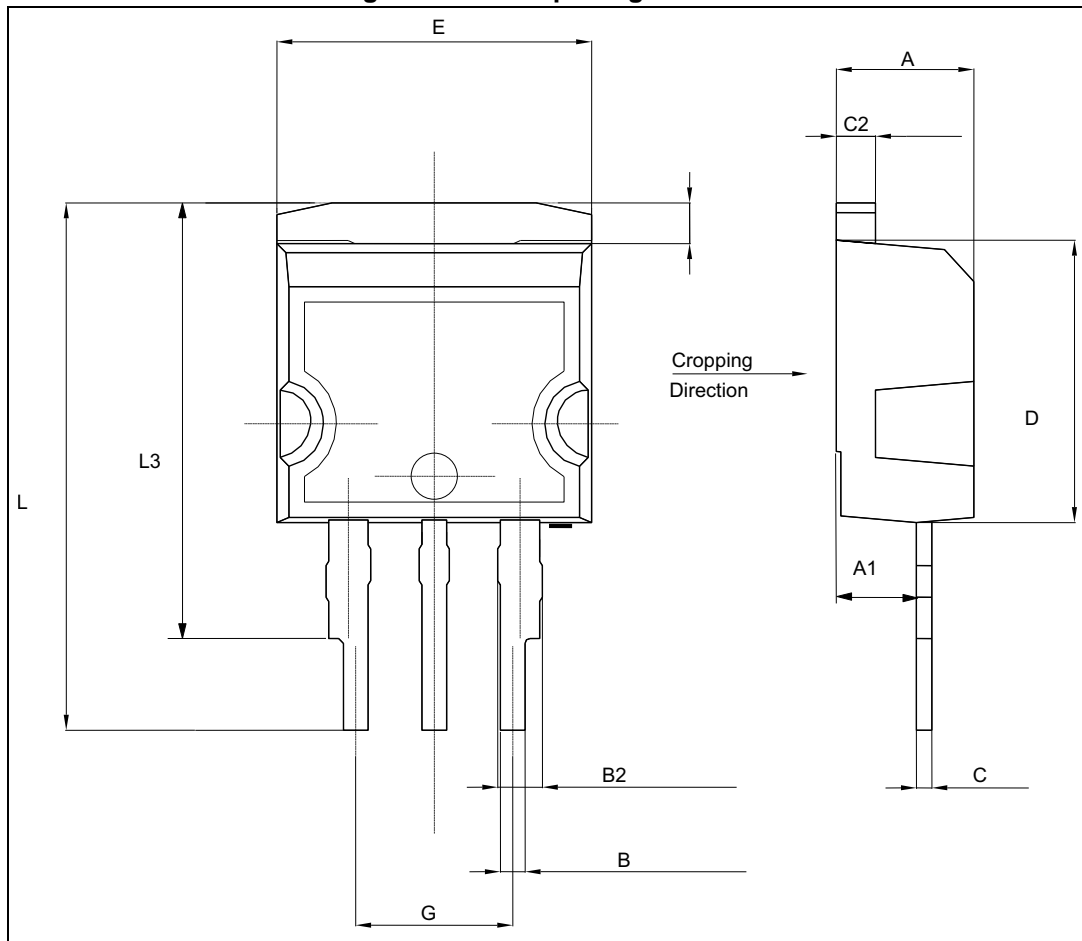


Table 9. I<sup>2</sup>PAK package mechanical data

| Ref. | Dimensions  |       |        |        |
|------|-------------|-------|--------|--------|
|      | Millimeters |       | Inches |        |
|      | Min.        | Max.  | Min.   | Max.   |
| A    | 4.4         | 4.6   | 0.1739 | 0.1818 |
| A1   | 2.49        | 2.69  | 0.0984 | 0.1063 |
| B    | 0.7         | 0.93  | 0.0277 | 0.0368 |
| B2   | 1.14        | 1.7   | 0.0451 | 0.0672 |
| C    | 0.45        | 0.6   | 0.0178 | 0.0237 |
| C2   | 1.23        | 1.36  | 0.0486 | 0.0538 |
| D    | 8.95        | 9.35  | 0.3538 | 0.3696 |
| E    | 10          | 10.4  | 0.3953 | 0.4111 |
| G    | 4.88        | 5.28  | 0.1929 | 0.2087 |
| L    | 16.7        | 17.5  | 0.6601 | 0.6917 |
| L2   | 1.27        | 1.4   | 0.0502 | 0.0553 |
| L3   | 13.82       | 14.42 | 0.5462 | 0.5700 |

## 5 Ordering information

**Table 10. Ordering information**

| Order code   | Marking  | Package            | Weight | Base Qty | Packing mode  |
|--------------|----------|--------------------|--------|----------|---------------|
| ACST610-8FP  | ACST6108 | TO-220FPAB         | 2.4 g  | 50       | Tube          |
| ACST610-8G   |          | D <sup>2</sup> PAK | 1.5 g  | 50       | Tube          |
| ACST610-8GTR |          | D <sup>2</sup> PAK | 1.5 g  | 1000     | Tape and reel |
| ACST610-8R   |          | I <sup>2</sup> PAK | 2.3 g  | 50       | Tube          |
| ACST610-8T   |          | TO-220AB           | 1.5 g  | 50       | Tube          |

## 6 Revision history

**Table 11. Document revision history**  
**Table 12.**

| Date        | Revision | Changes                                                                                                                                         |
|-------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| Jan-2002    | 7F       | Previous issue.                                                                                                                                 |
| 09-May-2005 | 8        | Layout update. No content change.                                                                                                               |
| 18-Dec-2009 | 9        | Document structure and parameter presentation revised for consistency with other ACST documents. No technical changes. Order codes updated.     |
| 01-Jul-2010 | 10       | Updated <i>Figure 20</i> .                                                                                                                      |
| 30-May-2017 | 11       | Updated features in cover page and <a href="#">Table 2</a> .<br>Updated <a href="#">Section 4: Package information</a> .<br>Minor text changes. |

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