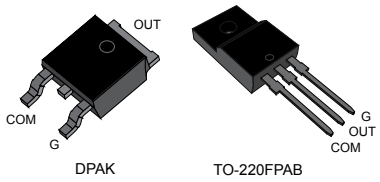
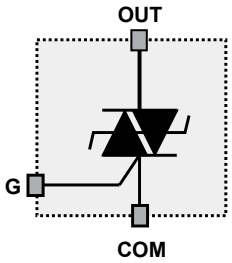
# ACST2

Datasheet

## 2 A - 800 V overvoltage protected AC switch




DPAK TO-220FPAB




## Features

- Triac with overvoltage crowbar technology
- High noise immunity: static dV/dt > 500 V/µs
- 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
  - Interfaces directly with the micro-controller
  - High immunity against fast transients described in IEC 61000-4-4 standards

## Applications

- AC mains static switching in appliance and industrial control systems
- Driving low power highly inductive loads like solenoid, pump, fan, and micro-motor

| Product status link |
|---|
| ACST2 |

| Product summary | |
|---|---|
| $I_{T(RMS)}$ | 2 A |
| $V_{DRM}/V_{RRM}$ | 800 V |
| $I_{GT}$ | 10 mA |

## Description

The ACST2 series belongs to the ACS / ACST power switch family. This high performance device is suited to home appliances or industrial systems and drives loads up to 2 A.

This ACST2 switch embeds a Triac structure with a high voltage clamping device to absorb the inductive turn-off energy and withstand line transients such as those described in the IEC 61000-4-5 standards. The component needs a low gate current to be activated ($I_{GT}$ < 10 mA) and still shows a high electrical noise immunity complying with IEC standards such as IEC 61000-4-4 (fast transient burst test).

# 1 Characteristics

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

| Symbol | Parameter | | | Value | Unit |
|---|---|---|---|---|---|
| $I_{T(RMS)}$ | On-state rms current (full sine wave) | TO-220FPAB | $T_c$ = 105 °C | 2 | A |
| | | DPAK | $T_c$ = 110 °C | | |
| $I_{TSM}$ | Non repetitive surge peak on-state current $T_j$ initial = 25 °C, (full cycle sine wave) | f = 50 Hz | $t_p$ = 20 ms | 8.0 | A |
| | | f = 60 Hz | $t_p$ = 16.7 ms | 8.4 | |
| $I^2t$ | $I^2t$ for fuse selection | | $t_p$ = 10 ms | 0.5 | $A^2s$ |
| dI/dt | Critical rate of rise on-state current $I_G$ = 2 x $I_{GT}$, tr ≤ 100 ns | f = 120 Hz | $T_j$ = 125 °C | 50 | A/µs |
| $V_{PP}$(1) | Non repetitive line peak pulse voltage(1) | | $T_j$ = 25 °C | 2 | kV |
| $P_{G(AV)}$ | Average gate power dissipation | | $T_j$ = 125 °C | 0.1 | W |
| $P_{GM}$ | Peak gate power dissipation ($t_p$ = 20 µs) | | $T_j$ = 125 °C | 10 | W |
| $I_{GM}$ | Peak gate current ($t_p$ = 20 µs) | | $T_j$ = 125 °C | 1.6 | A |
| $T_{stg}$ | Storage temperature range | | | -40 to +150 | °C |
| $T_j$ | Operating junction temperature range | | | -40 to +125 | °C |
| $T_L$ | Lead temperature for soldering during 10 s (at 3 mm from plastic case) | | | 260 | °C |
| $V_{ins}$ | Insulation rms voltage (60 seconds) | | | 2000 | V |

1. *according to test described by standard IEC 61000-4-5, see Figure 16 for conditions*

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

| Symbol | Test conditions | Quadrant | | Value | Unit |
|---|---|---|---|---|---|
| $I_{GT}$ (1) | $V_{OUT}$ = 12 V, $R_L$ = 33 Ω | I - II - III | Max. | 10 | mA |
| $V_{GT}$ | | | Max. | 1.1 | V |
| $V_{GD}$ | $V_{OUT}$ = $V_{DRM}$, $R_L$ = 3.3 kΩ, $T_j$ = 125 °C | I - II - III | Min. | 0.2 | V |
| $I_H$(2) | $I_{OUT}$ = 100 mA | | Max. | 10 | mA |
| $I_L$ | $I_G$ = 1.2 x $I_{GT}$ | I - III | Max. | 25 | mA |
| | | II | Max. | 35 | |
| dV/dt(2) | $V_{OUT}$ = 67% $V_{DRM}$, gate open, $T_j$ = 125 °C | | Min. | 500 | V/µs |
| (dI/dt)c(2) | (dV/dt)c = 15 V/µs, $T_j$ = 125 °C | | Min. | 0.5 | A/ms |
| $V_{CL}$ | $I_{CL}$ = 0.1 mA, $t_p$ = 1 ms | | 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 3. Static characteristics**

| Symbol | Test conditions | | | Value | Unit |
|---|---|---|---|---|---|
| $V_{TM}$ (1) | $I_{OUT}$ = 2.8 A, $t_p$ = 500 µs | $T_j$ = 25 °C | Max. | 2 | V |
| $V_{T0}$ (1) | Threshold voltage | $T_j$ = 125 °C | Max. | 0.9 | V |
| $R_D$ (1) | Dynamic resistance | $T_j$ = 125 °C | Max. | 250 | mΩ |
| $I_{DRM}$ | $V_{OUT}$ = $V_{DRM}$/ $V_{RRM}$ | $T_j$ = 25 °C | Max. | 10 | µA |
| $I_{RRM}$ | | $T_j$ = 125 °C | | 0.5 | mA |

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

**Table 4. Thermal characteristics**

| Symbol | Parameter | | Value | Unit |
|---|---|---|---|---|
| $R_{th(j-c)}$ | Junction to case for full cycle sine wave conduction | DPAK | 4.5 | °C/W |
| | | TO-220FPAB | 7 | |
| $R_{th(j-a)}$ | Junction to ambient | TO-220FPAB | 60 | |
| | Junction to ambient, $S_{CU}$ (1) = 0.5 cm² | DPAK | 70 | |

1. *$S_{CU}$ = copper surface under tab*

## 1.1 Characteristics (curves)

**Figure 1. Maximum power dissipation versus on-state RMS current (full cycle)**

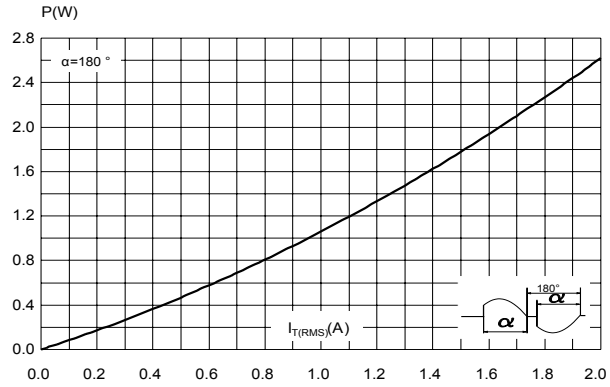



**Figure 2. On-state RMS current versus case temperature**

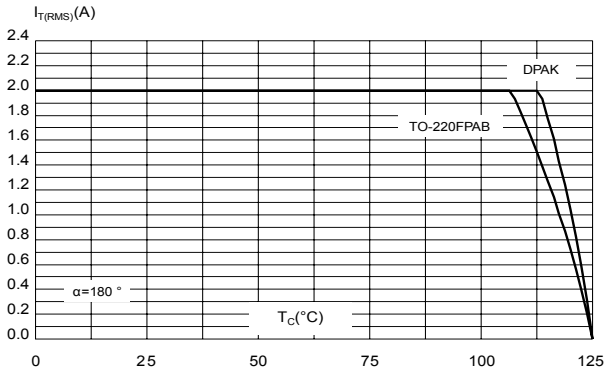



**Figure 3. On-state RMS current versus ambient temperature**

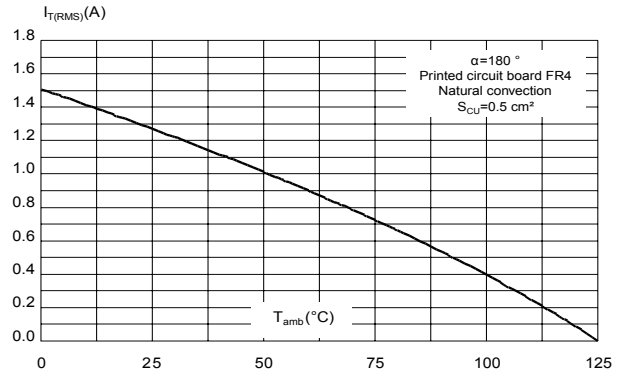



**Figure 4. Relative variation of thermal impedance junction to case versus pulse duration (TO-220FPAB)**

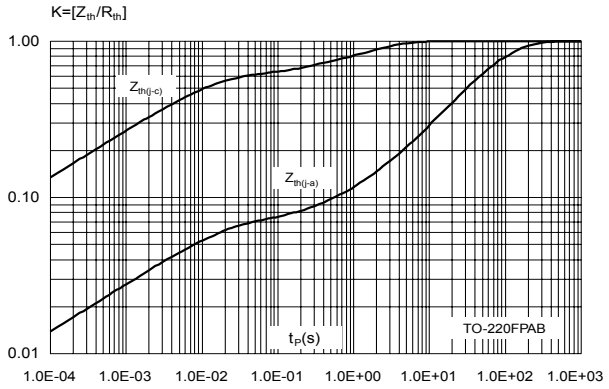



**Figure 5. Relative variation of thermal impedance junction to case versus pulse duration (DPAK)**

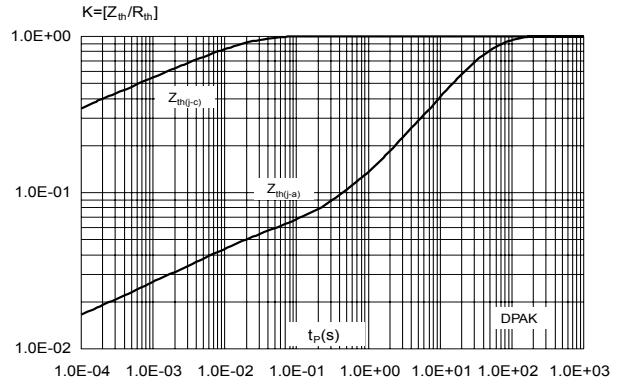



**Figure 6. Relative variation of gate trigger, holding and latching current versus junction temperature (typical value)**

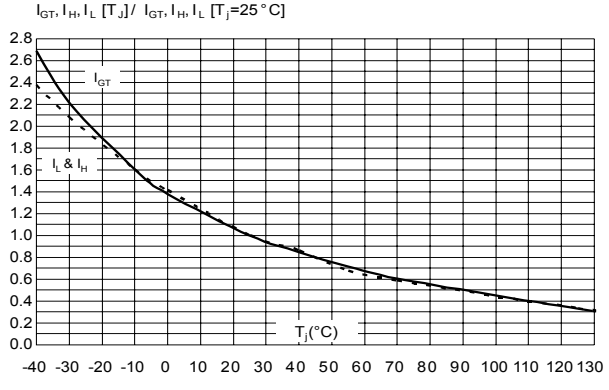


**Figure 7. Relative variation of static dV/dt versus junction temperature**

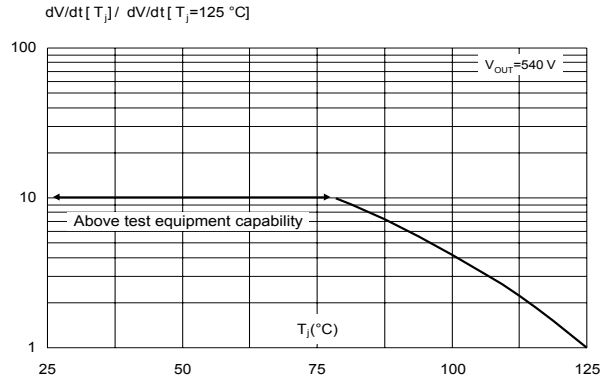



**Figure 8. Relative variation of critical rate of decrease of main current versus reapplied dV/dt (typical values)**

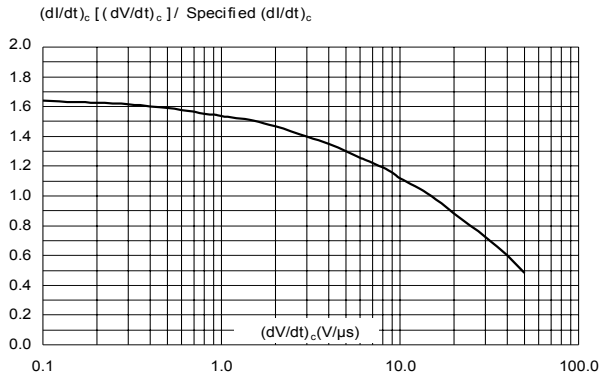



**Figure 9. Relative variation of critical rate of decrease of main current versus junction temperature**

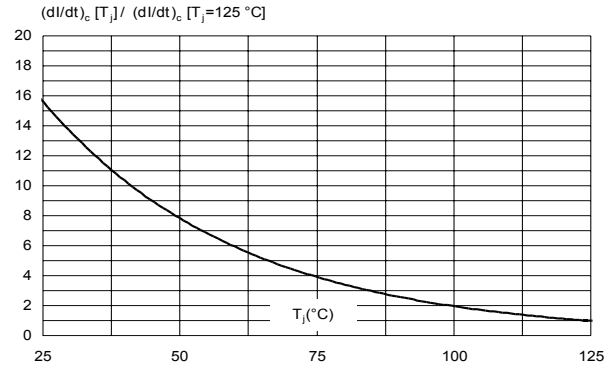



**Figure 10. Surge peak on-state current versus number of cycles**

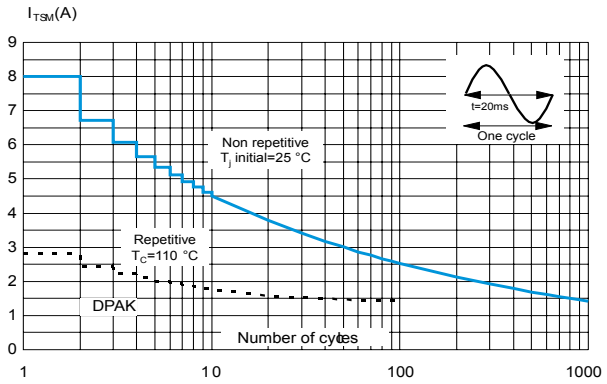



**Figure 11. Non repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10 ms and corresponding value**

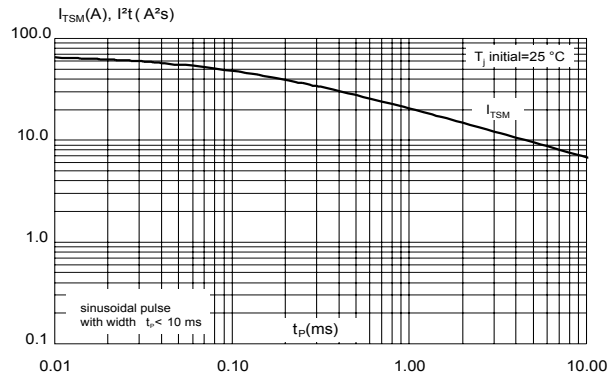



**Figure 12. On-state characteristics (maximum values)**

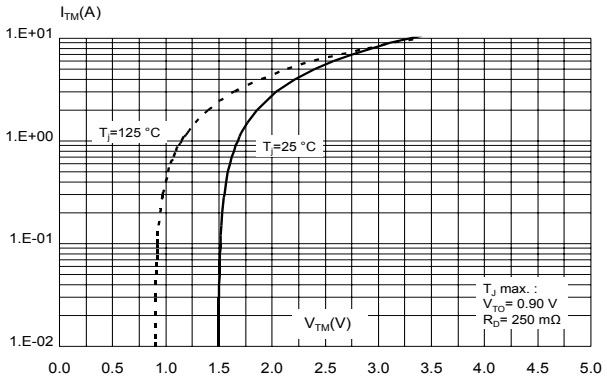


**Figure 13. Thermal resistance junction to ambient versus copper surface under tab (typical values)**

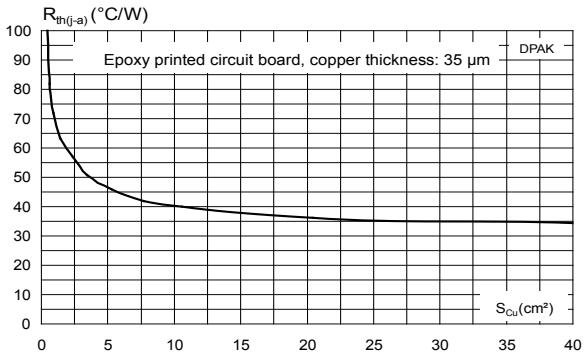
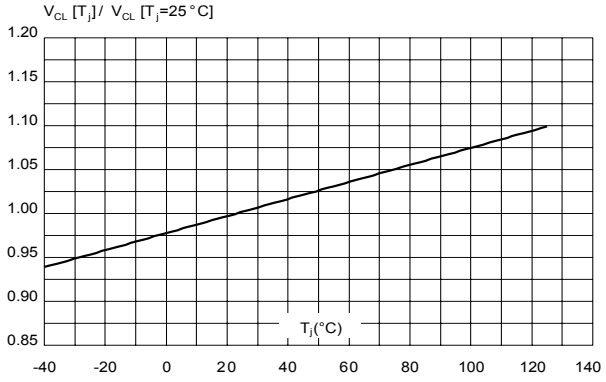



**Figure 14. Relative variation of clamping voltage $V_{CL}$ versus junction temperature**

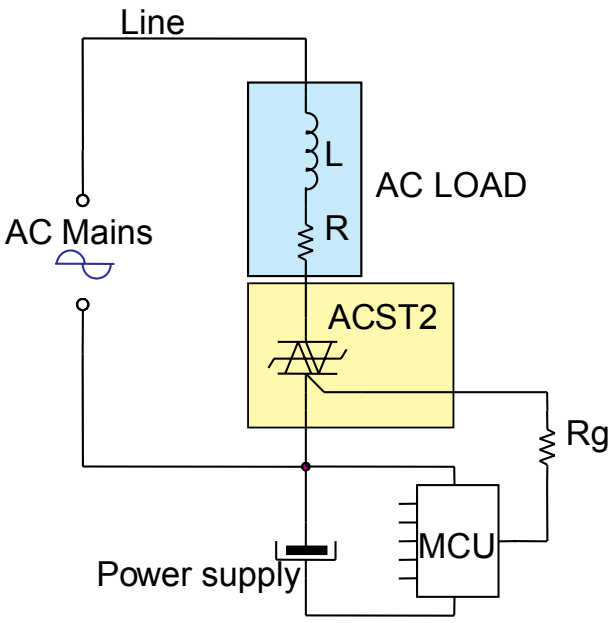


# 2 Application information

## 2.1 Typical application descriptions

The ACST2 device has been designed to switch on and off highly inductive or resistive loads such as pump, valve, fan, or bulb lamp. Thanks to its high sensitivity ($I_{GT}$ max = 10 mA), the ACST2 can be driven directly by logic level circuits through a resistor as shown on the typical application diagram. Thanks to its thermal and turn-off commutation performances, the ACST2 switch can drive, without any additional snubber, an inductive load up to 2 A.

**Figure 15. AC induction motor control – typical diagram**



## 2.2 AC line transient voltage ruggedness

In comparison with standard Triacs, which are not robust against surge voltage, the ACST2 is self-protected against over-voltage, specified by the new parameter $V_{CL}$. In addition, the ACST2 is a sensitive device ($I_{GT}$ = 10 mA), but provides a high noise immunity level against fast transients. The ACST2 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 16 represents the ACST2 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 ACST2 folds back safely to the on state as shown in Figure 17. The ACST2 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 16. Overvoltage ruggedness test circuit for resistive and inductive loads for IEC 61000-4-5 standards**

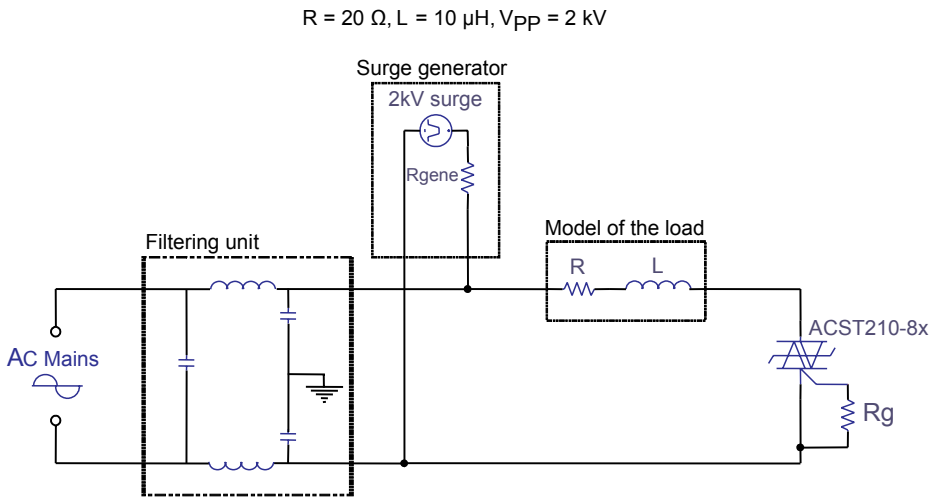
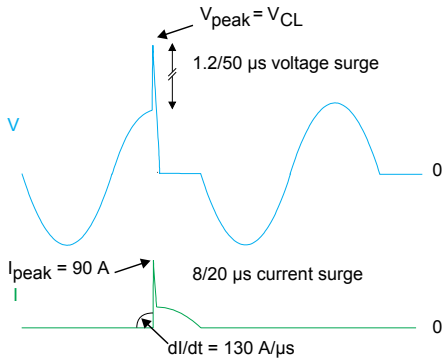



**Figure 17. Typical voltage and current waveforms across the ACST4 during IEC 61000-4-5 standard test**



# 3 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. ECOPACK is an ST trademark.

## 3.1 TO-220FPAB package information

- Epoxy meets UL94, V0
- Recommended torque: 0.4 to 0.6 N·m

**Figure 18. TO-220FPAB package outline**

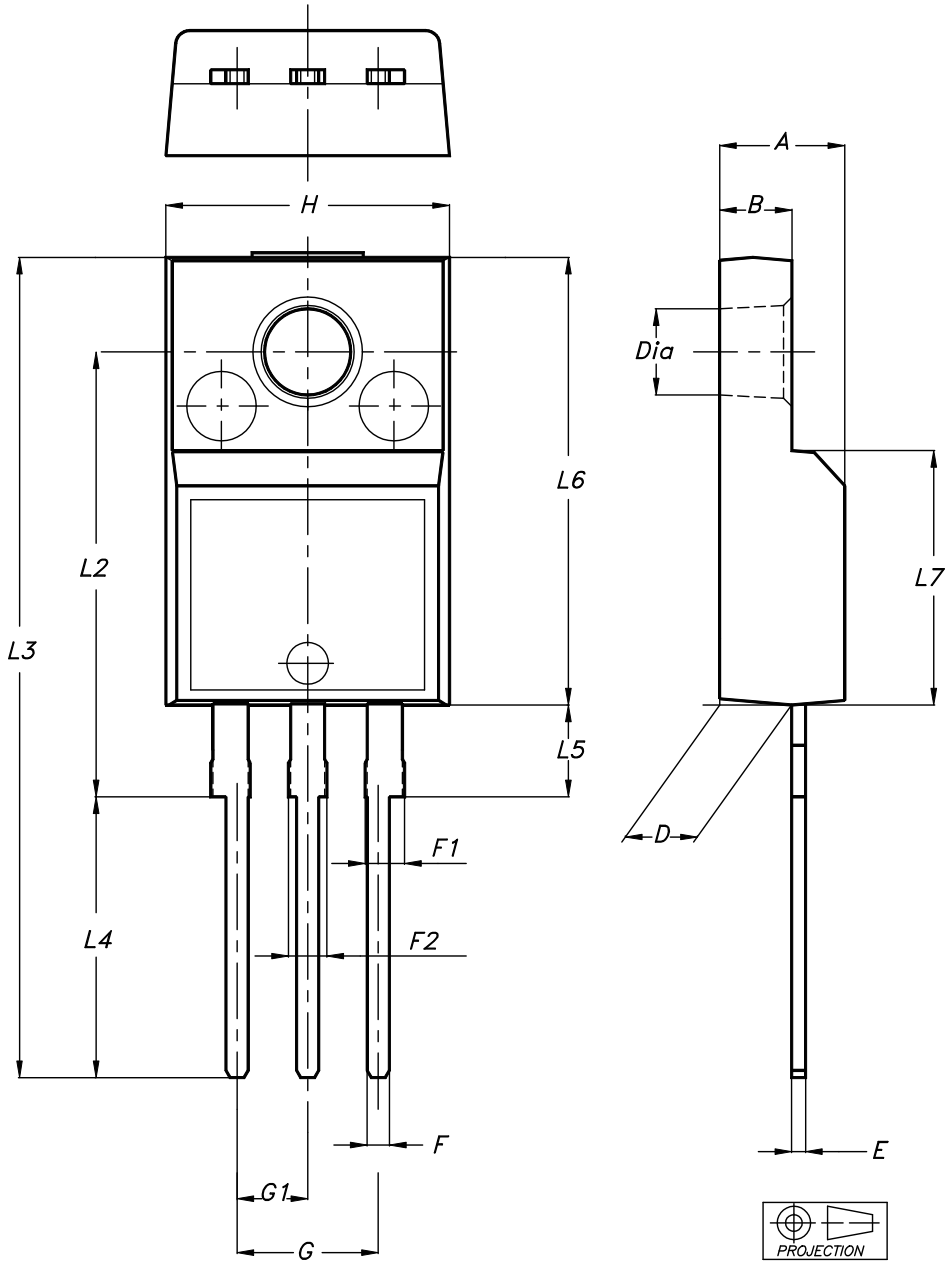


Table 5. **TO-220FPAB package mechanical data**

| Ref. | Dimensions | | | |
|---|---|---|---|---|
| | Millimeters | | Inches | |
| | Min. | Max. | Min. | Max. |
| A | 4.40 | 4.60 | 0.1739 | 0.1818 |
| B | 2.5 | 2.7 | 0.0988 | 0.1067 |
| D | 2.50 | 2.75 | 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 | 10.00 | 10.40 | 0.3953 | 0.4111 |
| L2 | 16.00 typ. | | 0.6324 typ. | |
| L3 | 28.60 | 30.60 | 1.1304 | 1.2095 |
| L4 | 9.80 | 10.6 | 0.3874 | 0.4190 |
| L5 | 2.90 | 3.60 | 0.1146 | 0.1423 |
| L6 | 15.90 | 16.40 | 0.6285 | 0.6482 |
| L7 | 9.00 | 9.30 | 0.3557 | 0.3676 |
| Dia | 3.0 | 3.20 | 0.1186 | 0.1265 |

## 3.2 DPAK package information

- Molding compounded resin is halogen free and meets UL94 flammability standard, level V0
- Lead-free package leads plating

**Figure 19. DPAK package outline**

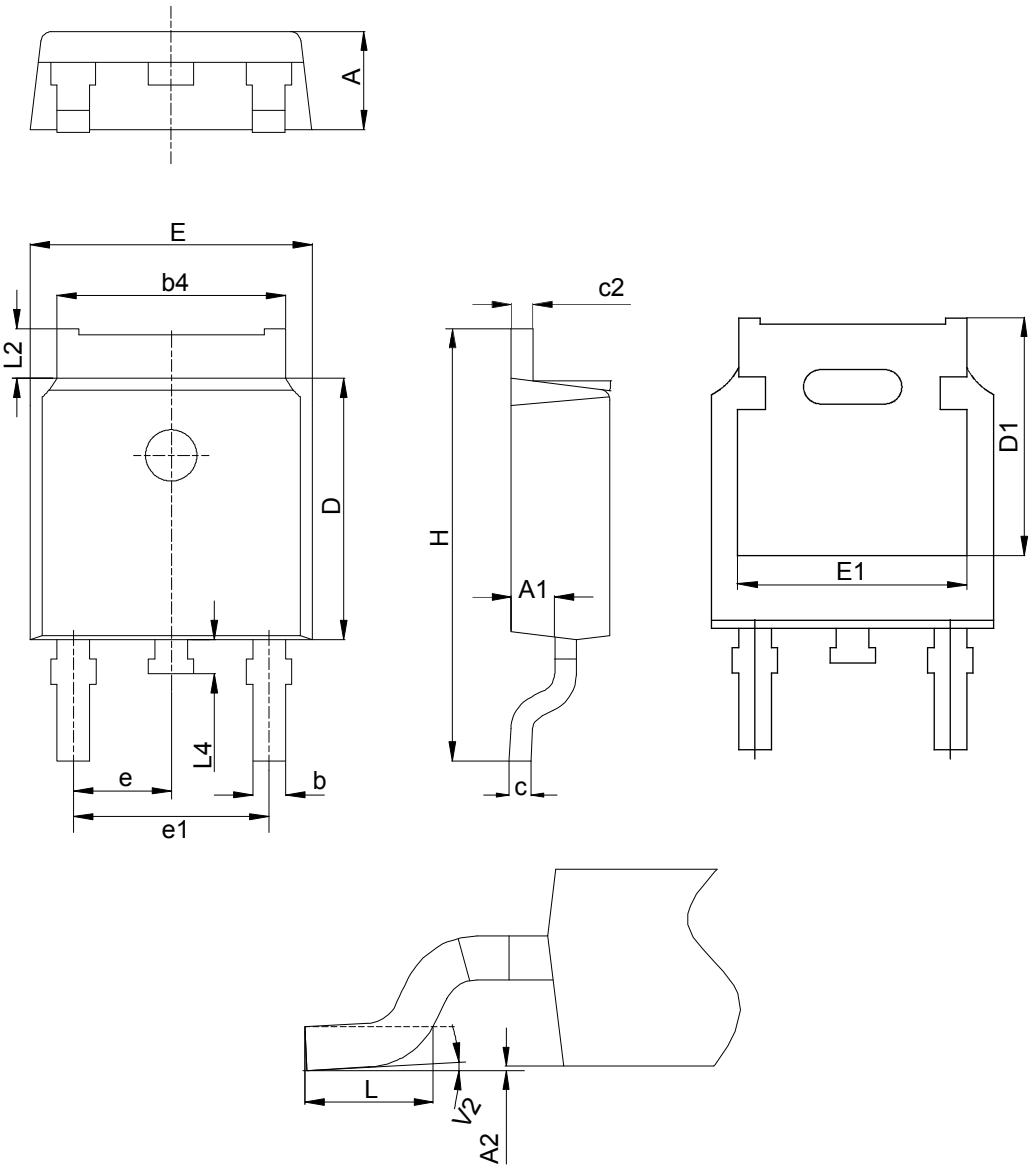


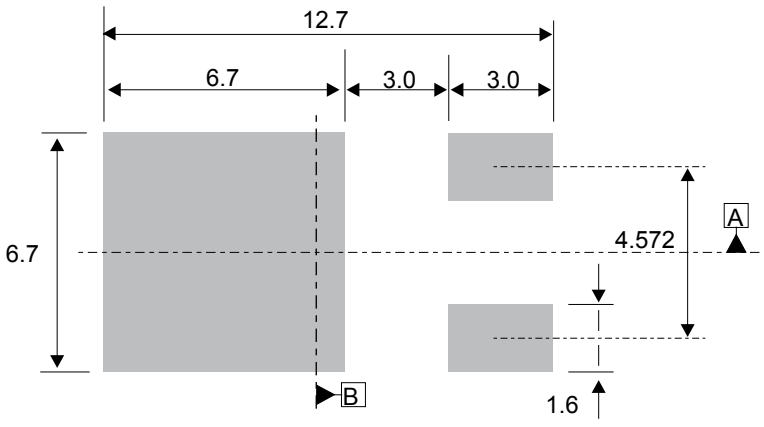
**Table 6. DPAK package mechanical data**

| Ref. | Dimensions | | | | | |
|---|---|---|---|---|---|---|
| | Millimeters | | | Inches[1] | | |
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | 2.18 | | 2.40 | 0.0858 | | 0.0945 |
| A1 | 0.90 | | 1.10 | 0.0354 | | 0.0433 |
| A2 | 0.03 | | 0.23 | 0.0012 | | 0.0091 |
| b | 0.64 | | 0.90 | 0.0252 | | 0.354 |
| b4 | 4.95 | | 5.46 | 0.1949 | | 0.2150 |
| c | 0.46 | | 0.61 | 0.0181 | | 0.0240 |
| c2 | 0.46 | | 0.60 | 0.0181 | | 0.0236 |
| D | 5.97 | | 6.22 | 0.2350 | | 0.2449 |
| D1 | 4.95 | | 5.60 | 0.1949 | | 0.2205 |
| E | 6.35 | | 6.73 | 0.2500 | | 0.2650 |
| E1 | 4.32 | | 5.50 | 0.1701 | | 0.2165 |
| e | | 2.286 | | | 0.0900 | |
| e1 | 4.40 | | 4.70 | 0.1732 | | 0.1850 |
| H | 9.35 | | 10.40 | 0.3681 | | 0.4094 |
| L | 1.00 | | 1.78 | 0.0394 | | 0.0701 |
| L2 | | | 1.27 | | | 0.0500 |
| L4 | 0.60 | | 1.02 | 0.0236 | | 0.0402 |
| V2[2] | -8° | | +8° | -8° | | +8° |

1. *Dimensions in inches are given for reference only*
2. *Degree*

*Note: This package drawing may slightly differ from the physical package. However, all the specified dimensions are guaranteed.*

**Figure 20. DPAK recommended footprint (dimensions are in mm)**



# 4 Ordering information

Figure 21. **Ordering information scheme**

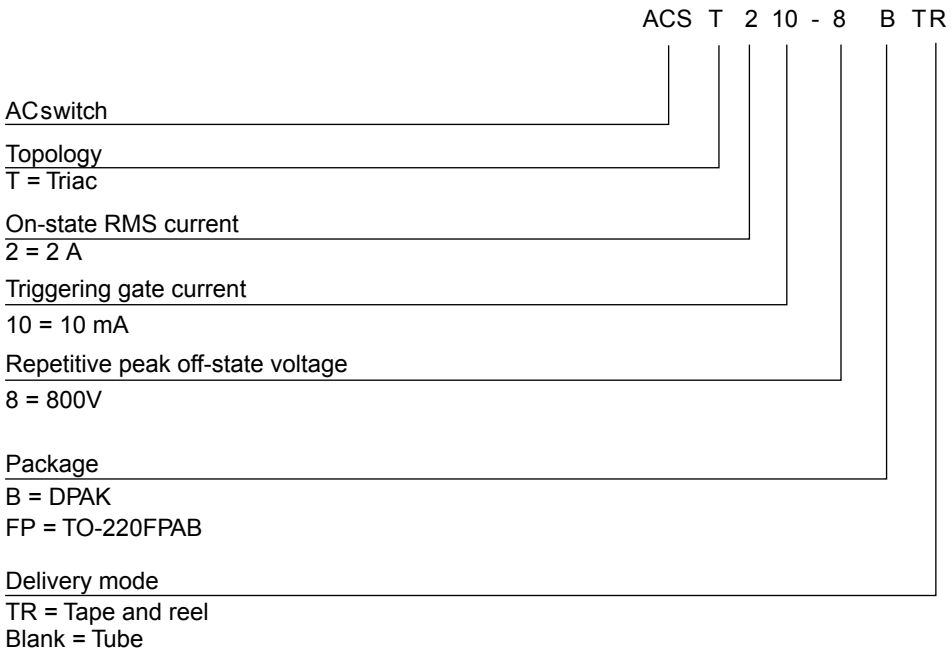



Table 7. **Ordering information**

| Order code | Marking | Package | Weight | Base qty. | Packing mode |
|---|---|---|---|---|---|
| ACST210-8B | ACST2108 | DPAK | 0.3 g | 50 | Tube |
| ACST210-8BTR | | DPAK | | 2500 | Tape and reel |
| ACST210-8FP | | TO-220FPAB | 2.4 g | 50 | Tube |

## Revision history

Table 8. **Document revision history**

| Date | Version | Changes |
|---|---|---|
| 01-Mar-2007 | 1 | Initial release. |
| 13-Apr-2010 | 2 | Updated ECOPACK statement. Reformatted for consistency with other datasheets in this product class. |
| 01-Jul-2010 | 3 | Updated Figure 22. |
| 24-May-2014 | 4 | Updated DPAK package information and reformatted to current standard. |
| 14-Jun-2017 | 5 | Updated features in cover page and Table 2.<br>Updated Figure 8, Figure 9, Figure 10, Figure 14 and Section 3.<br>Minor text changes. |
| 19-Dec-2019 | 6 | Update DPAK package information. |

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