

AC power switch

Main applications

- AC static switching in appliance control systems
- Drive of low power high inductive or resistive loads like
 - spray pump in dishwashers
 - an in air-conditioners

Features

- Blocking voltage: $V_{DRM} / V_{RRM} = \pm 700 \text{ V}$
- Avalanche controlled: $V_{CL \text{ typ}} = 1100 \text{ V}$
- Nominal conducting current : $I_{T(RMS)} = 4 \text{ A}$
- High surge current capability: 30 A for 20 ms full wave
- Gate triggering current: $I_{GT} < 10 \text{ mA}$ or 25 mA
- Switch integrated driver
- High noise immunity: static $dV/dt > 500 \text{ V}/\mu\text{s}$

Benefits

- Enables equipment to meet IEC 61000-4-5
- High off-state reliability with planar technology
- No external overvoltage protection needed
- Reduces the power component factor
- Interfaces directly with the microcontroller
- Direct interface with the microcontroller for the ACST4-7S ($I_{GT} < 10 \text{ mA}$)

Description

The ACST4 belongs to the AC power switch family built around the ASD™ technology. This high performance device is adapted to home appliances or industrial systems and drives loads up to 4 A.

The ACS™ 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.

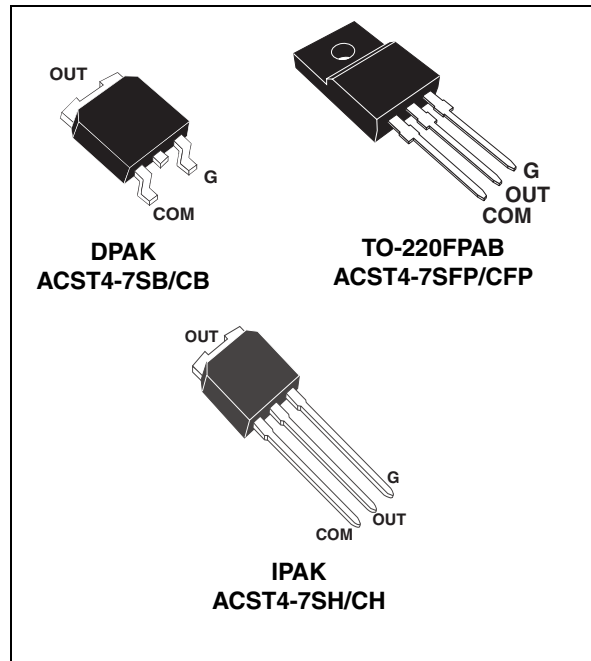
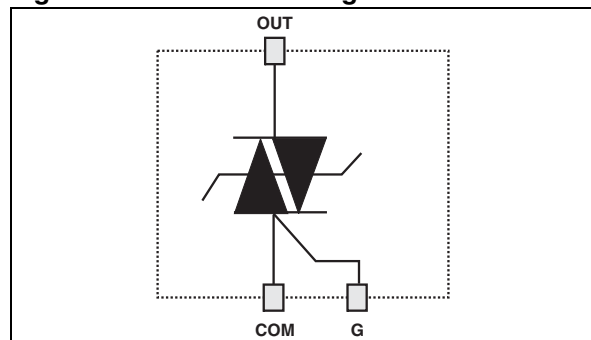


Figure 1. Functional diagram



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1 Characteristics

Table 1. Absolute ratings (limiting values)
For either positive or negative polarity of pin OUT voltage in respect to pin COM voltage

| Symbol | Parameter | | Value | Unit |
|-------------------|--|---------------------------|----------------------------------|------------------------------|
| V_{DRM}/V_{RRM} | Repetitive peak off-state voltage | | $T_j = -10^\circ\text{C}$ 700 | V |
| $I_{T(RMS)}$ | RMS on-state current full cycle sine wave 50 to 60 Hz | DPAK, IPAK | $T_c = 110^\circ\text{C}$ | 4 A |
| | | TO-220FPAB | $T_c = 100^\circ\text{C}$ | |
| I_{TSM} | Non repetitive surge peak on-state current | | $F = 50\text{ Hz}$ | 30 A |
| | T_j initial = 25°C , full cycle sine wave | | $F = 60\text{ Hz}$ | 33 A |
| I^2t | Fusing capability | | $t_p = 10\text{ ms}$ | 6.4 A^2s |
| di/dt | Repetitive on-state current critical rate of rise $I_G = 10\text{ mA}$ ($t_r < 100\text{ ns}$) | $T_j = 125^\circ\text{C}$ | $F = 120\text{ Hz}$ | 50 $\text{A}/\mu\text{s}$ |
| V_{PP} | Non repetitive line peak pulse voltage ⁽¹⁾ | | 2 | kV |
| T_{stg} | Storage temperature range | | - 40 to + 150 | $^\circ\text{C}$ |
| T_j | Operating junction temperature range | | - 30 to + 125 | $^\circ\text{C}$ |
| T_l | Maximum lead soldering temperature during 10 s | | 260 | $^\circ\text{C}$ |

1. according to test described by IEC 61000-4-5 standard and [Figure 3](#).

Table 2. Gate characteristics (maximum values)

| Symbol | Parameter | Value | Unit |
|-------------|---|-------|------|
| $P_{G(AV)}$ | Average gate power dissipation | 0.1 | W |
| P_{GM} | Peak gate power dissipation ($t_p = 20\ \mu\text{s}$) | 10 | A |
| I_{GM} | Peak gate current ($t_p = 20\ \mu\text{s}$) | 1 | V |

Table 3. Thermal resistances

| Symbol | Parameter | | Value | Unit |
|---------------|--|--|-------|---------------------------|
| $R_{th(j-a)}$ | Junction to ambient | $S^{(1)} = 0.5\text{ cm}^2$ DPAK, IPAK | 70 | $^\circ\text{C}/\text{W}$ |
| | | TO-220FPAB | 60 | $^\circ\text{C}/\text{W}$ |
| $R_{th(j-l)}$ | Junction to tab/lead for full cycle sine wave conduction | DPAK, IPAK | 2.6 | $^\circ\text{C}/\text{W}$ |
| | | TO-220FPAB | 4.6 | $^\circ\text{C}/\text{W}$ |

1. S = Copper surface under Tab

Table 4. Parameter description

| Parameter symbol | Parameter description |
|-------------------|---|
| I_{GT} | Triggering gate current |
| V_{GT} | Triggering gate voltage |
| V_{GD} | Non-triggering gate voltage |
| I_H | Holding current |
| I_L | Latching current |
| V_{TM} | Peak on-state voltage drop |
| V_{TO} | On state threshold voltage |
| R_d | On state dynamic resistance |
| I_{DRM}/I_{RRM} | Maximum forward or reverse leakage current |
| dV/dt | Critical rate of rise of off-state voltage |
| $(dV/dt)_c$ | Critical rate of rise of commutating off-state voltage |
| $(dI/dt)_c$ | Critical rate of decrease of commutating on-state current |
| V_{CL} | Clamping voltage |
| I_{CL} | Clamping current |

Table 5. Electrical characteristics

For either positive or negative polarity of pin OUT voltage respect to pin COM voltage

| Symbol | Test conditions | | | | ACST4-7S | ACST4-7C | Unit |
|-------------------|--|-----------------|----------------------------|-----|----------|----------|------------------|
| I_{GT} | $V_{OUT} = 12\text{ V DC}$ $R_L = 33\ \Omega$ | QI - QII - QIII | $T_j = 25^\circ\text{ C}$ | MAX | 10 | 25 | mA |
| V_{GT} | $V_{OUT} = 12\text{ V DC}$ $R_L = 33\ \Omega$ | QI - QII - QIII | $T_j = 25^\circ\text{ C}$ | MAX | 1 | 1.1 | V |
| V_{GD} | $V_{OUT} = V_{DRM}$ $R_L = 3.3\ \Omega$ | | $T_j = 125^\circ\text{ C}$ | MIN | 0.2 | | V |
| I_H | $I_{OUT} = 100\text{ mA}$ Gate open | | $T_j = 25^\circ\text{ C}$ | MAX | 20 | 35 | mA |
| I_L | $I_G = 2 \times I_{GTmax}$ | | $T_j = 25^\circ\text{ C}$ | MAX | 40 | 60 | mA |
| V_{TM} | $I_{OUT} = 5.6\text{ A}$ $t_p = 380\ \mu\text{s}$ | | $T_j = 25^\circ\text{ C}$ | MAX | 1.5 | | V |
| V_{TO} | | | $T_j = 125^\circ\text{ C}$ | MAX | 0.90 | | V |
| R_d | | | $T_j = 125^\circ\text{ C}$ | MAX | 100 | | m Ω |
| I_{DRM}/I_{RRM} | $V_{OUT} = 700\text{ V}$ | | $T_j = 25^\circ\text{ C}$ | MAX | 10 | | μA |
| | | | $T_j = 125^\circ\text{ C}$ | MAX | 500 | | |
| dV/dt | $V_{OUT} = 460\text{ V}$ Gate open | | $T_j = 110^\circ\text{ C}$ | MIN | 200 | 500 | V/ μs |
| $(dI/dt)_c$ | $(dI/dt)_c = 15\text{ V}/\mu\text{s}$ | | $T_j = 125^\circ\text{ C}$ | MIN | 2.0 | 2.5 | A/ms |
| V_{CL} | $I_{CL} = 1\text{ mA}$ $t_p = 1\text{ ms}$ | | $T_j = 25^\circ\text{ C}$ | TYP | 1100 | | V |

2 AC line switch basic application

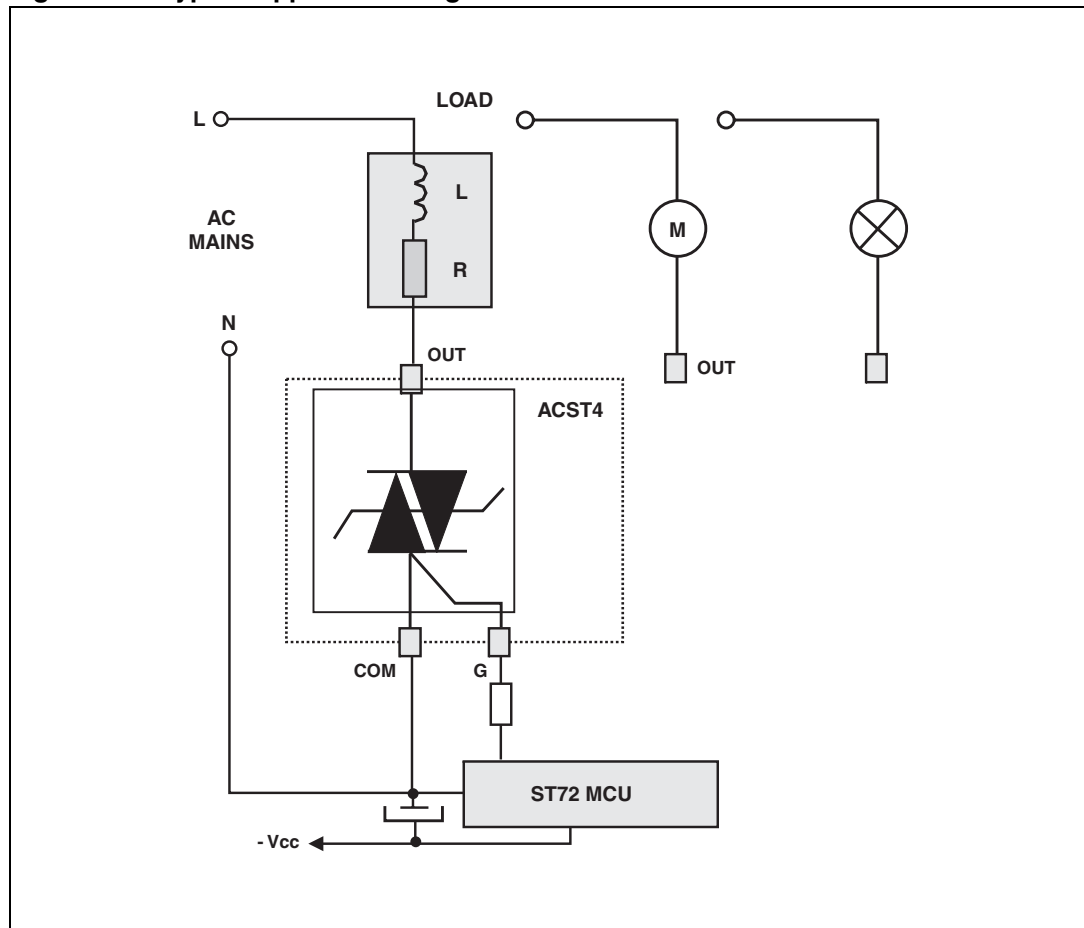
The ACST4 device has been designed to switch on and off low power, but highly inductive or resistive loads such as dishwashers spray pumps, and air-conditioners fan.

- **Pin COM:** Common drive reference to connect to the power line neutral
- **Pin G:** Switch Gate input to connect to the digital controller
- **Pin OUT:** Switch Output to connect to the load

ACST4-7S triggering current has to be sunk from the gate pin G. The switch can then 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 ACST4 switch is able to drive with no turn off additional snubber an inductive load up to 4 A.

Figure 2. Typical application diagram



3 AC line transient voltage ruggedness

The ACST4 switch is able to sustain safely the AC line transient voltages either by clamping the low energy spikes or by breaking over under high energy shocks, even with high turn-on current rises.

The test circuit of the [Figure 6](#). is representative of the final ACST application and is also used to stress the ACST switch according to the IEC 61000-4-5 standard conditions. Thanks to the load, the ACST switch sustains the voltage spikes up to 2 kV above the peak line voltage. It will break over safely even on resistive load where the turn on current rate of rise, is as high as shown on [Figure 7](#). Such non-repetitive test can be done 10 times on each AC line voltage polarity.

Figure 3. Overvoltage ruggedness test circuit for resistive and inductive loads according to IEC 61000-4-5 standards.

$R = 150 \Omega$, $L = 10 \mu\text{H}$, $V_{PP} = 2 \text{ kV}$.

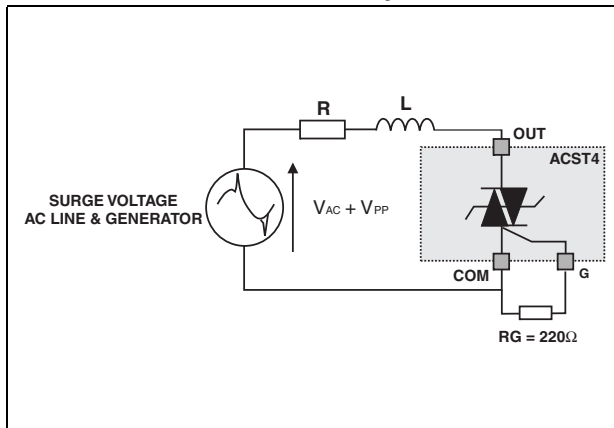


Figure 4. Current and voltage of the ACST4 during IEC 61000-4-5 standard test with R, L and V_{PP} .

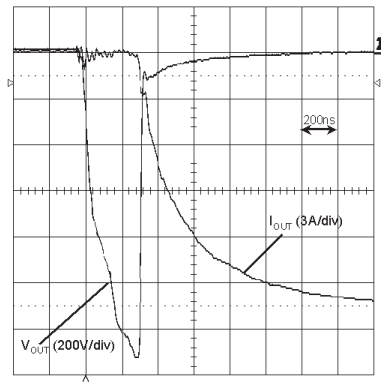


Figure 5. Maximum power dissipation versus RMS on-state current.

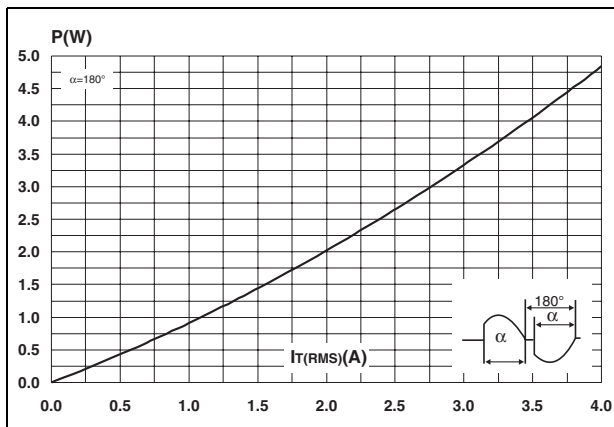


Figure 6. RMS on-state current versus case temperature.

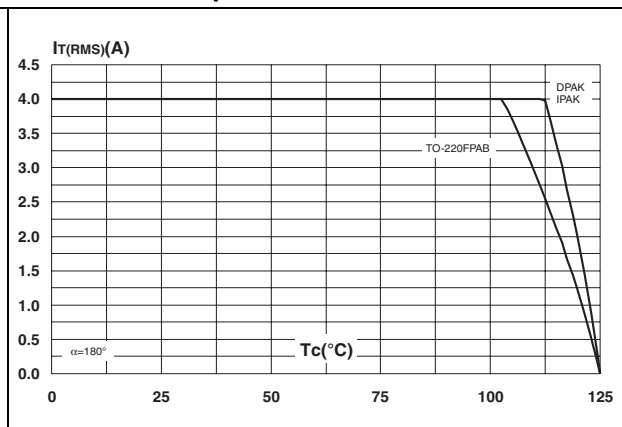


Figure 7. RMS on-state current versus ambient temperature.

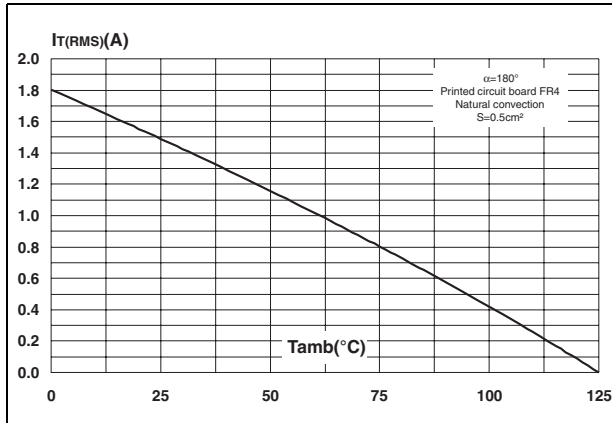


Figure 8. Relative variation of thermal impedance versus pulse duration.

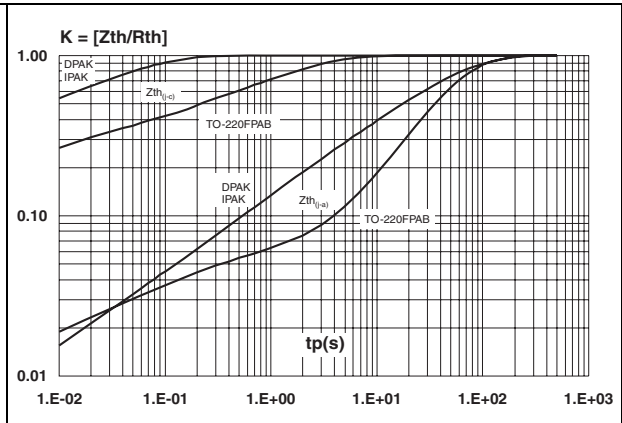


Figure 9. Relative variation of gate trigger current, holding current and latching versus junction temperature (typical values).

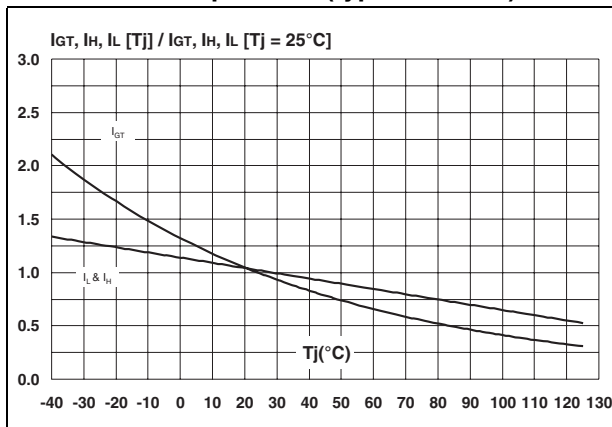


Figure 10. Relative variation of static dV/dt versus junction temperature.

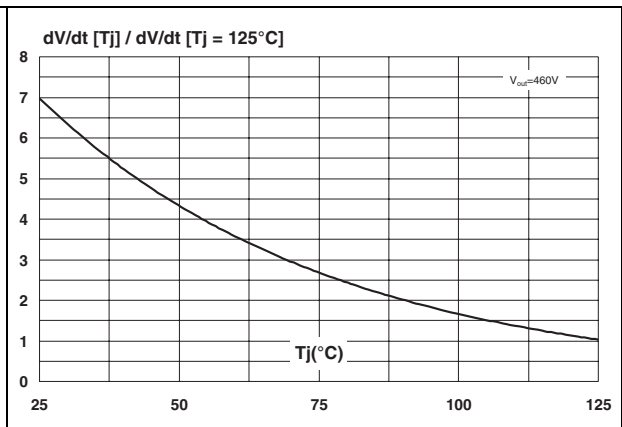


Figure 11. Relative variation of critical rate of decrease of main current versus reapplied dV/dt (typical values).

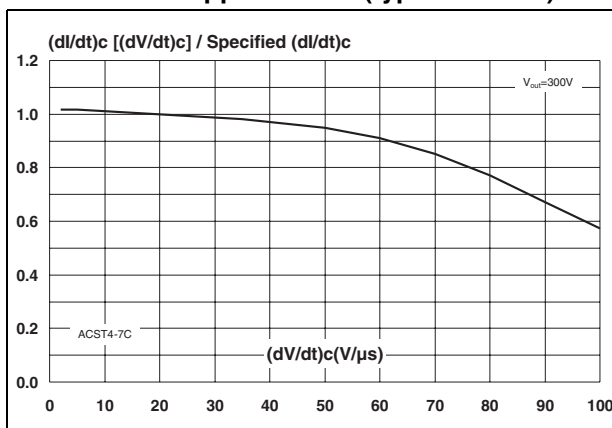


Figure 12. Relative variation of critical rate of decrease of main current versus reapplied dV/dt (typical values).

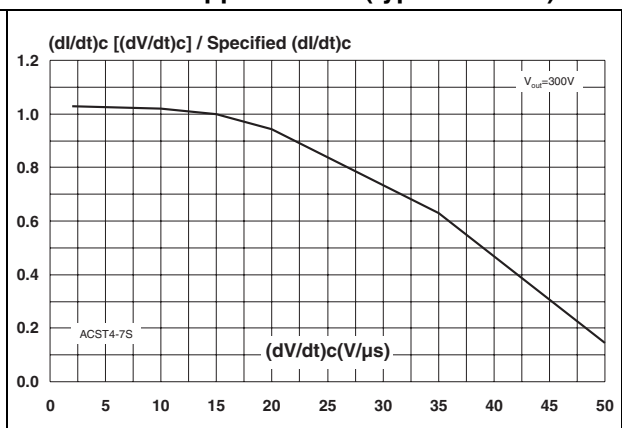


Figure 13. Relative variation of critical rate of decrease of main current versus junction temperature.

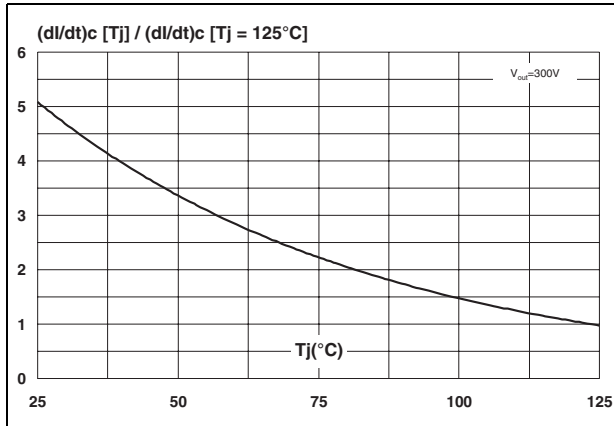


Figure 14. Surge peak on-state current versus number of cycles.

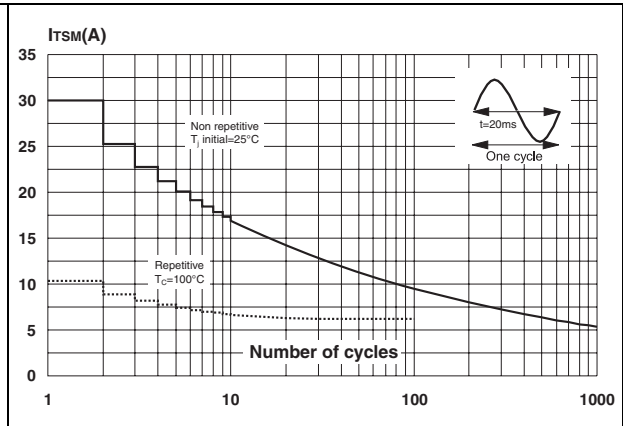


Figure 15. Non repetitive surge peak on-state current for a sinusoidal pulse with width $t_p < 10$ ms, and corresponding value of I^2t .

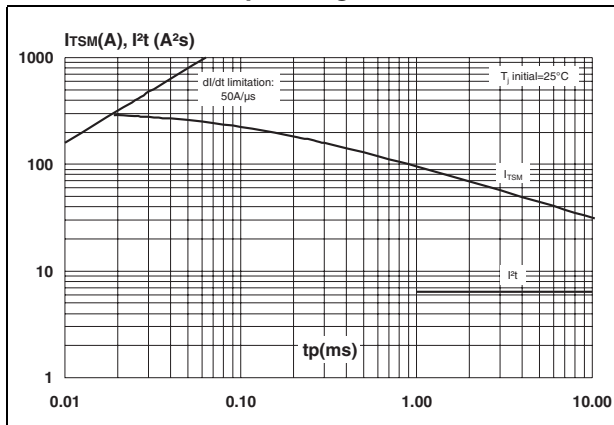


Figure 16. On-state characteristics (maximum values).

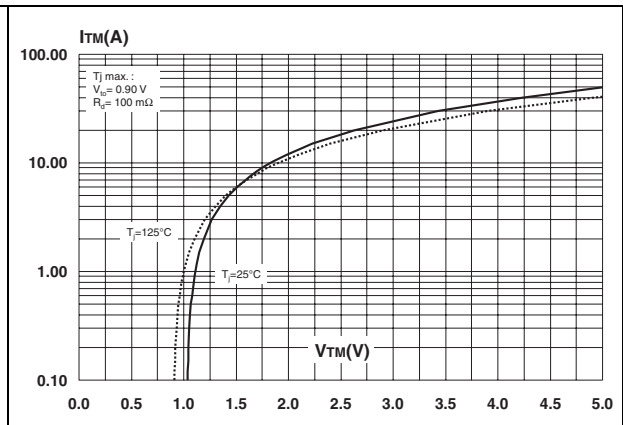
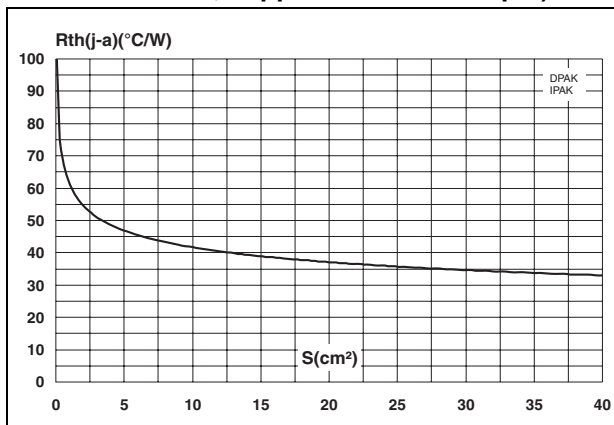
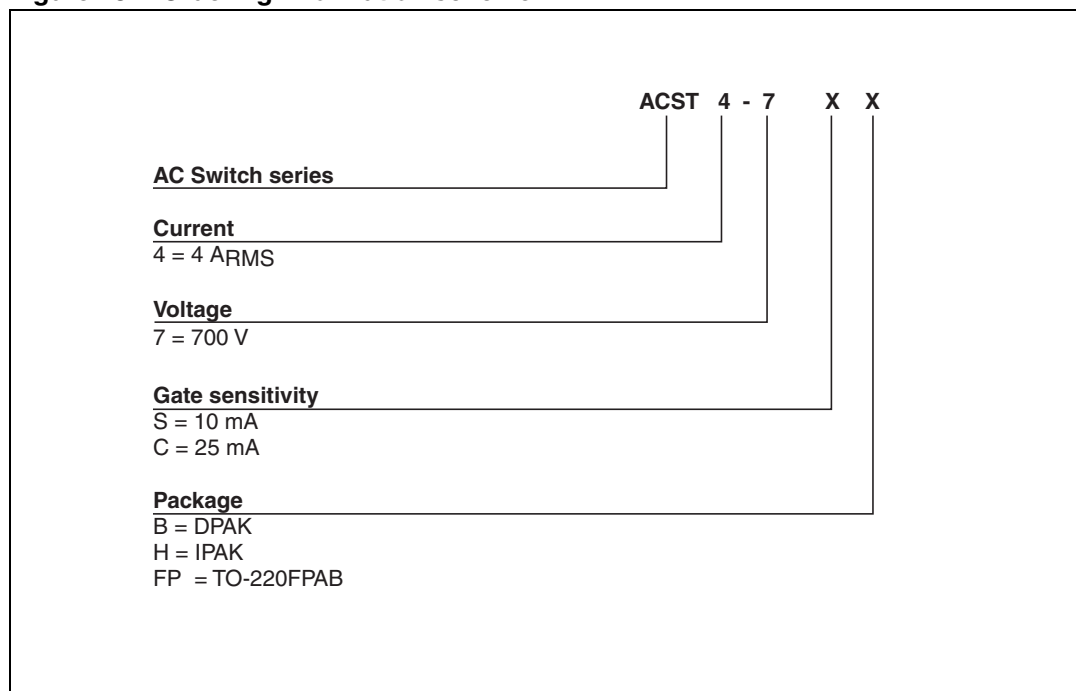


Figure 17. Thermal resistance junction to ambient versus copper surface under tab (printed circuit board FR4, copper thickness: 35 μm).



4 Ordering information scheme

Figure 18. Ordering information scheme



5 Package information

- Epoxy meets UL94, V0
- Recommended torque values 0.4 to 0.6 Nm

Table 6. DPAK dimensions

| Ref. | Dimensions | | | |
|------|-------------|-------|------------|-------|
| | Millimeters | | Inches | |
| | Min. | Max. | Min. | Max. |
| A | 2.20 | 2.40 | 0.086 | 0.094 |
| A1 | 0.90 | 1.10 | 0.035 | 0.043 |
| A2 | 0.03 | 0.23 | 0.001 | 0.009 |
| B | 0.64 | 0.90 | 0.025 | 0.035 |
| B2 | 5.20 | 5.40 | 0.204 | 0.212 |
| C | 0.45 | 0.60 | 0.017 | 0.023 |
| C2 | 0.48 | 0.60 | 0.018 | 0.023 |
| D | 6.00 | 6.20 | 0.236 | 0.244 |
| E | 6.40 | 6.60 | 0.251 | 0.259 |
| G | 4.40 | 4.60 | 0.173 | 0.181 |
| H | 9.35 | 10.10 | 0.368 | 0.397 |
| L2 | 0.80 typ. | | 0.031 typ. | |
| L4 | 0.60 | 1.00 | 0.023 | 0.039 |
| V2 | 0° | 8° | 0° | 8° |

Figure 19. Footprint (dimensions in mm)

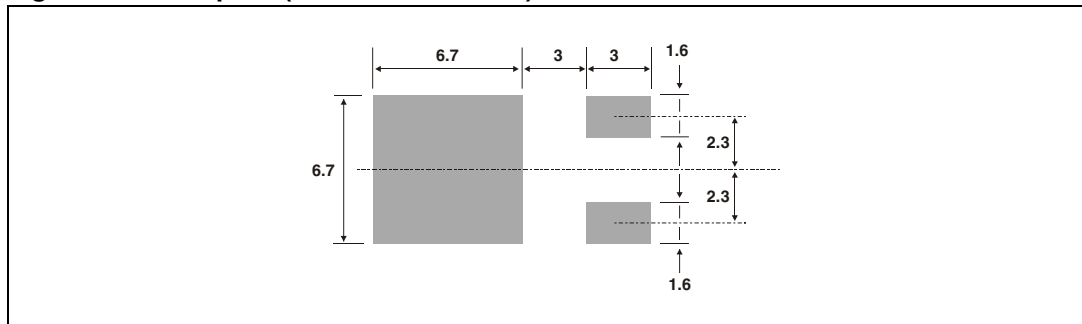
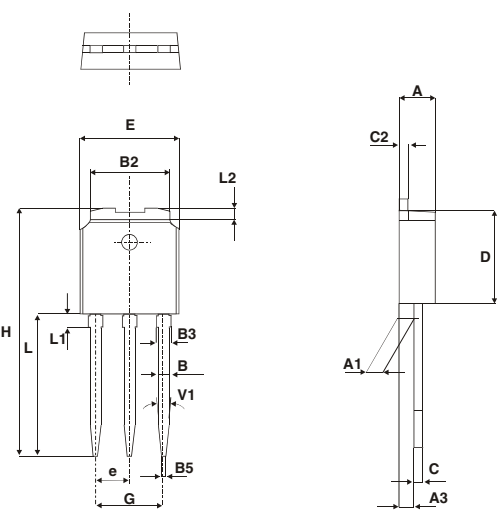


Table 7. IPAK dimensions



| Ref. | Dimensions | | | | | |
|------|-------------|-------|------|--------|-------|-------|
| | Millimeters | | | Inches | | |
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | 2.20 | | 2.40 | 0.086 | | 0.094 |
| A1 | 0.90 | | 1.10 | 0.035 | | 0.043 |
| A3 | 0.70 | | 1.30 | 0.027 | | 0.051 |
| B | 0.64 | | 0.90 | 0.025 | | 0.035 |
| B2 | 5.20 | | 5.40 | 0.204 | | 0.212 |
| B3 | | | 0.95 | | | 0.037 |
| B5 | | 0.30 | | | 0.035 | |
| C | 0.45 | | 0.60 | 0.017 | | 0.023 |
| C2 | 0.48 | | 0.60 | 0.019 | | 0.023 |
| D | 6 | | 6.20 | 0.236 | | 0.244 |
| E | 6.40 | | 6.60 | 0.252 | | 0.260 |
| e | | 2.28 | | | 0.090 | |
| G | 4.40 | | 4.60 | 0.173 | | 0.181 |
| H | | 16.10 | | | 0.634 | |
| L | 9 | | 9.40 | 0.354 | | 0.370 |
| L1 | 0.8 | | 1.20 | 0.031 | | 0.047 |
| L2 | | 0.80 | 1 | | 0.031 | 0.039 |
| V1 | | 10° | | | 10° | |

Table 8. TO-220FPAB dimensions

| Ref. | Dimensions | | | |
|------|-------------|------|-----------|-------|
| | Millimeters | | Inches | |
| | Min. | Max. | Min. | Max. |
| A | 4.4 | 4.6 | 0.173 | 0.181 |
| B | 2.5 | 2.7 | 0.098 | 0.106 |
| D | 2.5 | 2.75 | 0.098 | 0.108 |
| E | 0.45 | 0.70 | 0.018 | 0.027 |
| F | 0.75 | 1 | 0.030 | 0.039 |
| F1 | 1.15 | 1.70 | 0.045 | 0.067 |
| F2 | 1.15 | 1.70 | 0.045 | 0.067 |
| G | 4.95 | 5.20 | 0.195 | 0.205 |
| G1 | 2.4 | 2.7 | 0.094 | 0.106 |
| H | 10 | 10.4 | 0.393 | 0.409 |
| L2 | 16 Typ. | | 0.63 Typ. | |
| L3 | 28.6 | 30.6 | 1.126 | 1.205 |
| L4 | 9.8 | 10.6 | 0.386 | 0.417 |
| L5 | 2.9 | 3.6 | 0.114 | 0.142 |
| L6 | 15.9 | 16.4 | 0.626 | 0.646 |
| L7 | 9.00 | 9.30 | 0.354 | 0.366 |
| Dia. | 3.00 | 3.20 | 0.118 | 0.126 |

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: www.st.com.

6 Ordering information

Table 9. Ordering information

| Part number | Marking | Package | Weight | Base qty | Packing mode |
|--------------|---------|------------|--------|----------|---------------|
| ACST4-7SB | ACST47S | DPAK | 0.3 g | 75 | Tube |
| ACST4-7SB-TR | ACST47S | DPAK | 0.3 g | 2500 | Tape and reel |
| ACST4-7SH | ACST47S | IPAK | 0.4 g | 75 | Tube |
| ACST4-7SFP | ACST47S | TO-220FPAB | 2.4 g | 50 | Tube |
| ACST4-7CB | ACST47C | DPAK | 0.3 g | 75 | Tube |
| ACST4-7CB-TR | ACST47C | DPAK | 0.3 g | 2500 | Tape and reel |
| ACST4-7CH | ACST47C | IPAK | 0.4 g | 75 | Tube |
| ACST4-7CFP | ACST47C | TO-220FPAB | 2.4 g | 50 | Tube |

7 Revision history

Table 10. Revision history

| Date | Revision | Changes |
|-------------|----------|---|
| Jan-2003 | 3A | Previous update |
| 04-Jul-2007 | 4 | Reformatted to current standard. Added IPAK package |

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