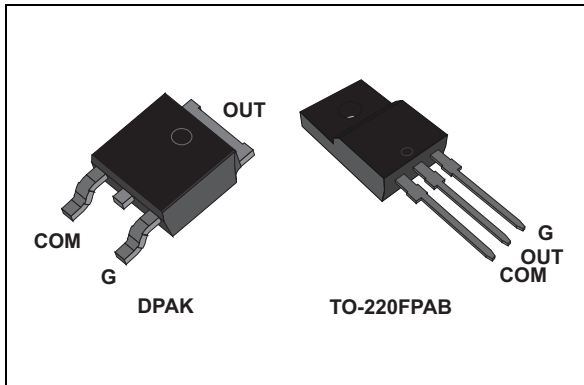


## Overvoltage protected AC switch

Datasheet - production data



### Description

The ACST4 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 4 A.

This ACST4 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 ACST410 needs a low gate current to be activated ( $I_{GT} < 10 \text{ mA}$ ) and still shows a high electrical noise immunity complying with IEC standards such as IEC 61000-4-4 (fast transient burst test).

Provides UL 1557 certified insulation rated at 2000 V rms.

### Features

- Triac with overvoltage protection
- Low  $I_{GT}$  (<10 mA) or high immunity ( $I_{GT} < 35 \text{ mA}$ ) version
- High noise immunity: static  $dV/dt > 1000 \text{ V}/\mu\text{s}$
- TO-220FPAB insulated package complies with UL 1557 standard (file ref: E81734)

### 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

Figure 1. Functional diagram

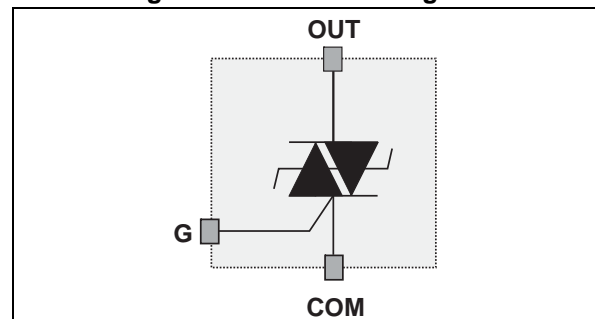


Table 1. Device summary

Symbol	Value	Unit
$I_{T(RMS)}$	4	A
$V_{DRM}/V_{RRM}$	800	V
$I_{GT}(ACST410)$	10	mA
$I_{GT}(ACST435)$	35	mA

TM: ACS is a trademark of STMicroelectronics

# 1 Characteristics

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

Symbol	Parameter		Value	Unit
$I_{T(RMS)}$	On-state rms current (full sine wave)	TO-220FPAB $T_c = 102\text{ °C}$	4	A
		DPAK $T_c = 112\text{ °C}$		
		DPAK with 0.5 cm <sup>2</sup> copper $T_{amb} = 60\text{ °C}$	1	
$I_{TSM}$	Non repetitive surge peak on-state current (full cycle sine wave, $T_j$ initial = 25 °C)	F = 60 Hz $t_p = 16.7\text{ ms}$	32	A
		F = 50 Hz $t_p = 20\text{ ms}$	30	A
$I^2t$	$I^2t$ Value for fusing	$t_p = 10\text{ ms}$	6	A <sup>2</sup> s
dI/dt	Critical rate of rise of on-state current $I_G = 2 \times I_{GT}$ , $t_r = 100\text{ ns}$	F = 120 Hz $T_j = 125\text{ °C}$	100	A/ $\mu$ s
$V_{PP}^{(1)}$	Non repetitive line peak mains 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 junction temperature range		-40 to +150	°C
$T_j$	Operating junction temperature range		-40 to +125	
$T_l$	Maximum lead soldering temperature during 10 s (at 3 mm from plastic case)		260	°C
$V_{INS(RMS)}$	Insulation rms voltage	TO-220FPAB	2000	V

1. According to test described in IEC 61000-4-5 standard and [Figure 19](#)

**Table 3. Electrical characteristics ( $T_j = 25\text{ °C}$ , unless otherwise specified)**

Symbol	Test conditions	Quadrant		ACST410	ACST435	Unit
$I_{GT}^{(1)}$	$V_{OUT} = 12\text{ V}$ , $R_L = 33\text{ }\Omega$	I - II - III	MAX	10	35	mA
$V_{GT}$	$V_{OUT} = 12\text{ V}$ , $R_L = 33\text{ }\Omega$	I - II - III	MAX	1.0	1.1	V
$V_{GD}$	$V_{OUT} = V_{DRM}$ , $R_L = 3.3\text{ k}\Omega$ , $T_j = 125\text{ °C}$	I - II - III	MIN	0.2		V
$I_H^{(2)}$	$I_{OUT} = 500\text{ mA}$		MAX	20	25	mA
$I_L$	$I_G = 1.2 \times I_{GT}$	I - II - III	MAX	40	60	mA
dV/dt <sup>(2)</sup>	$V_{OUT} = 67\% V_{DRM}$ gate open, $T_j = 125\text{ °C}$		MIN	500	1000	V/ $\mu$ s
(dI/dt) <sub>c</sub> <sup>(2)</sup>	without snubber, $T_j = 125\text{ °C}$		MIN		5	A/ms
(dI/dt) <sub>c</sub> <sup>(2)</sup>	(dV/dt) <sub>c</sub> = 15 V/ $\mu$ s, $T_j = 125\text{ °C}$			2		A/ms
$V_{CL}$	$I_{CL} = 0.1\text{ mA}$ , $t_p = 1\text{ ms}$		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 4. Static electrical characteristics**

Symbol	Test conditions			Value	Unit
$V_{TM}^{(1)}$	$I_{TM} = 5.6 \text{ A}$ , $t_p = 500 \mu\text{s}$	$T_j = 25 \text{ }^\circ\text{C}$	MAX	1.7	V
$V_{TO}^{(1)}$	Threshold voltage	$T_j = 125 \text{ }^\circ\text{C}$	MAX	0.9	V
$R_D^{(1)}$	Dynamic resistance	$T_j = 125 \text{ }^\circ\text{C}$	MAX	110	m $\Omega$
$I_{DRM}$ $I_{RRM}$	$V_{OUT} = V_{DRM} / V_{RRM}$	$T_j = 25 \text{ }^\circ\text{C}$	MAX	20	$\mu\text{A}$
		$T_j = 125 \text{ }^\circ\text{C}$		0.5	mA

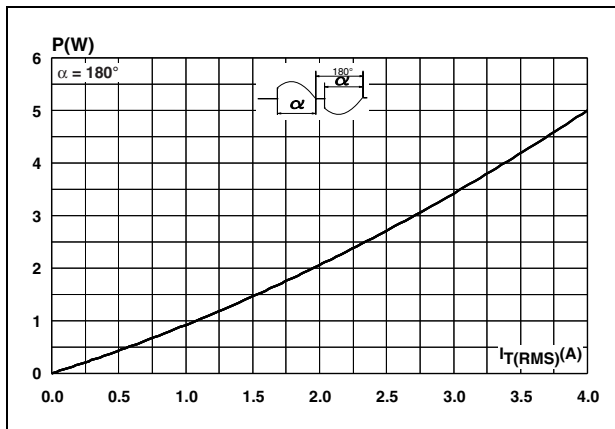
1. For both polarities of OUT pin referenced to COM pin

**Table 5. Thermal resistances**

Symbol	Parameter		Value	Unit
$R_{th(j-c)}$	Junction to case for full cycle sine wave conduction	DPAK	2.6	$^\circ\text{C/W}$
		TO-220FPAB	4.6	
$R_{th(j-a)}$	Junction to ambient	TO-220FPAB	60	
		$S_{CU}^{(1)} = 0.5 \text{ cm}^2$ DPAK	70	

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

**Figure 2. Maximum power dissipation versus on-state rms current**



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

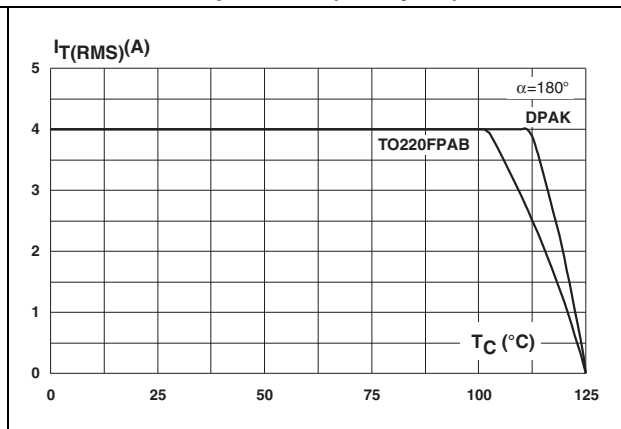


Figure 4. On-state rms current versus ambient temperature (free air convection, full cycle)

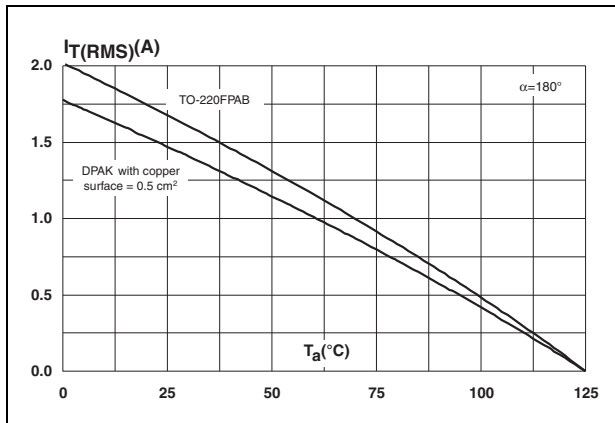


Figure 5. Relative variation of thermal impedance versus pulse duration

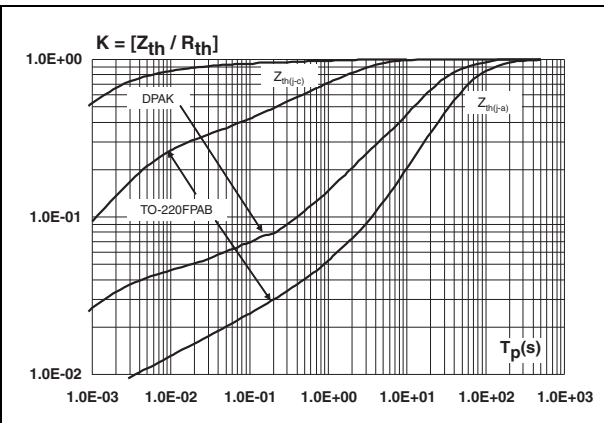


Figure 6. Relative variation of gate trigger current ( $I_{GT}$ ) and voltage ( $V_{GT}$ ) versus junction temperature

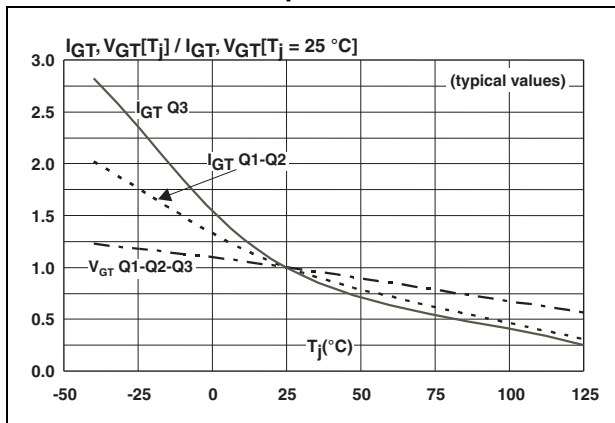


Figure 7. Relative variation of holding current ( $I_H$ ) and latching current ( $I_L$ ) versus junction temperature

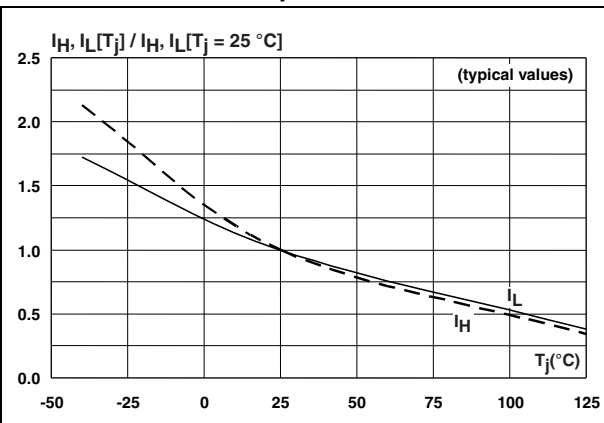


Figure 8. Surge peak on-state current versus number of cycles

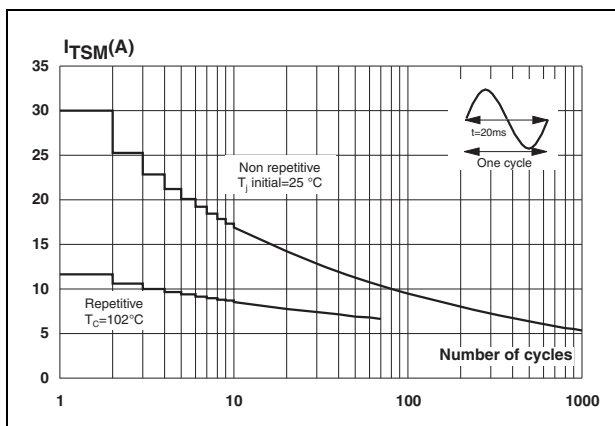


Figure 9. Non repetitive surge peak on-state current and corresponding value of  $I^2t$  versus sinusoidal pulse width

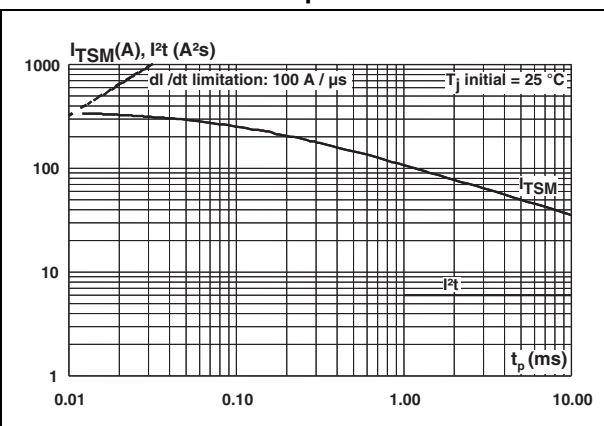


Figure 10. On-state characteristics (maximum values)

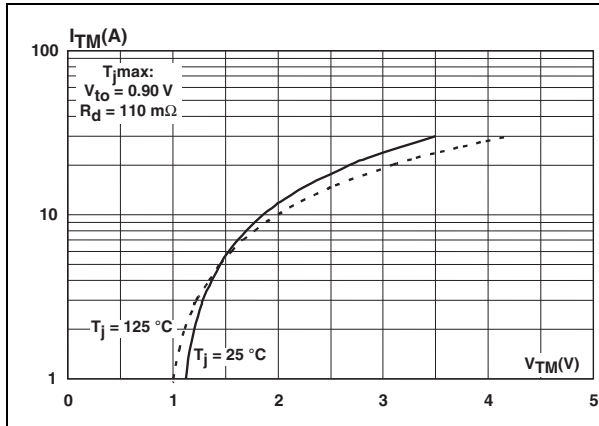


Figure 11. Relative variation of critical rate of decrease of main current  $(di/dt)_c$  versus junction temperature

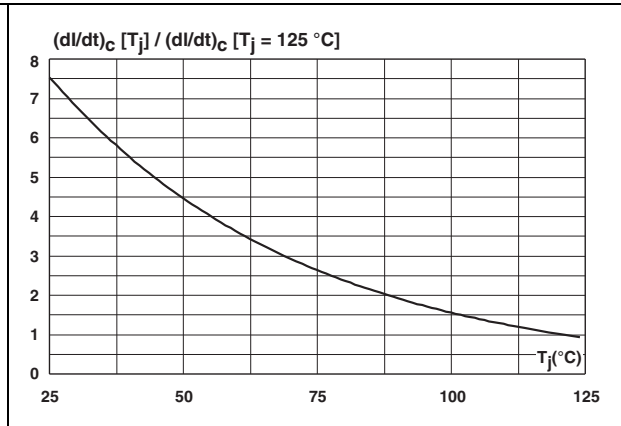


Figure 12. Relative variation of static dV/dt immunity versus junction temperature (gate open)

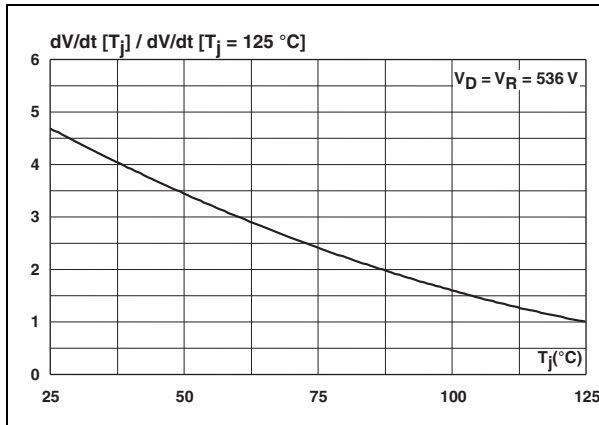


Figure 13. Relative variation of leakage current versus junction temperature

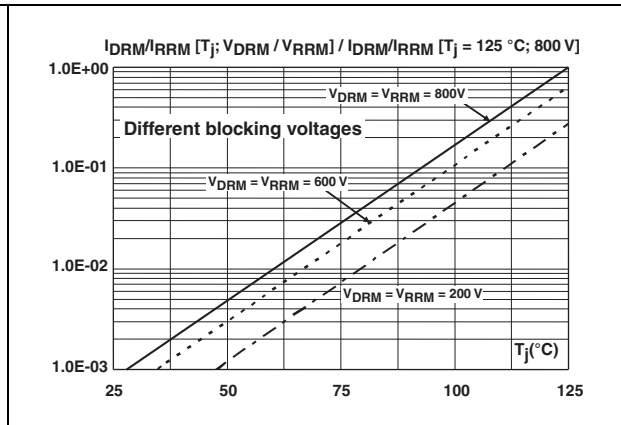


Figure 14. Relative variation of the clamping voltage  $(V_{CL})$  versus junction temperature (minimum values)

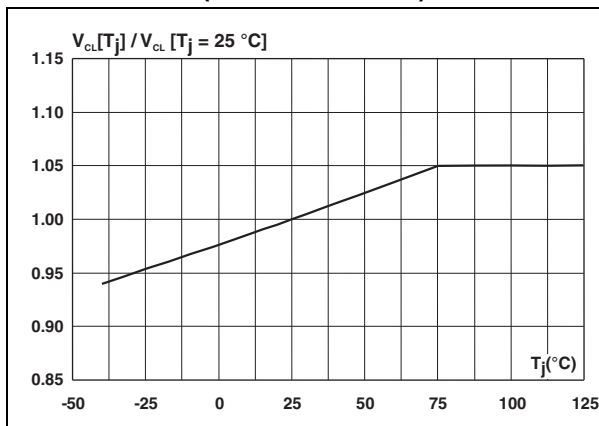
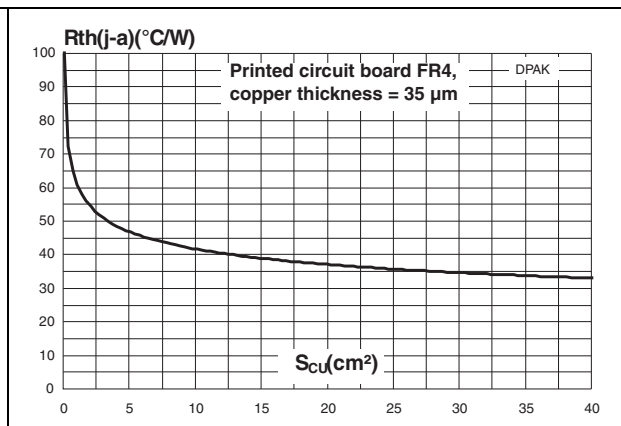


Figure 15. Thermal resistance junction to ambient versus copper surface under tab



## 2 Application information

### 2.1 Typical application description

The ACST4 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 ACST4 switch is able to drive an inductive load up to 4 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 ACST4 can be driven directly by an MCU through a simple gate resistor as shown [Figure 16](#) and [Figure 17](#).

Figure 16. Compressor control – typical diagrams

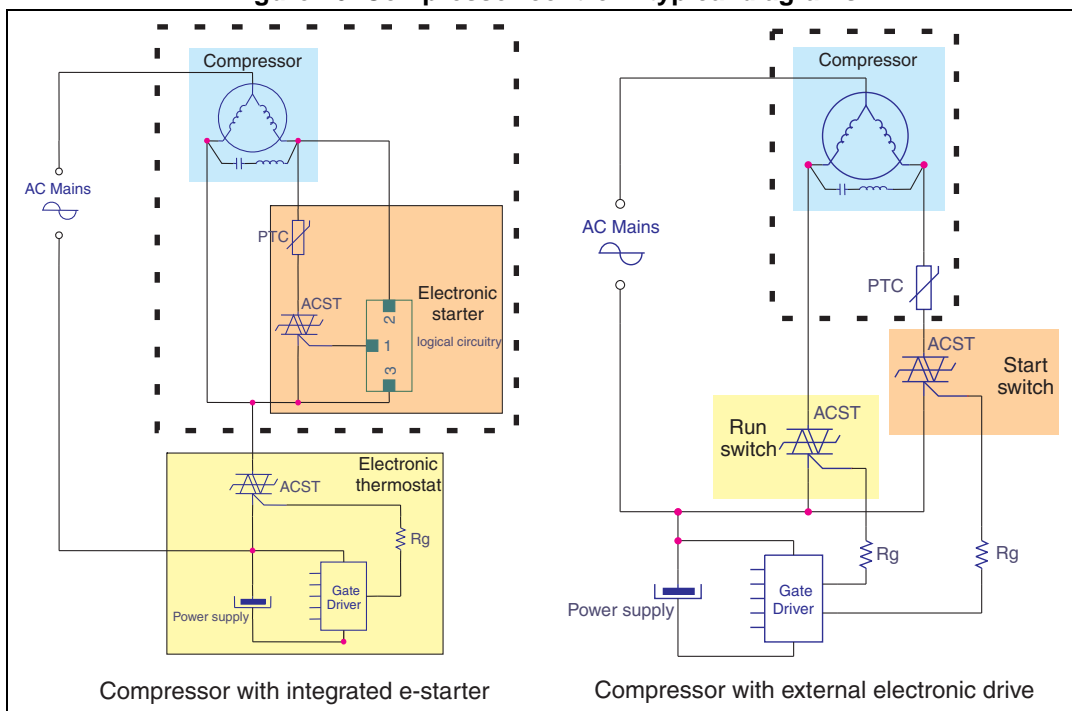
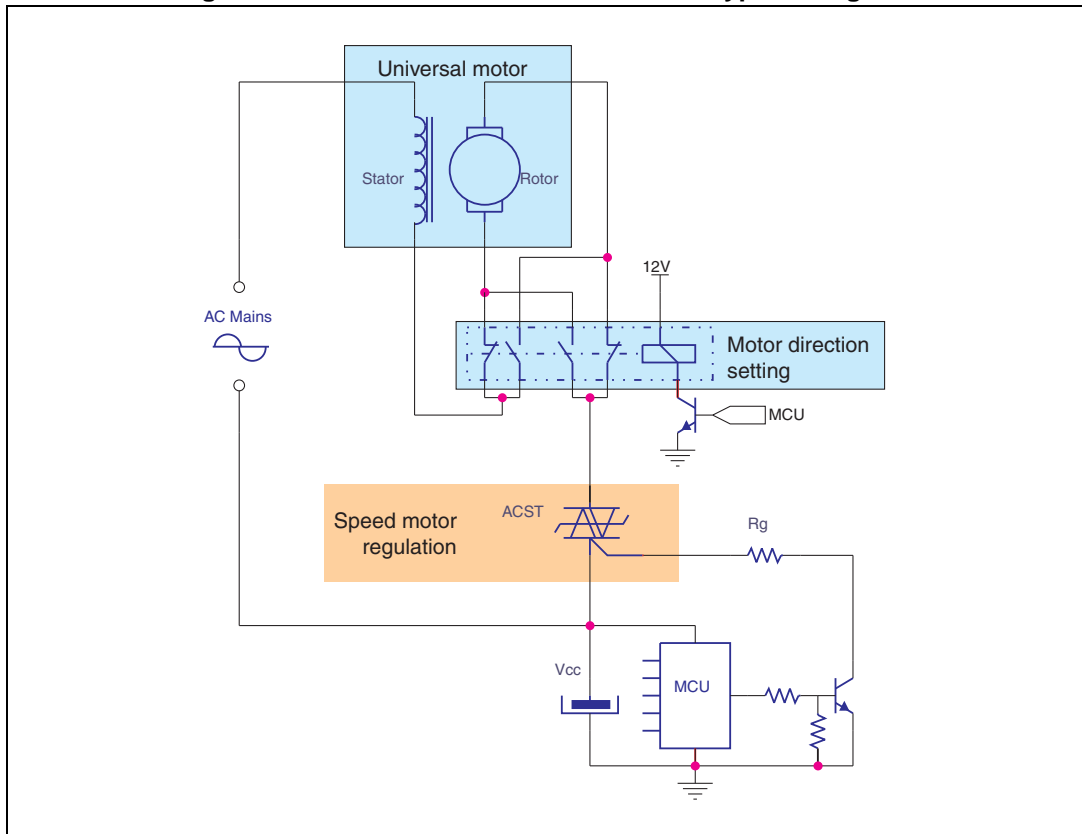


Figure 17. Universal drum motor control – typical diagram

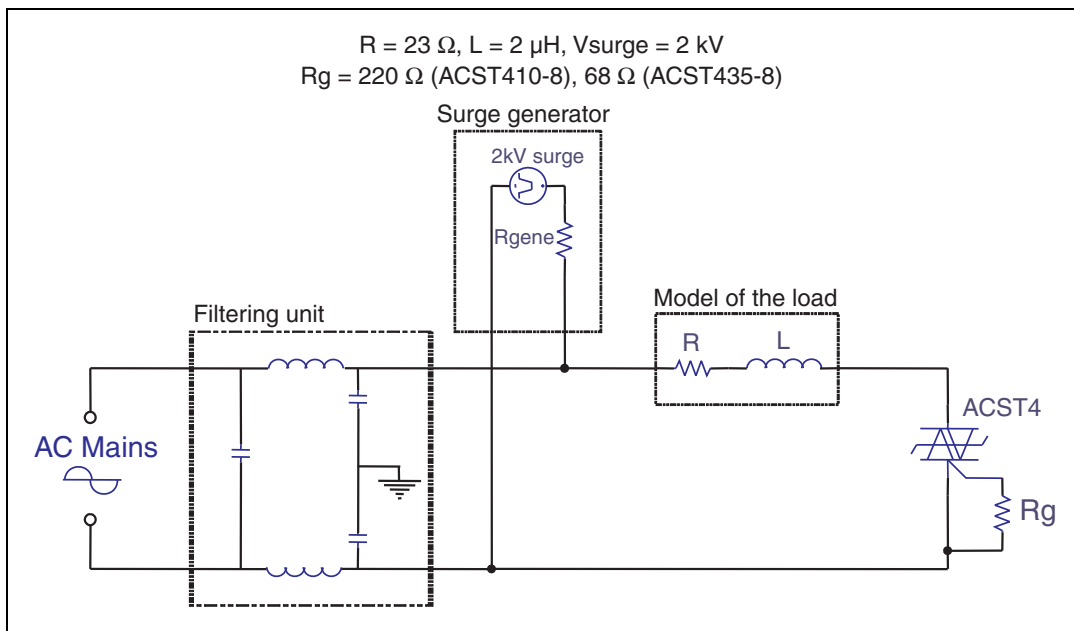


## 2.2 AC line transient voltage ruggedness

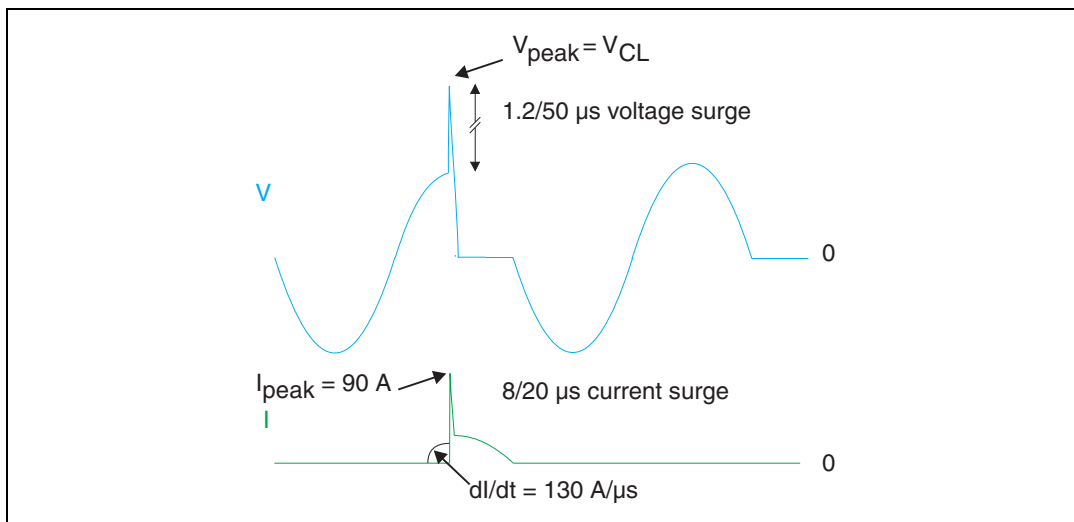
In comparison with standard Triacs, which are not robust against surge voltage, the ACST4 is self-protected against over-voltage, specified by the new parameter  $V_{CL}$ . The ACST4 switch can safely withstand AC line transient voltages either by clamping the low energy spikes, such as inductive spikes 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 ACST4 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 ACST4 folds back safely to the on state as shown in [Figure 19](#). The ACST4 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 ACST4 during IEC 61000-4-5 standard test**





### 3 Package information

- Epoxy meets UL94, V0
- Cooling method: by conduction (C)
- Recommended torque (TO-220FPAB): 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.

Figure 20. TO-220FPAB dimension definitions

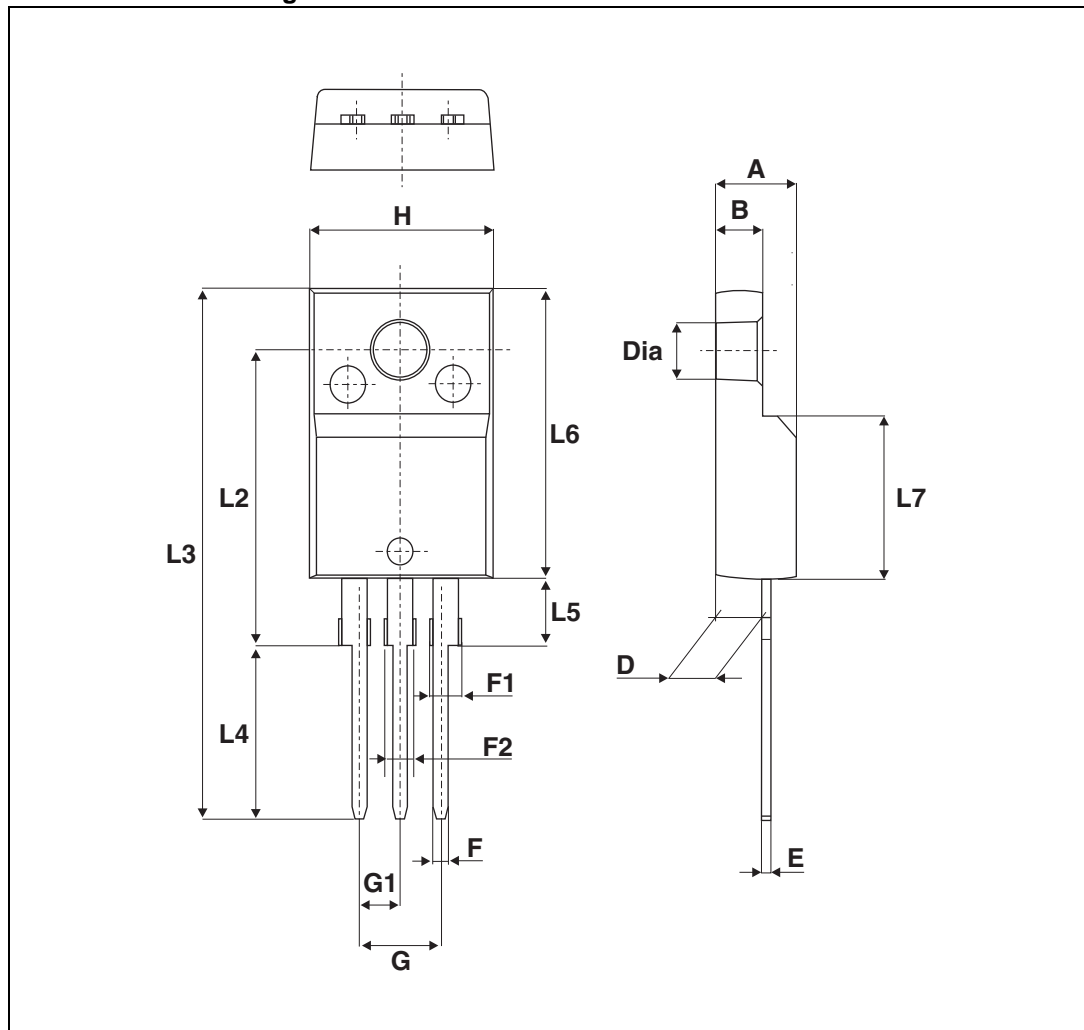
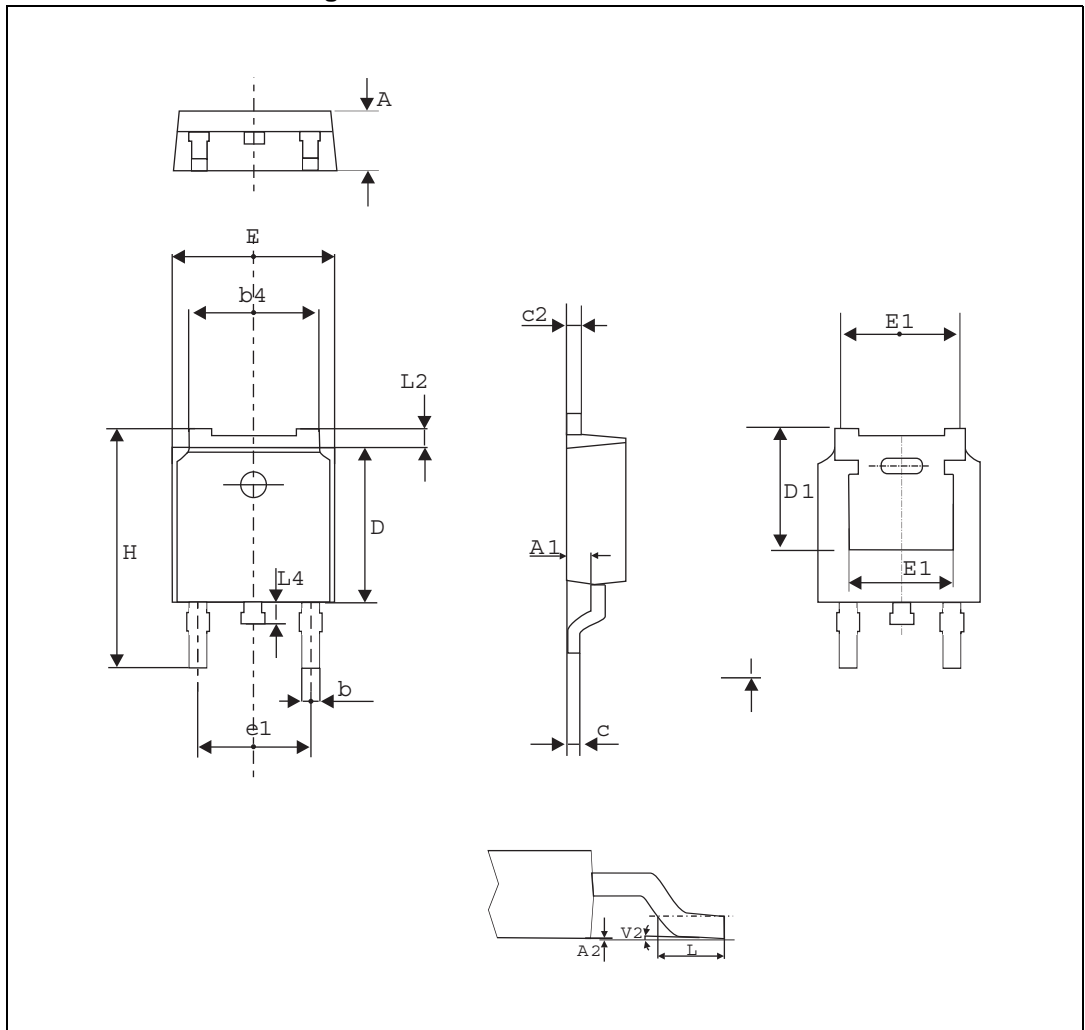


Table 6. TO-220FPAB dimension values

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	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			0.63	
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

Figure 21. DPAK dimension definitions

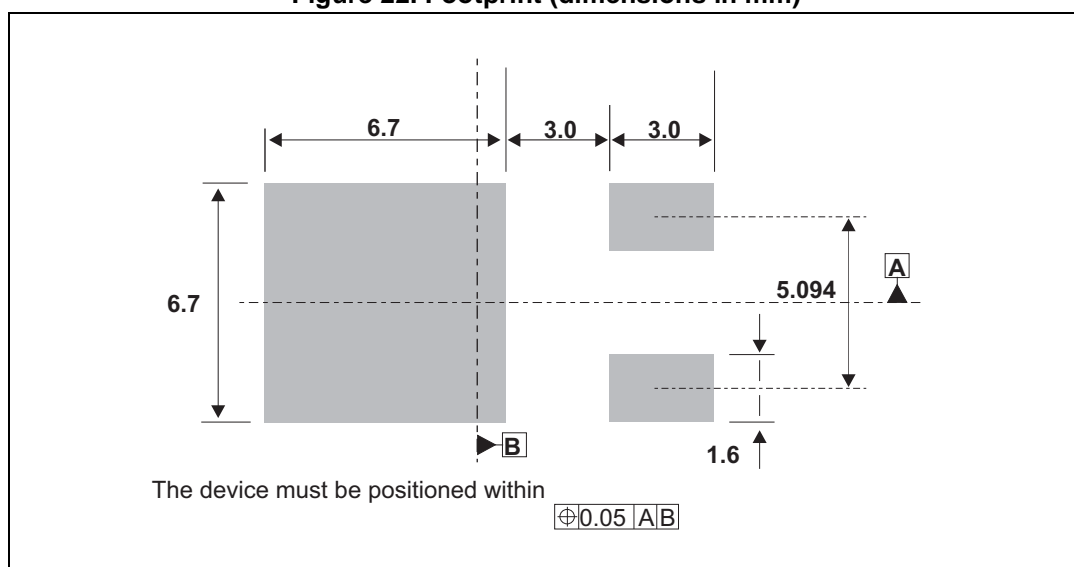


**Note:** This package drawing may slightly differ from the physical package. However, all the specified dimensions are guaranteed.

Table 7. DPAK dimension values

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	2.18		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
b4	4.95		5.46	0.195		0.215
c	0.46		0.61	0.018		0.024
c2	0.46		0.60	0.018		0.023
D	5.97		6.22	0.235		0.244
D1	5.10			0.201		
E	6.35		6.73	0.250		0.264
E1		4.32			0.170	
e1	4.40		4.70	0.173		0.185
H	9.35		10.40	0.368		0.409
L	1.00		1.78	0.039		0.070
L2			1.27			0.05
L4	0.60		1.02	0.023		0.040
V2	0°		8°	0°		8°

Figure 22. Footprint (dimensions in mm)



## 4 Ordering information

Figure 23. Ordering information scheme

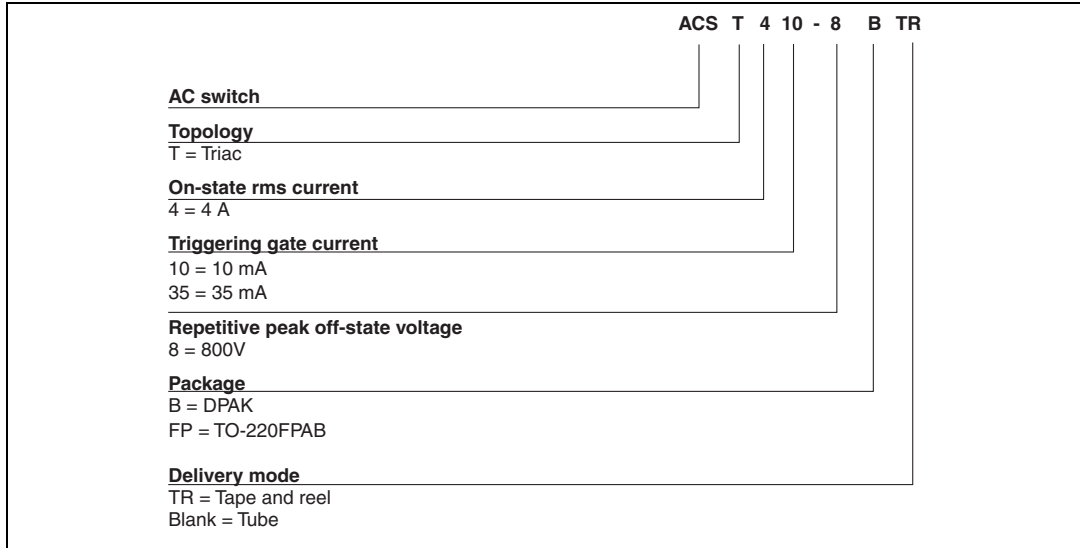


Table 8. Ordering information

Order code	Marking	Package	Weight	Base Qty	Delivery mode
ACST410-8B	ACST4108	DPAK	1.5 g	50	Tube
ACST410-8BTR		DPAK	1.5 g	1000	Tape and reel
ACST410-8FP		TO-220FPAB	2.4 g	50	Tube
ACST435-8B	ACST4358	DPAK	1.5 g	50	Tube
ACST435-8BTR		DPAK	1.5 g	1000	Tape and reel
ACST435-8FP		TO-220FPAB	2.4 g	50	Tube

## 5 Revision history

Table 9. Document revision history

Date	Revision	Changes
Jan-2003	3A	Previous update.
04-Jul-2007	4	Reformatted to current standard. Added package.
18-Dec-2009	5	$V_{DRM}/V_{RRM}$ updated to 800 V. Order codes updated.
02-Jun-2014	6	Updated DPAK package information and reformatted to current standard.
21-Oct-2014	7	Updated <a href="#">Table 2</a> , <a href="#">Table 3</a> , <a href="#">Table 4</a> , <a href="#">Features</a> and <a href="#">Description</a> .

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