

## Overvoltage protected AC switch

### **Features**

- Triac with overvoltage crowbar technology
- High noise immunity: static dV/dt > 500 V/µs
- ACST210-8FP, in the TO-220FPAB package, provides insulation voltage rated at 1500 V rms

### **Benefits**

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

## **Applications**

- AC on/off static switching in appliances and industrial control systems
- Driving low power highly inductive loads like solenoid, pump, fan, and micro-motor

## **Description**

The ACST2 series belongs to the ACSTM/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 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 ( $I_{GT} < 10 \text{ mA}$ ) and still shows a high electrical noise immunity complying with IEC standards such as IEC 61000-4-4 (fast transient burst test).

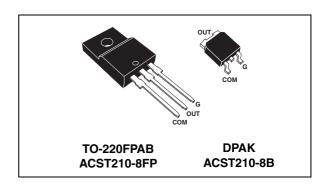


Figure 1. Functional diagram

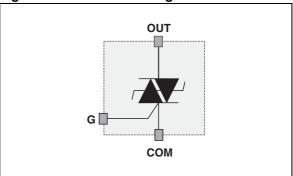


Table 1. Device summary

Symbol	Value	Unit
I <sub>T(RMS)</sub>	2	Α
$V_{DRM}/V_{RRM}$	800	V
I <sub>GT</sub>	10	mA

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# 1 Characteristics

Table 2. Absolute maximum ratings (limiting values)

Symbol	Paramete	Value	Unit		
	On atota rma current (full aina waya)	TO-220FPAB	T <sub>c</sub> = 105 °C	2	Α
I <sub>T(RMS)</sub>	On-state rms current (full sine wave)	DPAK	T <sub>c</sub> = 110 °C	2	
	Non repetitive surge peak on-state current	F = 60 Hz	t = 16.7 ms	8.4	Α
TSM	(full cycle sine wave, T <sub>J</sub> initial = 25 °C)	F = 50 Hz	t = 20 ms	8.0	
l <sup>2</sup> t	I <sup>2</sup> t Value for fusing	t <sub>p</sub> = 10 ms		0.5	A <sup>2</sup> s
dl/dt	Critical rate of rise of on-state current $I_G = 2 \times I_{GT}$ , $t_r = 100 \text{ ns}$	F = 120 Hz	Tj = 125 °C	50	A/μs
V <sub>PP</sub> <sup>(1)</sup>	Non repetitive line peak mains voltage <sup>(1)</sup> Tj = 25 °C		2	kV	
P <sub>G(AV)</sub>	Average gate power dissipation $Tj = 125$ °C		0.1	W	
P <sub>GM</sub>	Peak gate power dissipation ( $t_p = 20 \mu s$ ) Tj = 125 °C		10	W	
I <sub>GM</sub>	Peak gate current (t <sub>p</sub> = 20 μs)	Peak gate current ( $t_p = 20 \mu s$ ) Tj = 125 °C		1.6	Α
T <sub>stg</sub> T <sub>j</sub>	Storage junction temperature range Operating junction temperature range			-40 to +150 -40 to +125	°C
T <sub>I</sub>	Maximum lead soldering temperature during 10 s (at 3 mm from plastic case)			260	°C
V <sub>INS(RMS)</sub>	Insulation rms voltage		T0-220FPAB	1500	V

<sup>1.</sup> According to test described in IEC 61000-4-5 standard and Figure 18

Table 3. Electrical characteristics ( $T_i = 25$  °C, unless otherwise specified)

Symbol	Test conditions	Quadrant		Value	Unit
I <sub>GT</sub> <sup>(1)</sup>	$V_{OUT}$ = 12 V, $R_L$ = 33 $\Omega$	I - II - III	MAX	10	mA
V <sub>GT</sub>	$V_{OUT}$ = 12 V, $R_L$ = 33 $\Omega$	1 - 11 - 111	MAX	1.1	V
$V_{GD}$	$V_{OUT} = V_{DRM}$ , $R_L = 3.3 \text{ k}\Omega$ , $T_j = 125 \text{ °C}$	1 - 11 - 111	MIN	0.2	٧
I <sub>H</sub> <sup>(2)</sup>	I <sub>OUT</sub> = 100 mA		MAX	10	mA
	1.0 v.l	I - III	MAX	25	mA
IL	$I_{G} = 1.2 \times I_{GT}$	II	MAX	35	IIIA
dV/dt (2)	V <sub>OUT</sub> = 67% V <sub>DRM</sub> gate open, T <sub>j</sub> = 125 °C		MIN	500	V/µs
(dl/dt)c (2)	(dV/dt)c = 15 V/μs, T <sub>j</sub> = 125 °C		MIN	0.5	A/ms
V <sub>CL</sub>	$I_{CL} = 0.1 \text{ mA}, t_p = 1 \text{ ms}, T_j = 25 ^{\circ}\text{C}$		MIN	850	V

<sup>1.</sup> Minimum  $\rm I_{GT}$  is guaranteed at 5% of  $\rm I_{GT}$  max

<sup>2.</sup> For both polarities of OUT pin referenced to COM pin

ACST2 Characteristics

Table 4. Static electrical characteristics

Symbol	Test conditions			Value	Unit
V <sub>TM</sub> <sup>(1)</sup>	$I_{TM} = 2.8 \text{ A}, t_p = 500  \mu\text{s}$	T <sub>j</sub> = 25 °C	MAX	2	V
V <sub>TO</sub> <sup>(1)</sup>	Threshold voltage	T <sub>j</sub> = 125 °C	MAX	0.9	V
R <sub>D</sub> <sup>(1)</sup>	Dynamic resistance	T <sub>j</sub> = 125 °C	MAX	250	mΩ
I <sub>DRM</sub>	V <sub>OUT</sub> = V <sub>DRM</sub> / V <sub>RRM</sub>	T <sub>j</sub> = 25 °C MAX	$T_j = 25  ^{\circ}C$	10	μA
I <sub>RRM</sub>	VOUT - VDRM / VRRM	T <sub>j</sub> = 125 °C	IVIAA	0.5	mA

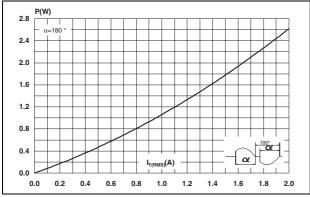
<sup>1.</sup> For both polarities of OUT pin referenced to COM pin

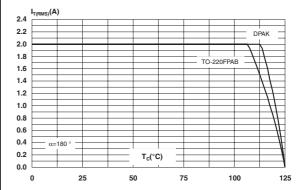
Table 5. Thermal resistances

Symbol	Parameter				Unit
D lunction to cook (AC)			DPAK	4.5	
R <sub>th(j-c)</sub>	lunction to case (AC)		TO-220FPAB	7	°C/W
В	Junction to ambient		TO-220FPAB	60	C/VV
$R_{th(j-a)}$	Junction to ambient	$S_{CU}^{(1)} = 0.5 \text{ cm}^2$	DPAK	70	

<sup>1.</sup>  $S_{CU} = copper surface under tab$ 

Figure 2. Maximum power dissipation versus Figure 3. On-state rms current versus case on-state rms current (full cycle) temperature

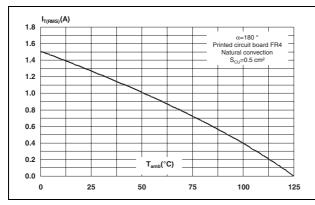




Characteristics ACST2

Figure 4. On-state rms current versus ambient temperature

Figure 5. Relative variation of thermal impedance versus pulse duration TO-220FPAB



1.00 K=[Z<sub>B</sub>/R<sub>m</sub>]

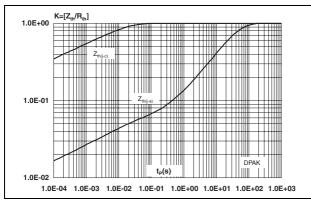
2.01

2.0(-1)

1.0E-04 1.0E-03 1.0E-02 1.0E-01 1.0E+00 1.0E+01 1.0E+02 1.0E+03

Figure 6. Relative variation of thermal impedance versus pulse duration DPAK

Figure 7. Relative variation of gate trigger, holding and latching current versus junction temperature



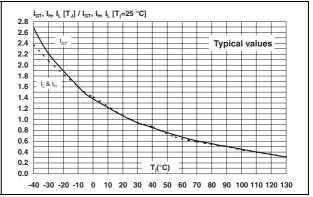
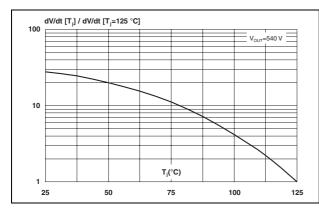
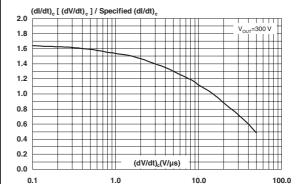


Figure 8. Relative variation of static dV/dt versus junction temperature

Figure 9. Relative variation of critical rate of decrease of main current versus reapplied dV/dt (typical values)

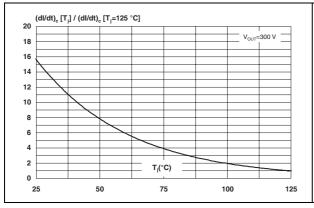


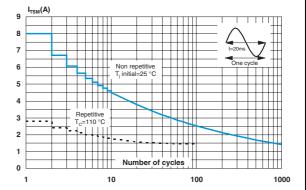


ACST2 **Characteristics** 

Figure 10. Relative variation of critical rate of Figure 11. Surge peak on-state current versus decrease of main current versus junction temperature

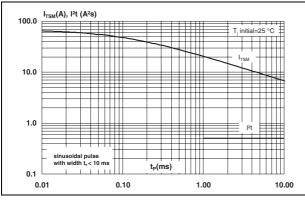
number of cycles





Non repetitive surge peak on-state Figure 13. current and corresponding value of I<sup>2</sup>t

**On-state characteristics (maximum** values)



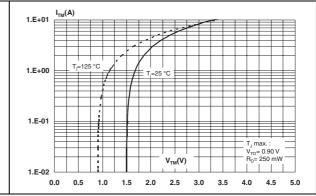
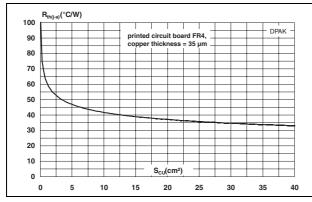
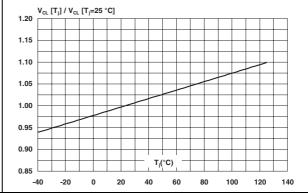


Figure 14. Thermal resistance junction to ambient versus copper surface under tab DPAK

Figure 15. Relative variation of clamping voltage V<sub>CL</sub> versus junction temperature



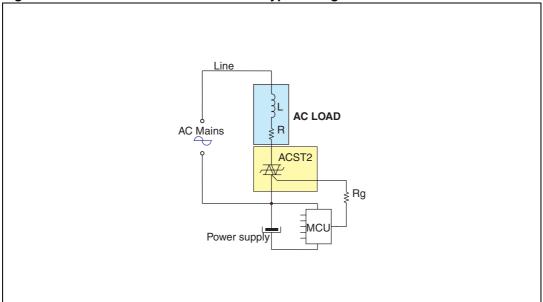


### **Application information** 2

#### Typical application description 2.1

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<sub>GT</sub> 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.



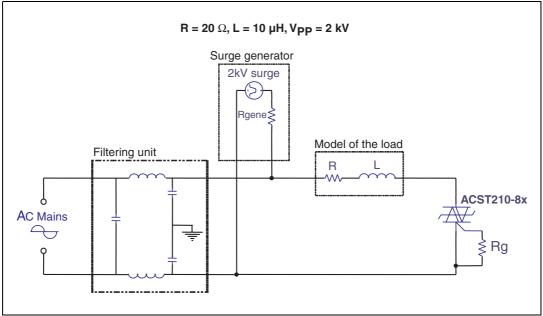


## 2.2 AC line transient voltage ruggedness

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 againast 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 17* 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 18*. 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 17. Overvoltage ruggedness test circuit for resistive and inductive loads for IEC 61000-4-5 standards



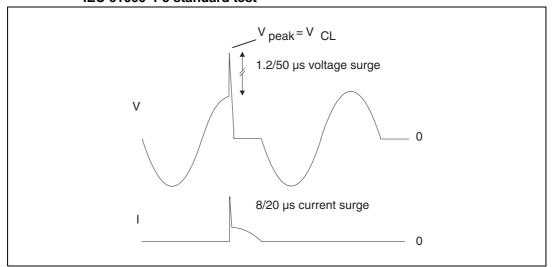


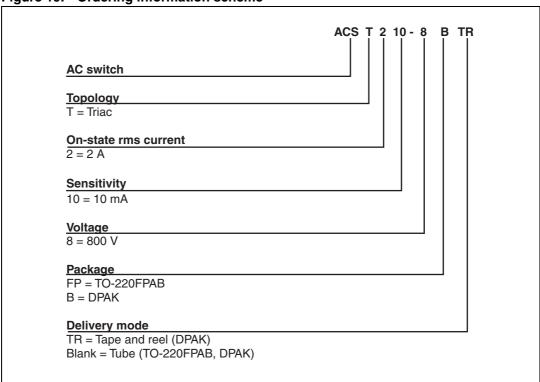
Figure 18. Typical current and voltage waveforms across the ACST2 during IEC 61000-4-5 standard test

## 2.3 Electrical noise immunity

The ACST2 is a sensitive device ( $I_{GT} = 10$  mA) and can be controlled directly though a simple resistor by a logic level circuit, and still provides a high electrical noise immunity. The intrinsic immunity of the ACST2 is shown by the specified dV/dt equal to 500 V/ $\mu$ s @ 125 °C. This immunity level is 5 to 10 times higher than the immunity provided by an equivalent standard technology Triac with the same sensitivity. In other words, the ACST2 is sensitive, but has an immunity usually available only for non-sensitive device ( $I_{GT}$  higher than 35 mA).

# 3 Ordering information scheme

Figure 19. Ordering information scheme



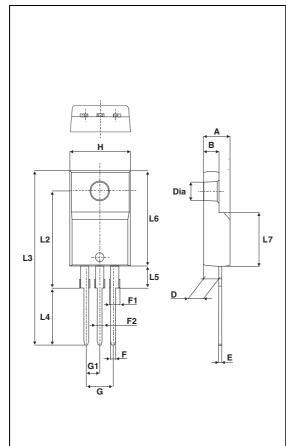
Package information ACST2

# 4 Package information

- Epoxy meets UL94, V0
- 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: <a href="https://www.st.com">www.st.com</a>. ECOPACK<sup>®</sup> is an ST trademark.

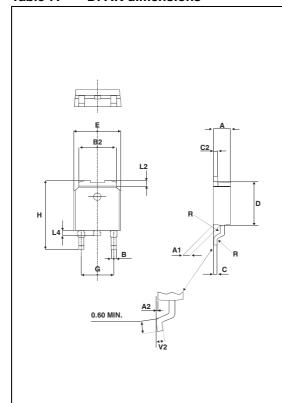
Table 6. TO-220FPAB dimensions



	Dimensions				
Ref.	Millin	neters	Inc	hes	
	Min.	Max.	Min.	Max.	
Α	4.4	4.6	0.173	0.181	
В	2.5	2.7	0.098	0.106	
D	2.5	2.75	0.098	0.108	
Е	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	
Н	10	10.4	0.393	0.409	
L2	16	Тур.	0.63	Тур.	
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	

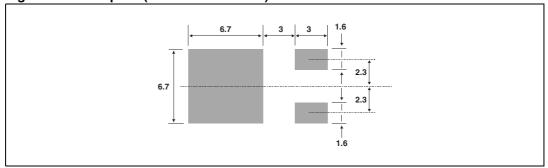
ACST2 Package information

Table 7. DPAK dimensions



	Dimensions				
Ref.	Millim	neters	Inc	hes	
	Min.	Max.	Min.	Max.	
Α	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	
В	0.64	0.90	0.025	0.035	
B2	5.20	5.40	0.204	0.212	
С	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	
Е	6.40	6.60	0.251	0.259	
G	4.40	4.60	0.173	0.181	
Н	9.35	10.10	0.368	0.397	
L2	0.80 typ.		0.03	1 typ.	
L4	0.60	1.00	0.023	0.039	
V2	0°	8°	0°	8°	

Figure 20. Footprint (dimensions in mm)



Ordering information ACST2

# 5 Ordering information

Table 8. Ordering information

Order code	Marking	Package	Weight	Base Qty	Packing mode
ACST210-8FP		TO-220FPAB	2.4g	50	Tube
ACST210-8B	ACST2108	DPAK	0.3g	50	Tube
ACST210-8B-TR		DPAK	0.3g	2500	Tape and Reel

# 6 Revision history

Table 9. Document revision history

Date	Revision	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 19.

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