

Overvoltage protected AC switch

Datasheet - production data

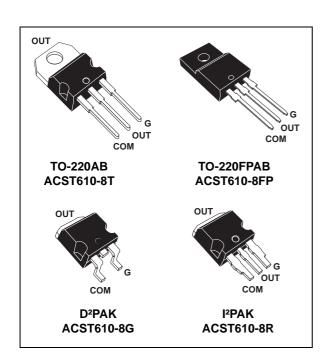
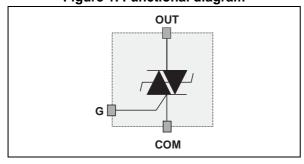


Figure 1. Functional diagram



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 ($I_{\rm GT}$ < 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	Α
V_{DRM}/V_{RRM}	800	V
I _{GT}	10	mA

Characteristics ACST6

1 Characteristics

Table 2. Absolute ratings (limiting values)

Symbol	Parameter			Value	Unit
		TO-220FPAB	T _c = 92 °C		
I _{T(RMS)}	On-state rms current (full sine wave)	TO-220AB/ D ² PAK / I ² PAK	T _c = 106 °C	6	А
		D ² PAK with 1 cm ² copper	T _{amb} = 62 °C	1.5	
	Non repetitive surge peak on-state current T _i	F = 60 Hz	$t_p = 16.7 \text{ ms}$	47	Α
I _{TSM}	initial = 25 °C, (full cycle sine wave)	F = 50 Hz	t _p = 20 ms	45	Α
l ² t	I ² t for fuse selection	t _p = 10 ms	13	A^2s	
dI/dt	Critical rate of rise on-state current $I_G = 2 \times I_{GT}$, $(t_r \le 100 \text{ ns})$		T _j = 125 °C	100	A/µs
V _{PP}	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)	1.6	Α		
T _{stg}	Storage temperature range	-40 to +150	°C		
T _j	Operating junction temperature range			-40 to +125	°C
T _I	Maximum lead solder temperature during 10 ms (at 3 mm from plastic case) 26			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	Tj		Value	Unit
I _{GT} ⁽¹⁾	V_{OUT} = 12 V, R_L = 33 Ω	1 - 11 - 111	25 °C	MAX.	10	mA
V _{GT}	V_{OUT} = 12 V, R_L = 33 Ω	1 - 11 - 111	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 mA		25 °C	MAX.	25	mA
ΙL	$I_{G} = 1.2 \times I_{GT}$	I - III	25 °C	MAX.	30	mA
ΙL	$I_G = 1.2 \times I_{GT}$		25 °C	MAX.	40	mA
dV/dt ⁽²⁾	V _{OUT} = 67 % V _{DRM} , gate open		125 °C	MIN.	500	V/µs
(dl/dt) _c ⁽²⁾	$(dV/dt)_{c} = 15 V/\mu s$		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

ACST6 Characteristics

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 _i = 25 °C	MAX.	1.4	V
VIM	$I_{OUT} = 8.5 \text{ A}, t_p = 500 \mu \text{s}$	71, - 25 0	IVI/A/X.	1.7	v
V _{T0} ⁽¹⁾	Threshold voltage	T _j = 125 °C	MAX.	0.9	V
R _d ⁽¹⁾	Dynamic resistance	T _j = 125 °C	MAX.	80	mΩ
I _{DRM} I _{RRM}	$V_{OUT} = V_{DRM} / V_{RRM}$	T _j = 25 °C	MAX.	20	μΑ
		T _j = 125 °C	MAX.	500	μΑ

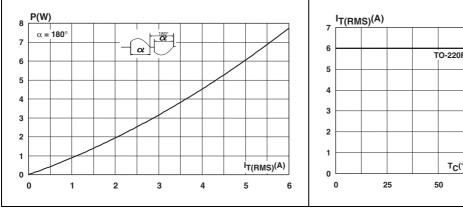
^{1.} For both polarities of OUT pin referenced to COM pin

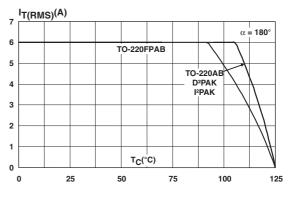
Table 5. Thermal resistances

Symbol	Parameter		Value	Unit
	Junction to ambient	TO-220AB TO-220FPAB	60	
Rt _{h(j-a)}		I ² PAK	65	°C/W
	Junction to ambient (soldered on 1 cm ² copper pad)	D ² PAK	45	
		TO-220FPAB	4.25	
R _{th(j-c)} Junction	Junction to case for full cycle sine wave conduction	TO-220AB D ² PAK , I ² PAK	2.5	°C/W

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

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

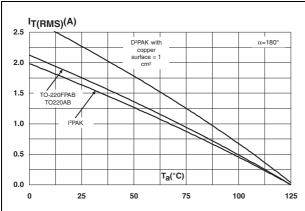




Characteristics ACST6

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

Figure 5. Relative variation of thermal impedance versus pulse duration



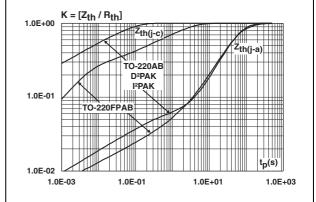
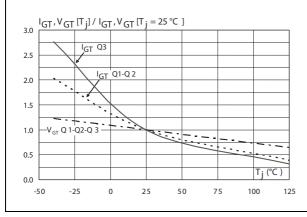


Figure 6. Relative variation of gate trigger current (I_{GT}) and voltage (V_{GT}) versus junction temperature (typical values)

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



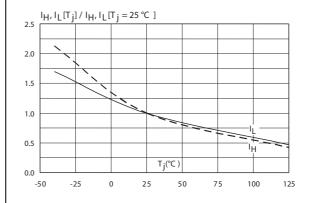
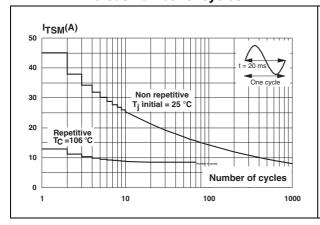
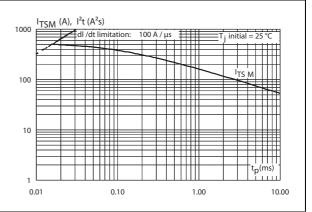


Figure 8. Surge peak on-state current versus number of cycles

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





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Figure 10. On-state characteristics (maximum values)

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

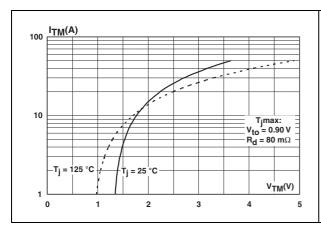
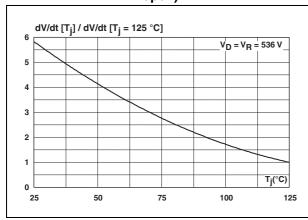


Figure 12. Relative variation of static dV/dt immunity versus junction temperature (gate open)

Figure 13. Relative variation of leakage current versus junction temperature



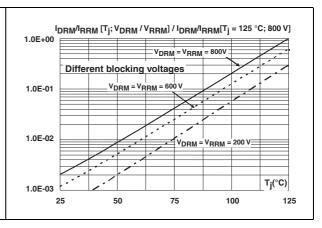
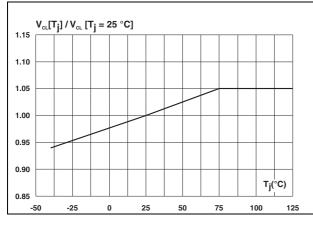
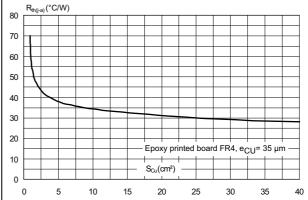


Figure 14. Relative variation of clamping voltage (V_{CL}) versus junction temperature (minimum values)

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*.

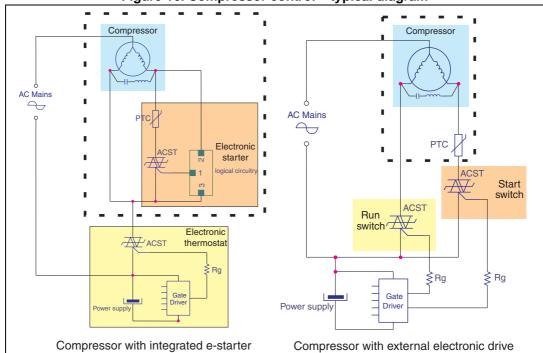


Figure 16. Compressor control – typical diagram

(T)

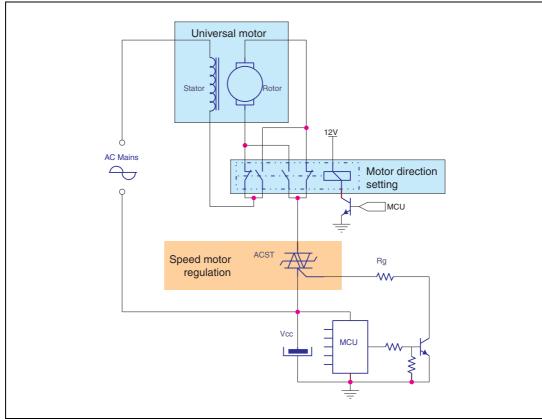


Figure 17. Universal drum motor control – typical diagram

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.



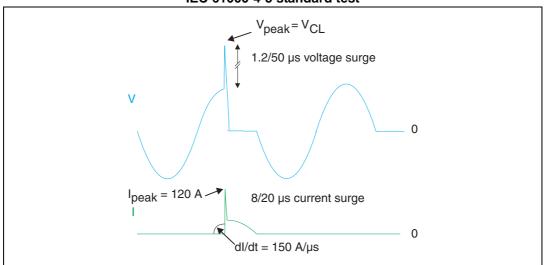
R = 18 Ω, L = 2 μH, Vsurge = 2 kV
Rg = 220 Ω
Surge generator

2kV surge
Rgene
AC Mains

ACST6

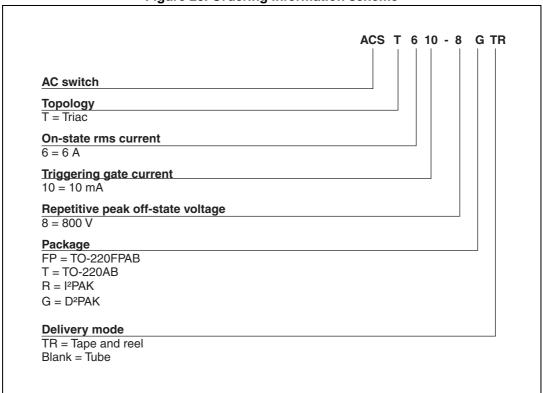
Figure 18. Overvoltage ruggedness test circuit for resistive and inductive loads for IEC 61000-4-5 standards

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[®] 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.



4.1 TO-220AB package information

øΡ H1 <u>D1</u> L20 L30 b1(X3) -Resin gate 0.5 mm max. protrusion ⁽¹⁾ b (X3) $^{(1)}\mbox{Resin}$ gate accepted in one of the two positions or in the symmetrical opposites

Figure 21. TO-220AB package outline

Table 6. TO-220AB package mechanical data

		Dimensions			
Ref.	Milli	Millimeters		hes	
	Min.	Max.	Min.	Max.	
А	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	
С	0.48	0.7	0.0189	0.0276	
D	15.25	15.75	0.6004	0.6201	
D1	1.2	1.27 typ.		0 typ.	
E	10	10.4	0.3937	0.4094	
е	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	28.9	28.90 typ.		8 typ.	
θР	3.75	3.85	0.1476	0.1516	
Q	2.65	2.95	0.1043	0.1161	

4.2 TO-220FPAB package information

L2 Dia L7
L7
L4
F1
G1
F1
E

Figure 22. TO-220FPAB package outline

Table 7. TO-220FPAB package mechanical data

	Dimensions			
Ref.	Millim	neters	Incl	hes
	Min.	Max.	Min.	Max.
А	4.40	4.60	0.1739	0.1818
В	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	1.15 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
Н	10.0	10.4	0.3953	0.4111
L2	16	Гур.	0.6324	4 Тур.
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 D²PAK package information

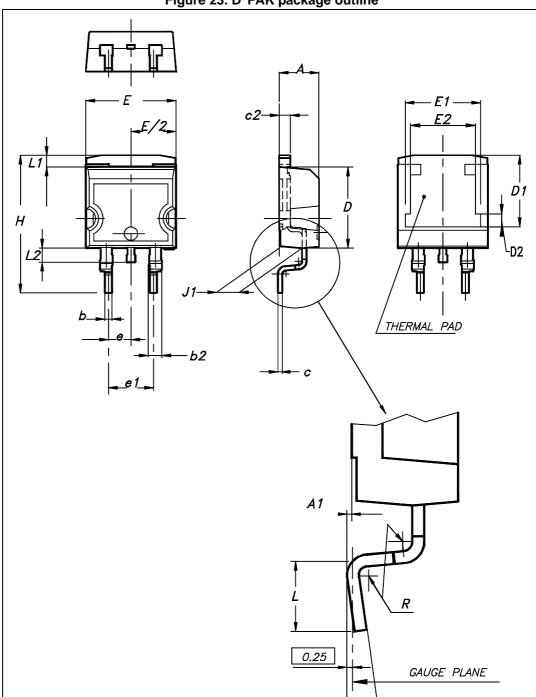
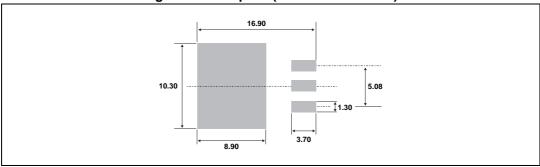


Figure 23. D²PAK package outline

Table 8. D²PAK package mechanical data

		Dime	ensions	
Ref.	Millir	neters	Inc	hes
	Min.	Max.	Min.	Max.
А	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
В	0.70	0.93	0.0277	0.0368
B2	1.14	1.70	0.0451	0.0672
С	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
Е	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
М	2.40	3.20	0.0949	0.1265
R	0.40	0.40 typ.		8 typ.
V2	0°	8°	0°	8°

Figure 24. Footprint (dimensions in mm)



4.4 I²PAK package information

Figure 25. I²PAK package outline

Table 9. I²PAK package mechanical data

		Dimensions			
Ref.	Millim	Millimeters		hes	
	Min.	Max.	Min.	Max.	
А	4.4	4.6	0.1739	0.1818	
A1	2.49	2.69	0.0984	0.1063	
В	0.7	0.93	0.0277	0.0368	
B2	1.14	1.7	0.0451	0.0672	
С	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		TO-220FPAB	2.4 g	50	Tube
ACST610-8G		D ² PAK	1.5 g	50	Tube
ACST610-8GTR	ACST6108	D ² PAK	1.5 g	1000	Tape and reel
ACST610-8R		I ² 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 Figure 20.
30-May-2017	11	Updated features in cover page and <i>Table 2</i> . Updated <i>Section 4: Package information</i> . Minor text changes.

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OT408,135 BT134-800E BT136D BTB16Q-600BW Z0409MF BTA06-600BRG BTA06-800BWRG BTA08-600BRG BTA08-800B

BT136-600,127 MAC97A6,116 BT137-600E,127 BTB16-600CW3G BTB16-600CW3G Z0109MN,135 T825T-6I T1220T-6I NTE5638

ACST1235-8FP BT136X-600E,127 MAC4DLM-1G BT134-600D,127 BTA08-600BW3G NTE56008 NTE56017 NTE56018 NTE56059

NTE5608 NTE5609 NTE5656 NTE56020