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Transient protected AC power switch

Features

- Triac with overvoltage crowbar technology
- Low I_{GT} (<10 mA) or high immunity (I_{GT}<35 mA) version</p>
- High noise immunity: static dV/dt > 2000 V/µs

Benefits

- Enables equipment to meet IEC 61000-4-5
- High off-state reliability with planar technology
- Need no external over voltage 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 like:
 - Universal drum motor of washing machine
 - Compressor for fridge or air conditioner

Description

The **ACST12 series** belongs to the ACS/ACST family built with the ASD (application specific discrete) technology. This high performance device is adapted to home appliances or industrial systems and drives loads up to 12 A.

This ACST12 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 ACST12-7S needs a low gate current to be activated ($I_{\rm GT}$ < 10 mA) and in the mean time provides a high electrical noise immunity such as those described in the IEC 61000-4-4 standards. The ACST12-7C offers an extremely high static dV/dt immunity of 2 kV/µs minimum.

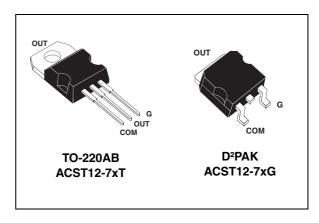


Figure 1. Functional diagram

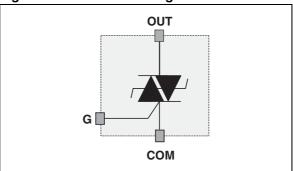


Table 1. Device summary

Symbol	Value	Unit
I _{T(RMS)}	12	Α
V _{DRM} /V _{RRM}	700	V
I _{GT}	10 or 35	mA

Characteristics ACST12

1 Characteristics

Table 2. Absolute ratings (limiting values)

Symbol	Parameter	Value	Unit		
I	On-state rms current full sine wave	TO-220AB D²PAK	T _c = 104 °C	12	Α
I _{T(RMS)}	Off-State firs current full sine wave	D ² PAK with 1cm ² of Cu		2	^
1.	Non repetitive surge peak on-state current	F = 60 Hz	$t_p = 16.7 \text{ ms}$	126	Α
I _{TSM}	T _j initial = 25 °C,(full cycle sine wave)	F = 50 Hz		120	Α
l ² t	I ² t for fuse selection	95	A ² s		
dI/dt	Critical rate of rise on-state current $I_G = 2 \times I_{GT_r} (t_r \le 100 \text{ ns})$ F = 120 Hz		T _j = 125 °C	100	A/µs
V _{PP}	Non repetitive line peak pulse voltage (1)	2	kV		
P _{G(AV)}	Average gate power dissipation	0.1	W		
P _{GM}	Peak gate power dissipation (t _p = 20 μs)	10	W		
I _{GM}	Peak gate current (t _p = 20 μs)	1	Α		
T _{stg}	Storage temperature range	- 40 to + 150	°C		
Tj	Operating junction temperature range			- 40 to + 125	°C

^{1.} According to test described in IEC 61000-4-5 standard and Figure 19

Table 3. Electrical characteristics

Cymhal	Test conditions	tions Quadrant T _i			Value		Unit
Symbol	rest conditions	Quadrant	T _j		ACST12-7Sx	ACST12-7Cx	Unit
I _{GT} ⁽¹⁾	$V_{OUT} = 12 \text{ V}, R_L = 33 \Omega$	1 - 11 - 111	25 °C	MAX.	10	35	mA
V_{GT}	$V_{OUT} = 12 \text{ V}, R_L = 33 \Omega$	1 - 11 - 111	25 °C	MAX.	1.0		V
V_{GD}	$V_{OUT} = V_{DRM}, R_L = 3.3 \Omega$	1 - 11 - 111	125 °C	MIN.	0.2		V
I _H ⁽²⁾	I _{OUT} = 500 mA		25 °C	MAX.	30	50	mA
IL	I _G = 1.2 x I _{GT}	1 - 11 - 111	25 °C	MAX.	50	70	mA
dV/dt ⁽²⁾	V _{OUT} = 67% V _{DRM} , gate open		125 °C	MIN.	200	2000	V/µs
(dl/dt)c ⁽²⁾	(dV/dt)c = 15 V/μs		125 °C	MIN.	5.3		A/ms
(ui/ut)C ⁽⁻⁾	Without snubber		125 0	MIN.		14	A/IIIS
V _{CL}	$I_{CL} = 0.1 \text{ mA}, t_p = 1 \text{ ms}$	I _{CL} = 0.1 mA, t _p = 1 ms			85	50	V

^{1.} Minimum $I_{\mbox{\scriptsize GT}}$ is guaranteed at 5% of $I_{\mbox{\scriptsize GT}}$ max

^{2.} For both polarities of OUT pin referenced to COM pin

ACST12 Characteristics

Table 4. Static characteristics

Symbol	Test conditions				Unit
V _{TM} ⁽¹⁾	$I_{OUT} = 17 \text{ A}, t_p = 500 \ \mu \text{s}$	T _j = 25 °C	MAX.	1.5	V
V _{T0} ⁽¹⁾	Threshold voltage	T _j = 125 °C	MAX.	0.9	V
R _d ⁽¹⁾	Dynamic resistance	T _j = 125 °C	MAX.	30	mΩ
I _{DRM} I _{RRM}	V -V /V	T _j = 25 °C	MAX.	20	μΑ
	$V_{OUT} = V_{DRM} / V_{RRM}$	T _j = 125 °C	IVIAA.	1.5	mA

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

Table 5. Thermal characteristics

Symbol	Parameter	Value	Unit	
В	lunction to age (AC)	TO-220AB	1.5	°C/W
R _{th(j-c)} June	lunction to case (AC)	D ² PAK	1.5	°C/W
D	Junction to ambient	TO-220AB	60	°C/W
R _{th(j-a)} Ju	ounction to ambient	D ² PAK with 1cm ² of Cu	45	°C/W

Figure 2. Maximum power dissipation vs. on-state rms current (full cycle)

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

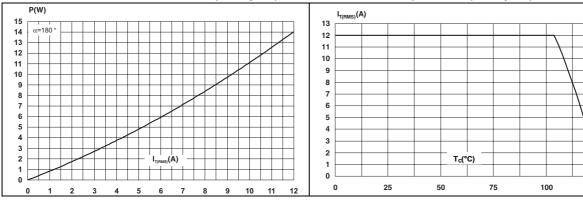
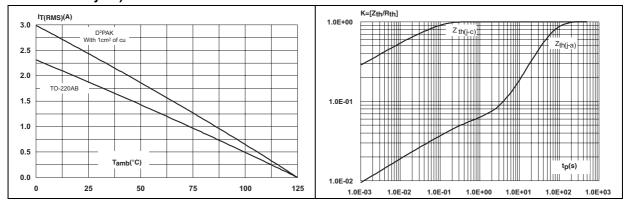


Figure 4. On-state rms current vs. ambient temperature (free air convection full cycle)

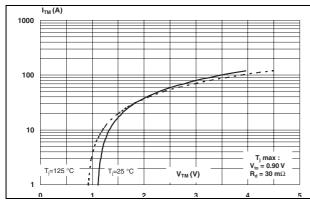
Figure 5. Relative variation of thermal impedance vs. pulse duration



Characteristics ACST12

Figure 6. On-state characteristics (maximum values)

Figure 7. Non repetitive surge peak on-state current vs. number of cycles (T_i initial = 25 °C)



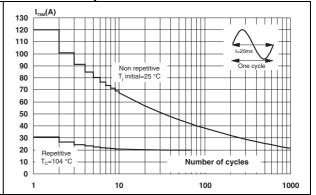
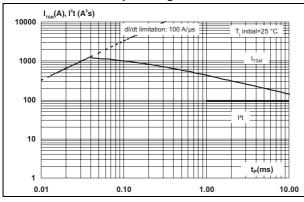


Figure 8. Non repetitive surge peak on-state Figure 9. current for a sinusoidal pulse and corresponding value of I²t

ure 9. Relative variation of gate triggering current (I_{GT}) and voltage (V_{GT}) vs. junction temperature (typical value)



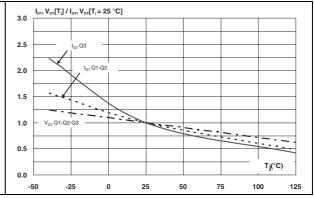
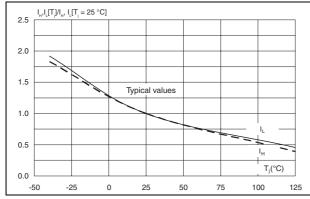
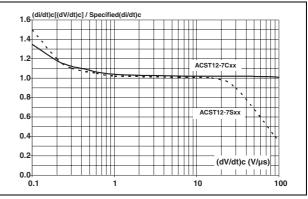


Figure 10. Relative variation of holding current (I_H) and latching current (I_L) vs. junction temperature

Figure 11. Relative variation of critical rate of decrease of main current (di/dt)c vs. (dV/dt)c





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ACST12 Characteristics

Figure 12. Relative variation of critical rate of Figure 13. Relative variation of static dV/dt decrease of main current vs. immunity vs. junction temperature junction temperature

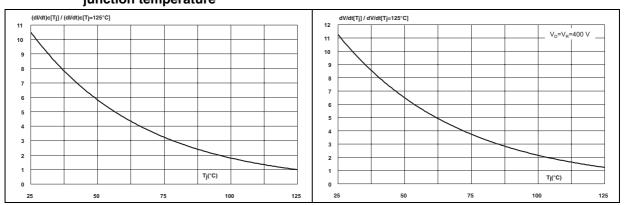
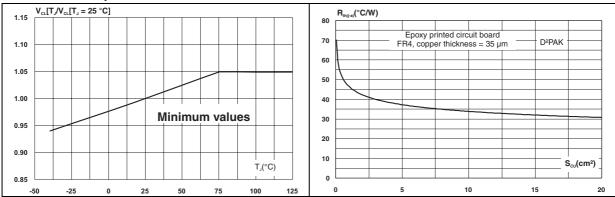


Figure 14. Relative variation of maximum clamping voltage, V_{CL} vs. junction temperature

Figure 15. Variation of thermal resistance junction to ambient vs. copper surface under tab

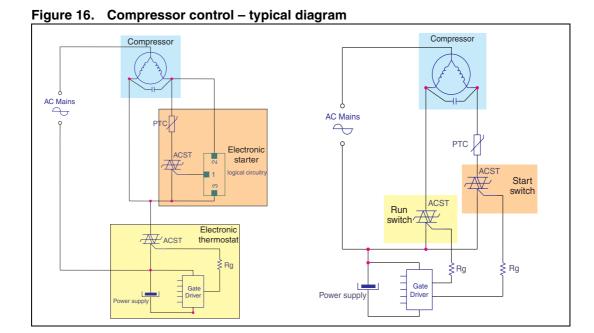


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2 Application information

2.1 Typical application description

The ACST12 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 ACST12 switch is able to drive, with no turn off additional snubber, an inductive load up to 12 A. 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 ACST12-7S can be driven directly by a MCU through a simple gate resistor as shown in *Figure 16*.



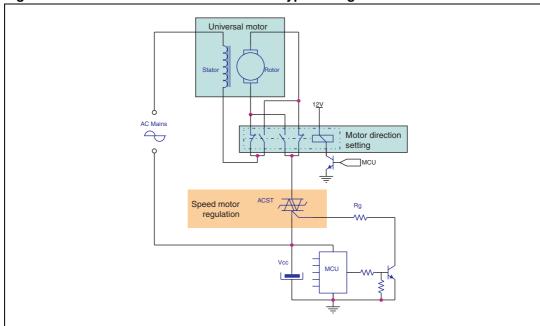


Figure 17. Universal drum motor control – typical diagram

2.2 AC line transient voltage ruggedness

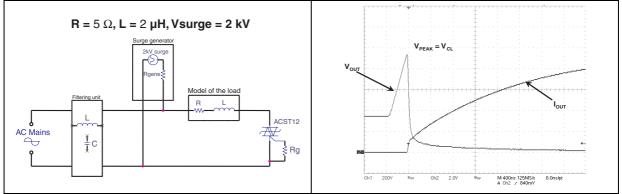
In comparison with standard TRIACs, which are not robust against surge voltage, the ACST12 is self-protected against over-voltage, specified by the new parameter V_{CL} . The ACST12 switch can safely withstand AC line transient voltages either by clamping the low energy spikes or by switching to the 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 rises.

The test circuit of *Figure 18* represents the ACST12 application, and is used to stress the ACST switch according to the IEC 61000-4-5 standard conditions. Thanks to the load which is limiting the current, the ACST switch withstands the voltage spikes up to 2 kV above the peak line voltage. The protection is based on an overvoltage crowbar technology. The ACST12 switches safely to the on state as shown in *Figure 19*. The ACST12 recovers its blocking voltage capability after the surge. Such a non repetitive test can be done at least 10 times on each AC line voltage polarity.

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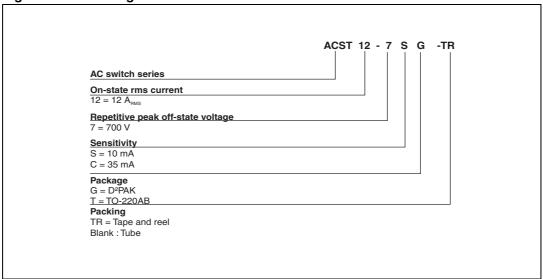
Figure 18. Overvoltage ruggedness test circuit Figure 19. Typical current and voltage for resistive and inductive loads for IEC 61000-4-5 standards

waveforms across the ACST12 during IEC 61000-4-5 standard test



Ordering information scheme 3

Figure 20. Ordering information scheme



ACST12 Package information

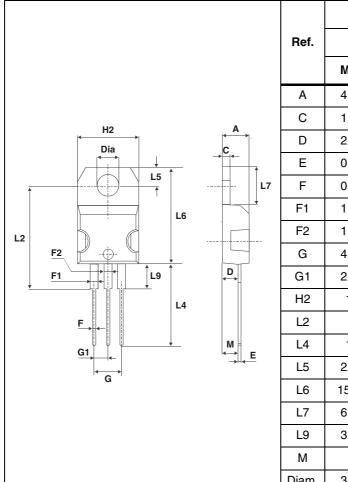
4 Package information

Epoxy meets UL94, V0

■ Recommende torque: 0.4 to 0.6 N·m

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.

Table 6. TO-220AB dimensions

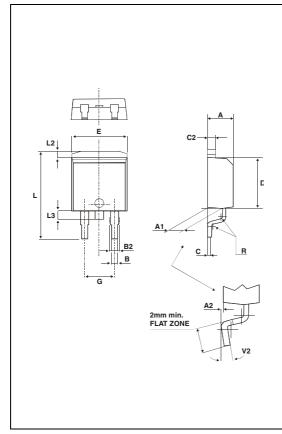


	Dimensions						
Ref.	Millim	neters	Inc	hes			
	Min.	Max.	Min.	Max.			
Α	4.40	4.60	0.173	0.181			
С	1.23	1.32	0.048	0.051			
D	2.40	2.72	0.094	0.107			
Е	0.49	0.70	0.019	0.027			
F	0.61	0.88	0.024	0.034			
F1	1.14	1.70	0.044	0.066			
F2	1.14	1.70	0.044	0.066			
G	4.95	5.15	0.194	0.202			
G1	2.40	2.70	0.094	0.106			
H2	10	10.40	0.393	0.409			
L2	16.4	typ.	0.645 typ.				
L4	13	14	0.511	0.551			
L5	2.65	2.95	0.104	0.116			
L6	15.25	15.75	0.600	0.620			
L7	6.20	6.60	0.244	0.259			
L9	3.50	3.93	0.137	0.154			
М	2.6	typ.	0.102	2 typ.			
Diam.	3.75	3.85	0.147	0.151			

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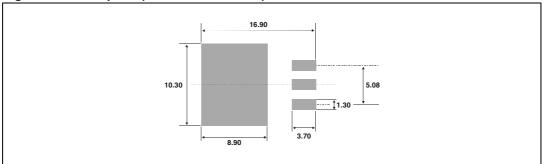
Package information ACST12

Table 7. D²PAK dimensions



	Dimensions					
Ref.	Millimete		rs Inche		Inches	
	Min.	Тур.	Max.	Min.	Тур.	Max.
Α	4.30		4.60	0.169		0.181
A1	2.49		2.69	0.098		0.106
A2	0.03		0.23	0.001		0.009
В	0.70		0.93	0.027		0.037
B2	1.25	1.40		0.048	0.055	
С	0.45		0.60	0.017		0.024
C2	1.21		1.36	0.047		0.054
D	8.95		9.35	0.352		0.368
Е	10.00		10.28	0.393		0.405
G	4.88		5.28	0.192		0.208
L	15.00		15.85	0.590		0.624
L2	1.27		1.40	0.050		0.055
L3	1.40		1.75	0.055		0.069
R	0.40				0.016	
V2	0°		8°	0°		8°

Figure 21. Footprint (dimensions in mm)



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ACST12 Ordering information

5 Ordering information

 Table 8.
 Ordering information

Order code	Marking	Package	Weight	Base qty	Packing mode
ACST12-7CT		TO-220AB	2.3 g	50	Tube
ACST12-7CG	ACST127C	D ² PAK	1.5 g	50	Tube
ACST12-7CG-TR		D ² PAK	1.5 g	1000	Tape and reel
ACST12-7ST		TO-220AB	2.3 g	50	Tube
ACST12-7SG	ACST127S	D ² PAK	1.5 g	50	Tube
ACST12-7SG-TR		D ² PAK	1.5 g	1000	Tape and reel

6 Revision history

Table 9. Document revision history

Date	Revision	Changes
02-Dec-2008	1	First issue

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