ACST12

Overvoltage protected AC switch

Features

- Triac with overvoltage crowbar technology
- Low I_{GT} (<10 mA) or high immunity (I_{GT}<35 mA) version
- 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

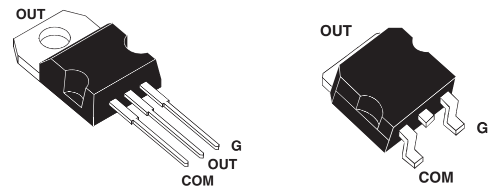
Applications

- AC mains static switching in appliance and industrial control systems
- Drive of medium power AC loads such as:
  - Universal motor of washing machine drum
  - Compressor for fridge or air conditioner

Description

The ACST12 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 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 standard. The ACST1210-7 needs a low gate current to be activated (I_{GT} < 10 mA) and still provides a high electrical noise immunity complying with the IEC 61000-4-4 standard. The ACST1235-7 offers an extremely high static dV/dt immunity of 2 kV/µs minimum.



TO-220AB
ACST1210-7T
ACST1235-7T

D^2PAK
ACST1210-7G
ACST1235-7G

Figure 1. Functional diagram

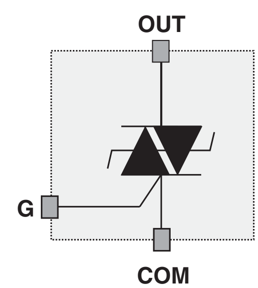


Table 1. Device summary

Symbol	Value	Unit
$I_{T(RMS)}$	12	A
V_{DRM}/V_{RRM}	700	V
I_{GT}	10 or 35	mA

1 Characteristics

Table 2. Absolute ratings (limiting values)

Symbol	Parameter			Value	Unit
$I_{T(RMS)}$	On-state rms current full sine wave	TO-220AB D^2PAK	T_c = 104 °C	12	A
		D^2PAK with 1cm^2 of Cu	T_{amb} = 47 °C	2	
I_{TSM}	Non repetitive surge peak on-state current T_j initial = 25 °C,(full cycle sine wave)	F = 60 Hz	t_p = 16.7 ms	126	A
		F = 50 Hz	t_p = 20.0 ms	120	A
I^2t	I^2t for fuse selection		t_p = 10 ms	95	A^2s
dI/dt	Critical rate of rise on-state current $I_G = 2 \times I_{GT}$, ($t_r \leq$ 100 ns)	F = 120 Hz	T_j = 125 °C	100	A/µs
V_{PP}	Non repetitive line peak pulse voltage (1)		T_j = 125 °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)		T_j = 125 °C	1.6	A
T_{stg}	Storage temperature range			- 40 to + 150	°C
T_j	Operating junction temperature range			- 40 to + 125	°C
T_l	maximum lead soldering temperature during 10 s (at 3 mm from plastic case)			260	°C

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

Table 3. Electrical characteristics

Symbol	Test conditions	Quadrant	T_j		Value		Unit
					ACST1210-7	ACST1235-7	Unit
I_{GT} (1)	V_{OUT} = 12 V, R_L = 33 Ω	I - II - III	25 °C	MAX.	10	35	mA
V_{GT}	V_{OUT} = 12 V, R_L = 33 Ω	I - II - III	25 °C	MAX.	1.0		V
V_{GD}	$V_{OUT} = V_{DRM}$, R_L = 3.3 Ω	I - II - III	125 °C	MIN.	0.2		V
I_H (2)	I_{OUT} = 500 mA		25 °C	MAX.	30	50	mA
I_L	$I_G = 1.2 \times I_{GT}$	I - II - III	25 °C	MAX.	50	70	mA
dV/dt (2)	V_{OUT} = 67% V_{DRM}, gate open		125 °C	MIN.	200	2000	V/µs
(dI/dt)c (2)	(dV/dt)c = 15 V/µs		125 °C	MIN.	5.3		A/ms
	Without snubber			MIN.		14	
V_{CL}	I_{CL} = 0.1 mA, t_p = 1 ms		25 °C		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 characteristics

Symbol	Test conditions			Value	Unit
V_{TM}(1)	I_{OUT} = 17 A, t_p = 500 µs	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_{OUT} = V_{DRM}/ V_{RRM}	T_j = 25 °C	MAX.	20	µA
		T_j = 125 °C		1.5	mA

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

Table 5. Thermal characteristics

Symbol	Parameter		Value	Unit
$R_{th(j-c)}$	Junction to case (AC)	TO-220AB	1.5	°C/W
		D^2PAK		°C/W
$R_{th(j-a)}$	Junction to ambient	TO-220AB	60	°C/W
		D^2PAK with 1 cm^2 of Cu	45	°C/W

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

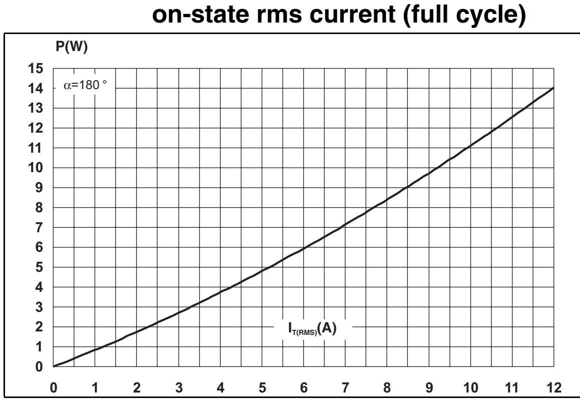


Figure 3. On-state rms current versus case temperature (full cycle)

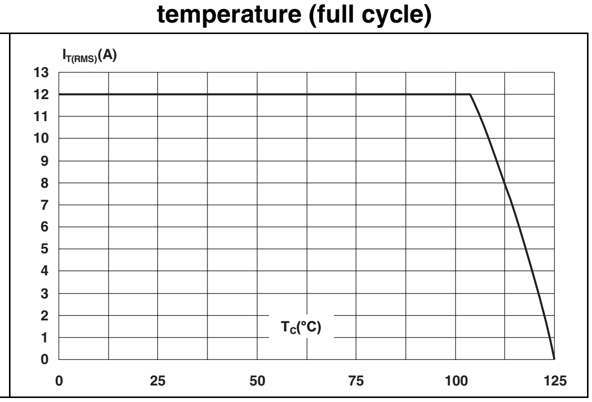


Figure 4. On-state rms current versus ambient temperature (free air convection full cycle)

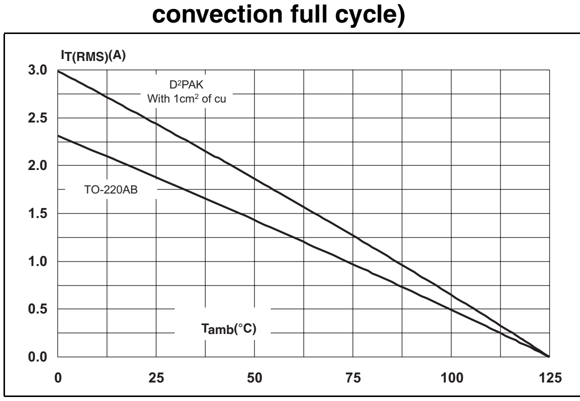


Figure 5. Relative variation of thermal impedance versus pulse duration

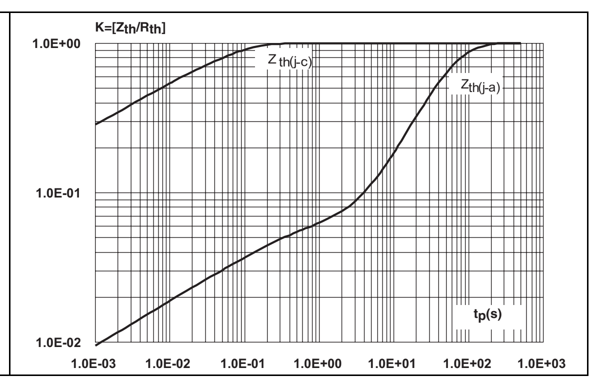


Figure 6. On-state characteristics (maximum values)

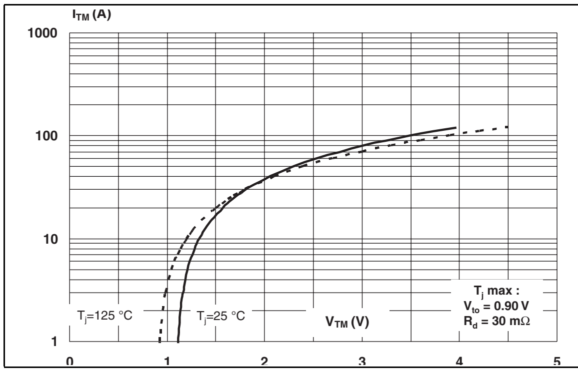


Figure 7. Non repetitive surge peak on-state current versus number of cycles (T_j initial = 25 °C)

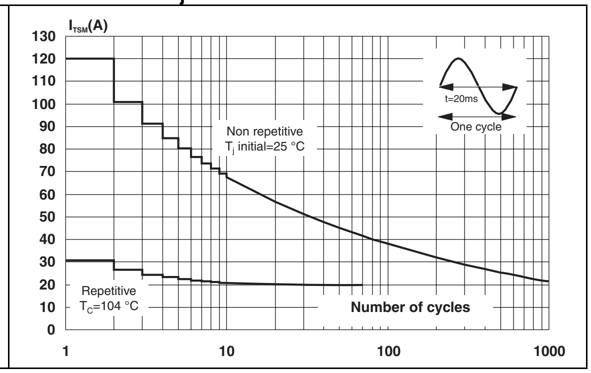


Figure 8. Non repetitive surge peak on-state current for a sinusoidal pulse and corresponding value of I^2t

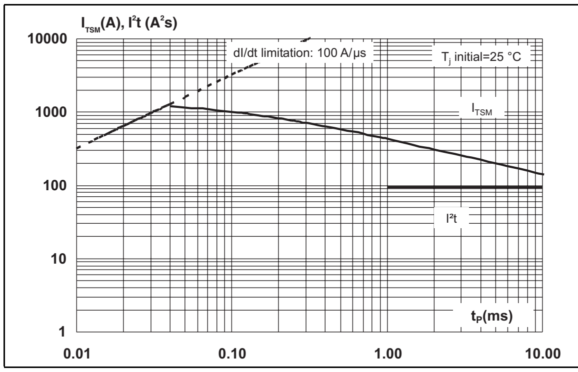


Figure 9. Relative variation of gate triggering current and gate voltage versus junction temperature (typical value)

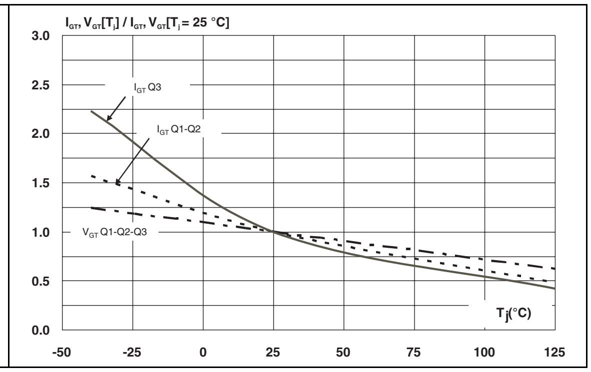


Figure 10. Relative variation of holding current (I_H) and latching current (I_L) versus junction temperature

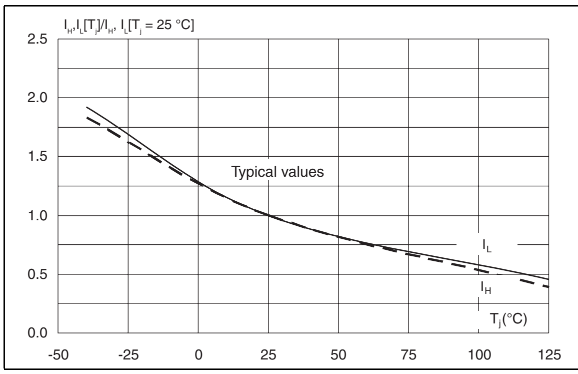


Figure 11. Relative variation of critical rate of decrease of main current (di/dt)c versus (dV/dt)c

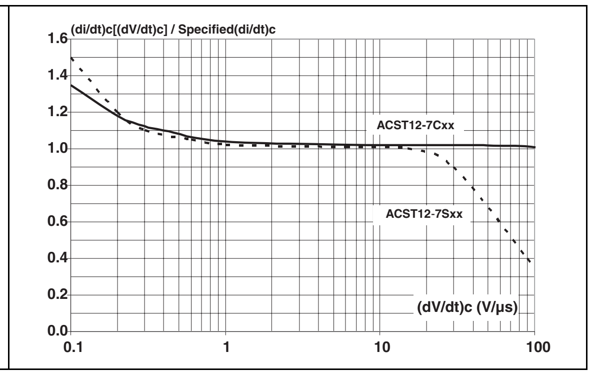


Figure 12. Relative variation of critical rate of decrease of main current versus junction temperature

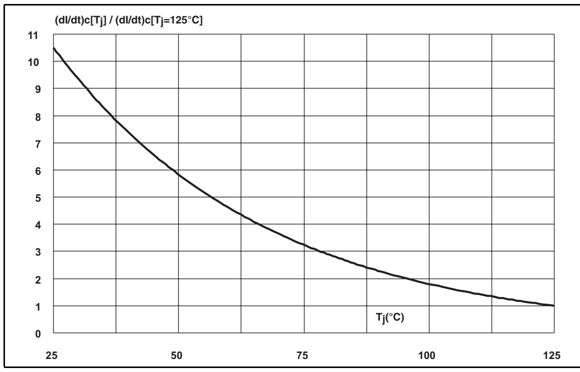


Figure 13. Relative variation of static dV/dt immunity versus junction temperature

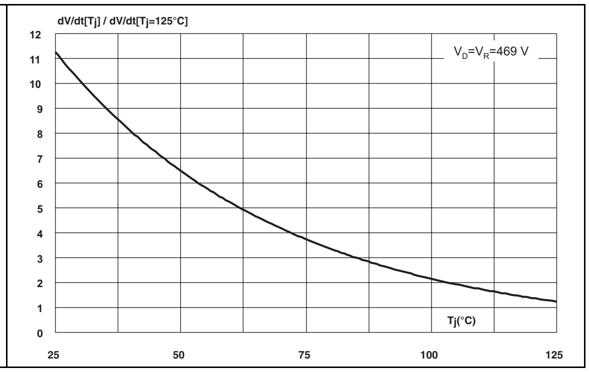


Figure 14. Relative variation of maximum clamping voltage, V_{CL} versus junction temperature

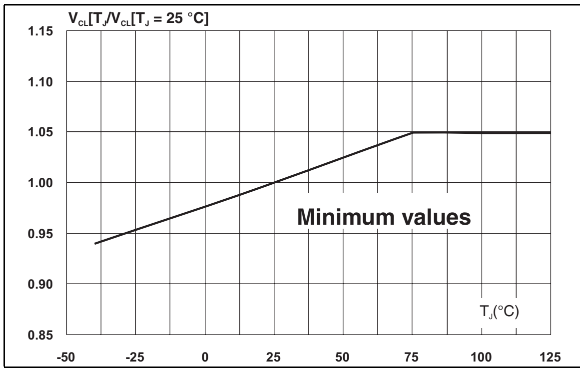
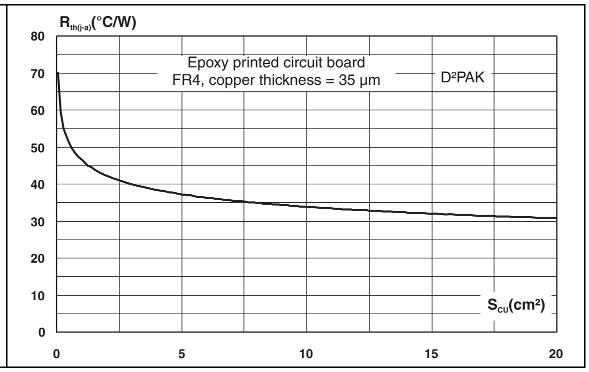


Figure 15. Variation of thermal resistance junction to ambient versus copper surface under tab



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 an inductive load up to 12 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 ACST1210-7 can be driven directly by a MCU through a simple gate resistor as shown in *Figure 16*.

Figure 16. Compressor control – typical diagrams

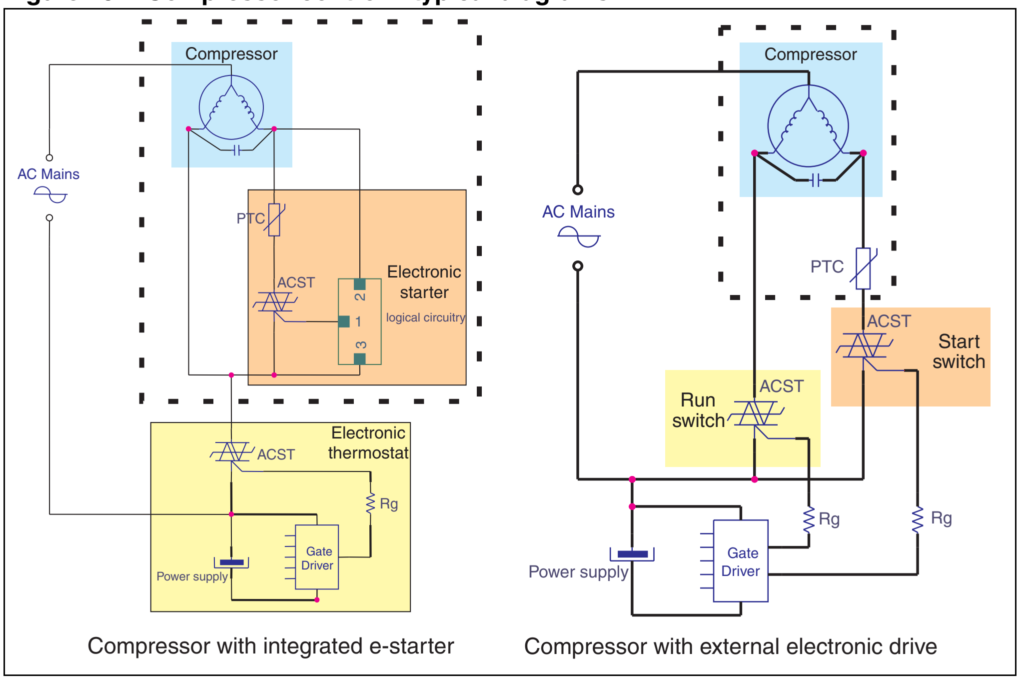
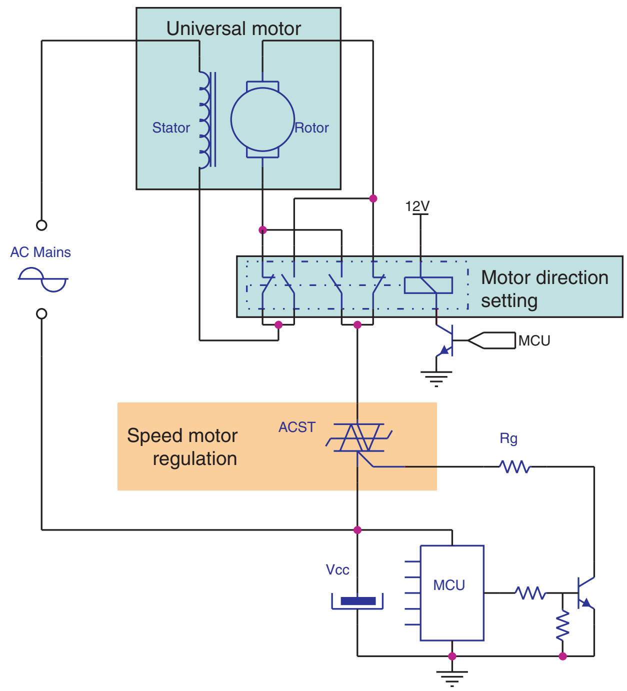


Figure 17. Universal drum motor control – typical diagram



2.2 AC line transient voltage ruggedness

In comparison with standard Triacs, which are not robust against surge voltage, the 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, such as the 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 ACST12 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 ACST12 folds back safely to the on state as shown in *Figure 19*. The ACST12 recovers its blocking voltage capability after the surge and the next zero crossing current. 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

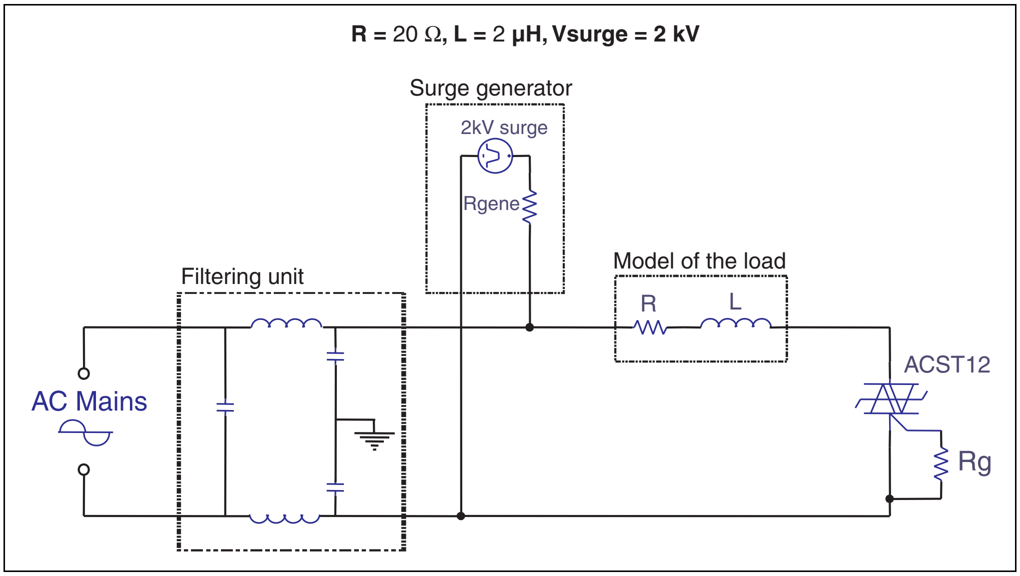
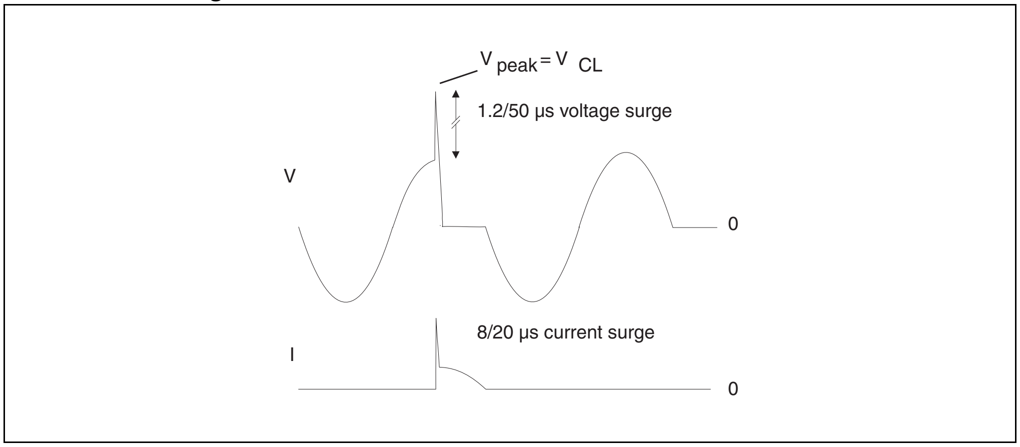
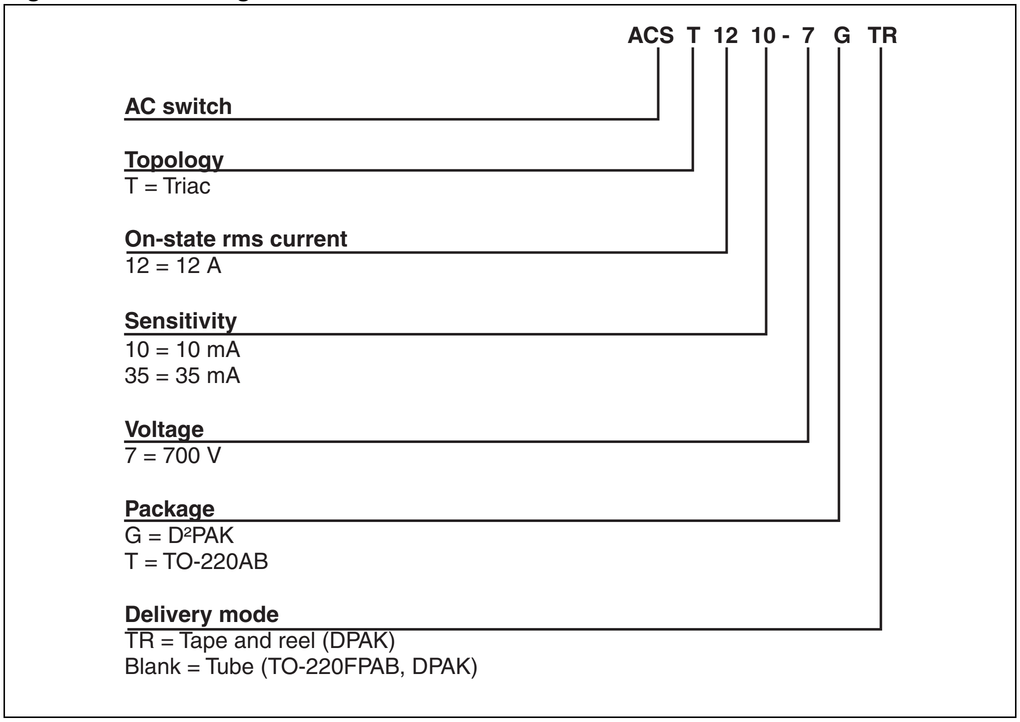


Figure 19. Typical voltage and current waveforms across the ACST12 during IEC 61000-4-5 standard test



3 Ordering information scheme

Figure 20. Ordering information scheme

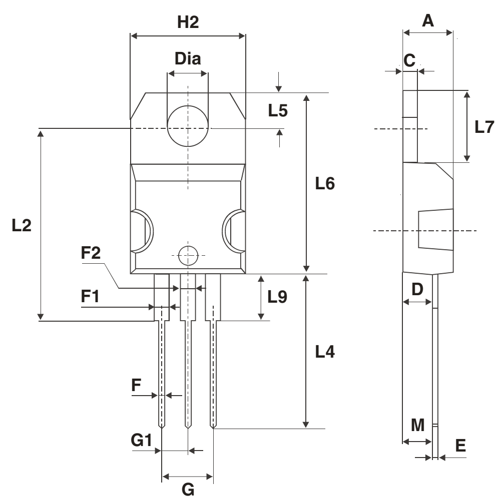


4 Package information

- Epoxy meets UL94, V0
- Recommended torque (TO-220AB): 0.4 to 0.6 N·m

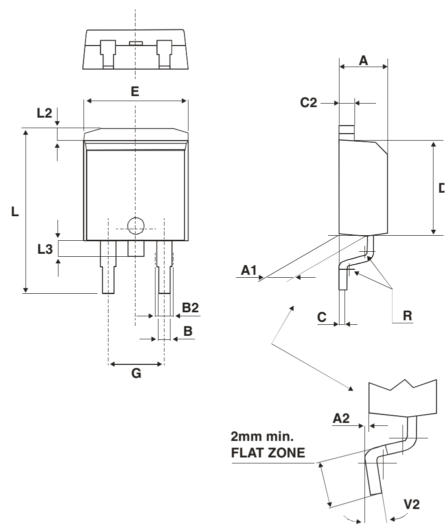
In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: www.st.com. ECOPACK® is an ST trademark.

Table 6. TO-220AB dimensions



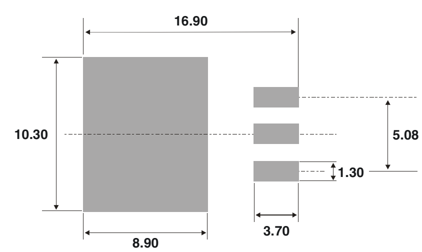
Ref.	Dimensions			
	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	4.40	4.60	0.173	0.181
C	1.23	1.32	0.048	0.051
D	2.40	2.72	0.094	0.107
E	0.49	0.70	0.019	0.027
F	0.61	0.88	0.024	0.034
F1	1.14	1.70	0.044	0.066
F2	1.14	1.70	0.044	0.066
G	4.95	5.15	0.194	0.202
G1	2.40	2.70	0.094	0.106
H2	10	10.40	0.393	0.409
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
M	2.6 typ.		0.102 typ.	
Diam.	3.75	3.85	0.147	0.151

Table 7. D^2PAK dimensions



Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	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
B	0.70		0.93	0.027		0.037
B2	1.25	1.40		0.048	0.055	
C	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
E	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)



5 Ordering information

Table 8. Ordering information

Order code	Marking	Package	Weight	Base qty	Packing mode
ACST1210-7T	ACST12107	TO-220AB	2.3 g	50	Tube
ACST1210-7G		D^2PAK	1.5 g	50	Tube
ACST1210-7GTR		D^2PAK	1.5 g	1000	Tape and reel
ACST1235-7T	ACST12357	TO-220AB	2.3 g	50	Tube
ACST1235-7G		D^2PAK	1.5 g	50	Tube
ACST1235-7GTR		D^2PAK	1.5 g	1000	Tape and reel

6 Revision history

Table 9. Document revision history

Date	Revision	Changes
02-Dec-2008	1	First issue.
13-Apr-2010	2	Updated ECOPACK statement. Reformatted for consistency with other datasheets in this product class.
01-Jul-2010	3	Updated *Figure 20.*

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