ACST12

Transient protected AC power 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

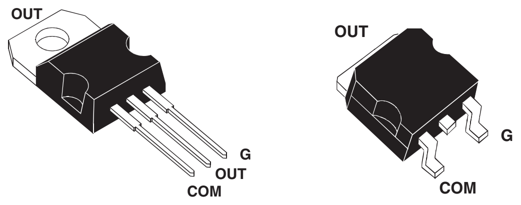
Applications

- AC mains static switching in appliance and industrial control systems
- Drive of medium power AC loads 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_{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.



TO-220AB
ACST12-7xT

D²PAK
ACST12-7xG

Figure 1. Functional diagram

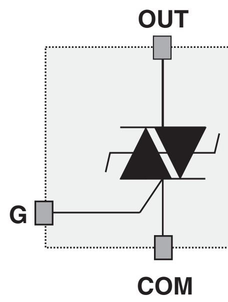


Table 1. Device summary

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 D²PAK	T_c = 104 °C	12	A
		D²PAK with 1cm² 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	A
T_{stg}	Storage temperature range			- 40 to + 150	°C
T_j	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

Symbol	Test conditions	Quadrant	T_j		Value		Unit
					ACST12-7Sx	ACST12-7Cx	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
		D²PAK		°C/W
$R_{th(j-a)}$	Junction to ambient	TO-220AB	60	°C/W
		D²PAK with 1cm² of Cu	45	°C/W

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

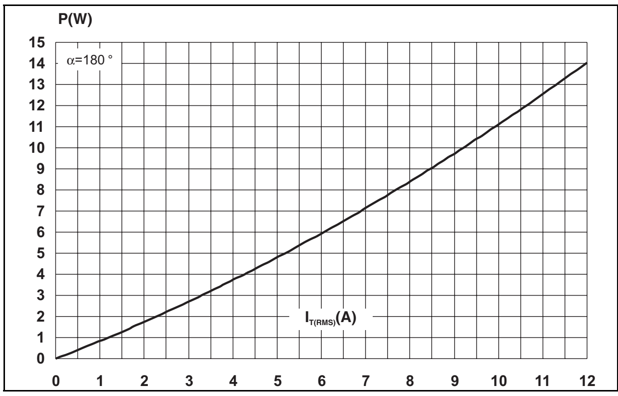


Figure 3. On-state rms current vs. case temperature (full cycle)

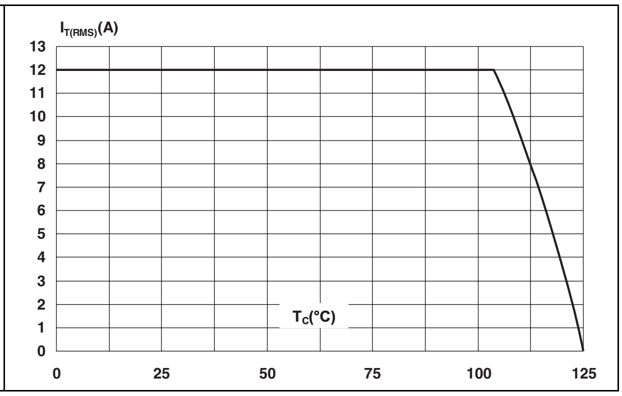


Figure 4. On-state rms current vs. ambient temperature (free air convection full cycle)

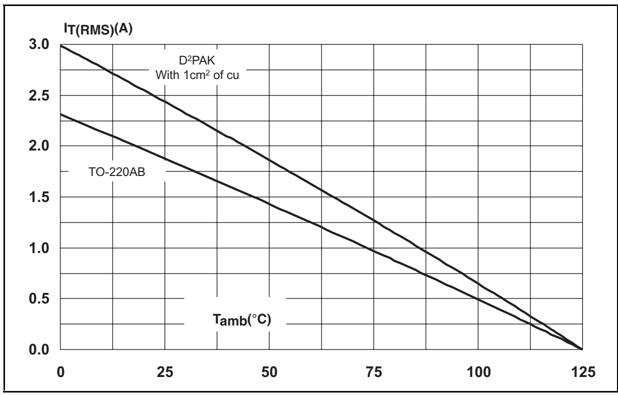


Figure 5. Relative variation of thermal impedance vs. pulse duration

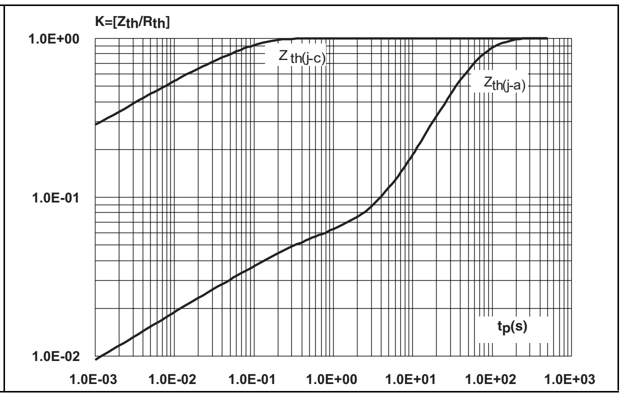


Figure 6. On-state characteristics (maximum values)

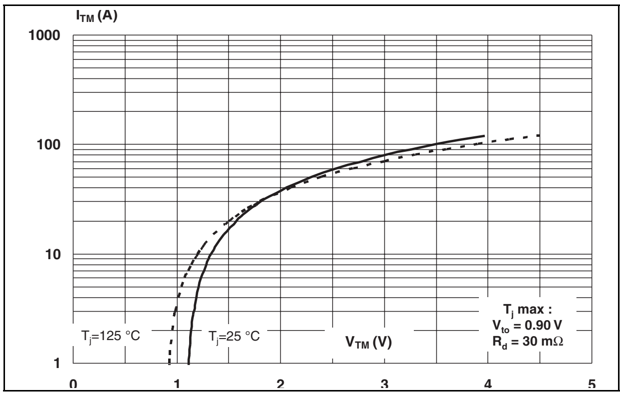


Figure 7. Non repetitive surge peak on-state current vs. number of cycles (T_j initial = 25 °C)

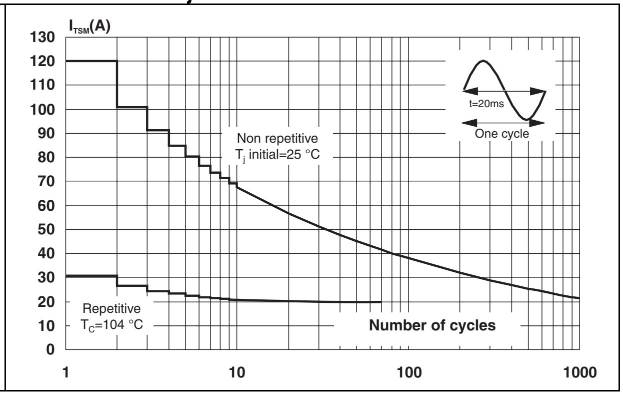


Figure 8. Non repetitive surge peak on-state current for a sinusoidal pulse and corresponding value of I²t

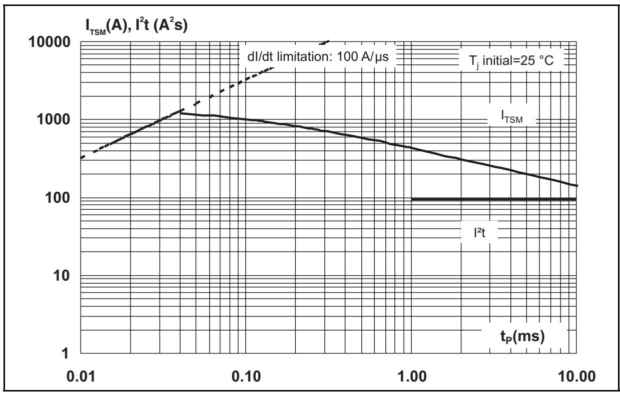


Figure 9. Relative variation of gate triggering current (I_{GT}) and voltage (V_{GT}) vs. junction temperature (typical value)

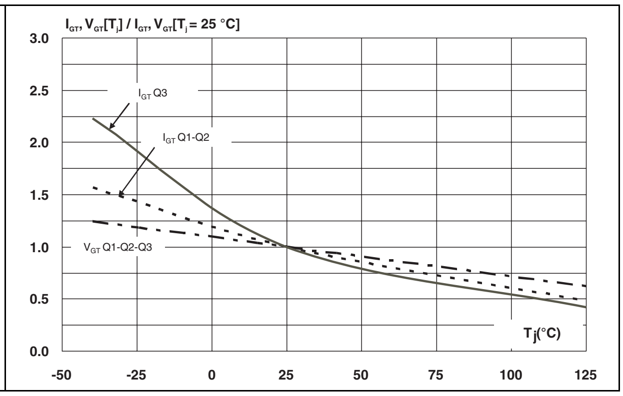


Figure 10. Relative variation of holding current (I_H) and latching current (I_L) vs. junction temperature

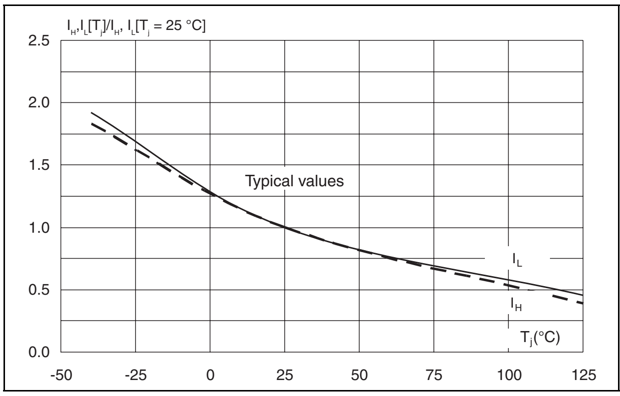


Figure 11. Relative variation of critical rate of decrease of main current (di/dt)c vs. (dV/dt)c

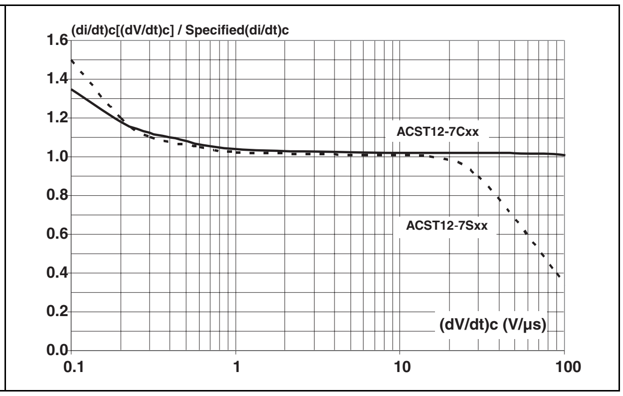


Figure 12. Relative variation of critical rate of decrease of main current vs. junction temperature

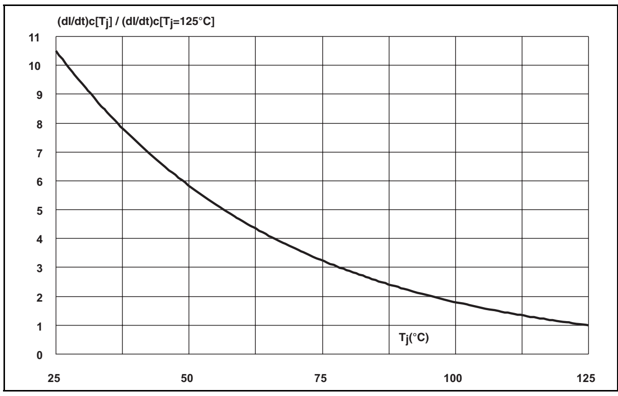


Figure 13. Relative variation of static dV/dt immunity vs. junction temperature

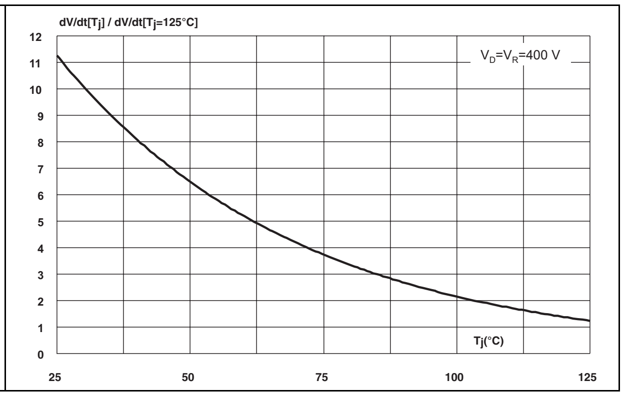


Figure 14. Relative variation of maximum clamping voltage, V_{CL} vs. junction temperature

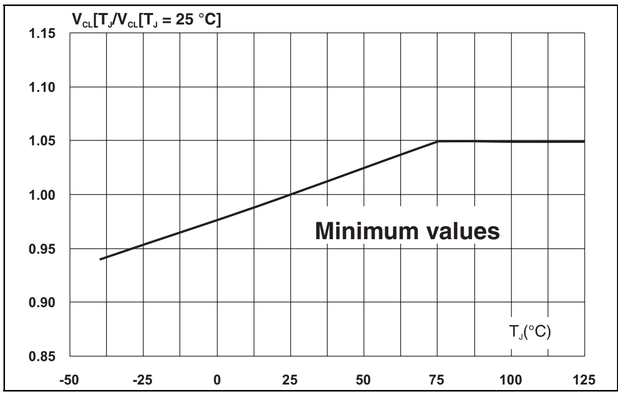
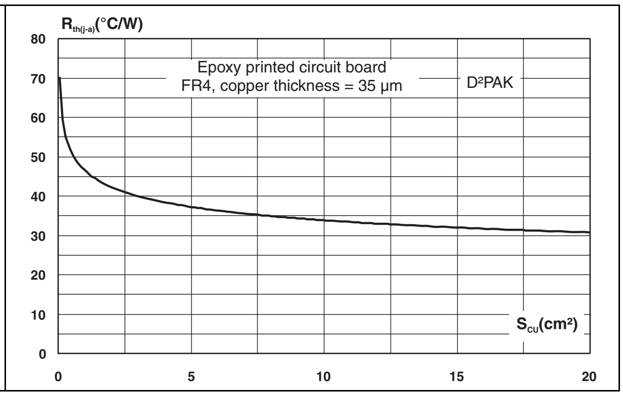


Figure 15. Variation of thermal resistance junction to ambient vs. copper surface under tab



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 16. Compressor control – typical diagram

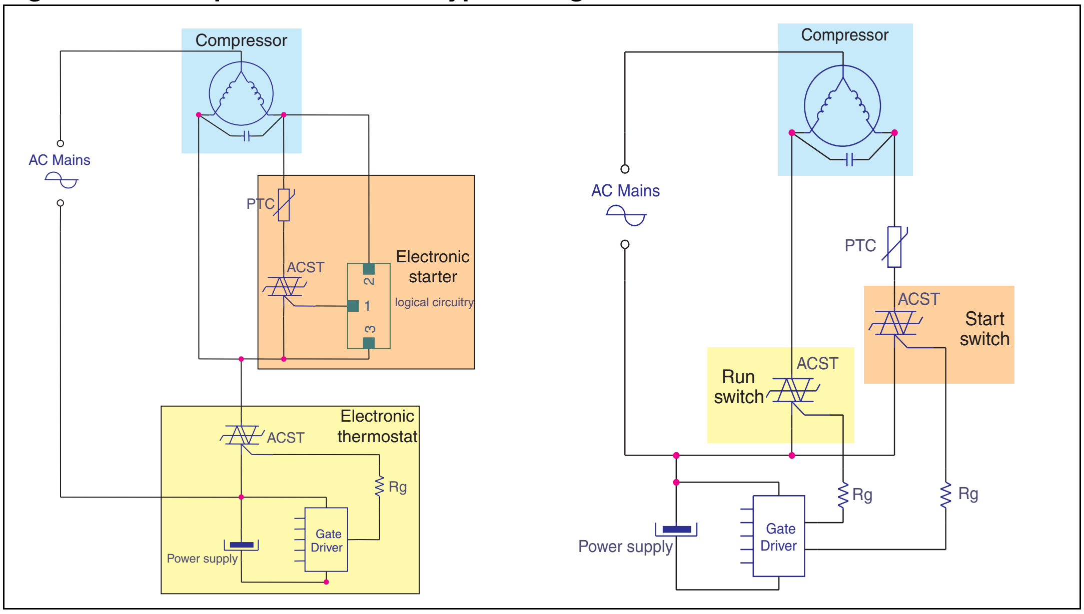
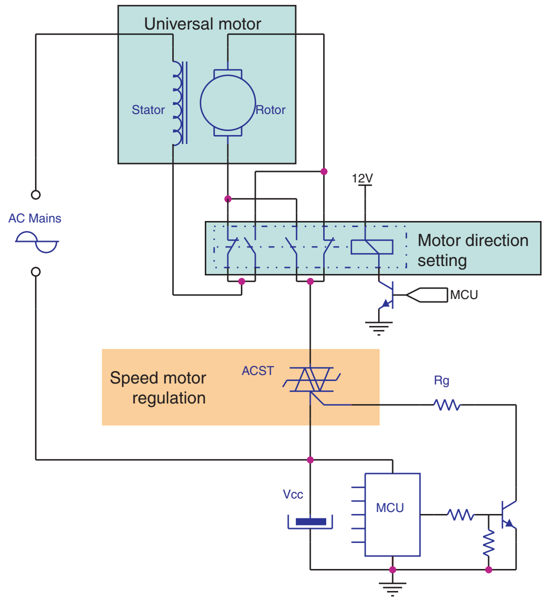


Figure 17. Universal drum motor control – typical diagram



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.

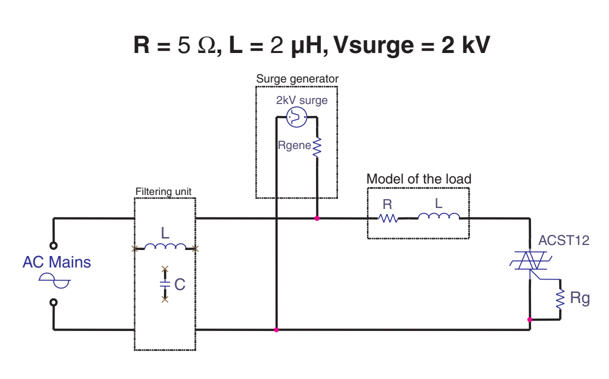


Figure 18. Overvoltage ruggedness test circuit for resistive and inductive loads for IEC 61000-4-5 standards

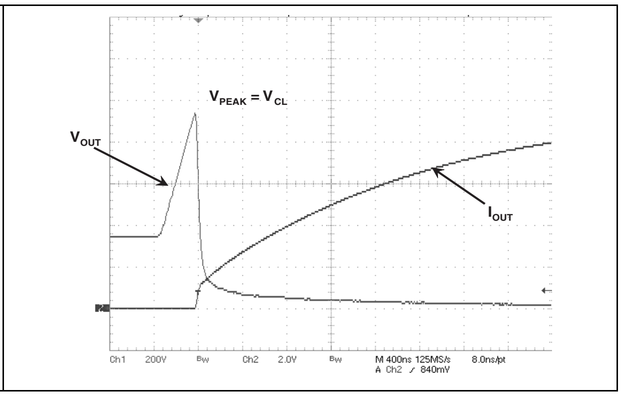


Figure 19. Typical current and voltage waveforms across the ACST12 during IEC 61000-4-5 standard test

3 Ordering information scheme

Figure 20. Ordering information scheme

ACST 12 - 7 S G -TR

AC switch series

On-state rms current
12 = 12 A_{RMS}

Repetitive peak off-state voltage
7 = 700 V

Sensitivity
S = 10 mA
C = 35 mA

Package
G = D²PAK
T = TO-220AB

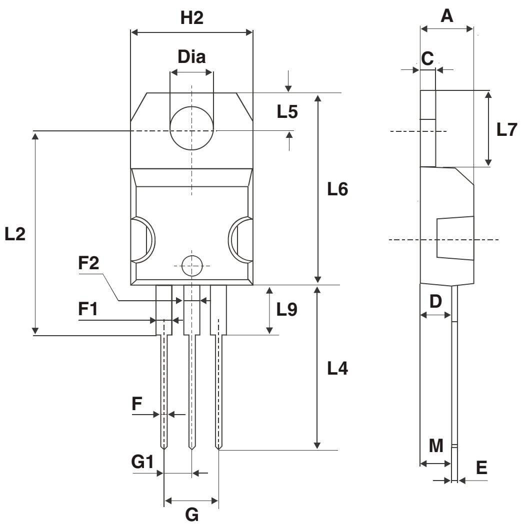
Packing
TR = Tape and reel
Blank : Tube

4 Package information

- Epoxy meets UL94, V0
- Recommende torque: 0.4 to 0.6 N·m

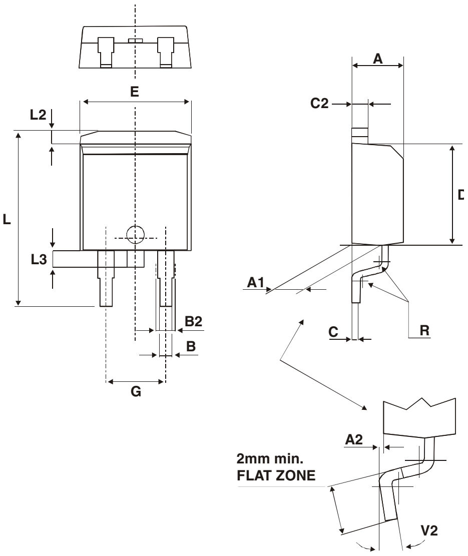
In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings 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



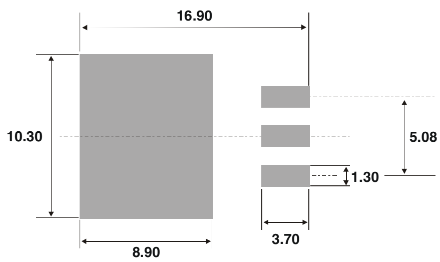
Ref.	Dimensions			
	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	4.40	4.60	0.173	0.181
C	1.23	1.32	0.048	0.051
D	2.40	2.72	0.094	0.107
E	0.49	0.70	0.019	0.027
F	0.61	0.88	0.024	0.034
F1	1.14	1.70	0.044	0.066
F2	1.14	1.70	0.044	0.066
G	4.95	5.15	0.194	0.202
G1	2.40	2.70	0.094	0.106
H2	10	10.40	0.393	0.409
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.	Millimeters Min.	Millimeters Typ.	Millimeters Max.	Inches Min.	Inches Typ.	Inches 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
ACST12-7CT	ACST127C	TO-220AB	2.3 g	50	Tube
ACST12-7CG		D^2PAK	1.5 g	50	Tube
ACST12-7CG-TR		D^2PAK	1.5 g	1000	Tape and reel
ACST12-7ST	ACST127S	TO-220AB	2.3 g	50	Tube
ACST12-7SG		D^2PAK	1.5 g	50	Tube
ACST12-7SG-TR		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