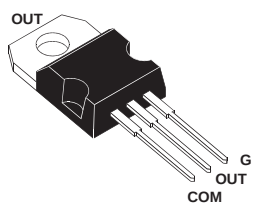
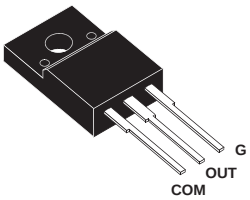
ACST10

Overvoltage protected AC switch

Datasheet - production data



TO-220AB



TO-220FPAB

Features

- Triac with overvoltage crowbar protection
- Low I_{GT} (< 10 mA) or high immunity (I_{GT} < 35 mA) version
- High noise immunity: static dV/dt > 2000 V/µs
- Provides UL certified insulation rated at 2000 V_{RMS}

Benefits

- Enables equipment to meet IEC 61000-4-5
- High off-state reliability with planar technology
- Need 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 ACST10 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 10 A.

This ACST10 switch has a Triac structure and a high voltage clamping device to absorb the inductive turn-off energy and withstand transients such as those described in the IEC 61000-4-5 standard. The ACST1010-7 needs a low gate current to be activated (I_{GT} < 10 mA) and still shows a high noise immunity complying with IEC 61000-4-4 standard. The ACST1035-7 offers a high static dV/dt immunity of 2 kV/µs minimum.

Figure 1. Functional diagram

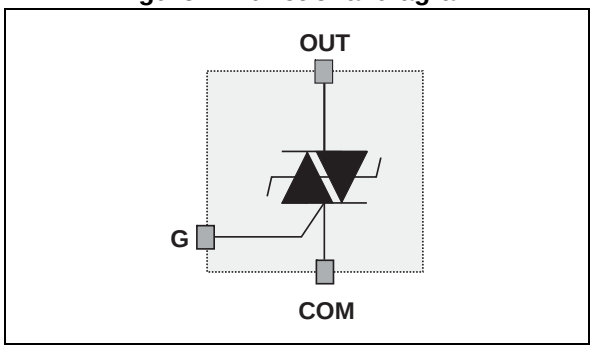


Table 1. Device summary

Symbol	Value	Unit
$I_{T(RMS)}$	10	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	T_c = 105 °C	10	A
		TO-220FPAB	T_c = 84 °C		
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	105	A
		F = 50 Hz	t_p = 20 ms	100	A
I^2t	I^2t for fuse selection		t_p = 10 ms	66	A^2s
dI/dt	Critical rate of rise on-state current I_G = 2 x $I_{GT,}$ ($t_r \leq$ 100 ns)	F = 120 Hz	T_j = 125 °C	100	A/µs
V_{PP}	Non repetitive line peak pulse voltage (1)		T_j = 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)		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 solder temperature during 10 ms (at 3 mm from case)			260	°C
V_{INS}	Insulation RMS voltage (60 seconds)	TO-220FPAB		2000	V

1. According to test described in IEC 61000-4-5 standard and *Figure 17*

Table 3. Electrical characteristics

Symbol	Test conditions	Quadrant	T_j		Value		Unit
					ACST1010-7	ACST1035-7	
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 x 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.	4.4		A/ms
	Without snubber					12	
V_{CL}	I_{CL} = 0.1 mA, t_p = 1 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

Table 4. Static characteristics

Symbol	Test conditions			Value	Unit
V_{TM}(1)	I_{OUT} = 14.1 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.	35	mΩ
I_{DRM} I_{RRM}	V_{OUT} = V_{DRM}/ V_{RRM}	T_j = 25 °C	Max.	20	µA
		T_j = 125 °C	Max.	1.2	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	1.7	°C/W
		TO-220FPAB	3.5	°C/W
$R_{th(j-a)}$	Junction to ambient	TO-220AB TO-220FPAB	60	°C/W

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

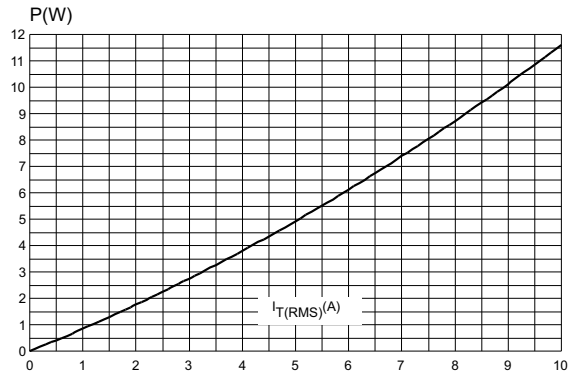


Figure 3. On-state RMS current vs. case temperature (full cycle)

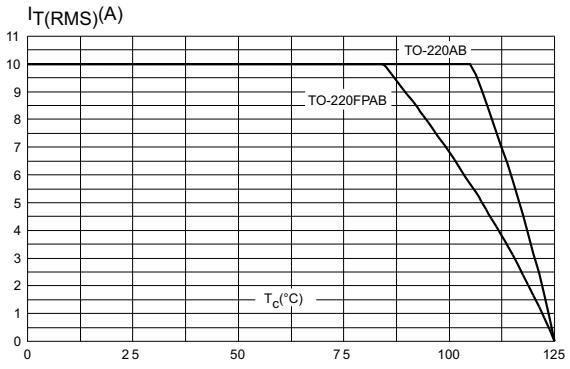


Figure 4. On-state RMS current vs. ambient temperature (free air convection full cycle)

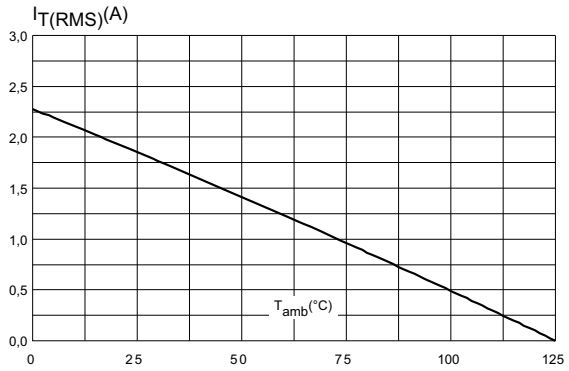


Figure 5. Relative variation of thermal impedance vs. pulse duration

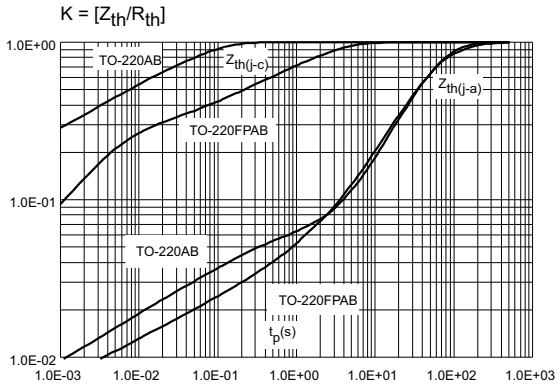


Figure 6. On-state characteristics (maximal values)

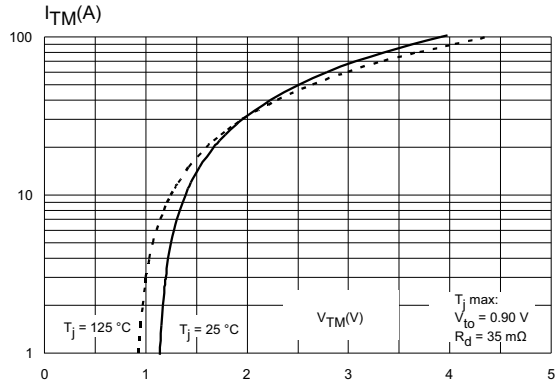


Figure 7. Surge peak on-state current vs. number of cycles

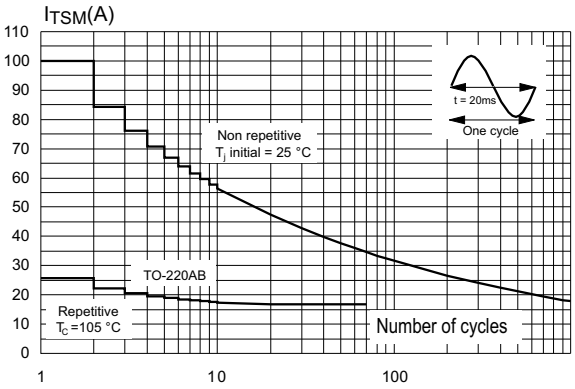


Figure 8. Non repetitive surge peak on-state current for a sinusoidal pulse

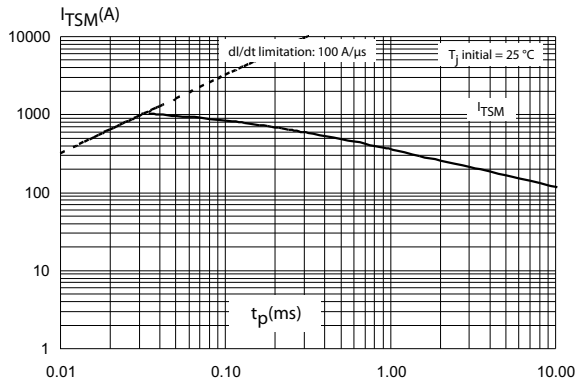


Figure 9. Relative variation of gate triggering current (I_{GT}) and gate triggering voltage (V_{GT}) vs. junction temperature

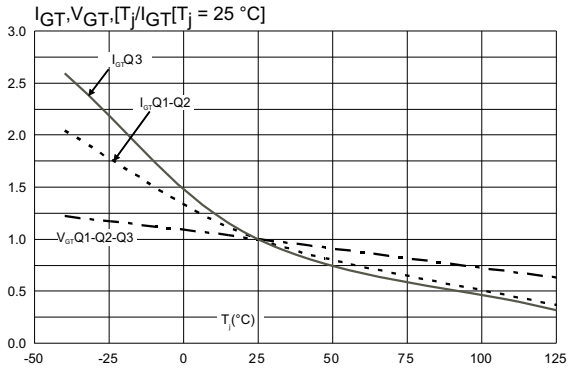


Figure 10. Relative variation of holding (I_H) and latching current (I_L) vs. junction temperature (typical values)

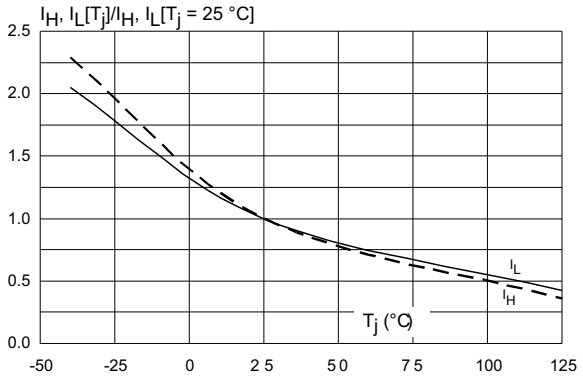


Figure 11. Relative variation of critical rate of decrease of main current (di/dt)c vs. (dV/dt)c

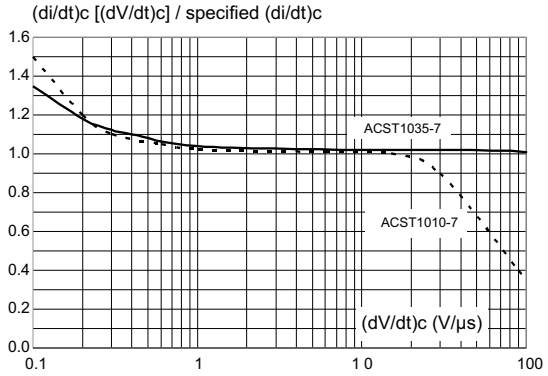


Figure 12. Relative variation of critical rate of decrease of main current (di/dt)c vs. junction temperature

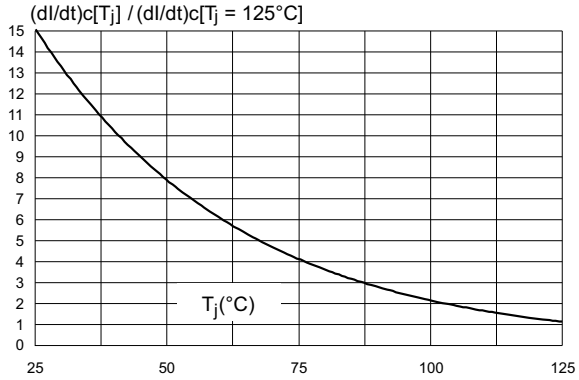


Figure 13. Relative variation of static dV/dt vs. junction temperature

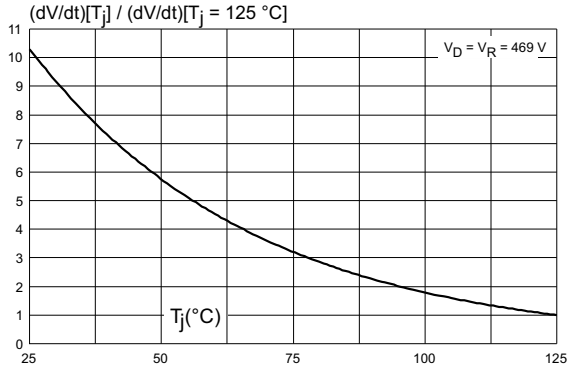
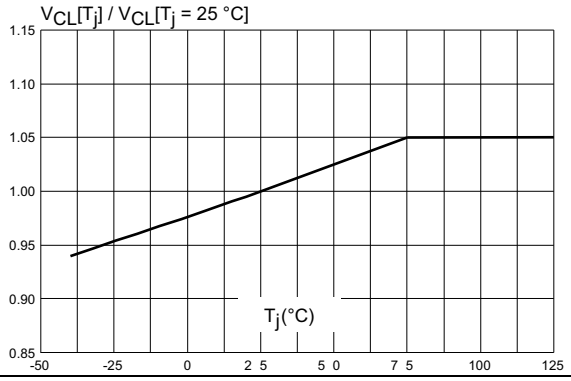


Figure 14. Relative variation of maximum clamping voltage V_{CL} vs. junction temperature (minimum values)



2 Application information

2.1 Typical application description

The ACST10 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 ACST10 switch is able to drive an inductive load up to 10 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 ACST1010-7 can be driven directly by an MCU through a simple gate resistor as shown *Figure 15*.

Figure 15. Compressor control – typical diagram

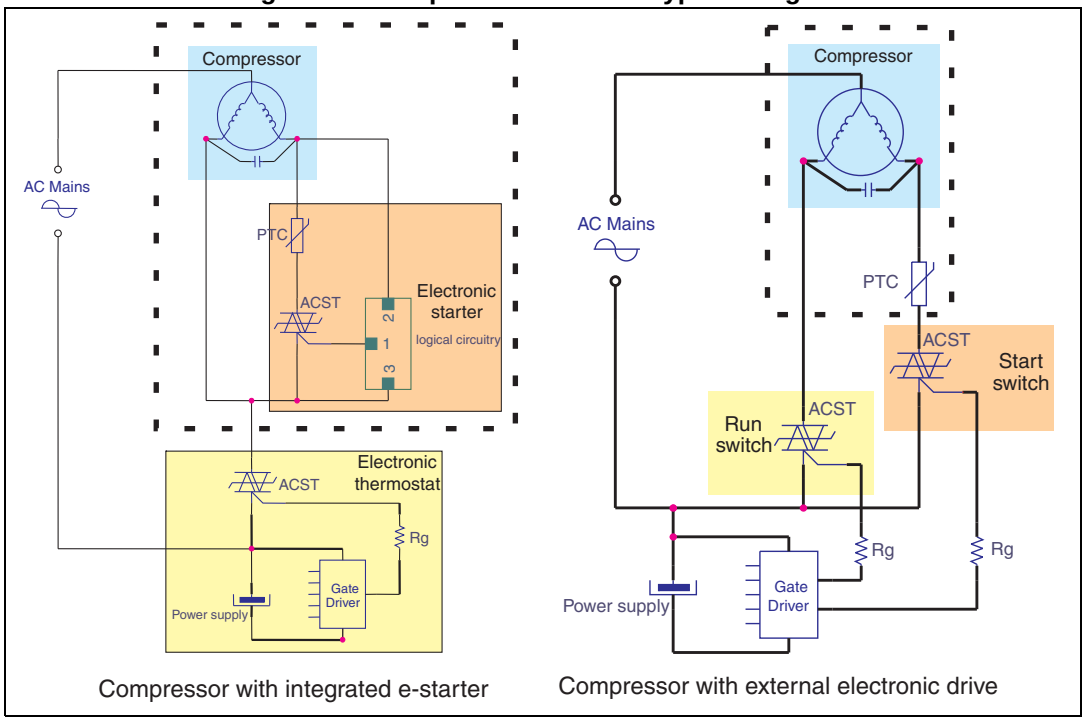
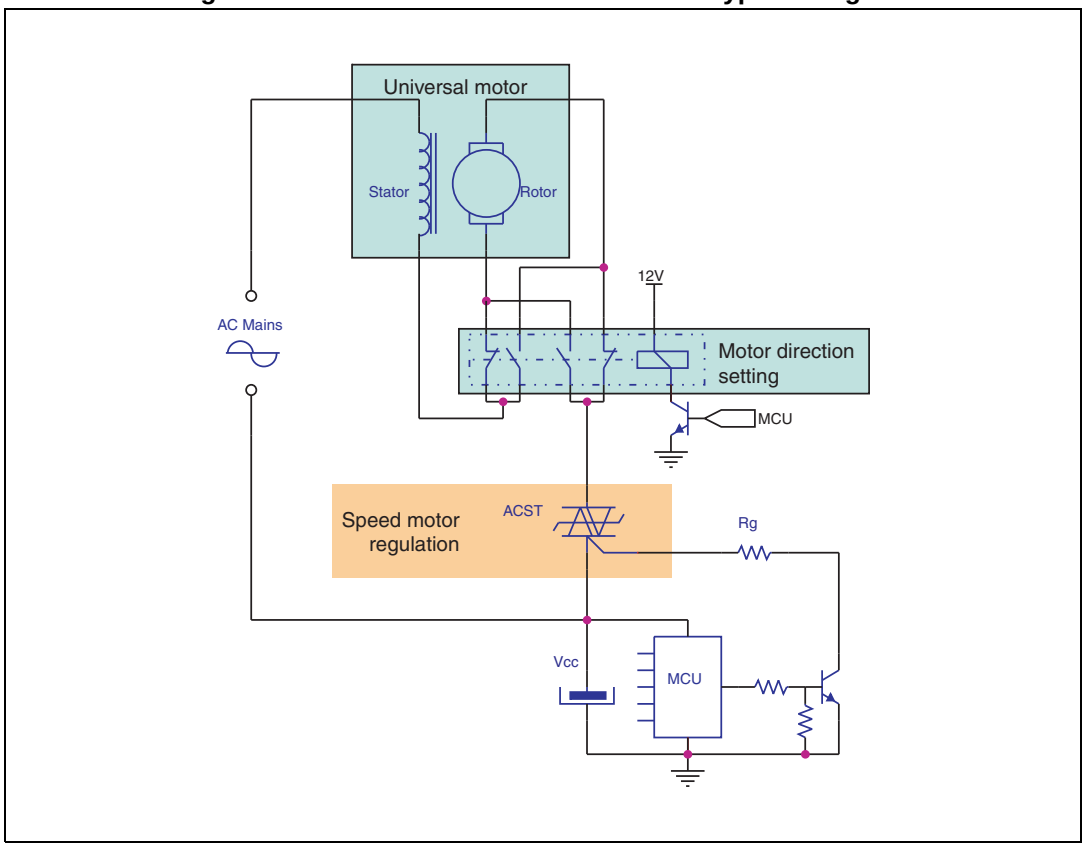


Figure 16. Universal drum motor control – typical diagram



2.2 AC line transient voltage ruggedness

In comparison with standard Triacs, which needs additional protection components against, the ACST10 is self-protected against overvoltage, specified by the new parameter V_{CL}. The ACST10 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 ACST10 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 ACST10 folds back safely to the on state as shown in *Figure 18*. The ACST10 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

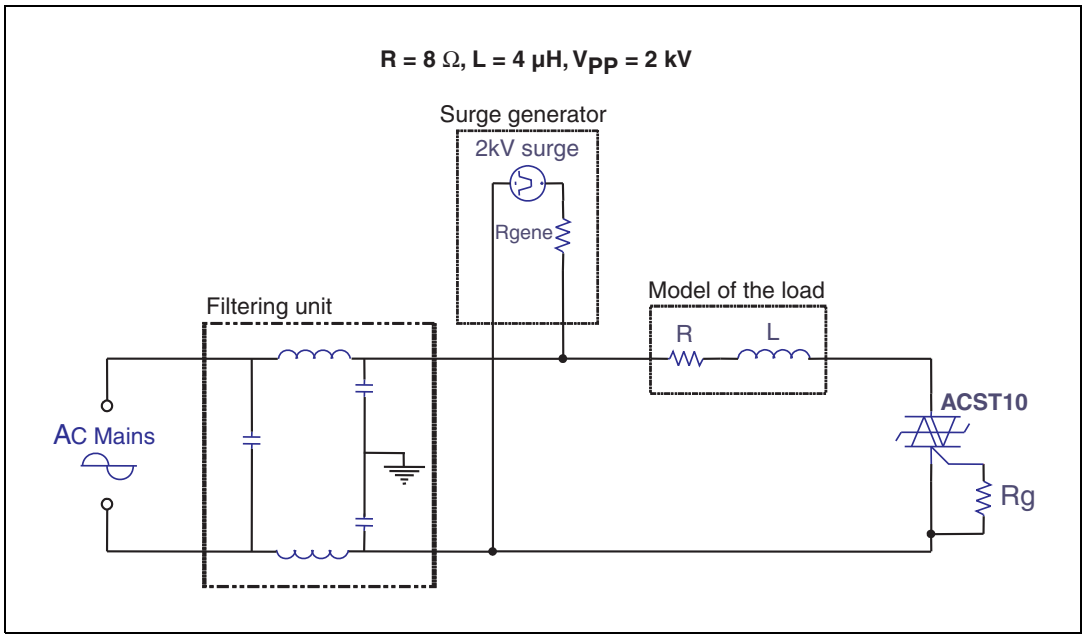
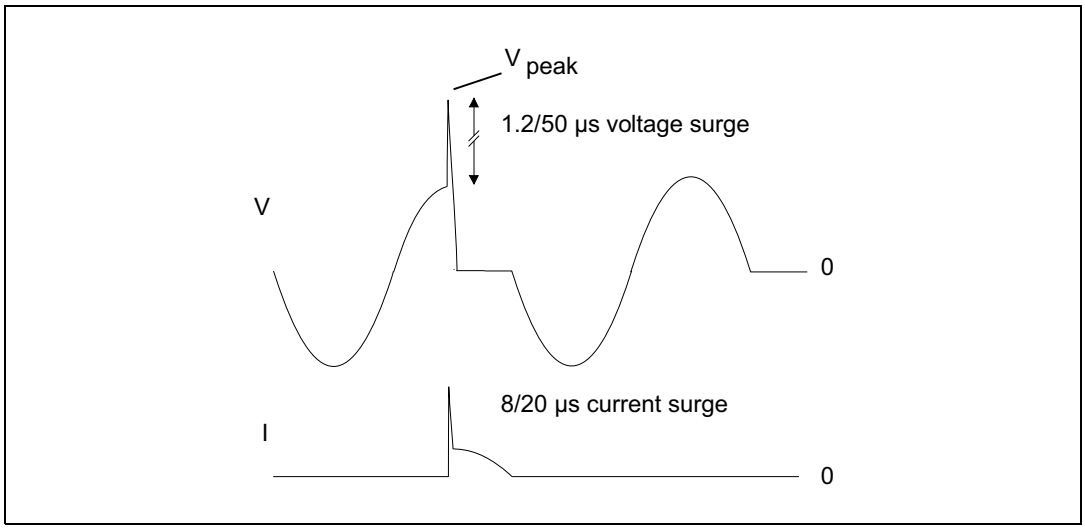


Figure 18. Typical current and voltage waveforms across the ACST10 during IEC 61000-4-5 standard test



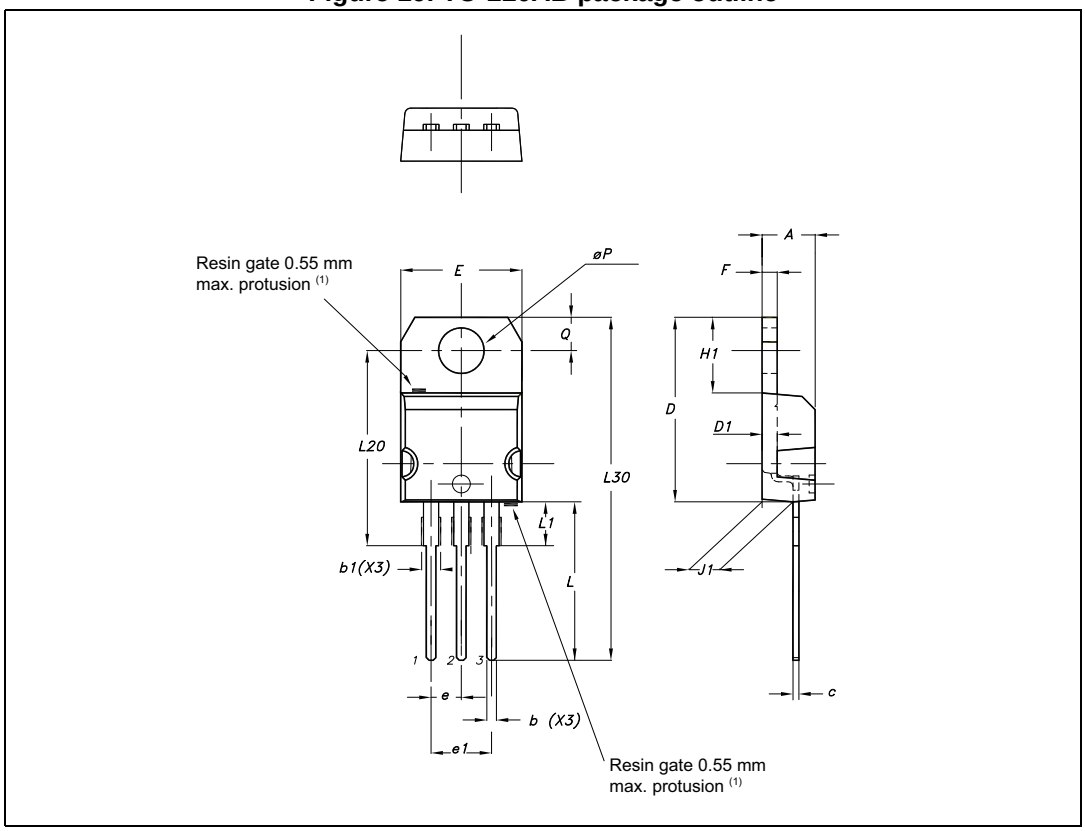
3 Package information

- Epoxy meets UL94, V0
- Recommended torque: 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.

3.1 TO-220AB package information

Figure 19. TO-220AB package outline



1. Resin gate position accepted in one of the two positions or in the symmetrical opposites.

Table 6. TO-220AB package mechanical data

Ref.	Dimensions					
	Millimeters			Inches[1]		
	Typ.	Min.	Max.	Typ.	Min.	Max.
A		4.40	4.60		0.1732	0.1811
b		0.61	0.88		0.0240	0.0346
b1		1.14	1.70		0.0449	0.0669
c		0.48	0.70		0.0189	0.0276
D		15.25	15.75		0.6004	0.6201
D1	1.27			0.0500		
E		10	10.40		0.3937	0.4094
e		2.40	2.70		0.0945	0.1063
e1		4.95	5.15		0.1949	0.2028
F		1.23	1.32		0.0484	0.0520
H1		6.20	6.60		0.2441	0.2598
J1		2.40	2.72		0.0945	0.1071
L		13	14		0.5118	0.5512
L1		3.50	3.93		0.1378	0.1547
L20	16.40			0.6457		
L30	28.90			1.1378		
Diam.P		3.75	3.85		0.1476	0.1516
Q		2.65	2.95		0.1043	0.1161

1. Values in inches are converted from mm and rounded to 4 decimal digits.

3.2 TO-220FPAB package information

Figure 20. TO-220FPAB package outline

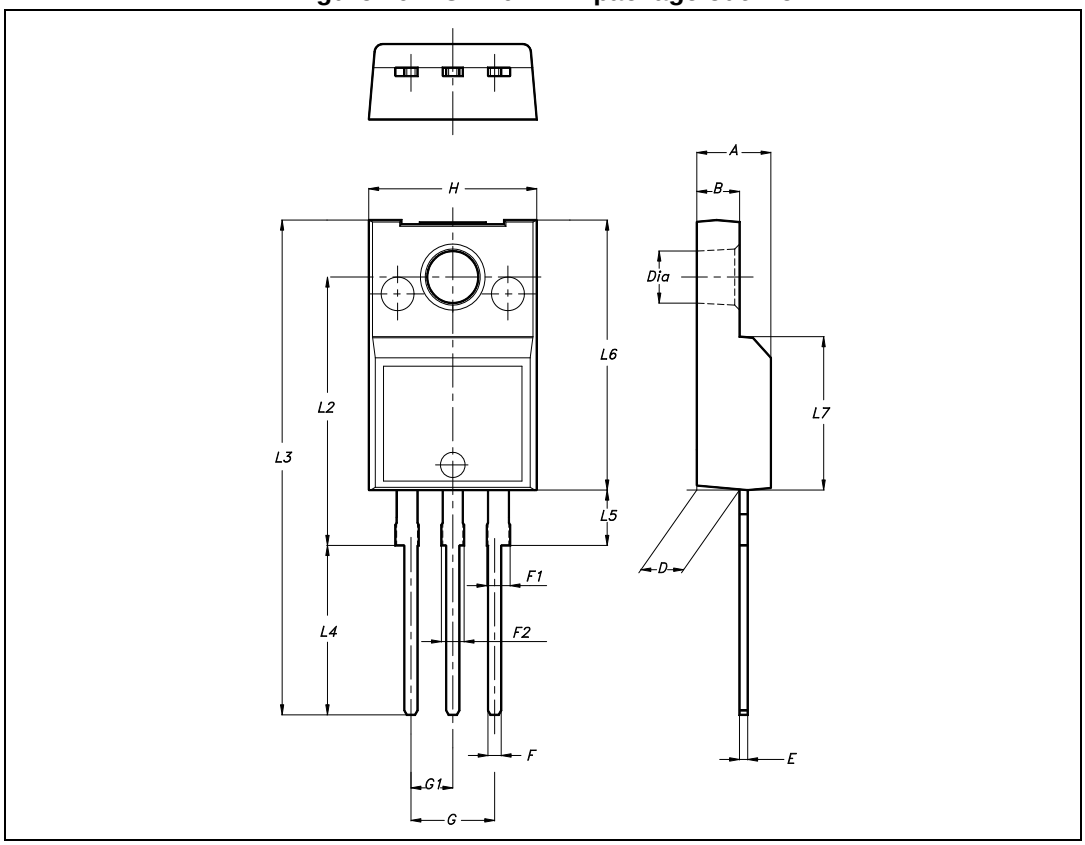


Table 7. TO-220FPAB package mechanical data

Ref.	Dimensions					
	Millimeters			Inches[1]		
	Typ.	Min.	Max.	Typ.	Min.	Max.
A		4.4	4.6		0.1732	0.1811
B		2.5	2.7		0.0984	0.1063
D		2.5	2.75		0.0984	0.1083
E		0.45	0.70		0.0177	0.0276
F		0.75	1		0.0295	0.0394
F1		1.15	1.70		0.0453	0.0669
F2		1.15	1.70		0.0453	0.0669
G		4.95	5.2		0.1949	0.2047
G1		2.4	2.7		0.0945	0.1063
H		10	10.40		0.3937	0.4094
L2	16			0.6299		
L3		28.6	30.6		1.1260	1.2047
L4		9.8	10.6		0.3858	0.4173
L5		2.9	3.6		0.1142	0.1417
L6		15.9	16.4		0.6260	0.6457
L7		9	9.3		0.3543	0.3661
Dia.		3	3.2		0.1181	0.1260

1. Values in inches are converted from mm and rounded to 4 decimal digits.

4 Ordering information

Figure 21. Ordering information scheme

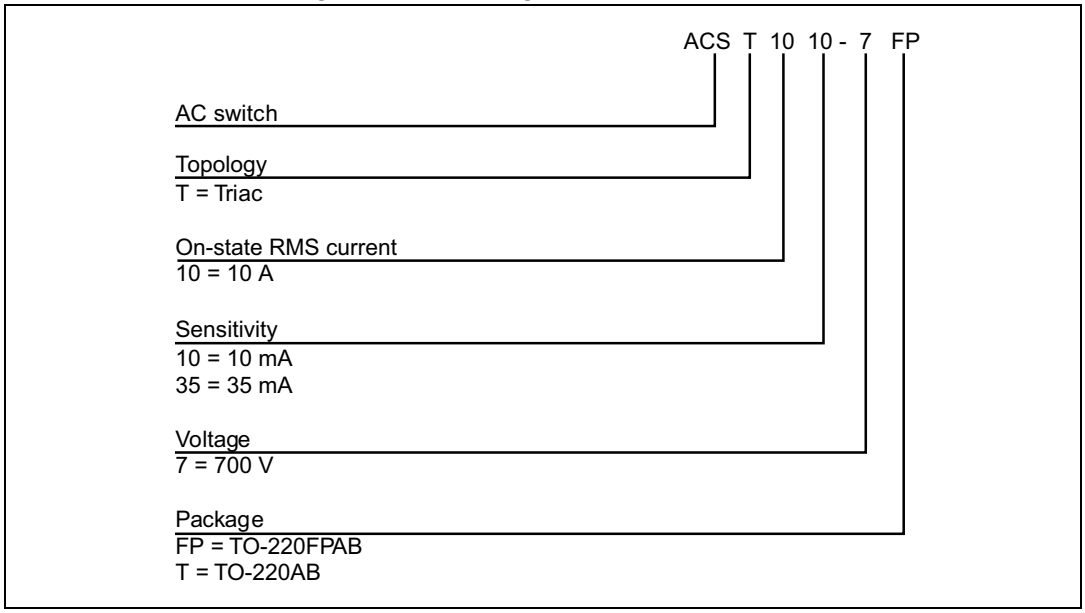


Table 8. Ordering information

Order code	Marking	Package	Weight	Base qty	Packing mode
ACST1010-7T	ACST10107	TO-220AB	2.3 g	50	Tube
ACST1010-7FP		TO-220FPAB	2.3 g	50	Tube
ACST1035-7T	ACST10357	TO-220AB	2.3 g	50	Tube
ACST1035-7FP		TO-220FPAB	2.3 g	50	Tube

5 Revision history

Table 9. Document revision history

Date	Revision	Changes
02-Dec-2008	1	First issue
13-Apr-2009	2	Updated ECOPACK statement. Reformatted for consistency with other datasheets in this product class.
01-Jul-2010	3	Updated order code in *Table 3*.
19-Sep-2016	4	Updated Features in cover page and *Table 2.* Updated *Figure 8*, *Figure 11*, *Figure 18*, *Figure 14* and *Figure 10*. Updated *Section 2.2*. Updated *Chapter 3: Package information*.