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## 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/ $\mu$ s
- TO-220FPAB insulated package: 1500 V rms

### 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 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/ $\mu$ s minimum.

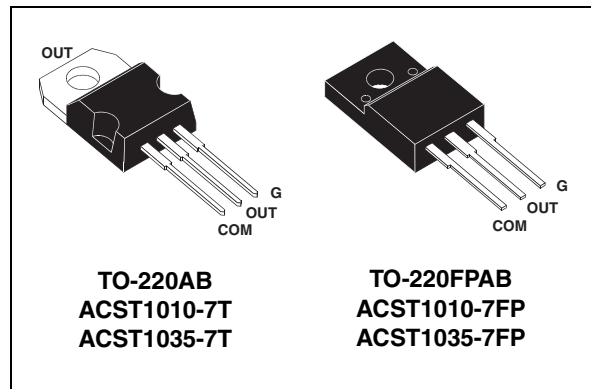


Figure 1. Functional diagram

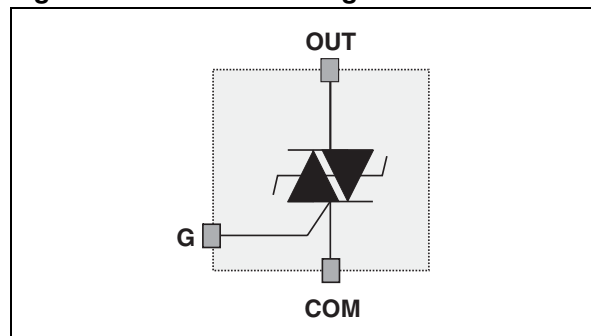


Table 1. Device summary

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

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# 1 Characteristics

**Table 2. Absolute ratings (limiting values)**

Symbol	Parameter		Value	Unit	
$I_{T(RMS)}$	On-state rms current (full sine wave)	TO-220AB	$T_c = 105\text{ }^\circ\text{C}$	10	A
		TO-220FPAB	$T_c = 84\text{ }^\circ\text{C}$		
$I_{TSM}$	Non repetitive surge peak on-state current $T_j$ initial = $25\text{ }^\circ\text{C}$ , ( full cycle sine wave)	F = 60 Hz	$t_p = 16.7\text{ ms}$	105	A
		F = 50 Hz	$t_p = 20\text{ ms}$	100	A
$I^2t$	$I^2t$ for fuse selection		$t_p = 10\text{ ms}$	66	$\text{A}^2\text{s}$
$di/dt$	Critical rate of rise on-state current $I_G = 2 \times I_{GT}$ , ( $t_r \leq 100\text{ ns}$ )	F = 120 Hz	$T_j = 125\text{ }^\circ\text{C}$	100	$\text{A}/\mu\text{s}$
$V_{PP}$	Non repetitive line peak pulse voltage <sup>(1)</sup>		$T_j = 25\text{ }^\circ\text{C}$	2	kV
$P_{G(AV)}$	Average gate power dissipation		$T_j = 125\text{ }^\circ\text{C}$	0.1	W
$P_{GM}$	Peak gate power dissipation ( $t_p = 20\text{ }\mu\text{s}$ )		$T_j = 125\text{ }^\circ\text{C}$	10	W
$I_{GM}$	Peak gate current ( $t_p = 20\text{ }\mu\text{s}$ )		$T_j = 125\text{ }^\circ\text{C}$	1.6	A
$T_{stg}$	Storage temperature range			-40 to +150	$^\circ\text{C}$
$T_j$	Operating junction temperature range			-40 to +125	$^\circ\text{C}$
$T_l$	Maximum lead solder temperature during 10 ms (at 3 mm from case)			260	$^\circ\text{C}$
$V_{INS(RMS)}$	Insulation rms voltage		T0-220FPAB	1500	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	
$I_{GT}^{(1)}$	$V_{OUT} = 12\text{ V}$ , $R_L = 33\text{ }\Omega$	I - II - III	$25\text{ }^\circ\text{C}$	MAX.	10	35	mA
$V_{GT}$	$V_{OUT} = 12\text{ V}$ , $R_L = 33\text{ }\Omega$	I - II - III	$25\text{ }^\circ\text{C}$	MAX.	1.0		V
$V_{GD}$	$V_{OUT} = V_{DRM}$ , $R_L = 3.3\text{ }\Omega$	I - II - III	$125\text{ }^\circ\text{C}$	MIN.	0.2		V
$I_H^{(2)}$	$I_{OUT} = 500\text{ mA}$		$25\text{ }^\circ\text{C}$	MAX.	30	50	mA
$I_L$	$I_G = 1.2 \times I_{GT}$	I - II - III	$25\text{ }^\circ\text{C}$	MAX.	50	70	mA
$dV/dt^{(2)}$	$V_{OUT} = 67\% V_{DRM}$ , gate open		$125\text{ }^\circ\text{C}$	MIN.	200	2000	$\text{V}/\mu\text{s}$
$(di/dt)_c^{(2)}$	$(dV/dt)_c = 15\text{ V}/\mu\text{s}$		$125\text{ }^\circ\text{C}$	MIN.	4.4		A/ms
	Without snubber					12	
$V_{CL}$	$I_{CL} = 0.1\text{ mA}$ , $t_p = 1\text{ ms}$		$25\text{ }^\circ\text{C}$	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**

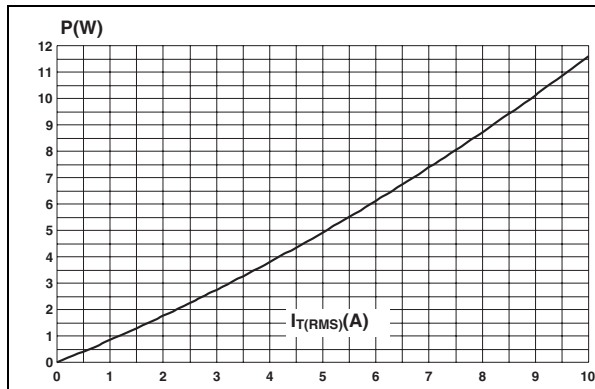
Symbol	Test conditions			Value	Unit
$V_{TM}^{(1)}$	$I_{OUT} = 14.1\text{ A}$ , $t_p = 500\ \mu\text{s}$	$T_j = 25\ ^\circ\text{C}$	MAX.	1.5	V
$V_{T0}^{(1)}$	Threshold voltage	$T_j = 125\ ^\circ\text{C}$	MAX.	0.9	V
$R_d^{(1)}$	Dynamic resistance	$T_j = 125\ ^\circ\text{C}$	MAX.	35	m $\Omega$
$I_{DRM}$ $I_{RRM}$	$V_{OUT} = V_{DRM}/V_{RRM}$	$T_j = 25\ ^\circ\text{C}$	MAX.	20	$\mu\text{A}$
		$T_j = 125\ ^\circ\text{C}$	MAX.	1.2	mA

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

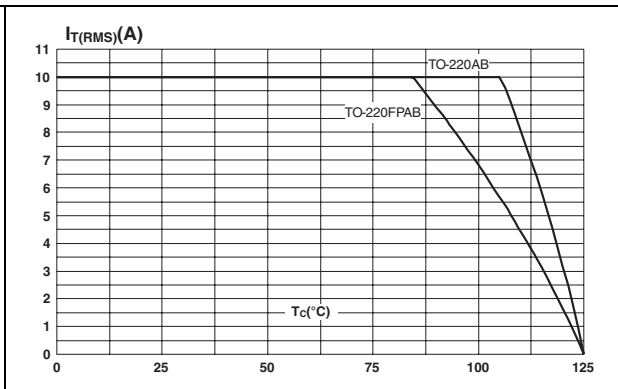
**Table 5. Thermal characteristics**

Symbol	Parameter		Value	Unit
$R_{th(j-c)}$	Junction to case (AC)	TO-220AB	1.7	$^\circ\text{C/W}$
		TO-220FPAB	3.5	$^\circ\text{C/W}$
$R_{th(j-a)}$	Junction to ambient	TO-220AB	60	$^\circ\text{C/W}$
		TO-220FPAB		

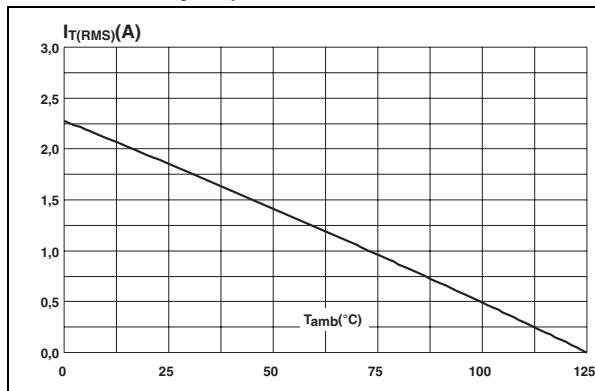
**Figure 2. Maximum power dissipation vs. rms on-state current (full cycle)**



**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**

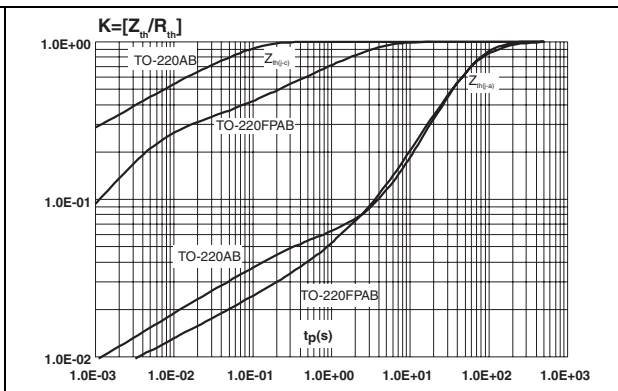


Figure 6. On-state characteristics (maximal values)

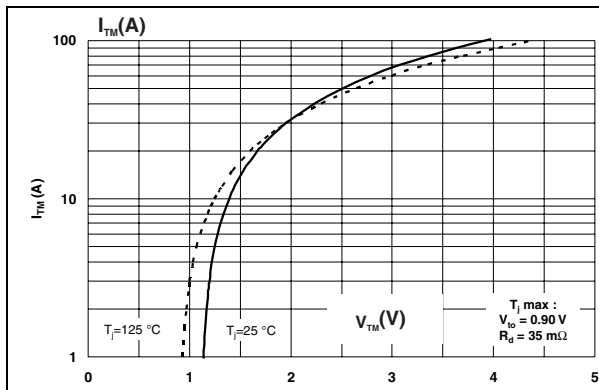


Figure 7. Non repetitive surge peak on-state current vs. number of cycles ( $T_j$  initial = 25 °C)

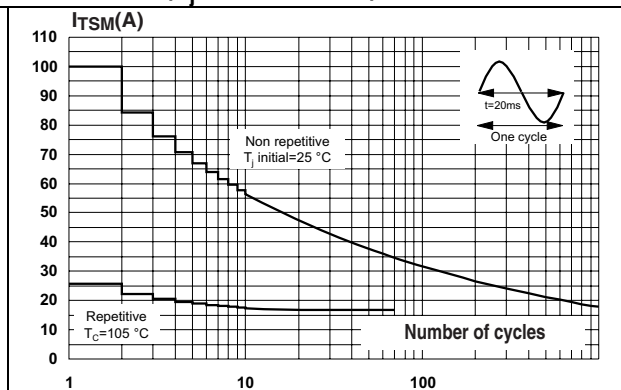


Figure 8. Non repetitive surge peak on-state current for a sinusoidal pulse and corresponding value of  $I^2t$

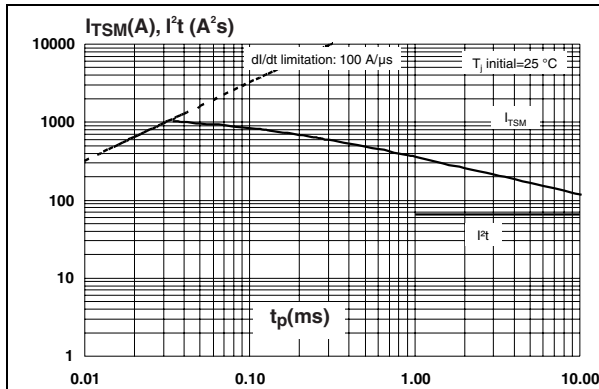


Figure 9. Relative variation of gate triggering current ( $I_{GT}$ ) and gate triggering voltage vs. junction temperature

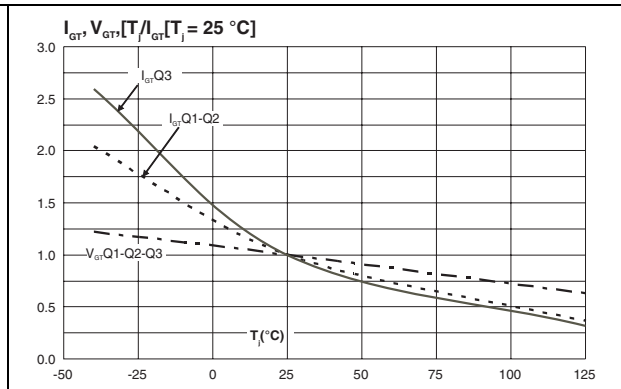


Figure 10. Relative variation of holding ( $I_H$ ) and latching current ( $I_L$ ) vs. junction temperature

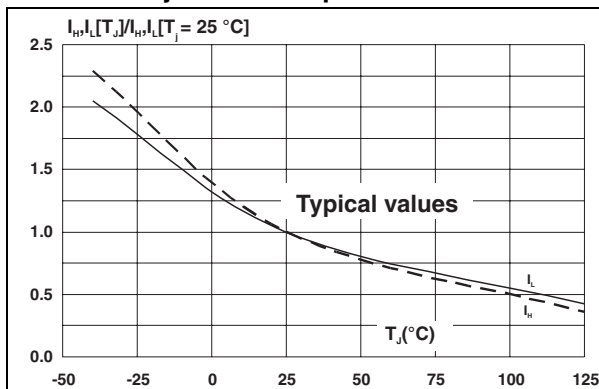
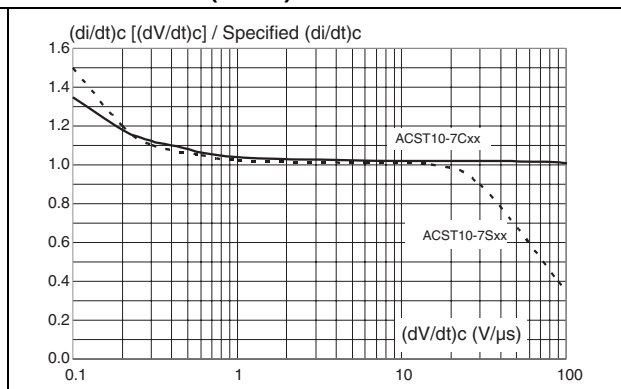
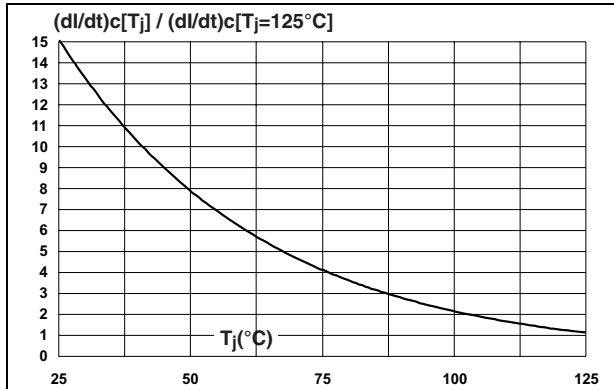


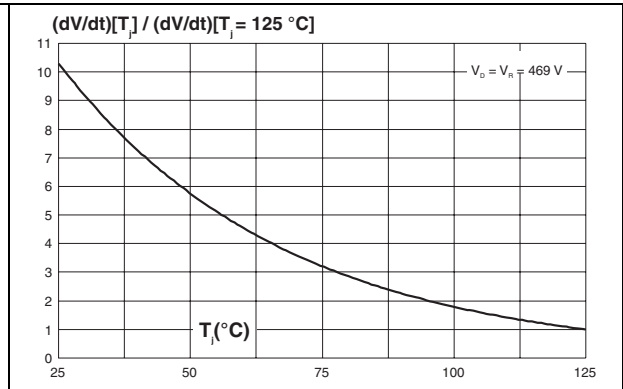
Figure 11. Relative variation of critical rate of decrease of main current ( $di/dt$ )c vs. ( $dV/dt$ )c



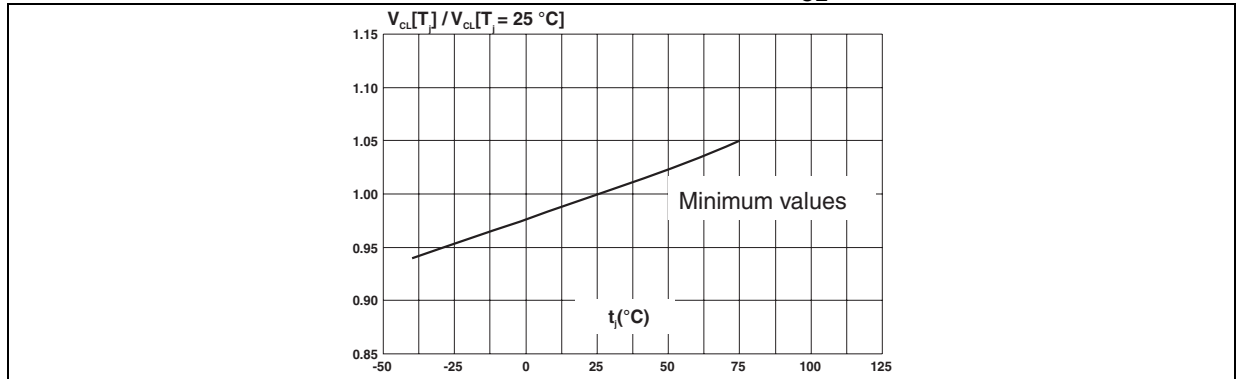
**Figure 12. Relative variation of critical rate of decrease of main current (di/dt)<sub>c</sub> vs. junction temperature**



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



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



## 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**

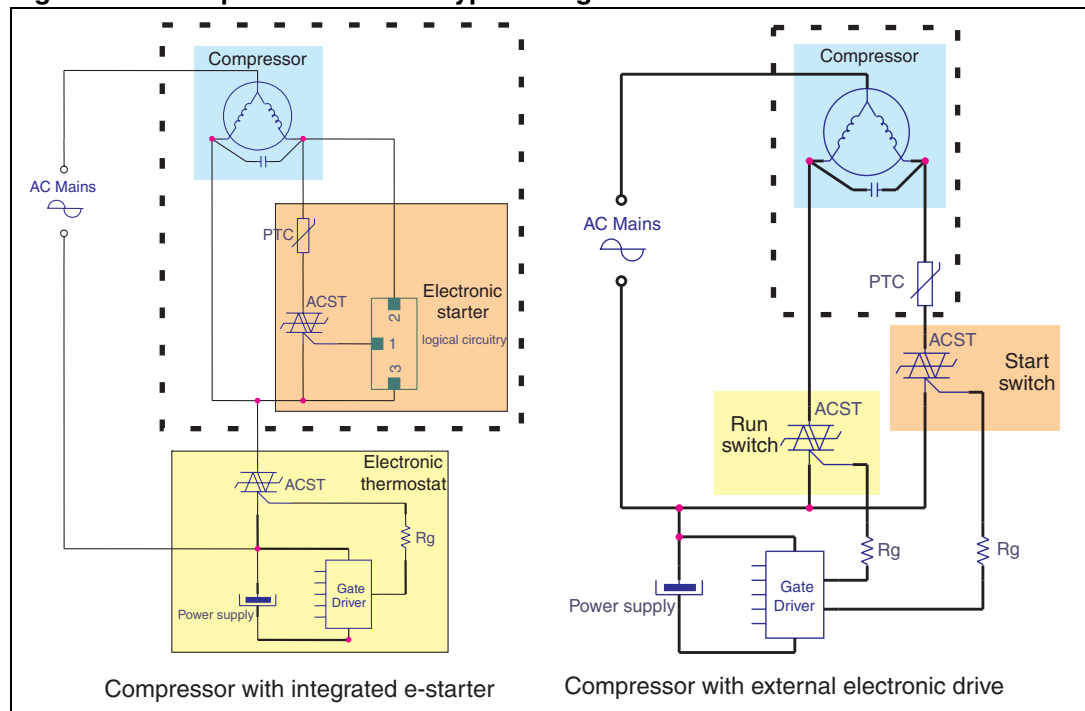
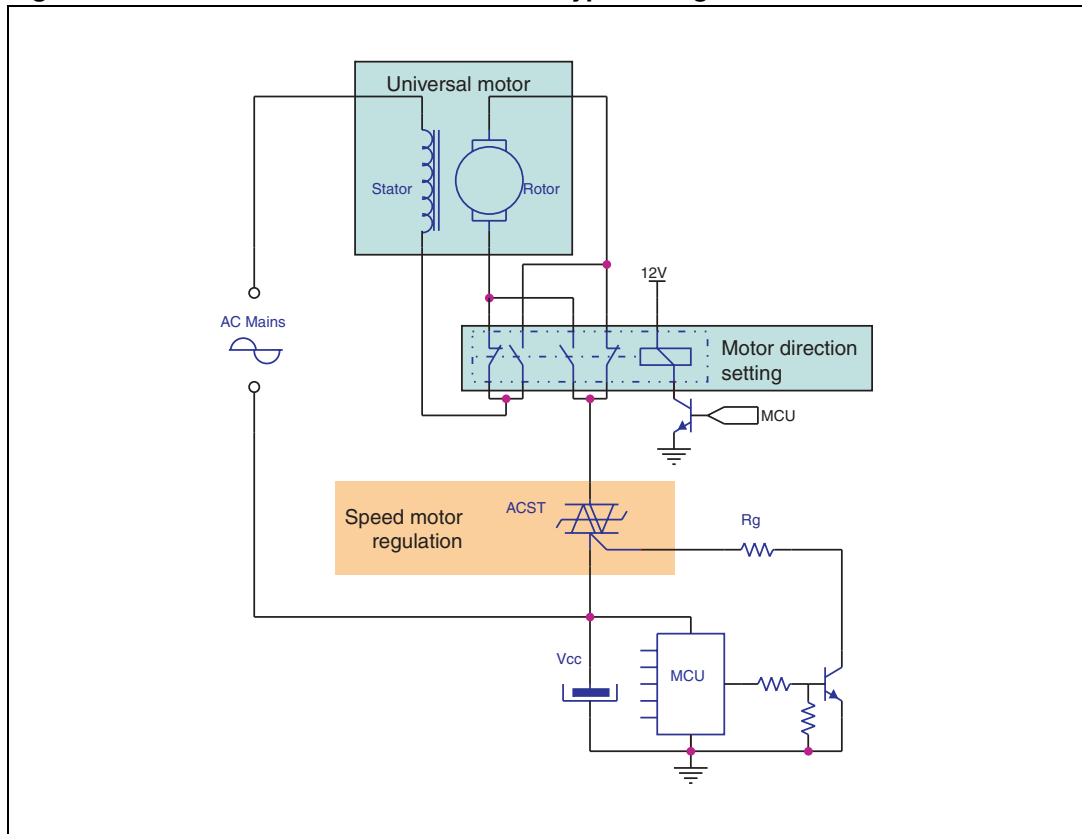


Figure 16. Universal drum motor control – typical diagram



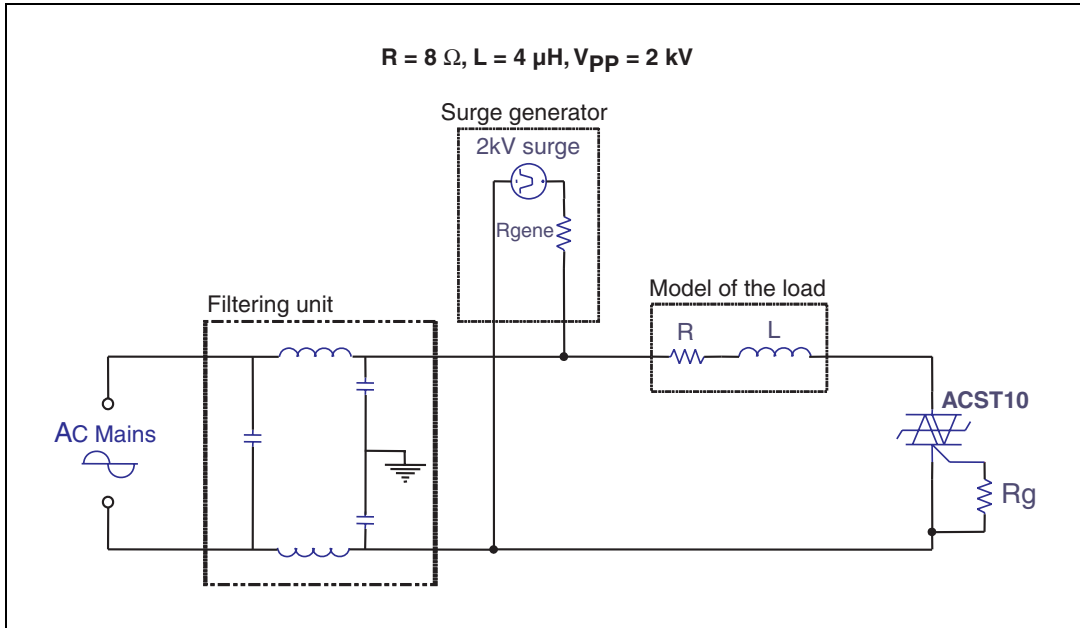
## 2.2 AC line transient voltage ruggedness

In comparison with standard Triacs, which are not robust against surge voltage, the ACST10 is self-protected against over-voltage, 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.

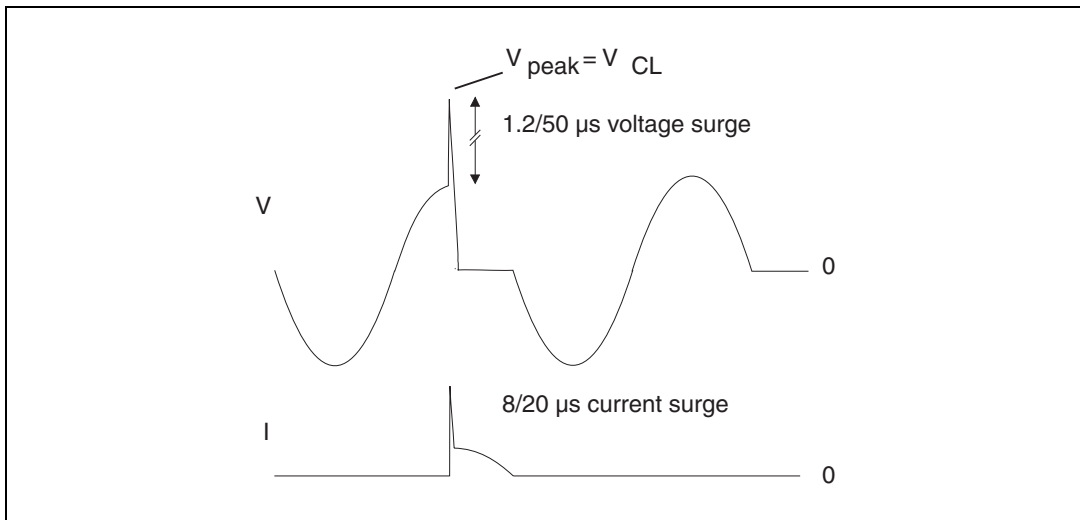
The test circuit of [Figure 17](#) represents the ACST10 application, and is used to stress the ACST switch according to the IEC 61000-4-5 standard conditions. With the additional effect of the load which is limiting the current, the ACST switch withstands the voltage spikes up to 2 kV on top of the 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**

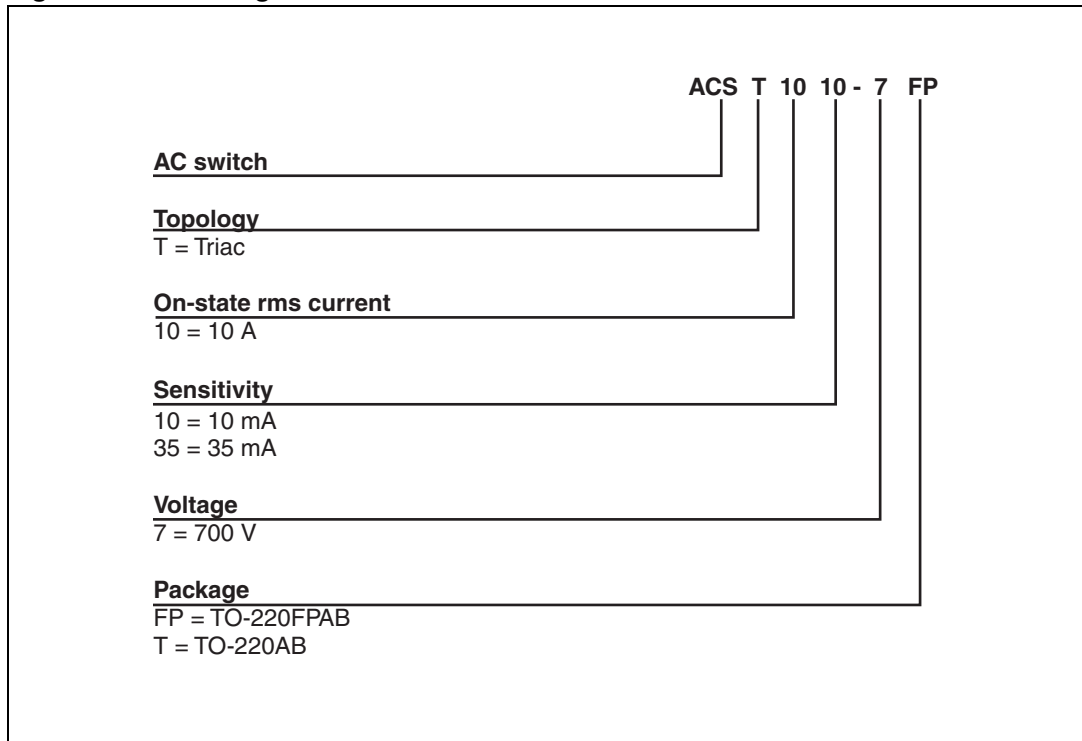


**Figure 18. Typical current and voltage waveforms across the ACST10 during IEC 61000-4-5 standard test**



### 3 Ordering information scheme

Figure 19. Ordering information scheme



# 4 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](http://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

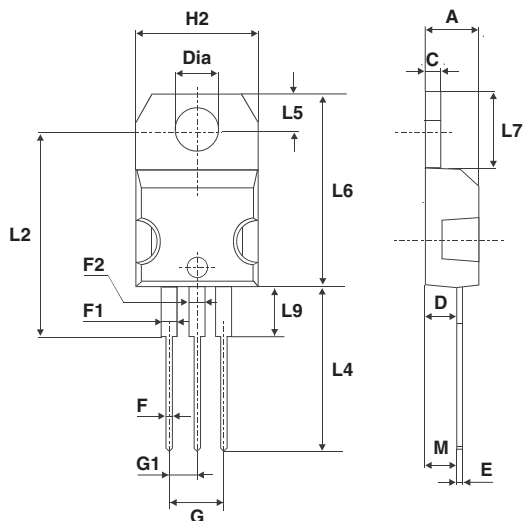
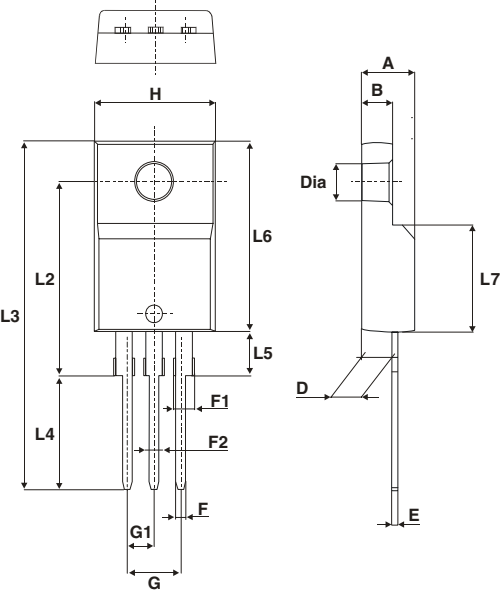


Table 7. TO-220FPAB dimensions



Ref.	Dimensions			
	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	4.4	4.6	0.173	0.181
B	2.5	2.7	0.098	0.106
D	2.5	2.75	0.098	0.108
E	0.45	0.70	0.018	0.027
F	0.75	1	0.030	0.039
F1	1.15	1.50	0.045	0.059
F2	1.15	1.50	0.045	0.059
G	4.95	5.20	0.195	0.205
G1	2.4	2.7	0.094	0.106
H	10	10.4	0.393	0.409
L2	16 Typ.		0.63 Typ.	
L3	28.6	30.6	1.126	1.205
L4	9.8	10.6	0.386	0.417
L5	2.9	3.6	0.114	0.142
L6	15.9	16.4	0.626	0.646
L7	9.00	9.30	0.354	0.366
Diam.	3.00	3.20	0.118	0.126

## 5 Ordering information

**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

## 6 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 <a href="#">Table 3</a> .

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