

# ACS102-6T

# Transient protected AC switch (ACS™)

### Features

- Needs no external protection snubber or varistor
- Enables equipment to meet IEC 61000-4-5
- Reduces component count by up to 80%
- Interfaces directly with the microcontroller
- Common package tab connection supports connection of several alternating current switches (ACS) on the same cooling pad
- Integrated structure based on ASD technology
- Overvoltage protection by crowbar technology
- High noise immunity static dV/dt > 300 V/µs

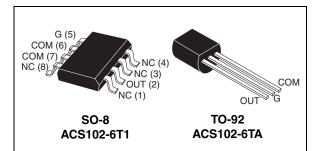
## Applications

- Alternating current on/off static switching in appliances and industrial control systems
- Drive of low-power, high-inductive or resistive loads like:
  - relay, valve, solenoid
  - dispenser, door lock
  - micro-motor

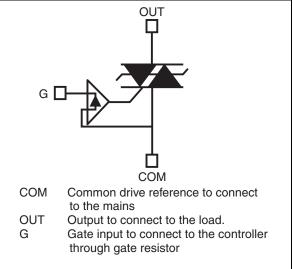
## Description

The ACS102-6T belongs to the AC line switch family. This high performance switch can control a load of up to 0.2A.

The ACS102-6T switch includes an overvoltage crowbar structure to absorb the overvoltage energy, and a gate level shifter driver to separate the digital controller from the main switch. It is triggered with a negative gate current flowing out of the gate pin.







#### Table 1.Device summary

Symbol	Value	Unit
I <sub>T(RMS)</sub>	0.2	А
V <sub>DRM</sub> /V <sub>RRM</sub>	600	V
I <sub>GT</sub>	5	mA

TM: ACS is a trademark of STMicroelectronics ASD: Application specific devices

# 1 Characteristics

Table 2. Abs	olute maximum	ratings (Tamb	= 25 °C, I	unless otherwise	e specified)
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Symbol	Paramete	Value	Unit		
	On state rms ourrent (full sine wave)	TO-92	$T_{amb} = 100 \ ^{\circ}C$	0.2	Α
'T(RMS)	I <sub>T(RMS)</sub> On-state rms current (full sine wave)		T <sub>amb</sub> = 100 °C	0.2	~
I	Non repetitive surge peak on-state current	f = 60 Hz	t = 16.7 ms	7.6	А
ITSM	(full cycle sine wave, $T_j$ initial = 25 °C)	f = 50 Hz	t = 20 ms	7.3	~
l²t	I <sup>2</sup> t Value for fusing	tp	= 10 ms	0.38	A²s
dl/dt	Critical rate of rise of on-state current $I_G = 2xI_{GT}$ , tr $\leq 100$ ns	f = 120  Hz		50	A/µs
V <sub>PP</sub>	Non repetitive line peak mains voltage <sup>(1)</sup>		T <sub>j</sub> = 25 °C	2	kV
I <sub>GM</sub>	Peak gate current $t_p = 20 \ \mu s$		T <sub>j</sub> = 125 °C	1	Α
V <sub>GM</sub>	Peak positive gate voltage	T <sub>j</sub> = 125 °C	10	V	
P <sub>G(AV)</sub>	Average gate power dissipation		T <sub>j</sub> = 125 °C	0.1	W
T <sub>stg</sub> T <sub>j</sub>	Storage junction temperature range Operating junction temperature range		-40 to +150 -30 to +125	°C	

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

#### Table 3. Electrical characteristics ( $T_j = 25 \text{ °C}$ , unless otherwise specified)

Symbol	Test conditions Quadrant			Value	Unit
I <sub>GT</sub> <sup>(1)</sup>	V <sub>OUT</sub> = 12 V, R <sub>I</sub> = 33 Ω	-	MAX	5	mA
V <sub>GT</sub>	$V_{OUT} = 12$ V, $n_L = 33.52$	-	MAX	0.9	V
V <sub>GD</sub>	$V_{OUT} = V_{DRM}$ , $R_L = 3.3 \text{ k}\Omega$ , $T_j = 125 \text{ °C}$	$V_{OUT} = V_{DRM}, R_L = 3.3 \text{ k}\Omega, T_j = 125 \text{ °C}$ II - III		0.15	V
I <sub>H</sub> <sup>(2)</sup>	I <sub>OUT</sub> = 100 mA			20	mA
۱ <sub>L</sub> (2)	$I_{G} = 1.2 \text{ x } I_{GT}$		MAX	25	mA
dV/dt <sup>(2)</sup>	$V_{OUT} = 67\% V_{DRM}$ , gate open, $T_j = 125 \text{ °C}$		MIN	300	V/µs
(dl/dt)c <sup>(2)</sup>	Without snubber (15 V/µs), turn-off time $\leq$ 20 ms, T	<sub>j</sub> = 125 °C	MIN	0.15	A/ms
V <sub>CL</sub>	$I_{CL} = 0.1 \text{ mA}, t_p = 1 \text{ ms}, T_j = 125 \text{ °C}$		MIN	650	V

1. Minimum  $I_{GT}$  is guaranteed at 10% of  $I_{GT}$  max

2. For both polarities of OUT referenced to COM



Symbol	Test conditions			Value	Unit
V <sub>TM</sub> <sup>(1)</sup>	I <sub>TM</sub> = 0.3 A, t <sub>p</sub> = 380 μs	Tj = 25 °C	MAX	1.2	V
V <sub>TO</sub> <sup>(1)</sup>		Tj = 125 °C	MAX	0.80	V
R <sub>D</sub> <sup>(1)</sup>		Tj = 125 °C	MAX	500	mΩ
I <sub>DRM</sub>	V. – 600 V	Tj = 25 °C	мах	2	μA
$V_{OUT} = 600 V$	Tj = 125 °C		0.2	mA	

#### Table 4. Static electrical characteristics

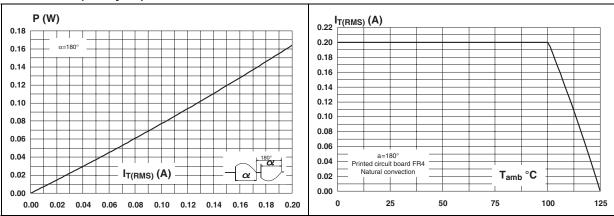
1. for both polarities of OUT referenced to COM

#### Table 5.Thermal resistance

Symbol	Parameter		Value	Unit	
R <sub>th (j-l)</sub>	Junction to lead (AC)		TO-92	60	
D	P lunction to ambient		TO-92	150	°C/W
⊓th (j-a)	R <sub>th (j-a)</sub> Junction to ambient	S = 40 mm <sup>2</sup>	SO-8	150	

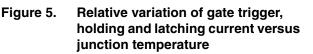
# Figure 2. Maximum power dissipation versus on-state rms current (full cycle)

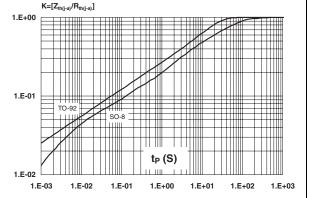
#### Figure 3. On-state rms current versus ambient temperature (full cycle)





#### Figure 4. Relative variation of junction to ambient thermal impedance versus pulse duration and package





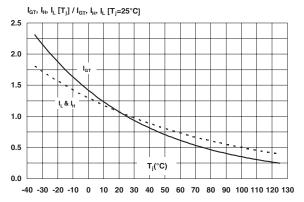


Figure 6. Non repetitive surge peak on-state F current versus number of cycles

Figure 7. Non repetitive surge peak on-state current for a sinusoidal pulse, and corresponding value of I<sup>2</sup>t

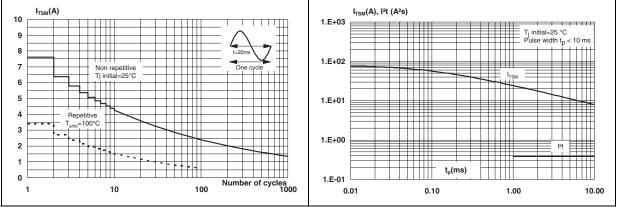
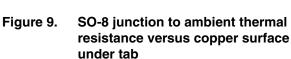
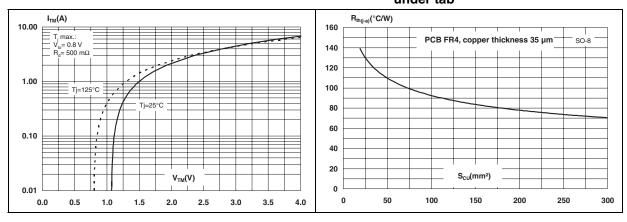


Figure 8. On-state characteristics (maximal values)

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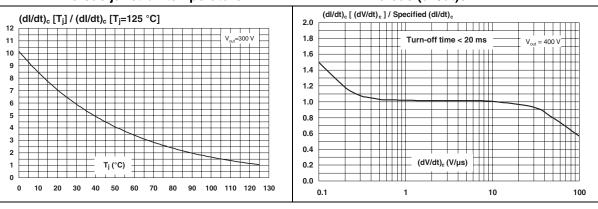


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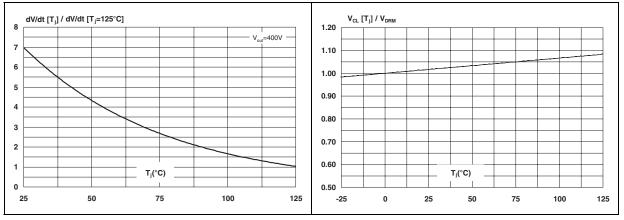
#### Figure 10. Relative variation of critical rate of decrease of main current (di/dt)c versus junction temperature

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



# Figure 12. Relative variation of static dV/dt versus junction temperature

Figure 13. Relative variation of the maximal clamping voltage versus junction temperature (min value)

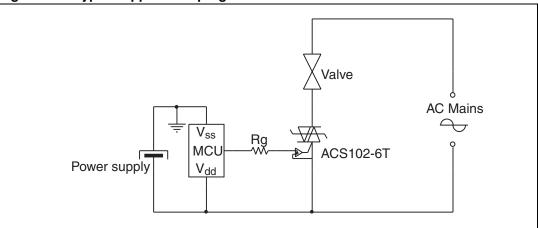




## 2 Alternating current line switch - basic application

The ACS102-6T switch is triggered by a negative gate current flowing from the gate pin G. The switch can be driven directly by the digital controller through a resistor as shown in *Figure 14*.

Thanks to its overvoltage protection and turn-off commutation performance, the ACS102-6T switch can drive a small power, high-inductive load with neither varistor nor additional turn-off snubber.



#### Figure 14. Typical application program

## 2.1 Protection against overvoltage: the best choice is ACS

In comparison with standard TRIACs, which are not robust against surge voltage, the ACS102-6T is overvoltage self-protected, specified by the new parameter  $V_{CL}$ . This feature is useful in two operating conditions: in case of turn-off of very inductive load, and in case of surge voltage that can occur on the electrical network.

#### 2.1.1 High inductive load switch-off: turn-off overvoltage clamping

With high inductive and low rms current loads the rate of decrease of the current is very low. An overvoltage can occur when the gate current is removed and the OUT current is lower than  $I_{\rm H}$ .

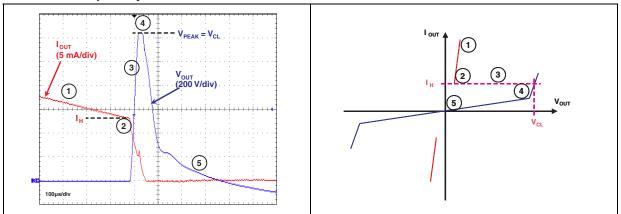
As shown in *Figure 15* and *Figure 16*, at the end of the last conduction half cycle, the load current decreases (1). The load current reaches the holding current level  $I_H$  (2), and the ACS turns off (3). The water valve, as an inductive load (up to 15 H), reacts as a current generator and an overvoltage is created, which is clamped by the ACS (4). The current flows through the ACS avalanche and decreases linearly to zero. During this time, the voltage across the switch is limited to the clamping voltage  $V_{CL}$ . The energy stored in the inductance of the load is dissipated in the clamping section that is designed for this purpose. When the energy has been dissipated, the ACS voltage falls back to the mains voltage value (5).



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#### Figure 15. Effect of the switching off of a high Figure 16. inductive load - typical clamping capability of ACS102-6T

Description of the different steps during switching off of a high inductive load



#### 2.1.2 Alternating current line transient voltage ruggedness

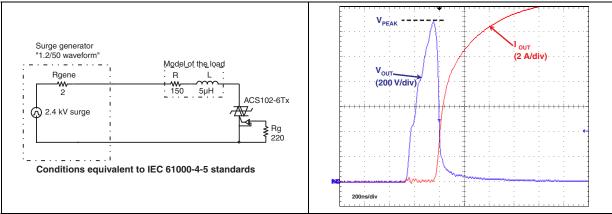
The ACS102-6T switch is able to withstand safely the AC line transients either by clamping the low energy spikes or by breaking over under high energy shocks, even with high turn-on current rise.

The test circuit shown in *Figure 17* is representative of the final ACS102-6T application, and is also used to test the ACS switch according to the IEC 61000-4-5 standard conditions. Thanks to the load limiting the current, the ACS102-6T switch withstands the voltage spikes up to 2 kV above the peak line voltage. The protection is based on an overvoltage crowbar technology. Actually, the ACS102-6T breaks over safely as shown in *Figure 18*. The ACS102-6T recovers its blocking voltage capability after the surge (switch off back at the next zero crossing of the current).

Such non-repetitive tests can be done 10 times on each AC line voltage polarity.

# Figure 17. Overvoltage ruggedness test circuit Figure 18. Typical current and voltage for resistive and inductive loads waveforms across the ACS<sup>-</sup>

waveforms across the ACS102-6T during IEC 61000-4-5 standard test



# **3** Ordering information scheme

#### Figure 19. Ordering information scheme

	ACS 1 02 - 6 T A -TR
AC Switch series	
Number of switches	
Current 02 = 0.2 A <sub>RMS</sub>	
Voltage	
6 = 600 V	
Sensitivity	
T = 5 mA	
Package A = TO-92	
1 = SO-8	
Packing	
TR = Tape and reel Blank = (TO-92) Bulk	
(SO-8) Tube	



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# 4 Package information

- Epoxy meets UL94, V0
- Lead-free packages

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

Table 6. TO-92 dimensions

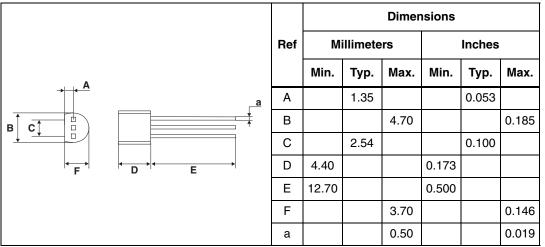
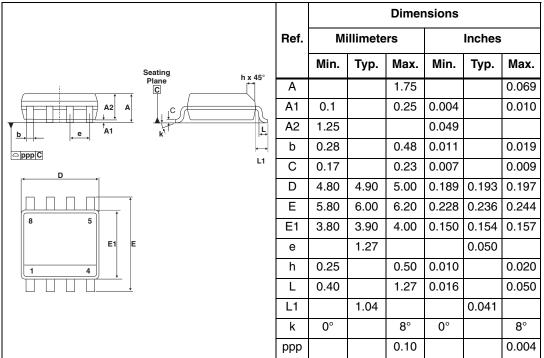
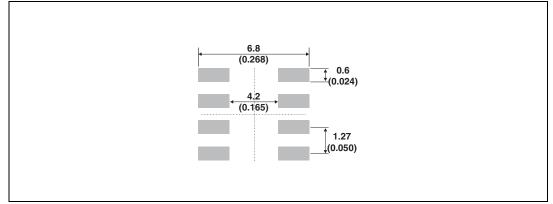


Table 7. SO-8 dimensions





#### Figure 20. Footprint, dimensions in mm (inches)



# 5 Ordering information

Order code	Marking	Package	Weight	Base qty	Packing mode
ACS102-6TA	ACS1026T	TO-92	0.2 g	2500	Bulk
ACS102-6TA-TR	ACS1026T	TO-92	0.2 g	2000	Tape and reel
ACS102-6T1	ACS1026T	SO-8	0.11 g	100	Tube
ACS102-6T1-TR	ACS1026T	SO-8	0.11 g	2500	Tape and reel

#### Table 8.Ordering information

# 6 Revision history

#### Table 9.Document revision history

Date	Revision	Changes
05-Jan-2006	1	Initial release.
07-Jun-2006	2	Reformatted to current standards. Replaced Figure 9.
24-May-2011	3	Added pin indications on first page. Corrected dimensions in Table 7.



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