

## **ACS108-6S**

# Overvoltage 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 micro-controller
- Common package tab connection supports connection of several alternating current switches (ACS) on the same cooling pad
- Integrated structure based on A.S.D.<sup>®</sup> technology
- Overvoltage protection by crowbar technology
- High noise immunity static dV/dt > 500 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
  - pump, fan, micro-motor

## **Description**

The ACS108-6S belongs to the AC line switch family. This high performance switch can control a load of up to 0.8 A.

The ACS108-6S 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.

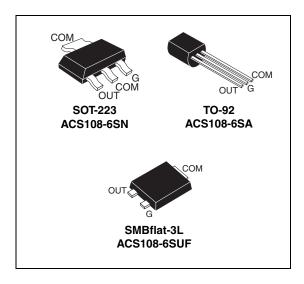


Figure 1. Functional diagram

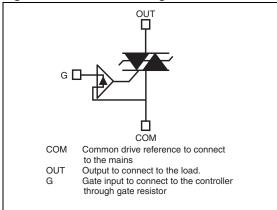


Table 1. Device summary

Symbol	Value	Unit
I <sub>T(RMS)</sub>	0.8	Α
$V_{DRM}/V_{RRM}$	600	V
I <sub>GT</sub>	10	mA

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TM: ACS is a trademark of STMicroelectronics

December 2010 Doc ID 11962 Rev 3 1/15

Characteristics ACS108-6S

# 1 Characteristics

Table 2. Absolute maximum ratings (T<sub>amb</sub> = 25 °C, unless otherwise specified)

Symbol	Paramete	Value	Unit		
		TO-92	T <sub>amb</sub> = 61 °C	0.45	Α
		10-32	T <sub>lead</sub> = 75 °C		
I	On-state rms current (full sine wave)	SOT-223	T <sub>amb</sub> = 75 °C		
I <sub>T(RMS)</sub>	On-state mis current (full sine wave)	301-223	T <sub>tab</sub> = 104 °C	0.8	Α
		SMBflat-3L	T <sub>amb</sub> = 62 °C		
		Sivibilat-3L	T <sub>tab</sub> = 113 °C		
	Non repetitive surge peak on-state	F = 60 Hz	t = 16.7 ms	7.6	_
I <sub>TSM</sub>	current (full cycle sine wave, T <sub>j</sub> initial = 25 °C)	F = 50 Hz	t = 20 ms	7.3	Α
I <sup>2</sup> t	I²t Value for fusing		t <sub>p</sub> = 10 ms	0.38	A <sup>2</sup> s
dl/dt	Critical rate of rise of on-state current $I_G = 2xI_{GT}$ , tr $\leq 100$ ns		T <sub>j</sub> = 125 °C	100	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 <sub>p</sub> = 20 μs	T <sub>j</sub> = 125 °C	1	Α
$V_{GM}$	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		

<sup>1.</sup> according to test described by IEC 61000-4-5 standard and Figure 19

Table 3. Electrical characteristics ( $T_j = 25$  °C, unless otherwise specified)

Symbol	Test conditions Quadrant			Value	Unit
I <sub>GT</sub> <sup>(1)</sup>	$V_{OUT}$ = 12 V, $R_L$ = 33 $\Omega$	II - III	Max.	10	mA
V <sub>GT</sub>	VOUT - 12 V, NL - 33 32	II - III	Max.	1	٧
$V_{GD}$	$V_{OUT} = V_{DRM}$ , $R_L = 3.3 \text{ k}\Omega$ , $T_j = 125 ^{\circ}\text{C}$	II - III	Min.	0.15	٧
I <sub>H</sub> <sup>(2)</sup>	I <sub>OUT</sub> = 100 mA		Max.	25	mA
I <sub>L</sub> <sup>(2)</sup>	$I_{G} = 1.2 \times I_{GT}$		Max.	30	mA
dV/dt <sup>(2)</sup>	$V_{OUT} = 67\% V_{DRM}$ , gate open, $T_j = 125 ^{\circ}\text{C}$		Min.	500	V/µs
(dl/dt)c <sup>(2</sup>	Without snubber (15 V/ $\mu$ s), turn-off time $\leq$ 20 ms, T $_{j}$ = 125 °C		Min.	0.3	A/ms
V <sub>CL</sub>	$I_{CL} = 0.1 \text{ mA}, t_p = 1 \text{ ms}, T_j = 125 \text{ °C}$		Min.	650	٧

<sup>1.</sup> Minimum  $I_{\mbox{\scriptsize GT}}$  is guaranteed at 10% of  $I_{\mbox{\scriptsize GT}}$  max

**577** 

<sup>2.</sup> For both polarities of OUT referenced to COM

ACS108-6S Characteristics

Table 4. Static electrical characteristics

Symbol	Test conditions	Value	Unit		
V <sub>TM</sub> <sup>(1)</sup>	$I_{TM} = 1.1 \text{ A}, t_p = 500 \ \mu \text{s}$	T <sub>j</sub> = 25 °C	Max.	1.3	V
V <sub>TO</sub> (1)	Threshold voltage	T <sub>j</sub> = 125 °C	Max.	0.90	V
R <sub>D</sub> <sup>(1)</sup>		T <sub>j</sub> = 125 °C	Max.	300	mΩ
I <sub>DRM</sub>	V 600 V	T <sub>j</sub> = 25 °C	Max.	2	μΑ
I <sub>RRM</sub>	V <sub>OUT</sub> = 600 V	T <sub>j</sub> = 125 °C	iviax.	0.2	mA

<sup>1.</sup> For both polarities of OUT referenced to COM

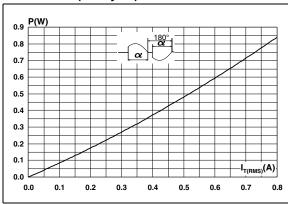
Table 5. Thermal resistance

Symbol	Parameter				Value	Unit
R <sub>th (j-l)</sub>	Junction to lead (AC)		TO-92	Max.	60	
R <sub>th (j-t)</sub>	Junction to tab (AC)		SOT-223	Max.	25	
R <sub>th (j-t)</sub>	Junction to tab (AC)		SMBflat-3L	Max.	14	°C/W
			TO-92	Max.	150	C/VV
R <sub>th (j-a)</sub>	R <sub>th (j-a)</sub> Junction to ambient	S = 5 cm <sup>2</sup>	SOT-223	Max.	60	
		3 = 3 (111-	SMBflat-3L	Max.	75	

Characteristics ACS108-6S

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

Figure 3. On-state rms current versus lead (TO-92) or tab (SOT-223, SMBflat-3L) temperature (full cycle)



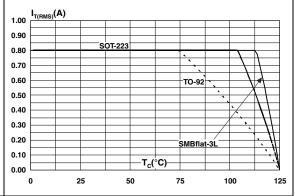
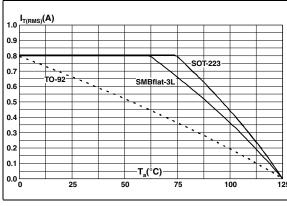


Figure 4. On-state rms current versus ambient temperature (free air convection)

Figure 5. Relative variation of thermal impedance junction to ambient versus pulse duration



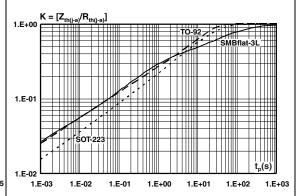
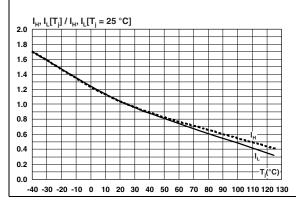
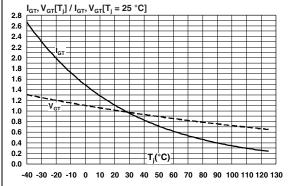


Figure 6. Relative variation of, holding and latching current versus junction temperature

Figure 7. Releative variation of  $I_{GT}$  and  $V_{GT}$  versus junction temperature



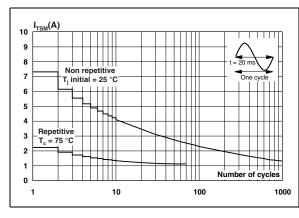


4/15 Doc ID 11962 Rev 3

ACS108-6S Characteristics

Figure 8. Non repetitive surge peak on-state Figure 9. current versus number of cycles

gure 9. Non repetitive surge peak on-state current for a sinusoidal pulse, and corresponding value of l<sup>2</sup>t



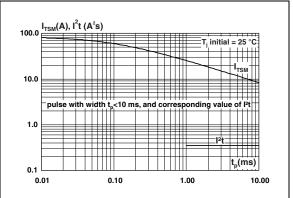
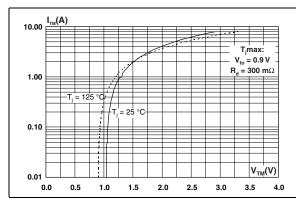


Figure 10. On-state characteristics (maximal values)

Figure 11. Relative variation of critical rate of decrease of main current versus junction temperature



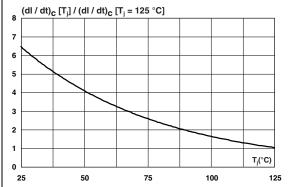
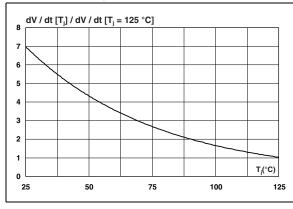
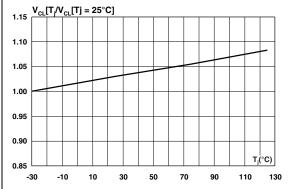


Figure 12. Relative variation of static dV/dt immunity versus junction temperature

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



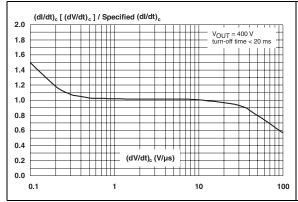


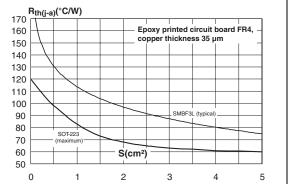
577

Characteristics ACS108-6S

Figure 14. Relative variation of critical rate ofdecrease of main current (di/dt)c versus (dV/dt)c

Figure 15. Thermal resistance junction to ambient versus copper surface under tab (SOT-223, SMBflat-3L)





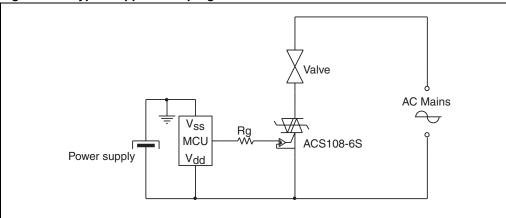
6/15 Doc ID 11962 Rev 3

## 2 Alternating current line switch - basic application

The ACS108-6S 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 16*.

Thanks to its overvoltage protection and turn-off commutation performance, the ACS108-6S switch can drive a small power high inductive load with neither varistor nor additional turn-off snubber.

Figure 16. 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 ACS108-6S is over-voltage 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.

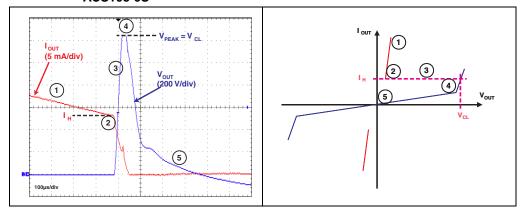
### 2.1.1 High inductive load switch-off: turn-off overvoltage clamping

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 17* and *Figure 18*, 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).

Effect of the switching off of a Figure 18. Description of the different high inductive load - typical clamping capability of ACS108-6S

steps during switching off of a high inductive load



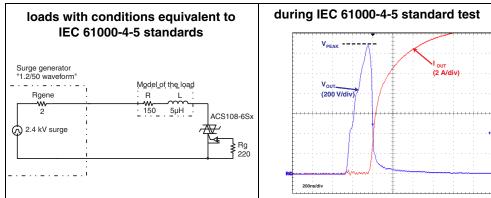
#### 2.1.2 Alternating current line transient voltage ruggedness

The ACS108-6S 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 rises.

The test circuit shown in Figure 19 is representative of the final ACS108-6S application, and is also used to test the ac switch according to the IEC 61000-4-5 standard conditions. Thanks to the load limiting the current, the ACS108-6S 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 ACS108-6S breaks over safely as shown in Figure 20. The ACS108-6S 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.

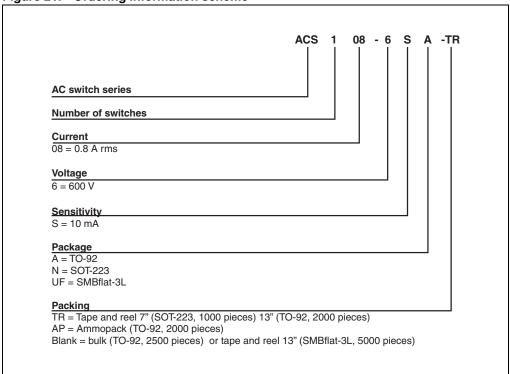
Figure 19. Overvoltage ruggedness test Figure 20. Typical current and voltage circuit for resistive and waveforms across the inductive ACS108-6S



8/15 Doc ID 11962 Rev 3

# 3 Ordering information scheme

Figure 21. Ordering information scheme

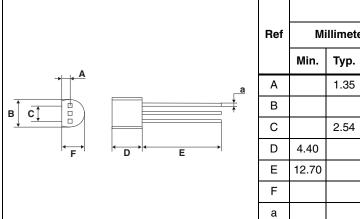


# 4 Package information

- 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: <a href="www.st.com">www.st.com</a>. ECOPACK<sup>®</sup> is an ST trademark.

Table 6. TO-92 dimensions

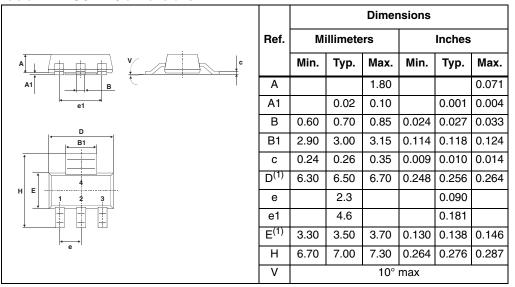


		Dimensions					
Ref	Millimeters		rs		Inches		
	Min.	Тур.	Max.	Min.	Тур.	Max.	
Α		1.35			0.053		
В			4.70			0.185	
С		2.54			0.100		
D	4.40			0.173			
Е	12.70			0.500			
F			3.70			0.146	
а			0.50			0.019	

10/15 Doc ID 11962 Rev 3

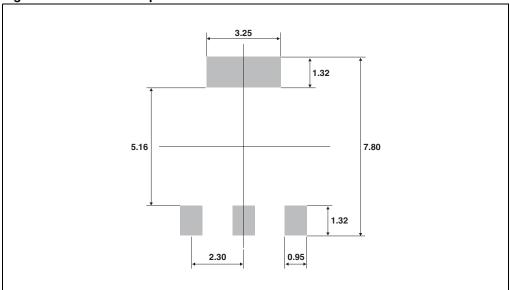
ACS108-6S Package information

Table 7. SOT-223 dimensions



1. Do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15mm (0.006inches)

Figure 22. SOT-223 footprint



Package information ACS108-6S

Table 8. SMBflat-3L dimensions

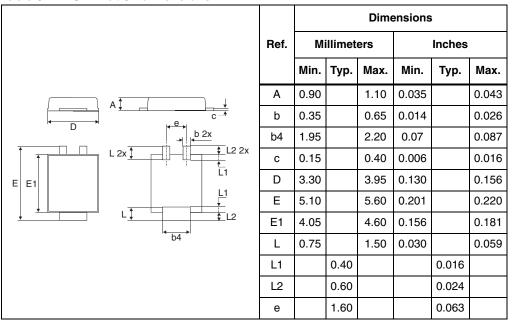
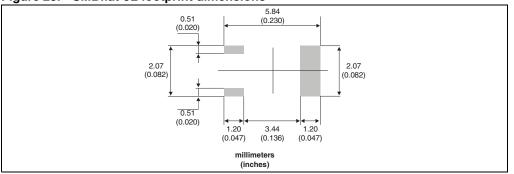


Figure 23. SMBflat-3L footprint dimensions



ACS108-6S Package information

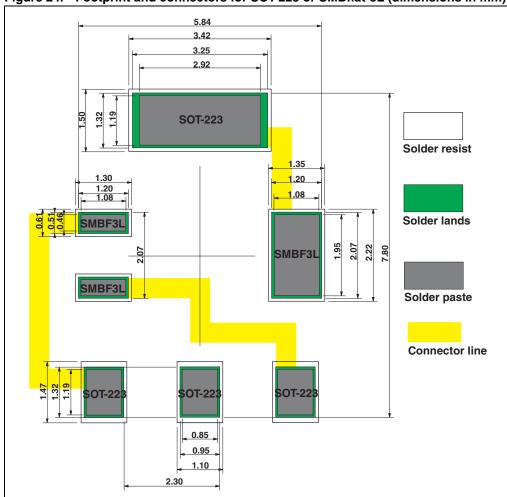


Figure 24. Footprint and connectors for SOT-223 or SMBflat-3L (dimensions in mm)

Ordering information ACS108-6S

# 5 Ordering information

Table 9. Ordering information

Order code	Marking	Package	Weight	Base Qty	Delivery mode
ACS108-6SA	ACS1086S	TO-92	0.2 g	2500	Bulk
ACS108-6SA-TR	ACS1086S	TO-92	0.2 g	2000	Tape and reel
ACS108-6SA-AP	ACS1086S	TO-92	0.2 g	2000	Ammopack
ACS108-6SN-TR	ACS1086S	SOT-223	0.11 g	1000	Tape and reel
ACS108-6SUF-TR	ACS1086S	SMBflat-3L	46.91 mg	5000	Tape and reel

# 6 Revision history

Table 10. Document revision history

Date	Revision	Changes
05-Jan-2005	1	Initial release.
07-Jun-2006	2	Reformatted to current standard. Replaced Figure 9.
14-Dec-2010 3		Updated Max. dimensions A1, B, B1, and c in <i>Table 7</i> . Added Epoxy meets UL94, V0 in <i>Package information</i> . Updated ECOPACK statement. Added SMBflat-3L package. Updated graphics.

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15/15