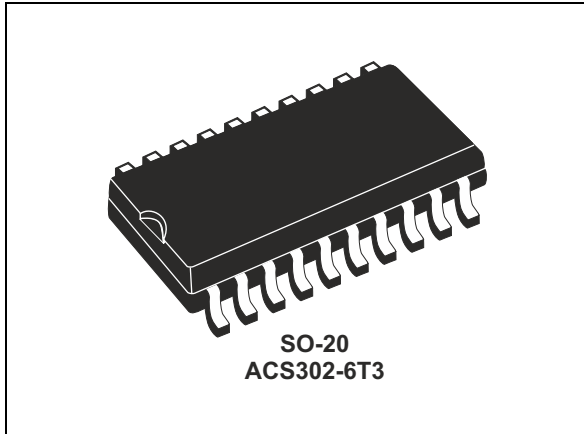


## 3-line overvoltage protected AC switch array

Datasheet - production data



### Features

- 3-line AC switch array
- Overvoltage protection
- High static immunity and dynamic commutation
- $V_{DRM}, V_{RRM} = 600\text{ V}$
- $T_J = 125\text{ }^\circ\text{C max.}$
- $I_{GT} < 5\text{ mA}$

### Application

Drive of low power highly inductive or resistive loads like:

- Relay, valve, solenoid
- Dispenser, door lock
- Pump, fan, micro-motor

Table 1. Device summary

Order code	Package	$V_{DRM}, V_{RRM}$	$I_{GT}$
ACS302-6T3	SO-20	600 V	5 mA

### Description

ACS302 offers 3 AC switches in one single package with 600 V blocking voltage, high commutation and noise immunity - all that is required for inductive load control.

Its high integration allows reduced space consumption of PCB.

ACS302 enables inductive application to be compliant with IEC 61000-4-4 and IEC 61000-4-5.

Figure 1. Pinout

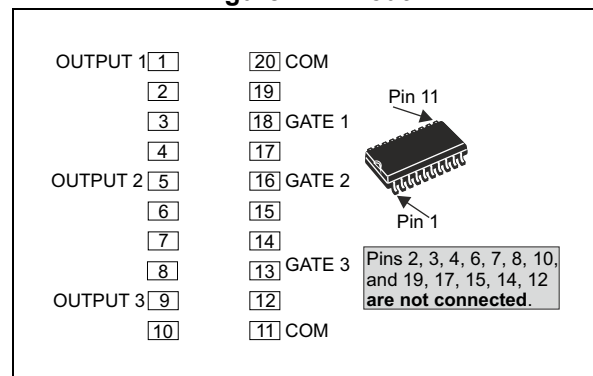
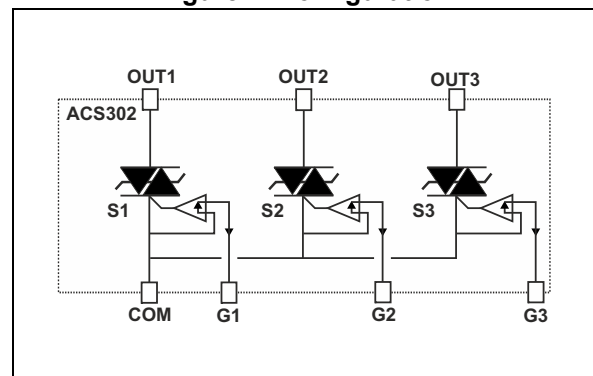


Figure 2. Configuration



ACS is a registered trademark of STMicroelectronics

# 1 Characteristics

**Table 2. Absolute maximum ratings – for one switch and  $T_J = 25\text{ °C}$ , unless otherwise specified**

Symbol	Parameter			Value	Unit	
$I_{T(RMS)}$	On-state rms current (180° conduction angle, full sine wave)	1 switch ON	$T_a = 110\text{ °C}$	0.2	A	
		2 or 3 switches ON	$T_a = 90\text{ °C}$	0.4	A	
$I_{TSM}$	Non repetitive surge peak on-state current ( $T_J$ initial = 25 °C)			$t_p = 16.7\text{ms}$	7.6	A
				$t_p = 20\text{ ms}$	7.3	
$I^2t$	$I^2t$ value for fusing		$t_p = 10\text{ms}$	0.38	$A^2s$	
$di/dt$	Critical rate of rise of on-state current $I_G = 2 \times I_{GT}$ , $t_r \leq 100\text{ ns}$		$F = 120\text{ Hz}$	50	$A/\mu s$	
$V_{DRM}$ , $V_{RRM}$	Repetitive peak off-state voltage		$T_J = 125\text{ °C}$	600	V	
$V_{pp}^{(1)}$	Non-repetitive line peak pulse voltage			2	kV	
$I_{GM}$	Peak gate current	$T_J = 125\text{ °C}$	$t_p = 20\text{ }\mu s$	1	A	
$P_{GM}$	Peak gate power	$T_J = 125\text{ °C}$	$t_p = 20\text{ }\mu s$	10	W	
$P_{G(AV)}$	Average gate power dissipation			0.1	W	
$T_{stg}$	Storage junction temperature range			-40 to +150	°C	
$T_J$	Operating junction temperature range			-40 to +125	°C	
$T_L$	Maximum lead temperature for soldering during 10 s.			260	°C	

1. According to test described by IEC 61000-4-5 standard and figure 3

**Table 3. Electrical characteristics (for one switch and  $T_J = 25\text{ °C}$ , unless otherwise specified)**

Symbol	Test conditions	Quadrants		Value	Unit
$I_{GT}$	$V_{OUT} = 12\text{ V}$ , $R_L = 33\text{ }\Omega$	II - III	MIN	0.25	mA
			MAX	5	
$V_{GT}$	$V_{OUT} = 12\text{ V}$ , $R_L = 33\text{ }\Omega$		MAX	0.9	V
$V_{GD}$	$V_{OUT} = V_{DRM}$ , $R_L = 3.3\text{ k}\Omega$ , $T_J = 125\text{ °C}$	II - III	MIN	0.15	V
$I_H$	$I_T = 100\text{ mA}$ , gate open		MAX	20	mA
$I_L$	$I_G = 1.2 I_{GT}$	II - III	MAX	25	mA
$dV/dt$	$V_{OUT} = 400\text{ V}$ , gate open	$T_J = 125\text{ °C}$	MIN	300	$V/\mu s$
$(di/dt)_c$	$(dV/dt)_c = 15\text{ V}/\mu s$ , turn-off time $\leq 20\text{ ms}$	$T_J = 125\text{ °C}$	MIN	0.15	$A/ms$
$t_{gt}$	$I_{TM} = 1\text{ A}$ , $V_D = 400\text{ V}$ , $I_G = 100\text{ mA}$ , $dI_G/dt = 100\text{ mA}/\mu s$ , $R_L = 400\text{ }\Omega$		TYP	2	$\mu s$
$V_{CL}$	$I_{CL} = 0.1\text{ mA}$ , $t_p = 1\text{ ms}$		MIN	650	V

Table 4. Static electrical characteristics (for one switch)

Symbol	Test conditions		Value	Unit	
$V_{TM}$	$I_{TM} = 0.3 \text{ A}$ , $t_p = 380 \mu\text{s}$	$T_j = 25^\circ\text{C}$	MAX	1.2	V
$V_{TO}$	Threshold voltage	$T_j = 125^\circ\text{C}$		0.8	V
$R_D$	Dynamic resistance	$T_j = 125^\circ\text{C}$		500	m $\Omega$
$I_{DRM}$ , $I_{RRM}$	$V_{OUT} = 600 \text{ V}$	$T_j = 25^\circ\text{C}$		2	$\mu\text{A}$
		$T_j = 125^\circ\text{C}$	200	$\mu\text{A}$	

Table 5. Thermal resistance

Symbol	Parameter	Value	Unit
$R_{th(j-a)}$	Junction to ambient (AC)	80	$^\circ\text{C/W}$

Figure 3. Maximum power dissipation versus rms on-state current (per switch).

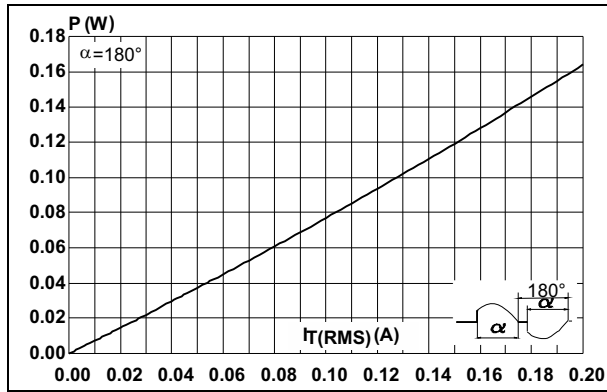


Figure 4. On-state rms current versus ambient temperature (free air convection)

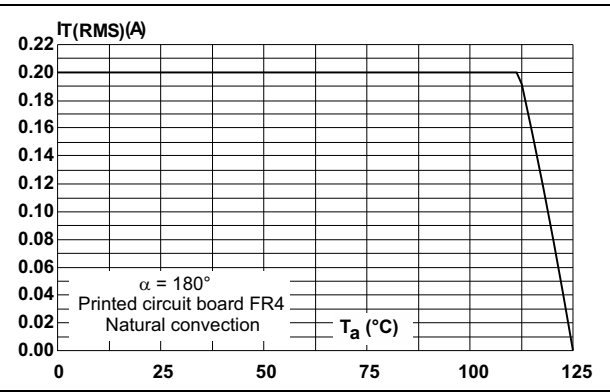


Figure 5. Relative variation of thermal impedance junction to ambient versus pulse duration

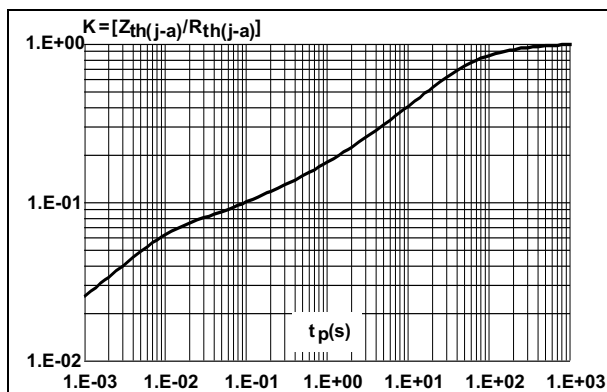


Figure 6. Relative variation of gate triggering current and voltage (IGT, VGT) versus junction temperature (typical values)

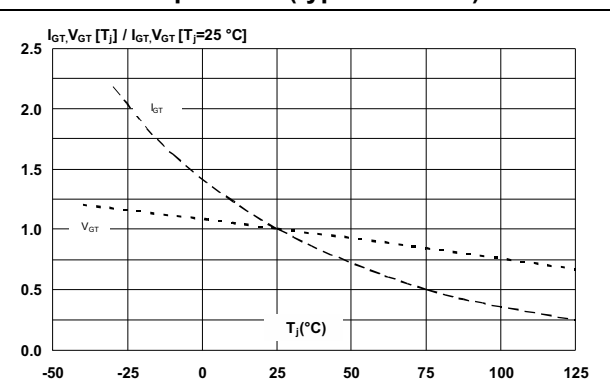


Figure 7. Relative variation of holding current and latching current ( $I_H$ ,  $I_L$ ) versus junction temperature (typical values)

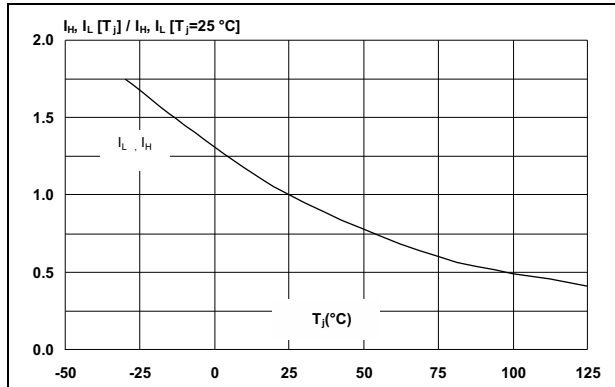


Figure 8. Surge peak on-state current versus number of cycles

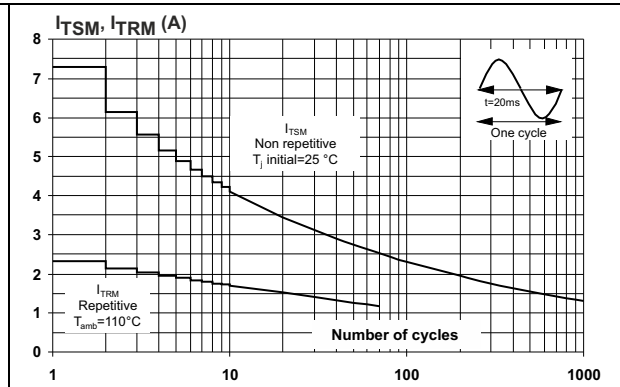


Figure 9. Non-repetitive surge peak on-state current for a sinusoidal pulse with width  $t_p < 10\text{ms}$ , and corresponding value of  $I^2t$

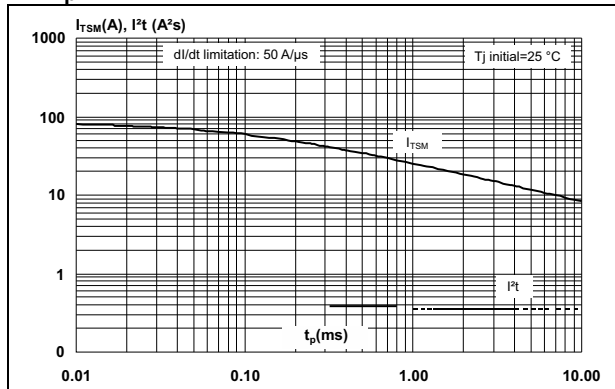


Figure 10. On-state characteristics (maximum values)

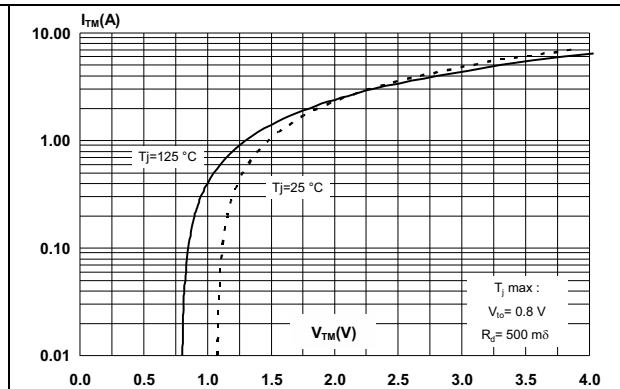


Figure 11. Relative variation of critical rate of decrease of current  $(dI/dt)_c$  versus junction temperature (typical values)

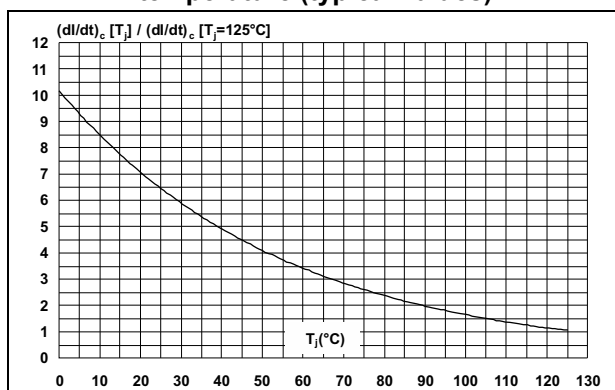


Figure 12. Relative variation of critical rate of decrease of current  $(dI/dt)_c$  versus  $dV/dt$  (typical values)

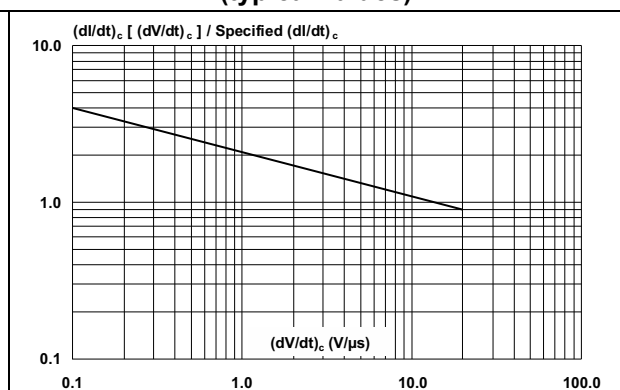


Figure 13. Relative variation of dV/dt immunity versus junction temperature (typical values)

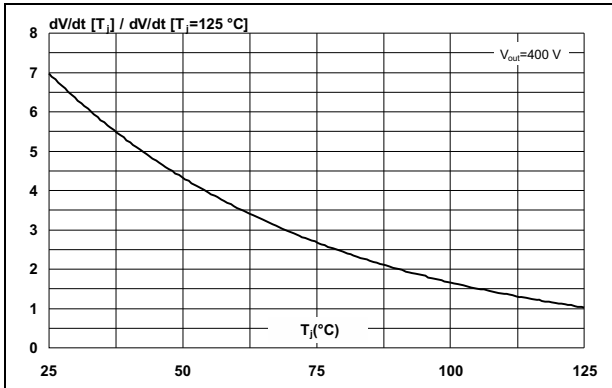


Figure 14. Relative variation of leakage current versus junction temperature (typical values)

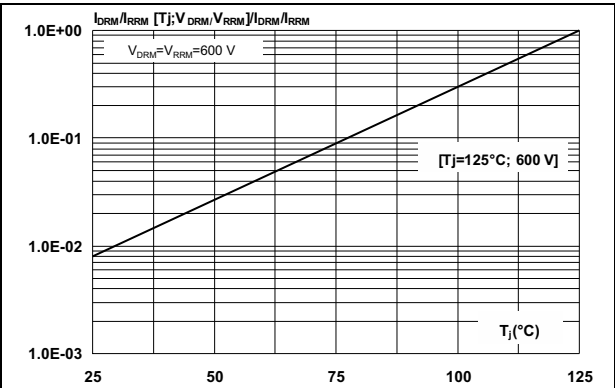
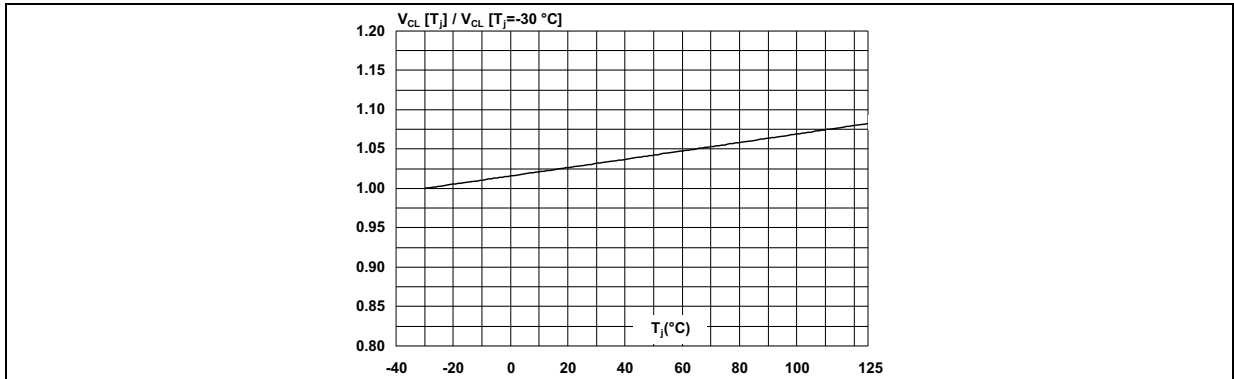


Figure 15. Relative variation of clamping voltage (V<sub>CL</sub>) versus junction temperature (minimum values)



## 2 AC line switch basic application

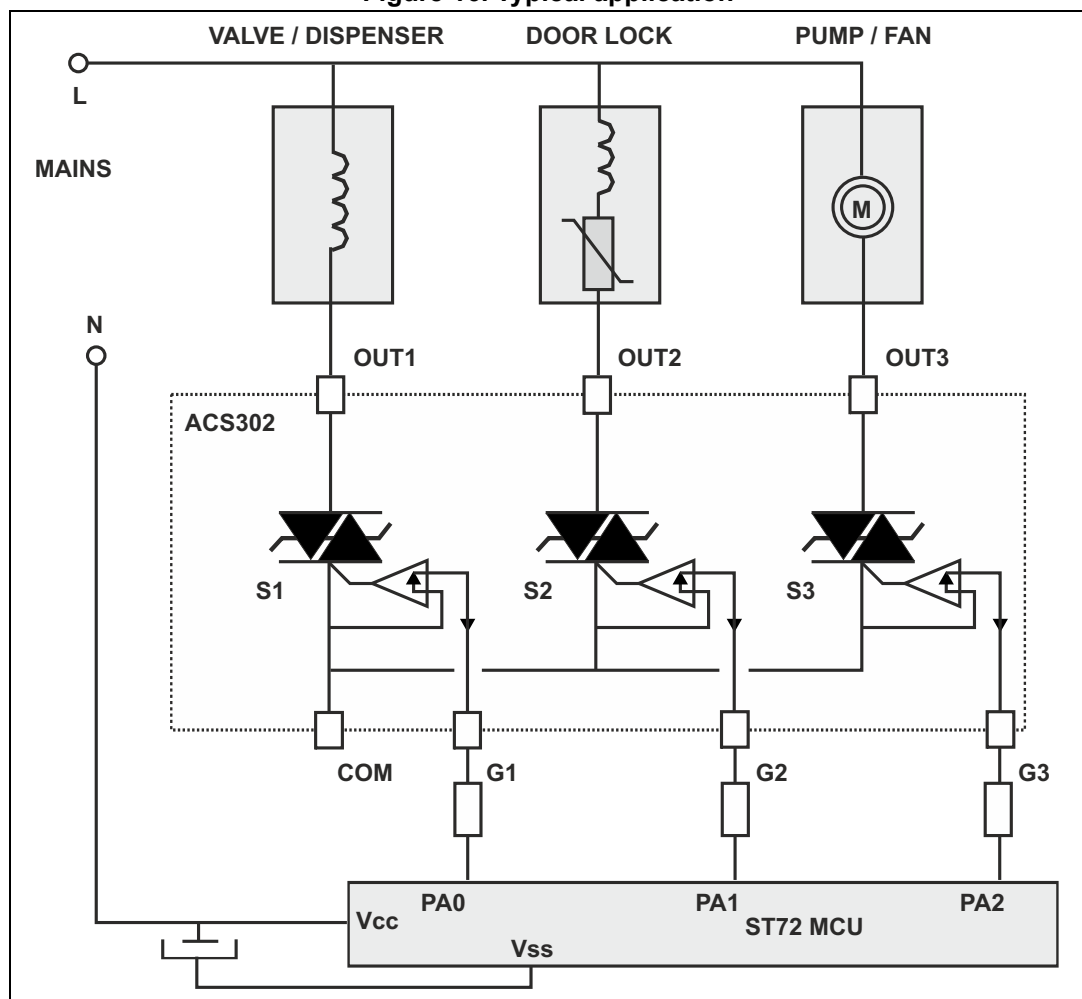
The ACS302 device is well adapted to washing machines, dishwashers, tumble driers, refrigerators, water heaters, and cooking products. It has been designed especially to switch ON and OFF low power loads such as solenoids, valves, relays, micro-motors, pumps, fans, door locks and low power lamps.

- **Pin COM:** Common drive reference, to connect to the power line neutral
- **Pin G:** Switch gate input to connect to the digital controller through a resistor
- **Pin OUT:** Switch output, to connect to the load

Each ACS<sup>®</sup> is triggered with a negative gate current flowing out of the gate pin G. It can be driven directly by the digital controller through a resistor as shown on the typical application diagram. No protection devices are required between the gates and common terminals.

In appliance systems, this ACS drives slow power loads in full cycle ON / OFF mode. Thanks to its thermal and turn off commutation performances, the ACS302 switch is able to drive three loads up to 0.2 A each such as two water valves and a door lock in a dishwasher, without any additional turn-off snubber.

Figure 16. Typical application

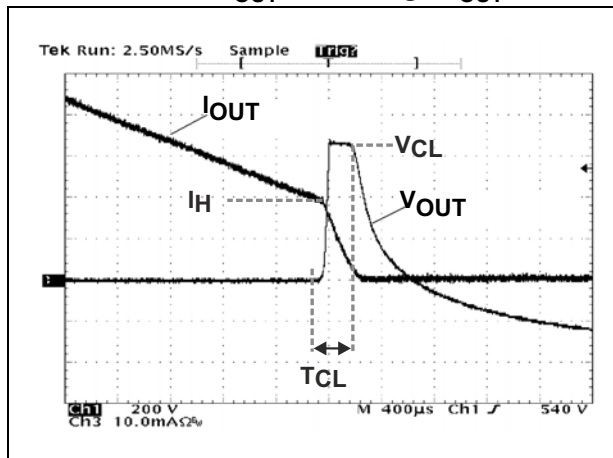


## 2.1 High Inductive switch-off operation

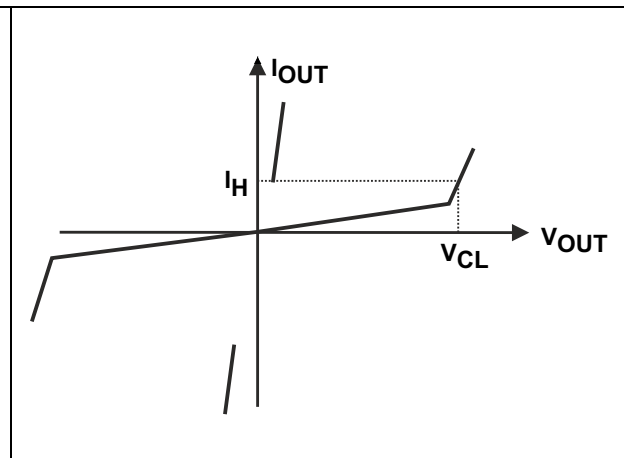
In [Figure 17](#), at the end of the last conduction half-cycle, the load current reaches the holding current level  $I_H$ , and the ACS turns off. Because of the inductance  $L$  of the load, the current flows through the avalanche diode  $D$  and decreases linearly to zero. During this time, the voltage across the switch is limited to the clamping voltage  $V_{CL}$ .

The energy stored in the inductance of the load depends on the holding current  $I_H$  ([Figure 18](#)) and the inductance (up to 10 H). The energy stored can reach about 20 mJ and is dissipated in the clamping diode section that is especially designed for that purpose.

**Figure 17. Turn-off operation of the ACS302 with an electro-valve: waveform of the pin OUT current  $I_{OUT}$  and voltage  $V_{OUT}$**



**Figure 18. ACS302 switch static characteristic**



## 2.2 AC line transient voltage ruggedness

The ACS302 is able to withstand safely the AC line transient voltages either by clamping the low energy spikes or by breaking over under high energy shocks.

The test circuit shown in [Figure 19](#) is representative of the final ACS application and is also used to stress the ACS according to the IEC 61000-4-5 standard conditions. Thanks to the load, the ACS withstands the voltage spikes up to 2 kV above the peak line voltage. It will break over safely even on resistive load where the turn on current rise is high as shown in [Figure 20](#). Such non repetitive test can be done 10 times on each AC line voltage polarity.

Figure 19. Overvoltage ruggedness test circuit for resistive and inductive loads according to IEC 61000-4-5 standard

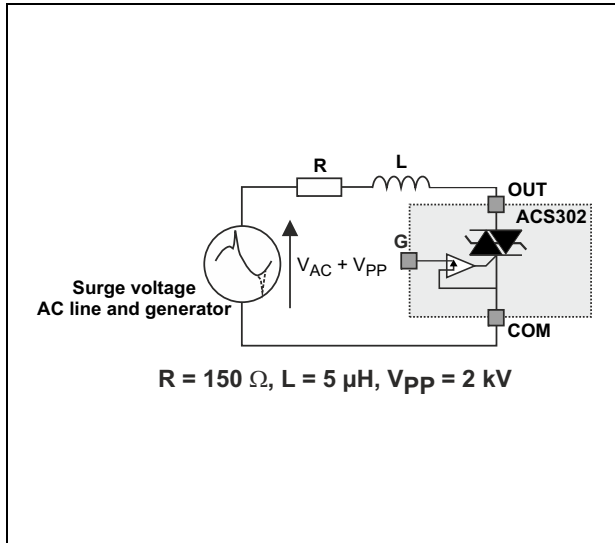
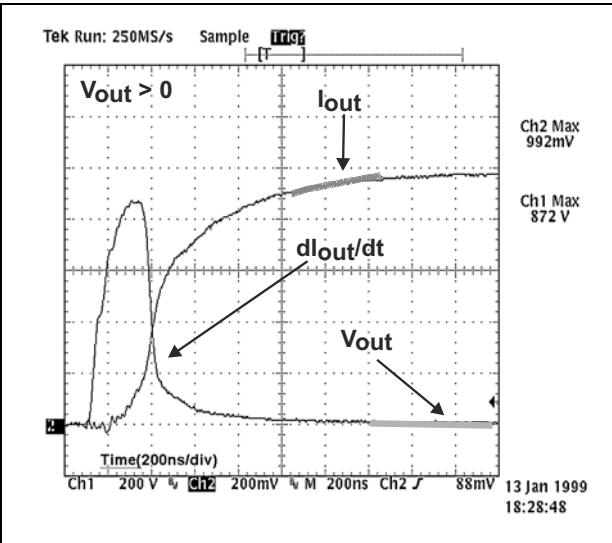


Figure 20. Current and voltage of the ACS during IEC 61000-4-5 standard test with  $R = 150 \Omega, L = 5 \mu H, V_{pp} = 2 kV$





### 3 Package information

- Epoxy meets UL94, V0
- Lead-free package

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.

Figure 21. SO-20 dimension definitions

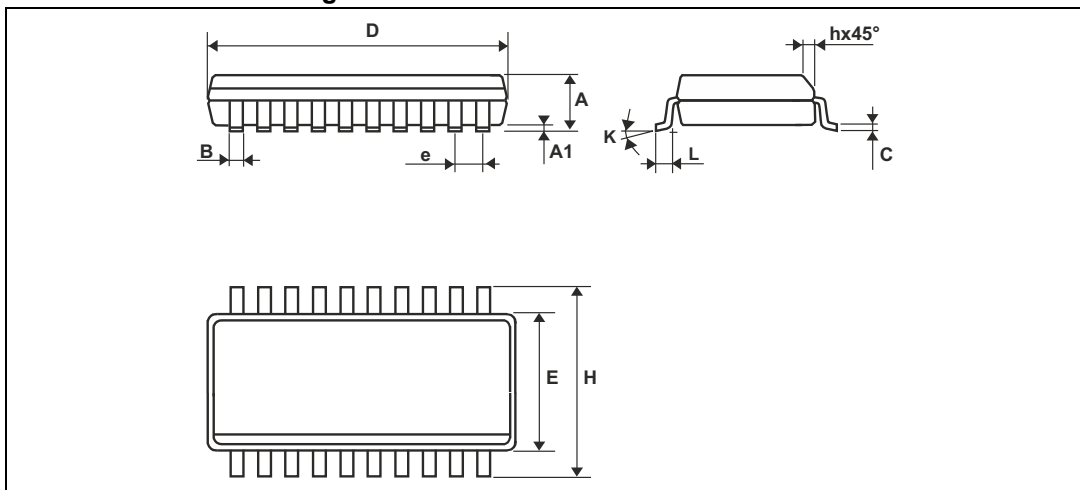
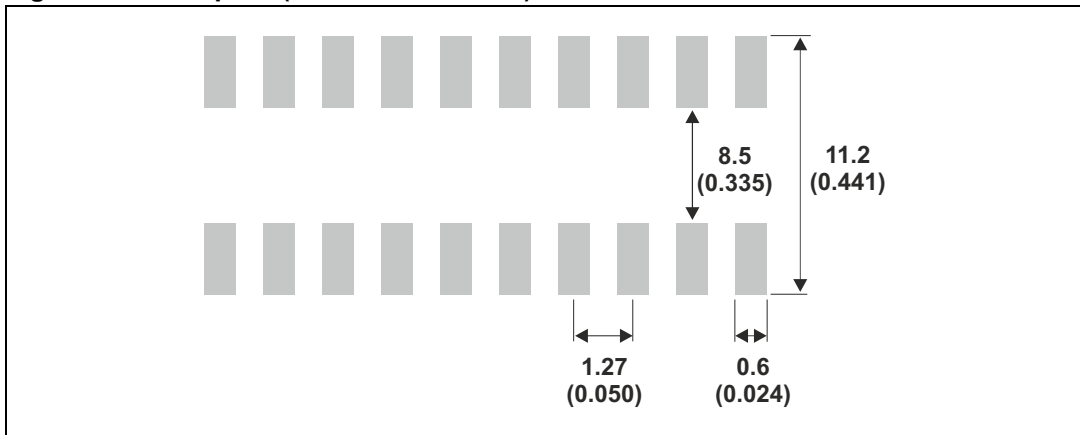


Table 6. SO-20 dimensions

Ref.	dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	2.35		2.65	0.092		0.104
A1	0.10		0.30	0.004		0.008
B	0.33		0.51	0.013		0.020
C	0.23		0.32	0.009		0.013
D	12.6		13.0	0.484		0.512
E	7.40		7.60	0.291		0.299
e		1.27			0.050	
H	10.0		10.65	0.394		0.419
h	0.25		0.75	0.010		0.029
L	0.40		1.27	0.016		0.050
K	8° (max)					

Figure 22. Footprint (dimensions in mm)



## 4 Ordering Information

Figure 23. Ordering information scheme

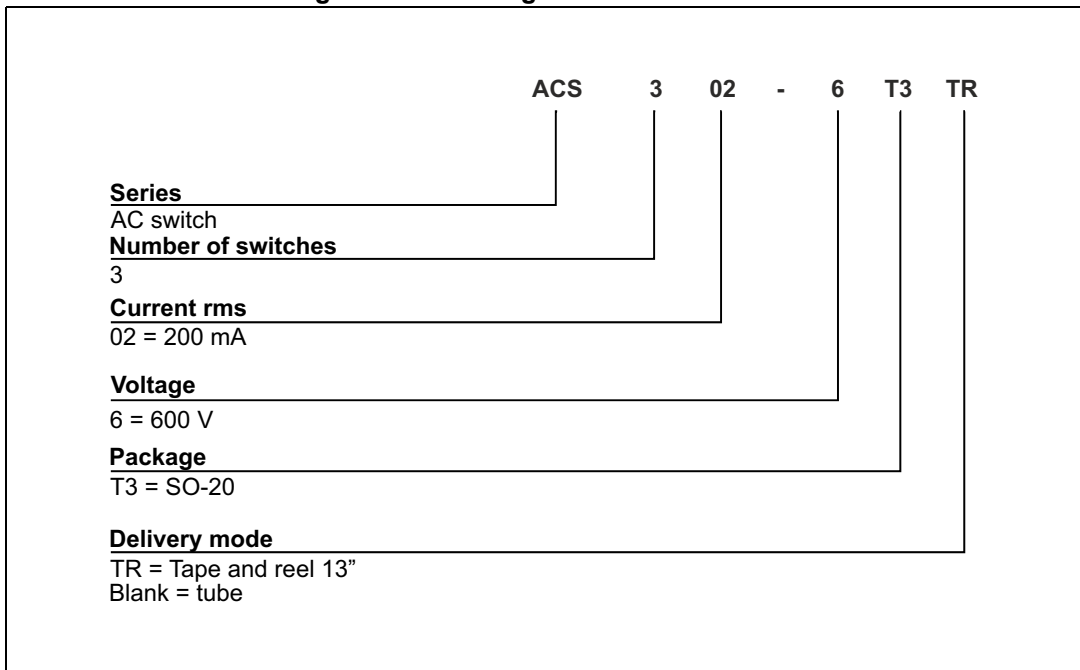


Table 7. Ordering information

Order code	Marking	Package	Weight	Base Qty	Delivery mode
ACS302-6T3-TR	ACS302-6	SO-20	0.55g	1,000	Tape and Reel 13"
ACS302-6T3	ACS302-6	SO-20	0.55g	40	Tube

## 5 Revision history

**Table 8. Document revision history**

Date	Revision	Changes
01-Jul-2013	1	First release.

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