

### Applications

- AC static switching in appliance control systems
- Drive of low power high inductive or resistive loads like:
  - relay, valve, solenoid, dispenser
  - pump, fan, micro-motor
  - defrost heater

### Description

The ACS120 belongs to the AC line switch family. This high performance switch circuit is able to control a load of up to 2 A.

The AC switch embeds a high voltage clamping structure to absorb the inductive turn off 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.

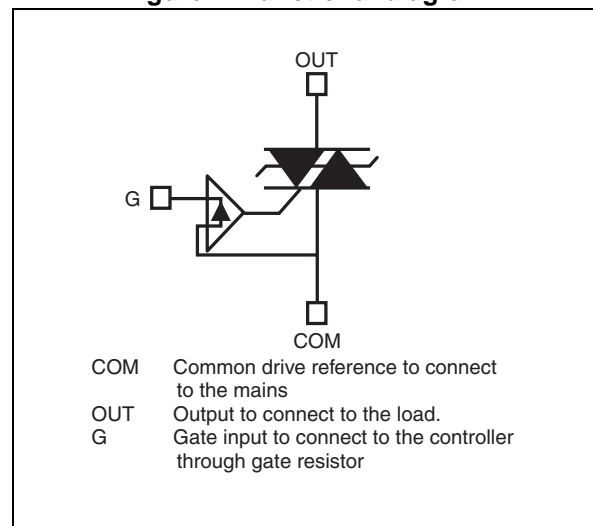
### Features

- Blocking voltage:  $V_{DRM} / V_{RRM} = \pm 700 \text{ V}$
- Avalanche controlled:  $V_{CL} \text{ typ.} = 1100 \text{ V}$
- Nominal conducting current:  $I_{T(RMS)} = 2 \text{ A}$
- Gate triggering current:  $I_{GT} < 10 \text{ mA}$
- Switch integrated driver
- High noise immunity: static  $dV/dt > 500 \text{ V}/\mu\text{s}$

### Benefits

- Needs no more external protection snubber or varistor
- Enables equipment to meet IEC 61000-4-5
- Reduces component count up to 80%
- Interfaces directly with the micro controller
- Eliminates any gate kick back on the micro-controller
- Allows straightforward connection of several AC switches on same cooling pad.

Figure 1. Functional diagram



# 1 Characteristics

**Table 1. Absolute ratings** (limiting values)

For either positive or negative polarity of pin OUT voltage in respect to pin COM voltage

Symbol	Parameter		Value	Unit	
$V_{DRM}/V_{RRM}$	Repetitive peak off-state voltage		700	V	
$I_{T(RMS)}$	On-state rms current full cycle sine wave 50 to 60 Hz	DPAK	$T_c = 119\text{ °C}$	2	A
		TO-220FPAB	$T_c = 117\text{ °C}$		
		TO-220AB	$T_c = 119\text{ °C}$		
$I_{TSM}$	Non repetitive surge peak on-state current $T_j$ initial = 25 °C, full cycle sine wave		F = 50 Hz	20	A
			F = 60 Hz	21	A
$I^2t$	Fusing capability		$t_p = 10\text{ ms}$	2.6	A <sup>2</sup> s
$di/dt$	Repetitive on-state current critical rate of rise $I_G = 10\text{ mA}$ ( $t_r < 100\text{ ns}$ )	$T_j = 125\text{ °C}$	F = 120 Hz	50	A/ $\mu$ s
$V_{PP}$	Non repetitive line peak pulse voltage <sup>(1)</sup>		2	kV	
$T_{stg}$	Storage temperature range		- 40 to + 150	°C	
$T_j$	Operating junction temperature range		- 30 to + 125	°C	
$T_l$	Maximum lead soldering temperature during 10 s		260	°C	

1. According to test described by IEC 61000-4-5 standard and [Figure 5](#)

**Table 2. Switch Gate characteristics** (maximum values)

Symbol	Parameter	Value	Unit
$P_{G(AV)}$	Average gate power dissipation	0.1	W
$I_{GM}$	Peak gate current ( $t_p = 20\text{ }\mu$ s)	1	A
$V_{GM}$	Peak positive gate voltage (in respect to pin COM)	5	V

**Table 3. Thermal resistances**

Symbol	Parameter		Value	Unit	
$R_{th(j-a)}$	Junction to ambient	S = 0.5 cm <sup>2</sup> ( <sup>1</sup> )	DPAK	70	°C/W
			TO-220FPAB	60	°C/W
			TO-220AB	60	°C/W
$R_{th(j-c)}$	Junction to tab/lead for full cycle sine wave conduction		DPAK	2.6	°C/W
			TO-220FPAB	3.5	°C/W
			TO-220AB	2.6	°C/W

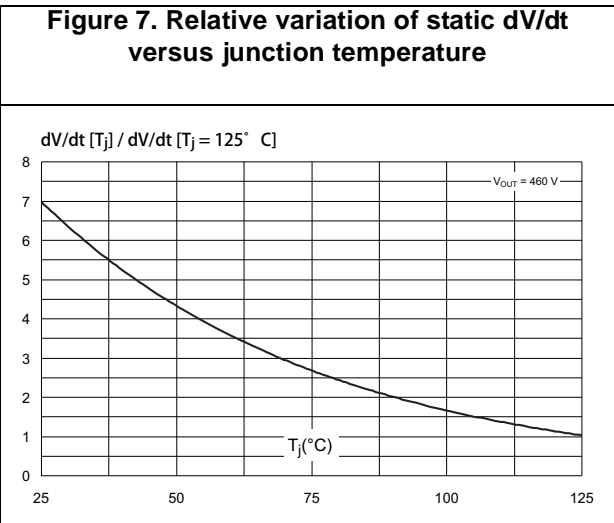
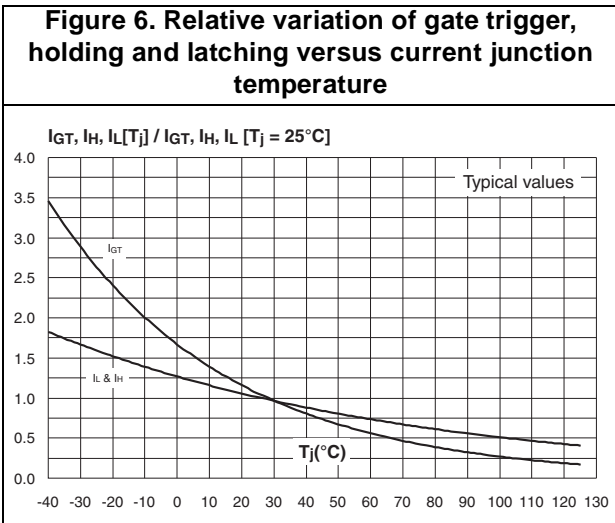
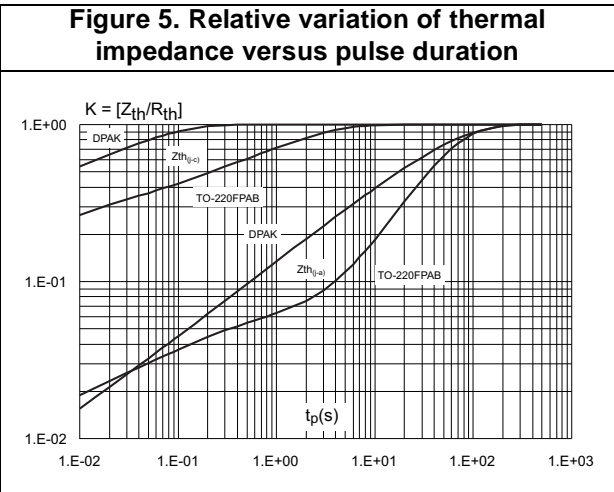
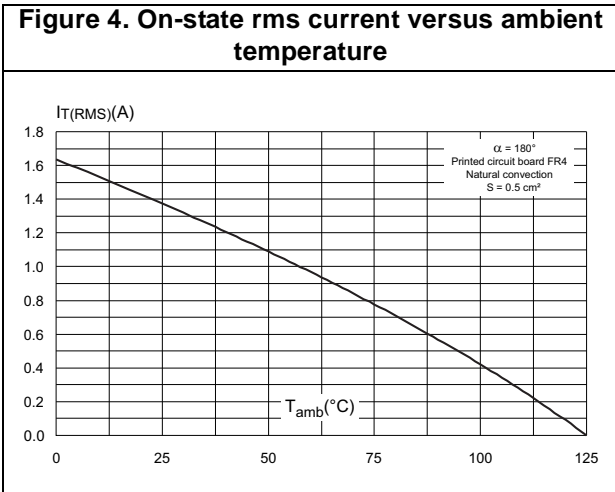
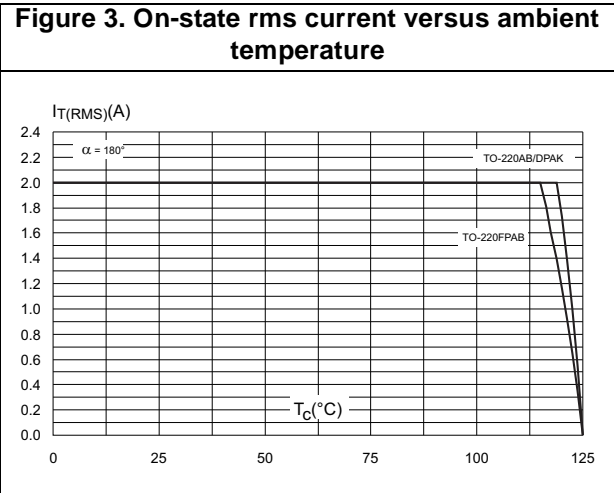
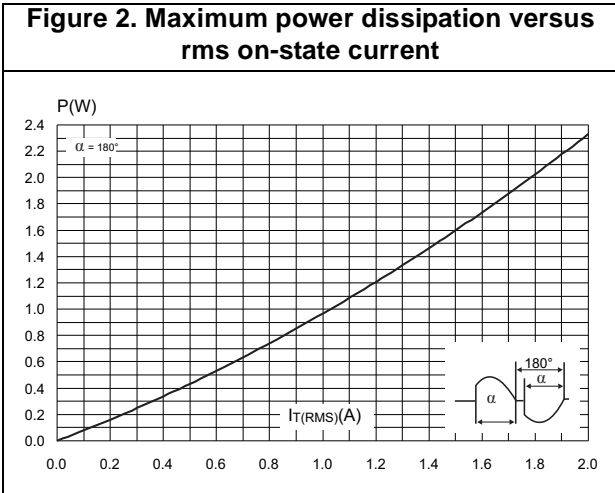
1. S = Copper surface under tab

Table 4. Parameter description

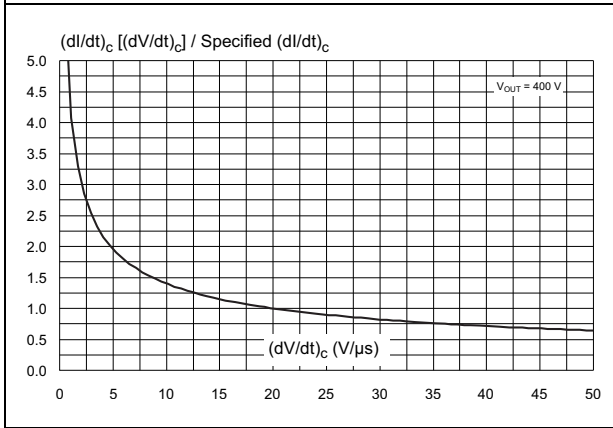
Parameter Symbol	Parameter description
$I_{GT}$	Triggering gate current
$V_{GT}$	Triggering gate voltage
$V_{GD}$	Non-triggering gate voltage
$I_H$	Holding current
$I_L$	Latching current
$V_{TM}$	Peak on-state voltage drop
$V_{TO}$	On state threshold voltage
$R_d$	On state dynamic resistance
$I_{DRM} / I_{RRM}$	Maximum forward or reverse leakage current
dV/dt	Critical rate of rise of off-state voltage
(dV/dt) <sub>c</sub>	Critical rate of rise of commutating off-state voltage
(dI/dt) <sub>c</sub>	Critical rate of decrease of commutating on-state current
$V_{CL}$	Clamping voltage
$I_{CL}$	Clamping current

Table 5. Electrical characteristics

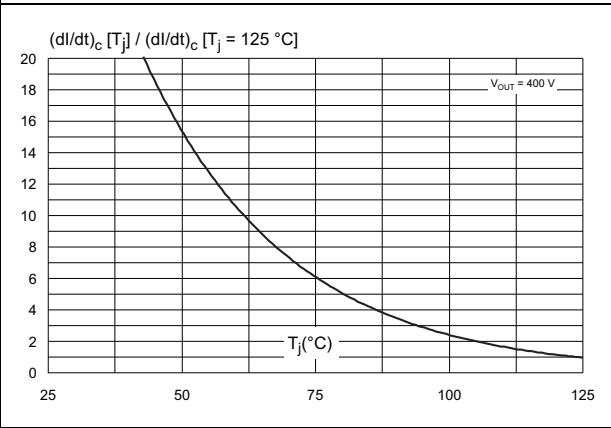
Symbol	Test conditions			Values	Unit	
$I_{GT}$	$V_{OUT} = 12V$ (DC), $R_L = 140 \Omega$	QII -QIII	$T_j = 25^\circ C$	MAX	10	mA
$V_{GT}$	$V_{OUT} = 12V$ (DC), $R_L = 140 \Omega$	QII -QIII	$T_j = 25^\circ C$	MAX	1	V
$V_{GD}$	$V_{OUT} = V_{DRM}$ , $R_L = 3.3 k\Omega$		$T_j = 125^\circ C$	MIN	0.15	V
$I_H$	$I_{OUT} = 100$ mA gate open		$T_j = 25^\circ C$	MAX	45	mA
$I_L$	$I_G = 20$ mA		$T_j = 25^\circ C$	MAX	65	mA
$V_{TM}$	$I_{OUT} = 2.8$ A, $t_p = 380 \mu s$		$T_j = 25^\circ C$	MAX	1.3	V
$V_{TO}$			$T_j = 125^\circ C$	MAX	0.85	V
$R_d$			$T_j = 125^\circ C$	MAX	200	m $\Omega$
$I_{DRM} / I_{RRM}$	$V_{OUT} = 700$ V		$T_j = 25^\circ C$	MAX	2	$\mu A$
			$T_j = 125^\circ C$	MAX	200	
dV/dt	$V_{OUT} = 460$ V gate open		$T_j = 110^\circ C$	MIN	500	V/ $\mu s$
(dI/dt) <sub>c</sub>	(dV/dt) <sub>c</sub> = 20 V/ $\mu s$		$T_j = 125^\circ C$	MIN	1	A/ms
$V_{CL}$	$I_{CL} = 1$ mA, $t_p = 1$ ms		$T_j = 25^\circ C$	TYP	1100	V



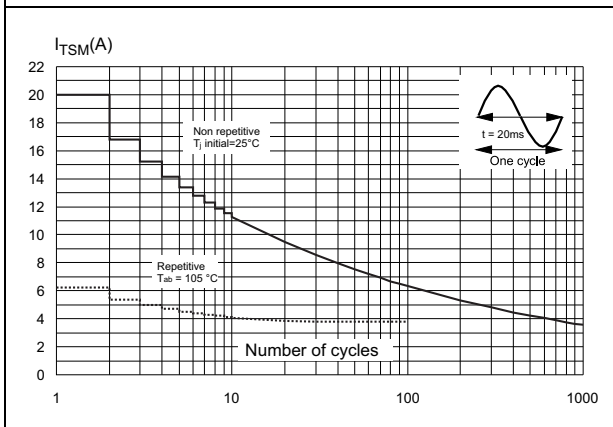
**Figure 8. Relative variation of critical rate of decrease of main current versus reappplied dV/dt (typical values)**



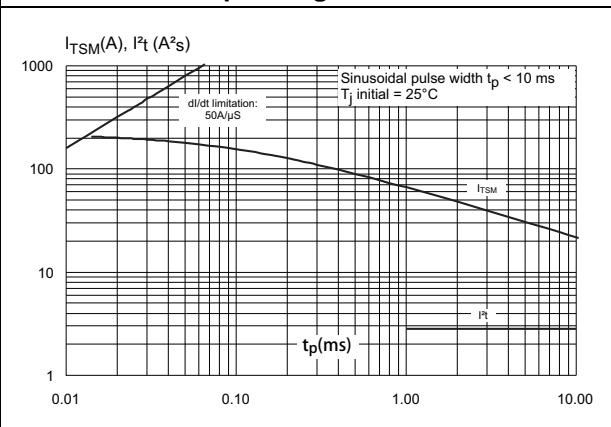
**Figure 9. Relative variation of critical rate of decrease of main current versus junction temperature**



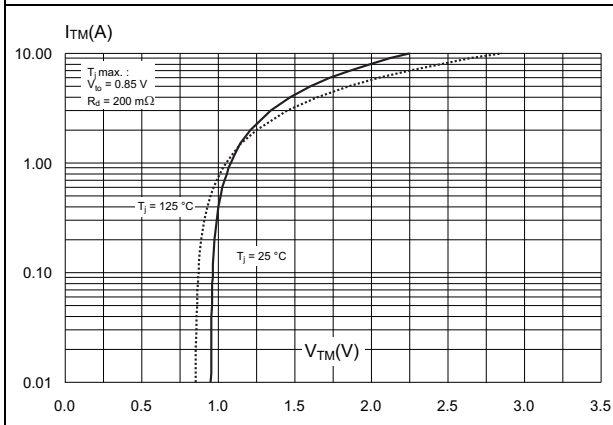
**Figure 10. Surge peak on-state current versus number of cycles**



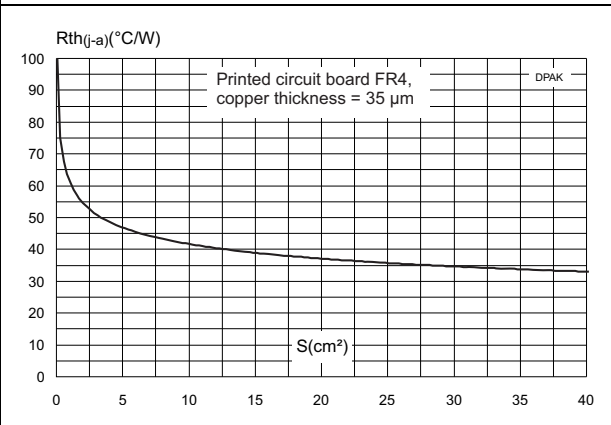
**Figure 11. Non repetitive surge peak on-state current and corresponding value of I²t**



**Figure 12. On-state characteristics (maximum values)**



**Figure 13. Thermal resistance junction to ambient versus copper surface under tab**



## 2 AC line switch basic application

The ACS120 device is well adapted to washing machine, dishwasher, tumble drier, refrigerator, air-conditioning systems, and cookware. It has been designed especially to switch on and off low power loads such as solenoid, valve, relay, dispenser, micro-motor, pump, fan and defrost heaters.

This AC switch is triggered by a negative gate current flowing out of the gate pin G. It can be driven directly by the digital MCU through a resistor as shown on the typical application diagram.

Thanks to its thermal and turn off commutation performances, the ACS120 switch can drive, with no additional turn off snubber, an inductive load up to 2 A.

Figure 14. Typical application diagram

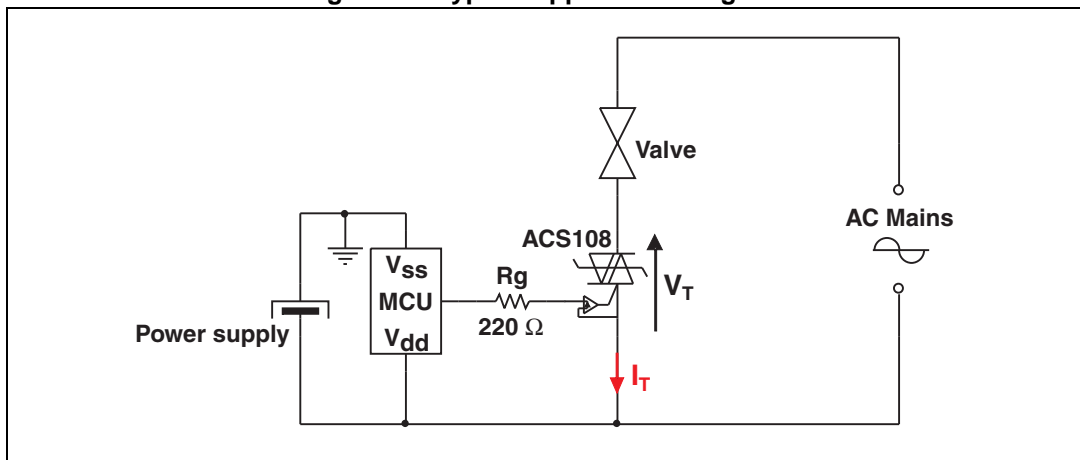


Figure 15. Turn-off operation of the ACS120 switch with an electro-valve

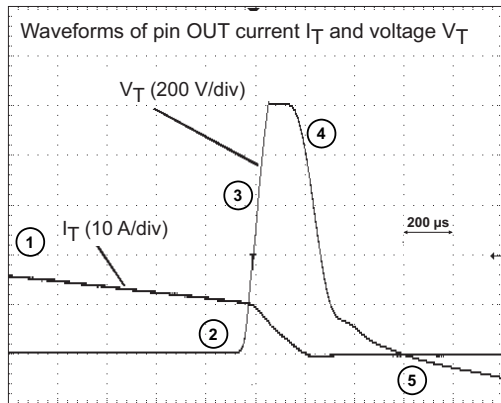


Figure 16. ACS120 switch static characteristic

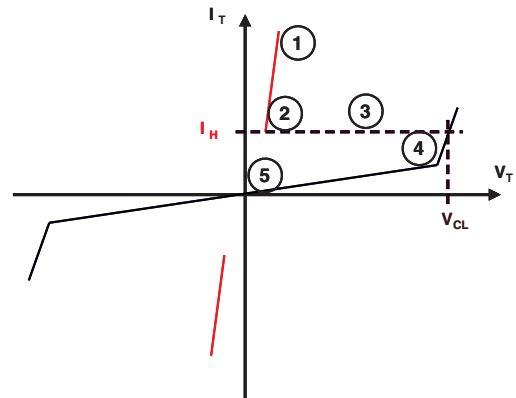


Figure 17. Overvoltage ruggedness test circuit for resistive and inductive loads

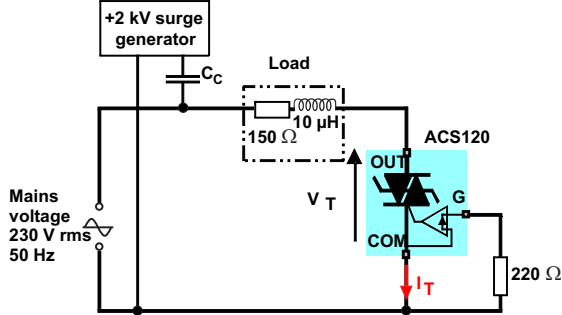
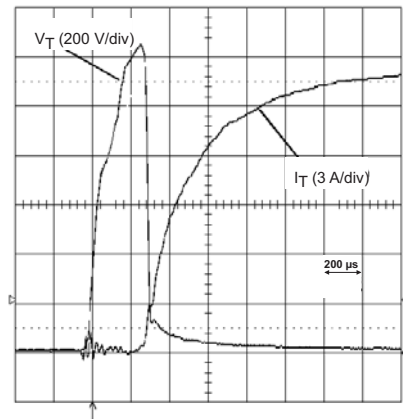


Figure 18. Current and Voltage of the ACS120 during IEC 61000-4-5 standard test with R, L and  $V_{PP}$



### 3 Package information

- Epoxy meets UL94, V0
- Lead-free package
- 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.

Figure 19. TO-220FPAB dimension definitions

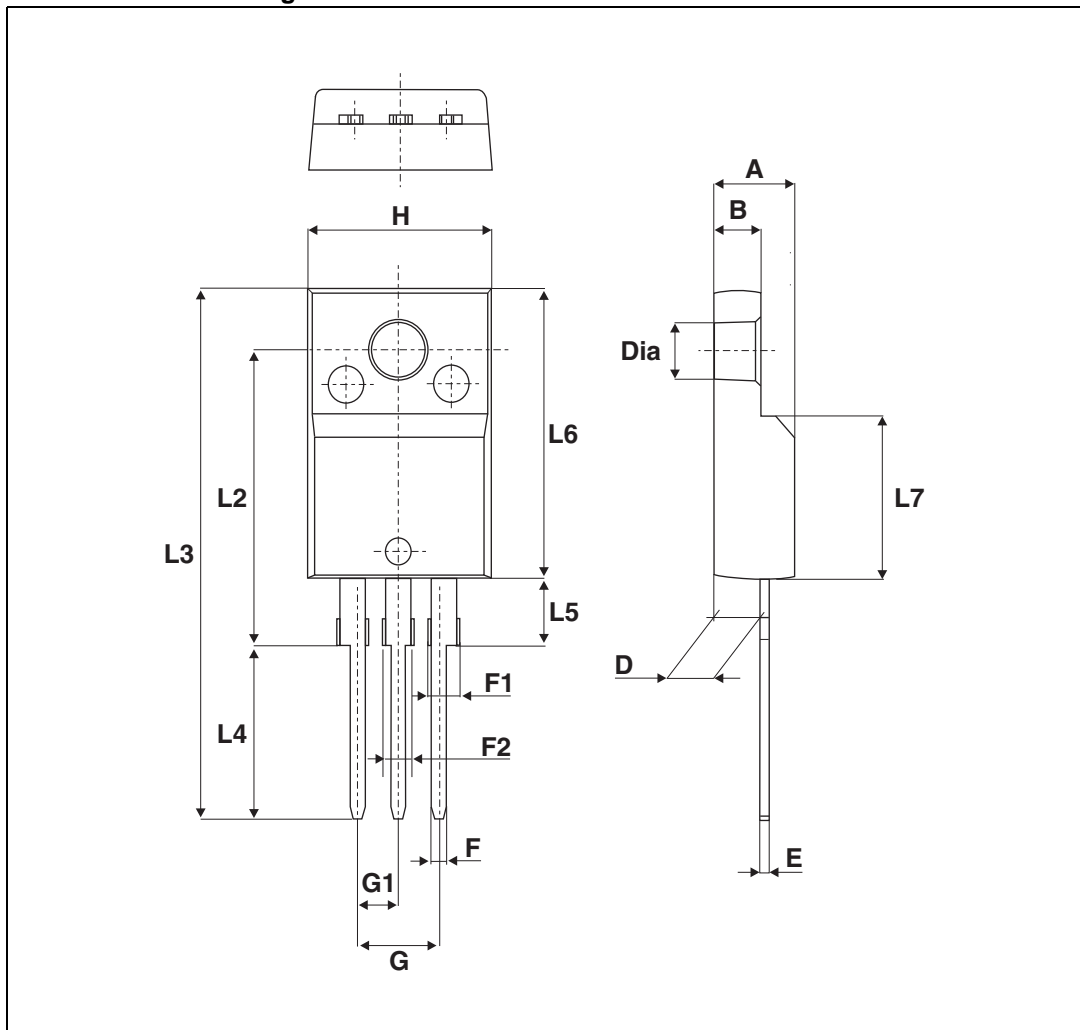
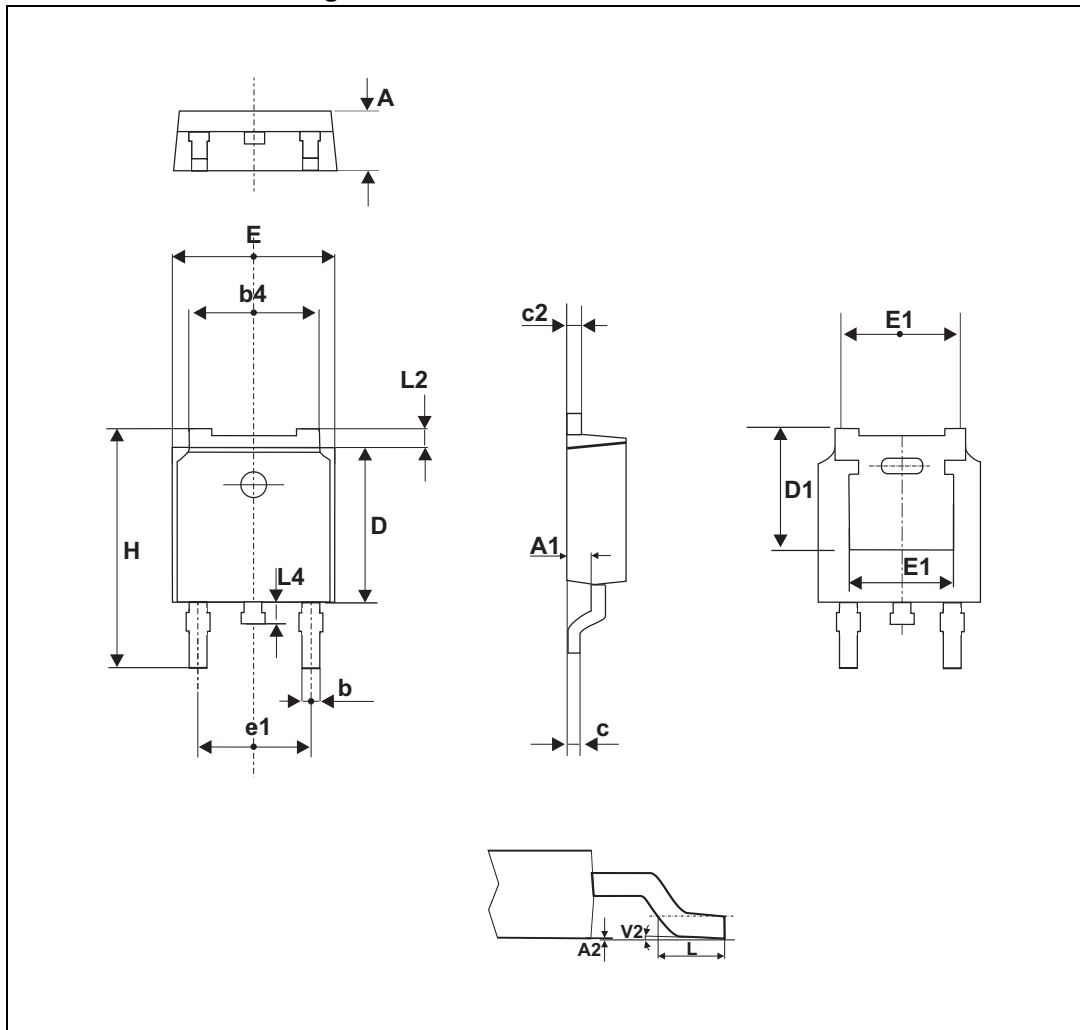




Table 6. TO-220FPAB dimension values

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	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		1.70	0.045		0.067
F2	1.15		1.70	0.045		0.067
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			0.63	
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
Dia.	3.00		3.20	0.118		0.126

Figure 20. DPAK dimension definitions



Note: This package drawing may slightly differ from the physical package. However, all the specified dimensions are guaranteed.

Table 7. DPAK dimension values

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	2.18		2.40	0.086		0.094
A1	0.90		1.10	0.035		0.043
A2	0.03		0.23	0.001		0.009
b	0.64		0.90	0.025		0.035
b4	4.95		5.46	0.195		0.215
c	0.46		0.61	0.018		0.024
c2	0.46		0.60	0.018		0.023
D	5.97		6.22	0.235		0.244
D1	5.10			0.201		
E	6.35		6.73	0.250		0.264
E1		4.32			0.170	
e1	4.40		4.70	0.173		0.185
H	9.35		10.40	0.368		0.409
L	1.00		1.78	0.039		0.070
L2			1.27			0.05
L4	0.60		1.02	0.023		0.040
V2	0°		8°	0°		8°

Figure 21. Footprint (dimensions in mm)

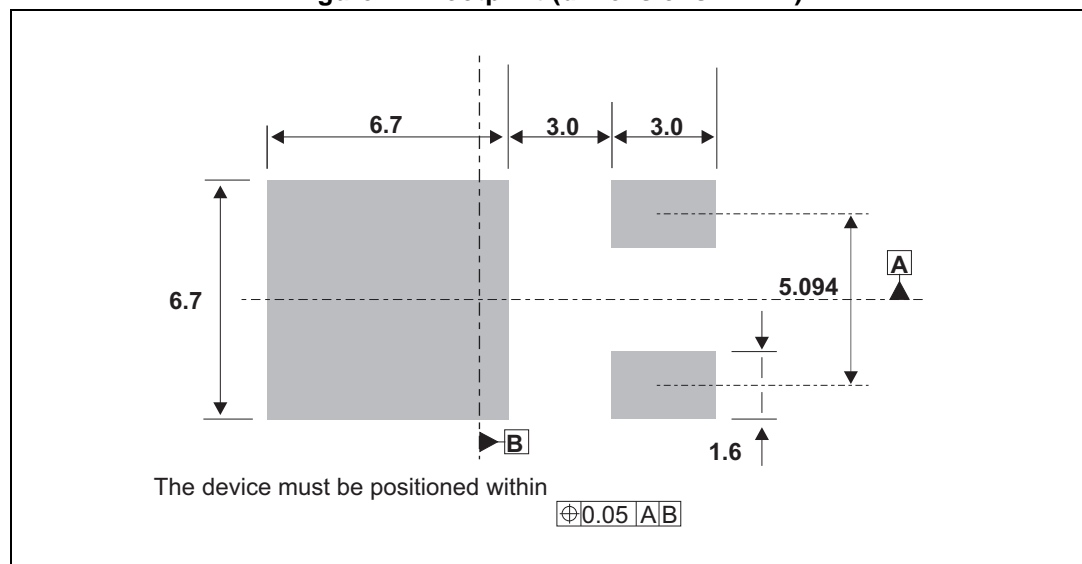


Figure 22. TO-220AB dimension definitions

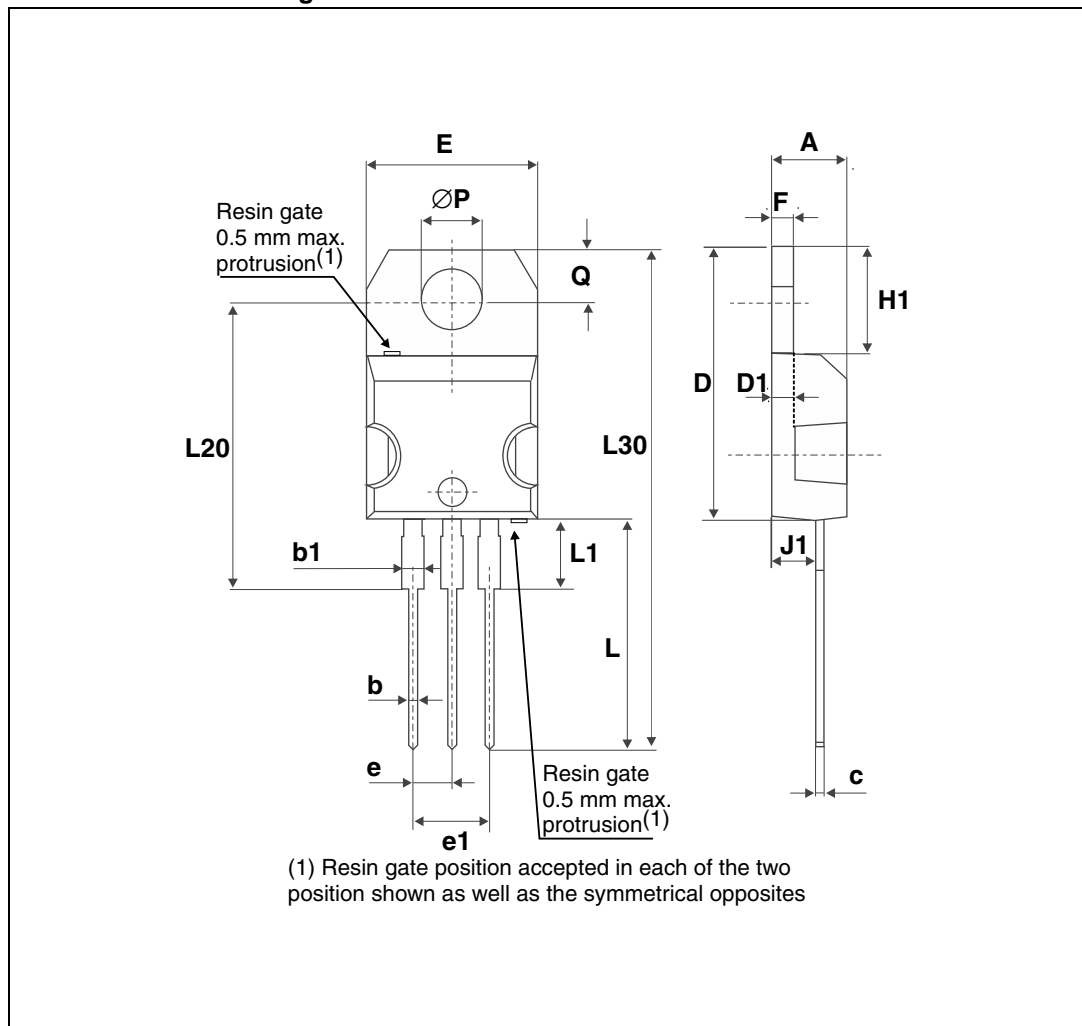


Table 8. TO-220AB dimension values

Ref.	Dimensions			
	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	4.40	4.60	0.17	0.18
b	0.61	0.88	0.024	0.035
b1	1.14	1.70	0.045	0.067
c	0.48	0.70	0.019	0.027
D	15.25	15.75	0.60	0.62
D1	1.27 typ.		0.05 typ.	
E	10	10.40	0.39	0.41
e	2.40	2.70	0.094	0.106
e1	4.95	5.15	0.19	0.20
F	1.23	1.32	0.048	0.052
H1	6.20	6.60	0.24	0.26
J1	2.40	2.72	0.094	0.107
L	13	14	0.51	0.55
L1	3.50	3.93	0.137	0.154
L20	16.40 typ.		0.64 typ.	
L30	28.90 typ.		1.13 typ.	
∅P	3.75	3.85	0.147	0.151
Q	2.65	2.95	0.104	0.116

## 4 Ordering information

Figure 23. Ordering information scheme

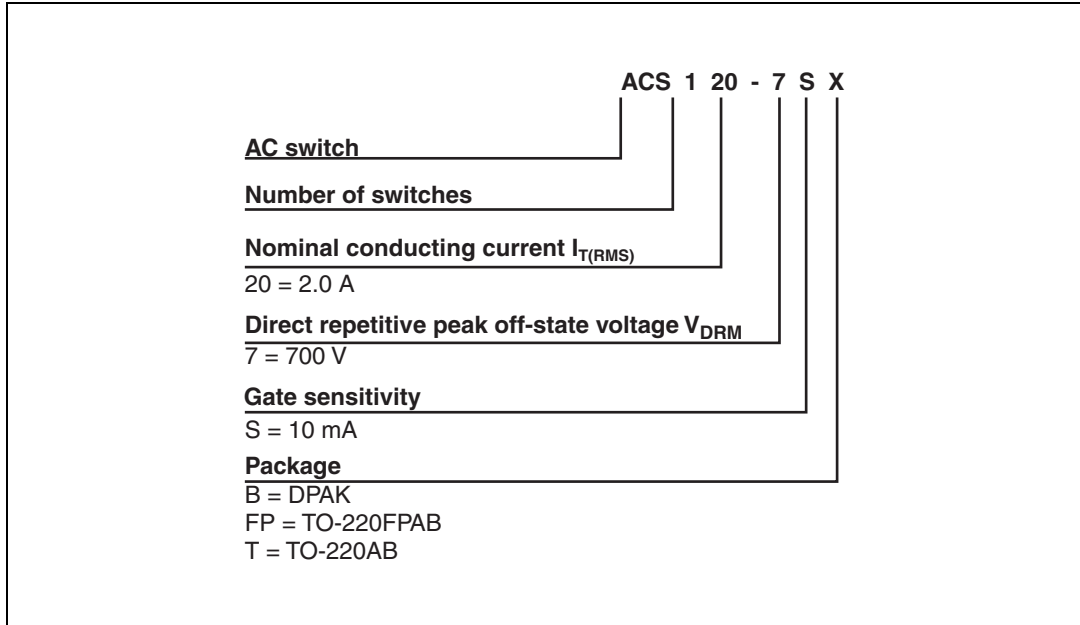


Table 9. Ordering information

Order code	Marking	Package	Weight	Base Qty	Packing mode
ACS120-7SB	ACS1207S	DPAK	0.3 g	75	Tube
ACS120-7SB-TR	ACS1207S	DPAK	0.3 g	2500	Tape and reel
ACS120-7SFP	ACS1207S	TO-220FPAB	2.4 g	50	Tube
ACS120-7ST	ACS1207S	TO-220AB	2.3 g	250	Bulk

## 5 Revision history

**Table 10. Document revision history**

Date	Revision	Changes
Apr-2004	1	Previous release.
28-Jan-2011	2	Added ECOPACK statement. Updated $T_c$ values in <a href="#">Table 1</a> .
28-May-2014	3	Updated DPAK package information and reformatted to current standard.

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