



# ACS120-7SB/SFP/ST

## ASD™ AC Switch Family

## AC LINE SWITCH

### MAIN 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

### FEATURES

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

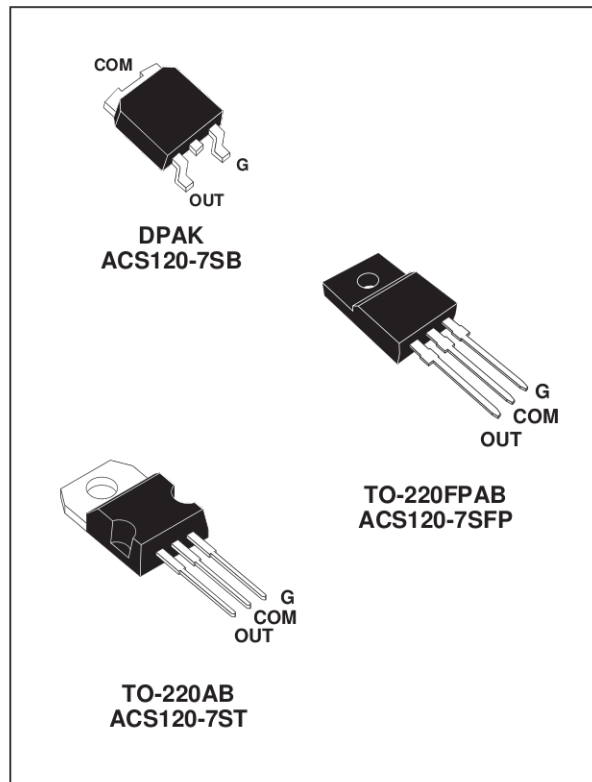
### BENEFITS

- 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 microcontroller
- Eliminates any gate kick back on the microcontroller
- Allows straightforward connection of several ACS™ on same cooling pad.

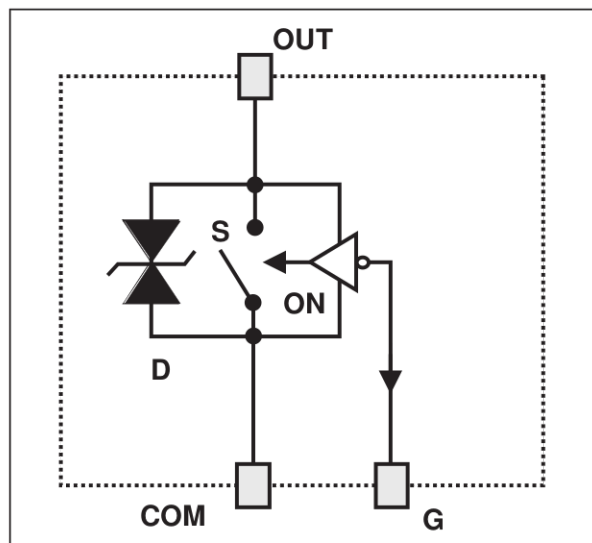
### DESCRIPTION

The ACS120 belongs to the AC line switch family built around the ASD™ concept. This high performance switch circuit is able to control a load up to 2 A.

The ACS™ 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.



### FUNCTIONAL DIAGRAM



## ACS120-7SB/SFP/ST

### 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  |                       | $T_j = -10\text{ °C}$<br>700 | V                   |
| $I_{T(RMS)}$        | RMS on-state current full cycle sine wave 50 to 60 Hz  | DPAK                  | $T_c = 115\text{ °C}$<br>2   | A                   |
|                     |  | TO-220FPAB            | $T_c = \text{ °C}$           |                     |
|                     |  | TO-220AB              | $T_c = 115\text{ °C}$        |                     |
| $I_{TSM}$           | Non repetitive surge peak on-state current<br>$T_j$ initial = 25°C, full cycle sine wave         | $F = 50\text{ Hz}$    | 20                           | A                   |
|                     |  | $F = 60\text{ Hz}$    | 11                           | A                   |
| $I^2t$              | Fusing capability  |                       | $t_p = 10\text{ ms}$         | A <sup>2</sup> s    |
| $di/dt$             | Repetitive on-state current critical rate of rise $I_G = 10\text{ mA}$ ( $t_r < 100\text{ ns}$ ) | $T_j = 125\text{ °C}$ | $F = 120\text{ Hz}$<br>50    | A/ $\mu\text{s}$    |
| $V_{PP}$            | Non repetitive line peak pulse voltage   |                       | note 1<br>2                  | kV                  |
| $T_{stg}$           | Storage temperature range  |                       |                              | - 40 to + 150<br>°C |
| $T_j$               | Operating junction temperature range   |                       |                              | - 30 to + 125<br>°C |
| $T_I$               | Maximum lead soldering temperature during 10s  |                       |                              | 260<br>°C           |

Note 1: according to test described by IEC61000-4-5 standard & Figure 3.

### GATE CHARACTERISTICS (maximum values)

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

### THERMAL RESISTANCES

| Symbol        | Parameter  |                              | Value | Unit |
|---------------|--|------------------------------|-------|------|
| $R_{th(j-a)}$ | Junction to ambient                                      | $S = 0.5\text{ cm}^2$   DPAK | 70    | °C/W |
|               |  | TO-220FPAB                   | 60    | °C/W |
|               |  | TO-220AB                     | 60    | °C/W |
| $R_{th(j-l)}$ | 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 |

S = Copper surface under Tab

## 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                |
| $(dV/dt)_c$         | Critical rate of rise of commutating off-state voltage    |
| $(dI/dt)_c$         | Critical rate of decrease of commutating on-state current |
| $V_{CL}$            | Clamping voltage  |
| $I_{CL}$            | Clamping current  |

## ELECTRICAL CHARACTERISTICS

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

| 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          |
| $V_{GD}$            | $V_{OUT}=V_{DRM}$ $R_L=3.3k\Omega$ |                 |            | $T_j=125^\circ C$ | MIN    | 0.15 | V          |
| $I_H$               | $I_{OUT}=100mA$ gate open          |                 |            | $T_j=25^\circ C$  | MAX    | 45   | mA         |
| $I_L$               | $I_G=20mA$                         |                 |            | $T_j=25^\circ C$  | MAX    | 65   | mA         |
| $V_{TM}$            | $I_{OUT}=2.8A$ $t_p=380\mu s$      |                 |            | $T_j=25^\circ C$  | 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 $\Omega$ |
| $I_{DRM} / I_{RRM}$ | $V_{OUT}=700V$                     |                 |            | $T_j=25^\circ C$  | MAX    | 2    | $\mu A$    |
|                     |                                    |                 |            | $T_j=125^\circ C$ | MAX    | 200  |            |
| $dV/dt$             | $V_{OUT}=460V$ gate open           |                 |            | $T_j=110^\circ C$ | MIN    | 500  | V/ $\mu s$ |
| $(dI/dt)_c$         | $(dV/dt)_c=20V/\mu s$              |                 |            | $T_j=125^\circ C$ | MIN    | 1    | A/ms       |
| $V_{CL}$            | $I_{CL}=1mA$ $t_p=1ms$             |                 |            | $T_j=25^\circ C$  | TYP    | 1100 | V          |

## ACS120-7SB/SFP/ST

### 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 & off low power loads such as solenoid, valve, relay, dispenser, micro-motor, pump, fan and defrost heaters.

Pin COM: Common drive reference to connect to the power line neutral

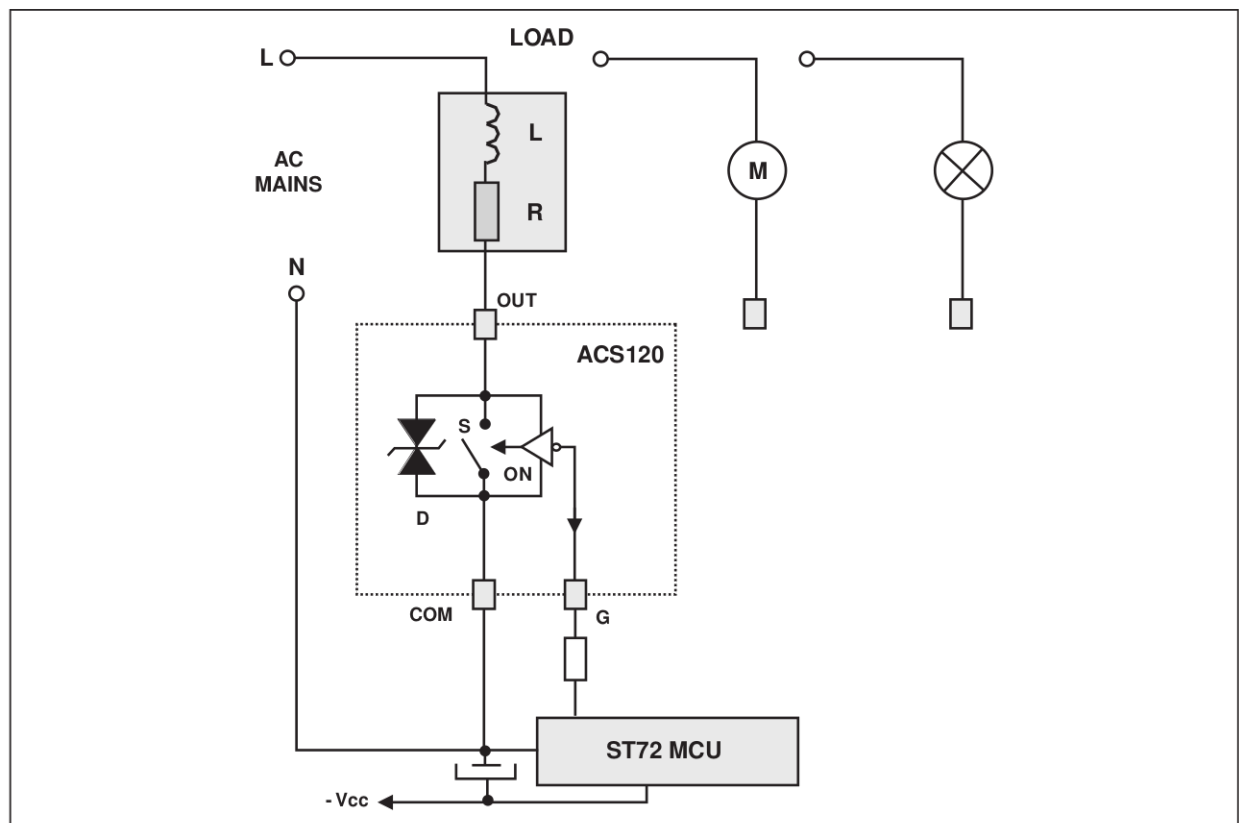
Pin G: Switch Gate input to connect to the digital controller

Pin OUT: Switch Output to connect to the load

This ACS™ switch 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.

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

### TYPICAL APPLICATION DIAGRAM

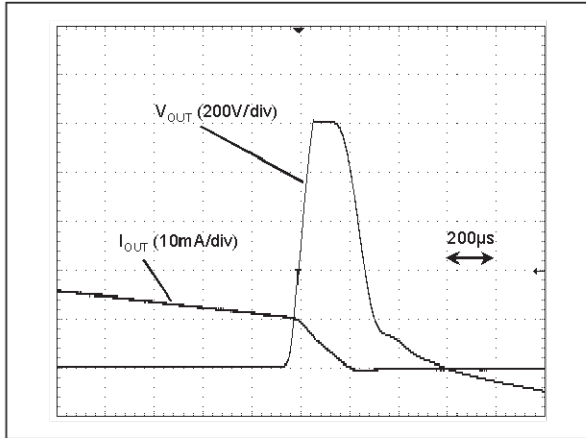


### HIGH INDUCTIVE SWITCH-OFF OPERATION

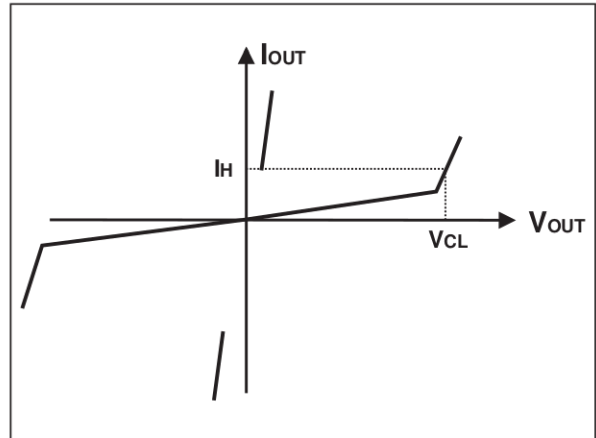
At the end of the last conduction half-cycle, the load current reaches the holding current level  $I_H$ , and the ACS™ switch turns off. Because of the inductance  $L$  of the load, the current flows then through the avalanche diode  $D$  and decreases linearly to zero. During this time, the voltage 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  $I_H$  and the inductance (up to 10 H); it can reach about 10 mJ and is dissipated in the clamping diode section. The ACS switch sustains the turn off energy because its clamping section is designed for that purpose.

**Fig. A:** Turn-off operation of the ACS120 switch with an electro-valve: waveform of the pin OUT current  $I_{OUT}$  and voltage  $V_{OUT}$ .



**Fig. B:** ACS120 switch static characteristic.

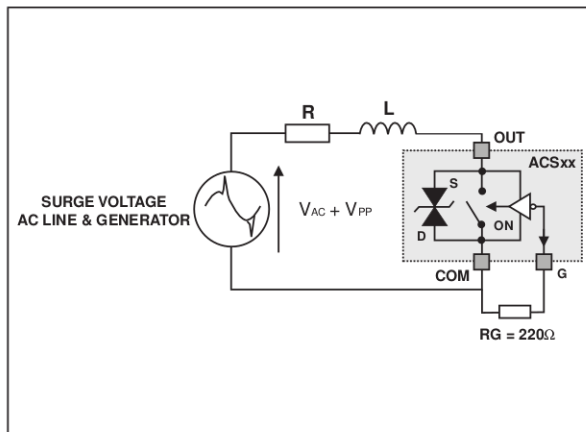


**AC LINE TRANSIENT VOLTAGE RUGGEDNESS**

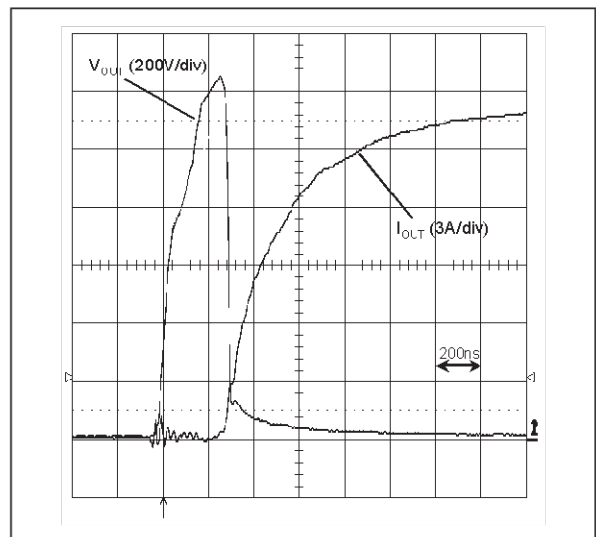
The ACS120 switch is able to sustain safely the AC line transient voltages either by clamping the low energy spikes or by breaking over under high energy shocks, even with high turn-on current rises.

The test circuit of the figure C is representative of the final ACS application and is also used to stress the ACS switch according to the IEC 61000-4-5 standard conditions. Thanks to the load, the ACS switch sustains 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 on figure D. Such non repetitive test can be done 10 times on each AC line voltage polarity.

**Fig. C:** Overvoltage ruggedness test circuit for resistive and inductive loads according to IEC61000-4-5 standards.  
 $R = 150\Omega$ ,  $L = 10\mu H$ ,  $V_{PP} = 2kV$ .



**Fig. D:** Current and Voltage of the ACS120 during IEC61000-4-5 standard test with  $R$ ,  $L$  &  $V_{PP}$ .



**OTHER FIGURES**

Maximum power dissipation vs RMS on state current.

RMS on-state current vs ambient temperature, case temperature

Relative variation of thermal impedance junction to ambient vs pulse duration and package

Relative variation of gate trigger current vs junction temperature

Relative variation of holding, latching and gate current vs junction

Relative variation of  $dV/dt$  vs  $T_j$

Relative variation of  $(dV/dt)_c$  vs  $(di/dt)_c$

Surge peak on-state current vs number of cycles

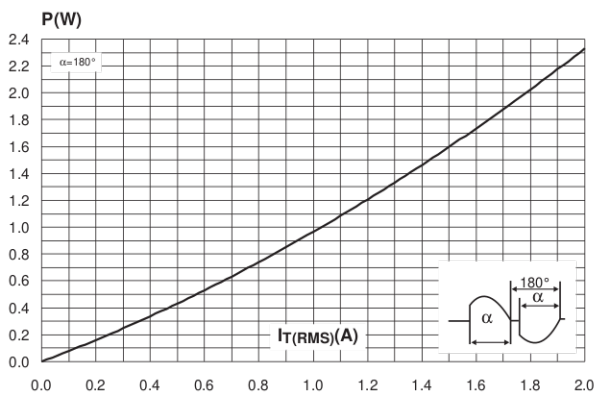
Non repetitive surge peak on-state current for a sinusoidal pulse with  $t_p < 10ms$ , and corresponding of  $I_T^2t$ .

On-state characteristics (maximal values)

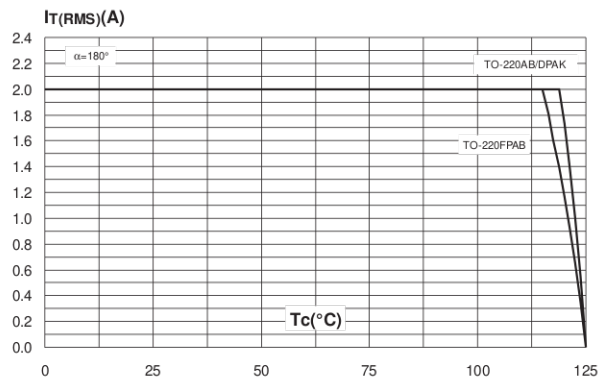
Thermal resistance junction to ambient vs copper surface under tab (DPAK)

Relative variation of critical  $(di/dt)_c$  vs junction temperature

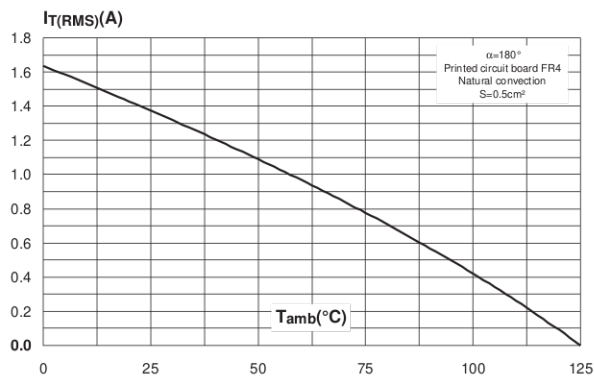
**Fig. 1:** Maximum power dissipation versus RMS on-state current.



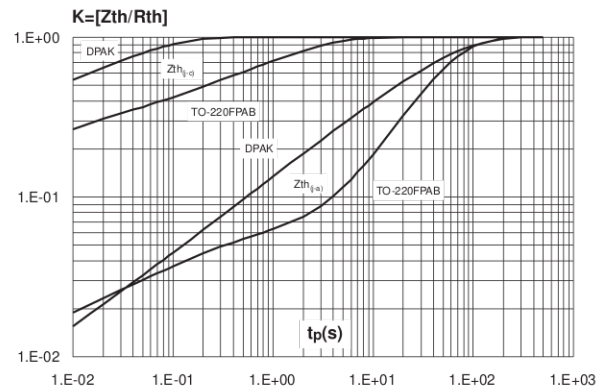
**Fig. 2-1:** RMS on-state current versus case temperature.



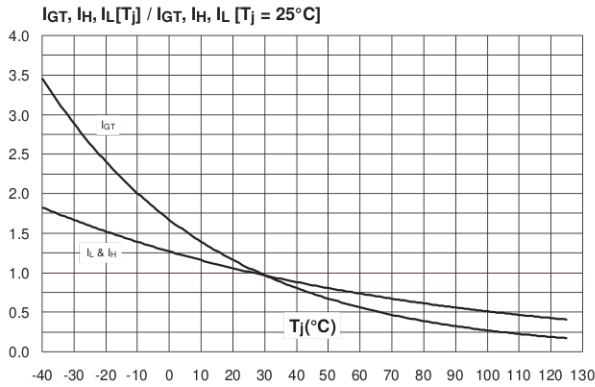
**Fig. 2-2:** RMS on-state current versus ambient temperature.



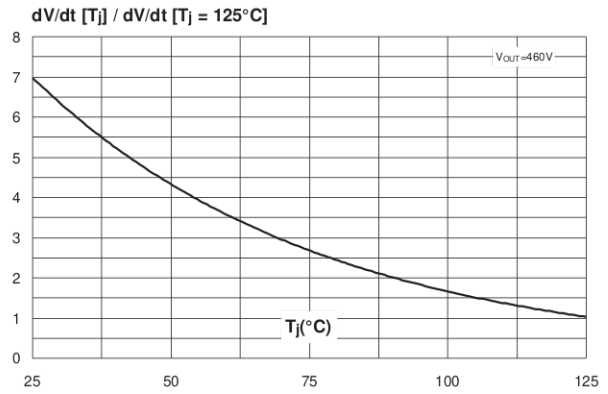
**Fig. 3:** Relative variation of thermal impedance versus pulse duration.



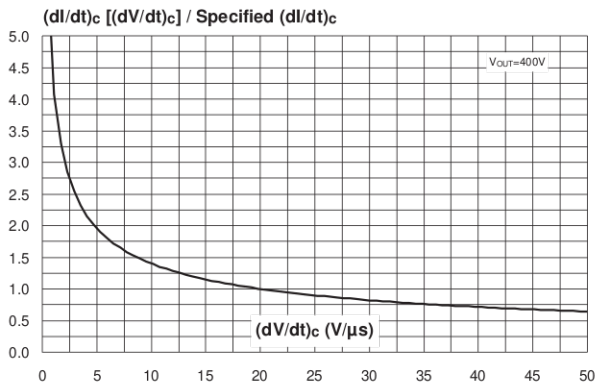
**Fig. 4:** Relative variation of gate trigger current, holding current and latching versus junction temperature (typical values).



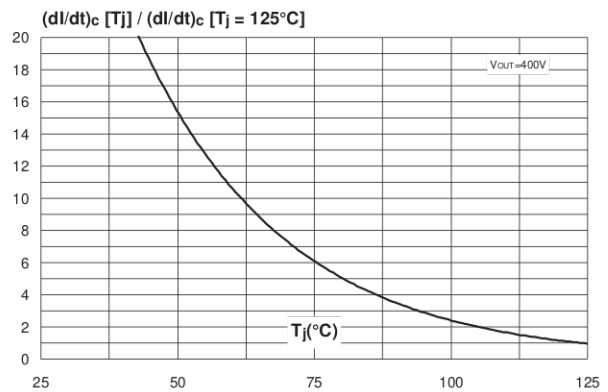
**Fig. 5:** Relative variation of static dV/dt versus junction temperature.



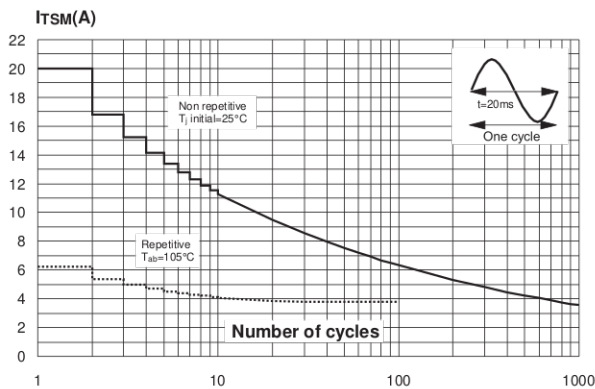
**Fig. 6:** Relative variation of critical rate of decrease of main current versus reapplied dV/dt (typical values).



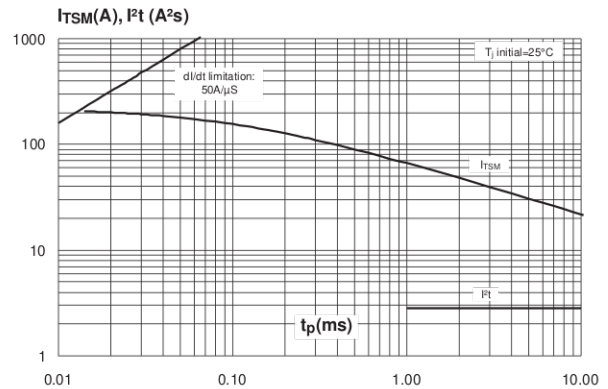
**Fig. 7:** Relative variation of critical rate of decrease of main current versus junction temperature.



**Fig. 8:** Surge peak on-state current versus number of cycles.

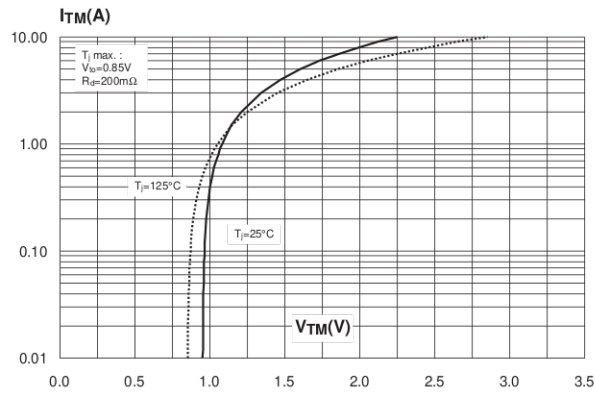


**Fig. 9:** Non repetitive surge peak on-state current for a sinusoidal pulse with width  $t_p < 10\text{ms}$ , and corresponding value of  $I^2t$ .

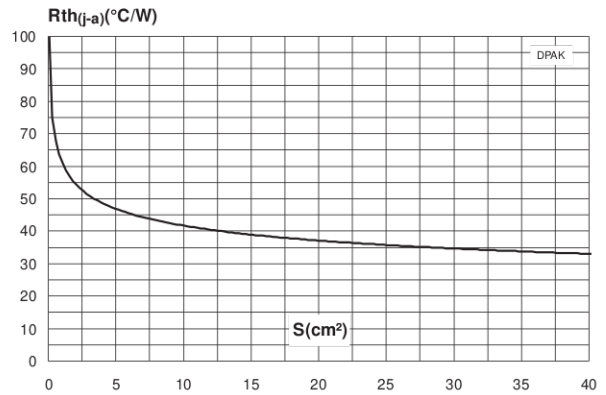


# ACS120-7SB/SFP/ST

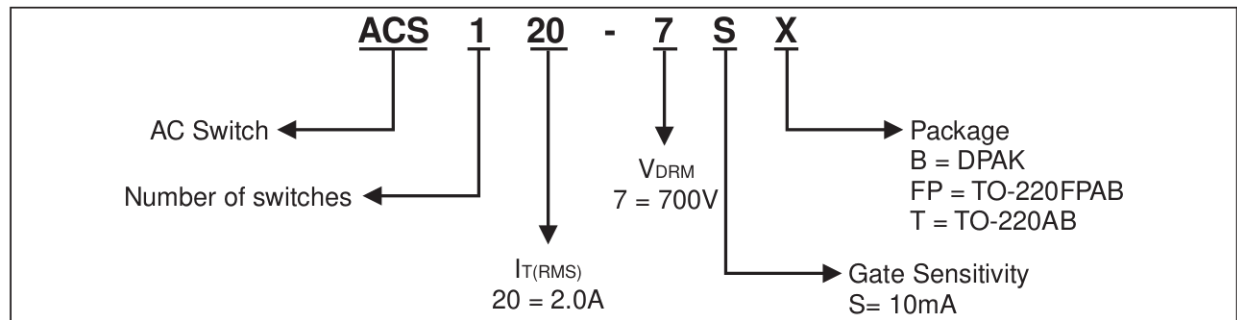
**Fig. 10:** On-state characteristics (maximum values).



**Fig. 11:** Thermal resistance junction to ambient versus copper surface under tab (printed circuit board FR4, copper thickness: 35µm)

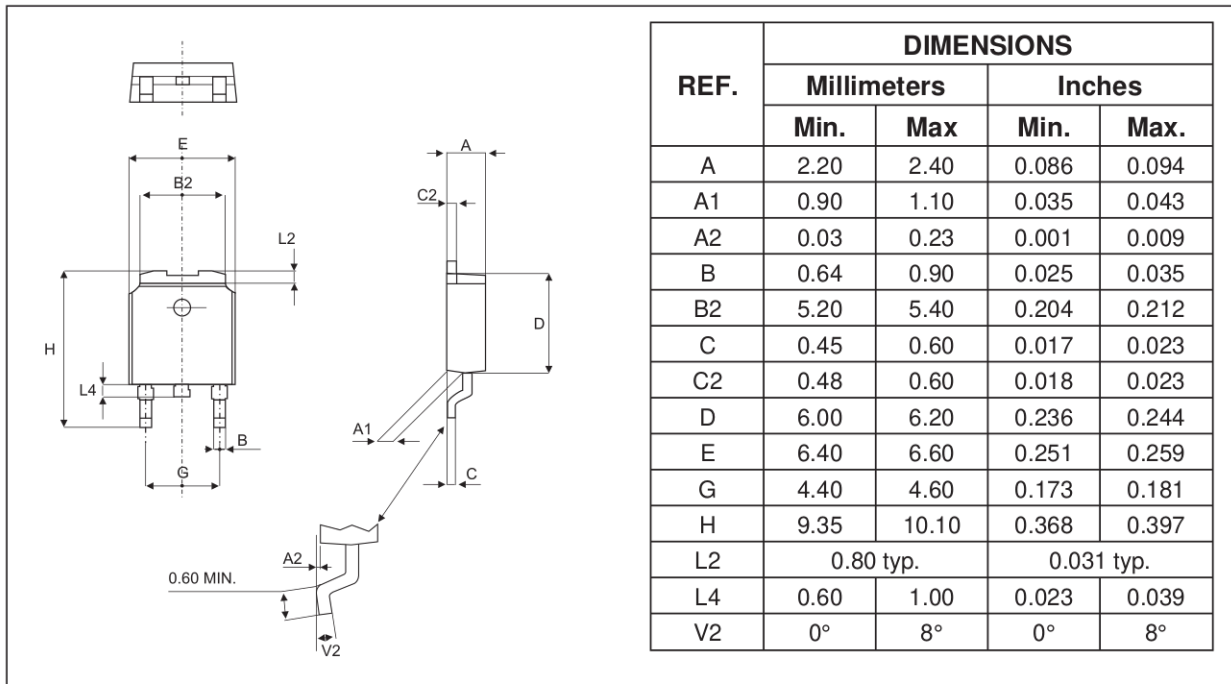


## ORDERING INFORMATION

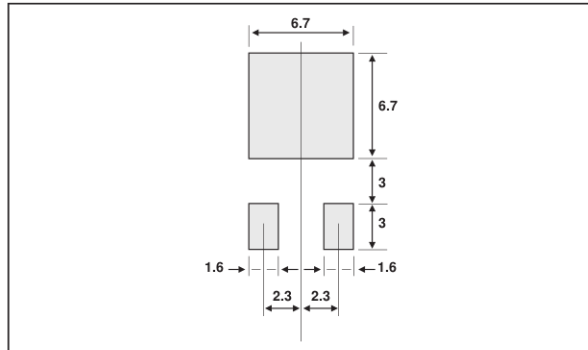




**PACKAGE OUTLINE MECHANICAL DATA**  
DPAK

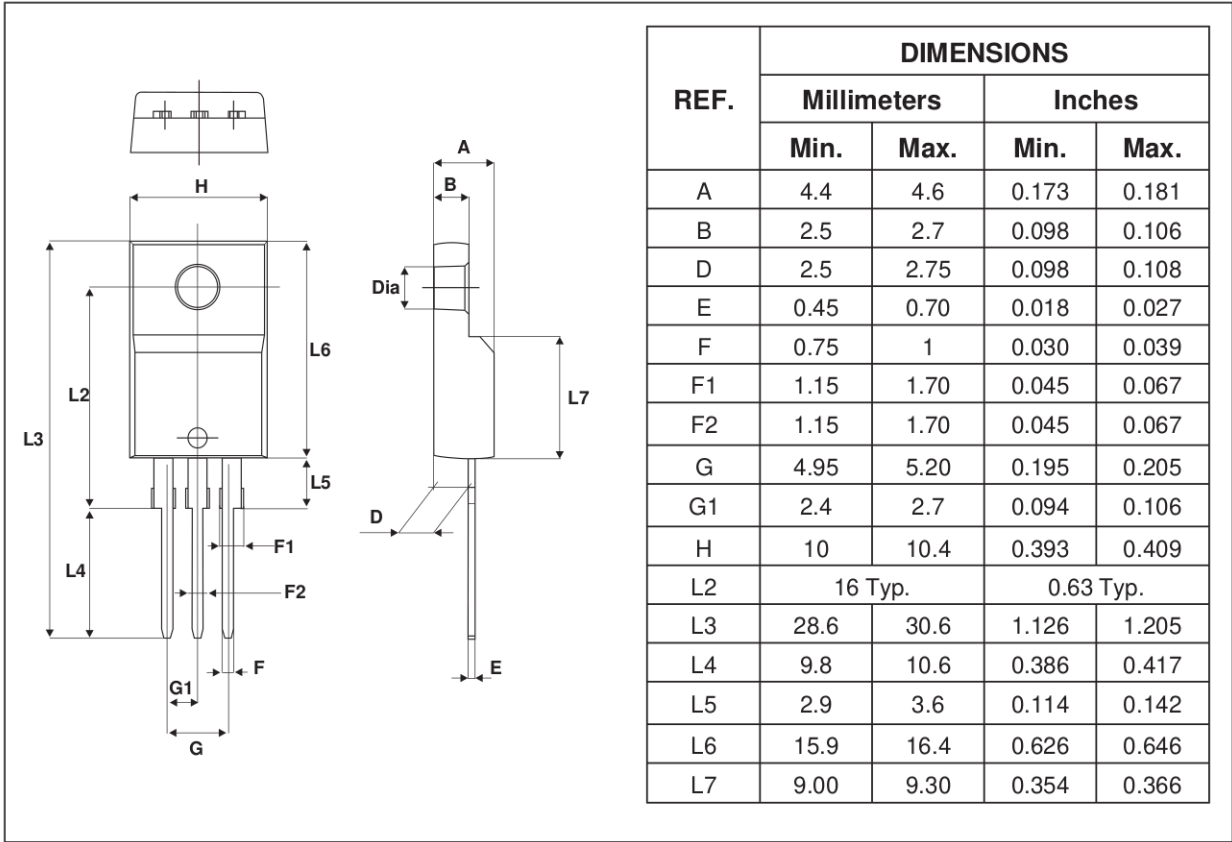


**FOOT PRINT**  
DPAK

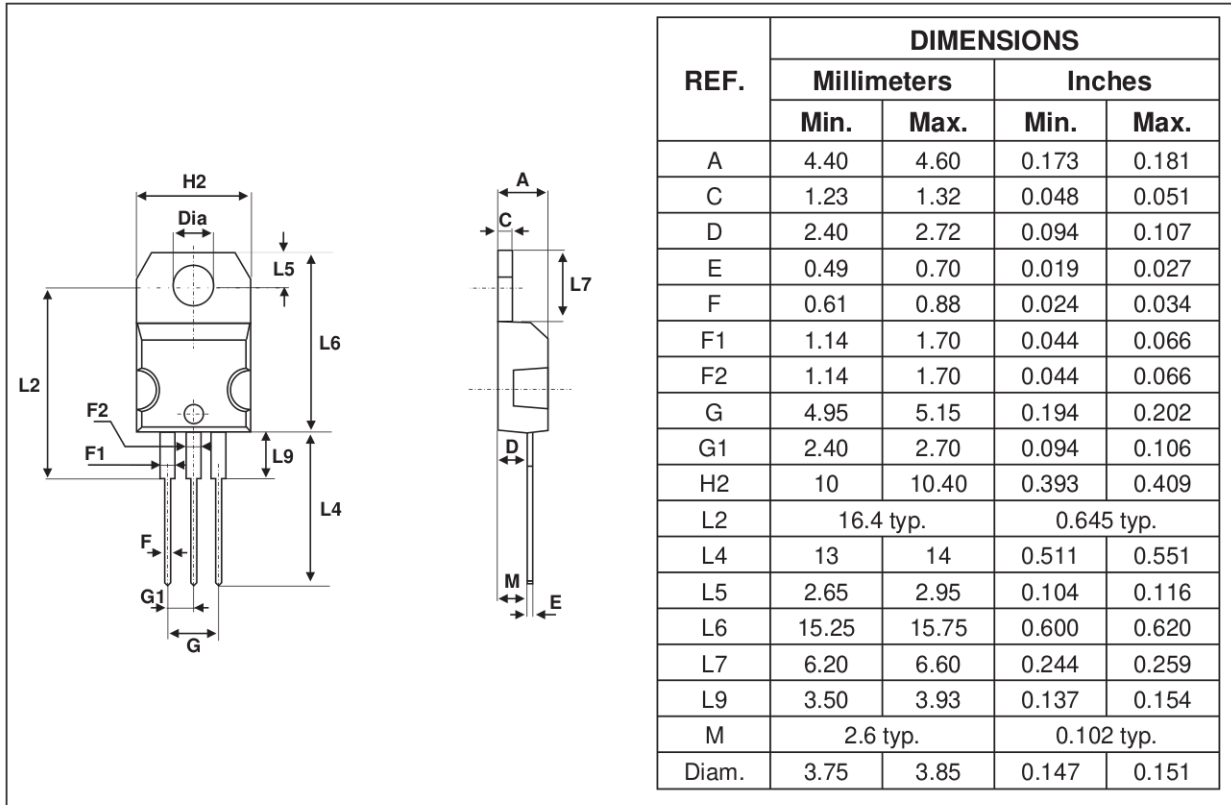


**ACS120-7SB/SFP/ST**

**PACKAGE OUTLINE MECHANICAL DATA**  
TO-220FPAB



**PACKAGE OUTLINE MECHANICAL DATA**  
TO-220AB



**OTHER INFORMATION**

| Ordering type | Marking  | Package    | Weight | Base qty | Delivery mode |
|---------------|----------|------------|--------|----------|---------------|
| ACS120-7SB    | ACS1207S | DPAK       | 0.3 g  | 75       | Tube          |
| ACS120-7SB-TR | ACS1207S | DPAK       | 0.3 g  | 2500     | Tape & reel   |
| ACS120-7SFP   | ACS1207S | TO-220FPAB | 2.4 g  | 50       | Tube          |
| ACS120-7ST    | ACS1207S | TO-220AB   | 2.3 g  | 250      | Bulk          |

- Epoxy meets UL94,V0

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