

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.

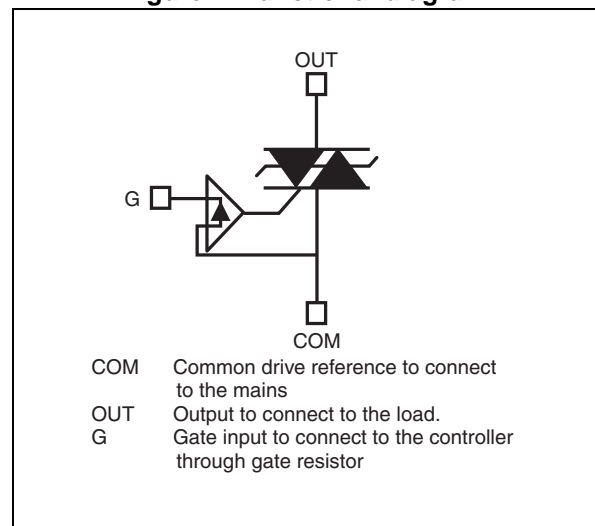
Features

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

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 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 ² 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/ μ s |
| V_{PP} | Non repetitive line peak pulse voltage ⁽¹⁾ | | 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 ² (¹) | 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 |
| $(dV/dt)_c$ | 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 |

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 Ω |
| I_{DRM} / I_{RRM} | $V_{OUT} = 700$ V | | $T_j = 25^\circ C$ | MAX | 2 | μA |
| | | | $T_j = 125^\circ C$ | MAX | 200 | |
| dV/dt | $V_{OUT} = 460$ V gate open | | $T_j = 110^\circ C$ | MIN | 500 | V/ μs |
| $(dI/dt)_c$ | $(dV/dt)_c = 20$ V/ μs | | $T_j = 125^\circ C$ | MIN | 1 | A/ms |
| V_{CL} | $I_{CL} = 1$ mA, $t_p = 1$ ms | | $T_j = 25^\circ C$ | TYP | 1100 | V |

Figure 2. Maximum power dissipation versus rms on-state current

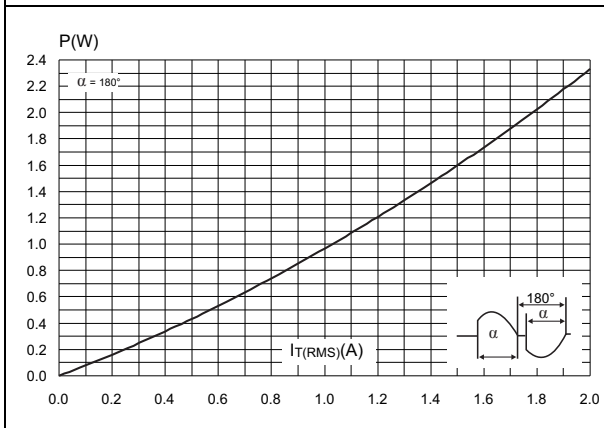


Figure 3. On-state rms current versus ambient temperature

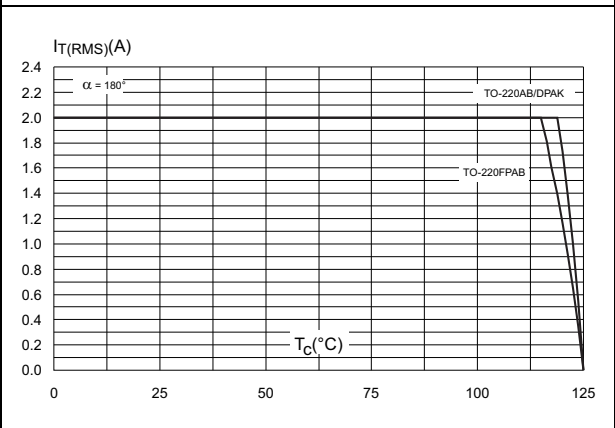


Figure 4. On-state rms current versus ambient temperature

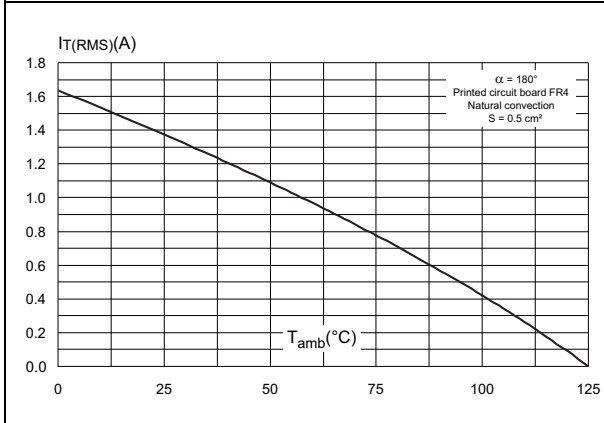


Figure 5. Relative variation of thermal impedance versus pulse duration

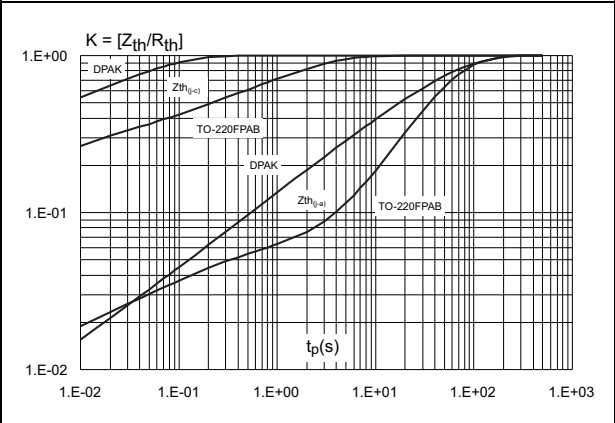


Figure 6. Relative variation of gate trigger, holding and latching versus current junction temperature

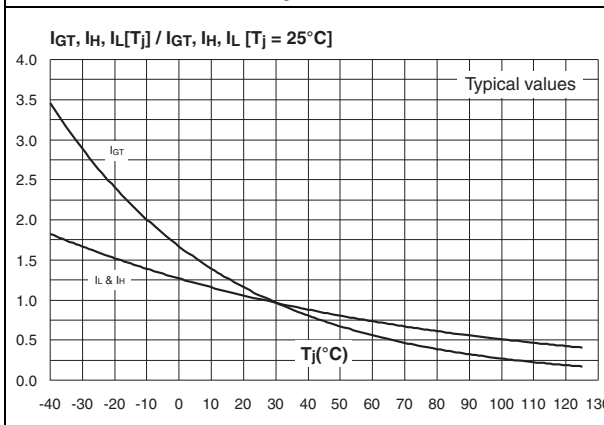


Figure 7. Relative variation of static dV/dt versus junction temperature

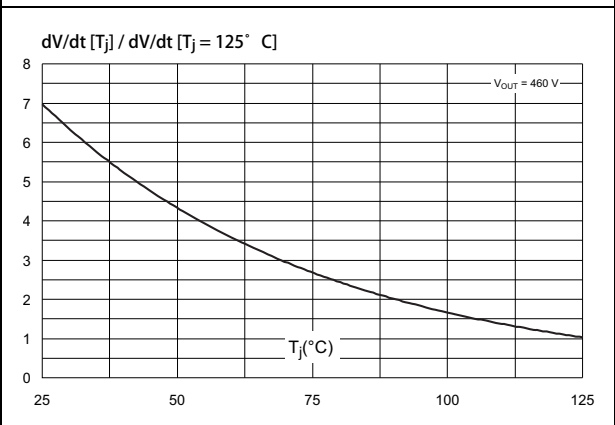


Figure 8. Relative variation of critical rate of decrease of main current versus reappplied dV/dt (typical values)

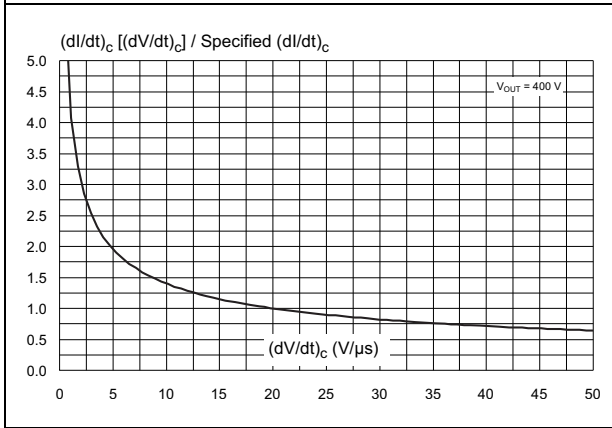


Figure 9. Relative variation of critical rate of decrease of main current versus junction temperature

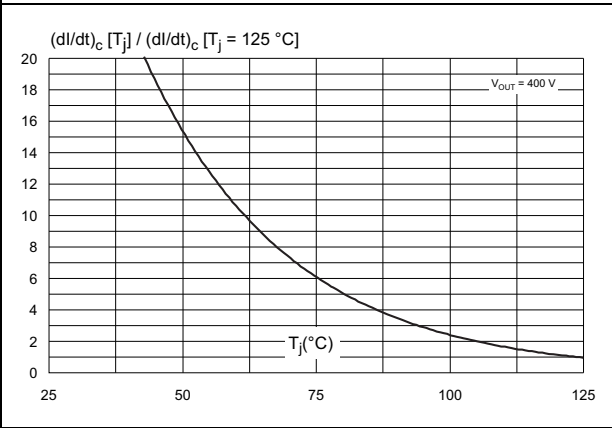


Figure 10. Surge peak on-state current versus number of cycles

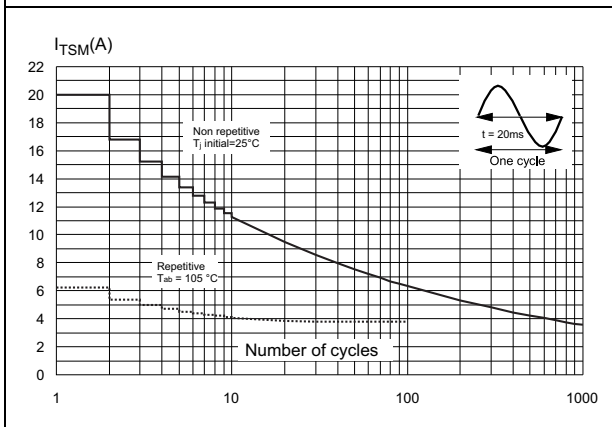


Figure 11. Non repetitive surge peak on-state current and corresponding value of I²t

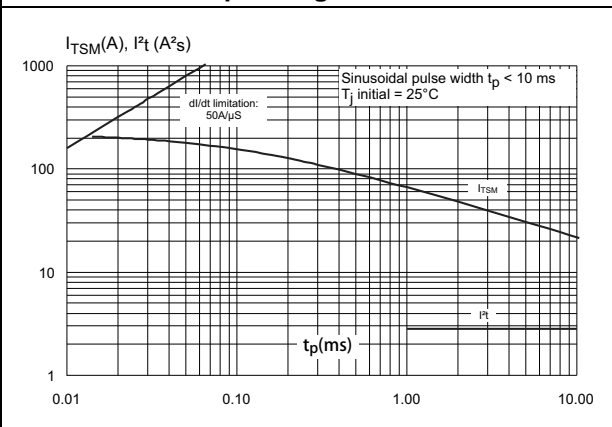


Figure 12. On-state characteristics (maximum values)

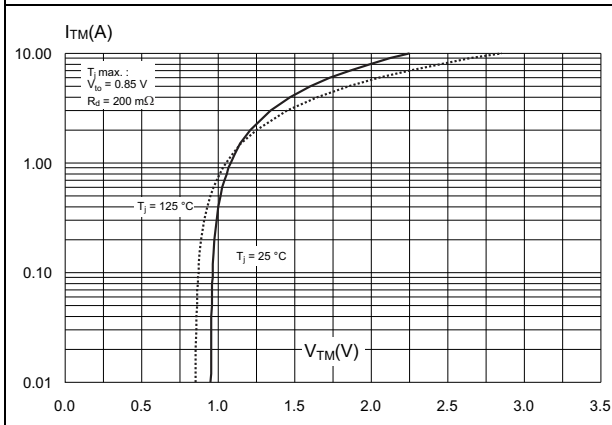
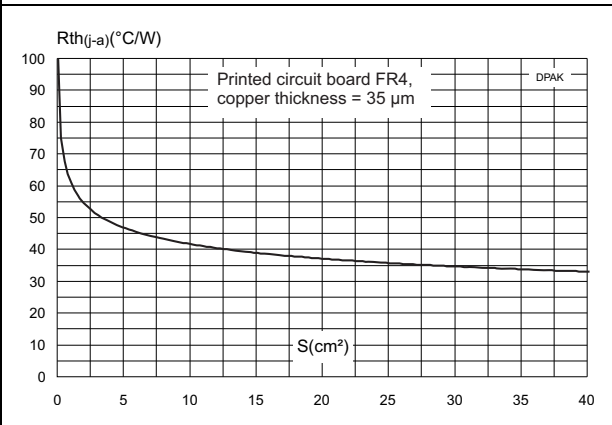


Figure 13. Thermal resistance junction to ambient versus copper surface under tab



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

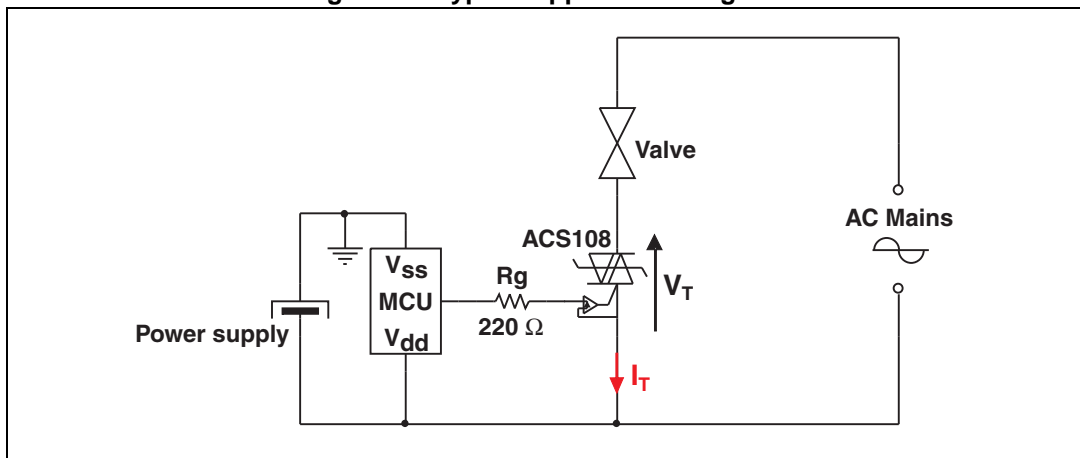


Figure 15. Turn-off operation of the ACS120 switch with an electro-valve

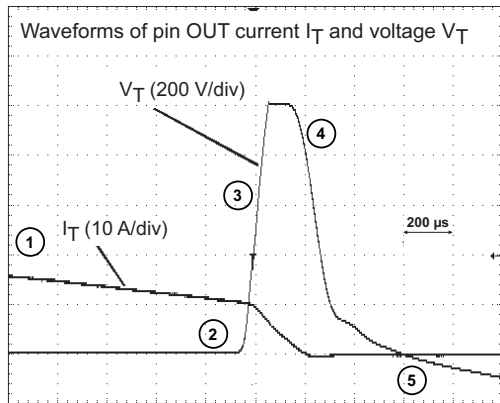


Figure 16. ACS120 switch static characteristic

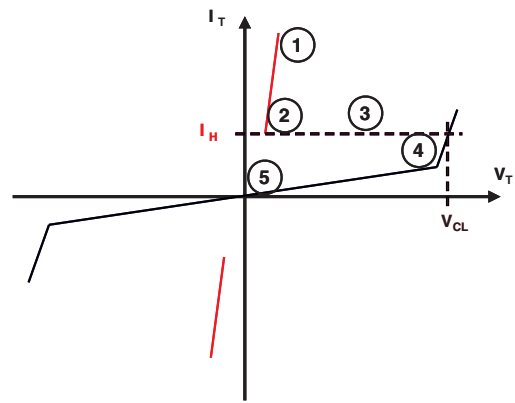


Figure 17. Overvoltage ruggedness test circuit for resistive and inductive loads

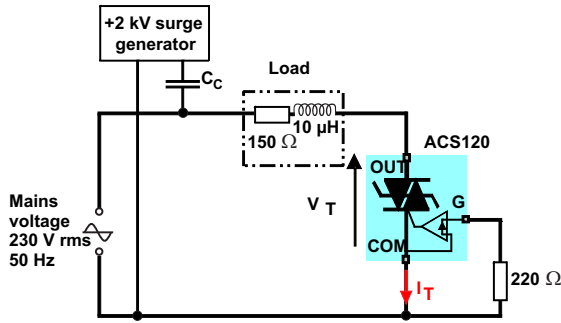
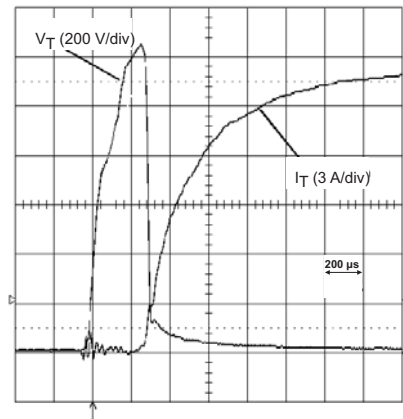


Figure 18. Current and Voltage of the ACS120 during IEC 61000-4-5 standard test with R, L and V_{PP}



3 Package information

- Epoxy meets UL94, V0
- Lead-free package
- Recommended torque: 0.4 to 0.6 N·m

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Figure 19. TO-220FPAB dimension definitions

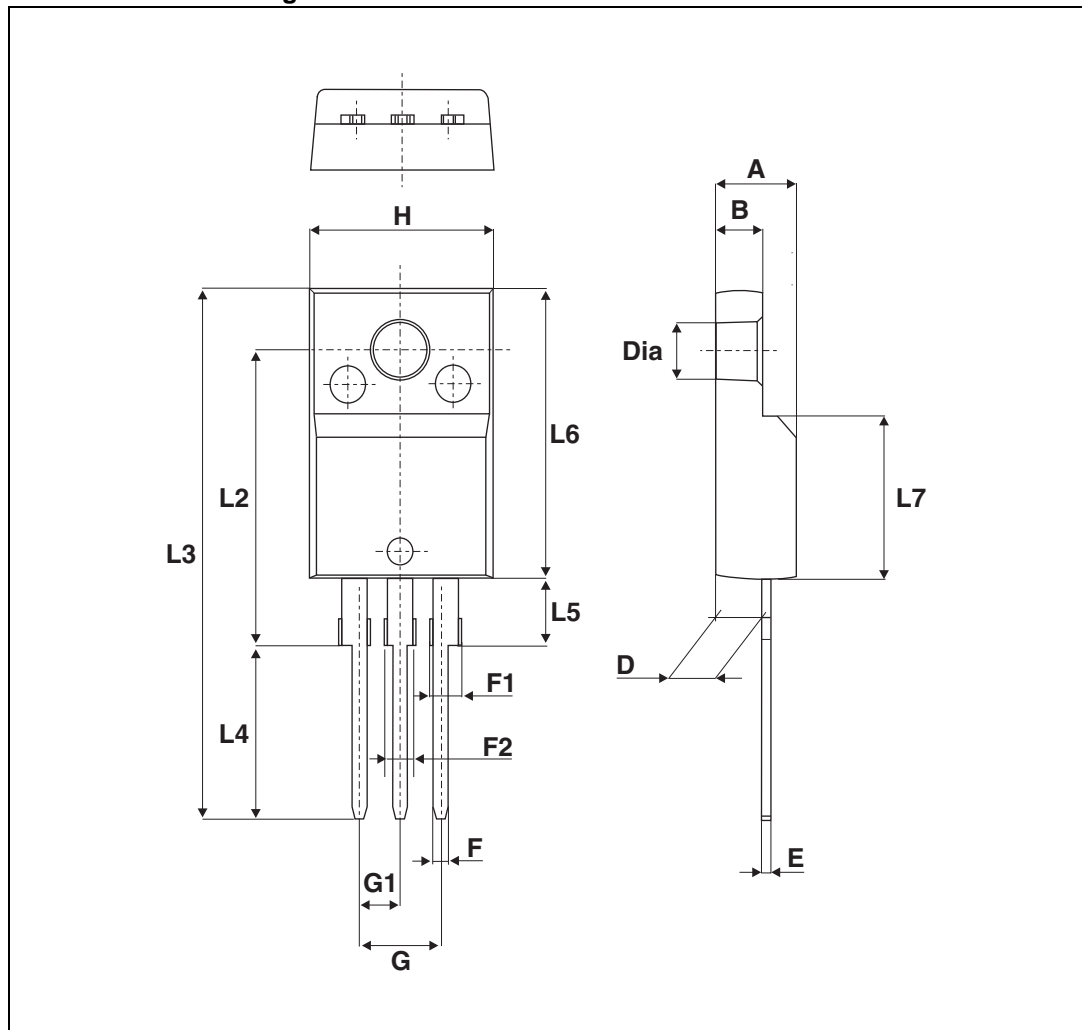
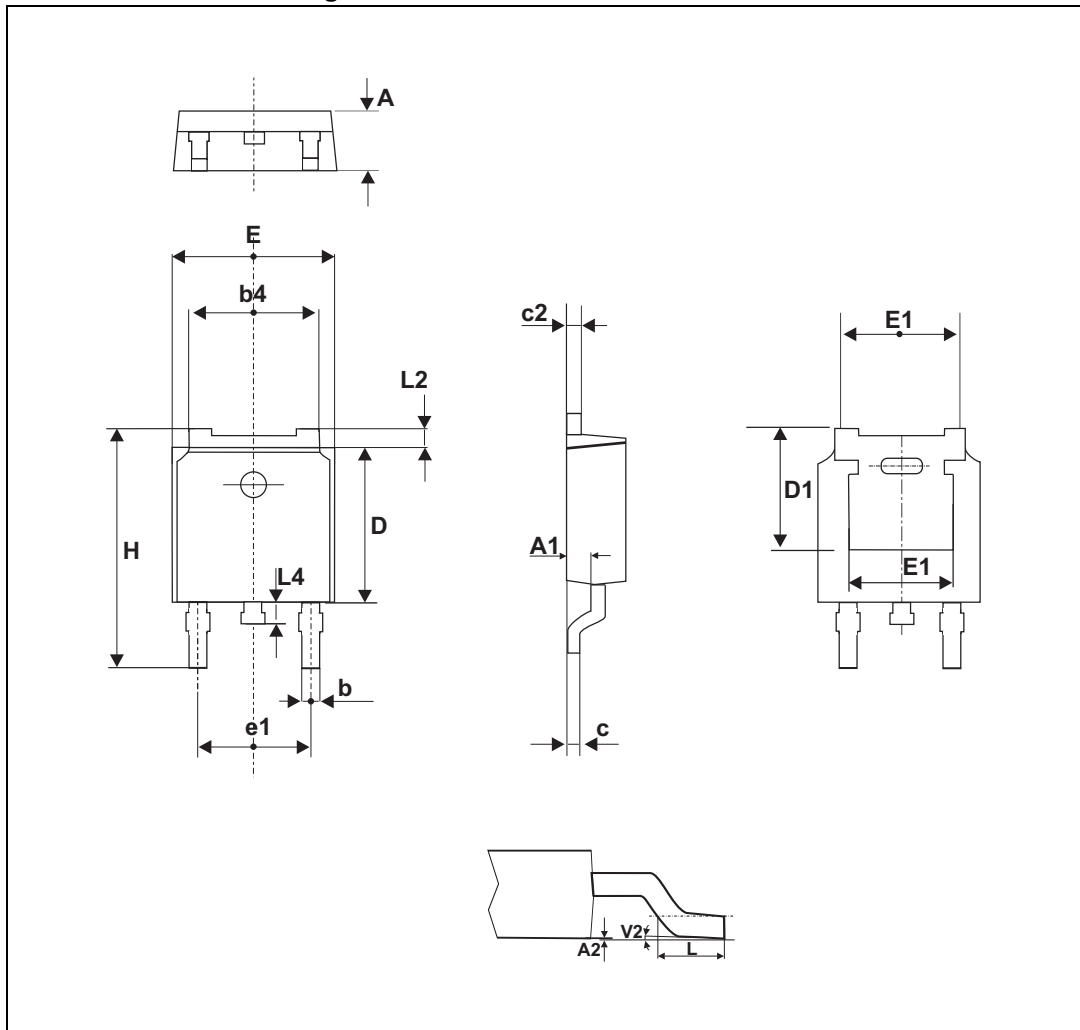


Table 6. TO-220FPAB dimension values

| 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)

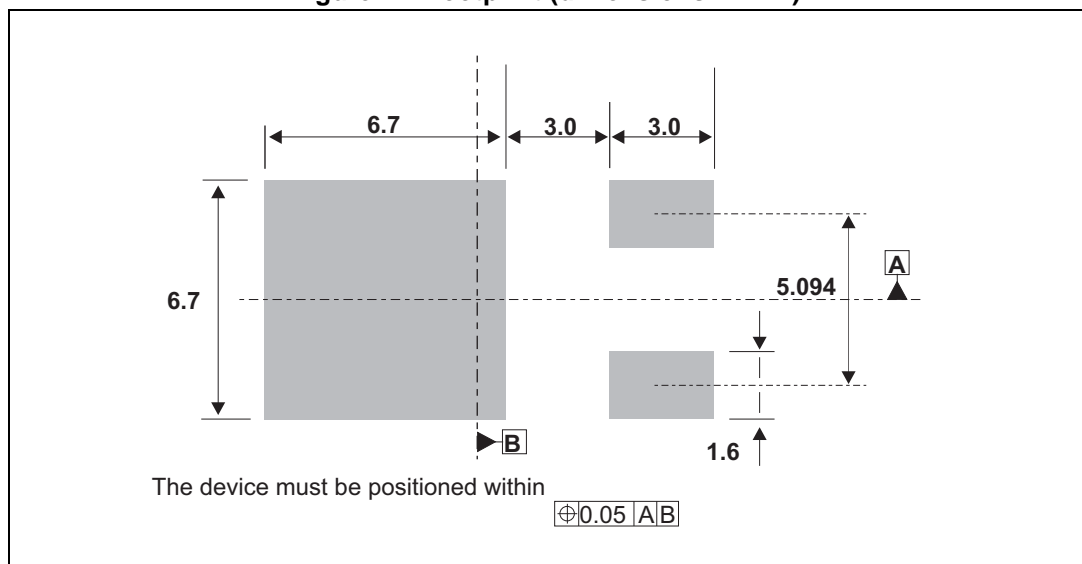


Figure 22. TO-220AB dimension definitions

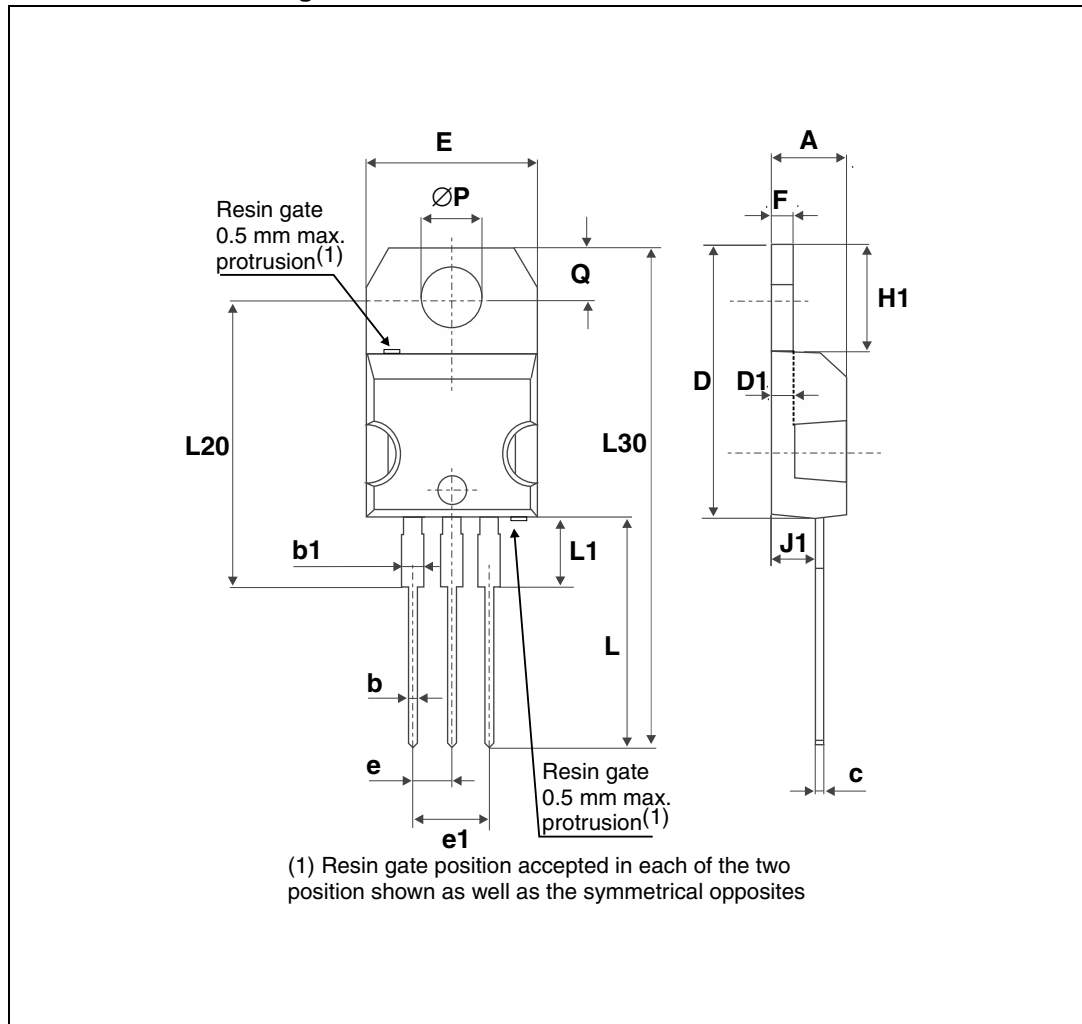


Table 8. TO-220AB dimension values

| 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. | |
| ØP | 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

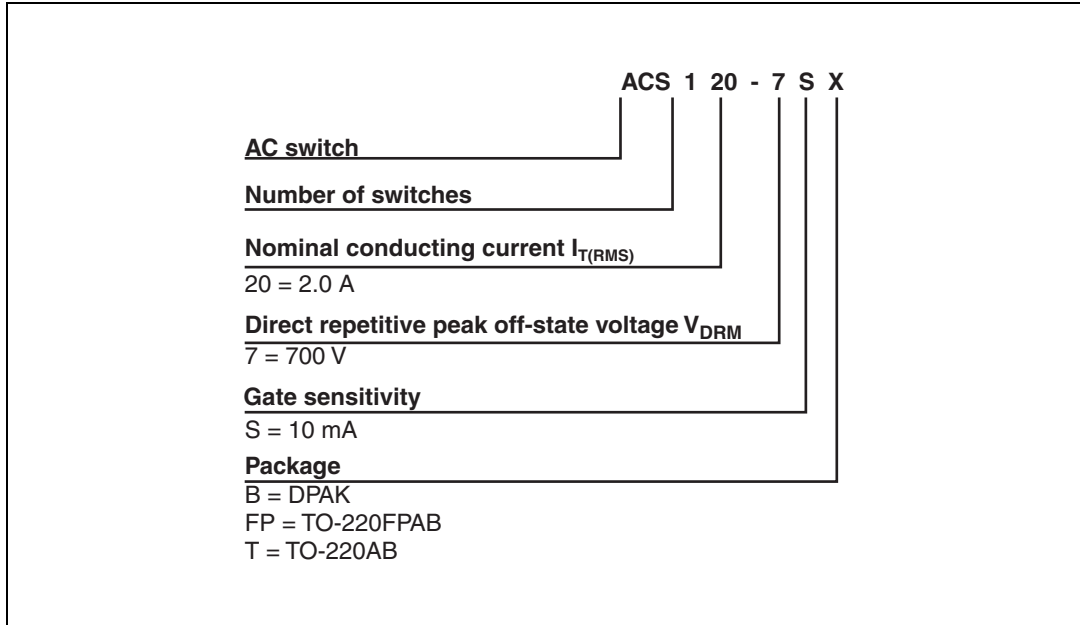


Table 9. Ordering information

| 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 Table 1 . |
| 28-May-2014 | 3 | Updated DPAK package information and reformatted to current standard. |

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