

Overvoltage protected AC switch

Datasheet – production data

Features

- Enables equipment to meet IEC 61000-4-5 surge with overvoltage crowbar technology
- High noise immunity against static dV/dt and IEC 61000-4-4 burst
- High junction temperature: $T_j = 150\text{ }^\circ\text{C}$
- Needs no external over-voltage protection
- V_{CL} gives headroom before clamping then crowbar action
- Reduces component count
- ECOPACK[®]2 compliant component
- Complies with UL standards (File ref: E81734)
- Provides UL certified insulation rated at 1500 V rms

Applications

- AC static switching in appliances and industrial control systems
- Drive of medium power AC loads such as:
 - Coffee making appliances
 - Universal drum motor of washing machine
 - Compressor of fridge or air conditioner
 - Heating and cooking appliances
 - Vacuum cleaners
 - Solid state relays

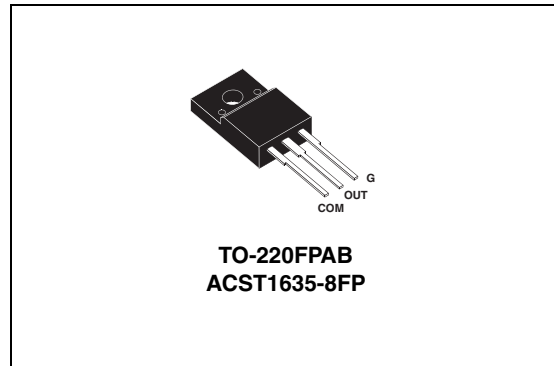
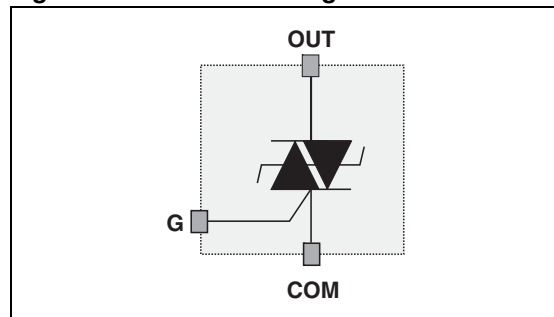


Figure 1. Functional diagram



Description

The ACST1635-8FP belongs to the AC power switch range built with A.S.D.[®] technology. This high performance device is designed for home appliances or industrial systems and drives loads up to 16 A.

This ACST1635-8FP switch embeds a Triac structure with a high voltage crowbar device to absorb the inductive turn-off energy and withstand line surges such as those described in the IEC 61000-4-5 (surge immunity test).

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1 Characteristics

Table 1. Absolute ratings (limiting values)

Symbol	Parameter		Value	Unit
$I_{T(RMS)}$	On-state rms current (full sine wave)	$T_c = 84\text{ °C}$	16	A
I_{TSM}	Non repetitive surge peak on-state current T_j initial = 25 °C, (full cycle sine wave)	$F = 50\text{ Hz}$, $t_p = 20\text{ ms}$	140	A
		$F = 60\text{ Hz}$, $t_p = 16.7\text{ ms}$	147	
I^2t	I^2t for fuse selection	$t_p = 10\text{ ms}$	130	A ² s
V_{DRM}/V_{RRM}	Repetitive peak off-stage voltage, gate open	$T_j = 150\text{ °C}$	800	V
di/dt	Critical rate of rise on-state current $I_G = 2 \times I_{GT}$, $t_r \leq 100\text{ ns}$	$F = 120\text{ Hz}$	100	A/ μ s
$V_{PP}^{(1)}$	Non repetitive line peak pulse voltage	$T_j = 25\text{ °C}$	2	kV
$P_{G(AV)}$	Average gate power dissipation	$T_j = 150\text{ °C}$	0.1	W
P_{GM}	Peak gate power dissipation ($t_p = 20\text{ }\mu$ s)	$T_j = 150\text{ °C}$	10	W
I_{GM}	Peak gate current ($t_p = 20\text{ }\mu$ s)	$T_j = 150\text{ °C}$	1	A
T_{stg}	Storage temperature range		-40 to +150	°C
T_j	Operating junction temperature range		-40 to +150	°C
T_L	Lead temperature for soldering during 10 s		260	°C
V_{ins}	Insulation rms voltage (60 seconds)		1.5	kV

1. according to test described by standard IEC 61000-4-5

Table 2. Electrical characteristics

Symbol	Test conditions	Quadrant	T_j	Value		Unit
I_{GT}	$V_{OUT} = 12\text{ V}$, $R_L = 33\text{ }\Omega$	I - II - III	25 °C	MAX.	35	mA
I_{GT}	$V_{OUT} = 12\text{ V}$, $R_L = 33\text{ }\Omega$	I - II - III	25 °C	MIN.	1.75	mA
V_{GT}	$V_{OUT} = 12\text{ V}$, $R_L = 33\text{ }\Omega$	I - II - III	25 °C	MAX.	1.0	V
V_{GD}	$V_{OUT} = V_{DRM}$, $R_L = 3.3\text{ k}\Omega$	I - II - III	150 °C	MIN.	0.2	V
$I_H^{(1)}$	$I_{OUT} = 500\text{ mA}$		25 °C	MAX.	30	mA
I_L	$I_G = 1.2 \times I_{GT}$	I - II - III	25 °C	MAX.	40	mA
dV/dt ⁽¹⁾	$V_{OUT} = 67\% V_{DRM}$, gate open		125 °C	MIN.	1000	V/ μ s
dV/dt ⁽¹⁾	$V_{OUT} = 67\% V_{DRM}$, gate open		150 °C	MIN.	300	V/ μ s
(di/dt) _c ⁽¹⁾	(dV/dt) _c = 0.1 V/ μ s		125 °C	MIN.	36	A/ms
			150 °C	MIN.	12	A/ms
(di/dt) _c ⁽¹⁾	Without snubber		125 °C	MIN.	12	A/ms
			150 °C	MIN.	4	A/ms
V_{CL}	$I_{CL} = 0.1\text{ mA}$, $t_p = 1\text{ ms}$		25 °C	MIN.	850	V

1. For both polarities of OUT pin referenced to COM pin

Table 3. Static characteristics

Symbol	Test conditions			Value	Unit
$V_{TM}^{(1)}$	$I_{OUT} = 22.6 \text{ A}$, $t_p = 500 \mu\text{s}$	$T_j = 25 \text{ }^\circ\text{C}$	MAX.	1.5	V
$V_{T0}^{(1)}$	Threshold voltage	$T_j = 150 \text{ }^\circ\text{C}$	MAX.	0.9	V
$R_d^{(1)}$	Dynamic resistance	$T_j = 150 \text{ }^\circ\text{C}$	MAX.	30	$\text{m}\Omega$
I_{DRM} I_{RRM}	$V_{OUT} = V_{DRM} / V_{RRM}$	$T_j = 25 \text{ }^\circ\text{C}$	MAX.	1	μA
		$T_j = 125 \text{ }^\circ\text{C}$		500	μA
		$T_j = 150 \text{ }^\circ\text{C}$		2	mA

1. For both polarities of OUT pin referenced to COM pin

Table 4. Thermal characteristics

Symbol	Parameter	Value	Unit
$R_{th(j-c)}$	Junction to case (AC)	3.2	$^\circ\text{C}/\text{W}$
$R_{th(j-a)}$	Junction to ambient	60	$^\circ\text{C}/\text{W}$

Figure 2. Maximum power dissipation versus rms on-state current **Figure 3. On-state rms current versus case temperature**

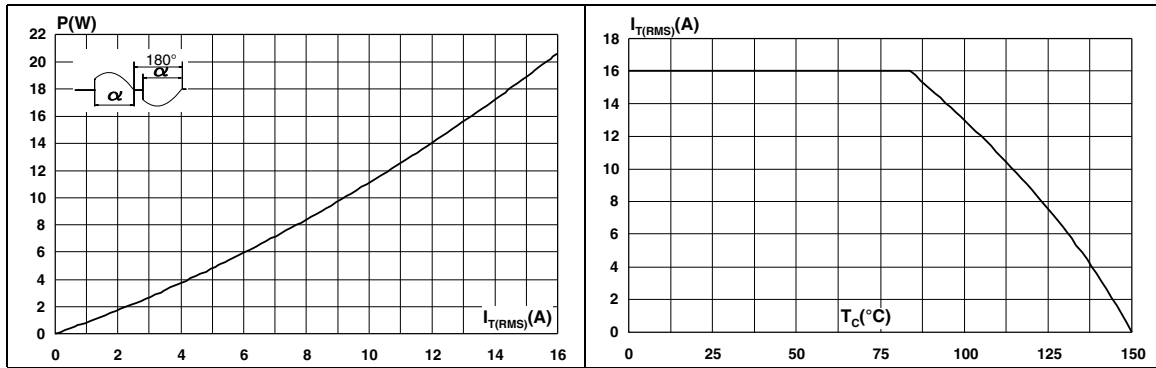


Figure 4. On-state rms current versus ambient temperature (free air convection) **Figure 5. Relative variation of thermal impedance versus pulse duration**

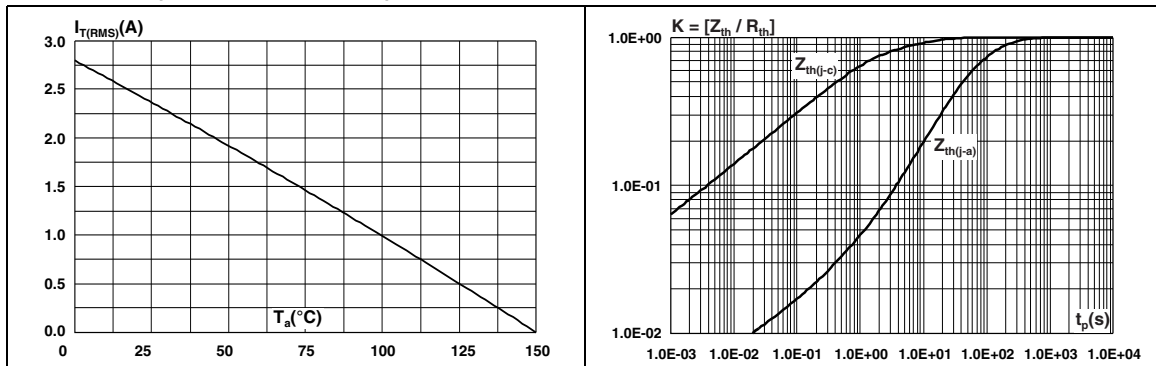


Figure 6. On-state characteristics (maximum values)

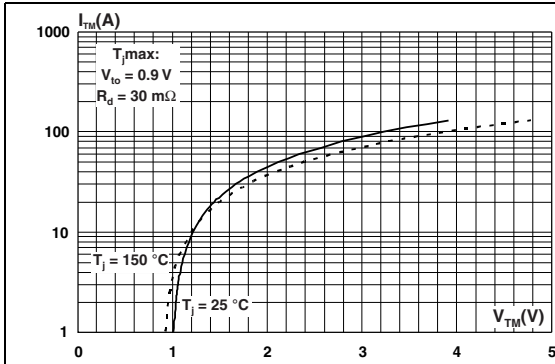


Figure 7. Surge peak on-state current versus number of cycles

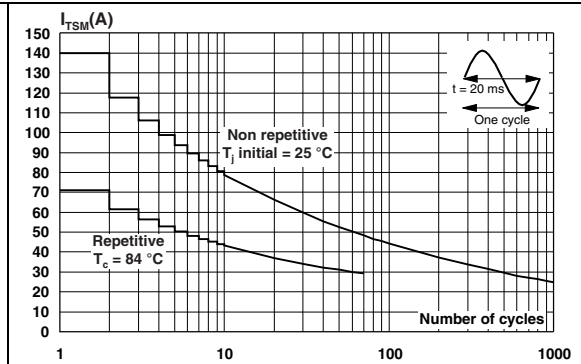


Figure 8. Non repetitive surge peak on-state current for a sinusoidal

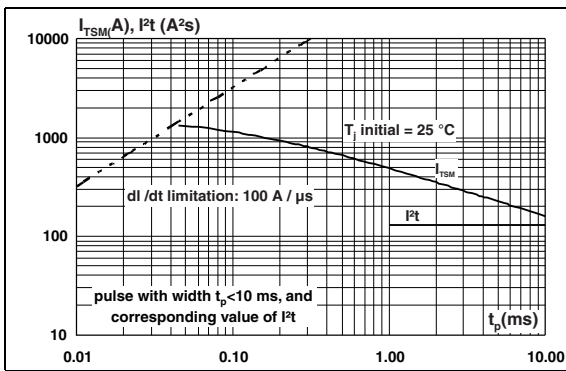


Figure 9. Relative variation of gate trigger current and gate trigger voltage versus junction temperature

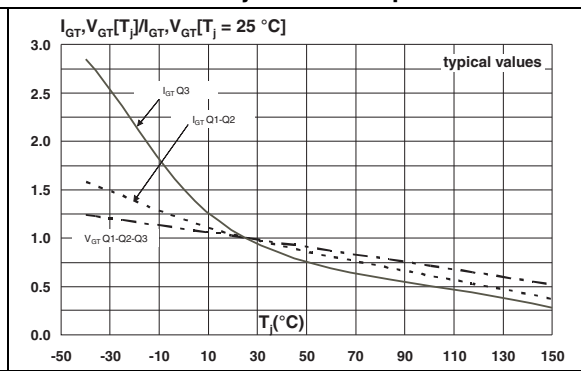


Figure 10. Relative variation of holding current and latching current versus junction temperature

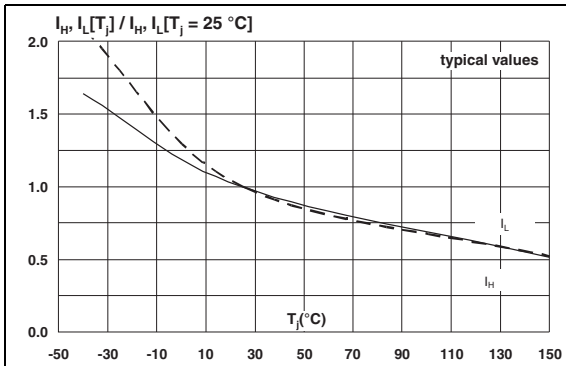


Figure 11. Relative variation of critical rate of decrease of main current (di/dt)c versus reapplied (dV/dt)c

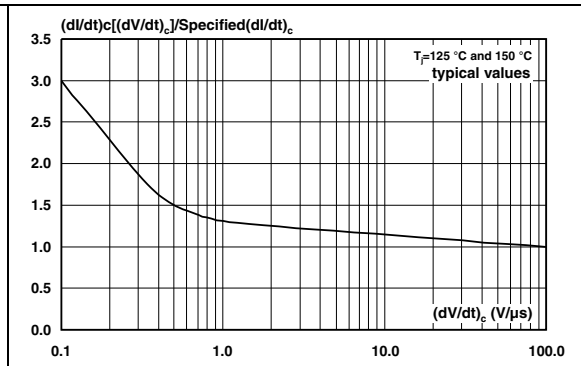


Figure 12. Relative variation of critical rate of decrease of main current versus junction temperature

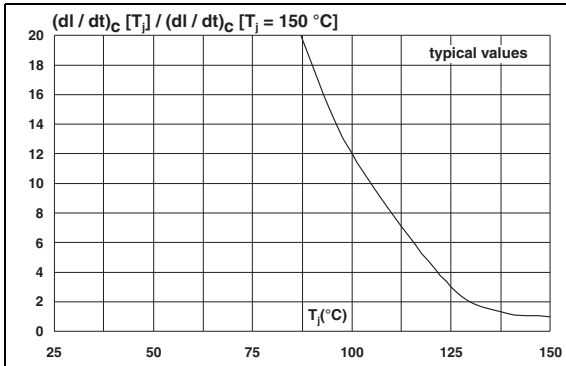


Figure 13. Relative variation of static dV/dt immunity versus junction temperature (typical values)

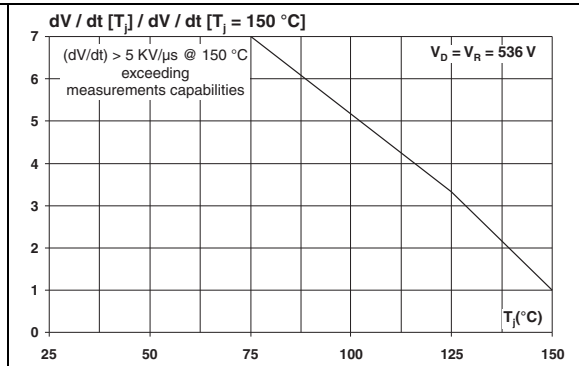


Figure 14. Relative variation of the maximal clamping voltage versus junction temperature (minimum value)

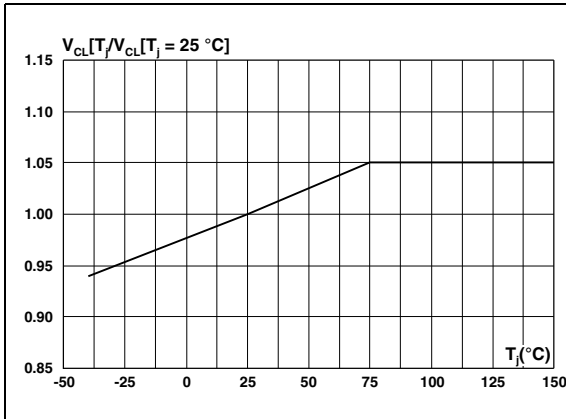
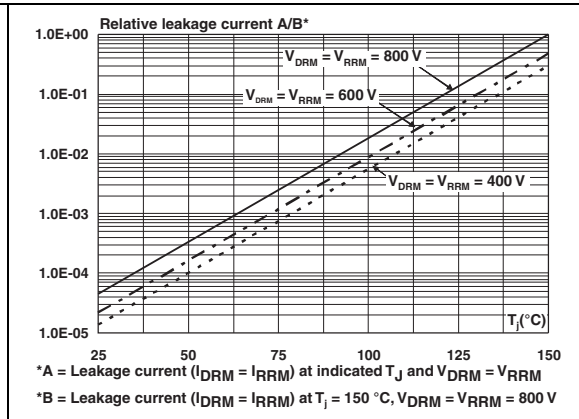


Figure 15. Relative variation of Leakage current versus junction temperature



2 Application information

2.1 Typical application descriptions

The ACST1635-8FP device can be used to control medium power load, such as AC motors in home appliances. Thanks to its thermal and turn off commutation performances, the ACST1635-8FP switch is able to drive an inductive load up to 16 A with no turn off additional snubber. It also provides high thermal performances in static and transient modes such as the compressor inrush current or high torque operating conditions of an AC motor.

Figure 16. AC induction motor control - typical diagram

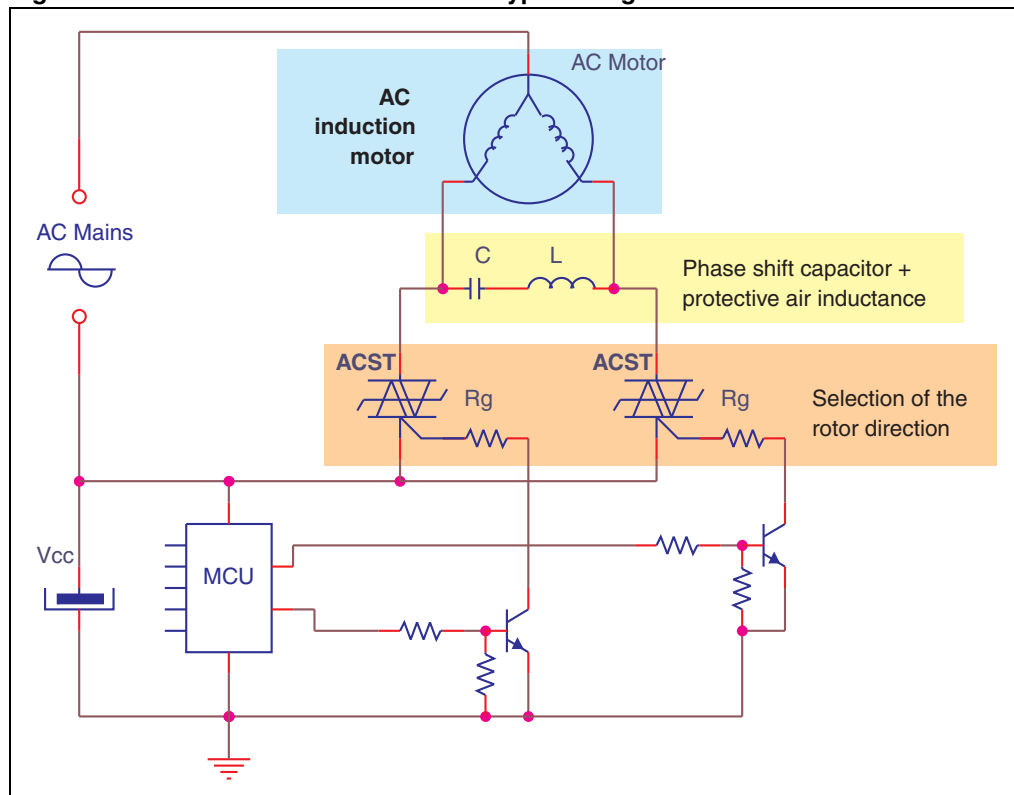
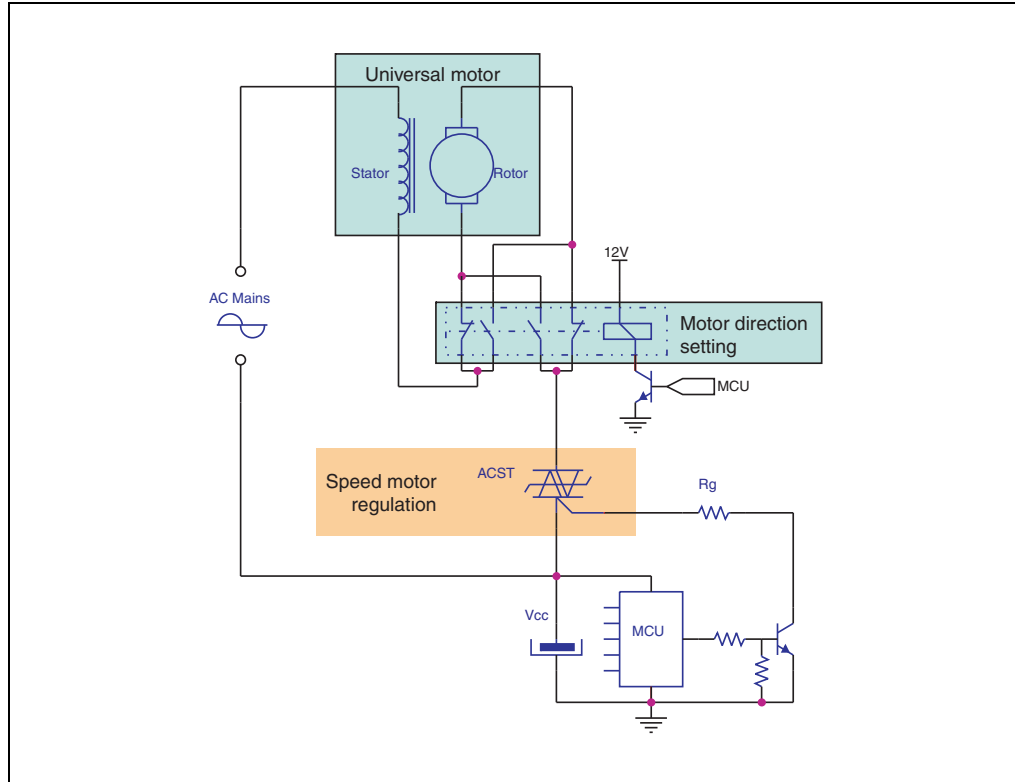
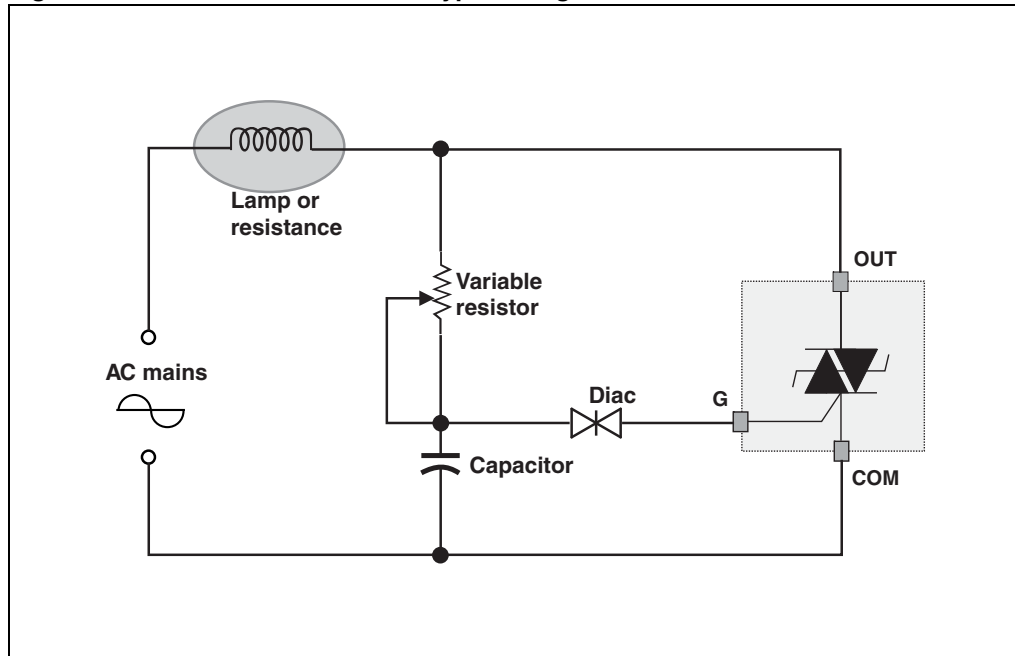


Figure 17. Universal drum motor control – typical diagram



The ACST1635-8FP device is also very effective in controlling resistive loads.

Figure 18. Resistive load control - typical diagram



2.2 AC line transient voltage ruggedness

In comparison with standard Triacs, which needs additional protection components against surge voltage, the ACST1635-8FP is self-protected against over-voltage, specified by the new parameter V_{CL} . The ACST1635-8FP switch can safely withstand AC line transient voltages either by clamping the low energy spikes, such as the inductive spikes at switch off, or by switching to the on state (for less than 10 ms) to dissipate higher energy shocks through the load. This safety feature works even with high turn-on current ramp-up.

The test circuit of *Figure 19* represents the ACST1635-8FP application, and is used to stress the ACST switch according to the IEC 61000-4-5 standard conditions. With the additional effect of the load which is limiting the current, the ACST switch withstands the voltage spikes up to 2 kV on top of the peak line voltage. The protection is based on an overvoltage crowbar technology. The ACST1635-8FP folds back safely to the on state as shown in *Figure 20*. The ACST1635-8FP recovers its blocking voltage capability after the surge and the next zero crossing current. Such a non repetitive test can be done at least 10 times on each AC line voltage polarity.

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

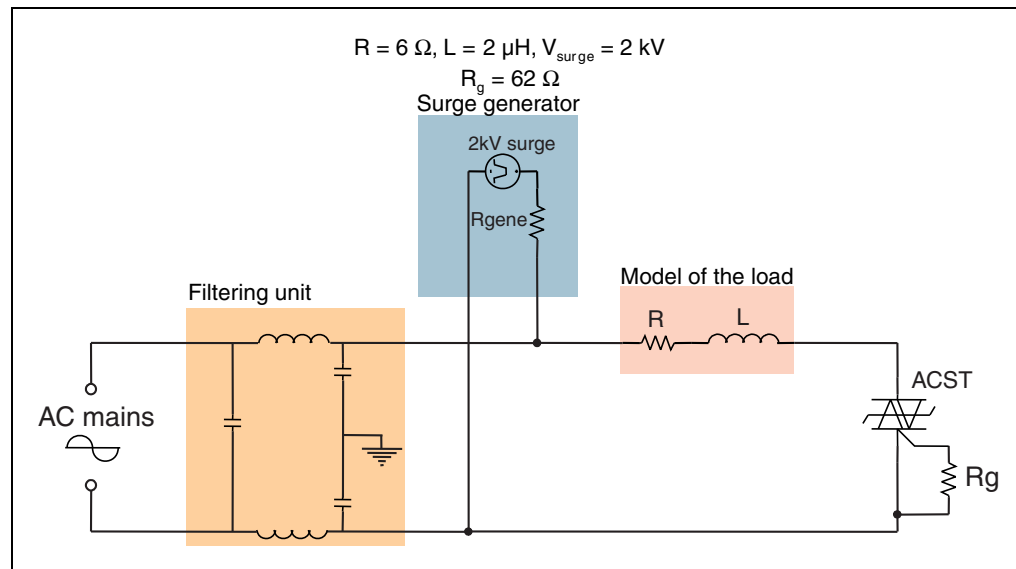
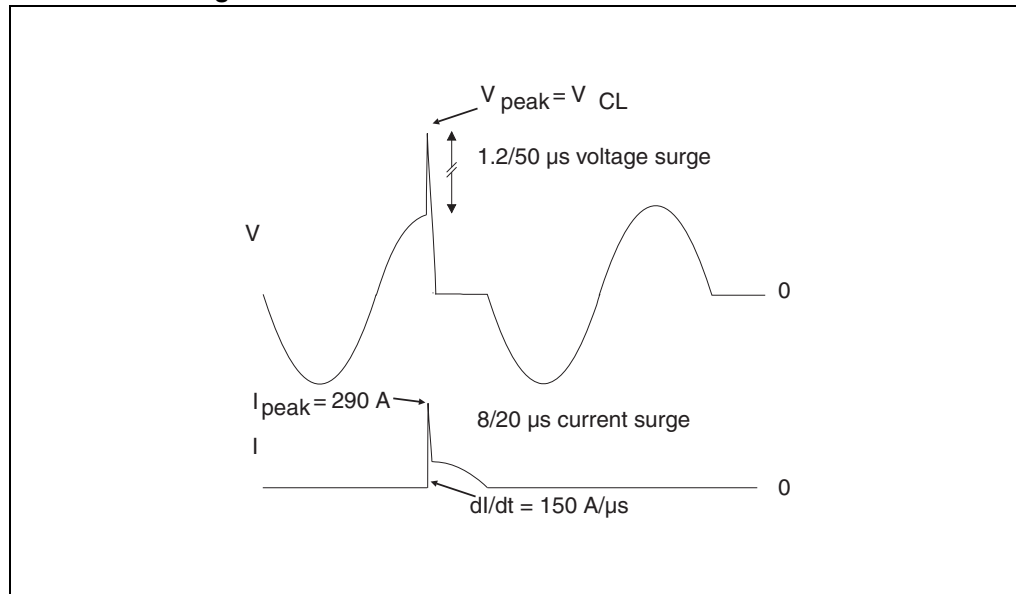
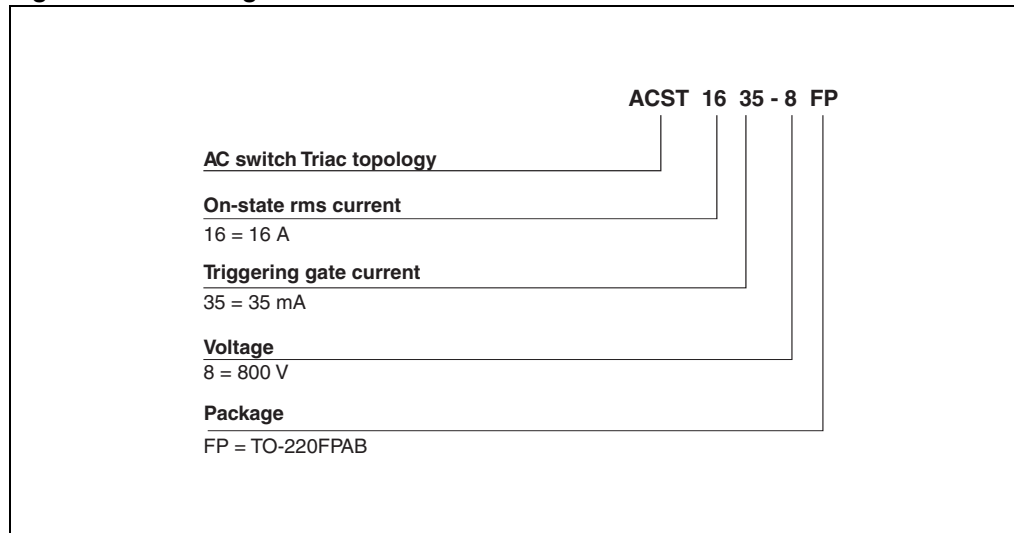


Figure 20. Typical voltage and current waveforms across the ACST1635-8FP during IEC 61000-4-5 standard test



3 Ordering information scheme

Figure 21. Ordering information scheme



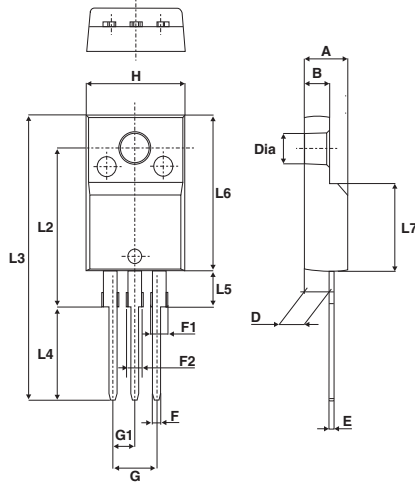
4 Package information

- Epoxy meets UL94, V0
- 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. ECOPACK[®] is an ST trademark.

Table 5. TO-220FPAB dimensions

Ref.	Dimensions			
	Millimeters		Inches	
	Min.	Max.	Min.	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 Typ.		0.63 Typ.	
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



5 Ordering information

Table 6. Ordering information

Order code	Marking	Package	Weight	Base qty.	Packing mode
ACST1635-8FP	ACST1635-8FP	TO-220FPAB	2.0 g	50	Tube

6 Revision history

Table 7. Document revision history

Date	Revision	Changes
12-Sep-2012	1	First issue.

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