AC power switch

Main applications

- AC static switching in appliance control systems
- Drive of low power high inductive or resistive loads like
  - spray pump in dishwashers
  - an in air-conditioners

Features

- Blocking voltage: V_{DRM} /V_{RRM} = ±700 V
- Avalanche controlled: V_{CL} typ = 1100 V
- Nominal conducting current : $I_{T(RMS)}$ = 4 A
- High surge current capability: 30 A for 20 ms full wave
- Gate triggering current: I_{GT} < 10 mA or 25 mA
- Switch integrated driver
- High noise immunity: static dV/dt > 500 V/µs

Benefits

- Enables equipment to meet IEC 61000-4-5
- High off-state reliability with planar technology
- No external overvoltage protection needed
- Reduces the power component factor
- Interfaces directly with the microcontroller
- Direct interface with the microcontroller for the ACST4-7S (I_{GT} < 10 mA)

Description

The ACST4 belongs to the AC power switch family built around the ASD™ technology. This high performance device is adapted to home appliances or inductrial systems and drives loads up to 4 A.

The ACS™ switch embeds a Triac structure with a high voltage clamping device to absorb the inductive turn-off energy and withstand line transients such as those described in the IEC 61000-4-5 standards.

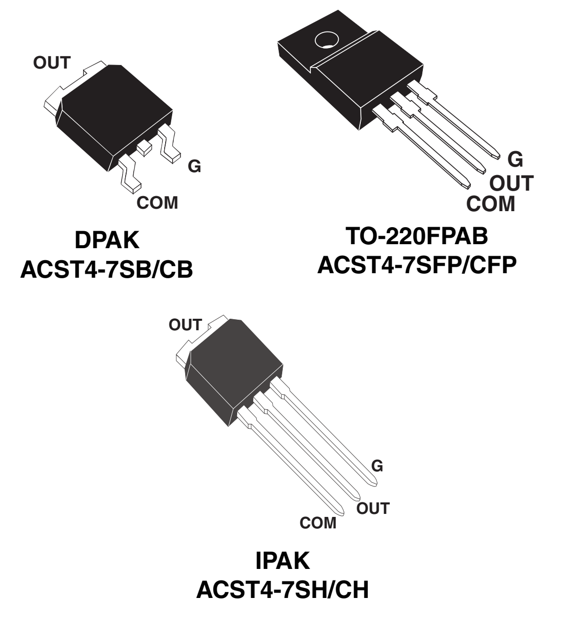
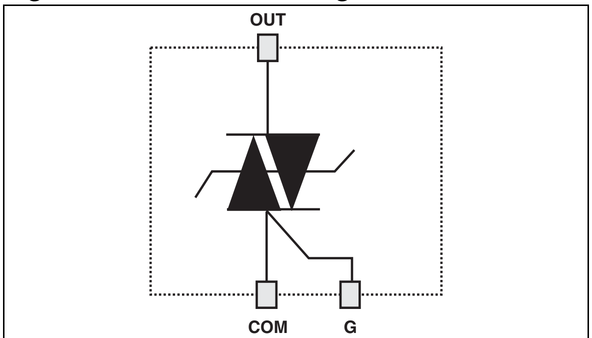


Figure 1. Functional diagram



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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		T_j = -10° C	700	V
$I_{T(RMS)}$	RMS on-state current full cycle sine wave 50 to 60 Hz	DPAK, IPAK	T_c = 110° C	4	A
		TO-220FPAB	T_c = 100° C		
I_{TSM}	Non repetitive surge peak on-state current		F = 50 Hz	30	A
	T_j initial = 25° C, full cycle sine wave		F = 60 Hz	33	A
I^2t	Fusing capability		t_p = 10 ms	6.4	A^2s
dI/dt	Repetitive on-state current critical rate of rise I_G = 10 mA (t_r < 100 ns)	T_j = 125° C	F = 120 Hz	50	A/µs
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 3.*

Table 2. Gate characteristics (maximum values)

Symbol	Parameter	Value	Unit
$P_{G(AV)}$	Average gate power dissipation	0.1	W
P_{GM}	Peak gate power dissipation (t_p = 20 µs)	10	A
I_{GM}	Peak gate current (t_p = 20 µs)	1	V

Table 3. Thermal resistances

Symbol	Parameter			Value	Unit
$R_{th\ (j-a)}$	Junction to ambient	S(1) = 0.5 cm²	DPAK, IPAK	70	° C/W
		TO-220FPAB		60	° C/W
$R_{th\ (j-l)}$	Junction to tab/lead for full cycle sine wave conduction	DPAK, IPAK		2.6	° C/W
		TO-220FPAB		4.6	° 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
Rd	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
For either positive or negative polary of pin OUT voltage respect to pin COM voltage

Symbol	Test conditions				ACST4-7S	ACST4-7C	Unit
I_{GT}	V_{OUT} = 12 V DC R_L = 33 Ω	QI - QII - QIII	Tj = 25° C	MAX	10	25	mA
V_{GT}	V_{OUT} = 12 V DC R_L = 33 Ω	QI - QII - QIII	Tj = 25° C	MAX	1	1.1	V
V_{GD}	V_{OUT} = V_{DRM}	R_L = 3.3 Ω	Tj = 125° C	MIN	0.2		V
I_H	I_{OUT} = 100 mA	Gate open	Tj = 25° C	MAX	20	35	mA
I_L	I_G = 2 x $_{IGt}$max		Tj = 25° C	MAX	40	60	mA
V_{TM}	I_{OUT} = 5.6 A	t_p = 380 µs	Tj = 25° C	MAX	1.5		V
V_{TO}			Tj = 125° C	MAX	0.90		V
Rd			Tj = 125° C	MAX	100		mΩ
I_{DRM} / I_{RRM}	V_{OUT} = 700 V		Tj = 25° C	MAX	10		µA
			Tj = 125° C	MAX	500		
dV/dt	V_{OUT} = 460 V	Gate open	Tj = 110° C	MIN	200	500	V/µs
(dI/dt)c	(dI/dt)c = 15 V/ µs		Tj = 125° C	MIN	2.0	2.5	A/ms
V_{CL}	I_{CL} = 1mA	t_p = 1ms	Tj = 25° C	TYP	1100		V

2 AC line switch basic application

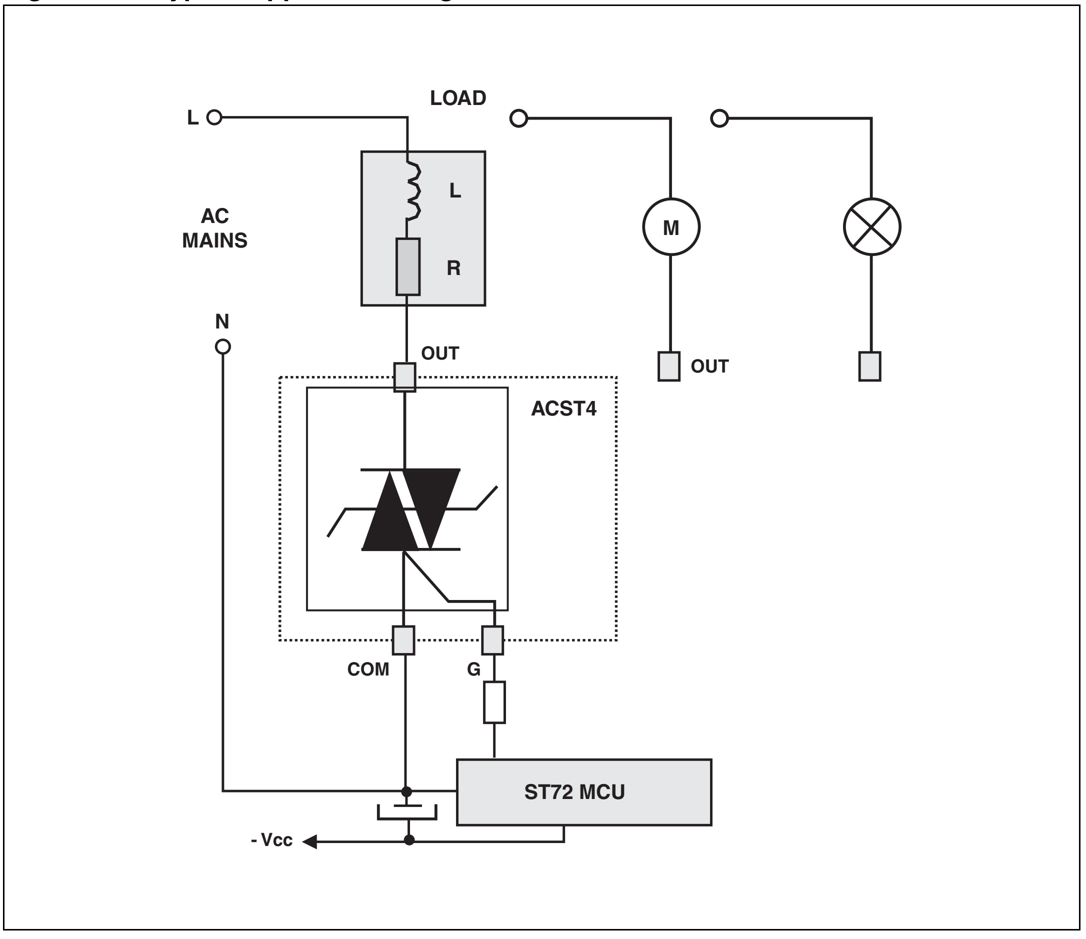
The ACST4 device has been designed to switch on and off low power, but highly inductive or resistive loads such as dishwashers spray pumps, and air-conditioners fan.

- **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

ACST4-7S triggering current has to be sunk from the gate pin G. The switch can then be driven directly by logic level circuits through a resistor as shown on the typical application diagram .

Thanks to its thermal and turn off commutation performances, the ACST4 switch is able to drive with no turn off additional snubber an inductive load up to 4 A.

Figure 2. Typical application diagram



3 AC line transient voltage ruggedness

The ACST4 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 6.* is representative of the final ACST application and is also used to stress the ACST switch according to the IEC 61000-4-5 standard conditions. Thanks to the load, the ACST 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 rate of rise, is as high as shown on *Figure 7.* Such non-repetitive test can be done 10 times on each AC line voltage polarity.

Figure 3. Overvoltage ruggedness test circuit for resistive and inductive loads according to IEC 61000-4-5 standards. R = 150 Ω, L = 10 µH, V_{PP} = 2 kV.

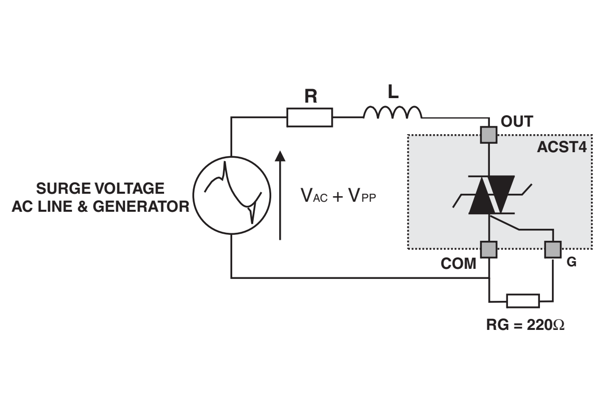


Figure 4. Current and voltage of the ACST4 during IEC 61000-4-5 standard test with R, L and V_{PP}.

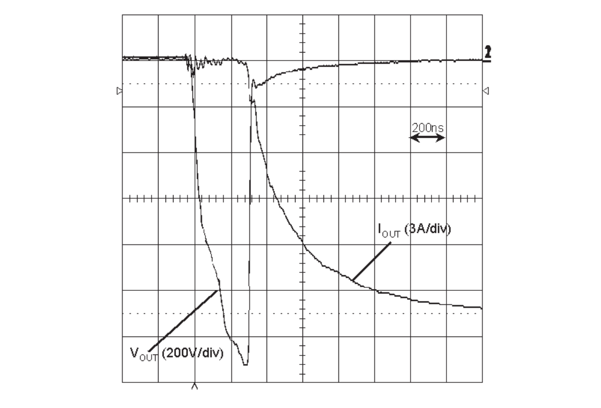


Figure 5. Maximum power dissipation versus RMS on-state current.

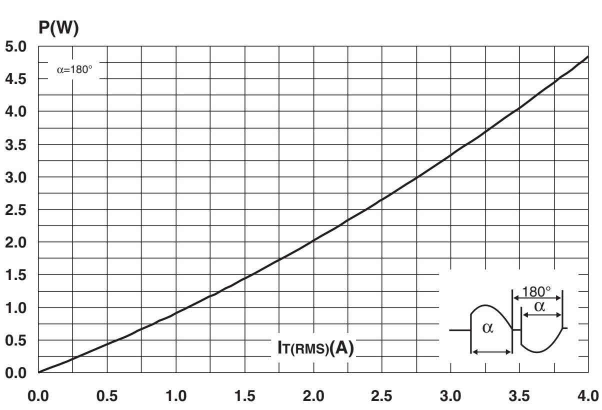


Figure 6. RMS on-state current versus case temperature.

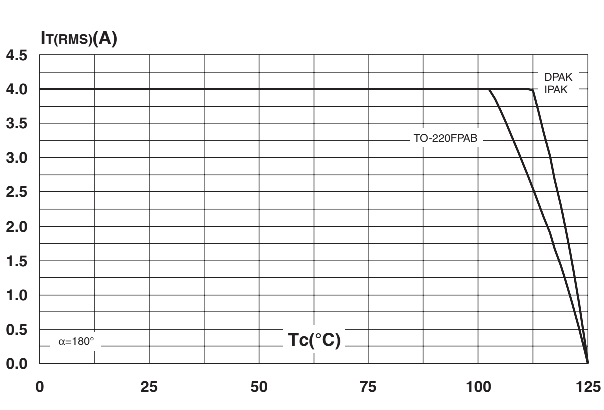


Figure 7. RMS on-state current versus ambient temperature.

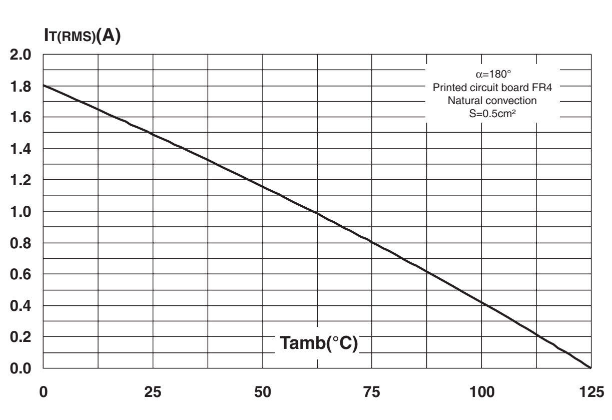


Figure 8. Relative variation of thermal impedance versus pulse duration.

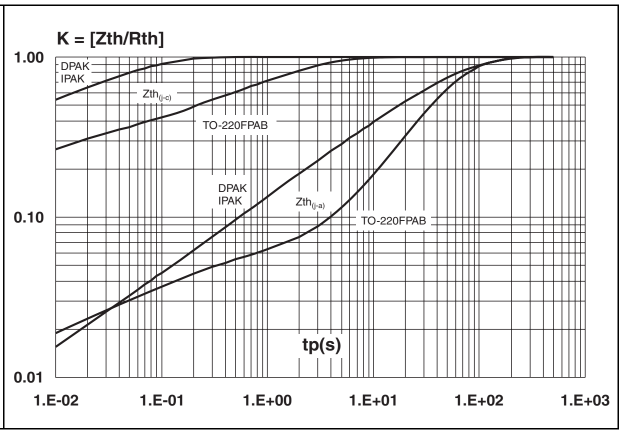


Figure 9. Relative variation of gate trigger current, holding current and latching versus junction temperature (typical values).

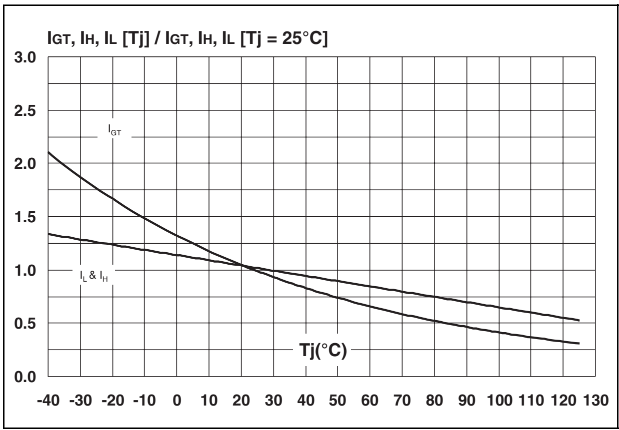


Figure 10. Relative variation of static dV/dt versus junction temperature.

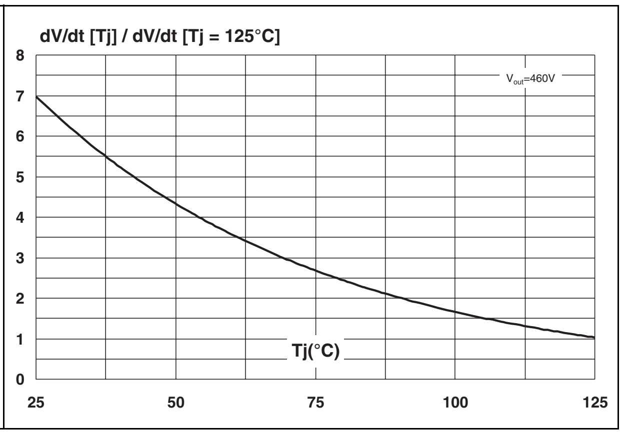


Figure 11. Relative variation of critical rate of decrease of main current versus reapplied dV/dt (typical values).

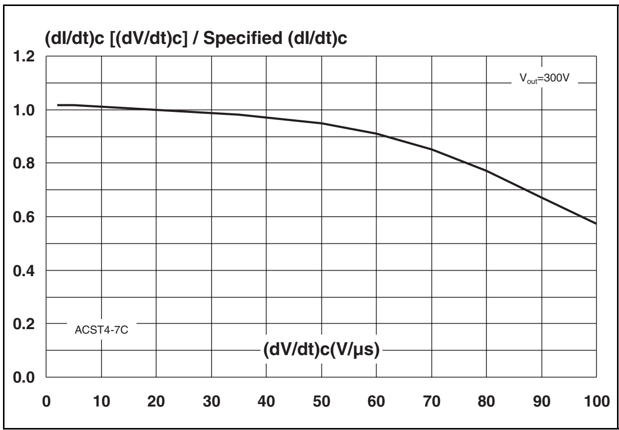


Figure 12. Relative variation of critical rate of decrease of main current versus reapplied dV/dt (typical values).

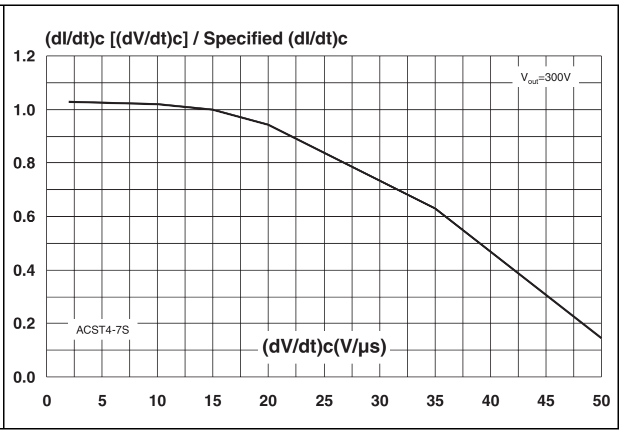


Figure 13. Relative variation of critical rate of decrease of main current versus junction temperature.

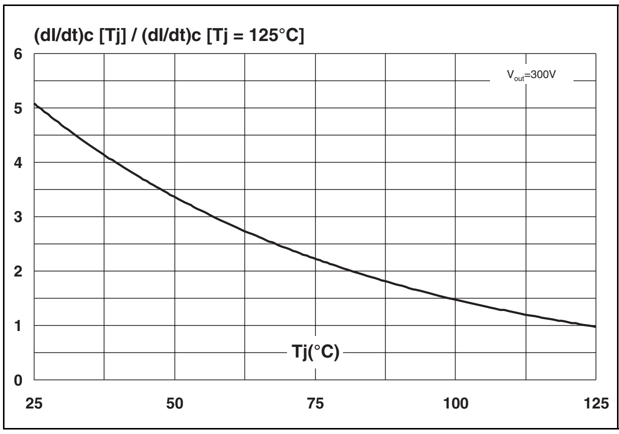


Figure 14. Surge peak on-state current versus number of cycles.

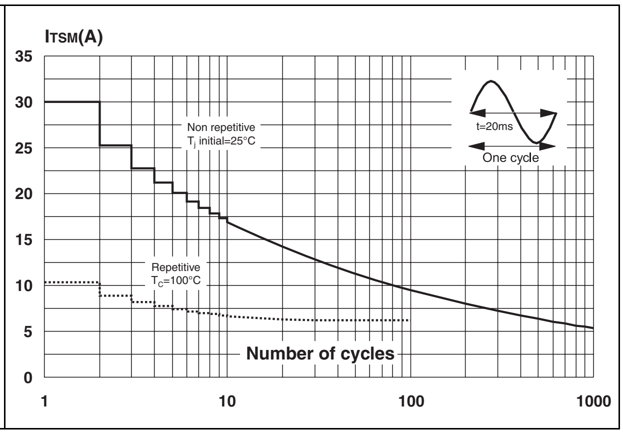


Figure 15. Non repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10 ms, and corresponding value of I²t.

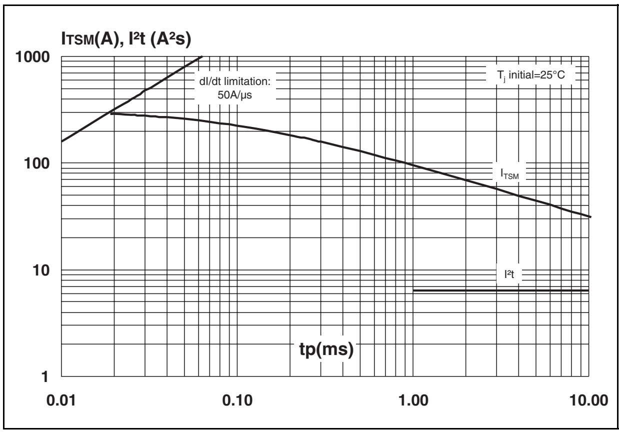


Figure 16. On-state characteristics (maximum values).

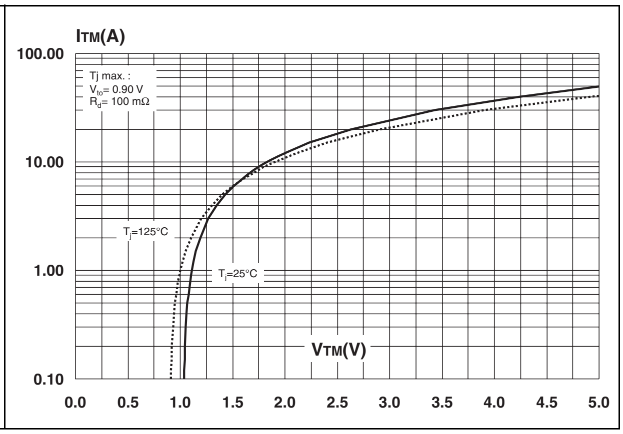
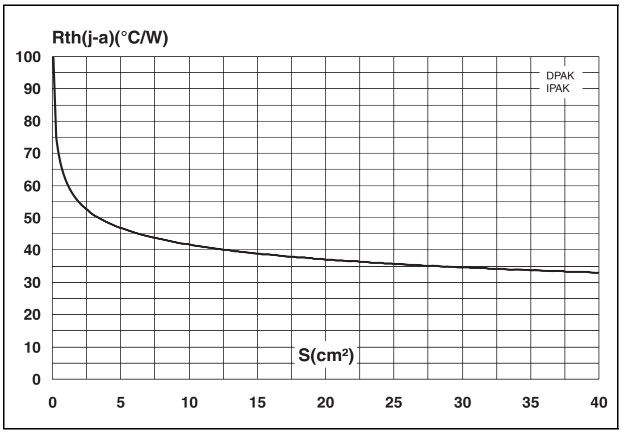
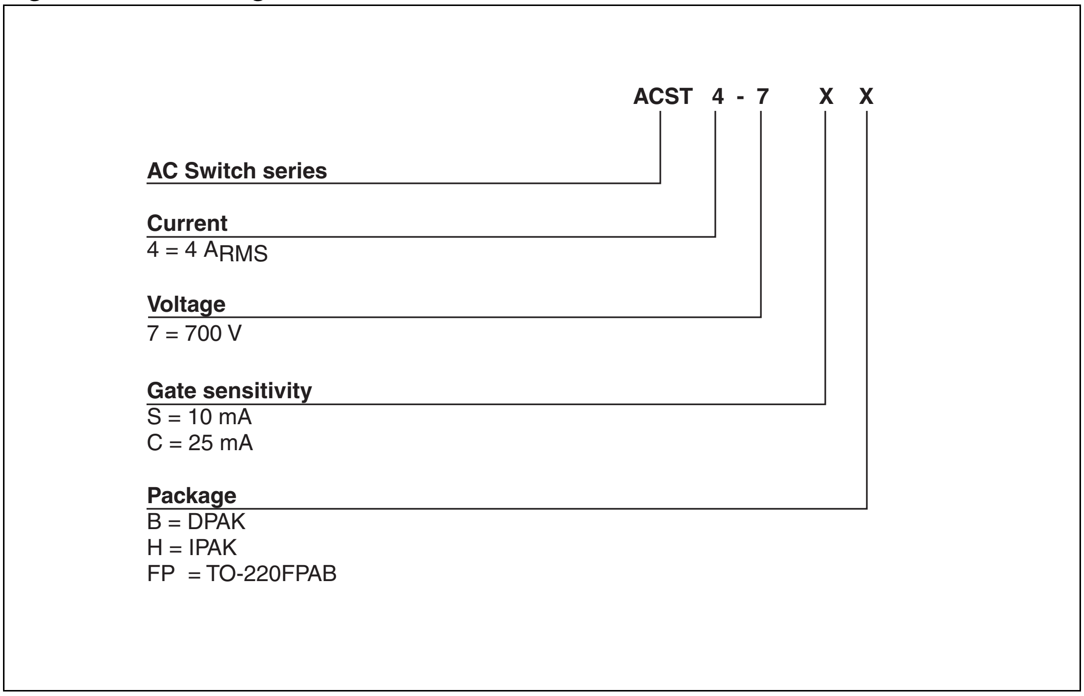


Figure 17. Thermal resistance junction to ambient versus copper surface under tab (printed circuit board FR4, copper thickness: 35 µm).



4 Ordering information scheme

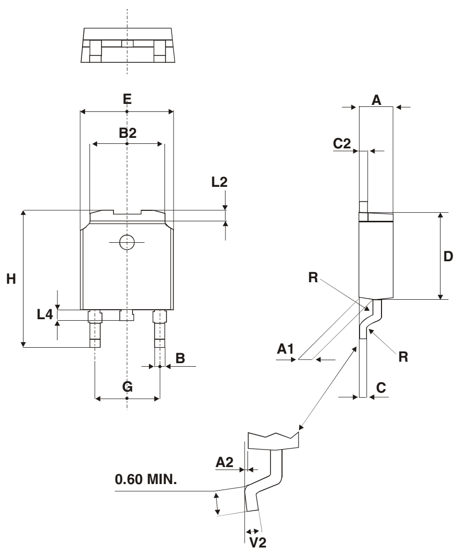
Figure 18. Ordering information scheme



5 Package information

- Epoxy meets UL94, V0
- Recommended torque values 0.4 to 0.6 Nm

Table 6. DPAK dimensions



Ref.	Dimensions			
	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	2.20	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
B2	5.20	5.40	0.204	0.212
C	0.45	0.60	0.017	0.023
C2	0.48	0.60	0.018	0.023
D	6.00	6.20	0.236	0.244
E	6.40	6.60	0.251	0.259
G	4.40	4.60	0.173	0.181
H	9.35	10.10	0.368	0.397
L2	0.80 typ.		0.031 typ.	
L4	0.60	1.00	0.023	0.039
V2	0°	8°	0°	8°

Figure 19. Footprint (dimensions in mm)

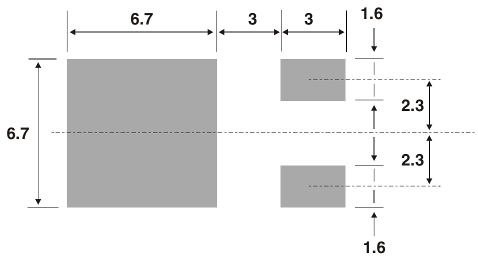
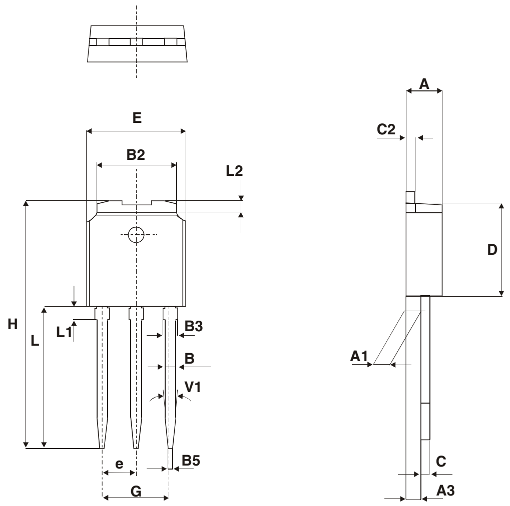
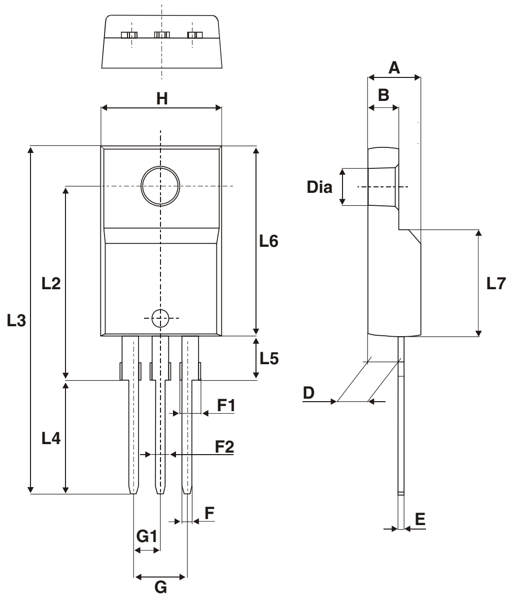


Table 7. IPAK dimensions



Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	2.20		2.40	0.086		0.094
A1	0.90		1.10	0.035		0.043
A3	0.70		1.30	0.027		0.051
B	0.64		0.90	0.025		0.035
B2	5.20		5.40	0.204		0.212
B3			0.95			0.037
B5		0.30			0.035	
C	0.45		0.60	0.017		0.023
C2	0.48		0.60	0.019		0.023
D	6		6.20	0.236		0.244
E	6.40		6.60	0.252		0.260
e		2.28			0.090	
G	4.40		4.60	0.173		0.181
H		16.10			0.634	
L	9		9.40	0.354		0.370
L1	0.8		1.20	0.031		0.047
L2		0.80	1		0.031	0.039
V1		10°			10°	

Table 8. 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

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: www.st.com.

6 Ordering information

Table 9. Ordering information

Part number	Marking	Package	Weight	Base qty	Packing mode
ACST4-7SB	ACST47S	DPAK	0.3 g	75	Tube
ACST4-7SB-TR	ACST47S	DPAK	0.3 g	2500	Tape and reel
ACST4-7SH	ACST47S	IPAK	0.4 g	75	Tube
ACST4-7SFP	ACST47S	TO-220FPAB	2.4 g	50	Tube
ACST4-7CB	ACST47C	DPAK	0.3 g	75	Tube
ACST4-7CB-TR	ACST47C	DPAK	0.3 g	2500	Tape and reel
ACST4-7CH	ACST47C	IPAK	0.4 g	75	Tube
ACST4-7CFP	ACST47C	TO-220FPAB	2.4 g	50	Tube

7 Revision history

Table 10. Revision history

Date	Revision	Changes
Jan-2003	3A	Previous update
04-Jul-2007	4	Reformatted to current standard. Added IPAK package