7 A, 1200 V very fast IGBT with ultrafast diode

Features

- High voltage capability
- High speed
- Very soft ultrafast recovery anti-parallel diode

Applications

- Home appliance
- Lighting

Description

This high voltage and very fast IGBT shows an excellent trade-off between low conduction losses and fast switching performance. It is designed in PowerMESH™ technology combined with high voltage ultrafast diode.

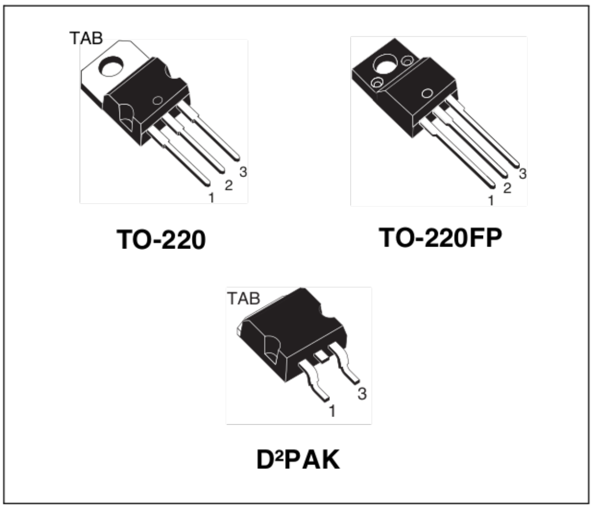


Figure 1. Internal schematic diagram

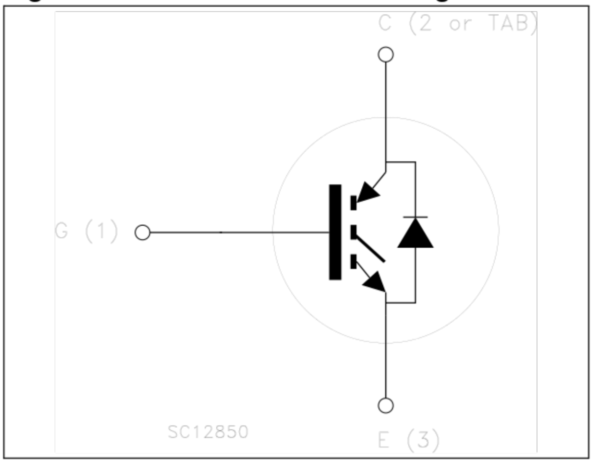


Table 1. Device summary

Order codes	Marking	Packages	Packaging
STGB3NC120HDT4	GB3NC120HD	D²PAK	Tape and reel
STGF3NC120HD	GF3NC120HD	TO-220FP	Tube
STGP3NC120HD	GP3NC120HD	TO-220	Tube

Contents

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		TO-220FP	TO-220/D²PAK	
V_{CES}	Collector-emitter voltage (V_{GE} = 0)	1200		V
I_C (1)	Continuous collector current at T_C = 25 °C	6	14	A
I_C (1)	Continuous collector current at T_C = 100 °C	3	7	A
I_{CL} (2)	Turn-off latching current	14		A
I_{CP} (3)	Pulsed collector current	20		A
V_{GE}	Gate-emitter voltage	± 20		V
I_F	Diode RMS forward current at T_C = 25 °C	3		A
I_{FSM}	Surge non repetitive forward current t_p=10 ms sinusoidal	12		A
P_{TOT}	Total dissipation at T_C = 25 °C	25	75	W
V_{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink	2500		V
T_J	Operating junction temperature	-55 to 150		°C

1. Calculated according to the iterative formula:

$$I_C(T_C) = \frac{T_{j(max)} - T_C}{R_{thj-c} \times V_{CE(sat)(max)}(T_{j(max)}, I_C(T_C))}$$

2. V_{clamp} = 80 % V_{CES}, T_j = 150 °C, R_G = 10 Ω, V_{GE} = 15 V
3. Pulse width limited by maximum junction temperature and turn-off within RBSOA

Table 3. Thermal data

Symbol	Parameter	Value		Unit
		TO-220FP	TO-220/D²PAK	
R_{thJC}	Thermal resistance junction-case IGBT	5	1.65	°C/W
	Thermal resistance junction-case (diode)	3.5		°C/W
R_{thJA}	Thermal resistance junction-ambient	62.5		°C/W

2 Electrical characteristics

T_J = 25 °C unless otherwise specified.

Table 4. Static electrical characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{GE} = 0)	I_C = 1 mA	1200			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE}= 15 V, I_C= 3 A V_{GE}= 15 V, I_C= 3 A, T_J=125 °C		2.3 2.2	2.8	V V
$V_{GE(th)}$	Gate threshold voltage	V_{CE}= V_{GE}, I_C= 250µA	2		5	V
I_{CES}	Collector cut-off current (V_{GE} = 0)	V_{CE} = 1200 V V_{CE} = 1200 V, T_J=125 °C			50 1	µA mA
I_{GES}	Gate-emitter leakage current (V_{CE} = 0)	V_{GE} =± 20 V			± 100	nA
g_{fs} (1)	Forward transconductance	V_{CE} = 25 V, I_C= 3 A		4		S

1. Pulse duration: 300 µs, duty cycle 1.5%

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{ies} C_{oes} C_{res}	Input capacitance Output capacitance Reverse transfer capacitance	V_{CE} = 25 V, f = 1 MHz, V_{GE}=0	-	470 45 6	-	pF pF pF
Q_g Q_{ge} Q_{gc}	Total gate charge Gate-emitter charge Gate-collector charge	V_{CE} = 960 V, I_C= 3 A,V_{GE}=15 V	-	24 3 10	-	nC nC nC

Table 6. Switching on/off (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$ t_r $(di/dt)_{on}$	Turn-on delay time Current rise time Turn-on current slope	V_{CC} = 800 V, I_C = 3 A R_G= 10 Ω, V_{GE}= 15 V, *(see Figure 20)*	-	15 3.5 880	-	ns ns A/µs
$t_{d(on)}$ t_r $(di/dt)_{on}$	Turn-on delay time Current rise time Turn-on current slope	V_{CC} = 800 V, I_C = 3 A R_G= 10 Ω, V_{GE}= 15 V, T_J= 125 °C *(see Figure 20)*	-	14.5 4 770	-	ns ns A/µs
$t_r(V_{off})$ $t_d(_{off})$ t_f	Off voltage rise time Turn-off delay time Current fall time	V_{CC} = 800 V, I_C = 3 A R_G= 10 Ω, V_{GE}= 15 V, *(see Figure 20)*	-	72 118 250	-	ns ns ns
$t_r(V_{off})$ $t_d(_{off})$ t_f	Off voltage rise time Turn-off delay time Current fall time	V_{CC} = 800 V, I_C = 3 A R_G= 10 Ω, V_{GE}= 15 V, T_J= 125 °C *(see Figure 20)*	-	132 210 470	-	ns ns ns

Table 7. Switching energy (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
Eon (1) E_{off} (2) E_{ts}	Turn-on switching losses Turn-off switching losses Total switching losses	V_{CC} = 800 V, I_C = 3 A R_G= 10 Ω, V_{GE}= 15 V, *(see Figure 20)*	-	236 290 526	-	µJ µJ µJ
Eon (1) E_{off} (2) E_{ts}	Turn-on switching losses Turn-off switching losses Total switching losses	V_{CC} = 800 V, I_C = 3 A R_G= 10 Ω, V_{GE}= 15 V, T_J= 125 °C *(see Figure 20)*	-	360 620 980	-	µJ µJ µJ

1. Eon is the turn-on losses when a typical diode is used in the test circuit in figure 2. If the IGBT is offered in a package with a co-pack diode, the co-pack diode is used as external diode. IGBTs & Diode are at the same temperature (25 °C and 125 °C)
2. Turn-off losses include also the tail of the collector current

Table 8. Collector-emitter diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_F	Forward on-voltage	I_F = 1.5 A I_F = 1.5 A, T_J = 125 °C	-	1.6 1.3	2.0	V V
t_{rr} Q_{rr} I_{rrm}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_F = 3 A, V_R = 40 V, di/dt = 100 A/µs *(see Figure 23)*	-	51 85 3.3		ns nC A
t_{rr} Q_{rr} I_{rrm}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_F = 3 A, V_R = 40 V, T_J = 125 °C, di/dt = 100 A/µs *(see Figure 23)*	-	64 133 4.2		ns nC A

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

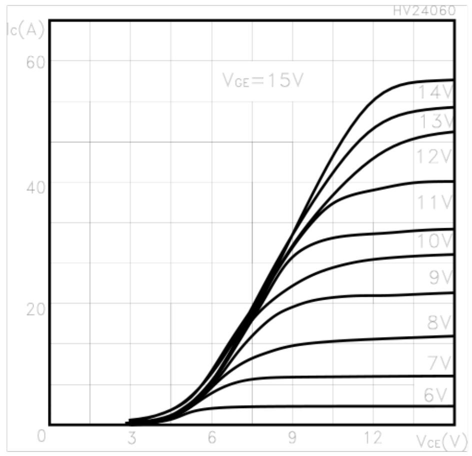


Figure 3. Transfer characteristics

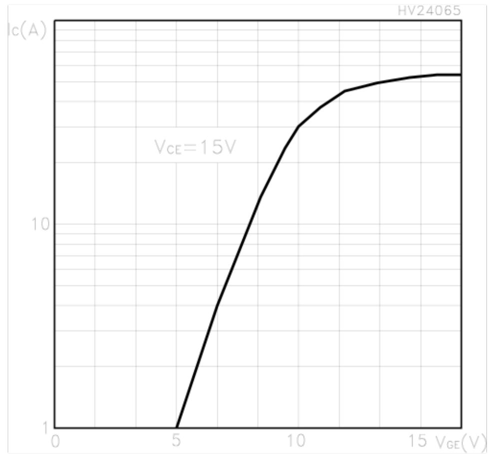


Figure 4. Transconductance

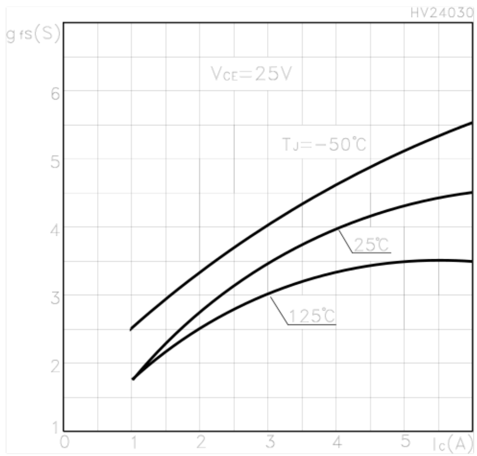


Figure 5. Collector-emitter on voltage vs. temperature

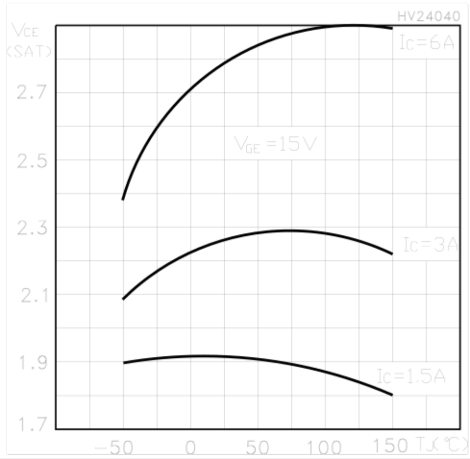


Figure 6. Collector-emitter on voltage vs. collector current

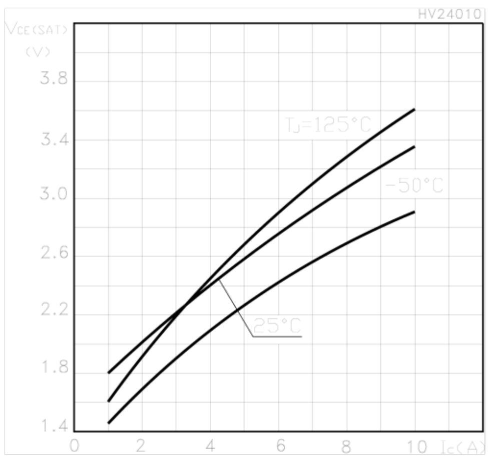


Figure 7. Normalized gate threshold voltage vs. temperature

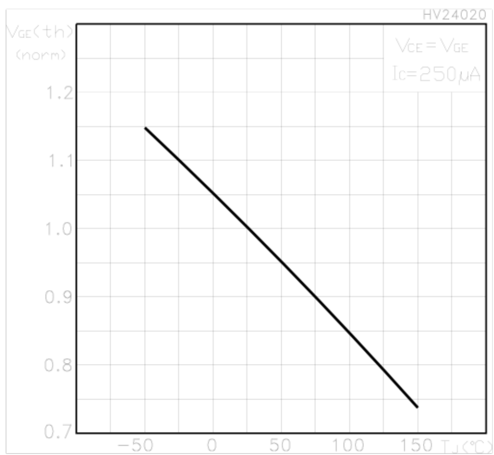


Figure 8. Normalized breakdown voltage vs. temperature

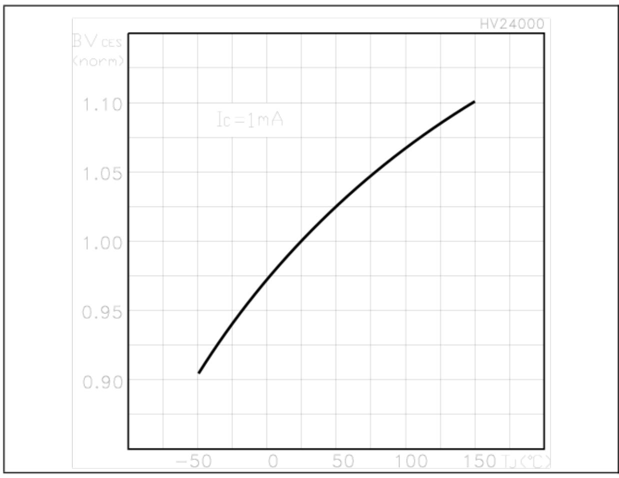


Figure 9. Gate charge vs. gate-source voltage

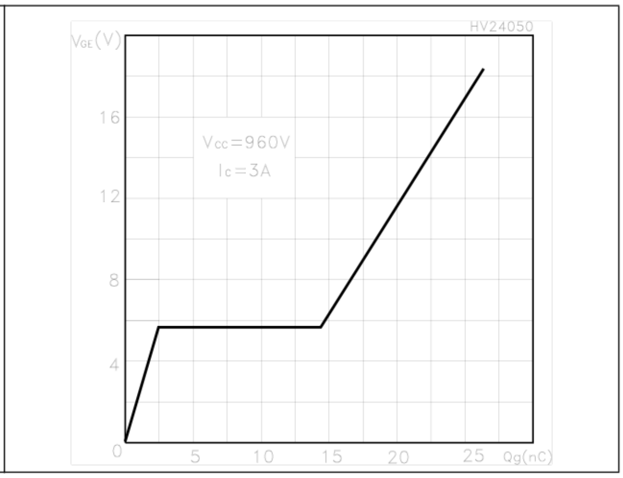


Figure 10. Capacitance variations

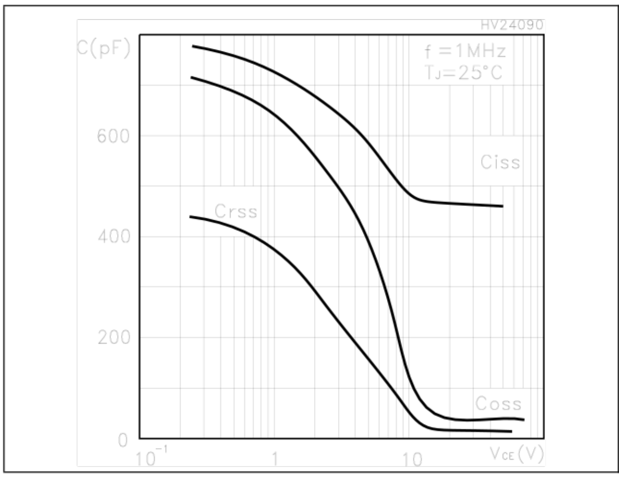


Figure 11. Switching losses vs. temperature

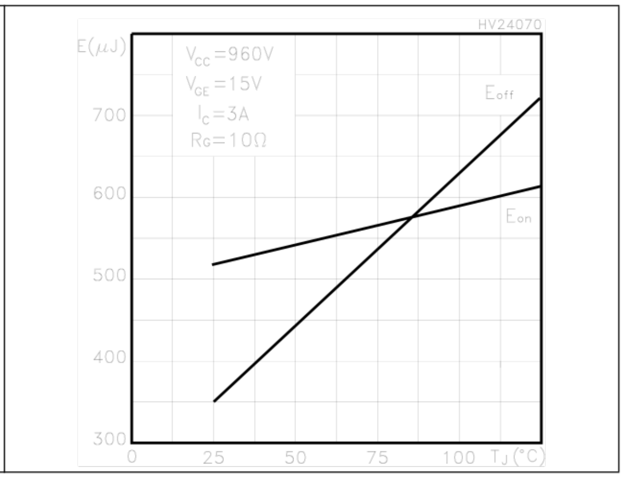


Figure 12. Switching losses vs. gate resistance

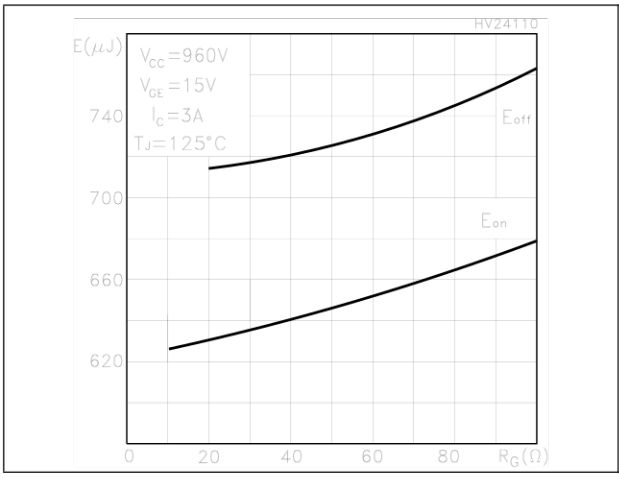


Figure 13. Switching losses vs. collector current

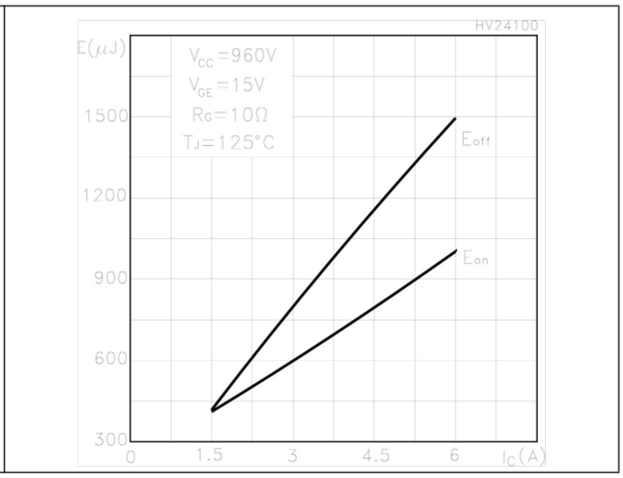


Figure 14. Collector-emitter diode characteristics

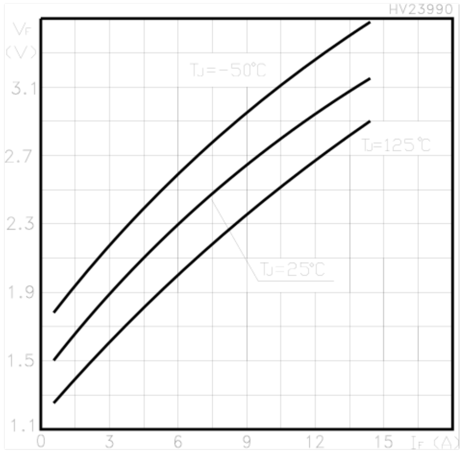


Figure 15. Power losses @ I_C = 3 A

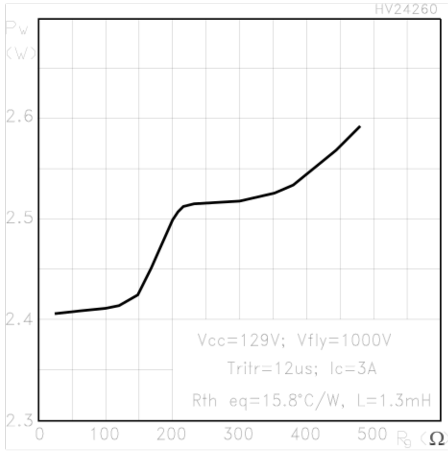


Figure 16. Power losses @ I_C = 2 A

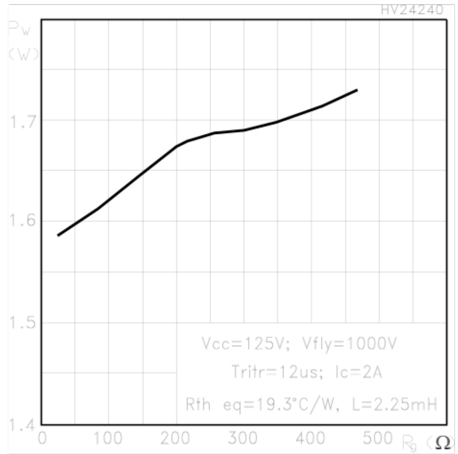


Figure 17. Thermal impedance for TO-220

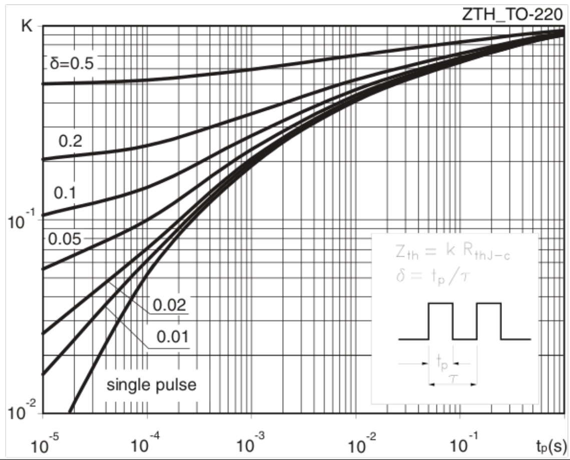


Figure 18. Turn-off SOA

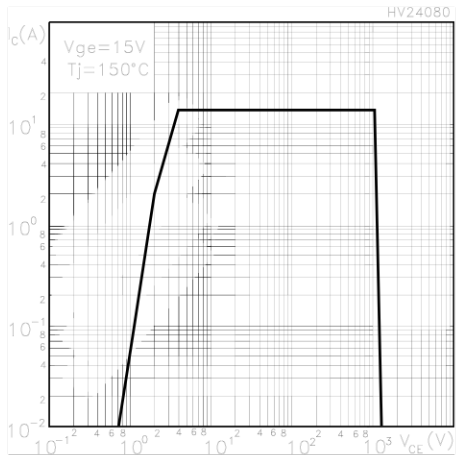
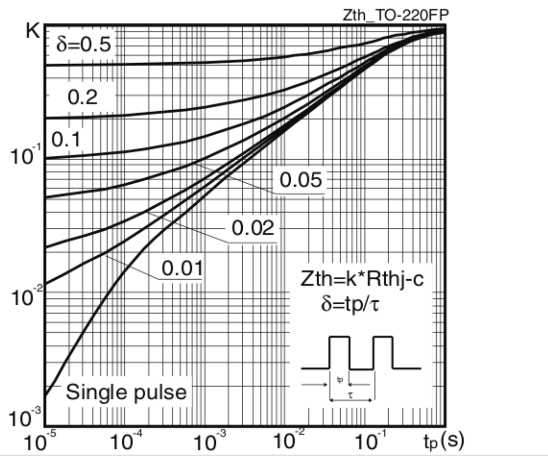


Figure 19. Thermal impedance for TO-220FP



3 Test circuit

Figure 20. Test circuit for inductive load switching

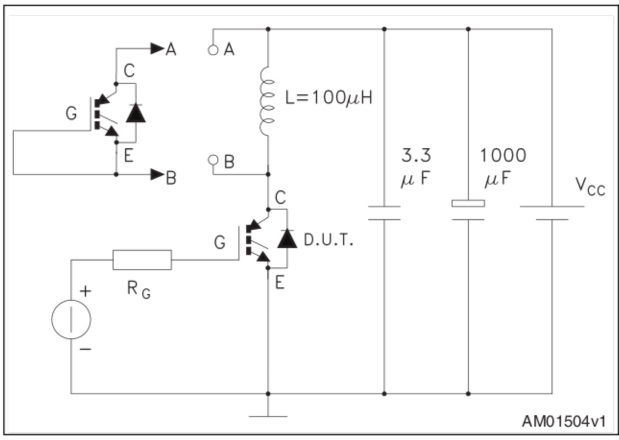


Figure 21. Gate charge test circuit

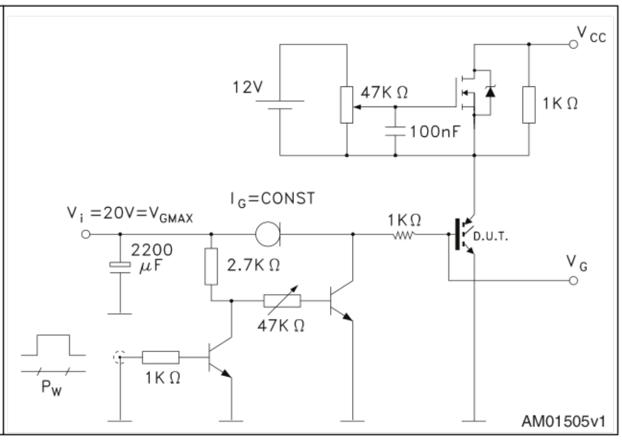


Figure 22. Switching waveform

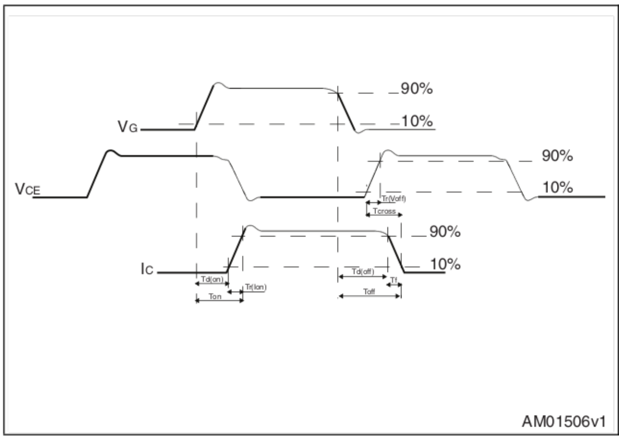
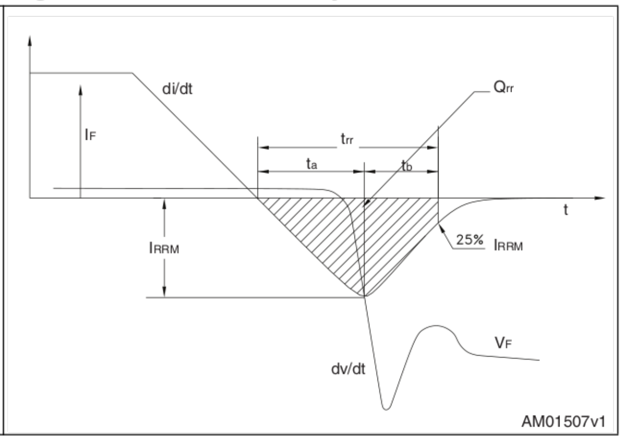


Figure 23. Diode recovery time waveform



4 Package mechanical data

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 9. D²PAK (TO-263) mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
A1	0.03		0.23
b	0.70		0.93
b2	1.14		1.70
c	0.45		0.60
c2	1.23		1.36
D	8.95		9.35
D1	7.50		
E	10		10.40
E1	8.50		
e		2.54	
e1	4.88		5.28
H	15		15.85
J1	2.49		2.69
L	2.29		2.79
L1	1.27		1.40
L2	1.30		1.75
R		0.4	
V2	0°		8°

D²PAK (TO-263) drawing

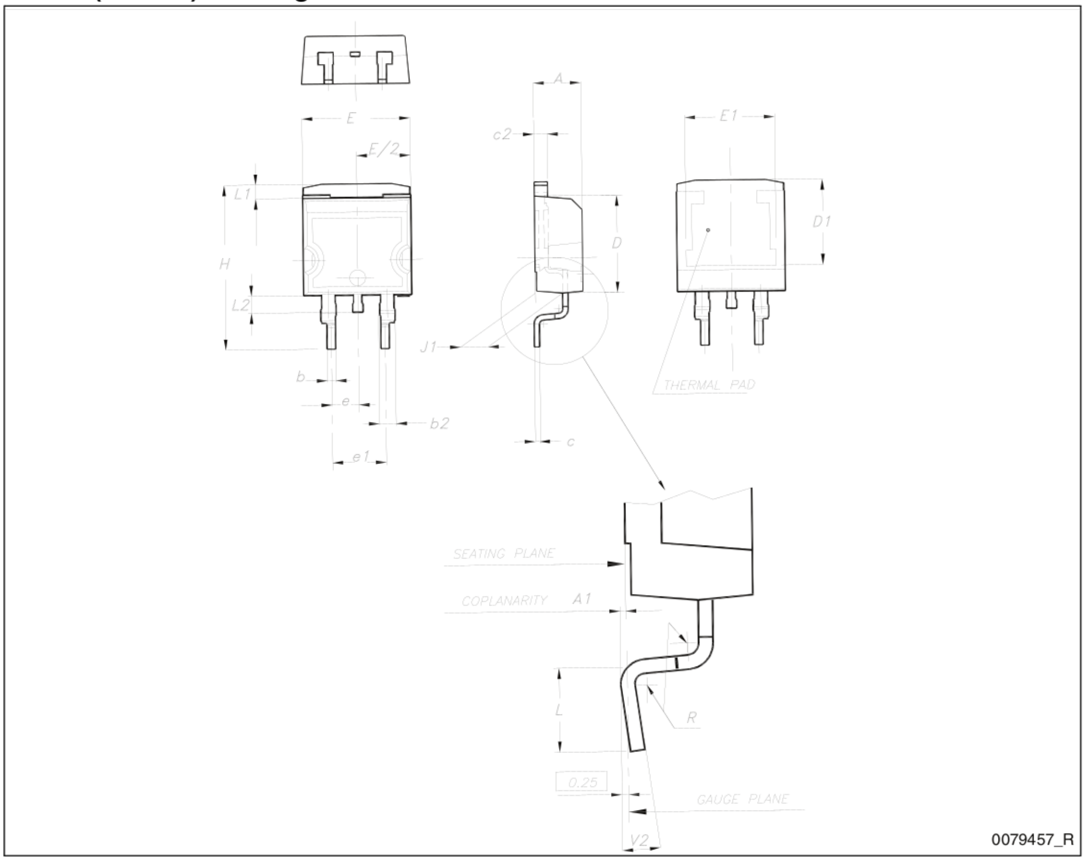


Table 10. TO-220FP mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.4		4.6
B	2.5		2.7
D	2.5		2.75
E	0.45		0.7
F	0.75		1
F1	1.15		1.70
F2	1.15		1.70
G	4.95		5.2
G1	2.4		2.7
H	10		10.4
L2		16	
L3	28.6		30.6
L4	9.8		10.6
L5	2.9		3.6
L6	15.9		16.4
L7	9		9.3
Dia	3		3.2

Figure 24. TO-220FP drawing

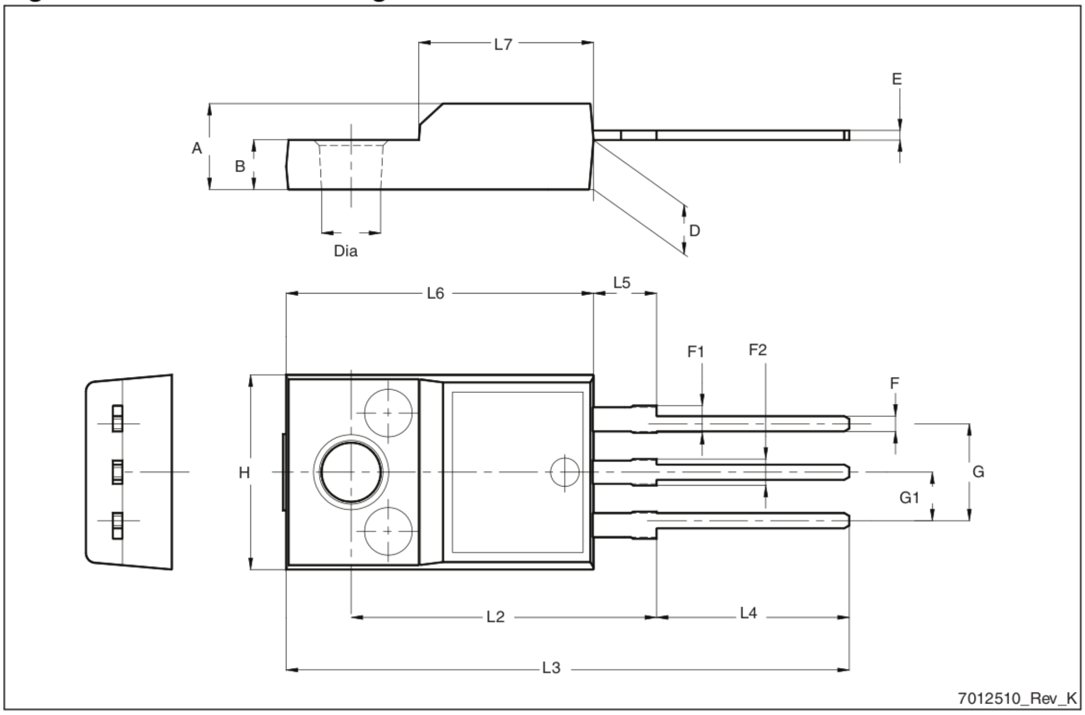
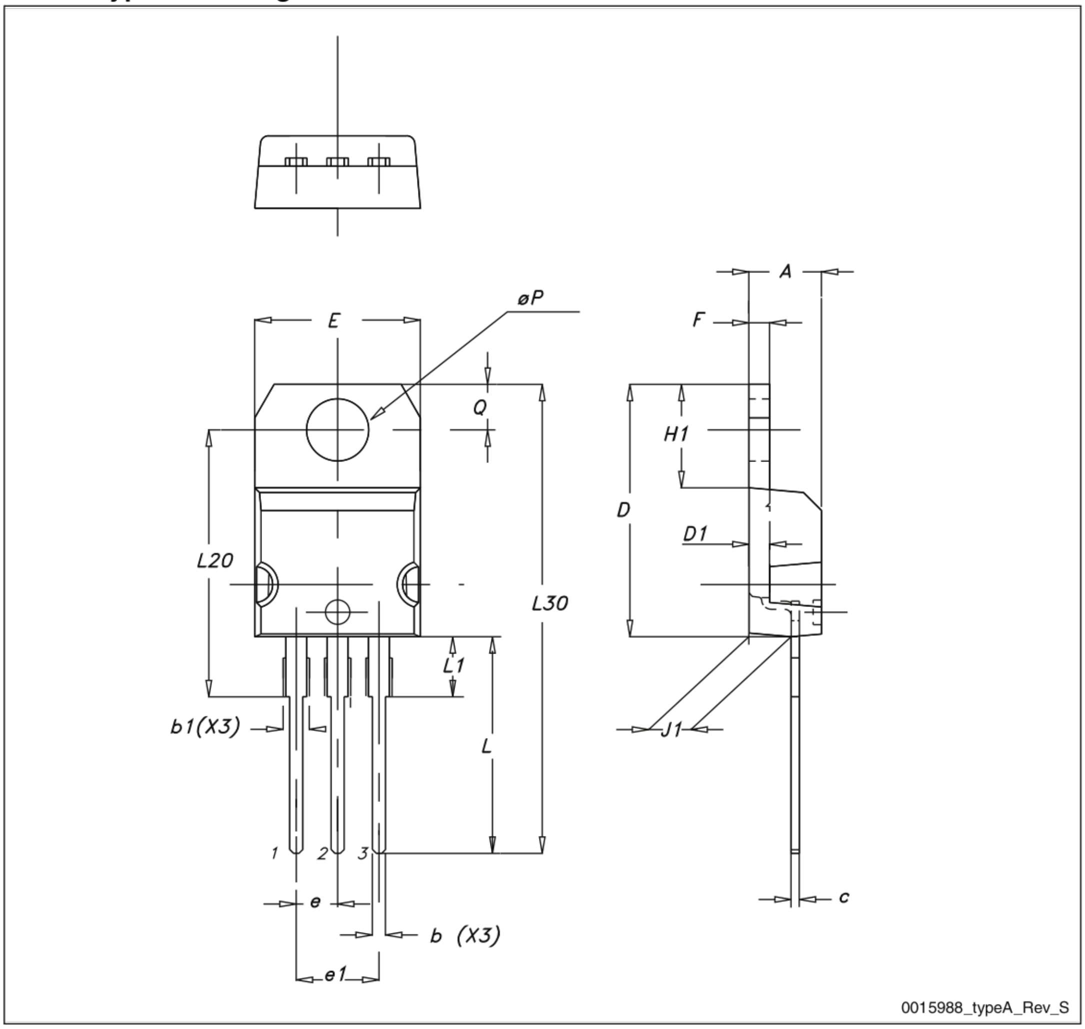


Table 11. TO-220 type A mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.70
c	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10		10.40
e	2.40		2.70
e1	4.95		5.15
F	1.23		1.32
H1	6.20		6.60
J1	2.40		2.72
L	13		14
L1	3.50		3.93
L20		16.40	
L30		28.90	
∅P	3.75		3.85
Q	2.65		2.95

TO-220 type A drawing



5 Revision history

Table 12. Document revision history

Date	Revision	Changes
13-Dec-2004	1	First release.
21-Jan-2005	2	Modified *Figure 18: Turn-off SOA*.
03-May-2010	3	Added new package, mechanical data: TO-220.
25-Jan-2011	4	Added new package, mechanical data: D^2PAK.