STGBL6NC60DI, STGDL6NC60DI
STGFL6NC60DI, STGPL6NC60DI

6 A, 600 V hyper fast IGBT

Features

- Low C_{RES} / C_{IES} ratio (no cross-conduction susceptibility)
- Very high frequency operation
- Very soft ultrafast recovery antiparallel diode

Applications

- High frequency inverters
- SMPS and PFC (hard switching too)
- High frequency motor drive

Description

Thanks to a new lifetime control system, this new PowerMESH™ technology-based series of devices exhibits very low turn-off energy, representing the best trade-off between on-state voltage and switching losses and thus allowing very high operating frequencies.

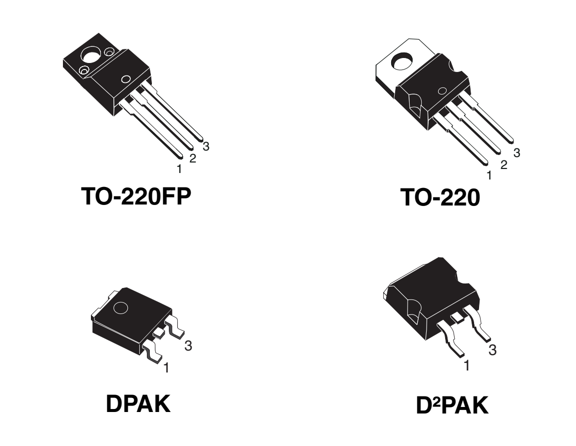


Figure 1. Internal schematic diagram

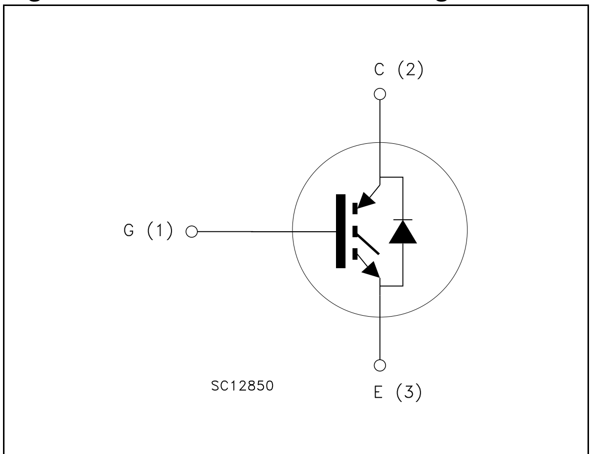


Table 1. Device summary

Order codes	Marking	Package	Packaging
STGBL6NC60DIT4	GBL6NC60DI	D²PAK	Tape and reel
STGDL6NC60DIT4	GDL6NC60DI	DPAK	Tape and reel
STGPL6NC60DI	GPL6NC60DI	TO-220	Tube
STGFL6NC60DI	GFL6NC60DI	TO-220FP	Tube

Contents

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value			Unit
		DPAK	TO-220 D²PAK	TO-220FP	
V_{CES}	Collector-emitter voltage (V_{GE} = 0)	600			V
I_C (1)	Collector current (continuous) at T_C = 25 °C	13	14	7	A
I_C (1)	Collector current (continuous) at T_C = 100 °C	5	6	3	A
I_{CL} (2)	Turn-off latching current	18			A
I_{CP} (3)	Pulsed collector current	18			A
V_{GE}	Gate-emitter voltage	±20			V
I_F	Diode RMS forward current at T_C = 25 °C	10			A
I_{FSM}	Surge non repetitive forward current t_p=10ms sinusoidal	25			A
P_{TOT}	Total dissipation at T_C = 25 °C	50	56	22	W
V_{ISO}	Isolation withstand voltage (RMS) from all three leads to external heat sink (t=1 s; T_C=25 °C)	--	--	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. Vclamp = 80%,(V_{CES}), Tj =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
		DPAK	TO-220 D²PAK	TO-220FP	
$R_{thj\text{-}case}$	Thermal resistance junction-case IGBT max.	2.5	2.2	5.6	°C/W
	Thermal resistance junction-case diode max.	4.5	4	7	°C/W
$R_{thj\text{-}amb}$	Thermal resistance junction-ambient max.	100	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	600			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} = 15 V, I_C= 1.5 A V_{GE} = 15 V, I_C= 3 A V_{GE}= 15 V, I_C= 3 A,T_j=125°C		1.9 2.2 2	2.9	V V V
$V_{GE(th)}$	Gate threshold voltage	V_{CE}= V_{GE}, I_C= 250 µA	3.75		5.75	V
I_{CES}	Collector cut-off current (V_{GE} = 0)	V_{CE} = 600 V V_{CE} = 600 V, T_j= 125 °C			50 5	µA mA
I_{GES}	Gate-emitter leakage current (V_{CE} = 0)	V_{GE} = ±20 V			±100	nA
g_{fs}	Forward transconductance	V_{CE} = 15 V, I_C= 3 A		3		S

Table 5. Dynamic electrical characteristics

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	-	208 32.5 5.4	-	pF pF pF
Q_g Q_{ge} Q_{gc}	Total gate charge Gate-emitter charge Gate-collector charge	V_{CE} = 390 V, I_C = 3 A, V_{GE} = 15 V *(see Figure 17)*	-	12 2.6 4.9	-	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} = 390 V, I_C = 3 A R_G= 10 Ω, V_{GE} = 15 V *(see Figure 18)*	-	6.7 3.7 930	-	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} = 390 V, I_C = 3 A R_G = 10 Ω, V_{GE} = 15 V, Tj =125 °C *(see Figure 18)*	-	6.5 4 820	-	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} = 390 V, I_C = 3 A, R_{GE} = 10 Ω, V_{GE} = 15 V *(see Figure 18)*	-	17 46 47	-	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} = 390 V, I_C = 3 A, R_{GE} = 10 Ω, V_{GE} =15 V, Tj = 125 °C *(see Figure 18)*	-	35 67 55	-	ns ns ns

Table 7. Switching energy (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
E_{on} (1) E_{off}(2) E_{ts}	Turn-on switching losses Turn-off switching losses Total switching losses	V_{CC} = 390 V, I_C = 3 A R_G = 10 Ω, V_{GE}=15 V *(see Figure 18)*	-	32 24 56	-	µJ µJ µJ
E_{on} (1) E_{off}(2) E_{ts}	Turn-on switching losses Turn-off switching losses Total switching losses	V_{CC} = 390 V, I_C = 3 A R_G = 10 Ω, V_{GE} = 15 V, Tj = 125 °C *(see Figure 18)*	-	51 46 97	-	µJ µJ µJ

1. Eon is the turn-on losses when a typical diode is used in the test circuit in *(see Figure 19)*. If the IGBT is offered in a package with a co-pak diode, the co-pack diode is used as external diode. IGBTs and 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 A I_F = 3 A I_F = 3 A, Tj=125 °C	-	 1.8 1.3	1.7	V 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 19)*	-	23 21 1.5		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 19)*	-	47 51 2		ns nC A

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

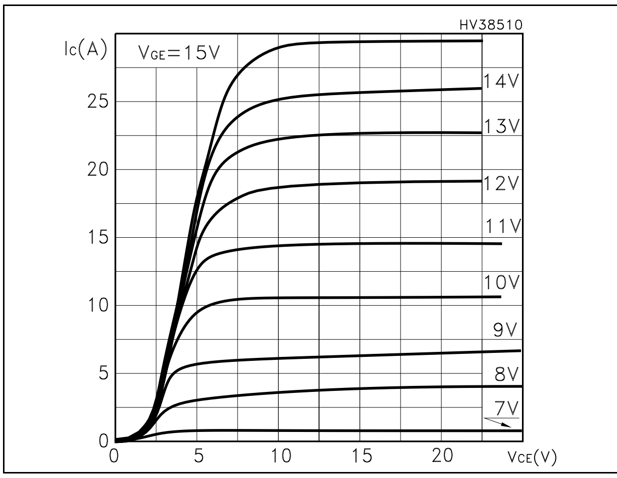


Figure 3. Transfer characteristics

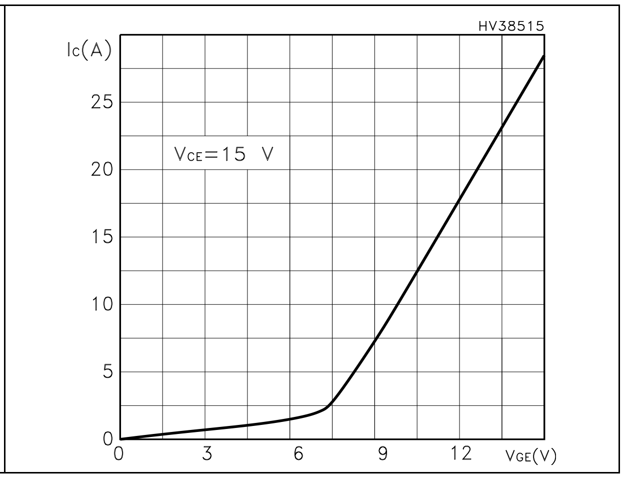


Figure 4. Transconductance

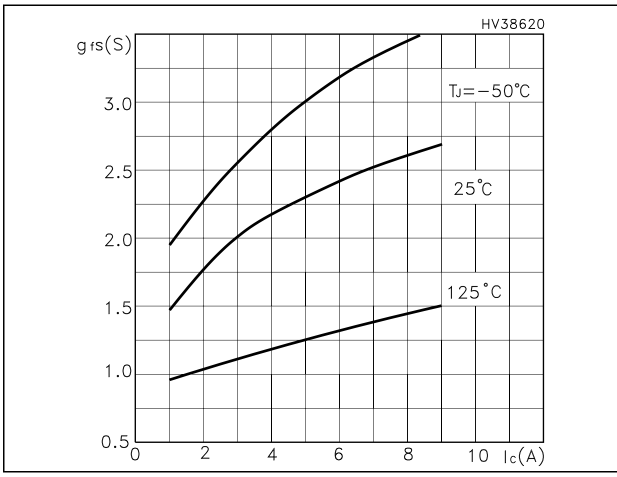


Figure 5. Collector-emitter on voltage vs temperature

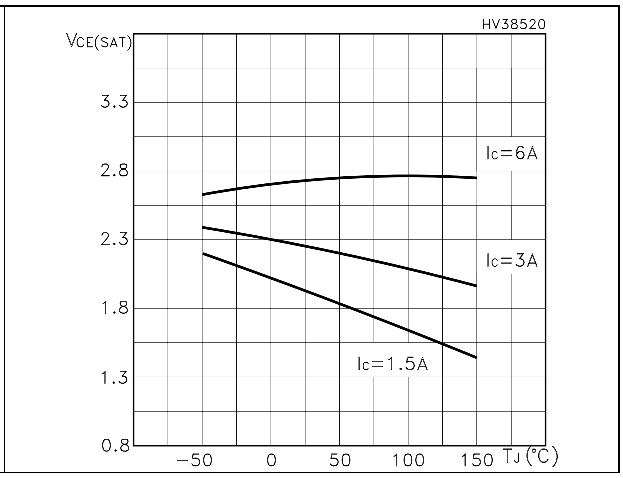


Figure 6. Gate charge vs gate-source voltage

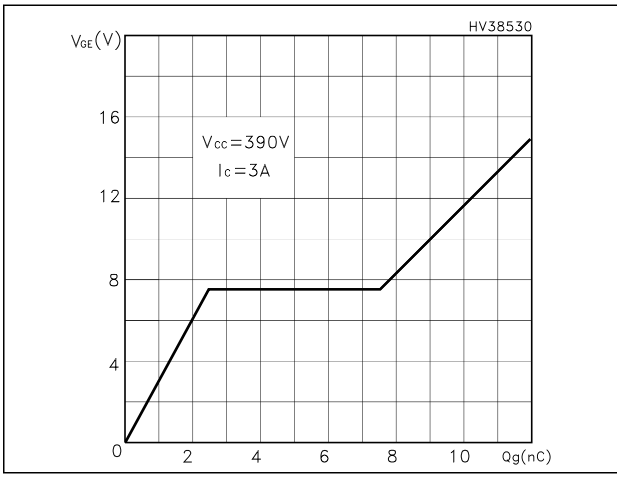


Figure 7. Capacitance variations

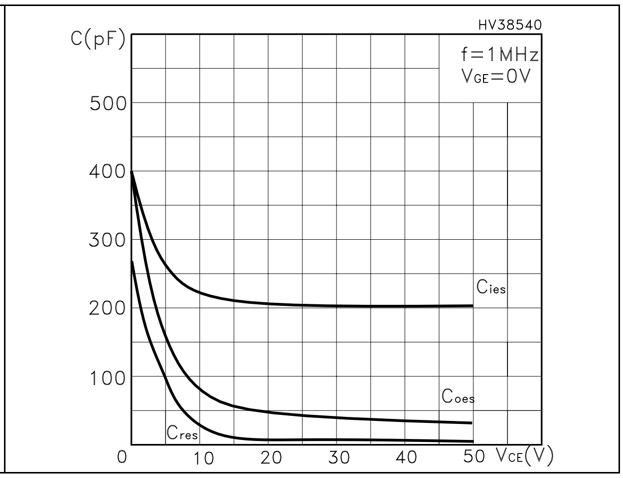


Figure 8. Normalized gate threshold voltage vs temperature

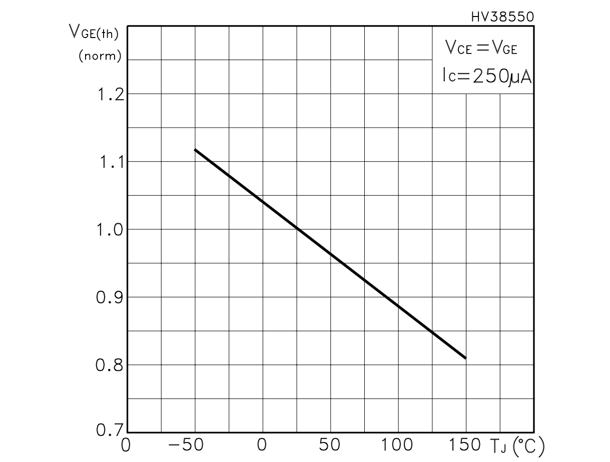


Figure 9. Collector-emitter on voltage vs collector current

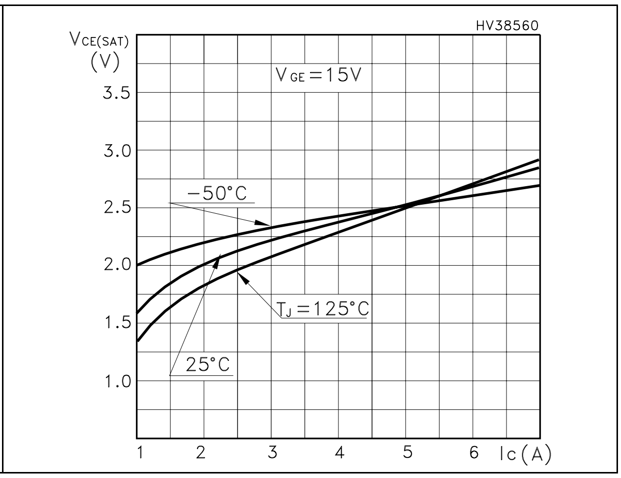


Figure 10. Normalized breakdown voltage vs temperature

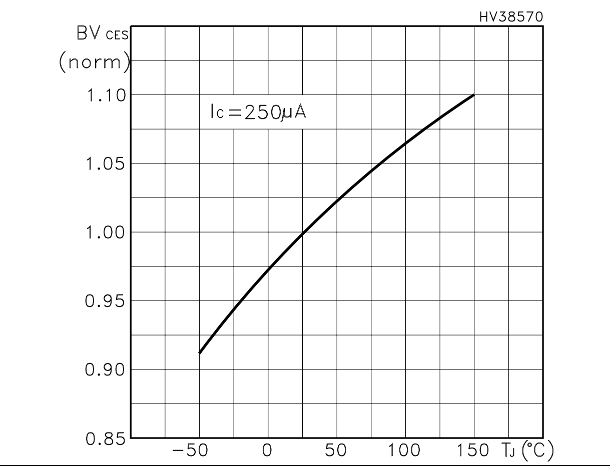


Figure 11. Switching losses vs temperature

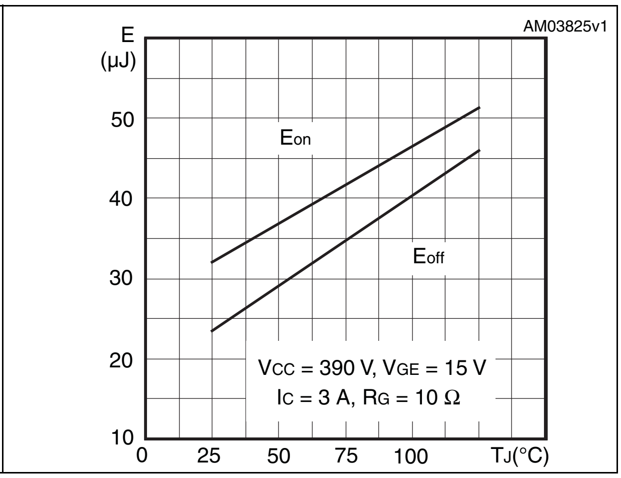


Figure 12. Switching losses vs gate resistance

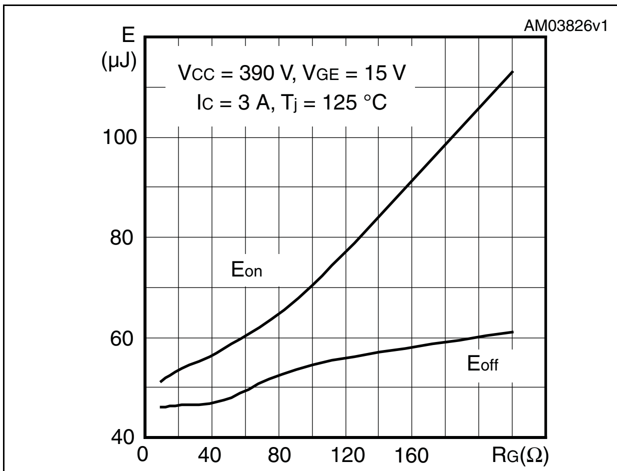


Figure 13. Switching losses vs collector current

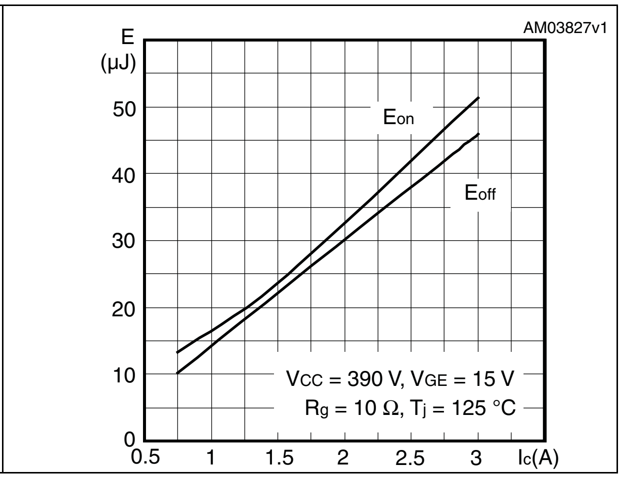


Figure 14. RBSOA

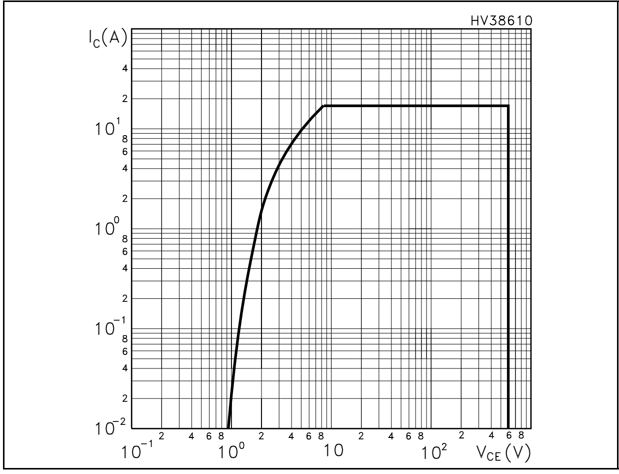
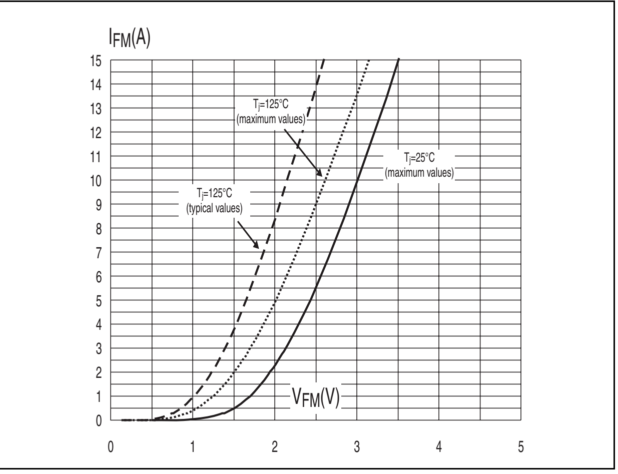


Figure 15. Forward voltage drop versus forward current



3 Test circuits

Figure 16. Test circuit for inductive load switching

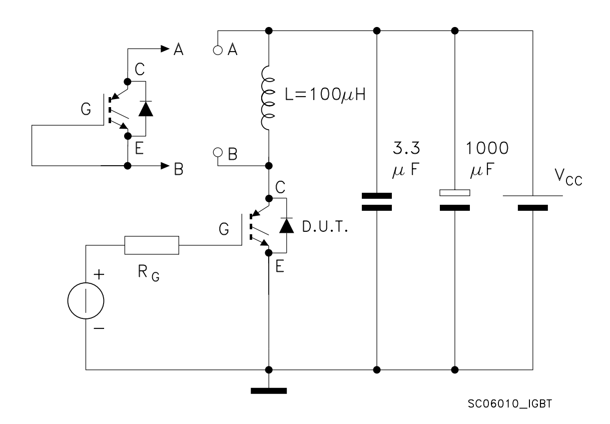


Figure 17. Gate charge test circuit

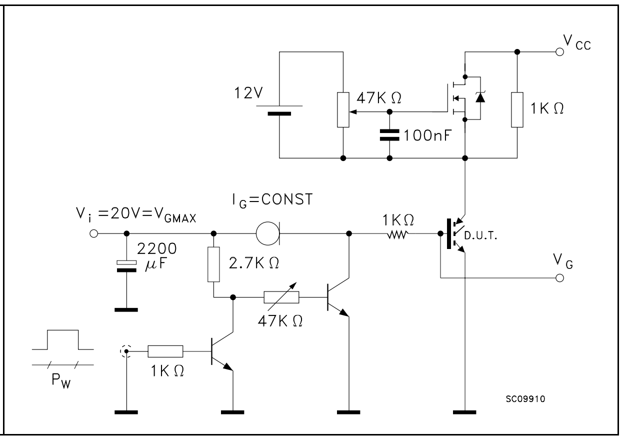


Figure 18. Switching waveform

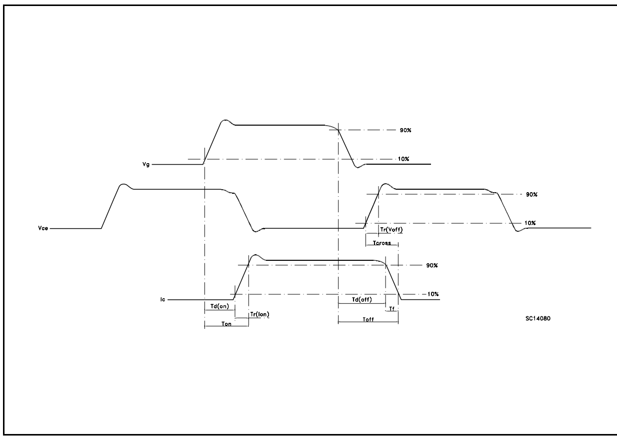
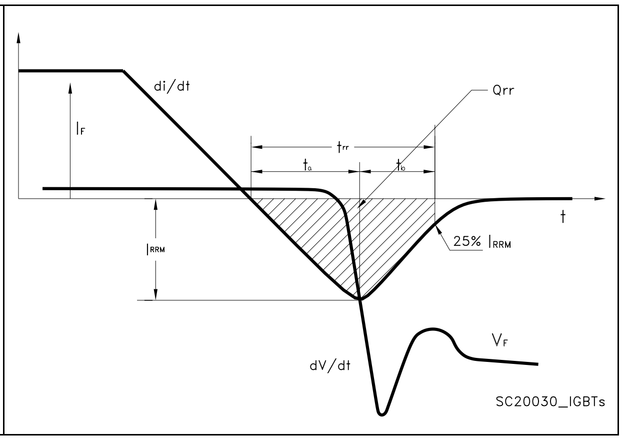


Figure 19. Diode recovery time waveform

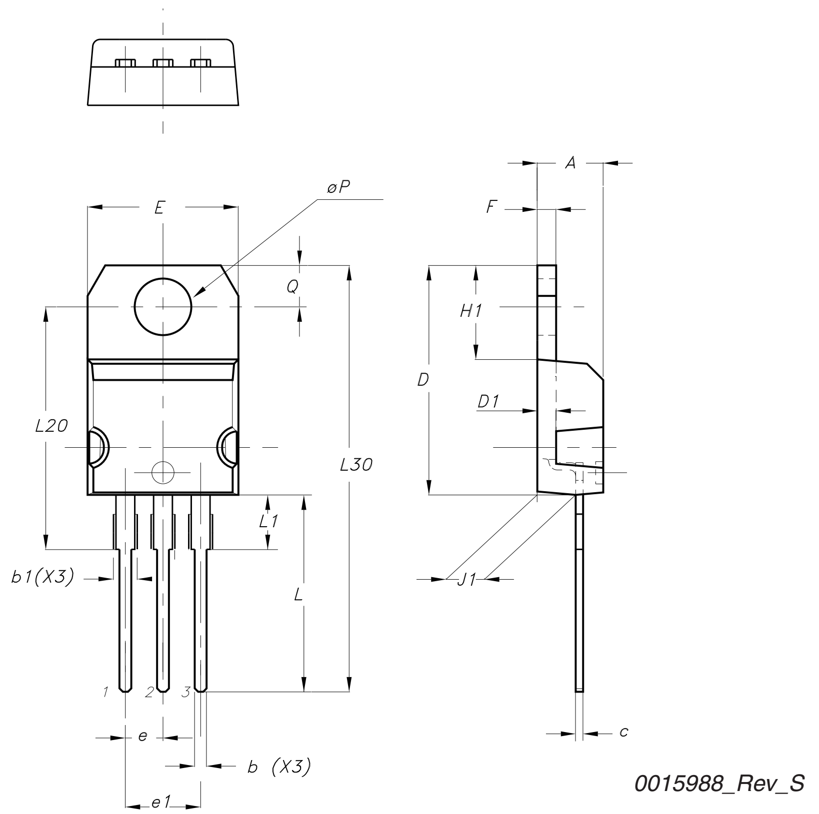


4 Package mechanical data

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.

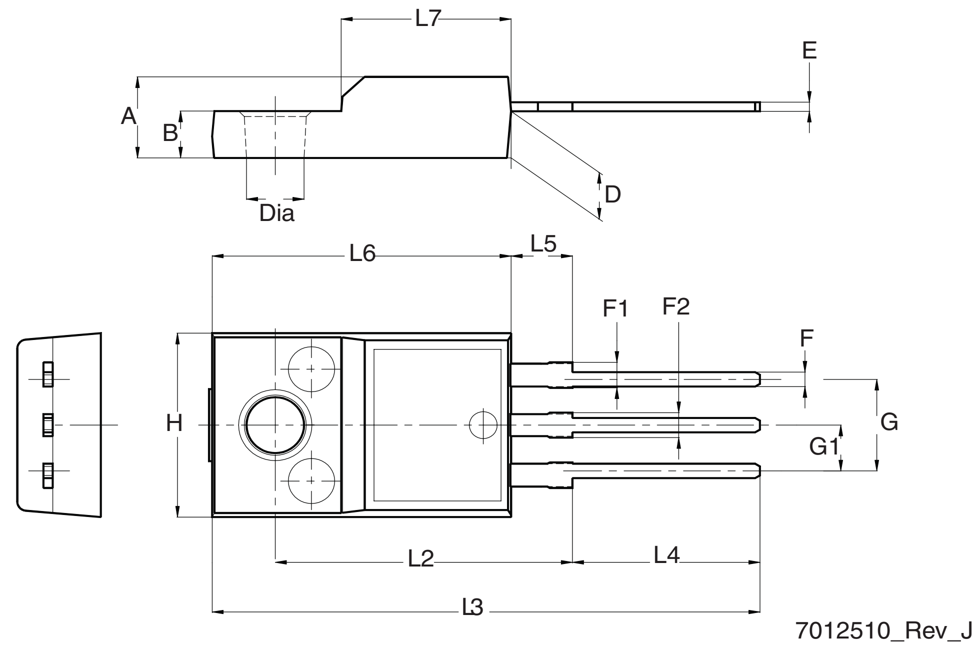
TO-220 type A mechanical data

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



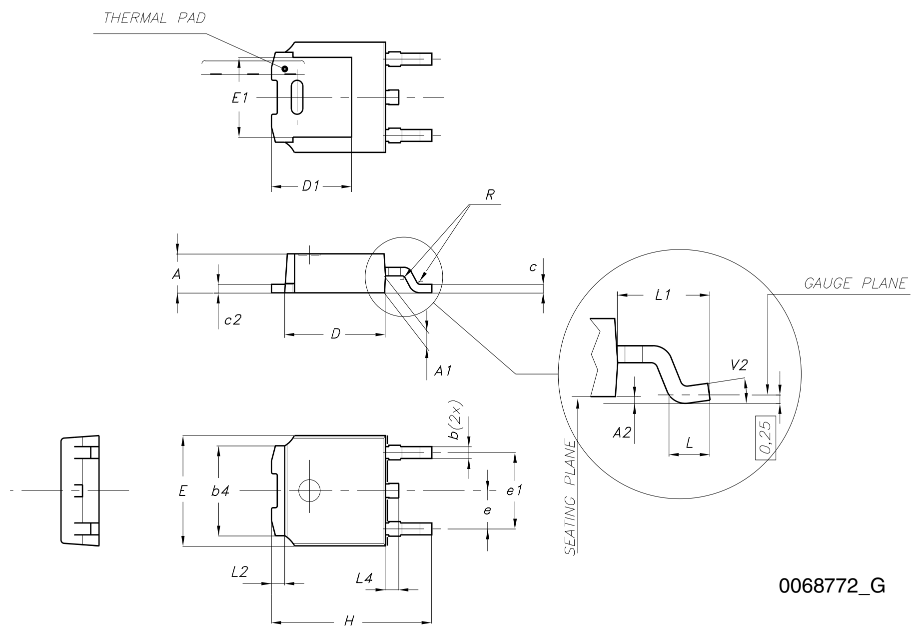
TO-220FP mechanical data

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		1.5
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



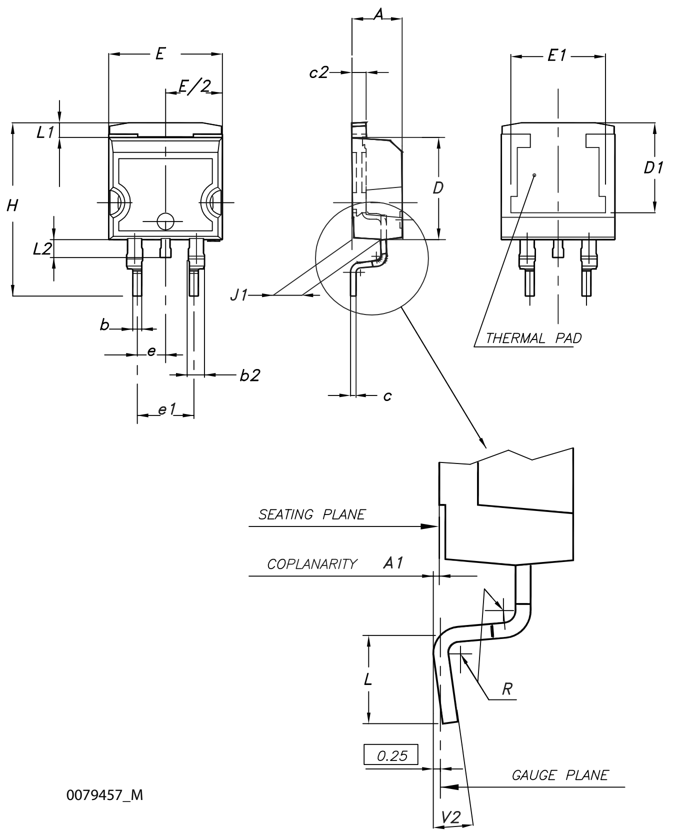
TO-252 (DPAK) mechanical data

DIM.	mm.		
	min.	typ	max.
A	2.20		2.40
A1	0.90		1.10
A2	0.03		0.23
b	0.64		0.90
b4	5.20		5.40
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
D1		5.10	
E	6.40		6.60
E1		4.70	
e		2.28	
e1	4.40		4.60
H	9.35		10.10
L	1		
L1		2.80	
L2		0.80	
L4	0.60		1
R		0.20	
V2	0 °		8 °



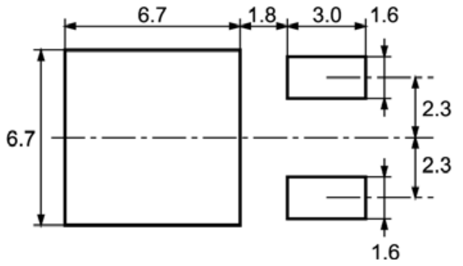
D^2PAK (TO-263) mechanical data

Dim	mm			inch		
	Min	Typ	Max	Min	Typ	Max
A	4.40		4.60	0.173		0.181
A1	0.03		0.23	0.001		0.009
b	0.70		0.93	0.027		0.037
b2	1.14		1.70	0.045		0.067
c	0.45		0.60	0.017		0.024
c2	1.23		1.36	0.048		0.053
D	8.95		9.35	0.352		0.368
D1	7.50			0.295		
E	10		10.40	0.394		0.409
E1	8.50			0.334		
e		2.54			0.1	
e1	4.88		5.28	0.192		0.208
H	15		15.85	0.590		0.624
J1	2.49		2.69	0.099		0.106
L	2.29		2.79	0.090		0.110
L1	1.27		1.40	0.05		0.055
L2	1.30		1.75	0.051		0.069
R		0.4			0.016	
V2	0°		8°	0°		8°



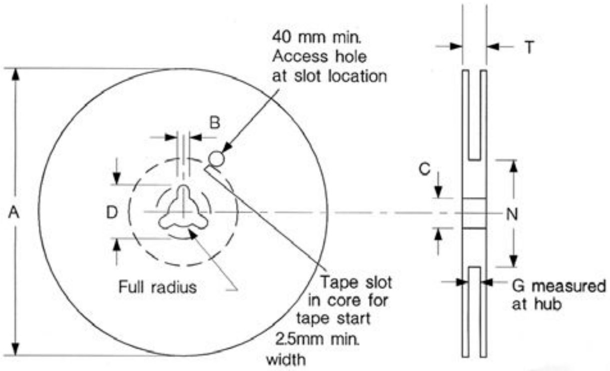
5 Packaging mechanical data

DPAK FOOTPRINT



All dimensions are in millimeters

TAPE AND REEL SHIPMENT



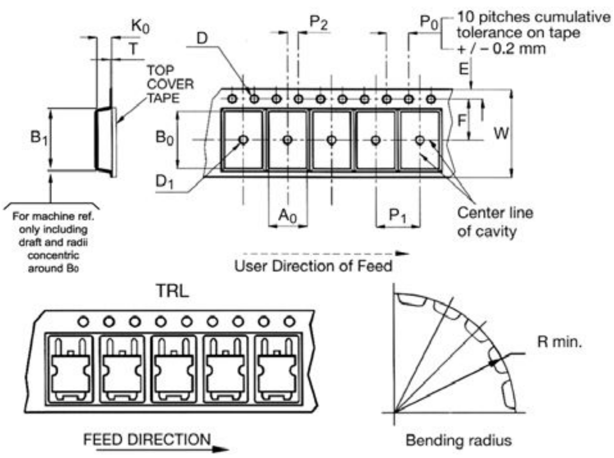
REEL MECHANICAL DATA

DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A		330		12.992
B	1.5		0.059	
C	12.8	13.2	0.504	0.520
D	20.2		0.795	
G	16.4	18.4	0.645	0.724
N	50		1.968	
T		22.4		0.881

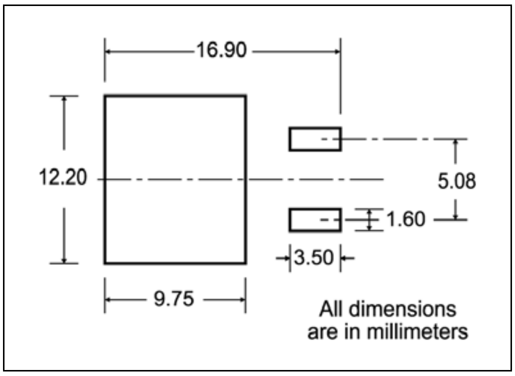
BASE QTY	BULK QTY
2500	2500

TAPE MECHANICAL DATA

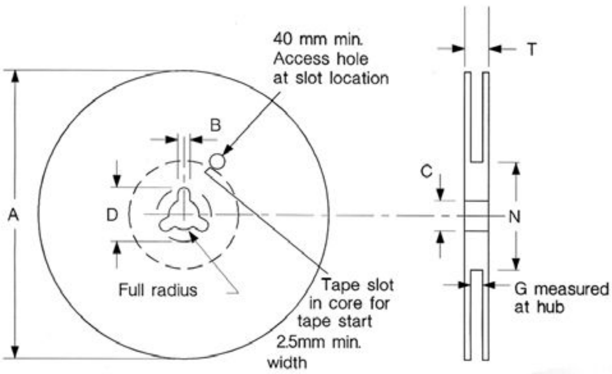
DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A0	6.8	7	0.267	0.275
B0	10.4	10.6	0.409	0.417
B1		12.1		0.476
D	1.5	1.6	0.059	0.063
D1	1.5		0.059	
E	1.65	1.85	0.065	0.073
F	7.4	7.6	0.291	0.299
K0	2.55	2.75	0.100	0.108
P0	3.9	4.1	0.153	0.161
P1	7.9	8.1	0.311	0.319
P2	1.9	2.1	0.075	0.082
R	40		1.574	
W	15.7	16.3	0.618	0.641



D²PAK FOOTPRINT



TAPE AND REEL SHIPMENT



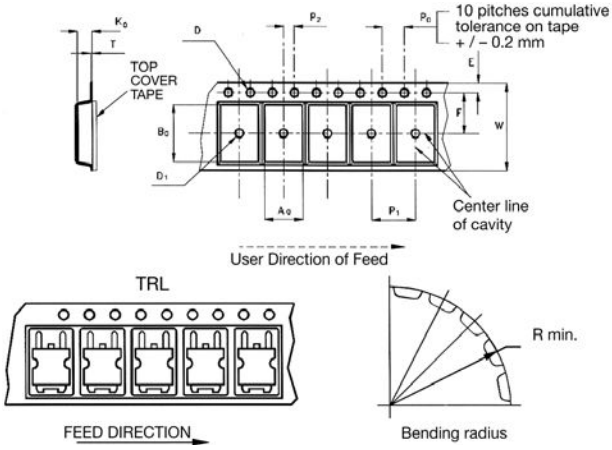
REEL MECHANICAL DATA

DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A		330		12.992
B	1.5		0.059	
C	12.8	13.2	0.504	0.520
D	20.2		0795	
G	24.4	26.4	0.960	1.039
N	100		3.937	
T		30.4		1.197

BASE QTY	BULK QTY
1000	1000

TAPE MECHANICAL DATA

DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A0	10.5	10.7	0.413	0.421
B0	15.7	15.9	0.618	0.626
D	1.5	1.6	0.059	0.063
D1	1.59	1.61	0.062	0.063
E	1.65	1.85	0.065	0.073
F	11.4	11.6	0.449	0.456
K0	4.8	5.0	0.189	0.197
P0	3.9	4.1	0.153	0.161
P1	11.9	12.1	0.468	0.476
P2	1.9	2.1	0.075	0.082
R	50		1.574	
T	0.25	0.35	0.0098	0.0137
W	23.7	24.3	0.933	0.956



* on sales type

6 Revision history

Table 9. Document revision history

Date	Revision	Changes
27-Mar-2009	1	First release
13-Aug-2009	2	Document status promoted from preliminary data to datasheet, inserted *Section 2.1: Electrical characteristics (curves)*, updated TO-220 and TO-220FP package mechanical data