

4.5 A, 600 V very fast IGBT with Ultrafast diode

Features

- Minimal tail current
- Low conduction and switching losses
- Ultrafast soft recovery antiparallel diode

Applications

Motor drive

Description

The STGD3HF60HD is based on a new advanced planar technology concept to yield an IGBT with more stable switching performance (E_{off}) versus temperature, as well as lower conduction losses.

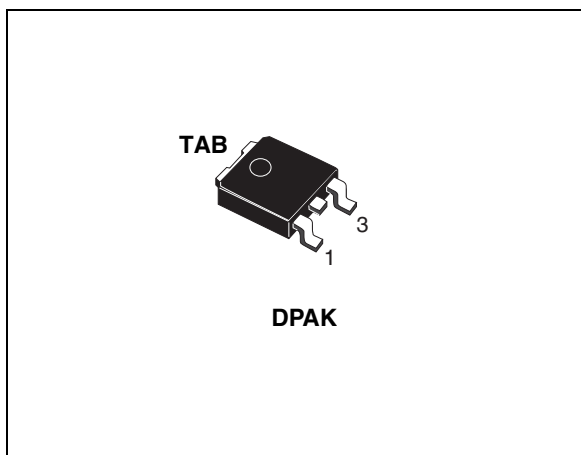


Figure 1. Internal schematic diagram

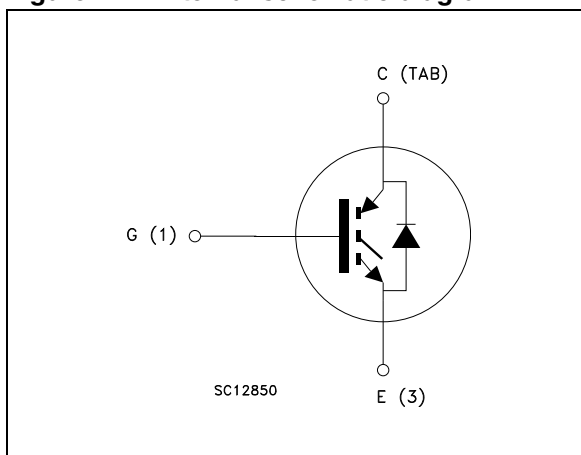


Table 1. Device summary

Order codes	Marking	Package	Packaging
STGD3HF60HDT4	GD3HF60HD	DPAK	Tape and reel

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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CES}	Collector-emitter voltage ($V_{GE} = 0$)	600	V
$I_C^{(1)}$	Continuous collector current at $T_C = 25\text{ °C}$	7.5	A
$I_C^{(1)}$	Continuous collector current at $T_C = 100\text{ °C}$	4.5	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 $T_C = 25\text{ °C}$	10	A
I_{FSM}	Surge non repetitive forward current $t_p=10\text{ms}$ sinusoidal	25	A
P_{TOT}	Total dissipation at $T_C = 25\text{ °C}$	38	W
T_j	Operating junction temperature	- 55 to 150	$^{\circ}\text{C}$

1. Calculated according to the iterative formula:

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

2. $V_{\text{clamp}} = 80\% \cdot (V_{CES})$, $T_j = 150\text{ °C}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$.

3. Pulse width limited by maximum junction temperature and turn-off within RBSOA.

Table 3. Thermal data

Symbol	Parameter	Value	Unit
$R_{thj\text{-case}}$	Thermal resistance junction-case IGBT	3.3	$^{\circ}\text{C/W}$
	Thermal resistance junction-case diode	5	$^{\circ}\text{C/W}$
$R_{thj\text{-amb}}$	Thermal resistance junction-ambient	100	$^{\circ}\text{C/W}$

2 Electrical characteristics

($T_j=25\text{ °C}$ unless otherwise specified).

Table 4. Static electrical characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage ($V_{GE} = 0$)	$I_C = 1\text{ mA}$	600			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}$, $I_C = 0.5\text{ A}$, $T_j = 125\text{ °C}$ $V_{GE} = 15\text{ V}$, $I_C = 1.5\text{ A}$ $V_{GE} = 15\text{ V}$, $I_C = 1.5\text{ A}$, $T_j = 125\text{ °C}$		1.4 2.45 1.85	2.95	V
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}$, $I_C = 250\text{ }\mu\text{A}$	3.75		5.75	V
I_{CES}	Collector cut-off current ($V_{GE} = 0$)	$V_{CE} = 600\text{ V}$ $V_{CE} = 600\text{ V}$, $T_j = 125\text{ °C}$			250 1	μA mA
I_{GES}	Gate-emitter leakage current ($V_{CE} = 0$)	$V_{GE} = \pm 20\text{ V}$			± 100	nA
g_{fs}	Forward transconductance	$V_{CE} = 15\text{ V}$, $I_C = 1.5\text{ A}$		1.5		S

Table 5. Dynamic electrical characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{ies}	Input capacitance	$V_{CE} = 25\text{ V}$, $f = 1\text{ MHz}$, $V_{GE} = 0$	-	152	-	pF
C_{oes}	Output capacitance			14		pF
C_{res}	Reverse transfer capacitance			3		pF
Q_g	Total gate charge	$V_{CE} = 480\text{ V}$, $I_C = 1.5\text{ A}$, $V_{GE} = 15\text{ V}$ (see Figure 18)	-	12	-	nC
Q_{ge}	Gate-emitter charge			2		nC
Q_{gc}	Gate-collector charge			6		nC

Table 6. Switching on/off (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 400\text{ V}, I_C = 1.5\text{ A}$		11		ns
t_r	Current rise time	$R_G = 100\ \Omega, V_{GE} = 15\text{ V}$	-	4	-	ns
$(di/dt)_{on}$	Turn-on current slope	(see Figure 19)		285		A/ μ s
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 400\text{ V}, I_C = 1.5\text{ A}$		10		ns
t_r	Current rise time	$R_G = 100\ \Omega, V_{GE} = 15\text{ V},$	-	5	-	ns
$(di/dt)_{on}$	Turn-on current slope	$T_j = 125\text{ }^\circ\text{C}$ (see Figure 19)		265		A/ μ s
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 400\text{ V}, I_C = 1.5\text{ A},$		26		ns
$t_{d(off)}$	Turn-off delay time	$R_{GE} = 100\ \Omega, V_{GE} = 15\text{ V}$	-	60	-	ns
t_f	Current fall time	(see Figure 19)		50		ns
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 400\text{ V}, I_C = 1.5\text{ A},$		64		ns
$t_{d(off)}$	Turn-off delay time	$R_{GE} = 100\ \Omega, V_{GE} = 15\text{ V},$	-	69	-	ns
t_f	Current fall time	$T_j = 125\text{ }^\circ\text{C}$ (see Figure 19)		71		ns

Table 7. Switching energy (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 400\text{ V}, I_C = 1.5\text{ A}$		19		μ J
$E_{off}^{(2)}$	Turn-off switching losses	$R_G = 100\ \Omega, V_{GE} = 15\text{ V}$	-	12	-	μ J
E_{ts}	Total switching losses	(see Figure 19)		31		μ J
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 400\text{ V}, I_C = 1.5\text{ A}$		38		μ J
$E_{off}^{(2)}$	Turn-off switching losses	$R_G = 100\ \Omega, V_{GE} = 15\text{ V},$	-	35	-	μ J
E_{ts}	Total switching losses	$T_j = 125\text{ }^\circ\text{C}$ (see Figure 19)		73		μ J

1. E_{on} is the turn-on losses when a typical diode is used in the test circuit in (see Figure 20). If the IGBT is offered in a package with a co-pak diode, the co-pak 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	$I_F = 1.5\text{ A}$ $I_F = 1.5\text{ A}, T_j = 125\text{ }^\circ\text{C}$	-	1.4 1.15	1.8	V
t_{rr}	Reverse recovery time	$I_F = 1.5\text{ A}, V_R = 40\text{ V},$		85		ns
Q_{rr}	Reverse recovery charge	$di/dt = 100\text{ A}/\mu\text{s}$	-	124		nC
I_{rrm}	Reverse recovery current	(see Figure 20)		3		A
t_{rr}	Reverse recovery time	$I_F = 1.5\text{ A}, V_R = 40\text{ V},$		114		ns
Q_{rr}	Reverse recovery charge	$T_j = 125\text{ }^\circ\text{C}, di/dt = 100\text{ A}/\mu\text{s}$	-	194		nC
I_{rrm}	Reverse recovery current	(see Figure 20)		3.5		A

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

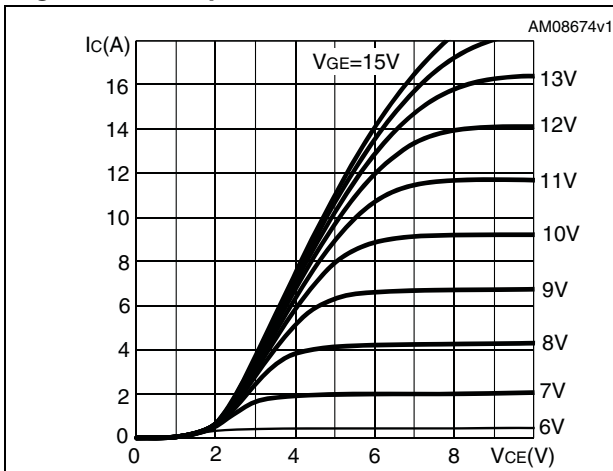


Figure 3. Output characteristic details

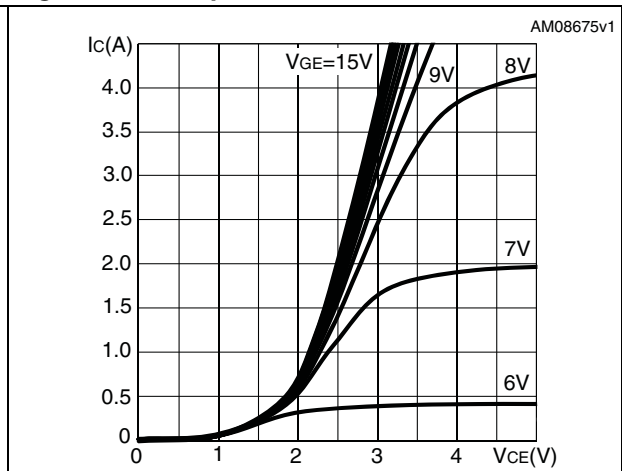


Figure 4. Transfer characteristics

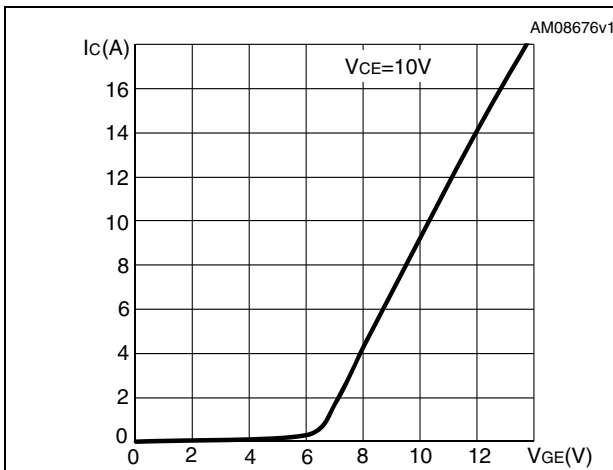


Figure 5. Collector-emitter on voltage vs collector current

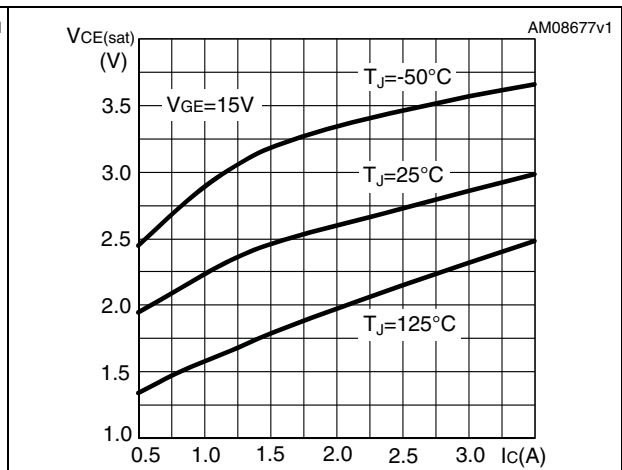


Figure 6. Collector-emitter on voltage vs temperature

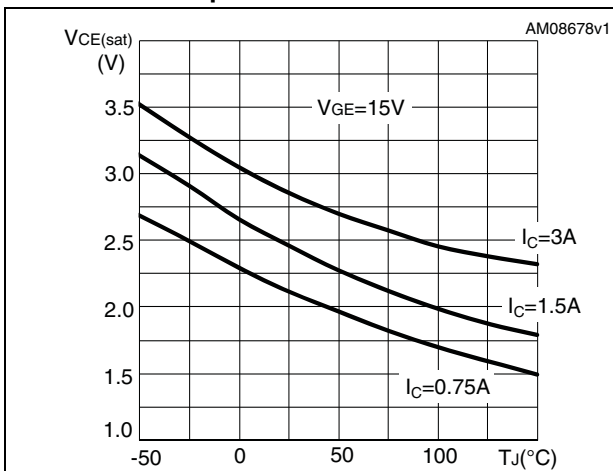


Figure 7. Breakdown voltage vs temperature

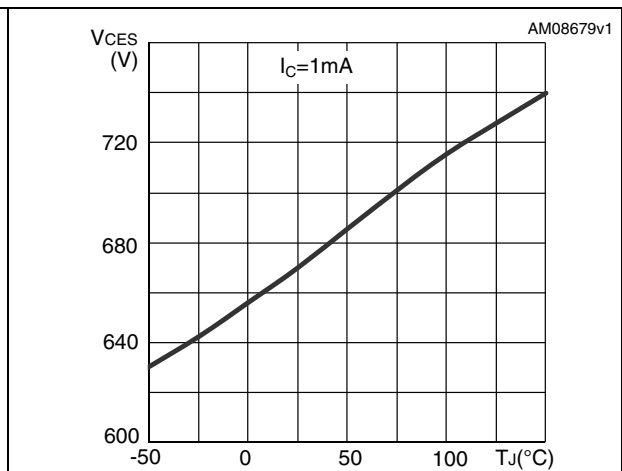


Figure 8. Gate threshold voltage vs temperature

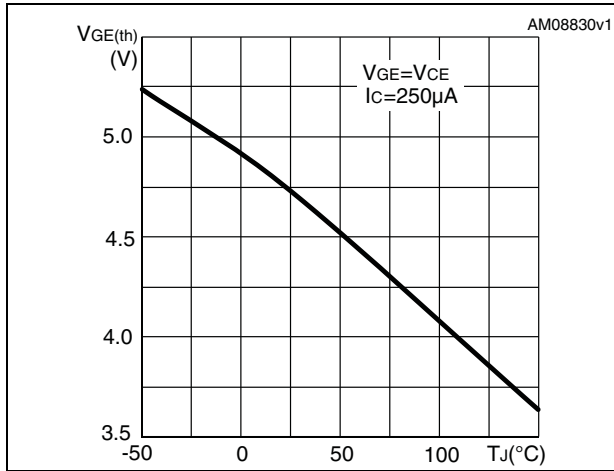


Figure 9. Gate charge vs gate-emitter voltage

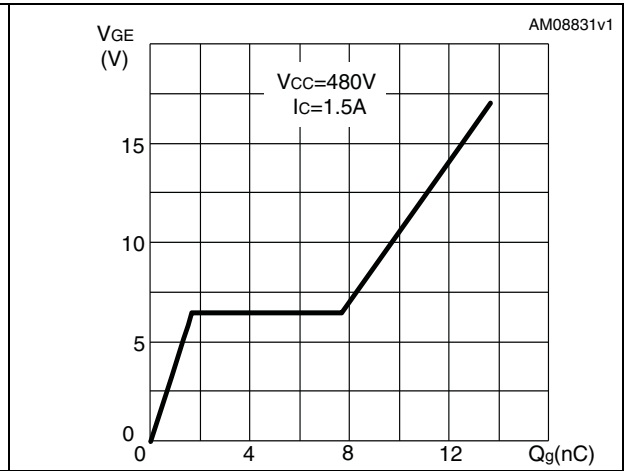


Figure 10. Capacitance variations

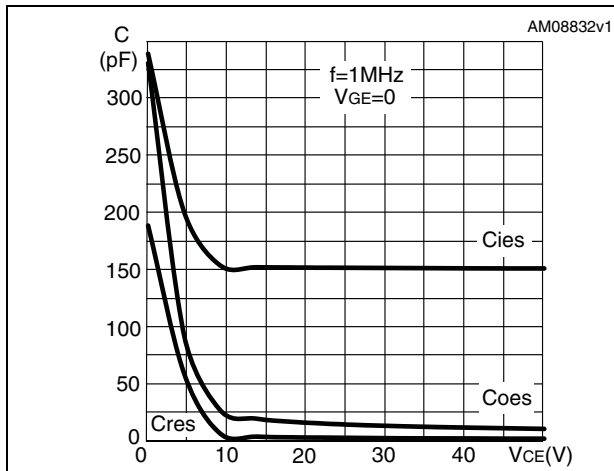


Figure 11. Switching losses vs collector current

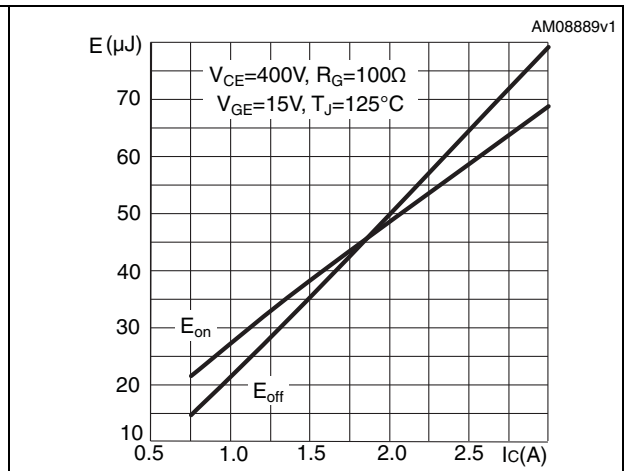


Figure 12. Switching losses vs gate resistance Figure 13. Switching losses vs temperature

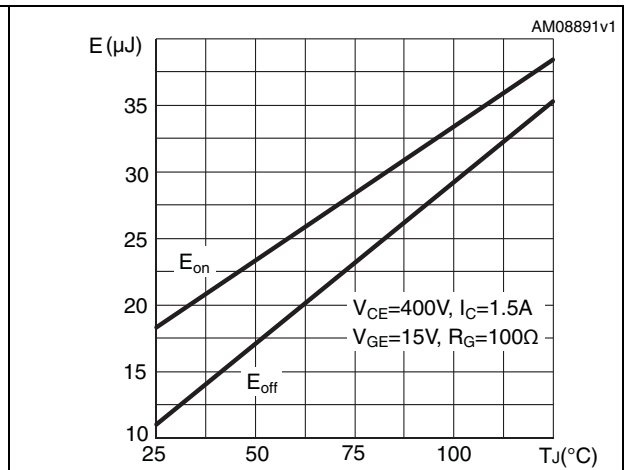
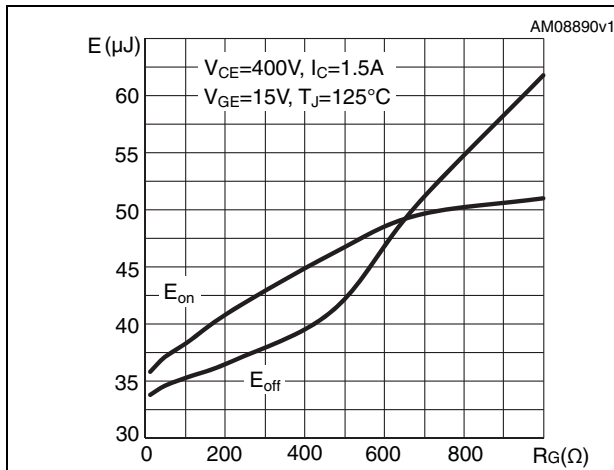


Figure 14. Turn-off SOA

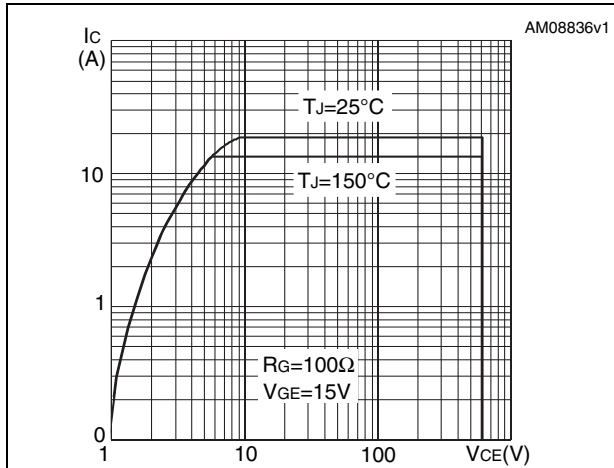


Figure 15. Diode forward on voltage

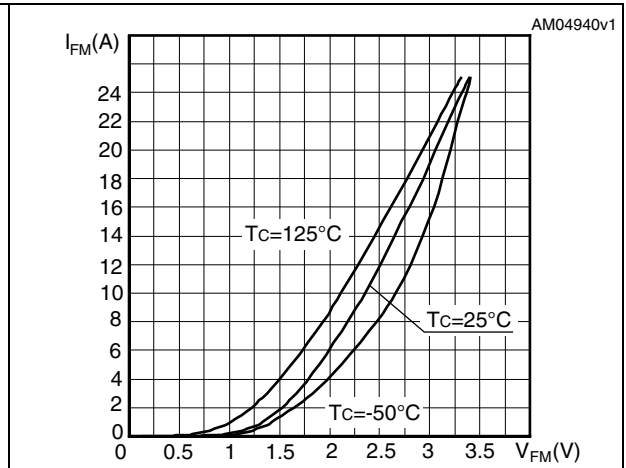
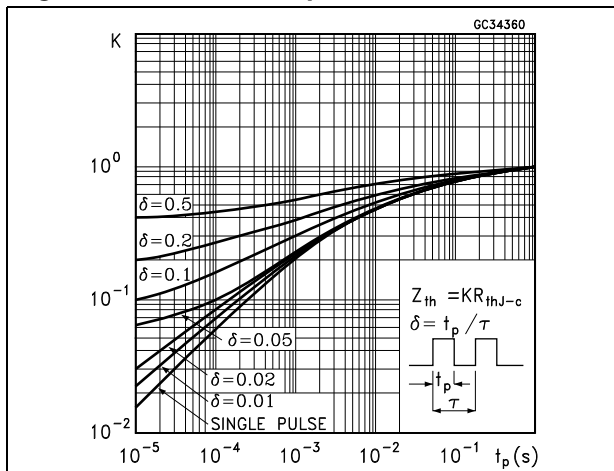


Figure 16. Thermal impedance



3 Test circuits

Figure 17. Test circuit for inductive load switching

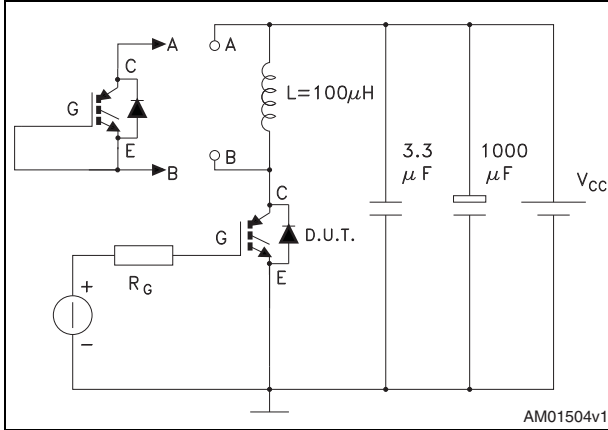


Figure 18. Gate charge test circuit

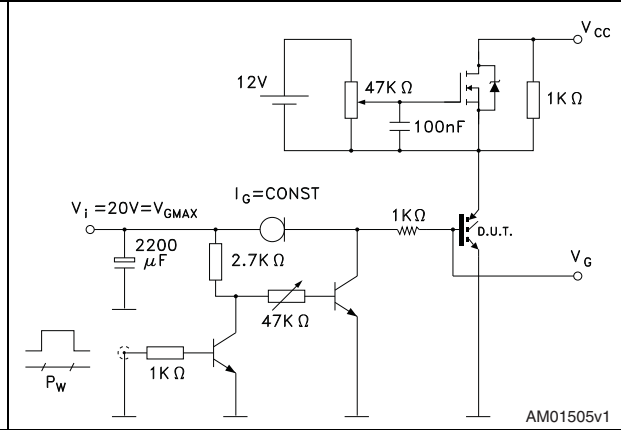


Figure 19. Switching waveform

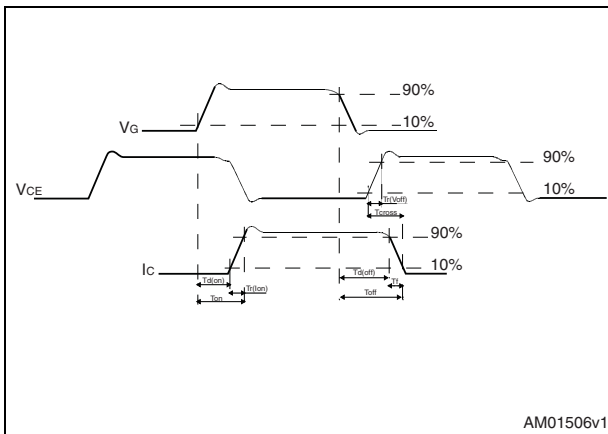
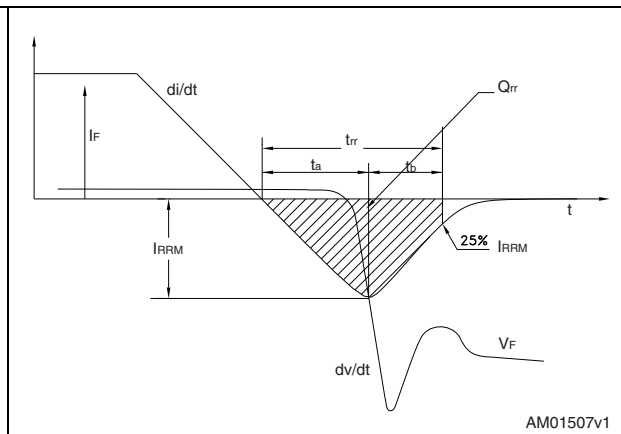


Figure 20. Diode recovery time waveform



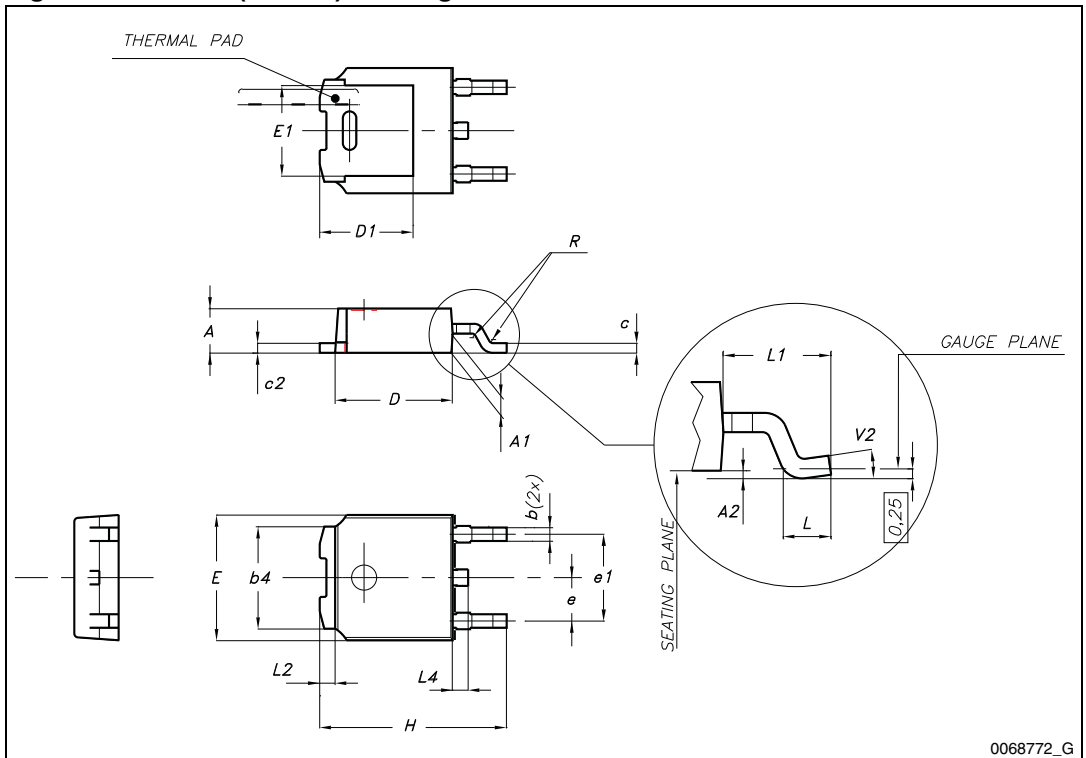
4 Package mechanical data

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. DPAK (TO-252) 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°

Figure 21. DPAK (TO-252) drawing

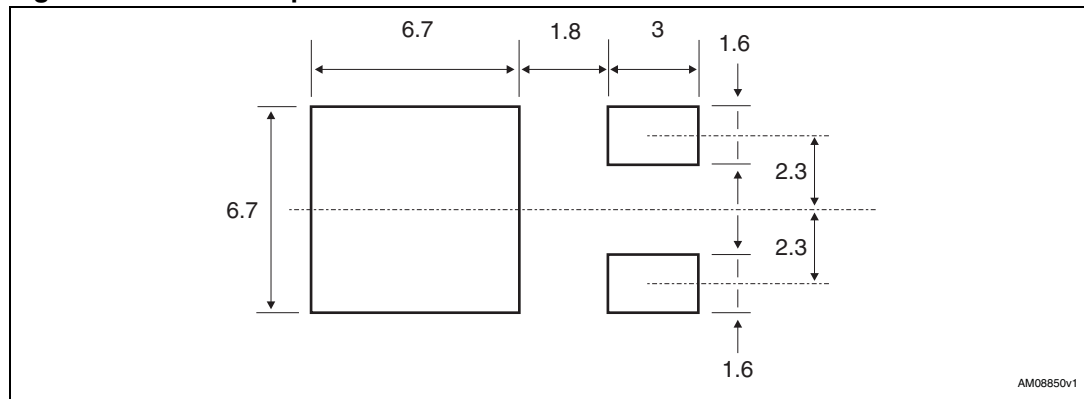


5 Packaging mechanical data

Table 10. DPAK (TO-252) tape and reel mechanical data

Tape			Reel		
Dim.	mm		Dim.	mm	
	Min.	Max.		Min.	Max.
A0	6.8	7	A		330
B0	10.4	10.6	B	1.5	
B1		12.1	C	12.8	13.2
D	1.5	1.6	D	20.2	
D1	1.5		G	16.4	18.4
E	1.65	1.85	N	50	
F	7.4	7.6	T		22.4
K0	2.55	2.75			
P0	3.9	4.1	Base qty.	2500	
P1	7.9	8.1	Bulk qty.	2500	
P2	1.9	2.1			
R	40				
T	0.25	0.35			
W	15.7	16.3			

Figure 22. DPAK footprint^(a)



a. All dimension are in millimeters

Figure 23. Tape for DPAK (TO-252)

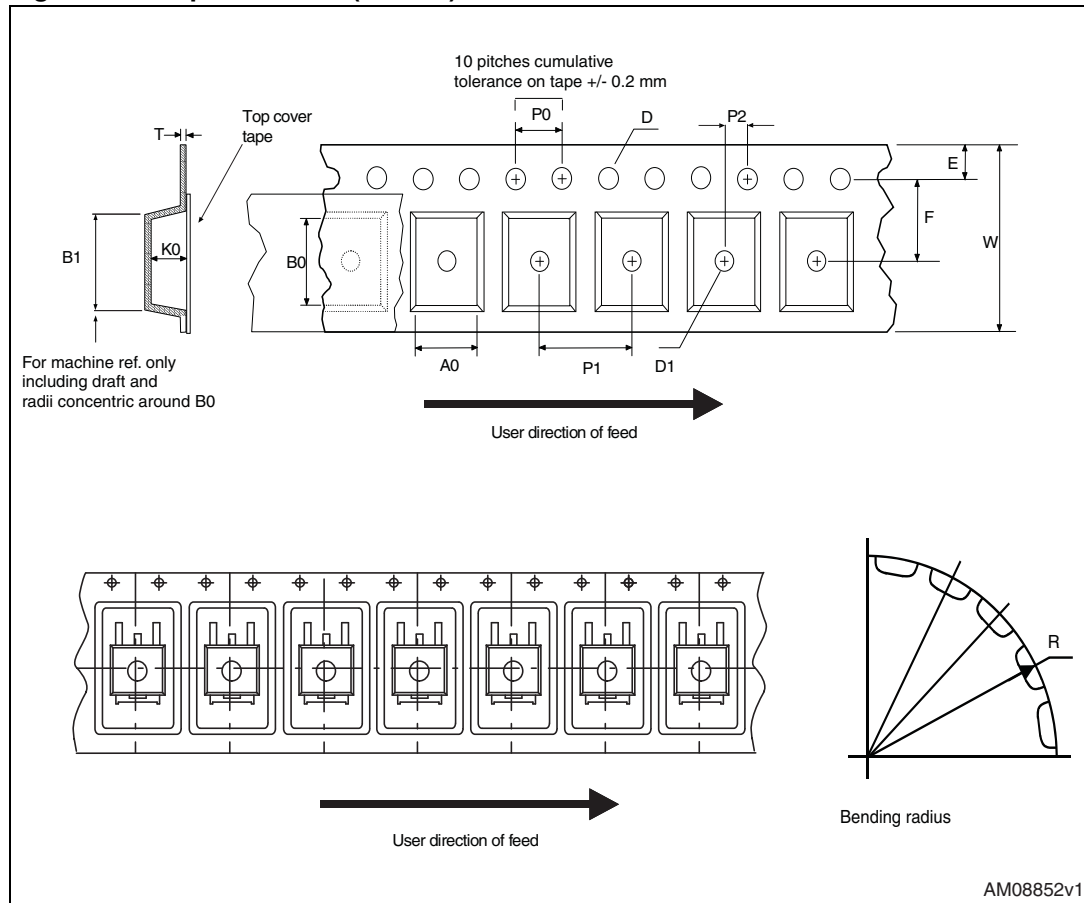
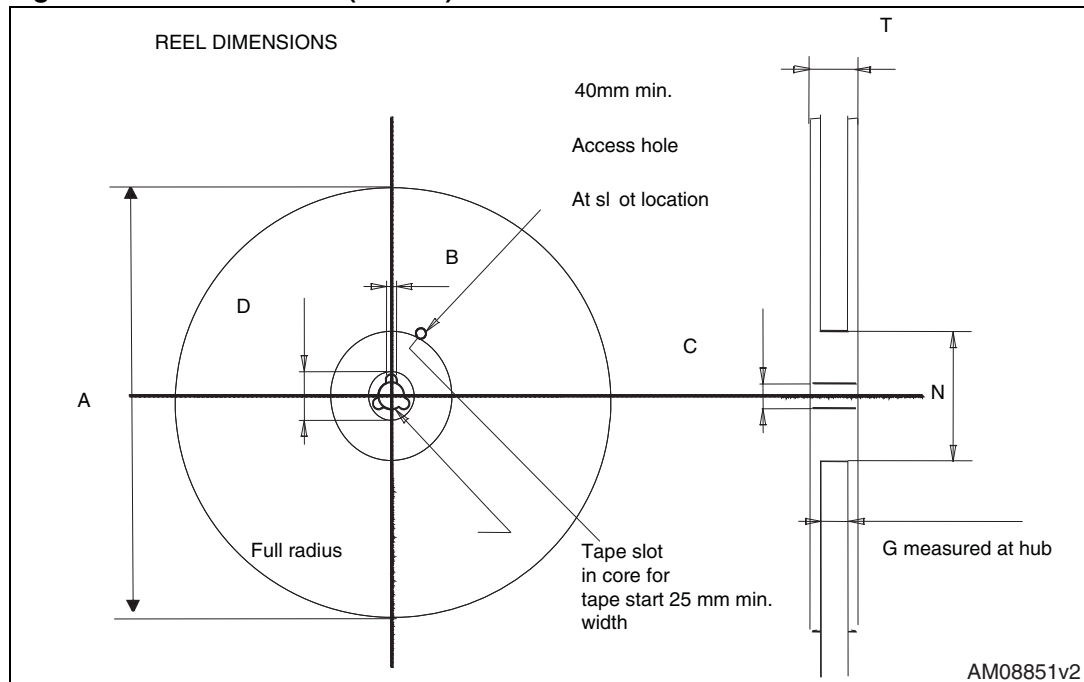


Figure 24. Reel for DPAK (TO-252)



6 Revision history

Table 11. Document revision history

Date	Revision	Changes
29-Jun-2010	1	First release.
09-Sep-2010	2	Some values changed in Table 2 .
22-Dec-2010	3	Document status promoted from preliminary data to datasheet.

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