



STGB19NC60KD, STGF19NC60KD, STGP19NC60KD

20 A, 600 V short-circuit rugged IGBT

Datasheet — production data

Features

- Low on-voltage drop ($V_{CE(sat)}$)
- Low C_{res} / C_{ies} ratio (no cross conduction susceptibility)
- Short circuit withstand time 10 μ s
- IGBT co-packaged with Ultrafast free-wheeling diode

Applications

- High frequency inverters
- Motor drivers

Description

This IGBT utilizes the advanced PowerMESH™ process resulting in an excellent trade-off between switching performance and low on-state behavior.

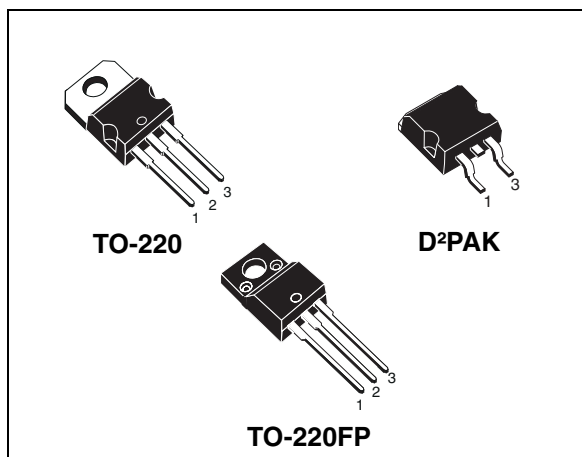


Figure 1. Internal schematic diagram

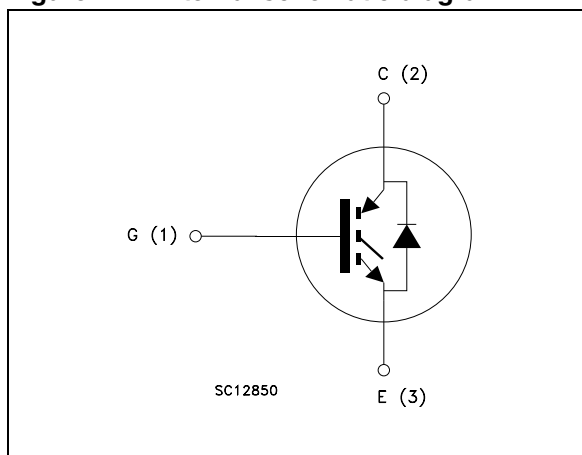


Table 1. Device summary

Order codes	Marking	Packages	Packaging
STGB19NC60KDT4	GB19NC60KD	D²PAK	Tape and reel
STGF19NC60KD	GF19NC60KD	TO-220FP	Tube
STGP19NC60KD	GP19NC60KD	TO-220	Tube

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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		D ² PAK TO-220	TO-220FP	
V _{CES}	Collector-emitter voltage (V _{GE} = 0)	600		V
I _C ⁽¹⁾	Collector current (continuous) at T _C = 25 °C	35	16	A
I _C ⁽¹⁾	Collector current (continuous) at T _C = 100 °C	20	10	A
I _{CL} ⁽²⁾	Turn-off latching current	75		A
I _{CP} ⁽³⁾	Pulsed collector current	75		A
V _{GE}	Gate-emitter voltage	±20		V
I _F	Diode RMS forward current at T _C = 25 °C	20		A
I _{FSM}	Surge non repetitive forward current t _p = 10 ms sinusoidal	50		A
P _{TOT}	Total dissipation at T _C = 25 °C	125	32	W
t _{scw}	Short circuit withstand time, V _{CE} = 0.5 V _{(BR)CES} T _j = 125 °C, R _G = 10 Ω, V _{GE} = 12 V	10		μs
T _j	Operating junction temperature	– 55 to 150		°C

1. Calculated according to the iterative formula:

$$I_c(T_c) = \frac{T_{J(MAX)} - T_c}{R_{thj-c} \times V_{CE(sat)(MAX)} \cdot (T_c, I_c)}$$

2. V_{clamp} = 80%·(V_{CES}), T_j = 150°C, R_G = 10 Ω, V_{GE} = 15 V

3. Pulse width limited by max. junction temperature allowed

Table 3. Thermal resistance

Symbol	Parameter	Value		Unit
		D ² PAK TO-220	TO-220FP	
R _{thj-case}	Thermal resistance junction-case IGBT max.	0.95	3.9	°C/W
	Thermal resistance junction-case diode max.	3	5.6	°C/W
R _{thj-amb}	Thermal resistance junction-ambient max.	62.5		°C/W

2 Electrical characteristics

($T_{CASE} = 25\text{ °C}$ unless otherwise specified)

Table 4. Static

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	$V_{GE} = 15\text{ V}$, $I_C = 12\text{ A}$		2.0	2.75	V
		$V_{GE} = 15\text{ V}$, $I_C = 12\text{ A}$, $T_c = 125\text{ °C}$		1.65		V
I_{CES}	Collector cut-off current ($V_{GE} = 0$)	$V_{CE} = 600\text{ V}$ $V_{CE} = 600\text{ V}$, $T_c = 125\text{ °C}$			150 1	μA mA
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}$, $I_C = 250\text{ }\mu\text{A}$	4.5		6.5	V
I_{GES}	Gate-emitter leakage current ($V_{CE} = 0$)	$V_{GE} = \pm 20\text{ V}$			± 100	nA
$g_{fs}^{(1)}$	Forward transconductance	$V_{CE} = 15\text{ V}$, $I_C = 12\text{ A}$		15		S

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

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{ies}	Input capacitance	$V_{CE} = 25\text{ V}$, $f = 1\text{ MHz}$, $V_{GE} = 0$		1170		pF
C_{oes}	Output capacitance			127		pF
C_{res}	Reverse transfer capacitance			28		pF
Q_g	Total gate charge	$V_{CE} = 480\text{ V}$, $I_C = 12\text{ A}$,		55		nC
Q_{ge}	Gate-emitter charge	$V_{GE} = 15\text{ V}$		11		nC
Q_{gc}	Gate-collector charge	(see Figure 21)		26		nC

Table 6. Switching on/off (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 480\text{ V}$, $I_C = 12\text{ A}$		30		ns
t_r	Current rise time	$R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, (see Figure 20)		8		ns
$(di/dt)_{on}$	Turn-on current slope			1450		A/ μ s
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 480\text{ V}$, $I_C = 12\text{ A}$		30		ns
t_r	Current rise time	$R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, $T_c = 125\text{ }^\circ\text{C}$		8		ns
$(di/dt)_{on}$	Turn-on current slope	(see Figure 20)		1380		A/ μ s
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 480\text{ V}$, $I_C = 12\text{ A}$		35		ns
$t_{d(off)}$	Turn-off delay time	$R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, (see Figure 20)		105		ns
t_f	Current fall time			85		ns
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 480\text{ V}$, $I_C = 12\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$		65		ns
$t_{d(off)}$	Turn-off delay time	$T_c = 125\text{ }^\circ\text{C}$		145		ns
t_f	Current fall time	(see Figure 20)		125		ns

Table 7. Switching energy (inductive load)

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
E_{on}	Turn-on switching losses	$V_{CC} = 480\text{ V}$, $I_C = 12\text{ A}$		165		μ J
$E_{off}^{(1)}$	Turn-off switching losses	$R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, (see Figure 20)		255		μ J
E_{ts}	Total switching losses			420		μ J
E_{on}	Turn-on switching losses	$V_{CC} = 480\text{ V}$, $I_C = 12\text{ A}$		250		μ J
$E_{off}^{(1)}$	Turn-off switching losses	$R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, $T_c = 125\text{ }^\circ\text{C}$		445		μ J
E_{ts}	Total switching losses	(see Figure 20)		695		μ J

1. 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	$I_F = 12\text{ A}$ $I_F = 12\text{ A}$, $T_c = 125\text{ }^\circ\text{C}$		1.9 1.6		V V
t_{rr}	Reverse recovery time	$I_F = 12\text{ A}$, $V_R = 40\text{ V}$, $di/dt = 100\text{ A}/\mu\text{s}$		31		ns
Q_{rr}	Reverse recovery charge	(see Figure 23)		30		nC
I_{rrm}	Reverse recovery current			2		A
t_{rr}	Reverse recovery time	$I_F = 12\text{ A}$, $V_R = 40\text{ V}$, $T_c = 125\text{ }^\circ\text{C}$, $di/dt = 100\text{ A}/\mu\text{s}$		50 70		ns nC
Q_{rr}	Reverse recovery charge	(see Figure 23)				
I_{rrm}	Reverse recovery current			4		A

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

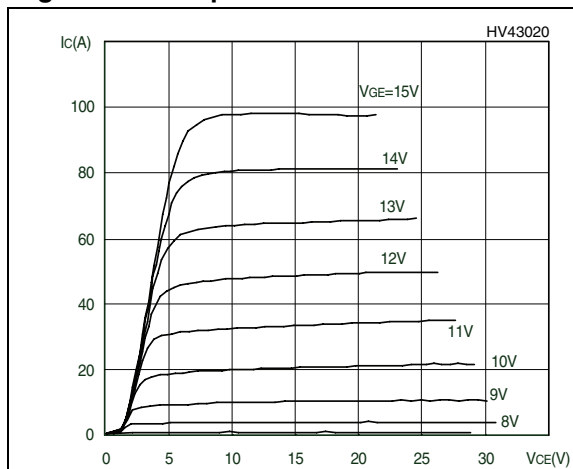


Figure 3. Transfer characteristics

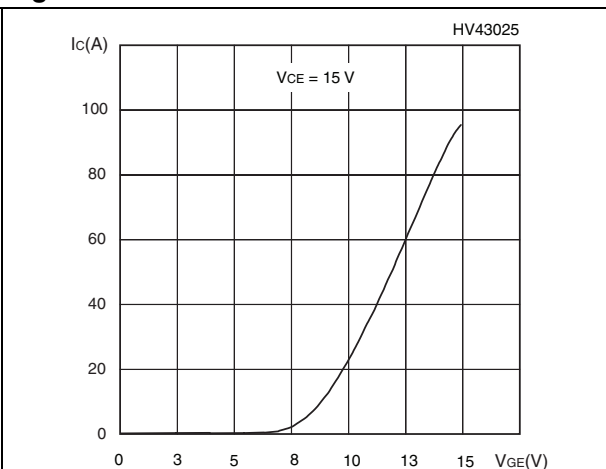


Figure 4. Transconductance

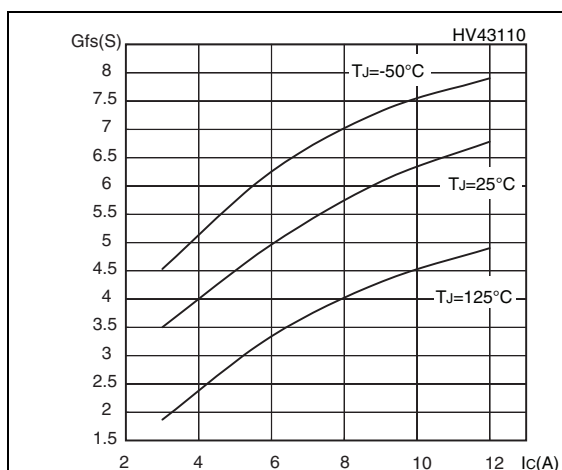


Figure 5. Collector-emitter on voltage vs. temperature

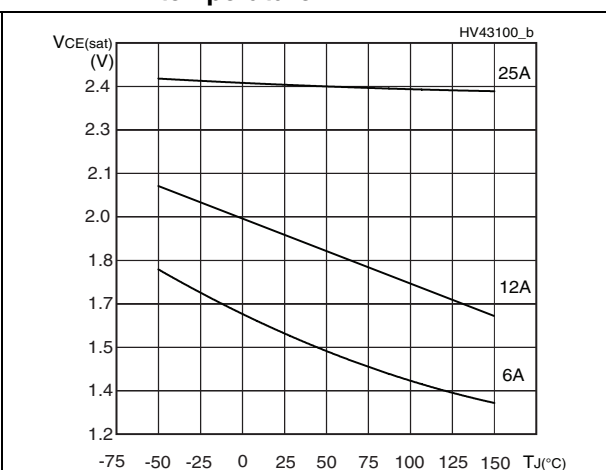


Figure 6. Gate charge vs. gate-source voltage

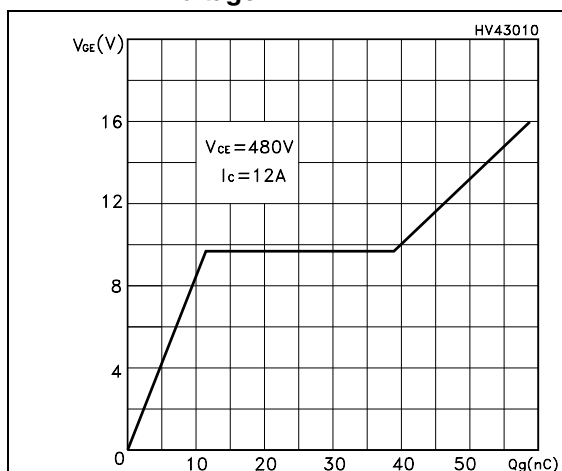


Figure 7. Capacitance variations

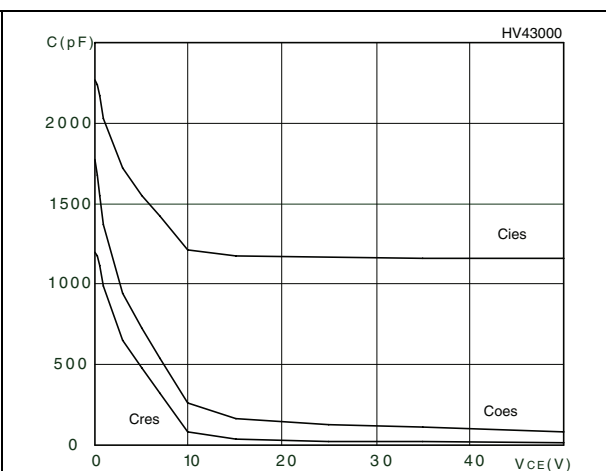


Figure 8. Normalized gate threshold voltage vs. temperature

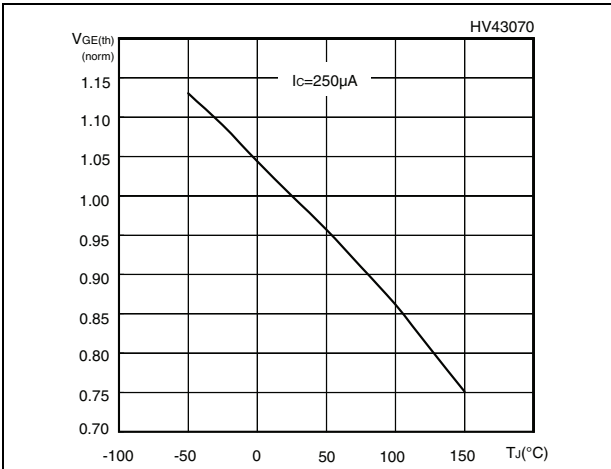


Figure 9. Collector-emitter on voltage vs. collector current

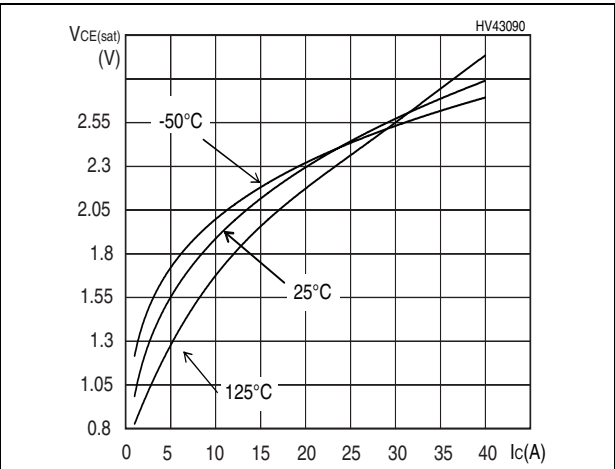


Figure 10. Normalized breakdown voltage vs. temperature

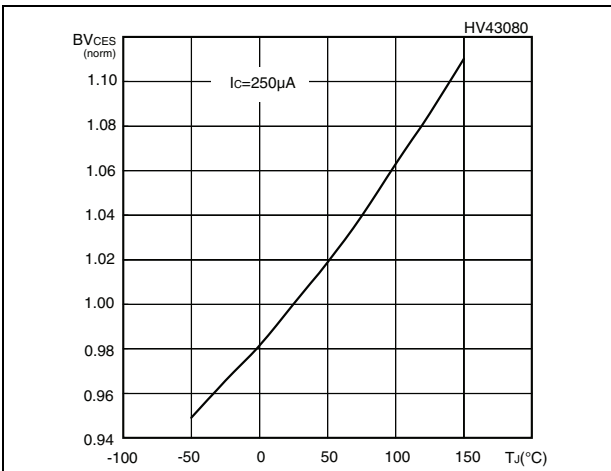


Figure 11. Switching losses vs. temperature

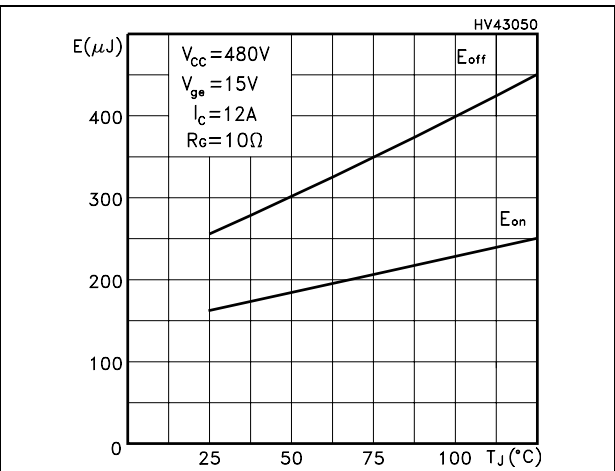


Figure 12. Switching losses vs. gate resistance

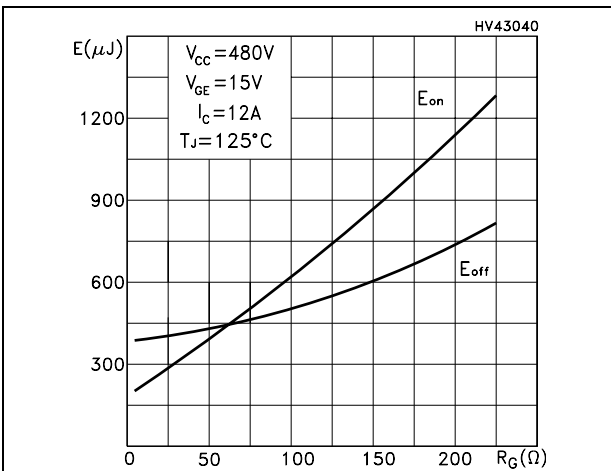


Figure 13. Switching losses vs. collector current

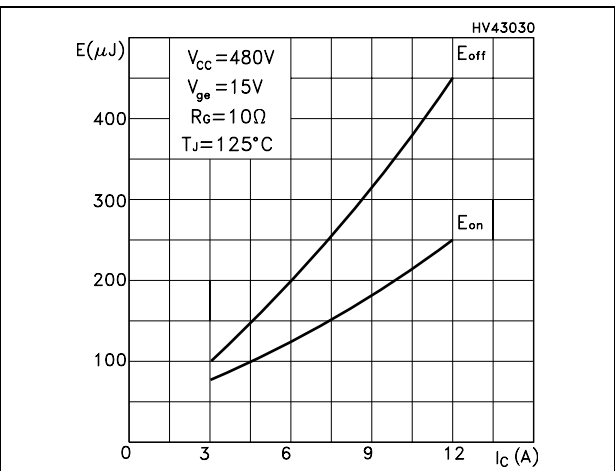


Figure 14. Turn-off SOA

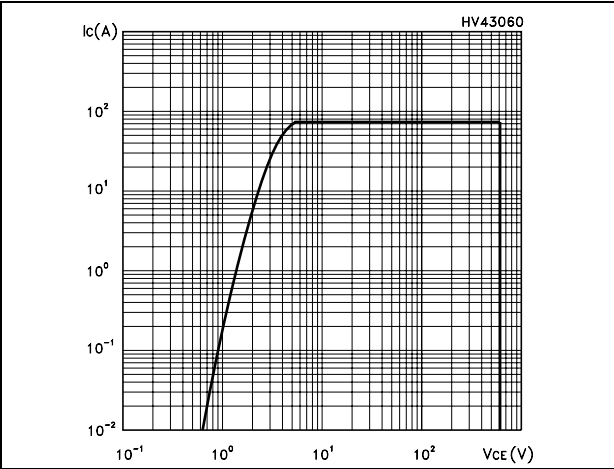


Figure 15. Emitter-collector diode characteristics

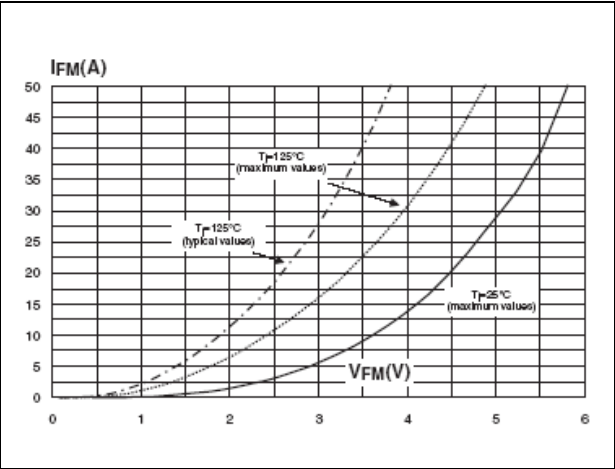


Figure 16. Thermal impedance for TO-220, D²PAK

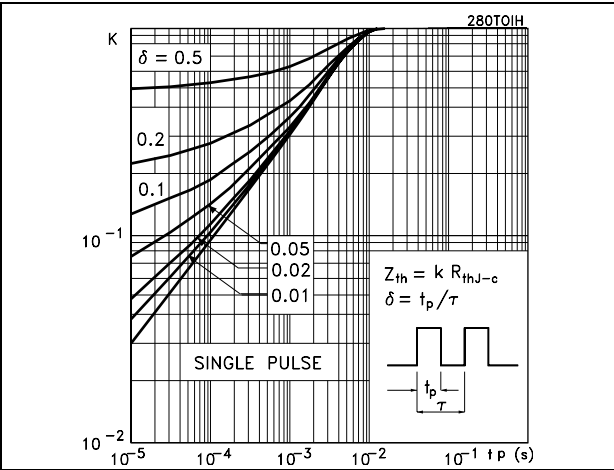


Figure 17. Thermal impedance for TO-220FP

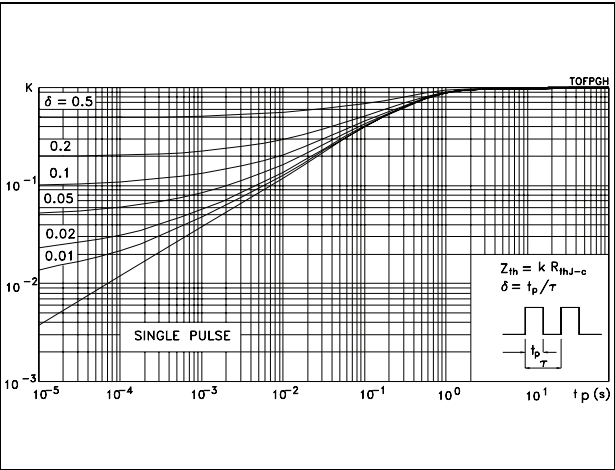


Figure 18. Maximum DC collector current vs. T_{CASE} for TO-220FP

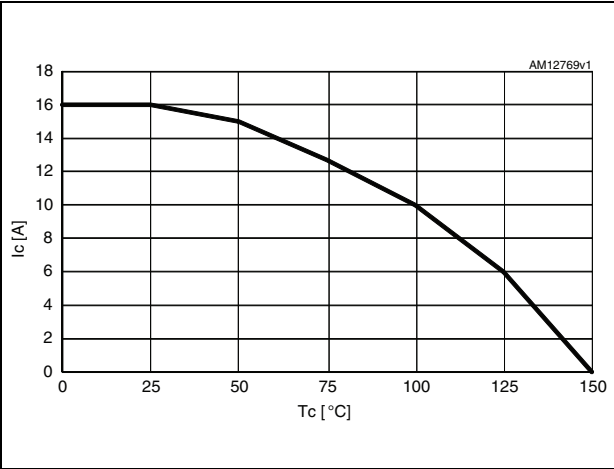
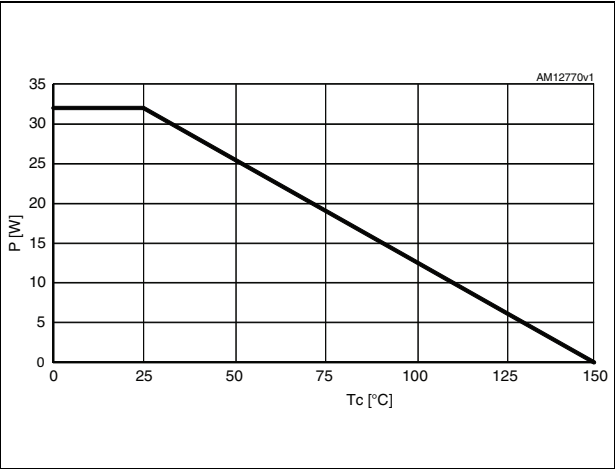


Figure 19. Maximum power dissipation vs. T_{CASE} for TO-220FP



3 Test circuits

Figure 20. Test circuit for inductive load switching

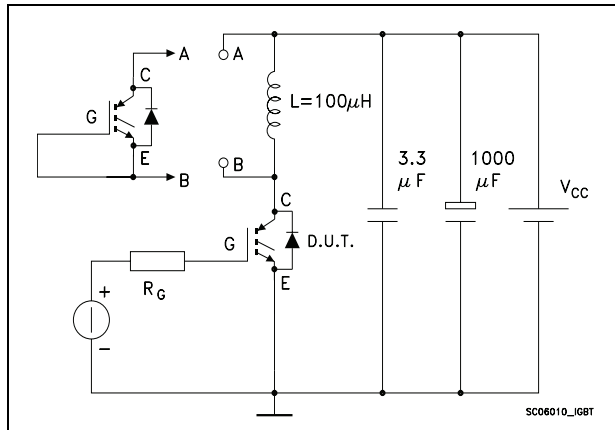


Figure 21. Gate charge test circuit

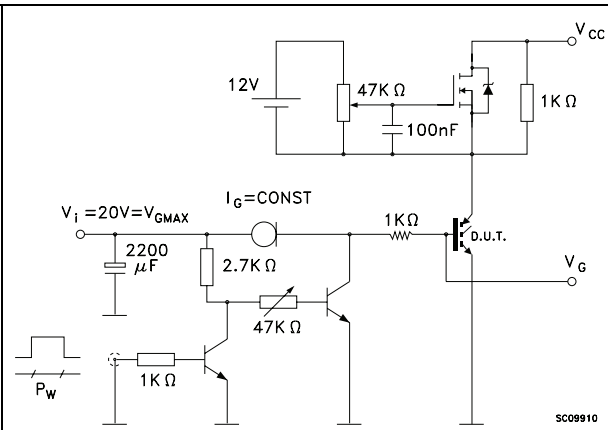


Figure 22. Switching waveforms

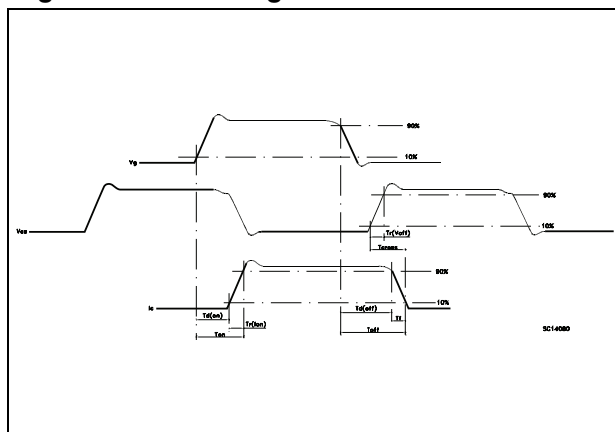
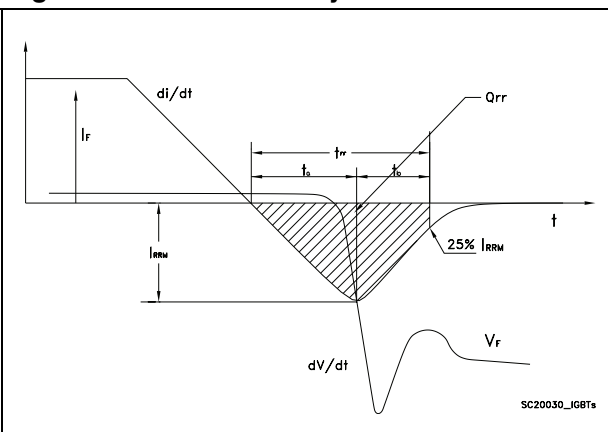


Figure 23. Diode recovery times waveform

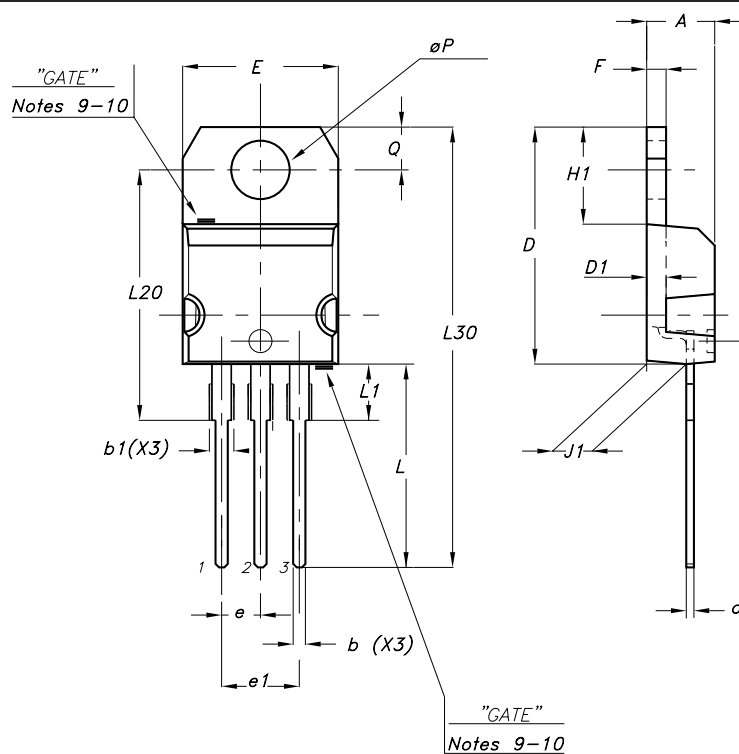


4 Package mechanical data

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 mechanical data

Dim	mm			inch		
	Min	Typ	Max	Min	Typ	Max
A	4.40		4.60	0.173		0.181
b	0.61		0.88	0.024		0.034
b1	1.14		1.70	0.044		0.066
c	0.48		0.70	0.019		0.027
D	15.25		15.75	0.6		0.62
D1		1.27			0.050	
E	10		10.40	0.393		0.409
e	2.40		2.70	0.094		0.106
e1	4.95		5.15	0.194		0.202
F	1.23		1.32	0.048		0.051
H1	6.20		6.60	0.244		0.256
J1	2.40		2.72	0.094		0.107
L	13		14	0.511		0.551
L1	3.50		3.93	0.137		0.154
L20		16.40			0.645	
L30		28.90			1.137	
ØP	3.75		3.85	0.147		0.151
Q	2.65		2.95	0.104		0.116



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Table 9. 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

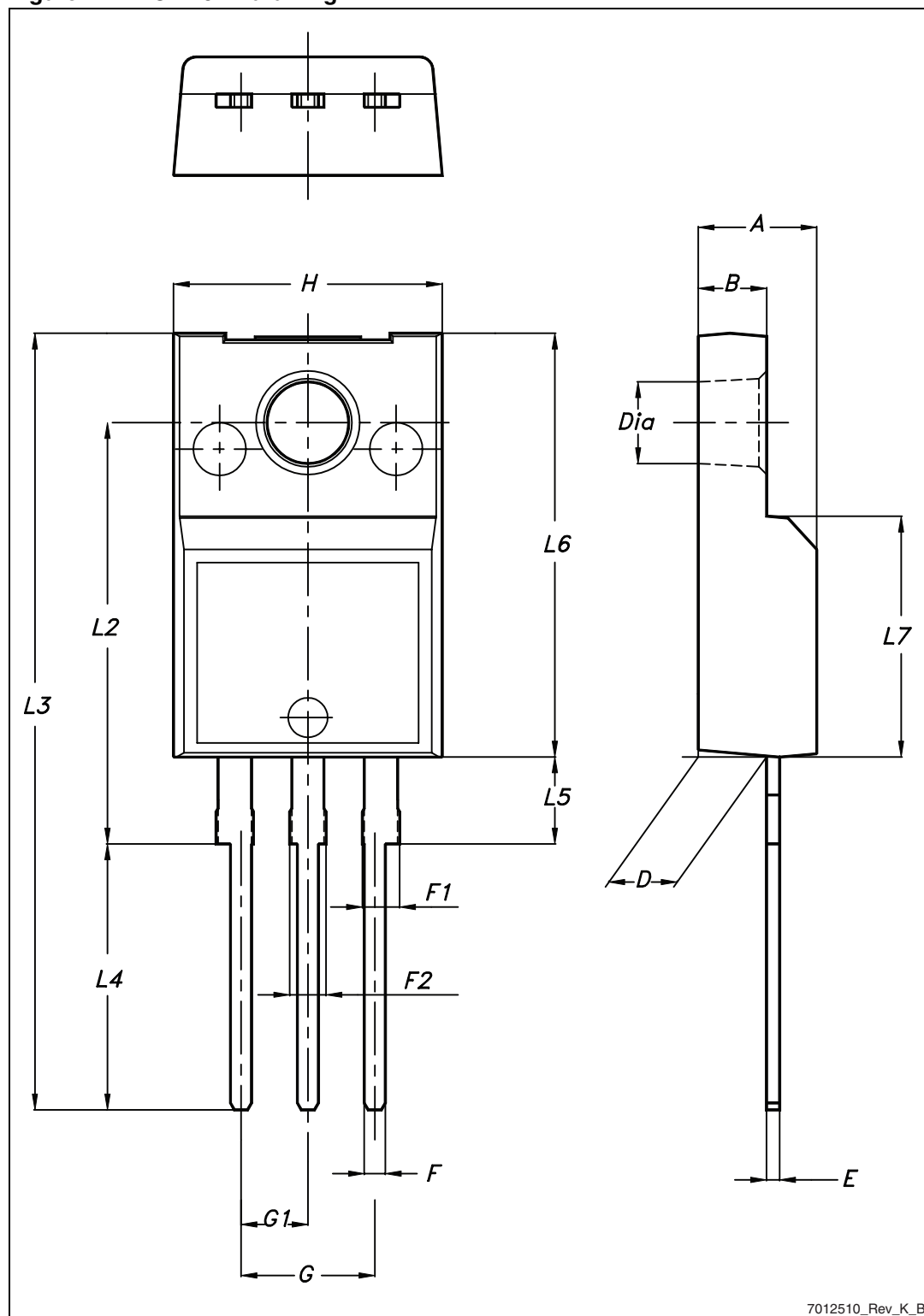
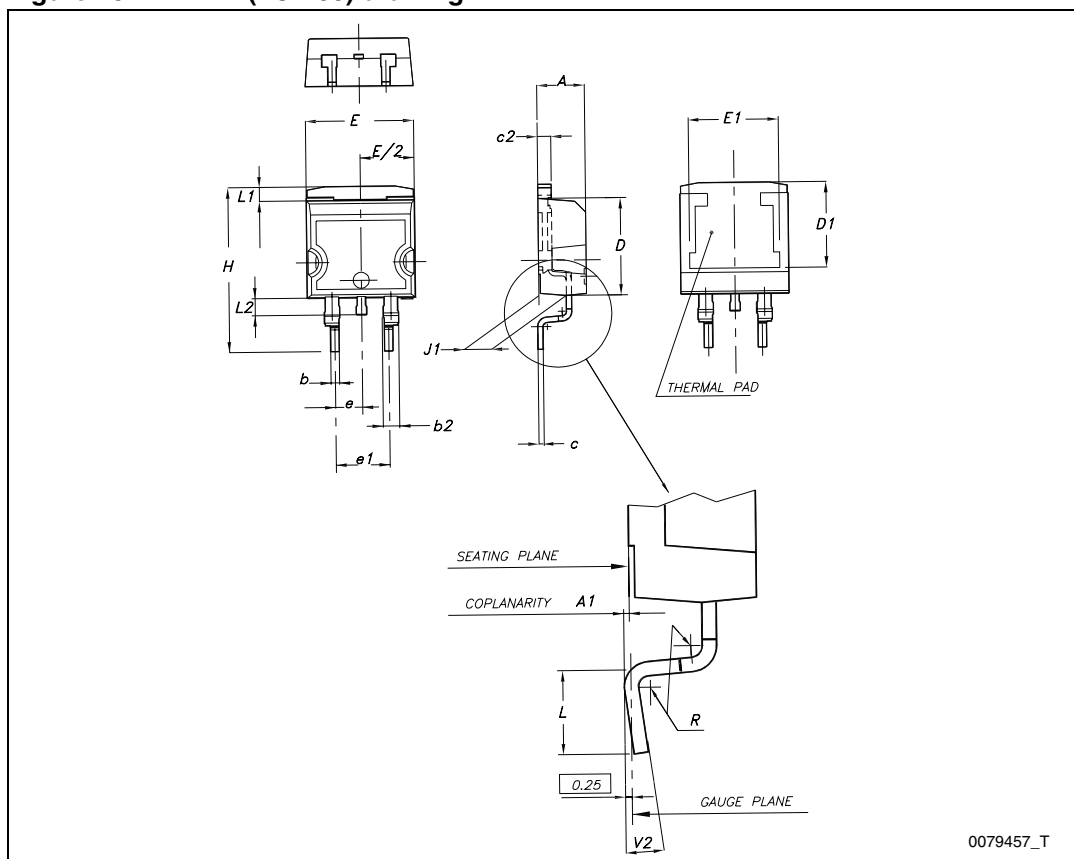
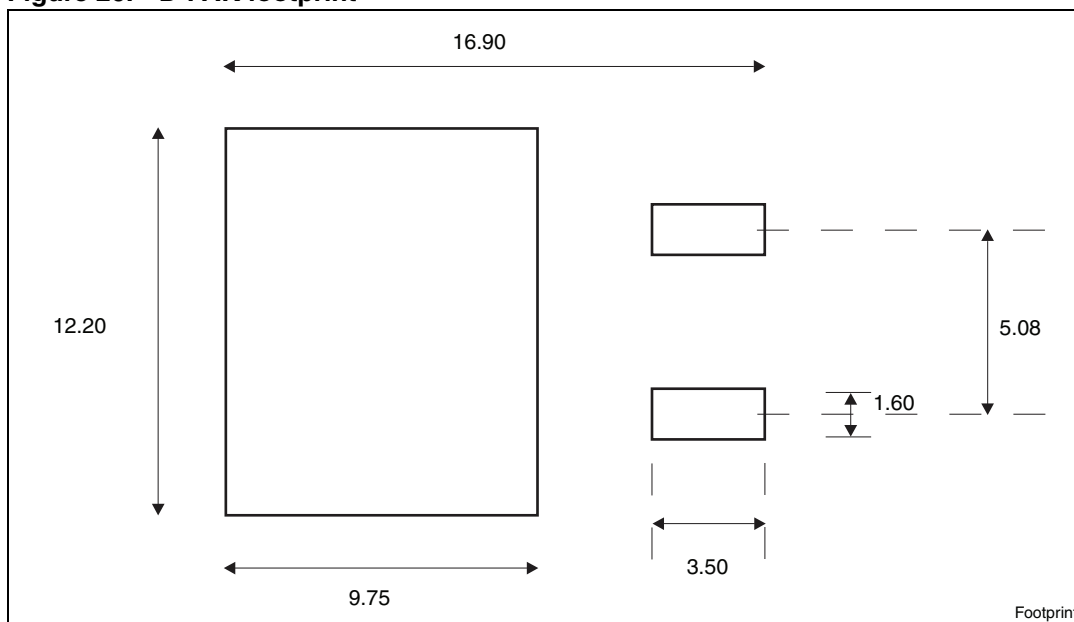


Table 10. D²PAK (TO-263) mechanical data

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°

Figure 25. D²PAK (TO-263) drawingFigure 26. D²PAK footprint (a)

a. All dimension are in millimeters

5 Packing mechanical data

Table 11. D²PAK (TO-263) tape and reel mechanical data

Tape			Reel		
Dim.	mm		Dim.	mm	
	Min.	Max.		Min.	Max.
A0	10.5	10.7	A		330
B0	15.7	15.9	B	1.5	
D	1.5	1.6	C	12.8	13.2
D1	1.59	1.61	D	20.2	
E	1.65	1.85	G	24.4	26.4
F	11.4	11.6	N	100	
K0	4.8	5.0	T		30.4
P0	3.9	4.1			
P1	11.9	12.1	Base qty		1000
P2	1.9	2.1	Bulk qty		1000
R	50				
T	0.25	0.35			
W	23.7	24.3			

Figure 27. Tape

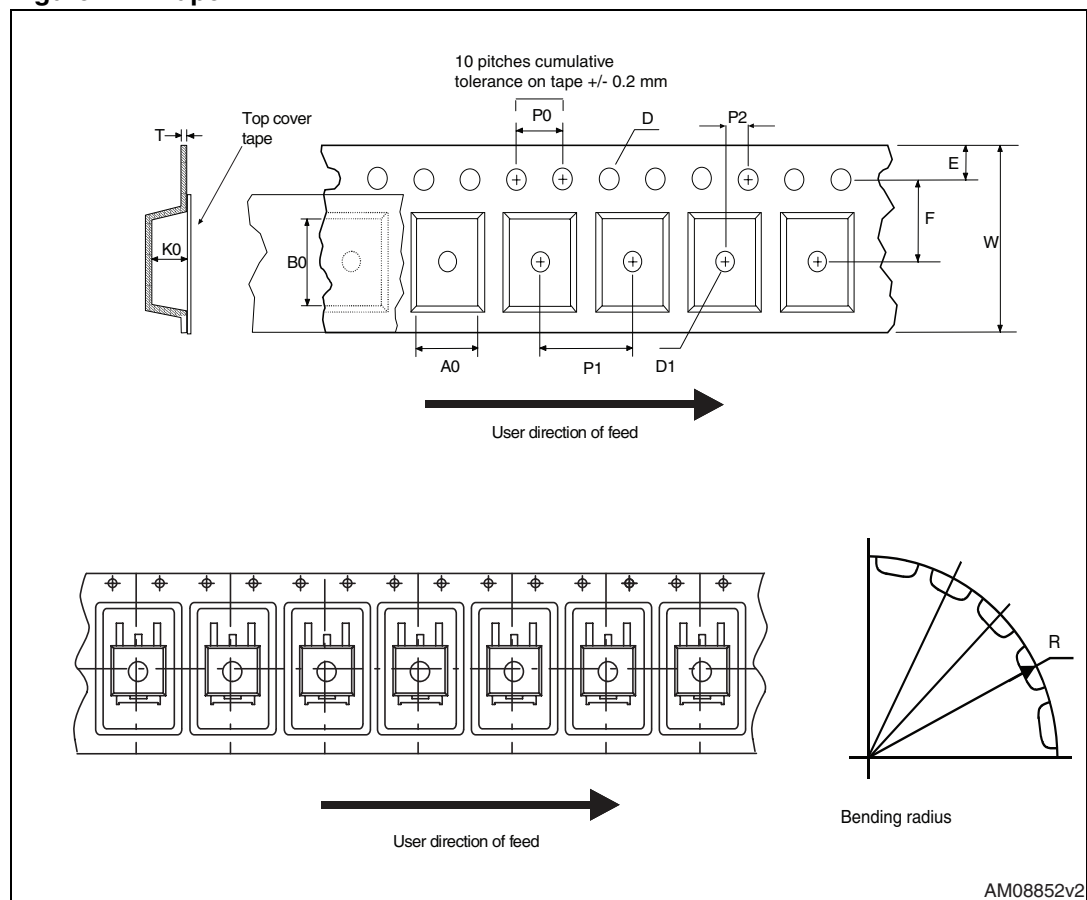
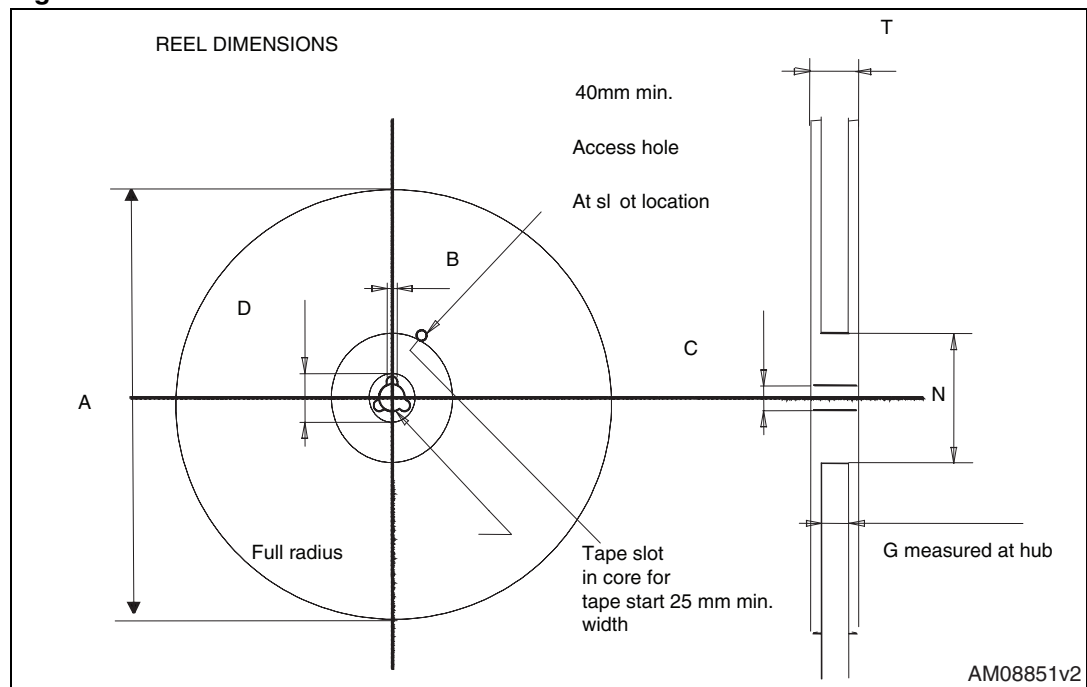


Figure 28. Reel



6 Revision history

Table 12. Document revision history

Date	Revision	Changes
08-May-2008	1	Initial release
28-May-2008	2	– Value on Table 3: Thermal resistance has been changed. – Inserted Figure 16: Thermal impedance for TO-220, D²PAK and Figure 17: Thermal impedance for TO-220FP
31-Jul-2012	3	Added: Figure 18 and Figure 19 on page 8 .

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