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STD2HNK60Z, STD2HNK60Z-1
STF2HNK60Z, STD2HNK60Z-AP

N-channel 600 V, 4.4 Ω, 2 A Zener-protected SuperMESH™ Power MOSFET in TO-92-TO-220FP-DPAK-IPAK packages

Datasheet — production data

Features

Order codes	V_{DSS}	$R_{DS(on)}$ max.	I_D	P_{TOT}
STD2HNK60Z	600 V	< 4.8 Ω	2 A	45 W
STD2HNK60Z-1	600 V	< 4.8 Ω	2 A	45 W
STF2HNK60Z	600 V	< 4.8 Ω	2 A	20 W
STQ2HNK60ZR-AP	600 V	< 4.8 Ω	0.5 A	3 W

- Gate charge minimized
- 100% avalanche tested
- Extremely high dv/dt capability
- ESD improved capability
- New high voltage benchmark

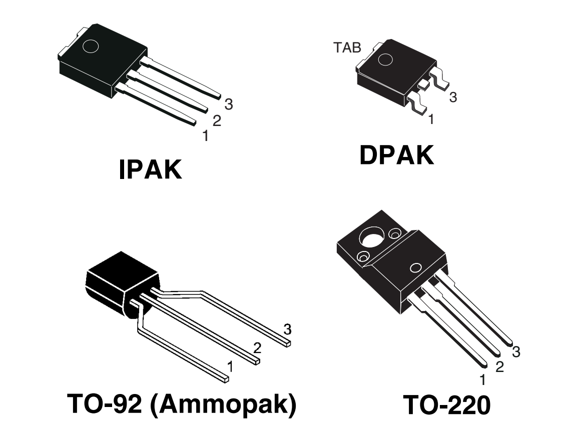
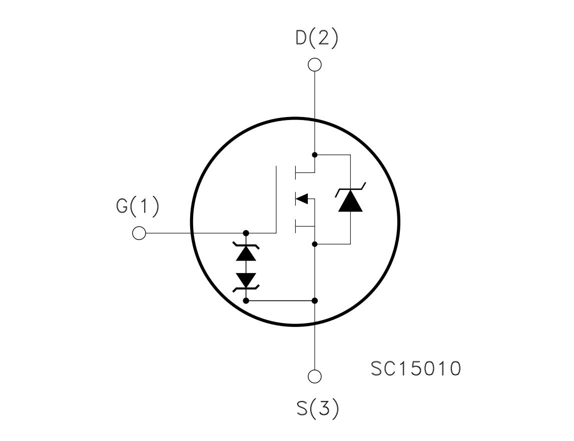


Figure 1. Internal schematic diagram



Applications

- Switching applications

Description

These devices are N-channel Zener-protected Power MOSFETs developed using STMicroelectronics' SuperMESH™ technology, achieved through optimization of ST's well established strip-based PowerMESH™ layout. In addition to a significant reduction in on-resistance, this device is designed to ensure a high level of dv/dt capability for the most demanding applications.

Table 1. Device summary

Order codes	Marking	Package	Packaging
STD2HNK60Z	D2HNK60Z	DPAK	Tape and reel
STD2HNK60Z-1	D2HNK60Z	IPAK	Tube
STF2HNK60Z	F2HNK60Z	TO-220FP	Tube
STQ2HNK60ZR-AP	Q2HNK60ZR	TO-92	Ammopak

Contents

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value			Unit
		IPAK,DPAK	TO-220FP	TO-92	
V_{DS}	Drain-source voltage	600			V
V_{GS}	Gate-source voltage	±30			V
I_D	Drain current (continuous) at T_C = 25 °C	2.0	2.0	0.5	A
I_D	Drain current (continuous) at T_C=100 °C	1.26	1.26	0.32	A
I_{DM} (1)	Drain current (pulsed)	8	8	2	A
P_{TOT}	Total dissipation at T_C = 25 °C	45	20	3	W
	Derating factor	0.36	0.16	0.025	W/°C
$V_{ESD(G-S)}$	Gate source ESD (HBM-C=100 pF, R=1.5 kΩ)	2000			V
V_{ISO}	Insulation withstand voltage (DC)		2500		V
dv/dt (2)	Peak diode recovery voltage slope	4.5			V/ns
T_J T_{stg}	Operating junction temperature Storage temperature	- 55 to 150			°C
T_l	Maximum lead temperature for soldering purpose	300		260	°C

1. Pulse width limited by safe operating area.
2. $I_{SD} \leq 2$ A, di/dt ≤ 200 A/µs, V_{DD} =80%$V_{(BR)DSS}$.

Table 3. Thermal data

Symbol	Parameter	IPAK/DPAK	TO-220FP	TO-92	Unit
$R_{thj-case}$	Thermal resistance junction-case max	2.77	6.25		°C/W
$R_{thj-amb}$	Thermal resistance junction-ambient max	100	62.5	120	°C/W
$R_{thj-lead}$	Thermal resistance junction-lead max			40	°C/W

Table 4. Avalanche data

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetitive or not repetitive (pulse width limited by Tjmax)	2	A
E_{AS}	Single pulse avalanche energy (starting Tj = 25 °C, I_D=I_{AR}, V_{DD} = 50 mV)	120	mJ

2 Electrical characteristics

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

Table 5. On/off states

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	I_D = 1 mA, V_{GS}= 0	600			V
I_{DSS}	Zero gate voltage drain current (V_{GS} = 0)	V_{DS} =600 V, V_{DS} = 600 V,Tc=125 °C			1 50	µA µA
I_{GSS}	Gate body leakage current (V_{DS} = 0)	V_{GS} = ±20 V			±10	µA
$V_{GS(th)}$	Gate threshold voltage	V_{DS}= V_{GS}, I_D = 50 µA	3	3.75	4.5	V
$R_{DS(on)}$	Static drain-source on-resistance	V_{GS}= 10 V, I_D= 1 A		4.4	4.8	Ω

Table 6. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
g_{fs} (1)	Forward transconductance	V_{DS} =15 V, I_D = 1 A	-	1.5		S
C_{iss} C_{oss} C_{rss}	Input capacitance Output capacitance Reverse transfer capacitance	V_{DS} = 25 V, f=1 MHz, V_{GS}=0	-	280 38 7		pF pF pF
$C_{oss\ eq}$ (2)	Equivalent output capacitance	V_{GS}=0, V_{DS} =0 to 480 V	-	30		pF
Q_g Q_{gs} Q_{gd}	Total gate charge Gate-source charge Gate-drain charge	V_{DD}=480 V, I_D = 2 A V_{GS} =10 V *(see Figure 19)*	-	11 2.25 6	15	nC nC nC

1. Pulsed: pulse duration=300µs, duty cycle 1.5%
2. $C_{oss\ eq}$ is defined as a constant equivalent capacitance giving the same charging time as C_{oss} when V_{DS} increases from 0 to 80% V_{DSS}

Table 7. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$ t_r	Turn-on delay time Rise time	V_{DD}=300 V, I_D=1 A, R_G=4.7 Ω, V_{GS}=10 V *(see Figure 18)*	-	10 30	-	ns ns
$t_{d(off)}$ t_f	Turn-off delay time Fall time		-	23 50	-	ns ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD} I_{SDM}(1)	Source-drain current Source-drain current (pulsed)		-		2 8	A A
V_{SD}(2)	Forward on voltage	I_{SD} = 2 A, V_{GS} = 0	-		1.3	V
t_{rr} Q_{rr} I_{RRM}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_{SD}=2 A, di/dt = 100 A/µs, V_{DD}=20 V	-	178 445 5		ns nC A
t_{rr} Q_{rr} I_{RRM}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_{SD}=2 A, di/dt = 100 A/µs, V_{DD}=20 V, Tj=150 °C	-	200 500 5		ns nC A

1. Pulse width limited by safe operating area
2. Pulsed: pulse duration=300µs, duty cycle 1.5%

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for TO-92

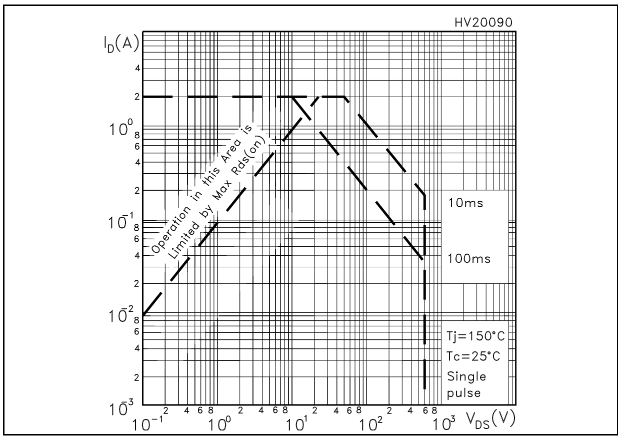


Figure 3. Thermal impedance for TO-92

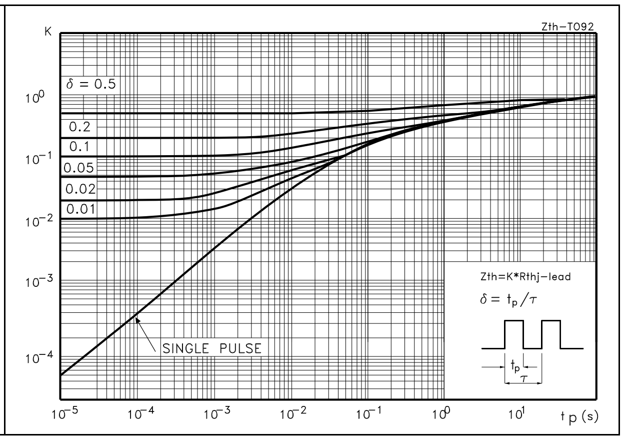


Figure 4. Safe operating area for TO-220FP

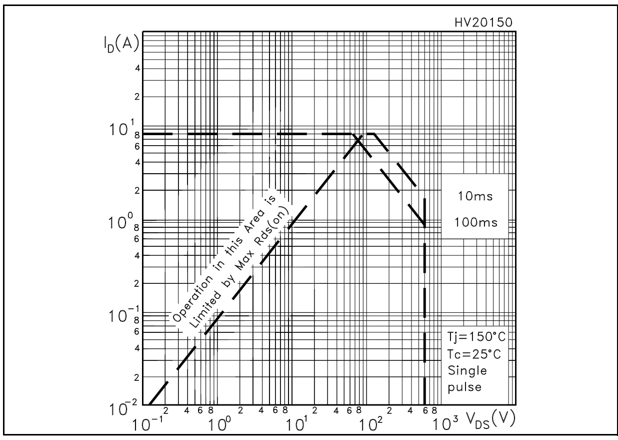


Figure 5. Thermal impedance for TO-220FP

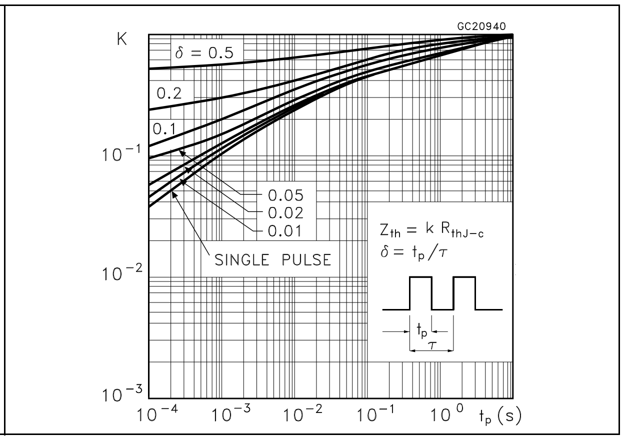


Figure 6. Safe operating area for IPAK/DPAK

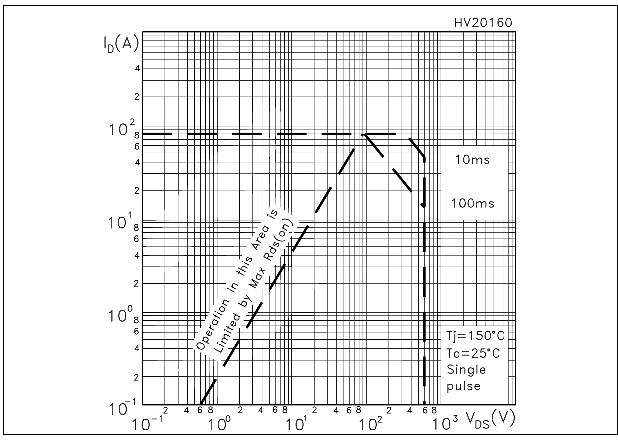


Figure 7. Thermal impedance for IPAK/DPAK

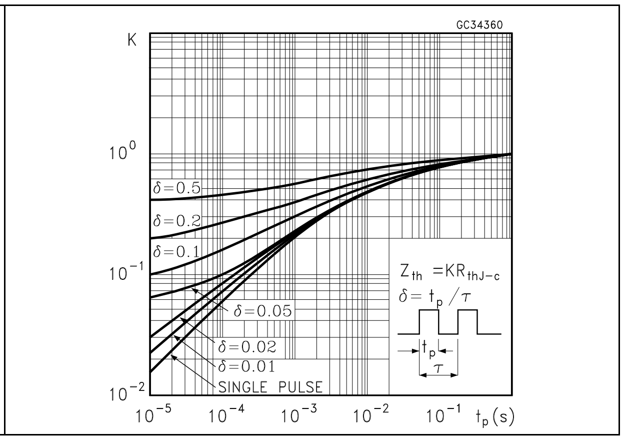


Figure 8. Output characteristics

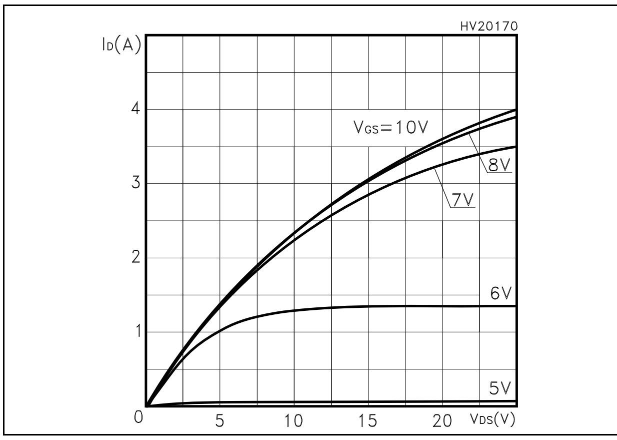


Figure 9. Transfer characteristics

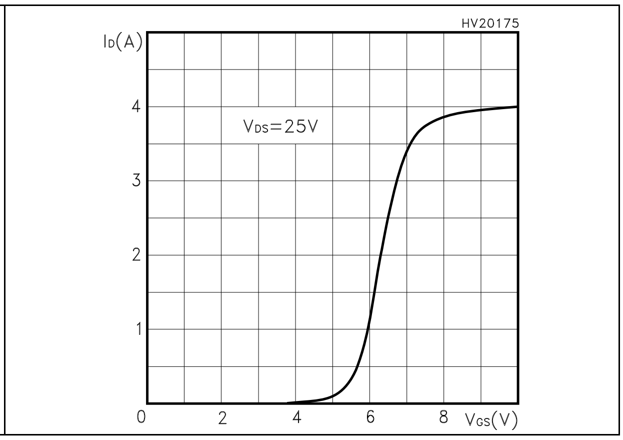


Figure 10. Normalized B_{VDSS} vs temperature

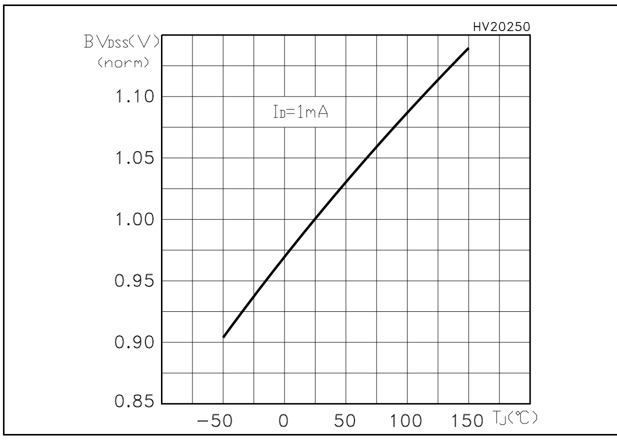


Figure 11. Static drain-source on-resistance

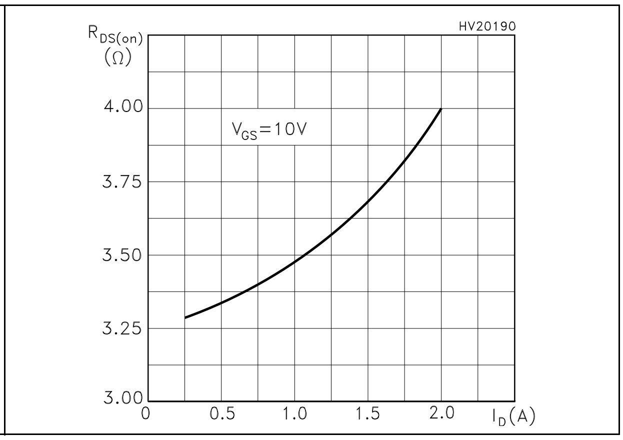


Figure 12. Gate charge vs gate-source voltage

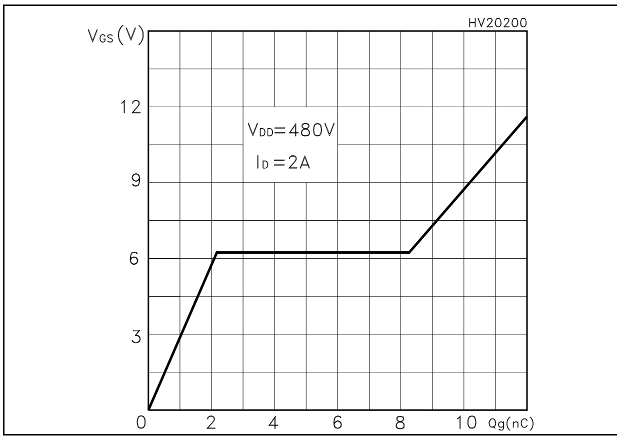


Figure 13. Capacitance variations

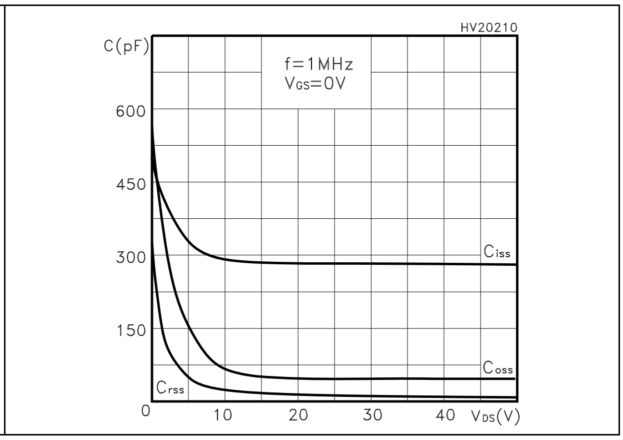


Figure 14. Normalized gate threshold voltage vs temperature

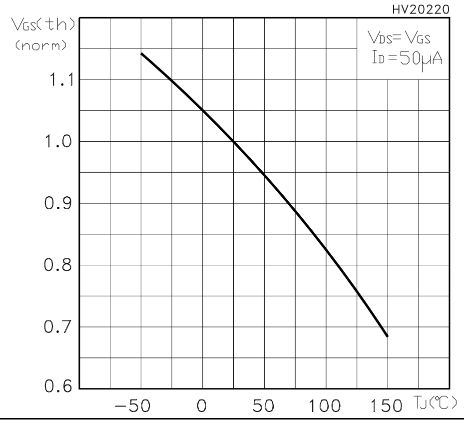


Figure 15. Normalized on-resistance vs temperature

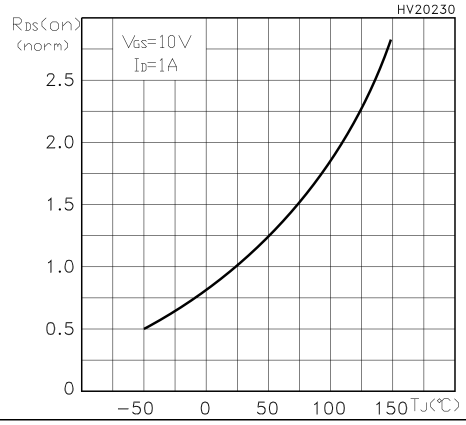


Figure 16. Source-drain diode forward characteristics

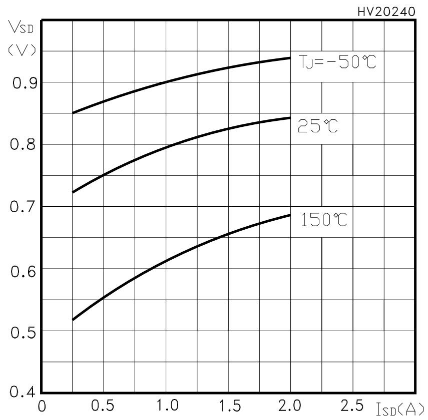
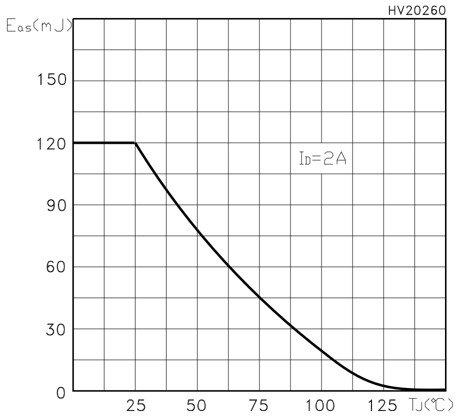


Figure 17. Maximum avalanche energy vs temperature



3 Test circuits

Figure 18. Switching times test circuit for resistive load

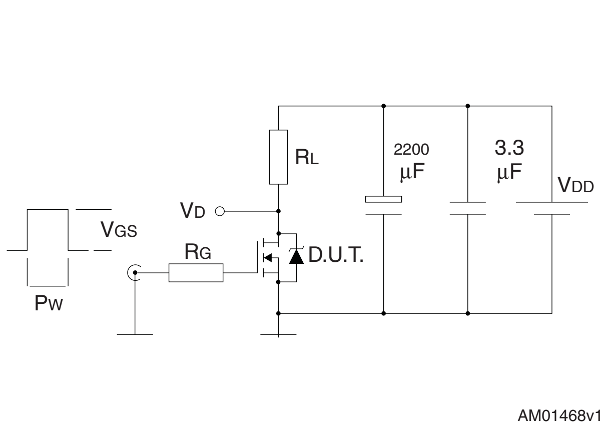


Figure 19. Gate charge test circuit

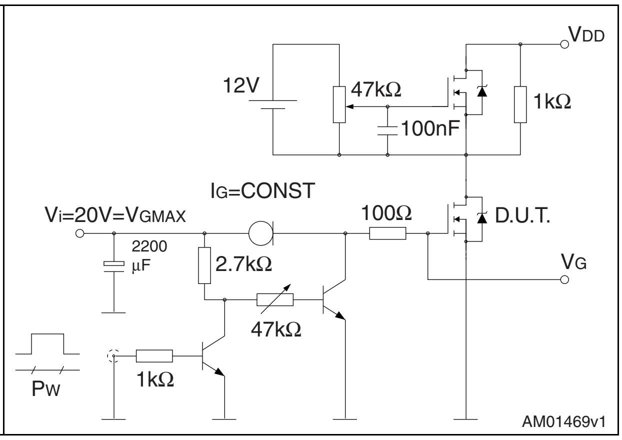


Figure 20. Test circuit for inductive load switching and diode recovery times

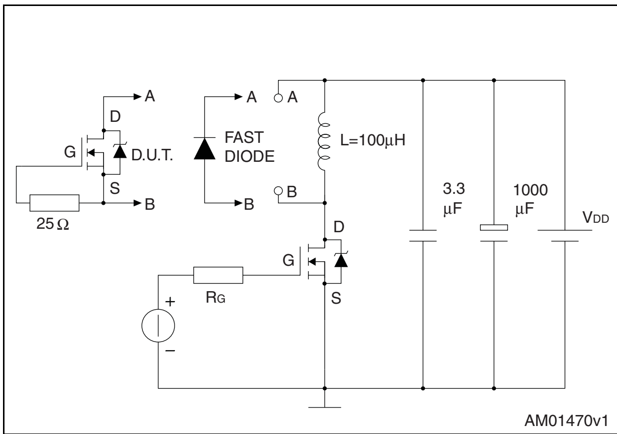


Figure 21. Unclamped inductive load test circuit

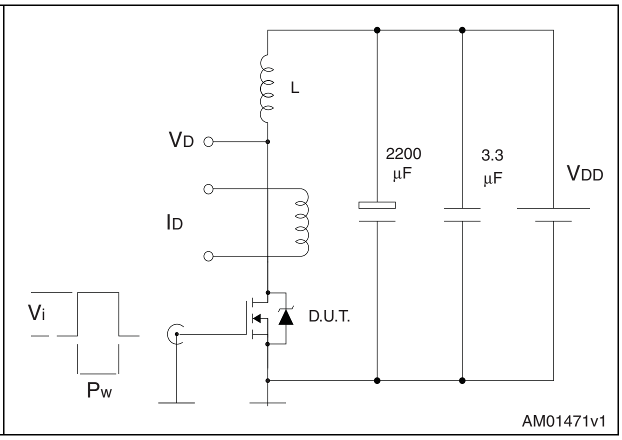


Figure 22. Unclamped inductive waveform

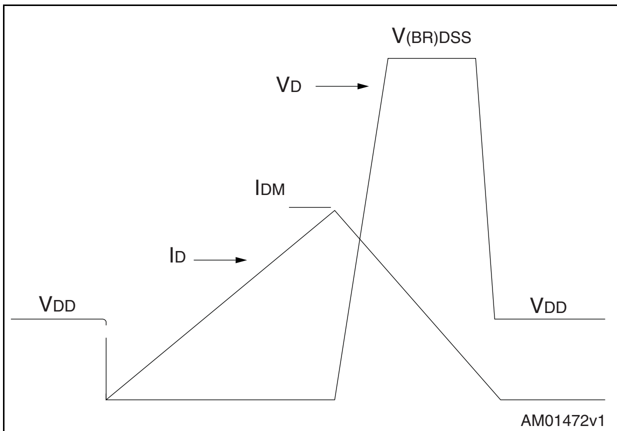
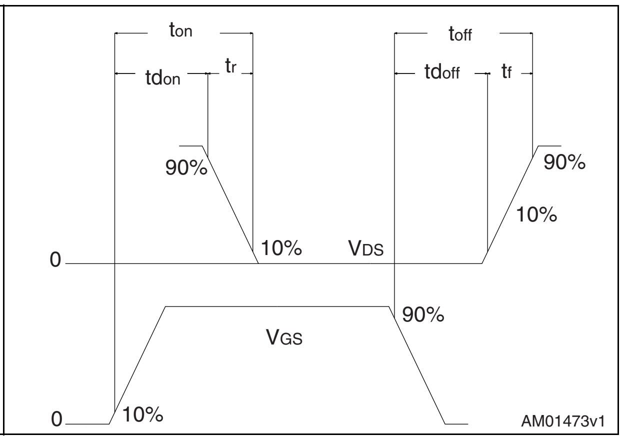


Figure 23. Switching time waveform



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. IPAK (TO-251) mechanical data

DIM.	mm.		
	min.	typ	max.
A	2.20		2.40
A1	0.90		1.10
b	0.64		0.90
b2			0.95
b4	5.20		5.40
B5		0.3	
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
E	6.40		6.60
e		2.28	
e1	4.40		4.60
H		16.10	
L	9.00		9.40
L1	0.80		1.20
L2		0.80	1.00
V1		10 °	

Figure 24. IPAK (TO-251) drawing

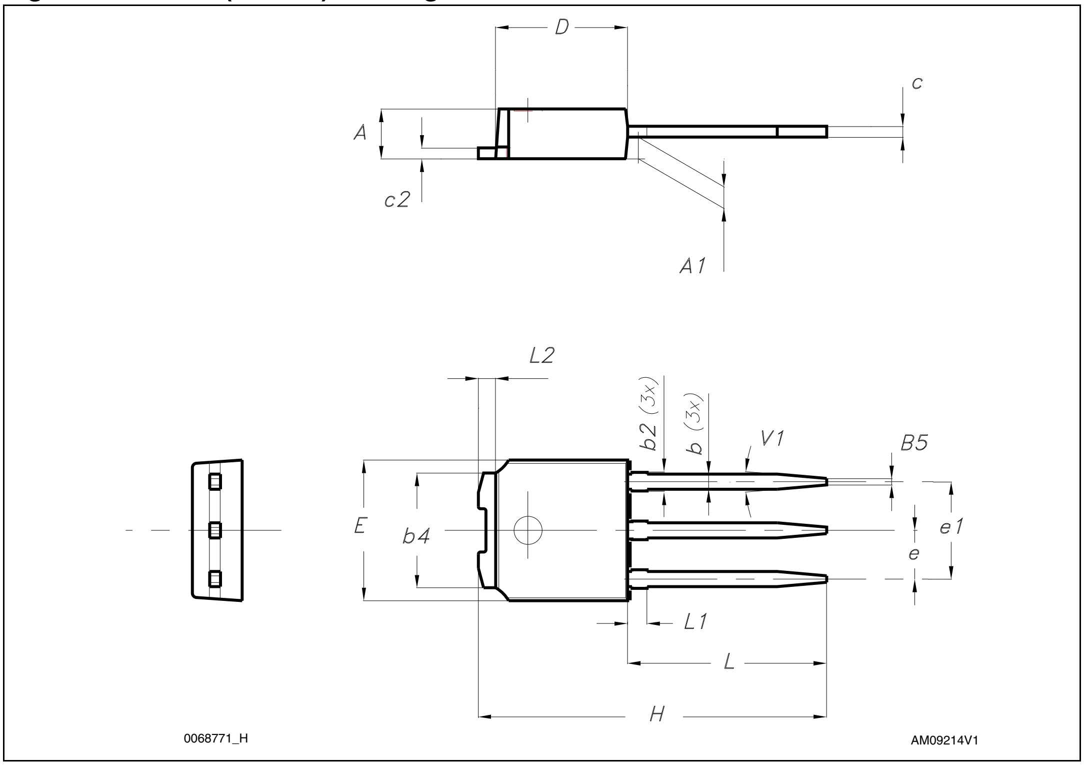


Table 10. DPAK (TO-252) mechanical data

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		1.50
L1		2.80	
L2		0.80	
L4	0.60		1
R		0.20	
V2	0°		8°

Figure 25. DPAK (TO-252) drawing

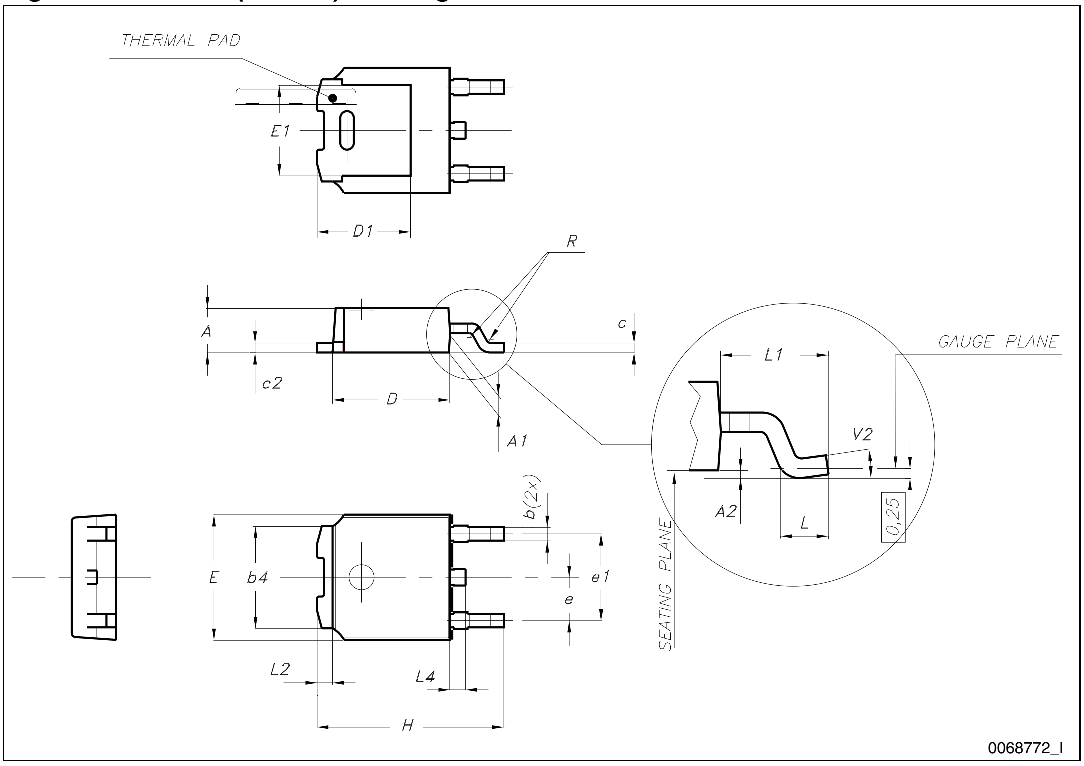
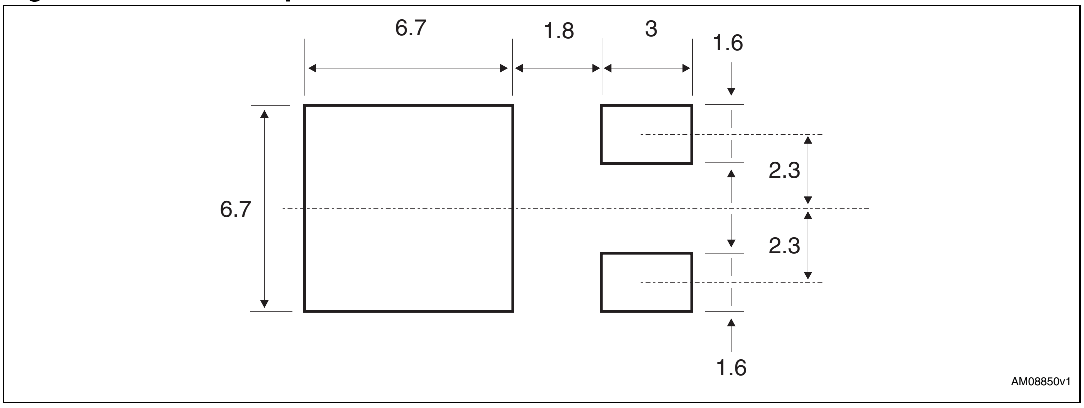


Figure 26. DPAK footprint[(a)]



a. All dimensions are in millimeters

Table 11. 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 27. TO-220FP drawing

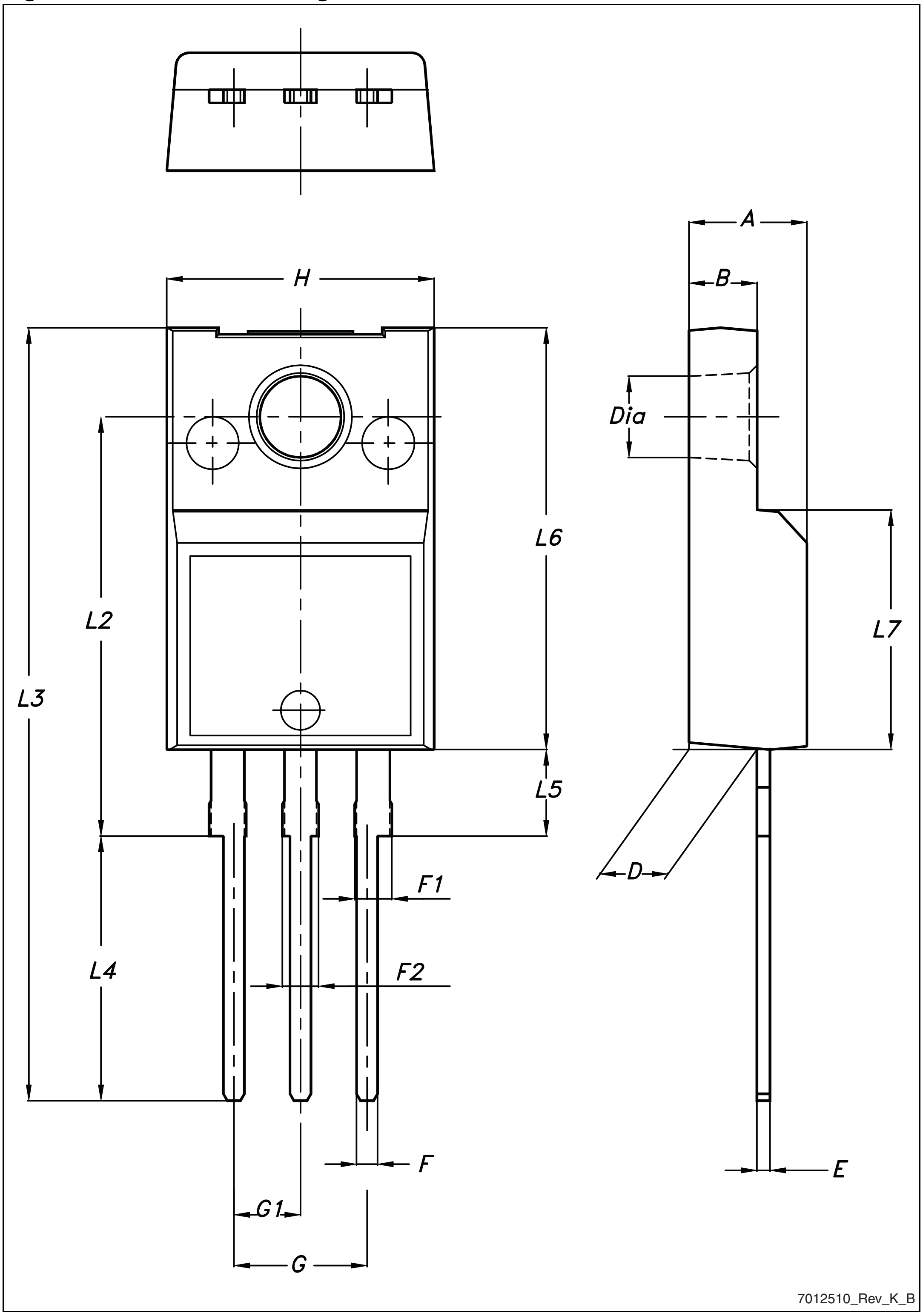
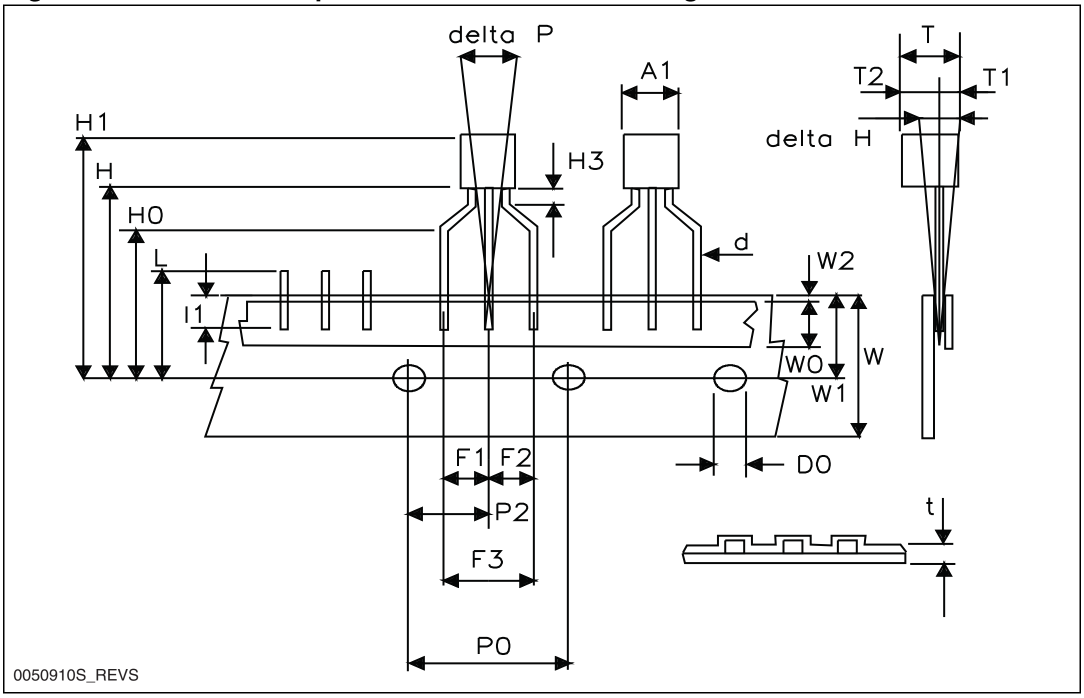


Table 12. TO-92 ammopack mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A1			4.80
T			3.80
T1			1.60
T2			2.30
d			0.48
P0	12.50	12.70	12.90
P2	5.65	6.35	7.05
F1, F2	2.44	2.54	2.94
F3	4.98	5.08	5.48
delta H	-2.00		2.00
W	17.50	18.00	19.00
W0	5.70	6.00	6.30
W1	8.50	9.00	9.25
W2			0.50
H	18.50		20.50
H3	0.5	1	1.5
H0	15.50	16.00	16.50
H1			25.00
D0	3.80	4.00	4.20
t			0.90
L			11.00
I1	3.00		
delta P	-1.00		1.00

Figure 28. TO-92 ammopack mechanical data drawing



5 Packaging mechanical data

Table 13. 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 29. Tape for DPAK (TO-252)

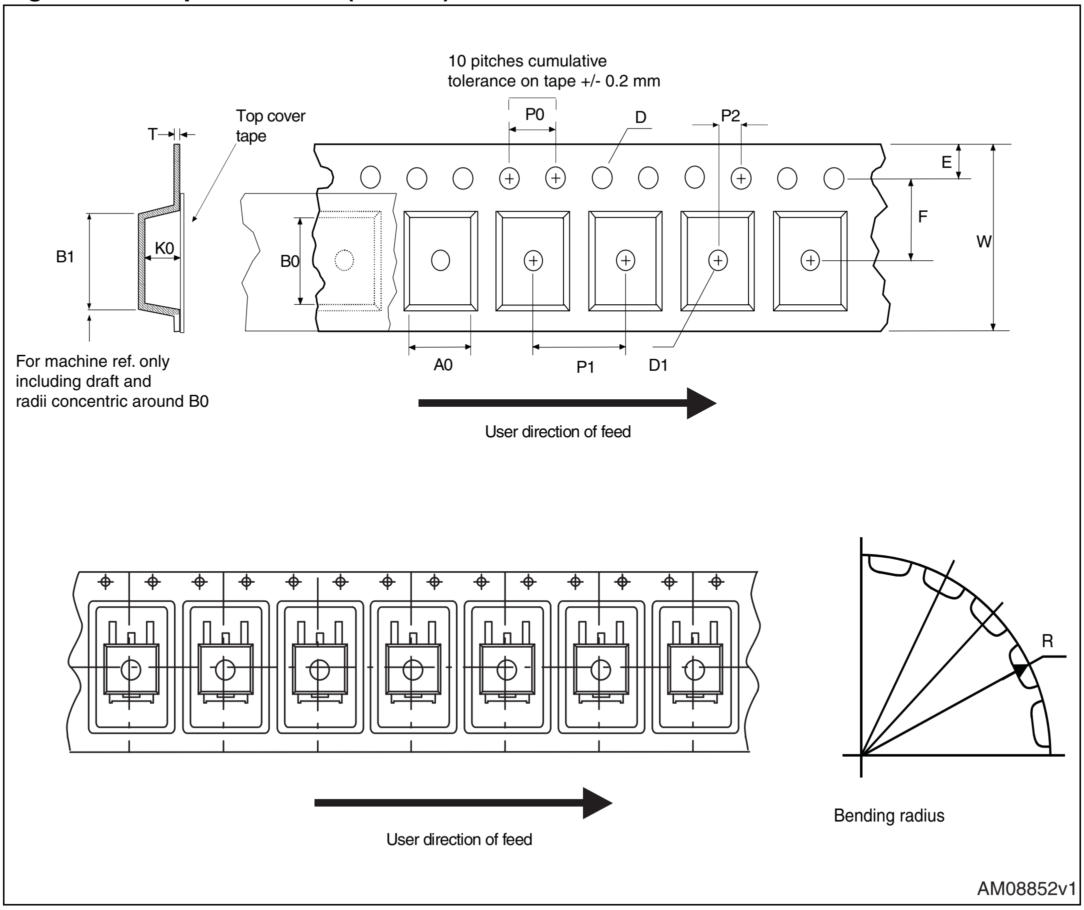
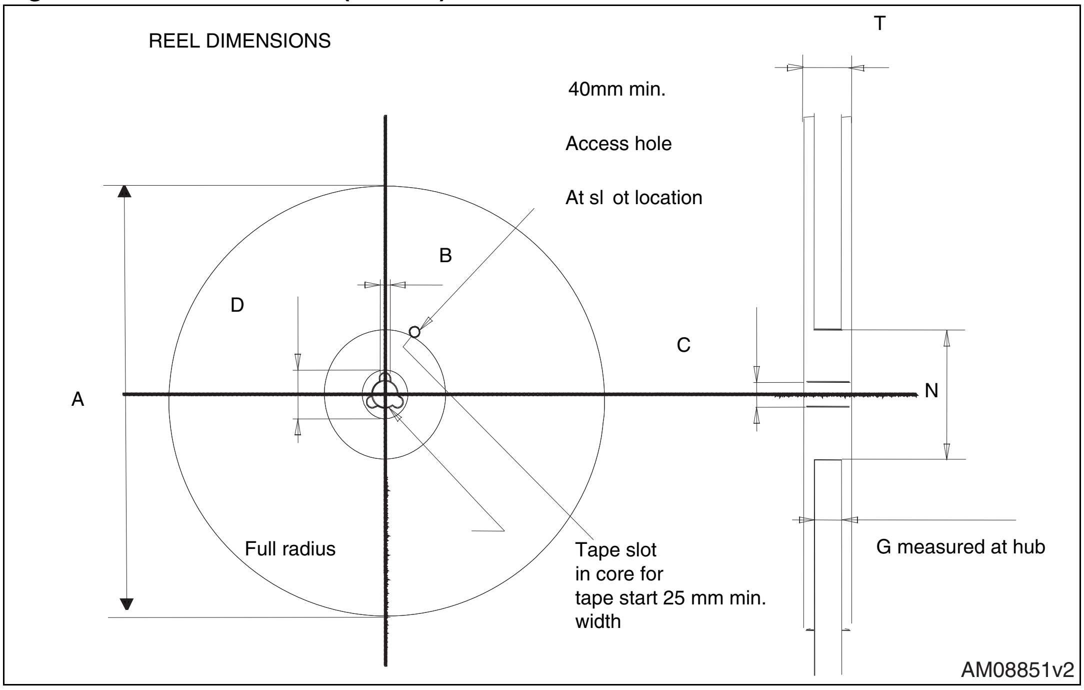


Figure 30. Reel for DPAK (TO-252)



6 Revision history

Table 14. Document revision history

Date	Revision	Changes
09-Mar-2004	1	First release
23-Mar-2004	2	Modified title
02-Apr-2005	3	Added new section: *Electrical characteristics (curves)*
06-Mar-2006	4	Inserted DPAK. The document has been reformatted
25-May-2012	5	Corrected unit in *Table 5: On/off states*