STB21NM60ND, STF21NM60ND, STP21NM60ND, STW21NM60ND

N-channel 600 V, 0.17 Ω typ., 17 A FDmesh™ II Power MOSFET in D²PAK, TO-220FP, TO-220 and TO-247 packages

Datasheet - production data

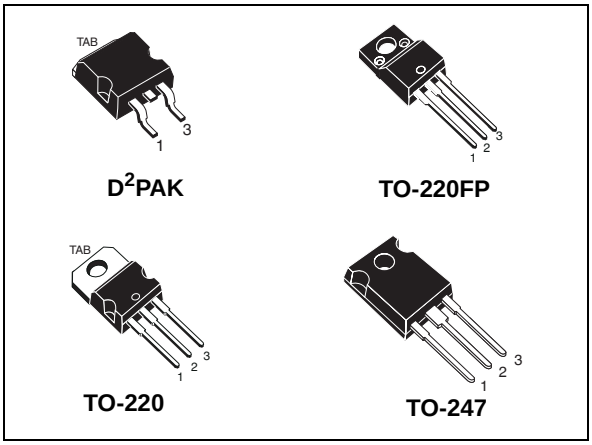
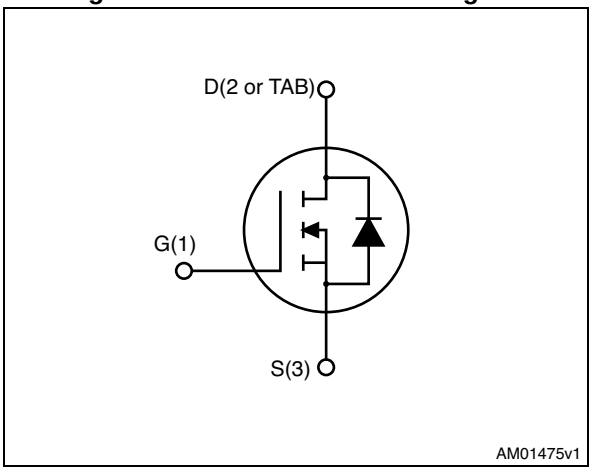


Figure 1. Internal schematic diagram



Features

Order codes	V_{DSS} @ $T_J$max	$R_{DS(on)}$ max	I_D
STB21NM60ND	650 V	0.22 Ω	17 A
STF21NM60ND	650 V	0.22 Ω	17 A
STP21NM60ND	650 V	0.22 Ω	17 A
STW21NM60ND	650 V	0.22 Ω	17 A

- Intrinsic fast-recovery body diode
- Worldwide best $R_{DS(on)}$*area amongst the fast recovery diode devices
- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance
- Extremely high dv/dt and avalanche capabilities

Applications

- Switching applications

Description

These FDmesh™ II Power MOSFETs with intrinsic fast-recovery body diode are produced using the second generation of MDmesh™ technology. Utilizing a new strip-layout vertical structure, these revolutionary devices feature extremely low on-resistance and superior switching performance. They are ideal for bridge topologies and ZVS phase-shift converters.

Table 1. Device summary

Order codes	Marking	Package	Packaging
STB21NM60ND	21NM60ND	D²PAK	Tape and reel
STF21NM60ND	21NM60ND	TO-220FP	Tube
STP21NM60ND	21NM60ND	TO-220	Tube
STW21NM60ND	21NM60ND	TO-247	Tube

This is information on a product in full production. www.st.com

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Contents

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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		TO-220, D^2PAK TO-247	TO-220FP	
V_{DS}	Drain-source voltage	600		V
V_{GS}	Gate- source voltage	±25		V
I_D	Drain current (continuous) at T_C = 25 °C	17	17(1)	A
I_D	Drain current (continuous) at T_C = 100 °C	10	10(1)	A
I_{DM} (2)	Drain current (pulsed)	68	68(1)	A
P_{TOT}	Total dissipation at T_C = 25 °C	140	30	W
dv/dt(3)	Peak diode recovery voltage slope	40		V/ns
Viso	Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1 s;T_C=25 °C)		2500	V
T_{stg}	Storage temperature	- 55 to 150		°C
T_J	Max. operating junction temperature	150		

1. Limited by maximum junction temperature.
2. Pulse width limited by safe operating area.
3. $I_{SD} \leq 17$ A, di/dt $\leq$ 600 A/μs, V_{DD} = 80% $V_{(BR)DSS}$; $V_{DS(peak)} \leq V_{(BR)DSS}$

Table 3. Thermal data

Symbol	Parameter	Value				Unit
		D^2PAK	TO-220FP	TO-220	TO-247	
Rthj-case	Thermal resistance junction-case max	0.89	4.17	0.89		°C/W
Rthj-amb	Thermal resistance junction-ambient max		62.5		50	°C/W

Table 4. Avalanche characteristics

Symbol	Parameter	Max value	Unit
I_{AS}	Avalanche current, repetitive or not-repetitive (pulse width limited by T_J max)	8.5	A
E_{AS}	Single pulse avalanche energy (starting T_J = 25 °C, I_D = I_{AS}, V_{DD} = 50 V)	610	mJ

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2 Electrical characteristics

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

Table 5. On/off states

Symbol	Parameter	Test conditions	Value			Unit
			Min.	Typ.	Max.	
$V_{(BR)DSS}$	Drain-source breakdown voltage	I_D = 1 mA, V_{GS} = 0	600			V
dv/dt(1)	Drain source voltage slope	V_{DD}= 480 V, I_D= 17 A, V_{GS}= 10 V		48		V/ns
I_{DSS}	Zero gate voltage drain current (V_{GS} = 0)	V_{DS} = 600 V V_{DS} = 600 V, T_C=125 °C			1 100	µA µA
I_{GSS}	Gate-body leakage current (V_{DS} = 0)	V_{GS} = ± 20 V			±100	nA
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 250 µA	3	4	5	V
$R_{DS(on)}$	Static drain-source on-resistance	V_{GS} = 10 V, I_D = 8.5 A		0.170	0.220	Ω

1. Characteristic value at turn off on inductive load

Table 6. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss} C^{oss} C_{rss}	Input capacitance Output capacitance Reverse transfer capacitance	V_{DS} = 50 V, f = 1 MHz, V_{GS} = 0	-	1800 90 8	-	pF pF pF
$C_{oss\ eq.}$(1)	Equivalent output capacitance	V_{GS} = 0, V_{DS} = 0 to 480 V	-	300	-	pF
$t_{d(on)}$ t_r $t_{d(off)}$ t_f	Turn-on delay time Rise time Turn-off delay time Fall time	V_{DD} =300 V, I_D = 8.5 A R_G = 4.7 Ω, V_{GS} = 10 V *(see Figure 23),* *(see Figure 18)*	-	18 16 70 48	-	ns ns ns ns
Q_g Q_{gs} Q_{gd}	Total gate charge Gate-source charge Gate-drain charge	V_{DD} = 480 V, I_D = 17 A, V_{GS} = 10 V, *(see Figure 19)*	-	60 10 30	-	nC nC nC
R_G	Gate input resistance	f=1 MHz Gate DC Bias=0 Test signal level=20 mV Open drain	-	3	-	Ω

1. $C_{oss\ eq.}$ 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}

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Table 7. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD} I_{SDM} (1)	Source-drain current Source-drain current (pulsed)				17 68	A A
V_{SD} (2)	Forward on voltage	I_{SD} = 17 A, V_{GS} = 0			1.6	V
t_{rr} Q_{rr} I_{RRM}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_{SD} = 17 A, V_{DD} = 60 V di/dt=100 A/µs *(see Figure 20)*		150 0.90 13		ns µC A
t_{rr} Q_{rr} I_{RRM}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_{SD} = 17 A,V_{DD} = 60 V di/dt=100 A/µs, T_J = 150 °C *(see Figure 20)*		210 1.6 15		ns µC A

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

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2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for TO-220, D²PAK

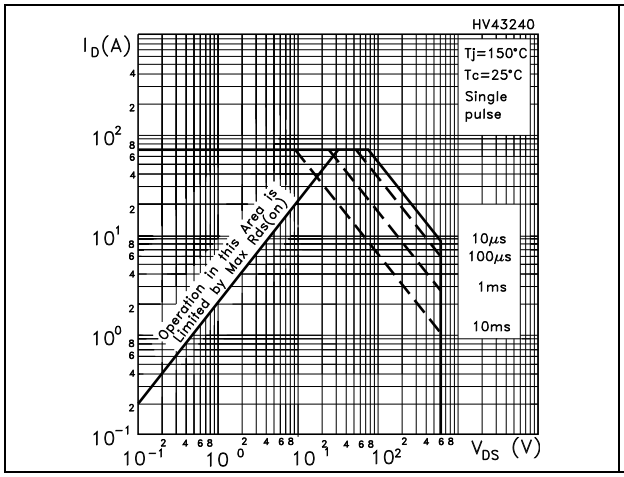

Figure 3. Thermal impedance for TO-220, D²PAK

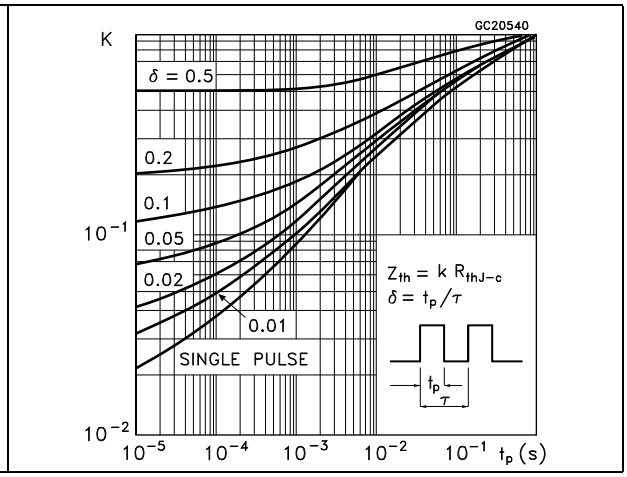

Figure 4. Safe operating area for TO-220FP

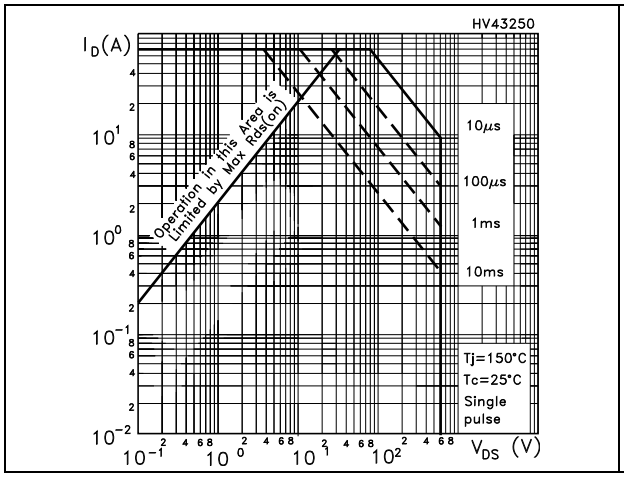

Figure 5. Thermal impedance for TO-220FP

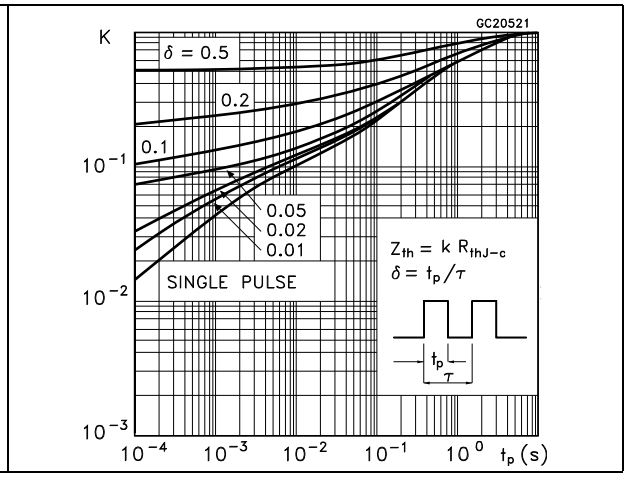

Figure 6. Safe operating area for TO-247

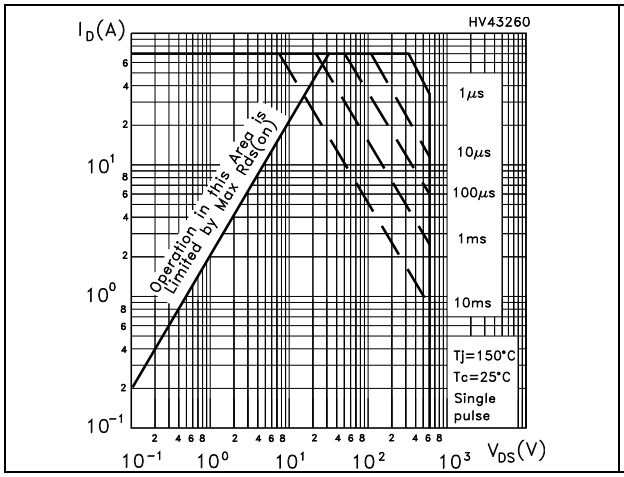

Figure 7. Thermal impedance for TO-247

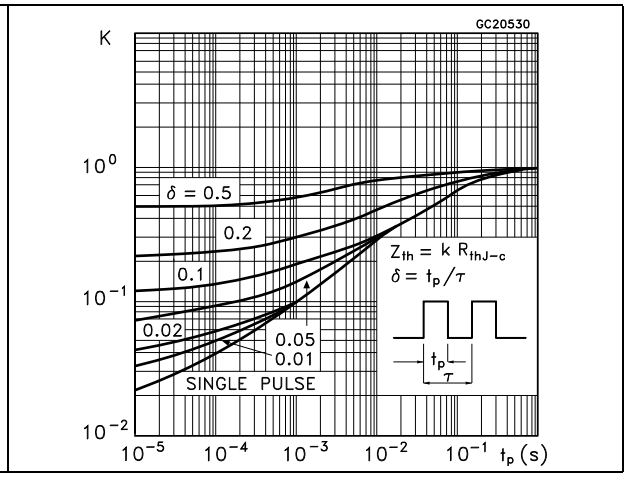

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Figure 8. Output characteristics

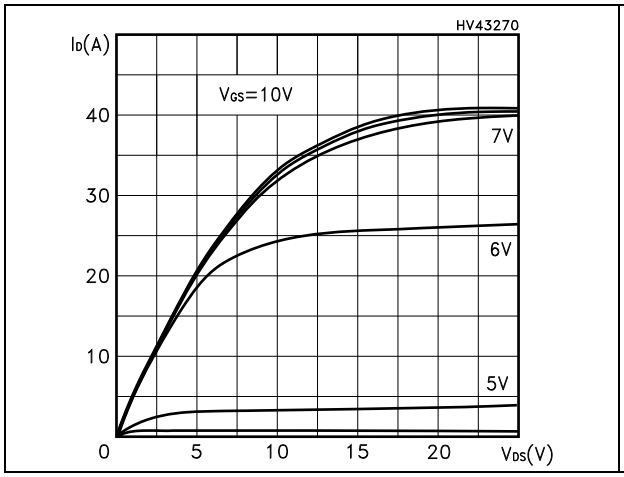

Figure 9. Transfer characteristics

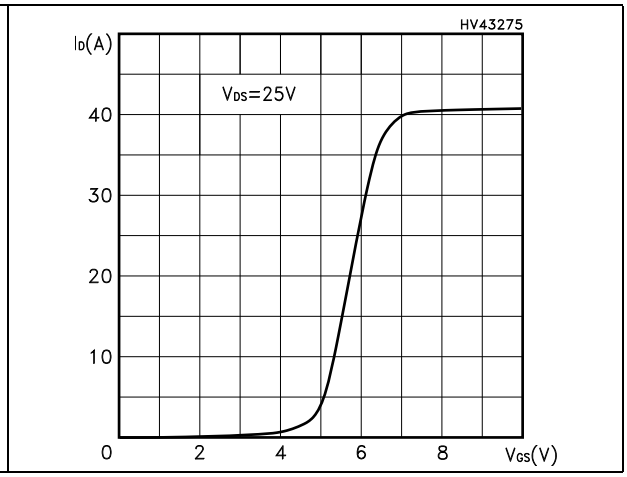

Figure 10. Transconductance

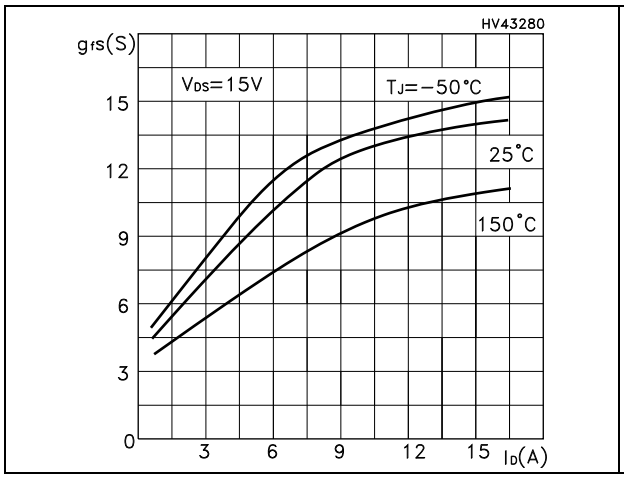

Figure 11. Static drain-source on-resistance

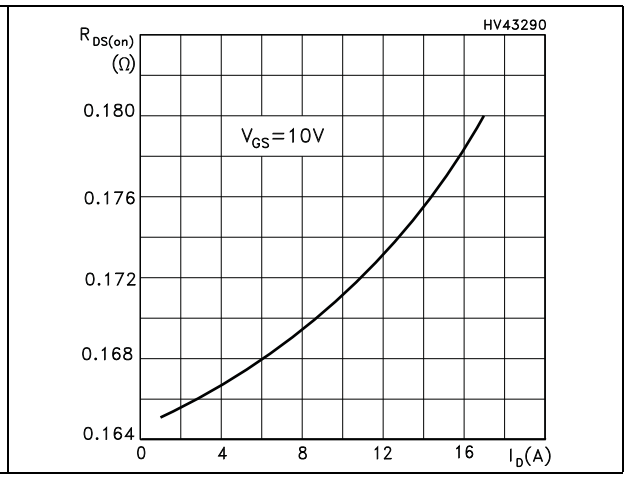

Figure 12. Gate charge vs gate-source voltage

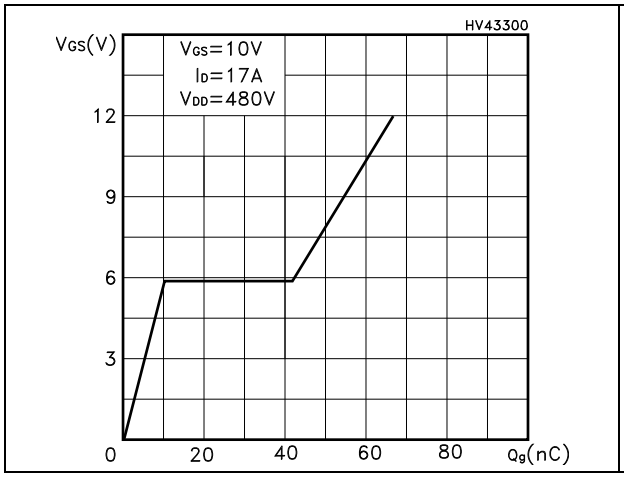

Figure 13. Capacitance variations

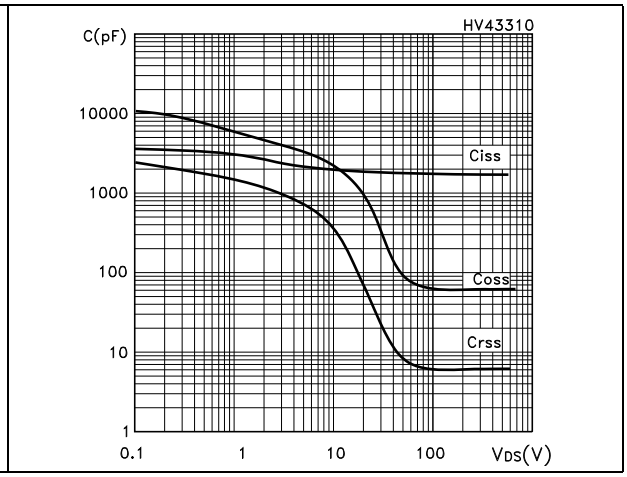

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Figure 14. Normalized gate threshold voltage vs temperature

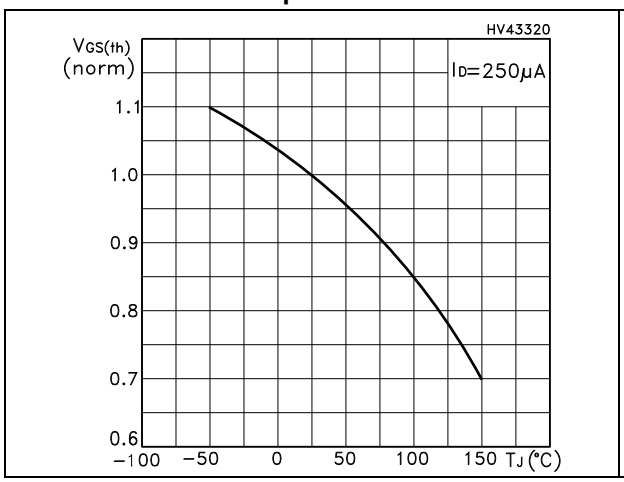


Figure 15. Normalized on-resistance vs temperature

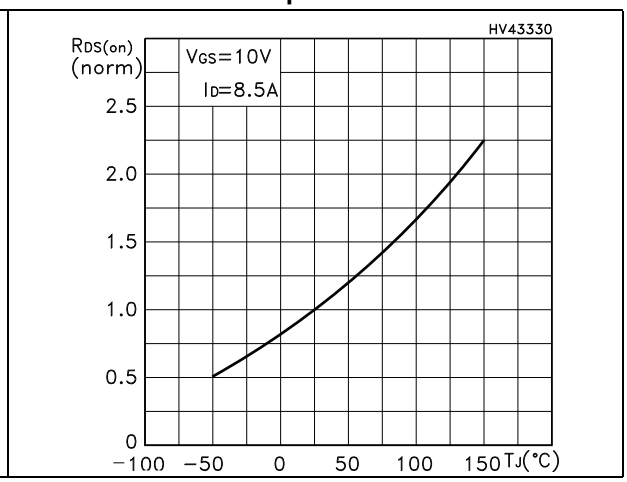


Figure 16. Source-drain diode forward characteristics

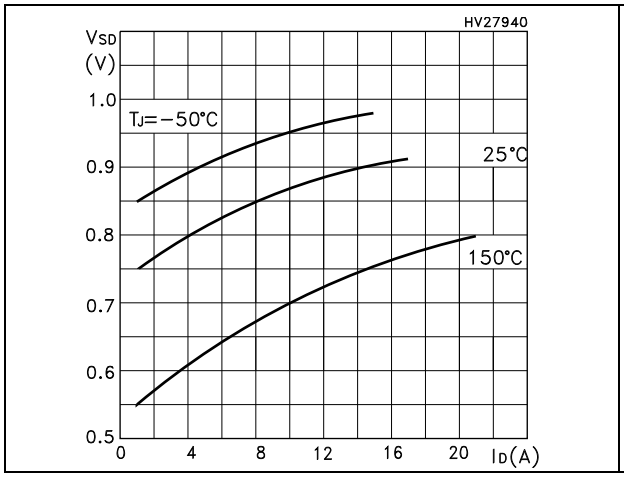
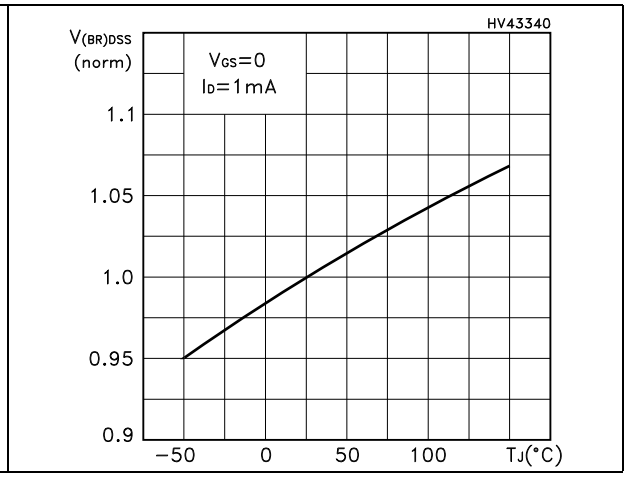


Figure 17. Normalized BV_{DSS} vs temperature



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3 Test circuits

Figure 18. Switching times test circuit for resistive load

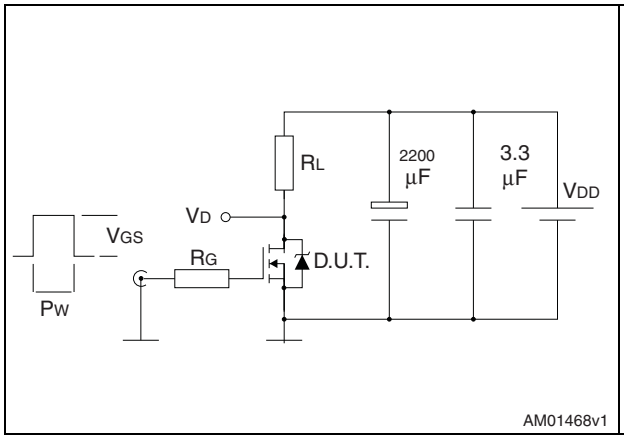


Figure 19. Gate charge test circuit

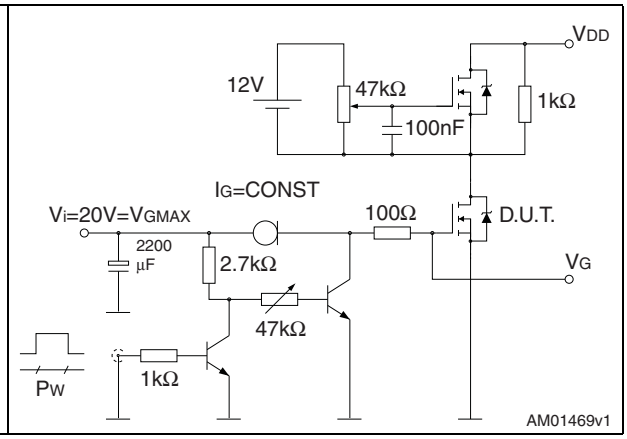


Figure 20. Test circuit for inductive load switching and diode recovery times

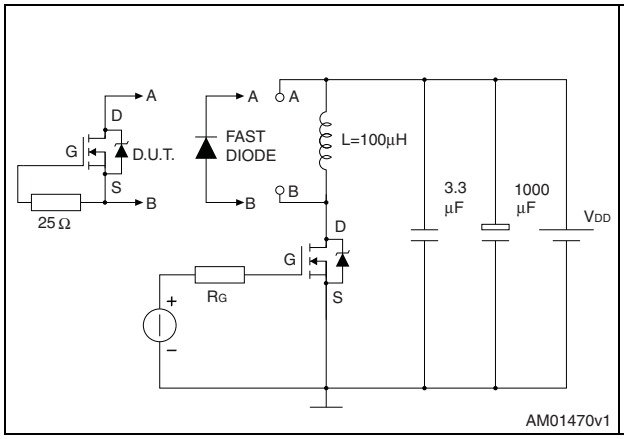


Figure 21. Unclamped inductive load test circuit

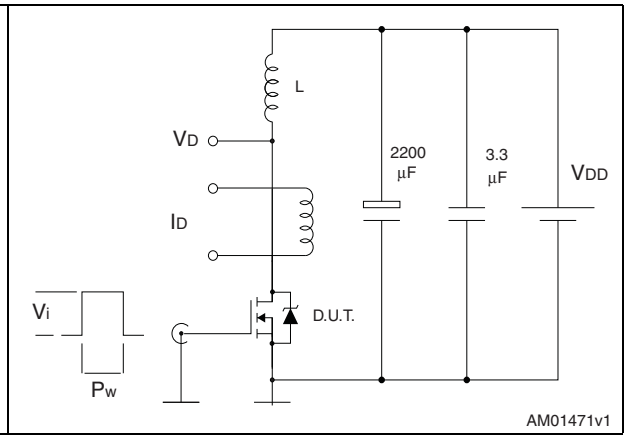


Figure 22. Unclamped inductive waveform

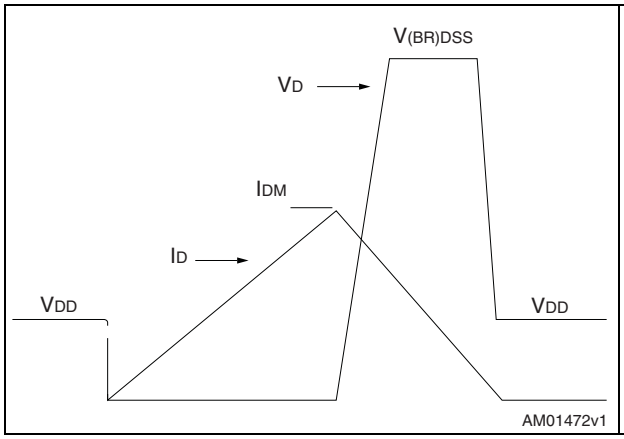
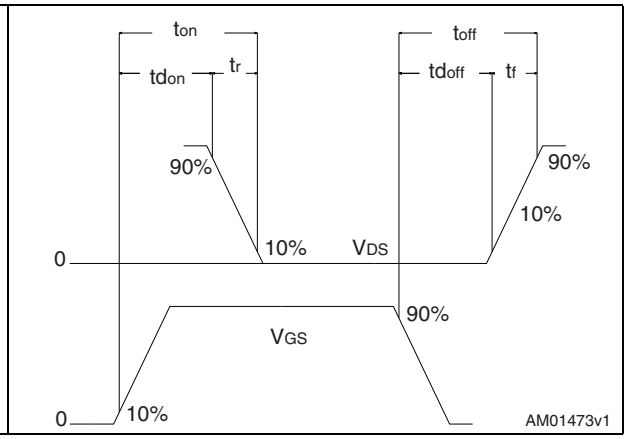


Figure 23. Switching time waveform



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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 8. 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°

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Figure 24. D²PAK (TO-263) drawing

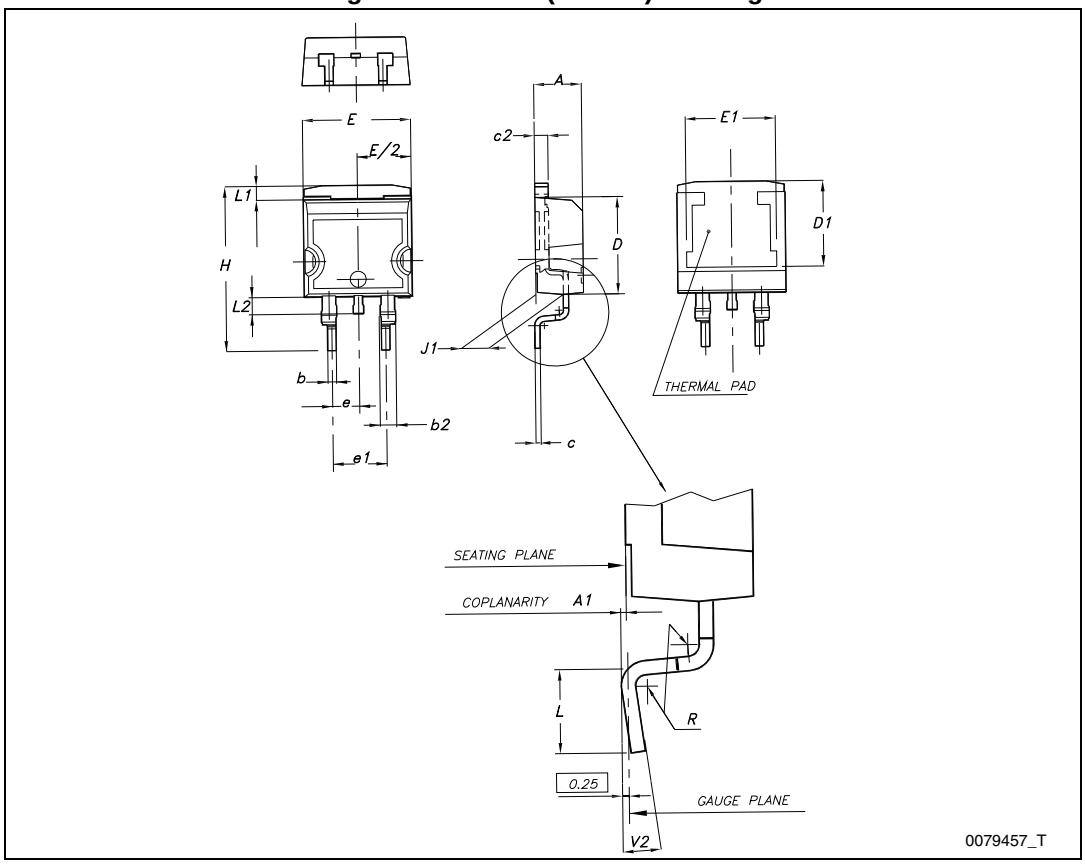
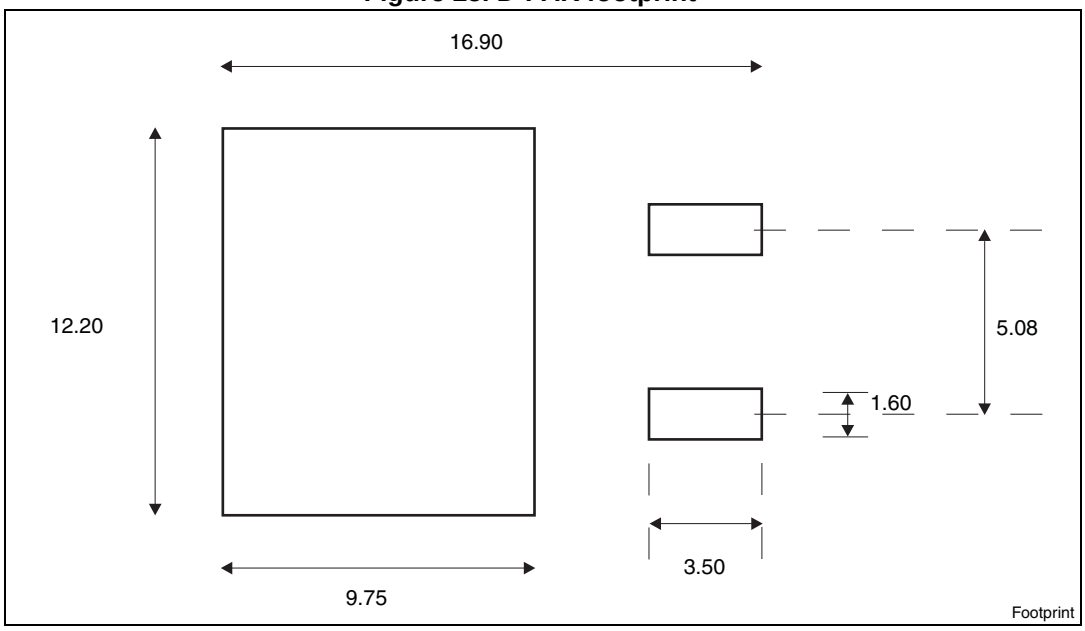


Figure 25. D²PAK footprint[a]



a. All dimensions are in millimeters

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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

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Figure 26. TO-220FP drawing

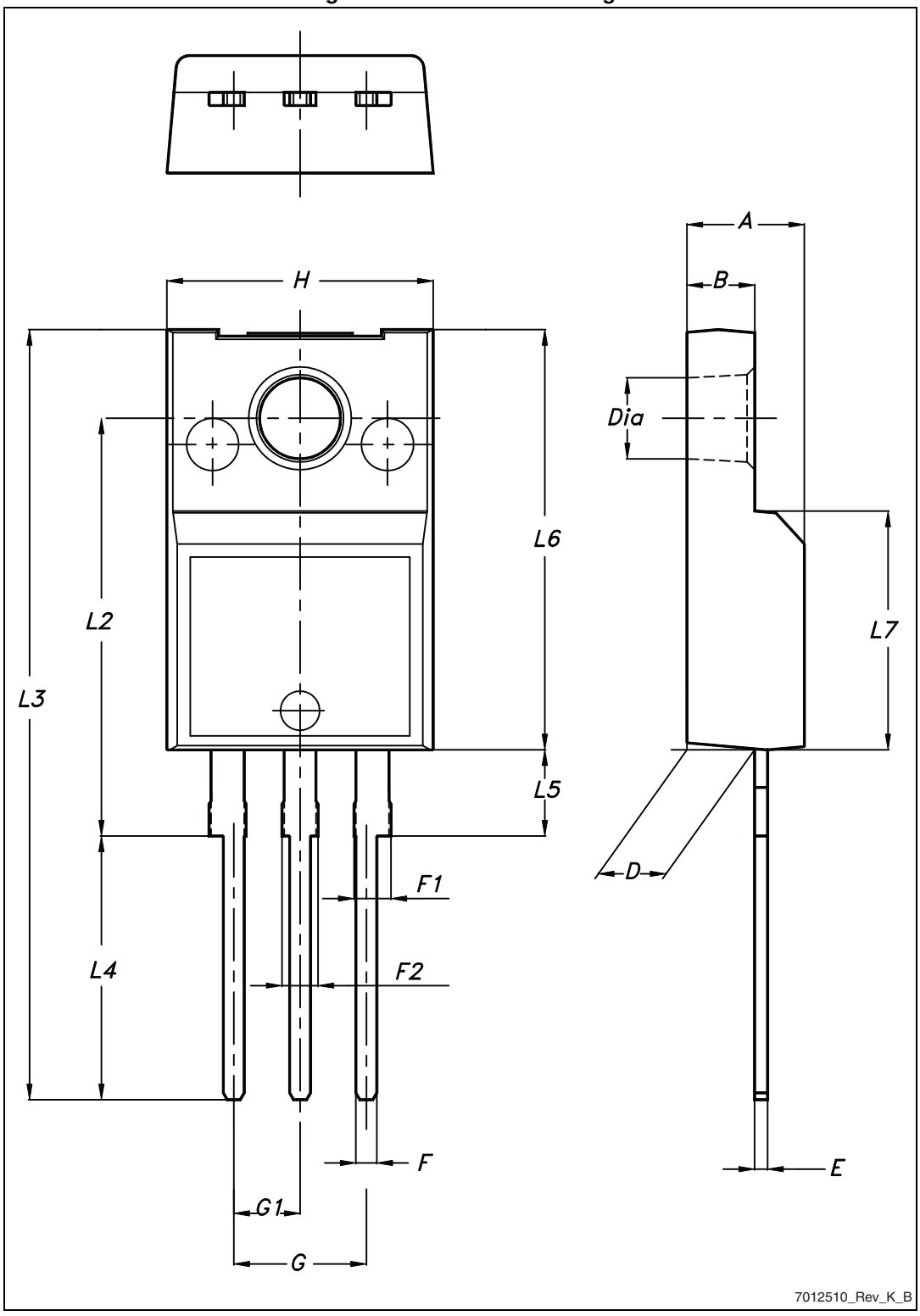

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Table 10. TO-220 type A mechanical data

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

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Figure 27. TO-220 type A drawing

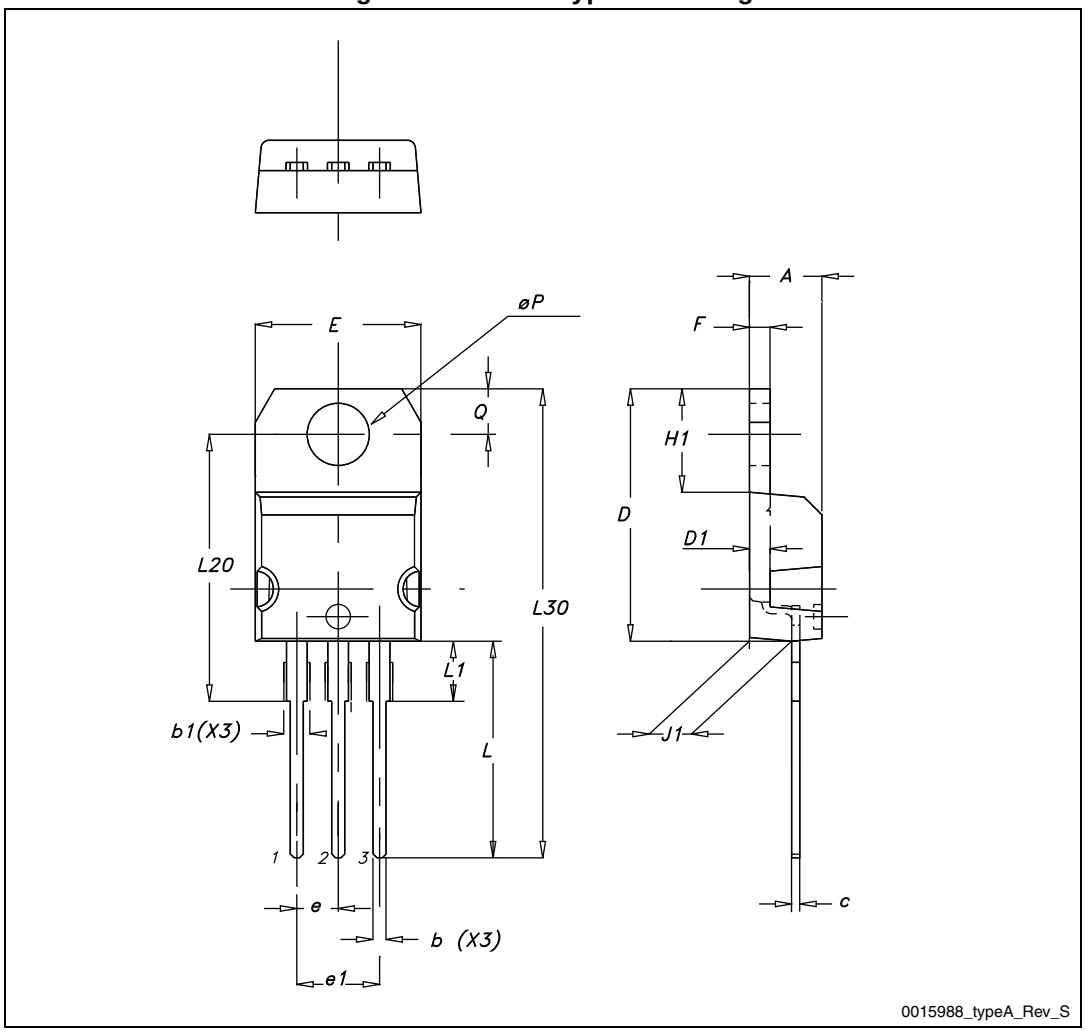

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Table 11. TO-247 mechanical data

Dim.	mm.		
	Min.	Typ.	Max.
A	4.85		5.15
A1	2.20		2.60
b	1.0		1.40
b1	2.0		2.40
b2	3.0		3.40
c	0.40		0.80
D	19.85		20.15
E	15.45		15.75
e	5.30	5.45	5.60
L	14.20		14.80
L1	3.70		4.30
L2		18.50	
∅P	3.55		3.65
∅R	4.50		5.50
S	5.30	5.50	5.70

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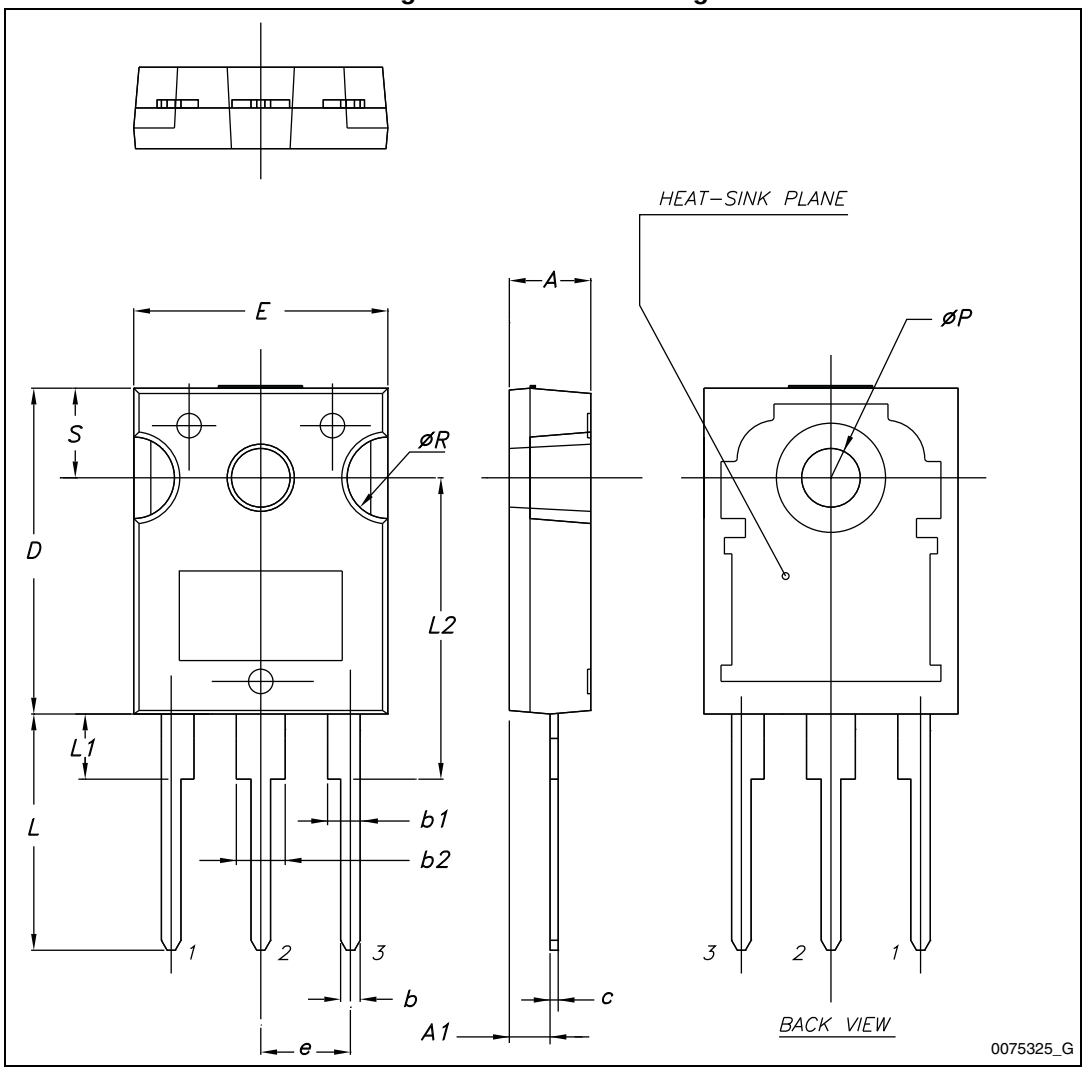
Figure 28. TO-247 drawing



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5 Packing mechanical data

Table 12. 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			

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Figure 29. Tape

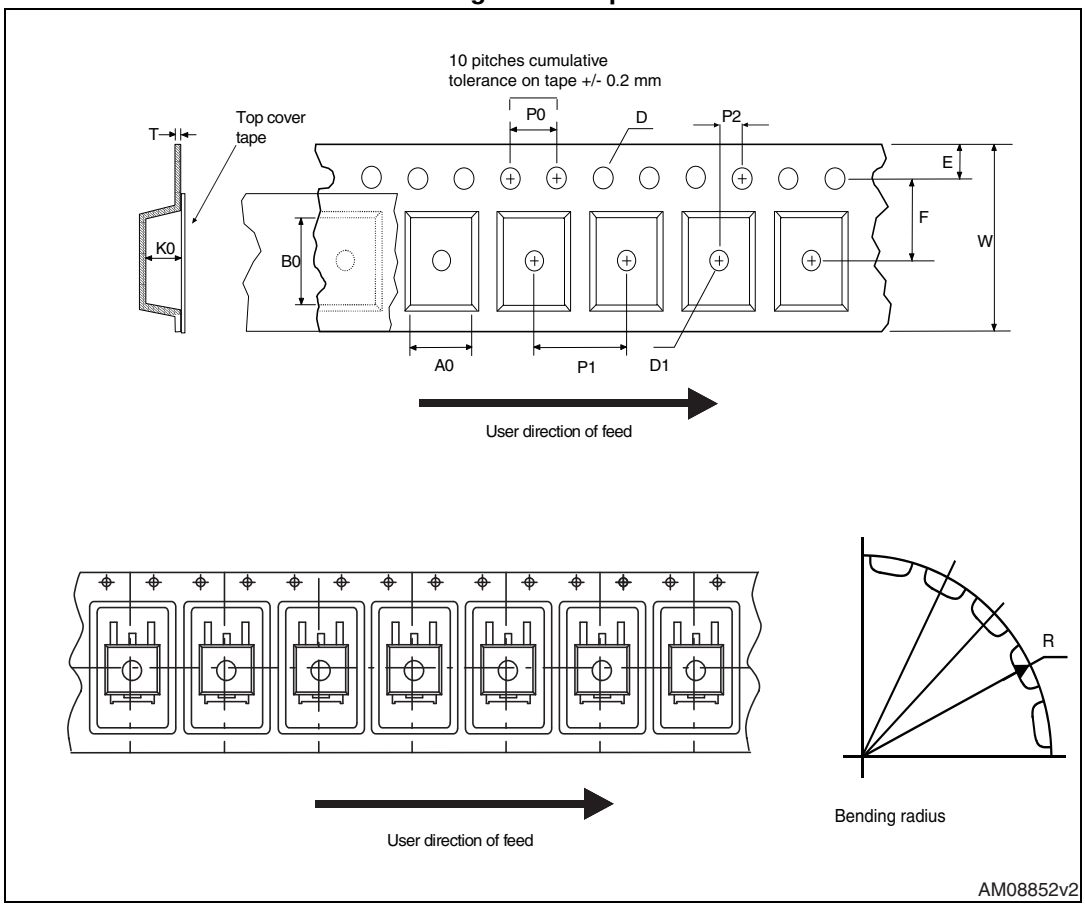
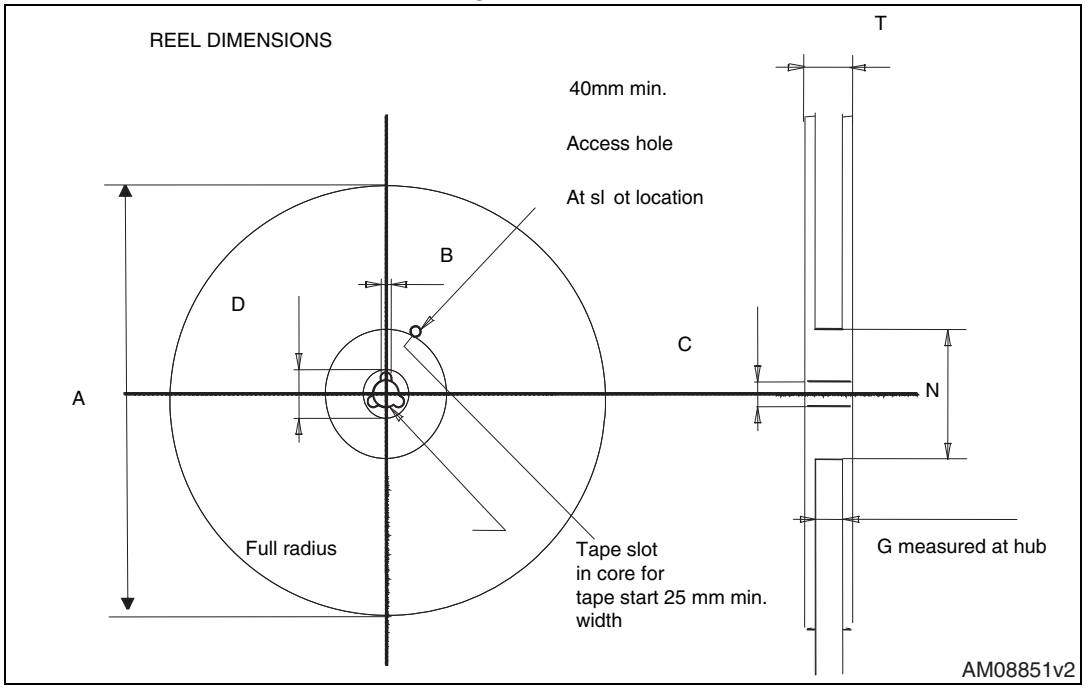


Figure 30. Reel



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6 Revision history

Table 13. Document revision history

Date	Revision	Changes
05-Sep-2007	1	First release.
22-Apr-2008	2	Datasheet status promoted from preliminary data to datasheet.
27-Mar-2009	3	*Figure 13* has been updated. Updated ECOPACK® statement (*Section 4: Package mechanical data*)
16-Nov-2012	4	*Section 4: Package mechanical data* has been updated Minor text changes.
06-Mar-2013	5	Updated dv/dt value on *Table 2: Absolute maximum ratings*.

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