



STB31N65M5, STF31N65M5, STFI31N65M5, STP31N65M5, STW31N65M5

life.augmented

N-channel 650 V, 0.124 Ω typ., 22 A MDmesh™ V Power MOSFET
in D²PAK, TO-220FP, I²PakFP, TO-220 and TO-247 packages

Datasheet – production data

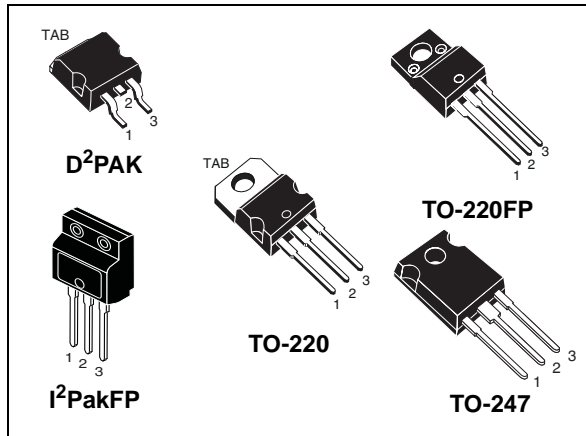
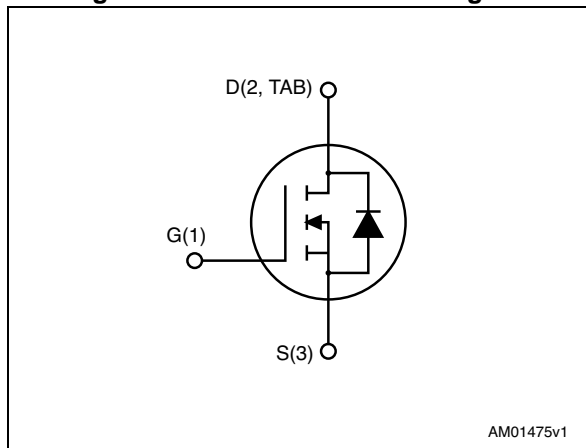


Figure 1. Internal schematic diagram



Features

Order codes	$V_{DSS} @ T_{Jmax}$	$R_{DS(on) max}$	I_D
STB31N65M5	710 V	< 0.148 Ω	22 A
STF31N65M5			
STFI31N65M5			
STP31N65M5			
STW31N65M5			

- Worldwide best $R_{DS(on)}$ * area
- Higher V_{DSS} rating and high dv/dt capability
- Excellent switching performance
- 100% avalanche tested

Applications

- Switching applications

Description

These devices are N-channel MDmesh™ V Power MOSFETs based on an innovative proprietary vertical process technology, which is combined with STMicroelectronics' well-known PowerMESH™ horizontal layout structure. The resulting product has extremely low on-resistance, which is unmatched among silicon-based Power MOSFETs, making it especially suitable for applications which require superior power density and outstanding efficiency.

Table 1. Device summary

Order code	Marking	Package	Packaging
STB31N65M5	31N65M5	D ² PAK	Tape and reel
STF31N65M5		TO-220FP	Tube
STFI31N65M5		I ² PakFP	
STP31N65M5		TO-220	
STW31N65M5		TO-247	

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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		D ² PAK TO-220 TO-247	TO-220FP I ² PakFP	
V _{GS}	Gate-source voltage	± 25		V
I _D	Drain current (continuous) at T _C = 25 °C	22	22 ⁽¹⁾	A
I _D	Drain current (continuous) at T _C = 100 °C	13.9	13.9 ⁽¹⁾	A
I _{DM} ⁽¹⁾	Drain current (pulsed)	88	88 ⁽¹⁾	A
P _{TOT}	Total dissipation at T _C = 25 °C	150	30	W
dv/dt ⁽²⁾	Peak diode recovery voltage slope	15		V/ns
dv/dt ⁽³⁾	MOSFET dv/dt ruggedness	50		V/ns
V _{ISO}	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		°C

- Limited by maximum junction temperature.
- I_{SD} ≤ 22 A, di/dt ≤ 400 A/μs; V_{DS peak} < V_{(BR)DSS}; V_{DD}=400 V
- V_{DS} ≤ 480 V

Table 3. Thermal data

Symbol	Parameter	Value				Unit
		D ² PAK	TO-220FP I ² PakFP	TO-220	TO-247	
R _{thj-case}	Thermal resistance junction-case max	0.83	4.17	0.83		°C/W
R _{thj-pcb} ⁽¹⁾	Thermal resistance junction-pcb max	30				°C/W
R _{thj-amb}	Thermal resistance junction-ambient max		62.5		50	°C/W

- When mounted on 1 inch² FR-4, 2 Oz copper board.

Table 4. Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetitive or not repetitive (pulse width limited by T_{jmax})	5	A
E_{AS}	Single pulse avalanche energy (starting $t_j=25^\circ\text{C}$, $I_d=I_{AR}$; $V_{dd}=50$)	410	mJ

2 Electrical characteristics

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

Table 5. On /off states

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 1\text{ mA}, V_{GS} = 0$	650			V
I_{DSS}	Zero gate voltage drain current ($V_{GS} = 0$)	$V_{DS} = 650\text{ V}$ $V_{DS} = 650\text{ V}, T_C = 125\text{ °C}$			1 100	μA μA
I_{GSS}	Gate-body leakage current ($V_{DS} = 0$)	$V_{GS} = \pm 25\text{ V}$			± 100	nA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$	3	4	5	V
$R_{DS(on)}$	Static drain-source on-resistance	$V_{GS} = 10\text{ V}, I_D = 11\text{ A}$		0.124	0.148	Ω

Table 6. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	$V_{DS} = 100\text{ V}, f = 1\text{ MHz},$ $V_{GS} = 0$	-	1865	-	pF
C_{oss}	Output capacitance			45		pF
C_{rss}	Reverse transfer capacitance			4.2		pF
$C_{o(tr)}^{(1)}$	Equivalent capacitance time related	$V_{DS} = 0\text{ to }520\text{ V}, V_{GS} = 0$	-	146	-	pF
$C_{o(er)}^{(2)}$	Equivalent capacitance energy related			43		pF
R_G	Intrinsic gate resistance	$f = 1\text{ MHz open drain}$	-	2.8	-	Ω
Q_g	Total gate charge	$V_{DD} = 520\text{ V}, I_D = 11\text{ A},$ $V_{GS} = 10\text{ V}$ (see Figure 20)	-	45	-	nC
Q_{gs}	Gate-source charge			11.5		nC
Q_{gd}	Gate-drain charge			20		nC

1. Time related 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}
2. Energy related is defined as a constant equivalent capacitance giving the same stored energy 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 (v)	Voltage delay time	$V_{DD} = 400\text{ V}$, $I_D = 14\text{ A}$,		46		ns
t_r (v)	Voltage rise time	$R_G = 4.7\ \Omega$, $V_{GS} = 10\text{ V}$	-	8	-	ns
t_f (i)	Current fall time	(see Figure 21 and		8.5		ns
$t_{c(off)}$	Crossing time	Figure 24)		11		ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		22	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		88	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 22\text{ A}$, $V_{GS} = 0$	-		1.5	V
t_{rr}	Reverse recovery time	$I_{SD} = 22\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$	-	336		ns
Q_{rr}	Reverse recovery charge	$V_{DD} = 100\text{ V}$ (see Figure 21)		5		μC
I_{RRM}	Reverse recovery current			30		A
t_{rr}	Reverse recovery time	$I_{SD} = 22\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$	-	406		ns
Q_{rr}	Reverse recovery charge	$V_{DD} = 100\text{ V}$, $T_j = 150\text{ }^\circ\text{C}$		6		μC
I_{RRM}	Reverse recovery current	(see Figure 21)		31		A

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

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for D²PAK and TO220

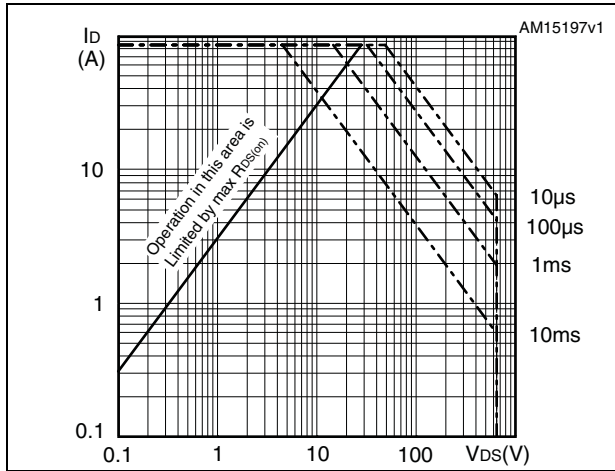


Figure 3. Thermal impedance for D²PAK and TO-220

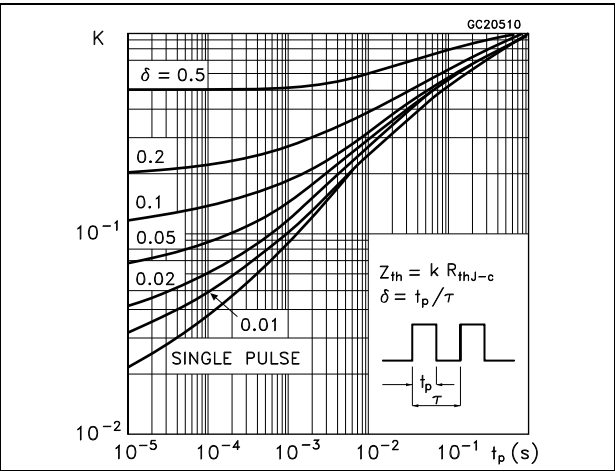


Figure 4. Safe operating area for TO-220FP and I²PakFP

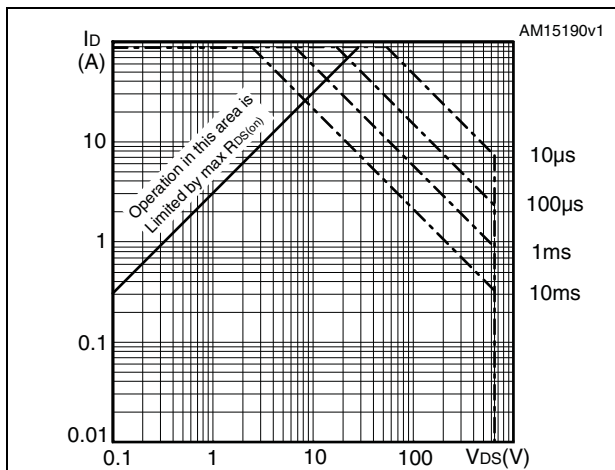


Figure 5. Thermal impedance for TO-220FP and I²PakFP

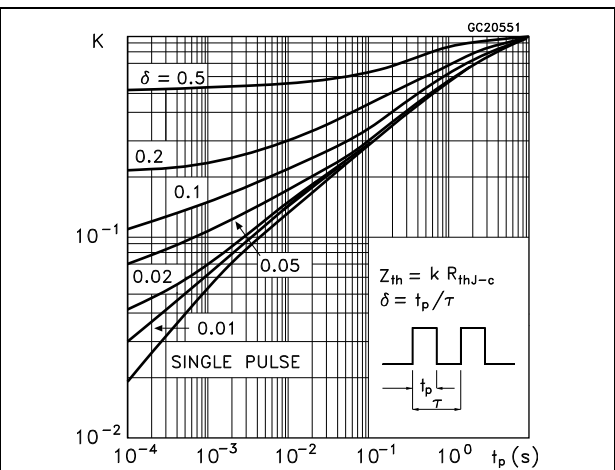


Figure 6. Safe operating area for TO-247

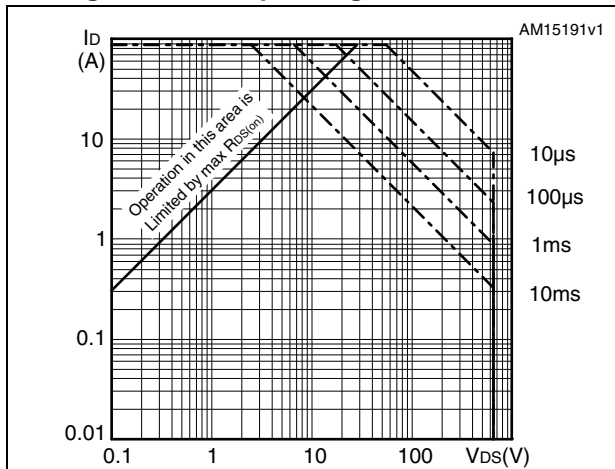


Figure 7. Thermal impedance for TO-247

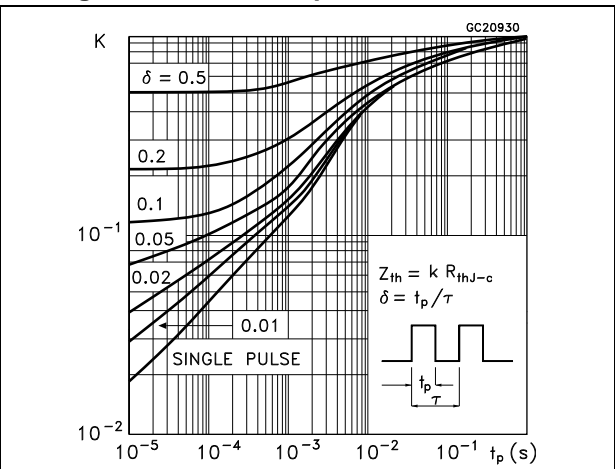


Figure 8. Output characteristics

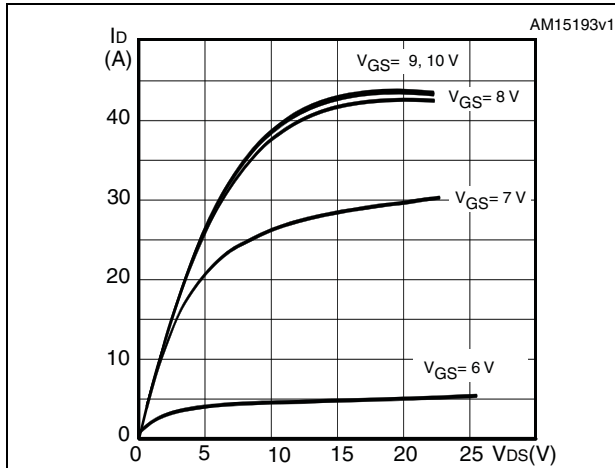


Figure 9. Transfer characteristics

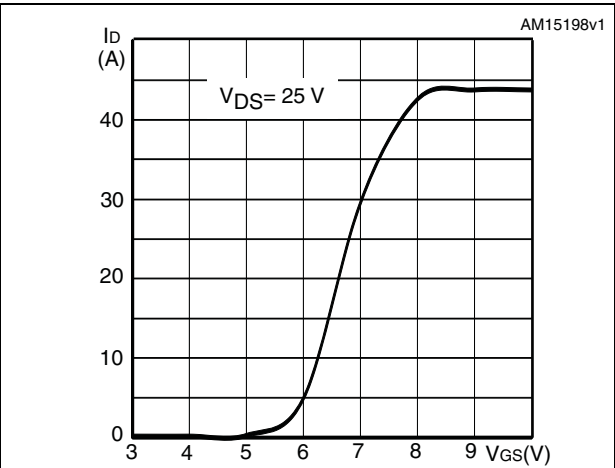


Figure 10. Gate charge vs gate-source voltage

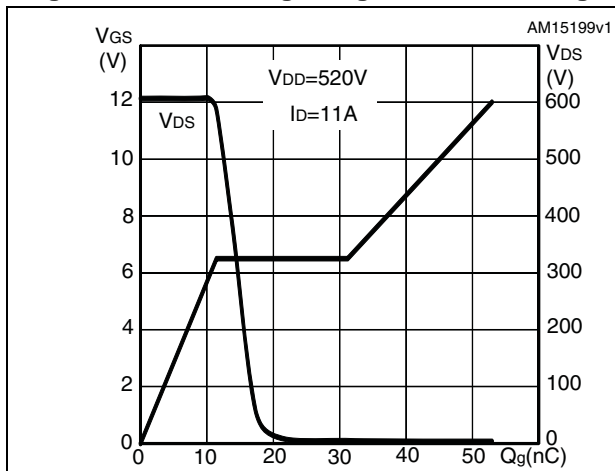


Figure 11. Static drain-source on-resistance

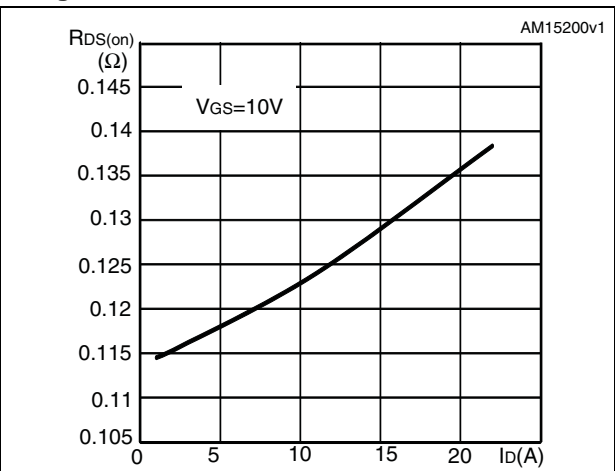


Figure 12. Capacitance variations

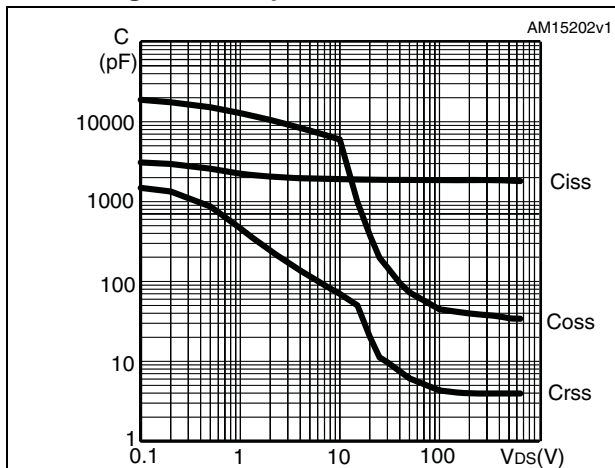


Figure 13. Output capacitance stored energy

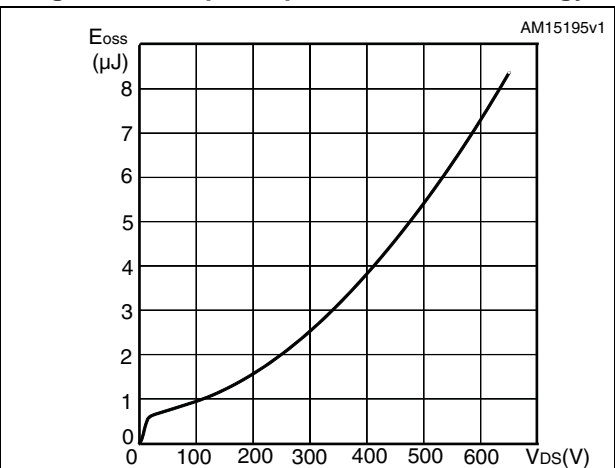


Figure 14. Normalized gate threshold voltage vs temperature

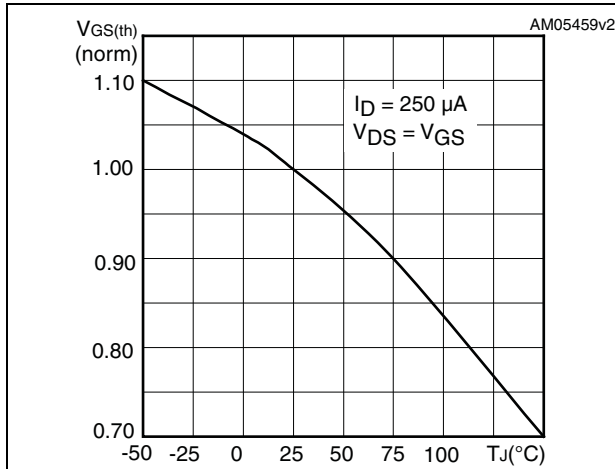


Figure 15. Normalized on-resistance vs temperature

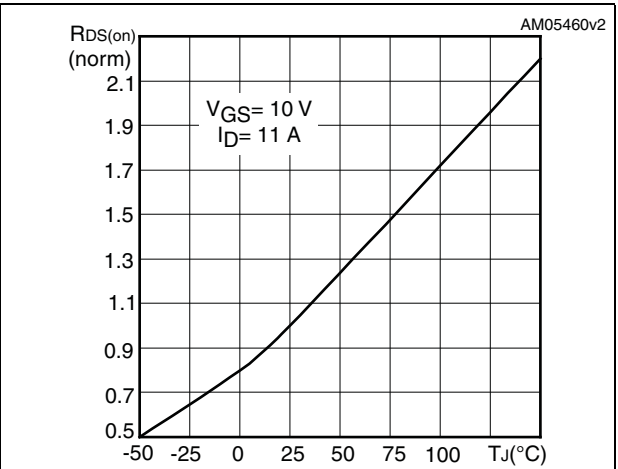


Figure 16. Source-drain diode forward characteristics

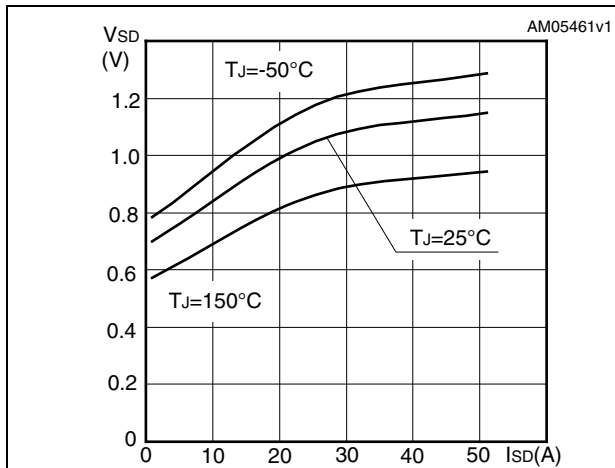


Figure 17. Normalized BVDS vs temperature

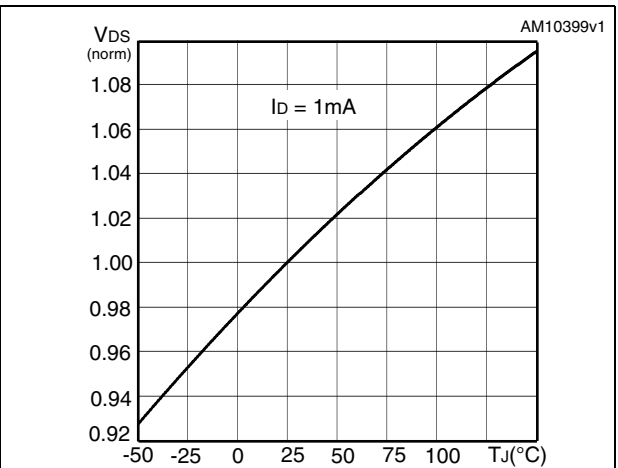
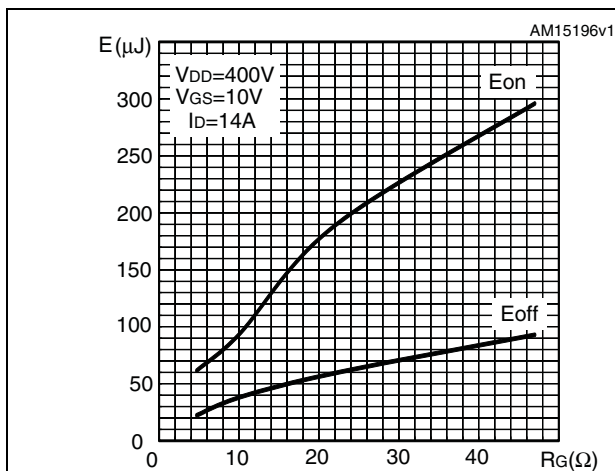


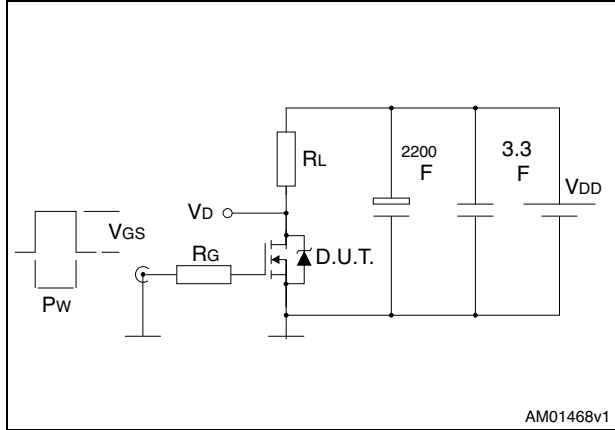
Figure 18. Switching losses vs gate resistance⁽¹⁾



1. Eon including reverse recovery of a SiC diode

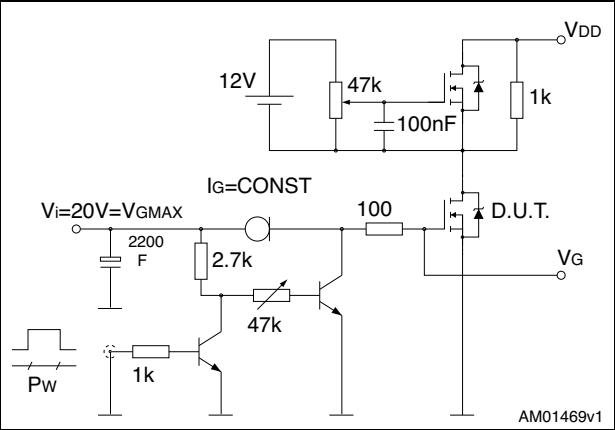
3 Test circuits

Figure 19. Switching times test circuit for resistive load



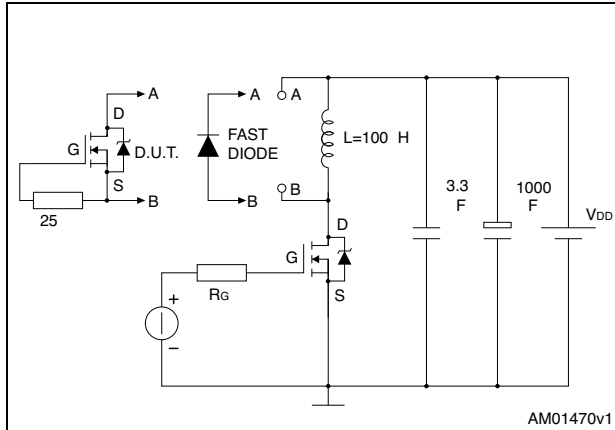
AM01468v1

Figure 20. Gate charge test circuit



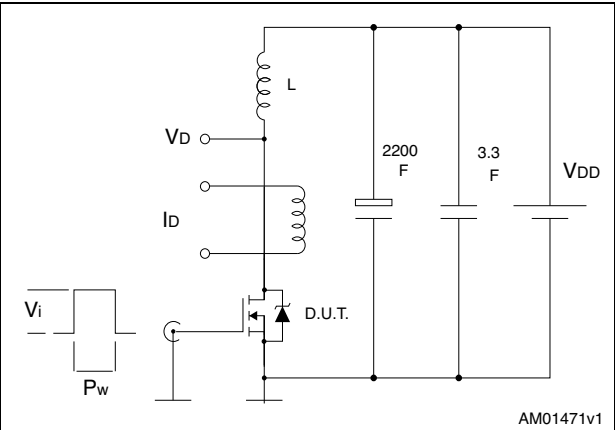
AM01469v1

Figure 21. Test circuit for inductive load switching and diode recovery times



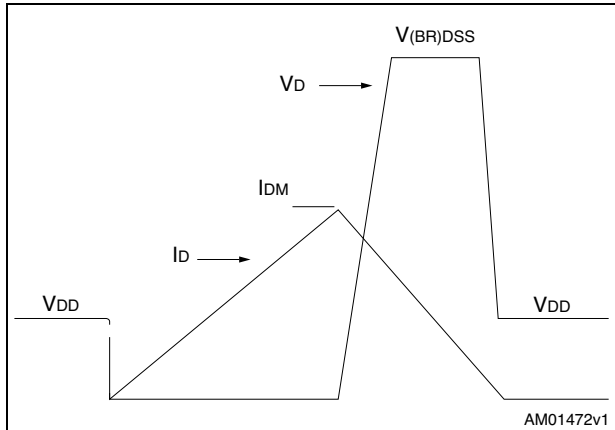
AM01470v1

Figure 22. Unclamped inductive load test circuit



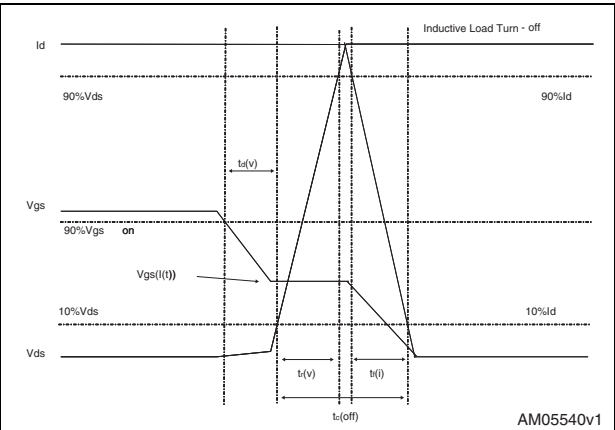
AM01471v1

Figure 23. Unclamped inductive waveform



AM01472v1

Figure 24. Switching time waveform



AM05540v1

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. 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) drawing

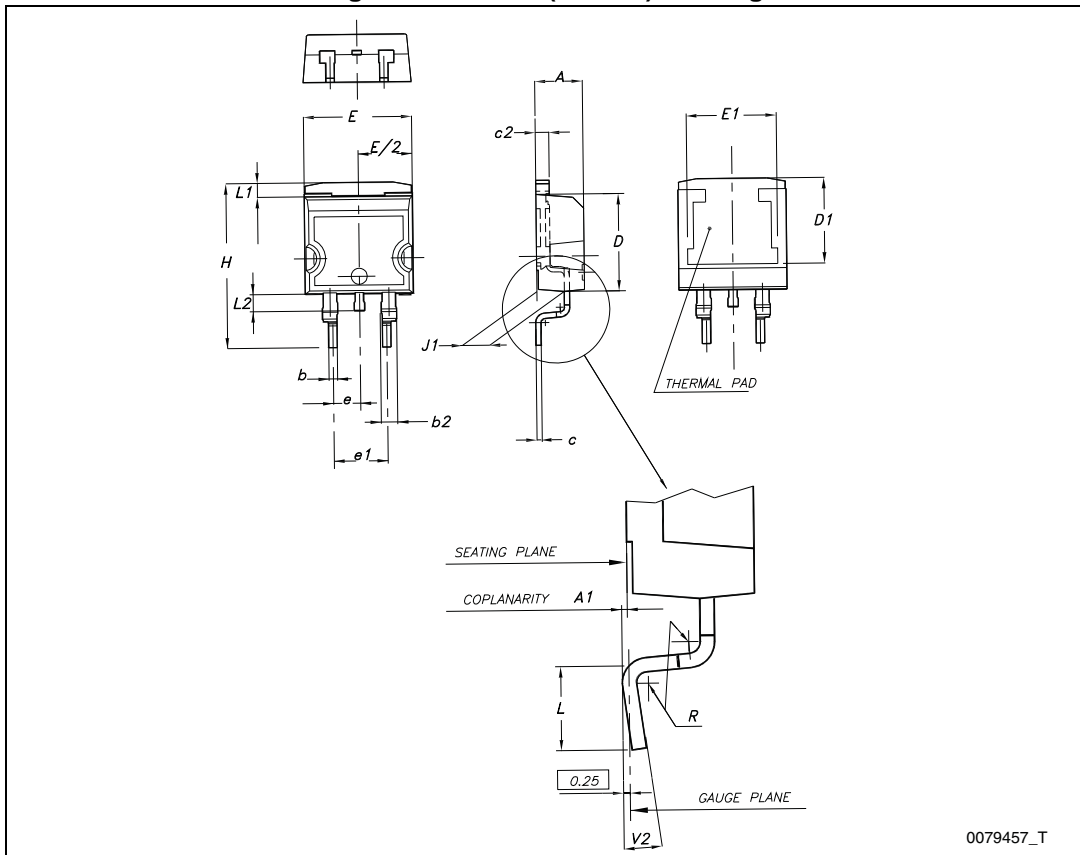
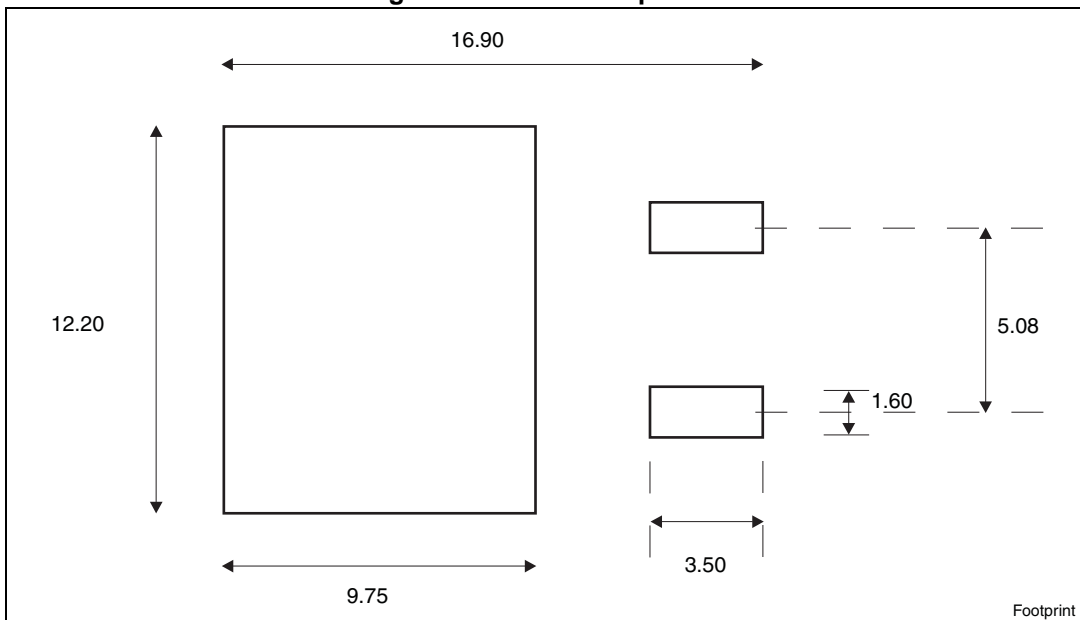


Figure 26. D²PAK footprint^(a)

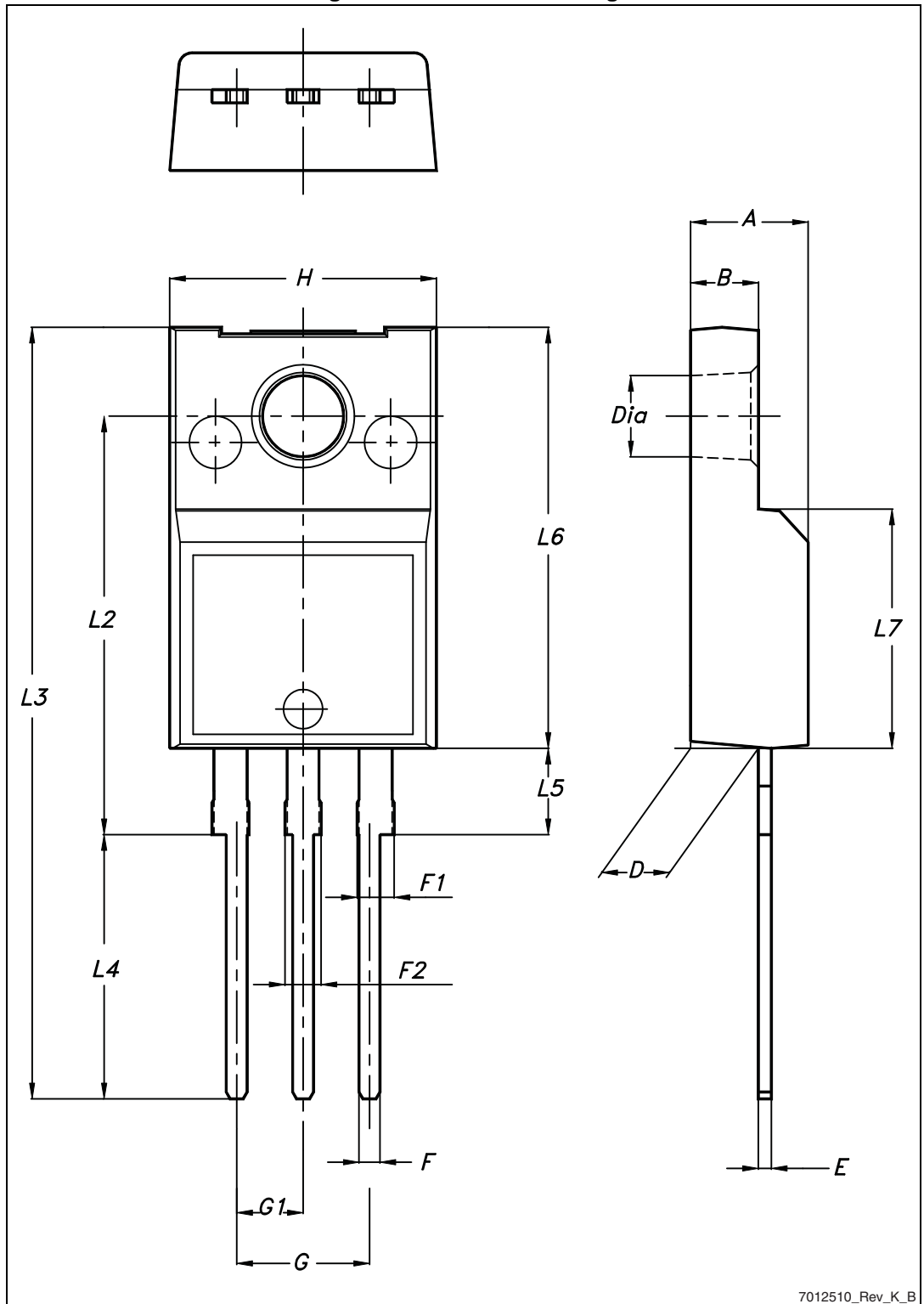


a. All dimension are in millimeters

Table 10. 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

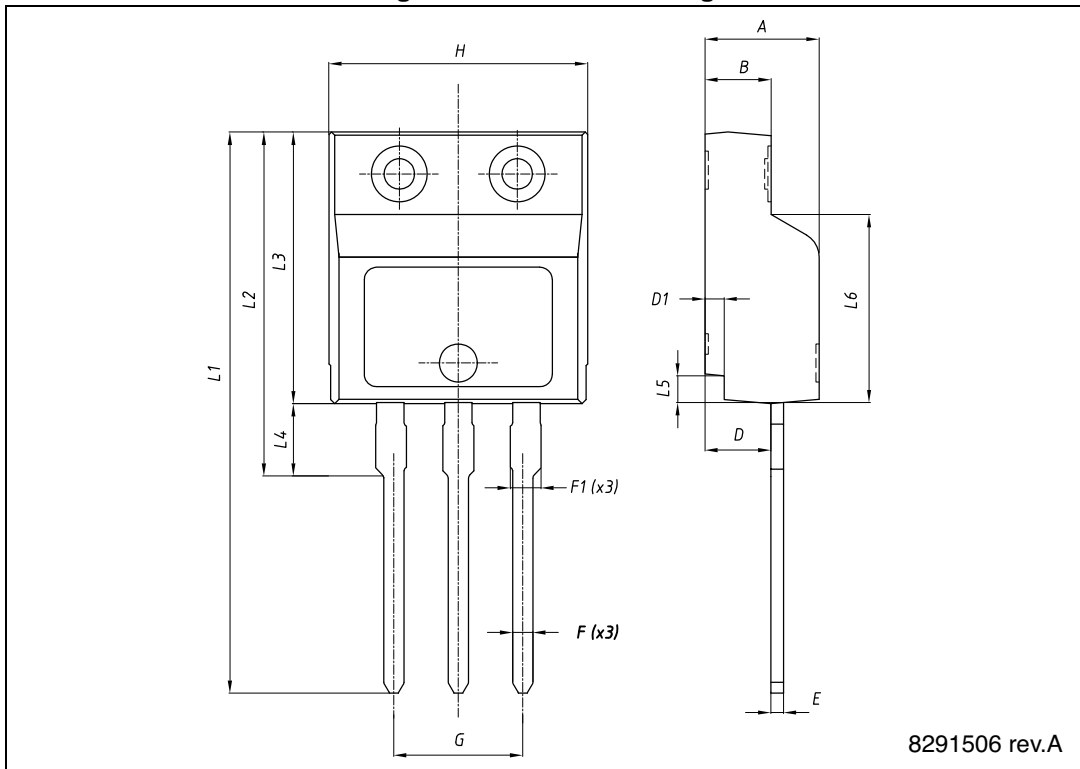


7012510_Rev_K_B

Table 11. I²PakFP mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40	-	4.60
B	2.50		2.70
D	2.50		2.75
D1	0.65		0.85
E	0.45		0.70
F	0.75		1.00
F1			1.20
G	4.95		5.20
H	10.00		10.40
L1	21.00		23.00
L2	13.20		14.10
L3	10.55		10.85
L4	2.70		3.20
L5	0.85		1.25
L6	7.30		7.50

Figure 28. I²PakFP drawing



8291506 rev.A

Table 12. 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	
ØP	3.75		3.85
Q	2.65		2.95

Figure 29. TO-220 type A drawing

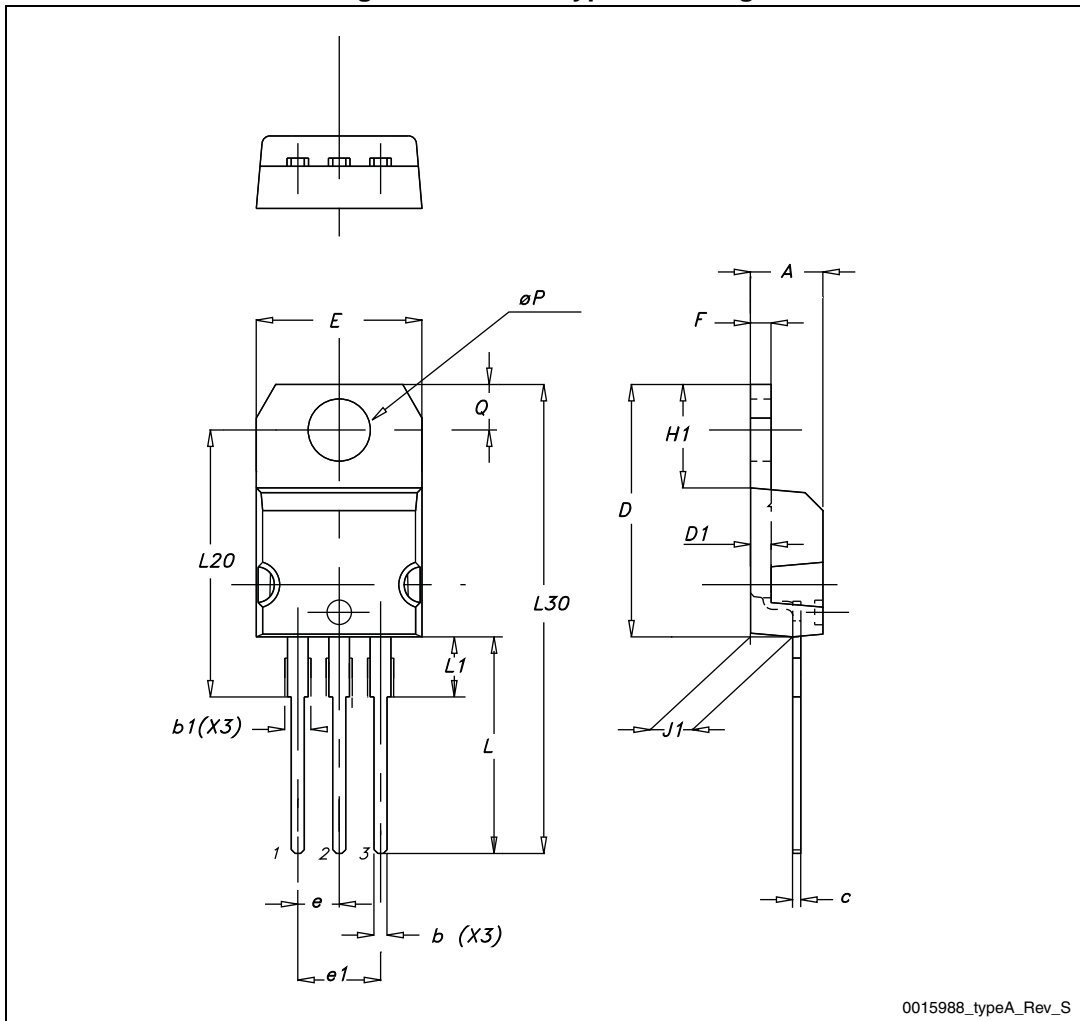
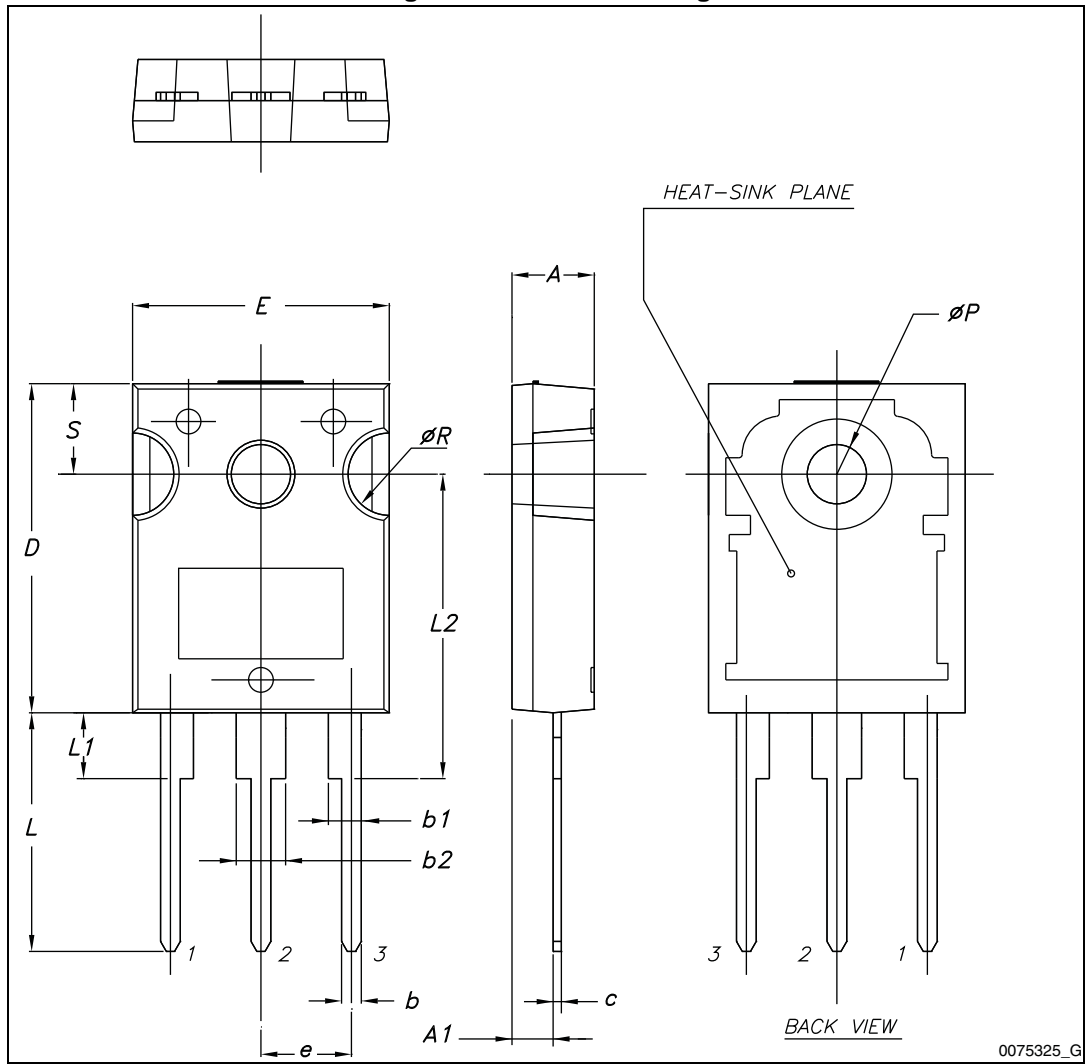


Table 13. TO-247 mechanical data

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	
ØP	3.55		3.65
ØR	4.50		5.50
S	5.30	5.50	5.70

Figure 30. TO-247 drawing



5 Packaging mechanical data

Table 14. 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 31. Tape

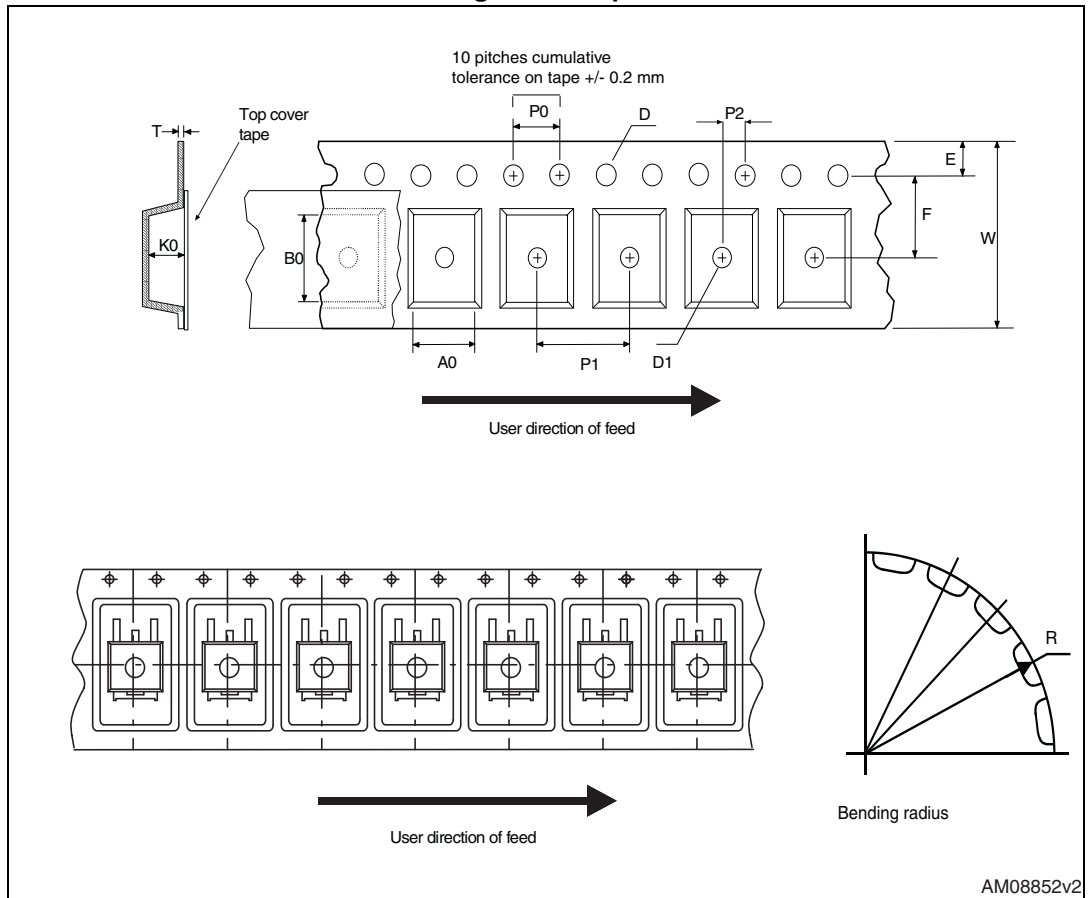
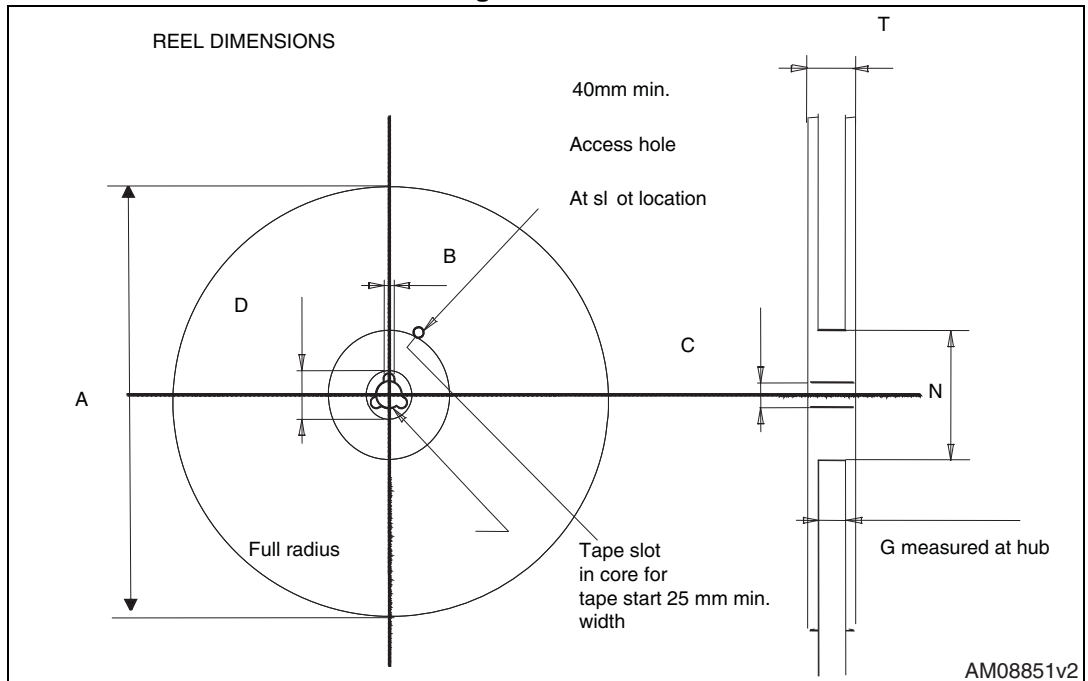


Figure 32. Reel



6 Revision history

Table 15. Document revision history

Date	Revision	Changes
23-Feb-2012	1	First release.
10-Sep-2012	2	<ul style="list-style-type: none">– Modified note 2 under the Table 2.– Updated typical values in Table 4, 5 and 6.– Added Section 2.1.– Minor text changes on the cover page.
05-Mar-2013	3	Added dv/dt value on Table 2: Absolute maximum ratings .

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