



STB35N65M5, STF35N65M5, STI35N65M5 STP35N65M5, STW35N65M5

N-channel 650 V, 0.085 Ω , 27 A, MDmesh™ V Power MOSFET
in D²PAK, TO-220FP, I²PAK, TO-220, TO-247

Features

Type	V _{DSS} @ T _{JMAX}	R _{DS(on)} max.	I _D
STB35N65M5	710 V	< 0.098 Ω	27 A
STF35N65M5	710 V	< 0.098 Ω	27 A ⁽¹⁾
STI35N65M5	710 V	< 0.098 Ω	27 A
STP35N65M5	710 V	< 0.098 Ω	27 A
STW35N65M5	710 V	< 0.098 Ω	27 A

1. Limited only by maximum temperature allowed

- Worldwide best R_{DS(on)}* area
- Higher V_{DSS} rating
- Excellent switching performance
- Easy to drive
- 100% avalanche tested
- High dv/dt capability

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 codes	Marking	Package	Packaging
STB35N65M5	35N65M5	D ² PAK	Tape and reel
STF35N65M5	35N65M5	TO-220FP	Tube
STI35N65M5	35N65M5	I ² PAK	Tube
STP35N65M5	35N65M5	TO-220	Tube
STW35N65M5	35N65M5	TO-247	Tube

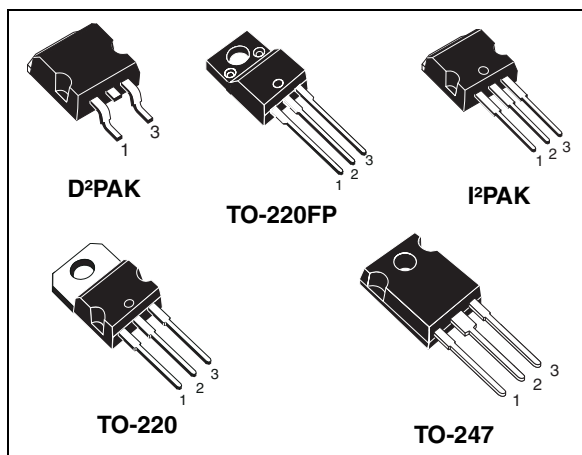
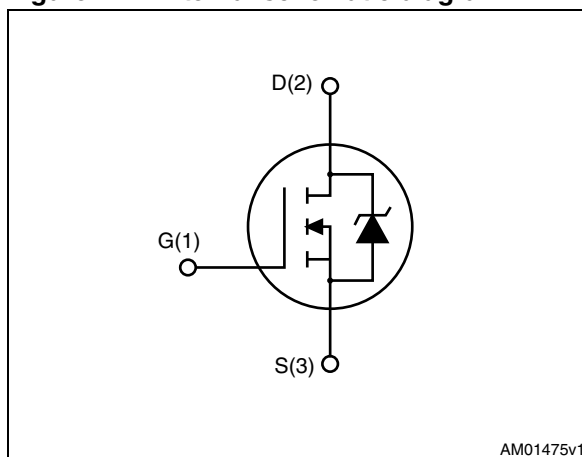


Figure 1. Internal schematic diagram



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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		TO-220, D ² PAK TO-247, I ² PAK	TO-220FP	
V _{GS}	Gate-source voltage	±25		V
I _D	Drain current (continuous) at T _C = 25 °C	27	27 ⁽¹⁾	A
I _D	Drain current (continuous) at T _C = 100 °C	17	17 ⁽¹⁾	A
I _{DM} ⁽²⁾	Drain current (pulsed)	108	108 ⁽¹⁾	A
P _{TOT}	Total dissipation at T _C = 25 °C	160	40	W
I _{AR}	Max current during repetitive or single pulse avalanche (pulse width limited by T _{JMAX})	9		A
E _{AS}	Single pulse avalanche energy (starting T _j = 25°C, I _D = I _{AR} , V _{DD} = 50V)	800		mJ
dv/dt ⁽³⁾	Peak diode recovery voltage slope	15		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

1. Limited only by maximum temperature allowed
2. Pulse width limited by safe operating area
3. I_{SD} ≤ 27 A, di/dt = 400 A/μs, peak V_{DS} < V_{(BR)DSS}

Table 3. Thermal data

Symbol	Parameter	Value					Unit
		D ² PAK	TO-220FP	I ² PAK	TO-220	TO-247	
R _{thj-case}	Thermal resistance junction-case max	0.78	3.1	0.78			°C/W
R _{thj-amb}	Thermal resistance junction-ambient max		62.5			50	°C/W
R _{thj-pcb}	Thermal resistance junction-pcb max	30					°C/W
T _l	Maximum lead temperature for soldering purpose		300				°C

2 Electrical characteristics

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

Table 4. 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 ($V_{GS} = 0$)	$V_{DS} = \text{Max rating}$ $V_{DS} = \text{Max rating}$, $T_C = 125\text{ }^{\circ}\text{C}$			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	$V_{GS} = 10\text{ V}$, $I_D = 13.5\text{ A}$		0.085	0.098	Ω

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss} C_{oss} C_{rss}	Input capacitance Output capacitance Reverse transfer capacitance	$V_{DS} = 100\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0$	-	3750 84 5.5	-	pF pF pF
$C_{o(tr)}^{(1)}$	Equivalent capacitance time related	$V_{GS} = 0$, $V_{DS} = 0\text{ to }520\text{ V}$	-	220	-	pF
$C_{o(er)}^{(2)}$	Equivalent capacitance energy related	$V_{GS} = 0$, $V_{DS} = 0\text{ to }520\text{ V}$	-	75	-	pF
R_G	Intrinsic gate resistance	$f = 1\text{ MHz}$ open drain	-	1.6	-	Ω
Q_g Q_{gs} Q_{gd}	Total gate charge Gate-source charge Gate-drain charge	$V_{DD} = 520\text{ V}$, $I_D = 13.5\text{ A}$, $V_{GS} = 10\text{ V}$ (see Figure 20)	-	83 19 35	-	nC nC nC

1. $C_{oss\text{ eq.}}$ 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. $C_{oss\text{ eq.}}$ 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 6. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(off)}$	Turn-off delay time	$V_{DD} = 400\text{ V}$, $I_D = 16\text{ A}$, $R_G = 4.7\ \Omega$, $V_{GS} = 10\text{ V}$ (see Figure 21)	-	60	-	ns
t_r	Rise time			12		ns
t_c	Cross time			28		ns
t_f	Fall time			16		ns

Table 7. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		27	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)				108	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 27\text{ A}$, $V_{GS} = 0$	-		1.5	V
t_{rr}	Reverse recovery time	$I_{SD} = 27\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 60\text{ V}$ (see Figure 24)	-	360		ns
Q_{rr}	Reverse recovery charge			7		μC
I_{RRM}	Reverse recovery current			36		A
t_{rr}	Reverse recovery time	$I_{SD} = 27\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 60\text{ V}$, $T_J = 150\text{ }^\circ\text{C}$ (see Figure 24)	-	425		ns
Q_{rr}	Reverse recovery charge			8		μC
I_{RRM}	Reverse recovery current			38		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 TO-220, D²PAK

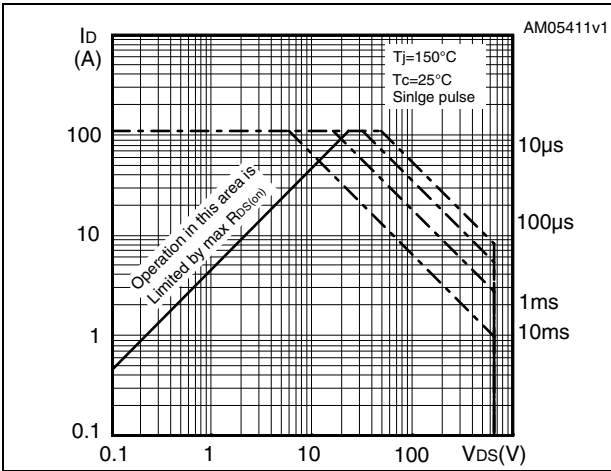


Figure 3. Thermal impedance for TO-220, D²PAK

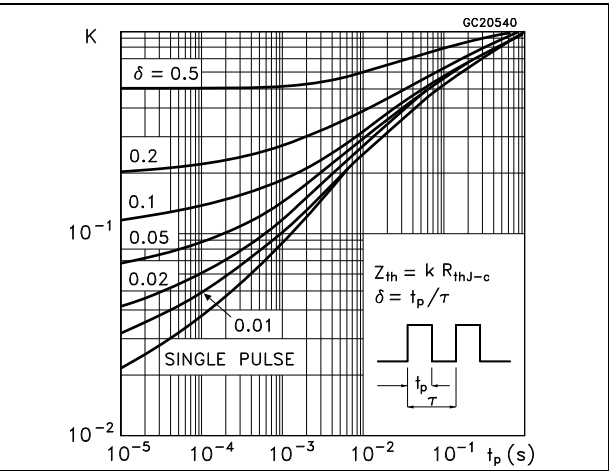


Figure 4. Safe operating area for TO-220FP

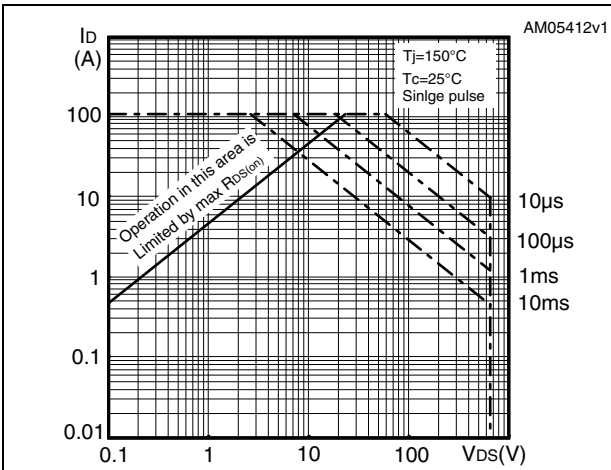


Figure 5. Thermal impedance for TO-220FP

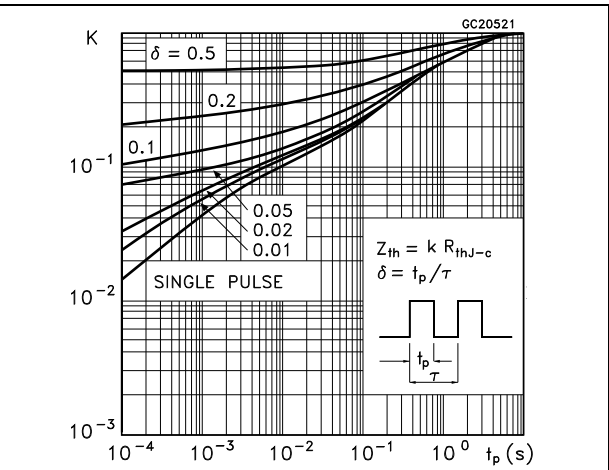


Figure 6. Safe operating area for TO-247

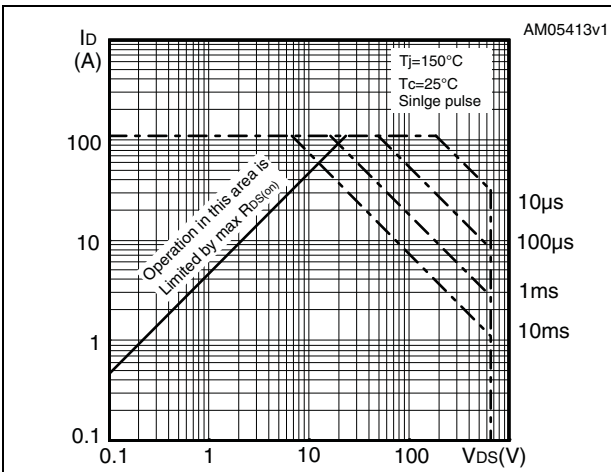


Figure 7. Thermal impedance for TO-247

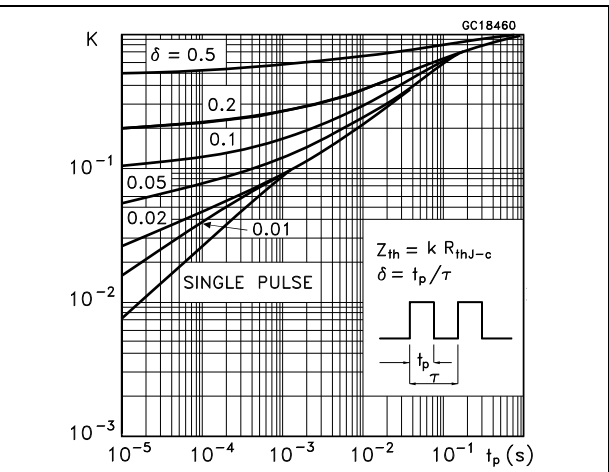


Figure 8. Output characteristics

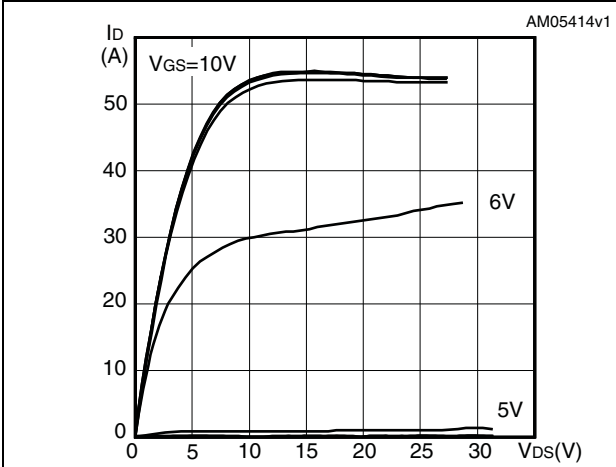


Figure 9. Transfer characteristics

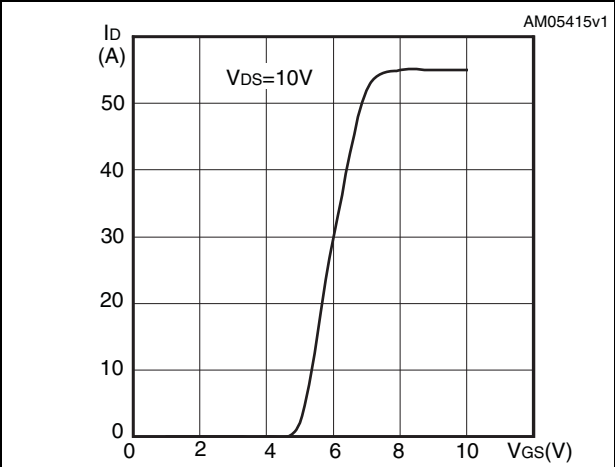


Figure 10. Gate charge vs gate-source voltage

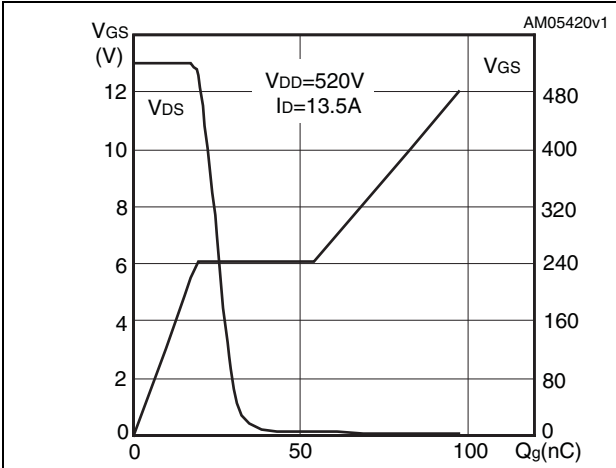


Figure 11. Static drain-source on resistance

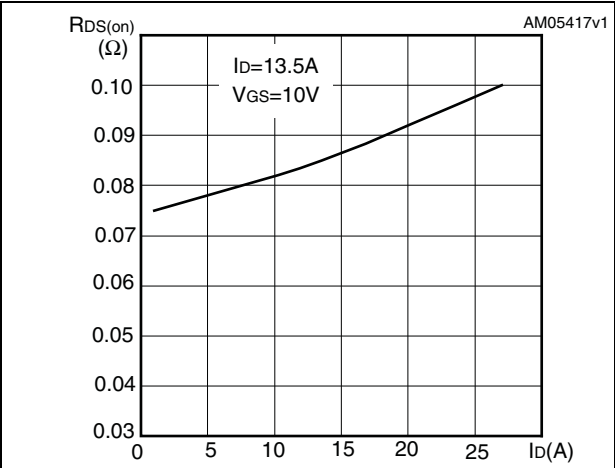


Figure 12. Capacitance variations

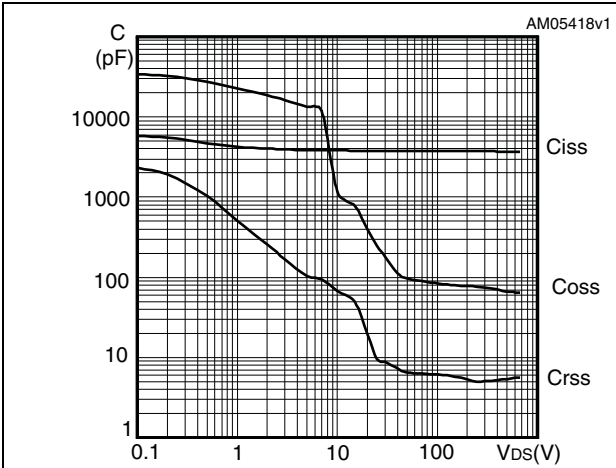


Figure 13. Output capacitance stored energy

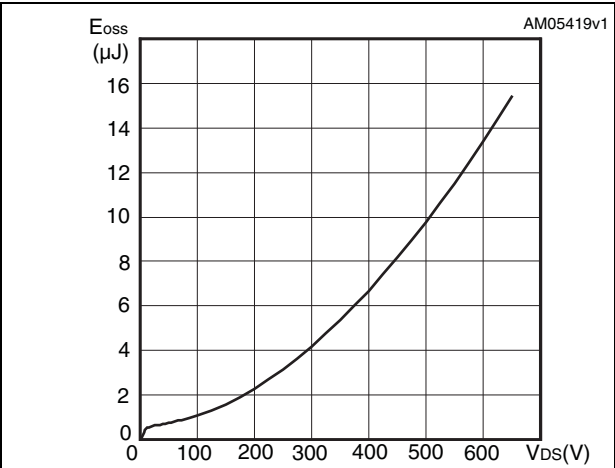


Figure 14. Normalized gate threshold voltage vs temperature

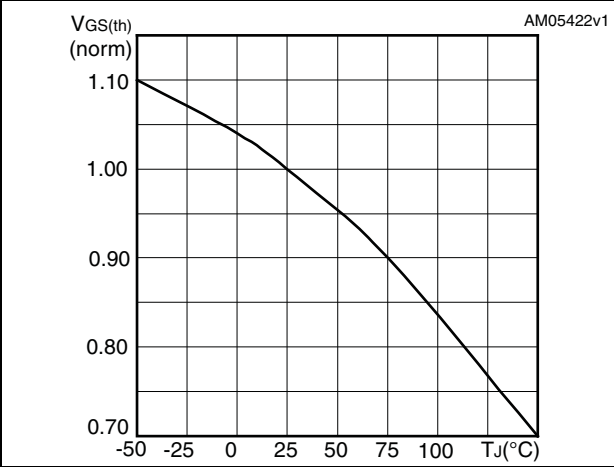


Figure 15. Normalized on resistance vs temperature

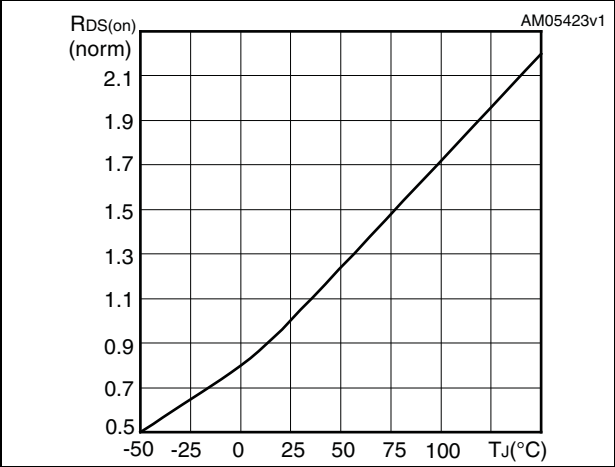


Figure 16. Source-drain diode forward characteristics

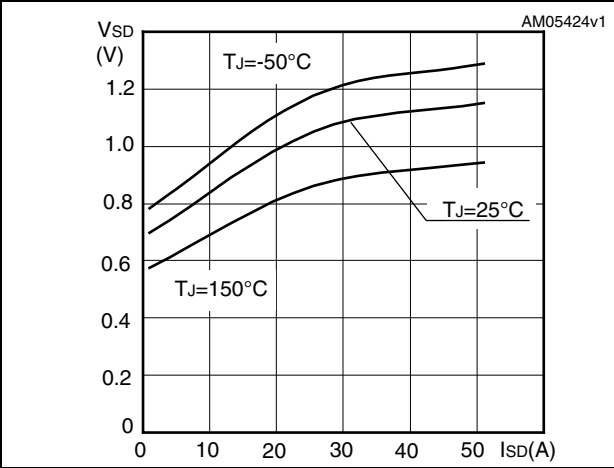


Figure 17. Normalized B_{VDSS} vs temperature

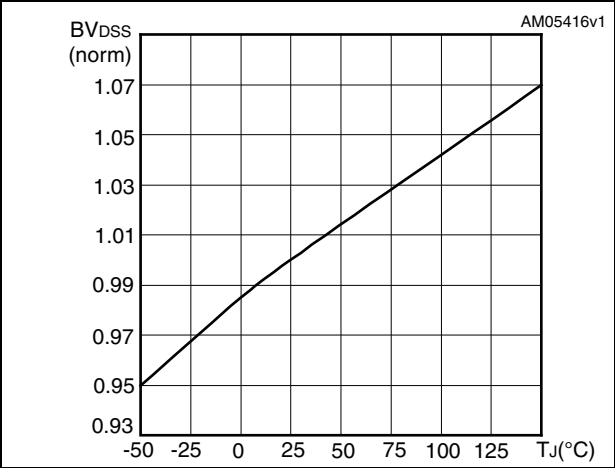
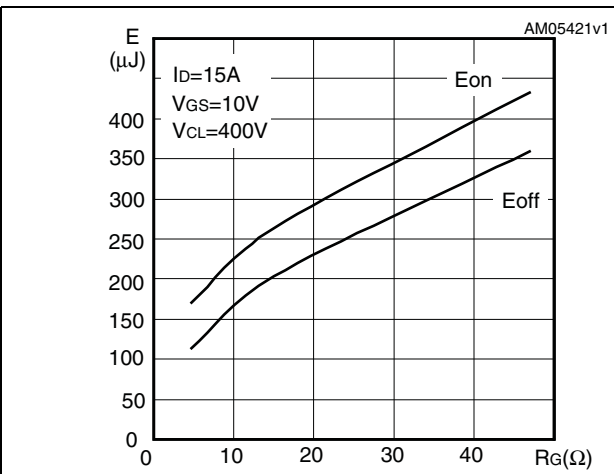


Figure 18. Switching losses vs gate resistance (1)



1. E_{on} including reverse recovery of a SiC diode

3 Test circuits

Figure 19. Switching times test circuit for resistive load

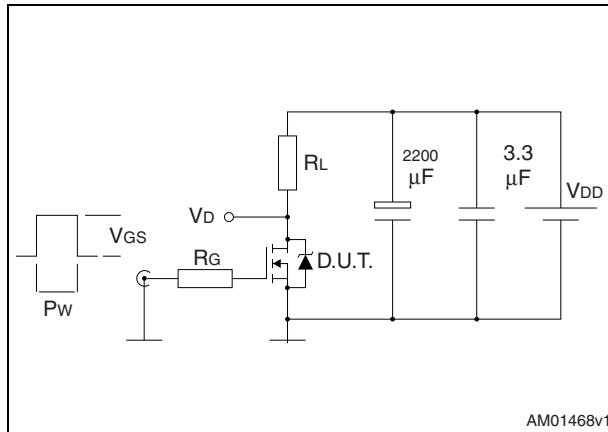


Figure 20. Gate charge test circuit

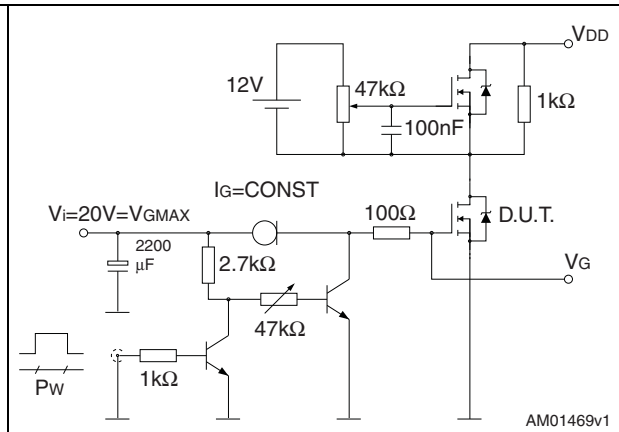


Figure 21. Test circuit for inductive load switching and diode recovery times

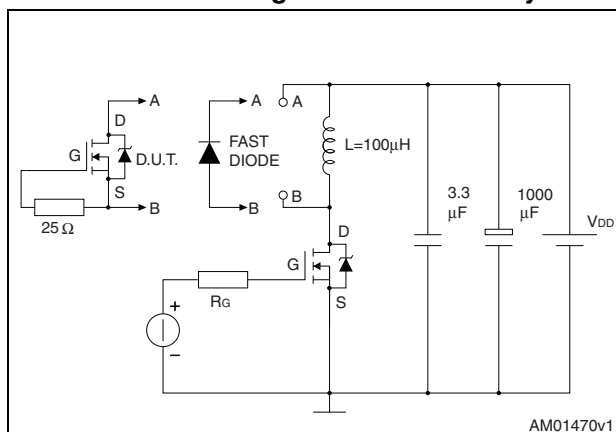


Figure 22. Unclamped inductive load test circuit

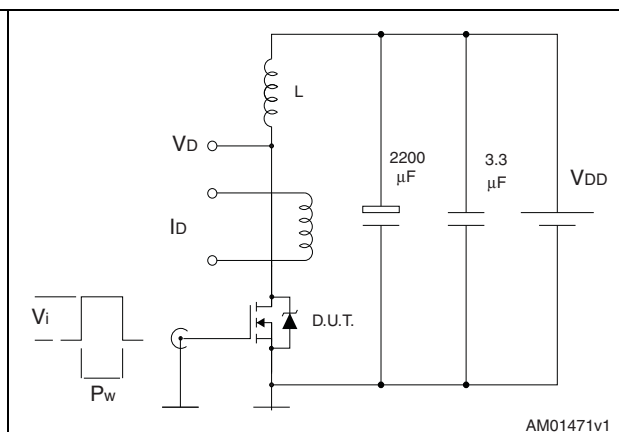


Figure 23. Unclamped inductive waveform

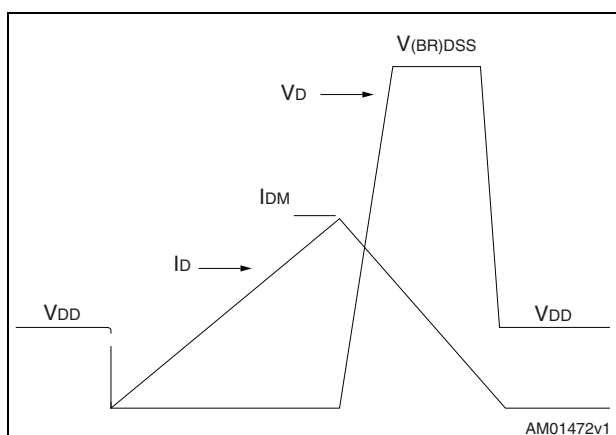
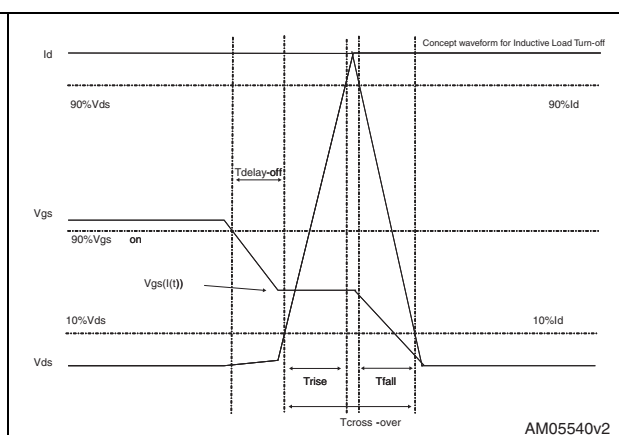


Figure 24. Switching time waveform



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 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°

Figure 25. D²PAK (TO-263) drawing

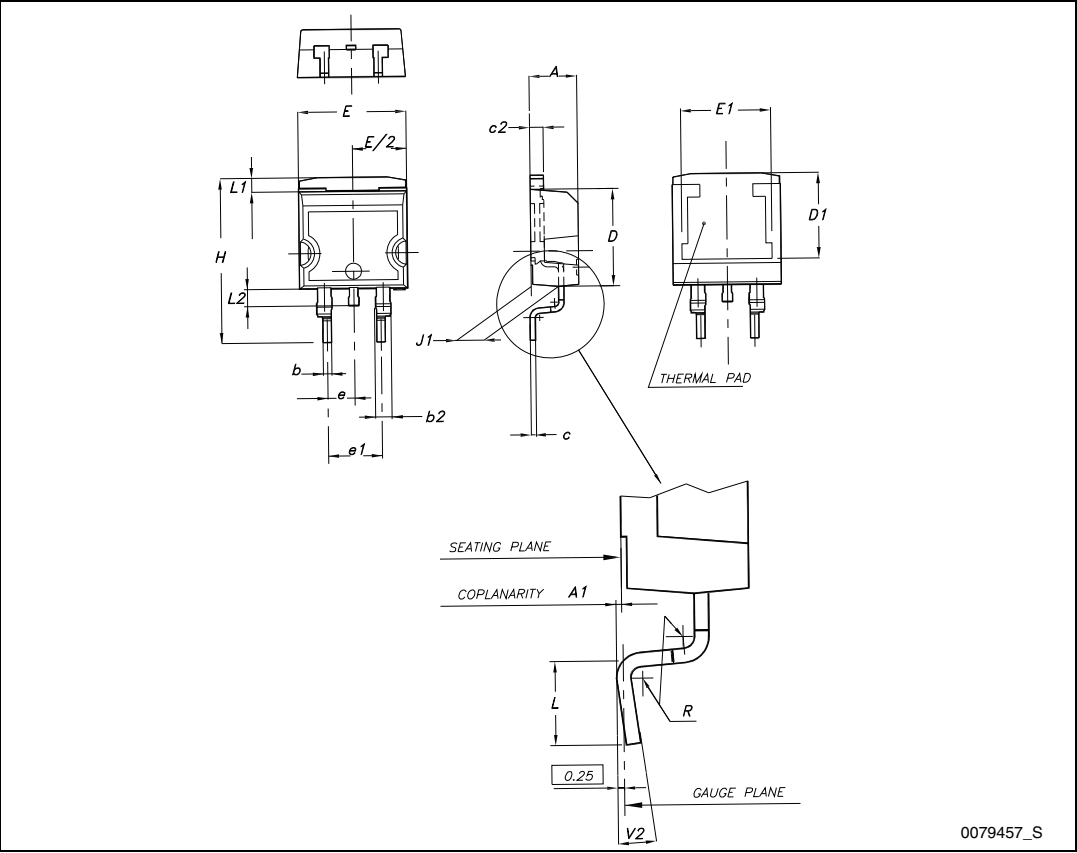
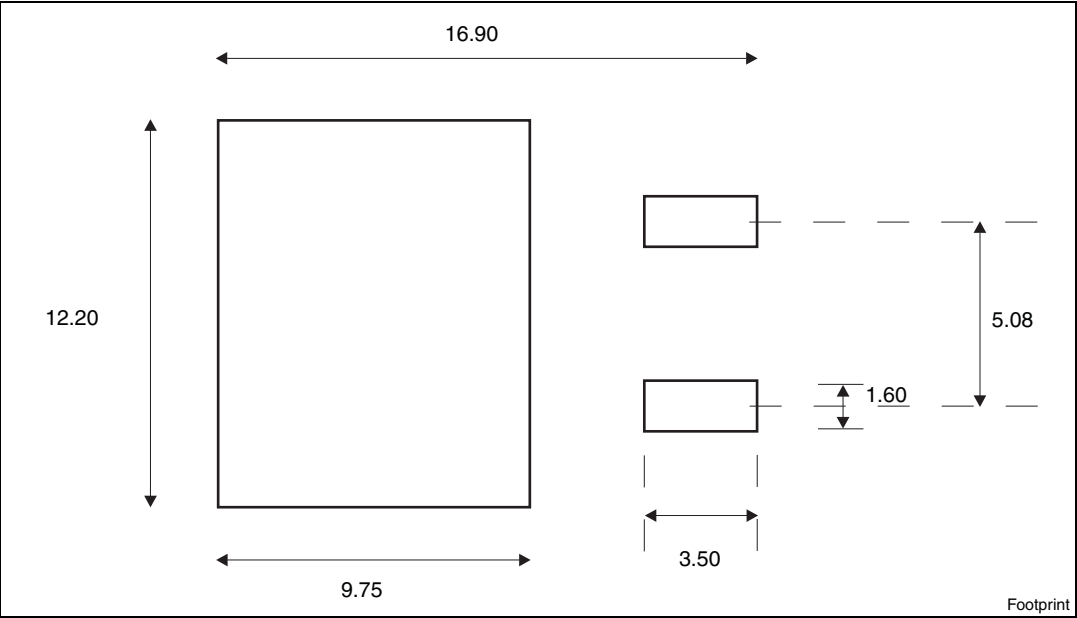


Figure 26. D²PAK footprint^(a)

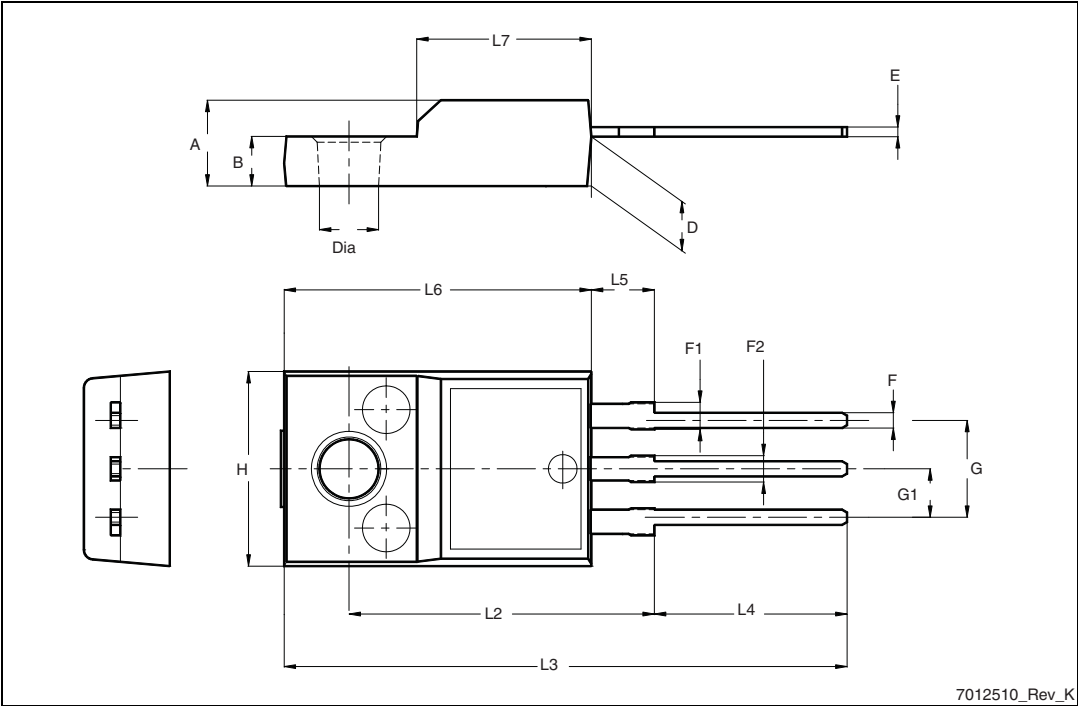


a. All dimensions are in millimeters

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 27. TO-220FP drawing



7012510_Rev_K

Table 10. I²PAK (TO-262) mechanical data

DIM.	mm.		
	min.	typ	max.
A	4.40		4.60
A1	2.40		2.72
b	0.61		0.88
b1	1.14		1.70
c	0.49		0.70
c2	1.23		1.32
D	8.95		9.35
e	2.40		2.70
e1	4.95		5.15
E	10		10.40
L	13		14
L1	3.50		3.93
L2	1.27		1.40

Figure 28. I²PAK (TO-262) drawing

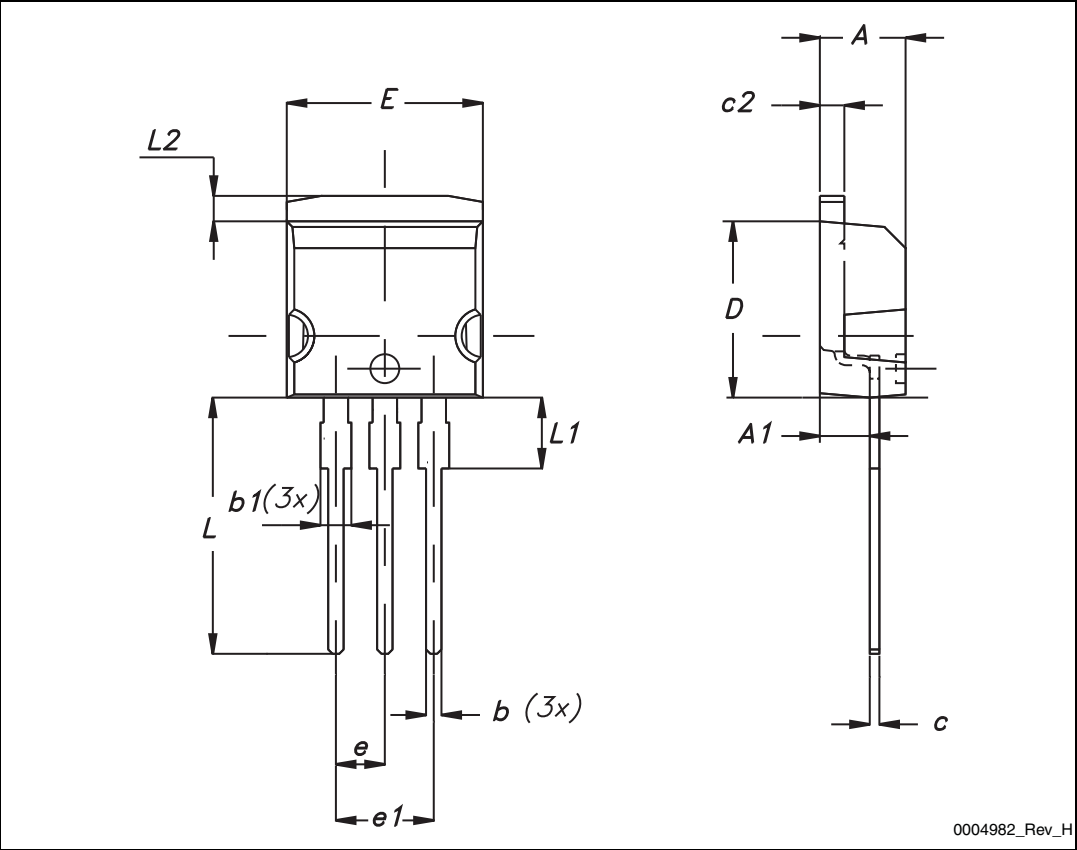


Table 11. TO-220 type A mechanical data

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

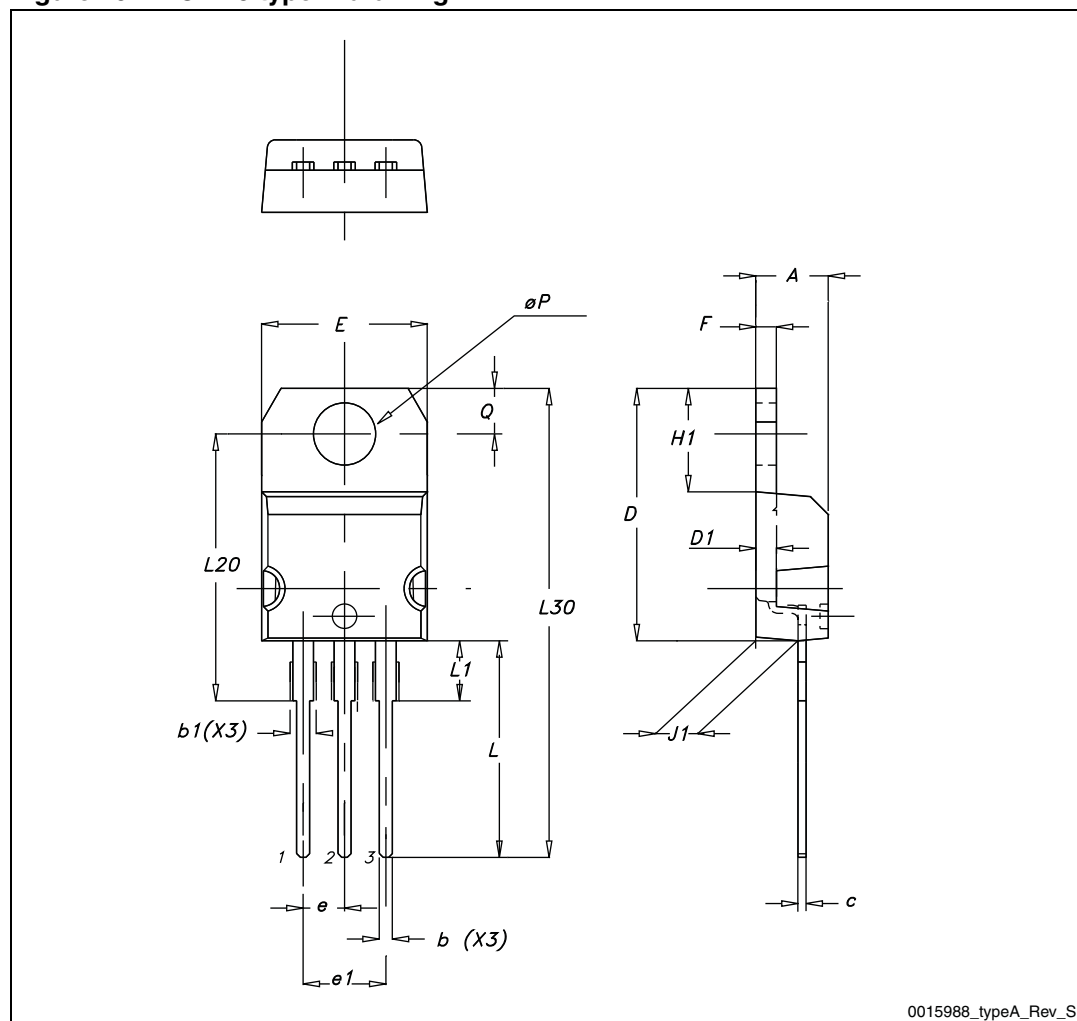
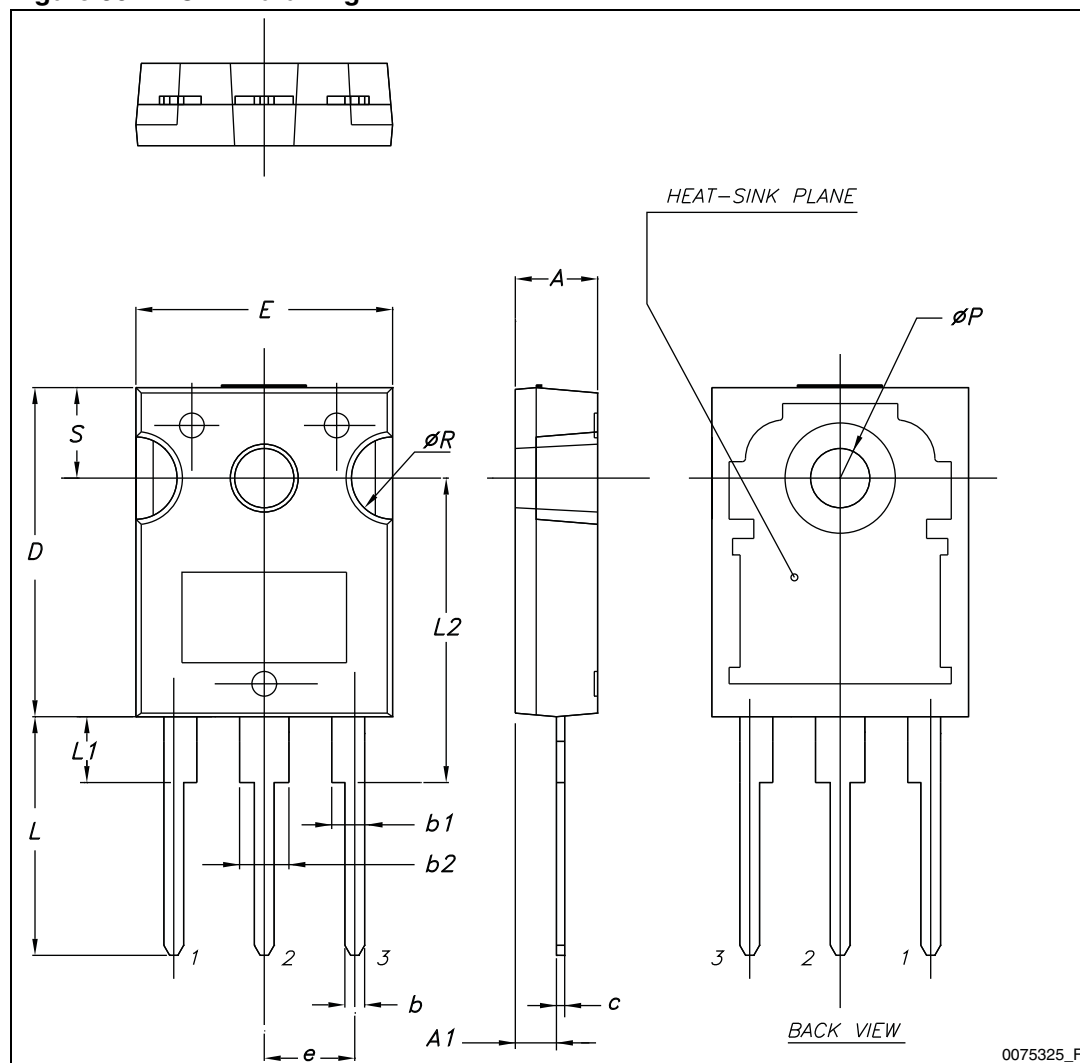


Table 12. TO-247 mechanical data

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		5.45	
L	14.20		14.80
L1	3.70		4.30
L2		18.50	
ØP	3.55		3.65
ØR	4.50		5.50
S		5.50	

Figure 30. TO-247 drawing



5 Packaging mechanical data

Table 13. 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

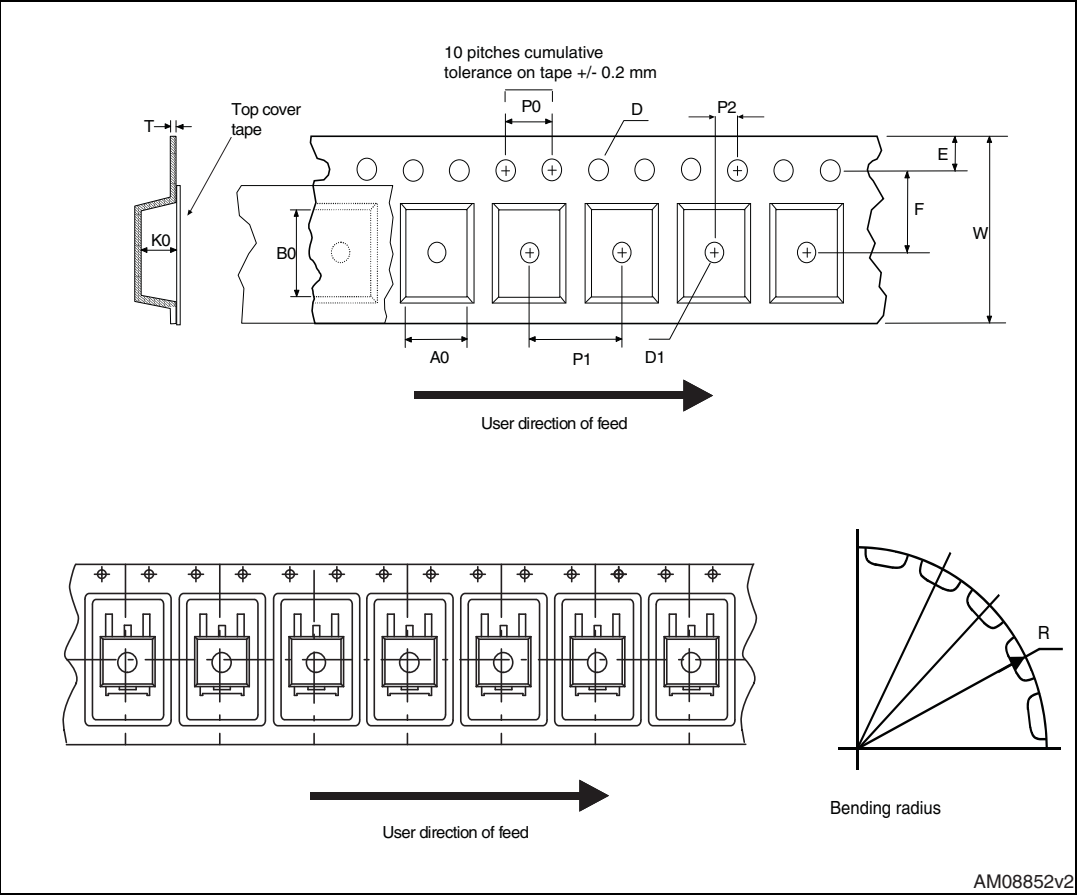
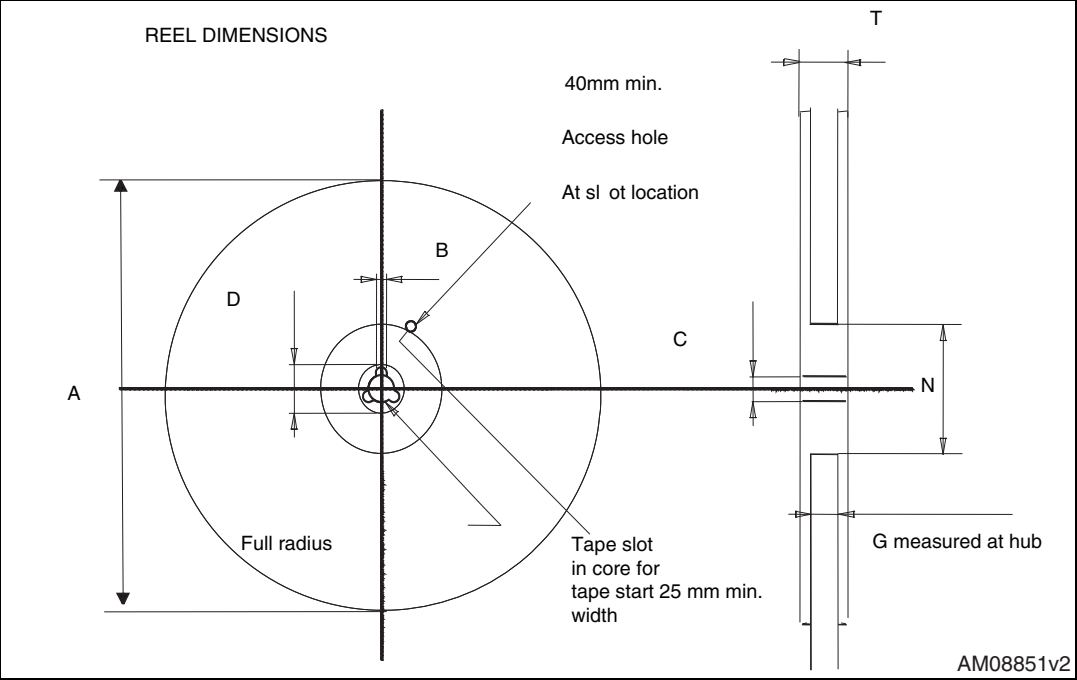


Figure 32. Reel



6 Revision history

Table 14. Document revision history

Date	Revision	Changes
29-Jul-2009	1	First release
01-Sep-2009	2	Figure 10 has been updated
06-Oct-2011	3	$C_{o(er)}$ and $C_{o(tr)}$ values changed in Table 5: Dynamic Table 6: Switching times parameters updates Figure 24: Switching time waveform has been corrected Minor text changes Section 4: Package mechanical data has been modified. Added: – Table 8: D²PAK (TO-263) mechanical data, Figure 25: D²PAK (TO-263) drawing and Figure 26: D²PAK footprint; – Table 9: TO-220FP mechanical data, and Figure 27: TO-220FP drawing; – Table 10: I²PAK (TO-262) mechanical data, and Figure 28: I²PAK (TO-262) drawing; – Table 11: TO-220 type A mechanical data, and Figure 29: TO-220 type A drawing; – Table 12: TO-247 mechanical data, and Figure 30: TO-247 drawing; Section 5: Packaging mechanical data has been modified. Added: – Table 13: D²PAK (TO-263) tape and reel mechanical data, Figure 31: Tape and Figure 32: Reel;

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