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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value			Unit
		D <sup>2</sup> PAK I <sup>2</sup> PAK	TO-220 TO-247	TO-220FP	
V <sub>GS</sub>	Gate- source voltage	± 30			V
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 25 °C	16		16 <sup>(1)</sup>	A
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 100 °C	10		10 <sup>(1)</sup>	A
I <sub>DM</sub> <sup>(2)</sup>	Drain current (pulsed)	64		64 <sup>(1)</sup>	A
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	125		30	W
dv/dt <sup>(3)</sup>	Peak diode recovery voltage slope	15			V/ns
V <sub>ISO</sub>	Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1 s; T <sub>C</sub> =25 °C)			2500	V
T <sub>J</sub> T <sub>stg</sub>	Operating junction temperature Storage temperature	-55 to 150			°C

- Limited only by maximum temperature allowed
- Pulse width limited by safe operating area
- I<sub>SD</sub> ≤ 16 A, di/dt ≤ 400 A/μs, V<sub>DSpeak</sub> ≤ V<sub>(BR)DSS</sub>, V<sub>DD</sub> = 80% V<sub>(BR)DSS</sub>

**Table 3. Thermal data**

Symbol	Parameter	Value					Unit
		D <sup>2</sup> PAK	I <sup>2</sup> PAK	TO-220	TO-247	TO-220FP	
R <sub>thj-case</sub>	Thermal resistance junction-case max.	1				4.17	°C/W
R <sub>thj-amb</sub>	Thermal resistance junction-ambient max.		62.5	50		62.5	°C/W
R <sub>thj-pcb</sub> <sup>(1)</sup>	Thermal resistance junction-pcb max.	30					°C/W
T <sub>J</sub>	Maximum lead temperature for soldering purpose		300				°C/W

- When mounted on 1inch<sup>2</sup> FR-4 board, 2 oz Cu

**Table 4. Thermal data**

Symbol	Parameter	Value	Unit
I <sub>AR</sub>	Avalanche current, repetitive or not-repetitive (pulse width limited by T <sub>J</sub> max)	6	A
E <sub>AS</sub>	Single pulse avalanche energy (starting T <sub>J</sub> = 25 °C, I <sub>D</sub> = I <sub>AR</sub> , V <sub>DD</sub> = 50 V)	300	mJ

## 2 Electrical characteristics

(T<sub>case</sub> = 25 °C unless otherwise specified)

**Table 5. On /off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V <sub>(BR)DSS</sub>	Drain-source breakdown voltage	I <sub>D</sub> = 1 mA, V <sub>GS</sub> = 0	600			V
I <sub>DSS</sub>	Zero gate voltage drain current (V <sub>GS</sub> = 0)	V <sub>DS</sub> = Max rating V <sub>DS</sub> = Max rating, T <sub>C</sub> = 125 °C			1 100	μA μA
I <sub>GSS</sub>	Gate-body leakage current (V <sub>DS</sub> = 0)	V <sub>GS</sub> = ± 25 V			100	nA
V <sub>GS(th)</sub>	Gate threshold voltage	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA	2	3	4	V
R <sub>DS(on)</sub>	Static drain-source on resistance	V <sub>GS</sub> = 10 V, I <sub>D</sub> = 8 A		0.2	0.22	

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C <sub>iss</sub>	Input capacitance	V <sub>DS</sub> = 50 V, f = 1 MHz, V <sub>GS</sub> = 0	-	1330	-	pF
C <sub>oss</sub>	Output capacitance			84		pF
C <sub>rss</sub>	Reverse transfer capacitance			4.6		pF
C <sub>oss eq.</sub> <sup>(1)</sup>	Output equivalent capacitance	V <sub>DS</sub> = 0 to 480 V, V <sub>GS</sub> = 0	-	181	-	pF
R <sub>g</sub>	Gate input resistance	f = 1 MHz open drain	-	4.7	-	
Q <sub>g</sub>	Total gate charge	V <sub>DD</sub> = 480 V, I <sub>D</sub> = 16 A,	-	44	-	nC
Q <sub>gs</sub>	Gate-source charge	V <sub>GS</sub> = 10 V		6		nC
Q <sub>gd</sub>	Gate-drain charge	(see Figure 18)		25		nC

1. C<sub>oss eq.</sub> is defined as a constant equivalent capacitance giving the same charging time as C<sub>oss</sub> when V<sub>DS</sub> increases from 0 to 80% V<sub>DS</sub>.

**Table 7. Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max	Unit	
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}$ , $I_D = 8\text{ A}$ , $R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$ (see Figure 17)		11		ns	
$t_{r(v)}$	Voltage rise time			18		ns	
$t_{d(off)}$	Turn-off delay time			-	74	-	ns
$t_{f(i)}$	Fall time				38		ns

**Table 8. Source drain diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max	Unit
$I_{SD}$	Source-drain current				16	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		64	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 16\text{ A}$ , $V_{GS} = 0$	-		1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 16\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$		296		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 60\text{ V}$	-	4		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current	(see Figure 19)		26.8		A

1. Pulse width limited by safe operating area
2. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

## 2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for TO-220, D<sup>2</sup>PAK, I<sup>2</sup>PAK

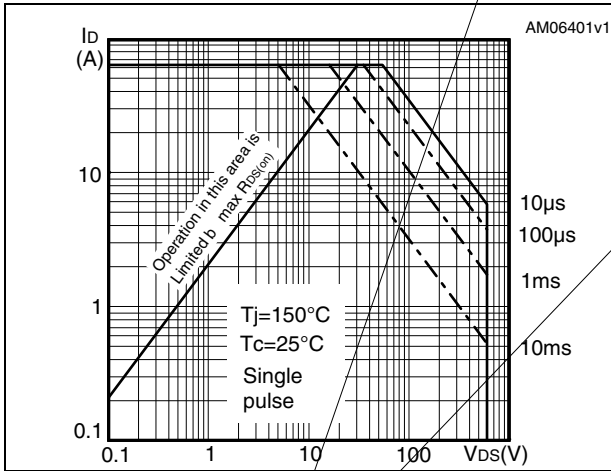


Figure 3. Thermal impedance for TO-220, D<sup>2</sup>PAK, I<sup>2</sup>PAK

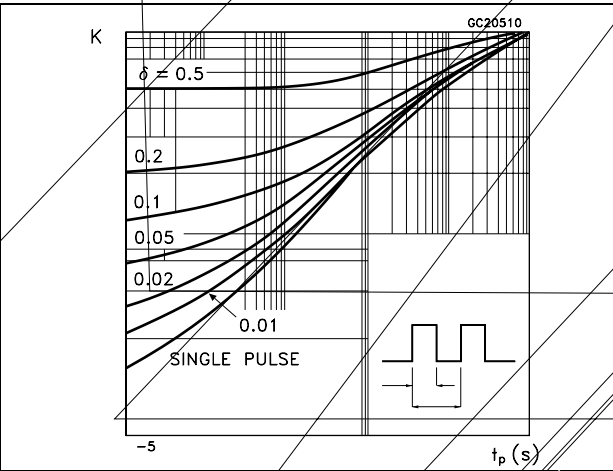


Figure 4. Safe operating area for TO-220FP

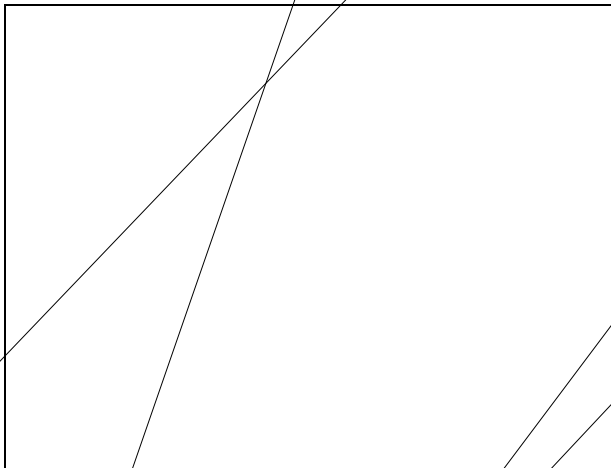


Figure 5. Thermal impedance for TO-220FP

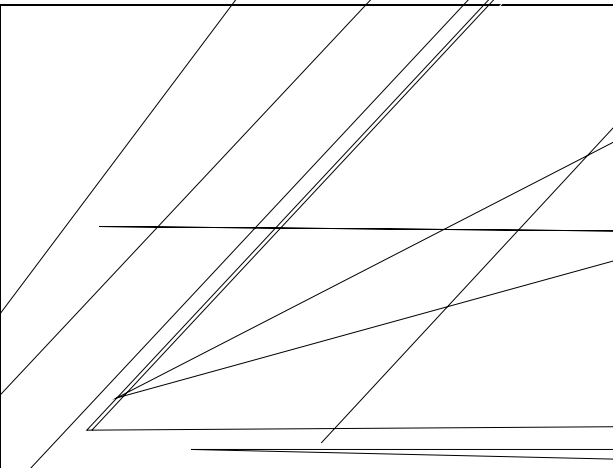


Figure 6. Safe operating area for TO-247

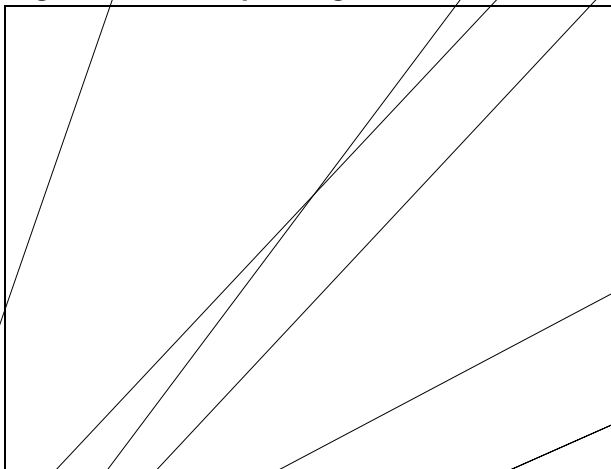


Figure 7. Thermal impedance for TO-247

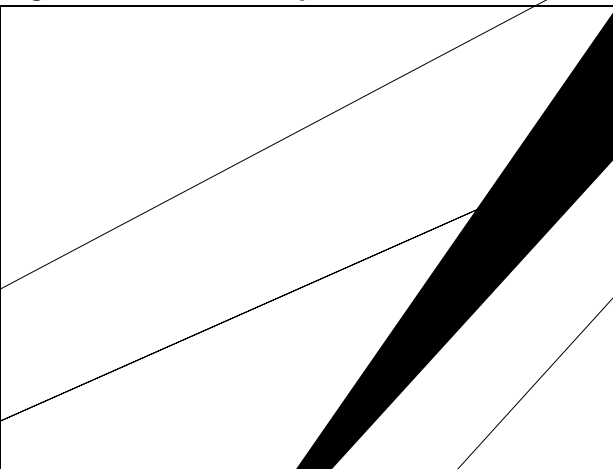


Figure 8. Output characteristics

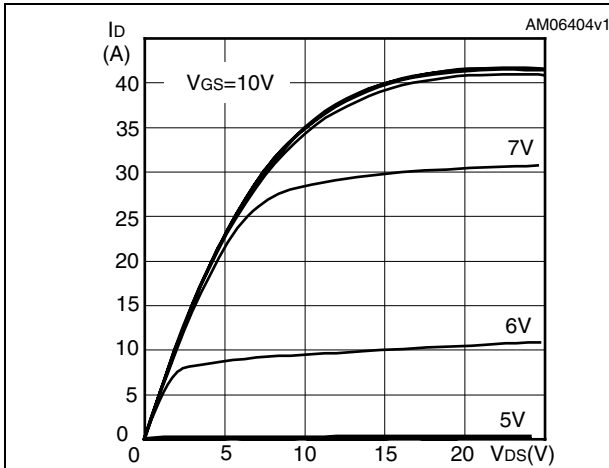


Figure 9. Transfer characteristics

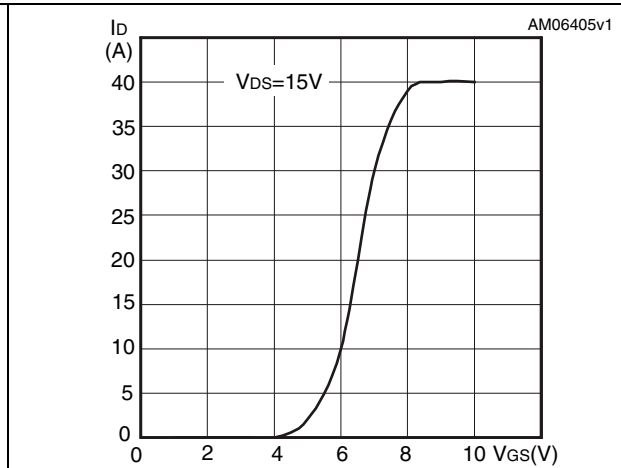


Figure 10. Gate charge vs gate-source voltage Figure 11. Static drain-source on resistance

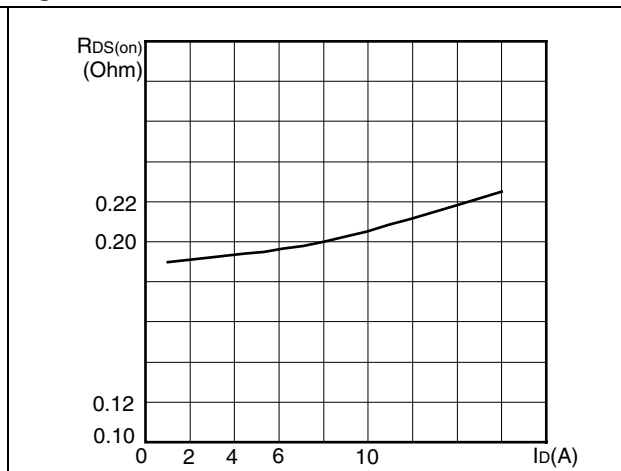
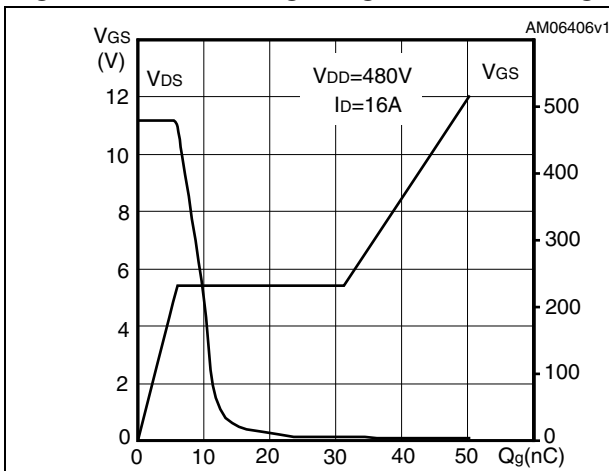


Figure 12. Capacitance variations

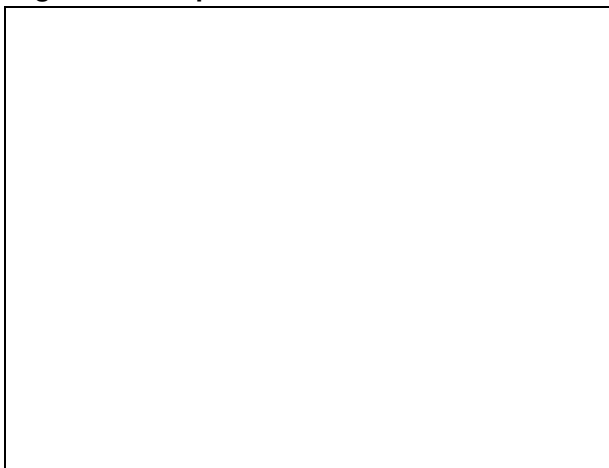


Figure 13. Output capacitance stored energy

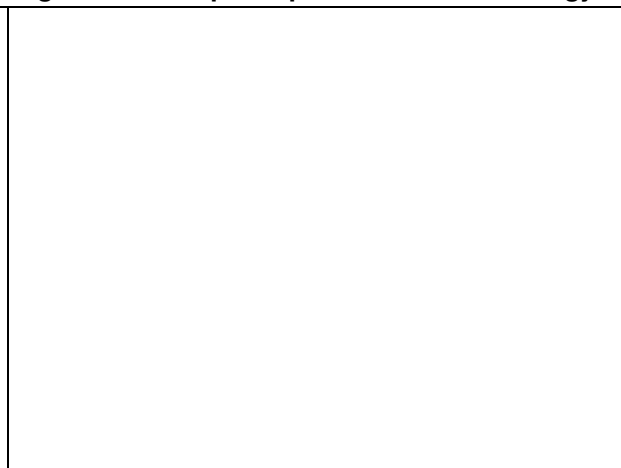


Figure 14. Normalized gate threshold voltage vs temperature

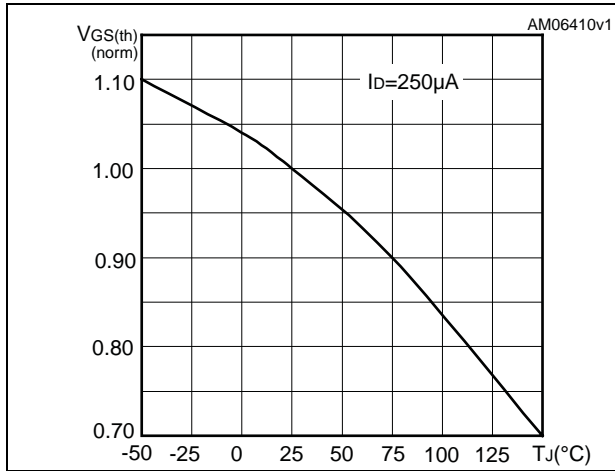


Figure 15. Normalized on resistance vs temperature

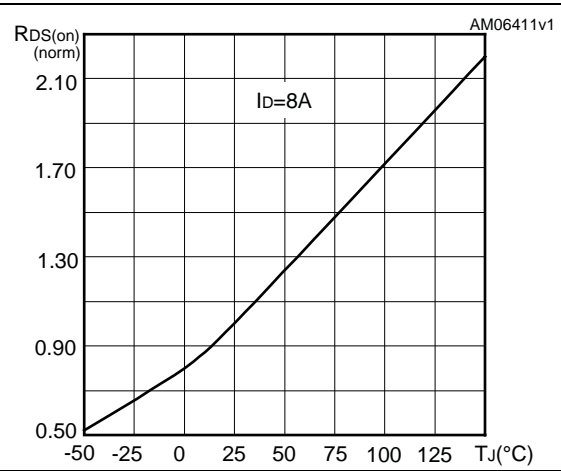
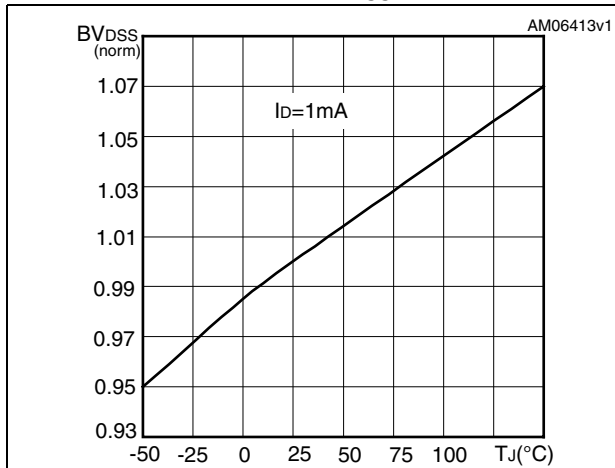


Figure 16. Normalized  $B_{VDSS}$  vs temperature





### 3 Test circuits

Figure 17. Switching times test circuit for resistive load

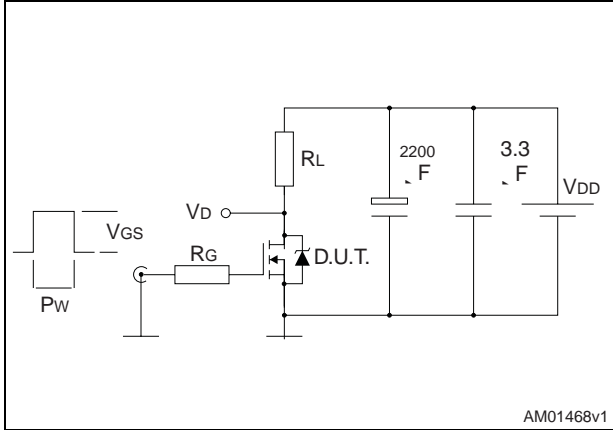


Figure 18. Gate charge test circuit

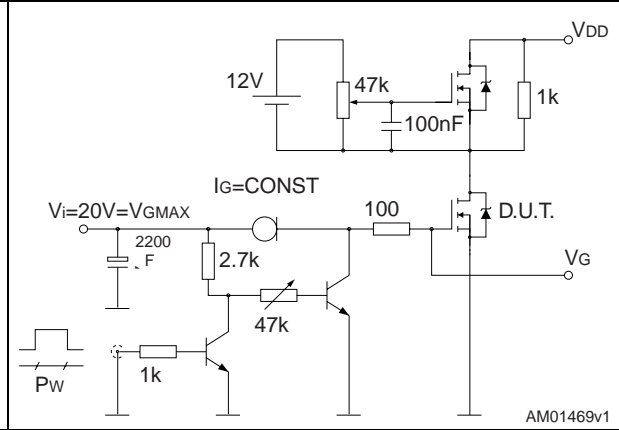


Figure 19. Test circuit for inductive load switching and diode recovery times

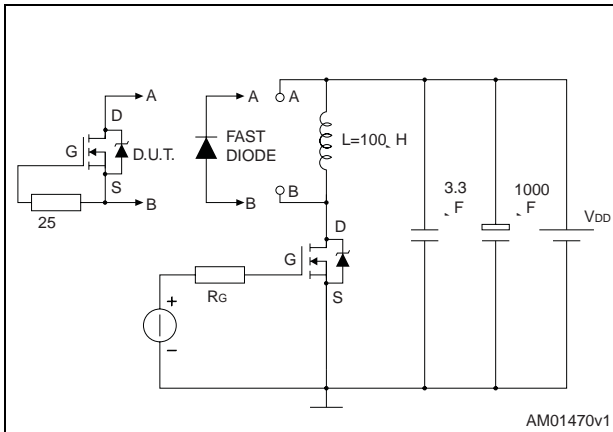


Figure 20. Unclamped inductive load test circuit

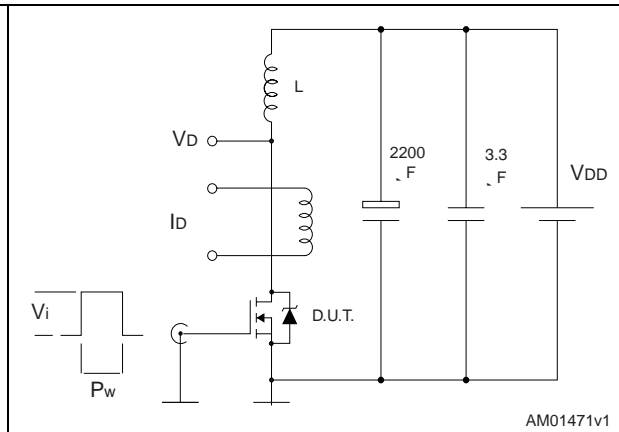


Figure 21. Unclamped inductive waveform

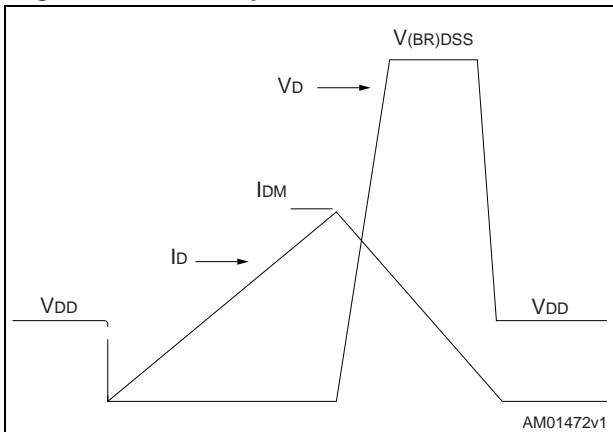
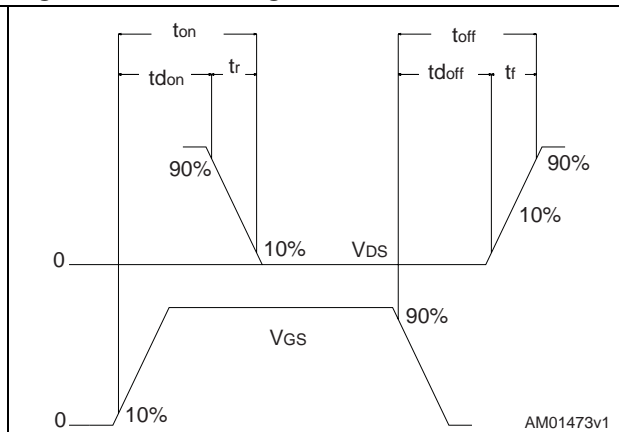
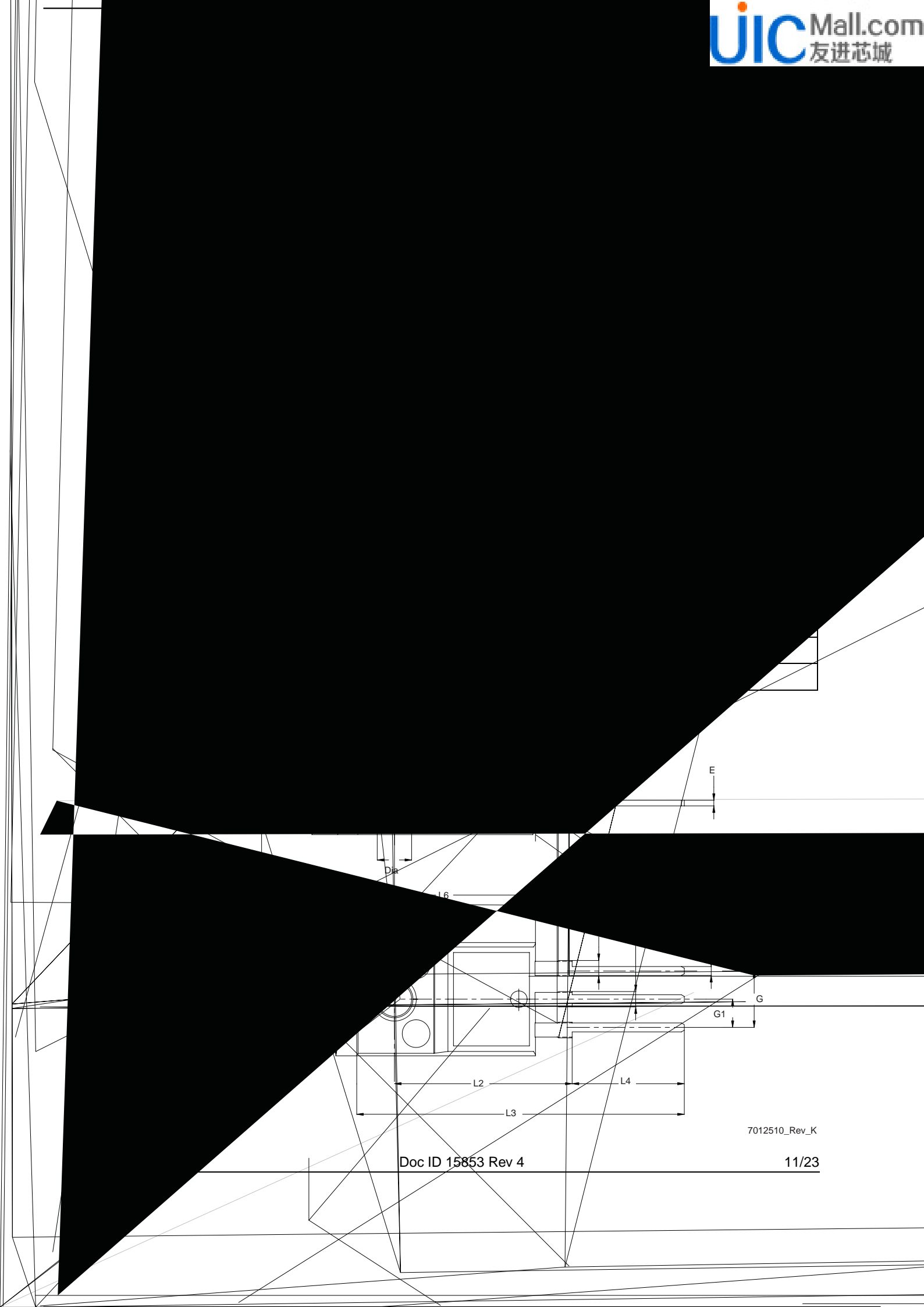


Figure 22. Switching time waveform



## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK is an ST trademark.





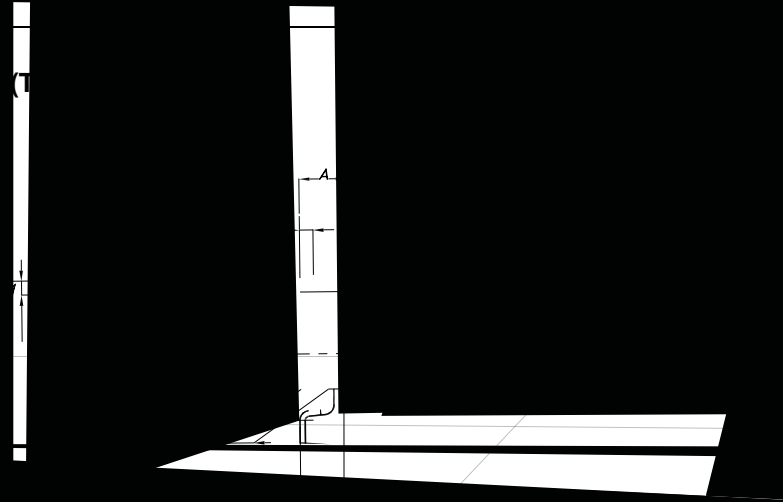


Table 11. TO-220 type A mechanical data

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	
P	3.75		3.85
Q	2.65		2.95

Figure 25 TO-220 type A drawing

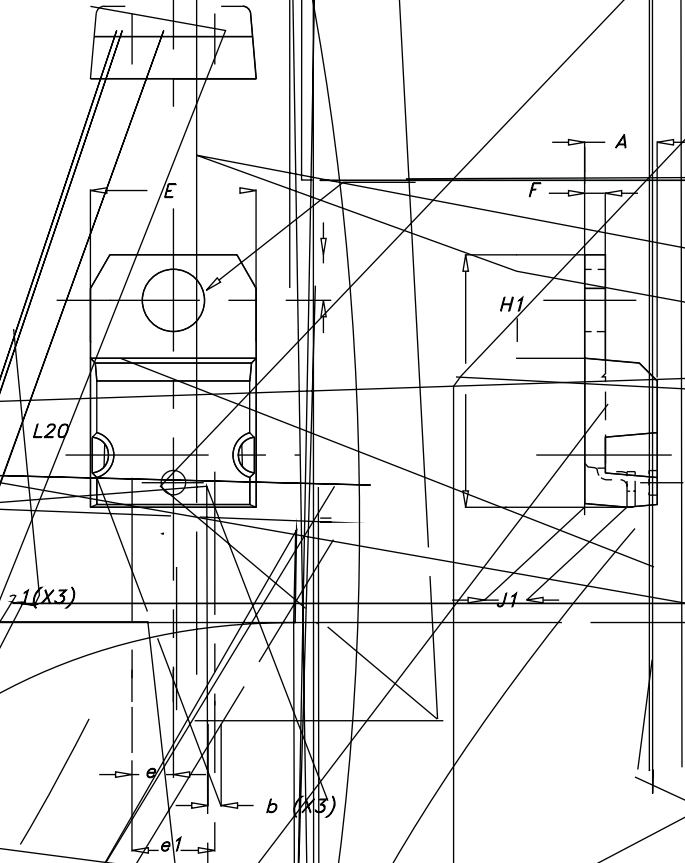
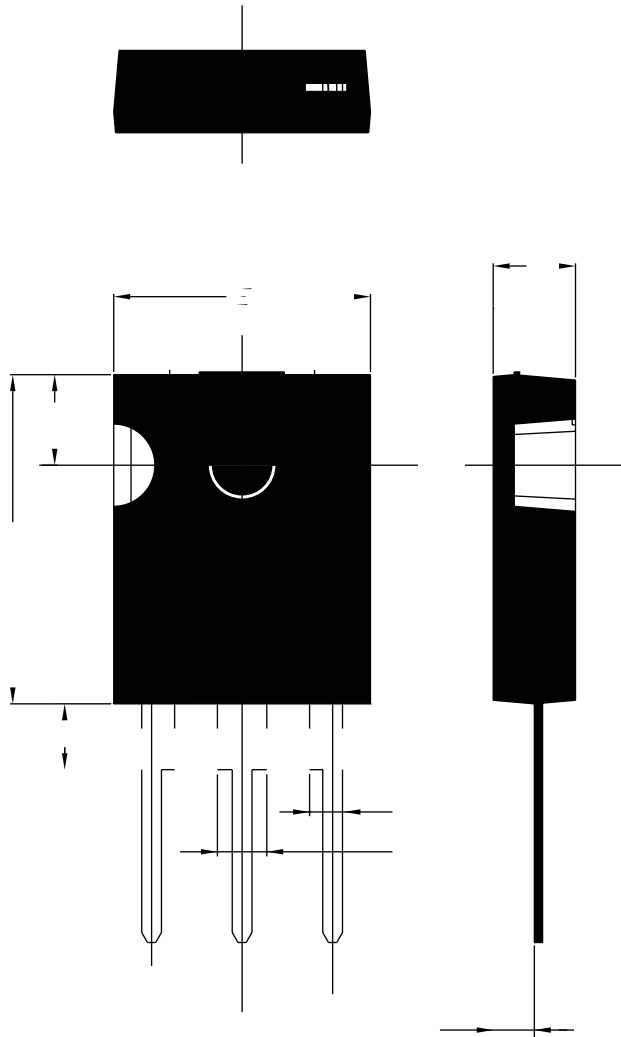


Table 12. TO-247 mechanical data

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	
P	3.55		3.65
R	4.50		5.50
S		5.50	



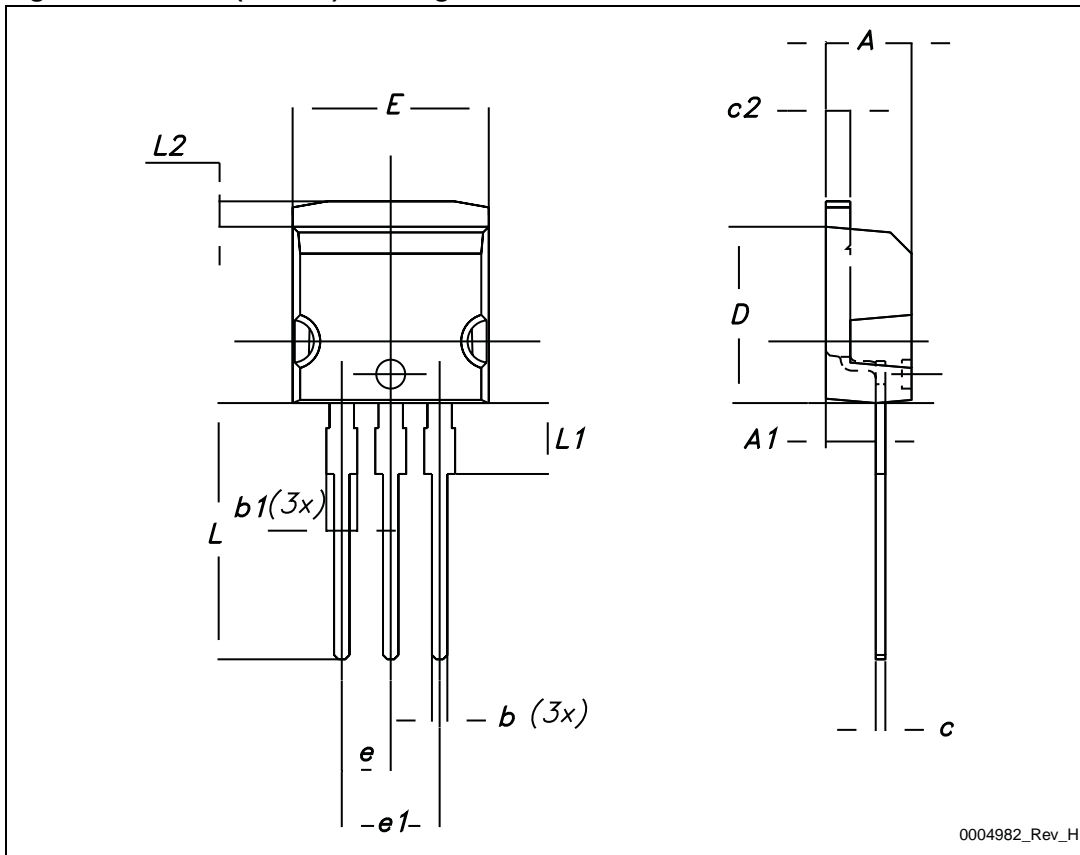
Figure 26. TO-247 drawing



**Table 13. I<sup>2</sup>PAK (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 27. I<sup>2</sup>PAK (TO-262) drawing

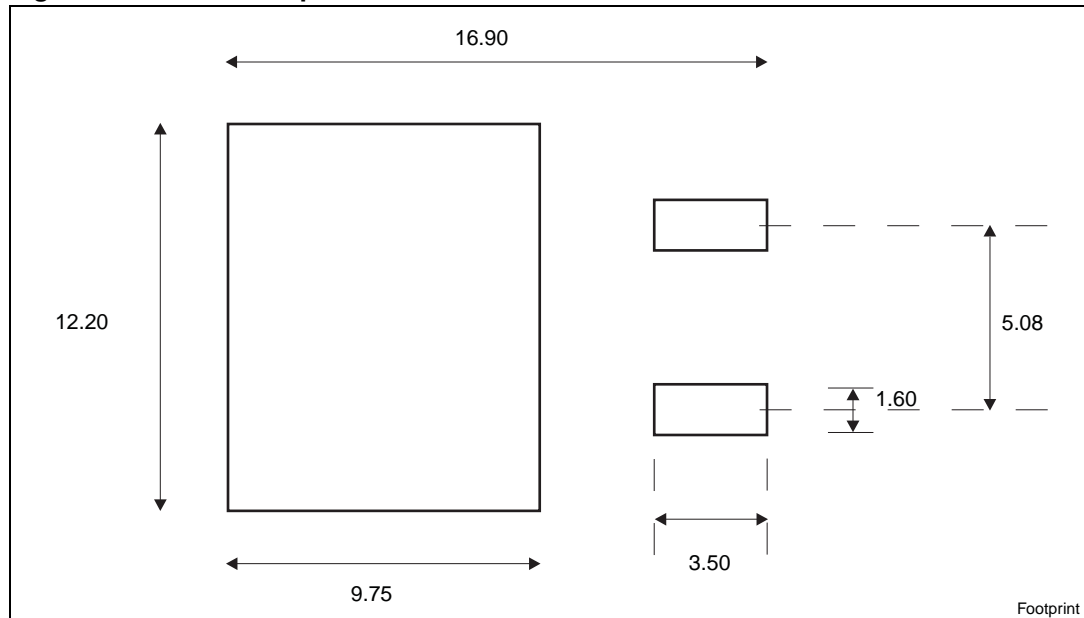


## 5 Packaging mechanical data

**Table 14. D<sup>2</sup>PAK (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 28. D<sup>2</sup>PAK footprint<sup>(a)</sup>**



a. All dimension are in millimeters



## 6 Revision history

**Table 15. Document revision history**

Date	Revision	Changes
02-Jul-2009	1	First release.
18-Feb-2010	2	Document status promoted from preliminary data to datasheet.
27-Aug-2010	3	New package, mechanical data has been inserted: I <sup>2</sup> PAK.
05-Nov-2011	4	Some value changed in <a href="#">Table 5: On /off states</a> .

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