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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		TO-220, TO-247 D ² PAK, I ² PAK	TO-220FP	
V _{GS}	Gate- source voltage	± 25		V
I _D	Drain current (continuous) at T _C = 25 °C	42	42 ⁽¹⁾	A
I _D	Drain current (continuous) at T _C = 100 °C	26.5	26.5 ⁽¹⁾	A
I _{DM} ⁽²⁾	Drain current (pulsed)	168	168 ⁽¹⁾	A
P _{TOT}	Total dissipation at T _C = 25 °C	250	40	W
I _{AR}	Max current during repetitive or single pulse avalanche (pulse width limited by T _{JMAX})	11		A
E _{AS}	Single pulse avalanche energy (starting T _J = 25°C, I _D = I _{AR} , V _{DD} = 50V)	960		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 by maximum junction temperature.

2. Pulse width limited by safe operating area.

3. I_{SD} ≤ 42 A, di/dt ≤ 400 A/μs, V_{Peak} < V_{(BR)DSS}, V_{DD} = 400 V

Table 3. Thermal data

Symbol	Parameter	Value					Unit
		D ² PAK	I ² PAK	TO-220	TO-247	TO-220FP	
R _{thj-case}	Thermal resistance junction-case max	0.50				3.1	°C/W
R _{thj-amb}	Thermal resistance junction-ambient max		62.5		50	62.5	°C/W
R _{thj-pcb}	Thermal resistance junction-pcb max ⁽¹⁾	30					°C/W

1. When mounted on 1inch² FR-4 board, 2 oz Cu.

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 ($V_{GS} = 0$)	$V_{DS} = 650\text{ V}$ $V_{DS} = 650\text{ V}$, $T_C = 125\text{ }^{\circ}\text{C}$			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	$V_{GS} = 10\text{ V}$, $I_D = 21\text{ A}$		0.056	0.063	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	$V_{DS} = 100\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0$	-	4200 115 9	-	pF pF pF
$C_{o(er)}^{(1)}$	Equivalent output capacitance energy related	$V_{GS} = 0$, $V_{DS} = 0$ to 80% $V_{(BR)DSS}$	-	93	-	pF
$C_{o(tr)}^{(2)}$	Equivalent output capacitance time related	$V_{GS} = 0$, $V_{DS} = 0$ to 80% $V_{(BR)DSS}$	-	303	-	pF
R_G	Intrinsic gate resistance	$f = 1\text{ MHz}$ open drain	-	1.3	-	Ω
Q_g Q_{gs} Q_{gd}	Total gate charge Gate-source charge Gate-drain charge	$V_{DD} = 520\text{ V}$, $I_D = 21\text{ A}$, $V_{GS} = 10\text{ V}$ (see Figure 20)	-	98 23 40	-	nC nC nC

1. $C_{o(er)}^{(1)}$ is a constant capacitance value that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS}
2. $C_{o(tr)}^{(2)}$ is a constant capacitance value that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS}

Table 6. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(V)}$	Voltage delay time	$V_{DD} = 400\text{ V}$, $I_D = 28\text{ A}$, $R_G = 4.7\ \Omega$, $V_{GS} = 10\text{ V}$ (see Figure 21)	-	73	-	ns
$t_{r(V)}$	Voltage rise time			15		ns
$t_{f(i)}$	Current fall time			12		ns
$t_{c(off)}$	Crossing time			19		ns

Table 7. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		42	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)				168	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 42\text{ A}$, $V_{GS} = 0$	-		1.5	V
t_{rr}	Reverse recovery time	$I_{SD} = 42\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 100\text{ V}$ (see Figure 21)	-	418		ns
Q_{rr}	Reverse recovery charge			8		μC
I_{RRM}	Reverse recovery current			40		A
t_{rr}	Reverse recovery time	$I_{SD} = 42\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 100\text{ V}$, $T_j = 150\text{ }^\circ\text{C}$ (see Figure 21)	-	528		ns
Q_{rr}	Reverse recovery charge			12		μC
I_{RRM}	Reverse recovery current			44		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, I²PAK and TO-220

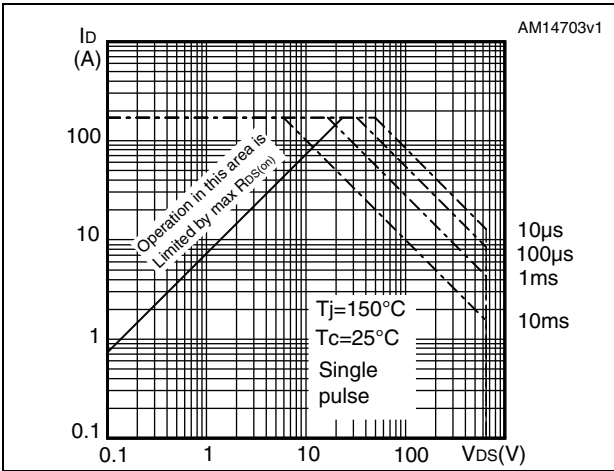


Figure 3. Thermal impedance for D²PAK, I²PAK and TO-220

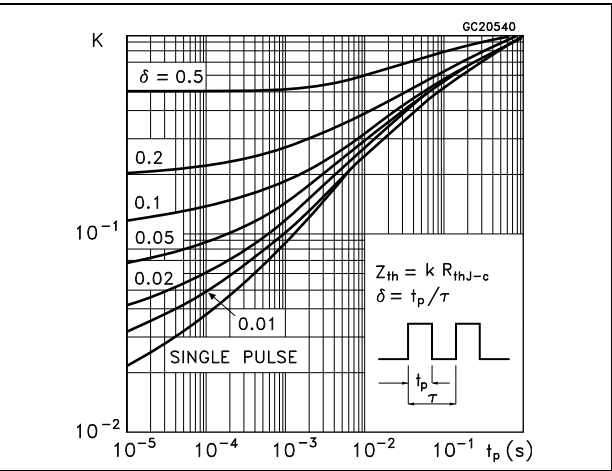


Figure 4. Safe operating area for TO-220FP

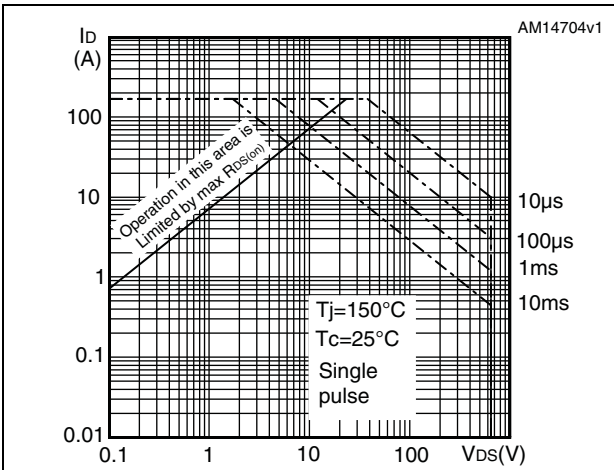


Figure 5. Thermal impedance for TO-220FP

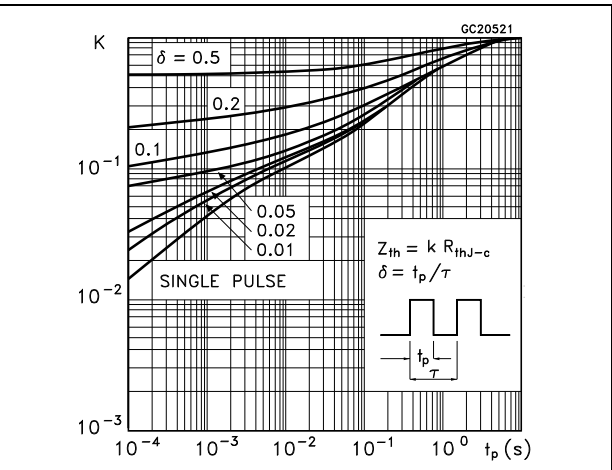


Figure 6. Safe operating area for TO-247

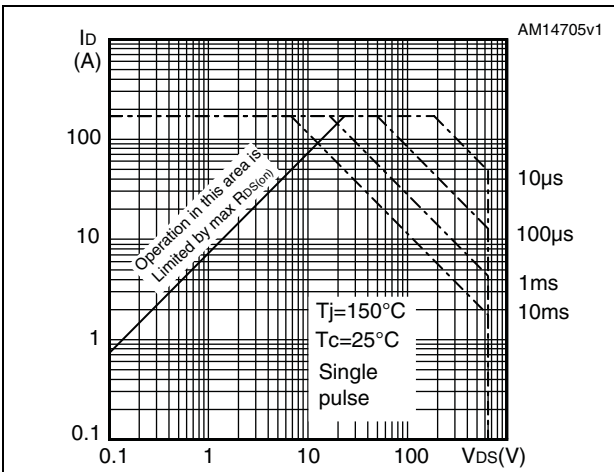


Figure 7. Thermal impedance for TO-247

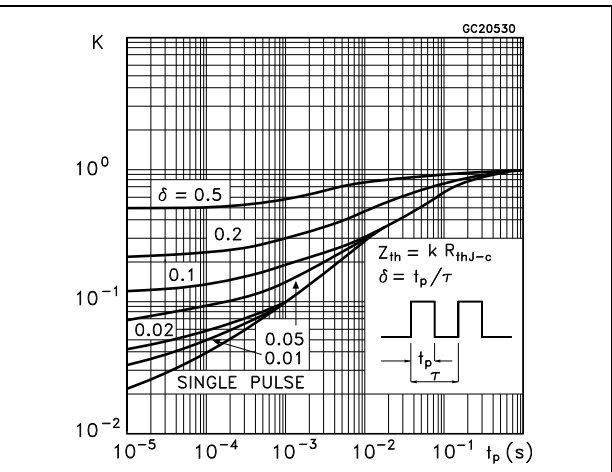


Figure 8. Output characteristics

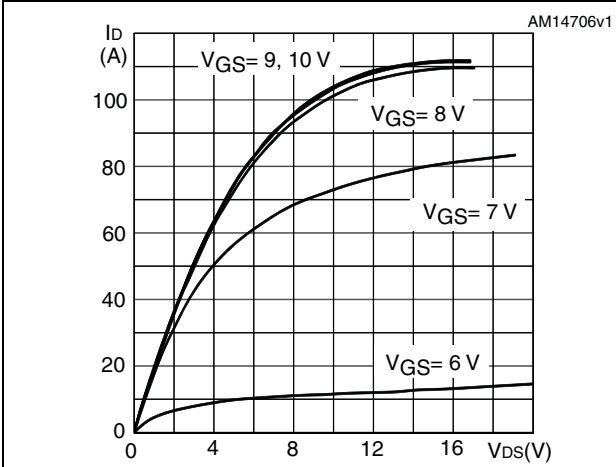


Figure 9. Transfer characteristics

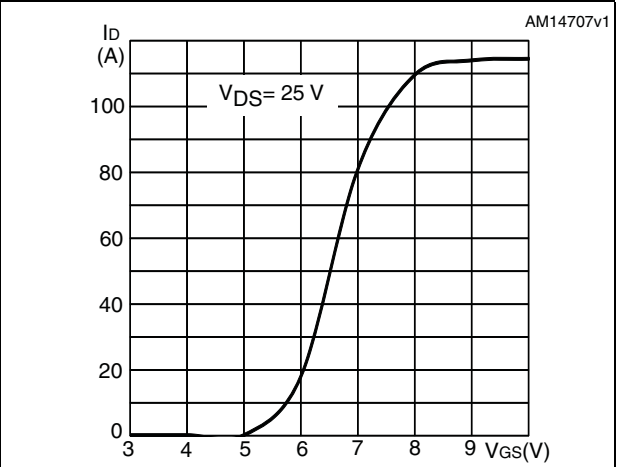


Figure 10. Gate charge vs gate-source voltage

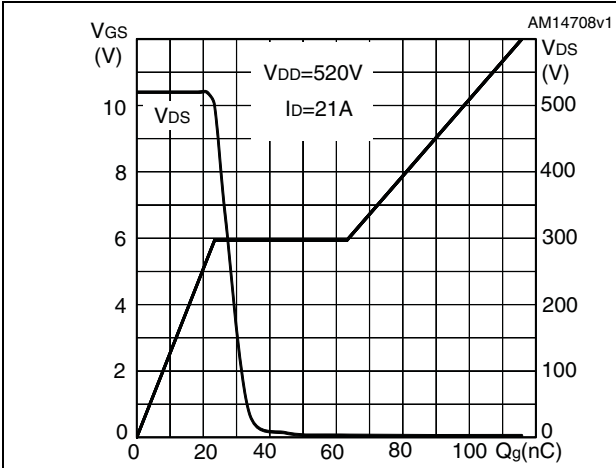


Figure 11. Static drain-source on-resistance

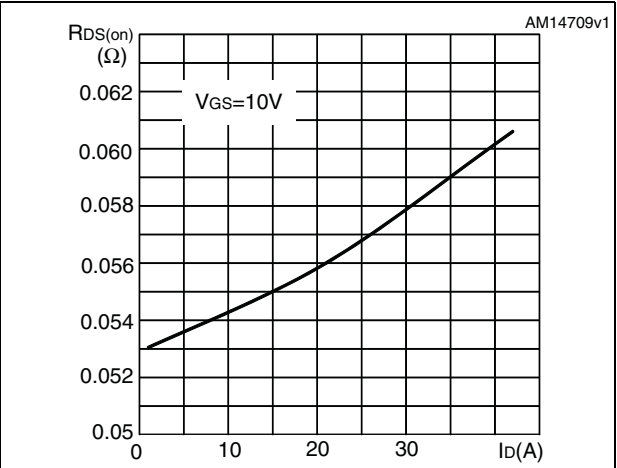


Figure 12. Capacitance variations

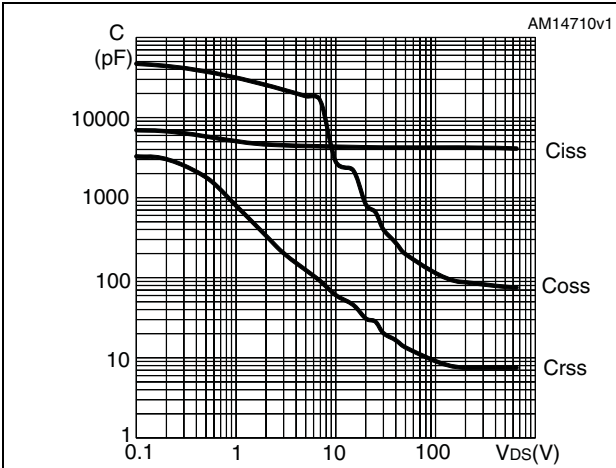


Figure 13. Output capacitance stored energy

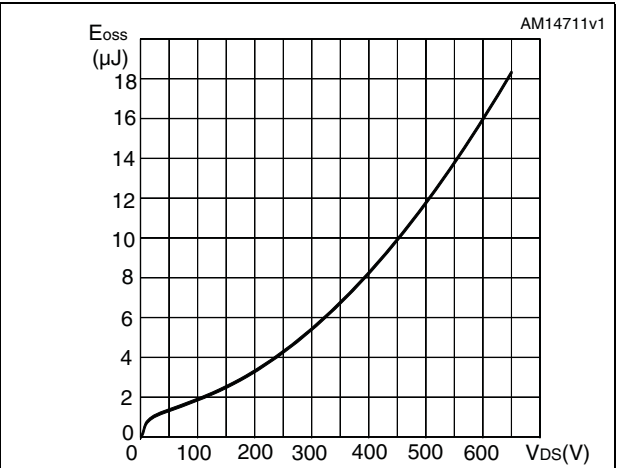


Figure 14. Normalized gate threshold voltage vs temperature

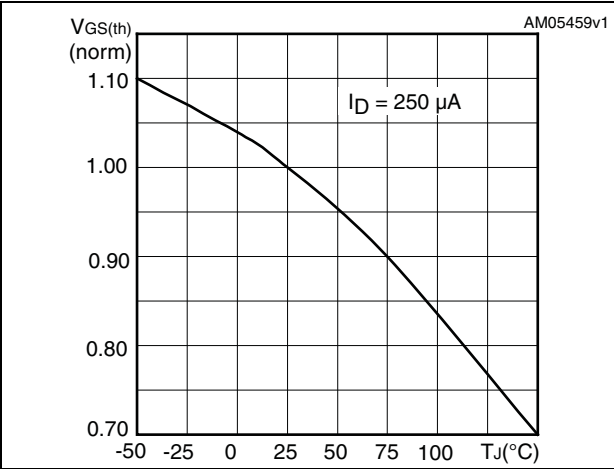


Figure 15. Normalized on-resistance vs temperature

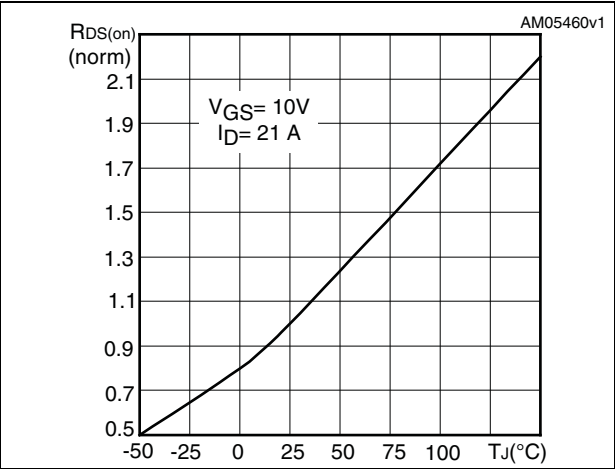


Figure 16. Source-drain diode forward characteristics

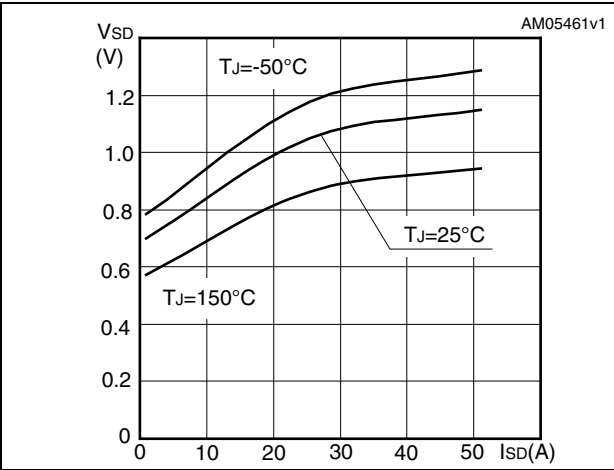


Figure 17. Normalized B_{VDS} vs temperature

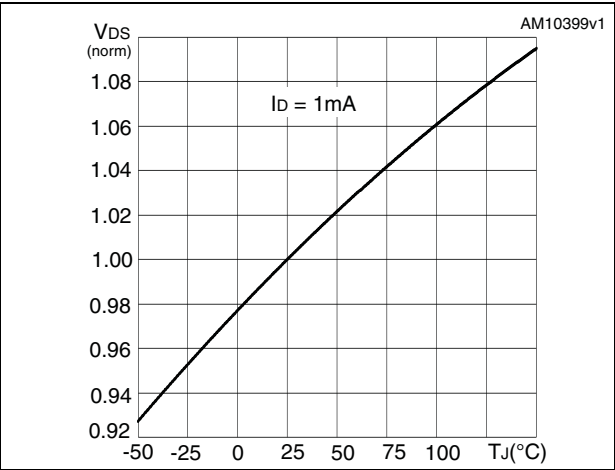
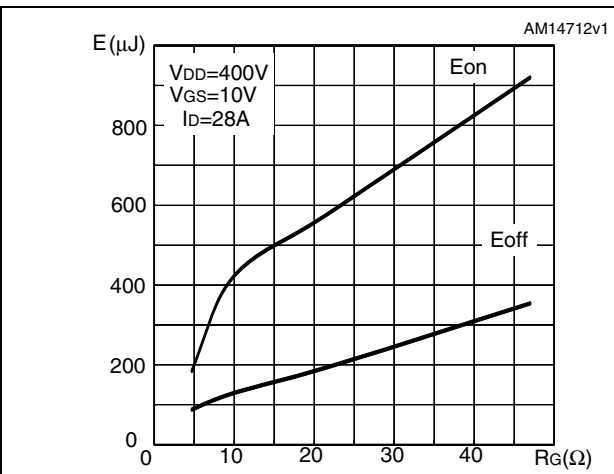


Figure 18. Switching losses vs gate resistance (1)



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

3 Test circuits

Figure 19. Switching times test circuit for resistive load

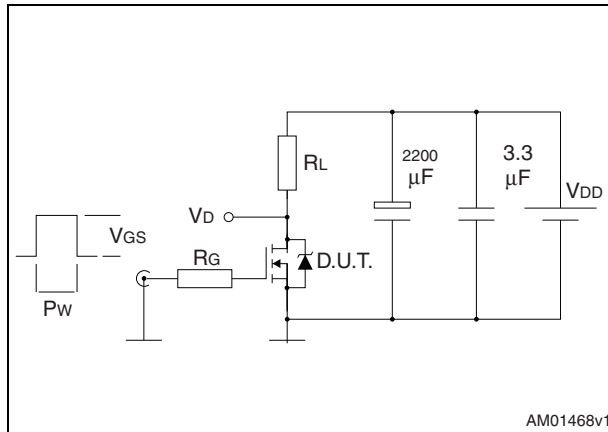


Figure 20. Gate charge test circuit

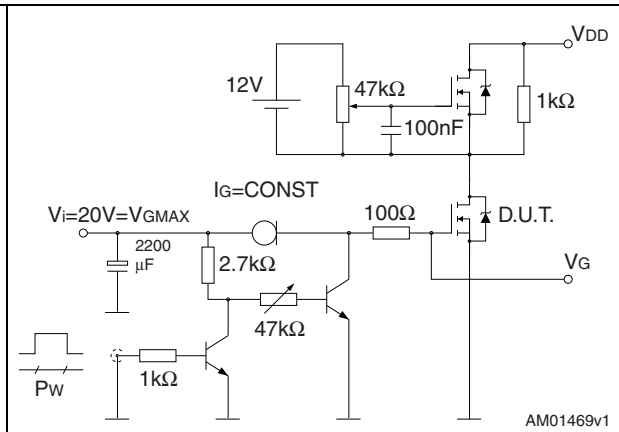


Figure 21. Test circuit for inductive load switching and diode recovery times

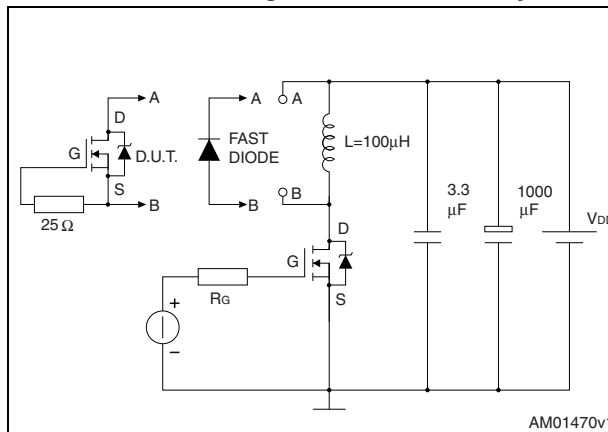


Figure 22. Unclamped inductive load test circuit

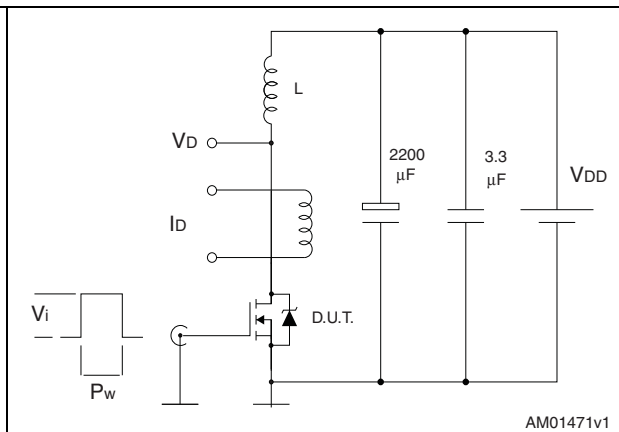


Figure 23. Unclamped inductive waveform

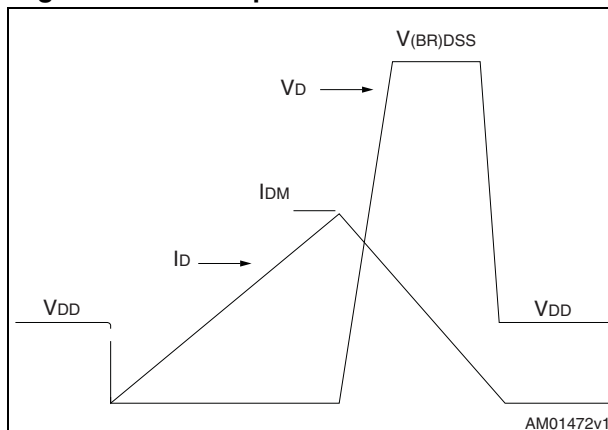
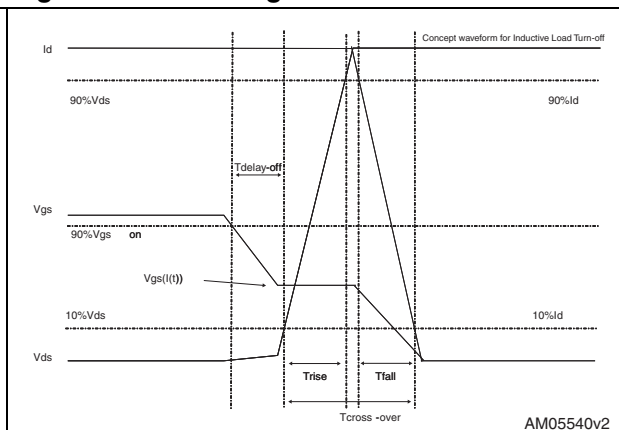


Figure 24. Switching time waveform



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

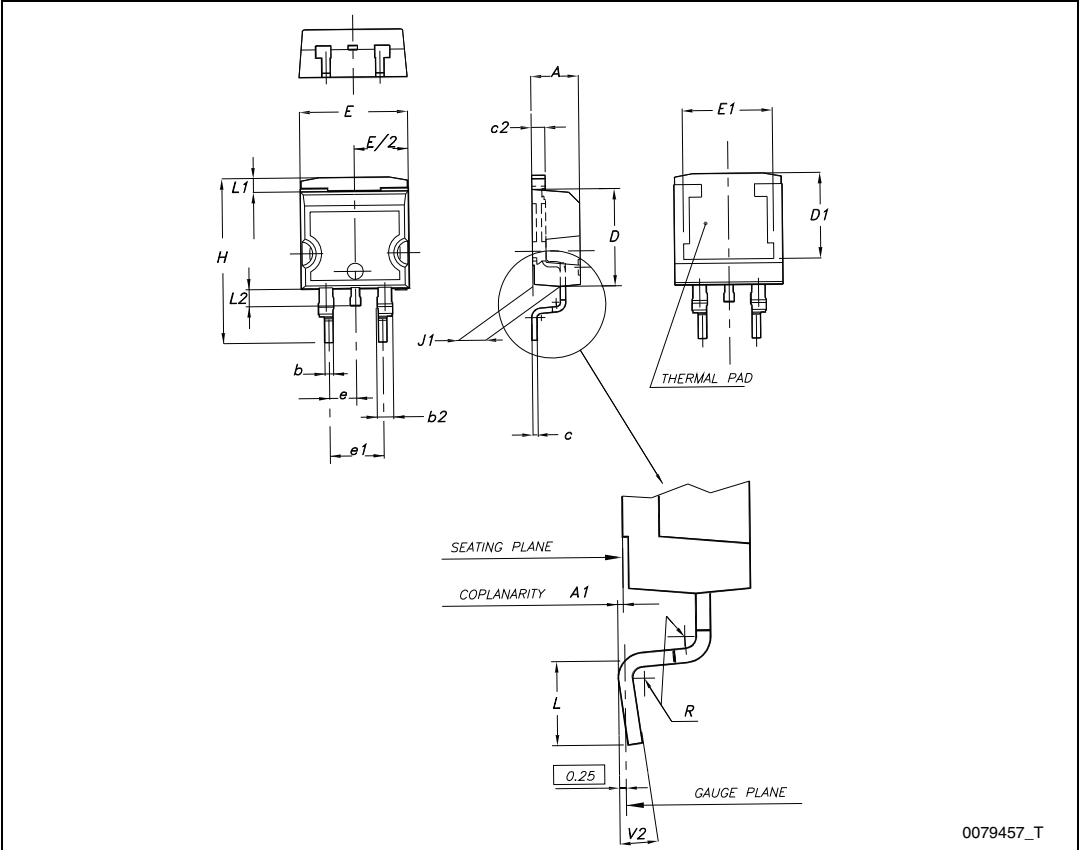
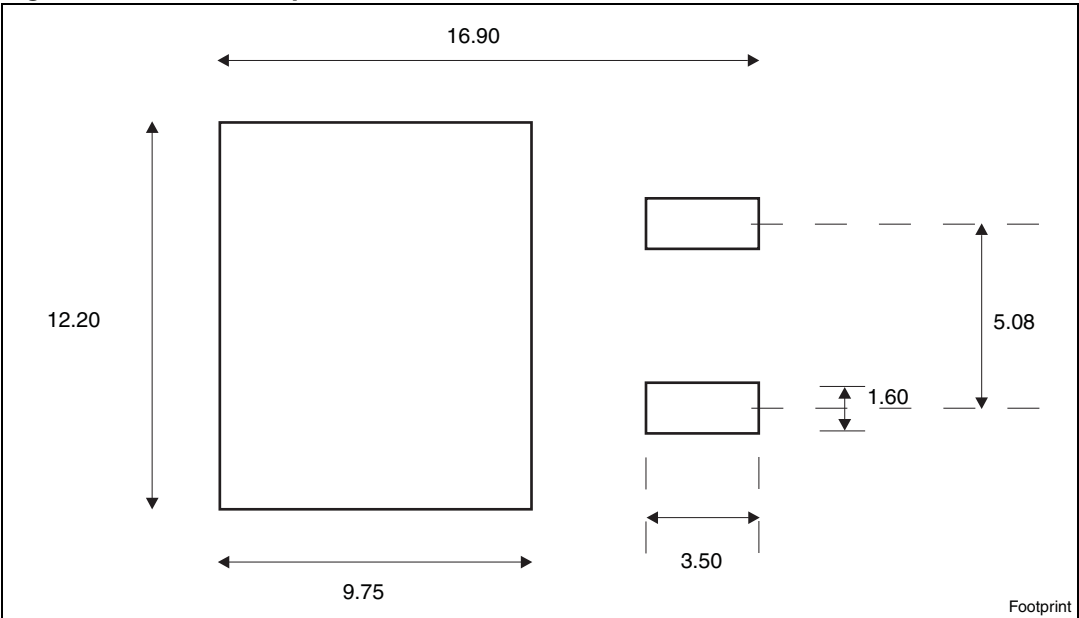


Figure 26. D²PAK footprint^(a)



a. All dimension 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

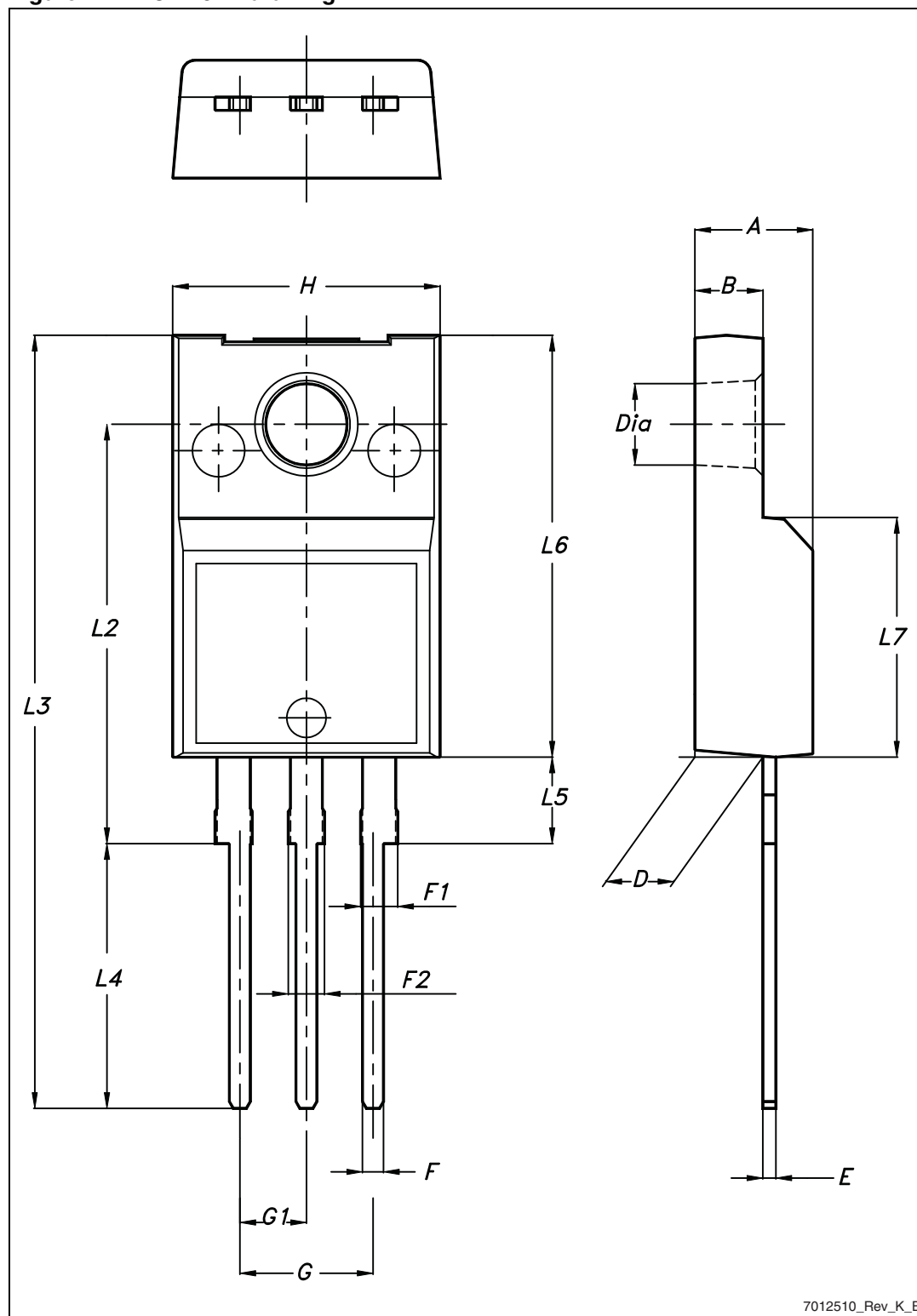


Table 10. I²PAK (TO-262) mechanical data

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

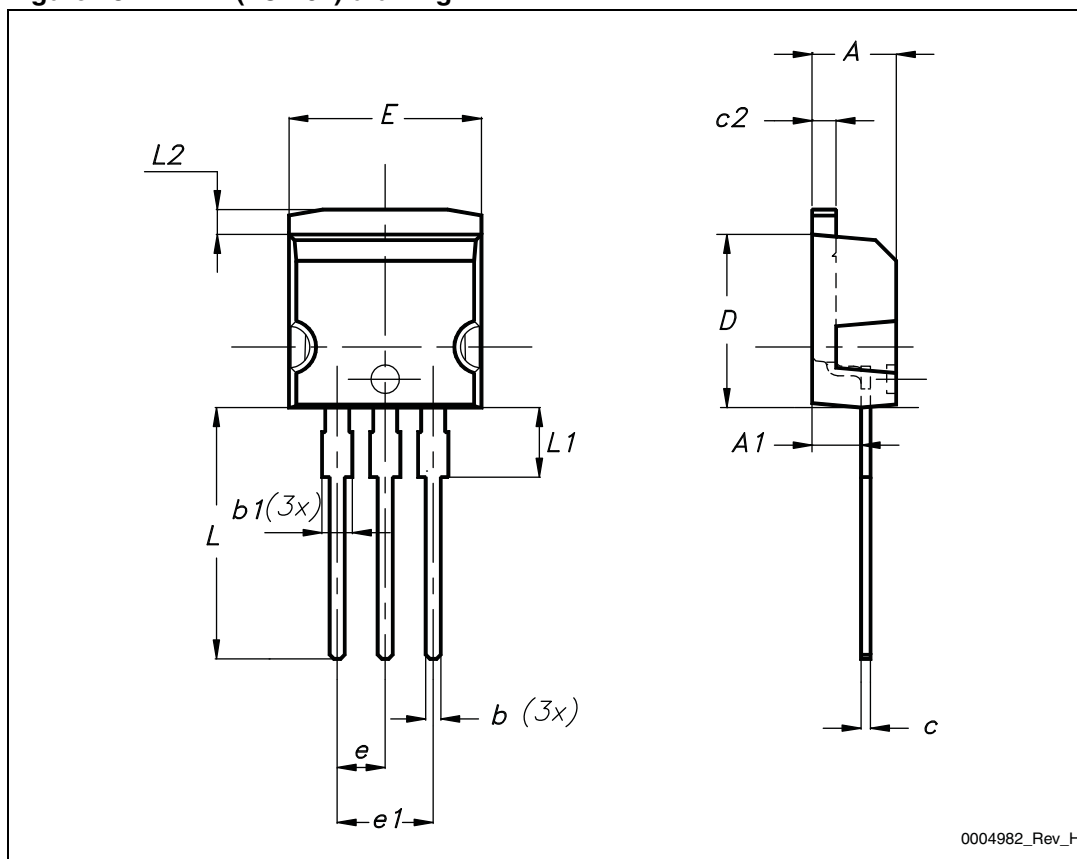


Table 11. TO-220 type A mechanical data

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

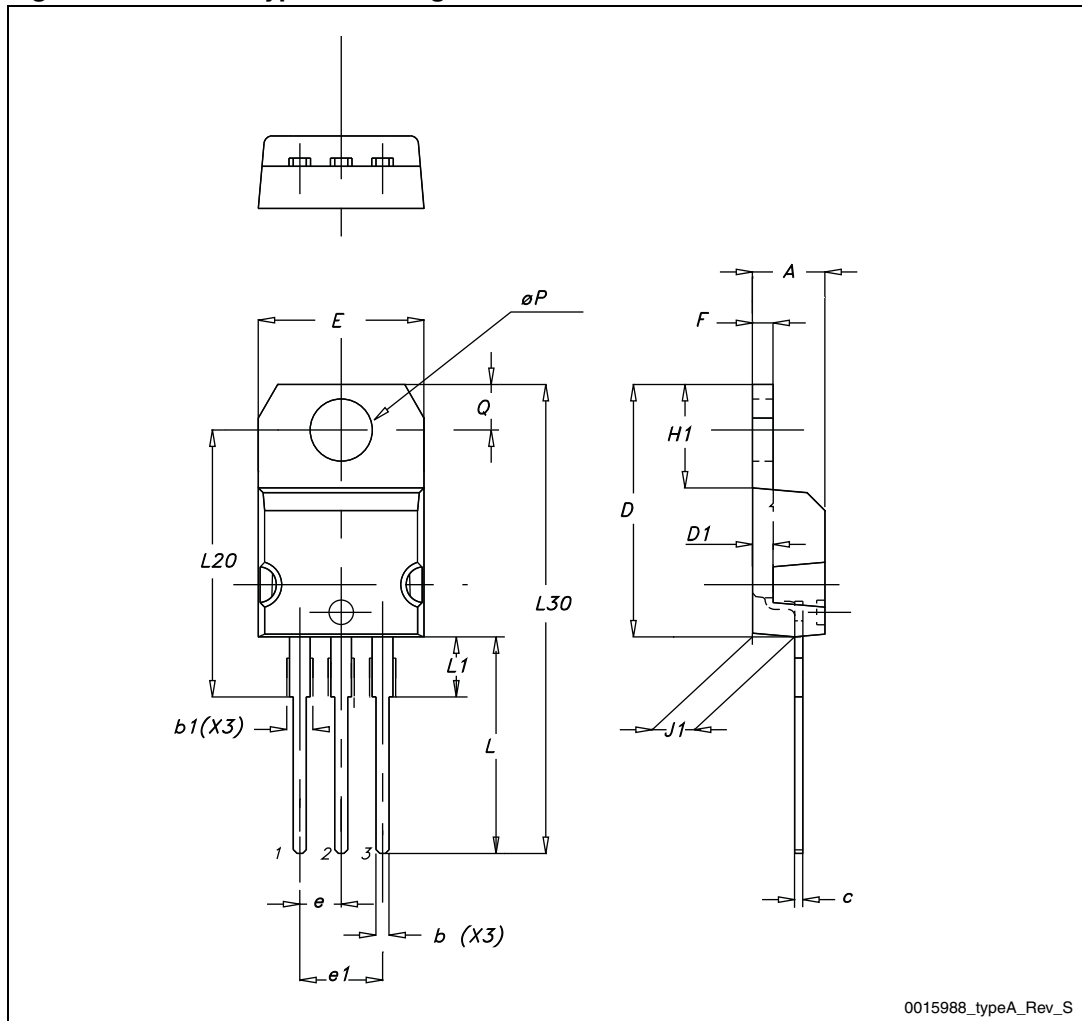
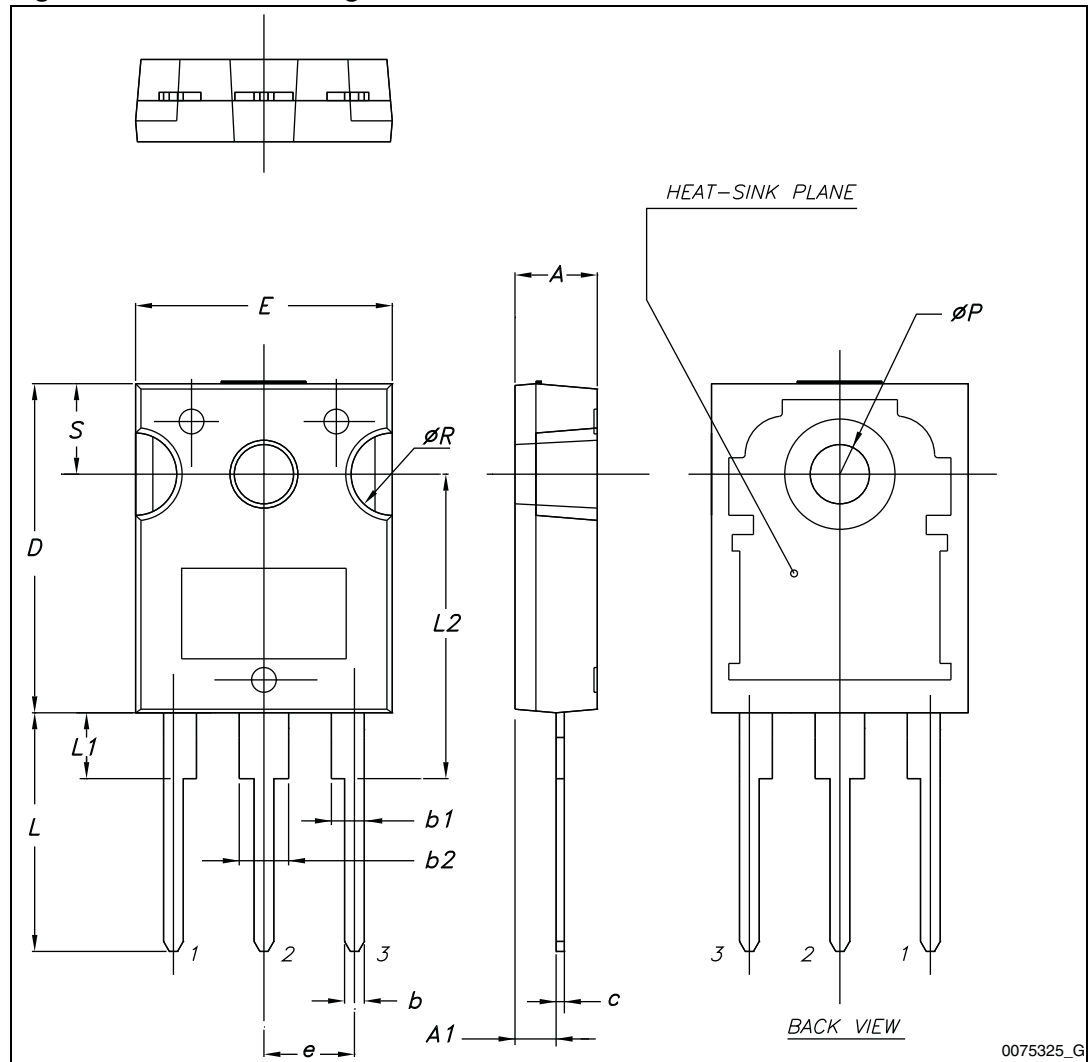


Table 12. TO-247 mechanical data

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	5.30	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 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

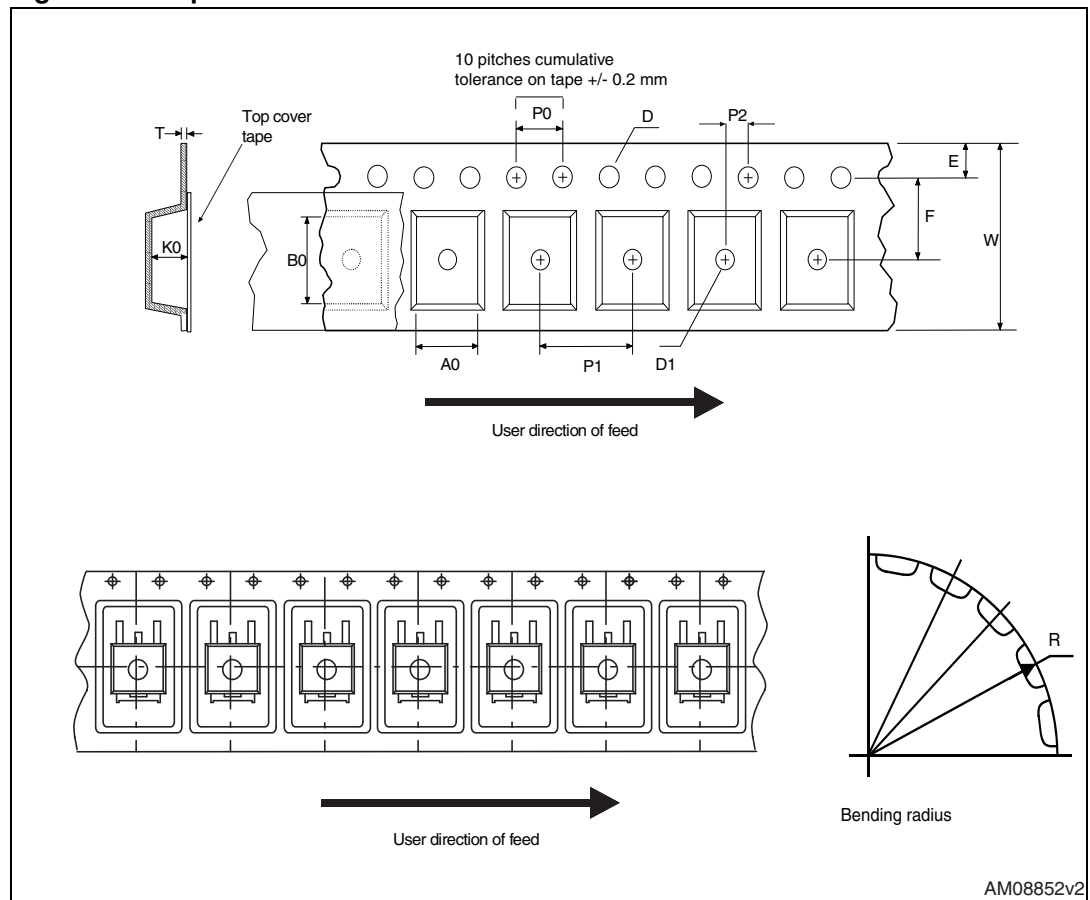
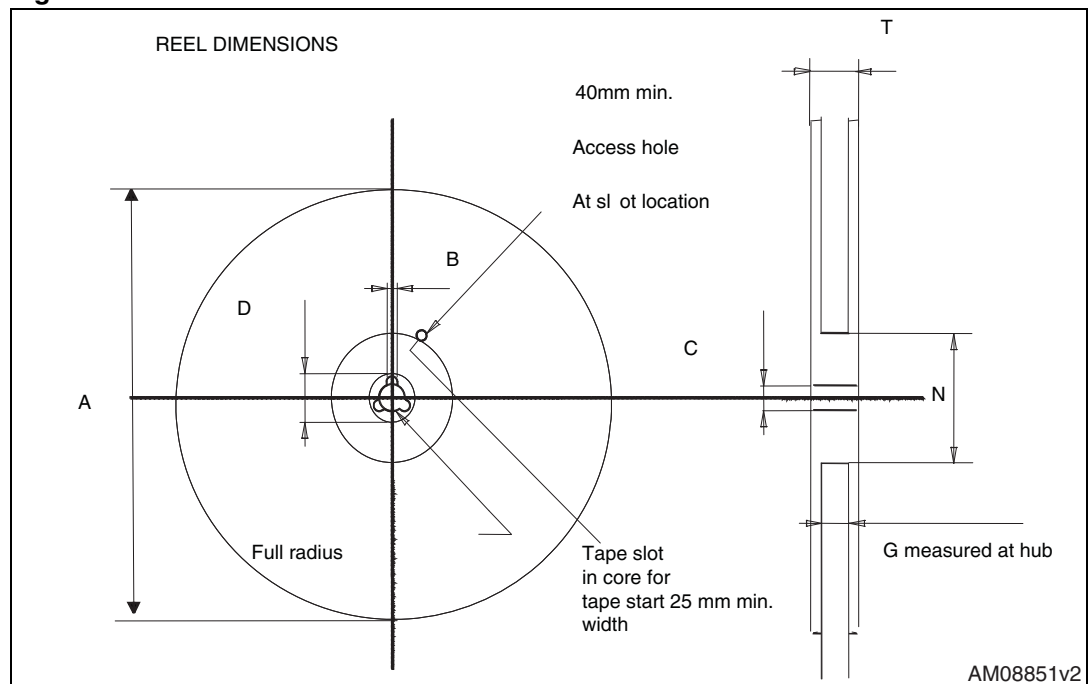


Figure 32. Reel



6 Revision history

Table 14. Document revision history

Date	Revision	Changes
06-Apr-2012	1	First release.
04-Jul-2012	2	Document status promoted from preliminary to production data. Added Section 2.1: Electrical characteristics (curves) .
21-Aug-2012	3	Updated symbols and parameters in Table 6: Switching times . Minor text change on the cover page.

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