STB40N60M2, STF40N60M2, STFI40N60M2, STP40N60M2, STW40N60M2

N-channel 600 V, 0.078 Ω typ., 34 A MDmesh II Plus™ low Q_g Power MOSFETs in D^2PAK, TO-220FP, I^2PAKFP, TO-220 and TO-247

Datasheet – production data

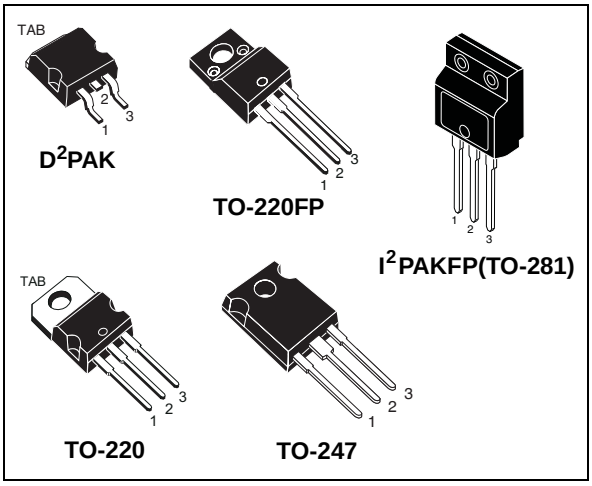
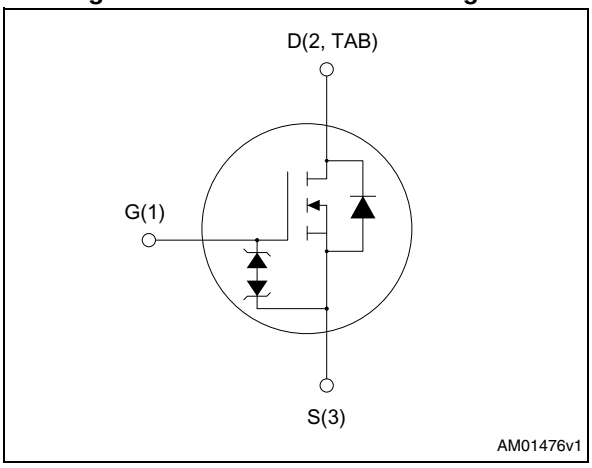


Figure 1. Internal schematic diagram



Features

Order codes	V_{DS} @ T_{Jmax}	$R_{DS(on)}$ max	I_D
STB40N60M2	650 V	0.088 Ω	34 A
STF40N60M2			
STFI40N60M2			
STP40N60M2			
STW40N60M2			

- Extremely low gate charge
- Lower $R_{DS(on)}$ x area vs previous generation
- MDmesh II Plus. low Q_g
- Low gate input resistance
- 100% avalanche tested
- Zener-protected

Applications

- Switching applications
- LLC converters, resonant converters

Description

These devices are N-channel Power MOSFETs developed using a new generation of MDmesh™ technology: MDmesh II Plus™ low Q_g. These revolutionary Power MOSFETs associate a vertical structure to the company's strip layout to yield one of the world's lowest on-resistance and gate charge. They are therefore suitable for the most demanding high efficiency converters.

Table 1. Device summary

Order codes	Marking	Package	Packaging
STB40N60M2	40N60M2	D^2PAK	Tape and reel
STF40N60M2		TO-220FP	Tube
STFI40N60M2		I^2PAKFP(TO-281)	
STP40N60M2		TO-220	
STW40N60M2		TO-247	

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

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2.1 Electrical characteristics (curves) 6

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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		D^2PAK, TO-220, TO-247	TO220FP, I^2PAKFP	
V_{GS}	Gate-source voltage	± 25		V
I_D (1)	Drain current (continuous) at T_C = 25 °C	34		A
I_D (1)	Drain current (continuous) at T_C = 100 °C	22		A
I_{DM} (1),(2)	Drain current (pulsed)	136		A
P_{TOT}	Total dissipation at T_C = 25 °C	250	40	W
dv/dt (3)	Peak diode recovery voltage slope	15		V/ns
dv/dt(4)	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			°C

1. Limited by maximum junction temperature
2. Pulse width limited by safe operating area.
3. $I_{SD} \leq 34$ A, di/dt ≤ 400 A/μs; $V_{DS\ peak} < V_{(BR)DSS}$, V_{DD}=400 V.
4. $V_{DS} \leq 480$ V

Table 3. Thermal data

Symbol	Parameter	Value				Unit
		D^2PAK	TO-220FP, I^2PAKFP	TO-220	TO-247	
$R_{thj\text{-}case}$	Thermal resistance junction-case max	0.50	3.13	0.50		°C/W
$R_{thj\text{-}pcb}$	Thermal resistance junction-pcb max(1)	30				°C/W
$R_{thj\text{-}amb}$	Thermal resistance junction-ambient max		62.5		50	°C/W

1. 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})	6	A
E_{AS}	Single pulse avalanche energy (starting T_j=25°C, I_D= I_{AR}; V_{DD}=50 V)	500	mJ

2 Electrical characteristics

(T_C = 25 °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 mA, V_{GS} = 0	600			V
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} = ± 25 V			±10	µA
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 250 µA	2	3	4	V
$R_{DS(on)}$	Static drain-source on-resistance	V_{GS} = 10 V, I_D = 17 A		0.078	0.088	Ω

Table 6. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	V_{DS} = 100 V, f = 1 MHz, V_{GS} = 0	-	2500	-	pF
C_{oss}	Output capacitance		-	117	-	pF
C_{rss}	Reverse transfer capacitance		-	2.4	-	pF
$C_{oss\ eq.}$ (1)	Equivalent output capacitance	V_{DS} = 0 to 480 V, V_{GS} = 0	-	342	-	pF
R_G	Intrinsic gate resistance	f = 1 MHz, I_D = 0	-	4.4	-	Ω
Q_g	Total gate charge	V_{DD} = 480 V, I_D = 34 A, V_{GS} = 10 V (see *Figure 19*)	-	57	-	nC
Q_{gs}	Gate-source charge		-	10	-	nC
Q_{gd}	Gate-drain charge		-	25.5	-	nC

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}

Table 7. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	V_{DD} = 300 V, I_D = 34 A, R_G = 4.7 Ω, V_{GS} = 10 V (see *Figure 18* and *Figure 23*)	-	20.5	-	ns
t_r	Rise time		-	13.5	-	ns
$t_{d(off)}$	Turn-off-delay time		-	96	-	ns
t_f	Fall time		-	11	-	ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-	34		A
I_{SDM} (1)	Source-drain current (pulsed)		-	136		A
V_{SD} (2)	Forward on voltage	I_{SD} = 34 A, V_{GS} = 0	-		1.6	V
t_{rr}	Reverse recovery time	I_{SD} = 34 A, di/dt = 100 A/µs V_{DD} = 60 V (see *Figure 23*)	-	440		ns
Q_{rr}	Reverse recovery charge		-	8.2		µC
I_{RRM}	Reverse recovery current		-	37		A
t_{rr}	Reverse recovery time	I_{SD} = 34 A, di/dt = 100 A/µs V_{DD} = 60 V, T_j = 150 °C (see *Figure 23*)	-	568		ns
Q_{rr}	Reverse recovery charge		-	11.5		µC
I_{RRM}	Reverse recovery current		-	40.5		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 TO-220

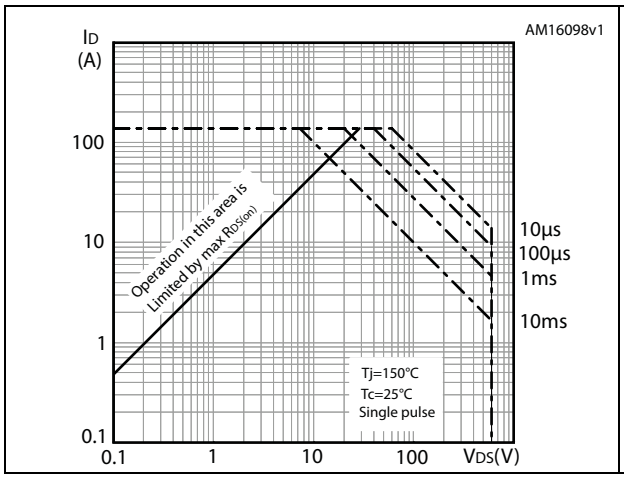


Figure 3. Thermal impedance D²PAK and TO-220

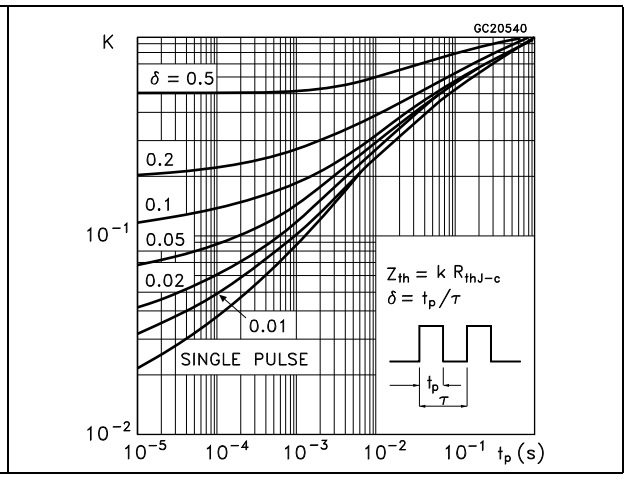


Figure 4. Safe operating area for TO-220FP and I²PAKFP

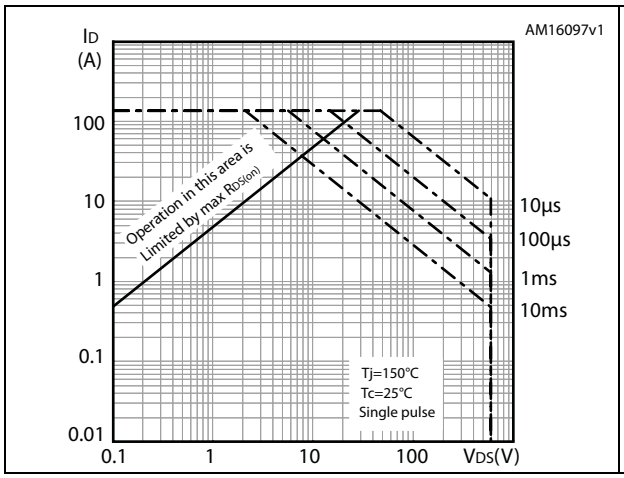


Figure 5. Thermal impedance for TO-220FP and I²PAKFP

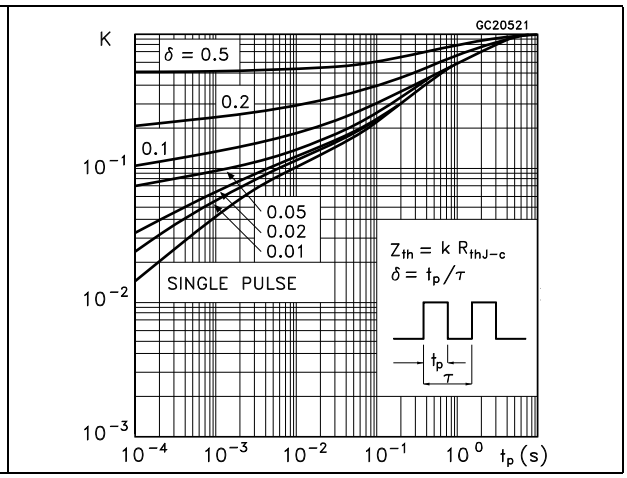


Figure 6. Safe operating area for TO-247

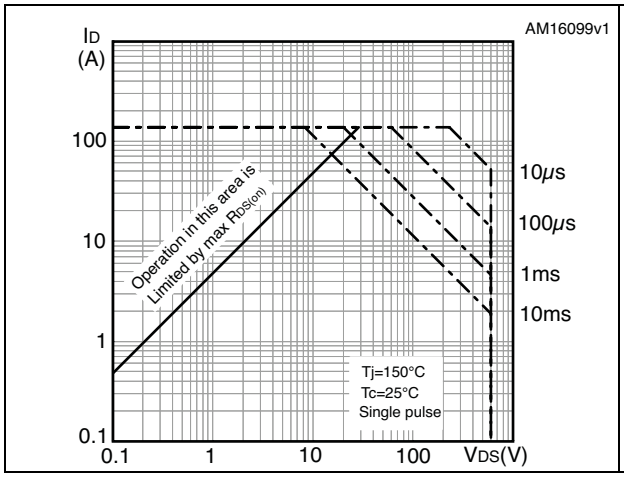


Figure 7. Thermal impedance for TO-247

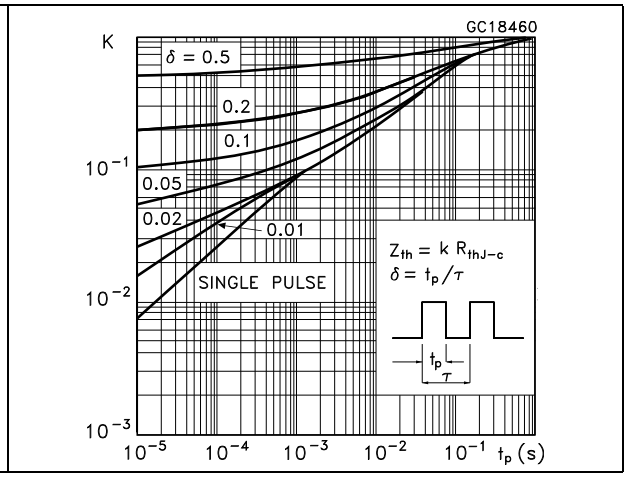


Figure 8. Output characteristics

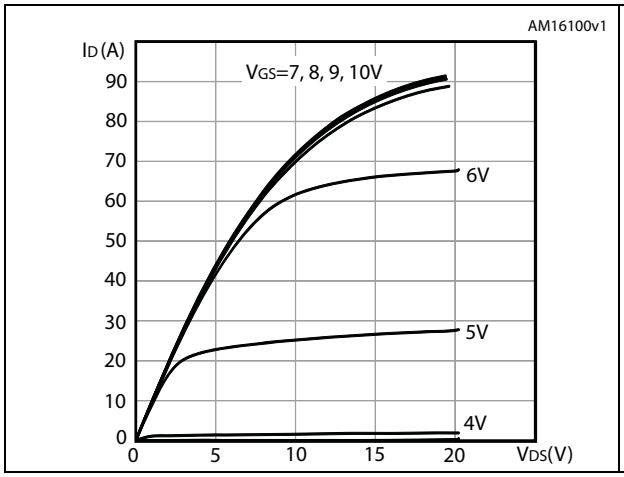


Figure 9. Transfer characteristics

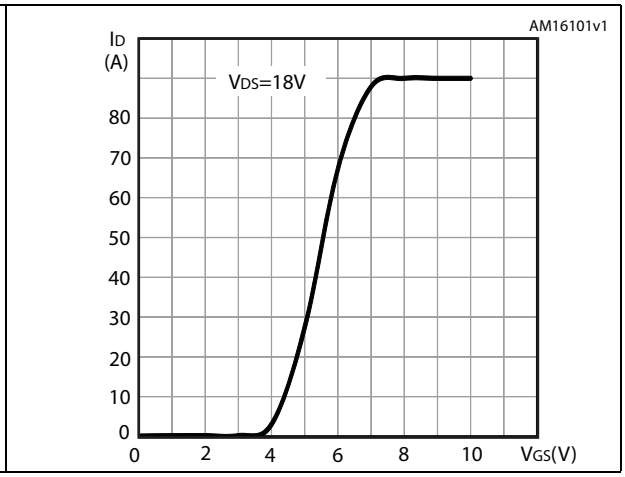


Figure 10. Gate charge vs gate-source voltage

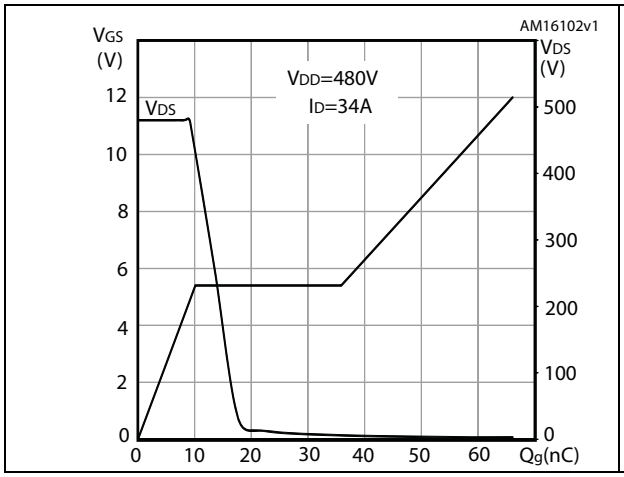


Figure 11. Static drain-source on-resistance

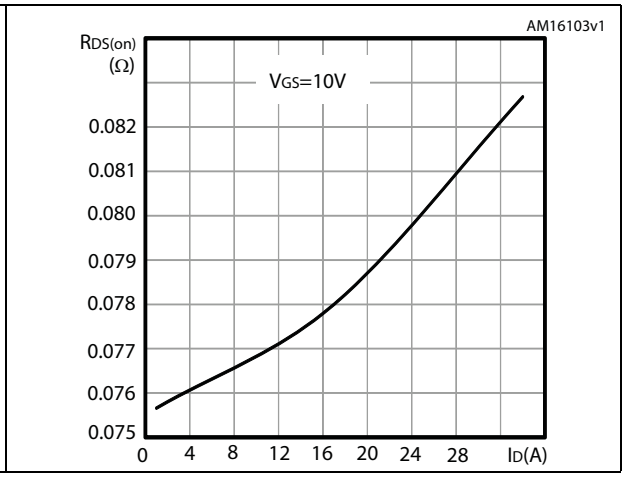


Figure 12. Capacitance variations

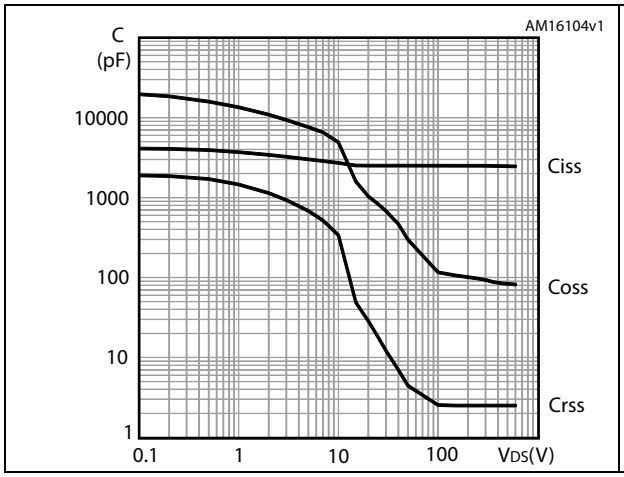


Figure 13. Output capacitance stored energy

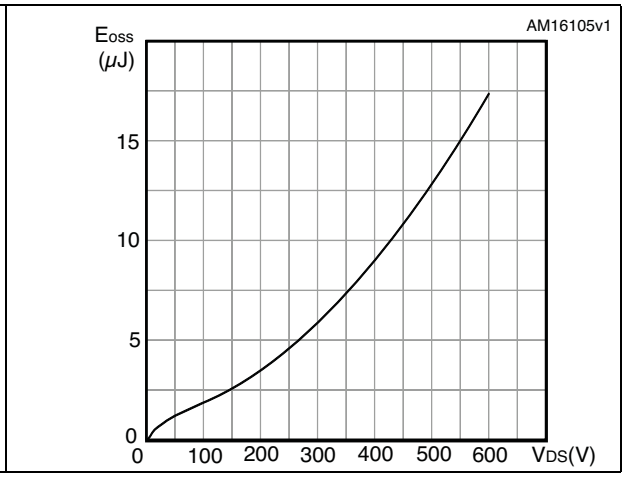


Figure 14. Normalized gate threshold voltage vs temperature

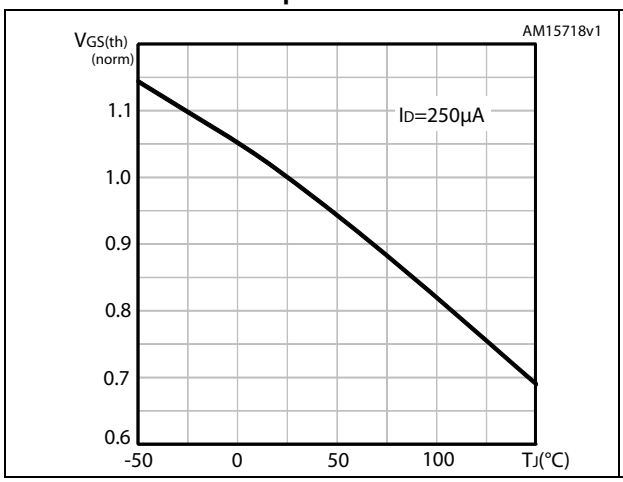


Figure 15. Normalized on-resistance vs temperature

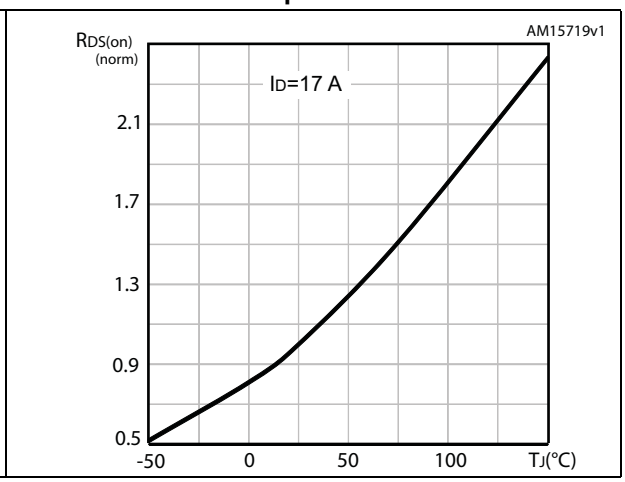


Figure 16. Normalized V_{DS} vs temperature

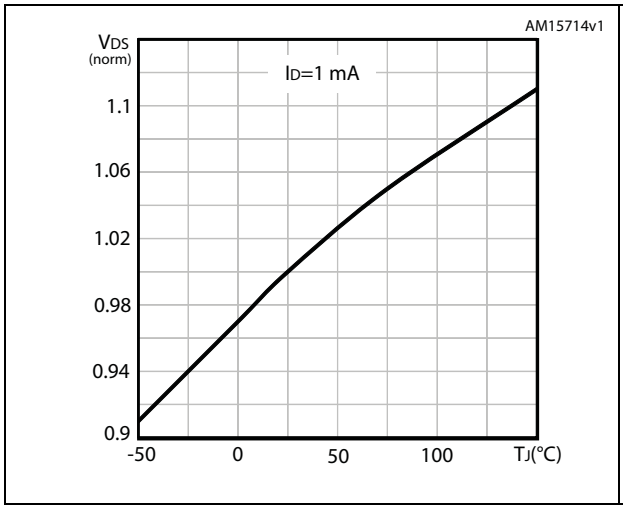
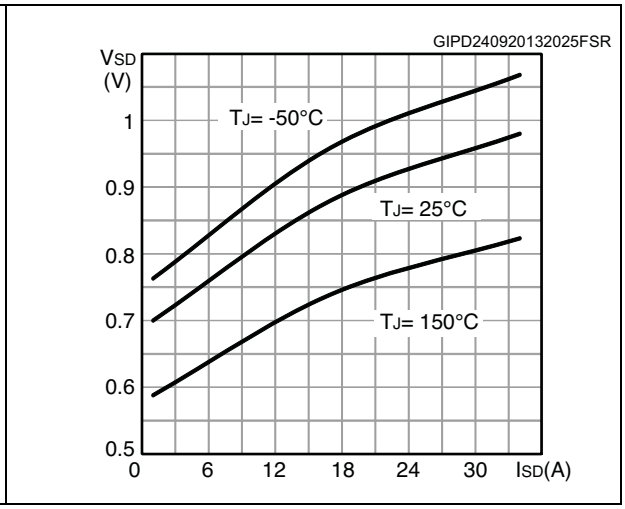


Figure 17. Source-drain diode forward vs temperature



3 Test circuits

Figure 18. Switching times test circuit for resistive load

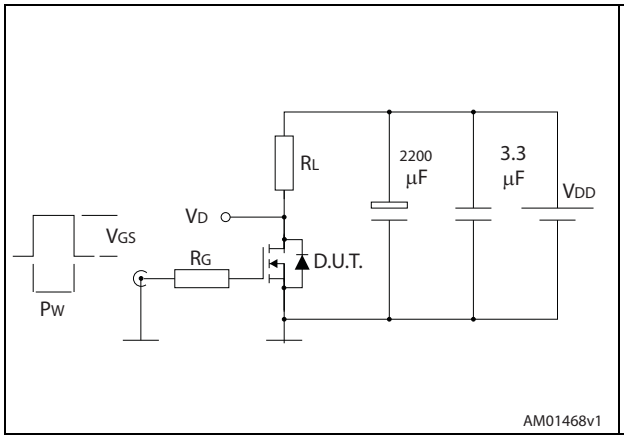


Figure 19. Gate charge test circuit

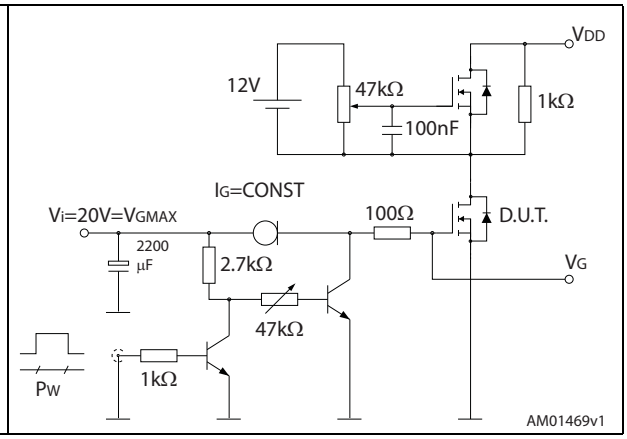


Figure 20. Test circuit for inductive load switching and diode recovery times

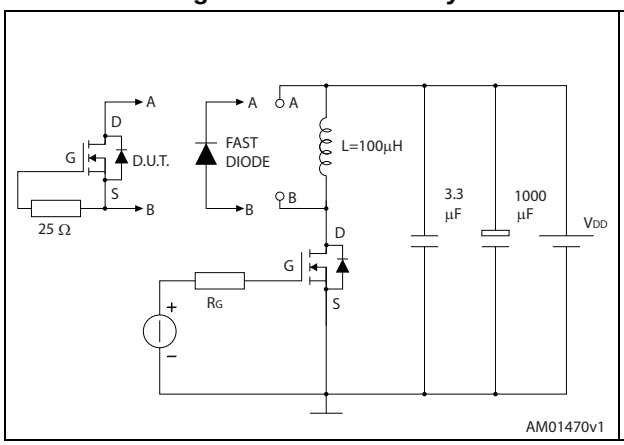


Figure 21. Unclamped inductive load test circuit

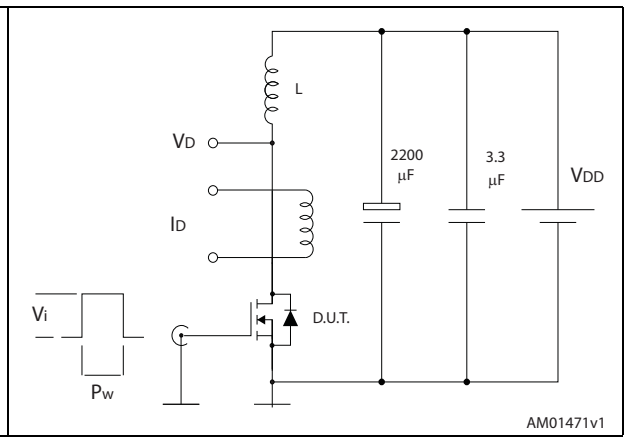


Figure 22. Unclamped inductive waveform

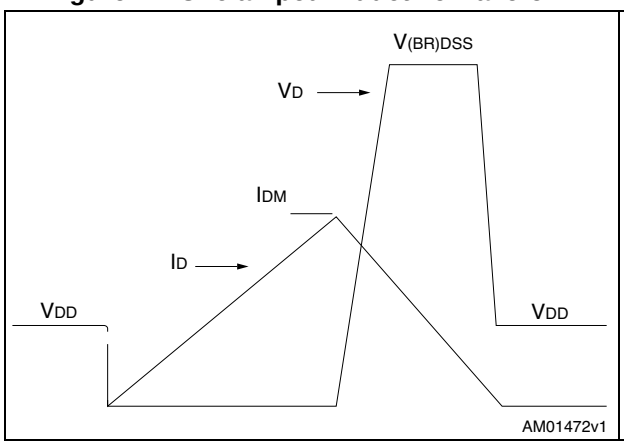
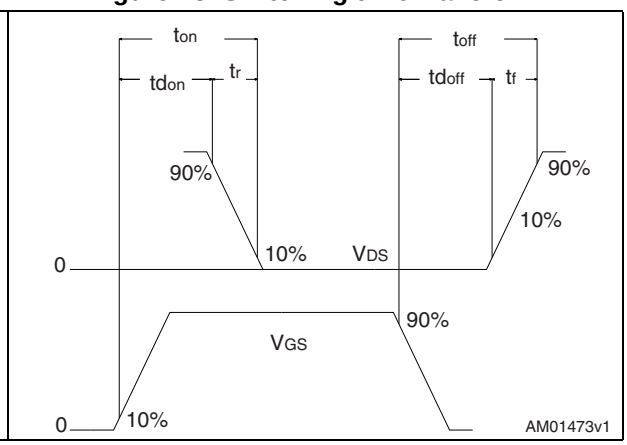


Figure 23. Switching time waveform



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 24. D²PAK (TO-263) drawing

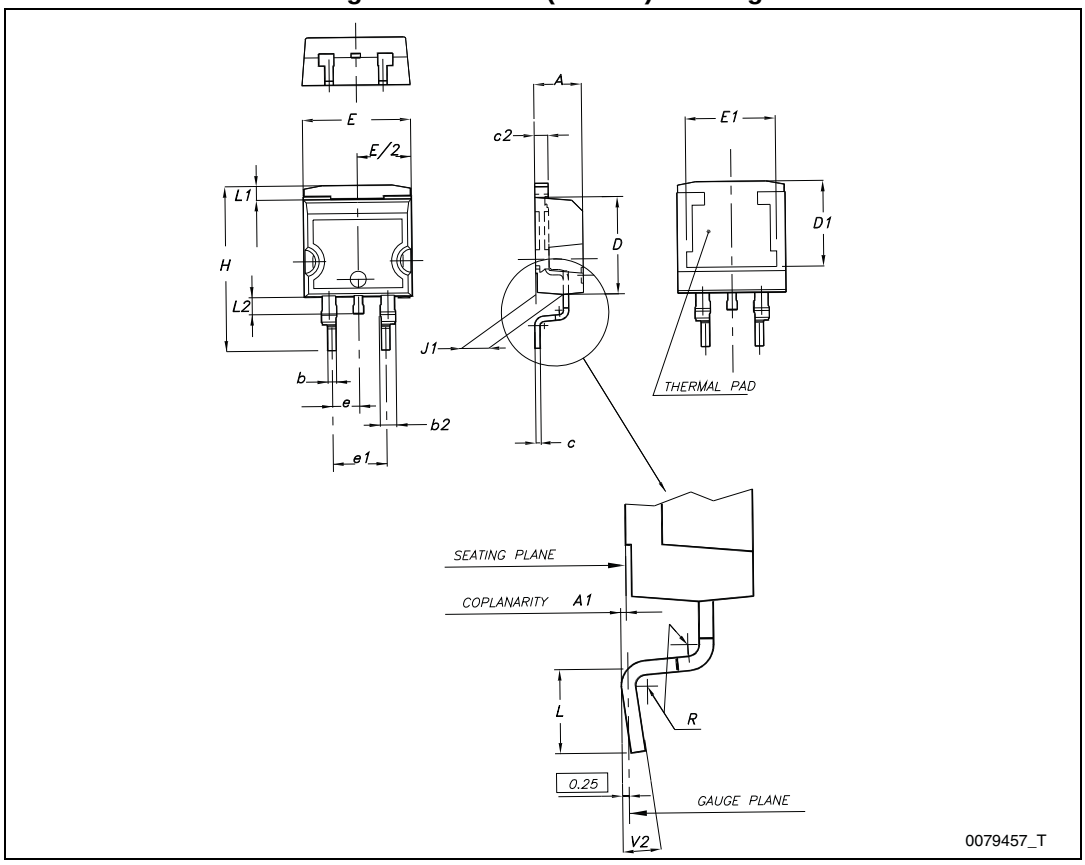
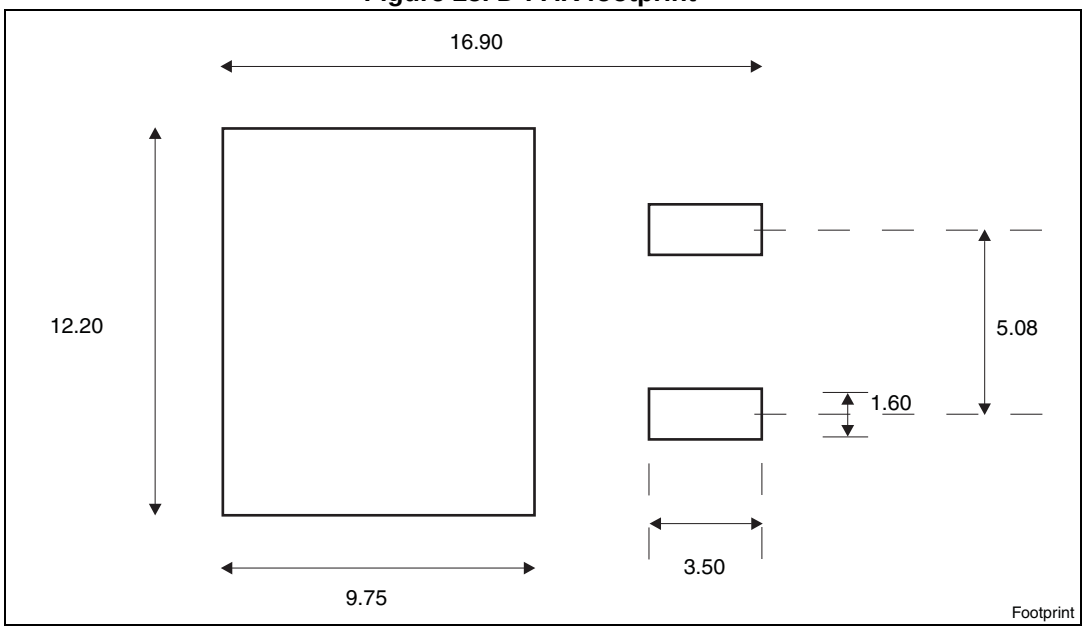


Figure 25. D²PAK footprint[a]



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 26. TO-220FP drawing

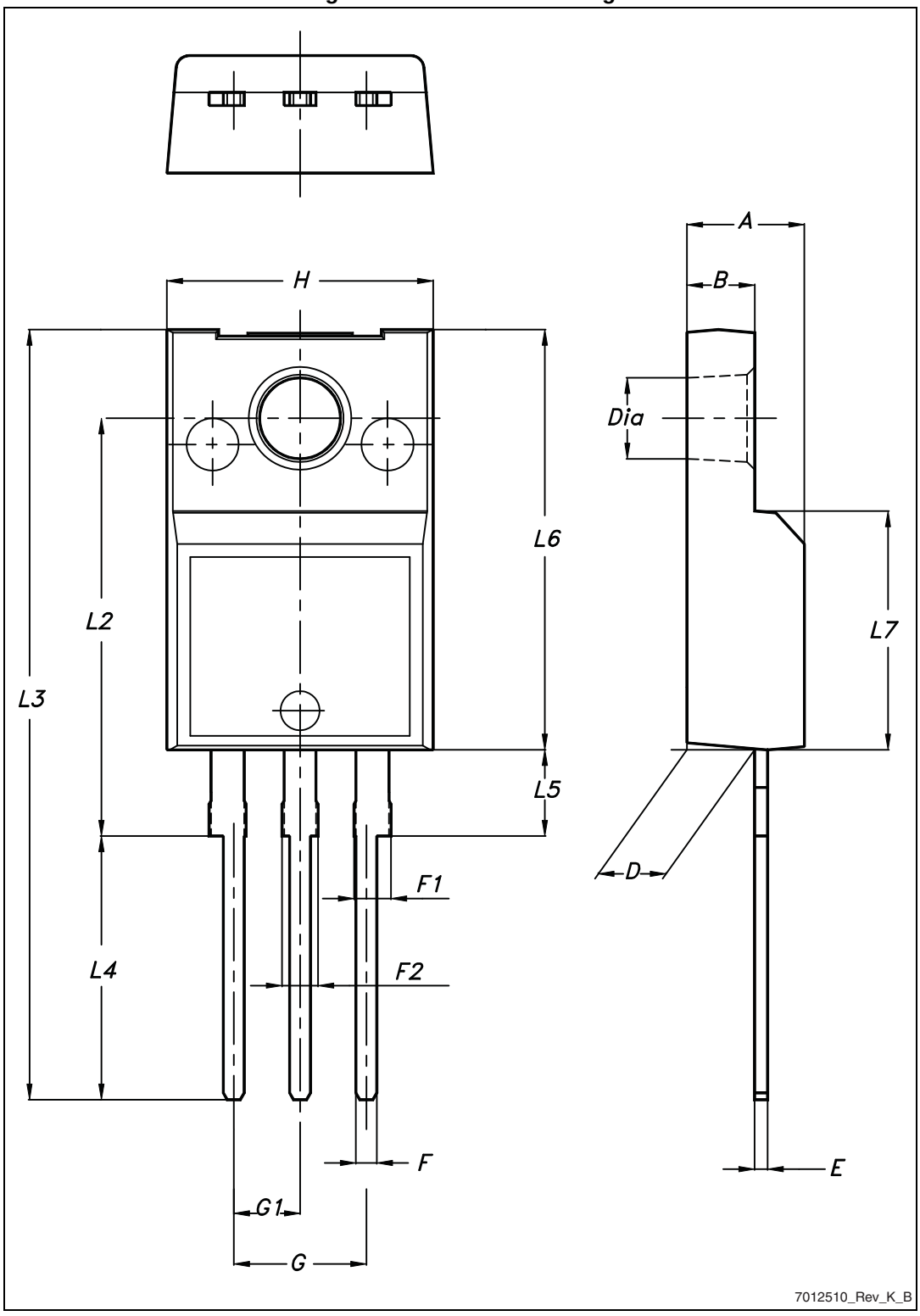


Table 11. I^2PAKFP (TO-281) mechanical data

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 27. I^2PAKFP (TO-281) drawing

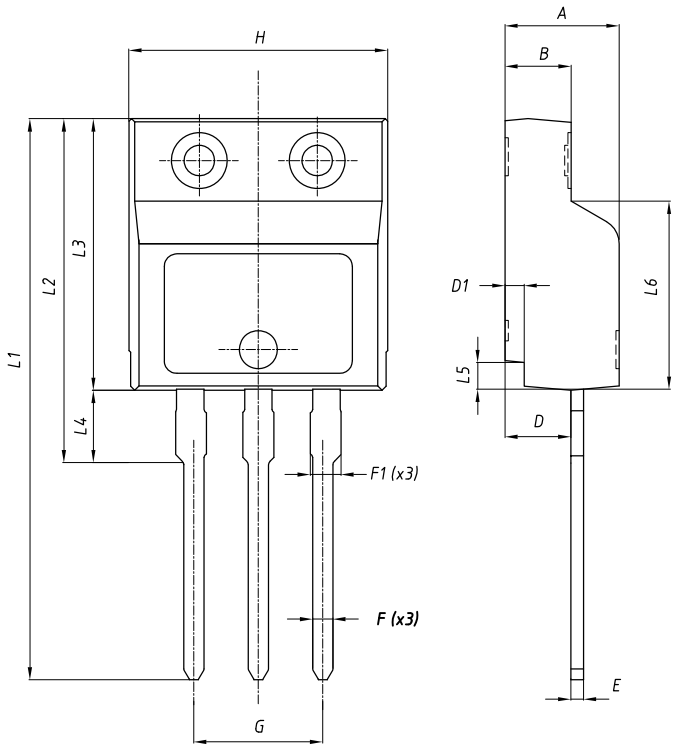


Table 12. TO-220 type A mechanical data

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	
∅P	3.75		3.85
Q	2.65		2.95

Figure 28. TO-220 type A drawing

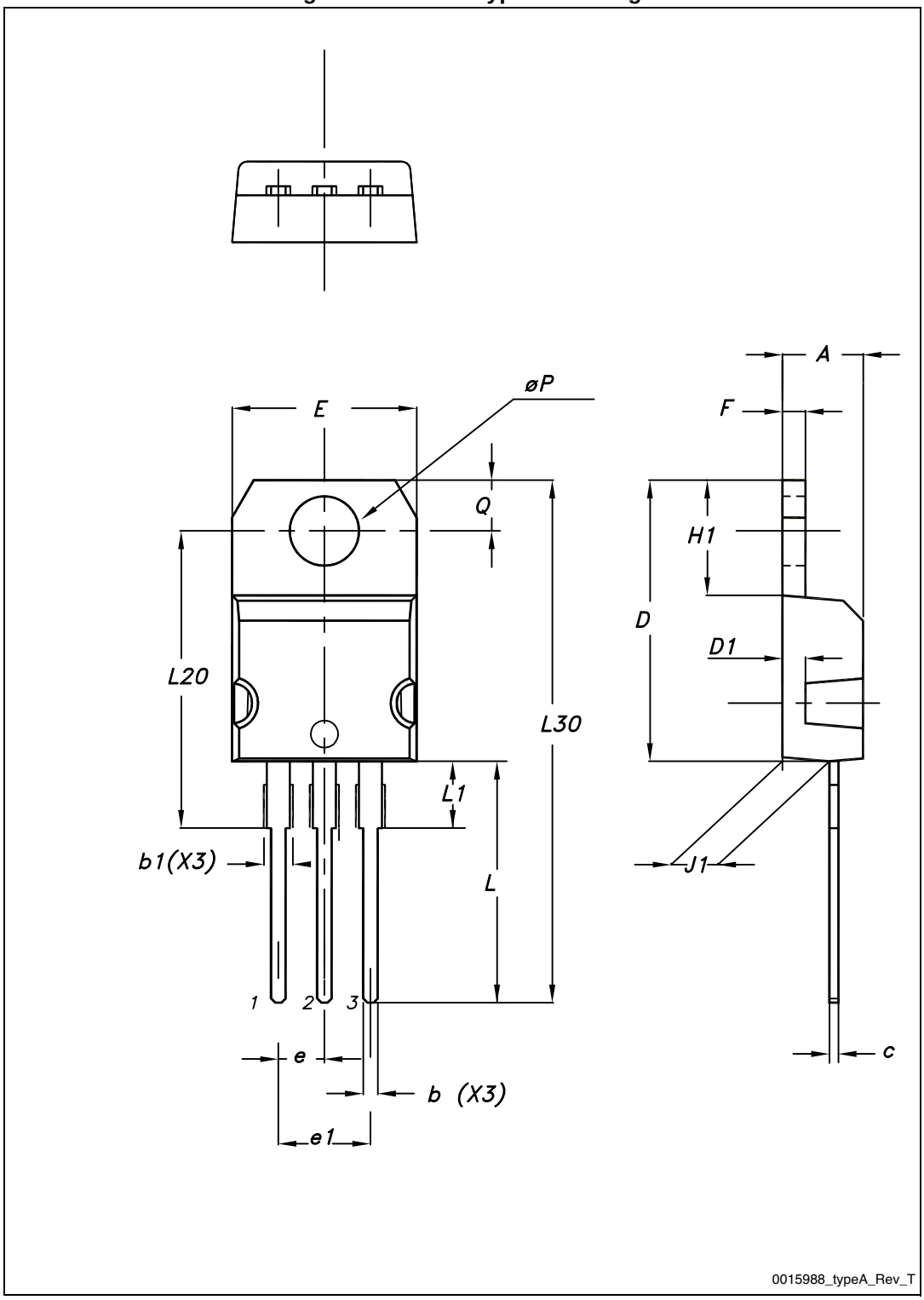
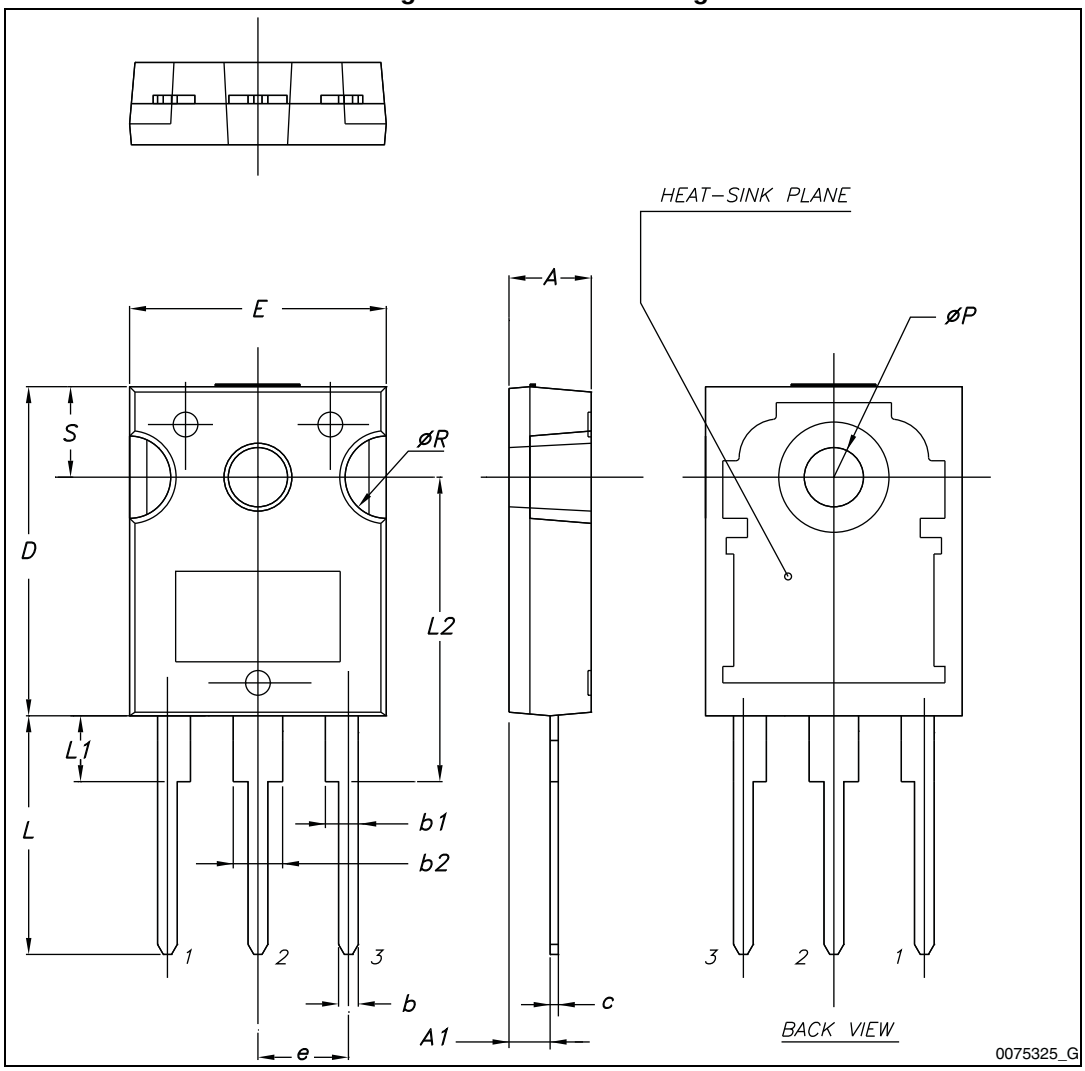


Table 13. TO-247 mechanical data

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	
∅P	3.55		3.65
∅R	4.50		5.50
S	5.30	5.50	5.70

Figure 29. 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 30. Tape

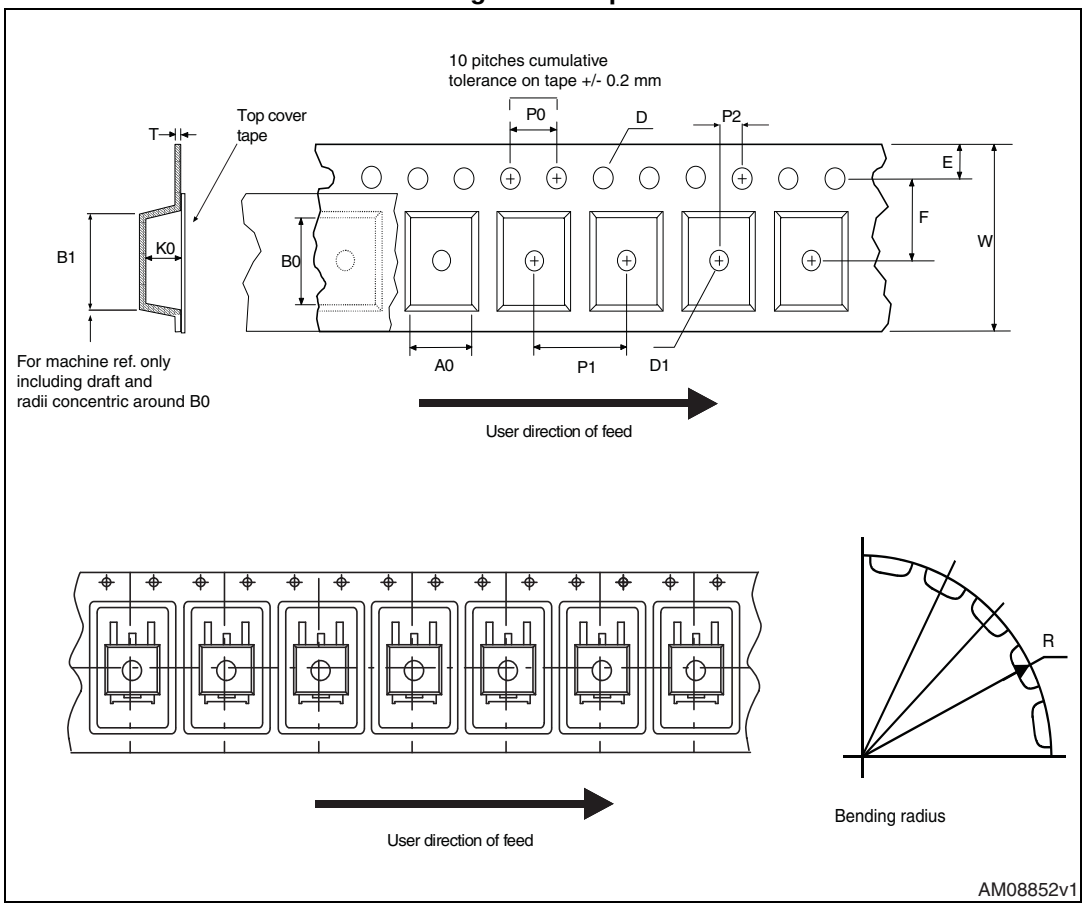
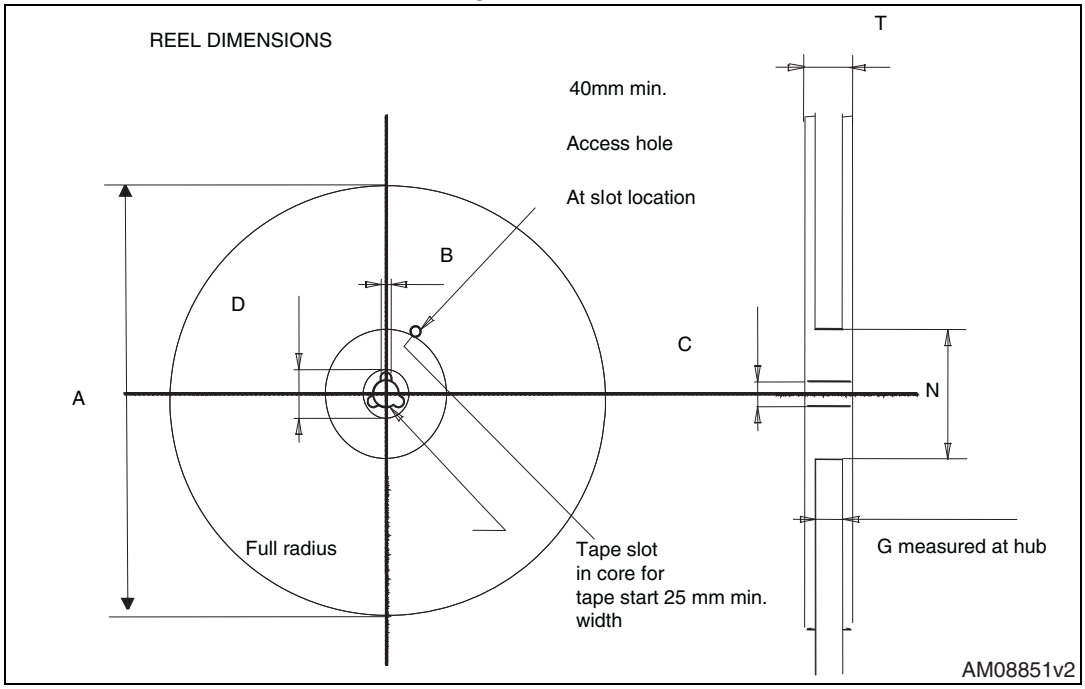


Figure 31. Reel



6 Revision history

Table 15. Document revision history

Date	Revision	Changes
01-Jul-2013	1	First release.
23-Sep-2013	2	– Added: TO-220FP and I^2PAKFP packages – Inserted: V_{ISO} in *Table 2* – Modified: values in *Table 4*, the entire typical values in *Table 6*, *7* and *8* – Updated: *Section 4: Package mechanical data* – Minor text changes

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