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STP13N60M2, STU13N60M2, STW13N60M2

N-channel 600 V, 0.35 Ω typ., 11 A MDmesh II Plus™ low Q_g Power MOSFETs in TO-220, IPAK and TO-247 packages
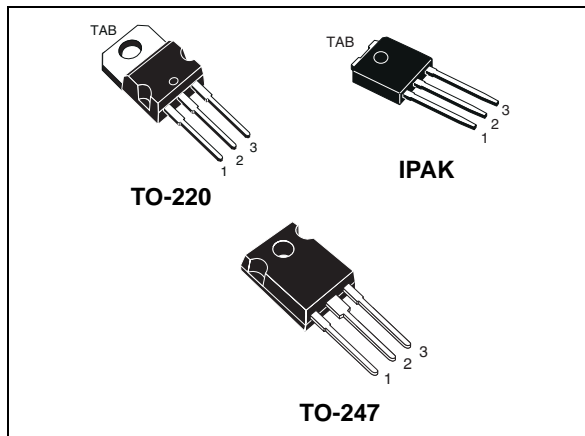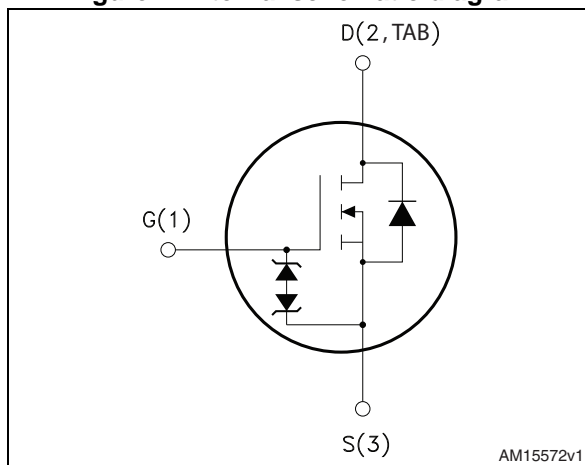
Datasheet − production data

TO-220

IPAK

TO-247

Figure 1. Internal schematic diagram

Features

Order codes	V_{DS} @ T_{Jmax}	$R_{DS(on)}$ max	I_D
STP13N60M2			
STU13N60M2	650 V	0.38 Ω	11 A
STW13N60M2			

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

Applications

- Switching applications

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
STP13N60M2		TO-220	
STU13N60M2	13N60M2	IPAK	Tube
STW13N60M2		TO-247	

Contents

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{GS}	Gate-source voltage	± 25	V
I_D	Drain current (continuous) at T_C = 25 °C	11	A
I_D	Drain current (continuous) at T_C = 100 °C	7	A
I_{DM} [(1)]	Drain current (pulsed)	44	A
P_{TOT}	Total dissipation at T_C = 25 °C	110	W
dv/dt[(2)]	Peak diode recovery voltage slope	15	V/ns
dv/dt[(3)]	MOSFET dv/dt ruggedness	50	V/ns
T_{stg}	Storage temperature	- 55 to 150	°C
T_j	Max. operating junction temperature		°C

1. Pulse width limited by safe operating area.

2. $I_{SD} \leq$ 11 A, di/dt $\leq$ 400 A/μs; $V_{DS\ peak}$ < $V_{(BR)DSS}$, V_{DD}=400 V.

3. $V_{DS} \leq$ 480 V

Table 3. Thermal data

Symbol	Parameter	Value			Unit
		TO-220	IPAK	TO-247	
$R_{thj-case}$	Thermal resistance junction-case max	1.14			°C/W
$R_{thj-amb}$	Thermal resistance junction-ambient max	62.5	100	50	°C/W

Table 4. Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetitive or not repetitive (pulse width limited by T_{jmax})	2.8	A
E_{AS}	Single pulse avalanche energy (starting T_j=25°C, I_D= I_{AR}; V_{DD}=50)	125	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			1	µA
		V_{DS} = 600 V, T_C=125 °C			100	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 = 5.5 A		0.35	0.38	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	-	580	-	pF
C_{oss}	Output capacitance		-	32	-	pF
C_{rss}	Reverse transfer capacitance		-	1.1	-	pF
$C_{oss\ eq.}$[1]	Equivalent output capacitance	V_{DS} = 0 to 480 V, V_{GS} = 0	-	120	-	pF
R_G	Intrinsic gate resistance	f = 1 MHz open drain	-	6.6	-	Ω
Q_g	Total gate charge	V_{DD} = 480 V, I_D = 11 A, V_{GS} = 10 V (see *Figure 17*)	-	17	-	nC
Q_{gs}	Gate-source charge		-	2.5	-	nC
Q_{gd}	Gate-drain charge		-	9	-	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 = 5.5 A, R_G = 4.7 Ω, V_{GS} = 10 V (see *Figure 16* and *21*)	-	11	-	ns
t_r	Rise time		-	10	-	ns
$t_{d(off)}$	Turn-off delay time		-	41	-	ns
t_f	Fall time		-	9.5	-	ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		11	A
I_{SDM} [1]	Source-drain current (pulsed)		-		44	A
V_{SD} [2]	Forward on voltage	I_{SD} = 11 A, V_{GS} = 0	-		1.6	V
t_{rr}	Reverse recovery time	I_{SD} = 11 A, di/dt = 100 A/μs V_{DD} = 60 V (see *Figure 18*)	-	297		ns
Q_{rr}	Reverse recovery charge		-	2.8		μC
I_{RRM}	Reverse recovery current		-	18.5		A
t_{rr}	Reverse recovery time	I_{SD} = 11 A, di/dt = 100 A/μs V_{DD} = 60 V, T_j=150 °C (see *Figure 18*)	-	394		ns
Q_{rr}	Reverse recovery charge		-	3.8		μC
I_{RRM}	Reverse recovery current		-	19		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 and TO-247
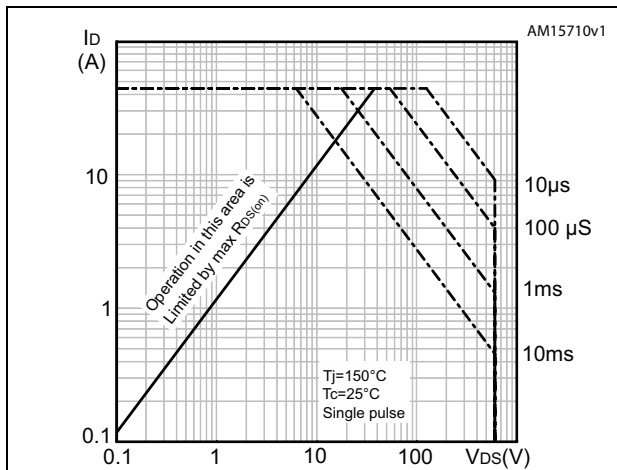
Figure 3. Thermal impedance for TO-220 and TO-247
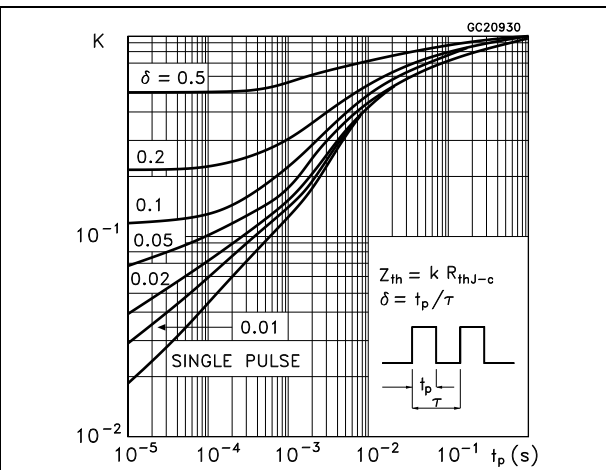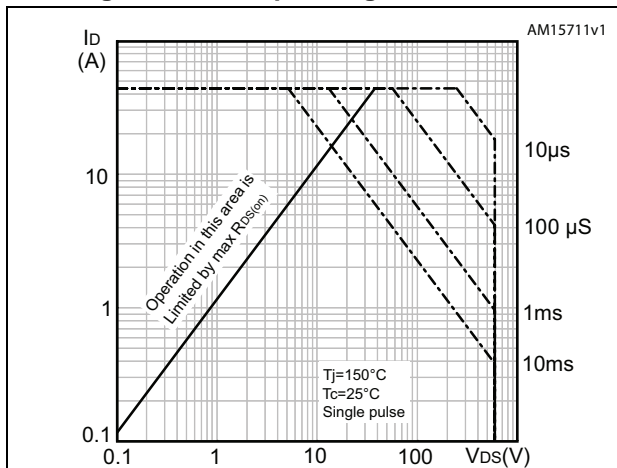

Figure 4. Safe operating area for IPAK

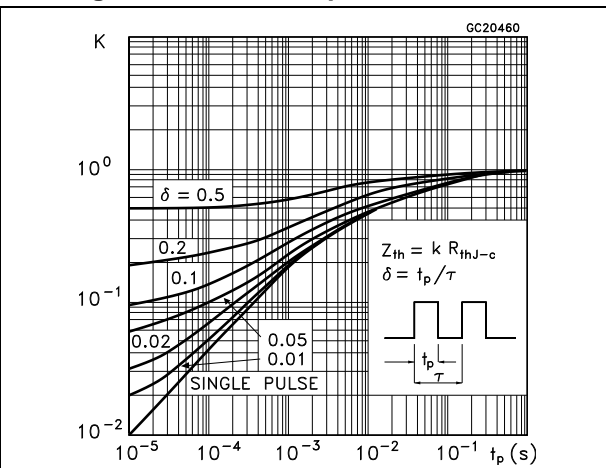**Figure 5. Thermal impedance for IPAK**

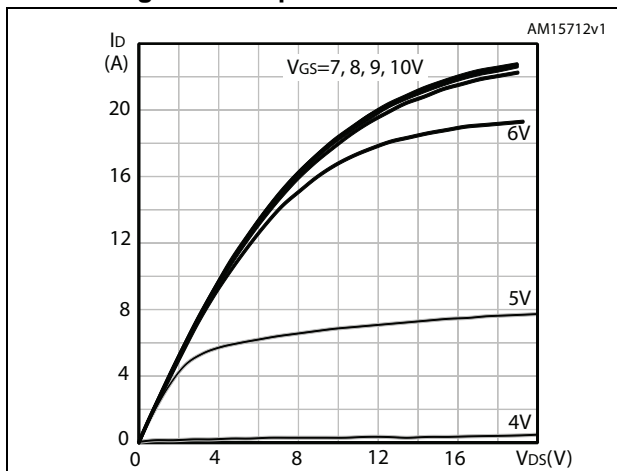**Figure 6. Output characteristics**
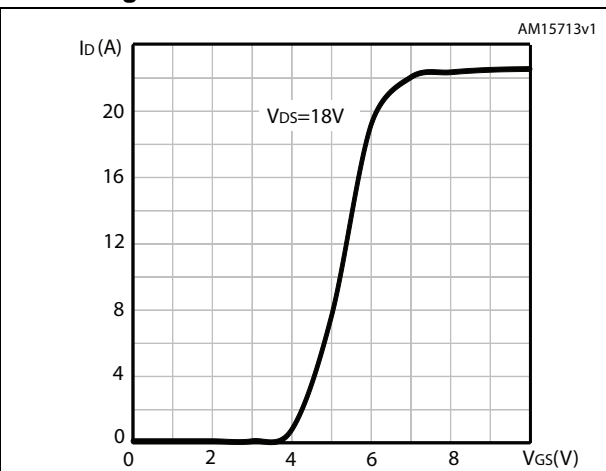

Figure 7. Transfer characteristics

Figure 8. Normalized V(BR)DSS vs temperature
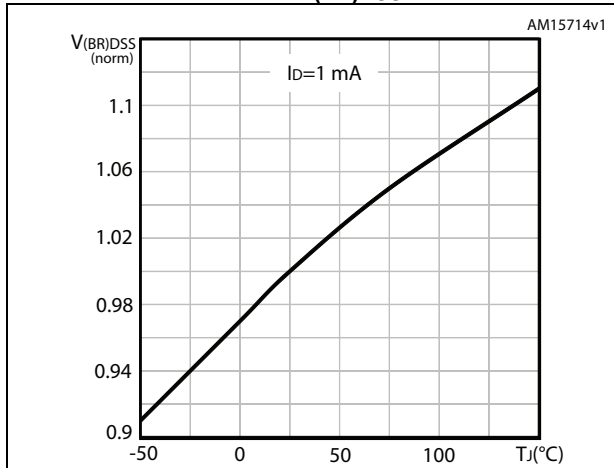
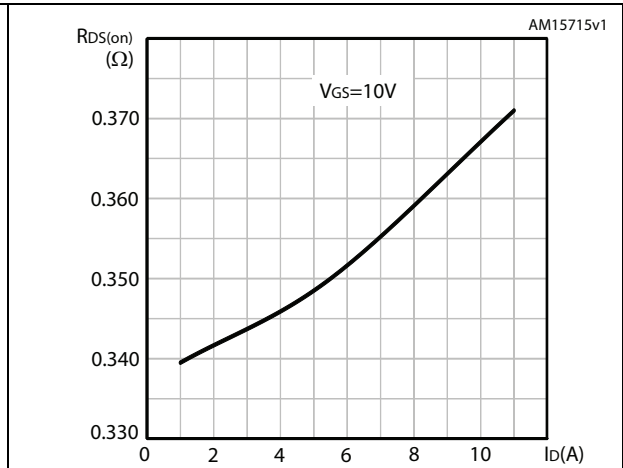**Figure 9. Static drain-source on-resistance**

Figure 10. Gate charge vs gate-source voltage
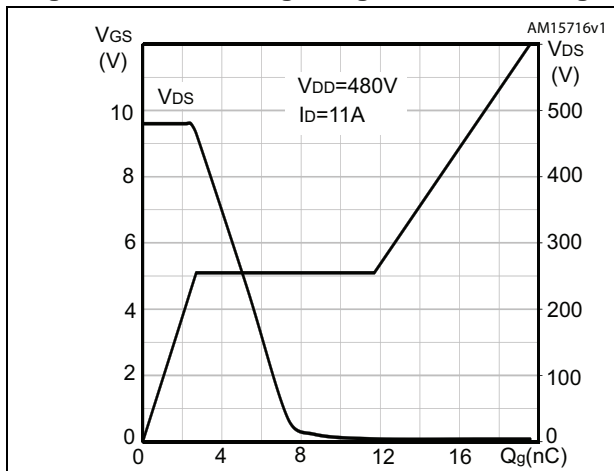

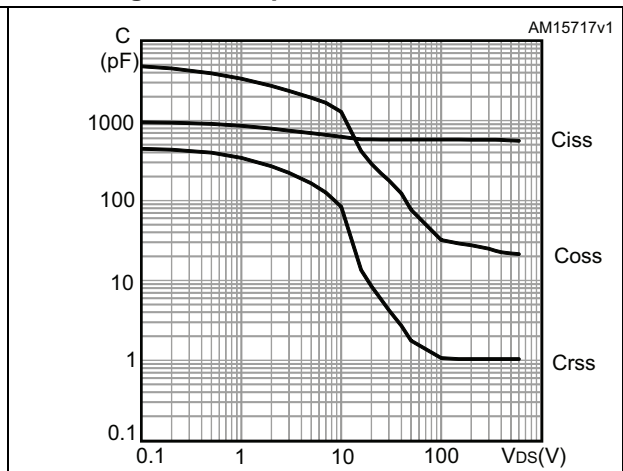**Figure 11. Capacitance variations**

Figure 12. Normalized gate threshold voltage vs temperature
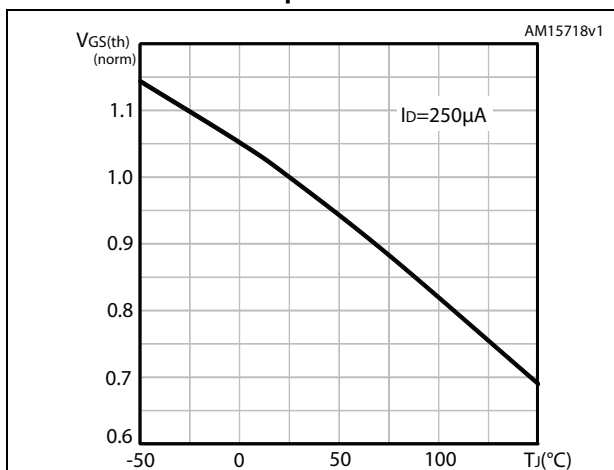

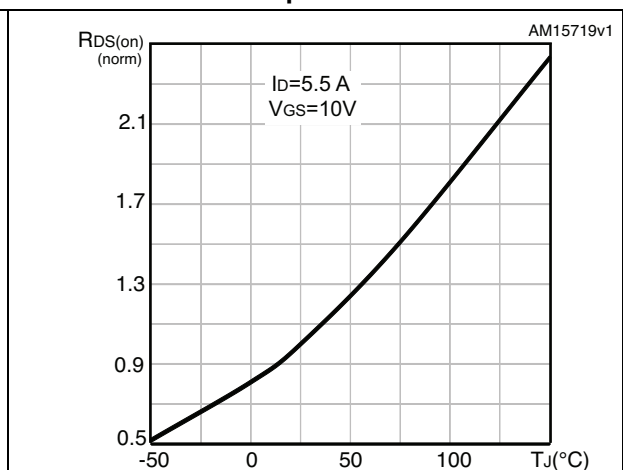**Figure 13. Normalized on-resistance vs temperature**

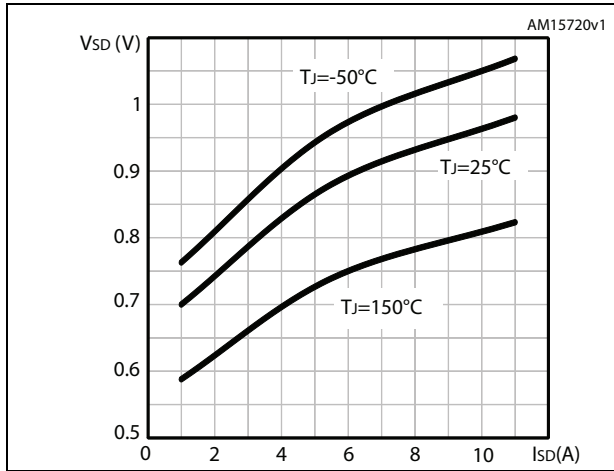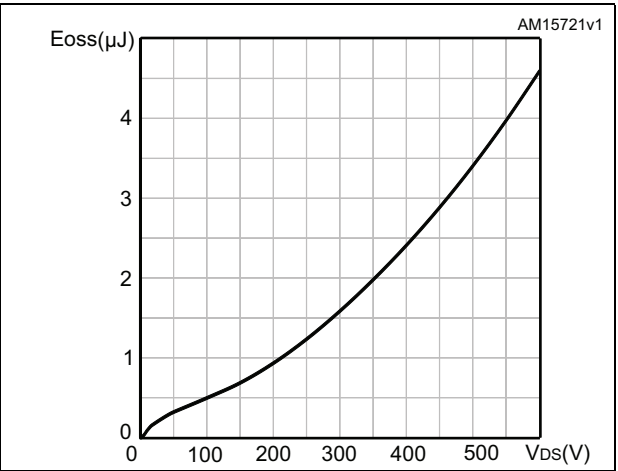**Figure 14. Source-drain diode forward characteristics**

Figure 15. Output capacitance stored energy

3 Test circuits

Figure 16. Switching times test circuit for resistive load

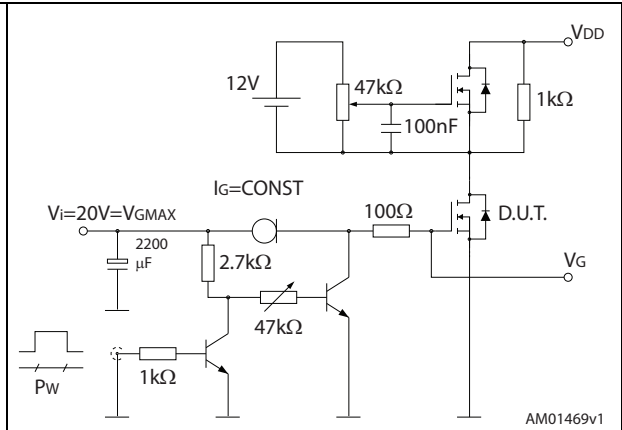Figure 17. Gate charge test circuit

Figure 18. Test circuit for inductive load switching and diode recovery times
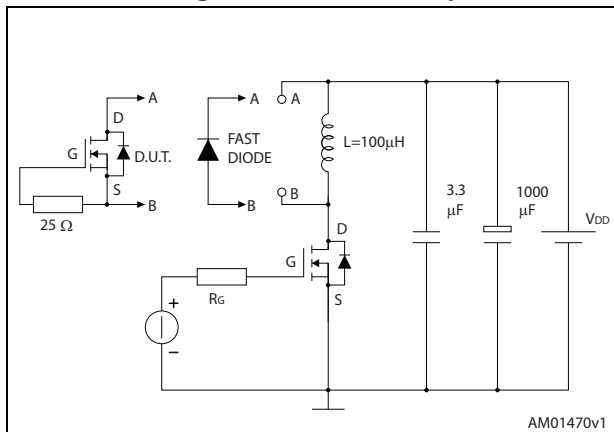
Figure 19. Unclamped inductive load test circuit
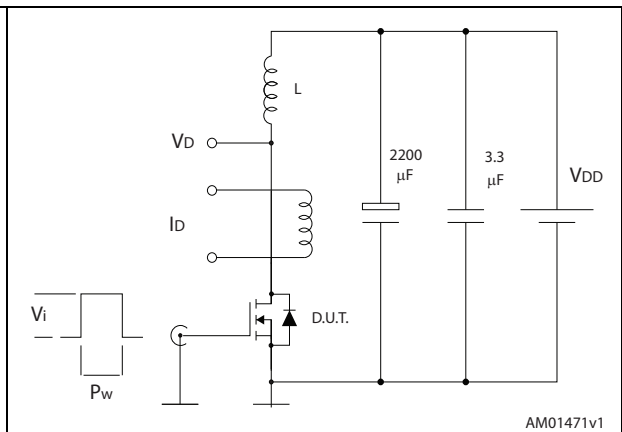
Figure 20. Unclamped inductive waveform
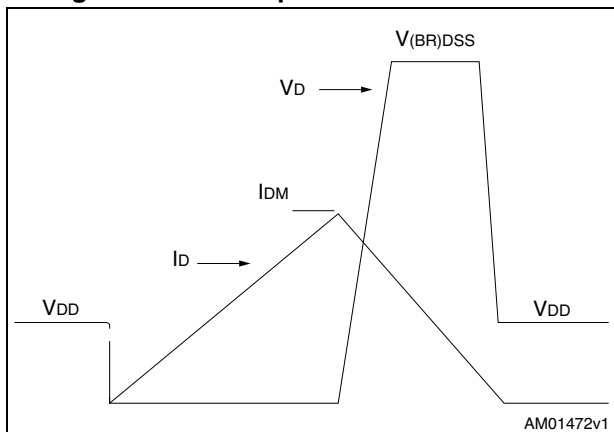
Figure 21. Switching time waveform
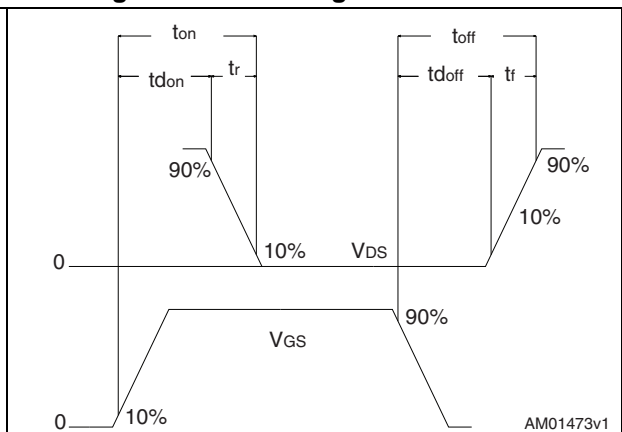
4 Package mechanical data

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.

Figure 22. TO-220 type A drawing

0015988_typeA_Rev_T
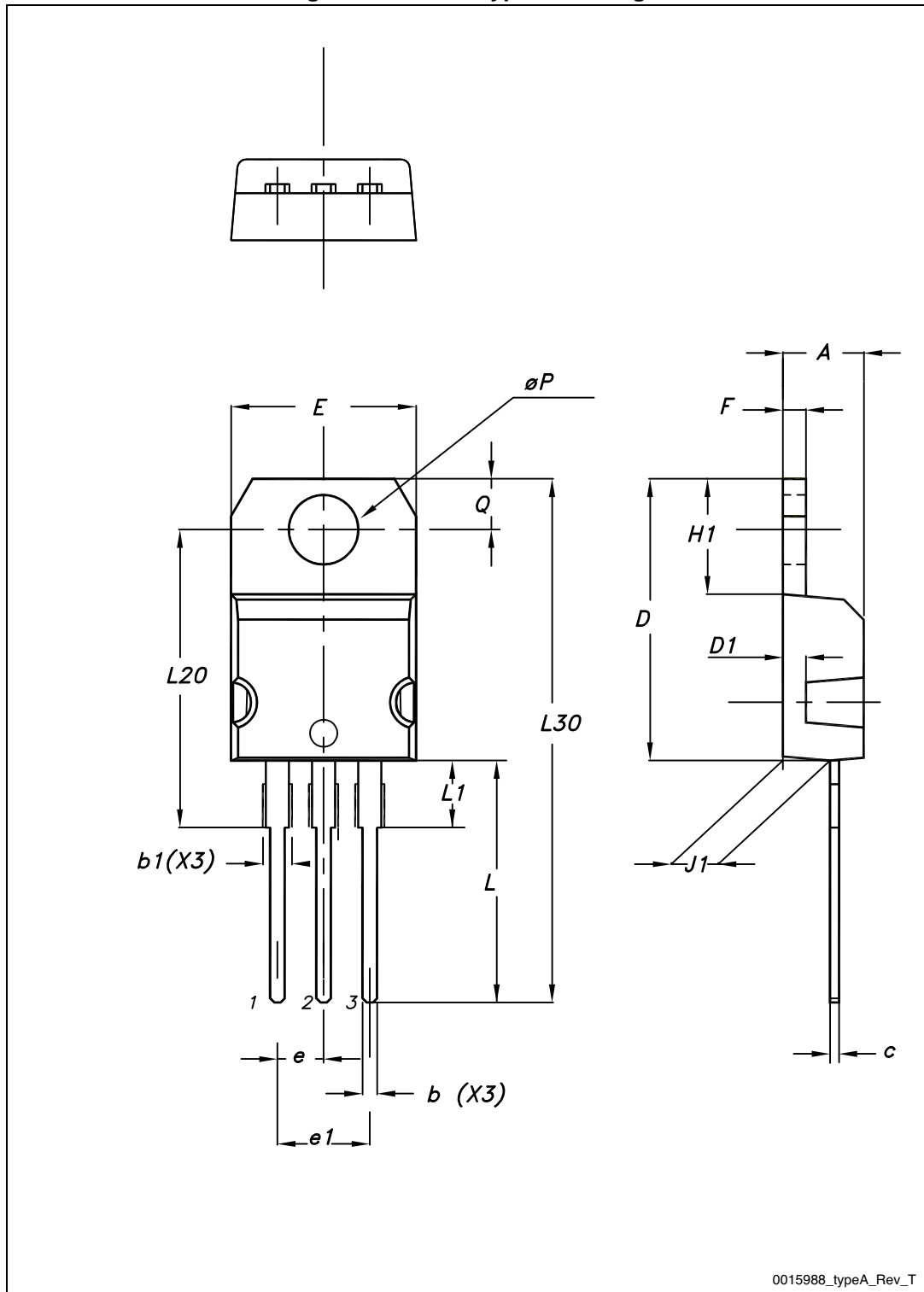
Table 9. TO-220 type A mechanical data

| 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	
$\varnothing$P	3.75		3.85
Q	2.65		2.95

Figure 23. IPAK (TO-251) drawing
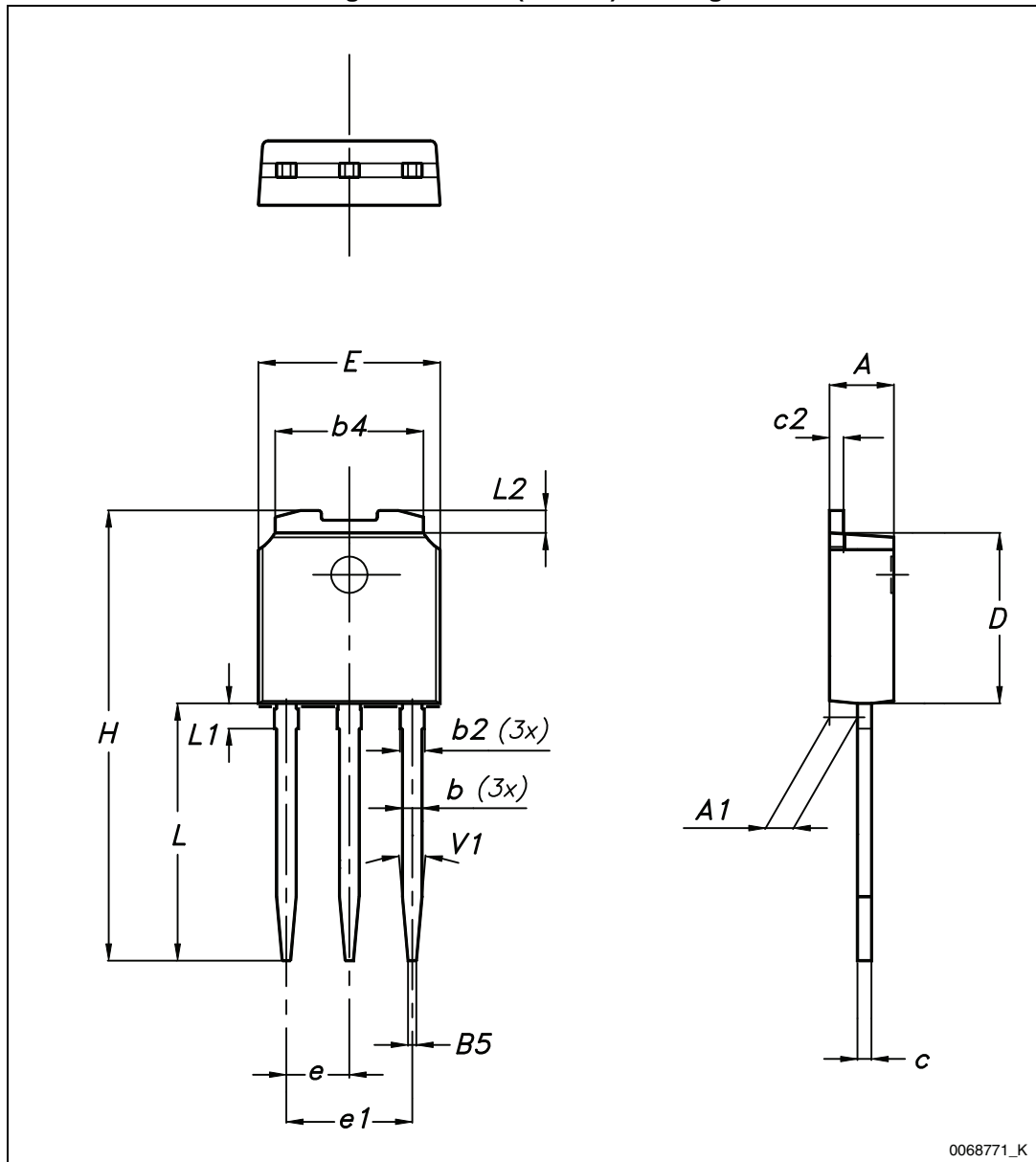
0068771_K

Table 10. IPAK (TO-251) mechanical data

DIM	mm.		
	min.	typ.	max.
A	2.20		2.40
A1	0.90		1.10
b	0.64		0.90
b2			0.95
b4	5.20		5.40
B5		0.30	
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
E	6.40		6.60
e		2.28	
e1	4.40		4.60
H		16.10	
L	9.00		9.40
L1	0.80		1.20
L2		0.80	1.00
V1		10°	

Figure 24. TO-247 drawing
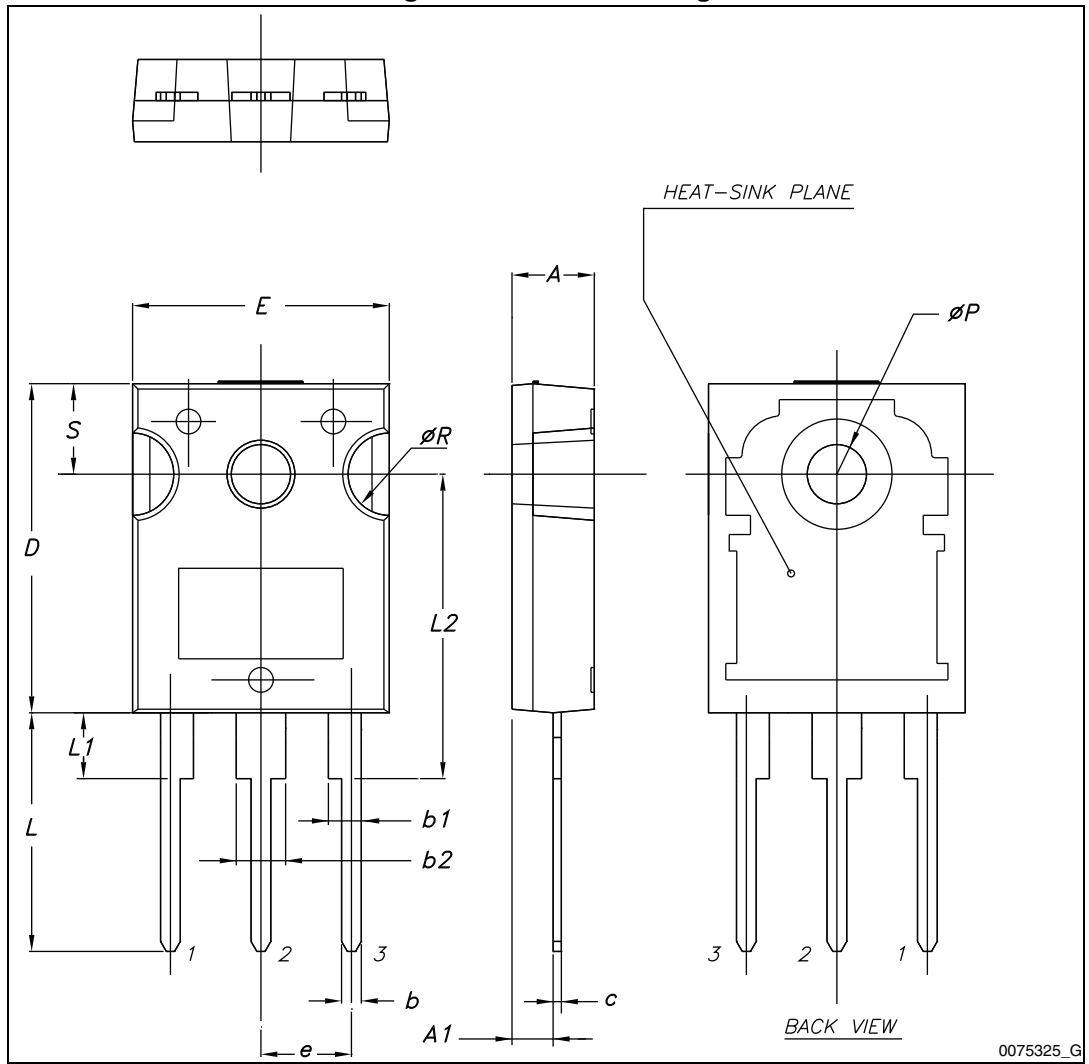
Table 11. TO-247 mechanical data

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

5 Revision history

Table 12. Document revision history

Date	Revision	Changes
18-Dec-2012	1	First release.
11-Apr-2013	2	– Added: note 3 in Table 2 – Modified: I_D value on Table 2, I_{AR}, I_{AS} on Table 4, $R_{DS(on)}$ on Table 5 – Updated: typical values for Table 6, 7 and 8 – Modified: Figure 1 – The part number STD13N60M2 has been moved to a separate datasheet – Added: Section 2.1: Electrical characteristics (curves)
17-Apr-2013	3	– Modified: $R_{thj-case}$ value on Table 3, t_{rr}, q_{rr} values, and t_{rr} for $T_J = 150\ °C$ on Table 8 – Minor text changes
28-Jun-2013	4	– Document status promoted from preliminary data to production data – Minor text changes
28-Feb-2014	5	– Updated: Figure 22 and Table 9 – Minor text changes

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