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

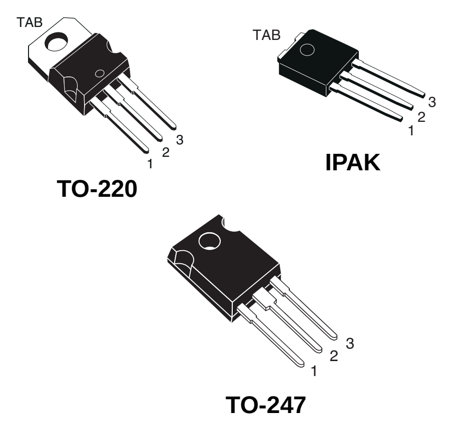
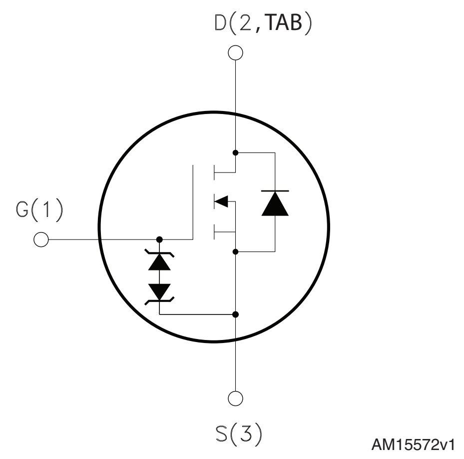


Figure 1. Internal schematic diagram



Features

Order codes	V_{DS} @ T_{Jmax}	$R_{DS(on)}$ max	I_D
STP13N60M2	650 V	0.38 Ω	11 A
STU13N60M2			
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	13N60M2	TO-220	Tube
STU13N60M2		IPAK	
STW13N60M2		TO-247	

This is information on a product in full production.

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		

1. Pulse width limited by safe operating area.
2. $I_{SD} \leq 11$ A, di/dt ≤ 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	
$R_{thj\text{-}case}$	Thermal resistance junction-case max	1.14			°C/W
$R_{thj\text{-}amb}$	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 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 = 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

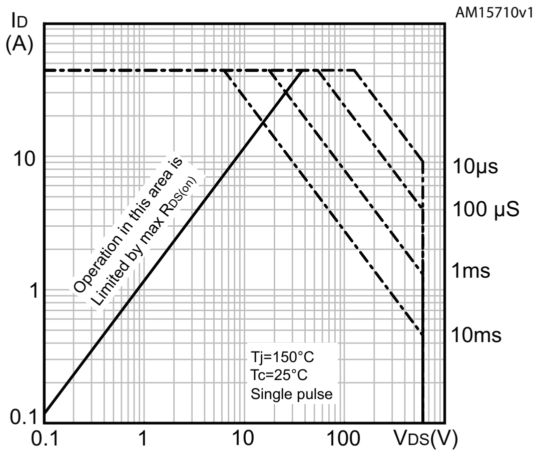


Figure 3. Thermal impedance for TO-220 and TO-247

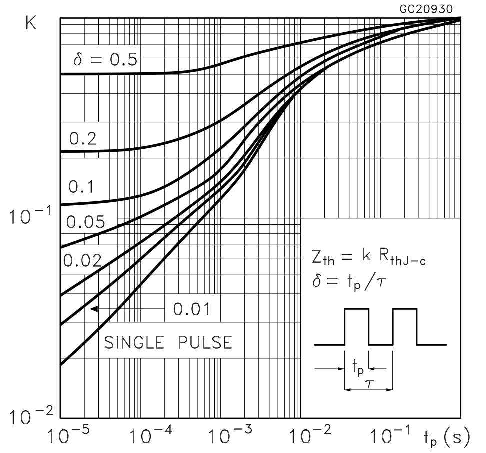


Figure 4. Safe operating area for IPAK

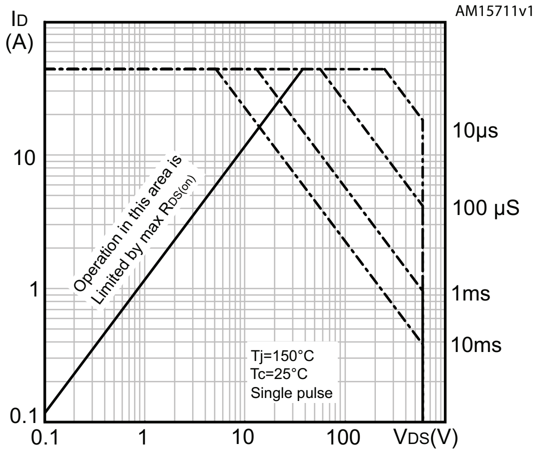


Figure 5. Thermal impedance for IPAK

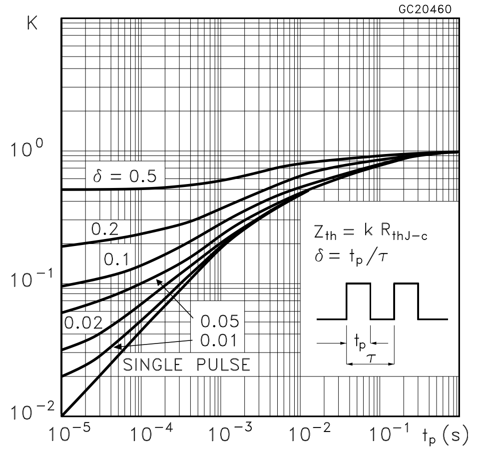


Figure 6. Output characteristics

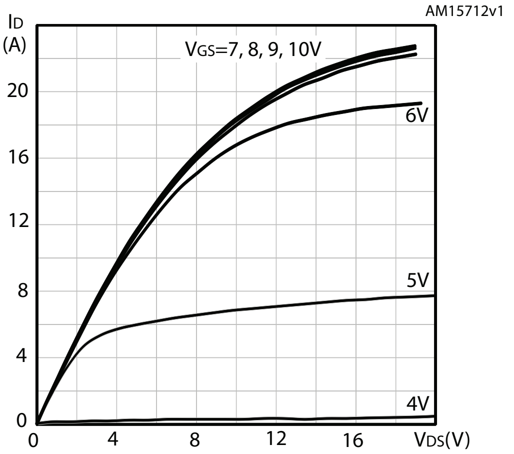


Figure 7. Transfer characteristics

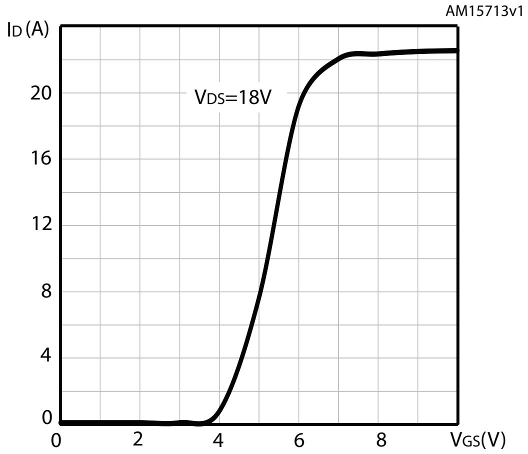


Figure 8. Normalized $V_{(BR)DSS}$ vs temperature

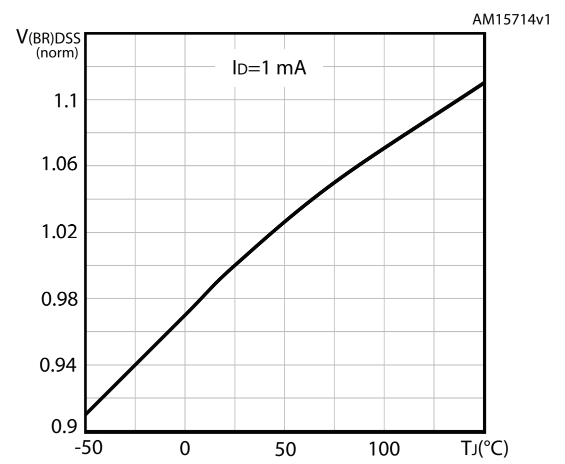


Figure 9. Static drain-source on-resistance

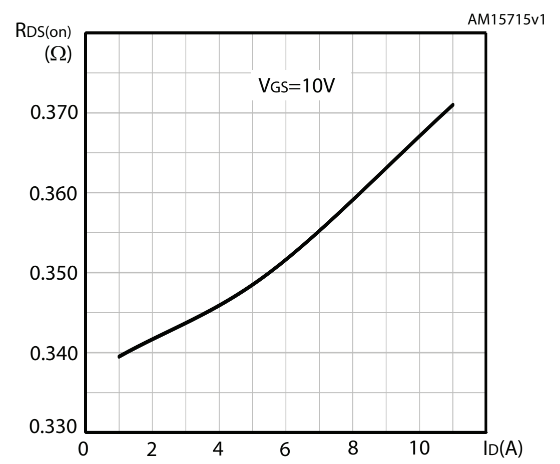


Figure 10. Gate charge vs gate-source voltage

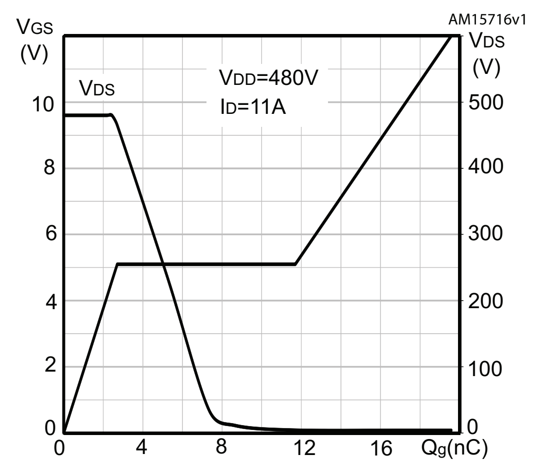


Figure 11. Capacitance variations

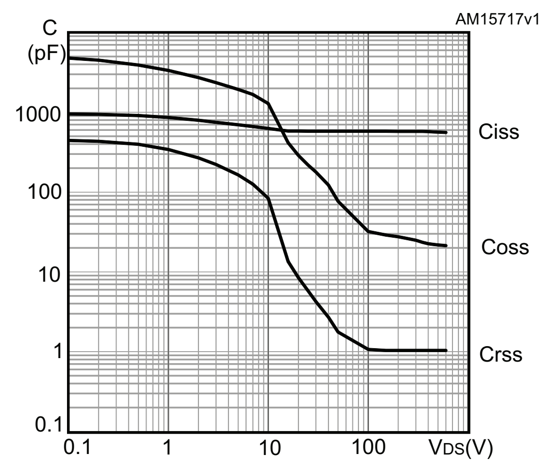


Figure 12. Normalized gate threshold voltage vs temperature

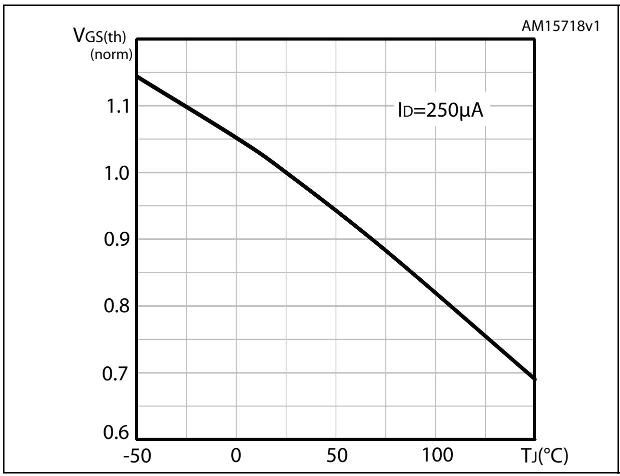


Figure 13. Normalized on-resistance vs temperature

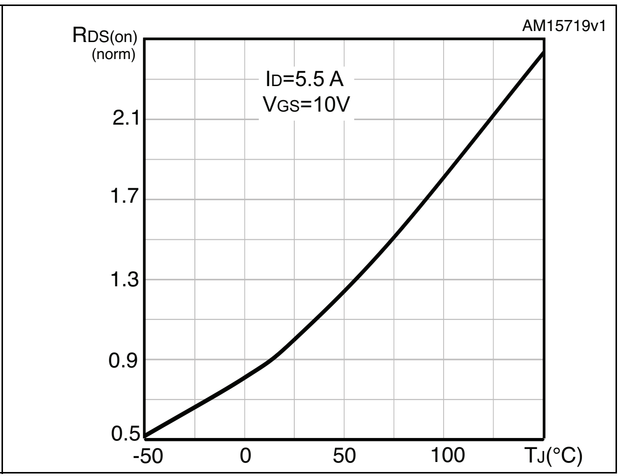


Figure 14. Source-drain diode forward characteristics

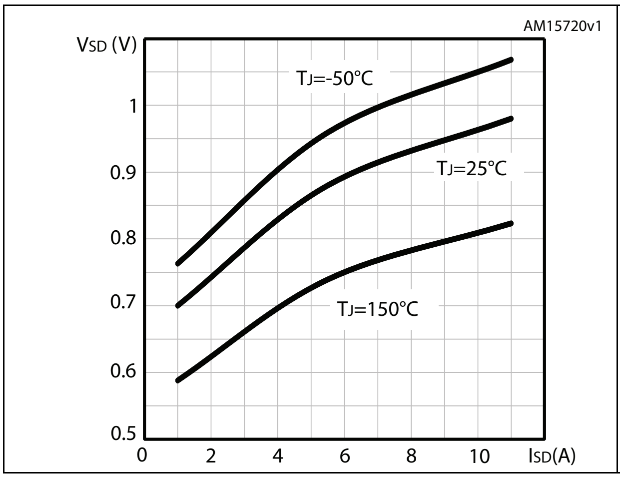
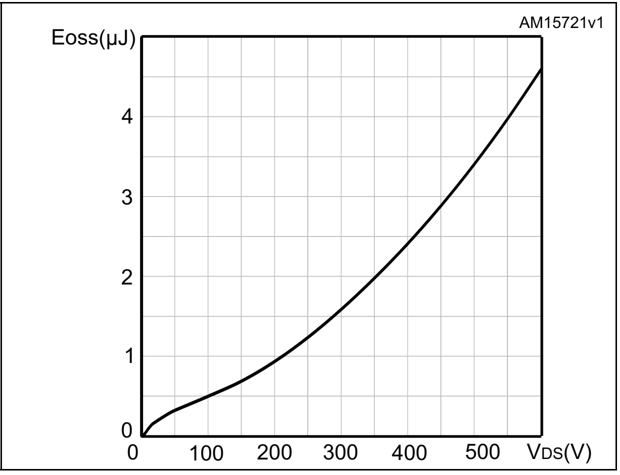


Figure 15. Output capacitance stored energy



3 Test circuits

Figure 16. Switching times test circuit for resistive load

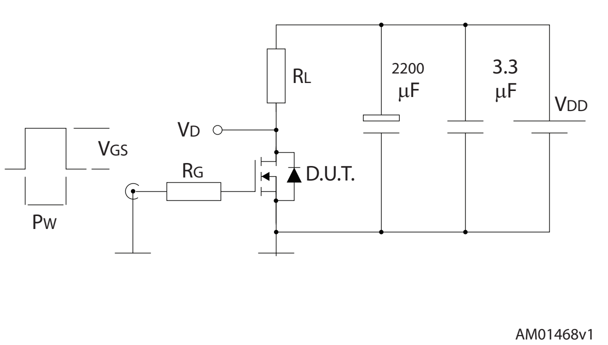


Figure 17. Gate charge test circuit

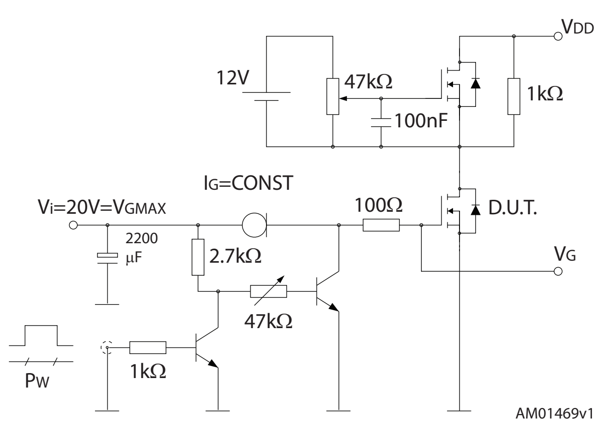


Figure 18. Test circuit for inductive load switching and diode recovery times

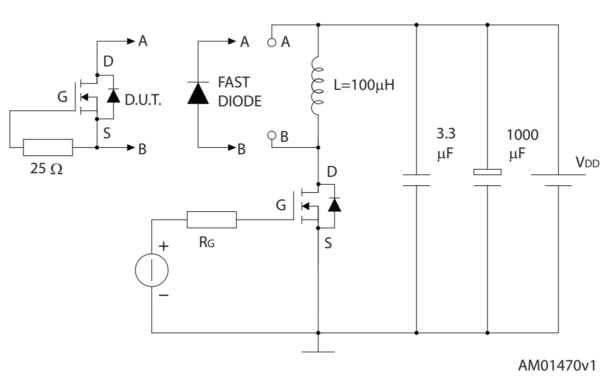


Figure 19. Unclamped inductive load test circuit

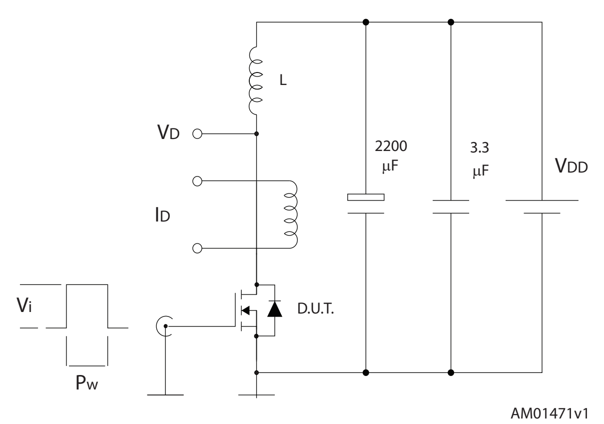


Figure 20. Unclamped inductive waveform

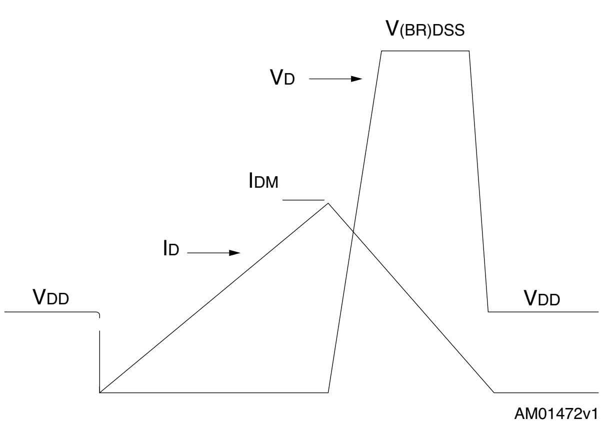
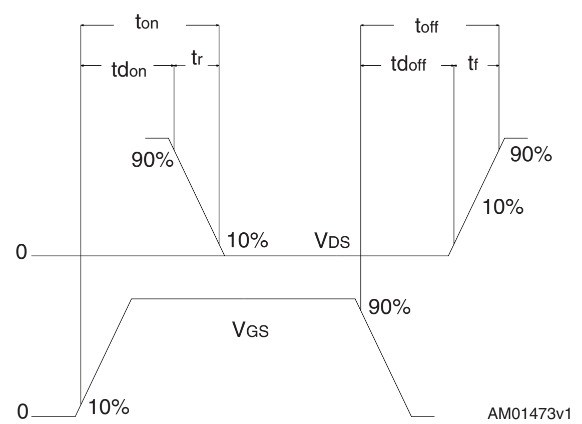


Figure 21. Switching time waveform



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

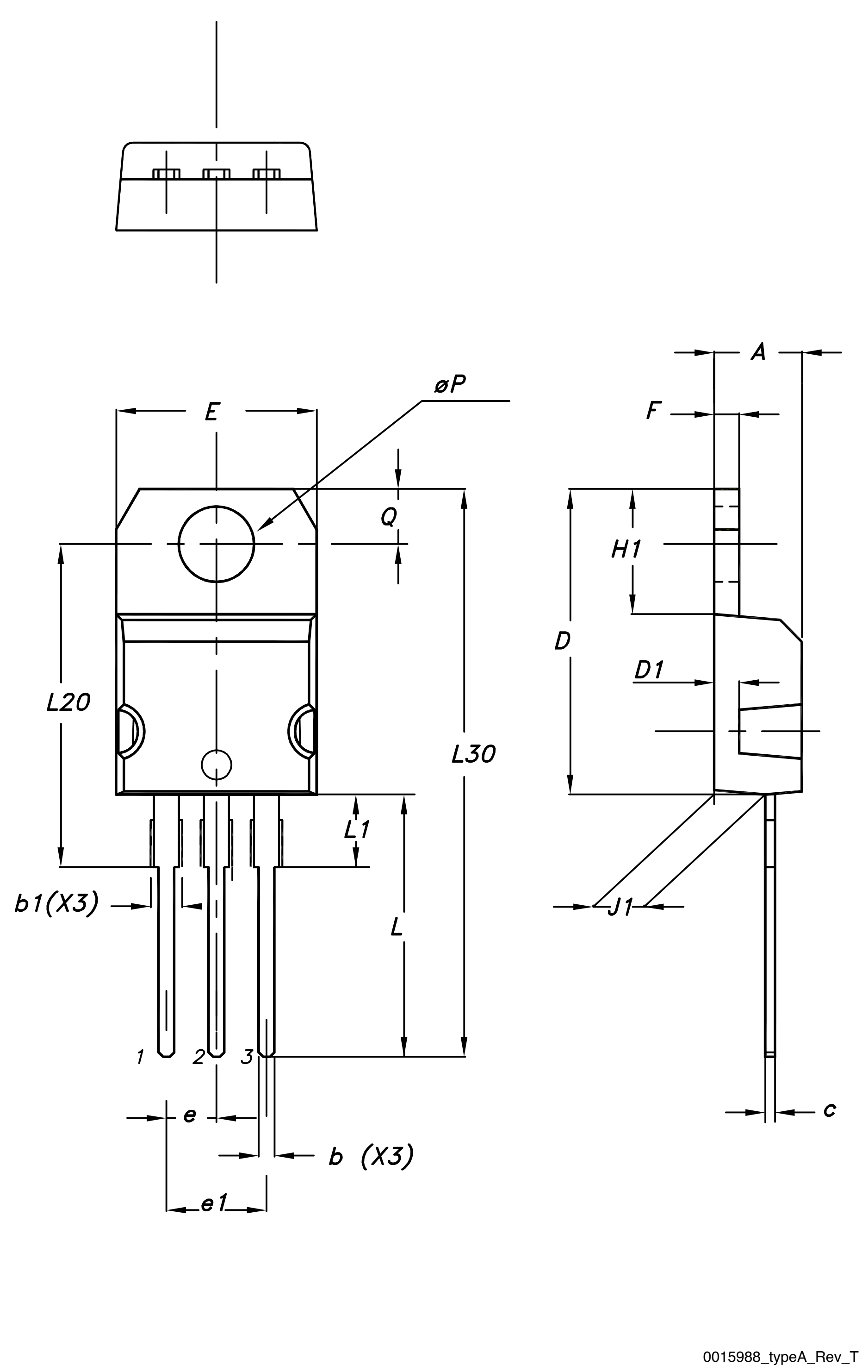


Table 9. TO-220 type A mechanical data

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	
∅P	3.75		3.85
Q	2.65		2.95

Figure 23. IPAK (TO-251) drawing

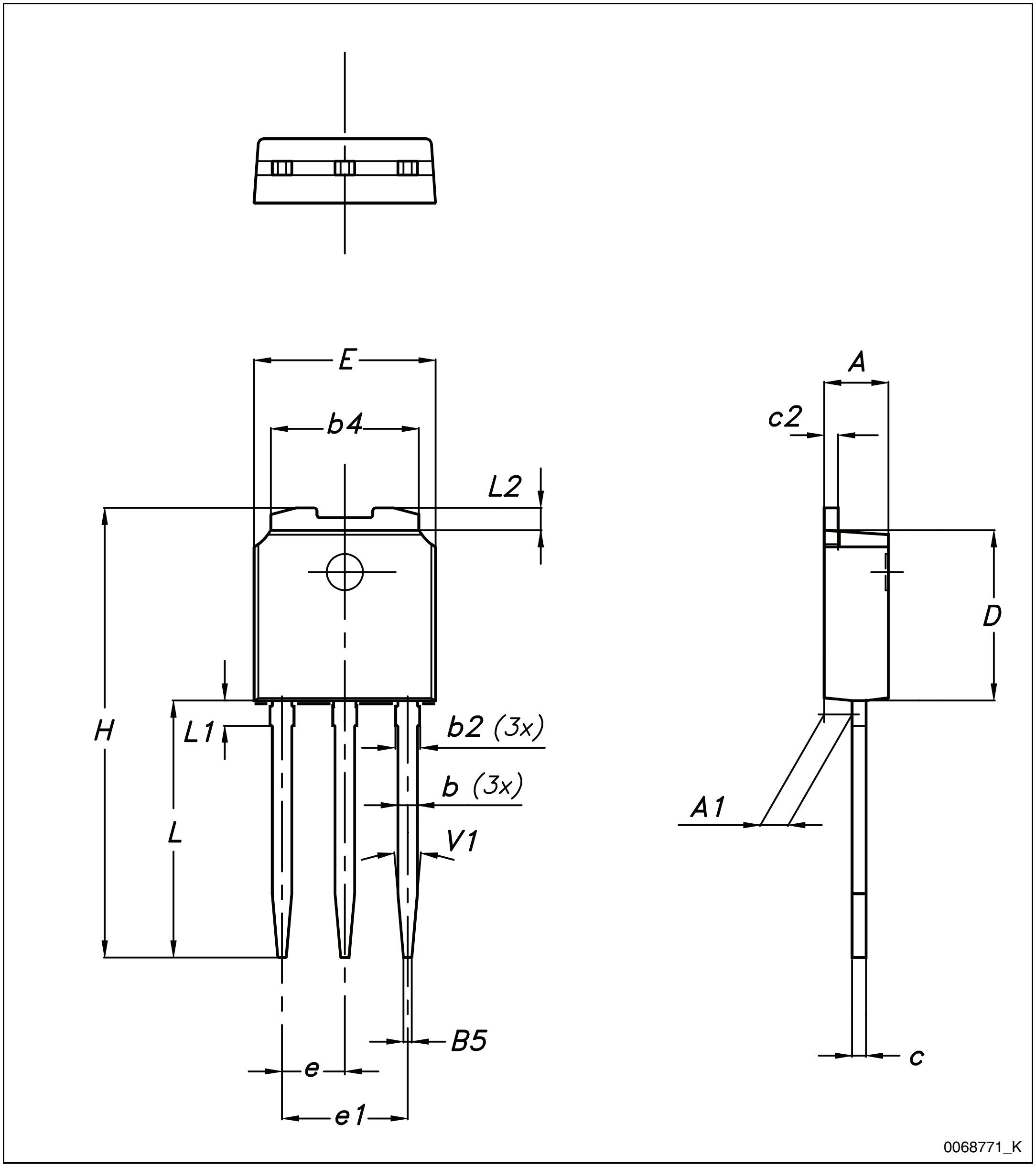


Table 10. IPAK (TO-251) mechanical data

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

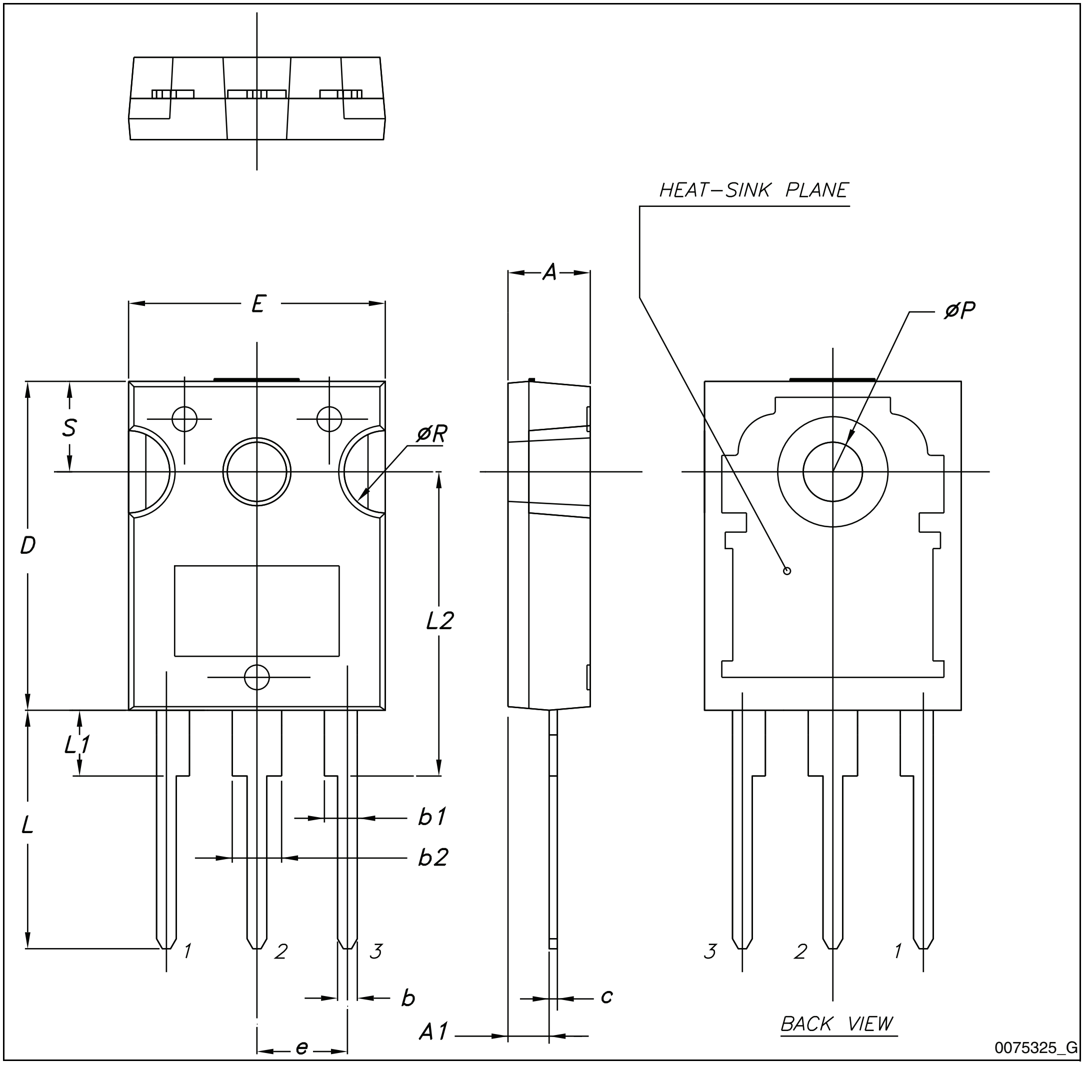


Table 11. TO-247 mechanical data

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: $R_{thj\text{-}case}$ 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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