STP13N65M2, STU13N65M2

N-channel 650 V, 0.37 Ω typ.,10 A MDmesh™ M2 Power MOSFETs in TO-220 and IPAK packages

Datasheet - production data

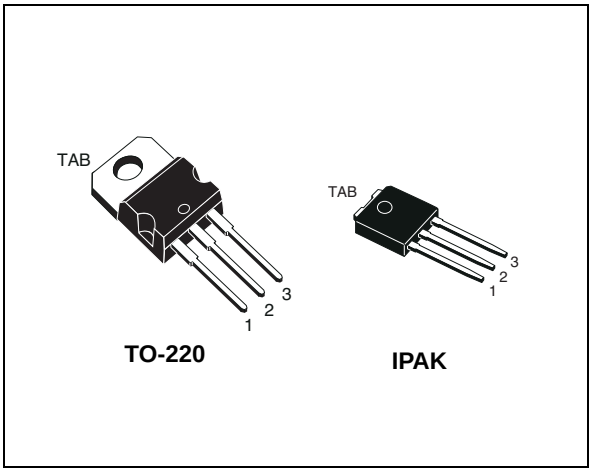
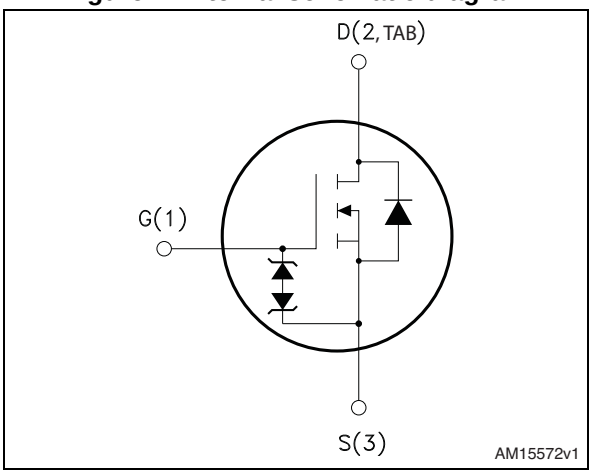


Figure 1. Internal schematic diagram



Features

Order code	V_{DS}	$R_{DS(on)}$ max	I_D
STP13N65M2	650 V	0.43Ω	10A
STU13N65M2			

- Extremely low gate charge
- Excellent output capacitance (C_{oss}) profile
- 100% avalanche tested
- Zener-protected

Applications

- Switching applications

Description

These devices are N-channel Power MOSFETs developed using MDmesh™ M2 technology. Thanks to their strip layout and improved vertical structure, the devices exhibit low on-resistance and optimized switching characteristics, rendering them suitable for the most demanding high efficiency converters.

Table 1. Device summary

Order code	Marking	Package	Packaging
STP13N65M2	13N65M2	TO-220	Tube
STU13N65M2		IPAK	

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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	10	A
I_D	Drain current (continuous) at T_C = 100 °C	6.3	A
I_{DM}(1)	Drain current (pulsed)	40	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	
T_{stg}	Storage temperature	- 55 to 150	°C
T_j	Max. operating junction temperature	150	

1. Pulse width limited by safe operating area.
2. $I_{SD} \leq 10$ A, di/dt ≤ 400 A/µs; $V_{DS\ peak} < V_{(BR)DSS}$, V_{DD}= 400 V
3. $V_{DS} \leq 520$ V

Table 3. Thermal data

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

Table 4. Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetitive or not repetitive (pulse width limited by T_{jmax})	1.8	A
E_{AS}	Single pulse avalanche energy (starting T_j = 25 °C, $I_D = I_{AR}$; V_{DD} = 50 V)	350	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	V_{GS} = 0 V, I_D = 1 mA	650			V
I_{DSS}	Zero gate voltage drain current	V_{GS} = 0 V, V_{DS} = 650 V			1	µA
		V_{GS} = 0 V, V_{DS} = 650 V, T_C = 125 °C			100	µA
I_{GSS}	Gate-body leakage current	V_{DS} = 0 V, 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 A		0.37	0.43	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 V	-	590	-	pF
C_{oss}	Output capacitance		-	27.5	-	pF
C_{rss}	Reverse transfer capacitance		-	1.1	-	pF
$C_{oss\ eq}$ (1)	Equivalent output capacitance	V_{GS} = 0 V, V_{DS} = 0 to 520 V	-	168.5	-	pF
R_G	Intrinsic gate resistance	f = 1 MHz open drain	-	6.5	-	Ω
Q_g	Total gate charge	V_{DD} = 520 V, I_D = 10 A, V_{GS} = 10 V, (see *Figure 17*)	-	17	-	nC
Q_{gs}	Gate-source charge		-	3.3	-	nC
Q_{gd}	Gate-drain charge		-	7	-	nC

1. Coss eq. is defined as a constant equivalent capacitance giving the same charging time as Coss when VDS increases from 0 to 80% VDSS

Table 7. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	V_{DD} = 325 V, I_D = 5 A, R_G = 4.7 Ω, V_{GS} = 10 V (see *Figure 16* and *Figure 21*)	-	11	-	ns
t_r	Rise time		-	7.8	-	ns
$t_{d(off)}$	Turn-off delay time		-	38	-	ns
t_f	Fall time		-	12	-	ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		10	A
I_{SDM} (1)	Source-drain current (pulsed)		-		40	A
V_{SD} (2)	Forward on voltage	V_{GS} = 0 V, I_{SD} = 10 A	-		1.6	V
t_{rr}	Reverse recovery time	I_{SD} =10 A, di/dt = 100 A/µs V_{DD} = 60 V (see *Figure 18*)	-	312		ns
Q_{rr}	Reverse recovery charge		-	2.7		µC
I_{RRM}	Reverse recovery current		-	17.5		A
t_{rr}	Reverse recovery time	I_{SD} = 10 A, di/dt = 100 A/µs, V_{DD} = 60 V, T_j = 150 °C (see *Figure 18*)	-	464		ns
Q_{rr}	Reverse recovery charge		-	4.1		µC
I_{RRM}	Reverse recovery current		-	17.5		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 TO-220

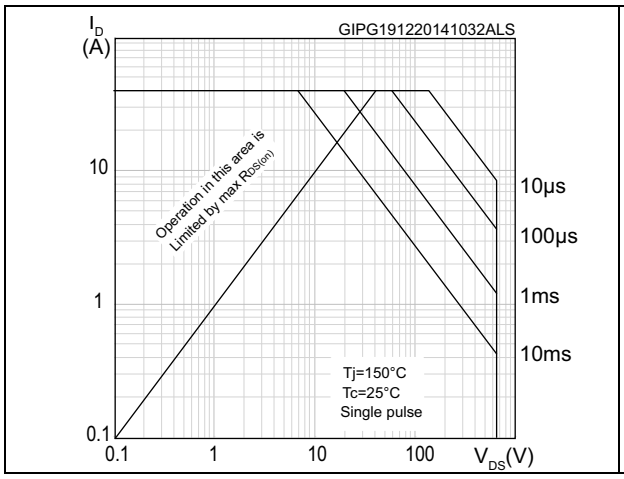


Figure 3. Thermal impedance for TO-220

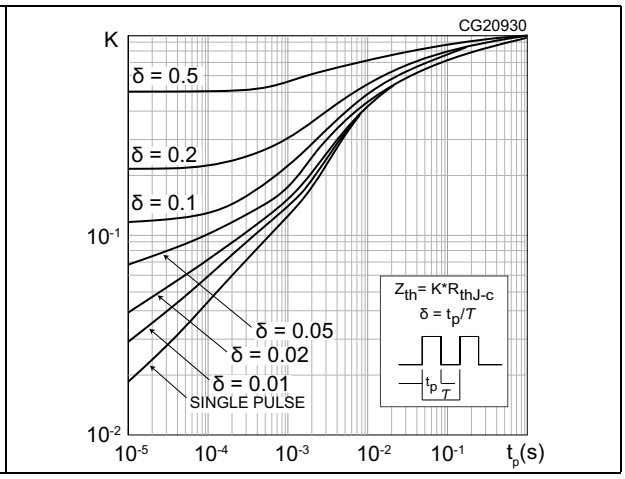


Figure 4. Safe operating area for IPAK

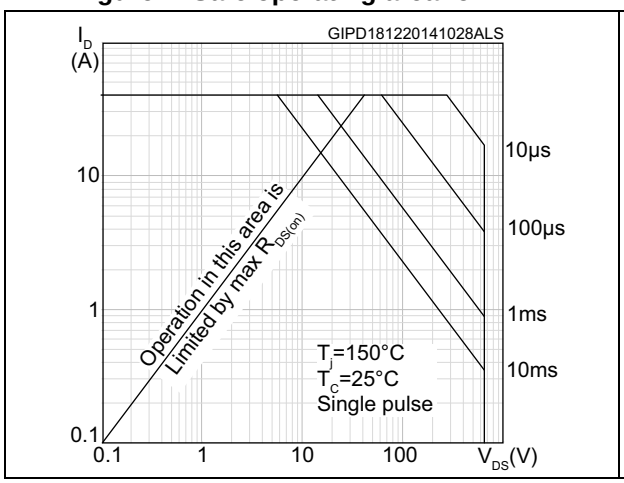


Figure 5. Thermal impedance for IPAK

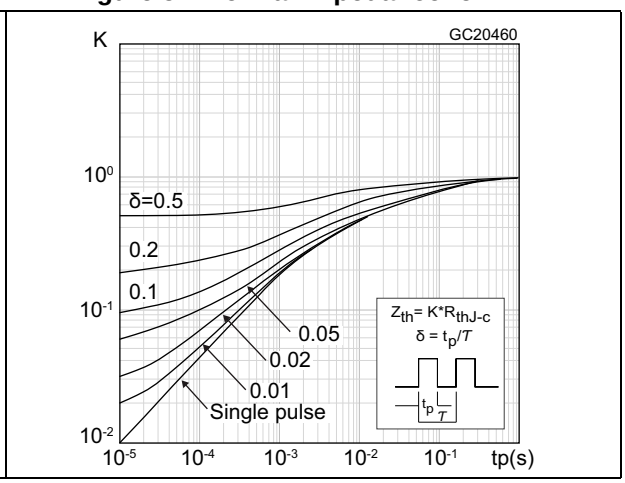


Figure 6. Output characteristics

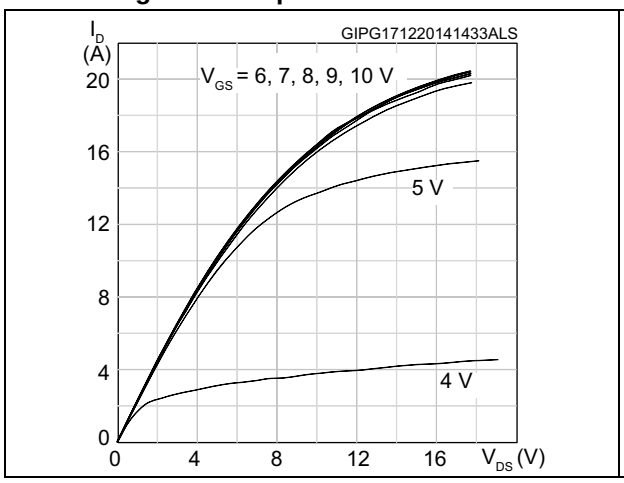


Figure 7. Transfer characteristics

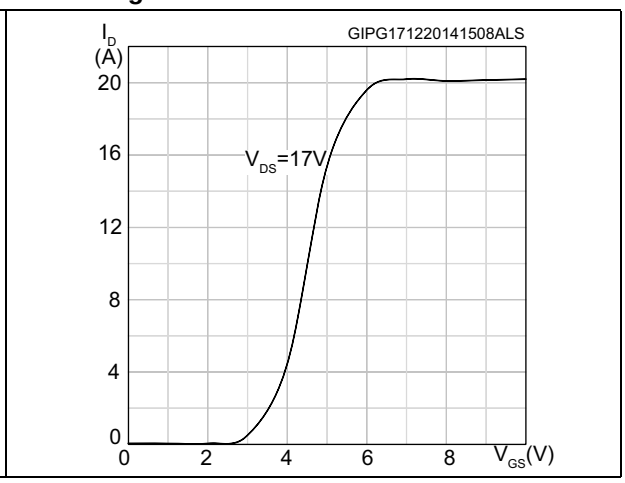


Figure 8. Normalized $V_{BR(DSS)}$ vs temperature

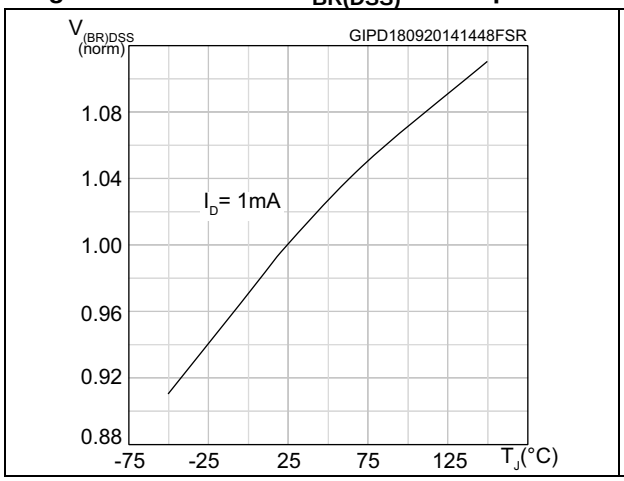


Figure 9. Static drain-source on-resistance

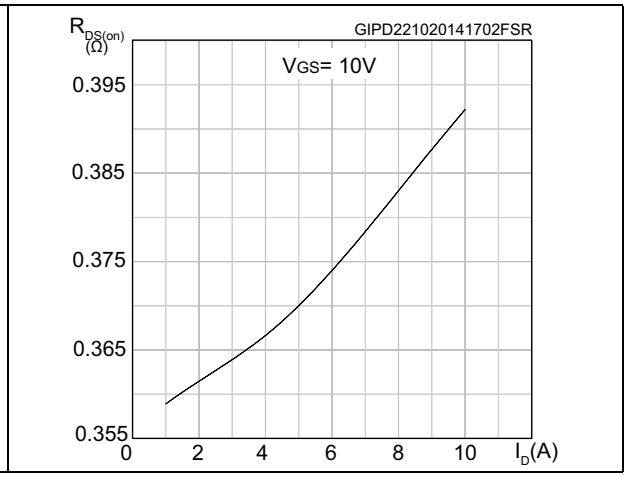


Figure 10. Gate charge vs gate-source voltage

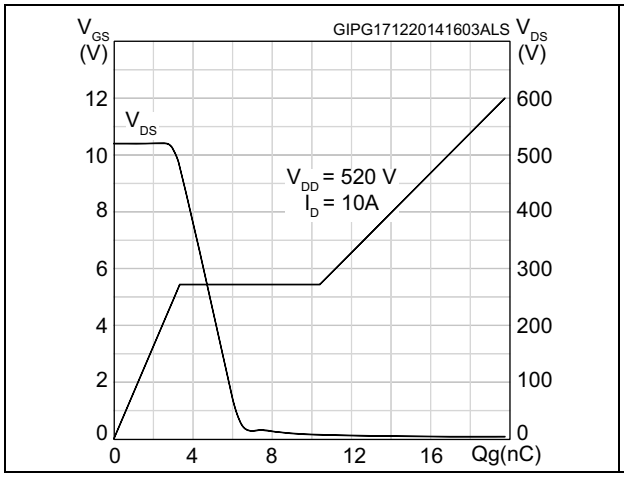


Figure 11. Capacitance variations

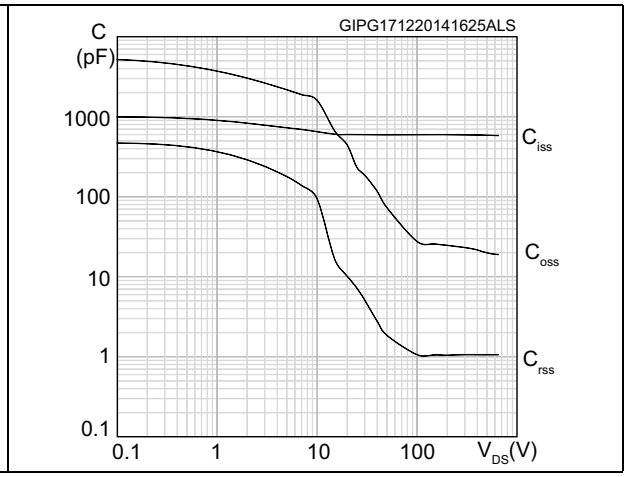


Figure 12. Normalized gate threshold voltage vs temperature

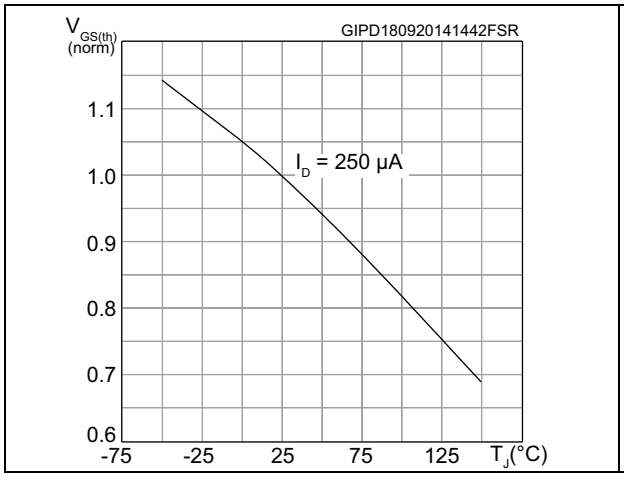


Figure 13. Normalized on-resistance vs temperature

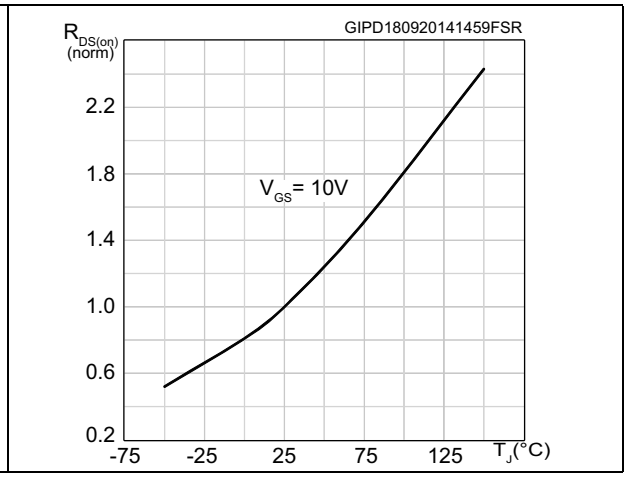


Figure 14. Source-drain diode forward characteristics

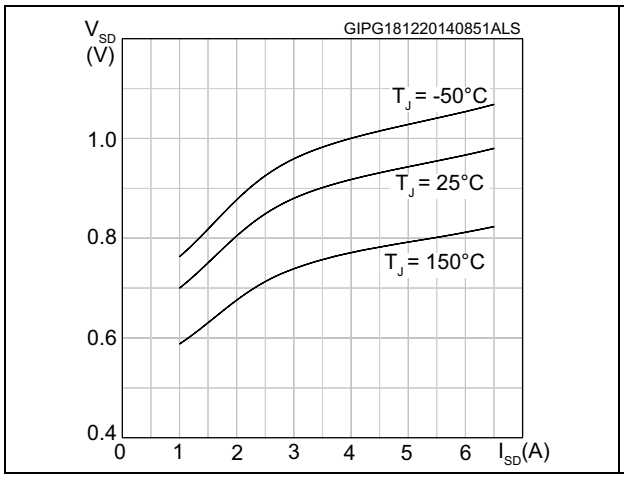
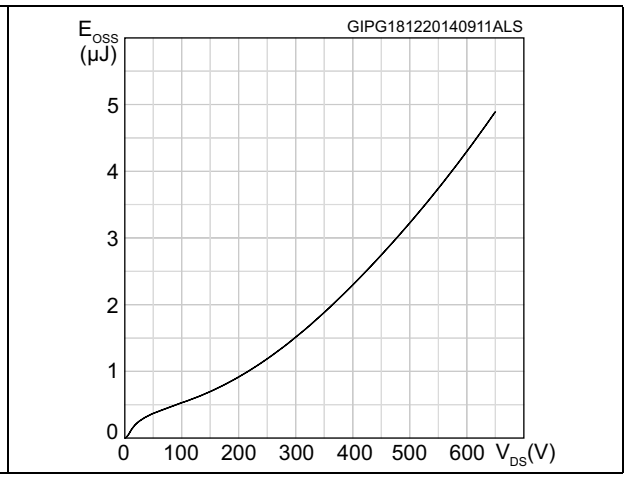


Figure 15. Output capacitance stored energy



3 Test circuits

Figure 16. Switching times test circuit for resistive load

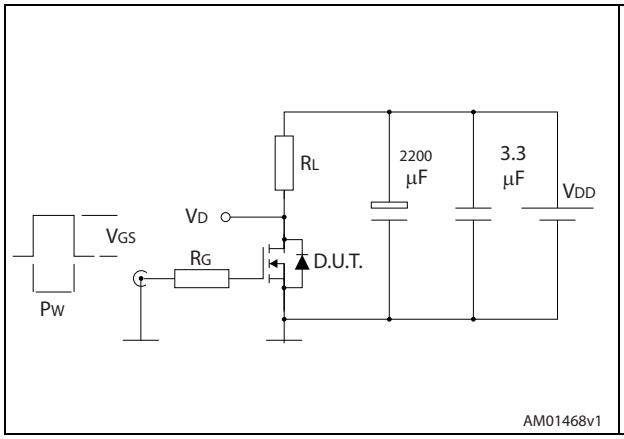


Figure 17. Gate charge test circuit

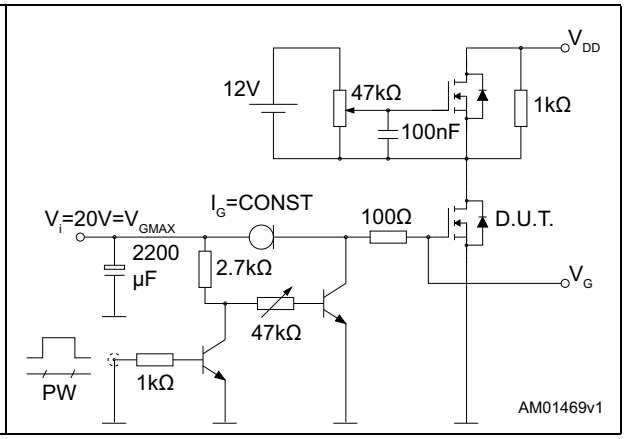


Figure 18. Test circuit for inductive load switching and diode recovery times

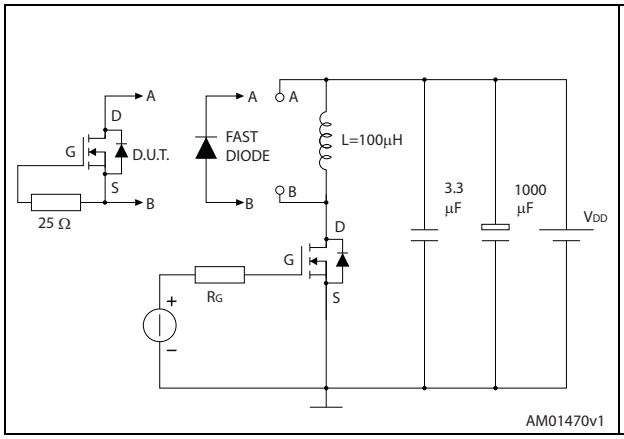


Figure 19. Unclamped inductive load test circuit

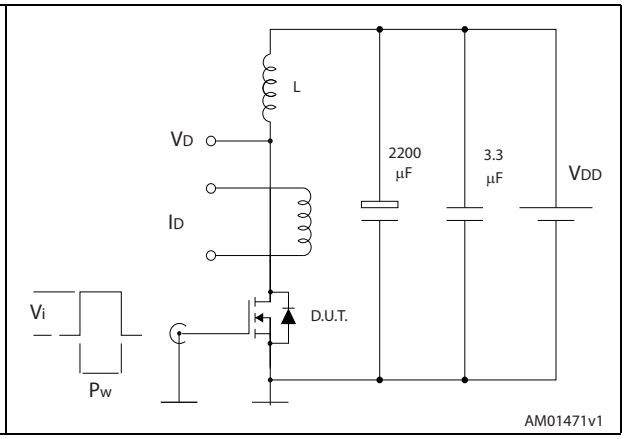


Figure 20. Unclamped inductive waveform

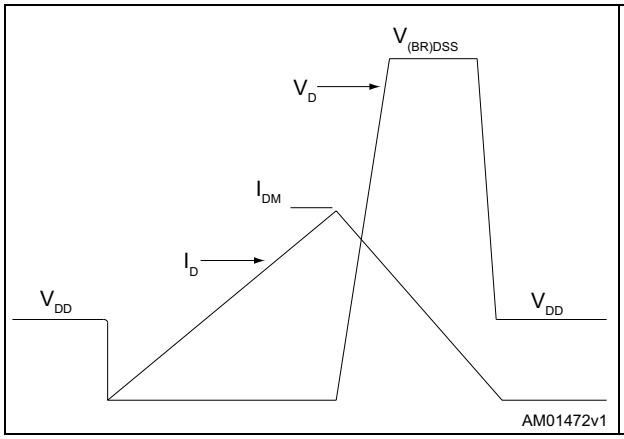
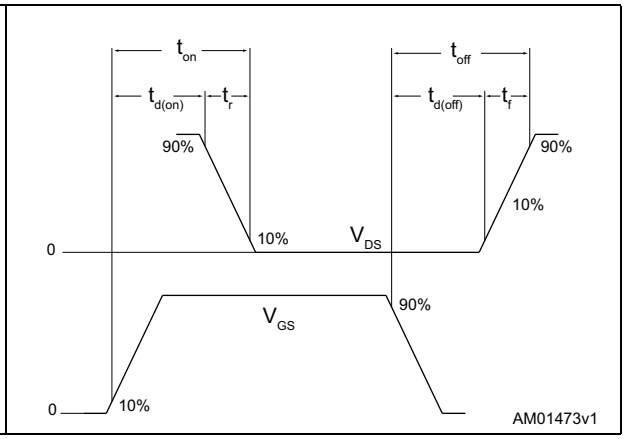


Figure 21. Switching time waveform



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.

4.1 TO-220, STP13N65M2

Figure 22. TO-220 type A drawing

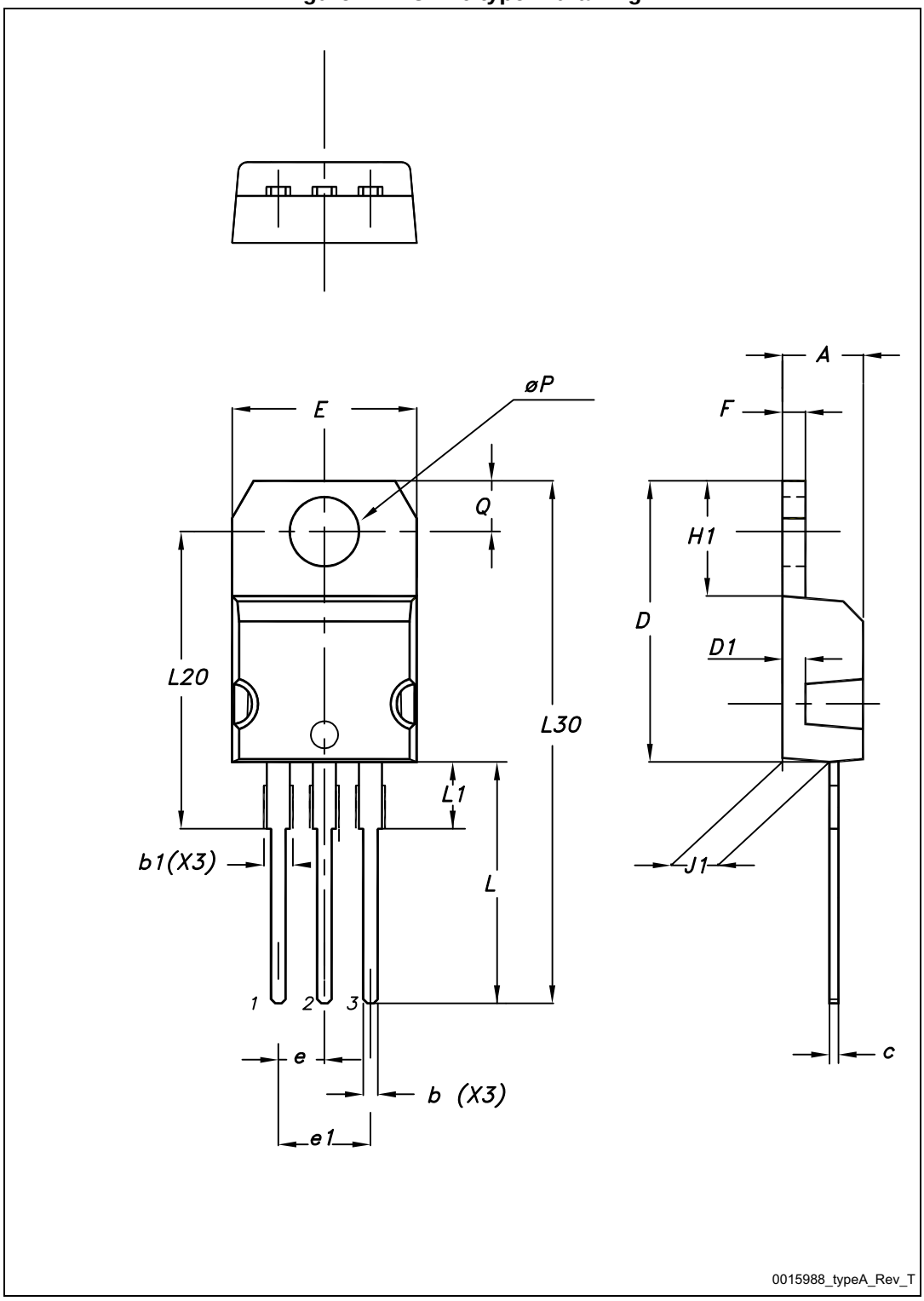


Table 9. TO-220 type A mechanical data

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

4.2 IPAK, STU13N65M2

Figure 23. IPAK (TO-251) drawing

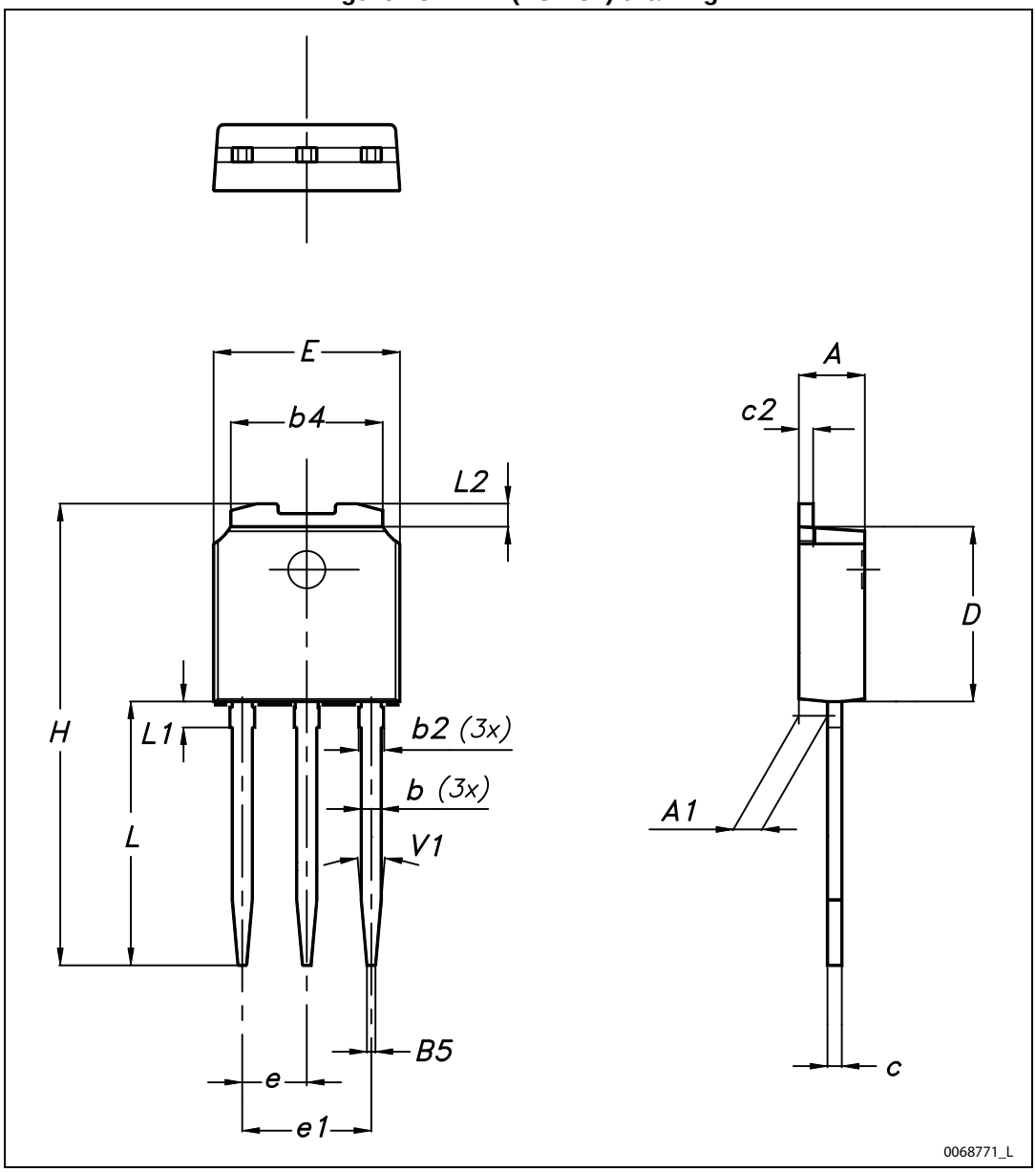


Table 10. IPAK (TO-251) mechanical data

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°	

5 Revision history

Table 11. Document revision history

Date	Revision	Changes
19-Dec-2014	1	First release.