STF6N60M2, STP6N60M2, STU6N60M2

N-channel 600 V, 1.06 Ω typ., 4.5 A MDmesh™ M2 Power MOSFETs in TO-220FP, TO-220 and IPAK packages

Datasheet - production data

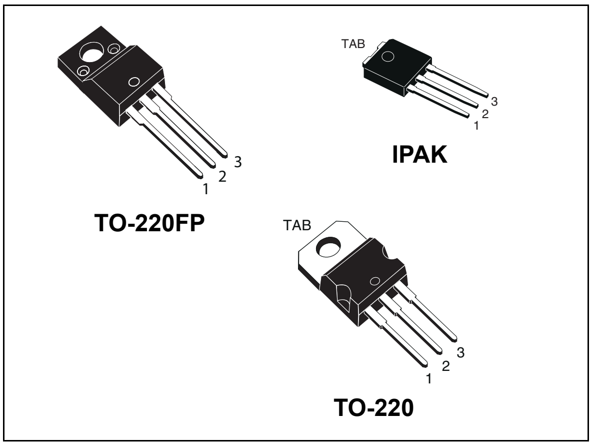
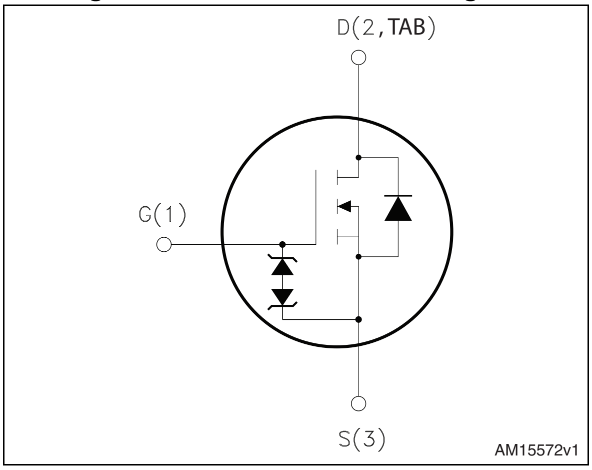


Figure 1. Internal schematic diagram



Features

Order code	V_{DS} @ T_{Jmax}	$R_{DS(on)}$ max	I_D
STF6N60M2	650 V	1.2 Ω	4.5 A
STP6N60M2			
STU6N60M2			

- 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	Packing
STF6N60M2	6N60M2	TO-220FP	Tube
STP6N60M2		TO-220	
STU6N60M2		IPAK	

Contents

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		TO-220FP	TO-220, IPAK	
V_{GS}	Gate-source voltage	± 25		V
I_D	Drain current (continuous) at T_C = 25 °C	4.5 (1)	4.5	A
I_D	Drain current (continuous) at T_C = 100 °C	2.9(1)	2.9	A
I_{DM}(2)	Drain current (pulsed)	18(1)	18	A
P_{TOT}	Total dissipation at T_C = 25 °C	20	60	W
V_{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1 s; T_C=25 °C)	2500		V
dv/dt(3)	Peak diode recovery voltage slope	15		V/ns
dv/dt(4)	MOSFET dv/dt ruggedness	50		V/ns
T_{stg}	Storage temperature	- 55 to 150		°C
T_j	Operating junction temperature	- 55 to 150		°C

1. Limited by maximum junction temperature.
2. Pulse width limited by safe operating area.
3. $I_{SD} \leq 4.5$ 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
		TO-220FP	TO-220	IPAK	
$R_{thj\text{-}case}$	Thermal resistance junction-case max	6.25	2.08		°C/W
$R_{thj\text{-}amb}$	Thermal resistance junction-ambient max	62.5		100	°C/W

Table 4. Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetitive or not repetitive (pulse width limited by T_{jmax})	1	A
E_{AS}	Single pulse avalanche energy (starting T_j=25°C, I_D= I_{AR}; V_{DD}=50)	86	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 = 2.25 A		1.06	1.2	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	-	232	-	pF
C_{oss}	Output capacitance		-	14	-	pF
C_{rss}	Reverse transfer capacitance		-	0.7	-	pF
$C_{oss\ eq.}$ (1)	Equivalent output capacitance	V_{DS} = 0 to 480 V, V_{GS} = 0	-	71	-	pF
R_G	Intrinsic gate resistance	f = 1 MHz open drain	-	6.5	-	Ω
Q_g	Total gate charge	V_{DD} = 480 V, I_D = 4.5 A, V_{GS} = 10 V (see *Figure 18*)	-	8	-	nC
Q_{gs}	Gate-source charge		-	1.7	-	nC
Q_{gd}	Gate-drain charge		-	4	-	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 = 1.65 A, R_G = 4.7 Ω, V_{GS} = 10 V (see *Figure 17* and *Figure 22*)	-	9.5	-	ns
t_r	Rise time		-	7.4	-	ns
$t_{d(off)}$	Turn-off delay time		-	24	-	ns
t_f	Fall time		-	22.5	-	ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		4.5	A
I_{SDM} (1)	Source-drain current (pulsed)		-		18	A
V_{SD} (2)	Forward on voltage	I_{SD} = 4.5 A, V_{GS} = 0	-		1.6	V
t_{rr}	Reverse recovery time	I_{SD} = 4.5 A, di/dt = 100 A/µs V_{DD} = 60 V (see *Figure 19*)	-	274		ns
Q_{rr}	Reverse recovery charge		-	1.47		µC
I_{RRM}	Reverse recovery current		-	10.7		A
t_{rr}	Reverse recovery time	I_{SD} = 4.5 A, di/dt = 100 A/µs V_{DD} = 60 V, T_j = 150 °C (see *Figure 19*)	-	376		ns
Q_{rr}	Reverse recovery charge		-	1.96		µC
I_{RRM}	Reverse recovery current		-	10.5		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-220FP

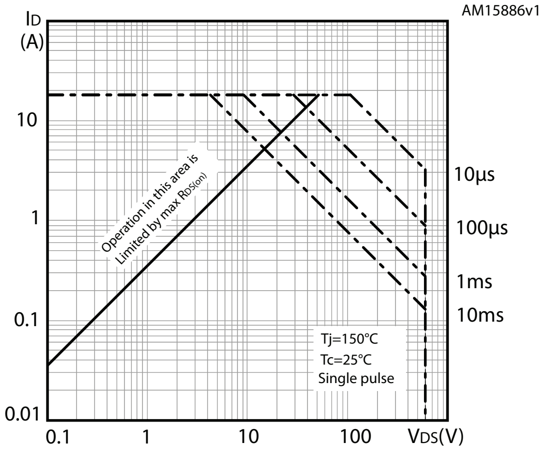


Figure 3. Thermal impedance for TO-220FP

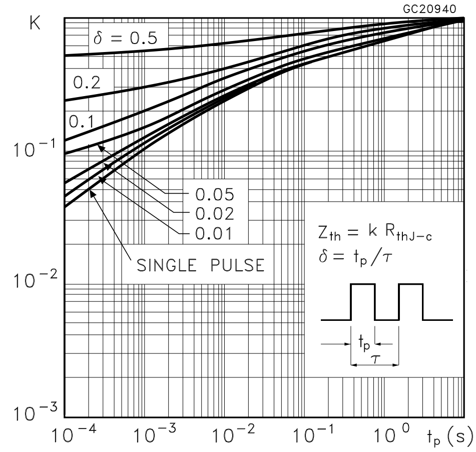


Figure 4. Safe operating area for TO-220

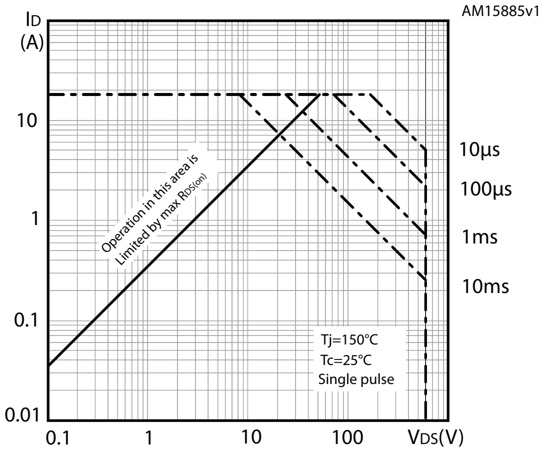


Figure 5. Thermal impedance for TO-220

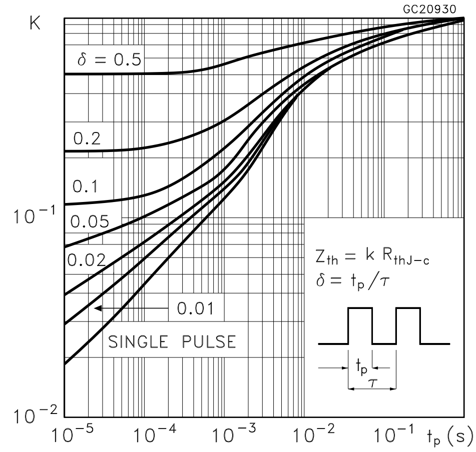


Figure 6. Safe operating area for IPAK

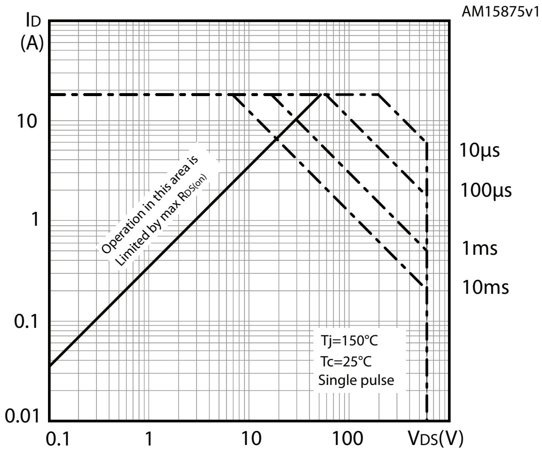


Figure 7. Thermal impedance for IPAK

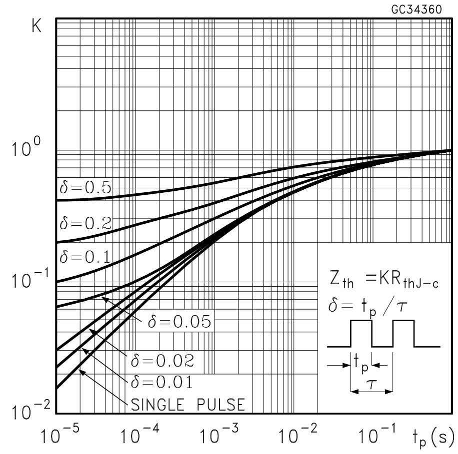


Figure 8. Output characteristics

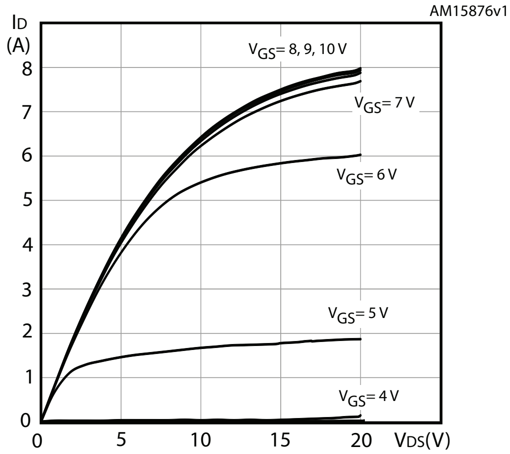


Figure 9. Transfer characteristics

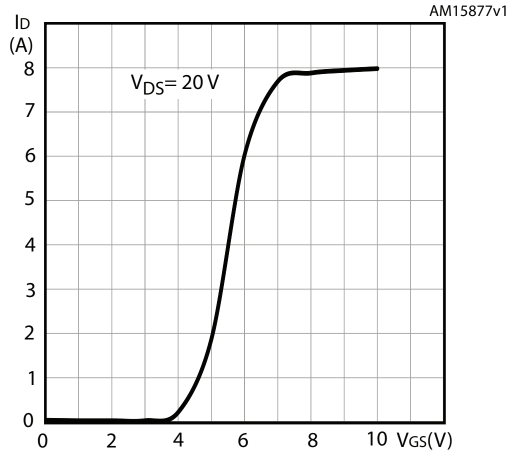


Figure 10. Gate charge vs gate-source voltage

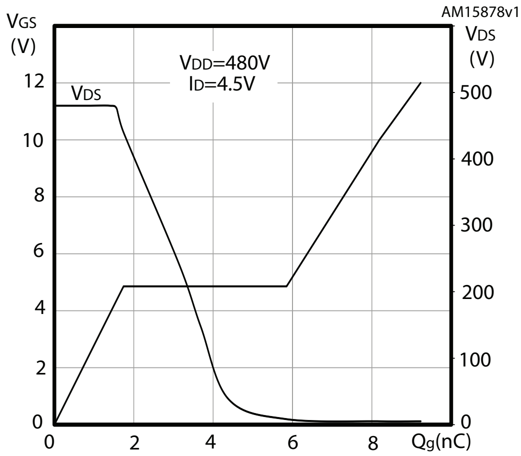


Figure 11. Static drain-source on-resistance

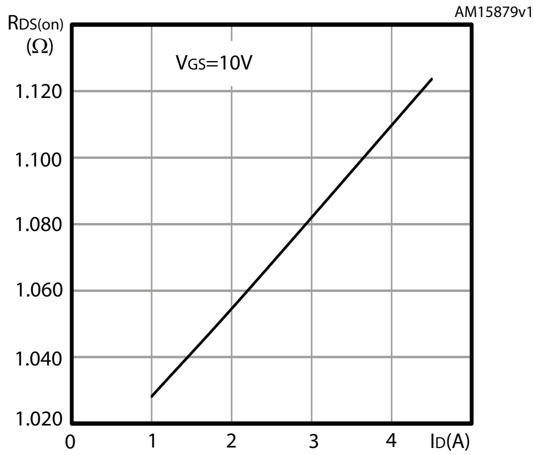


Figure 12. Capacitance variations

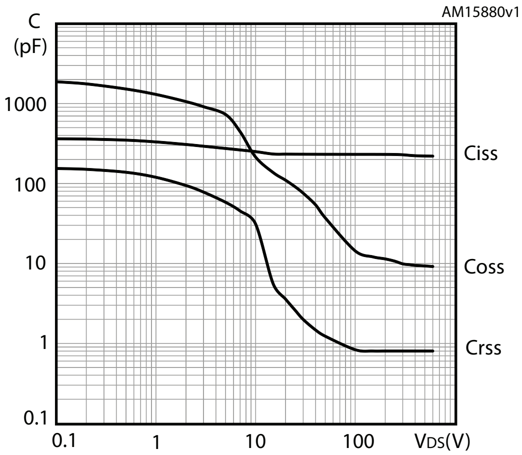


Figure 13. Normalized V_{DS} vs temperature

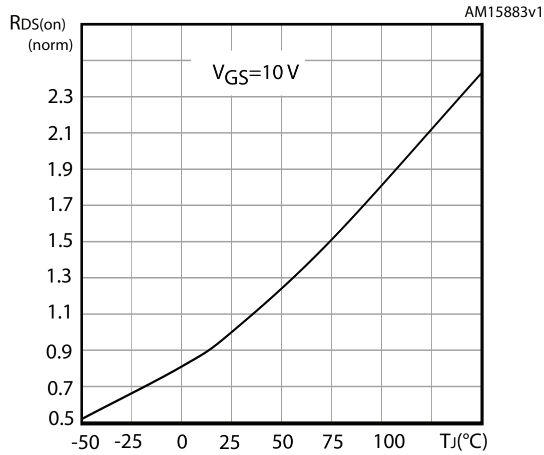


Figure 14. Normalized gate threshold voltage vs temperature

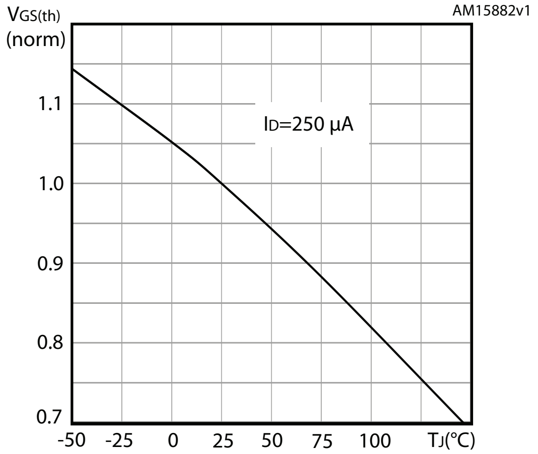


Figure 15. Normalized on-resistance vs temperature

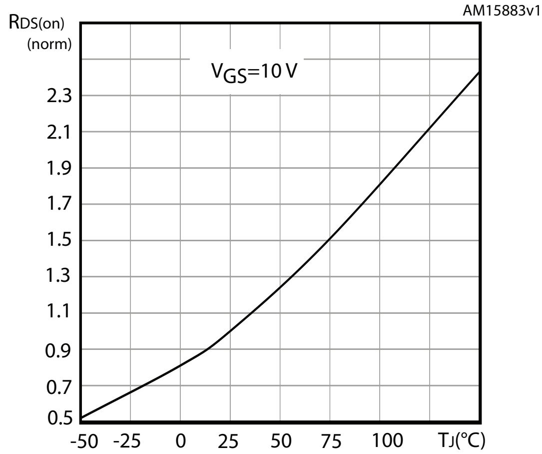
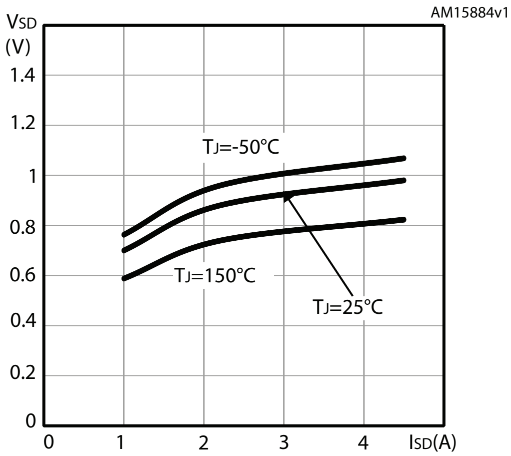


Figure 16. Source-drain diode forward characteristics



3 Test circuits

Figure 17. Switching times test circuit for resistive load

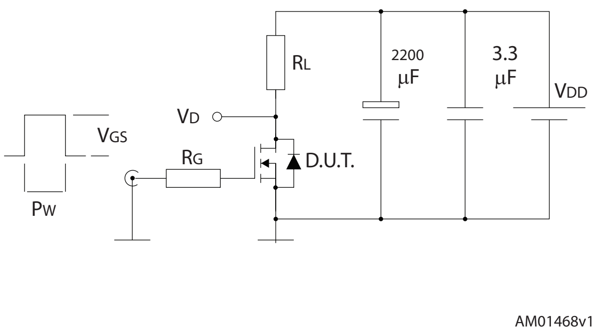


Figure 18. Gate charge test circuit

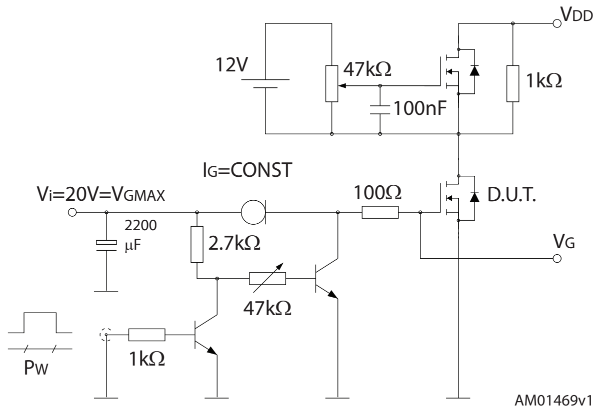


Figure 19. Test circuit for inductive load switching and diode recovery times

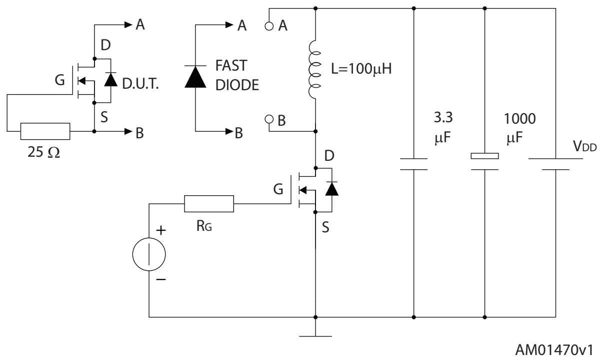


Figure 20. Unclamped inductive load test circuit

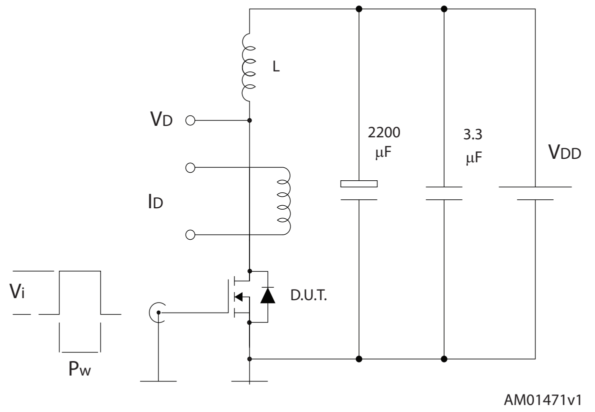


Figure 21. Unclamped inductive waveform

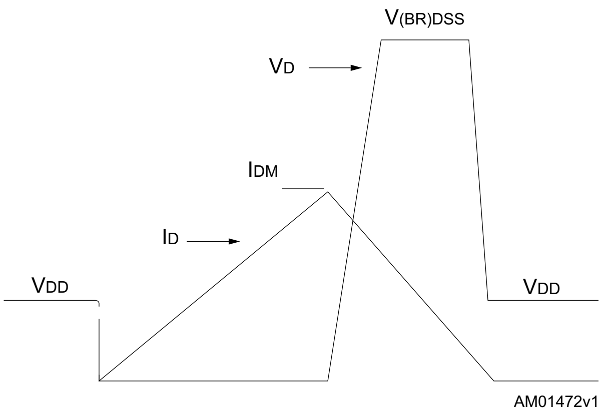
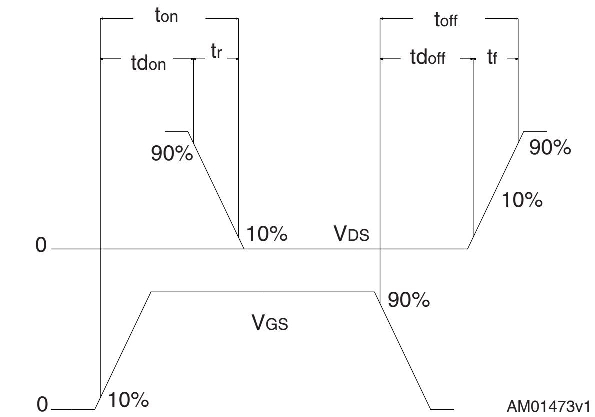


Figure 22. Switching time waveform



4 Package information

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-220FP package information

Figure 23. TO-220FP package outline

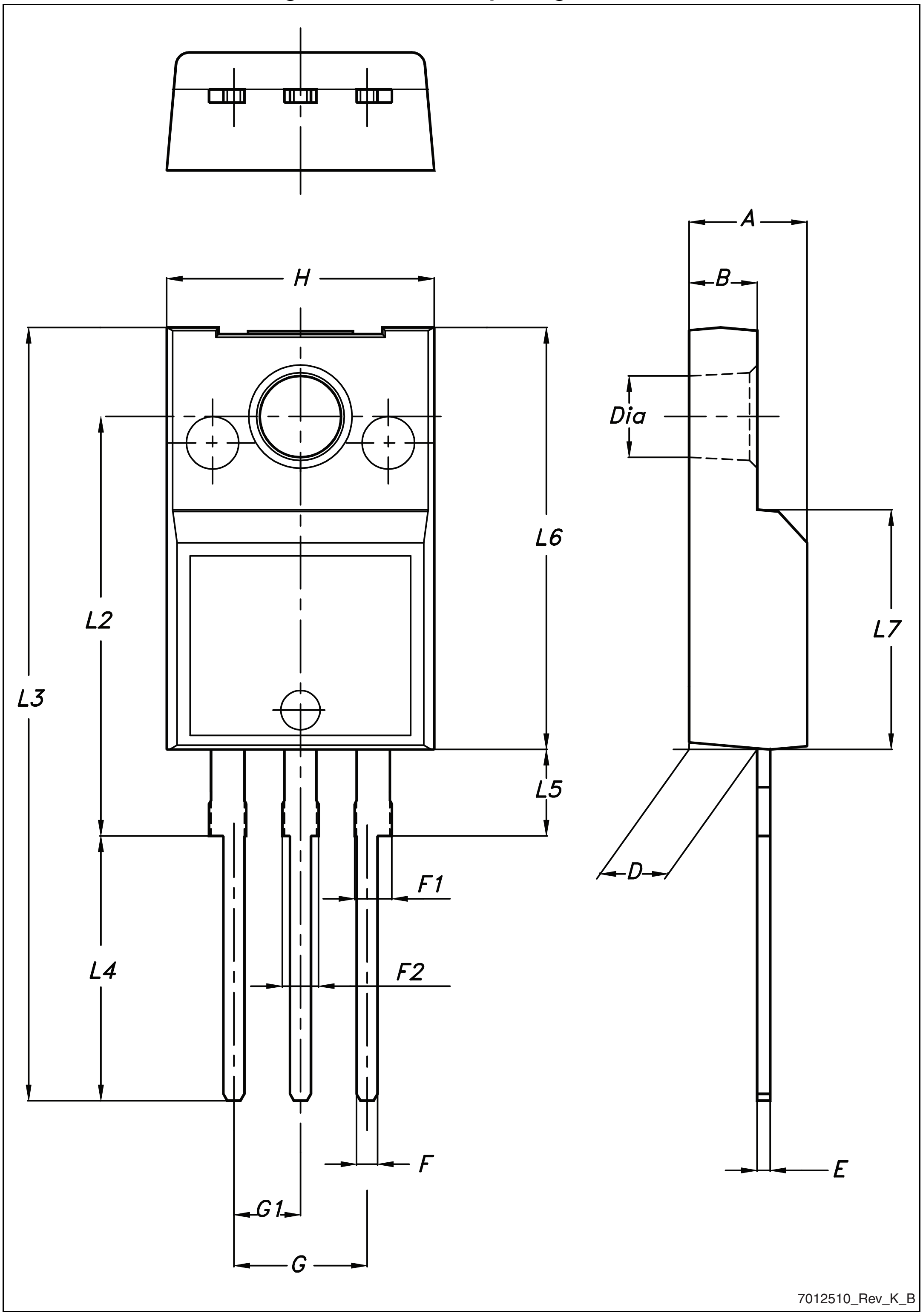


Table 9. TO-220FP mechanical data

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

4.2 TO-220 package information

Figure 24. TO-220 type A package outline

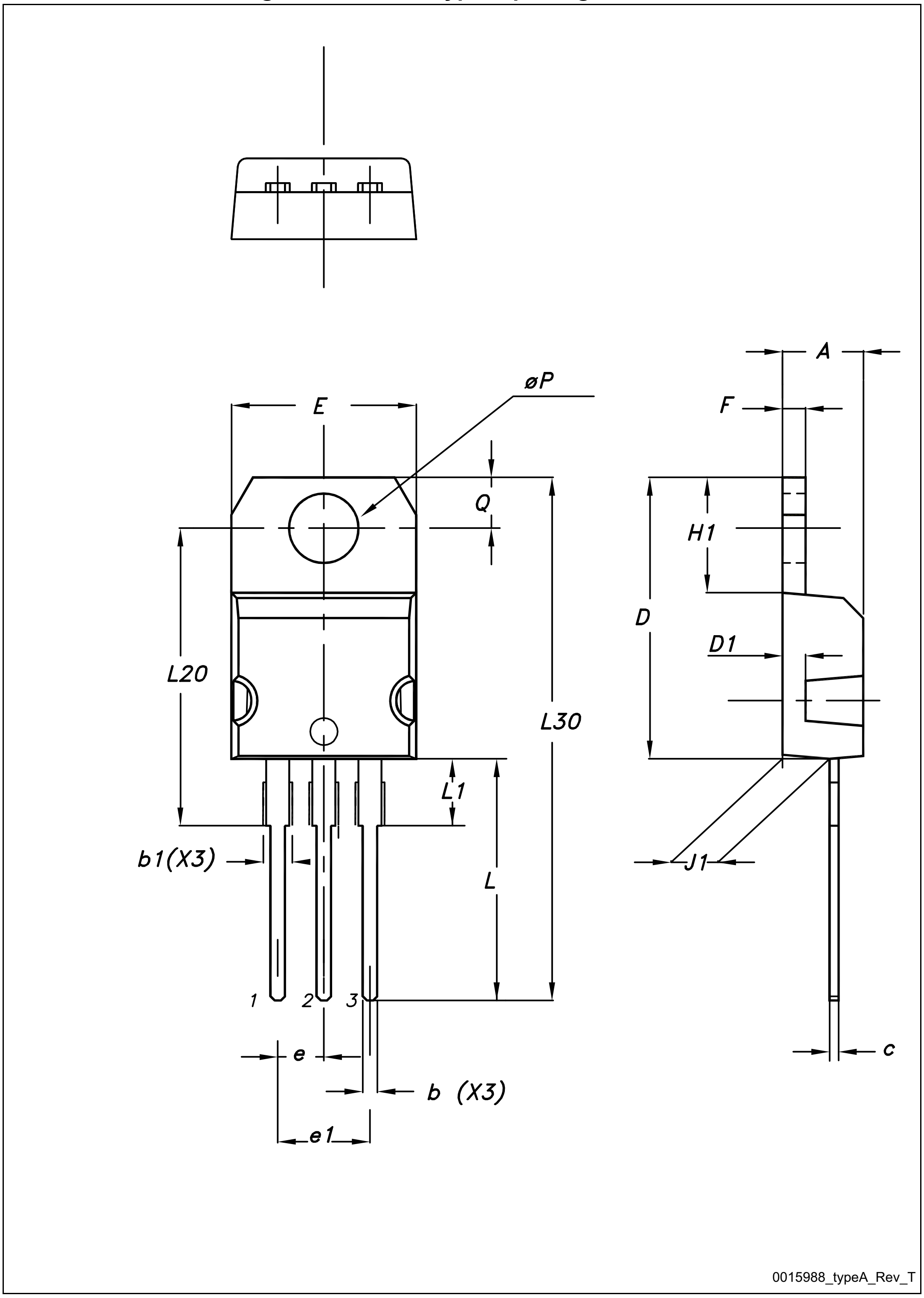


Table 10. TO-220 type A mechanical data

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

4.3 IPAK(TO-251) package information

Figure 25. IPAK (TO-251) type A package outline

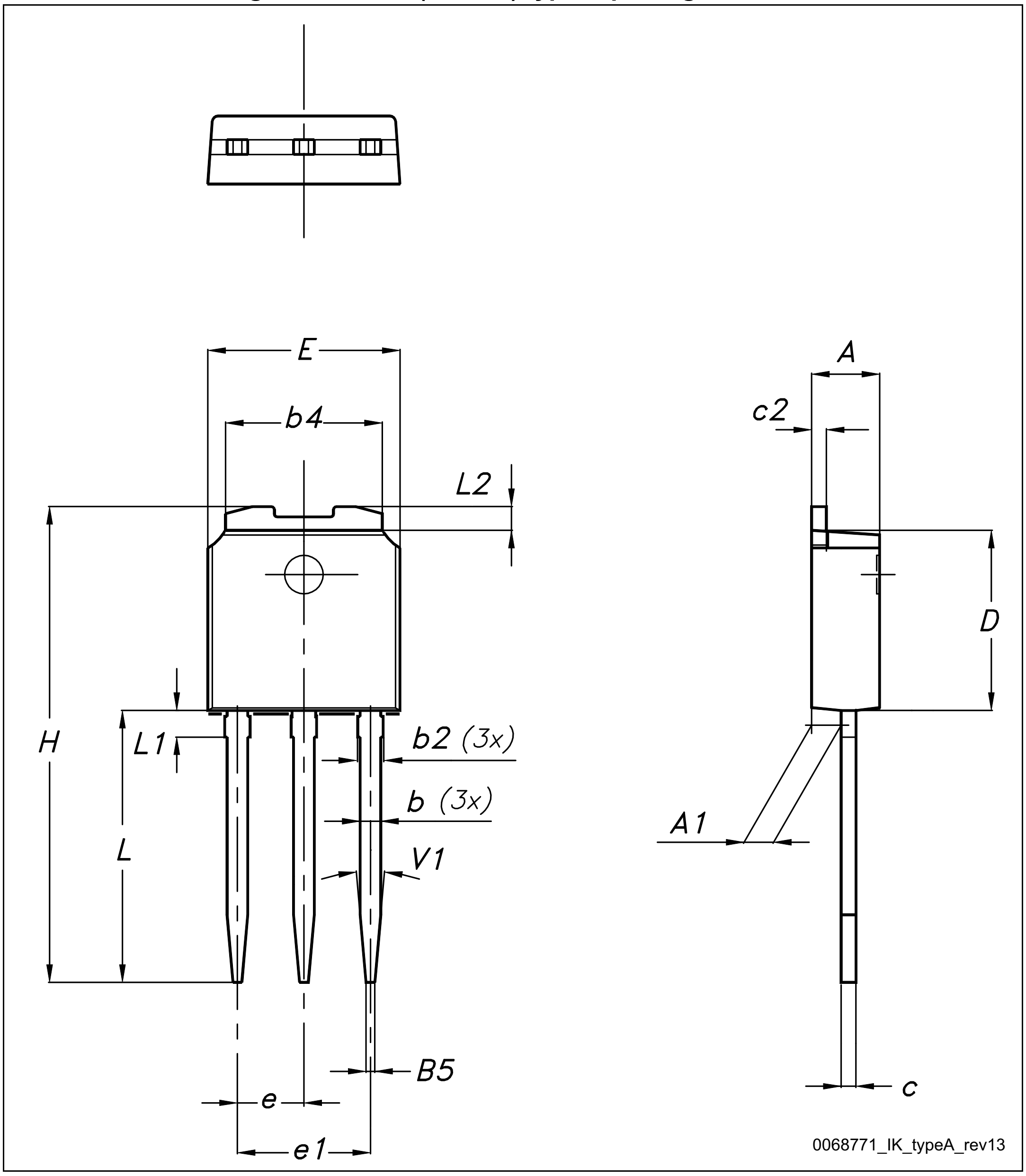


Table 11. IPAK (TO-251) type A mechanical data

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 12. Document revision history

Date	Revision	Changes
11-Jun-2013	1	First release.
01-Oct-2015	2	Updated title, features and description. Updated *Table 2.: Absolute maximum ratings* and *Table 8.: Source drain diode*. Updated *4.3: IPAK(TO-251) package information*. Minor text changes.