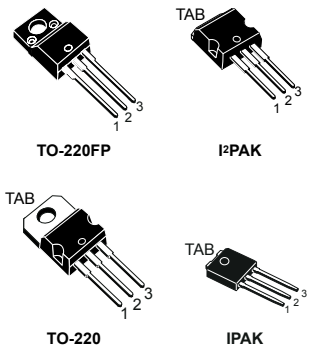
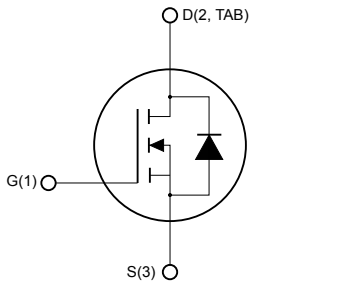
STF13NM60N, STI13NM60N
STP13NM60N, STU13NM60N

Datasheet

N-channel 600 V, 280 mΩ typ., 11 A MDmesh II Power MOSFETs in a TO-220FP, I²PAK, TO-220 and IPAK packages





Features

Order codes	V_{DS}	$R_{DS(on)}$ max.	I_D
STF13NM60N	600 V	360 mΩ	11 A
STI13NM60N			
STP13NM60N			
STU13NM60N			

- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance

Applications

- Switching applications

Description

These devices are N-channel Power MOSFETs developed using the second generation of MDmesh technology. 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.

Product status link
STF13NM60N
STI13NM60N
STP13NM60N
STU13NM60N

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		TO-220FP	I²PAK, TO-220, IPAK	
V_{DS}	Drain-source voltage	600		V
V_{GS}	Gate-source voltage	±25		V
I_D	Drain current (continuous) at T_C = 25 °C	11(1)	11	A
	Drain current (continuous) at T_C = 100 °C	6.9(1)	6.9	
I_{DM}(2)	Drain current pulsed	44(1)	44	A
P_{TOT}	Total power dissipation at T_C = 25 °C	25	90	W
dv/dt(3)	Peak diode recovery voltage slope	15		V/ns
V_{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s, T_C = 25 °C)	2.5		kV
T_J	Operating junction temperature range	-55 to 150		°C
T_{stg}	Storage temperature range			°C

1. *Limited by maximum junction temperature.*
2. *Pulse width limited by safe operating area.*
3. *I_{SD} ≤ 11 A, di/dt ≤ 400 A/µs, V_{DD} = 80% $V_{(BR)DSS}$.*

Table 2. Thermal data

Symbol	Parameter	Value			Unit
		TO-220FP	I²PAK, TO-220	IPAK	
$R_{thj\text{-}case}$	Thermal resistance junction-case	5	1.39		°C/W
$R_{thj\text{-}a}$	Thermal resistance junction-ambient	62.5		100	°C/W

Table 3. Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AS}	Avalanche current, repetitive or not repetitive (pulse width limited by T_J max)	3.5	A
E_{AS}	Single-pulse avalanche energy (starting T_J = 25 °C, I_D = I_{AS}, V_{DD} = 50 V)	200	mJ

2 Electrical characteristics

(T_C = 25 °C unless otherwise specified)

Table 4. Static

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	V_{GS} = 0 V, I_D = 1 mA	600			V
I_{DSS}	Zero gate voltage drain current	V_{GS} = 0 V, V_{DS} = 600 V			1	µA
		V_{GS} = 0 V, V_{DS} = 600 V, T_C = 125 °C (1)			100	
I_{GSS}	Gate-body leakage current	V_{DS} = 0 V, V_{GS} = ±25 V			±100	nA
$V_{GS(th)}$	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		280	360	mΩ

1. *Defined by design, not subject to production test.*

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	V_{DS} = 50 V, f = 1 MHz, V_{GS} = 0 V	-	790	-	pF
C_{oss}	Output capacitance		-	60	-	pF
C_{rss}	Reverse transfer capacitance		-	3.6	-	pF
$C_{oss\ eq.}$ (1)	Equivalent output capacitance	V_{DS} = 0 to 480 V, V_{GS} = 0 V	-	135	-	pF
Q_g	Total gate charge	V_{DD} = 480 V, I_D = 11 A, V_{GS} = 0 to 10 V (see Figure 17. Test circuit for gate charge behavior)	-	27	-	nC
Q_{gs}	Gate-source charge		-	4	-	nC
Q_{gd}	Gate-drain charge		-	14	-	nC
R_g	Gate input resistance	f = 1 MHz, open drain	-	4.7	-	Ω

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 6. 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. Test circuit for resistive load switching times and Figure 21. Switching time waveform)	-	3	-	ns
t_r	Rise time		-	8	-	ns
$t_{d(off)}$	Turn-off delay time		-	30	-	ns
t_f	Fall time		-	10	-	ns

Table 7. 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	V_{GS} = 0 V, I_{SD} = 11 A	-		1.5	V
t_{rr}	Reverse recovery time	I_{SD} = 11 A, di/dt = 100 A/µs, V_{DD} = 100 V (see Figure 18. Test circuit for inductive load switching and diode recovery times)	-	230		ns
Q_{rr}	Reverse recovery charge		-	2		µC
I_{RRM}	Reverse recovery current		-	18		A
t_{rr}	Reverse recovery time	I_{SD} = 11 A, di/dt = 100 A/µs, V_{DD} = 100 V, T_J = 150 °C (see Figure 18. Test circuit for inductive load switching and diode recovery times)	-	290		ns
Q_{rr}	Reverse recovery charge		-	2.5		µC
I_{RRM}	Reverse recovery current		-	17		A

1. *Pulse width is limited by safe operating area.*
2. *Pulse test: pulse duration = 300 µs, duty cycle 1.5%.*

2.1 Electrical characteristics (curves)

Figure 1. Safe operating area for I²PAK and TO-220

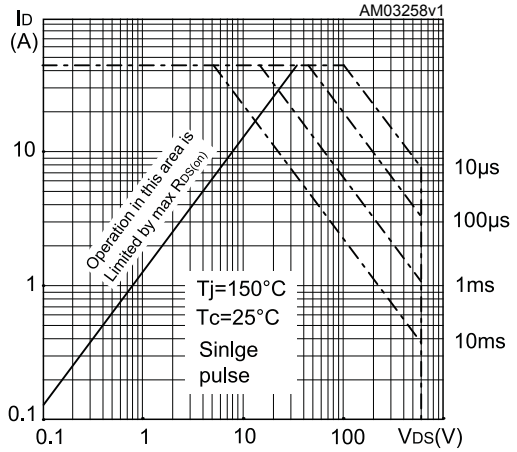


Figure 2. Thermal impedance for I²PAK and TO-220

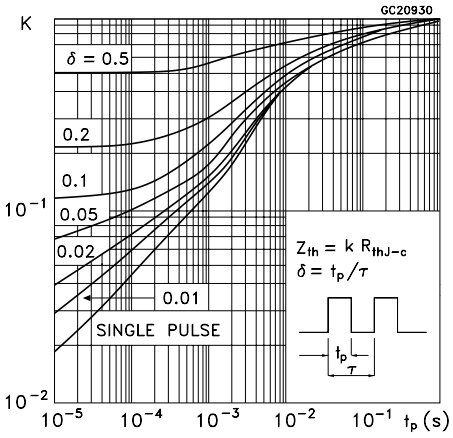


Figure 3. Safe operating area for TO-220FP

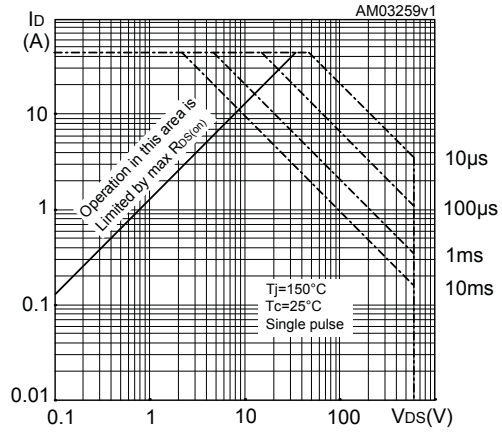


Figure 4. Thermal impedance for TO-220FP

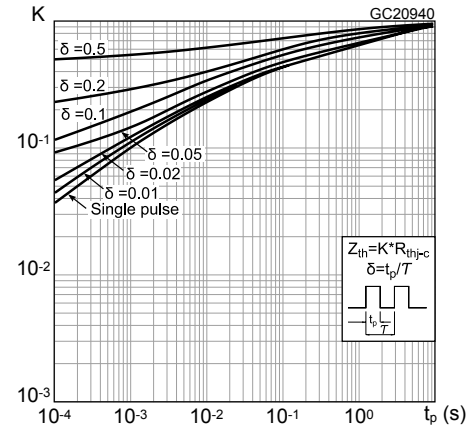


Figure 5. Safe operating area for IPAK

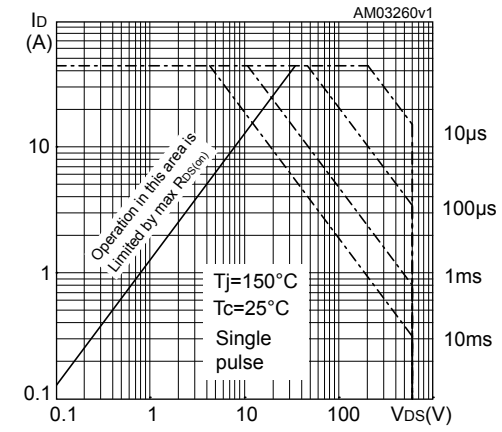


Figure 6. Thermal impedance for IPAK

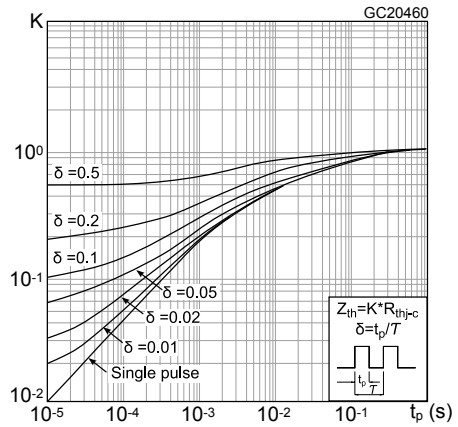


Figure 7. Output characteristics

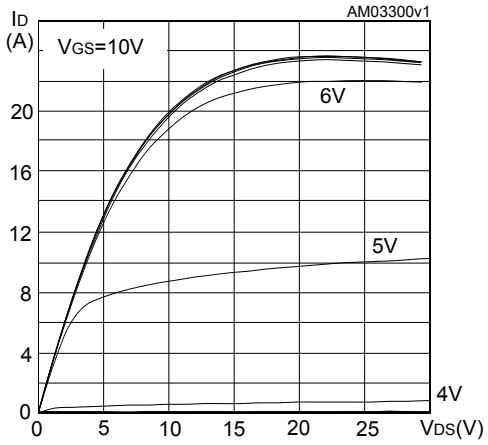


Figure 8. Transfer characteristics

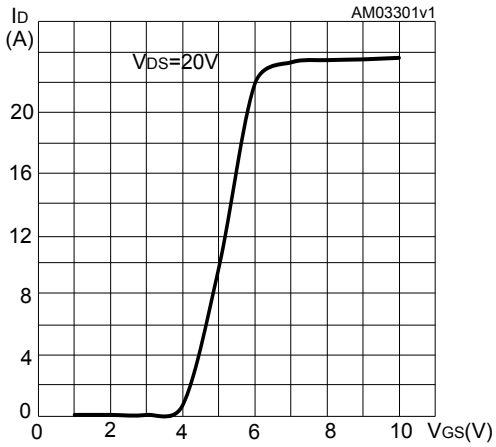


Figure 9. Normalized V_{DS} vs temperature

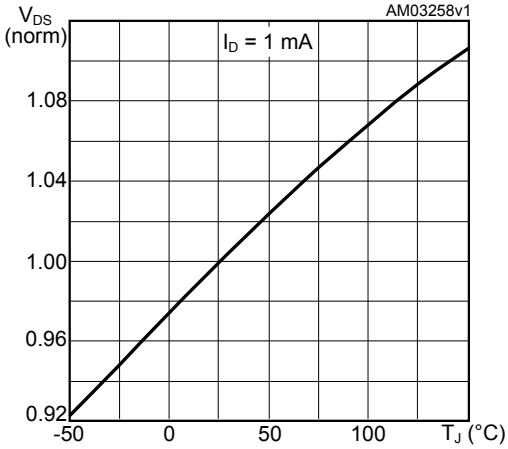


Figure 10. Static drain-source on-resistance

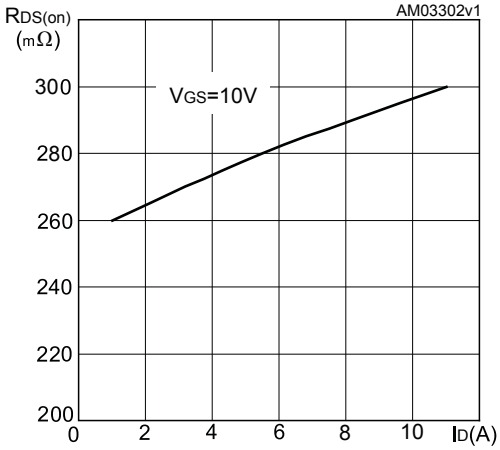


Figure 11. Gate charge vs gate-source voltage

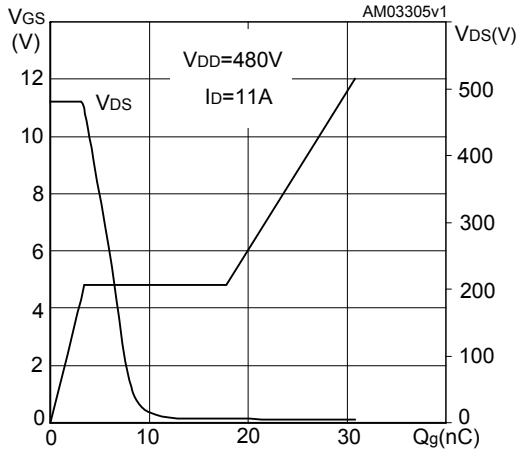


Figure 12. Capacitance variations

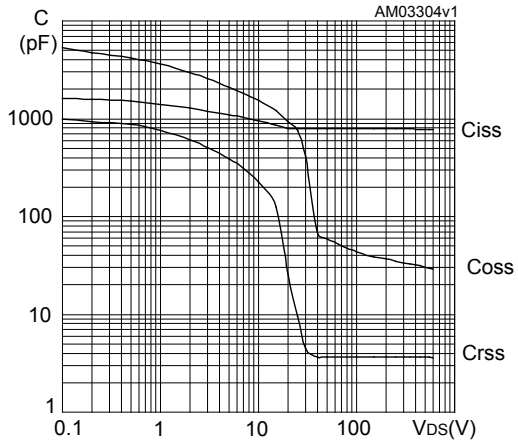


Figure 13. Normalized gate threshold voltage vs temperature

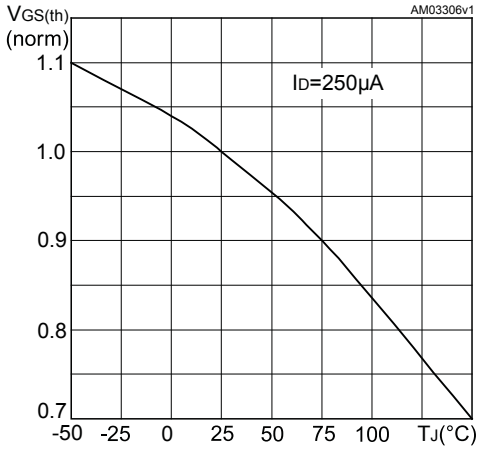


Figure 14. Normalized on resistance vs temperature

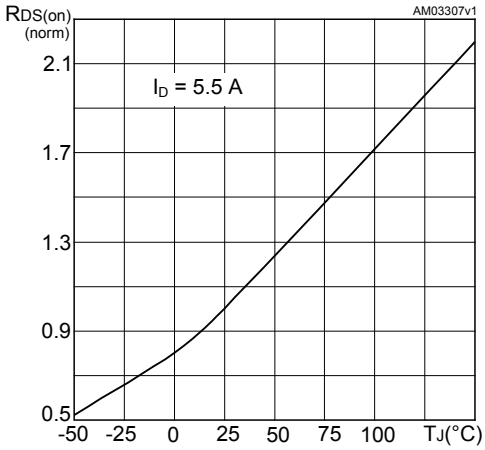
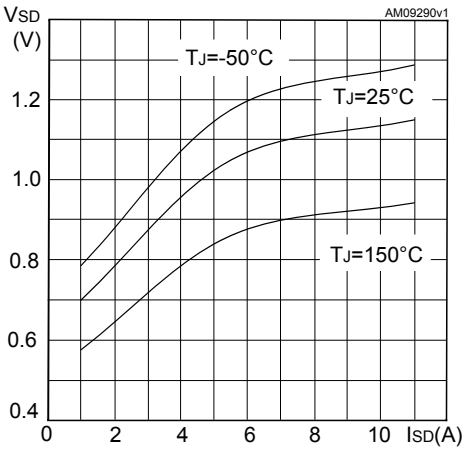


Figure 15. Source-drain diode forward characteristics



3 Test circuits

Figure 16. Test circuit for resistive load switching times

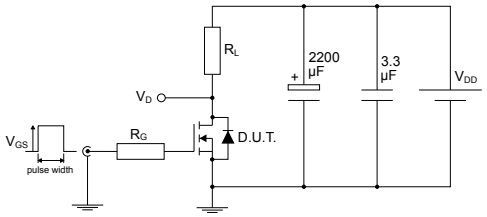


Figure 17. Test circuit for gate charge behavior

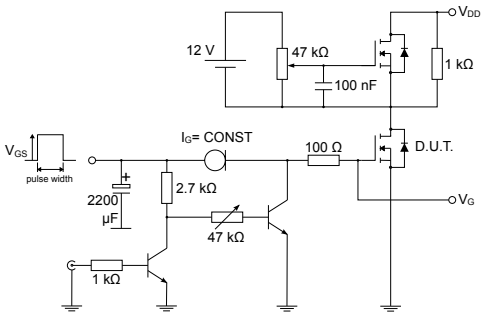


Figure 18. Test circuit for inductive load switching and diode recovery times

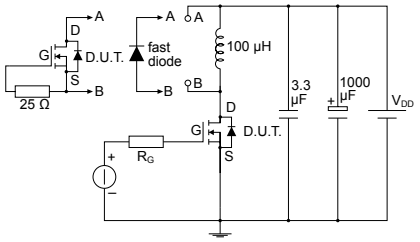


Figure 19. Unclamped inductive load test circuit

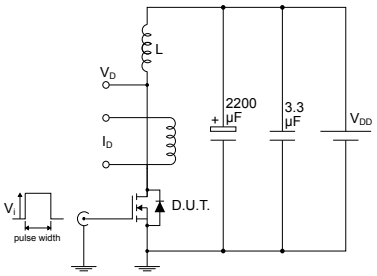


Figure 20. Unclamped inductive waveform

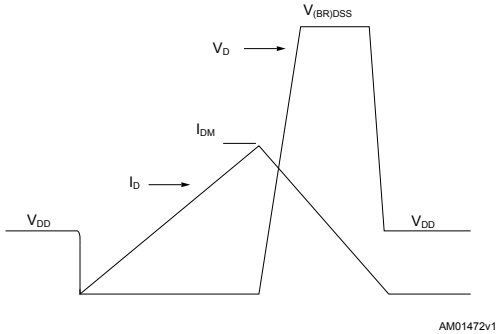
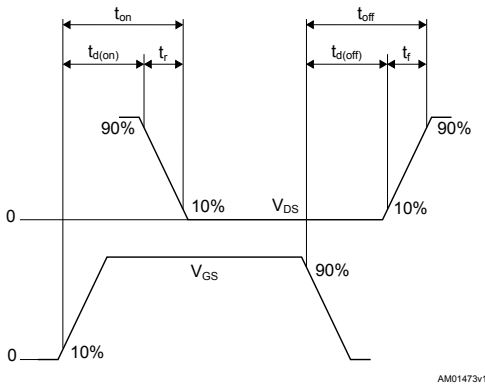


Figure 21. Switching time waveform



4 Package 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 22. **TO-220FP package outline**

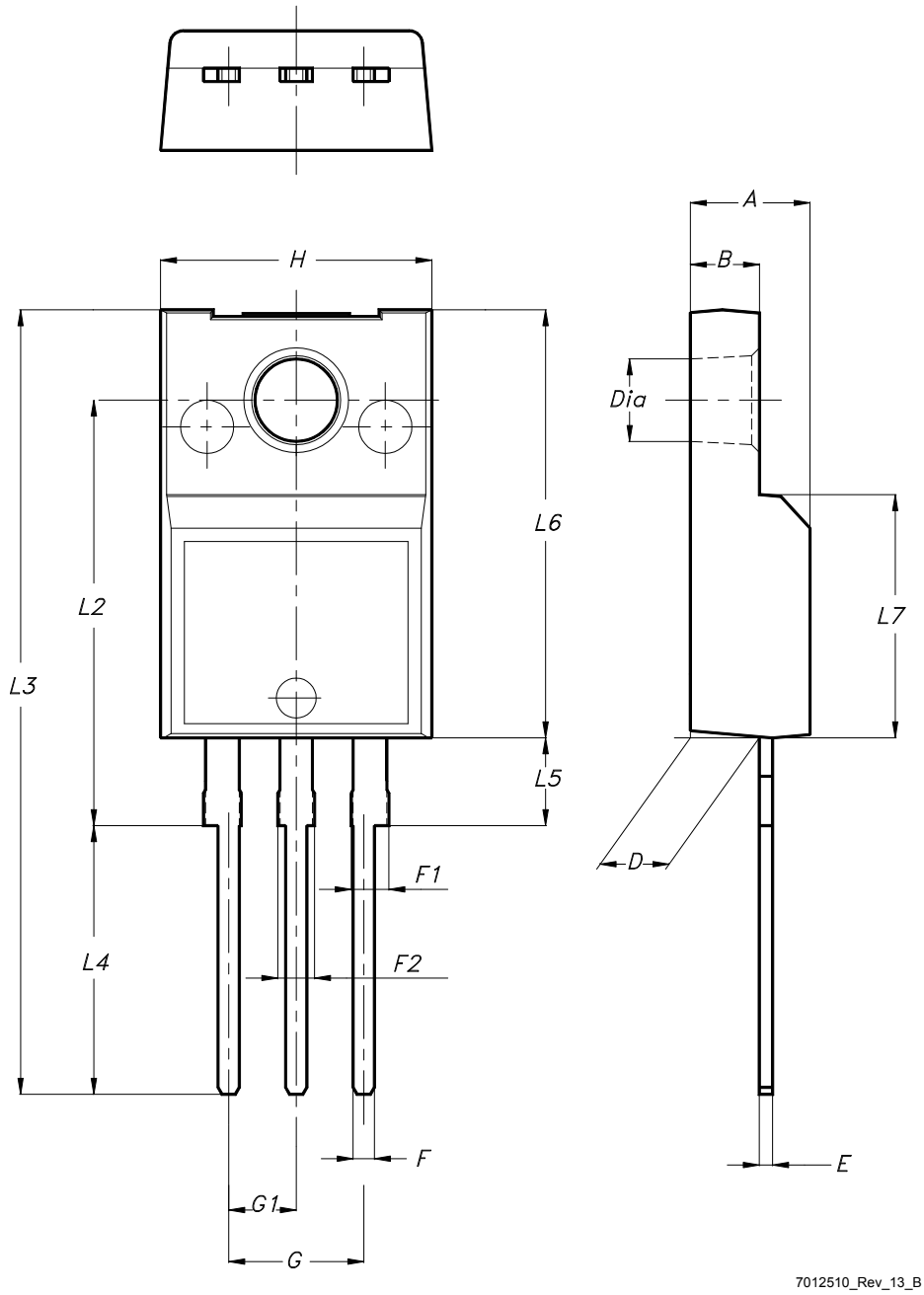


Table 8. **TO-220FP package mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
B	2.50		2.70
D	2.50		2.75
E	0.45		0.70
F	0.75		1.00
F1	1.15		1.70
F2	1.15		1.70
G	4.95		5.20
G1	2.40		2.70
H	10.00		10.40
L2		16.00	
L3	28.60		30.60
L4	9.80		10.60
L5	2.90		3.60
L6	15.90		16.40
L7	9.00		9.30
Dia	3.00		3.20

4.2 I²PAK package information

Figure 23. I²PAK package outline

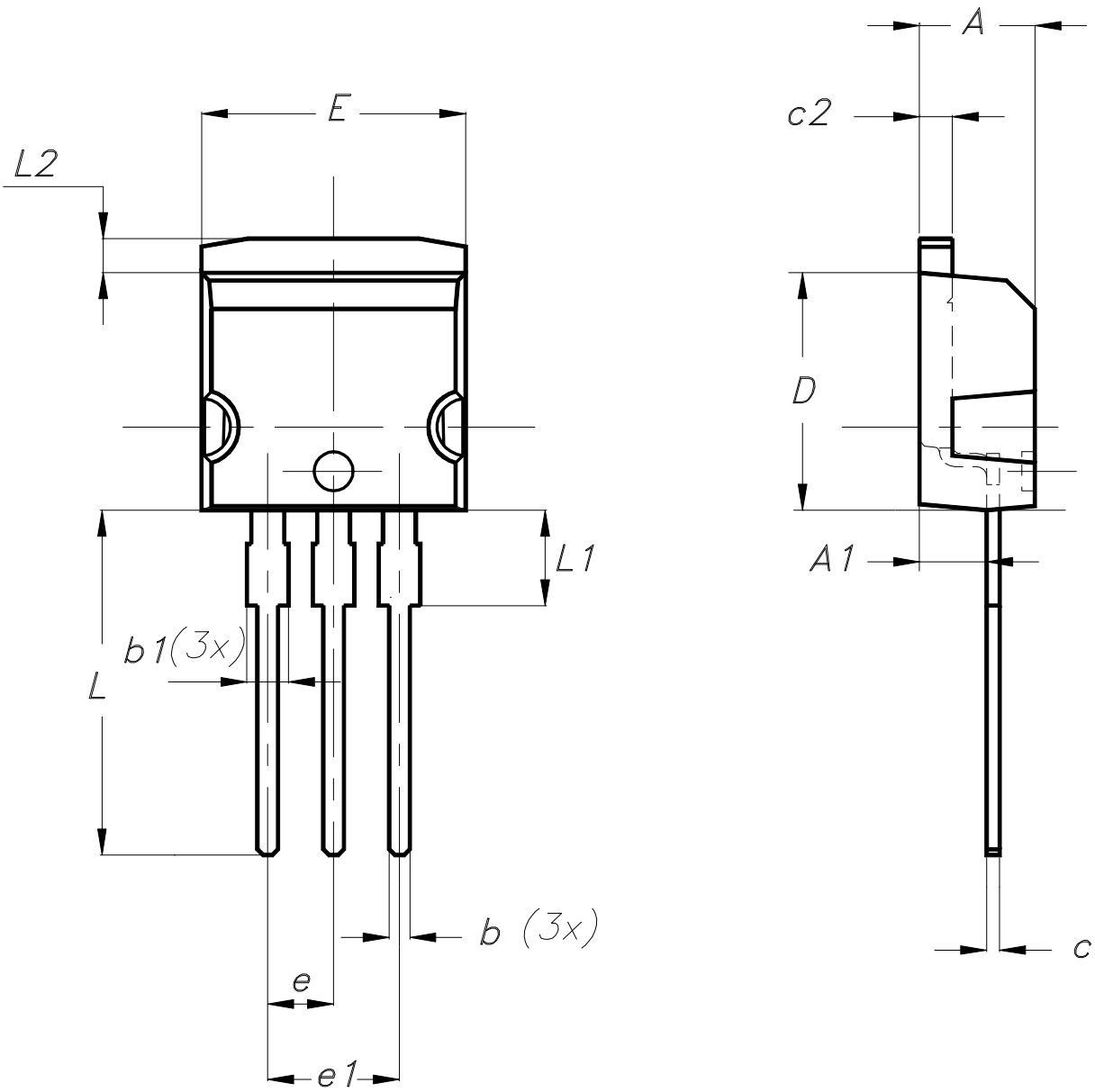


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Table 9. I²PAK package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40	-	4.60
A1	2.40	-	2.72
b	0.61	-	0.88
b1	1.14	-	1.70
c	0.49	-	0.70
c2	1.23	-	1.32
D	8.95	-	9.35
e	2.40	-	2.70
e1	4.95	-	5.15
E	10.00	-	10.40
L	13.00	-	14.00
L1	3.50	-	3.93
L2	1.27	-	1.40

4.3 TO-220 type A package information

Figure 24. **TO-220 type A package outline**

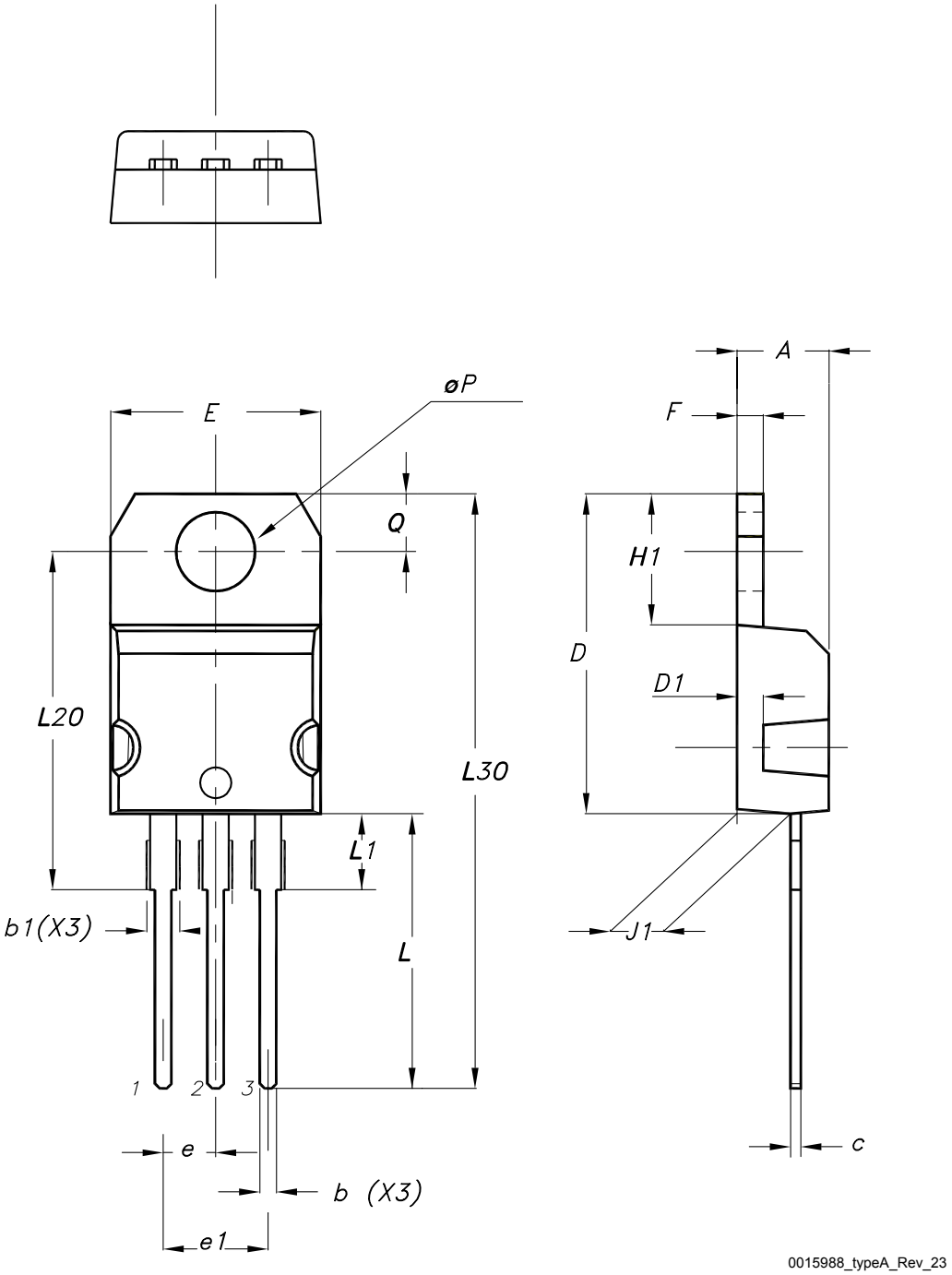

Table 10. **TO-220 type A package mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.55
c	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10.00		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	13.00		14.00
L1	3.50		3.93
L20		16.40	
L30		28.90	
øP	3.75		3.85
Q	2.65		2.95
Slug flatness		0.03	0.10

4.4 IPAK (TO-251) type A package information

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

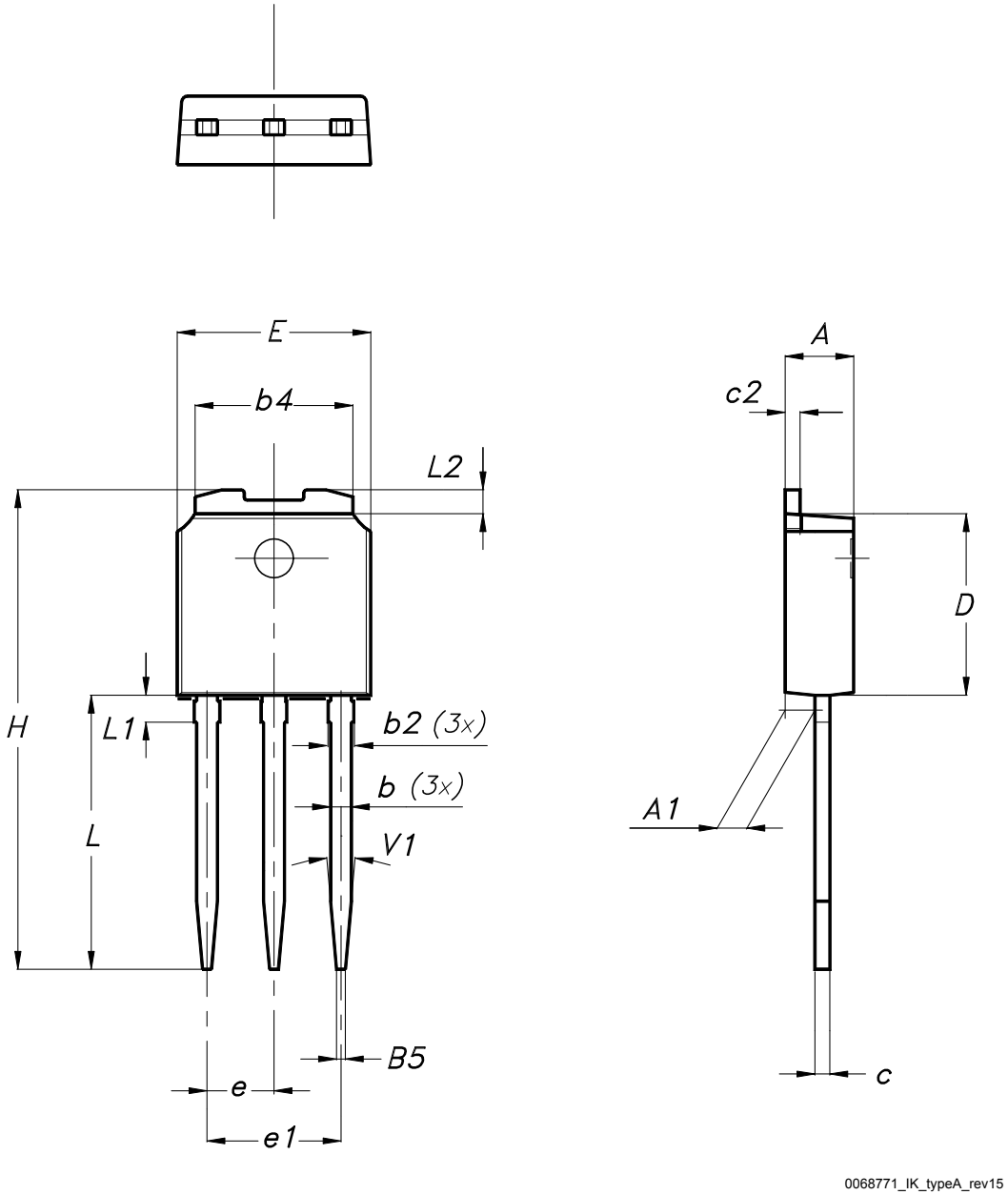

Table 11. **IPAK (TO-251) type A package mechanical data**

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 Ordering information

Table 12. **Order codes**

Order codes	Marking	Package	Packing
STF13NM60N	13NM60N	TO-220FP	Tube
STI13NM60N		I²PAK	
STP13NM60N		TO-220	
STU13NM60N		IPAK	

Revision history

Table 13. **Document revision history**

Date	Revision	Changes
29-Feb-2009	1	First release
13-Jan-2010	2	– Added new package, mechanical data: TO-247 – Added new package, mechanical data: D²PAK
08-Nov-2010	3	– Modified *Figure 4* – Added new package, mechanical data: I²PAK
18-Jan-2012	4	– Added new package, mechanical data: IPAK – Minor text changes
14-Nov-2012	5	The part numbers STB13NM60N and STD13NM60N have been moved to a separate datasheet. *Section 4: Package mechanical data* has been updated.
26-Oct-2020	6	The part number STW13NM60N have been moved to a separate datasheet and the document has been updated accordingly. Updated cover page. Updated Section 1 Electrical ratings. Updated Table 4. Static and Table 7. Source-drain diode. Updated Section 4 Package information. Added Section 5 Ordering information. Minor text changes.

Contents