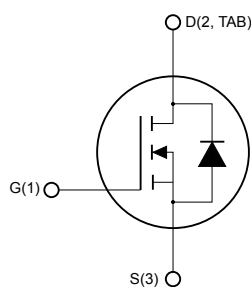
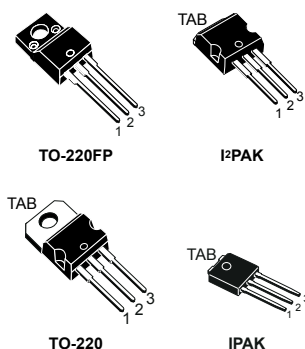


N-channel 600 V, 280 mΩ typ., 11 A MDmesh II Power MOSFETs
in a TO-220FP, I²PAK, TO-220 and IPAK packages



NG1D2TS3



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	I ² PAK, 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. $I_{SD} \leq 11$ A, $di/dt \leq 400$ A/μs, $V_{DD} = 80\% V_{(BR)DSS}$.

Table 2. Thermal data

Symbol	Parameter	Value			Unit
		TO-220FP	I ² PAK, TO-220	IPAK	
R _{thj-case}	Thermal resistance junction-case	5	1.39		°C/W
R _{thj-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

($T_C = 25\text{ }^{\circ}\text{C}$ unless otherwise specified)

Table 4. Static

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$V_{GS} = 0\text{ V}$, $I_D = 1\text{ mA}$	600			V
I_{DSS}	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$, $V_{DS} = 600\text{ V}$			1	μA
		$V_{GS} = 0\text{ V}$, $V_{DS} = 600\text{ V}$, $T_C = 125\text{ }^{\circ}\text{C}$ ⁽¹⁾			100	
I_{GSS}	Gate-body leakage current	$V_{DS} = 0\text{ V}$, $V_{GS} = \pm 25\text{ V}$			± 100	nA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$, $I_D = 250\text{ }\mu\text{A}$	2	3	4	V
$R_{DS(on)}$	Static drain-source on-resistance	$V_{GS} = 10\text{ V}$, $I_D = 5.5\text{ A}$		280	360	m Ω

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

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	$V_{DS} = 50\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0\text{ V}$	-	790	-	pF
C_{oss}	Output capacitance		-	60	-	pF
C_{rss}	Reverse transfer capacitance		-	3.6	-	pF
$C_{oss\text{ eq.}}^{(1)}$	Equivalent output capacitance	$V_{DS} = 0\text{ to }480\text{ V}$, $V_{GS} = 0\text{ V}$	-	135	-	pF
Q_g	Total gate charge	$V_{DD} = 480\text{ V}$, $I_D = 11\text{ A}$, $V_{GS} = 0\text{ to }10\text{ V}$ (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	$f = 1\text{ MHz}$, open drain	-	4.7	-	Ω

1. $C_{oss\text{ eq.}}$ 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	$V_{DD} = 300\text{ V}$, $I_D = 5.5\text{ A}$, $R_G = 4.7\text{ }\Omega$, $V_{GS} = 10\text{ V}$	-	3	-	ns
t_r	Rise time		-	8	-	ns
$t_{d(off)}$	Turn-off delay time	(see Figure 16. Test circuit for resistive load switching times and Figure 21. Switching time waveform)	-	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	$V_{GS} = 0\text{ V}$, $I_{SD} = 11\text{ A}$	-		1.5	V
t_{rr}	Reverse recovery time	$I_{SD} = 11\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 100\text{ V}$ (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	$I_{SD} = 11\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 100\text{ V}$, $T_J = 150\text{ }^\circ\text{C}$ (see Figure 18. Test circuit for inductive load switching and diode recovery times)	-	18		A
t_{rr}	Reverse recovery time		-	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)

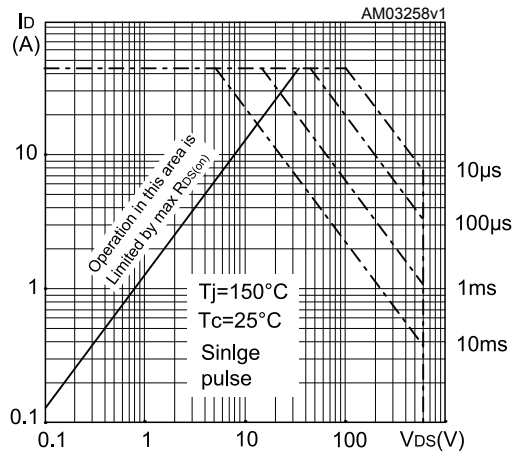
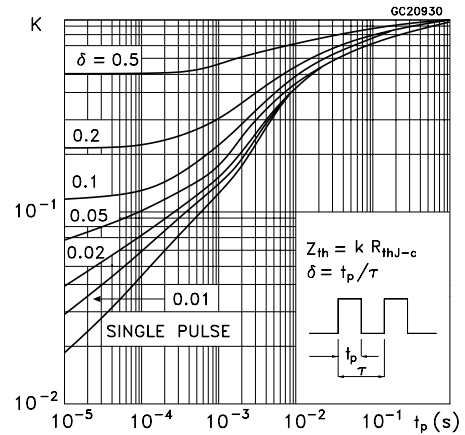
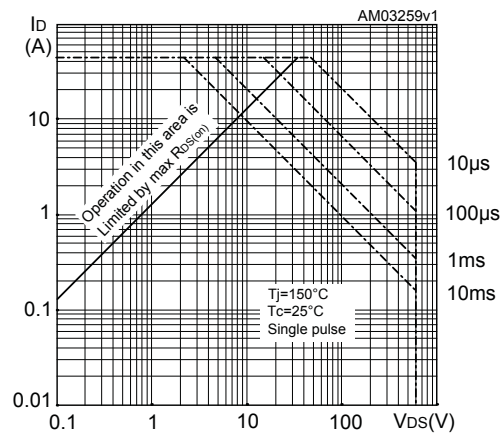
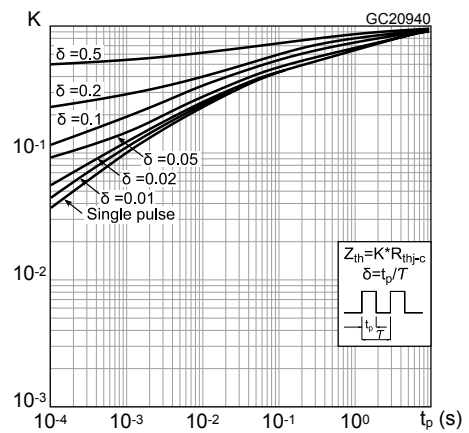
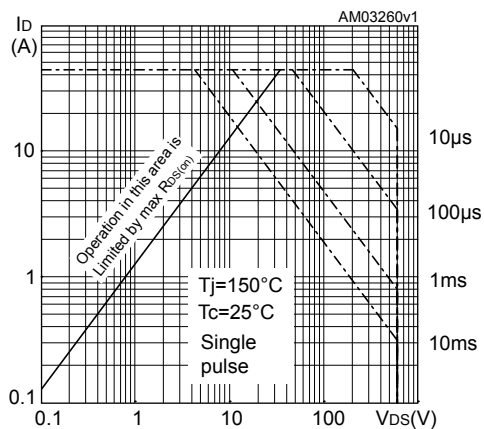
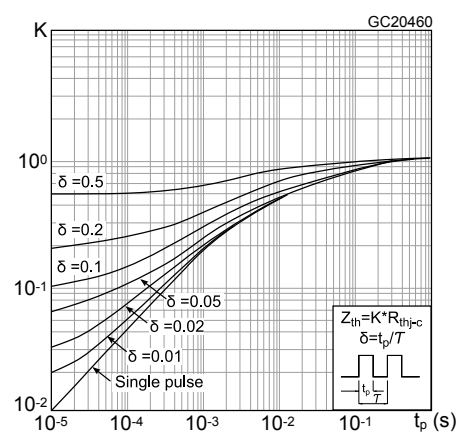
Figure 1. Safe operating area for I²PAK and TO-220

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


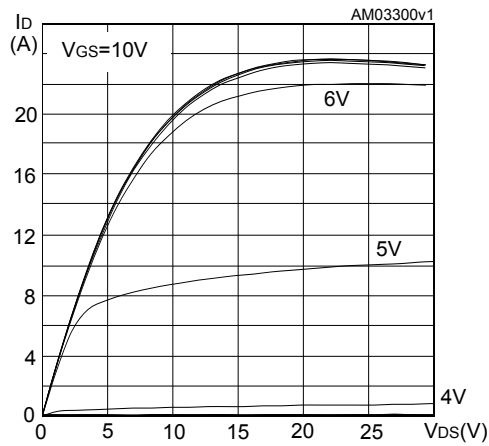
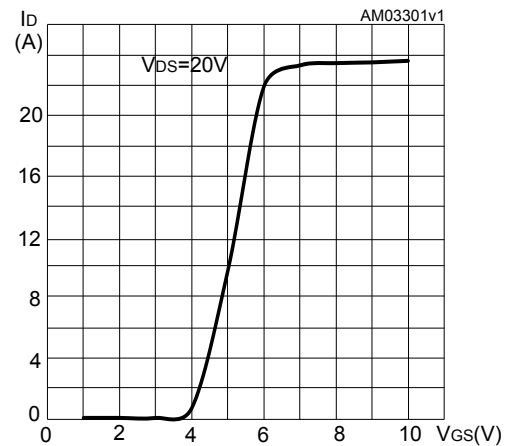
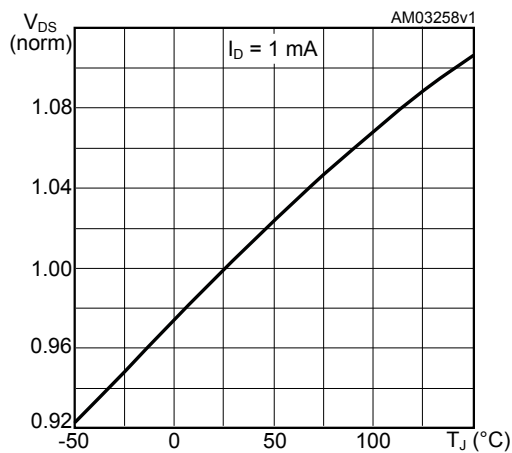
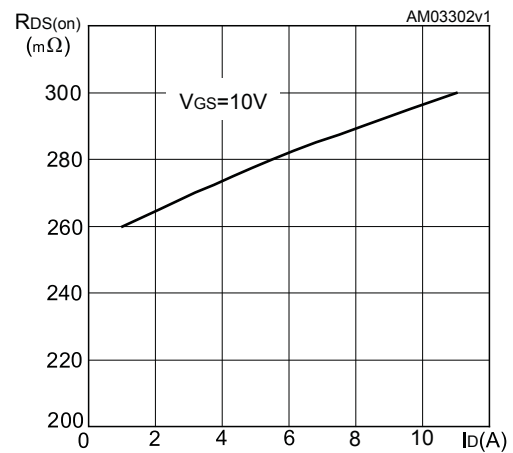
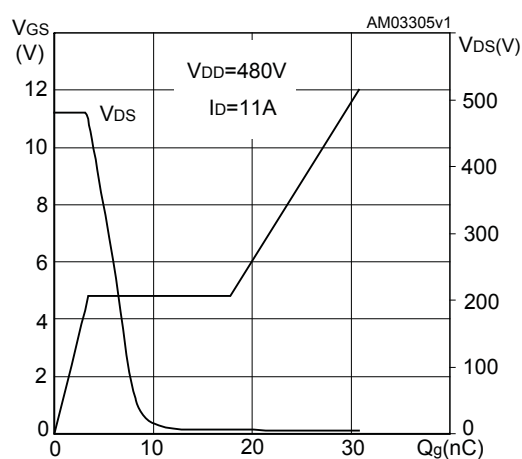
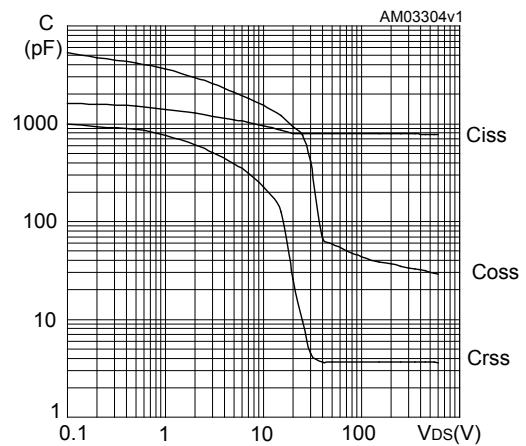
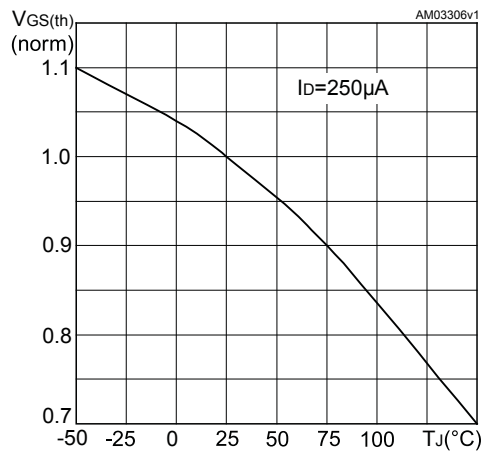
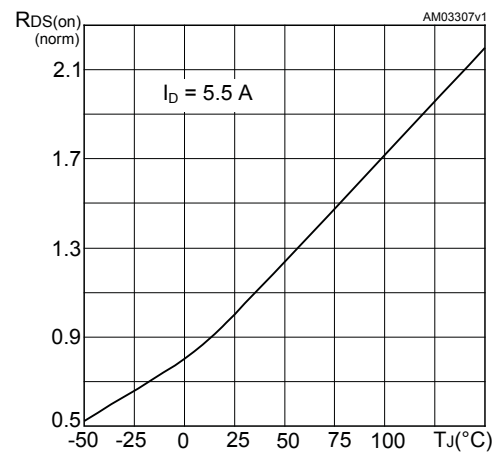
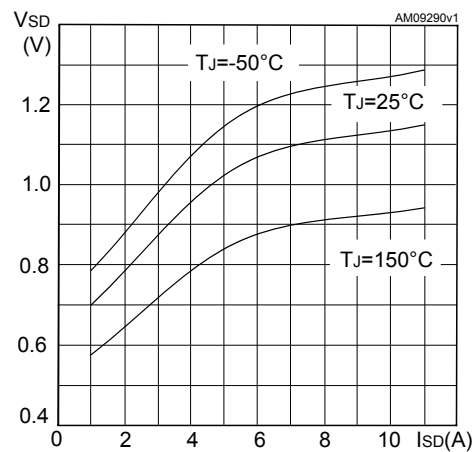
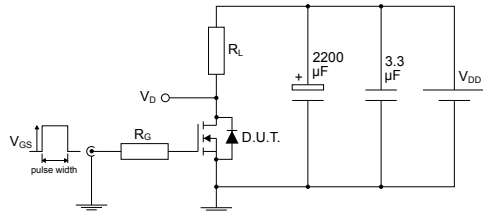
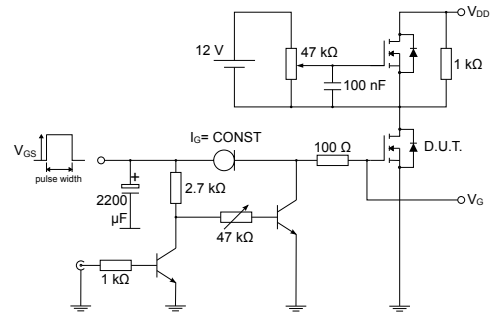
Figure 7. Output characteristics

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


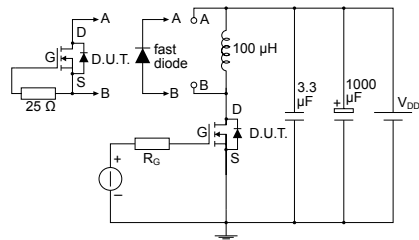
3 Test circuits

Figure 16. Test circuit for resistive load switching times


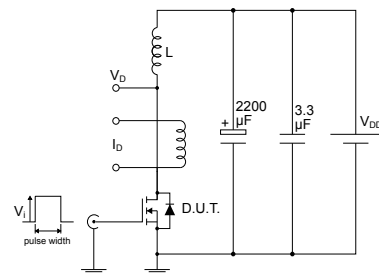
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Figure 17. Test circuit for gate charge behavior


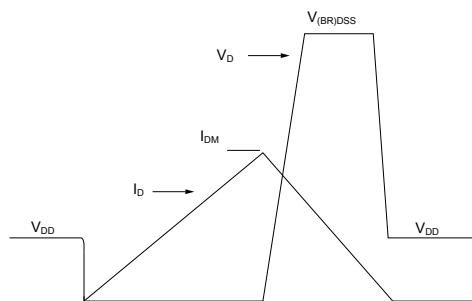
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Figure 18. Test circuit for inductive load switching and diode recovery times


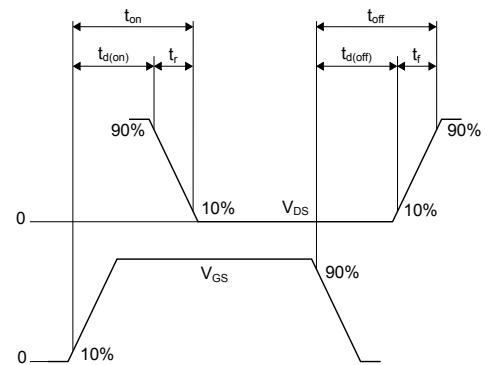
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Figure 19. Unclamped inductive load test circuit


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Figure 20. Unclamped inductive waveform


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Figure 21. Switching time waveform


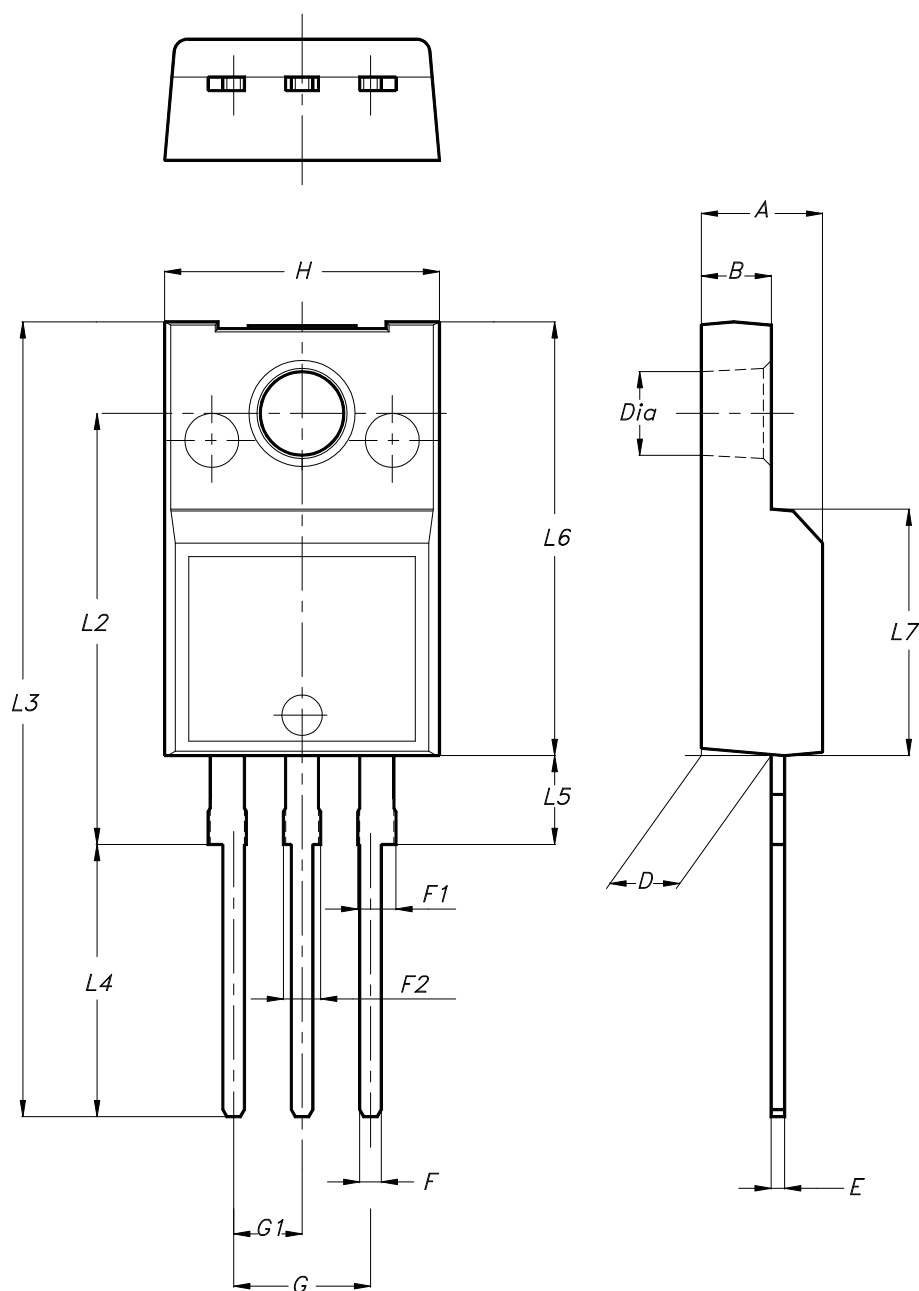
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4 Package information

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



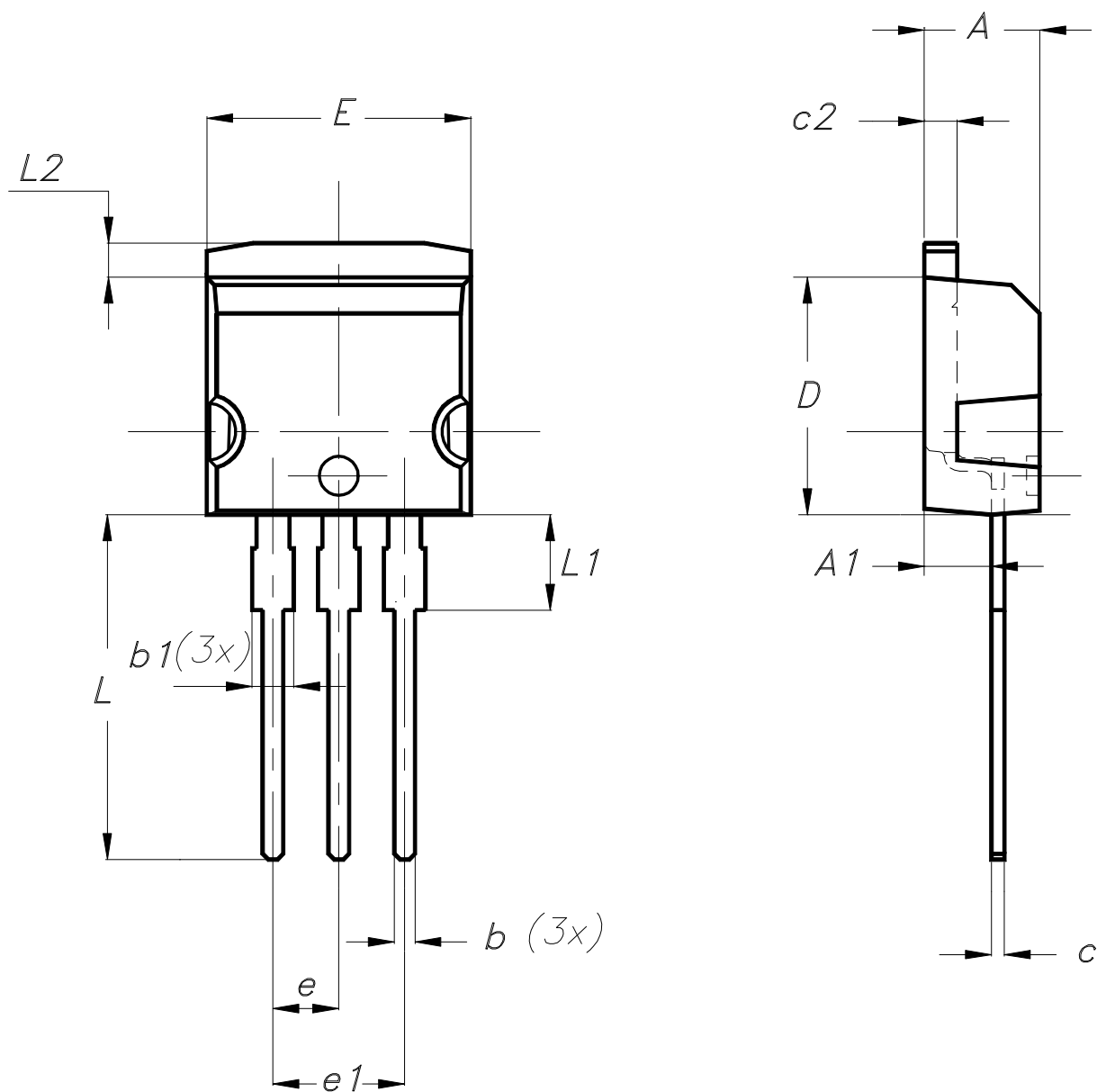
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Table 8. TO-220FP package mechanical data

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



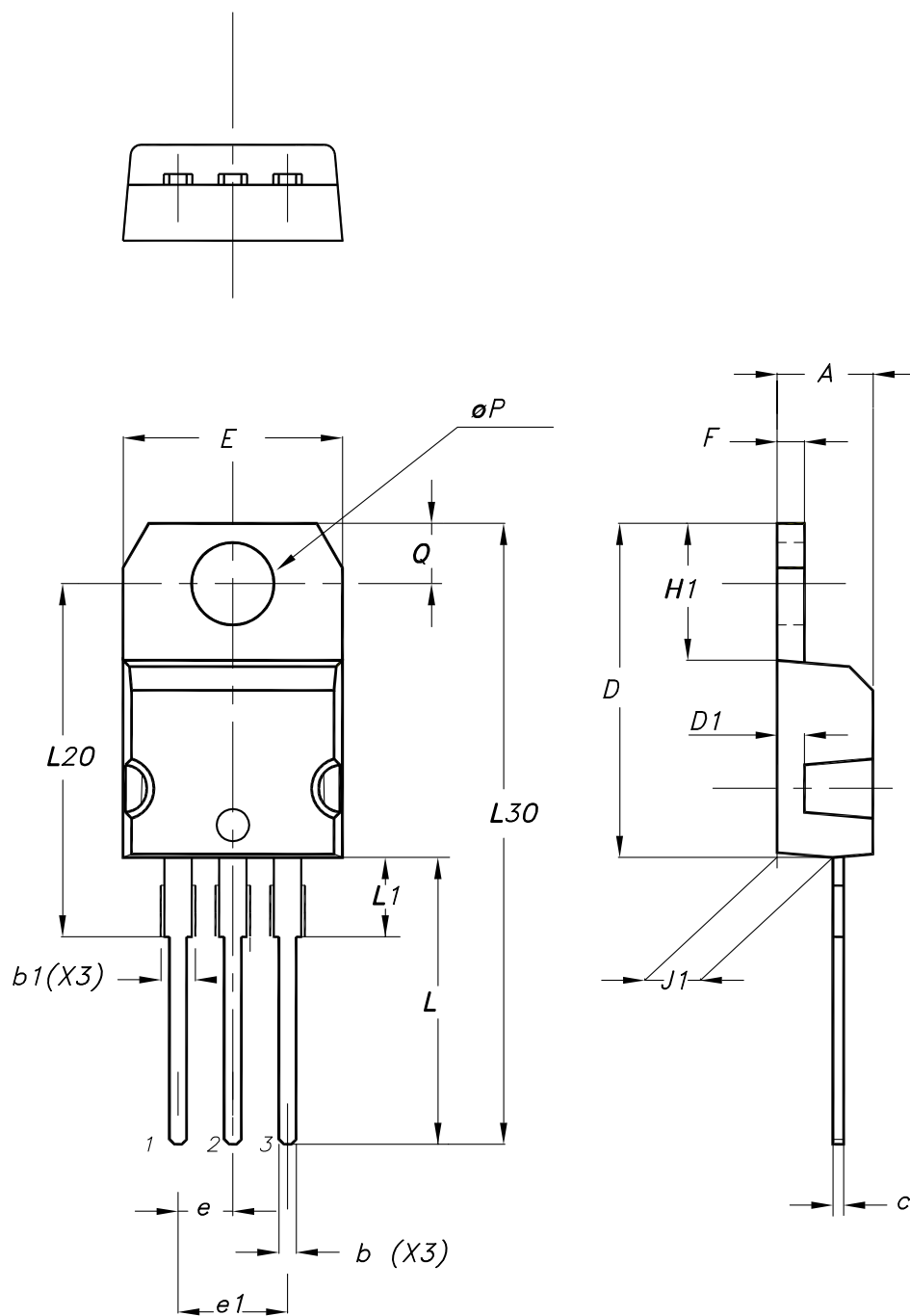
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Table 9. I²PAK package mechanical data

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



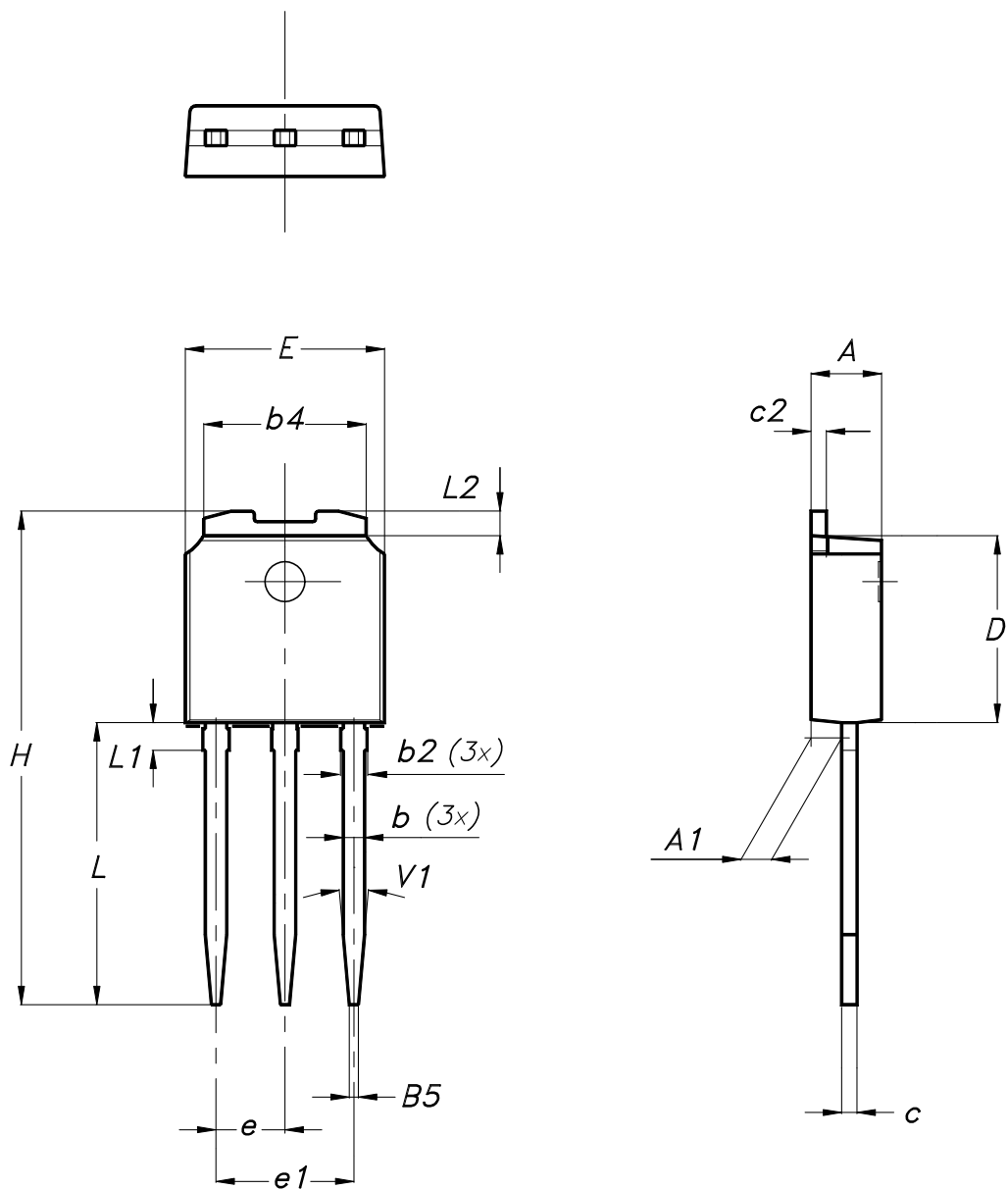
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Table 10. TO-220 type A package mechanical data

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



0068771_IK_typeA_rev15

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		I ² PAK	
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 <i>Figure 4</i> – 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. <i>Section 4: Package mechanical data</i> 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.

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