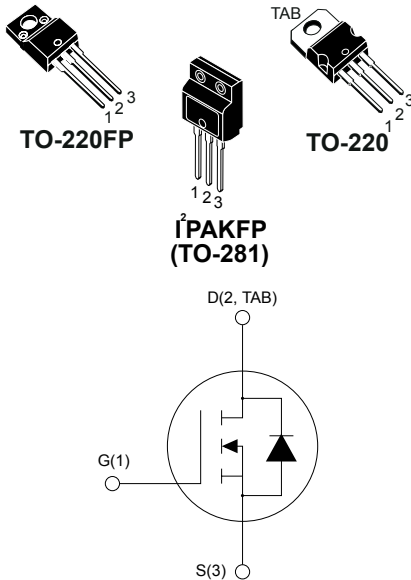


N-channel 650 V, 425 mΩ typ., 11 A MDmesh II Power MOSFETs in TO-220FP, I<sup>2</sup>PAKFP and TO-220 packages



## Features

Order codes	V <sub>DS</sub>	R <sub>DS(on)</sub> max.	I <sub>D</sub>
STF11NM65N	650 V	455 mΩ	11 A
STFI11NM65N			
STP11NM65N			

- 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 links

[STF11NM65N](#)
[STFI11NM65N](#)
[STP11NM65N](#)

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		TO-220FP, I <sup>2</sup> PAKFP	TO-220	
V <sub>DS</sub>	Drain-source voltage	650		V
V <sub>GS</sub>	Gate-source voltage	±25		V
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 25 °C	11		A
	Drain current (continuous) at T <sub>C</sub> = 100 °C	7		
I <sub>DM</sub> <sup>(1)</sup>	Drain current (pulsed)	44		A
P <sub>TOT</sub>	Total power dissipation at T <sub>C</sub> = 25 °C	25	110	W
I <sub>AR</sub>	Avalanche current, repetitive or non-repetitive (pulse width limited by T <sub>J</sub> max)	3		A
E <sub>AS</sub>	Single pulse avalanche energy (starting T <sub>J</sub> = 25 °C, I <sub>D</sub> = I <sub>AR</sub> , V <sub>DD</sub> = 50 V)	147		mJ
dv/dt <sup>(2)</sup>	Peak diode recovery voltage slope	15		V/ns
V <sub>ISO</sub>	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s, T <sub>C</sub> = 25 °C)	2.5		kV
T <sub>stg</sub>	Storage temperature range	-55 to 150		°C
T <sub>J</sub>	Operating junction temperature range			°C

1. Pulse width limited by safe operating area.

2.  $I_{SD} \leq 11$  A,  $di/dt \leq 400$  A/ $\mu$ s,  $V_{DS}(\text{peak}) \leq V_{(BR)DSS}$ .

**Table 2. Thermal data**

Symbol	Parameter	Value		Unit
		TO-220FP, I <sup>2</sup> PAKFP	TO-220	
R <sub>thJC</sub>	Thermal resistance, junction-to-case	5	1.14	°C/W
R <sub>thJA</sub>	Thermal resistance, junction-to-ambient	62.5		°C/W

## 2 Electrical characteristics

$T_C = 25\text{ °C}$  unless otherwise specified.

**Table 3. On/off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 1\text{ mA}$ , $V_{GS} = 0\text{ V}$	650			V
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$ , $V_{DS} = 650\text{ V}$			1	$\mu\text{A}$
		$V_{GS} = 0\text{ V}$ , $V_{DS} = 650\text{ V}$ , $T_C = 125\text{ °C}$ <sup>(1)</sup>			100	
$I_{GSS}$	Gate body leakage current	$V_{GS} = \pm 25\text{ V}$ , $V_{DS} = 0\text{ V}$			$\pm 100$	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	$V_{GS} = 10\text{ V}$ , $I_D = 5.5\text{ A}$		425	455	m $\Omega$

1. Specified by design, not tested in production.

**Table 4. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0\text{ V}$	-	800	-	pF
$C_{oss}$	Output capacitance		-	50	-	pF
$C_{riss}$	Reverse transfer capacitance		-	2.9	-	pF
$C_{oss\text{ eq.}}^{(1)}$	Equivalent output capacitance	$V_{GS} = 0\text{ V}$ , $V_{DS} = 0\text{ to }520\text{ V}$	-	133	-	pF
$R_g$	Intrinsic gate resistance	$f = 1\text{ MHz}$ , $I_D = 0\text{ A}$	-	4.2	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 520\text{ V}$ , $I_D = 11\text{ A}$ , $V_{GS} = 0\text{ to }10\text{ V}$ (see Figure 16. Test circuit for gate charge behavior)	-	29	-	nC
$Q_{gs}$	Gate-source charge		-	3.9	-	nC
$Q_{gd}$	Gate-drain charge		-	16	-	nC

1.  $C_{oss\text{ eq.}}$  is defined as the constant equivalent capacitance giving the same charging time as  $C_{oss}$  when  $V_{DS}$  increases from 0 to 80%  $V_{DSS}$ .

**Table 5. Switching times**

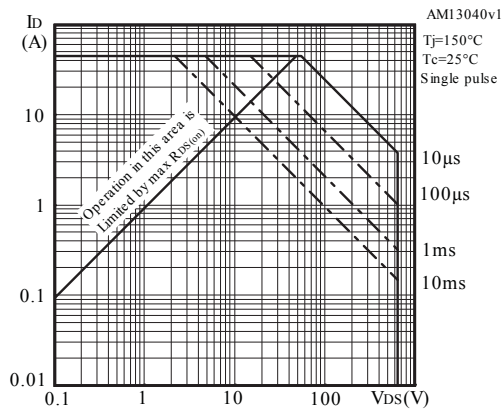
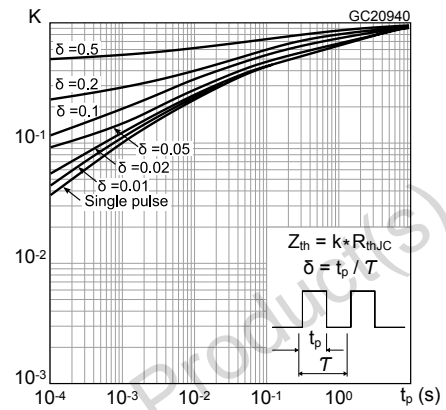
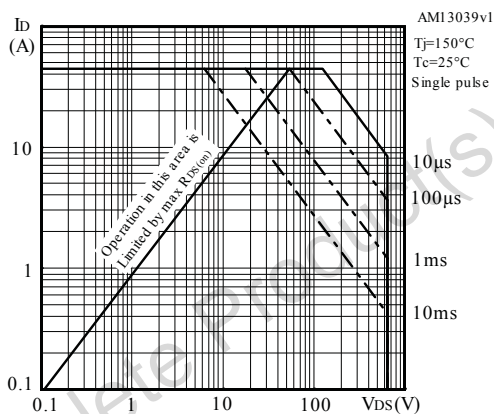
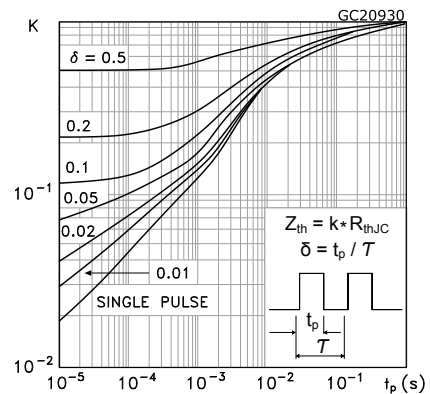
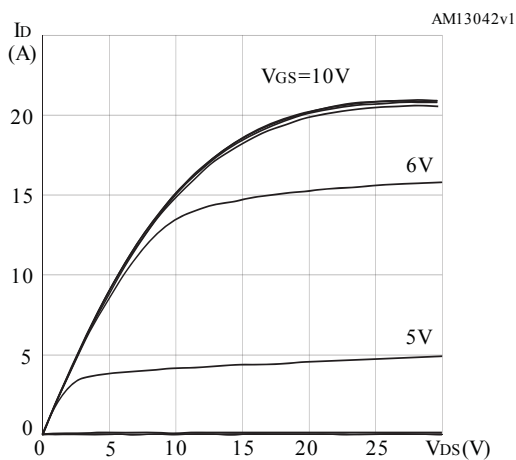
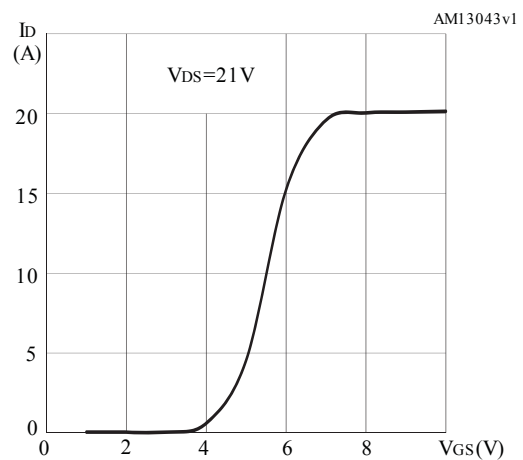
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 325\text{ V}$ , $I_D = 5.5\text{ A}$ , $R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$ (see Figure 15. Test circuit for resistive load switching times and Figure 20. Switching time waveform)	-	15.5	-	ns
$t_r$	Rise time		-	10.8	-	ns
$t_{d(off)}$	Turn-off delay time		-	11	-	ns
$t_f$	Fall time		-	47	-	ns

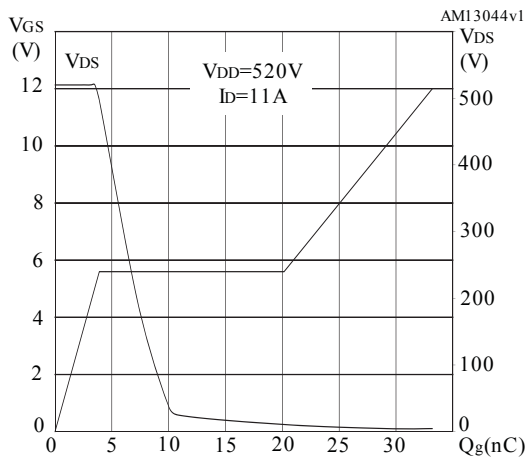
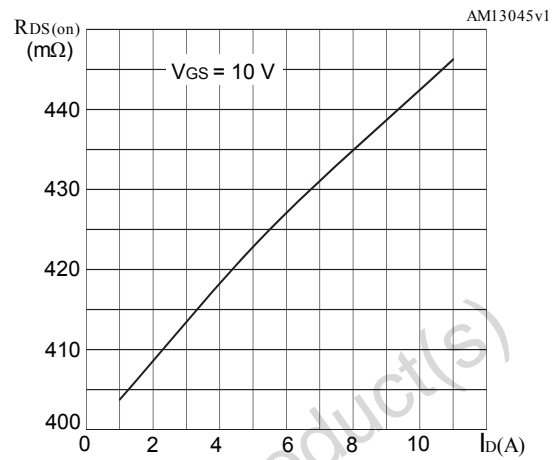
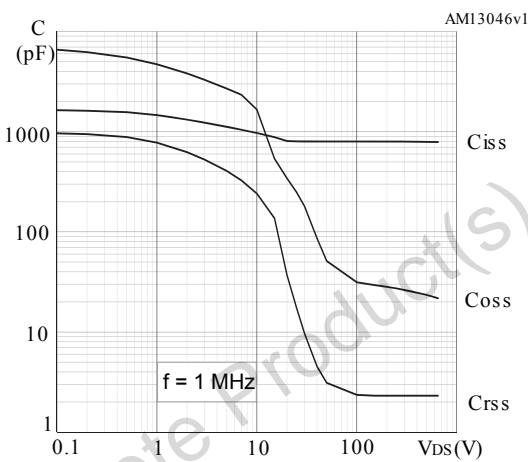
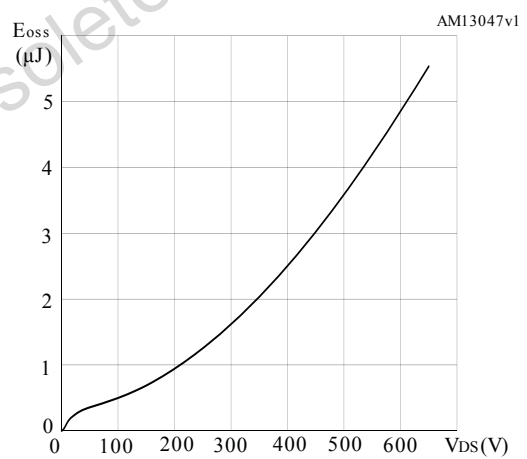
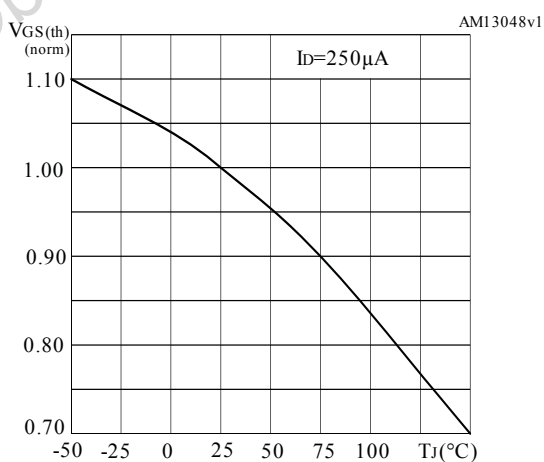
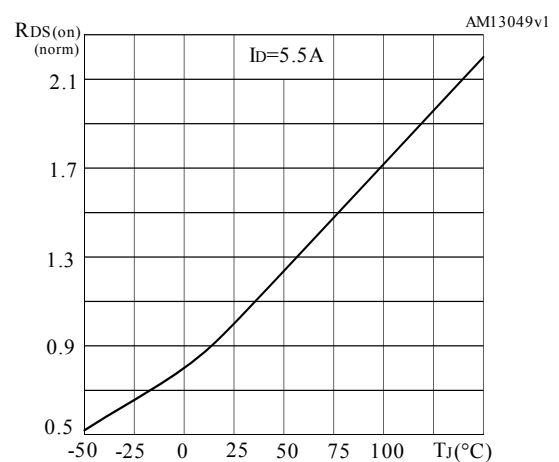
**Table 6. Source-drain diode**

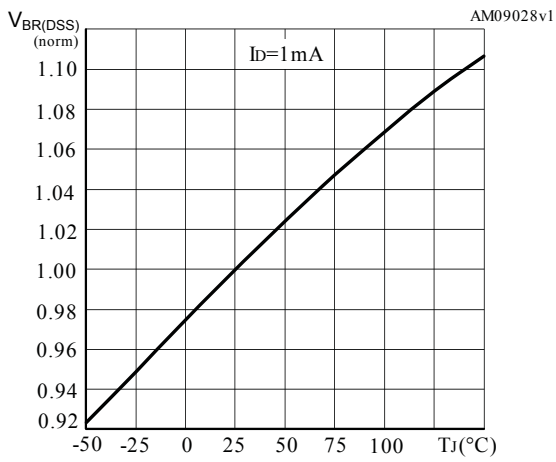
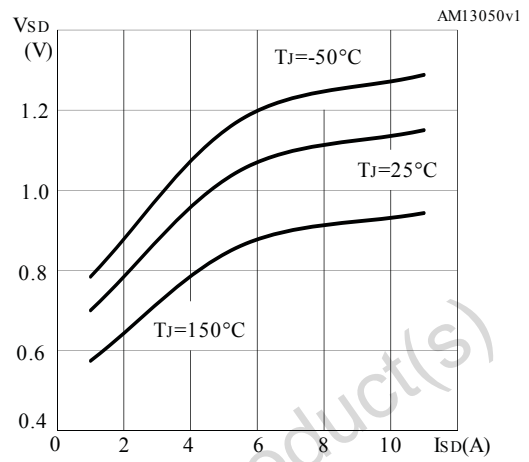
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		11	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		44	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 11\text{ A}$ , $V_{GS} = 0\text{ V}$	-		1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 11\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 60\text{ V}$	-	418		ns
$Q_{rr}$	Reverse recovery charge	(see Figure 17. Test circuit for inductive load switching and diode recovery times)	-	4.4		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	21		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 11\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 60\text{ V}$ ,	-	530		ns
$Q_{rr}$	Reverse recovery charge	$T_J = 150\text{ }^\circ\text{C}$ (see Figure 17. Test circuit for inductive load switching and diode recovery times)	-	5.6		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	21		A

1. Pulse width limited by safe operating area.

2. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%.

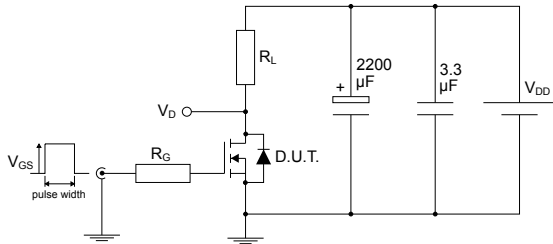
**2.1 Electrical characteristics (curves)**
**Figure 1. Safe operating area for TO-220FP and I<sup>2</sup>PAKFP**

**Figure 2. Normalized transient thermal impedance for TO-220FP and I<sup>2</sup>PAKFP**

**Figure 3. Safe operating area for TO-220**

**Figure 4. Normalized transient thermal impedance for TO-220**

**Figure 5. Typical output characteristics**

**Figure 6. Typical transfer characteristics**


**Figure 7. Typical gate charge characteristics**

**Figure 8. Typical drain-source on-resistance**

**Figure 9. Typical capacitance characteristics**

**Figure 10. Typical output capacitance stored energy**

**Figure 11. Normalized gate threshold vs temperature**

**Figure 12. Normalized on-resistance vs temperature**


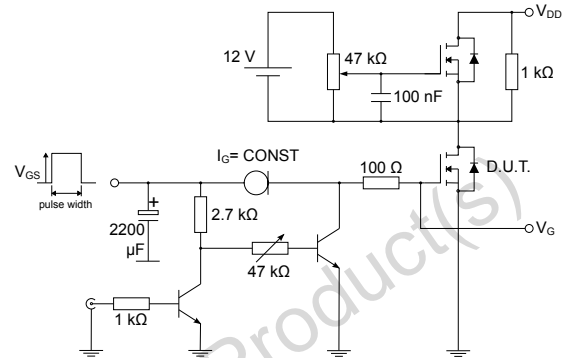
**Figure 13. Normalized breakdown voltage vs temperature**

**Figure 14. Typical reverse diode forward characteristics**


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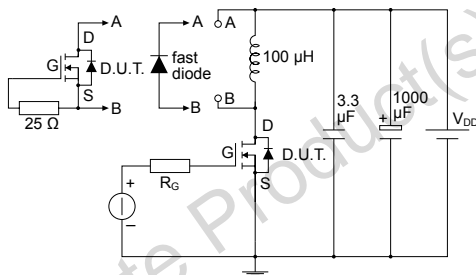
### 3 Test circuits

**Figure 15. Test circuit for resistive load switching times**


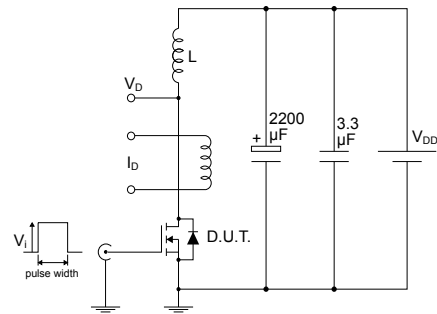
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**Figure 16. Test circuit for gate charge behavior**


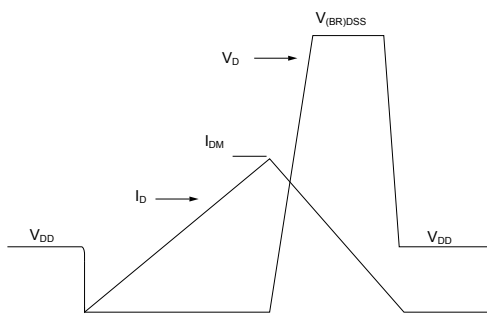
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**Figure 17. Test circuit for inductive load switching and diode recovery times**


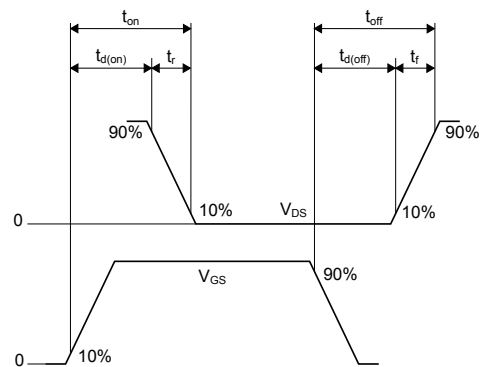
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**Figure 18. Unclamped inductive load test circuit**


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**Figure 19. Unclamped inductive waveform**


AM01472v1

**Figure 20. Switching time waveform**


AM01473v1

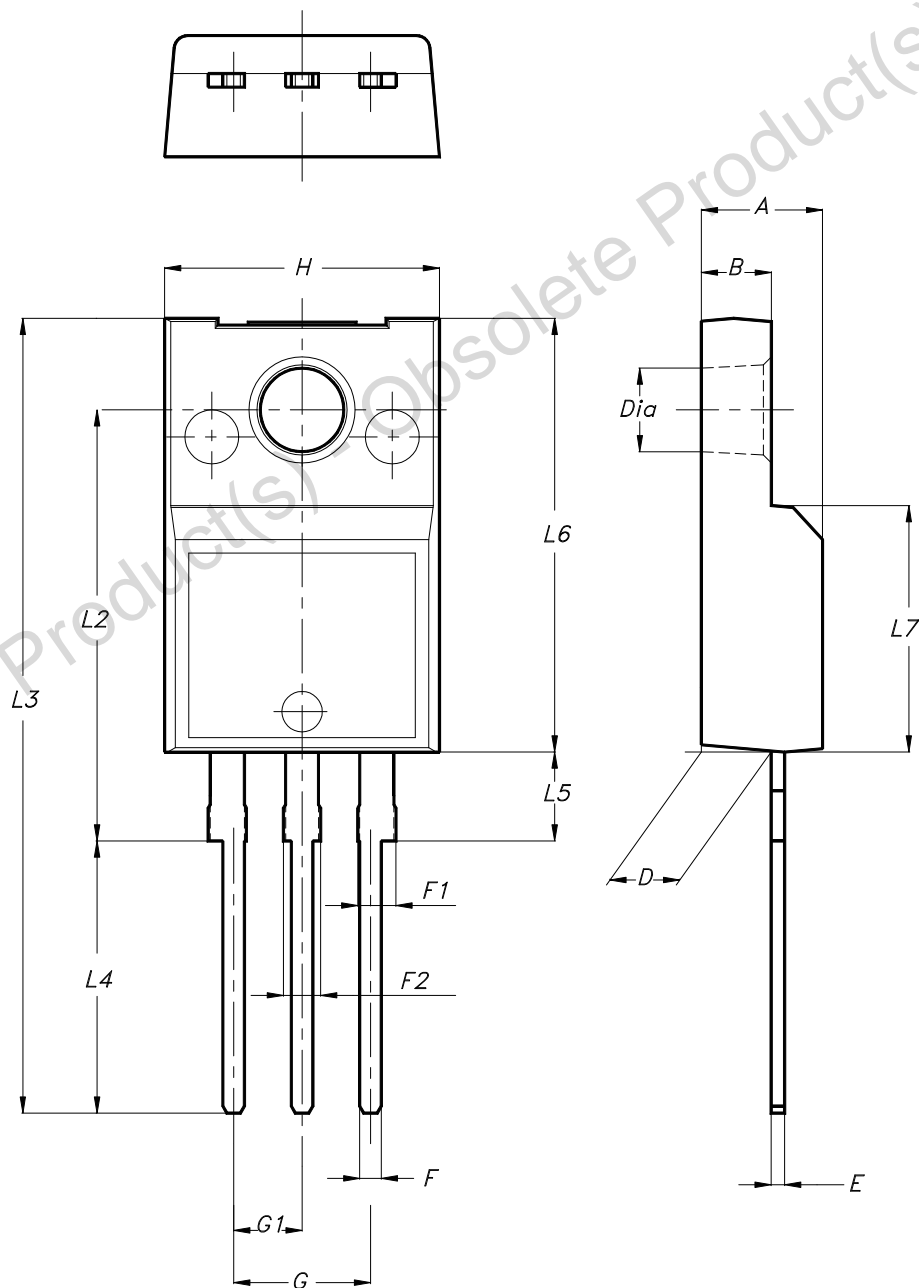


## 4 Package information

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](http://www.st.com). ECOPACK is an ST trademark.

### 4.1 TO-220FP type B package information

Figure 21. TO-220FP type B package outline



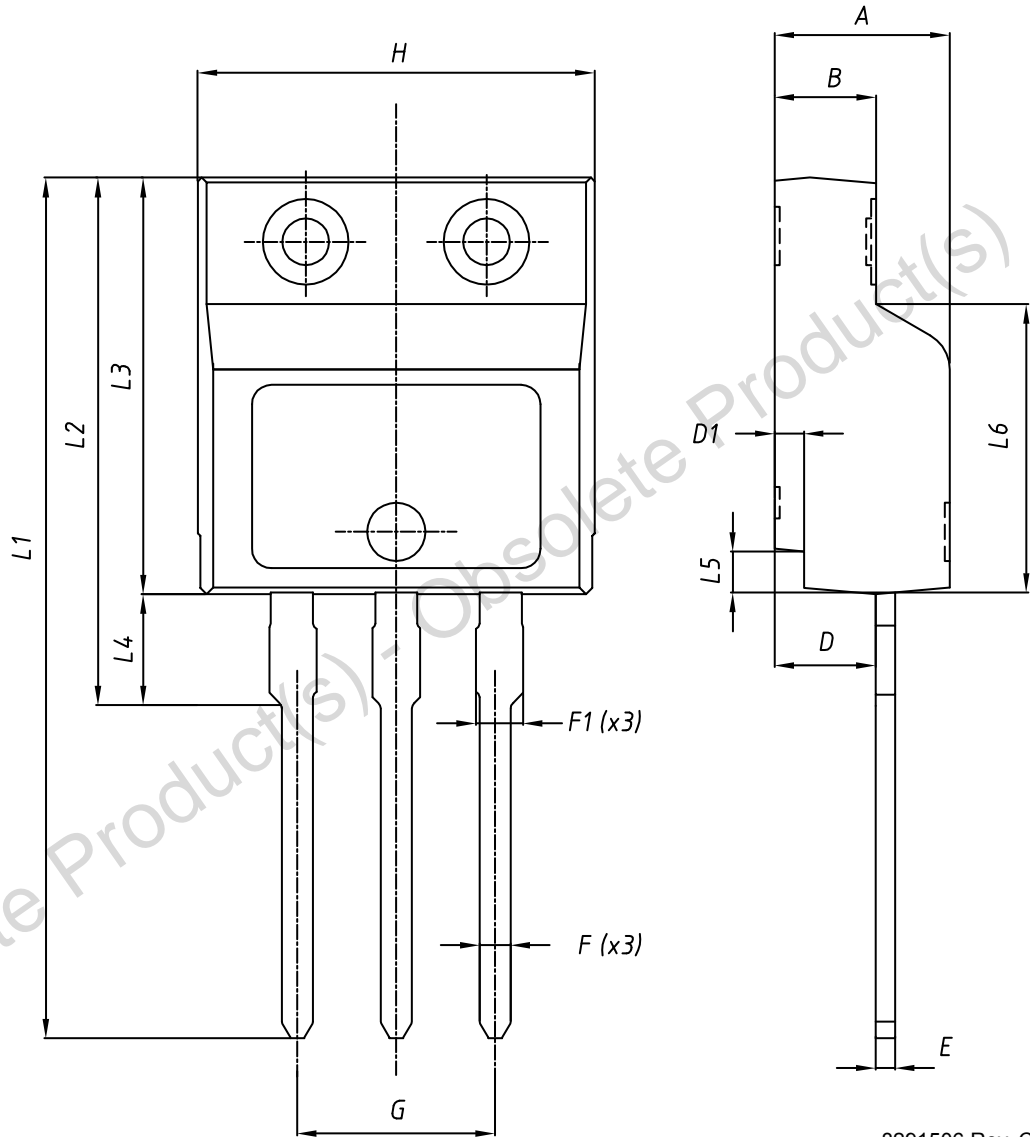
7012510\_B\_rev.14

**Table 7. TO-220FP type B 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 I<sup>2</sup>PAKFP (TO-281) package information

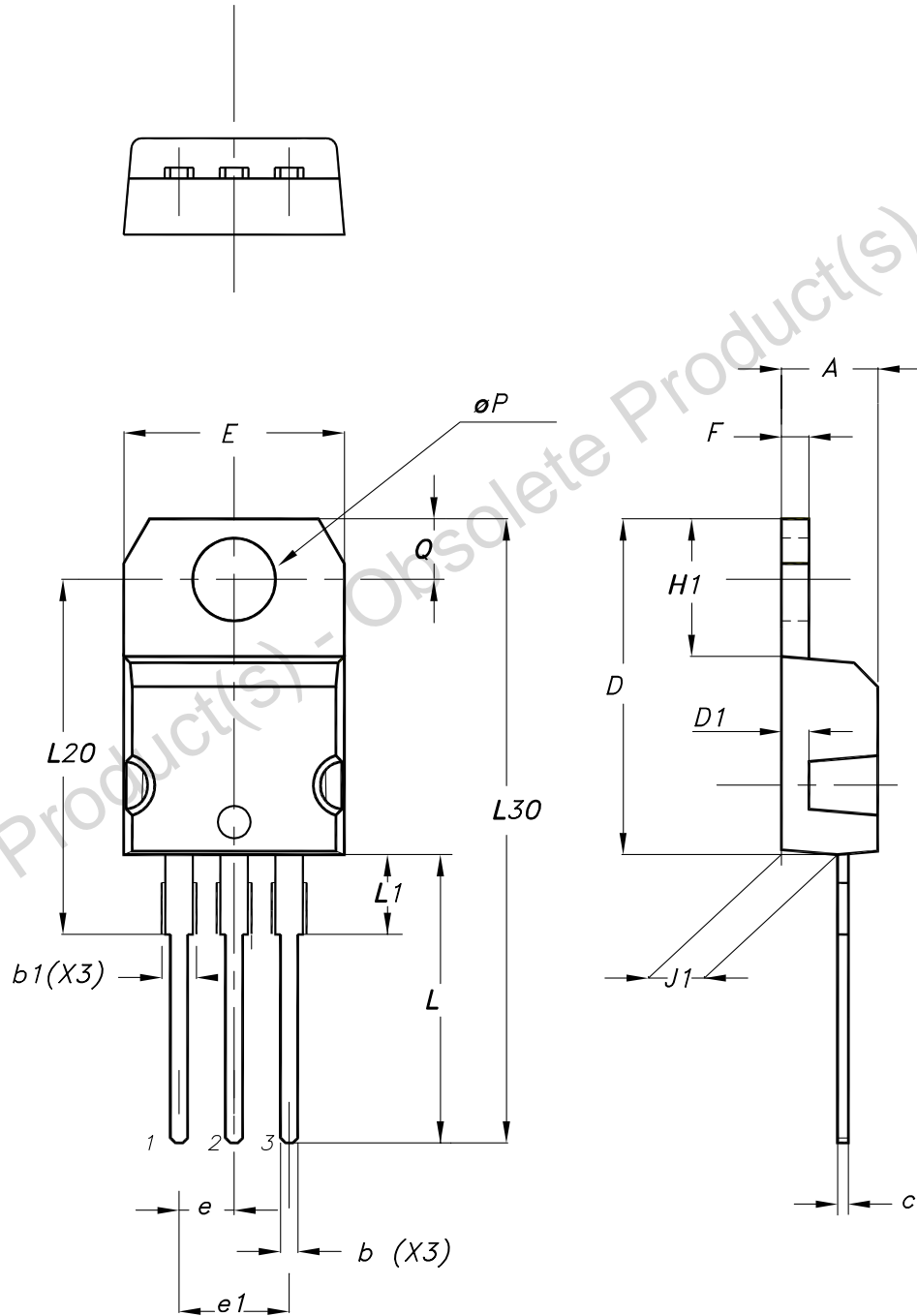
Figure 22. I<sup>2</sup>PAKFP (TO-281) package outline



8291506 Rev. C

**Table 8. I<sup>2</sup>PAKFP (TO-281) mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
B	2.50		2.70
D	2.50		2.75
D1	0.65		0.85
E	0.45		0.70
F	0.75		1.00
F1			1.20
G	4.95		5.20
H	10.00		10.40
L1	21.00		23.00
L2	13.20		14.10
L3	10.55		10.85
L4	2.70		3.20
L5	0.85		1.25
L6	7.50	7.60	7.70

**4.3 TO-220 type A package information**
**Figure 23. TO-220 type A package outline**


0015988\_typeA\_Rev\_23

**Table 9. 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

## 5 Ordering information

**Table 10. Order codes**

Order codes	Marking	Package	Packing
STF11NM65N	11NM65N	TO-220FP	Tube
STFI11NM65N		I <sup>2</sup> PAKFP	
STP11NM65N		TO-220	

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## Revision history

Table 11. Document revision history

Date	Version	Changes
08-May-2023	1	First release. Part numbers previously included in datasheet DS5257.

Obsolete Product(s) - Obsolete Product(s)





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