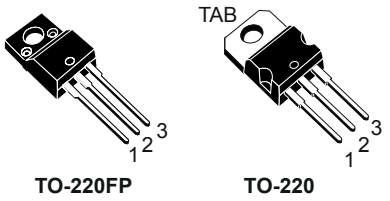
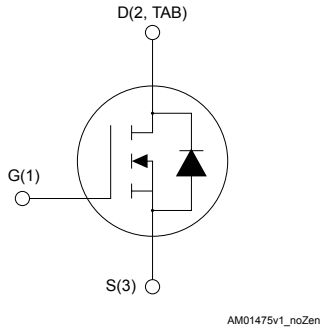
STF12N65M5, STP12N65M5

Datasheet

N-channel 650 V, 390 mΩ typ., 8.5 A MDmesh M5 Power MOSFET in a TO-220FP and TO-220 packages



TO-220FP **TO-220**



Features

Order code	V_{DS} @ T_J max.	$R_{DS(on)}$ max.	I_D
STF12N65M5	710 V	430 mΩ	8.5 A
STP12N65M5			

- Extremely low $R_{DS(on)}$
- Low gate charge and input capacitance
- Excellent switching performance
- 100% avalanche tested

Applications

- Switching applications

Description

This device is an N-channel Power MOSFET based on the MDmesh M5 innovative vertical process technology combined with the well-known PowerMESH horizontal layout. The resulting product offers extremely low on-resistance, making it particularly suitable for applications requiring high power and superior efficiency.

Product status links
STF12N65M5
STP12N65M5

Product summary	
Order code	**STF12N65M5**
Marking	12N65M5
Package	TO-220FP
Packing	Tube
Order code	**STP12N65M5**
Marking	12N65M5
Package	TO-220
Packing	Tube

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1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		TO-220FP	TO-220	
V_{DS}	Drain-source voltage	650		V
V_{GS}	Gate-source voltage	25		V
I_D	Drain current (continuous) at T_C = 25 °C	8.5(1)	8.5	A
	Drain current (continuous) at T_C = 100 °C	5.4(1)	5.4	
I_{DM}(2)	Drain current (pulsed)	34	34	A
P_{TOT}	Total power dissipation at T_C = 25 °C	25	70	W
I_{AR}	Avalanche current, repetitive or not repetitive (pulse width limited by T_J max.)	2.5		A
E_{AS}	Single pulse avalanche energy (starting T_J = 25 °C, I_D = I_{AR}, V_{DD} = 50 V)	150		mJ
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_{stg}	Storage temperature range	-55 to 150		°C
T_J	Operating junction temperature range			°C

1. *Limited by maximum junction temperature.*
2. *Pulse width is limited by safe operating area.*
3. *I_{SD} ≤ 8.5 A, di/dt ≤ 400 A/µs, V_{DS} (peak) < $V_{(BR)DSS}$, V_{DD} = 400 V.*

Table 2. Thermal data

Symbol	Parameter	Value		Unit
		TO-220FP	TO-220	
R_{thJC}	Thermal resistance, junction-to-case	5.00	1.79	°C/W
R_{thJA}	Thermal resistance, junction-to-ambient	62.5		°C/W

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2 Electrical characteristics

T_C = 25 °C unless otherwise specified.

Table 3. 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(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	3	4	5	V
$R_{DS(on)}$	Static drain-source on-resistance	V_{GS} = 10 V, I_D = 4.3 A		390	430	mΩ

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} = 100 V, f = 1 MHz, V_{GS} = 0 V	-	900	-	pF
C_{oss}	Output capacitance		-	22	-	pF
C_{rss}	Reverse transfer capacitance		-	2	-	pF
$C_{o(tr)}$(1)	Equivalent capacitance time related	V_{DS} = 0 to 520 V, V_{GS} = 0 V	-	64	-	pF
$C_{o(er)}$(2)	Equivalent capacitance energy related		-	21	-	pF
R_g	Intrinsic gate resistance	f = 1 MHz, I_D = 0 A	-	5	-	Ω
Q_g	Total gate charge	V_{DD} = 520 V, I_D = 4.25 A, V_{GS} = 0 to 10 V (see Figure 17. Test circuit for gate charge behavior)	-	20	-	nC
Q_{gs}	Gate-source charge		-	4.8	-	nC
Q_{gd}	Gate-drain charge		-	8.3	-	nC

1. *$C_{o(tr)}$ is an equivalent capacitance that provides the same charging time as C_{oss} while V_{DS} is rising from 0 V to the stated value.*
2. *$C_{o(er)}$ is an equivalent capacitance that provides the same stored energy as C_{oss} while V_{DS} is rising from 0 V to the stated value.*

Table 5. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(v)}$	Voltage delay time	V_{DD} = 400 V, I_D = 5 A, R_G = 4.7 Ω, V_{GS} = 10 V (see Figure 18. Test circuit for inductive load switching and diode recovery times and Figure 21. Switching time waveform)	-	22.6	-	ns
$t_{r(v)}$	Voltage rise time		-	17.6	-	ns
$t_{f(i)}$	Current fall time		-	15.6	-	ns
$t_{c(off)}$	Crossing time		-	23.4	-	ns

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Table 6. Source-drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		8.5	A
I_{SDM}(1)	Source-drain current (pulsed)		-		34	A
V_{SD}(2)	Forward on voltage	I_{SD} = 8.5 A, V_{GS} = 0 V	-		1.5	V
t_{rr}	Reverse recovery time	I_{SD} = 8.5 A, di/dt = 100 A/µs,	-	230		ns
Q_{rr}	Reverse recovery charge	V_{DD} = 100 V	-	2.2		µC
I_{RRM}	Reverse recovery current	(see Figure 18. Test circuit for inductive load switching and diode recovery times)	-	19		A
t_{rr}	Reverse recovery time	I_{SD} = 8.5 A, di/dt = 100 A/µs,	-	280		ns
Q_{rr}	Reverse recovery charge	V_{DD} = 100 V, T_J = 150 °C	-	2.7		µC
I_{RRM}	Reverse recovery current	(see Figure 18. Test circuit for inductive load switching and diode recovery times)	-	19		A

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

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2.1 Electrical characteristics (curves)

Figure 1. Safe operating area for TO-220FP

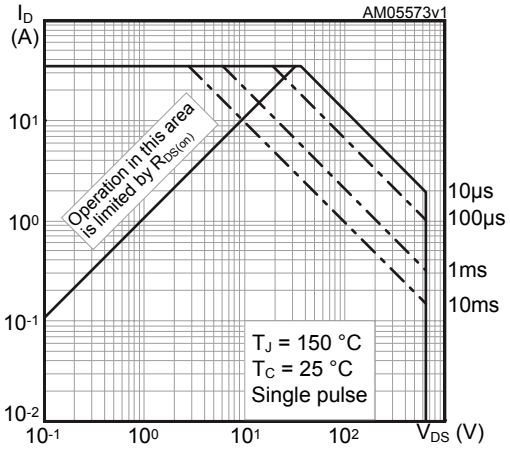

Figure 2. Normalized transient thermal impedance for TO-220FP

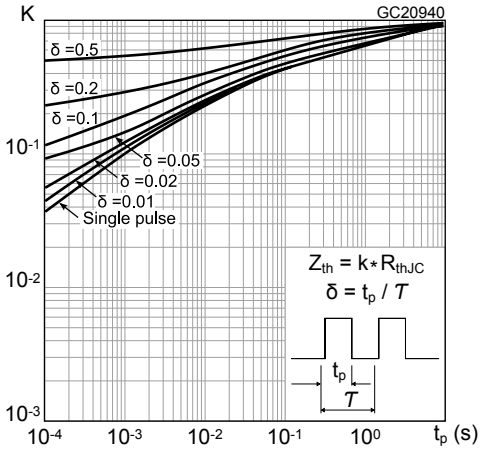

Figure 3. Safe operating area for TO-220

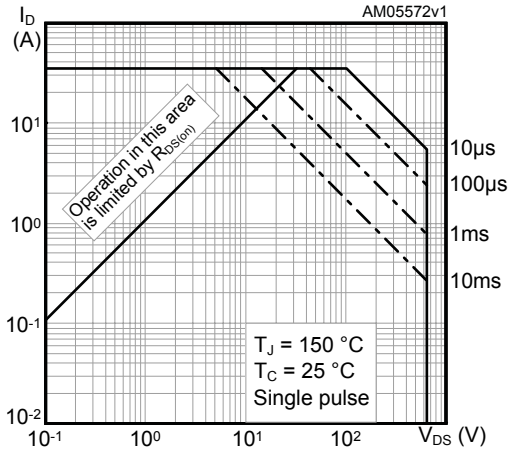

Figure 4. Normalized transient thermal impedance for TO-220

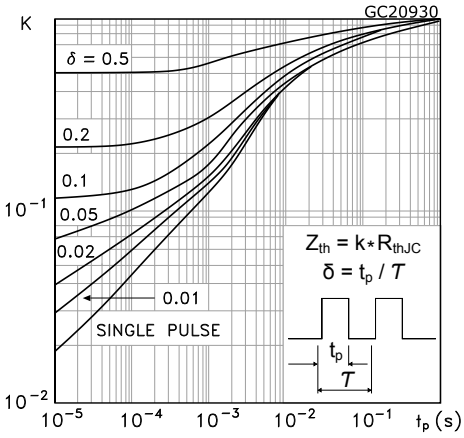

Figure 5. Typical output characteristics

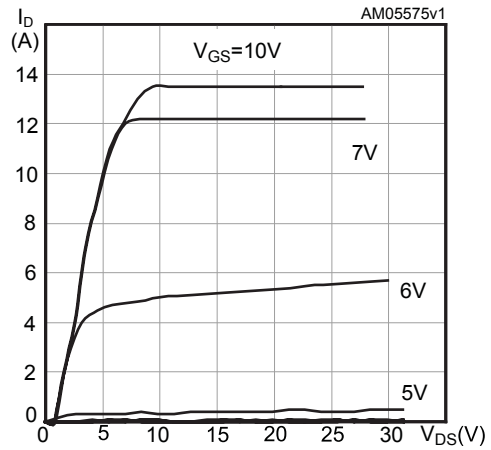

Figure 6. Typical transfer characteristics

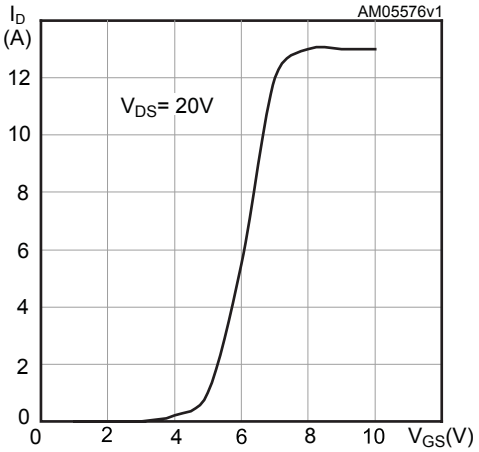

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Figure 7. Typical gate charge characteristics

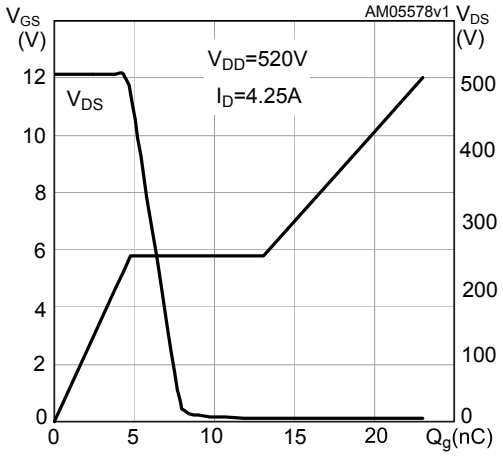

Figure 8. Typical drain-source on-resistance

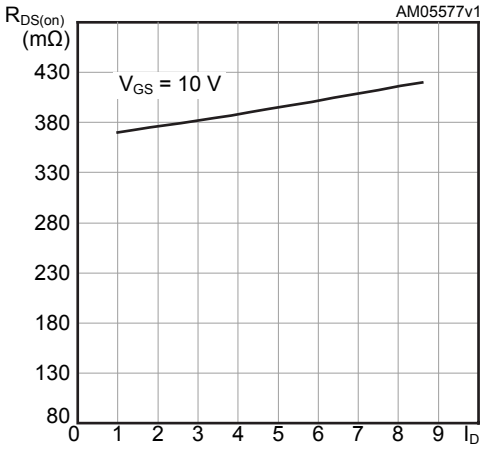

Figure 9. Typical capacitance characteristics

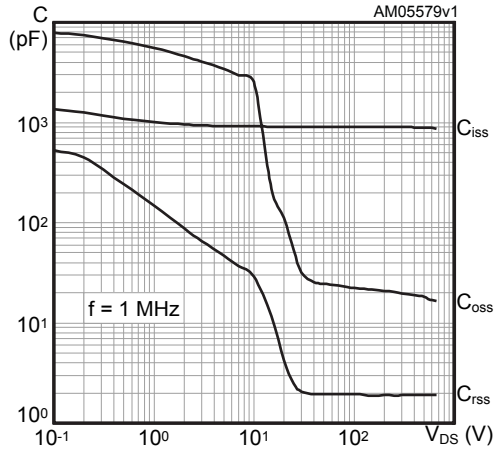

Figure 10. Typical output capacitance stored energy

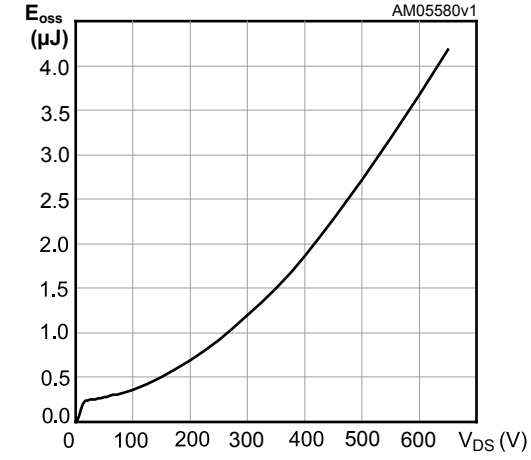

Figure 11. Normalized gate threshold voltage vs temperature

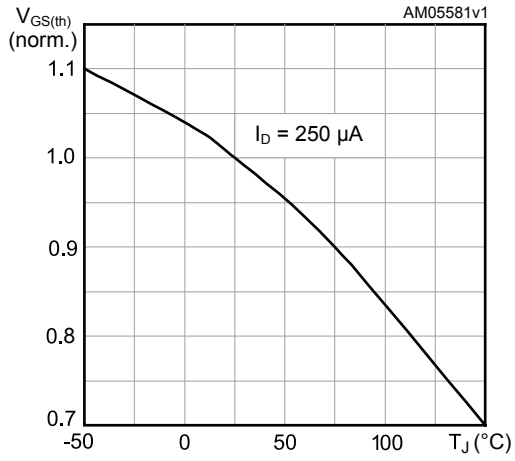

Figure 12. Normalized on-resistance vs temperature

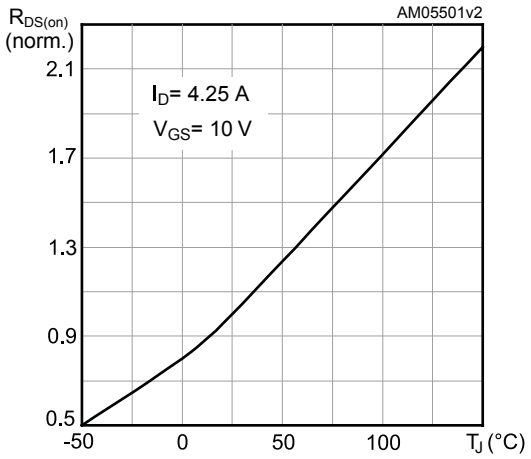

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Figure 13. Normalized breakdown voltage vs temperature

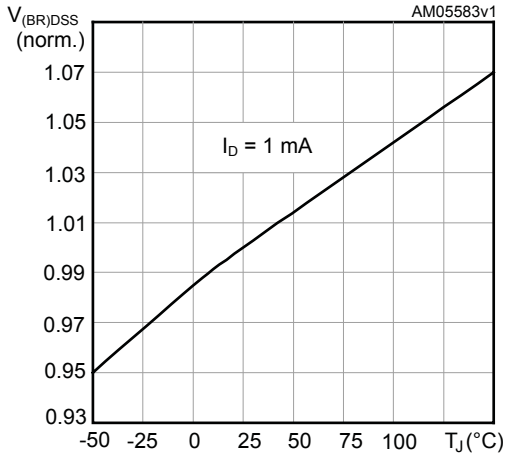


Figure 14. Typical reverse diode forward characteristics

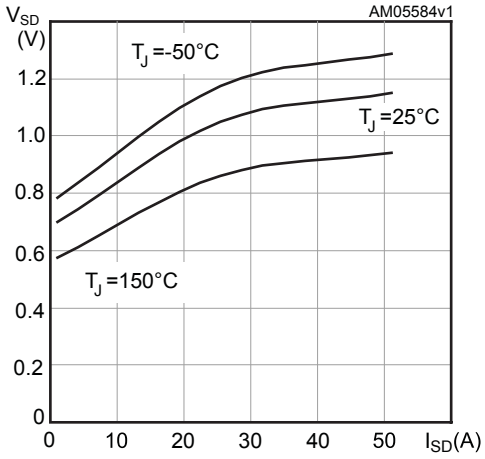
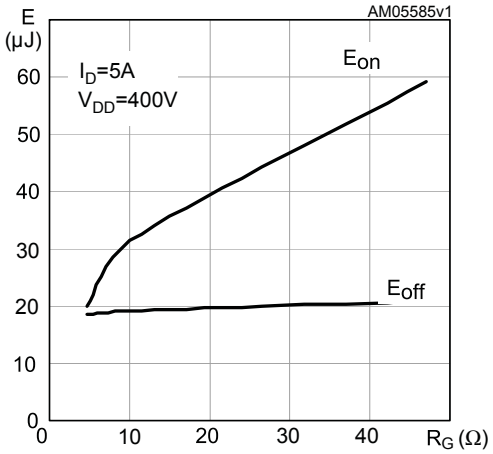


Figure 15. Typical switching energy vs gate resistance



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3 Test circuits

Figure 16. Test circuit for resistive load switching times

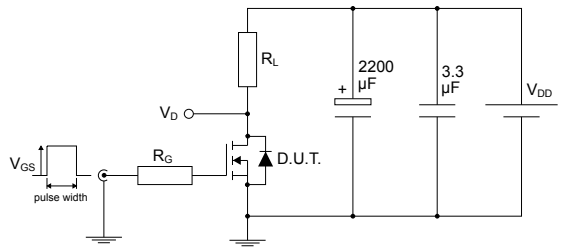


Figure 17. Test circuit for gate charge behavior

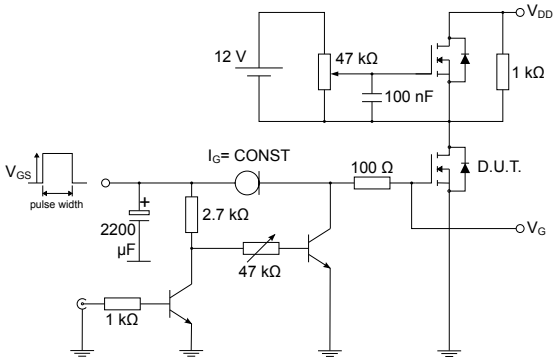


Figure 18. Test circuit for inductive load switching and diode recovery times

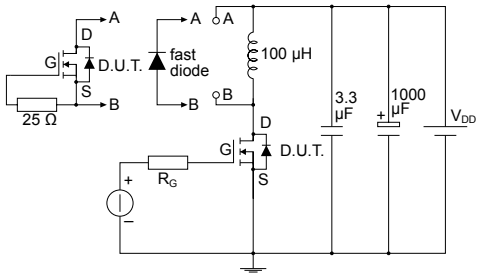


Figure 19. Unclamped inductive load test circuit

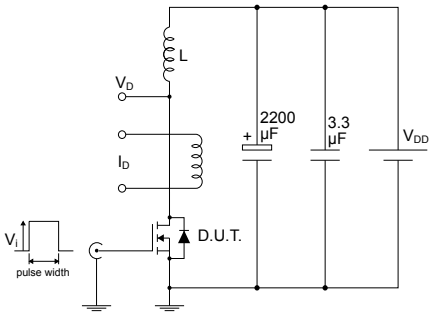


Figure 20. Unclamped inductive waveform

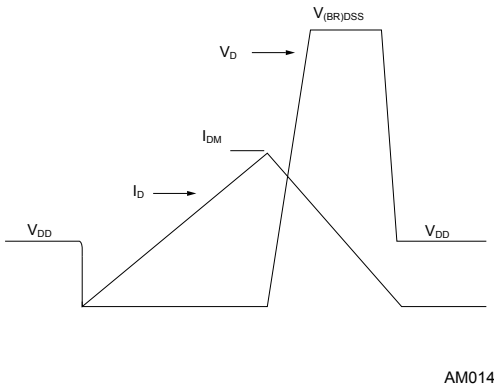
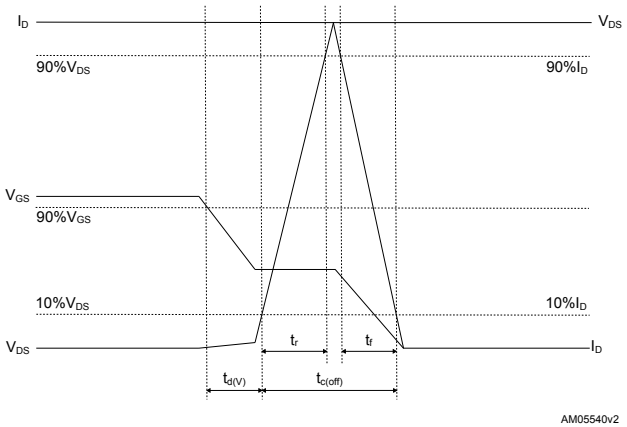


Figure 21. Switching time waveform



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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**

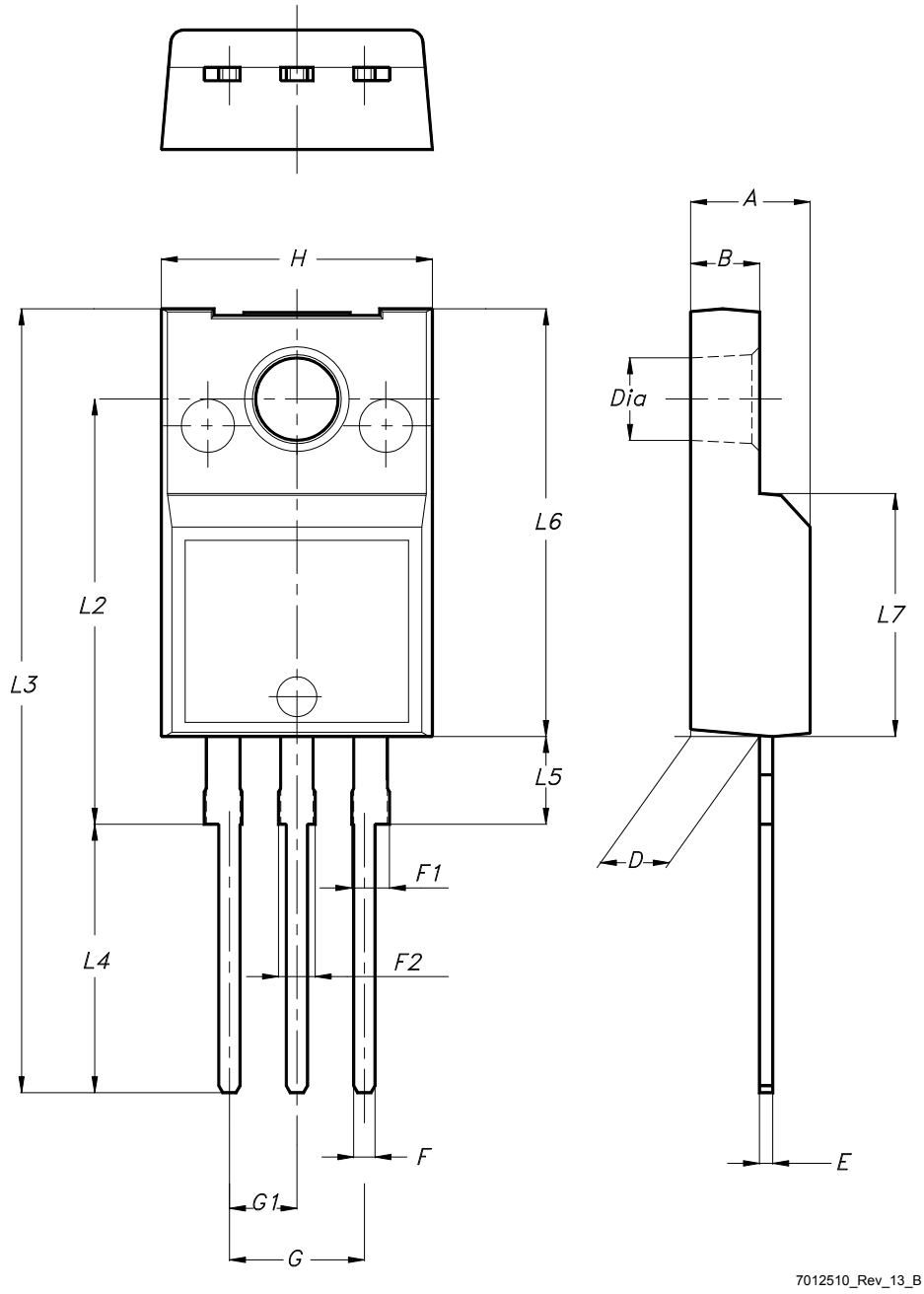

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Table 7. **TO-220FP package mechanical data**

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

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4.2 TO-220 type A package information

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

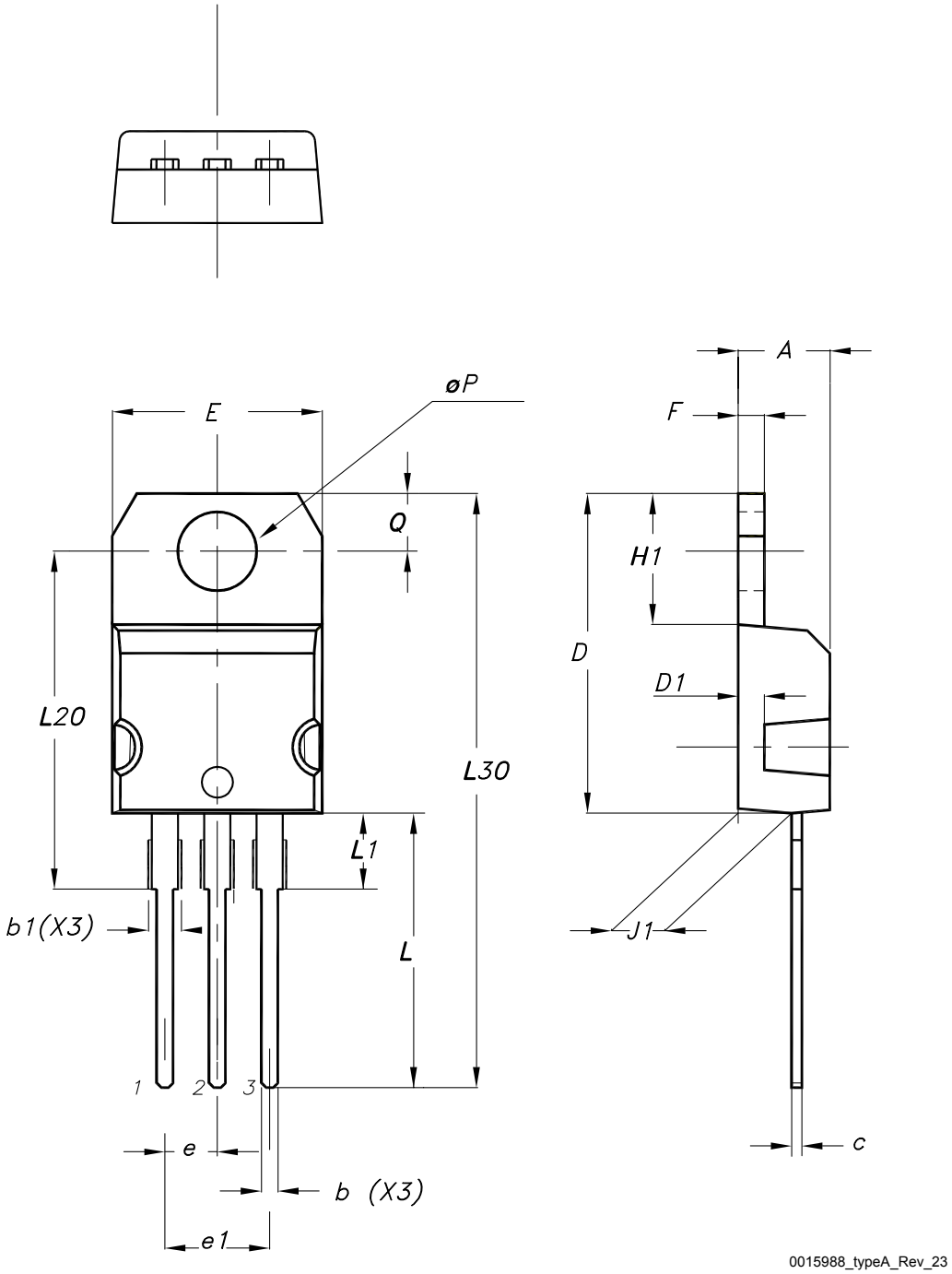

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Table 8. **TO-220 type A package mechanical data**

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

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Revision history

Table 9. **Document revision history**

Date	Version	Changes
24-Feb-2009	1	First release.
27-Feb-2009	2	Corrected package information on first page.
21-Jan-2010	3	Document status promoted from preliminary data to datasheet.
29-Jun-2010	4	– *Figure 15: Normalized on resistance vs temperature* has been updated. – V_{GS} value in *Table 4* has been corrected.
22-Jun-2011	5	Updated *Figure 18* and *Figure 20*. Updated gate charge in *Table 5* and switching time in *Table 6*.
11-Mar-2022	6	The part numbers STD12N65M5, STI12N65M5 and STU12N65M5 have been removed and the document has been updated accordingly. Updated title, Features and Description on cover page. Modified R_g value in the Table 4. Dynamic. Updated Section 4 Package information. Minor text changes.

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