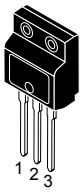
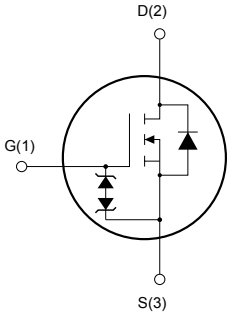
N-channel 600 V, 0.550 Ω typ., 7.5 A MDmesh™ M2 EP Power MOSFET in an I²PAKFP package



I²PAKFP (TO-281)



Features

Order code	V_{DS}	$R_{DS(on)}$ max.	I_D
STFI11N60M2-EP	600 V	0.595 Ω	7.5 A

- Extremely low gate charge
- Excellent output capacitance (C_{OSS}) profile
- Very low turn-off switching losses
- 100% avalanche tested
- Zener-protected

Applications

- Switching applications

Description

This device is an N-channel Power MOSFET developed using MDmesh™ M2 enhanced performance (EP) technology. Thanks to its strip layout and an improved vertical structure, the device exhibits low on-resistance, optimized switching characteristics with very low turn-off switching losses, rendering it suitable for the most demanding very high frequency converters.

Product status
STFI11N60M2-EP

Product summary	
Order code	STFI11N60M2-EP
Marking	11N60M2EP
Package	I²PAKFP (TO-281)
Packing	Tube

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{GS}	Gate-source voltage	±25	V
I_D	Drain current (continuous) at T_C = 25 °C	7.5	A
	Drain current (continuous) at T_C = 100 °C	4.7	A
I_{DM}(1)	Drain current (pulsed)	30	A
P_{TOT}	Total dissipation at T_C = 25 °C	25	W
dv/dt(2)	Peak diode recovery voltage slope	15	V/ns
dv/dt(3)	MOSFET dv/dt ruggedness	50	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		

1. *Pulse width limited by safe operating area.*
2. *I_{SD} ≤ 7.5 A, di/dt ≤ 400 A/µs, $V_{DS\ peak}$ < $V_{(BR)DSS}$, V_{DD} = 400 V*
3. *V_{DS} ≤ 480 V*

Table 2. Thermal data

Symbol	Parameter	Value	Unit
$R_{thj\text{-}case}$	Thermal resistance junction-case	5	°C/W
$R_{thj\text{-}amb}$	Thermal resistance junction-ambient	62.5	°C/W

Table 3. Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetitive or not repetitive (pulse width limited by T_{jmax})	2.4	A
E_{AS}	Single pulse avalanche energy (starting T_j = 25 °C, I_D = I_{AR}, V_{DD} = 50 V)	115	mJ

2 Electrical characteristics

T_C = 25 °C unless otherwise specified

Table 4. 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	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	µA
I_{GSS}	Gate-body leakage current	V_{DS} = 0 V, V_{GS} = ±25 V			±10	µA
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 250 µA	3.25	4	4.75	V
$R_{DS(on)}$	Static drain-source on-resistance	V_{GS} = 10 V, I_D = 3.75 A		0.550	0.595	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}= 100 V, f = 1 MHz, V_{GS} = 0 V	-	390	-	pF
C_{oss}	Output capacitance		-	22	-	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 V	-	49	-	pF
R_G	Intrinsic gate resistance	f = 1 MHz, I_D = 0 A	-	9	-	Ω
Q_g	Total gate charge	V_{DD} = 480 V, I_D = 7.5 A, V_{GS} = 0 to 10 V (see Figure 15. Test circuit for gate charge behavior)	-	12.4	-	nC
Q_{gs}	Gate-source charge		-	2.1	-	nC
Q_{gd}	Gate-drain charge		-	6	-	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 6. Switching energy

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{(off)}$	Turn-off energy (from 90% V_{GS} to 0% I_D)	V_{DD} = 400 V, I_D = 1 A, R_G = 4.7 Ω, V_{GS} = 10 V	-	2.5	-	µJ
		V_{DD} = 400 V, I_D = 3 A, R_G = 4.7 Ω, V_{GS} = 10 V	-	9	-	µJ

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 = 3.75 A,	-	9	-	ns
t_r	Rise time	R_G = 4.7 Ω, V_{GS} = 10 V	-	5.5	-	ns
$t_{d(off)}$	Turn-off-delay time	(see Figure 14. Test circuit for resistive load switching times and Figure 19. Switching time waveform)	-	26	-	ns
t_f	Fall time		-	8	-	ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		7.5	A
I_{SDM} (1)	Source-drain current (pulsed)		-		30	A
V_{SD} (2)	Forward on voltage	V_{GS} = 0 V, I_{SD} = 7.5 A	-		1.6	V
t_{rr}	Reverse recovery time	I_{SD} = 7.5 A, di/dt = 100 A/µs,	-	192		ns
Q_{rr}	Reverse recovery charge	V_{DD} = 60 V	-	1.32		µC
I_{RRM}	Reverse recovery current	(see Figure 16. Test circuit for inductive load switching and diode recovery times)	-	13.8		A
t_{rr}	Reverse recovery time	I_{SD} = 7.5 A, di/dt = 100 A/µs,	-	262		ns
Q_{rr}	Reverse recovery charge	V_{DD} = 60 V, T_j = 150 °C	-	1.74		µC
I_{RRM}	Reverse recovery current	(see Figure 16. Test circuit for inductive load switching and diode recovery times)	-	13.3		A

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

2.1 Electrical characteristics curves

Figure 1. Safe operating area

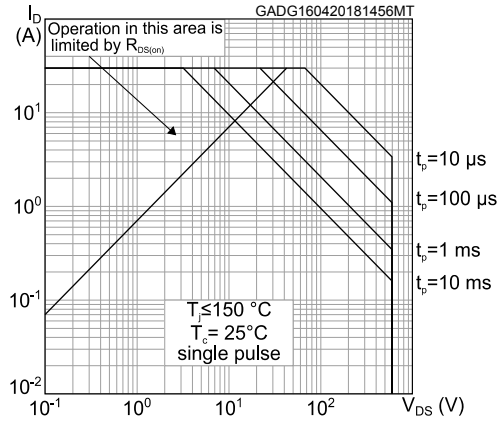


Figure 2. Thermal impedance

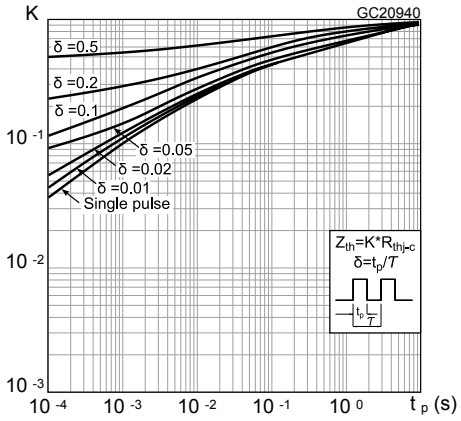


Figure 3. Output characteristics

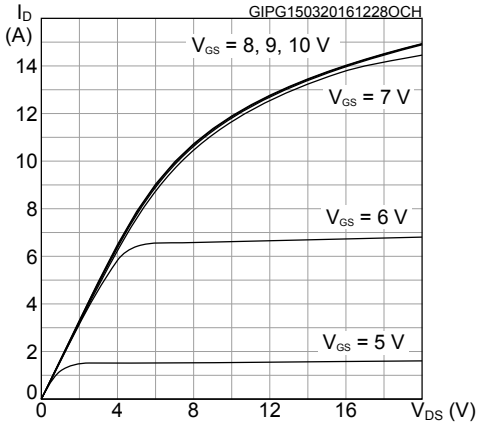


Figure 4. Transfer characteristics

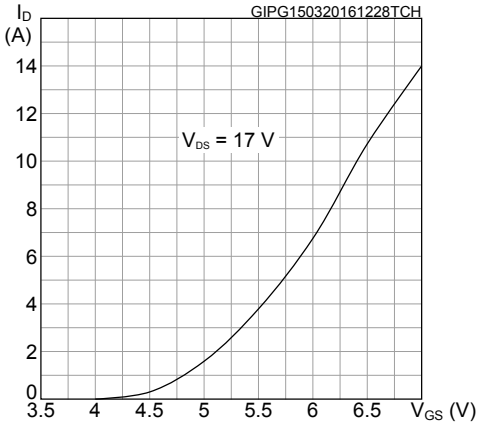


Figure 5. Gate charge vs gate-source voltage

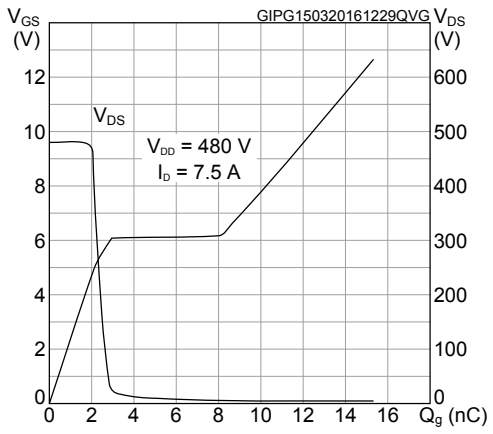


Figure 6. Static drain-source on-resistance

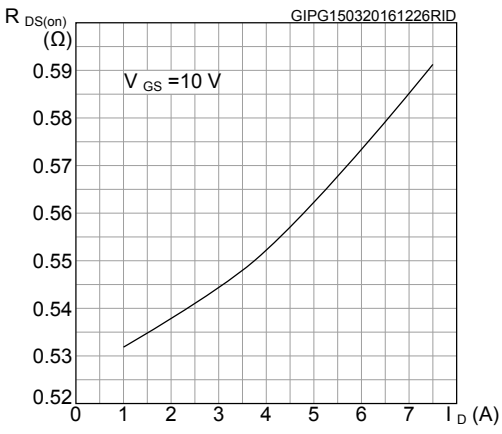


Figure 7. Capacitance variations

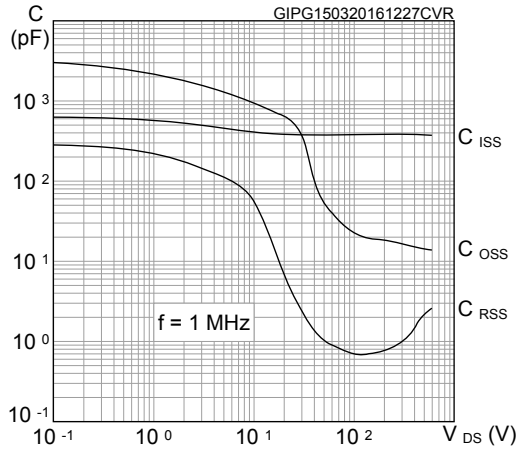


Figure 8. Turn-off switching energy vs drain current

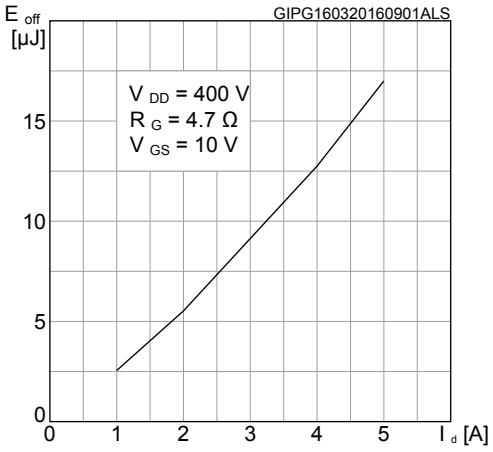


Figure 9. Normalized gate threshold voltage vs temperature

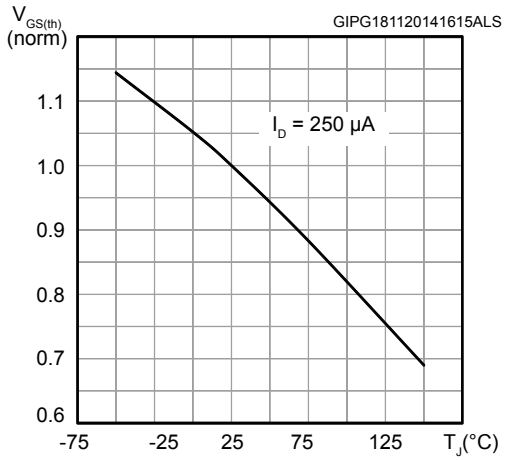


Figure 10. Normalized on-resistance vs temperature

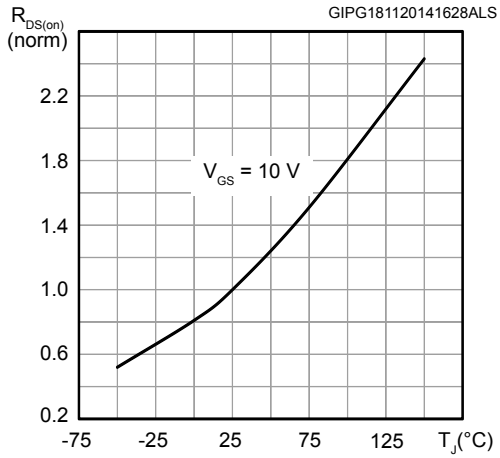


Figure 11. Normalized $V_{(BR)DSS}$ vs temperature

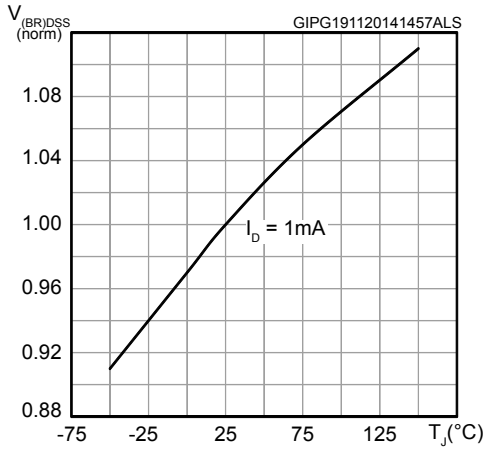


Figure 12. Output capacitance stored energy

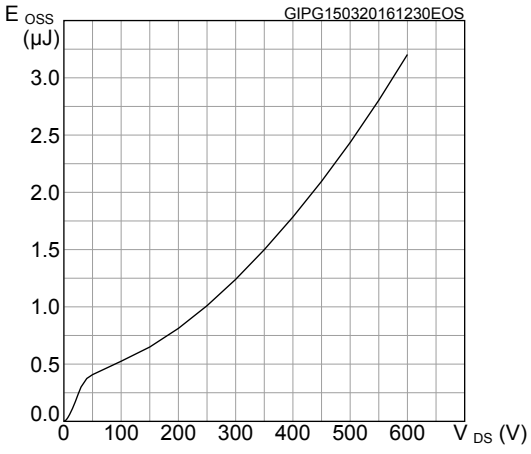
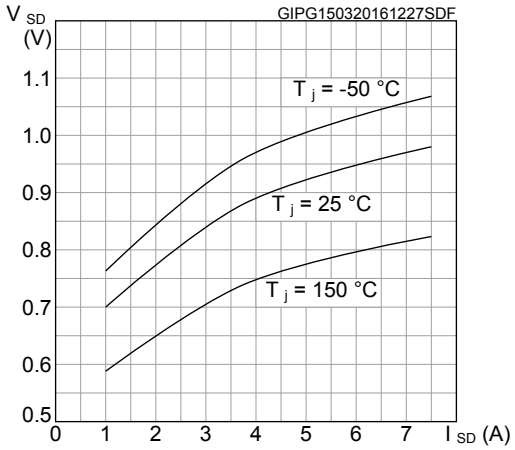


Figure 13. **Source-drain diode forward characteristics**



3 Test circuits

Figure 14. Test circuit for resistive load switching times

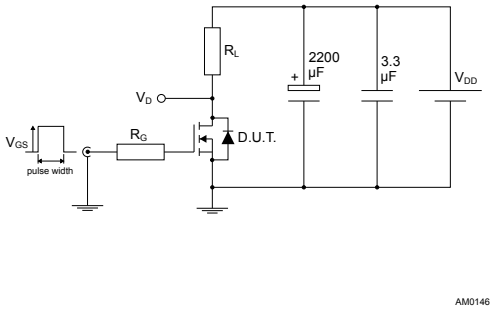


Figure 15. Test circuit for gate charge behavior

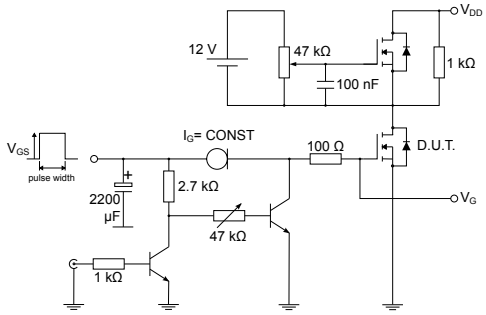


Figure 16. Test circuit for inductive load switching and diode recovery times

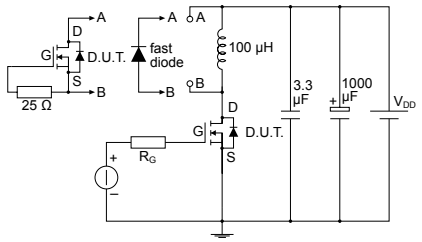


Figure 17. Unclamped inductive load test circuit

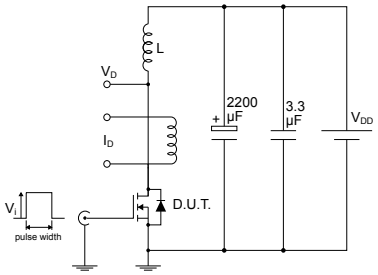


Figure 18. Unclamped inductive waveform

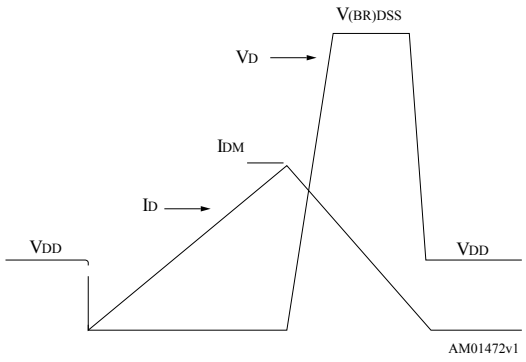
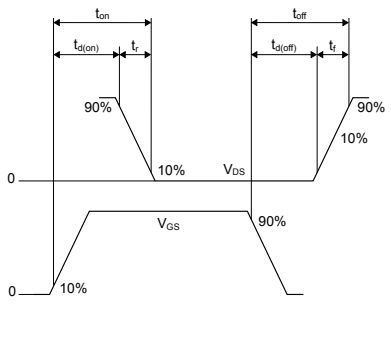


Figure 19. Switching time waveform

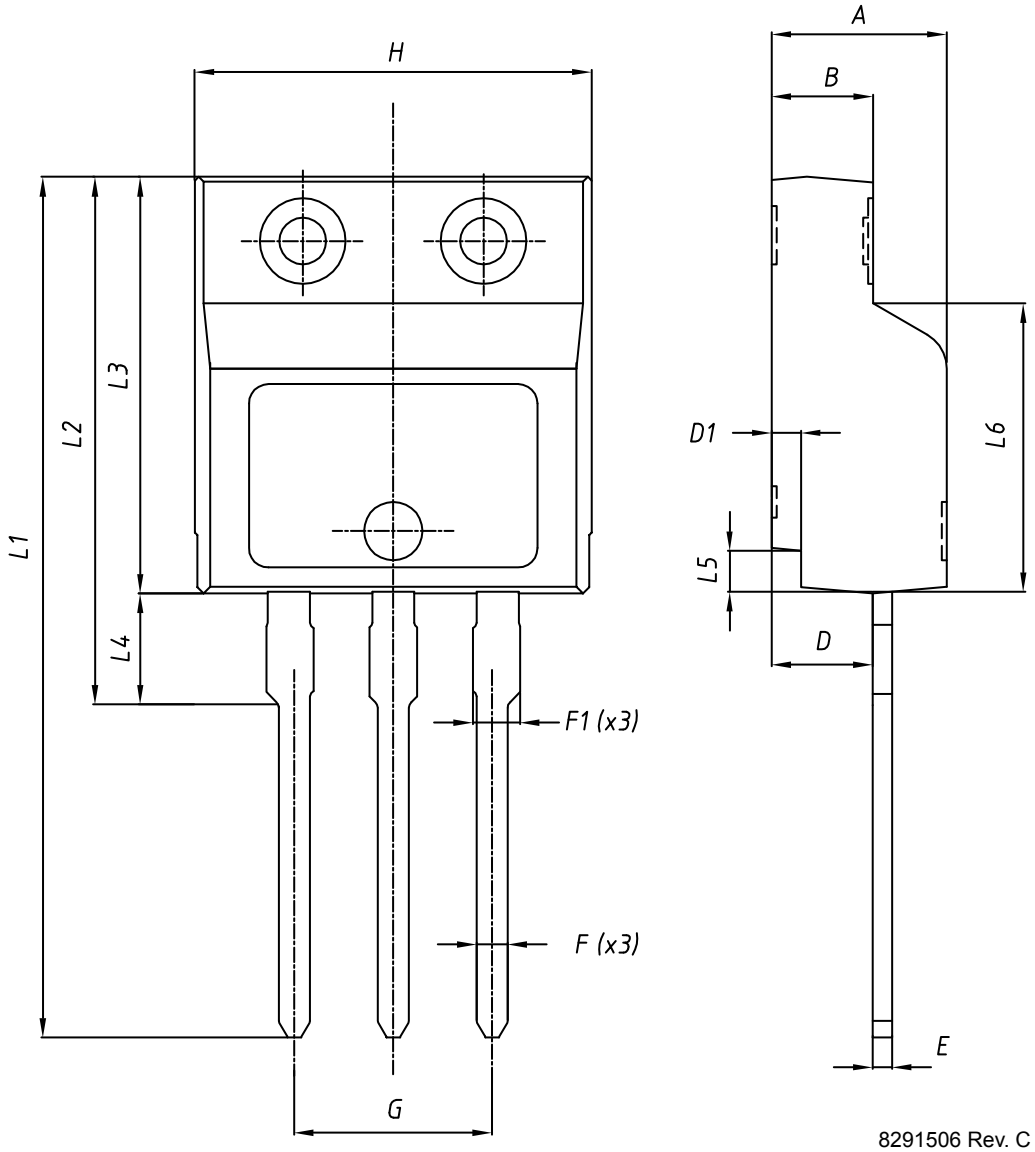


4 Package information

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 I²PAKFP (TO-281) package information

Figure 20. **I²PAKFP (TO-281) package outline**



8291506 Rev. C

Table 9. I²PAKFP (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

Revision history

Table 10. **Document revision history**

Date	Revision	Changes
12-Apr-2016	1	First release.
07-Oct-2016	2	Document status changed from preliminary to production data.
14-May-2018	3	Removed document maturity status from cover page. Updated Section 1 Electrical ratings, Section 2 Electrical characteristics and Section 2.1 Electrical characteristics curves. Minor text changes

Contents