Contents

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		TO-220FP	I^2PAKFP	
V_{DS}	Drain source voltage	650		V
V_{GS}	Gate source voltage	± 25		V
I_D	Drain current continuous Tc = 25 °C	12(1)		A
I_D	Drain current continuous Tc = 100 °C	7.56		A
I_{DM}(2)	Drain current pulsed	48		A
P_{TOT}	Total dissipation at Tc = 25 °C	30		W
dv/dt(3)	Peak diode recovery voltage slope	15		V/ns
V_{ISO}	Insulation withstand voltage (RMS from all three leads to external heatsink (t = 1 s; T_C = 25 °C)	2500		V
T_J	Operating junction temperature range	-55 to 150		°C
T_{stg}	Storage temperature range			

1. Limited by maximum junction temperature.
2. Pulse width limited by safe operating area.
3. I_{SD} ≤12 A, di/dt ≤ 400 A/µs, V_{DSpeak} ≤ $V_{(BR)DSS}$, VDD = 80 % $V_{(BR)DSS}$

Table 3. Thermal data

Symbol	Parameters	Value		Unit
		TO-220FP	I^2PAKFP	
R_{thjc}	Thermal resistance junction-case	4.17		°C/W
$R_{thj\text{-}amb}$	Thermal resistance junction-ambient	62.5		°C/W

Table 4. Avalanche characteristics

Symbol	Parameters	Value	Unit
I_{AS}	Avalanche current, repetitive or not-repetitive (pulse width limited by T_{jmax})	3	A
E_{AS}	Single pulse avalanche energy (starting T_J = 25 °C, I_D = I_{AR}, V_{DD} = 50 V)	187	mJ

2 Electrical characteristics

(T_{CASE} = 25 °C unless otherwise specified).

Table 5. On/off states

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	V_{GS} = 0, I_D = 1 mA	650			V
I_{DSS}	Zero gate voltage drain current	V_{DD} = 650 V, V_{GS}=0			1	µA
		V_{DD} = 650 V, V_{GS} = 0 T_C = 125 °C(1)			100	µA
I_{GSS}	Gate body leakage	V_{GS}= ±25 V, V_{DS} = 0 V			±100	nA
$V_{GS(th)}$	Gate threshold voltage	I_D= 250 µA, V_{GS} =V_{DS}	2	3	4	V
$R_{DS(on)}$	Static drain-source on-resistance	I_D= 6 A, V_{GS}= 10V		0.35	0.38	Ω

1. Defined by design, not subject to production test

Table 6. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Ma.	Unit
C_{iss}	Input capacitance	V_{DS}= 50 V, f = 1MHz, V_{GS}= 0 V	-	983	-	pF
C_{oss}	Output capacitance		-	57	-	pF
C_{rss}	Reverse capacitance		-	4.5	-	pF
C_{osseq} (1)	Equivalent output. capacitance	V_{DS} = 0 V to 520 V, V_{GS} = 0 V	-	146	-	pF
R_g	Intrinsic gate resistance	f = 1MHz I_D = 0 A	-	4.6	-	Ω
Q_g	Total gate charge	V_{DD}= 520 V, I_D=12 A, V_{GS}= 10 V (see *Figure 13: Gate charge test circuit*)	-	33.3	-	nC
Q_{gs}	Gate source charge		-	5.7	-	nC
Q_{gd}	Gate-drain charge		-	17	-	nC

1. Cross eq: 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 7. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	V_{DD}= 325 V, I_D = 6 A R_g= 4.7 Ω, V_{GS} = 10 V(see *Figure 12: Switching times test circuit for resistive load* and *Figure 17: Switching time waveform*)	-	55.5	-	ns
t_r	Rise time		-	8.5	-	ns
$t_{d(off)}$	Turn-off-delay time		-	14	-	ns
t_f	Fall time		-	11.4	-	ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source drain current		-		12	A
I_{SDM}(1)	Source drain current (pulsed)		-		48	A
V_{SD}(2)	Forward on voltage	I_{SD} = 12 A, V_{GS} = 0 V	-		1.6	V
t_{rr}	Reverse recovery time	I_{SD} = 12 A, di/dt = 100 A/µs V_{DD} = 60 V(see *Figure 14: Test circuit for inductive load switching and diode recovery times*)	-	428		ns
Q_{rr}	Reverse recovery charge		-	4.7		µC
I_{RRM}	Reverse recovery current		-	21.5		A
t_{rr}	Reverse recovery time	I_{SD}= 12 A, di/dt = 100 A/µs V_{DD} = 60 V, T_j = 150 °C (see *Figure 14: Test circuit for inductive load switching and diode recovery times*)	-	570		ns
Q_{rr}	Reverse recovery charge		-	6.2		µC
I_{RRM}	Reverse recovery current		-	22		A

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

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area

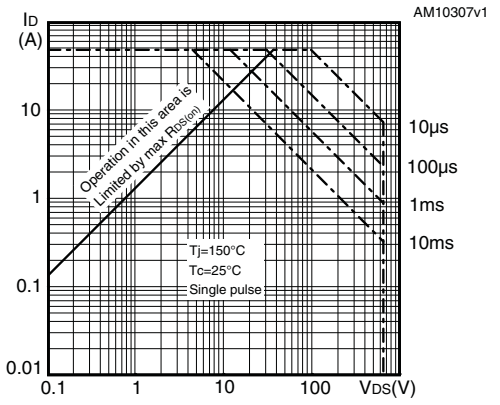


Figure 3. Thermal impedance

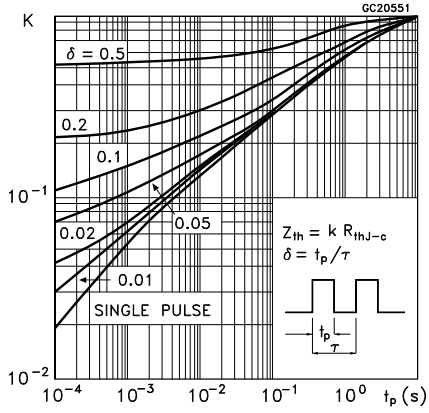


Figure 4. Output characteristics

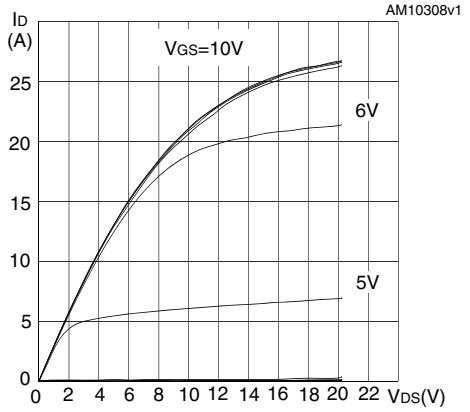


Figure 5. Transfer characteristics

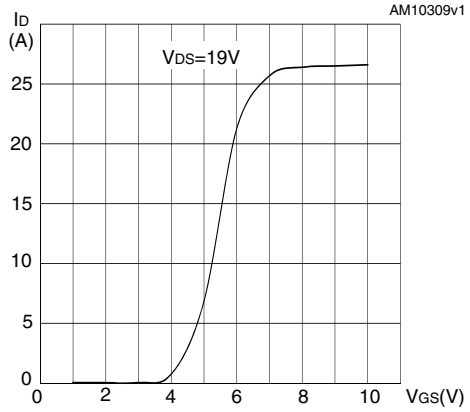


Figure 6. Static drain-source on-resistance

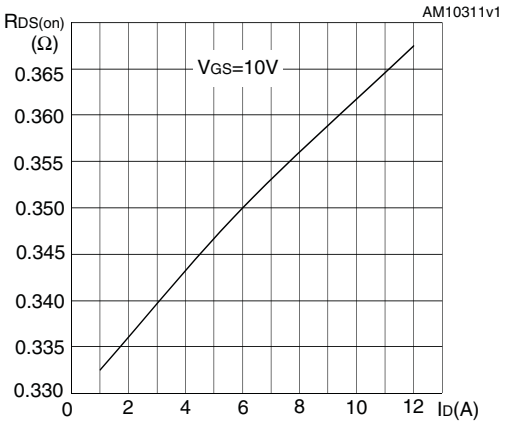


Figure 7. Gate charge vs gate-source voltage

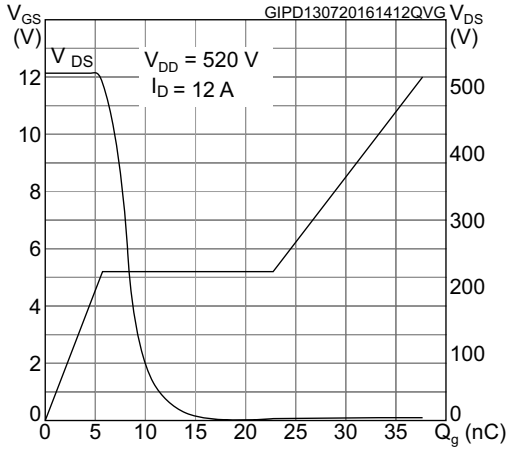


Figure 8. Capacitance variations

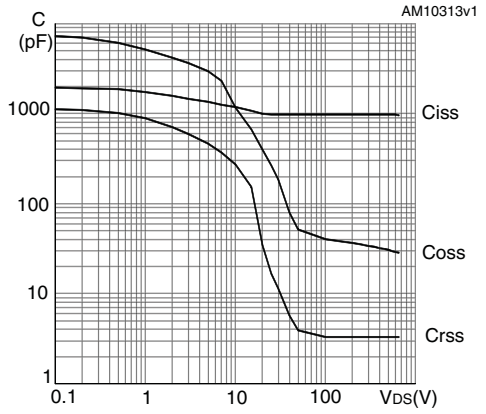


Figure 9. Normalized gate threshold voltage vs temperature

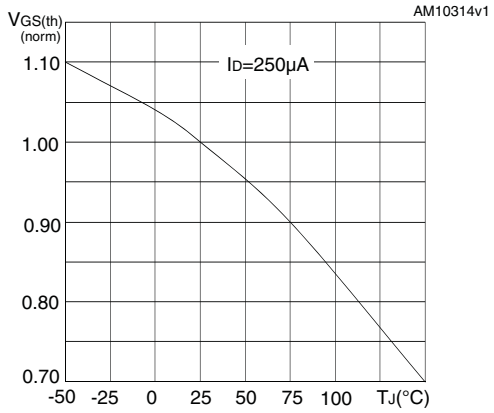
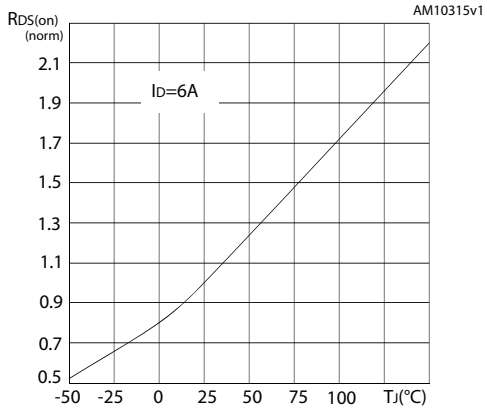


Figure 10. Normalized on-resistance vs temp.



Source-drain diode forward characteristics

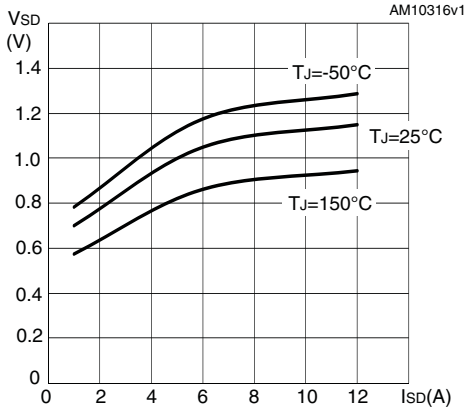
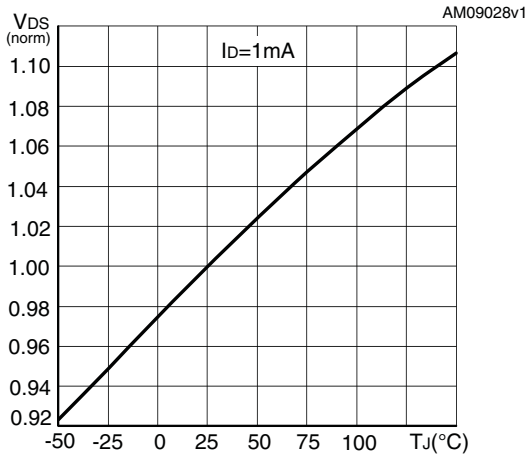


Figure 11. Normalized V_{DS} vs temperature



3 Test circuits

Figure 12. Switching times test circuit for resistive load

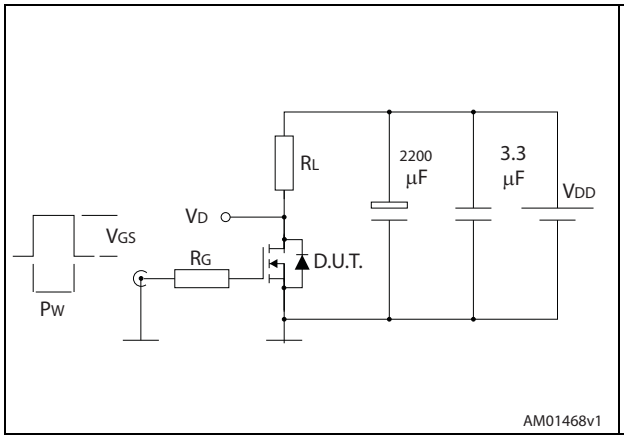


Figure 13. Gate charge test circuit

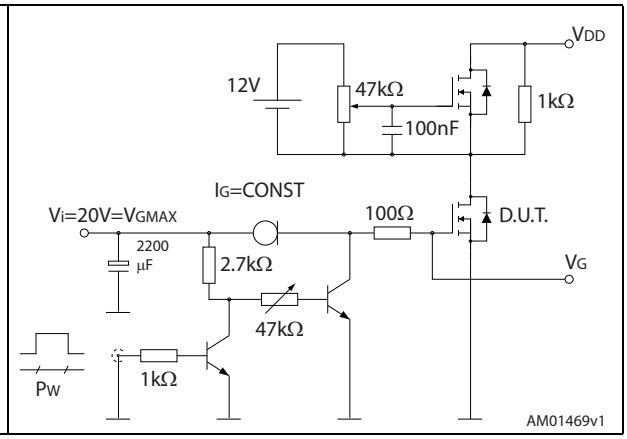


Figure 14. Test circuit for inductive load switching and diode recovery times

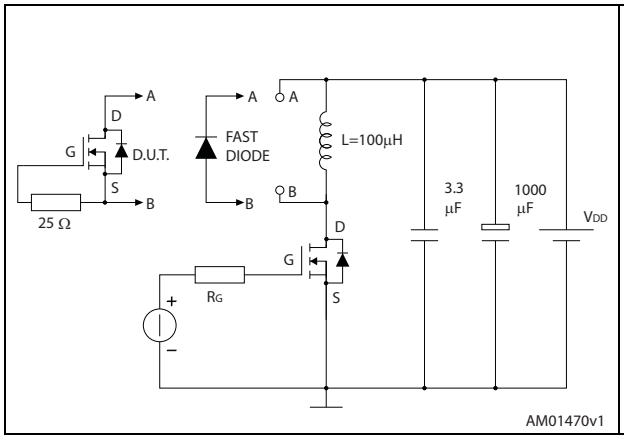


Figure 15. Unclamped inductive load test circuit

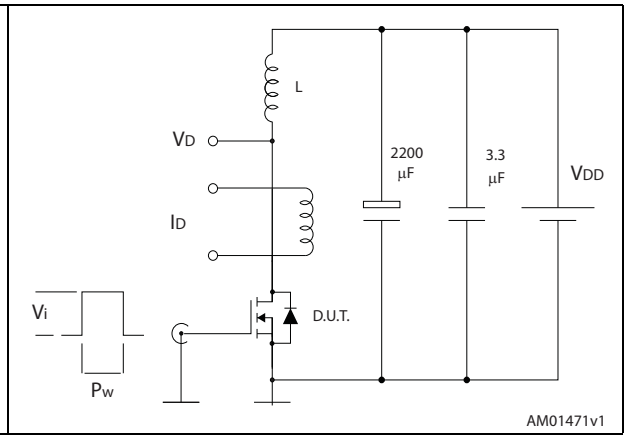


Figure 16. Unclamped inductive waveform

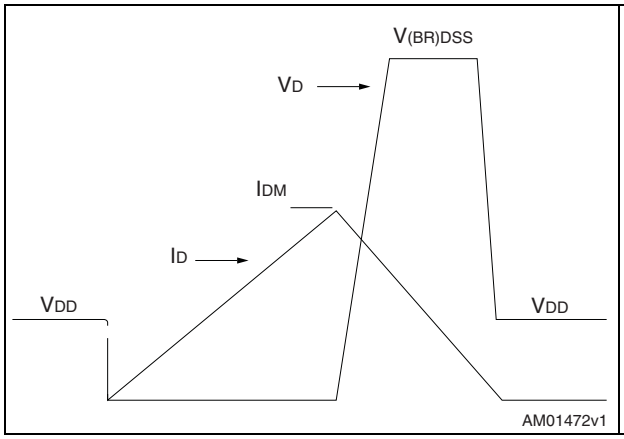
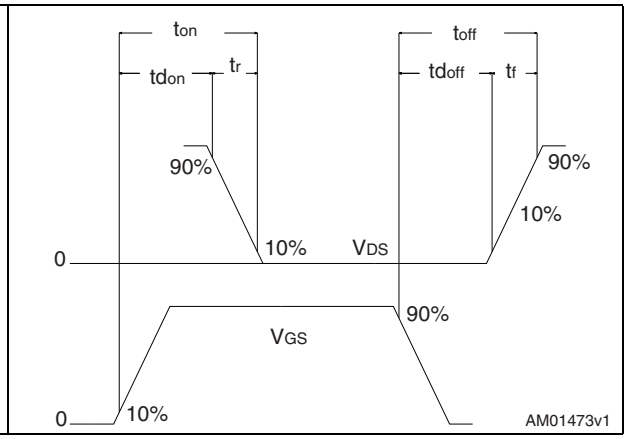


Figure 17. Switching time waveform



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 18. TO-220FP package outline

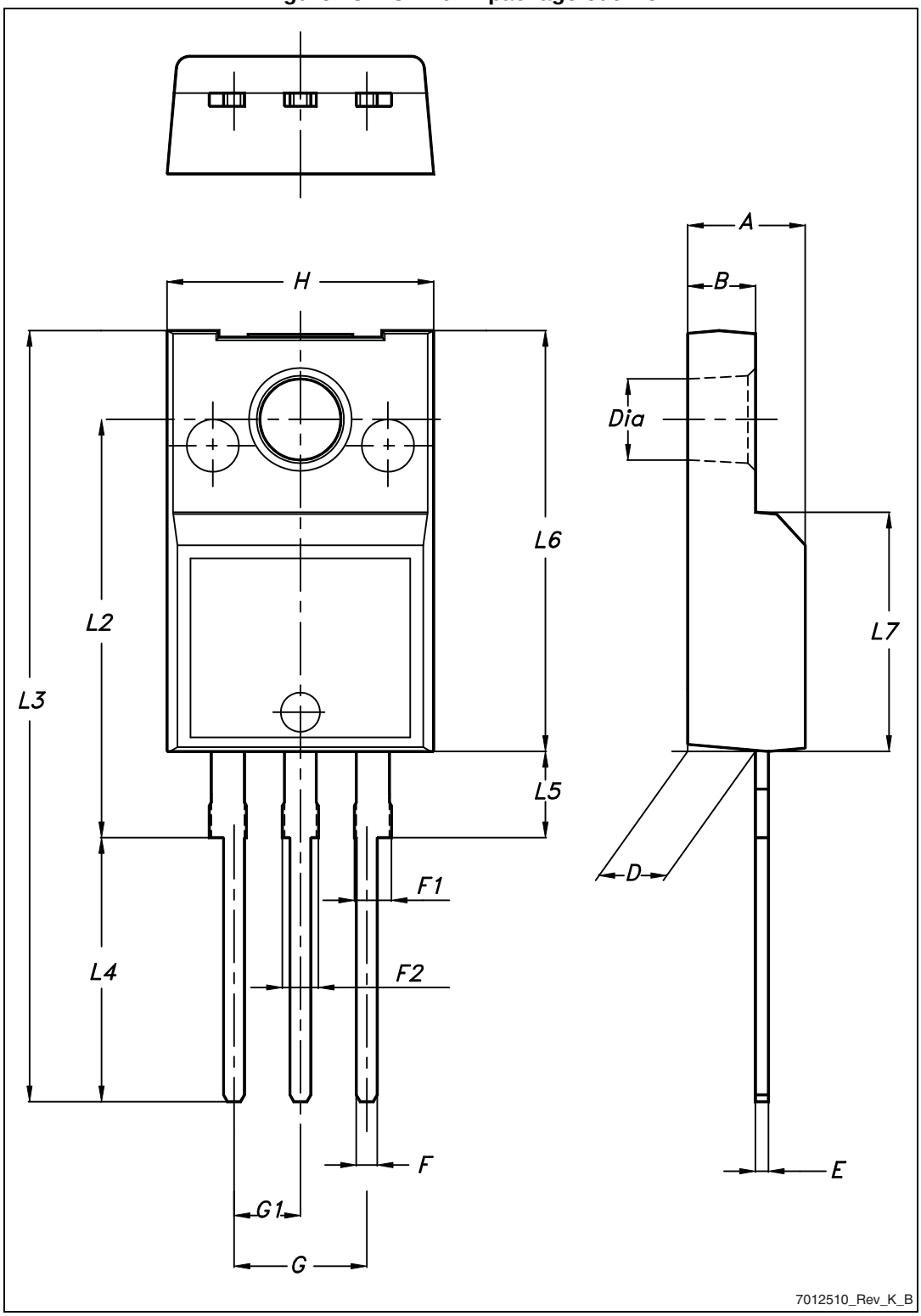


Table 9. TO-220FP package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.4		4.6
B	2.5		2.7
D	2.5		2.75
E	0.45		0.7
F	0.75		1
F1	1.15		1.70
F2	1.15		1.70
G	4.95		5.2
G1	2.4		2.7
H	10		10.4
L2		16	
L3	28.6		30.6
L4	9.8		10.6
L5	2.9		3.6
L6	15.9		16.4
L7	9		9.3
Dia	3		3.2

4.2 I²PAKFP (TO-281) package information

Figure 19. I²PAKFP (TO-281) package outline

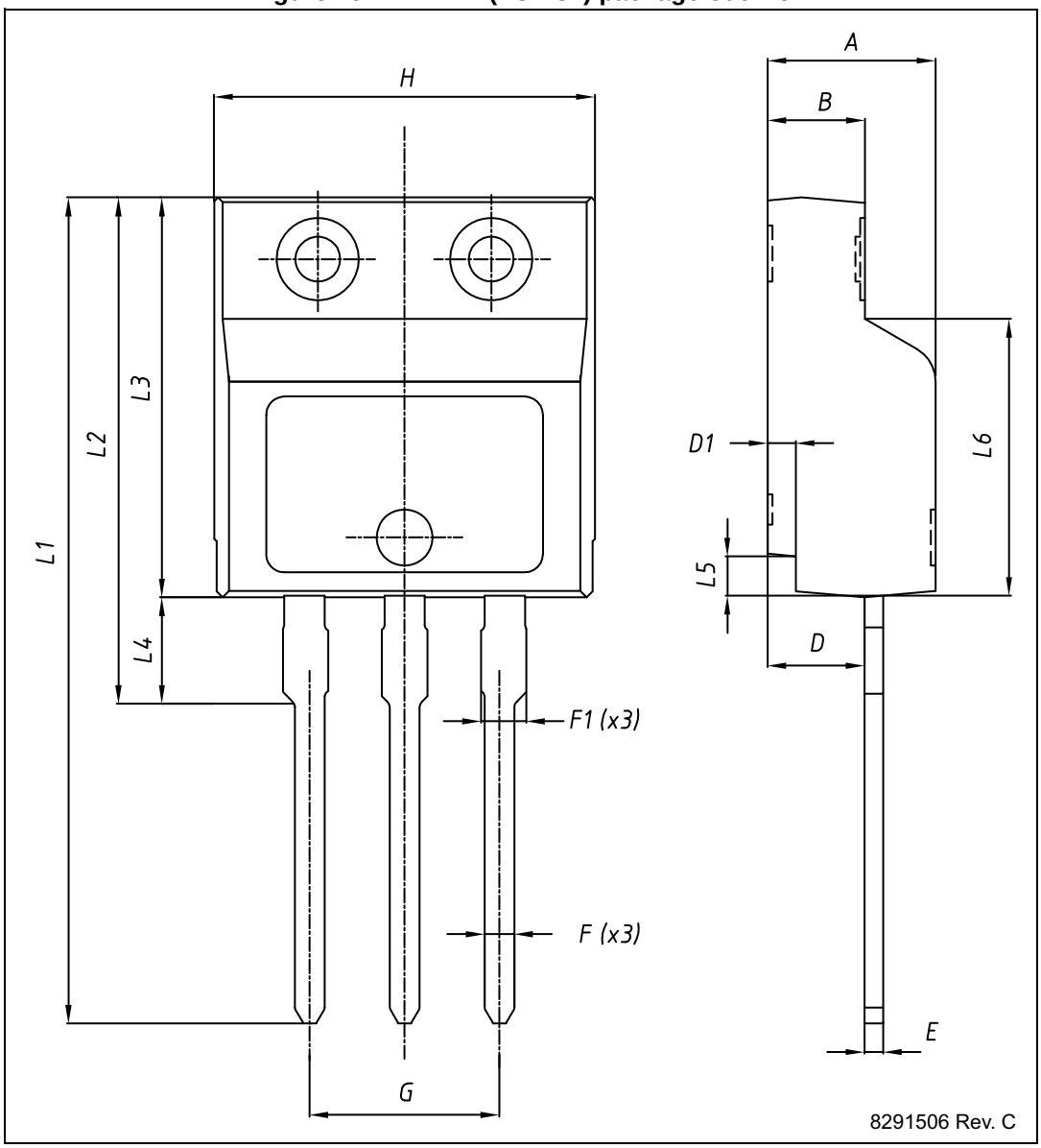


Table 10. I^2PAKFP (TO-281) package mechanical data

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

5 Revision history

Table 11. Document revision history

Date	Revision	Changes
11-May-2011	1	Initial release.
21-Jun-2011	2	Document status promoted form preliminary data to datasheet, added Section 2.1: Electrical characteristics (curves).
17-Jul-2013	3	– Added: I^2PAKFP package – Added: *Table 10* and *Figure 22* – Updated: *Section 4: Package information* – Minor text changes.
25-Jul-2016	4	The part number STP15NM65N has been moved to a separate datasheet. Minor text changes.