STD5N60M2, STP5N60M2, STU5N60M2

N-channel 600 V, 1.3 Ω typ., 3.5 A MDmesh™ M2 Power MOSFET in DPAK, TO-220 and IPAK packages

Datasheet - production data

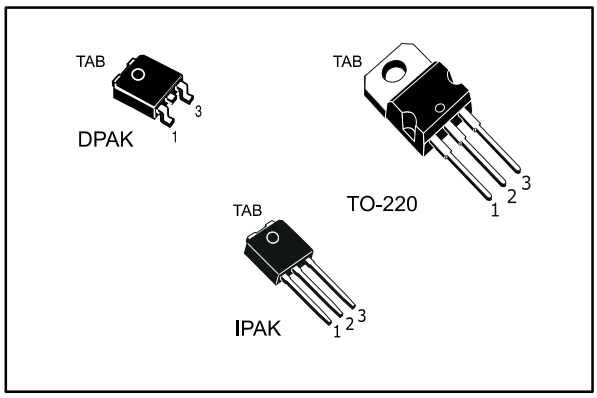
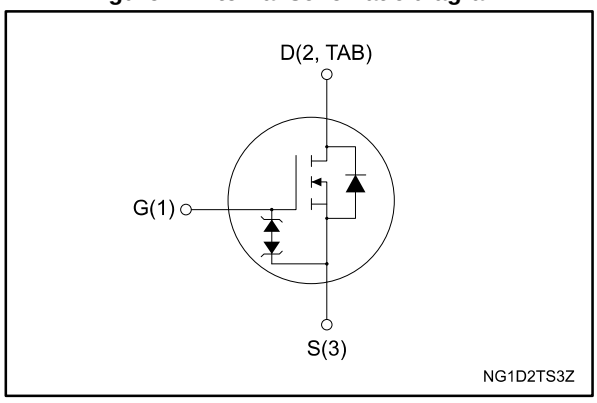


Figure 1: Internal schematic diagram



Features

Order code	V_{DS}@ T_{Jmax}	$R_{DS(on)}$ max.	I_D
STD5N60M2	650 V	1.4 Ω	3.5 A
STP5N60M2			
STU5N60M2			

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

Applications

- Switching applications

Description

These devices are N-channel Power MOSFETs developed using MDmesh™ M2 technology. Thanks to their strip layout and improved vertical structure, these devices exhibit low on-resistance and optimized switching characteristics, rendering them suitable for the most demanding high efficiency converters.

Table 1: Device summary

Order code	Marking	Package	Packing
STD5N60M2	5N60M2	DPAK	Tape and reel
STP5N60M2		TO-220	Tube
STU5N60M2		IPAK	

Contents

1 Electrical ratings

Table 2: Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{GS}	Gate-source voltage	±25	V
I_D	Drain current (continuous) at T_C = 25 °C	3.5	A
	Drain current (continuous) at T_C = 100 °C	2.2	
I_{DM} (1)	Drain current (pulsed)	14	A
P_{TOT}	Total dissipation at T_C = 25 °C	45	W
dv/dt (2)	Peak diode recovery voltage slope	15	V/ns
dv/dt (3)	MOSFET dv/dt ruggedness	50	
T_{stg}	Storage temperature range	-55 to 150	°C
T_j	Operating junction temperature range		

Notes:

(1) Pulse width limited by safe operating area.

(2) $I_{SD} \leq 3.5$ A, di/dt ≤ 400 A/µs; V_{DS} peak < $V_{(BR)DSS}$, V_{DD} = 400 V.

(3) $V_{DS} \leq 480$ V.

Table 3: Thermal data

Symbol	Parameter	Value			Unit
		DPAK	TO-220	IPAK	
$R_{thj\text{-}case}$	Thermal resistance junction-case max.	2.8			°C/W
$R_{thj\text{-}pcb}$	Thermal resistance junction-pcb max. (1)	50			
$R_{thj\text{-}amb}$	Thermal resistance junction-ambient max.		62.5	100	

Notes:

(1) When mounted on 1 inch² FR-4, 2 Oz copper board.

Table 4: Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetitive or not repetitive (pulse width limited by T_{jmax})	0.5	A
E_{AS}	Single pulse avalanche energy (starting T_j = 25 °C, $I_D = I_{AR}$; V_{DD} = 50 V)	80	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 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	
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	2	3	4	V
$R_{DS(on)}$	Static drain-source on-resistance	V_{GS} = 10 V, I_D = 1.7 A		1.3	1.4	Ω

Notes:

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

Table 6: Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	V_{DS} = 100 V, f = 1 MHz, V_{GS} = 0 V	-	211	-	pF
C_{oss}	Output capacitance		-	13	-	
C_{rss}	Reverse transfer capacitance		-	0.75	-	
$C_{oss\ eq.}$ (1)	Equivalent output capacitance	V_{DS} = 0 to 480 V, V_{GS} = 0 V	-	19.5	-	pF
R_G	Intrinsic gate resistance	f = 1 MHz open drain	-	6.2	-	Ω
Q_g	Total gate charge	V_{DD} = 480 V, I_D = 3.5 A, V_{GS} = 10 V (see *Figure 17: "Test circuit for gate charge behavior"*)	-	8	-	nC
Q_{gs}	Gate-source charge		-	1.6	-	
Q_{gd}	Gate-drain charge		-	4.4	-	

Notes:

(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 7: Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	V_{DD} = 300 V, I_D = 1.7 A, R_G = 4.7 Ω, V_{GS} = 10 V (see *Figure 16: "Test circuit for resistive load switching times"* and *Figure 21: "Switching time waveform"*)	-	12	-	ns
t_r	Rise time		-	3	-	
$t_{d(off)}$	Turn-off delay time		-	70	-	
t_f	Fall time		-	15	-	

Table 8: Source-drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		3.5	A
I_{SDM} (1)	Source-drain current (pulsed)		-		14	A
V_{SD} (2)	Forward on voltage	V_{GS} = 0 V, I_{SD} = 3.5 A	-		1.6	V
t_{rr}	Reverse recovery time	I_{SD} = 3.5 A, di/dt = 100 A/µs, V_{DD} = 60 V (see *Figure 18: "Test circuit for inductive load switching and diode recovery times"*)	-	220		ns
Q_{rr}	Reverse recovery charge		-	1.05		µC
I_{RRM}	Reverse recovery current		-	9.5		A
t_{rr}	Reverse recovery time	I_{SD} = 3.5 A, di/dt = 100 A/µs, V_{DD} = 60 V, T_j = 150 °C (see *Figure 18: "Test circuit for inductive load switching and diode recovery times"*)	-	314		ns
Q_{rr}	Reverse recovery charge		-	1.5		µC
I_{RRM}	Reverse recovery current		-	9.5		A

Notes:

(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 2: Safe operating area for DPAK and IPAK

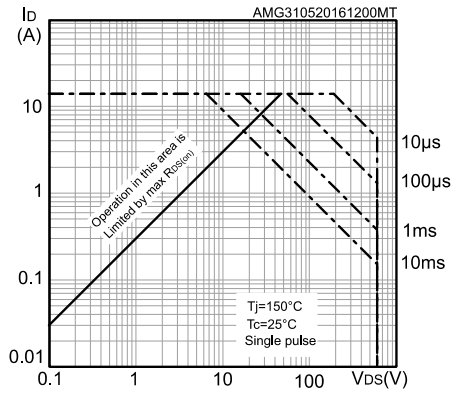


Figure 3: Thermal impedance for DPAK and IPAK

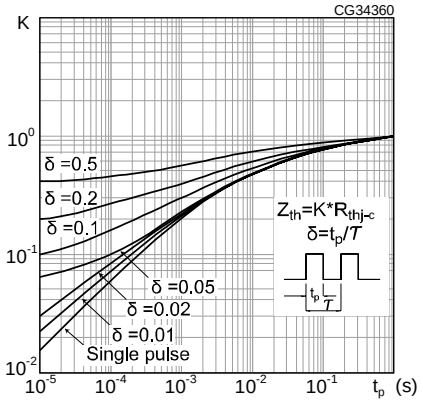


Figure 4: Safe operating area for TO-220

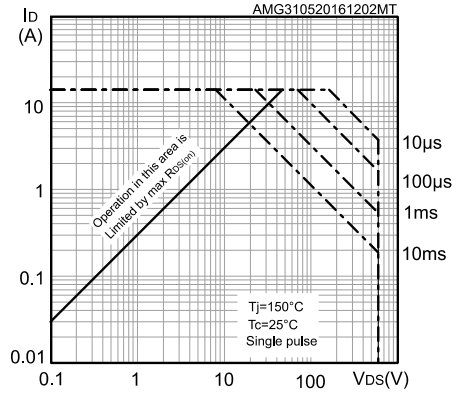


Figure 5: Thermal impedance for TO-220

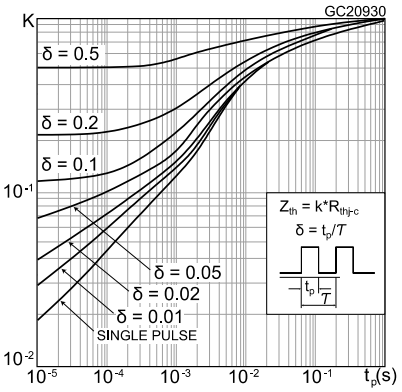


Figure 6: Output characteristics

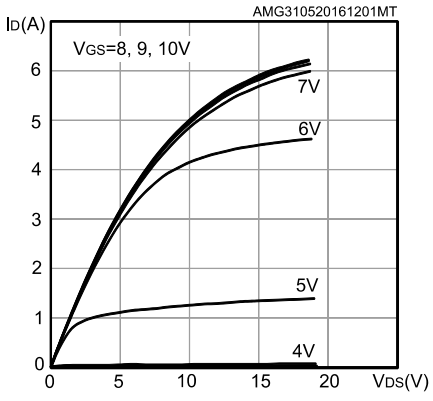


Figure 7: Transfer characteristics

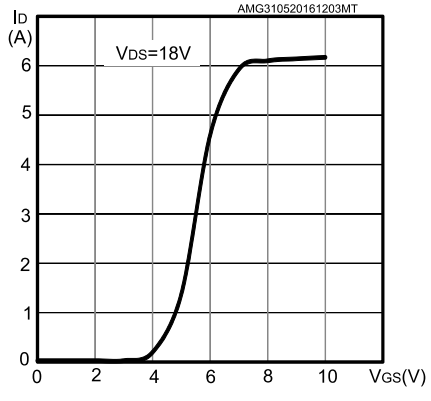


Figure 8: Gate charge vs gate-source voltage

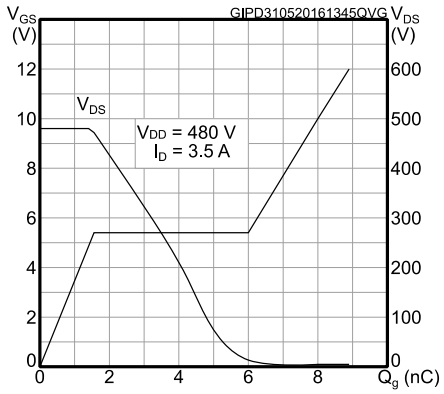


Figure 9: Static drain-source on-resistance

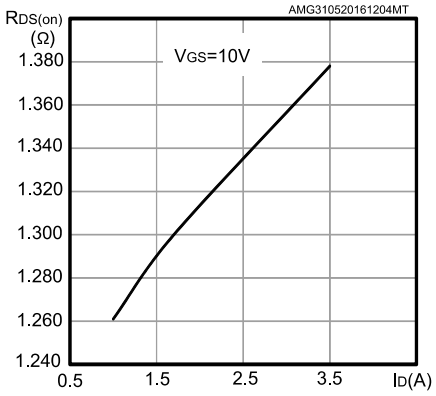


Figure 10: Capacitance variations

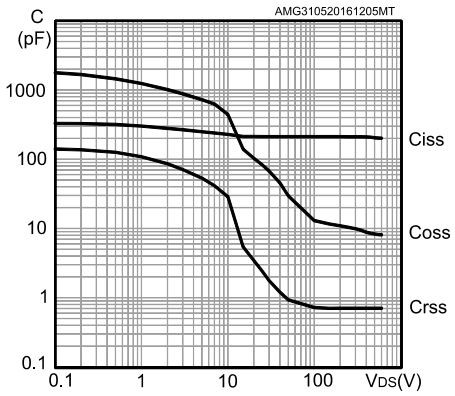


Figure 11: Output capacitance stored energy

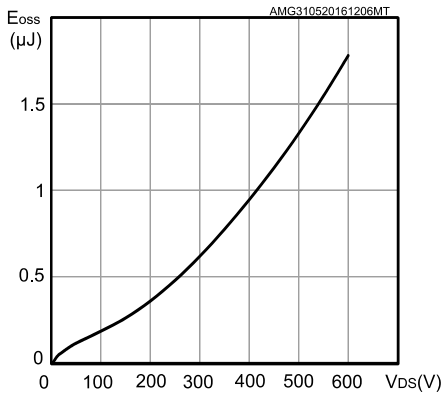


Figure 12: Normalized gate threshold voltage vs temperature

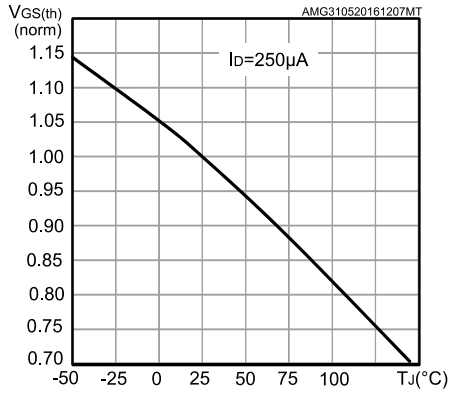


Figure 13: Normalized on-resistance vs temperature

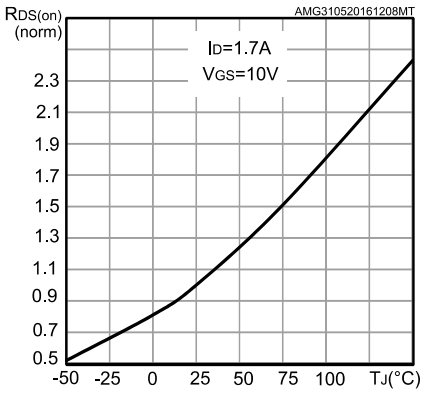


Figure 14: Normalized $V_{(BR)DSS}$ vs temperature

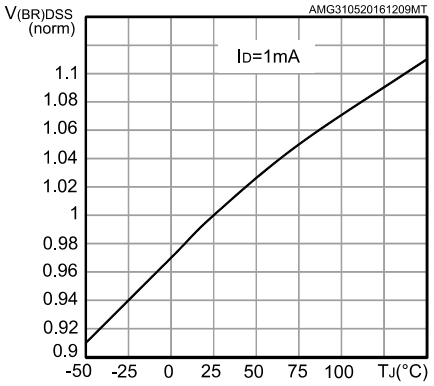
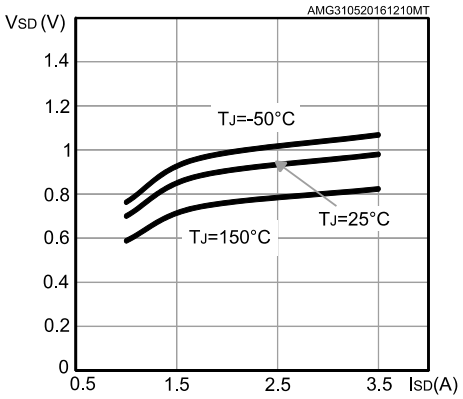


Figure 15: Source- drain diode forward characteristics



3 Test circuits

Figure 16: Test circuit for resistive load switching times

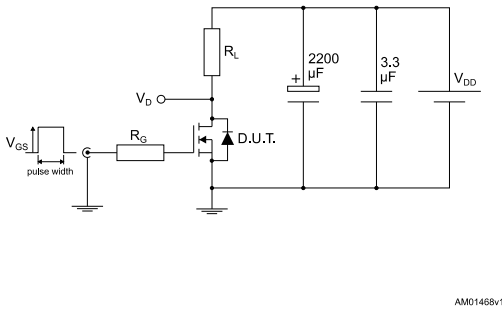


Figure 17: Test circuit for gate charge behavior

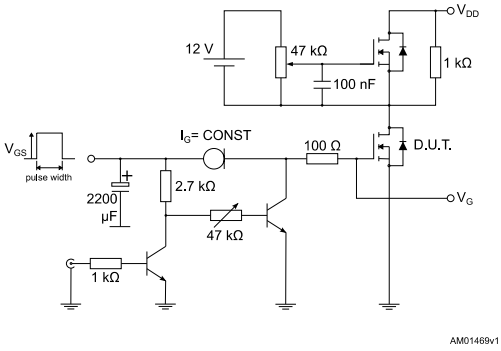


Figure 18: Test circuit for inductive load switching and diode recovery times

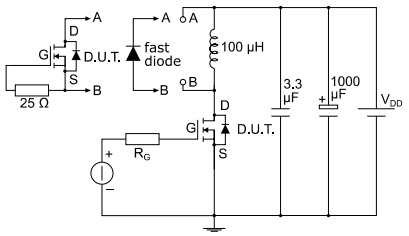


Figure 19: Unclamped inductive load test circuit

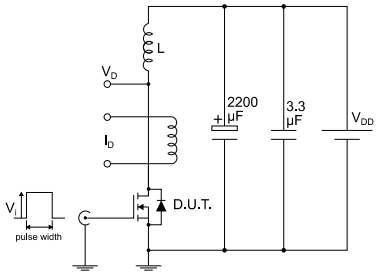


Figure 20: Unclamped inductive waveform

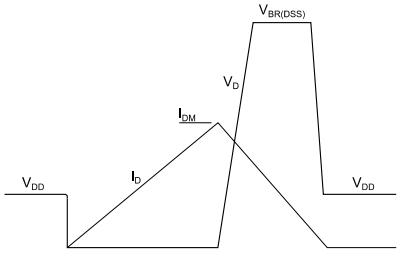
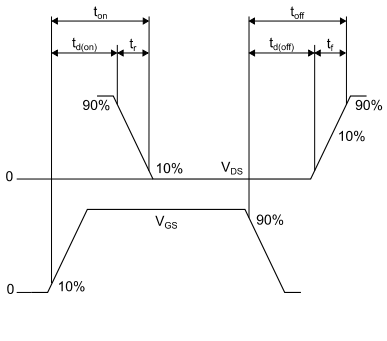


Figure 21: Switching time waveform



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 DPAK (TO-252) type A package information

Figure 22: DPAK (TO-252) type A package outline

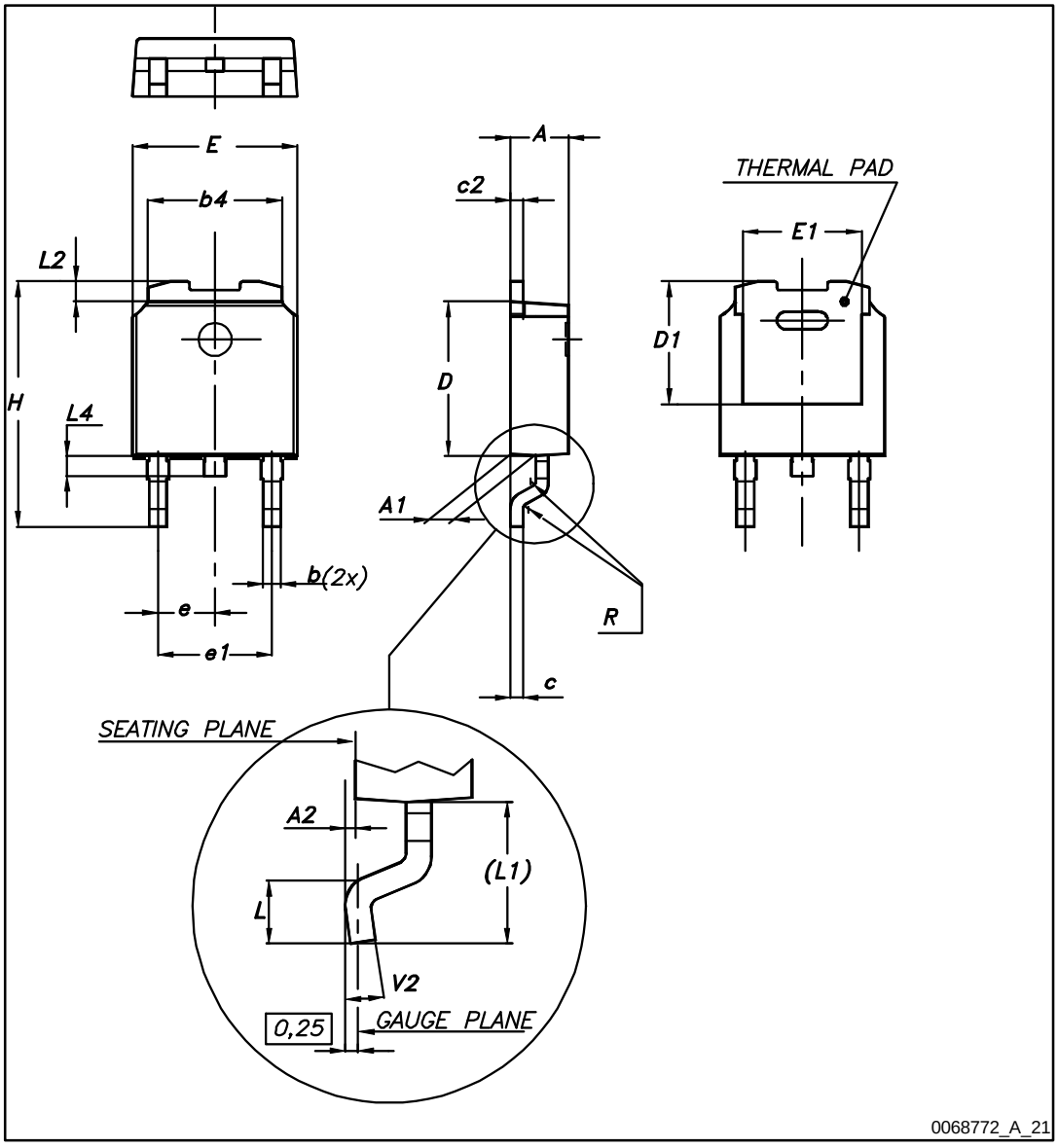


Table 9: DPAK (TO-252) type A mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	2.20		2.40
A1	0.90		1.10
A2	0.03		0.23
b	0.64		0.90
b4	5.20		5.40
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
D1	4.95	5.10	5.25
E	6.40		6.60
E1	4.60	4.70	4.80
e	2.16	2.28	2.40
e1	4.40		4.60
H	9.35		10.10
L	1.00		1.50
(L1)	2.60	2.80	3.00
L2	0.65	0.80	0.95
L4	0.60		1.00
R		0.20	
V2	0°		8°

4.2 DPAK TO-252 type C package information

Figure 23: DPAK (TO-252) type C package outline

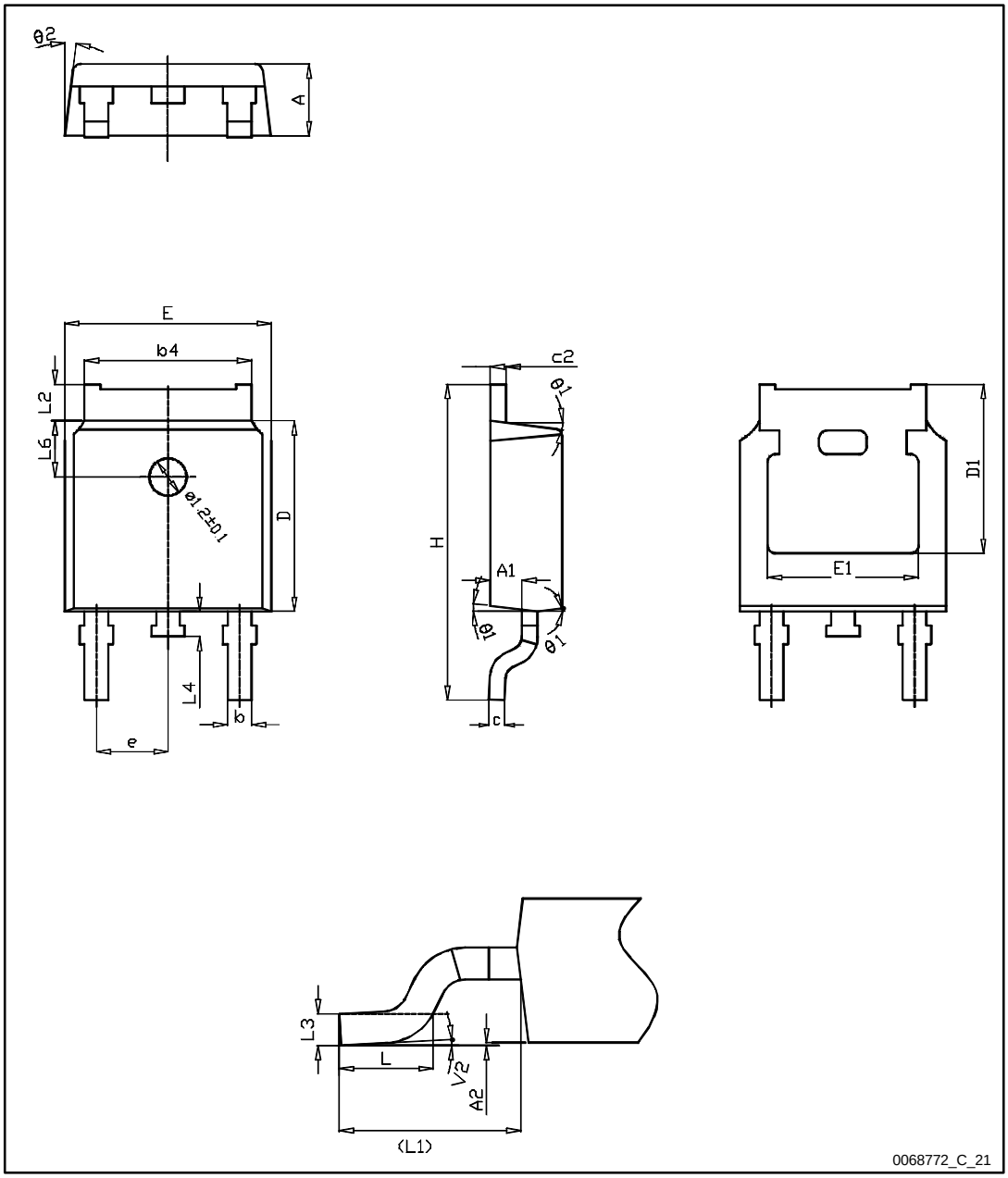
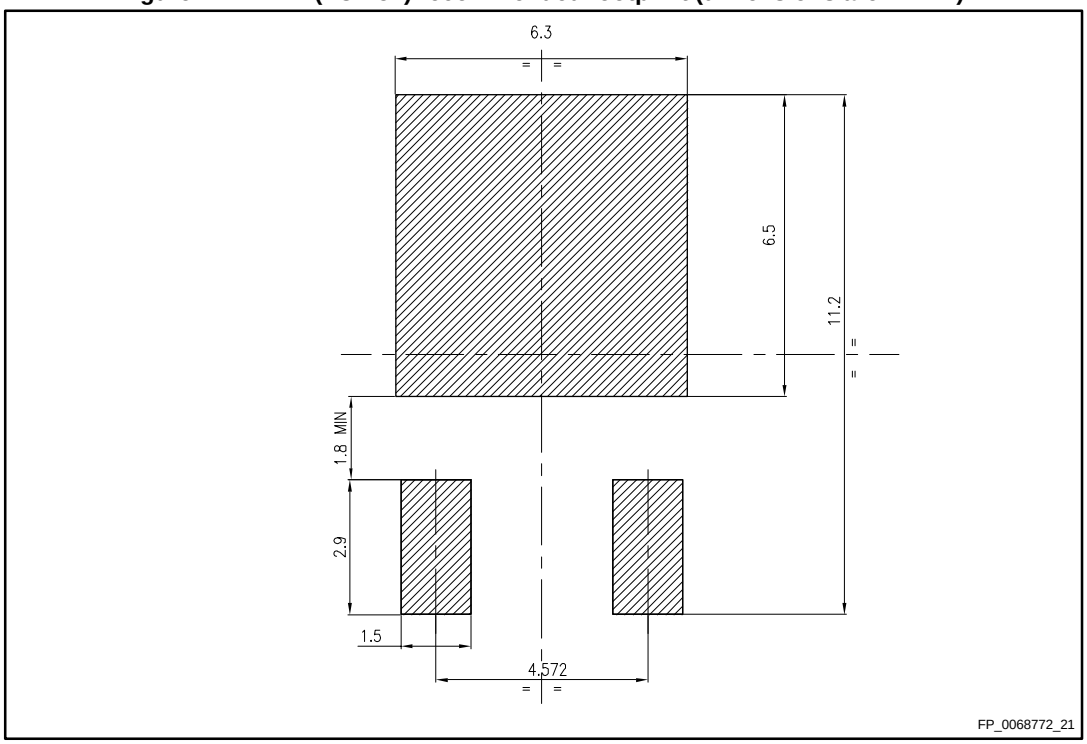


Table 10: DPAK (TO-252) type C mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	2.20	2.30	2.38
A1	0.90	1.01	1.10
A2	0.00		0.10
b	0.72		0.85
b4	5.13	5.33	5.46
c	0.47		0.60
c2	0.47		0.60
D	6.00	6.10	6.20
D1	5.25		
E	6.50	6.60	6.70
E1	4.70		
e	2.186	2.286	2.386
H	9.80	10.10	10.40
L	1.40	1.50	1.70
L1	2.90 REF		
L2	0.90		1.25
L3	0.51 BSC		
L4	0.60	0.80	1.00
L6	1.80 BSC		
θ1	5°	7°	9°
θ2	5°	7°	9°
V2	0°		8°

Figure 24: DPAK (TO-252) recommended footprint (dimensions are in mm)



4.3 DPAK (TO-252) packing information

Figure 255: DPAK (TO-252) tape outline

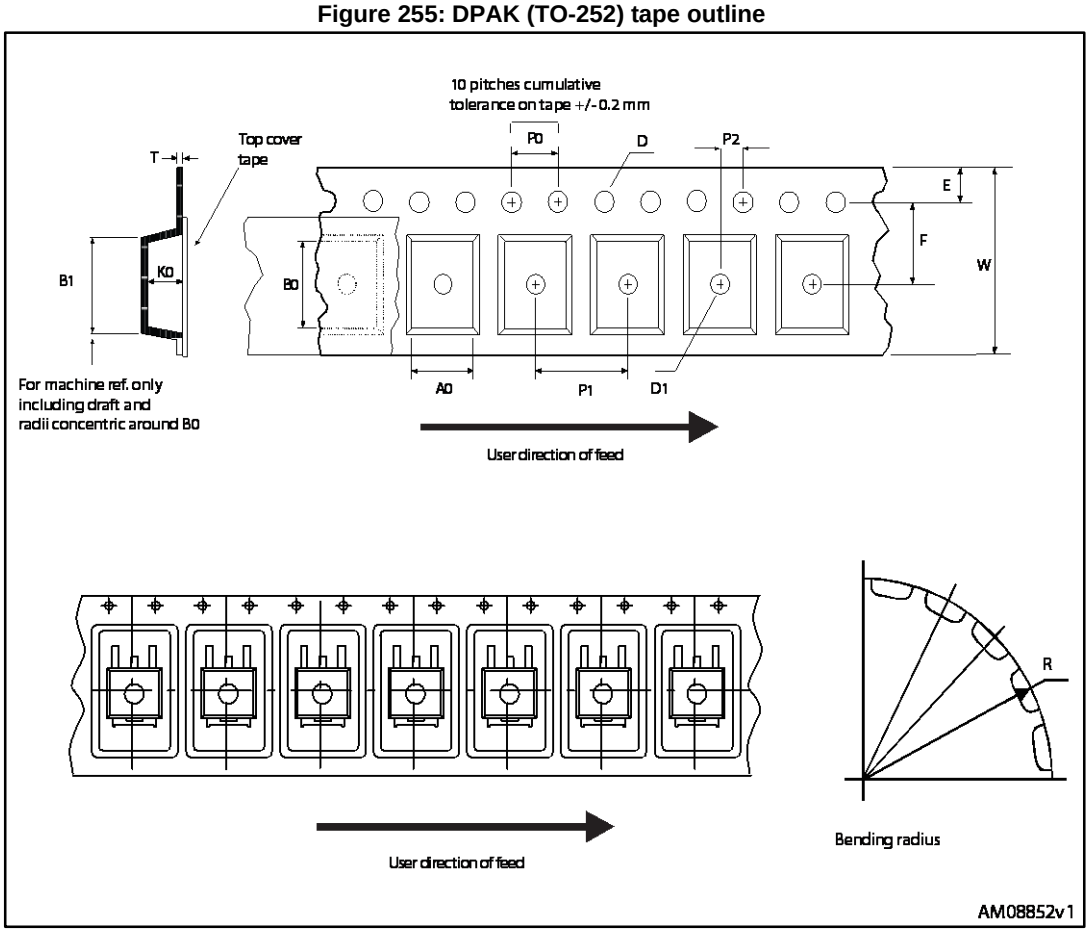


Figure 266: DPAK (TO-252) reel outline

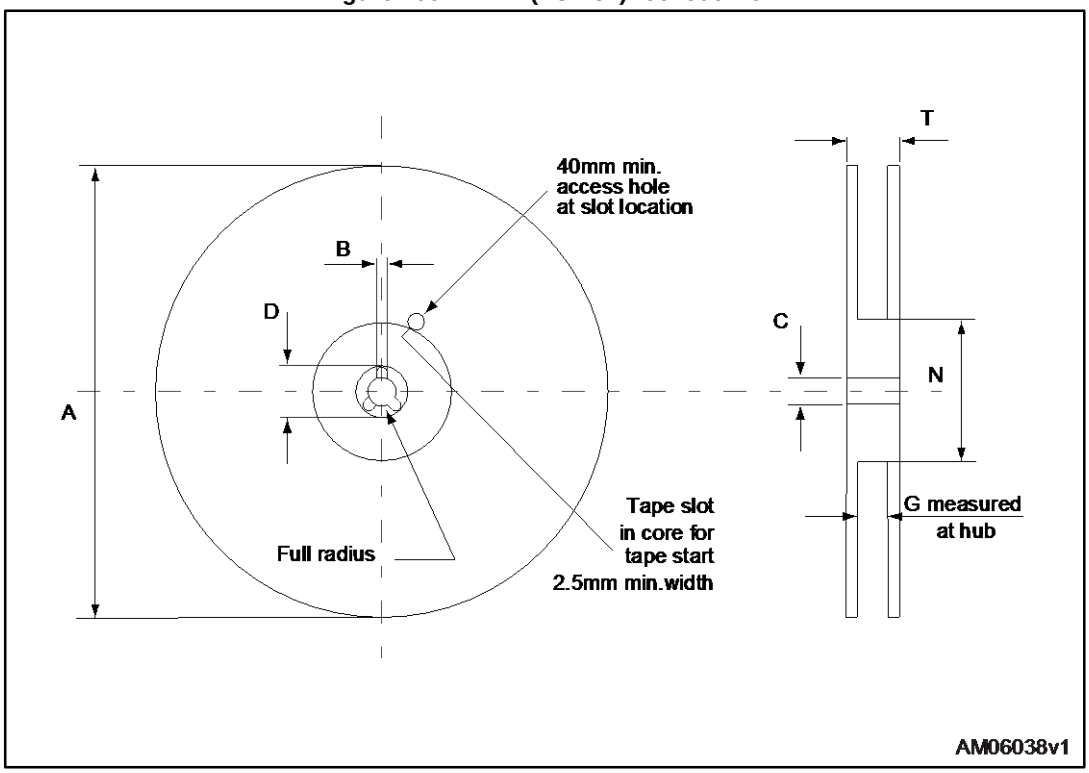


Table 11: DPAK (TO-252) tape and reel mechanical data

Tape			Reel		
Dim.	mm		Dim.	mm	
	Min.	Max.		Min.	Max.
A0	6.8	7	A		330
B0	10.4	10.6	B	1.5	
B1		12.1	C	12.8	13.2
D	1.5	1.6	D	20.2	
D1	1.5		G	16.4	18.4
E	1.65	1.85	N	50	
F	7.4	7.6	T		22.4
K0	2.55	2.75			
P0	3.9	4.1	Base qty.		2500
P1	7.9	8.1	Bulk qty.		2500
P2	1.9	2.1			
R	40				
T	0.25	0.35			
W	15.7	16.3			

4.4 TO-220 type A package information

Figure 277: TO-220 type A package outline

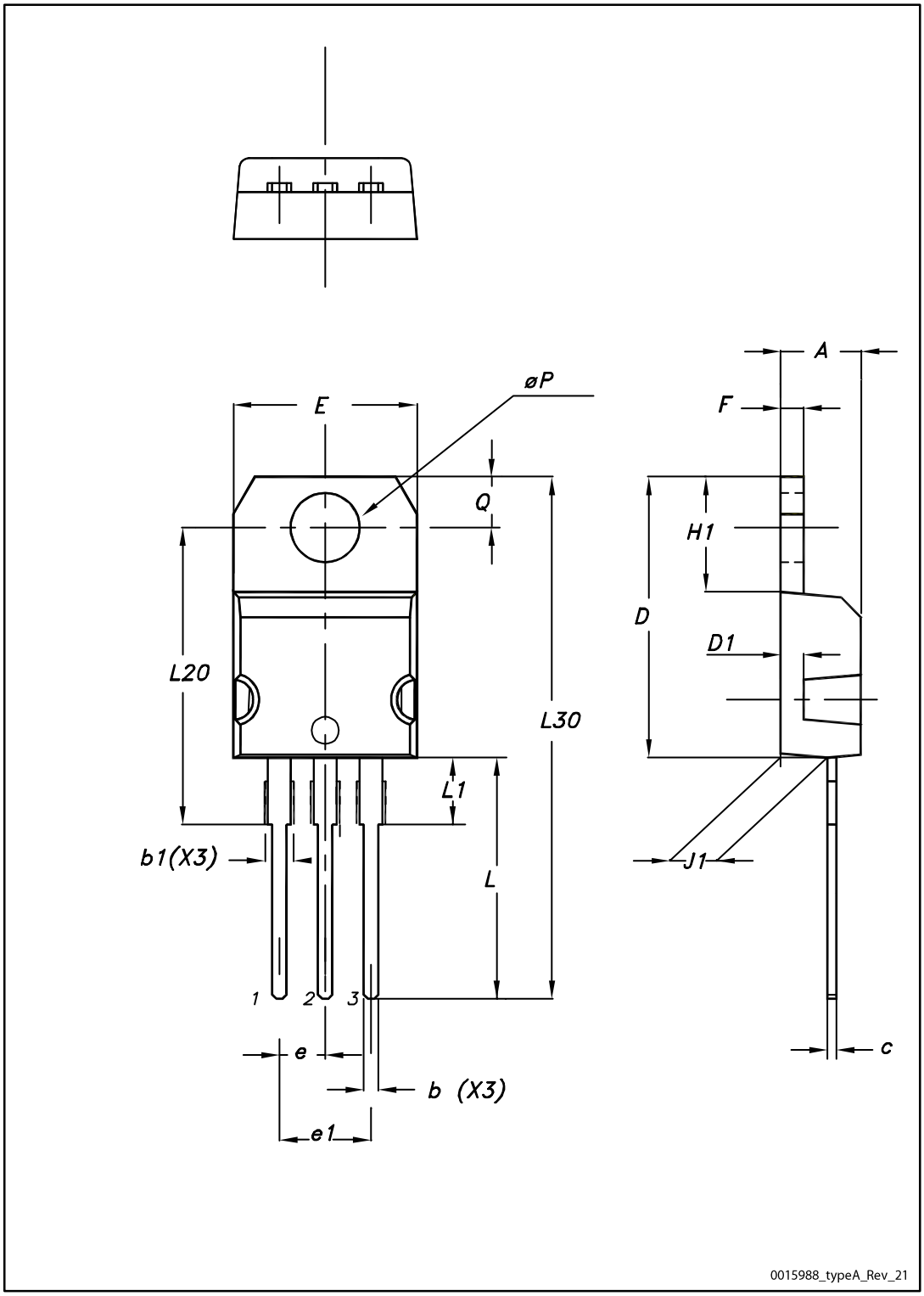


Table 12: TO-220 type A mechanical data

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

4.5 IPAK (TO-251) Type C package information

Figure 288: IPAK (TO-251) type C package outline

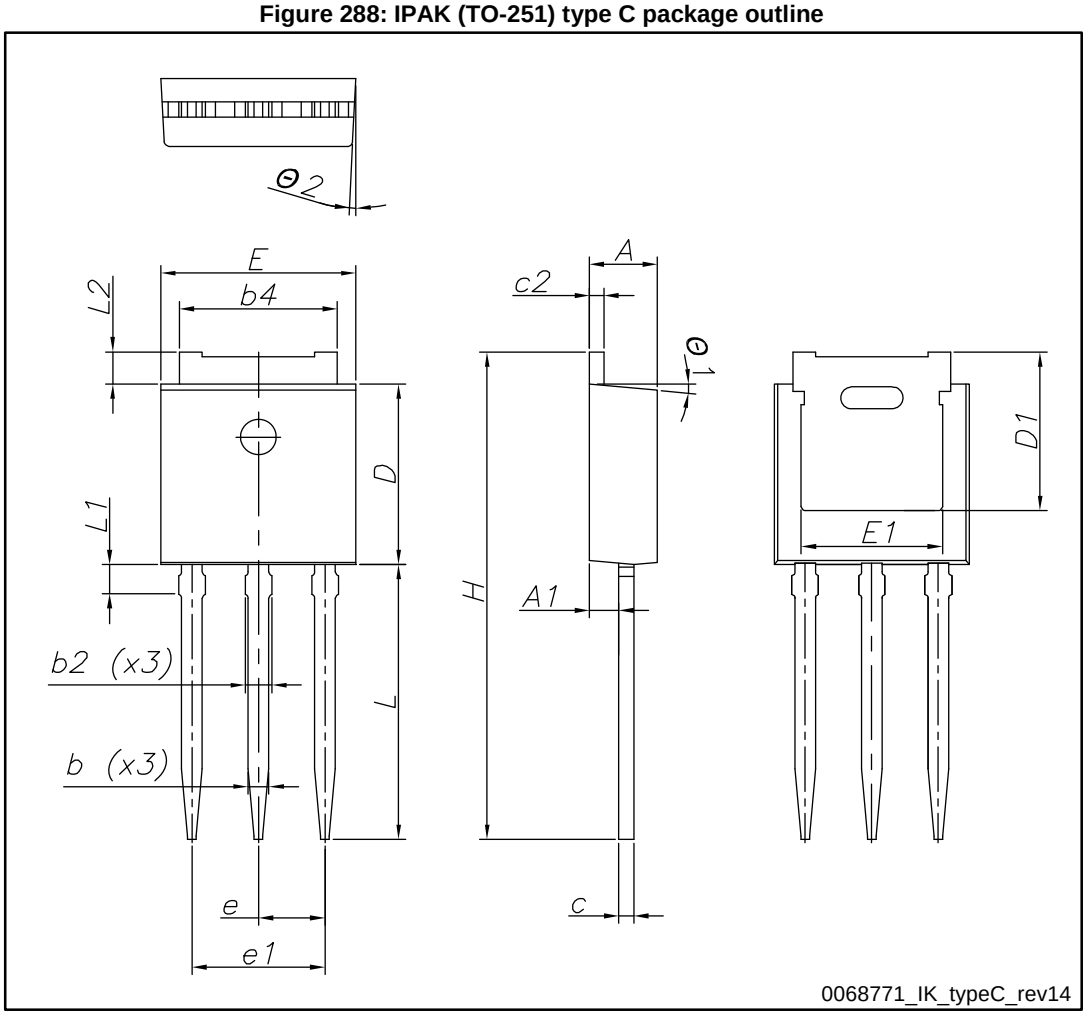


Table 13: IPAK (TO-251) type C package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	2.20	2.30	2.35
A1	0.90	1.00	1.10
b	0.66		0.79
b2			0.90
b4	5.23	5.33	5.43
c	0.46		0.59
c2	0.46		0.59
D	6.00	6.10	6.20
D1	5.20	5.37	5.55
E	6.50	6.60	6.70
E1	4.60	4.78	4.95
e	2.20	2.25	2.30
e1	4.40	4.50	4.60
H	16.18	16.48	16.78
L	9.00	9.30	9.60
L1	0.90	1.00	1.20
L2	0.90	1.08	1.25
θ1	3°	5°	7°
θ2	1°	3°	5°

5 Revision history

Table 14: Document revision history

Date	Revision	Changes
30-Sep-2013	1	First release.
20-Mar-2014	2	– Modified: ID, IDM and note 2 values in Table 2 – Modified: the entire values in Table 4 – Modified: RDS(on) typical and ID values in Table 5 – Modified: the entire typical values, ISD and ISDM in Table 6, 7 and 8 – Updated: Section 4.1: DPAK, STD5N60M2 – Minor text changes
08-Jun-2016	3	Updated title, features, applications and description in cover page. Updated Section 1: "Electrical ratings", Table 6: "Dynamic" and Section 2.1: "Electrical characteristics (curves)". Updated IPAK C Minor text changes
16-Jun-2016	4	Updated *Figure 1: "Internal schematic diagram"*. Updated *Table 7: "Switching times"* and *Table 8: "Source-drain diode"*. Minor text changes.

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