STGB6NC60HDT4, STGF6NC60HD, STGP6NC60HD

N-channel 600 V, 7 A, very fast PowerMESH™ IGBTs in D²PAK, TO-220FP and TO-220 packages

Datasheet - production data

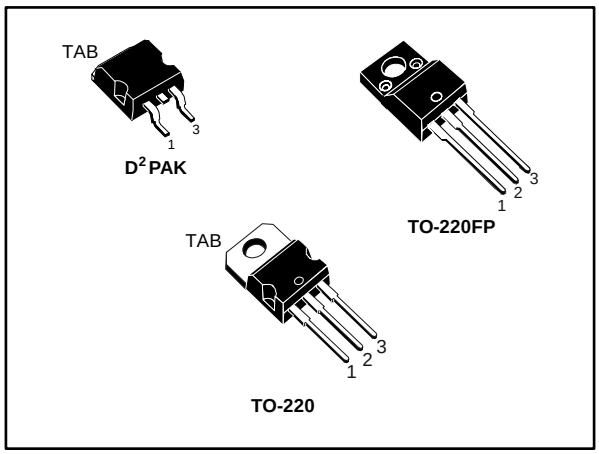
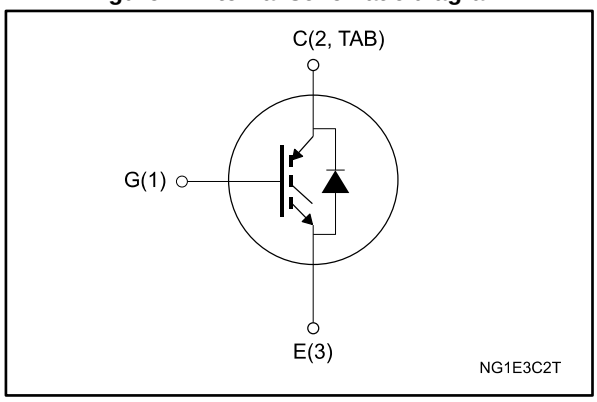


Figure 1: Internal schematic diagram



Features

- Low $V_{CE(sat)}$
- Low C_{RES}/C_{IES} ratio (no cross-conduction susceptibility)
- Very soft ultra fast recovery antiparallel diode
- High-frequency operation

Applications

- High-frequency inverters
- SMPS and PFC in both hard switch and resonant topologies
- Motor drivers

Description

Using the latest high-voltage technology based on a patented strip layout, STMicroelectronics has designed an advanced family of IGBTs, the PowerMESH™ IGBTs characterized by an outstanding performance. The “H” suffix identifies a family optimized for high-frequency applications which achieve very high switching performances (reduced tfall) while mantaining a low voltage drop.

Table 1: Device summary

Order code	Marking	Package	Packing
STGB6NC60HDT4	GB6NC60HD	D²PAK	Tape and reel
STGF6NC60HD	GF6NC60HD	TO-220FP	Tube
STGP6NC60HD	GP6NC60HD	TO-220	Tube

Contents

1 Electrical ratings

Table 2: Absolute maximum ratings

Symbol	Parameter	Value		Unit
		D²PAK, TO-220	TO-220FP	
V_{CES}	Collector-emitter voltage (V_{GE} = 0 V)	600		V
I_C(1)	Continuous collector current at T_C = 25 °C	15	6	A
	Continuous collector current at T_C = 100 °C	7	3	
I_{CM}(2)	Collector current (pulsed)	21		A
V_{GE}	Gate-emitter voltage	±20		V
I_F	Diode RMS forward current at T_C = 25 °C	10		A
P_{TOT}	Total dissipation at T_C = 25 °C	62.5	25	W
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

Notes:

(1)Calculated according to the iterative formula:

$$I_C(T_C) = \frac{T_{JMAX} - T_C}{R_{THJ-C} \times V_{CESAT(\mathrm{MAX})}(T_{J(max)} \times I_C(T_C))}$$

(2)Pulse width is limited by maximum junction temperature.

Table 3: Thermal data

Symbol	Parameter	Value		Unit
		D²PAK, TO-220	TO-220FP	
R_{thJC}	Thermal resistance junction-case	2	5	°C/W
R_{thJA}	Thermal resistance junction-ambient	62.5		°C/W

2 Electrical characteristics

T_C = 25 °C unless otherwise specified

Table 4: Static characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage	V_{GE} = 0 V, I_C = 1 mA	600			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} = 15 V, I_C = 3 A		1.9	2.5	V
		V_{GE} = 15 V, I_C = 3 A, T_C = 125 °C		1.7		
$V_{GE(th)}$	Gate threshold voltage	V_{CE} = V_{GE}, I_C = 250 µA	3.75		5.75	V
I_{CES}	Collector cut-off current	V_{GE} = 0 V, V_{CE} = 600 V			10	µA
		V_{GE} = 0 V, V_{CE} = 600 V, T_C = 125 °C(1)			1	mA
I_{GES}	Gate-emitter leakage current	V_{GE} = ±20 V, V_{CE} = 0 V			±100	nA

Notes:

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

Table 5: Dynamic characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{ies}	Input capacitance	V_{CE} = 25 V, f = 1 MHz, V_{GE} = 0 V	-	205	-	pF
C_{oes}	Output capacitance		-	32	-	
C_{res}	Reverse transfer capacitance		-	5.5	-	
Q_g	Total gate charge	V_{CE} = 390 V, I_C = 3 A, V_{GE} = 0 to 15 V (see *Figure 19: " Gate charge test circuit"*)	-	13.6	-	nC
Q_{ge}	Gate-emitter charge		-	3.4	-	
Q_{gc}	Gate-collector charge		-	5.1	-	
I_{CL}	Turn-off SOA minimum current	V_{clamp} = 390 V, T_J = 150 °C, R_G = 10 Ω, V_{GE} = 15 V	-	19	-	A

Table 6: Switching on/off characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	V_{CC} = 390 V, I_C = 3 A, R_G = 10 Ω, V_{GE} = 15 V (see *Figure 18: " Test circuit for inductive load switching"*)	-	12	-	ns
t_r	Current rise time		-	5	-	
$(di/dt)_{on}$	Turn-on current slope		-	612	-	A/µs
$t_{d(on)}$	Turn-on delay time	V_{CC} = 390 V, I_C = 3 A, R_G = 10 Ω, V_{GE} = 15 V, T_J = 125 °C (see *Figure 18: " Test circuit for inductive load switching"*)	-	13	-	ns
t_r	Current rise time		-	4.3	-	
$(di/dt)_{on}$	Turn-on current slope		-	560	-	A/µs
$t_r(V_{off})$	Off voltage rise time	V_{CC} = 390 V, I_C = 3 A, R_G = 10 Ω, V_{GE} = 15 V (see *Figure 18: " Test circuit for inductive load switching"*)	-	40	-	ns
t_d(off)	Turn-off delay time		-	76	-	
t_f	Current fall time		-	100	-	
$t_r(V_{off})$	Off voltage rise time	V_{CC} = 390 V, I_C = 3 A, R_G = 10 Ω, V_{GE} = 15 V, T_J = 125 °C (see *Figure 18: " Test circuit for inductive load switching"*)	-	60	-	ns
t_d(off)	Turn-off delay time		-	98	-	
t_f	Current fall time		-	124	-	

Table 7: Switching energy (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
E_{on} (1)	Turn-on switching energy	V_{CC} = 390 V, I_C = 3 A, R_G = 10 Ω, V_{GE} = 15 V (see *Figure 18: " Test circuit for inductive load switching"*)	-	20	-	µJ
E_{off} (2)	Turn-off switching energy		-	68	-	
E_{ts}	Total switching energy		-	88	-	
E_{on} (1)	Turn-on switching energy	V_{CC} = 390 V, I_C = 3 A, R_G = 10 Ω, V_{GE} = 15 V, T_J = 125 °C (see *Figure 18: " Test circuit for inductive load switching"*)	-	37	-	µJ
E_{off} (2)	Turn-off switching energy		-	93	-	
E_{ts}	Total switching energy		-	130	-	

Notes:

(1)Including the reverse recovery of the diode

(2)Including the tail of the collector current

Table 8: Collector-emitter diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_f	Forward on-voltage	I_f = 1.5 A	-	1.6	2.1	V
		I_f = 1.5 A, Tj = 125 °C	-	1.3		
t_{rr}	Reverse recovery time	I_f = 3 A ,V_R = 40 V, di/dt = 100 A/µs (see *Figure 21: " Diode reverse recovery waveform"*)	-	21		ns
Q_{rr}	Reverse recovery charge		-	14		nC
I_{rrm}	Reverse recovery current		-	1.36		A
t_{rr}	Reverse recovery time	I_f = 3 A ,V_R = 40 V, T_j = 125 °C, di/dt = 100 A/µs (see *Figure 21: " Diode reverse recovery waveform"*)	-	34		ns
Q_{rr}	Reverse recovery charge		-	32		nC
I_{rrm}	Reverse recovery current		-	1.88		A

2.1 Electrical characteristics (curves)

Figure 2: Output characteristics

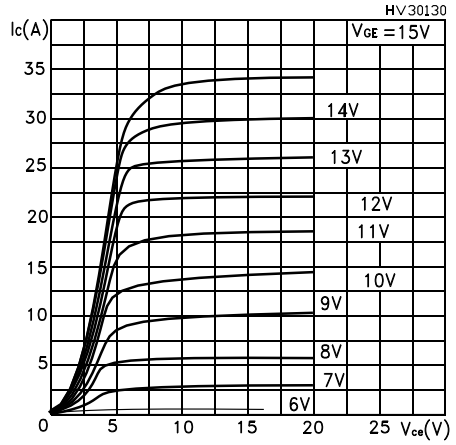


Figure 3: Transfer characteristics

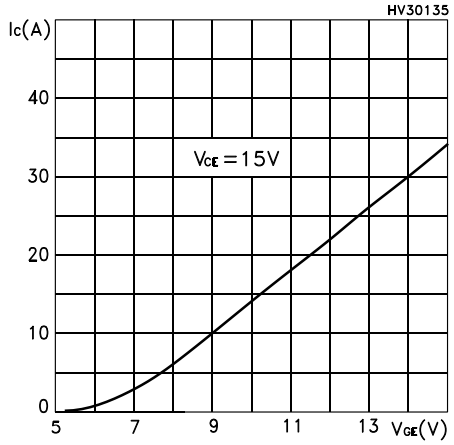


Figure 4: Transconductance

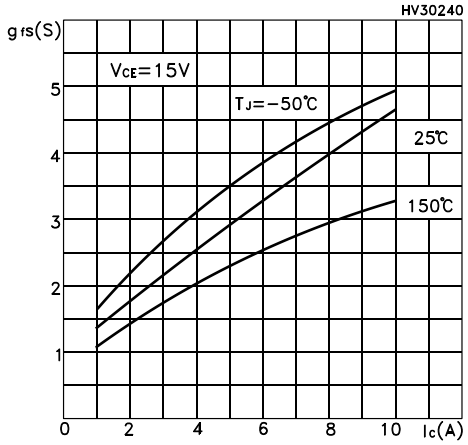


Figure 5: Collector-emitter on-voltage vs temperature

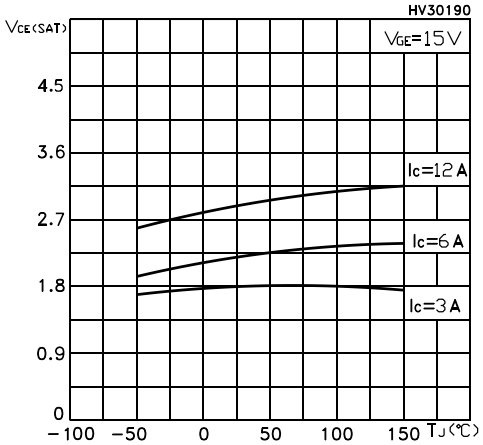


Figure 6: Gate charge vs gate-source voltage

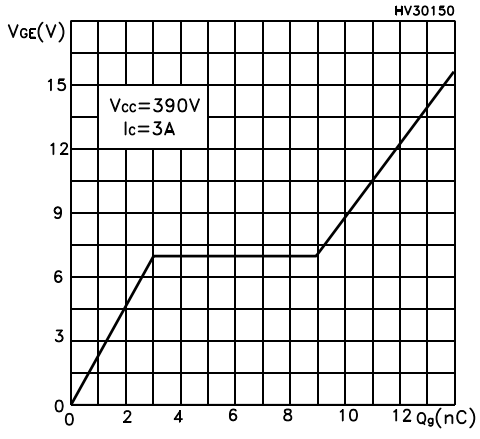


Figure 7: Capacitance variations

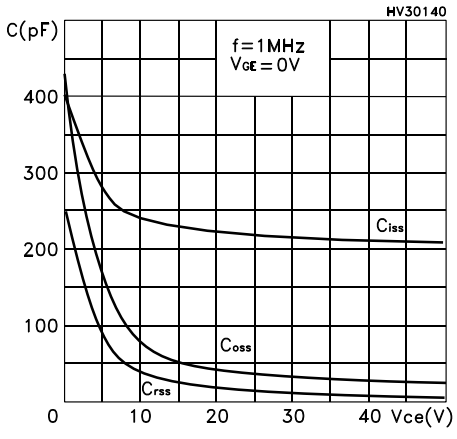


Figure 8: Normalized gate threshold voltage vs temperature

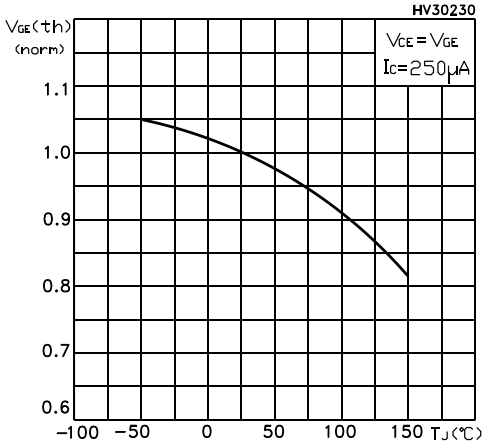


Figure 9: Collector-emitter on voltage vs collector current

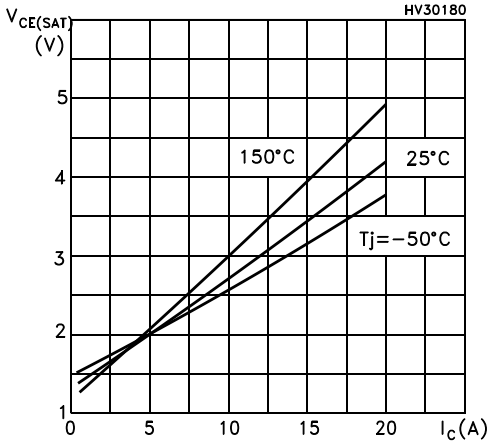


Figure 10: Normalized breakdown voltage vs temperature

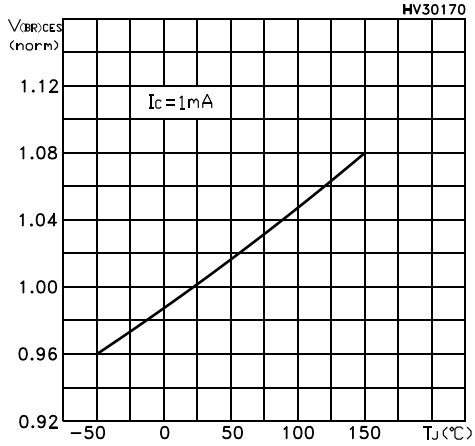


Figure 11: Switching energy vs temperature

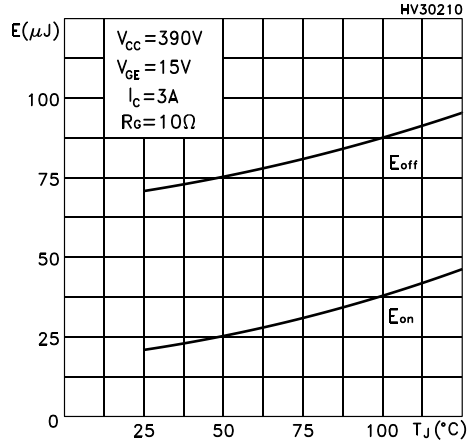


Figure 12: Switching energy vs gate resistance

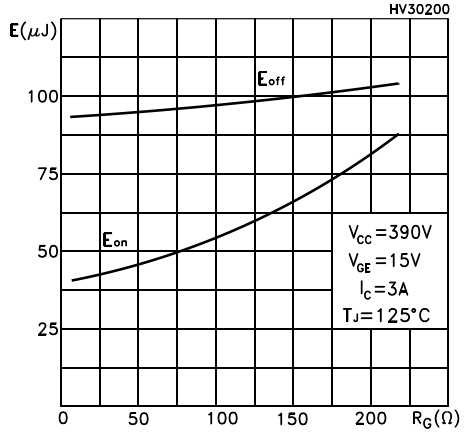


Figure 13: Switching energy vs collector current

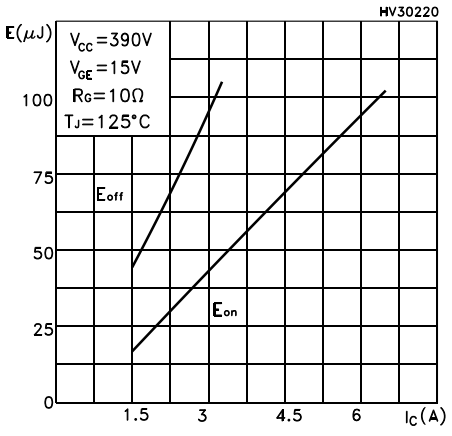


Figure 14: Thermal impedance for TO-220 / D2PAK

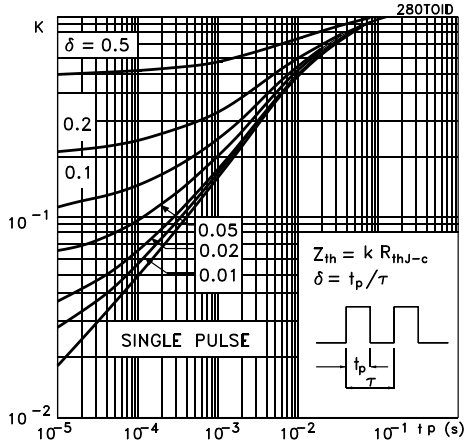


Figure 15: Turn-off SOA

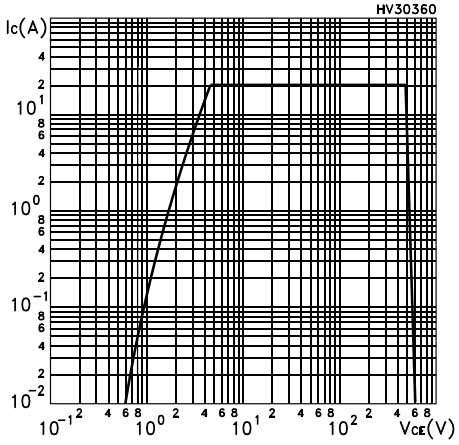


Figure 16: Thermal impedance for TO-220FP

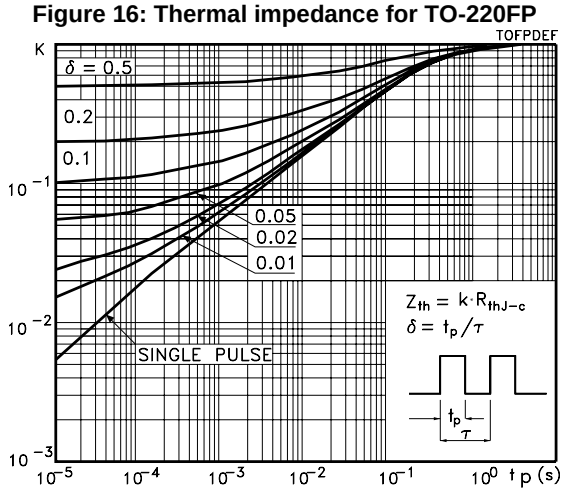
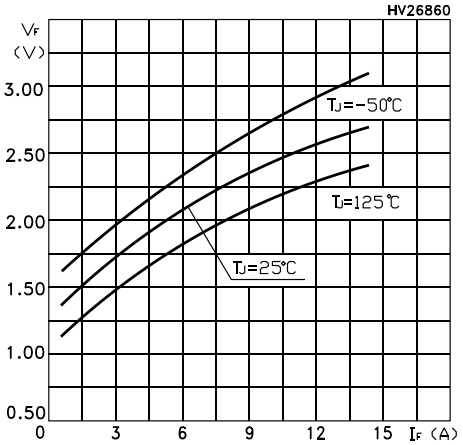


Figure 17: Emitter-collector diode characteristics



3 Test circuits

Figure 18: Test circuit for inductive load switching

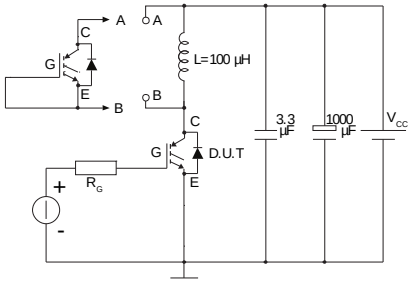


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Figure 19: Gate charge test circuit

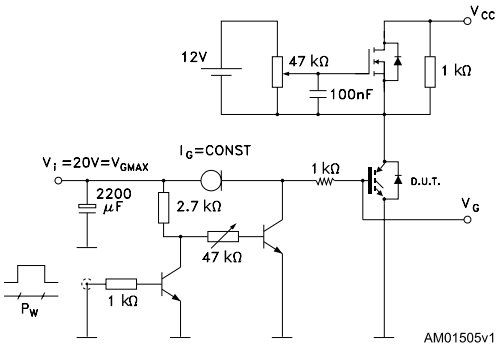

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Figure 20: Switching waveform

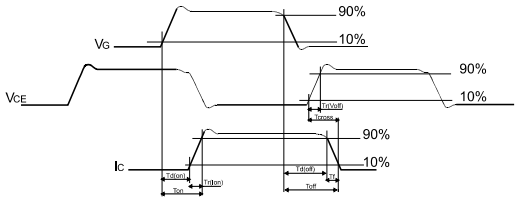

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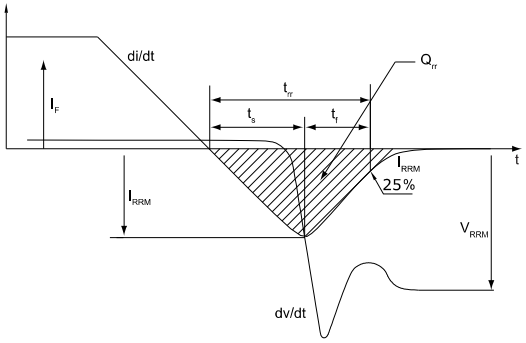
Figure 21: Diode reverse recovery waveform



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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 D²PAK package information

4.1.1 D²PAK (TO-263) type A package information

Figure 22: D²PAK (TO-263) type A package outline

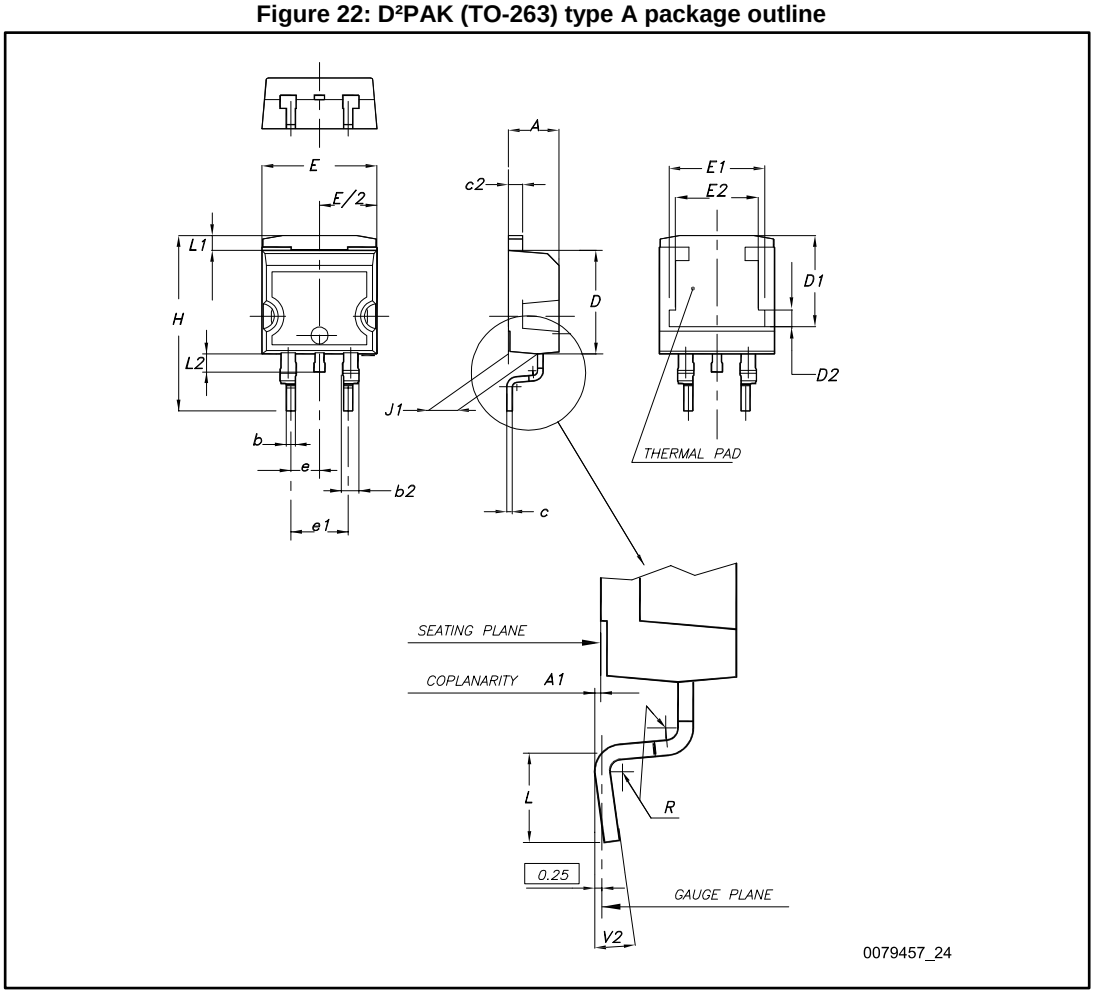


Table 9: D²PAK (TO-263) type A package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
A1	0.03		0.23
b	0.70		0.93
b2	1.14		1.70
c	0.45		0.60
c2	1.23		1.36
D	8.95		9.35
D1	7.50	7.75	8.00
D2	1.10	1.30	1.50
E	10.00		10.40
E1	8.50	8.70	8.90
E2	6.85	7.05	7.25
e		2.54	
e1	4.88		5.28
H	15.00		15.85
J1	2.49		2.69
L	2.29		2.79
L1	1.27		1.40
L2	1.30		1.75
R		0.40	
V2	0°		8°

4.1.2 D²PAK (TO-263) type B package information

Figure 23: D²PAK (TO-263) type B package outline

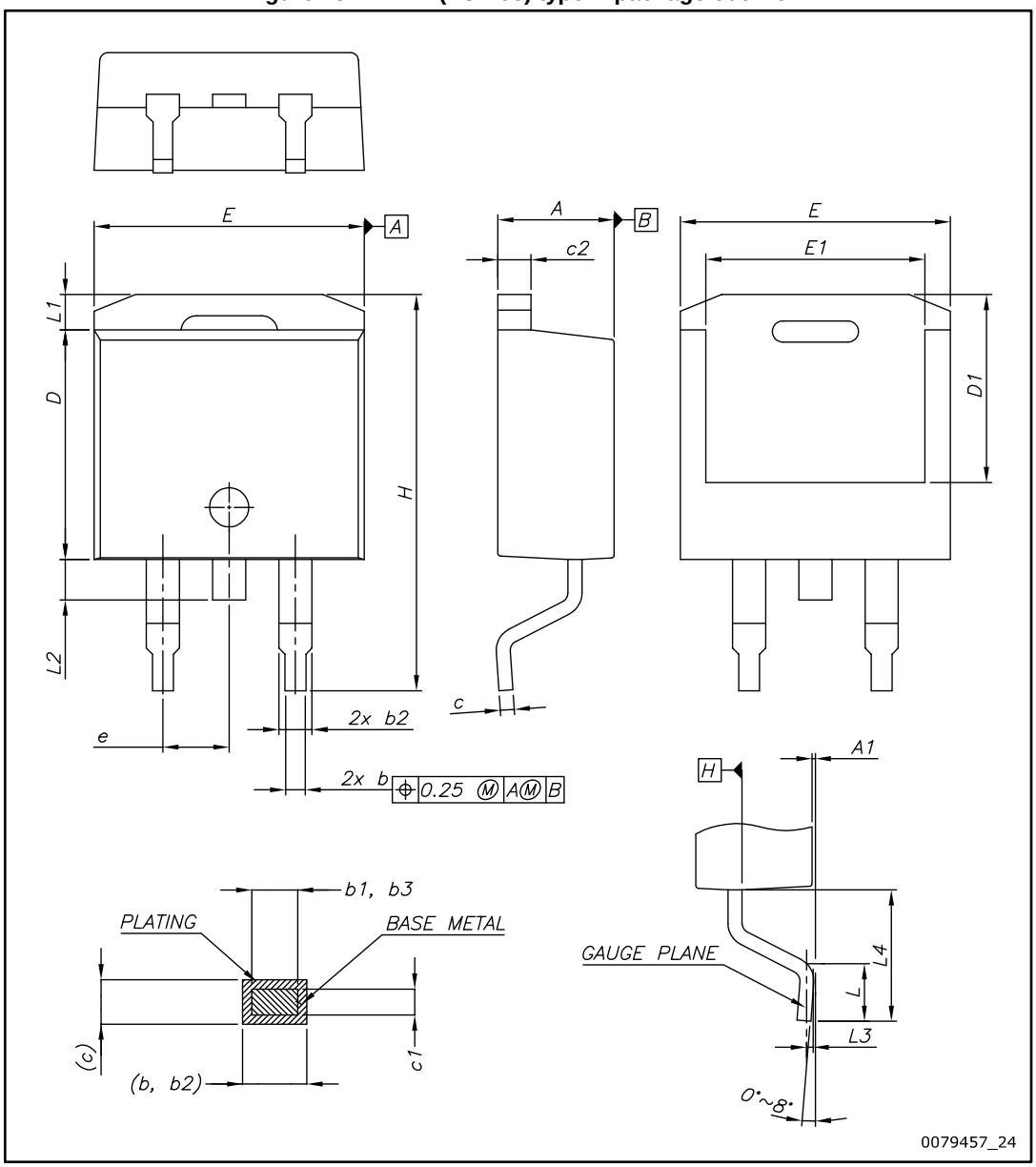
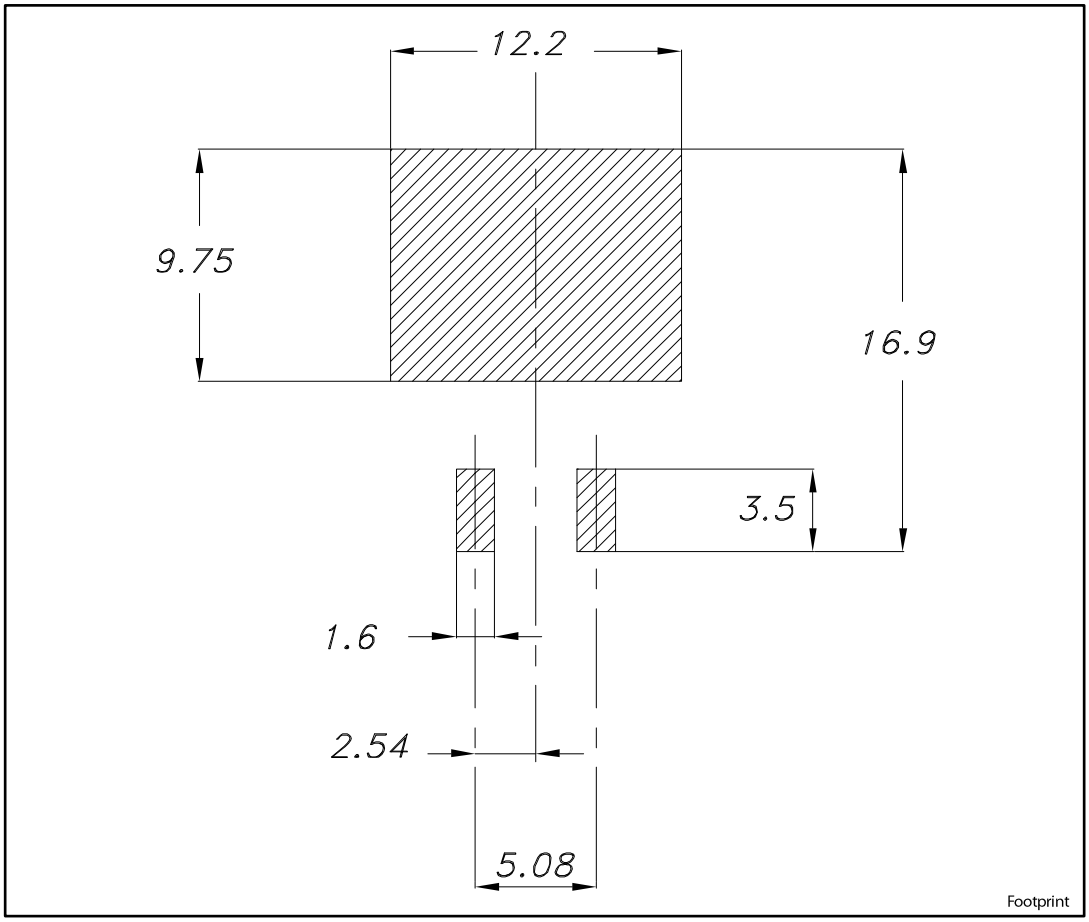


Table 10: D²PAK (TO-263) type B mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.36		4.56
A1	0		0.25
b	0.70		0.90
b1	0.51		0.89
b2	1.17		1.37
b3	1.36		1.46
c	0.38		0.694
c1	0.38		0.534
c2	1.19		1.34
D	8.60		9.00
D1	6.90		7.50
E	10.15		10.55
E1	8.10		8.70
e	2.54 BSC		
H	15.00		15.60
L	1.90		2.50
L1			1.65
L2			1.78
L3		0.25	
L4	4.78		5.28

Figure 24: D²PAK (TO-263) recommended footprint (dimensions are in mm)



4.2 D²PAK packing information

4.2.1 D²PAK type A packing information

Figure 25: D²PAK type A tape outline

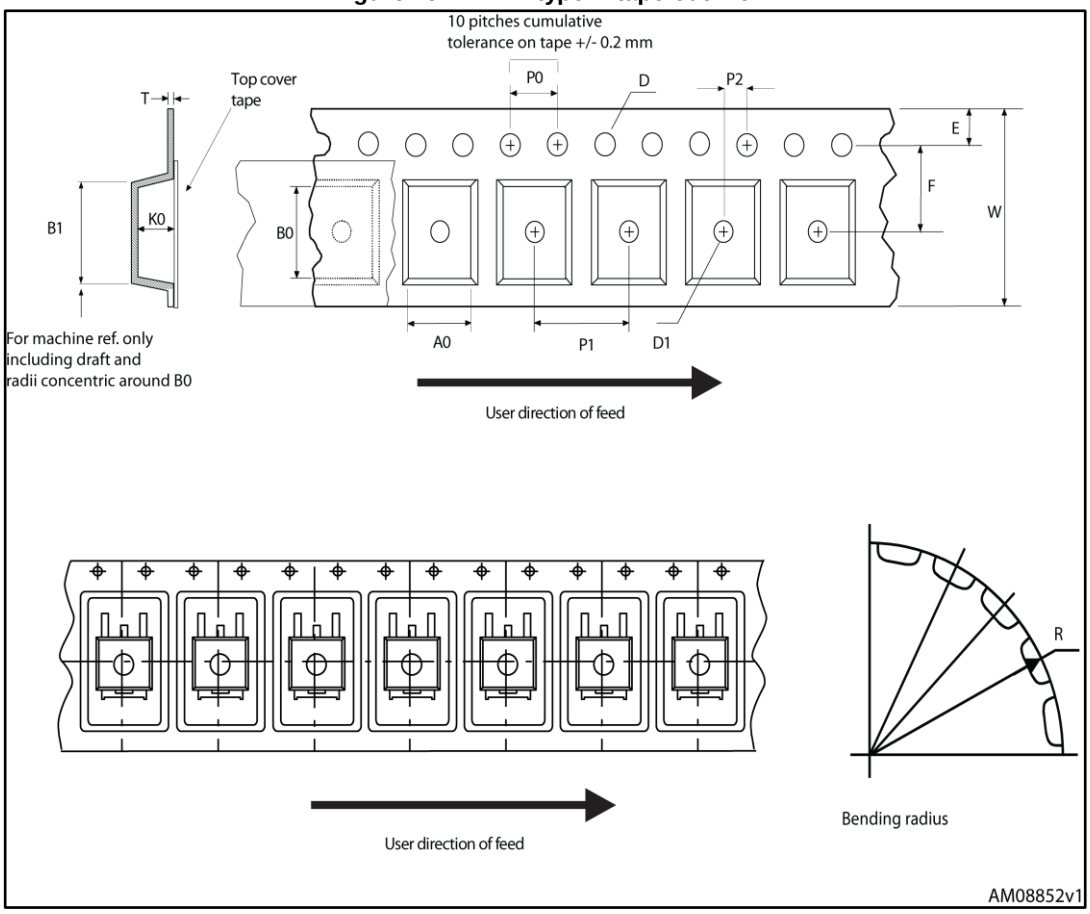


Figure 26: D²PAK type A reel outline

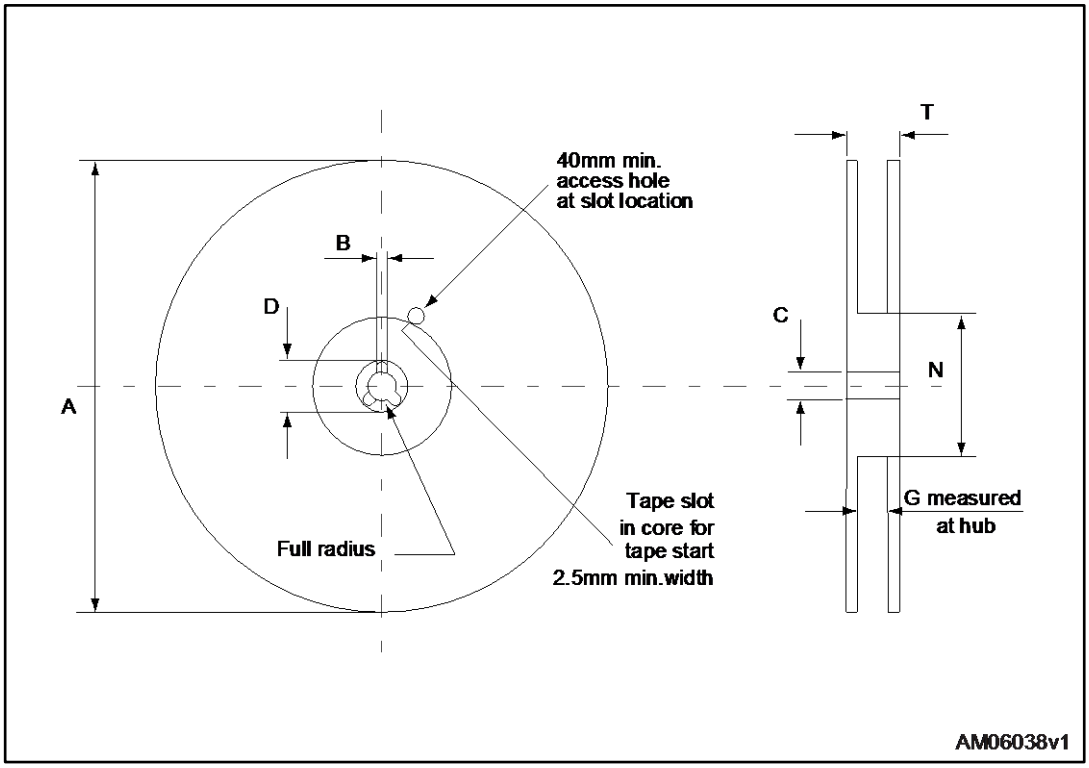


Table 11: D²PAK type A tape and reel mechanical data

Tape			Reel		
Dim.	mm		Dim.	mm	
	Min.	Max.		Min.	Max.
A0	10.5	10.7	A		330
B0	15.7	15.9	B	1.5	
D	1.5	1.6	C	12.8	13.2
D1	1.59	1.61	D	20.2	
E	1.65	1.85	G	24.4	26.4
F	11.4	11.6	N	100	
K0	4.8	5.0	T		30.4
P0	3.9	4.1			
P1	11.9	12.1	Base quantity		1000
P2	1.9	2.1	Bulk quantity		1000
R	50				
T	0.25	0.35			
W	23.7	24.3			

4.2.2 D²PAK type B packing information

Figure 27: D²PAK type B tape outline

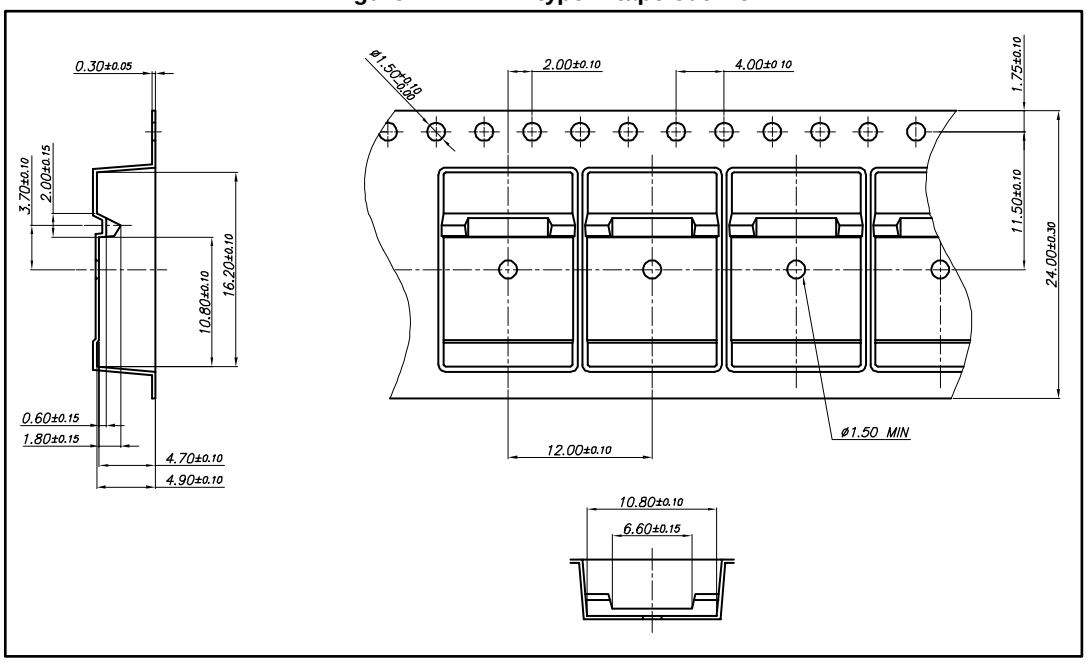


Figure 28: D²PAK type B reel outline

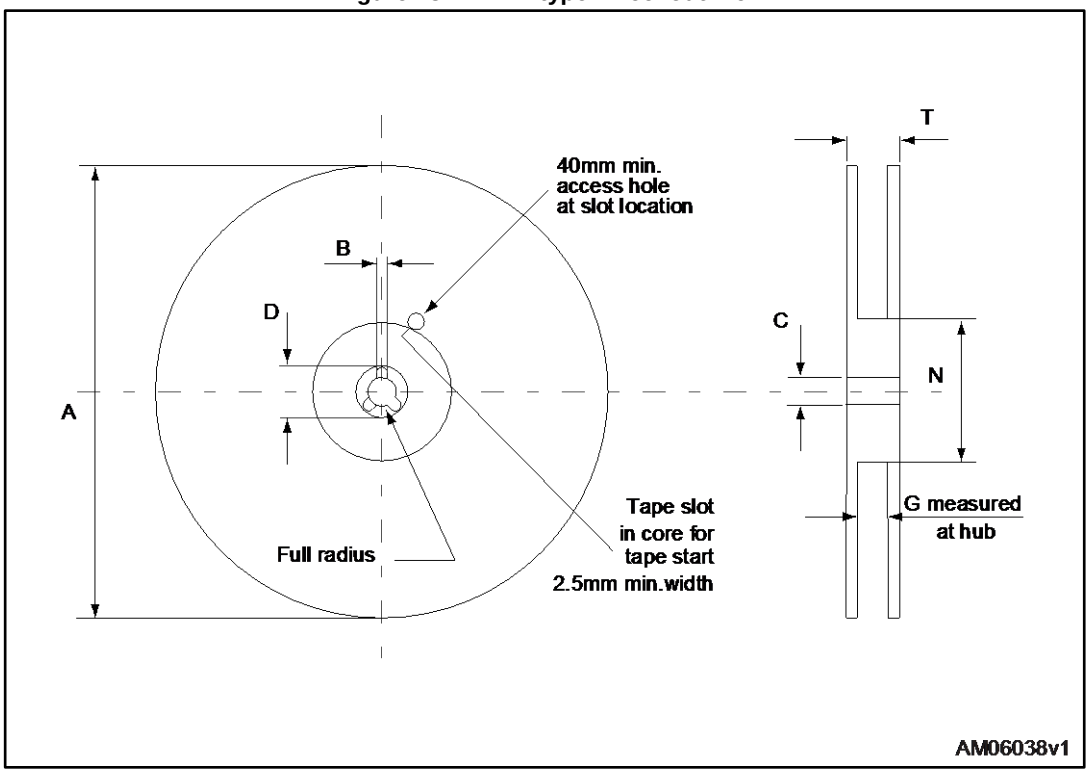


Table 12: D²PAK type B reel mechanical data

Dim.	mm	
	Min.	Max.
A		330
B	1.5	
C	12.8	13.2
D	20.2	
G	24.4	26.4
N	100	
T		30.4

4.3 TO-220FP package information

Figure 29: TO-220FP package outline

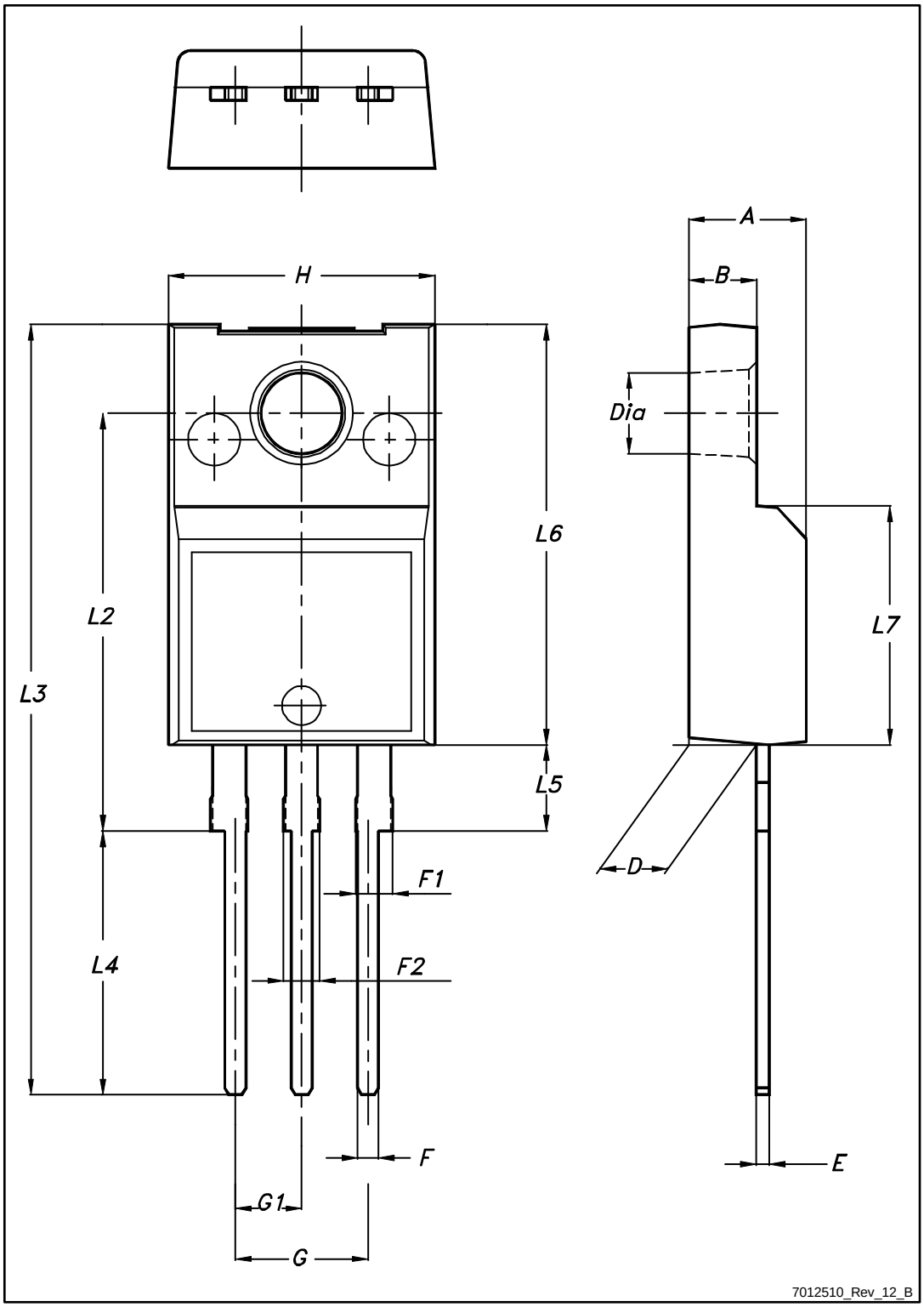


Table 13: TO-220FP package mechanical data

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

4.4 TO-220 type A package information

Figure 30: TO-220 type A package outline

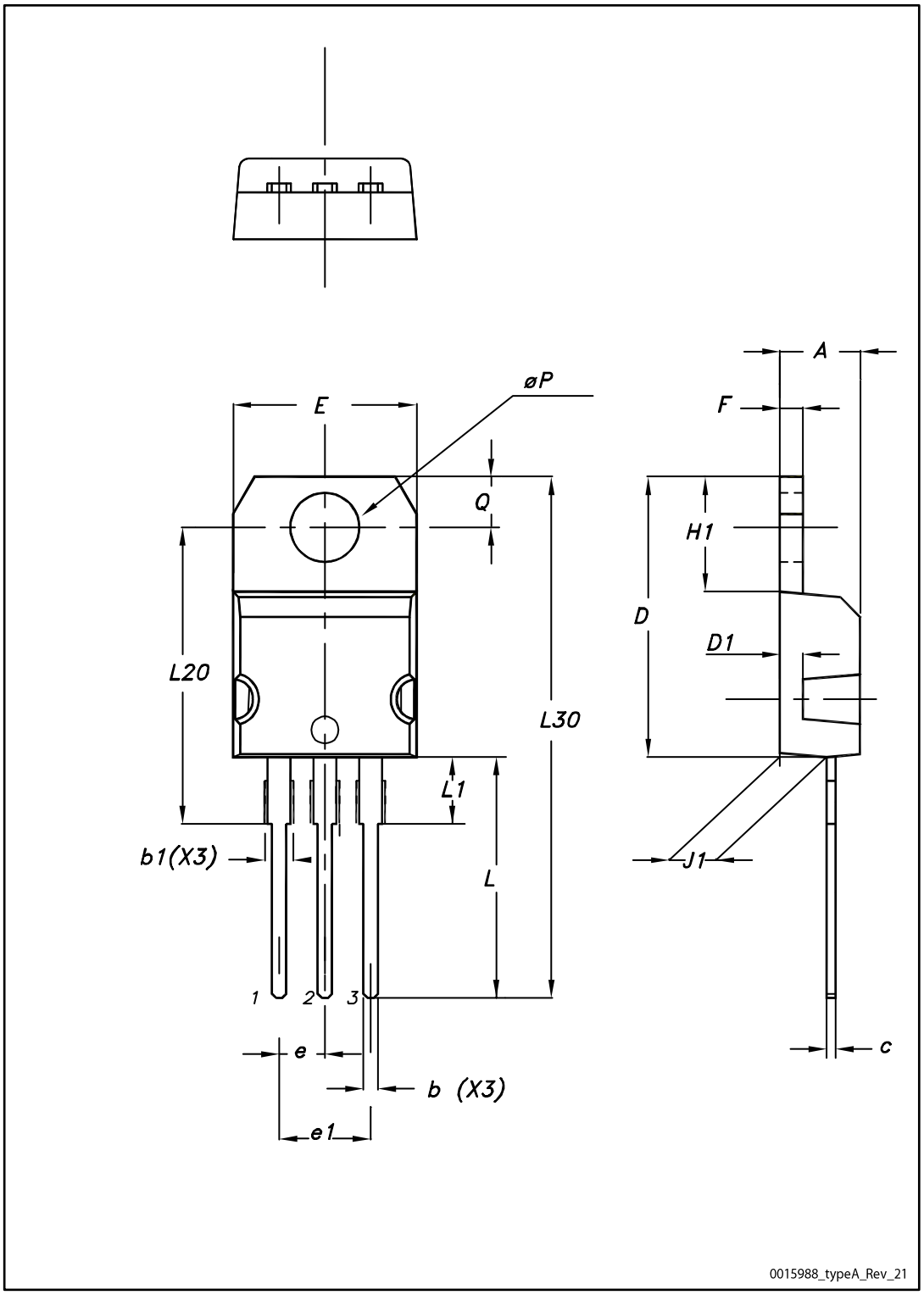


Table 14: TO-220 type A package mechanical data

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

5 Revision history

Table 15: Document revision history

Date	Revision	Changes
28-Nov-2005	1	First release
07-Mar-2006	2	Complete version
31-Jul-2006	3	Modified *Figure 10*.
26-Apr-2007	4	Inserted package I^2PAK
20-Nov-2017	5	Part number STGB6NC60HD-1 has been moved to a separate datasheet. Updated information on cover page. Updated *Table 2: "Absolute maximum ratings"* and *Table 4: "Static characteristics"*. Updated *Section 2.1: "Electrical characteristics (curves)"*. Updated *Section 4: "Package information"*. Minor text changes

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