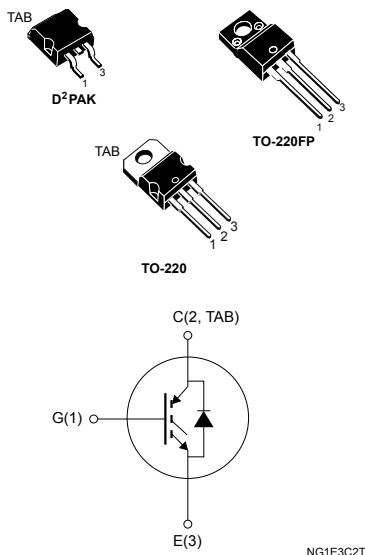


## N-channel 600 V, 7 A, very fast IGBT



### 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  $t_{fall}$ ) while maintaining a low voltage drop.



#### Product status link

[STGB6NC60HDT4](#)
[STGF6NC60HD](#)
[STGP6NC60HD](#)

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		D <sup>2</sup> PAK, TO-220	TO-220FP	
V <sub>CES</sub>	Collector-emitter voltage (V <sub>GE</sub> = 0 V)	600		V
I <sub>C</sub>	Continuous collector current at T <sub>C</sub> = 25 °C	15	6	A
	Continuous collector current at T <sub>C</sub> = 100 °C	7	3	
I <sub>CM</sub> <sup>(1)</sup>	Collector current (pulsed)	21		A
V <sub>GE</sub>	Gate-emitter voltage	±20		V
I <sub>F</sub>	Diode RMS forward current at T <sub>C</sub> = 25 °C	10		A
P <sub>TOT</sub>	Total power dissipation at T <sub>C</sub> = 25 °C	62.5	25	W
V <sub>ISO</sub>	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; T <sub>C</sub> = 25 °C)	2.5		kV
T <sub>STG</sub>	Storage temperature range	-55 to 150		°C
T <sub>J</sub>	Operating junction temperature range			°C

1. Pulse width is limited by maximum junction temperature.

**Table 2. Thermal data**

Symbol	Parameter	Value		Unit
		D <sup>2</sup> PAK, TO-220	TO-220FP	
R <sub>thJC</sub>	Thermal resistance junction-case	2	5	°C/W
R <sub>thJA</sub>	Thermal resistance junction-ambient	62.5		°C/W

## 2 Electrical characteristics

$T_C = 25\text{ °C}$  unless otherwise specified

**Table 3. Static characteristics**

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

1. Defined by design, not subject to production test

**Table 4. Dynamic characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$	Input capacitance	$V_{CE} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GE} = 0\text{ V}$	-	205	-	pF
$C_{oes}$	Output capacitance		-	32	-	
$C_{res}$	Reverse transfer capacitance		-	5.5	-	
$Q_g$	Total gate charge	$V_{CE} = 390\text{ V}$ , $I_C = 3\text{ A}$ , $V_{GE} = 0\text{ to }15\text{ V}$ (see Figure 18. Gate charge test circuit)	-	13.6	-	nC
$Q_{ge}$	Gate-emitter charge		-	3	-	
$Q_{gc}$	Gate-collector charge		-	6	-	
$I_{CL}$	Turn-off SOA minimum current	$V_{clamp} = 390\text{ V}$ , $T_J = 150\text{ °C}$ , $R_G = 10\text{ }\Omega$ , $V_{GE} = 15\text{ V}$	-	19	-	A

**Table 5. Switching characteristics (inductive load)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 390\text{ V}$ , $I_C = 3\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ (see Figure 17. Test circuit for inductive load switching)	-	12	-	ns
$t_r$	Current rise time		-	5	-	
$(di/dt)_{on}$	Turn-on current slope		-	612	-	
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 390\text{ V}$ , $I_C = 3\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$ (see Figure 17. Test circuit for inductive load switching)	-	13	-	ns
$t_r$	Current rise time		-	4.3	-	
$(di/dt)_{on}$	Turn-on current slope		-	560	-	
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 390\text{ V}$ , $I_C = 3\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ (see Figure 17. 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	$V_{CC} = 390\text{ V}$ , $I_C = 3\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$ (see Figure 17. Test circuit for inductive load switching)	-	60	-	ns
$t_{d(off)}$	Turn-off delay time		-	98	-	
$t_f$	Current fall time		-	124	-	

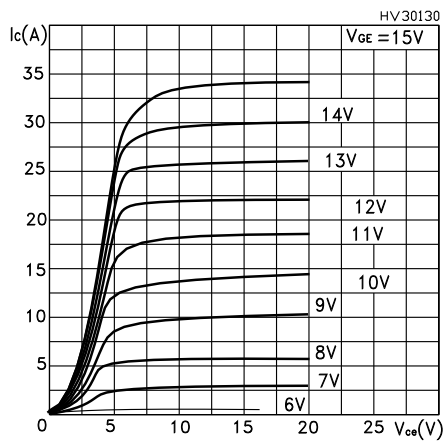
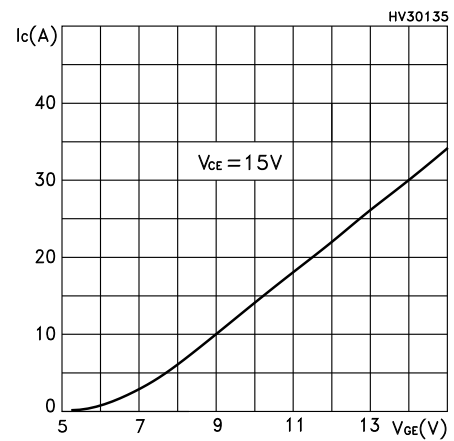
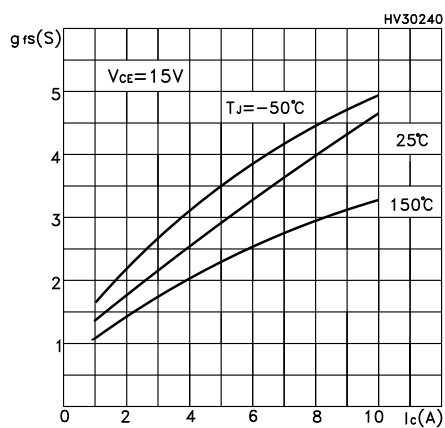
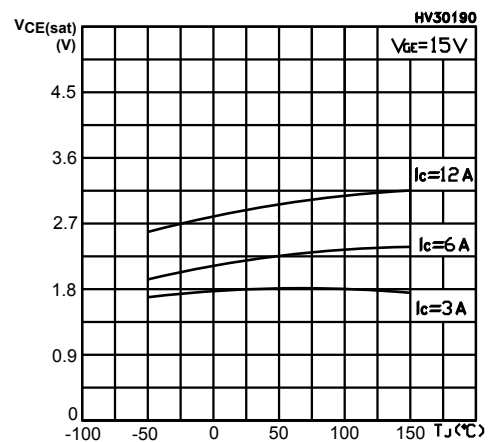
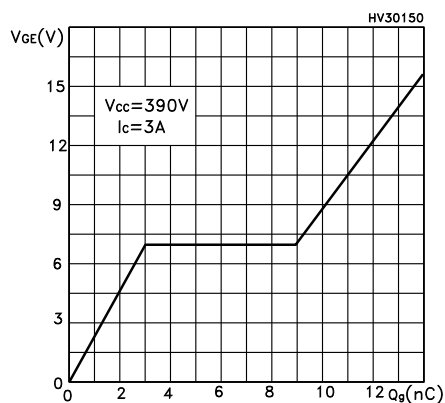
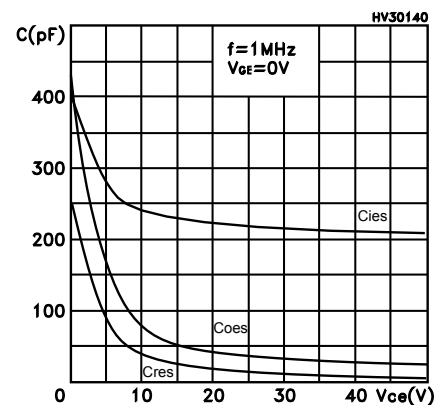
**Table 6. Switching energy (inductive load)**

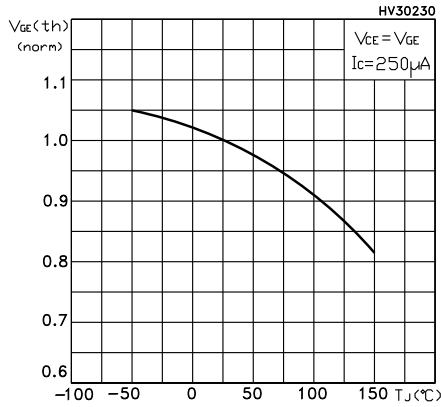
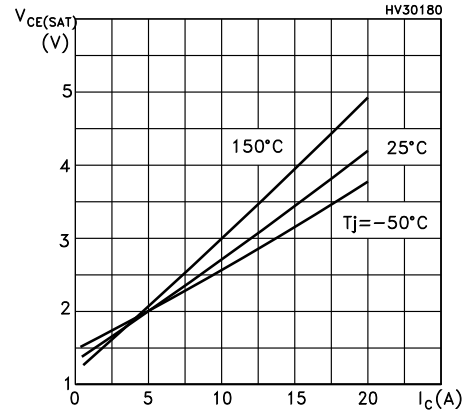
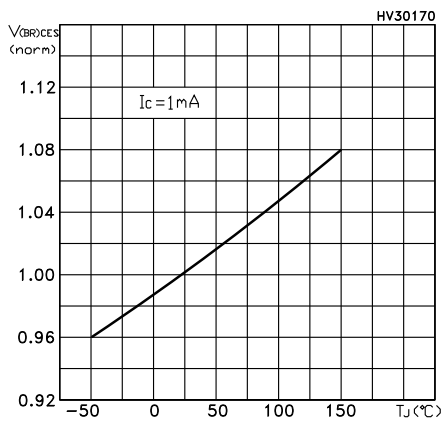
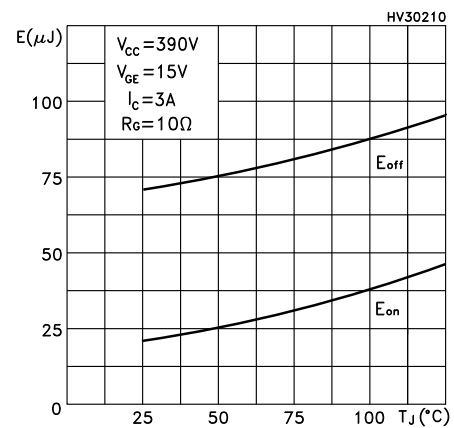
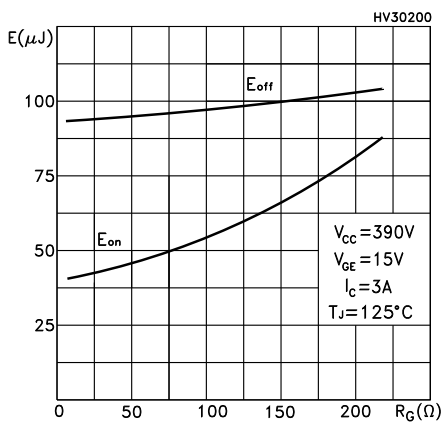
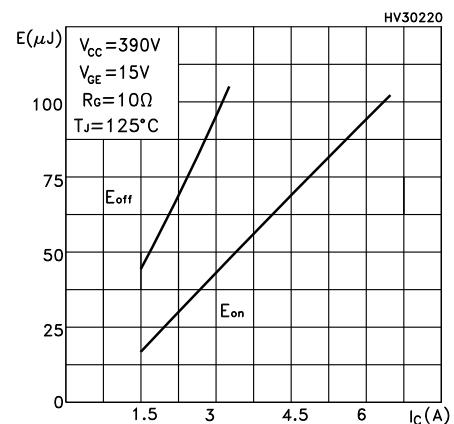
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}^{(1)}$	Turn-on switching energy	$V_{CC} = 390\text{ V}$ , $I_C = 3\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ (see )Figure 17. Test circuit for inductive load switching	-	20	-	$\mu$ J
$E_{off}^{(2)}$	Turn-off switching energy		-	68	-	
$E_{ts}$	Total switching energy		-	88	-	
$E_{on}^{(1)}$	Turn-on switching energy	$V_{CC} = 390\text{ V}$ , $I_C = 3\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$ (see )Figure 17. Test circuit for inductive load switching	-	37	-	$\mu$ J
$E_{off}^{(2)}$	Turn-off switching energy		-	93	-	
$E_{ts}$	Total switching energy		-	130	-	

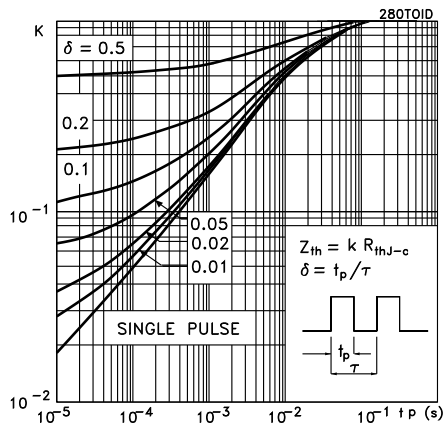
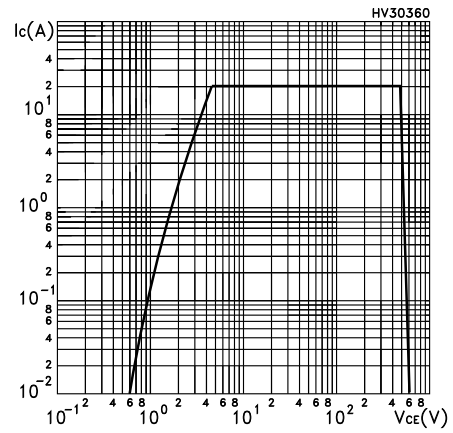
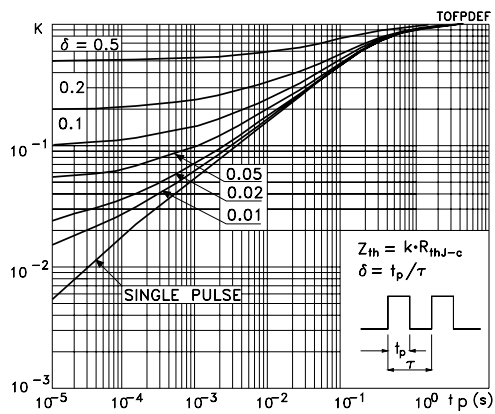
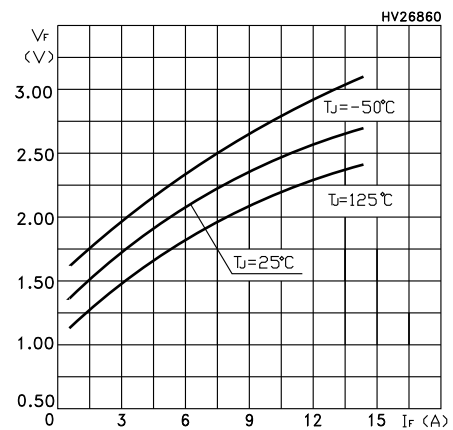
1. Including the reverse recovery of the diode
2. Including the tail of the collector current

**Table 7. Collector-emitter diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_f$	Forward on-voltage	$I_f = 1.5\text{ A}$	-	1.6	2.1	V
		$I_f = 1.5\text{ A}$ , $T_J = 125\text{ }^\circ\text{C}$	-	1.3		
$t_{rr}$	Reverse recovery time	$I_f = 3\text{ A}$ , $V_R = 40\text{ V}$ , $di/dt = 100\text{ A}/\mu\text{s}$ (see Figure 20. 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	$I_f = 3\text{ A}$ , $V_R = 40\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$ , $di/dt = 100\text{ A}/\mu\text{s}$ (see Figure 20. 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 1. Output characteristics**

**Figure 2. Transfer characteristics**

**Figure 3. Transconductance**

**Figure 4. Collector-emitter on-voltage vs temperature**

**Figure 5. Gate charge vs gate-source voltage**

**Figure 6. Capacitance variations**


**Figure 7. Normalized gate threshold voltage vs temperature**

**Figure 8. Collector-emitter on voltage vs collector current**

**Figure 9. Normalized breakdown voltage vs temperature**

**Figure 10. Switching energy vs temperature**

**Figure 11. Switching energy vs gate resistance**

**Figure 12. Switching energy vs collector current**


**Figure 13. Thermal impedance for TO-220 / D<sup>2</sup>PAK**

**Figure 14. Turn-off SOA**

**Figure 15. Thermal impedance for TO-220FP**

**Figure 16. Emitter-collector diode characteristics**


### 3 Test circuits

Figure 17. Test circuit for inductive load switching

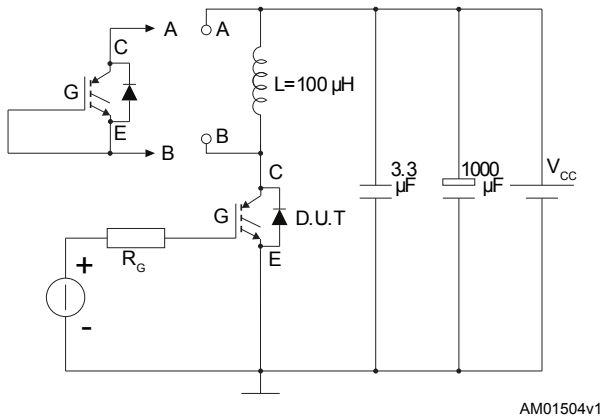


Figure 18. Gate charge test circuit

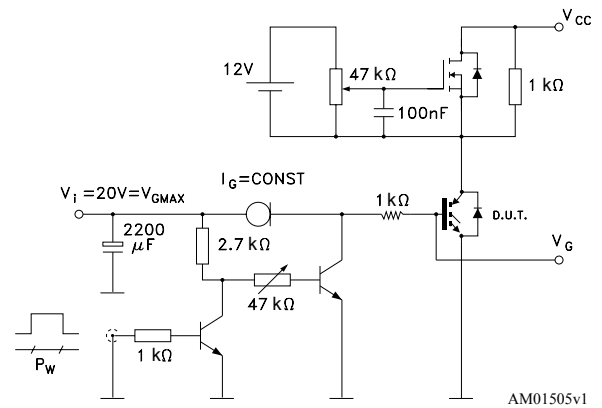


Figure 19. Switching waveform

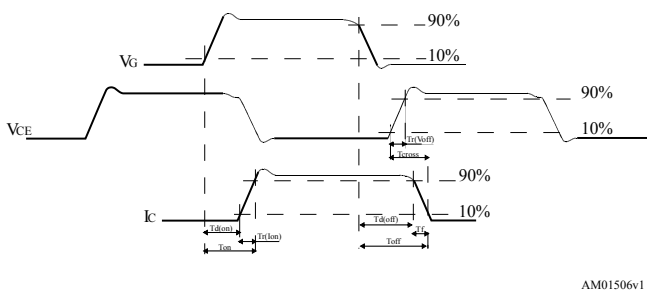
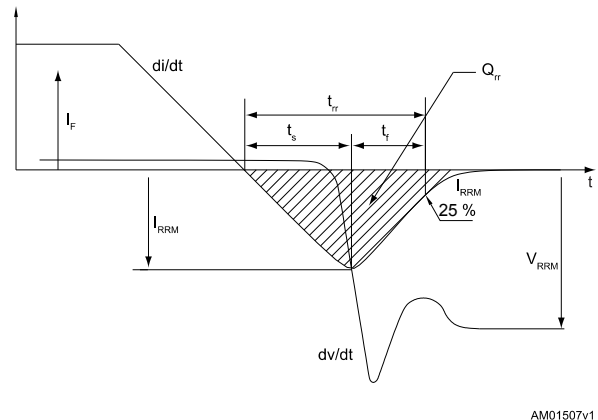


Figure 20. Diode reverse recovery waveform





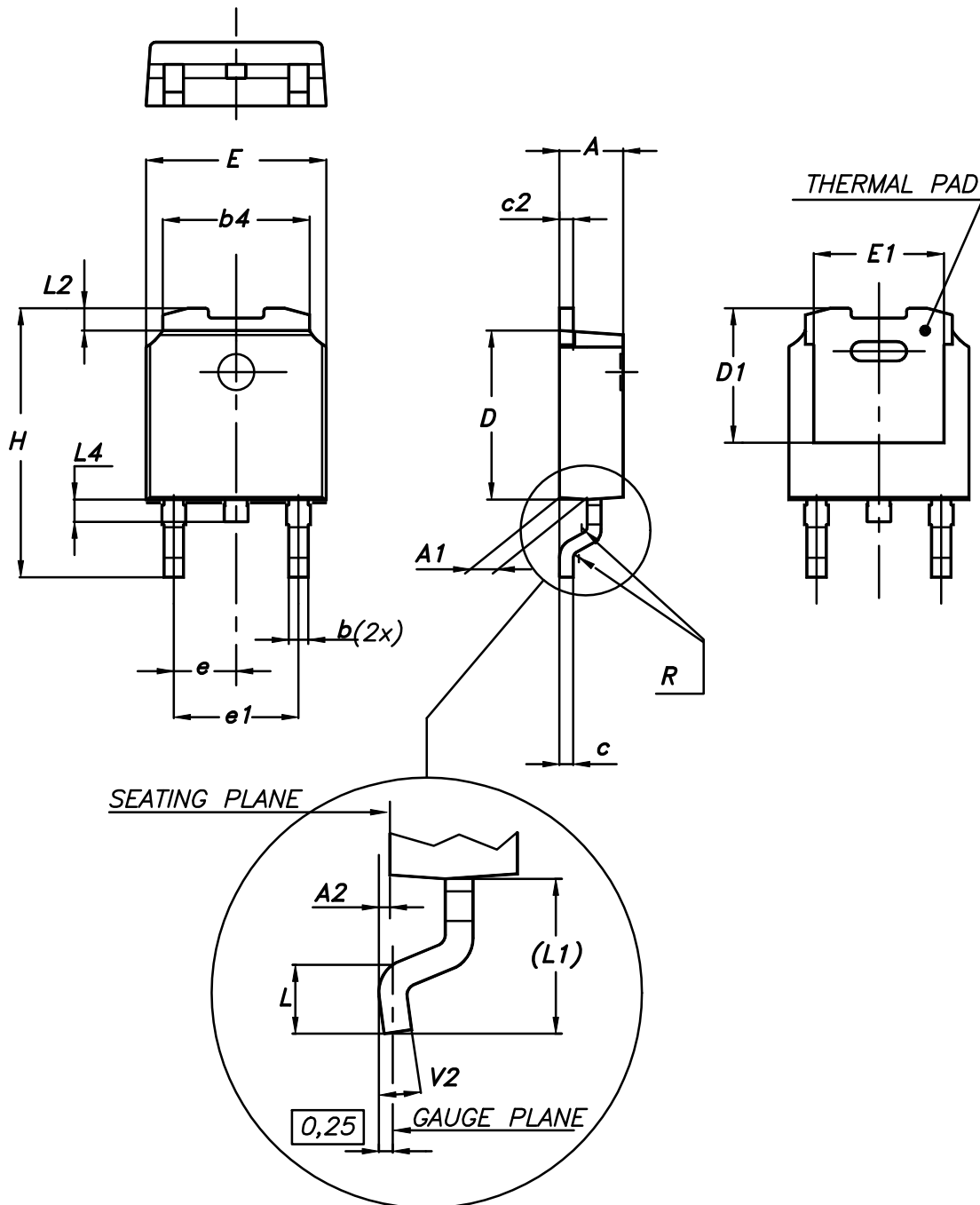
## 4 Package information

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In order to meet environmental requirements, ST offers these devices in different grades of **ECOPACK<sup>®</sup>** packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK<sup>®</sup> is an ST trademark.

4.1 D<sup>2</sup>PAK (TO-263) type A package information

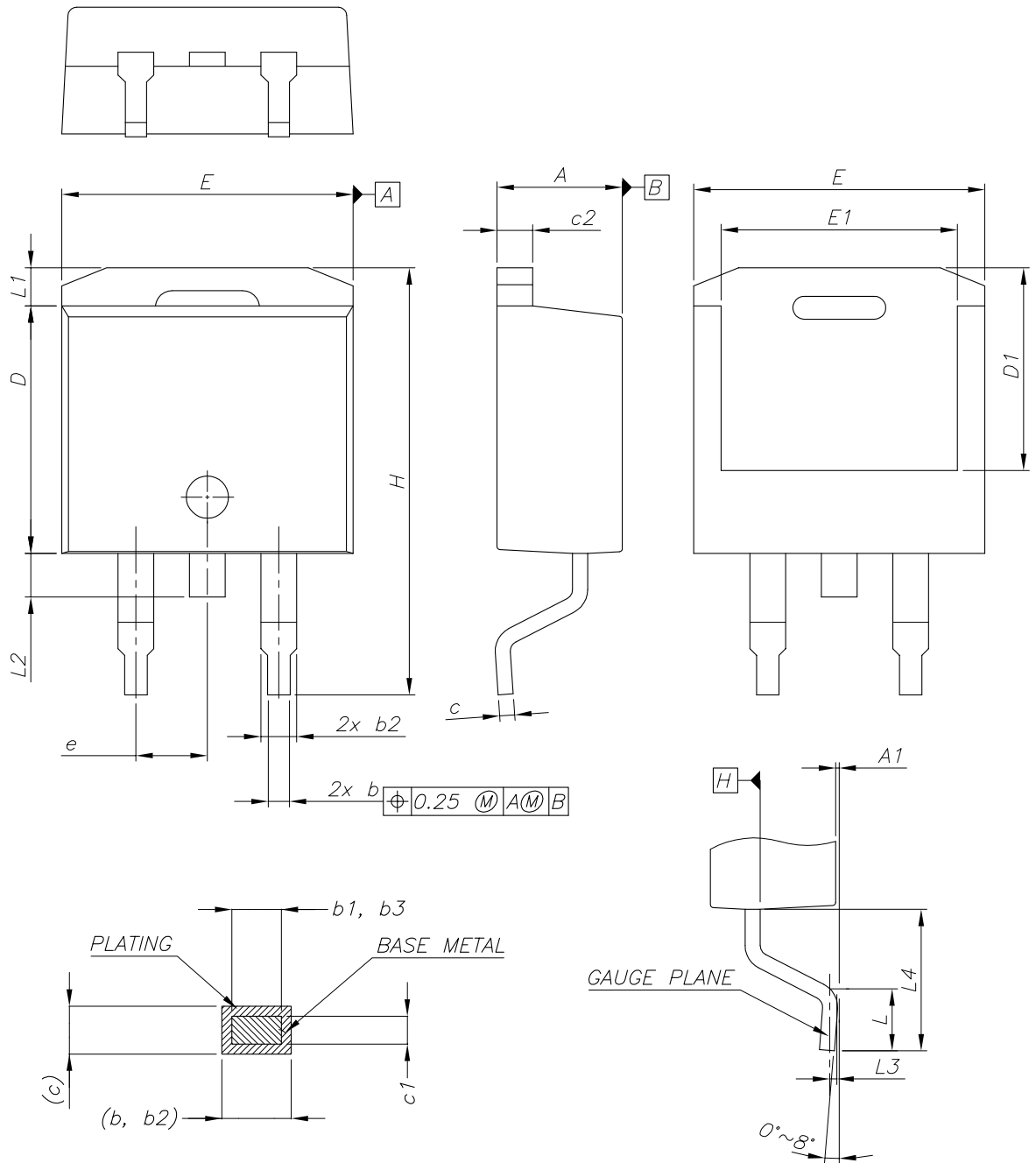
Figure 21. DPAK (TO-252) type A package outline



0068772\_A\_25

**Table 8. 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	2.159	2.286	2.413
e1	4.445	4.572	4.699
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°

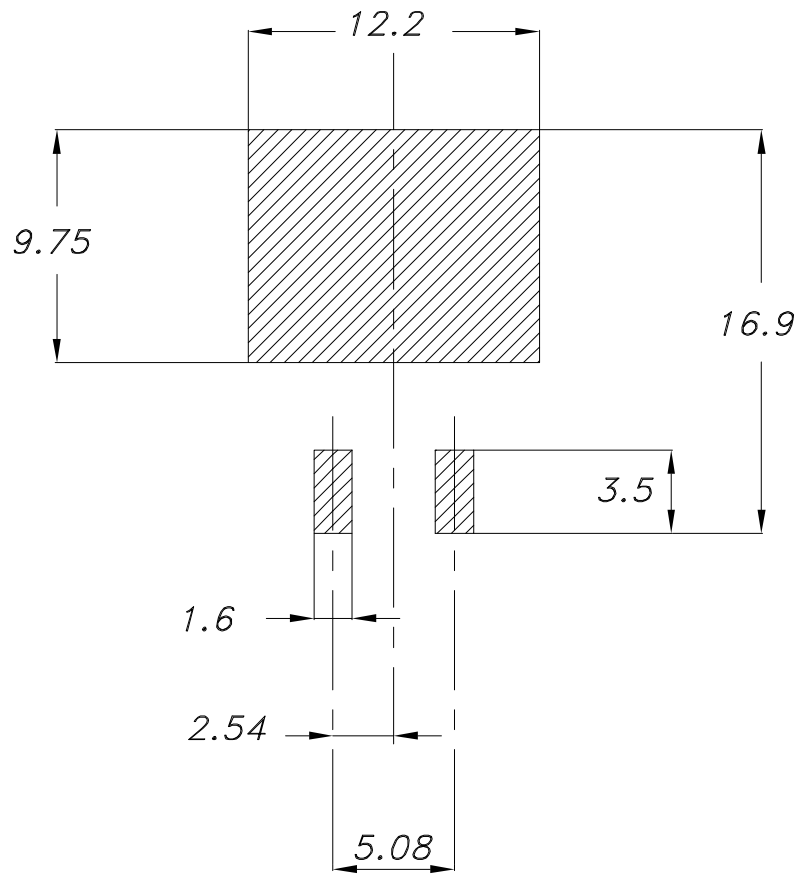
**4.2 D<sup>2</sup>PAK (TO-263) type B package information**
**Figure 22. D<sup>2</sup>PAK (TO-263) type B package outline**


0079457\_25\_B

**Table 9. D<sup>2</sup>PAK (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

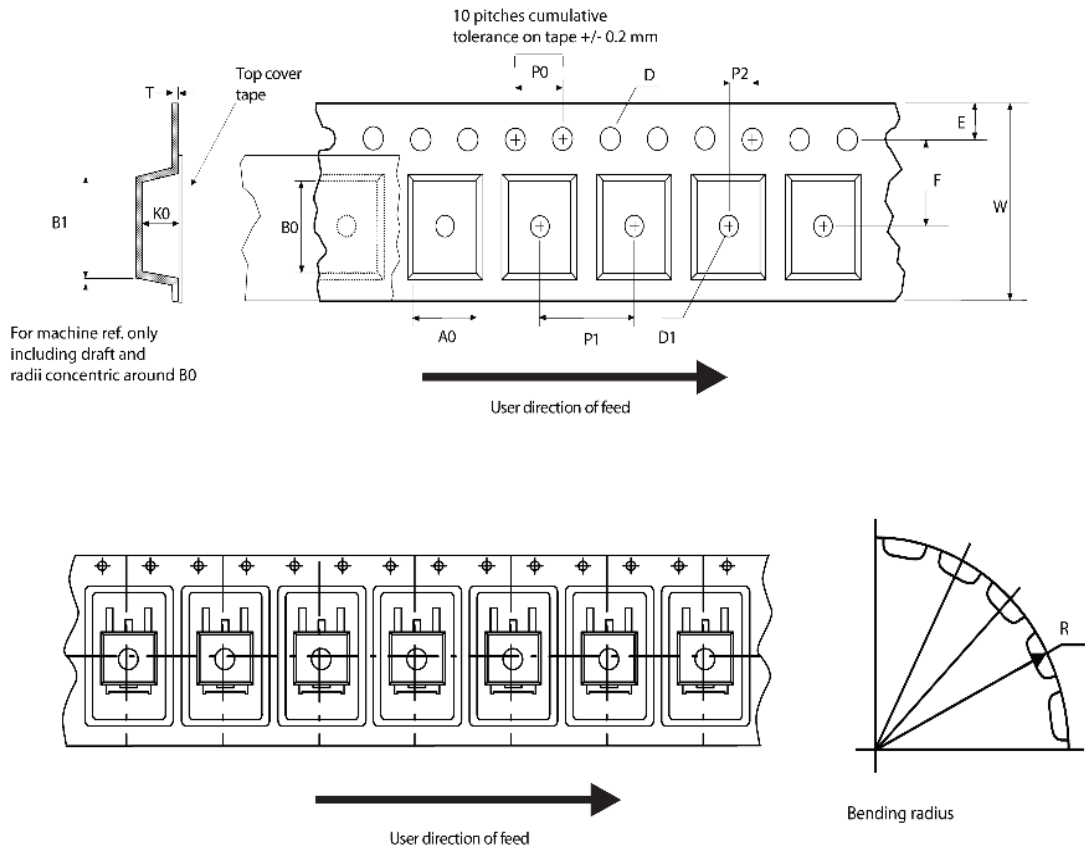
Figure 23. D<sup>2</sup>PAK (TO-263) recommended footprint (dimensions are in mm)



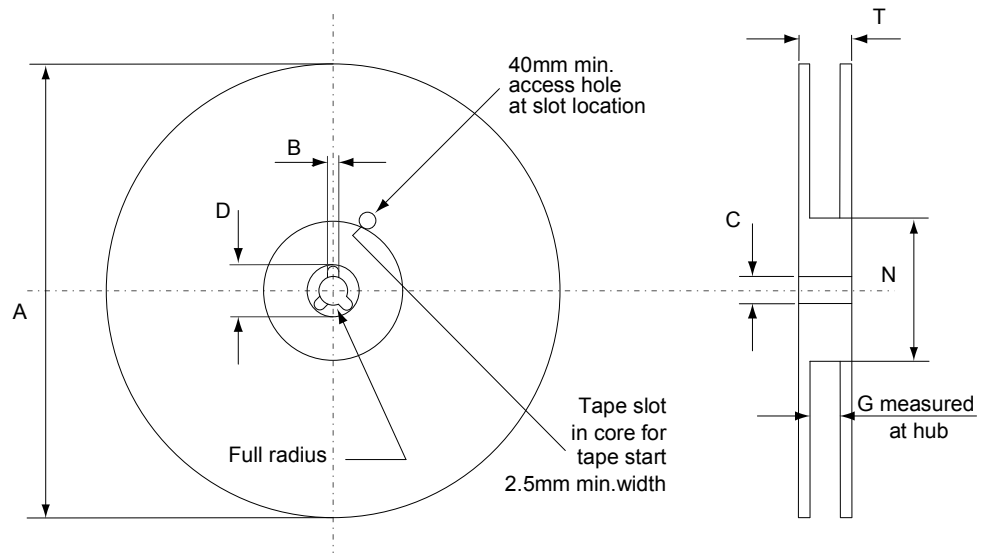
Footprint

4.2.1 Packing information

Figure 24. D<sup>2</sup>PAK tape outline



AM08852v1

**Figure 25. D<sup>2</sup>PAK reel outline**


AM06038v1

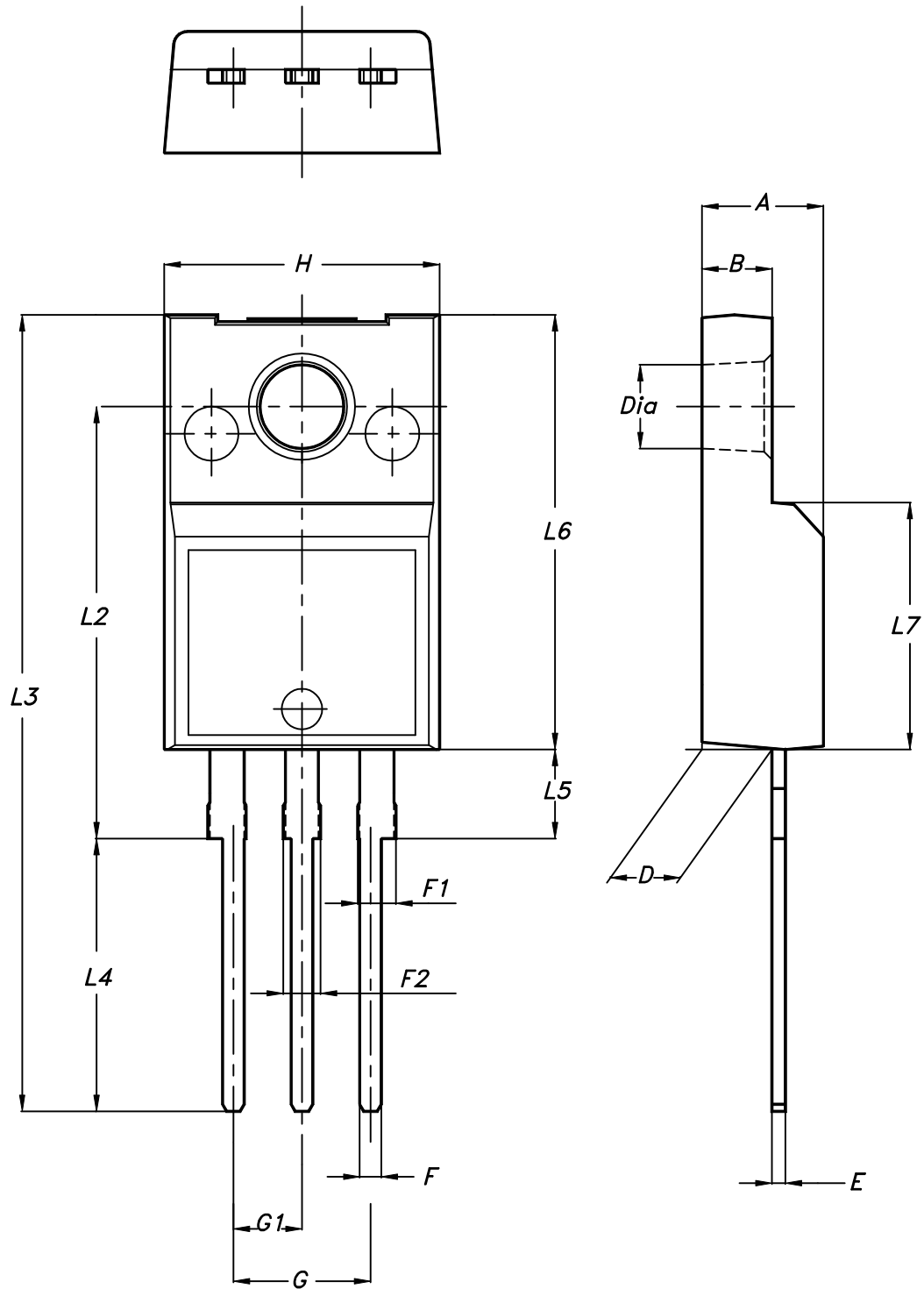
**Table 10. D<sup>2</sup>PAK tape and reel mechanical data**

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			



### 4.3 TO-220FP package information

Figure 26. TO-220FP package outline



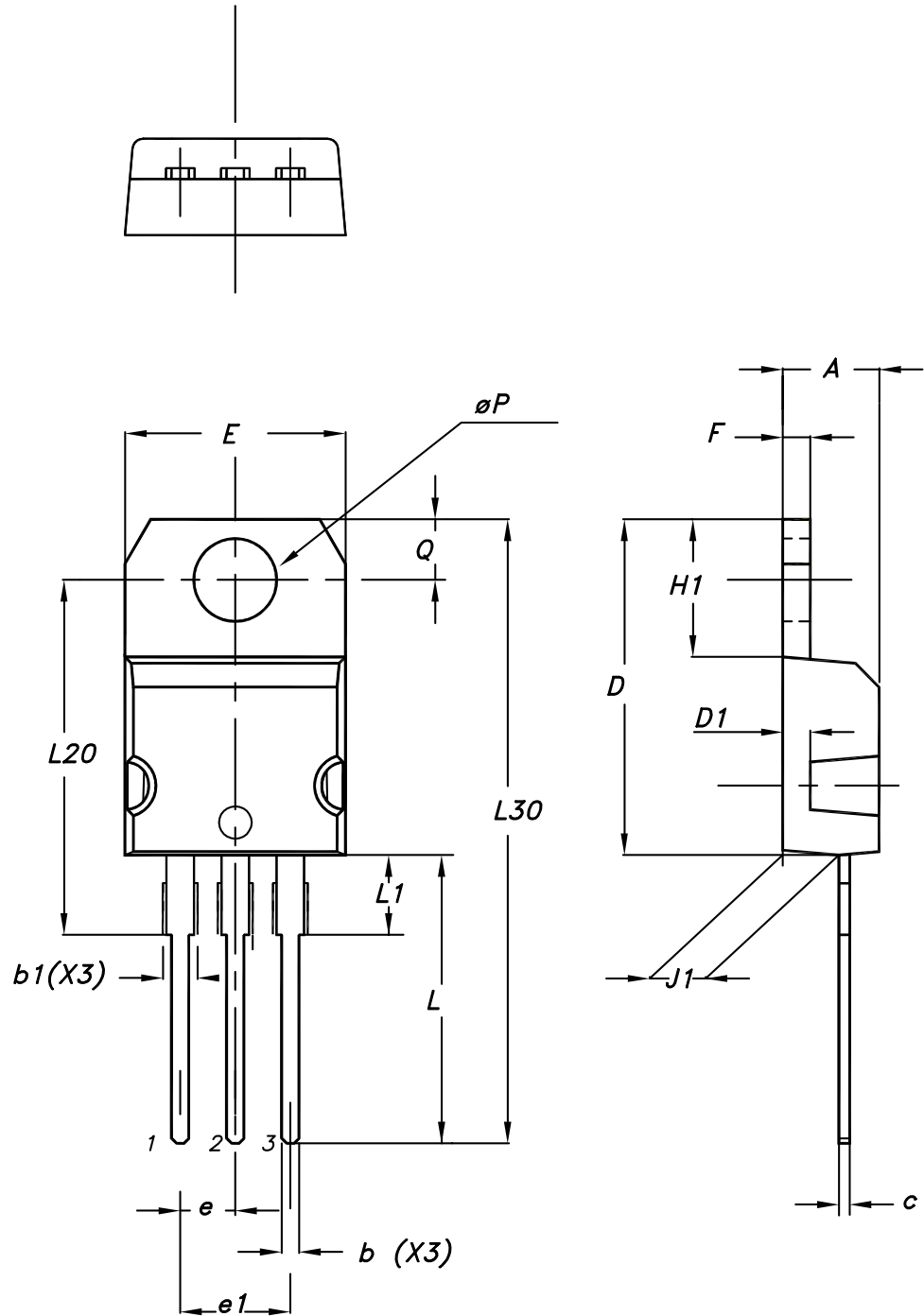
7012510\_Rev\_12\_B

**Table 11. 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 27. TO-220 type A package outline



0015988\_typeA\_Rev\_22

**Table 12. 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 Ordering information

**Table 13. Ordering information**

Order code	Marking	Package	Packing
STGB6NC60HDT4	GB6NC60HD	D <sup>2</sup> PAK	Tape and reel
STGF6NC60HD	GF6NC60HD	TO-220FP	Tube
STGP6NC60HD	GP6NC60HD	TO-220	Tube

## Revision history

**Table 14. Document revision history**

Date	Revision	Changes
28-Nov-2005	1	First release
07-Mar-2006	2	Complete version
31-Jul-2006	3	Modified <i>Figure 10</i> .
26-Apr-2007	4	Inserted package I <sup>2</sup> PAK
20-Nov-2017	5	<p>Part number STGB6NC60HD-1 has been moved to a separate datasheet.</p> <p>Updated information on cover page.</p> <p>Updated <i>Table 2: "Absolute maximum ratings"</i> and <i>Table 4: "Static characteristics"</i>.</p> <p>Updated <i>Section 2.1: "Electrical characteristics (curves)"</i>.</p> <p>Updated <i>Section 4: "Package information"</i>.</p> <p>Minor text changes</p>
23-Oct-2018	6	<p>Updated title in coverpage and <a href="#">Table 4. Dynamic characteristics</a>.</p> <p>Minor text changes.</p>

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