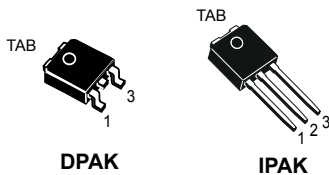
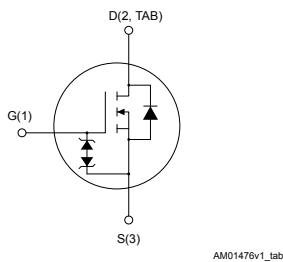


## N-channel 600 V, 3.5 $\Omega$ typ., 2 A SuperMESH Power MOSFETs in DPAK and IPAK packages



DPAK

IPAK



### Features

Order codes	$V_{DS}$	$R_{DS(on)}$ max.	$I_D$
STD2HNK60Z	600 V	4.8 $\Omega$	2 A
STD2HNK60Z-1			

- 100% avalanche tested
- Gate charge minimized
- Very low intrinsic capacitance
- Zener-protected

### Applications

- Switching applications

### Description

These high-voltage devices are Zener-protected N-channel Power MOSFETs developed using the SuperMESH technology by STMicroelectronics, an optimization of the well-established PowerMESH. In addition to a significant reduction in on-resistance, these devices are designed to ensure a high level of  $dv/dt$  capability for the most demanding applications.

#### Product status links

[STD2HNK60Z](#)

[STD2HNK60Z-1](#)

#### Product summary

Order code	STD2HNK60Z
Marking	D2HNK60Z
Package	DPAK
Packing	Tape and reel
Order code	STD2HNK60Z-1
Marking	D2HNK60Z
Package	IPAK
Packing	Tube

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{DS}$	Drain-source voltage	600	V
$V_{GS}$	Gate-source voltage	$\pm 30$	V
$I_D$	Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$	2.0	A
	Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$	1.26	
$I_{DM}^{(1)}$	Drain current (pulsed)	8	A
$P_{TOT}$	Total power dissipation at $T_C = 25\text{ }^\circ\text{C}$	45	W
ESD	Gate-source human body model ( $R = 1.5\text{ k}\Omega$ , $C = 100\text{ pF}$ )	2	kV
$dv/dt^{(2)}$	Peak diode recovery voltage slope	4.5	V/ns
$T_{STG}$	Storage temperature range	-55 to 150	$^\circ\text{C}$
$T_J$	Operating junction temperature range		$^\circ\text{C}$

1. Pulse width limited by safe operating area.

2.  $I_{SD} \leq 2\text{ A}$ ,  $di/dt \leq 200\text{ A}/\mu\text{s}$ ,  $V_{DS}(\text{peak}) \leq V_{(BR)DSS}$ ,  $V_{DD} = 80\% V_{(BR)DSS}$ .

**Table 2. Thermal data**

Symbol	Parameter	Value		Unit
		DPAK	IPAK	
$R_{thJC}$	Thermal resistance, junction-to-case	2.77		$^\circ\text{C}/\text{W}$
$R_{thJA}$	Thermal resistance, junction-to-ambient		100	$^\circ\text{C}/\text{W}$
$R_{thJB}^{(1)}$	Thermal resistance, junction-to-board	50		$^\circ\text{C}/\text{W}$

1. When mounted on 1 inch<sup>2</sup> FR-4, 2 Oz copper board.

**Table 3. Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AR}$	Avalanche current, repetitive or not repetitive ( $t_p$ limited by $T_J$ max)	2	A
$E_{AS}$	Single pulse avalanche energy (starting $T_J = 25\text{ }^\circ\text{C}$ , $I_D = I_{AR}$ ; $V_{DD} = 50\text{ V}$ )	120	mJ

## 2 Electrical characteristics

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

**Table 4. On/off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$V_{GS} = 0\text{ V}$ , $I_D = 1\text{ mA}$	600			V
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$			1	$\mu\text{A}$
		$V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$ , $T_C = 125\text{ °C}$ <sup>(1)</sup>			50	
$I_{GSS}$	Gate-body leakage current	$V_{DS} = 0\text{ V}$ , $V_{GS} = \pm 20\text{ V}$			$\pm 10$	$\mu\text{A}$
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$ , $I_D = 50\text{ }\mu\text{A}$	3	3.75	4.5	V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10\text{ V}$ , $I_D = 1\text{ A}$		3.5	4.8	$\Omega$

1. Specified By Design – Not tested in production.

**Table 5. Dynamic characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0\text{ V}$	-	280		pF
$C_{oss}$	Output capacitance		-	38		pF
$C_{rSS}$	Reverse transfer capacitance		-	7		pF
$C_{oss\ eq.}^{(1)}$	Equivalent output capacitance	$V_{DS} = 0\text{ to }480\text{ V}$ , $V_{GS} = 0\text{ V}$	-	30		pF
$Q_g$	Total gate charge	$V_{DD} = 480\text{ V}$ , $I_D = 2\text{ A}$ , $V_{GS} = 0\text{ to }10\text{ V}$ (see Figure 14. Test circuit for gate charge behavior)	-	11	15 <sup>(2)</sup>	nC
$Q_{gs}$	Gate-source charge		-	2.25		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%  $V_{DSS}$ .

2. Specified By Design – Not tested in production.

**Table 6. Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}$ , $I_D = 1\text{ A}$ , $R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$ (see Figure 13. Test circuit for resistive load switching times and Figure 18. Switching time waveform)	-	10	-	ns
$t_r$	Rise time		-	30	-	ns
$t_{d(off)}$	Turn-off delay time		-	23	-	ns
$t_f$	Fall time		-	50	-	ns

**Table 7. Source-drain diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		2	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		8	A
$V_{SD}^{(2)}$	Forward on voltage	$V_{GS} = 0\text{ V}$ , $I_{SD} = 2\text{ A}$	-		1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 2\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 20\text{ V}$	-	178		ns
$Q_{rr}$	Reverse recovery charge	(see Figure 15. Test circuit for inductive load switching and diode recovery times)	-	445		nC
$I_{RRM}$	Reverse recovery current		-	5		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 2\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,	-	200		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 20\text{ V}$ , $T_J = 150\text{ }^\circ\text{C}$	-	500		nC
$I_{RRM}$	Reverse recovery current	(see Figure 15. Test circuit for inductive load switching and diode recovery times)	-	5		A

1. Pulse width is limited by safe operating area.
2. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%.

## 2.1 Electrical characteristics (curves)

Figure 1. Safe operating area

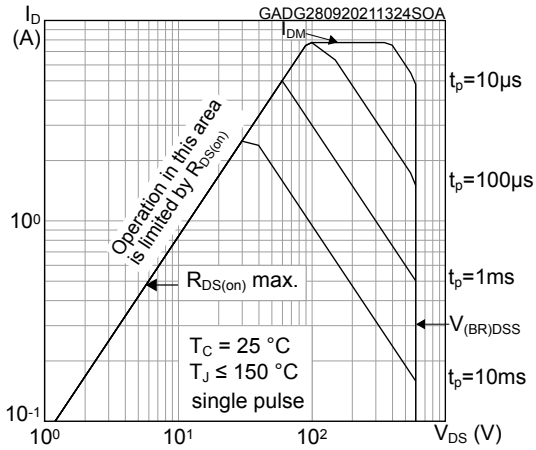


Figure 2. Thermal impedance

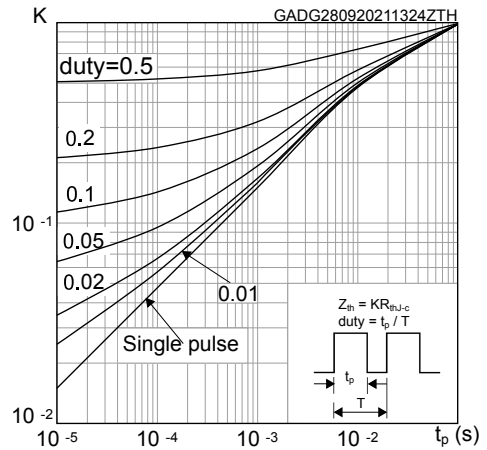


Figure 3. Output characteristics

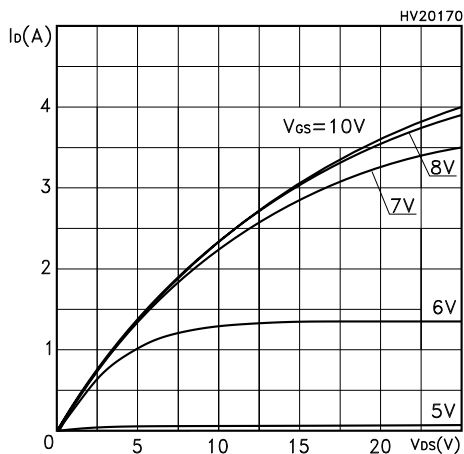


Figure 4. Transfer characteristics

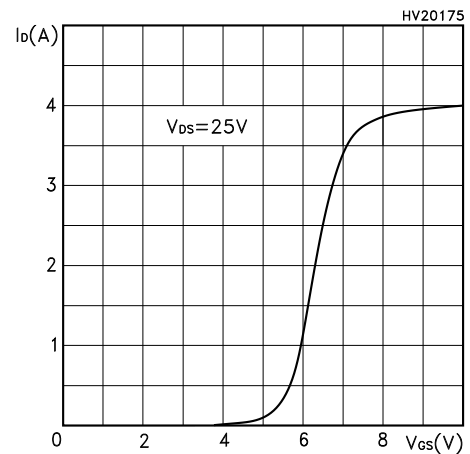


Figure 5. Normalized  $V_{(BR)DSS}$  vs temperature

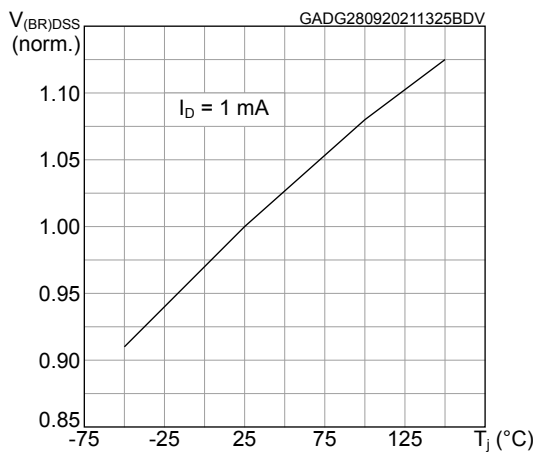


Figure 6. Static drain-source on-resistance

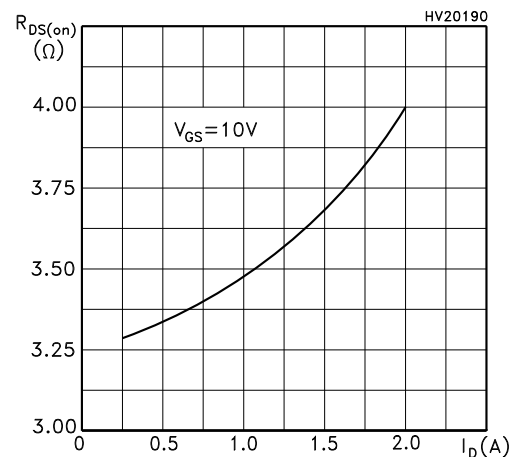


Figure 7. Gate charge vs gate-source voltage

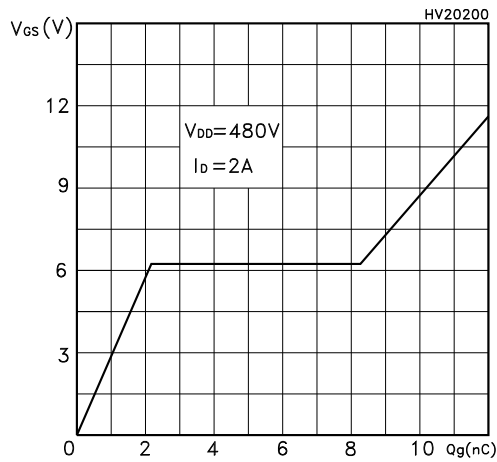


Figure 8. Capacitance variations

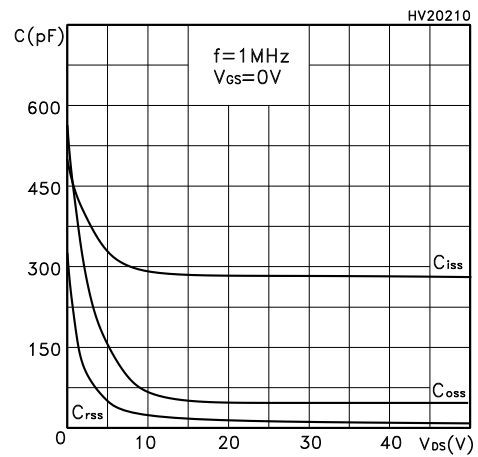


Figure 9. Normalized gate threshold voltage vs temperature

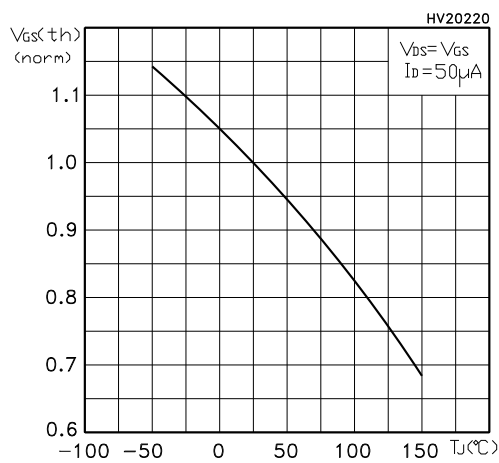


Figure 10. Normalized on-resistance vs temperature

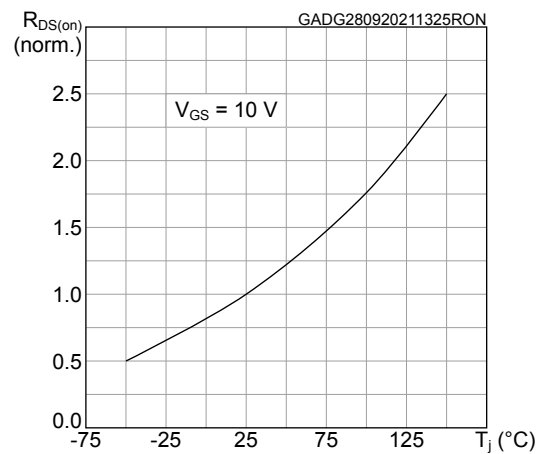


Figure 11. Source-drain diode forward characteristics

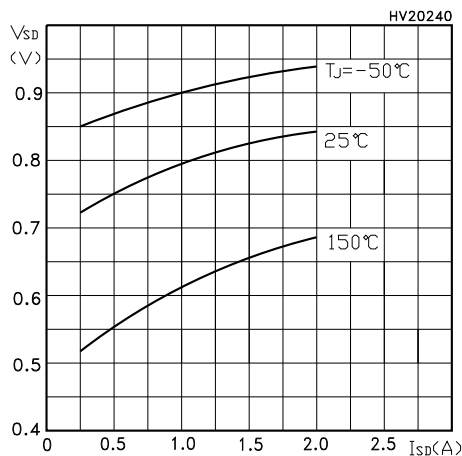
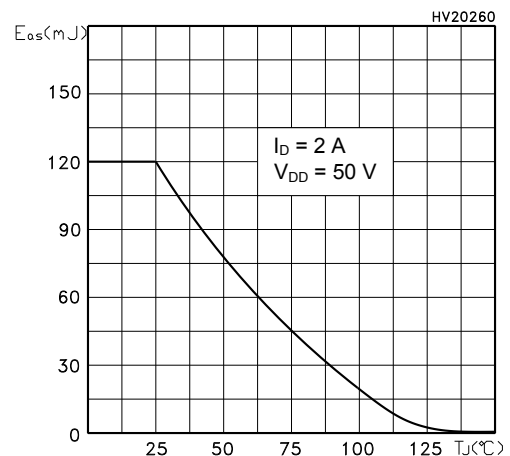
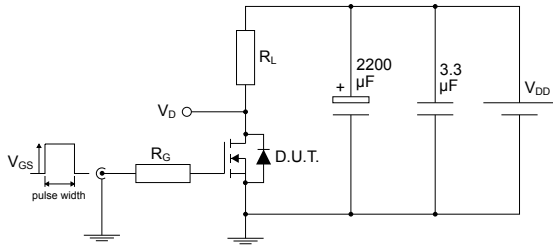


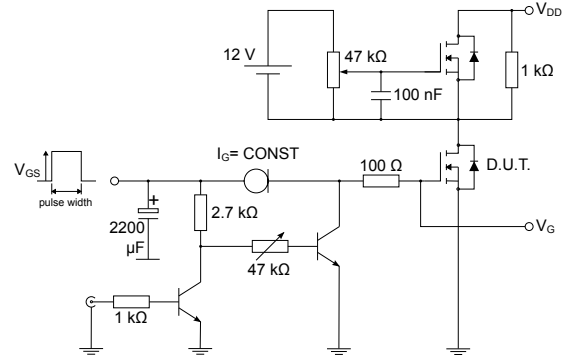
Figure 12. Maximum avalanche energy vs temperature



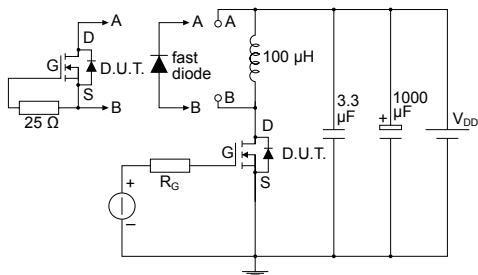
### 3 Test circuits

**Figure 13. Test circuit for resistive load switching times**


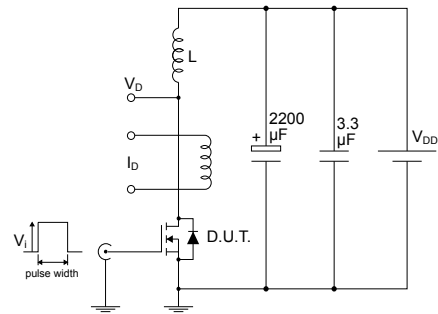
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**Figure 14. Test circuit for gate charge behavior**


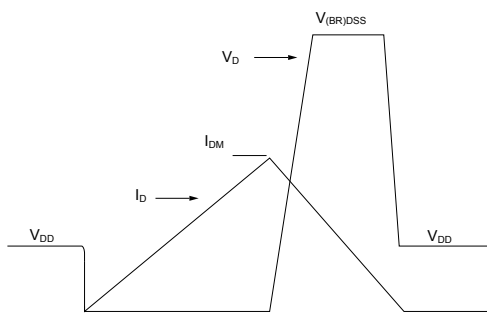
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**Figure 15. Test circuit for inductive load switching and diode recovery times**


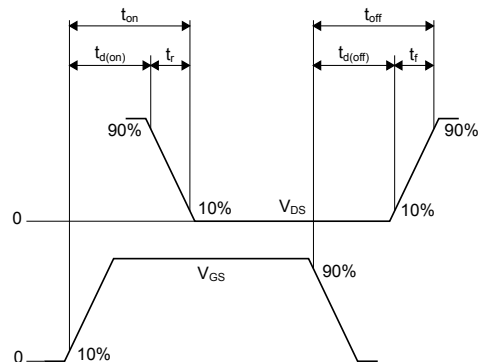
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**Figure 16. Unclamped inductive load test circuit**


AM01471v1

**Figure 17. Unclamped inductive waveform**


AM01472v1

**Figure 18. Switching time waveform**


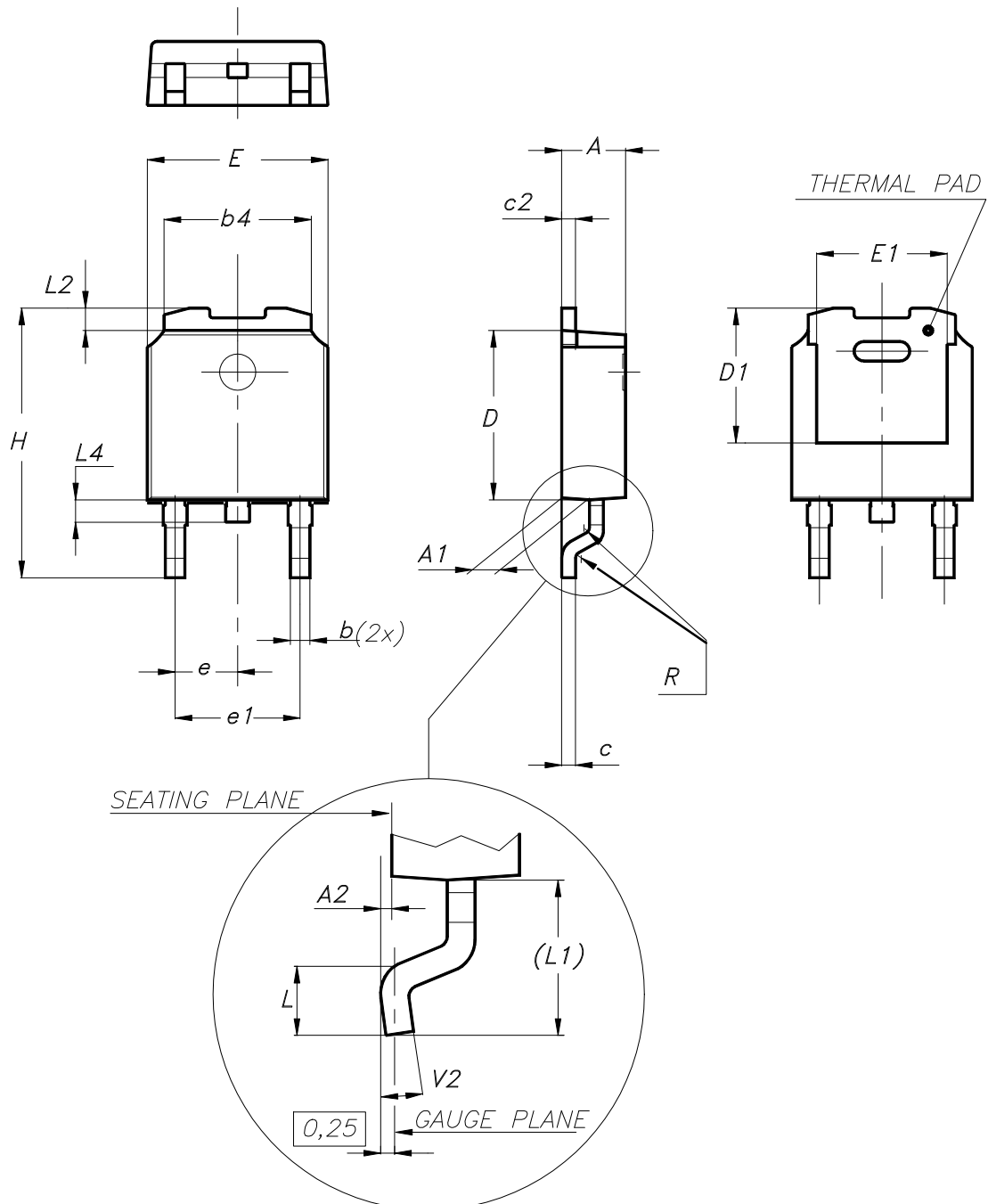
AM01473v1

## 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](http://www.st.com). ECOPACK is an ST trademark.

### 4.1 DPAK (TO-252) type A package information

Figure 19. DPAK (TO-252) type A package outline



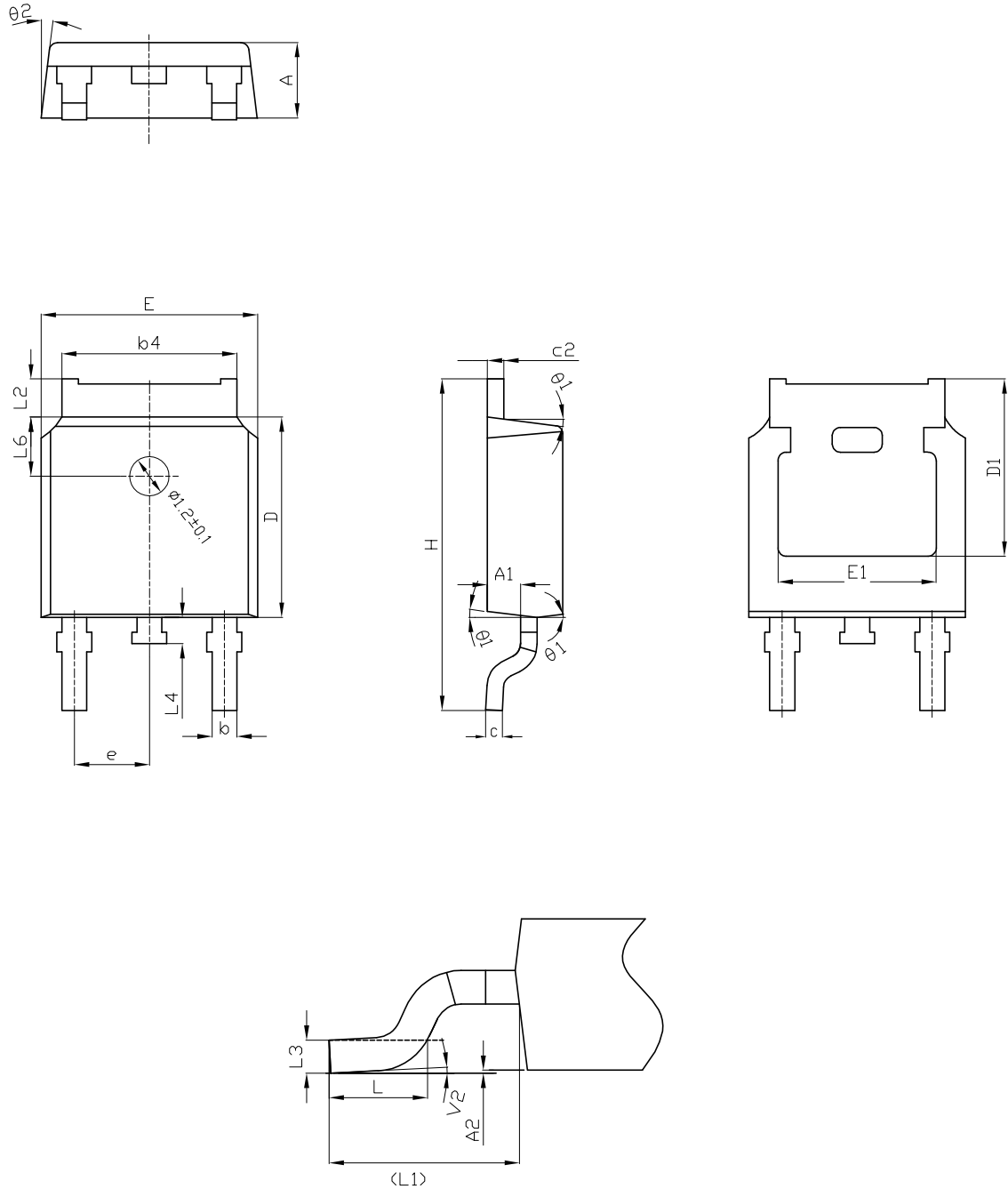


**Table 8. DPAK (TO-252) type A mechanical data**

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 DPAK (TO-252) type C package information

Figure 20. DPAK (TO-252) type C package outline

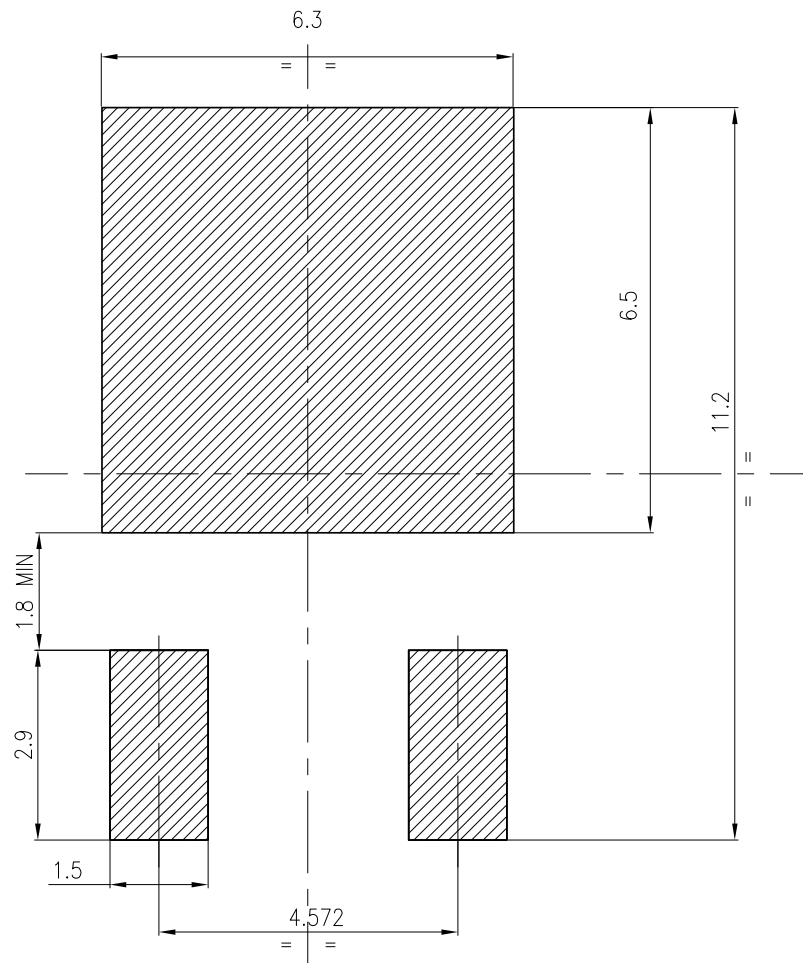


0068772\_C\_29

**Table 9. 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°

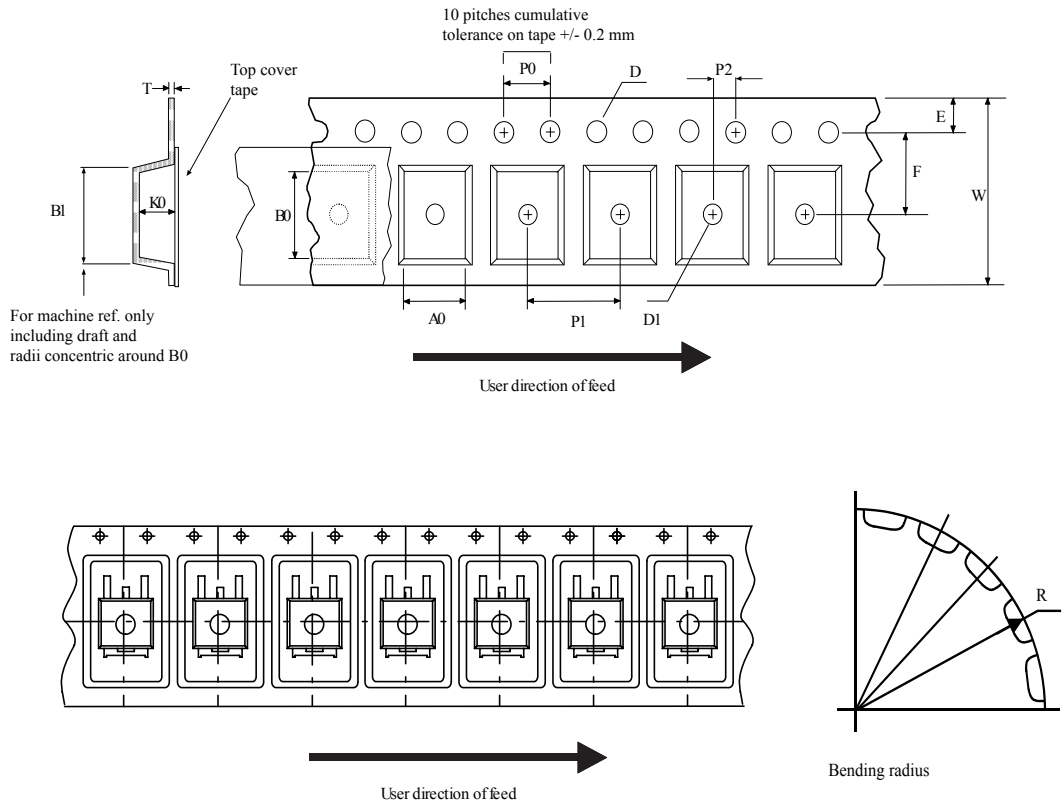
Figure 21. DPAK (TO-252) recommended footprint (dimensions are in mm)



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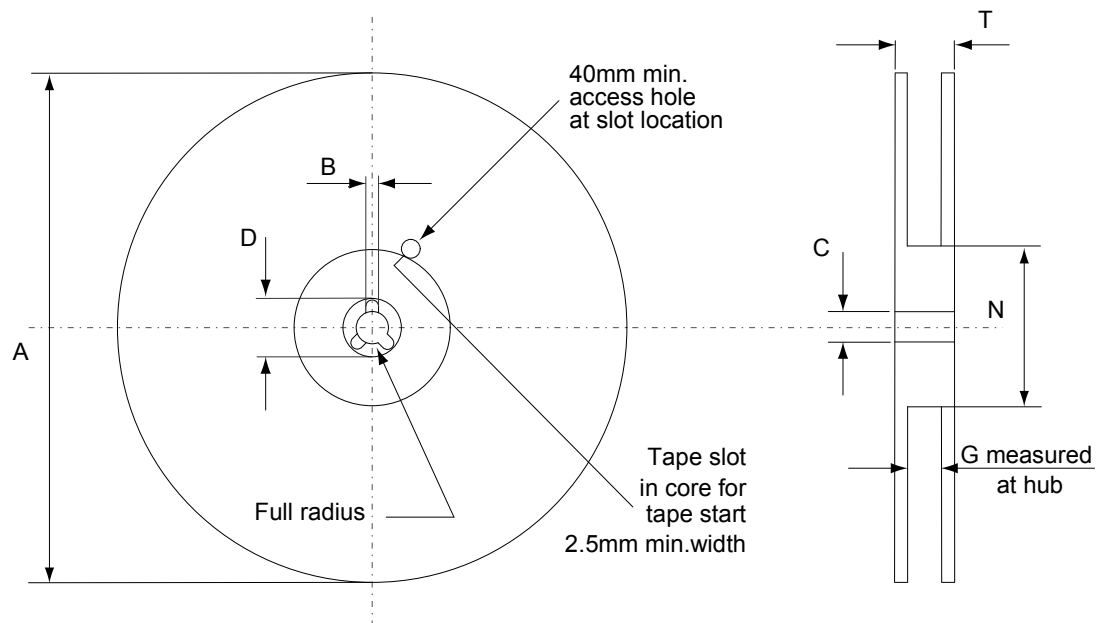
### 4.3 DPAK (TO-252) packing information

Figure 22. DPAK (TO-252) tape outline



AM08852v1

Figure 23. DPAK (TO-252) reel outline



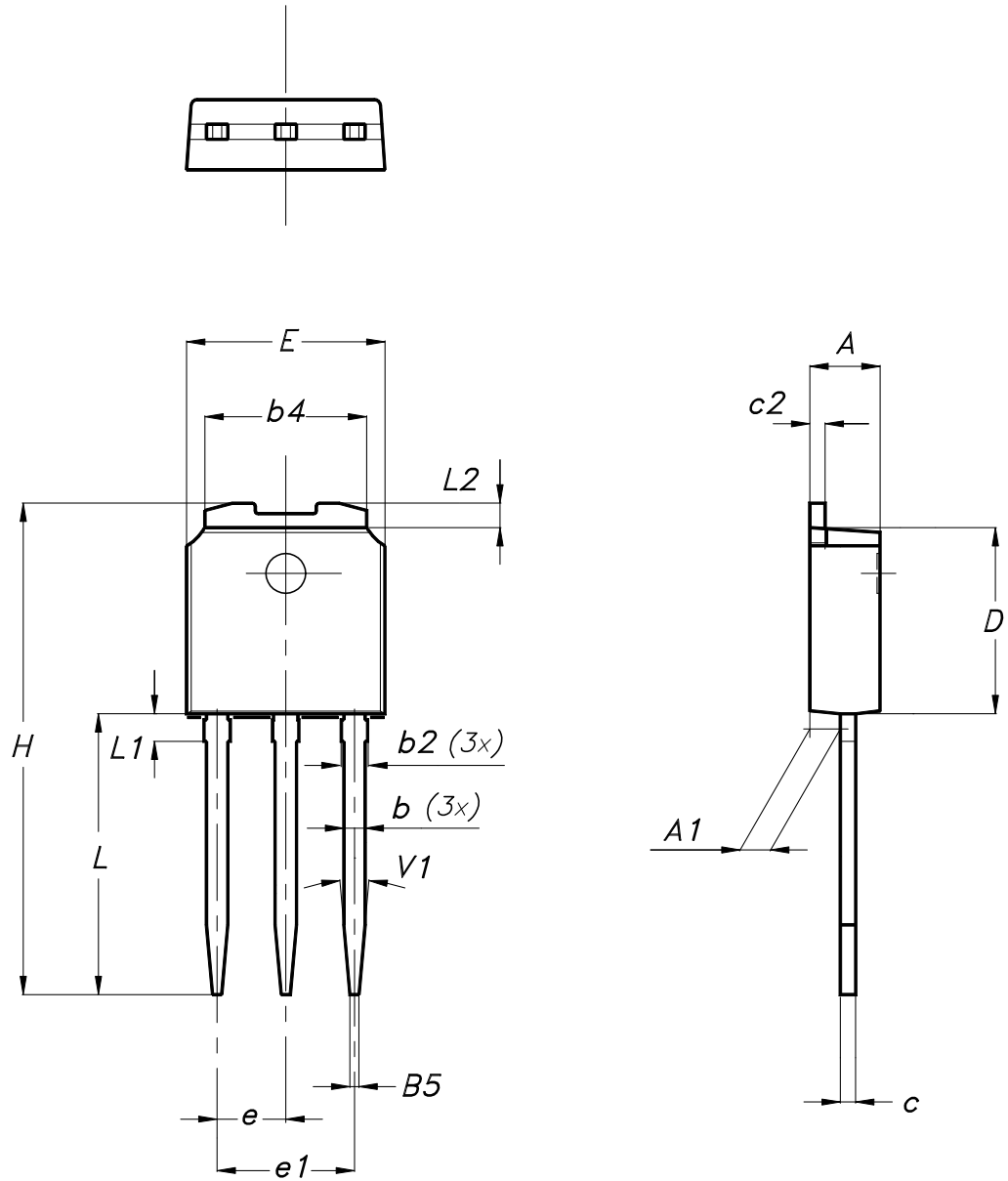
AM06038v1

Table 10. DPAK (TO-252) tape and reel mechanical data

Dim.	Tape		Dim.	Reel	
	mm			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 IPAK (TO-251) type A package information

Figure 24. IPAK (TO-251) type A package outline



0068771\_IK\_typeA\_rev15

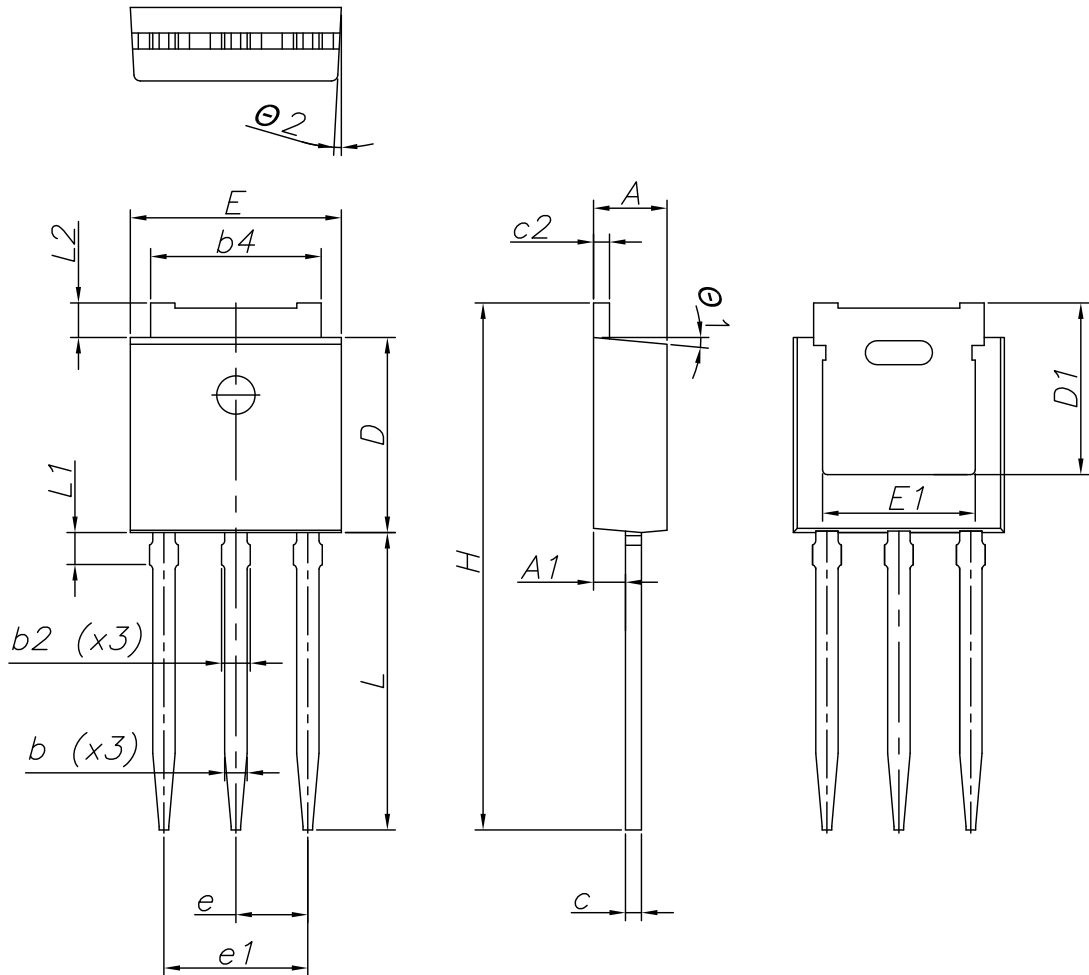
**Table 11. IPAK (TO-251) type A package mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	2.20		2.40
A1	0.90		1.10
b	0.64		0.90
b2			0.95
b4	5.20		5.40
B5		0.30	
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
E	6.40		6.60
e		2.28	
e1	4.40		4.60
H		16.10	
L	9.00		9.40
L1	0.80		1.20
L2		0.80	1.00
V1		10°	



#### 4.5 IPAK (TO-251) type C package information

Figure 25. IPAK (TO-251) type C package outline



0068771\_IK\_typeC\_rev15

**Table 12. 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	0.80	1.00	1.20
L2	0.90	1.08	1.25
θ1	3°	5°	7°
θ2	1°	3°	5°

## Revision history

**Table 13. Document revision history**

Date	Revision	Changes
09-Mar-2004	1	First release.
23-Mar-2004	2	Modified title
02-Apr-2005	3	Added new section: <i>Electrical characteristics (curves)</i>
06-Mar-2006	4	Inserted DPAK. The document has been reformatted
25-May-2012	5	Corrected unit in <i>Table 5: On/off states</i>
04-Jun-2018	6	Removed maturity status indication from cover page. The document status is production data. Updated title and features in cover page, <i>Section 1 Electrical ratings</i> , <i>Section 2 Electrical characteristics</i> and <i>Section 4 Package information</i> . Minor text changes.
06-Oct-2021	7	The part numbers STF2HNK60Z and STQ2HNK60ZR-AP have been moved to a separate datasheet and the document has been updated accordingly. Modified <i>Table 7. Source-drain diode</i> . Modified <i>Figure 1. Safe operating area</i> , <i>Figure 2. Thermal impedance</i> , <i>Figure 5. Normalized <math>V_{(BR)DSS}</math> vs temperature</i> and <i>Figure 10. Normalized on-resistance vs temperature</i> . Updated <i>Section 4 Package information</i> .

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[NTE2969](#) [NTE2976](#) [NTE455](#) [NTE6400A](#) [NTE2910](#) [NTE2916](#) [NTE2956](#) [NTE2911](#) [DMN2080UCB4-7](#) [TK10A80W,S4X\(S](#)  
[SSM6P69NU,LF](#) [DMP22D4UFO-7B](#) [DMN1006UCA6-7](#)