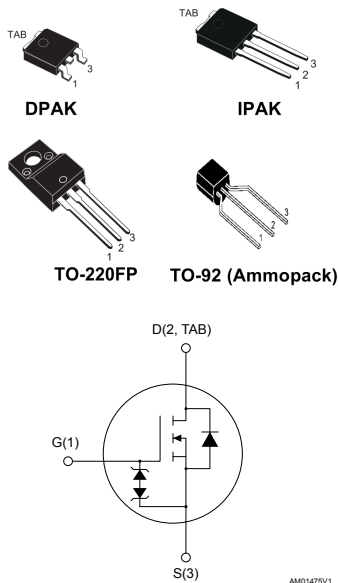


N-channel 600 V, 3.5 Ω typ., 2 A SuperMESH™ Power MOSFETs in DPAK, IPAK, TO-220FP and TO-92 packages



Features

Order code	V_{DS}	$R_{DS(on)max.}$	I_D	Package
STD2HNK60Z	600 V	4.8 Ω	2 A	DPAK
STD2HNK60Z-1				IPAK
STF2HNK60Z				TO-220FP
STQ2HNK60ZR-AP			0.5 A	TO-92

- Extremely high dv/dt capability
- 100% avalanche tested
- Gate charge minimized
- 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
STD2HNK60Z
STD2HNK60Z-1
STF2HNK60Z
STQ2HNK60ZR-AP

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value			Unit
		DPAK, IPAK	TO-220FP	TO-92	
V_{DS}	Drain-source voltage	600			V
V_{GS}	Gate-source voltage	± 30			V
I_D	Drain current (continuous) at $T_C = 25\text{ }^{\circ}\text{C}$	2.0	2.0 ⁽¹⁾	0.5	A
I_D	Drain current (continuous) at $T_C = 100\text{ }^{\circ}\text{C}$	1.26	1.26 ⁽¹⁾	0.32	A
I_{DM} ⁽²⁾	Drain current (pulsed)	8	8 ⁽¹⁾	2	A
P_{TOT}	Total dissipation at $T_C = 25\text{ }^{\circ}\text{C}$	45	20	3	W
ESD	Gate-source human body model ($R = 1.5\text{ k}\Omega$, $C = 100\text{ pF}$)	2			kV
V_{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat-sink ($t = 1\text{ s}$, $T_C = 25\text{ }^{\circ}\text{C}$)		2500		V
dv/dt ⁽³⁾	Peak diode recovery voltage slope	4.5			V/ns
T_j	Operating junction temperature range	-55 to 150			$^{\circ}\text{C}$
T_{stg}	Storage temperature range				

1. Limited by maximum junction temperature.

2. Pulse width limited by safe operating area.

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

Table 2. Thermal data

Symbol	Parameter	Value			Unit
		DPAK, IPAK	TO-220FP	TO-92	
$R_{thj-case}$	Thermal resistance junction-case	2.77	6.25		$^{\circ}\text{C}/\text{W}$
$R_{thj-amb}$	Thermal resistance junction-ambient	100	62.5	120	$^{\circ}\text{C}/\text{W}$
$R_{thj-pcb}$ ⁽¹⁾	Thermal resistance junction-pcb	50			$^{\circ}\text{C}/\text{W}$
$R_{thj-lead}$	Thermal resistance junction-lead			40	$^{\circ}\text{C}/\text{W}$

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

Table 3. Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetitive or not-repetitive (pulse width limited by $T_j \text{ Max}$)	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

($T_{CASE} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified)

Table 4. On/off states

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 1\text{ mA}$, $V_{GS} = 0\text{ V}$	600			V
I_{DSS}	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$, $V_{DS} = 600\text{ V}$			1	μA
		$V_{GS} = 0\text{ V}$, $V_{DS} = 600\text{ V}$, $T_C = 125\text{ }^{\circ}\text{C}$ ⁽¹⁾			50	μA
I_{GSS}	Gate body leakage current	$V_{DS} = 0\text{ V}$, $V_{GS} = \pm 20\text{ V}$			± 10	μA
$V_{GS(th)}$	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	Ω

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

Table 5. Dynamic

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		
C_{rss}	Reverse transfer capacitance			7		
$C_{oss\text{ eq.}}^{(1)}$	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 18. Test circuit for gate charge behavior)	-	11	15	nC
Q_{gs}	Gate-source charge			2.25		
Q_{gd}	Gate-drain charge			6		

1. $C_{oss\text{ eq.}}$ 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 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 17. Test circuit for resistive load switching times and Figure 22. Switching time waveform)	-	10	-	ns
t_r	Voltage rise time			30		
$t_{d(off)}$	Turn-off delay time			23		
t_f	Fall time			50		

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	
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 2\text{ A}$, $V_{GS} = 0\text{ V}$	-		1.3	V
t_{rr}	Reverse recovery time	$I_{SD} = 2\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 20\text{ V}$ (see Figure 19. Test circuit for inductive load switching and diode recovery times)	-	178		ns
Q_{rr}	Reverse recovery charge			445		nC
I_{RRM}	Reverse recovery current			5		A
t_{rr}	Reverse recovery time	$I_{SD} = 2\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 20\text{ V}$, $T_j = 150\text{ }^{\circ}\text{C}$ (see Figure 19. Test circuit for inductive load switching and diode recovery times)	-	200		ns
Q_{rr}	Reverse recovery charge			500		nC
I_{RRM}	Reverse recovery current			5		A

1. Pulse width limited by safe operating area.

2. Pulsed: pulse duration = 300 μs , duty cycle 1.5%.

2.1 Electrical characteristics curves

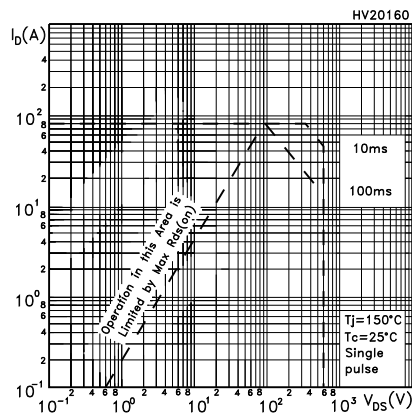
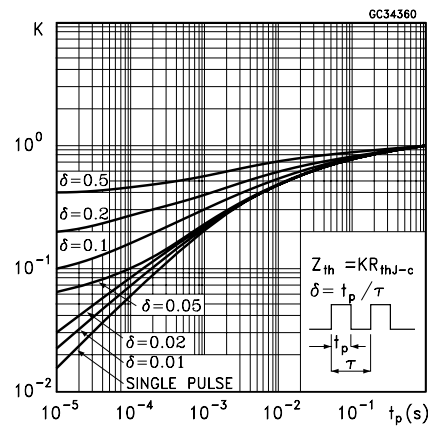
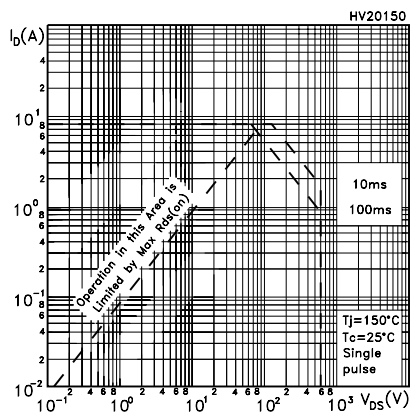
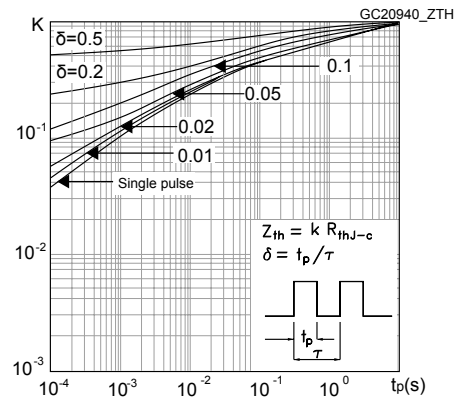
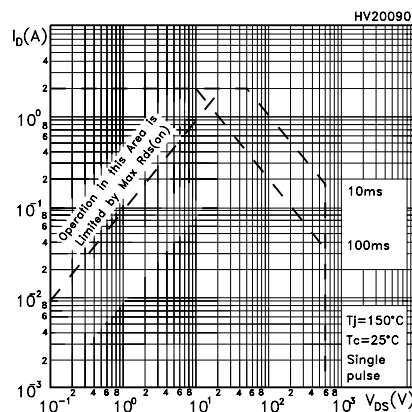
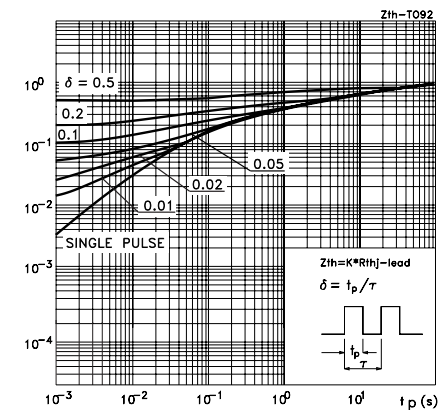
Figure 1. Safe operating area for DPAK/IPAK

Figure 2. Thermal impedance for DPAK/IPAK

Figure 3. Safe operating area for TO-220FP

Figure 4. Thermal impedance for TO-220FP

Figure 5. Safe operating area for TO-92

Figure 6. Thermal impedance for TO-92


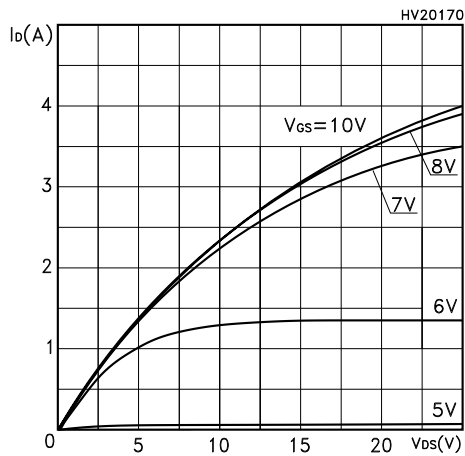
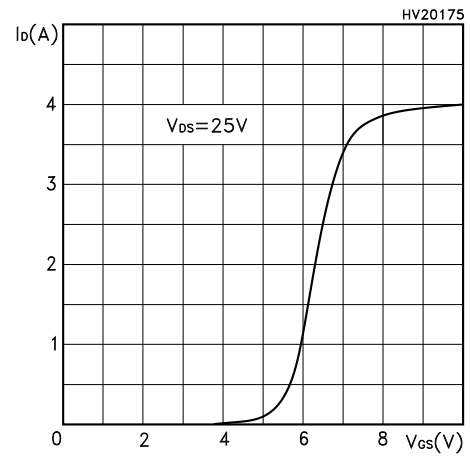
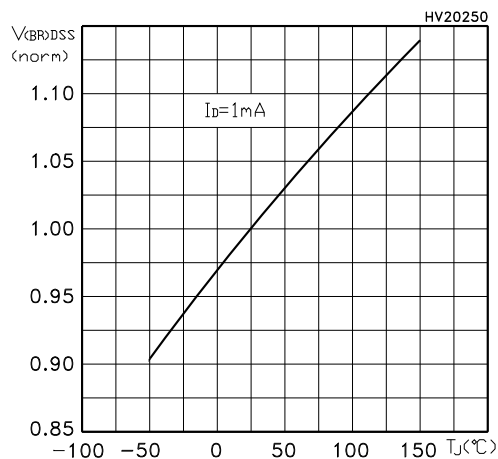
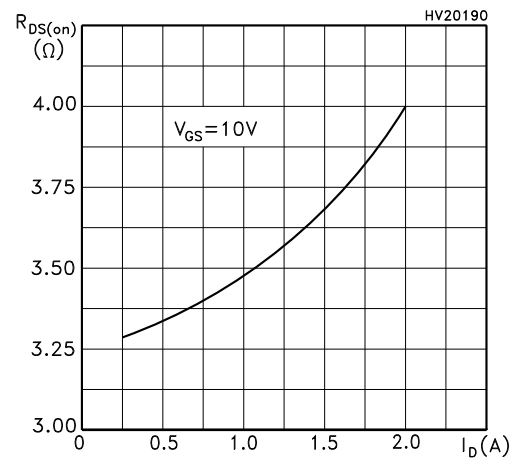
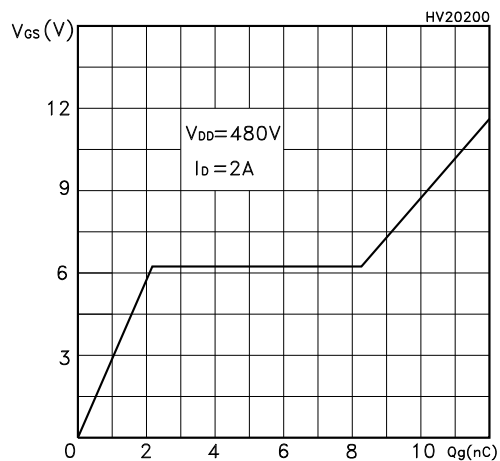
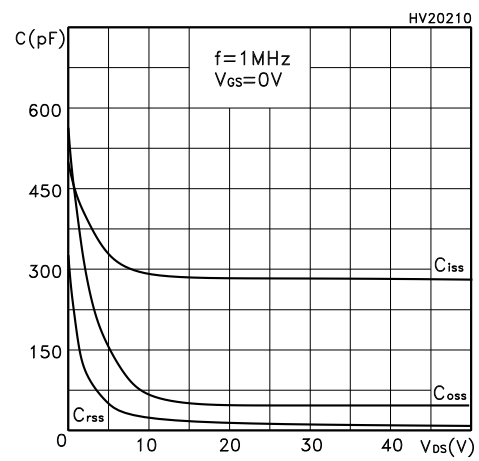
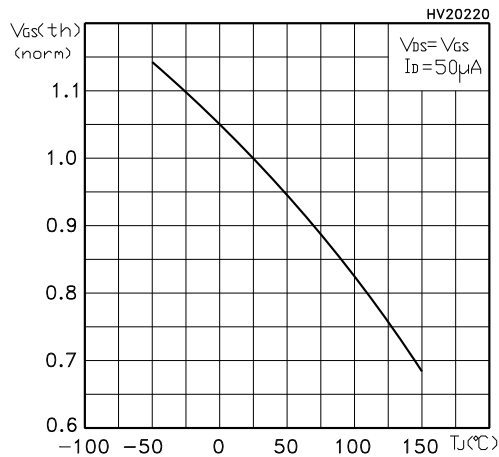
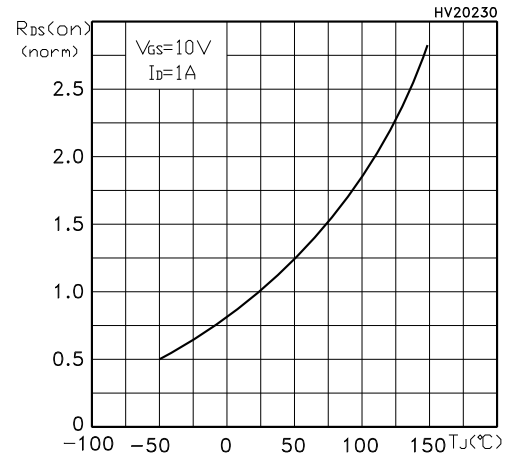
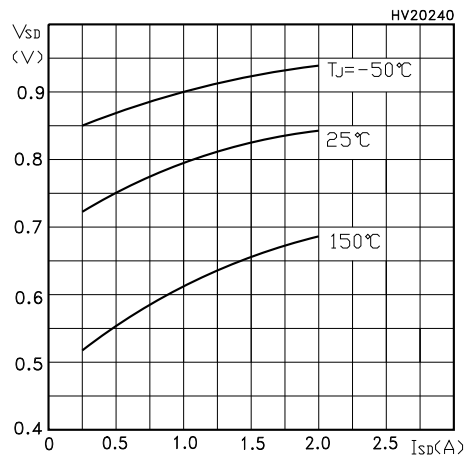
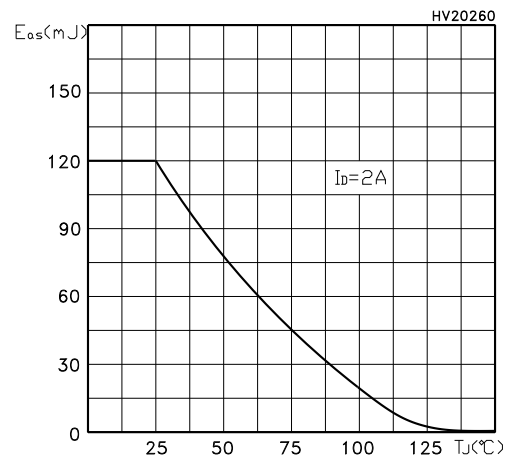
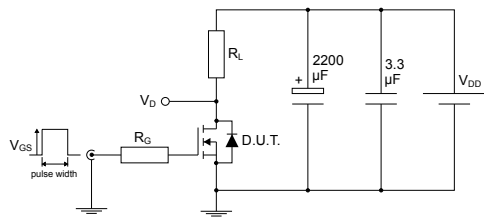
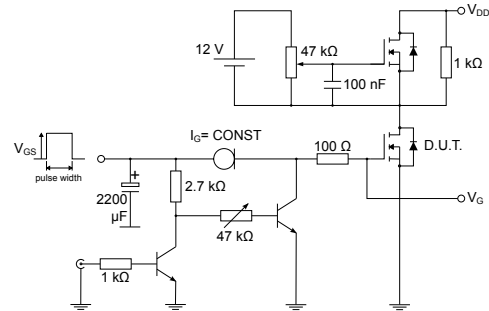
Figure 7. Output characteristics

Figure 8. Transfer characteristics

Figure 9. Normalized $V_{(BR)DSS}$ vs temperature

Figure 10. Static drain-source on-resistance

Figure 11. Gate charge vs gate-source voltage

Figure 12. Capacitance variations


Figure 13. Normalized gate threshold voltage vs temperature

Figure 14. Normalized on-resistance vs temperature

Figure 15. Source-drain diode forward characteristics

Figure 16. Maximum avalanche energy vs temperature


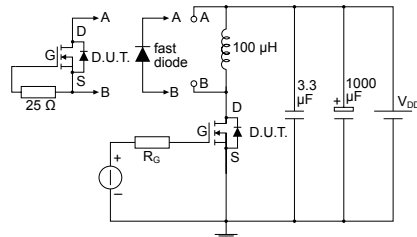
3 Test circuits

Figure 17. Test circuit for resistive load switching times


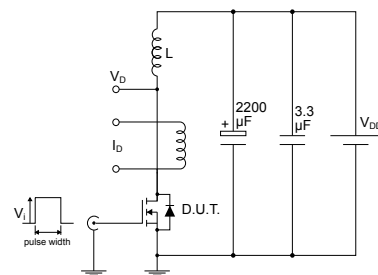
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Figure 18. Test circuit for gate charge behavior


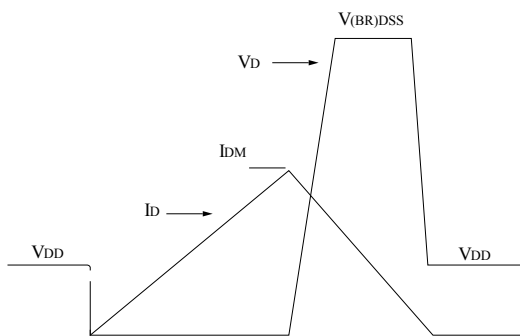
AM01469v1

Figure 19. Test circuit for inductive load switching and diode recovery times


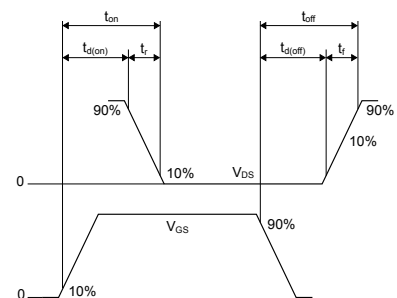
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Figure 20. Unclamped inductive load test circuit


AM01471v1

Figure 21. Unclamped inductive waveform


AM01472v1

Figure 22. Switching time waveform


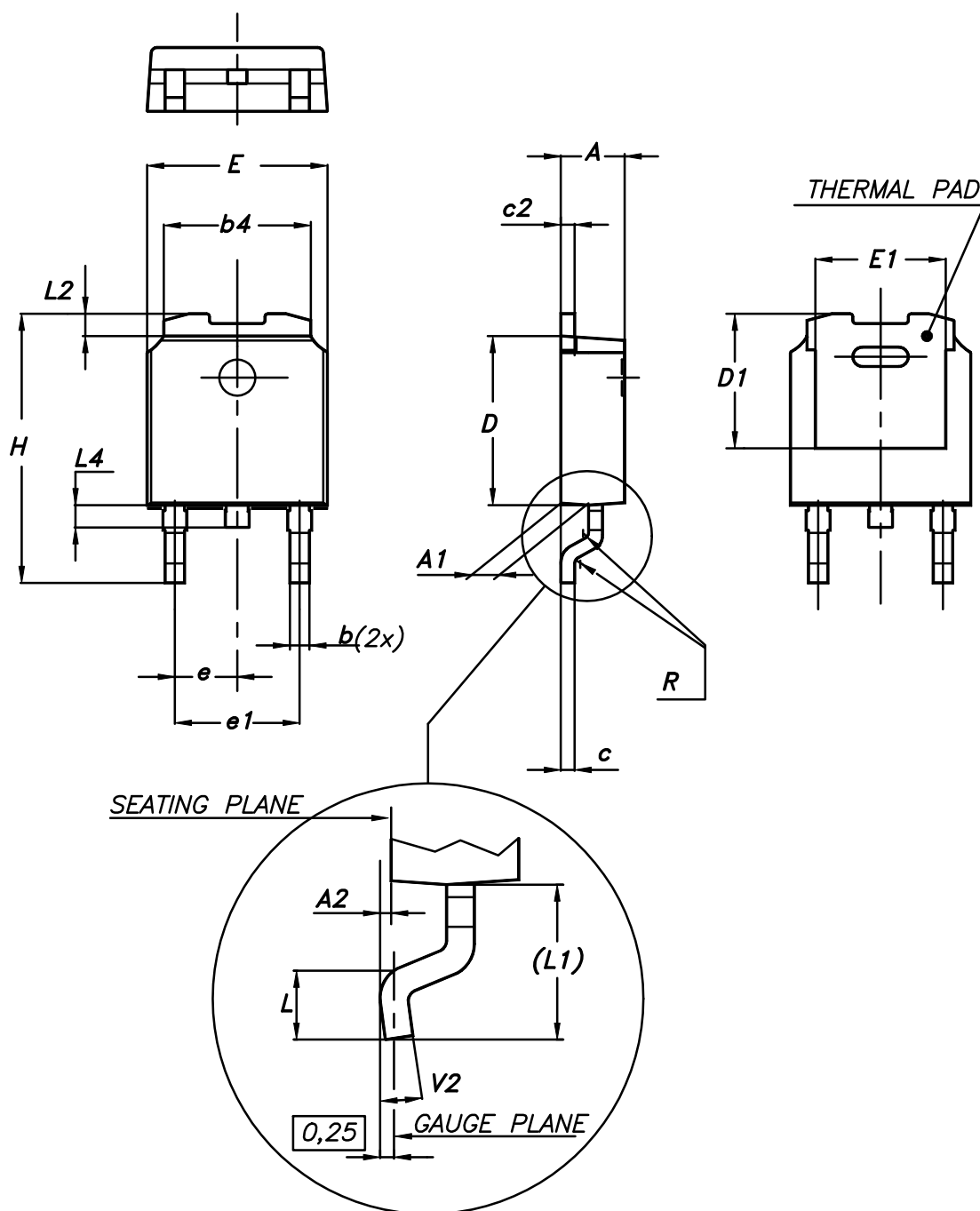
AM01473v1

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. ECOPACK® is an ST trademark.

4.1 DPAK (TO-252) type A package information

Figure 23. DPAK (TO-252) type A package outline



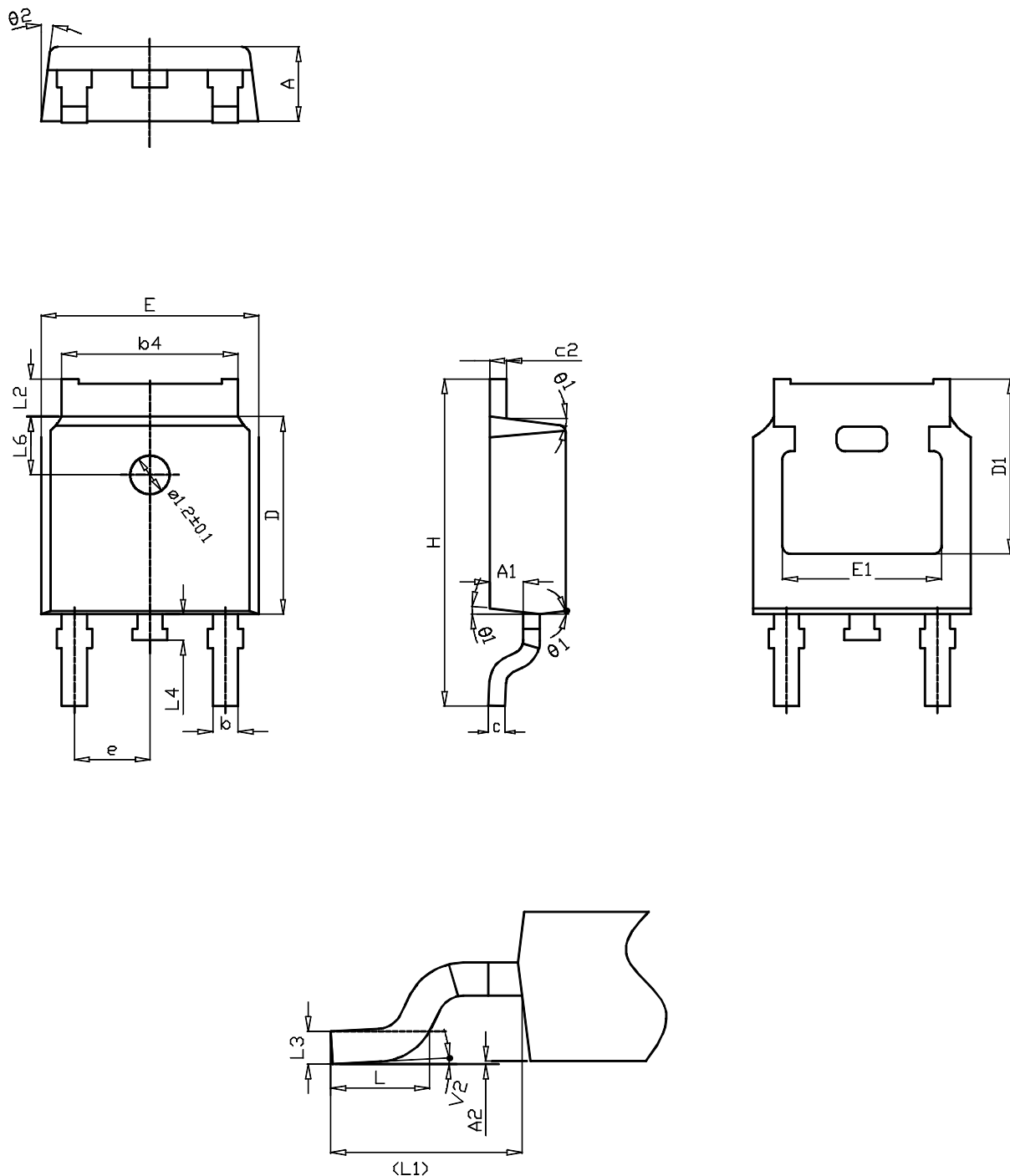
0068772_A_25

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 DPAK (TO-252) type C package information

Figure 24. DPAK (TO-252) type C package outline



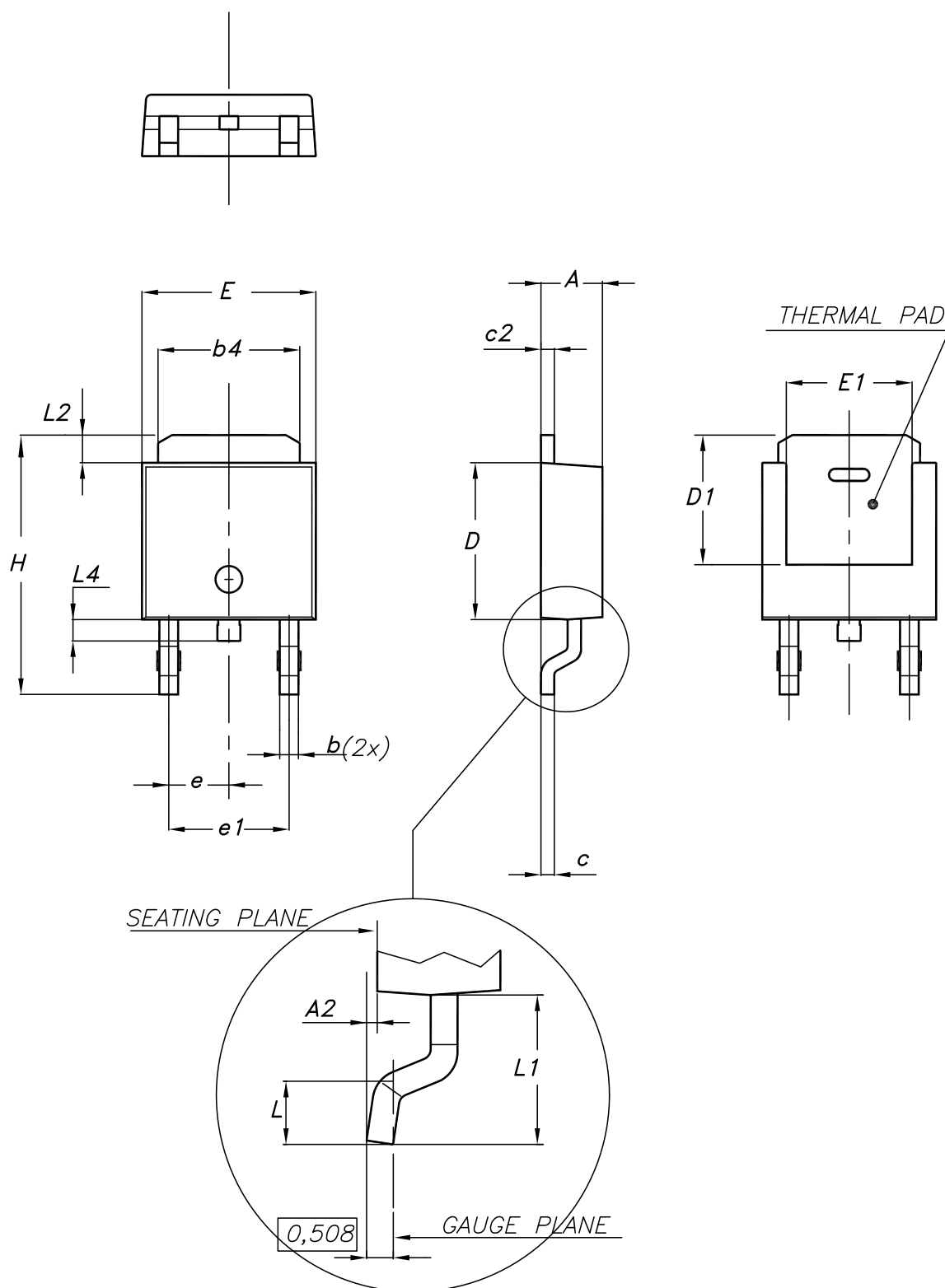
0068772_C_25

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°

4.3 DPAK (TO-252) type E package information

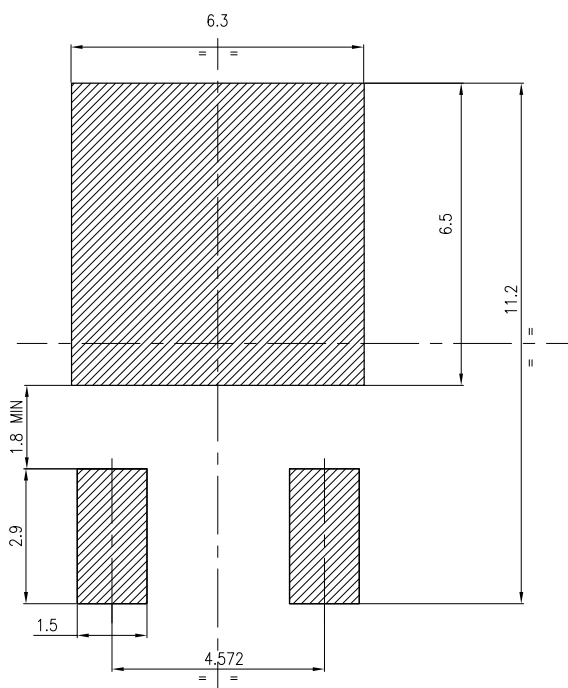
Figure 25. DPAK (TO-252) type E package outline



0068772_type-E_rev.25

Table 10. DPAK (TO-252) type E mechanical data

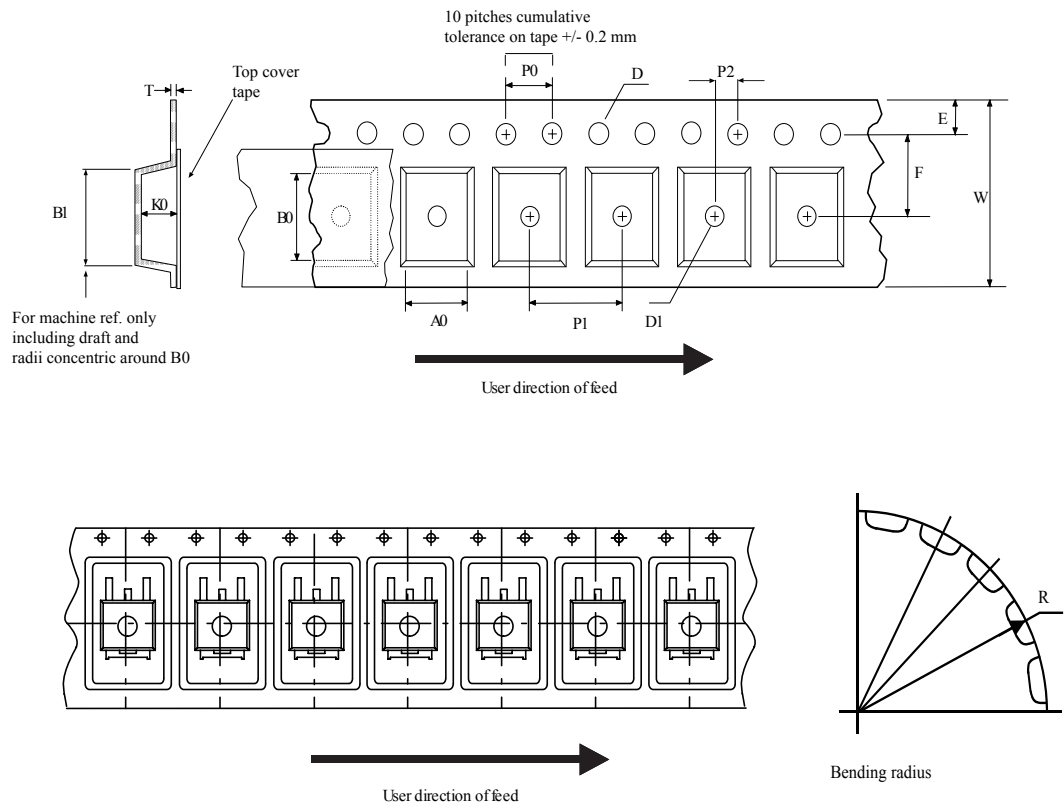
Dim.	mm		
	Min.	Typ.	Max.
A	2.18		2.39
A2			0.13
b	0.65		0.884
b4	4.95		5.46
c	0.46		0.61
c2	0.46		0.60
D	5.97		6.22
D1	5.21		
E	6.35		6.73
E1	4.32		
e		2.286	
e1		4.572	
H	9.94		10.34
L	1.50		1.78
L1		2.74	
L2	0.89		1.27
L4			1.02

Figure 26. DPAK (TO-252) recommended footprint (dimensions are in mm)


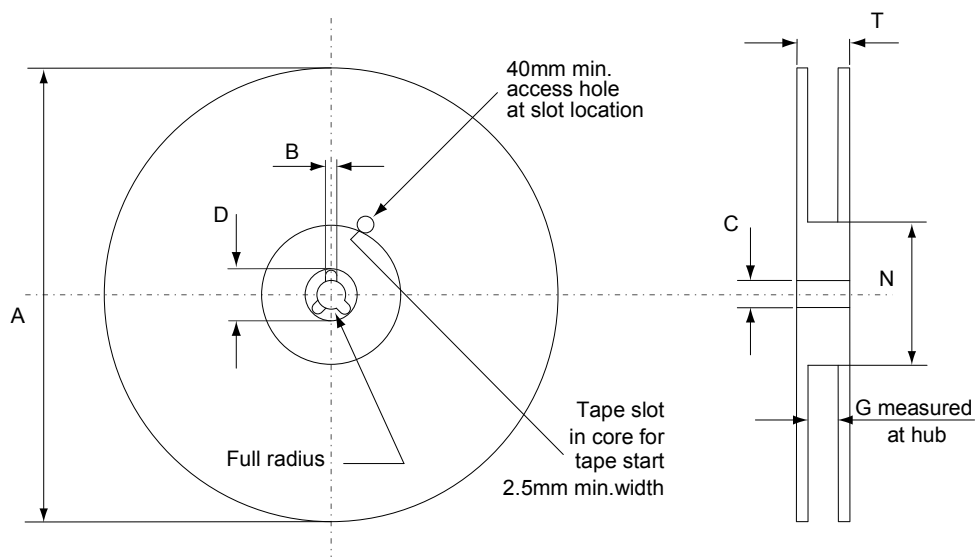
FP_0068772_25

4.4 DPAK (TO-252) packing information

Figure 27. DPAK (TO-252) tape outline



AM08852v1

Figure 28. DPAK (TO-252) reel outline


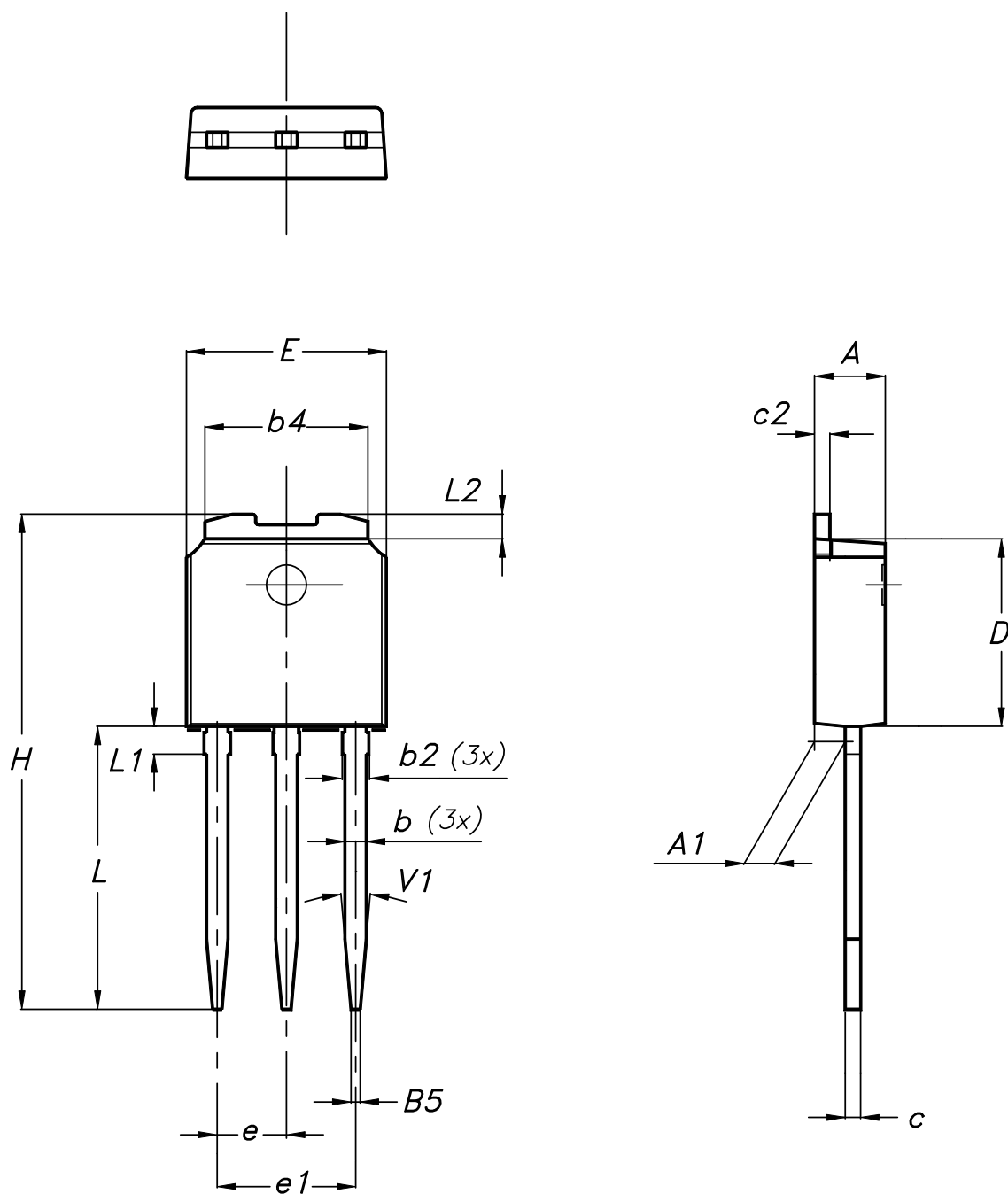
AM06038v1

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			

4.5 IPAK (TO-251) type A package information

Figure 29. IPAK (TO-251) type A package outline



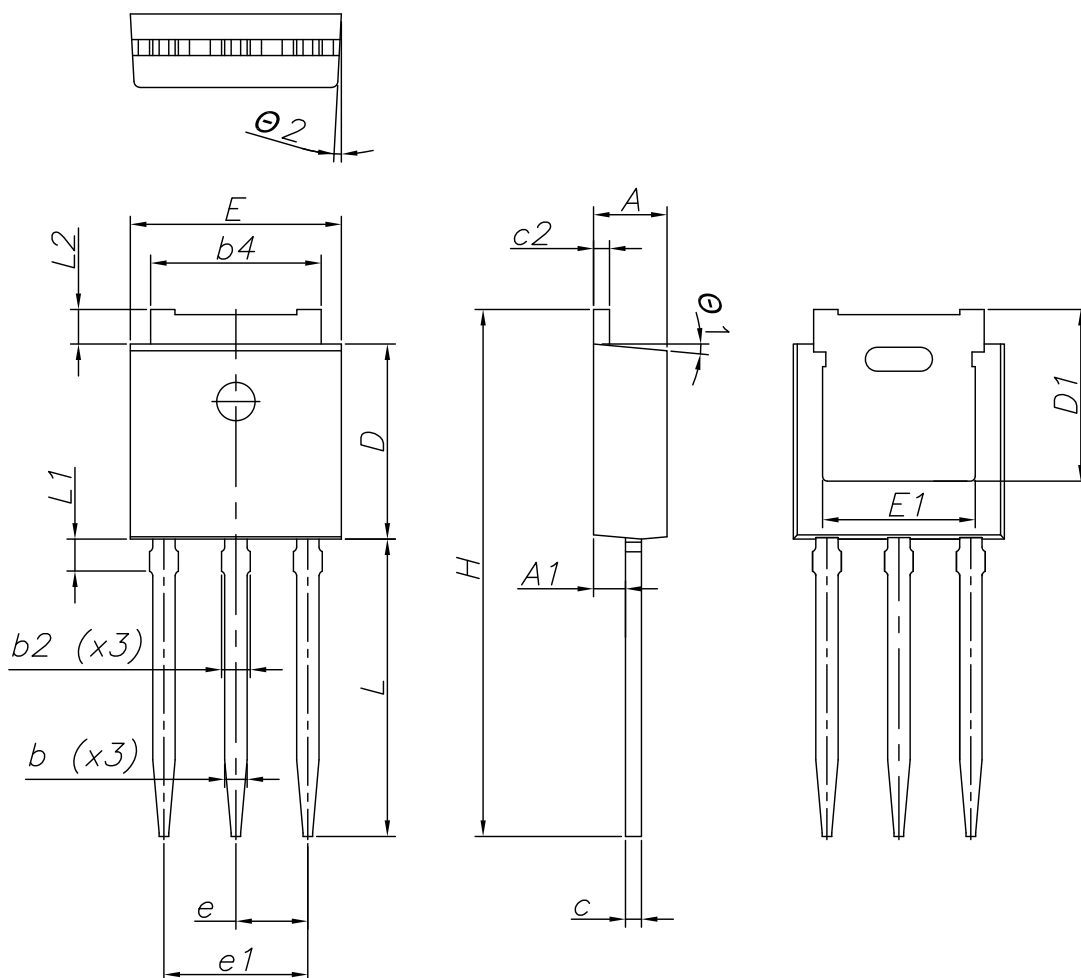
0068771_IK_typeA_rev14

Table 12. 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°	

4.6 IPAK (TO-251) type C package information

Figure 30. IPAK (TO-251) type C package outline



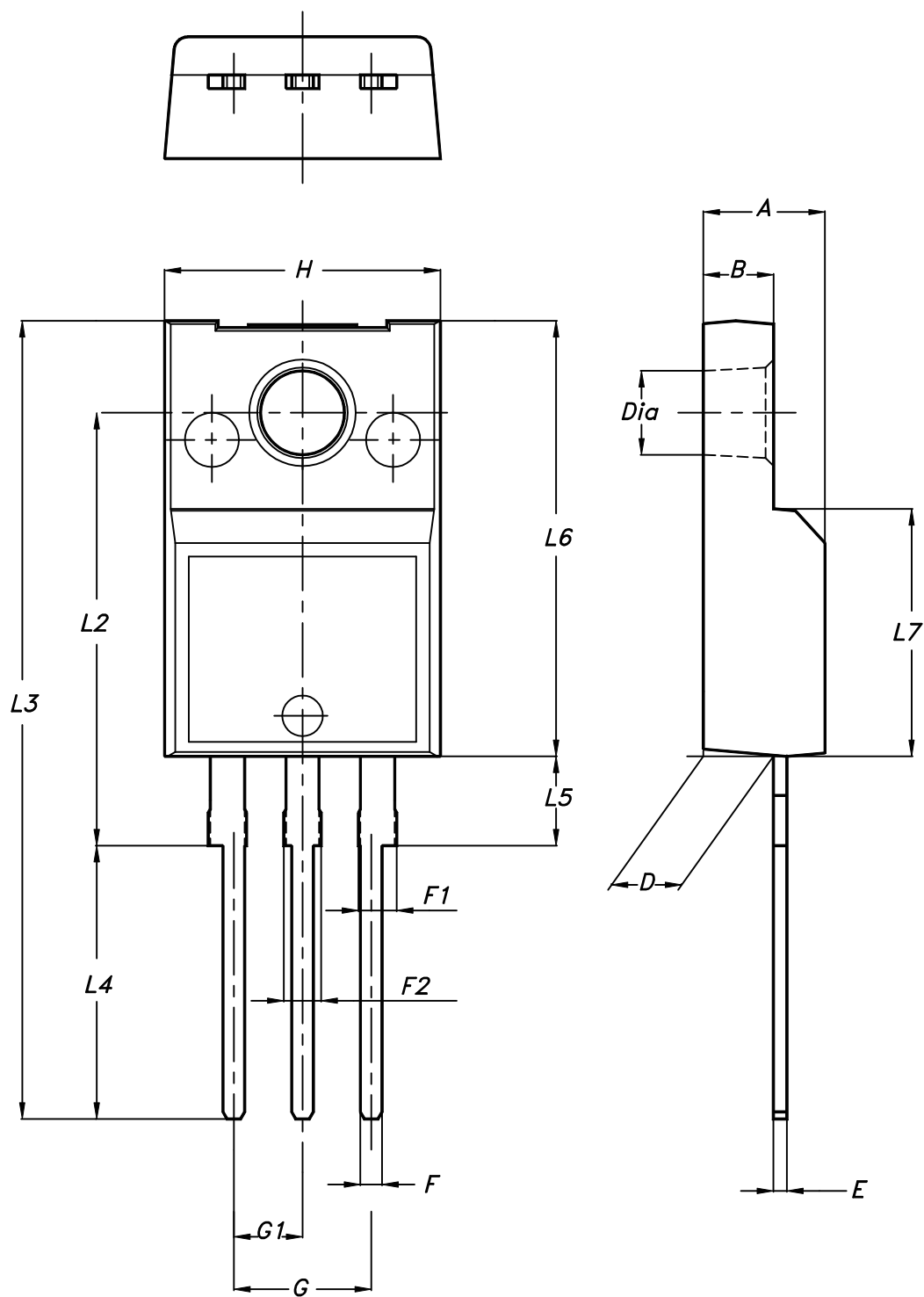
0068771_IK_typeC_rev14

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	0.80	1.00	1.20
L2	0.90	1.08	1.25
θ1	3°	5°	7°
θ2	1°	3°	5°

4.7 TO-220FP package information

Figure 31. TO-220FP package outline



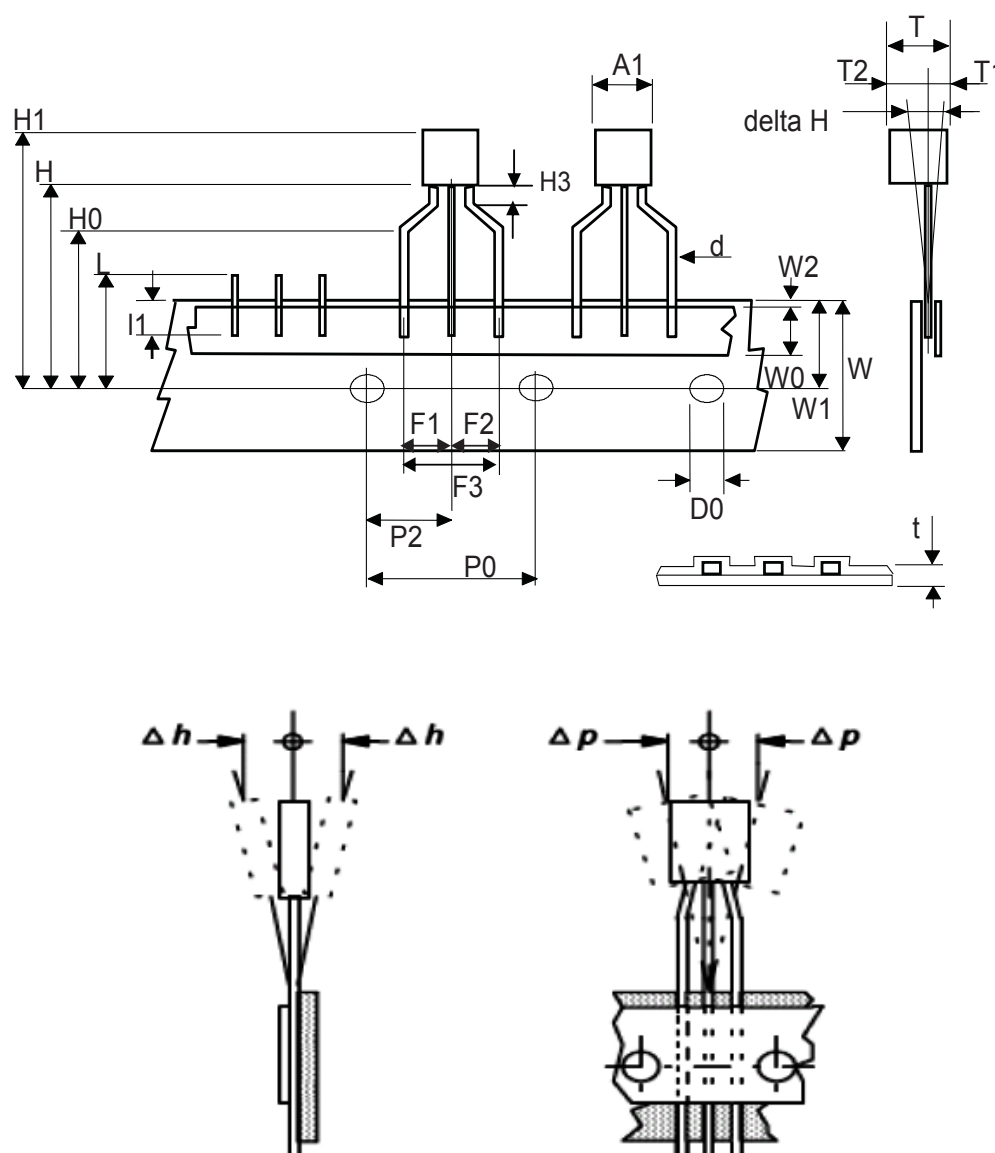
7012510_Rev_12_B

Table 14. 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

4.8 TO-92 Ammopack package information

Figure 32. TO-92 Ammopack package outline



0050910_Rev_22

Table 15. TO-92 Ammopack mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A1			4.80
T			3.80
T1			1.60
T2			2.30
d	0.45	0.47	0.48
P0	12.50	12.70	12.90
P2	5.65	6.35	7.05
F1, F2	2.40	2.50	2.94
F3	4.98	5.08	5.48
delta H	-2.00		2.00
W	17.50	18.00	19.00
W0	5.50	6.00	6.50
W1	8.50	9.00	9.25
W2			0.50
H		18.50	21.00
H0	15.50	16.00	18.20
H1		25.00	27.00
H3	0.50	1.00	2.00
D0	3.80	4.00	4.20
t			0.90
L			11.00
l1	3.00		
delta P	-1.00		1.00

5 Ordering information

Table 16. Order codes

Order code	Marking	Package	Packing
STD2HNC60Z	D2HNC60Z	DPAK	Tape and reel
STD2HNC60Z-1	D2HNC60Z	IPAK	Tube
STF2HNC60Z	F2HNC60Z	TO-220FP	Tube
STQ2HNC60ZR-AP	Q2HNC60ZR	TO-92	Ammopack

Revision history

Table 17. Document revision history

Date	Version	Changes
09-Mar-2004	1	First release
23-Mar-2004	2	Modified title
02-Apr-2005	3	Added new section: Electrical characteristics (curves)
06-Mar-2006	4	Inserted DPAK. The document has been reformatted
25-May-2012	5	Corrected unit in Table 5: On/off states
04-Jun-2018	6	Removed maturity status indication from cover page. The document status is production data. Updated title and features in cover page, Section 1 Electrical ratings, Section 2 Electrical characteristics and Section 4 Package information. Minor text changes.

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