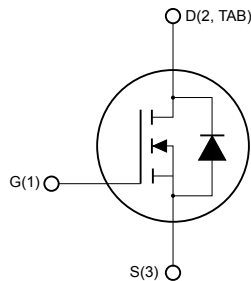
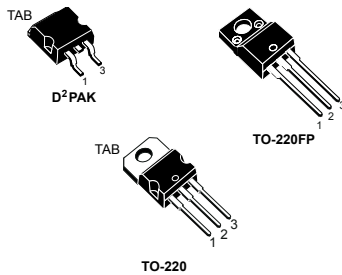


## N-channel 500 V, 300 mΩ typ., 12 A MDmesh Power MOSFETs in a D<sup>2</sup>PAK, TO-220 and TO-220FP packages



NG1D2TS3



### Features

Order codes	V <sub>DS</sub>	R <sub>DS(on)</sub> max.	I <sub>D</sub>
STB12NM50T4	500 V	350 mΩ	12 A
STP12NM50			
STP12NM50FP			

- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance

### Applications

- Switching applications

### Description

These N-channel Power MOSFETs are developed using STMicroelectronics' revolutionary MDmesh technology, which associates the multiple drain process with the company's PowerMESH horizontal layout. These devices offer extremely low on-resistance, high dv/dt and excellent avalanche characteristics. Utilizing ST's proprietary strip technique, these Power MOSFETs boast an overall dynamic performance which is superior to similar products on the market.

#### Product status link

[STB12NM50T4](#)
[STP12NM50](#)
[STP12NM50FP](#)

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		D <sup>2</sup> PAK, TO-220	TO-220FP	
V <sub>GS</sub>	Gate-source voltage	±30		V
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 25 °C	12	12 <sup>(1)</sup>	A
	Drain current (continuous) at T <sub>C</sub> = 100 °C	7.5	7.5 <sup>(1)</sup>	
I <sub>DM</sub> <sup>(2)</sup>	Drain current pulsed	48	48 <sup>(1)</sup>	A
P <sub>TOT</sub>	Total power dissipation at T <sub>C</sub> = 25 °C	160	35	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
dv/dt <sup>(3)</sup>	Peak diode recovery voltage slope	15		V/ns
T <sub>J</sub>	Operating junction temperature range	-65 to 150		°C
T <sub>stg</sub>	Storage temperature range			°C

- Limited by maximum junction temperature.
- Pulse width limited by safe operating area.
- I<sub>SD</sub> ≤ 12 A, di/dt ≤ 400 A/μs, V<sub>DD</sub> = 80% V<sub>(BR)DSS</sub>.

**Table 2. Thermal data**

Symbol	Parameter	Value			Unit
		D <sup>2</sup> PAK	TO-220	TO-220FP	
R <sub>thj-case</sub>	Thermal resistance junction-case	2.78		3.57	°C/W
R <sub>thj-a</sub>	Thermal resistance junction-ambient	62.5			°C/W
R <sub>thj-pcb</sub> <sup>(1)</sup>	Thermal resistance junction-pcb	35			°C/W

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

**Table 3. Avalanche characteristics**

Symbol	Parameter	Value	Unit
I <sub>AS</sub>	Avalanche current, repetitive or not repetitive (pulse width limited by T <sub>J</sub> max)	6	A
E <sub>AS</sub>	Single-pulse avalanche energy (starting T <sub>J</sub> = 25 °C, I <sub>D</sub> = I <sub>AS</sub> , V <sub>DD</sub> = 50 V)	400	mJ

## 2 Electrical characteristics

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

**Table 4. Static**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$V_{GS} = 0\text{ V}$ , $I_D = 250\text{ }\mu\text{A}$	500			V
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$ , $V_{DS} = 500\text{ V}$			1	$\mu\text{A}$
		$V_{GS} = 0\text{ V}$ , $V_{DS} = 500\text{ V}$ , $T_C = 125\text{ °C}$ <sup>(1)</sup>			10	
$I_{GSS}$	Gate-body leakage current	$V_{DS} = 0\text{ V}$ , $V_{GS} = \pm 30\text{ V}$			$\pm 100$	nA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$ , $I_D = 50\text{ }\mu\text{A}$	3	4	5	V
$R_{DS(on)}$	Static drain-source on-resistance	$V_{GS} = 10\text{ V}$ , $I_D = 6\text{ A}$		300	350	m $\Omega$

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

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0\text{ V}$	-	1000	-	pF
$C_{oss}$	Output capacitance		-	250	-	pF
$C_{rss}$	Reverse transfer capacitance		-	20	-	pF
$C_{oss\text{ eq.}}^{(1)}$	Equivalent output capacitance	$V_{DS} = 0\text{ to }400\text{ V}$ , $V_{GS} = 0\text{ V}$	-	90	-	pF
$t_{d(on)}$	Turn-on Delay Time	$V_{DD} = 250\text{ V}$ , $I_D = 6\text{ A}$ , $R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$	-	20	-	ns
$t_r$	Rise Time	(see Figure 13. Test circuit for resistive load switching times and Figure 18. Switching time waveform)	-	10	-	ns
$Q_g$	Total gate charge	$V_{DD} = 400\text{ V}$ , $I_D = 12\text{ A}$ , $V_{GS} = 0\text{ to }10\text{ V}$	-	28	-	nC
$Q_{gs}$	Gate-source charge	(see Figure 14. Test circuit for gate charge behavior)	-	8	-	nC
$Q_{gd}$	Gate-drain charge		-	16	-	nC
$R_g$	Gate input resistance	$f = 1\text{ MHz}$ , gate DC Bias = 0, test signal level = 20 mV, open drain	-	1.6	-	$\Omega$

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. Source-drain diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		12	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		48	A
$V_{SD}^{(2)}$	Forward on voltage	$V_{GS} = 0\text{ V}$ , $I_{SD} = 12\text{ A}$	-		1.5	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 12\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,	-	270		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 100\text{ V}$	-	2.23		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current	(see Figure 15. Test circuit for inductive load switching and diode recovery times)	-	16.5		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 12\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,	-	340		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 100\text{ V}$ , $T_J = 150\text{ }^\circ\text{C}$	-	3		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current	(see Figure 15. Test circuit for inductive load switching and diode recovery times)	-	18		A

1. Pulse width is limited by safe operating area.

2. Pulse test: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%.

## 2.1 Electrical characteristics (curves)

Figure 1. Safe operating area for D<sup>2</sup>PAK and TO-220

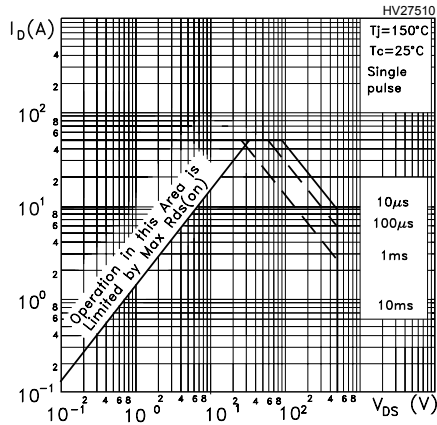


Figure 2. Thermal impedance for D<sup>2</sup>PAK and TO-220

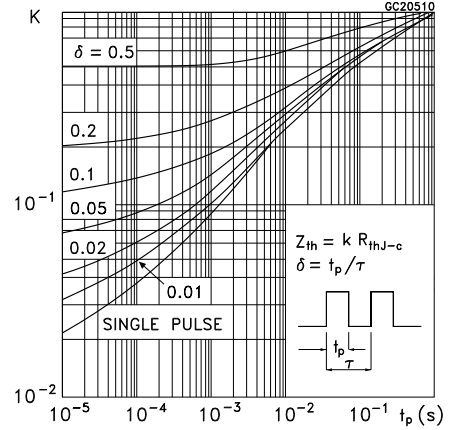


Figure 3. Safe operating area for TO-220FP

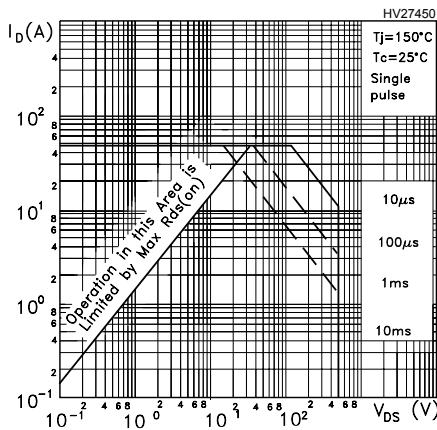


Figure 4. Thermal impedance for TO-220FP

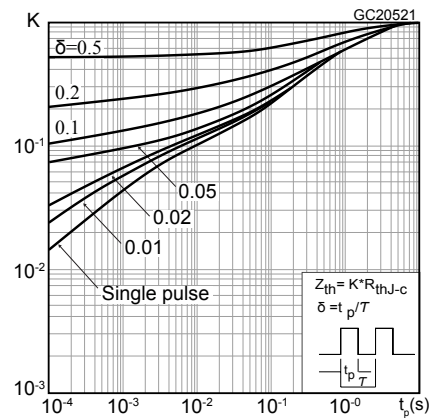


Figure 5. Output characteristics

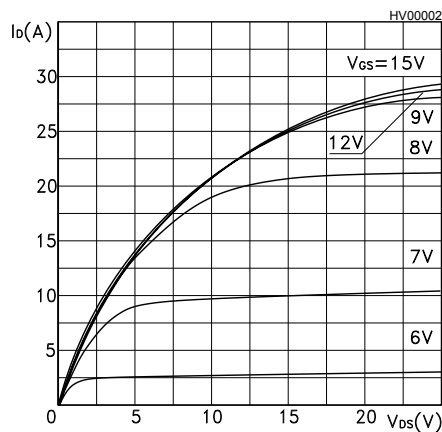
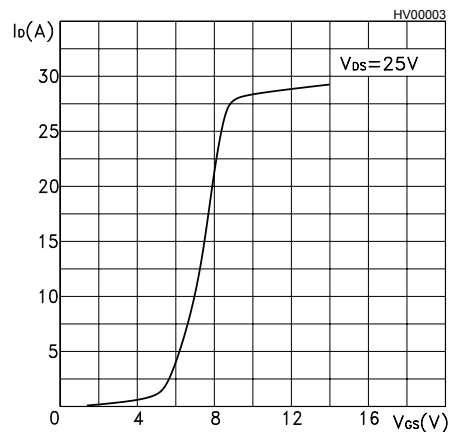
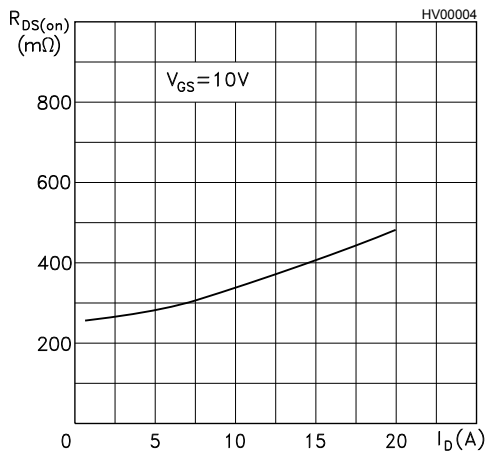
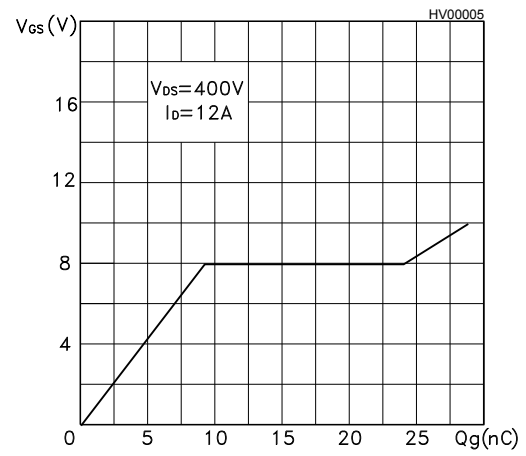
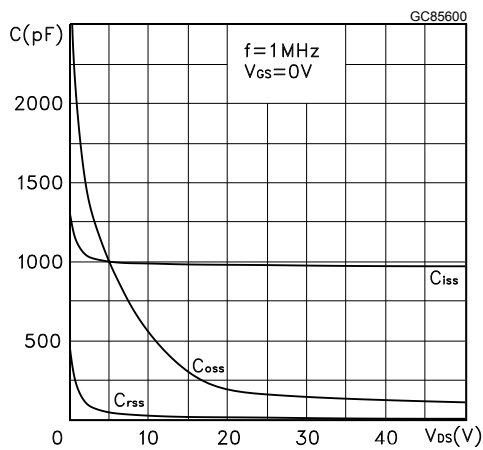
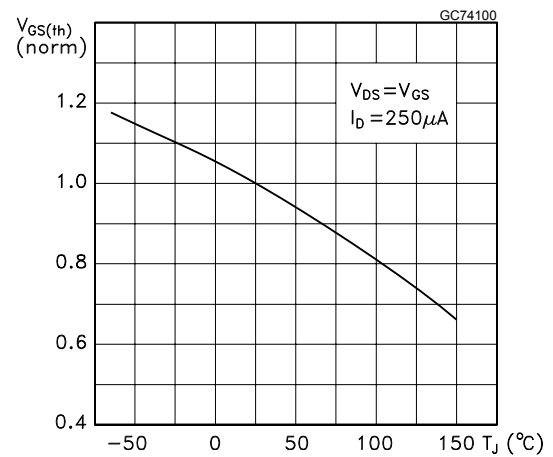
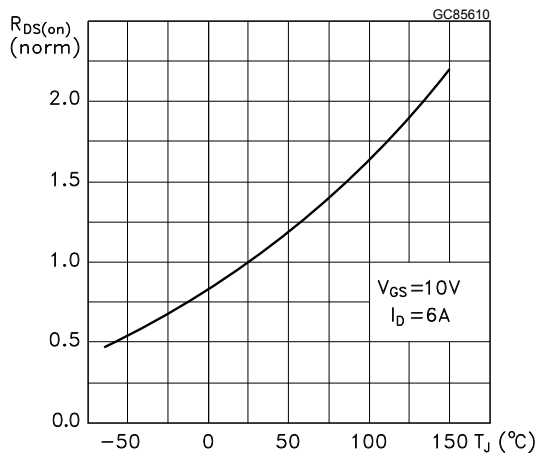
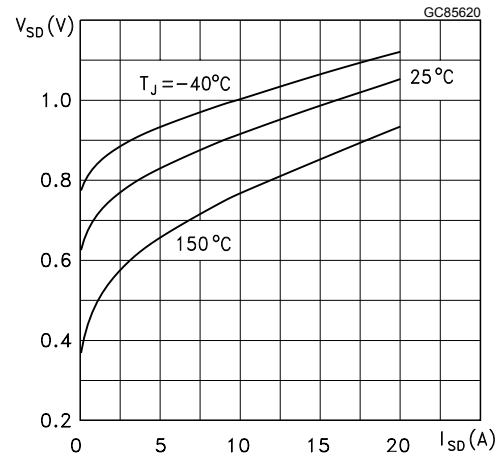
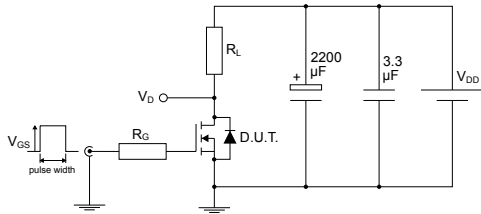


Figure 6. Transfer characteristics

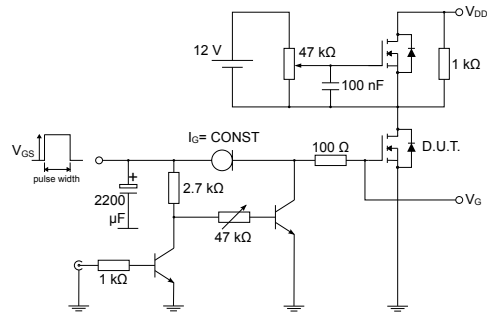


**Figure 7. Static drain-source on-resistance**

**Figure 8. Gate charge vs gate-source voltage**

**Figure 9. Capacitance variations**

**Figure 10. Normalized gate threshold voltage vs temperature**

**Figure 11. Normalized on resistance vs temperature**

**Figure 12. Source-drain diode forward characteristics**


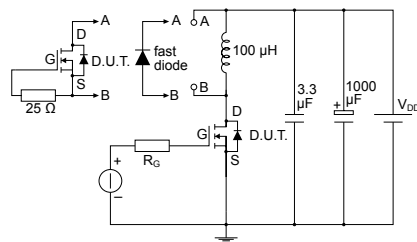
### 3 Test circuits

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


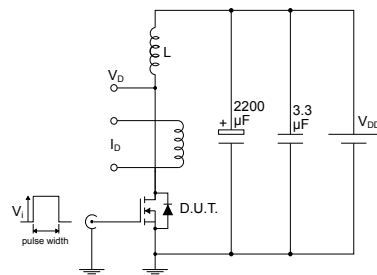
AM01468v1

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


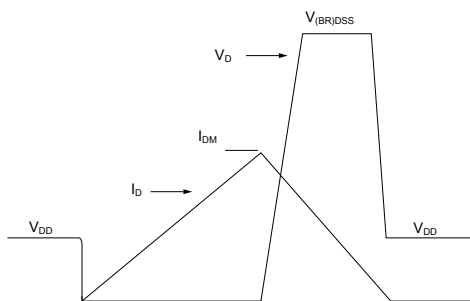
AM01469v1

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


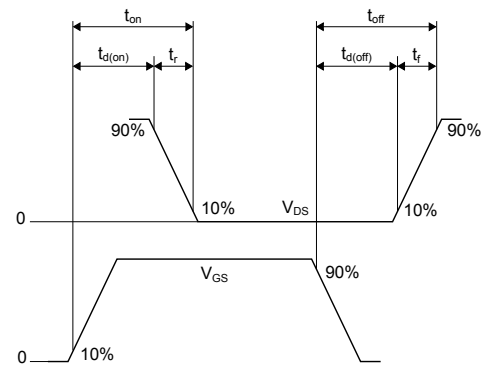
AM01470v1

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


AM01471v1

**Figure 17. Unclamped inductive waveform**


AM01472v1

**Figure 18. Switching time waveform**


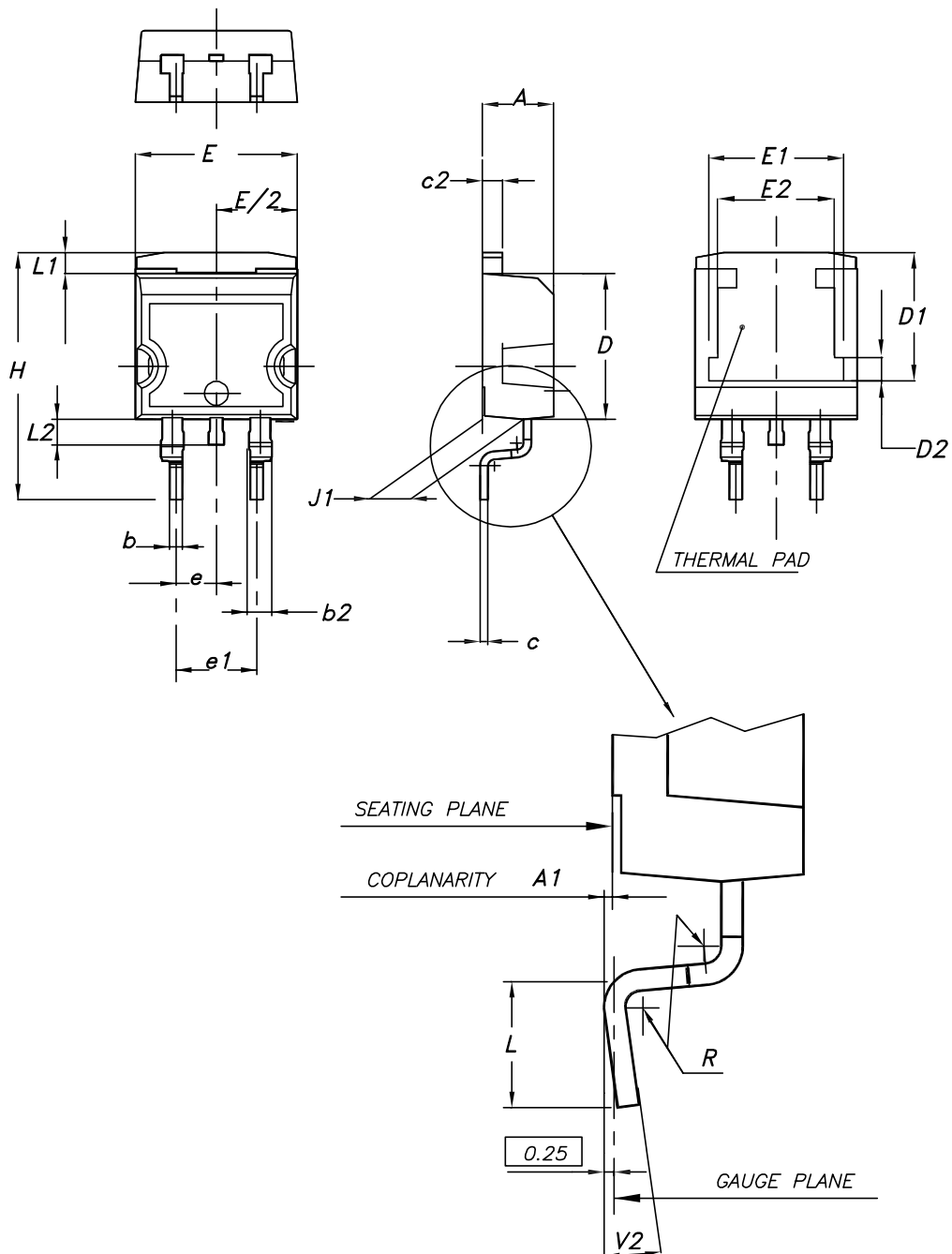
AM01473v1

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

Figure 19. D<sup>2</sup>PAK (TO-263) type A package outline



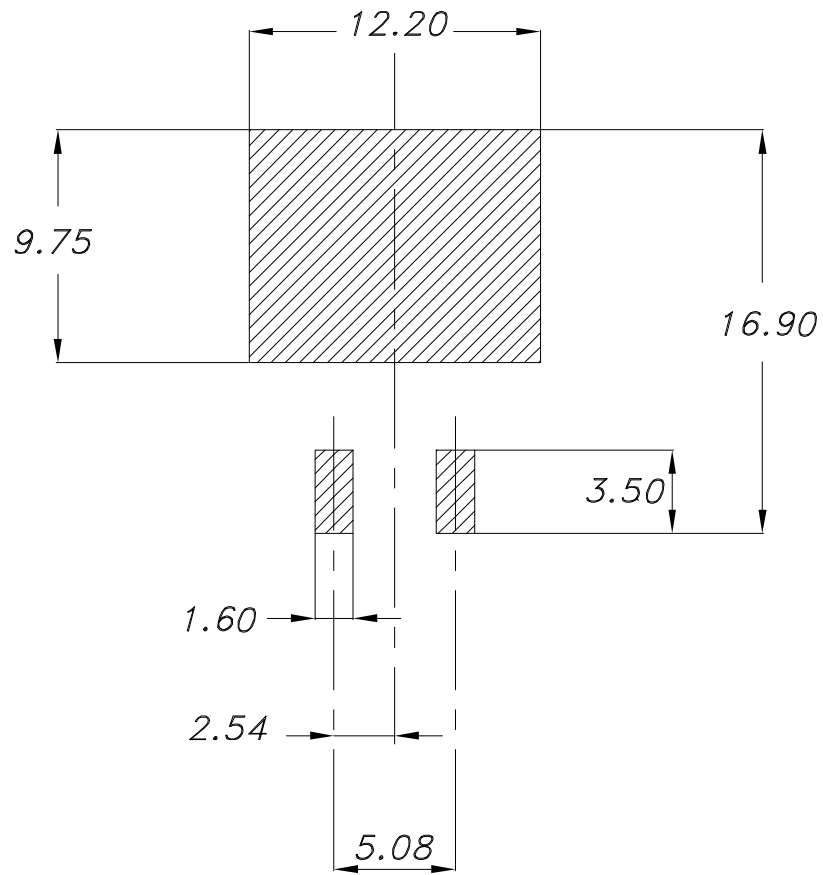
0079457\_26



**Table 7. D<sup>2</sup>PAK (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	8.30	8.50	8.70
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°

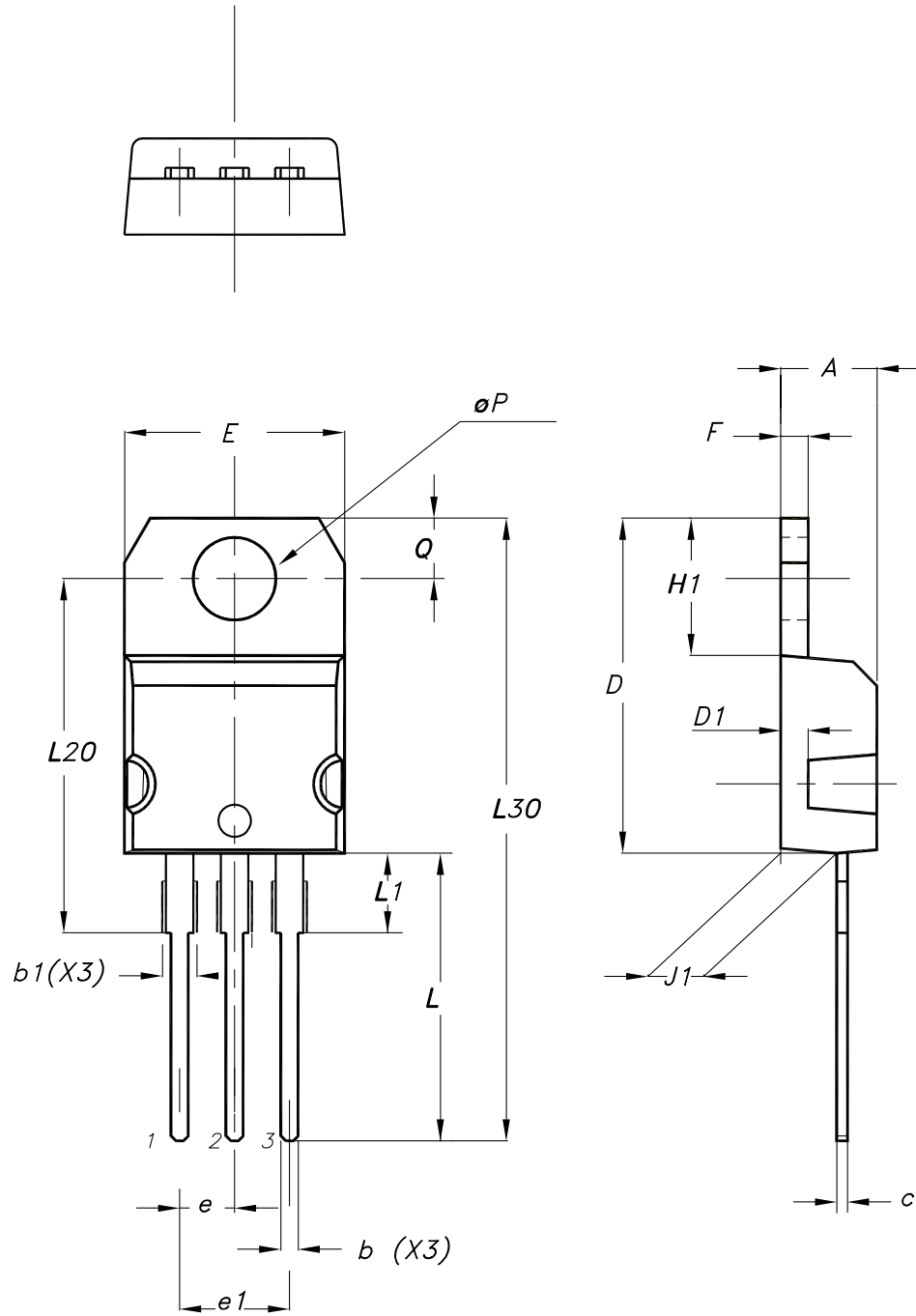
Figure 20. D<sup>2</sup>PAK (TO-263) recommended footprint (dimensions are in mm)



Footprint\_26

## 4.2 TO-220 type A package information

Figure 21. TO-220 type A package outline



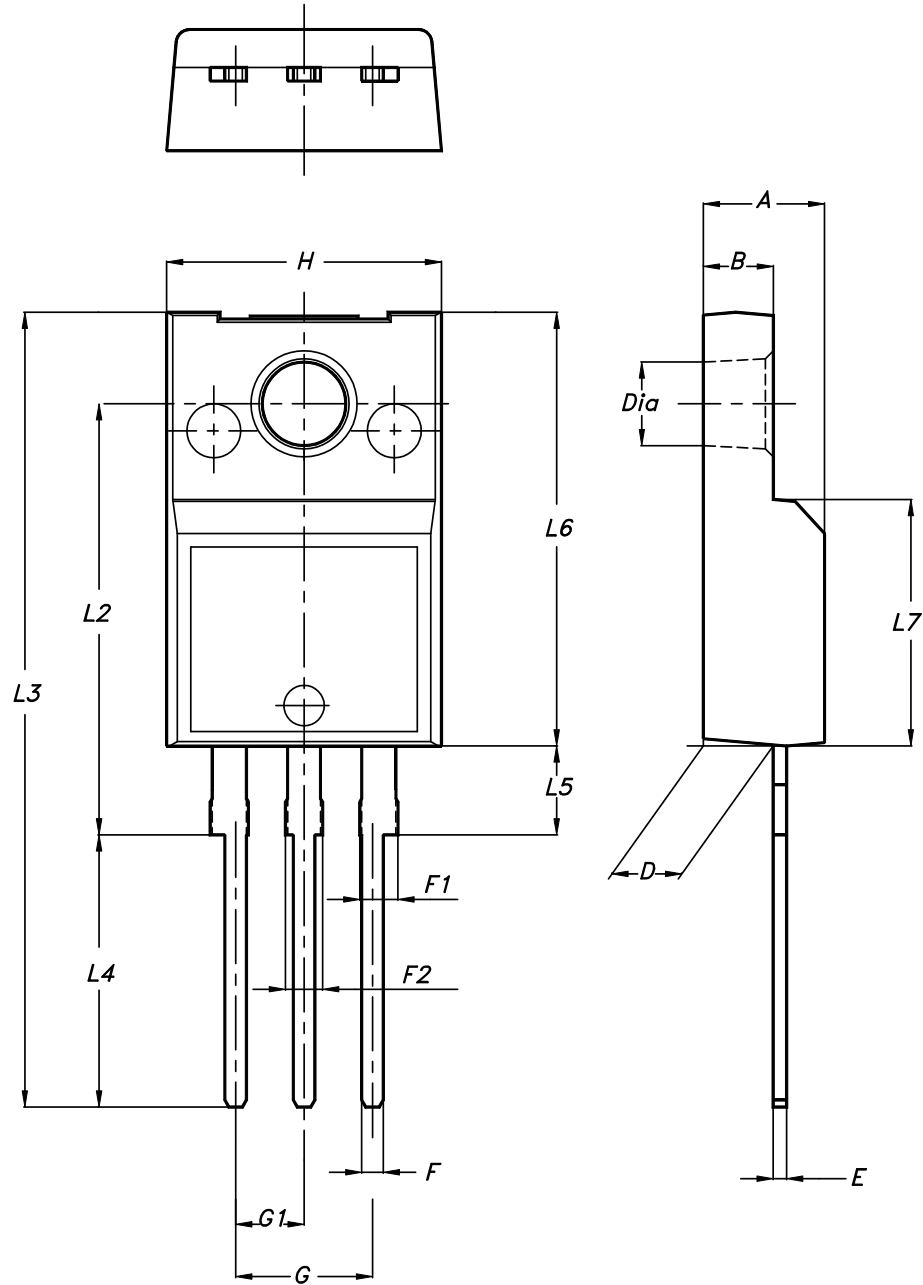
0015988\_typeA\_Rev\_23

**Table 8. 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
Slug flatness		0.03	0.10

### 4.3 TO-220FP package information

Figure 22. TO-220FP package outline



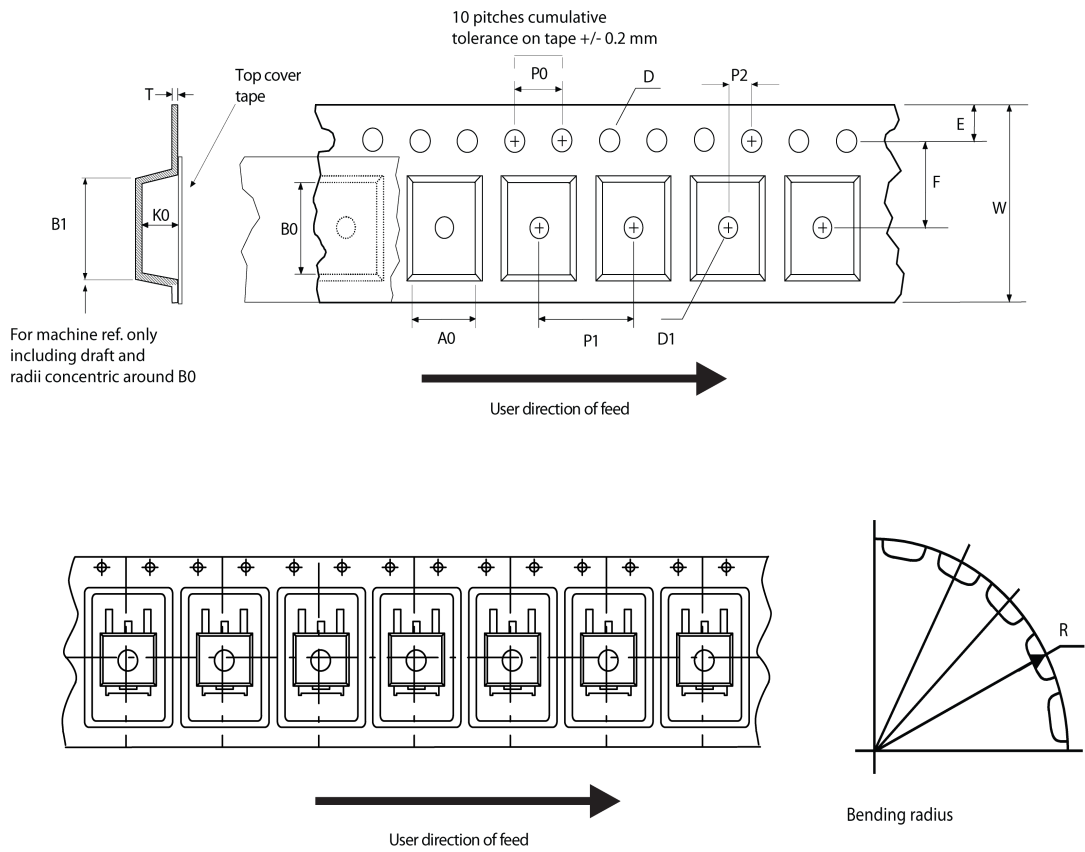
7012510\_Rev\_13\_B

**Table 9. TO-220FP package mechanical data**

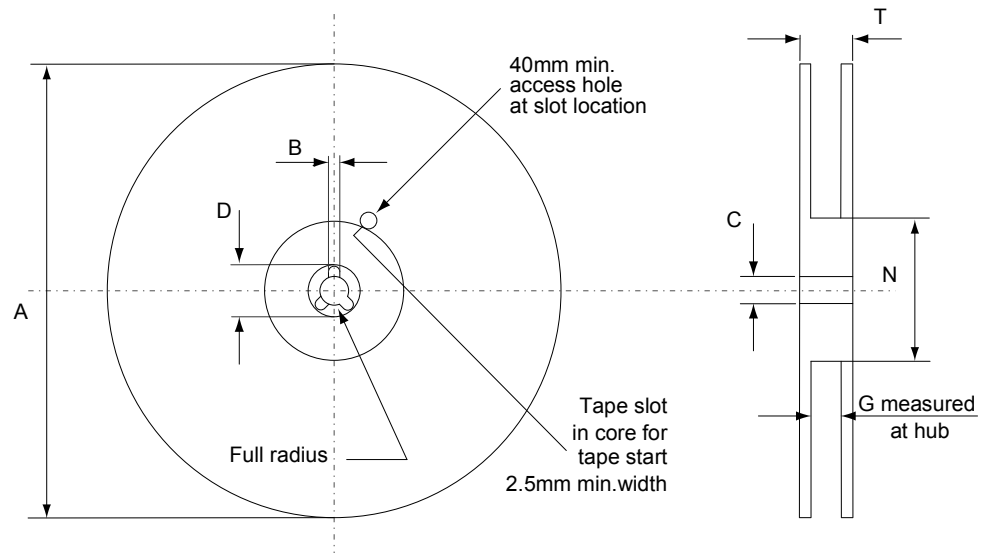
Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
B	2.50		2.70
D	2.50		2.75
E	0.45		0.70
F	0.75		1.00
F1	1.15		1.70
F2	1.15		1.70
G	4.95		5.20
G1	2.40		2.70
H	10.00		10.40
L2		16.00	
L3	28.60		30.60
L4	9.80		10.60
L5	2.90		3.60
L6	15.90		16.40
L7	9.00		9.30
Dia	3.00		3.20

#### 4.4 D<sup>2</sup>PAK packing information

Figure 23. D<sup>2</sup>PAK tape outline



AM08852v1

**Figure 24. 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	Base quantity Bulk quantity			
P1	11.9	12.1				1000
P2	1.9	2.1				1000
R	50					
T	0.25	0.35				
W	23.7	24.3				



## 5 Ordering information

**Table 11. Order codes**

Order codes	Marking	Package	Packing
STB12NM50T4	B12NM50	D <sup>2</sup> PAK	Tape and reel
STP12NM50	P12NM50	TO-220	Tube
STP12NM50FP	P12NM50FP	TO-220FP	Tube

## Revision history

**Table 12. Document revision history**

Date	Revision	Changes
14-Mar-2004	8	Preliminary version
15-Feb-2006	9	New voltage value on first page at $t_{jmax}$ .
05-Apr-2006	10	Inserted ecopack indication
27-Jul-2006	11	New template, no content change
22-Oct-2020	12	<p>The part number STB12NM50-1 have been moved to a separate datasheet and the document has been updated accordingly.</p> <p>Updated cover page.</p> <p>Updated <a href="#">Section 1 Electrical ratings</a> and <a href="#">Section 2 Electrical characteristics</a>.</p> <p>Added <a href="#">Section 5 Ordering information</a>.</p> <p>Minor text changes.</p>

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