



# STP4NM60 STD3NM60, STD3NM60-1

N-channel 600 V, 1.3  $\Omega$ , 3 A TO-220, DPAK, IPAK  
Zener-protected MDmesh™ Power MOSFET

## Features

Type	V <sub>DSS</sub> (@T <sub>jmax</sub> )	R <sub>DS(on)</sub> max	I <sub>D</sub>	P <sub>W</sub>
STD3NM60	650	< 1.5 $\Omega$	3 A	42 W
STD3NM60-1				
STP4NM60			4 A	69 W

- High dv/dt and avalanche capabilities
- Improved ESD capability
- Low input capacitance and gate charge
- Low gate input resistance
- Tight process control and high manufacturing yields

## Applications

- Switching

## Description

Modems technology applies the benefits of the multiple drain process to STMicroelectronics' well-known PowerMESH™ horizontal layout structure. The resulting product offers low on-resistance, high dv/dt capability and excellent avalanche characteristics.

Table 1. Device summary

Order code	Marking	Package	Packing
STD3NM60	D3NM60	DPAK	Tape and reel
STD3NM60-1	D3NM60	IPAK	Tube
STP4NM60	P4NM60	TO-220	Tube

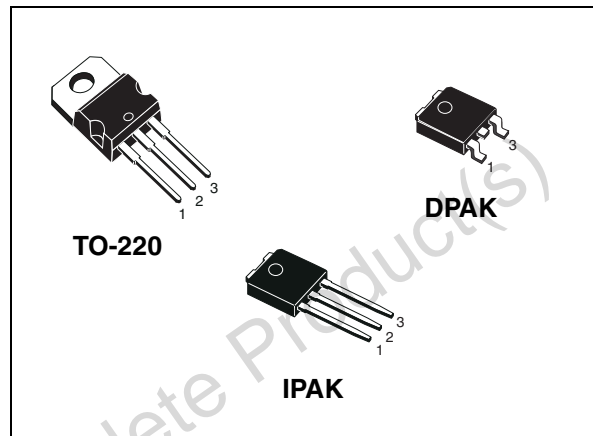
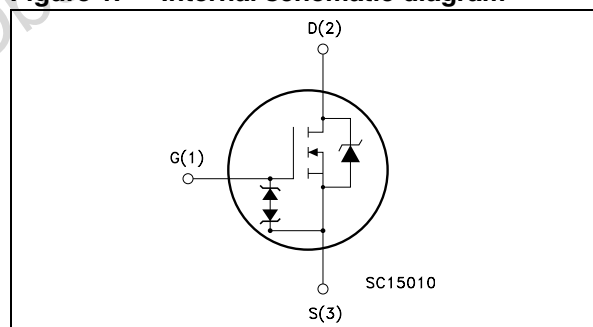


Figure 1. Internal schematic diagram



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Obsolete Product(s) - Obsolete Product(s)

# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		STP4NM60	STD3NM60 STD3NM60-1	
$V_{DS}$	Drain-source voltage ( $V_{GS}=0$ )	600		V
$V_{GS}$	Gate- source Voltage	$\pm 30$		V
$I_D$	Drain current (continuous) at $T_C=25^\circ\text{C}$	4	3	A
$I_D$	Drain current (continuous) at $T_C=100^\circ\text{C}$	2.52	1.9	A
$I_{DM}^{(1)}$	Drain current (pulsed)	16	12	A
$P_{TOT}$	Total dissipation at $T_C=25^\circ\text{C}$	69	42	W
	Derating factor	0.55	0.33	W/ $^\circ\text{C}$
$dv/dt^{(2)}$	Peak diode recovery voltage slope	15		V/ns
$T_j$	Operating junction temperature	-65 to 150		$^\circ\text{C}$
$T_{stg}$	Storage temperature			$^\circ\text{C}$

1. Pulse width limited by safe operating area
2.  $I_{SD} \leq 3\text{ A}$ ,  $di/dt \leq 400\ \mu\text{A}$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_j \leq T_{jMAX}$ .

**Table 3. Thermal data**

Symbol	Parameter	Value		Unit
		To-220	DPAK / IPAK	
$R_{thj-case}$	Thermal resistance junction-case max	1.82	3	$^\circ\text{C}/\text{W}$
$R_{thj-amb}$	Thermal resistance junction-ambient max	62.5		$^\circ\text{C}/\text{W}$
$T_l$	Maximum lead temperature for soldering purpose	300		$^\circ\text{C}$

**Table 4. Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AR}$	Avalanche current, repetitive or not-repetitive (pulse width limited by $T_{jmax}$ )	1.5	A
$E_{AS}$	Single pulse avalanche energy (starting $T_j=25^\circ\text{C}$ , $I_D=I_{AR}$ , $V_{DD}=50\text{ V}$ )	200	mJ

## 2 Electrical characteristics

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

**Table 5. On/off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 250\ \mu\text{A}$ , $V_{GS} = 0$	600			V
$I_{DSS}$	Zero gate voltage drain current ( $V_{GS} = 0$ )	$V_{DS} = \text{max rating}$ $V_{DS} = \text{max rating}$ , $T_C = 125\text{ °C}$			1 10	$\mu\text{A}$ $\mu\text{A}$
$I_{GSS}$	Gate-body leakage current ( $V_{DS} = 0$ )	$V_{GS} = \pm 20\text{V}$			$\pm 5$	$\mu\text{A}$
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$ , $I_D = 250\ \mu\text{A}$	3	4	5	V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10\text{ V}$ , $I_D = 1.5\text{ A}$		1.3	1.5	$\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$g_{fs}^{(1)}$	Forward transconductance	$V_{DS} = 15\text{ V}$ , $I_D = 1.5\text{ A}$	-	2.7	-	S
$C_{iss}$ $C_{oss}$ $C_{rss}$	Input capacitance Output capacitance Reverse transfer capacitance	$V_{DS} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0$	-	324 132 7.4	-	pF pF pF
$t_{d(on)}$ $t_r$ $t_{d(off)}$ $t_f$	Turn-on delay time Rise time Turn-off delay time Fall time	$V_{DD} = 300\text{ V}$ , $I_D = 1.5\text{ A}$ $R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 15</a> )	-	9 4 16.5 10.5	-	ns ns ns ns
$Q_g$ $Q_{gs}$ $Q_{gd}$	Total gate charge Gate-source charge Gate-drain charge	$V_{DD} = 480\text{ V}$ , $I_D = 3\text{ A}$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 21</a> )	-	10 3 4.7	14	nC nC nC

1. Pulsed: Pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5 %.

**Table 7. Source drain diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$ $I_{SDM}^{(1)}$	Source-drain current Source-drain current (pulsed)		-		3 12	A A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 3\text{ A}, V_{GS} = 0$	-		1.5	V
$t_{rr}$ $Q_{rr}$ $I_{RRM}$	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_{SD} = 3\text{ A}, di/dt = 100\text{ A}/\mu\text{s}, V_{DD} = 100\text{ V}, T_j = 25^\circ\text{C}$ (see <a href="#">Figure 17</a> )	-	224 1 9		ns nC A
$t_{rr}$ $Q_{rr}$ $I_{RRM}$	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_{SD} = 3\text{ A}, di/dt = 100\text{ A}/\mu\text{s}, V_{DD} = 100\text{ V}, T_j = 150^\circ\text{C}$ (see <a href="#">Figure 17</a> )	-	296 1.4 9.3		ns $\mu\text{C}$ A

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

**Table 8. Gate-source Zener diode (1)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$BV_{GSO}$	Gate-source breakdown voltage	$I_{gs} = \pm 1\text{ mA}$ (open drain)	30	-	-	V

1. The built-in back-to-back Zener diodes have specifically been designed to enhance not only the device's ESD capability, but also to make them safely absorb possible voltage transients that may occasionally be applied from gate to source. In this respect the Zener voltage is appropriate to achieve an efficient and cost-effective intervention to protect the device's integrity. These integrated Zener diodes thus avoid the usage of external components.

## 2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for TO-220

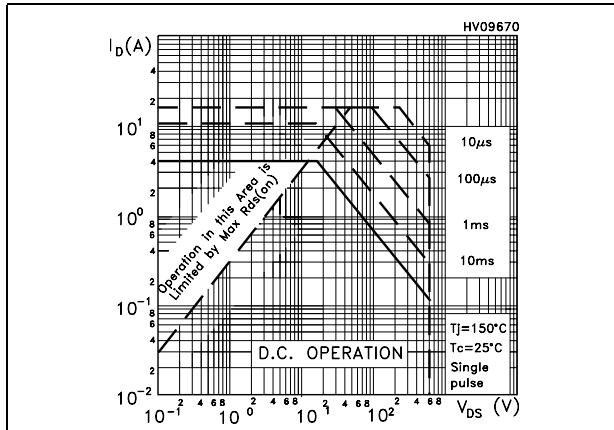


Figure 3. Thermal impedance for TO-220

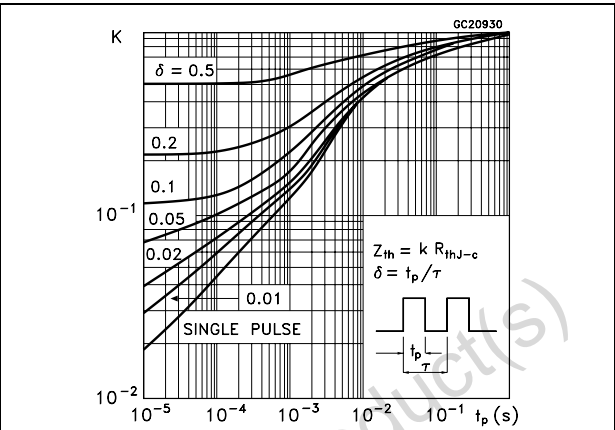


Figure 4. Safe operating area for DPAK and IPAK

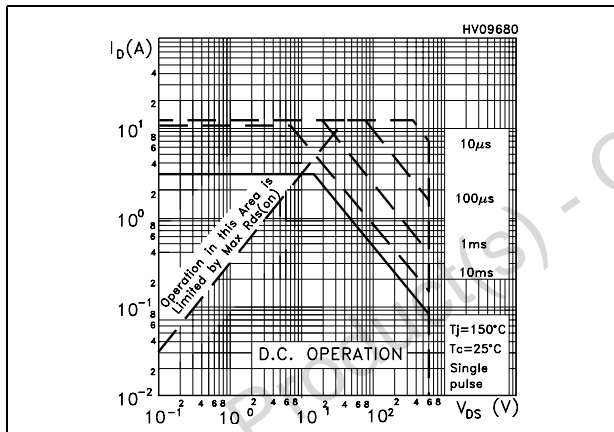


Figure 5. Thermal impedance for DPAK and IPAK

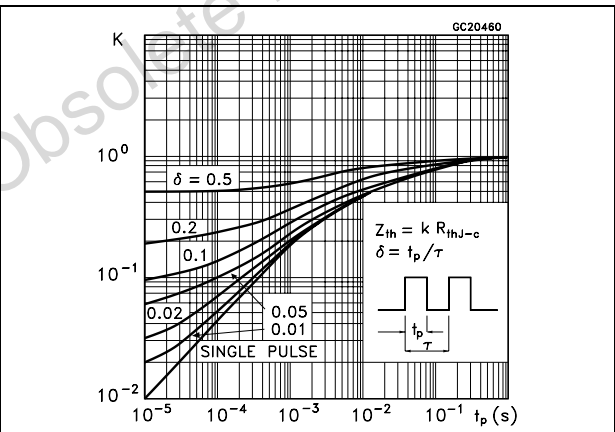


Figure 6. Output characteristics

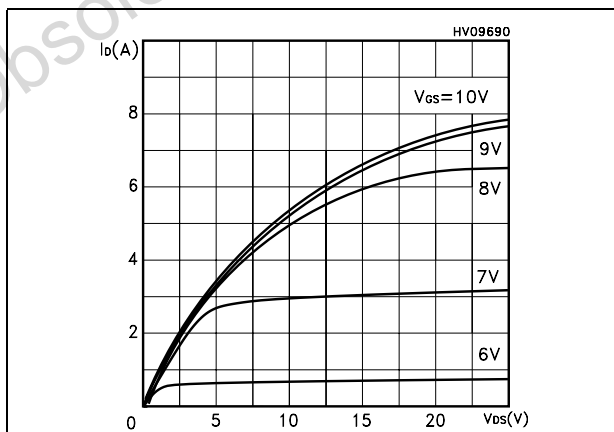


Figure 7. Transfer characteristics

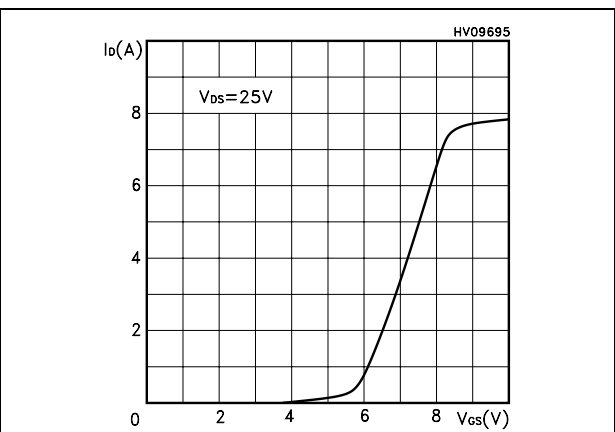


Figure 8. Transconductance

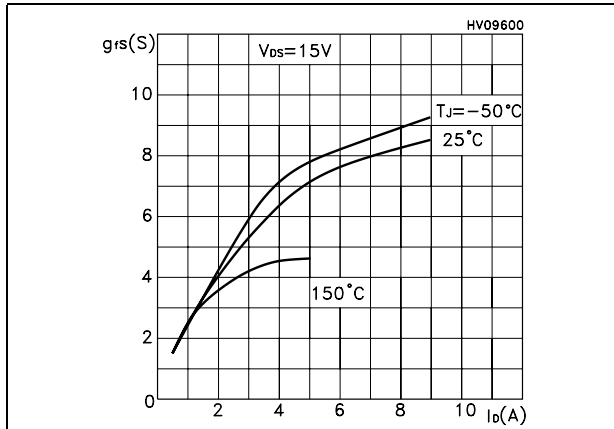


Figure 9. Static drain-source on resistance

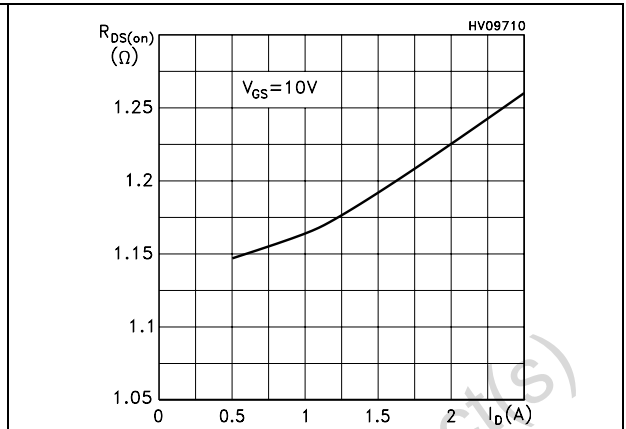


Figure 10. Gate charge vs gate-source voltage

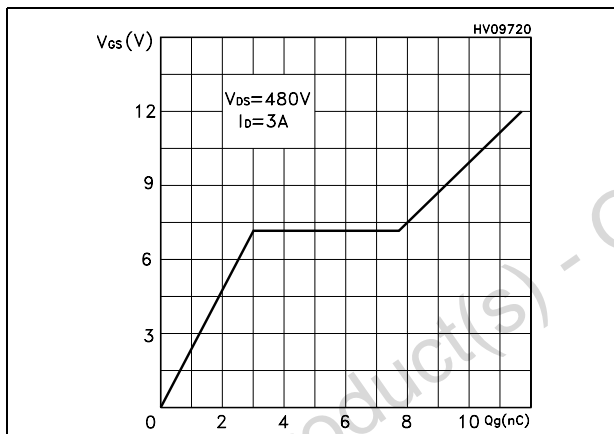


Figure 11. Capacitance variations

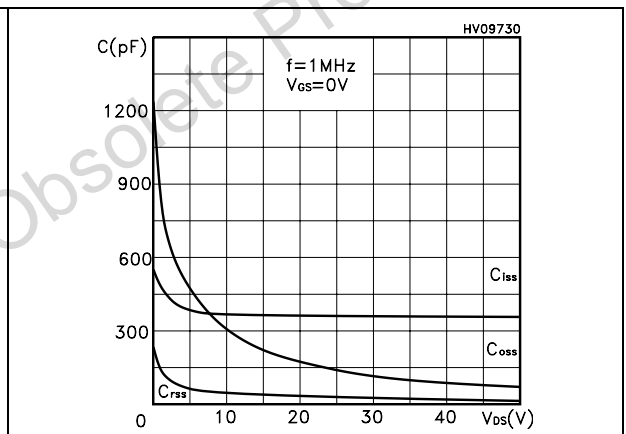


Figure 12. Normalized gate threshold voltage vs temperature

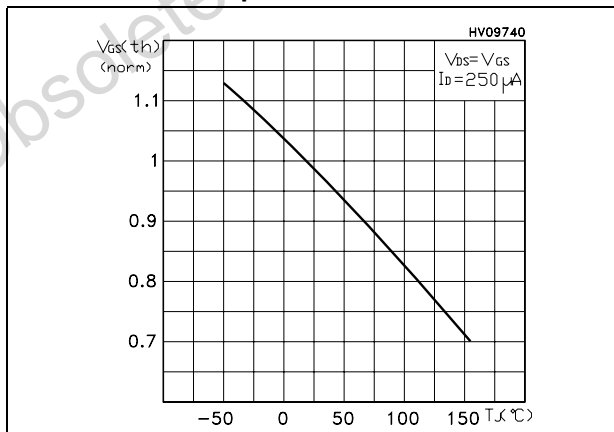
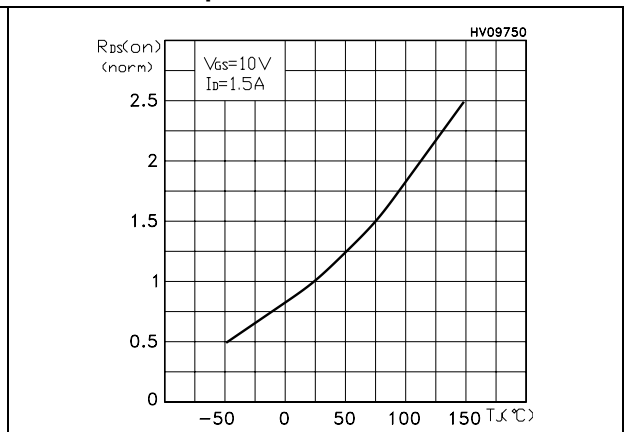
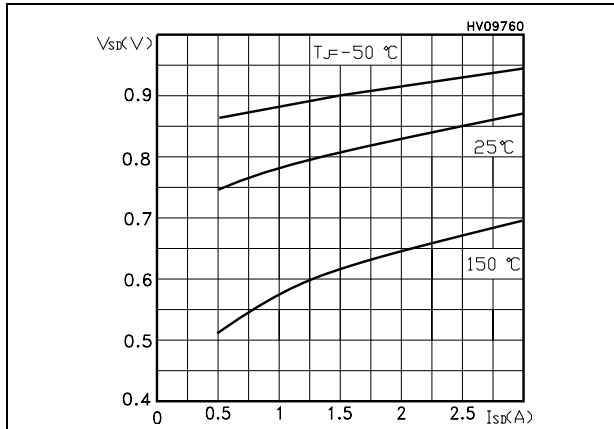


Figure 13. Normalized on resistance vs temperature



**Figure 14. Source-drain diode forward characteristics**



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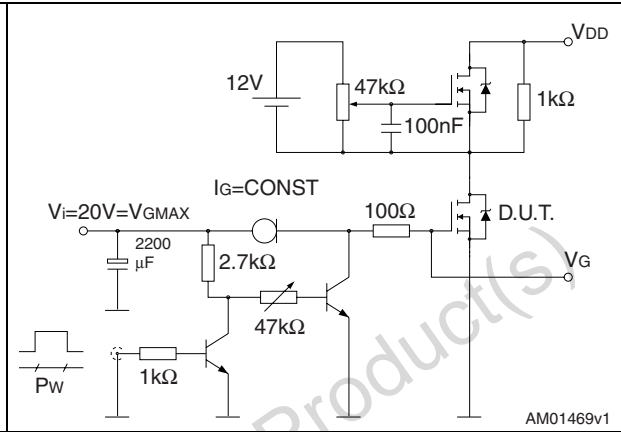
### 3 Test circuits

**Figure 15. Switching times test circuit for resistive load**



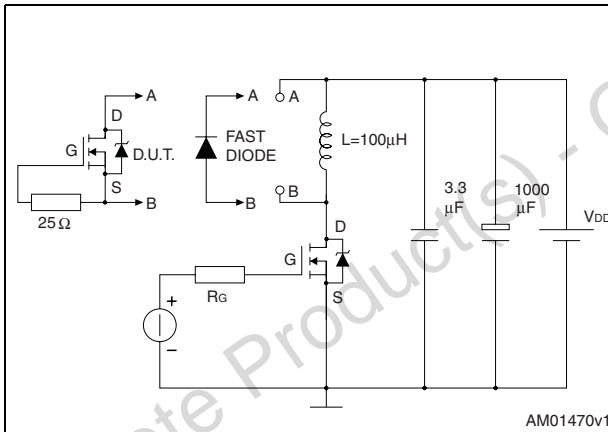
AM01468v1

**Figure 16. Gate charge test circuit**



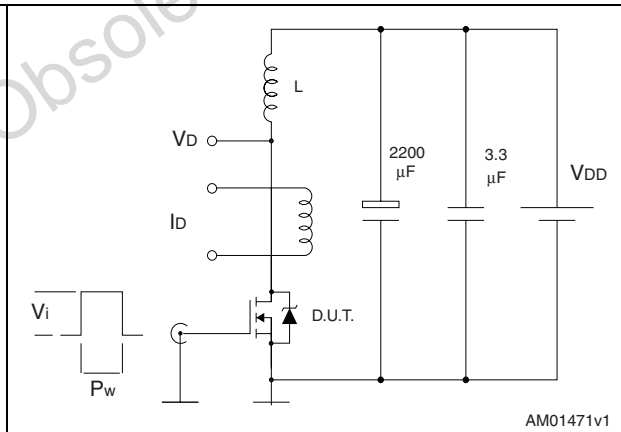
AM01469v1

**Figure 17. Test circuit for inductive load switching and diode recovery times**



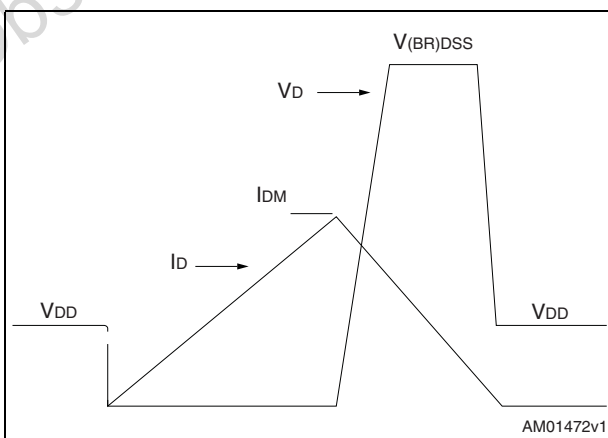
AM01470v1

**Figure 18. Unclamped inductive load test circuit**



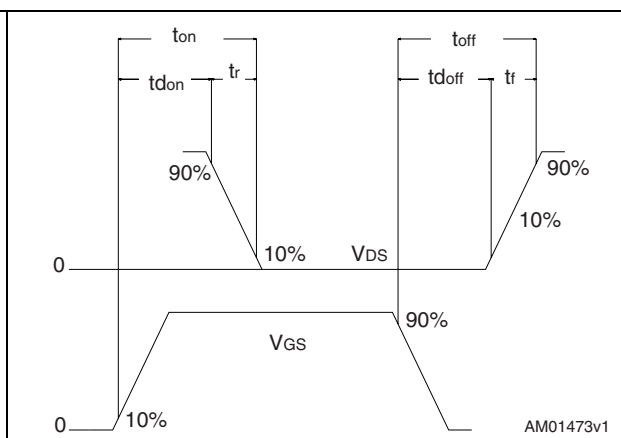
AM01471v1

**Figure 19. Unclamped inductive waveform**



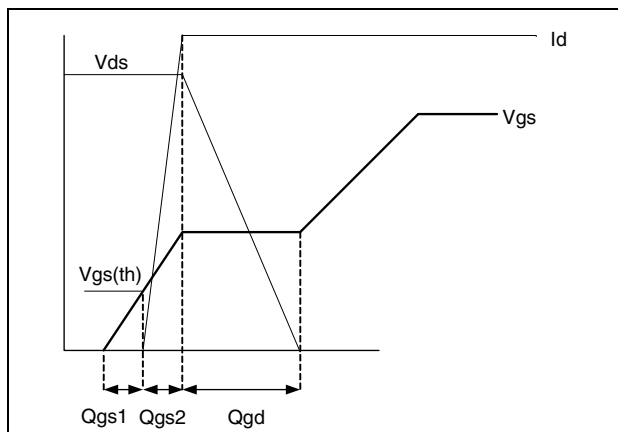
AM01472v1

**Figure 20. Switching time waveform**



AM01473v1

Figure 21. Gate charge waveform



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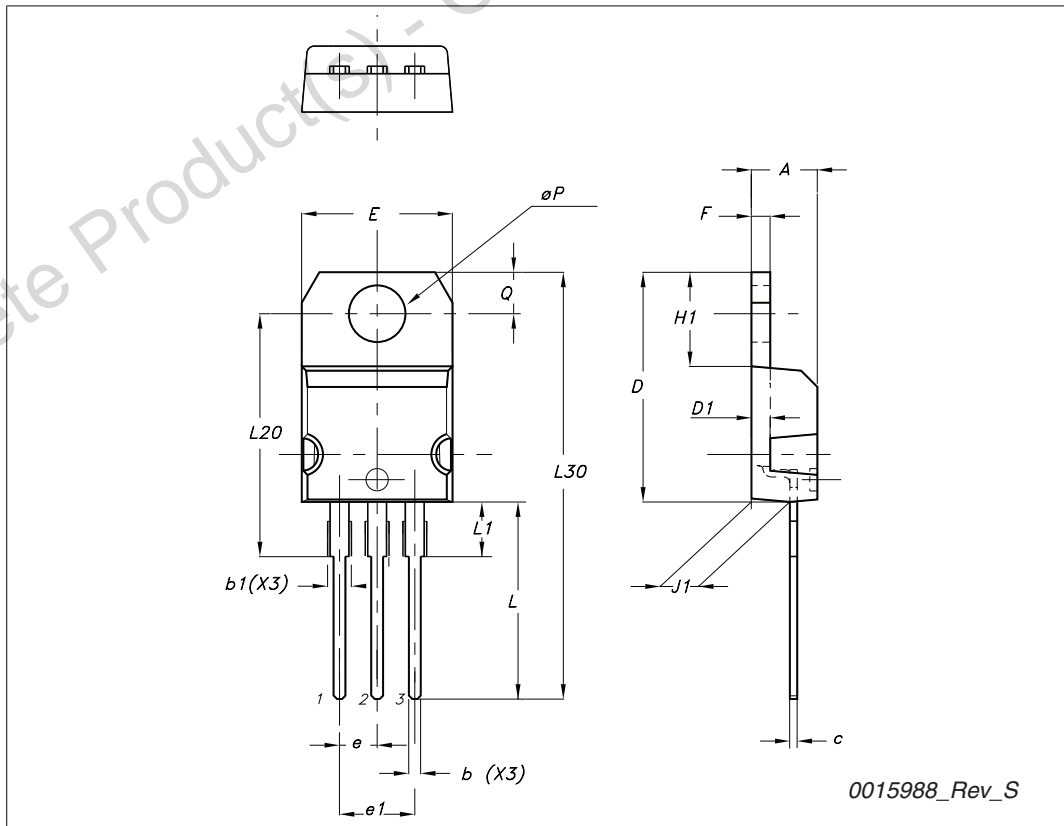
## 4 Package mechanical data

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.

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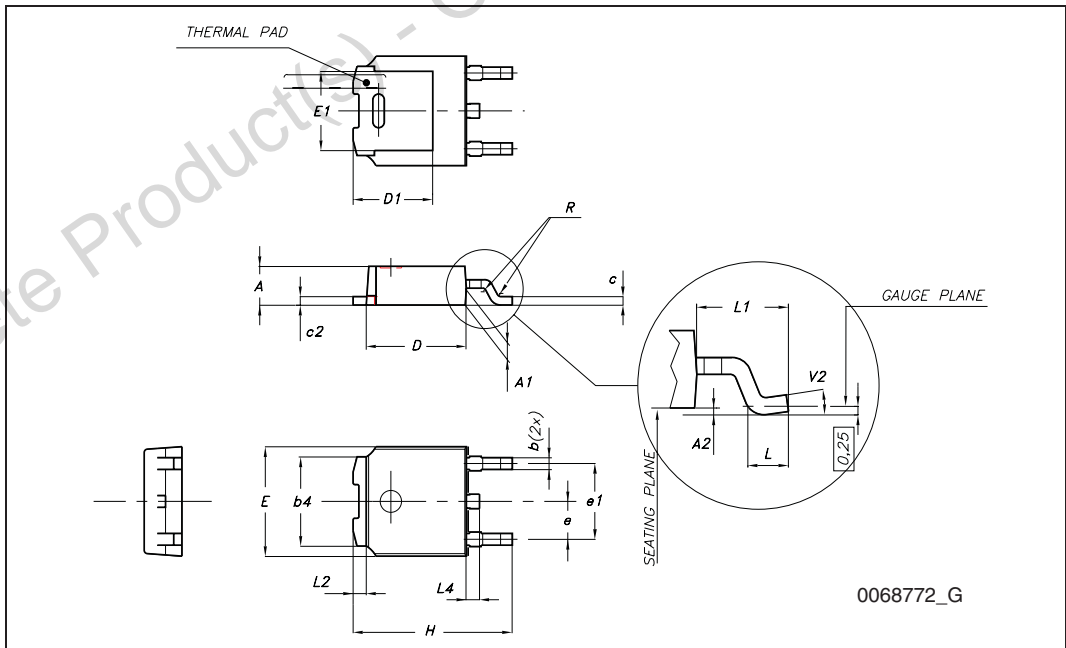
TO-220 type A mechanical data

Dim	mm		
	Min	Typ	Max
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.70
c	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10		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		14
L1	3.50		3.93
L20		16.40	
L30		28.90	
∅P	3.75		3.85
Q	2.65		2.95



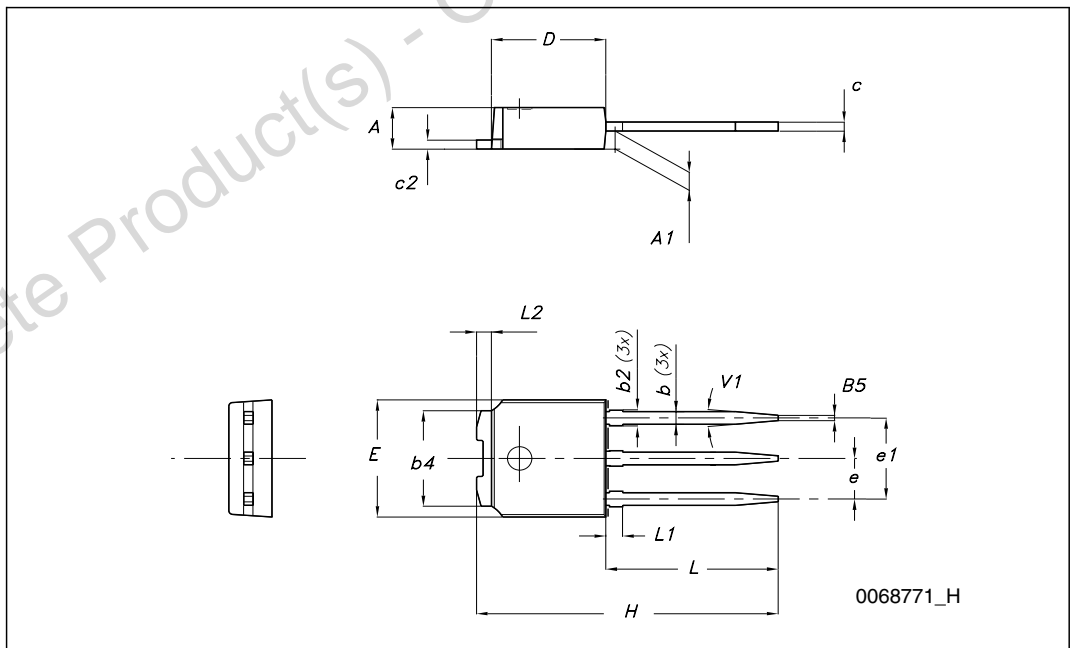
TO-252 (DPAK) mechanical data

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		5.10	
E	6.40		6.60
E1		4.70	
e		2.28	
e1	4.40		4.60
H	9.35		10.10
L	1		
L1		2.80	
L2		0.80	
L4	0.60		1
R		0.20	
V2	0°		8°



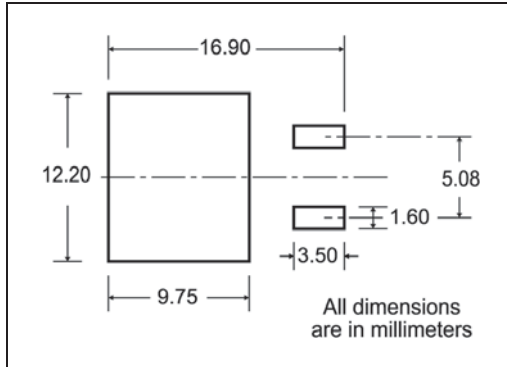
**TO-251 (IPAK) mechanical data**

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
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	
V1		10°	



# 5 Packaging mechanical data

D<sup>2</sup>PAK FOOTPRINT



TAPE AND REEL SHIPMENT

**TAPE MECHANICAL DATA**

DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A0	10.5	10.7	0.413	0.421
B0	15.7	15.9	0.618	0.626
D	1.5	1.6	0.059	0.063
D1	1.59	1.61	0.062	0.063
E	1.65	1.85	0.065	0.073
F	11.4	11.6	0.449	0.456
K0	4.8	5.0	0.189	0.197
P0	3.9	4.1	0.153	0.161
P1	11.9	12.1	0.468	0.476
P2	1.9	2.1	0.075	0.082
R	50		1.574	
T	0.25	0.35	0.0098	0.0137
W	23.7	24.3	0.933	0.956

**REEL MECHANICAL DATA**

DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A		330		12.992
B	1.5		0.059	
C	12.8	13.2	0.504	0.520
D	20.2		0.795	
G	24.4	26.4	0.960	1.039
N	100		3.937	
T		30.4		1.197

BASE QTY	BULK QTY
1000	1000

10 pitches cumulative tolerance on tape +/- 0.2 mm

## 6 Revision history

Table 9. Document revision history

Date	Revision	Changes
14-Jan-2004	3	
02-Sep-2009	4	Inserted $V_{DSS}$ value @ $T_{jmax} = 150\text{ °C}$ on cover page Document reformatted to improve readability

Obsolete Product(s) - Obsolete Product(s)



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