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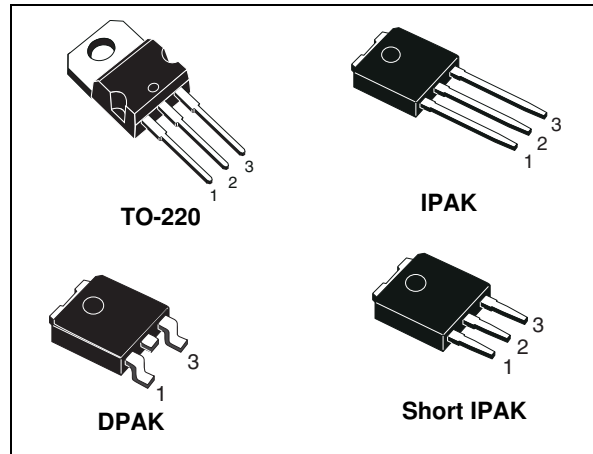
# STD60N3LH5, STP60N3LH5 STU60N3LH5, STU60N3LH5-S

N-channel 30 V, 0.0072  $\Omega$ , 48 A DPAK, IPAK, Short IPAK, TO-220  
STripFET™ V Power MOSFET

## Features

Order codes	V <sub>DSS</sub>	R <sub>DS(on)</sub> max	I <sub>D</sub>
STD60N3LH5	30 V	0.008 $\Omega$	48 A
STP60N3LH5	30 V	0.0084 $\Omega$	48 A
STU60N3LH5	30 V	0.0084 $\Omega$	48 A
STU60N3LH5-S	30 V	0.0084 $\Omega$	48 A

- R<sub>DS(on)</sub> \* Q<sub>g</sub> industry benchmark
- Extremely low on-resistance R<sub>DS(on)</sub>
- Very low switching gate charge
- High avalanche ruggedness
- Low gate drive power losses



## Application

Switching applications

## Description

This STripFET™V Power MOSFET technology is among the latest improvements, which have been especially tailored to achieve very low on-state resistance providing also one of the best-in-class figure of merit.

Figure 1. Internal schematic diagram

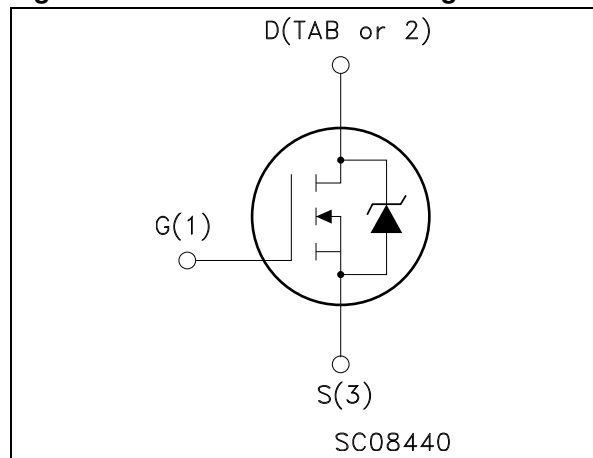


Table 1. Device summary

Order codes	Marking	Package	Packaging
STD60N3LH5	60N3LH5	DPAK	Tape and reel
STP60N3LH5	60N3LH5	TO-220	Tube
STU60N3LH5	60N3LH5	IPAK	
STU60N3LH5-S	60N3LH5	Short IPAK	

# Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{DS}$	Drain-source voltage ( $V_{GS} = 0$ )	30	V
$V_{DS}$	Drain-source voltage ( $V_{GS} = 0$ ) @ $T_{JMAX}$	35	V
$V_{GS}$	Gate-Source voltage	$\pm 20$	V
$I_D^{(1)}$	Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$	48	A
$I_D$	Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$	42.8	A
$I_{DM}^{(2)}$	Drain current (pulsed)	192	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ }^\circ\text{C}$	60	W
	Derating factor	0.4	W/ $^\circ\text{C}$
$E_{AS}^{(3)}$	Single pulse avalanche energy	160	mJ
$T_j$ $T_{stg}$	Operating junction temperature Storage temperature	-55 to 175	$^\circ\text{C}$

1. Limited by wire bonding.
2. Pulse width limited by safe operating area.
3. Starting  $T_j = 25\text{ }^\circ\text{C}$ ,  $I_D = 24\text{ A}$ ,  $V_{DD} = 12\text{ V}$ .

**Table 3. Thermal resistance**

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case max.	2.5	$^\circ\text{C}/\text{W}$
$R_{thj-amb}$	Thermal resistance junction-case max.	100	$^\circ\text{C}/\text{W}$
$T_j$	Maximum lead temperature for soldering purpose	275	$^\circ\text{C}$

## 2 Electrical characteristics

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

**Table 4. Static**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown Voltage	$I_D = 250\ \mu\text{A}$ , $V_{GS} = 0$	30			V
$I_{DSS}$	Zero gate voltage drain current ( $V_{GS} = 0$ )	$V_{DS} = 30\text{ V}$ $V_{DS} = 30\text{ V}$ , $T_c = 125\text{ °C}$			1 10	$\mu\text{A}$ $\mu\text{A}$
$I_{GSS}$	Gate body leakage current ( $V_{DS} = 0$ )	$V_{GS} = \pm 20\text{ V}$			$\pm 100$	nA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$ , $I_D = 250\ \mu\text{A}$	1	1.8	3	V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10\text{ V}$ , $I_D = 24\text{ A}$ SMD version		0.0072	0.008	$\Omega$
		$V_{GS} = 10\text{ V}$ , $I_D = 24\text{ A}$		0.0076	0.0084	$\Omega$
		$V_{GS} = 5\text{ V}$ , $I_D = 24\text{ A}$ SMD version		0.0088	0.011	$\Omega$
		$V_{GS} = 5\text{ V}$ , $I_D = 24\text{ A}$		0.0092	0.0114	$\Omega$

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0$	-	1350	1620	pF
$C_{oss}$	Output capacitance			265	318	pF
$C_{rss}$	Reverse transfer capacitance			32	38	pF
$Q_g$	Total gate charge	$V_{DD} = 15\text{ V}$ , $I_D = 48\text{ A}$	-	8.8	12.3	nC
$Q_{gs}$	Gate-source charge	$V_{GS} = 5\text{ V}$		4.7	6.6	nC
$Q_{gd}$	Gate-drain charge	( <i>Figure 14</i> )		2.2	3.1	nC
$Q_{gs1}$	Pre $V_{th}$ gate-to-source charge	$V_{DD} = 15\text{ V}$ , $I_D = 48\text{ A}$ $V_{GS} = 5\text{ V}$	-	2.2	3.1	nC
$Q_{gs2}$	Post $V_{th}$ gate-to-source charge			( <i>Figure 19</i> )	2.5	3.5
$R_G$	Gate input resistance	$f = 1\text{ MHz}$ gate bias Bias = 0 test signal level = 20 mV open drain	-	1.1	1.3	$\Omega$



**Table 6. Switching on/off (resistive load)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$ $t_r$	Turn-on delay time Rise time	$V_{DD}=10\text{ V}$ , $I_D=24\text{ A}$ , $R_G=4.7\ \Omega$ , $V_{GS}=10\text{ V}$ ( <i>Figure 13</i> and <i>Figure 18</i> )	-	6 33	-	ns ns
$t_{d(off)}$ $t_f$	Turn-off delay time Fall time	$V_{DD}=10\text{ V}$ , $I_D=24\text{ A}$ , $R_G=4.7\ \Omega$ , $V_{GS}=10\text{ V}$ ( <i>Figure 13</i> and <i>Figure 18</i> )	-	19 4.2	-	ns ns

**Table 7. Source drain diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$ $I_{SDM}$	Source-drain current Source-drain current (pulsed) <sup>(1)</sup>		-		48 192	A A
$V_{SD}$	Forward on voltage	$I_{SD}=24\text{ A}$ , $V_{GS}=0$	-		1.1	V
$t_{rr}$ $Q_{rr}$ $I_{RRM}$	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_{SD}=48\text{ A}$ , $di/dt=100\text{ A}/\mu\text{s}$ , $V_{DD}=20\text{ V}$ , ( <i>Figure 15</i> )	-	25 18.5 1.5		ns nC A

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

## 2.1 Electrical characteristics (curves)

Figure 2. Safe operating area

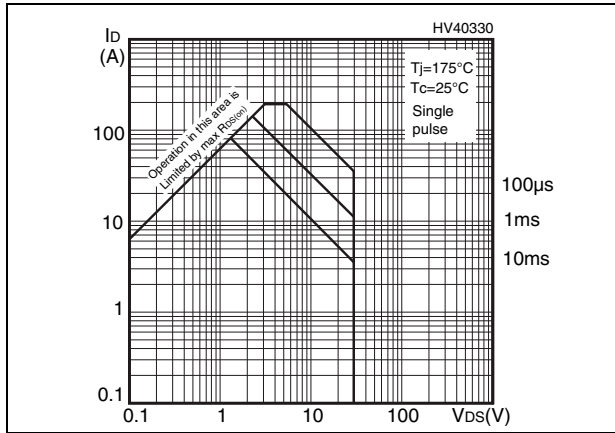


Figure 3. Thermal impedance

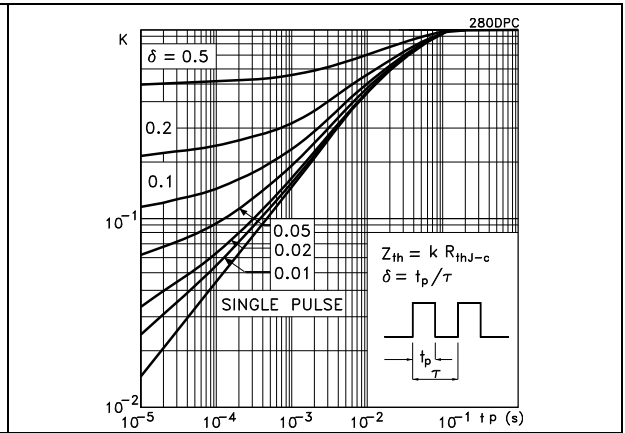


Figure 4. Output characteristics

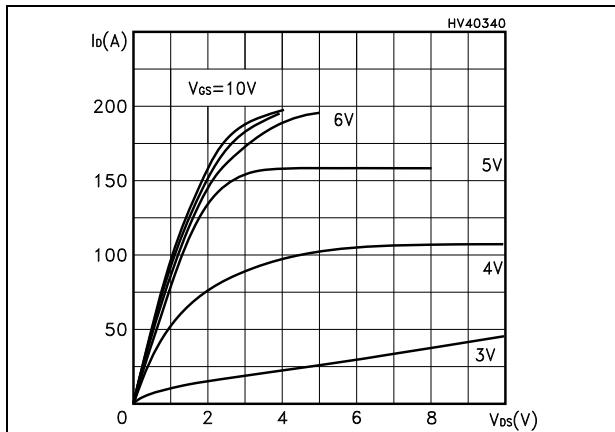


Figure 5. Transfer characteristics

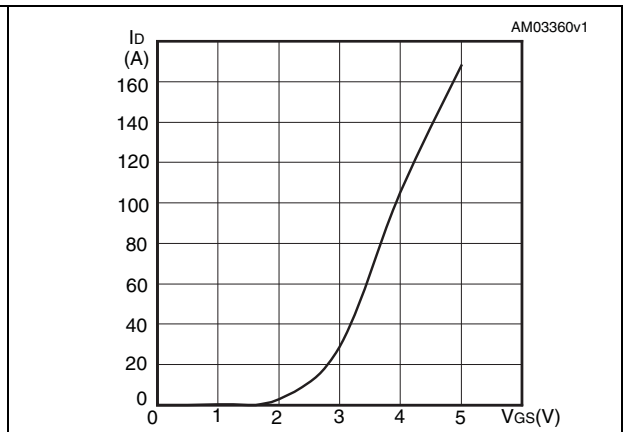


Figure 6. Normalized  $B_{V_{DSS}}$  vs temperature

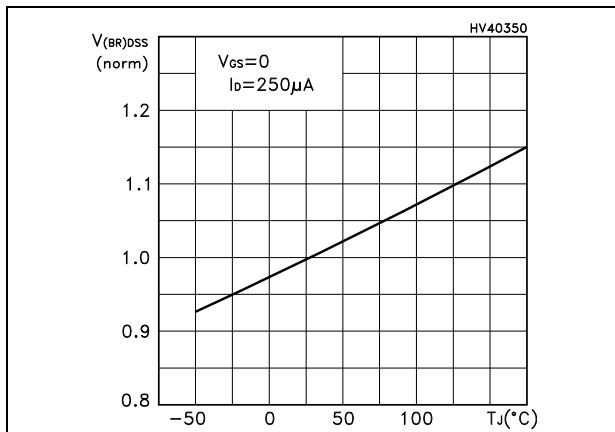


Figure 7. Static drain-source on resistance

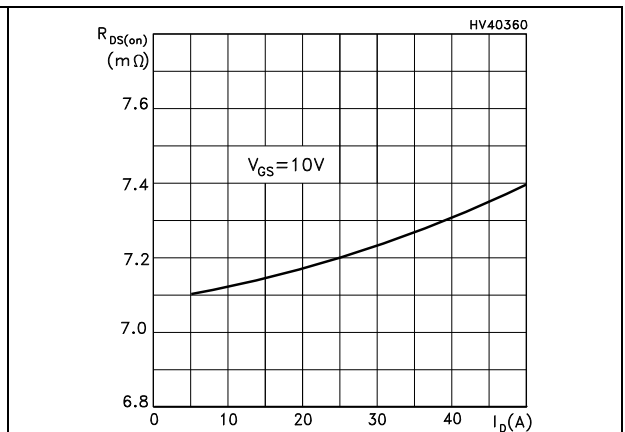


Figure 8. Gate charge vs gate-source voltage Figure 9. Capacitance variations

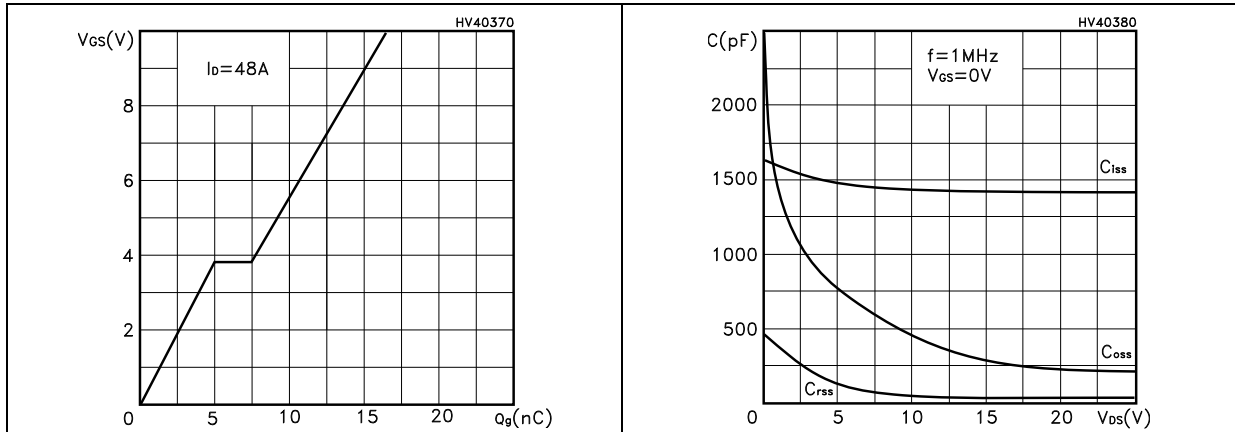


Figure 10. Normalized gate threshold voltage vs temperature Figure 11. Normalized on resistance vs temperature

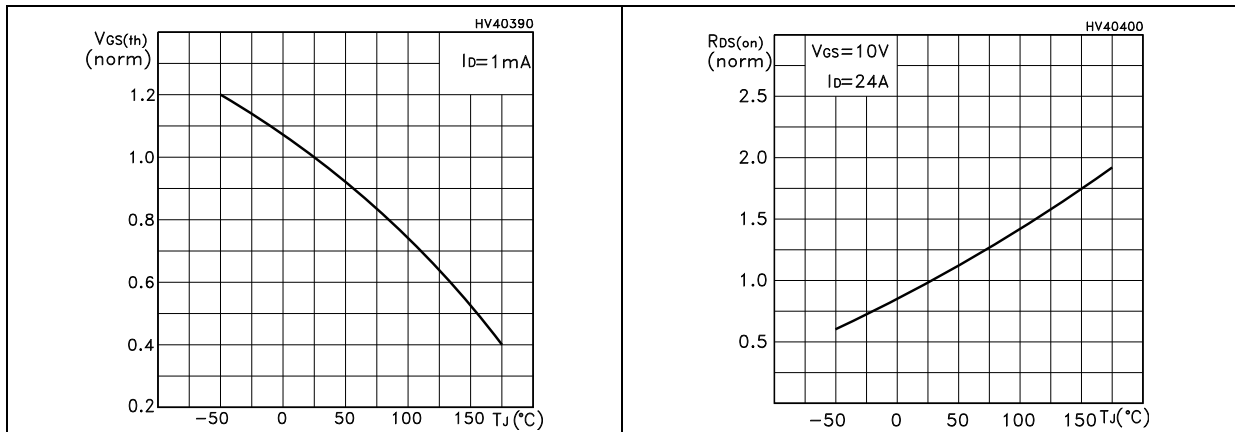
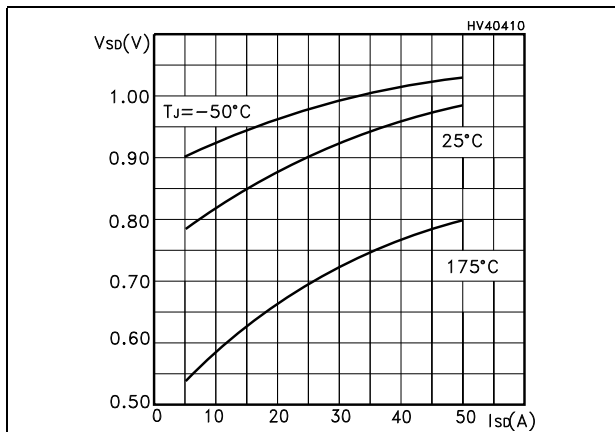


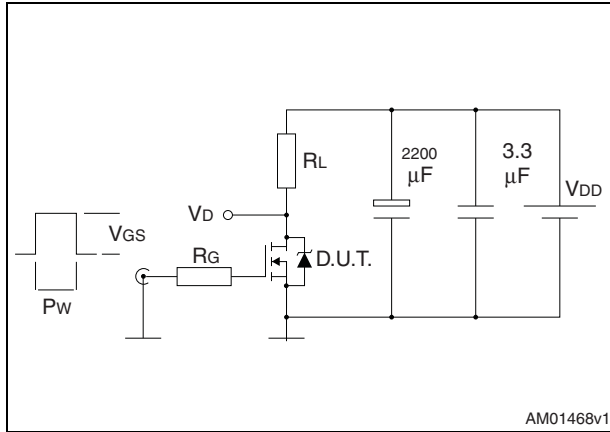
Figure 12. Source-drain diode forward characteristics





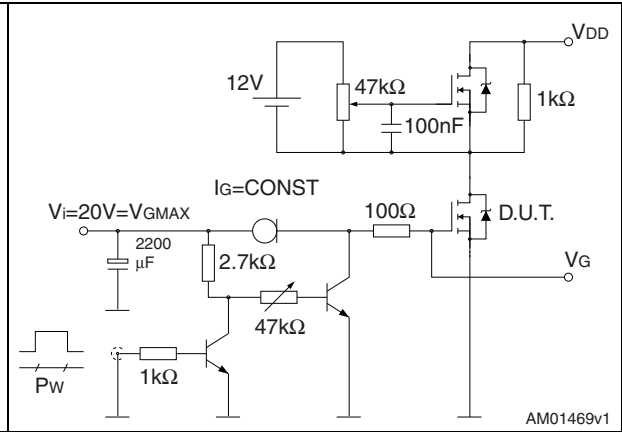
### 3 Test circuits

**Figure 13. Switching times test circuit for resistive load**



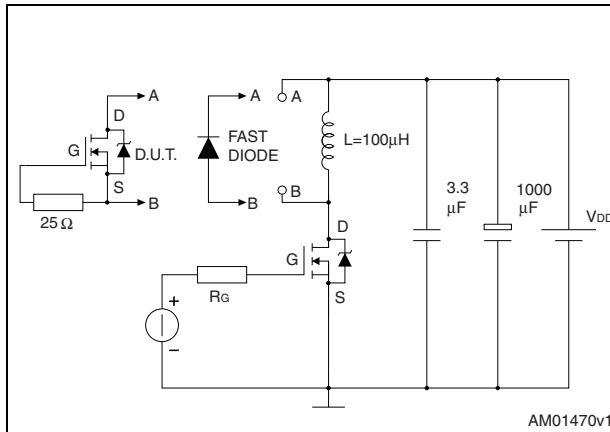
AM01468v1

**Figure 14. Gate charge test circuit**



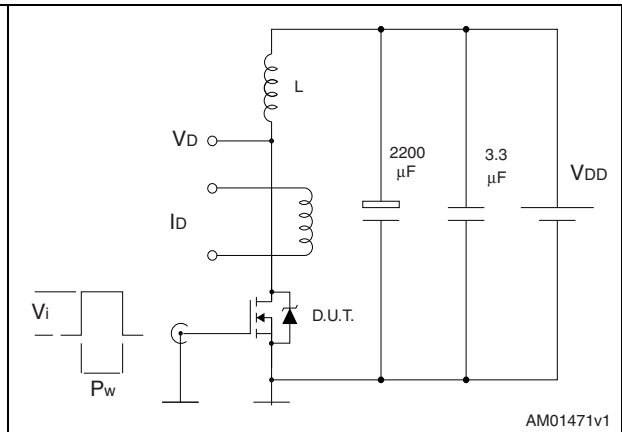
AM01469v1

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



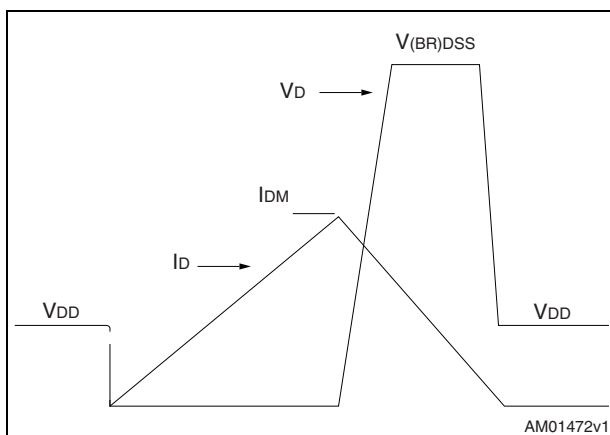
AM01470v1

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



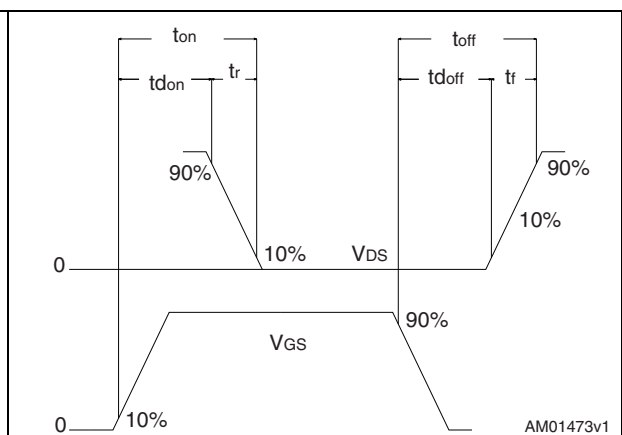
AM01471v1

**Figure 17. Unclamped inductive waveform**



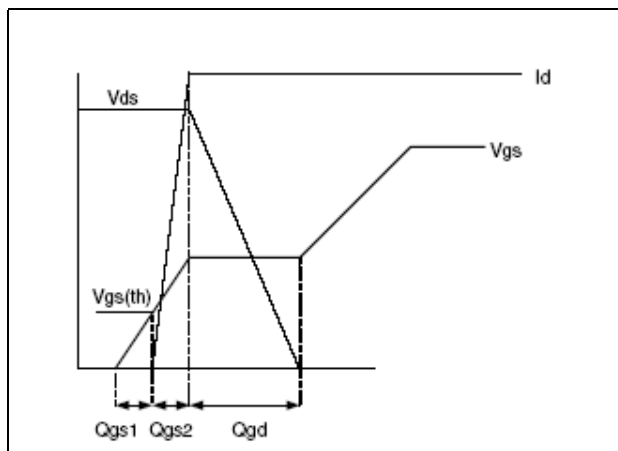
AM01472v1

**Figure 18. Switching time waveform**



AM01473v1

Figure 19. Gate charge waveform



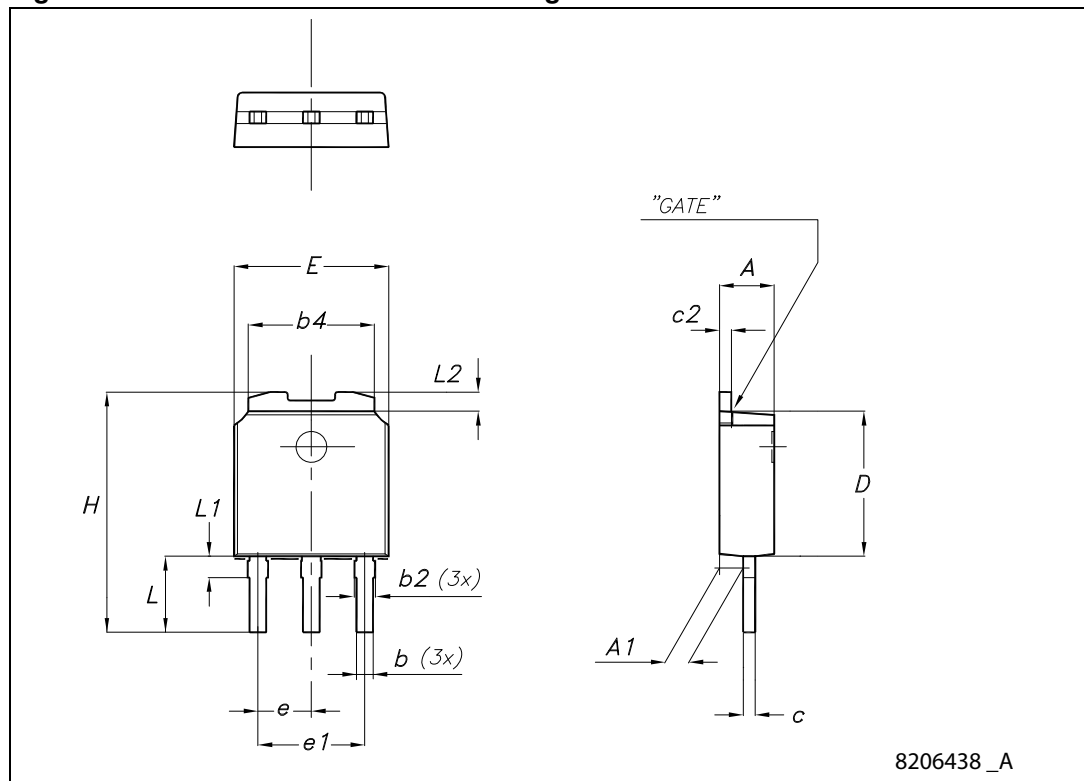
## 4 Package mechanical data

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 is an ST trademark.

Table 8. Short IPAK mechanical dimensions

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		2.25	
e1	4.40		4.60
H	9.80		10.40
L	3.00		3.40
L1	0.80		1.20
L2		0.80	1.00

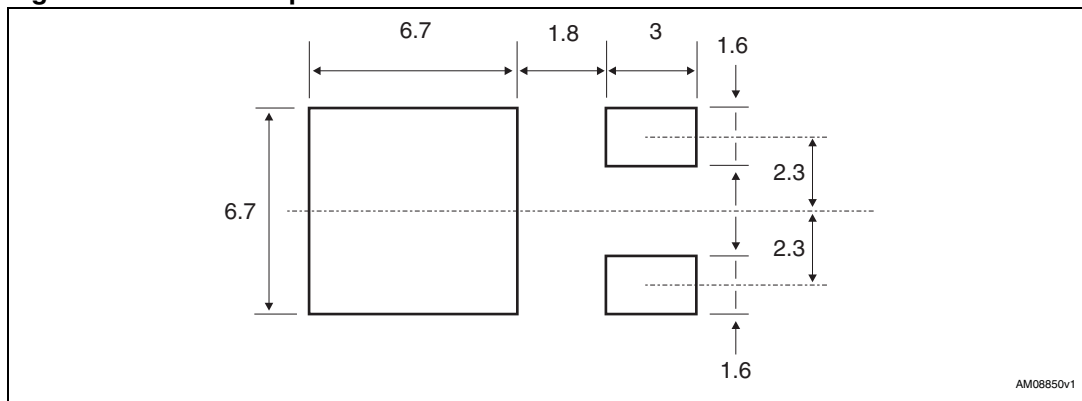
Figure 20. Short IPAK mechanical drawing



**Table 9. DPAK (TO-252) 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°

**Figure 21. DPAK footprint<sup>(a)</sup>**



a. All dimension are in millimeters

Figure 22. DPAK (TO-252) drawing

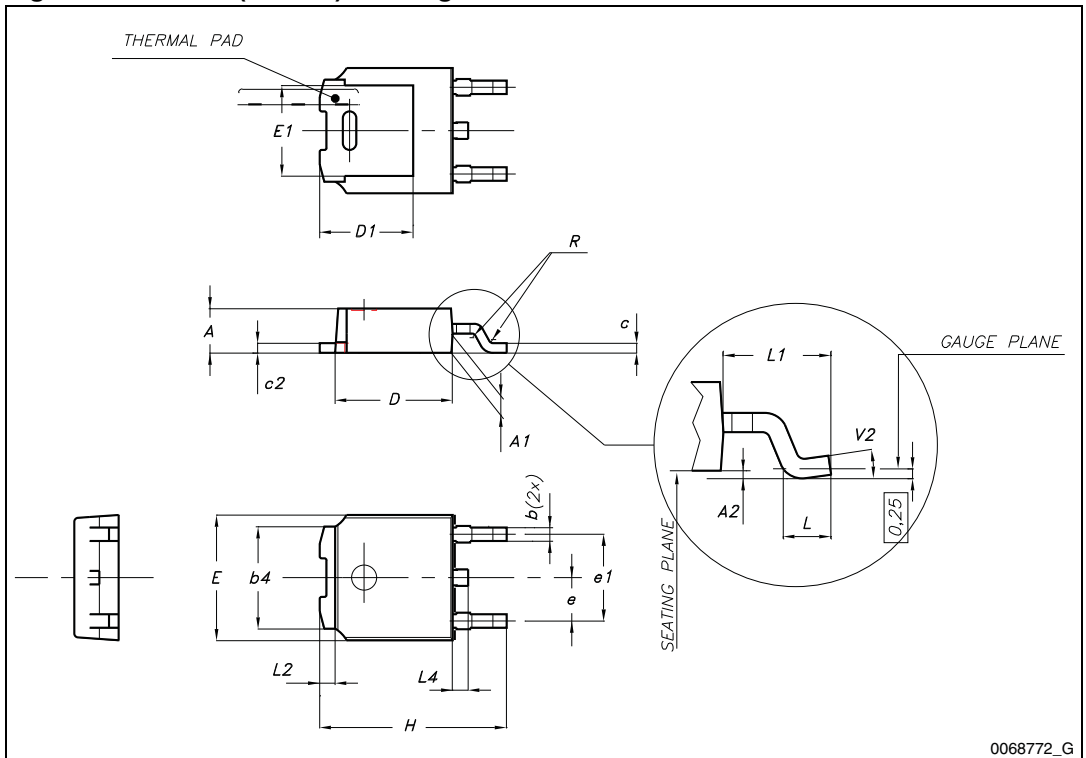




Table 10. IPAK (TO-251) mechanical data

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		0.3	
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°	

Figure 23. IPAK (TO-251) drawing

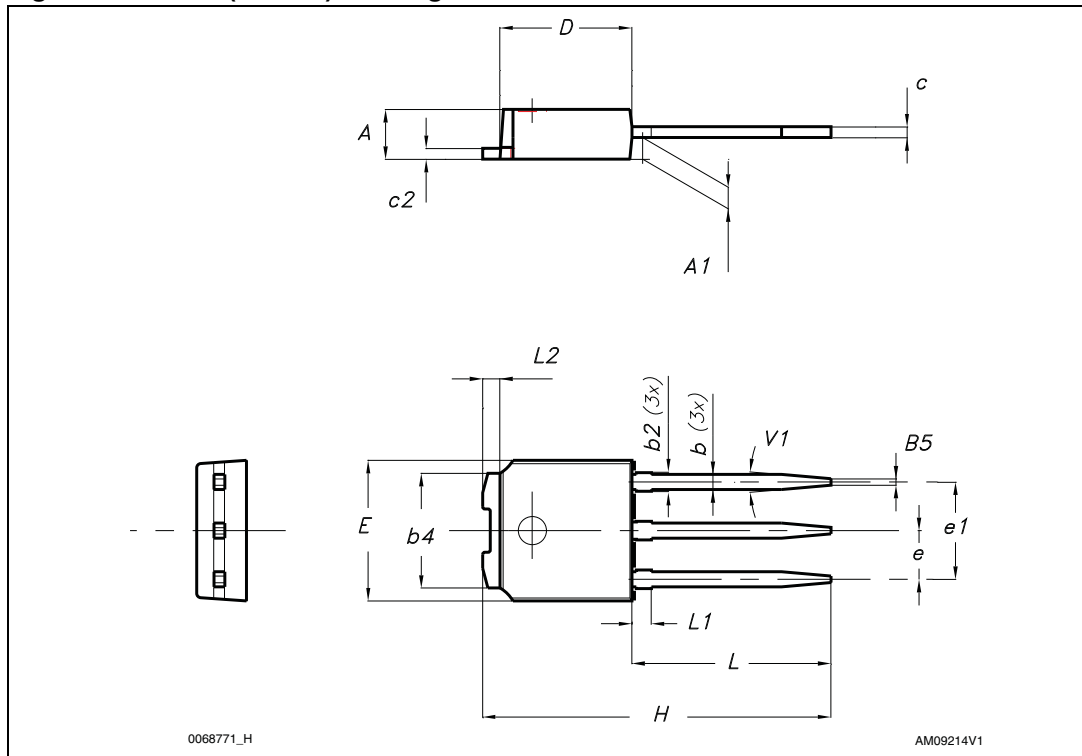
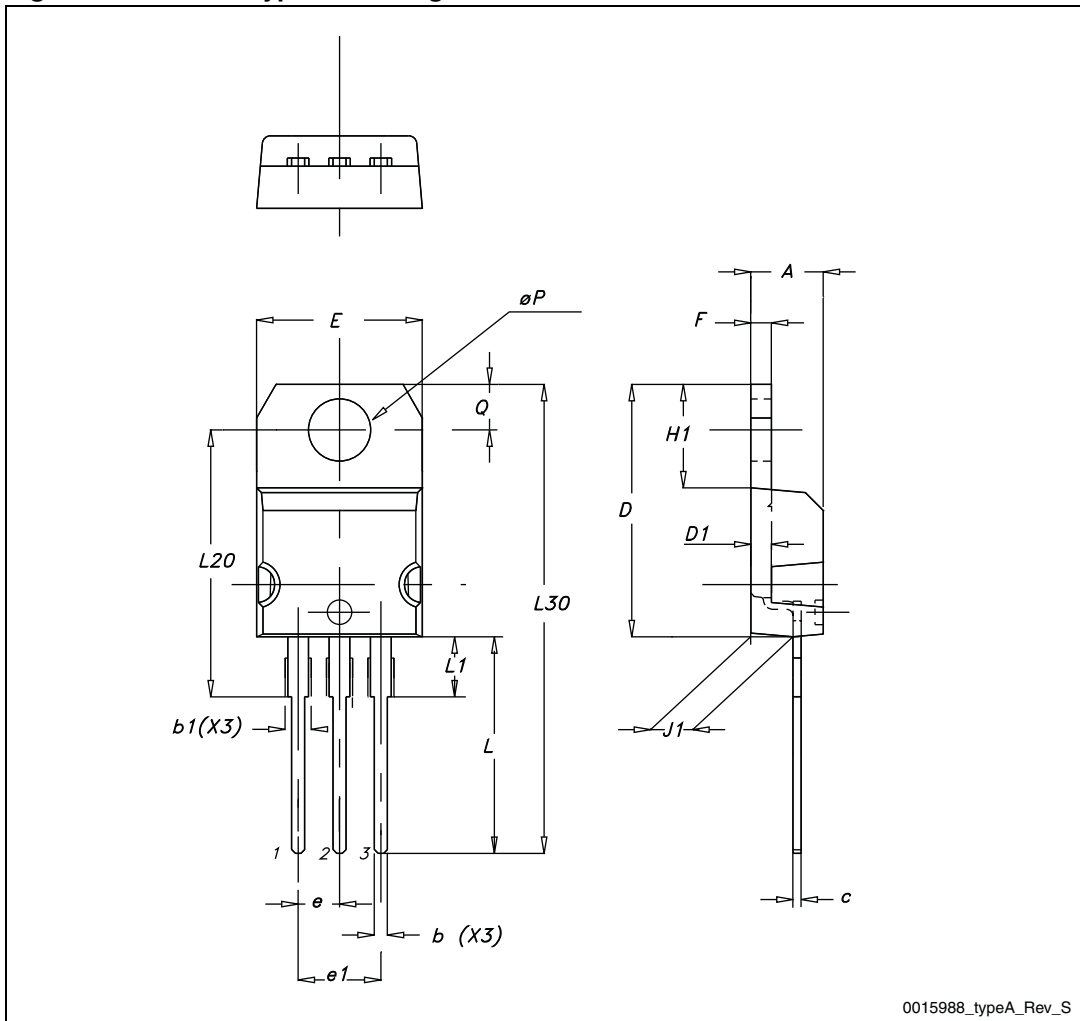


Table 11. TO-220 type A mechanical data

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	
ØP	3.75		3.85
Q	2.65		2.95

Figure 24. TO-220 type A drawing



## 5 Packaging mechanical data

Table 12. 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			

Figure 25. Tape for DPAK (TO-252)

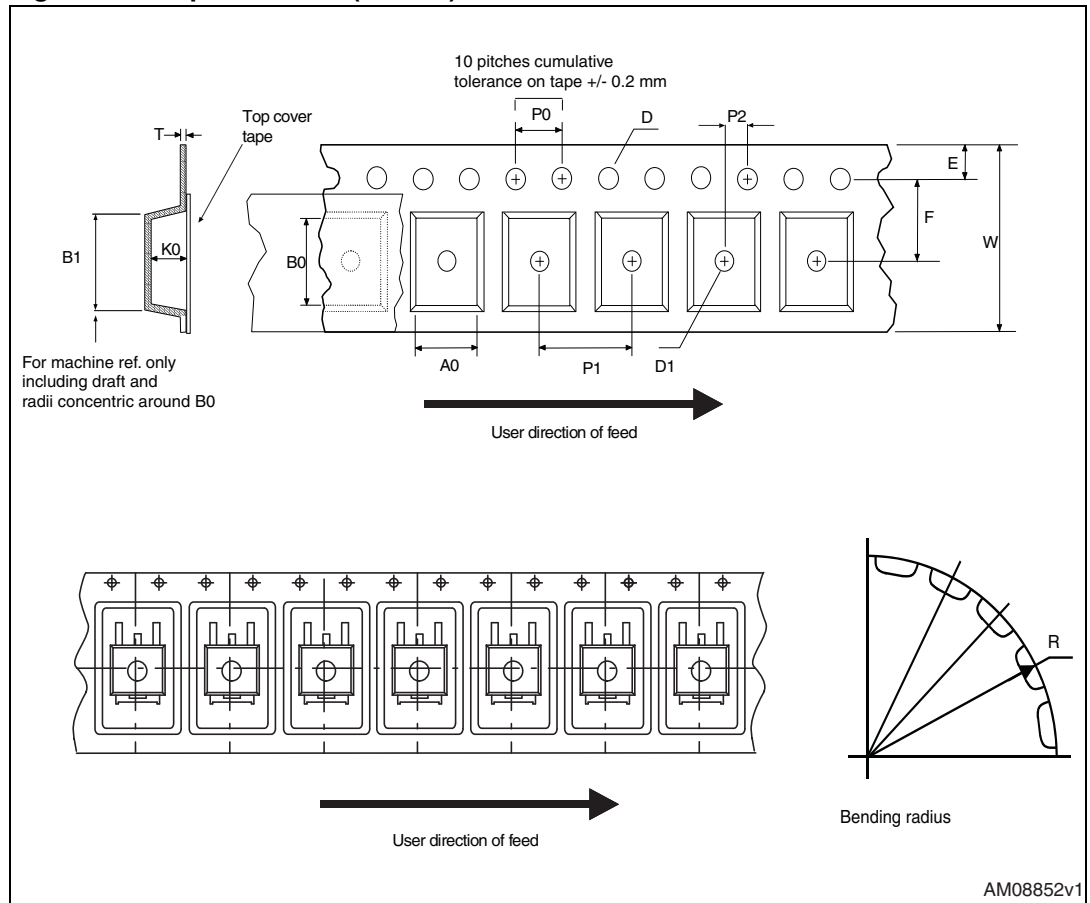
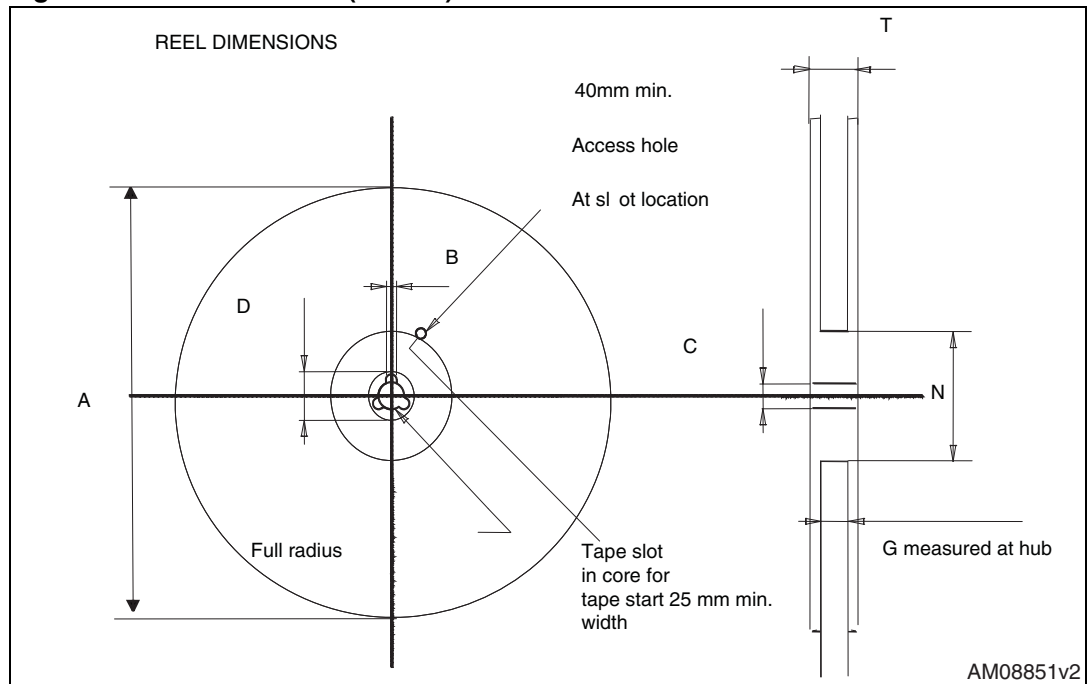


Figure 26. Reel for DPAK (TO-252)





## 6 Revision history

**Table 13. Document revision history**

Date	Revision	Changes
19-Oct-2007	1	First release
23-Sep-2008	2	$V_{GS}$ value has been changed on <a href="#">Table 2</a> and <a href="#">Table 5</a>
20-Apr-2009	3	<ul style="list-style-type: none"><li>– Inserted typical and maximum value in <math>V_{GS(th)}</math> parameter</li><li>– <a href="#">Figure 5: Transfer characteristics</a> has been updated</li><li>– Added device in TO-220</li></ul>
05-Apr-2011	4	<ul style="list-style-type: none"><li>– Added device in Short IPAK</li><li>– Added max values in <a href="#">Table 5: Dynamic</a></li><li>– <math>V_{GS}</math> value has been changed in <a href="#">Table 2</a> and <a href="#">Table 4</a></li></ul>

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