



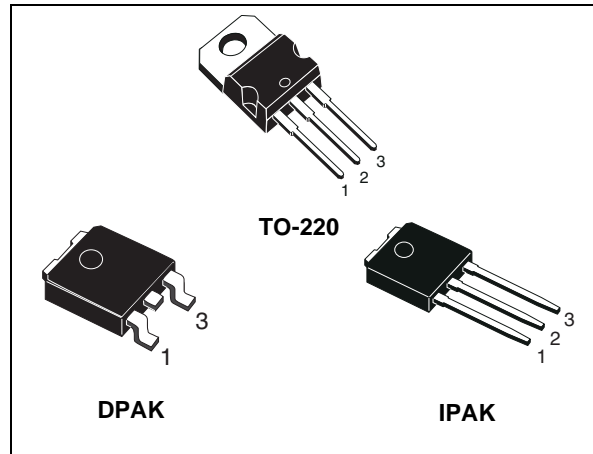
# STD60N3LH5 STP60N3LH5, STU60N3LH5

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

## Features

Type	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

- 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 FOM.

Figure 1. Internal schematic diagram

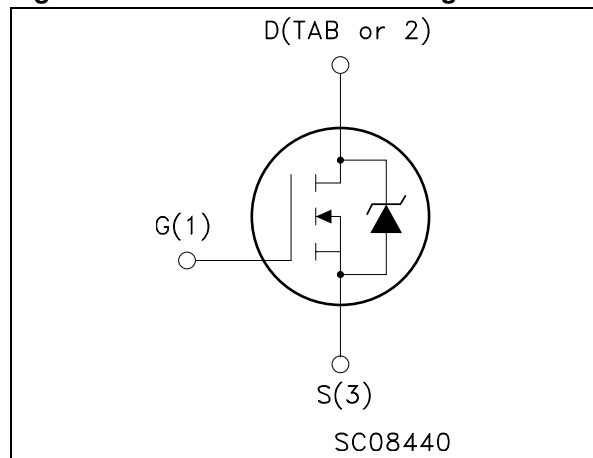


Table 1. Device summary

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

# 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	$\pm 22$	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	$^\circ\text{C/W}$
$R_{thj-amb}$	Thermal resistance junction-case max	100	$^\circ\text{C/W}$
$T_j$	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 ( $V_{DS} = 0$ )	$V_{GS} = \pm 22\text{ V}$			$\pm 100$	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	-	pF
$C_{oss}$	Output capacitance			265		pF
$C_{rss}$	Reverse transfer capacitance			32		pF
$Q_g$	Total gate charge	$V_{DD} = 15\text{ V}$ , $I_D = 48\text{ A}$	-	8.8	-	nC
$Q_{gs}$	Gate-source charge	$V_{GS} = 5\text{ V}$		4.7		nC
$Q_{gd}$	Gate-drain charge	( <i>Figure 14</i> )		2.2		nC
$Q_{gs1}$	Pre $V_{th}$ gate-to-source charge	$V_{DD} = 15\text{ V}$ , $I_D = 48\text{ A}$ $V_{GS} = 5\text{ V}$ ( <i>Figure 19</i> )	-	2.2	-	nC
$Q_{gs2}$	Post $V_{th}$ gate-to-source charge			2.5		nC
$R_G$	Gate input resistance	f=1 MHz gate bias Bias= 0 test signal level=20 mV open drain	-	1.1	-	$\Omega$

**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

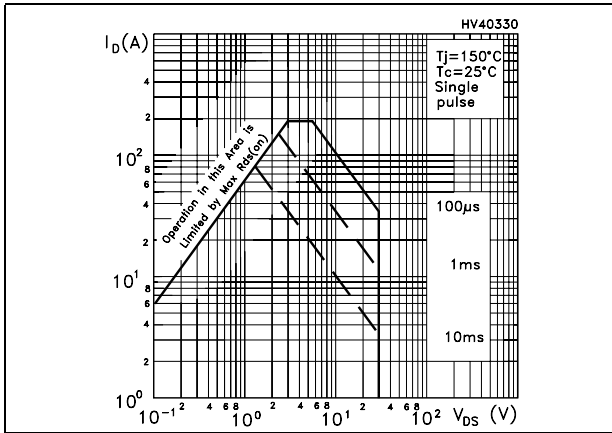


Figure 3. Thermal impedance

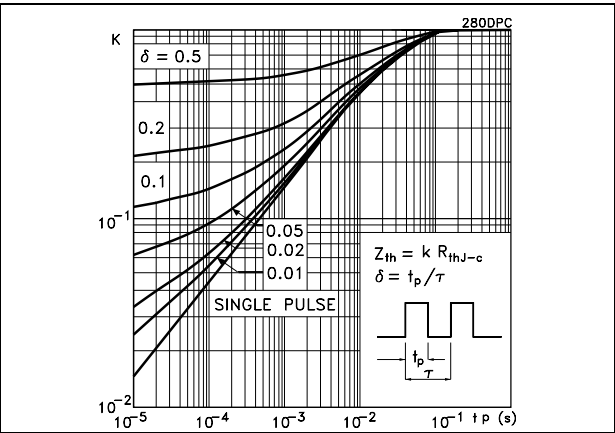


Figure 4. Output characteristics

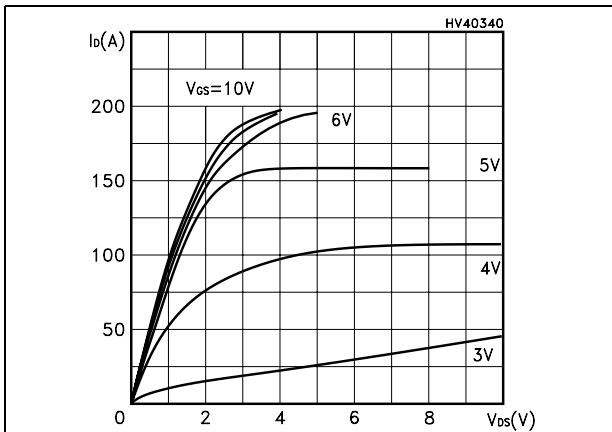


Figure 5. Transfer characteristics

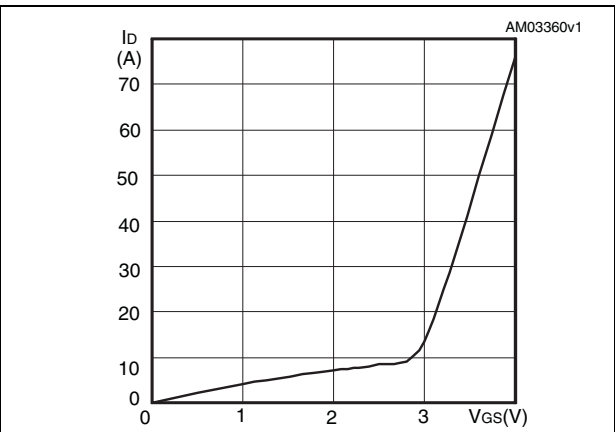


Figure 6. Normalized  $B_{V_{DSS}}$  vs temperature

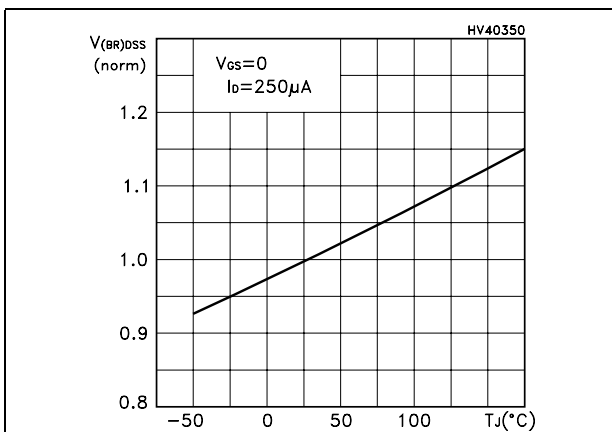


Figure 7. Static drain-source on resistance

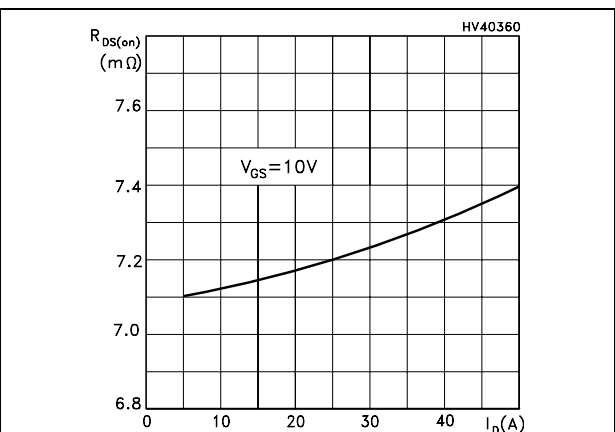


Figure 8. Gate charge vs gate-source voltage Figure 9. Capacitance variations

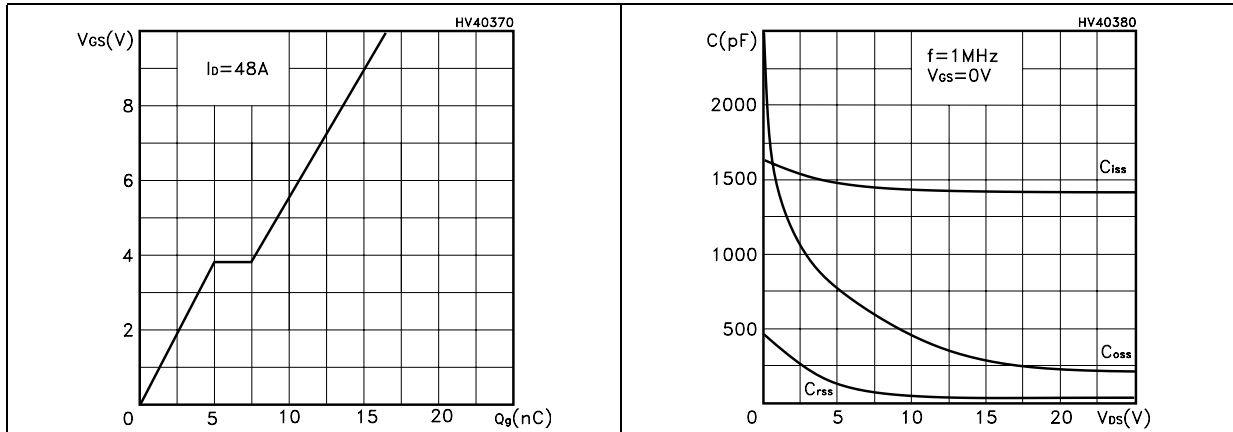


Figure 10. Normalized gate threshold voltage vs temperature Figure 11. Normalized on resistance vs temperature

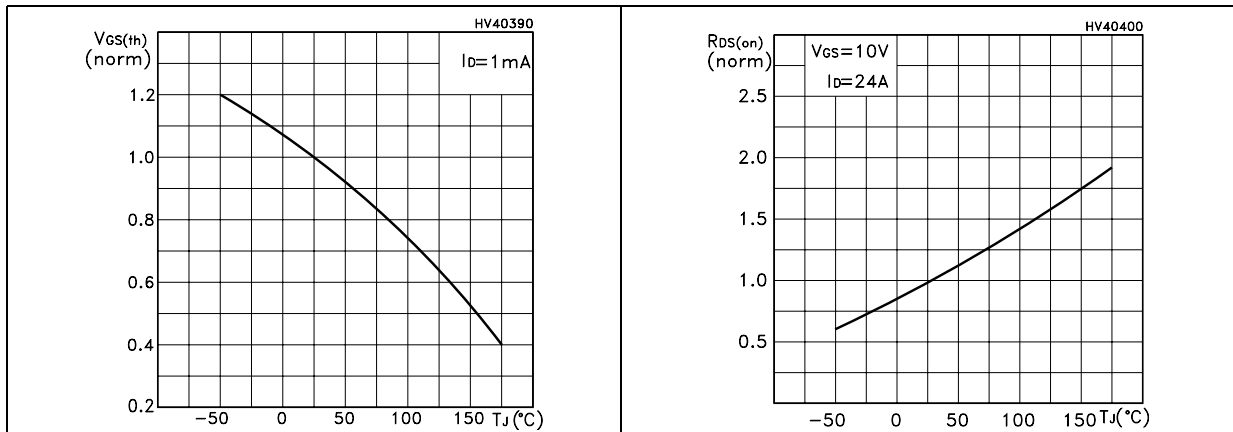
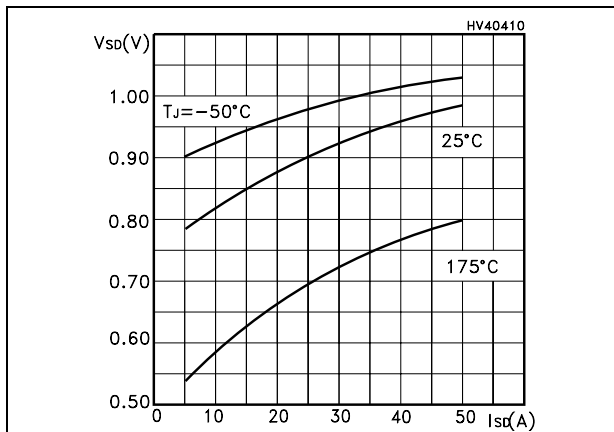


Figure 12. Source-drain diode forward characteristics



### 3 Test circuits

Figure 13. Switching times test circuit for resistive load

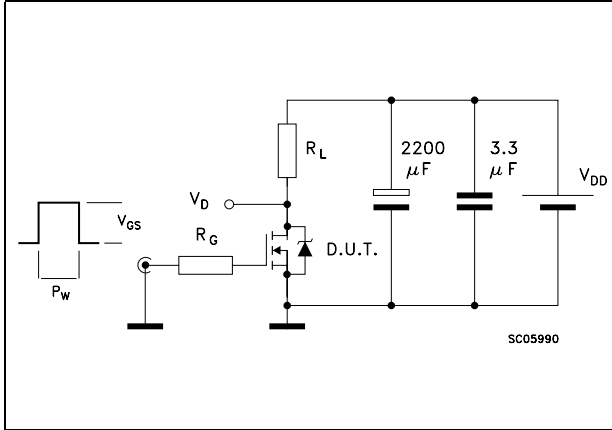


Figure 14. Gate charge test circuit

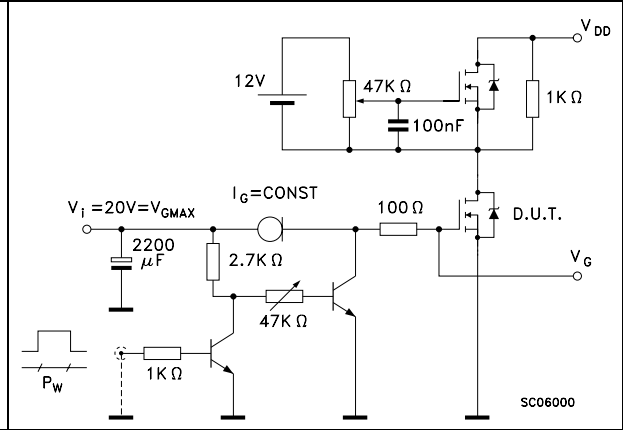


Figure 15. Test circuit for inductive load switching and diode recovery times

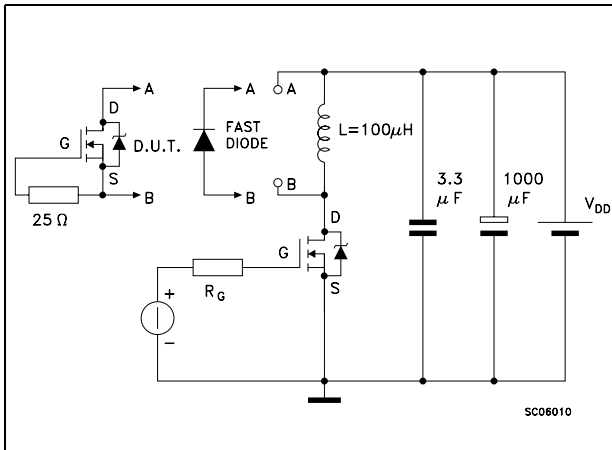


Figure 16. Unclamped inductive load test circuit

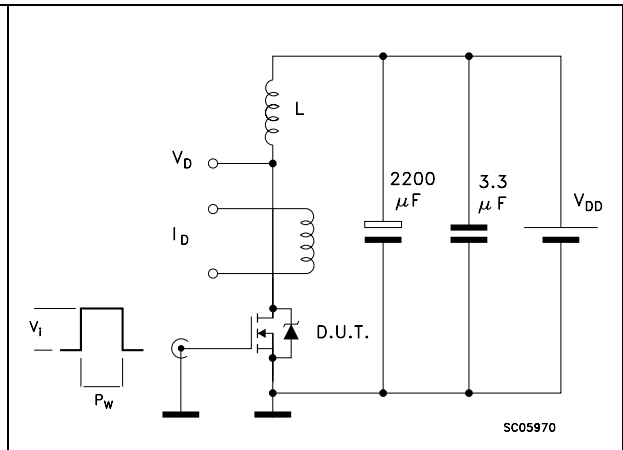


Figure 17. Unclamped inductive waveform

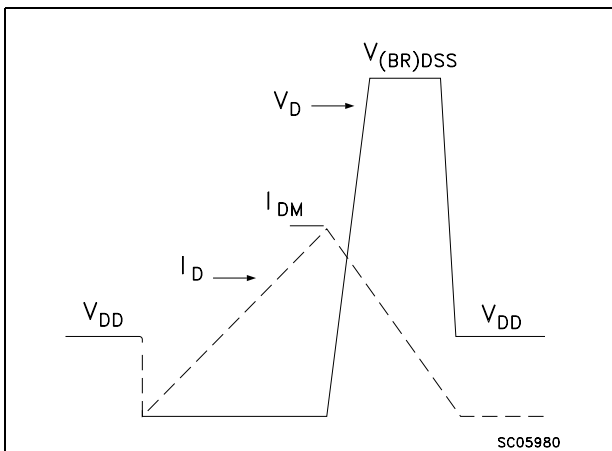


Figure 18. Switching time waveform

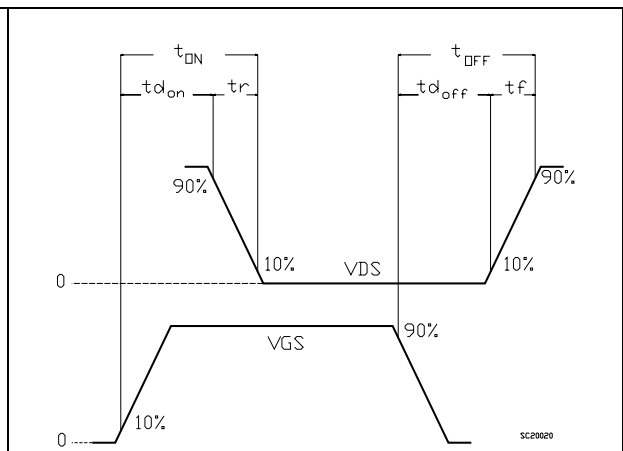
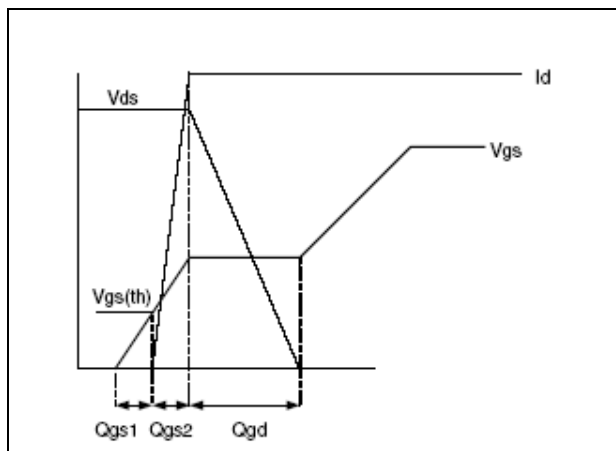




Figure 19. Gate charge waveform

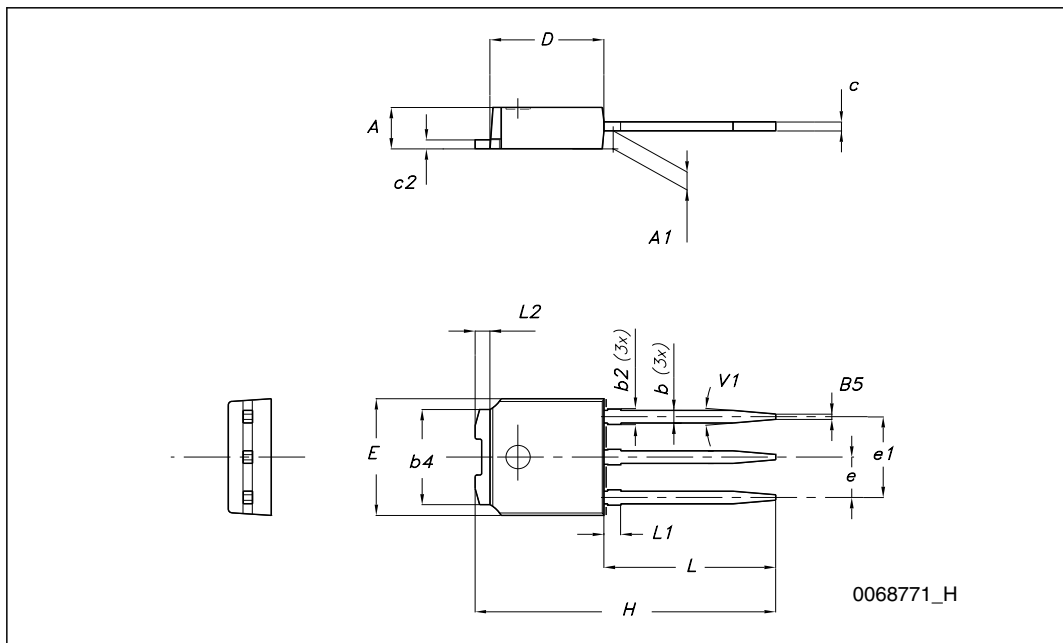


## 4 Package mechanical data

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.

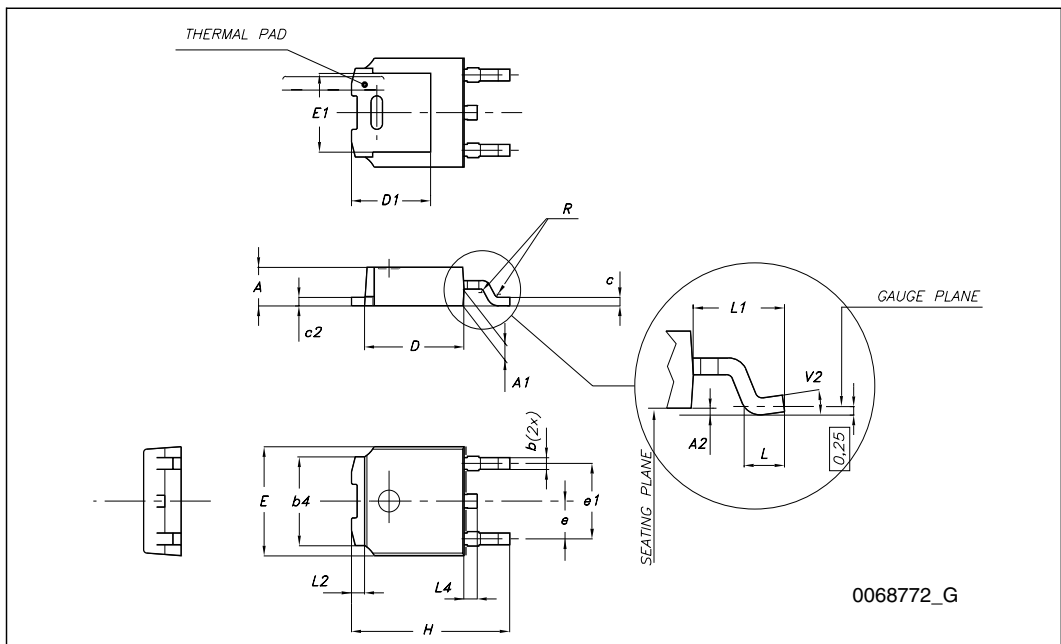
**TO-251 (IPAK) mechanical data**

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°	



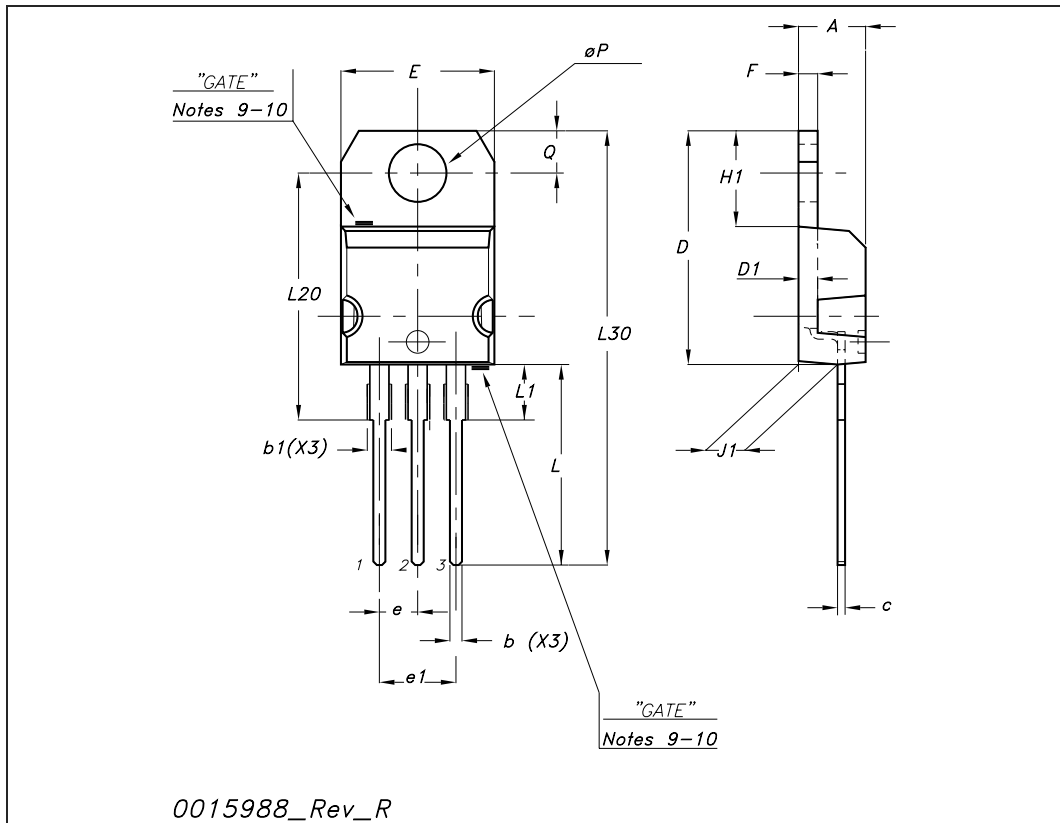
**TO-252 (DPAK) mechanical data**

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°



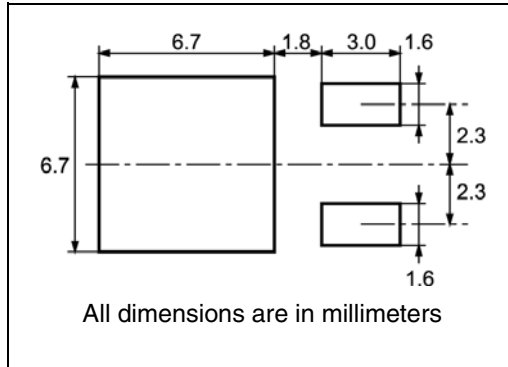
TO-220 mechanical data

Dim	mm			inch		
	Min	Typ	Max	Min	Typ	Max
A	4.40		4.60	0.173		0.181
b	0.61		0.88	0.024		0.034
b1	1.14		1.70	0.044		0.066
c	0.48		0.70	0.019		0.027
D	15.25		15.75	0.6		0.62
D1		1.27			0.050	
E	10		10.40	0.393		0.409
e	2.40		2.70	0.094		0.106
e1	4.95		5.15	0.194		0.202
F	1.23		1.32	0.048		0.051
H1	6.20		6.60	0.244		0.256
J1	2.40		2.72	0.094		0.107
L	13		14	0.511		0.551
L1	3.50		3.93	0.137		0.154
L20		16.40			0.645	
L30		28.90			1.137	
∅P	3.75		3.85	0.147		0.151
Q	2.65		2.95	0.104		0.116



## 5 Packaging mechanical data

### DPAK FOOTPRINT



### TAPE AND REEL SHIPMENT

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	16.4	18.4	0.645	0.724
N	50		1.968	
T		22.4		0.881

TAPE MECHANICAL DATA				
DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A0	6.8	7	0.267	0.275
B0	10.4	10.6	0.409	0.417
B1		12.1		0.476
D	1.5	1.6	0.059	0.063
D1	1.5		0.059	
E	1.65	1.85	0.065	0.073
F	7.4	7.6	0.291	0.299
K0	2.55	2.75	0.100	0.108
P0	3.9	4.1	0.153	0.161
P1	7.9	8.1	0.311	0.319
P2	1.9	2.1	0.075	0.082
R	40		1.574	
W	15.7	16.3	0.618	0.641

BASE QTY	BULK QTY
2500	2500

## 6 Revision history

**Table 8. 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>

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