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## STB20NM60D

N-channel 600V - 0.26Ω - 20A - D<sup>2</sup>PAK  
 FDmesh™ Power MOSFET

### General features

Type	V <sub>DSS</sub>	R <sub>DS(on)</sub>	I <sub>D</sub>	P <sub>w</sub>
STB20NM60D	600V	<0.29Ω	20A	45W

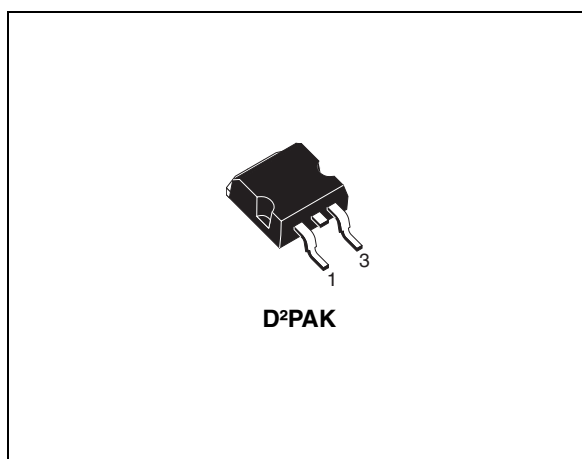
- High dv/dt and avalanche capabilities
- 100% Avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance
- Tight process control and high manufacturing yields

### Description

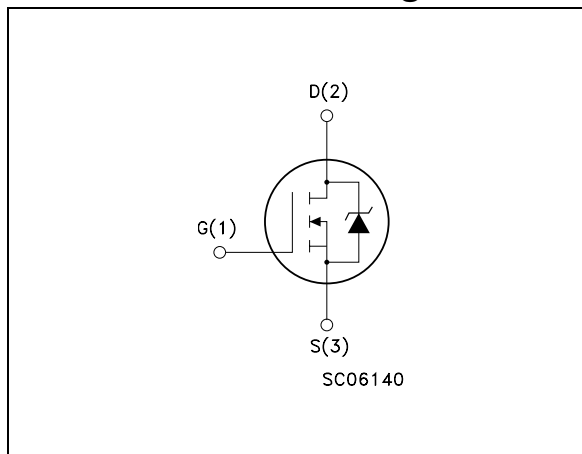
The FDmesh™ associates all advantages of reduced on-resistance and fast switching with an intrinsic fast-recovery body diode. It is therefore strongly recommended for bridge topologies, in particular ZVS phase-shift converters.

### Applications

- Switching application



### Internal schematic diagram



### Order codes

Part number	Marking	Package	Packaging
STB20NM60D	B20NM60D	D <sup>2</sup> PAK	Tape & reel

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## Contents

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Electrical ratings

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
V <sub>DS</sub>	Drain-source voltage (V <sub>GS</sub> = 0)	600	V
V <sub>DGR</sub>	Drain-gate voltage (R <sub>GS</sub> = 20 kΩ)	600	V
V <sub>GS</sub>	Gate- source voltage	± 30	V
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 25°C	20	A
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 100°C	12.6	A
I <sub>DM</sub> <sup>(1)</sup>	Drain current (pulsed)	80	A
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25°C	192	W
	Derating factor	1.20	W/°C
dv/dt <sup>(2)</sup>	Peak diode recovery voltage slope	20	V/ns
T <sub>j</sub>	Operating junction temperature	- 65 to 150	°C
T <sub>stg</sub>	Storage temperature		°C

1. Pulse width limited by safe operating area
2. I<sub>SD</sub> ≤ 20A, di/dt ≤ 400A/μs, V<sub>DD</sub> = 80%V<sub>(BR)DSS</sub>

**Table 2. Thermal resistance**

Symbol	Parameter	Value	Unit
R <sub>thj-case</sub>	Thermal resistance junction-case Max	0.65	°C/W
R <sub>thj-amb</sub>	Thermal resistance junction-ambient Max	62.5	°C/W
T <sub>l</sub>	Maximum lead temperature for soldering purpose	300	°C

**Table 3. Avalanche data**

Symbol	Parameter	Value	Unit
I <sub>AR</sub>	Avalanche current, repetitive or not-repetitive (pulse width limited by T <sub>j</sub> max)	10	A
E <sub>AS</sub>	Single pulse avalanche energy (starting T <sub>j</sub> = 25 °C, I <sub>D</sub> = I <sub>AR</sub> , V <sub>DD</sub> = 35 V)	700	mJ

Electrical characteristics

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## 2 Electrical characteristics

(T<sub>CASE</sub>=25°C unless otherwise specified)

**Table 4. On/off states**

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
V <sub>(BR)DSS</sub>	Drain-source breakdown voltage	I <sub>D</sub> = 250µA, V <sub>GS</sub> = 0	600			V
I <sub>DSS</sub>	Zero gate voltage drain current (V <sub>GS</sub> = 0)	V <sub>DS</sub> = Max rating V <sub>DS</sub> = Max rating, T <sub>C</sub> = 125 °C			1 10	µA µA
I <sub>GSS</sub>	Gate-body leakage current (V <sub>DS</sub> = 0)	V <sub>GS</sub> = ±30V			±10 0	µA
V <sub>GS(th)</sub>	Gate threshold voltage	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250µA	3	4	5	V
R <sub>DS(on)</sub>	Static drain-source on resistance	V <sub>GS</sub> = 10V, I <sub>D</sub> = 10A		0.26	0.29	Ω

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
g <sub>fs</sub> <sup>(1)</sup>	Forward transconductance	V <sub>DS</sub> > I <sub>D(on)</sub> × R <sub>DS(on)max</sub> , I <sub>D</sub> = 10A		9		S
C <sub>iss</sub>	Input capacitance	V <sub>DS</sub> = 25V, f = 1 MHz, V <sub>GS</sub> = 0		1300		pF
C <sub>oss</sub>	Output capacitance			500		pF
C <sub>rss</sub>	Reverse transfer capacitance			35		pF
C <sub>oss eq.</sub> <sup>(2)</sup>	Equivalent output capacitance	V <sub>GS</sub> = 0V, V <sub>DS</sub> = 0V to 480V		190		pF
R <sub>G</sub>	Gate input resistance	f=1 MHz Gate DC Bias = 0 Test signal level = 20mV open drain		2.7		Ω
Q <sub>g</sub>	Total gate charge	V <sub>DD</sub> = 480V, I <sub>D</sub> = 20A, V <sub>GS</sub> = 10V (see Figure 13)		37	52	nC
Q <sub>gs</sub>	Gate-source charge			10		nC
Q <sub>gd</sub>	Gate-drain charge			17		nC

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

2. C<sub>oss eq.</sub> is defined as a constant equivalent capacitance giving the same charging time as C<sub>oss</sub> when V<sub>DS</sub> increases from 0 to 80%

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**Electrical characteristics**

**Table 6. Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300V, I_D = 10A$ $R_G = 4.7\Omega, V_{GS} = 10V$ (see Figure 12)		25		ns
$t_r$	Rise time			12		ns
$t_{r(Voff)}$	Off-voltage rise time	$V_{DD} = 480V, I_D = 20A,$ $R_G = 4.7\Omega, V_{GS} = 10V$ (see Figure 12)		8		ns
$t_f$	Fall time			22		ns
$t_c$	Cross-over time			30		ns

**Table 7. Source drain diode**

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
$I_{SD}$	Source-drain current				20	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)				80	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 20A, V_{GS} = 0$			1.5	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 20A, T_j = 25^\circ C$ $di/dt = 100A/\mu s, V_{DD} = 60V$ (see Figure 17)		240		ns
$Q_{rr}$	Reverse recovery charge			1800		nC
$I_{RRM}$	Reverse recovery current			16		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 20A, T_j = 150^\circ C$ $di/dt = 100A/\mu s, V_{DD} = 60V$ (see Figure 17)		396		ns
$Q_{rr}$	Reverse recovery charge			2960		nC
$I_{RRM}$	Reverse recovery current			20		A

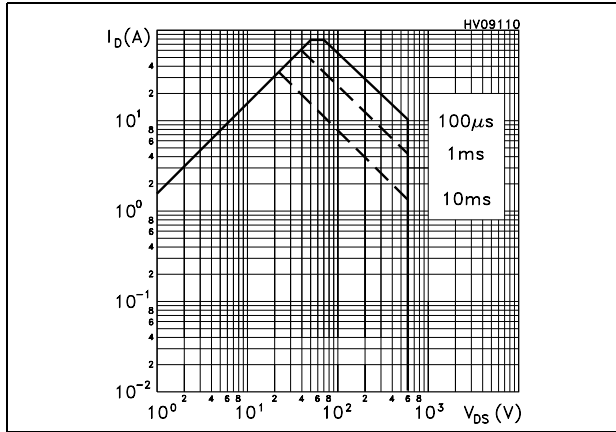
1. Pulse width limited by safe operating area
2. Pulsed: Pulse duration = 300  $\mu s$ , duty cycle 1.5 %.

**Electrical characteristics**

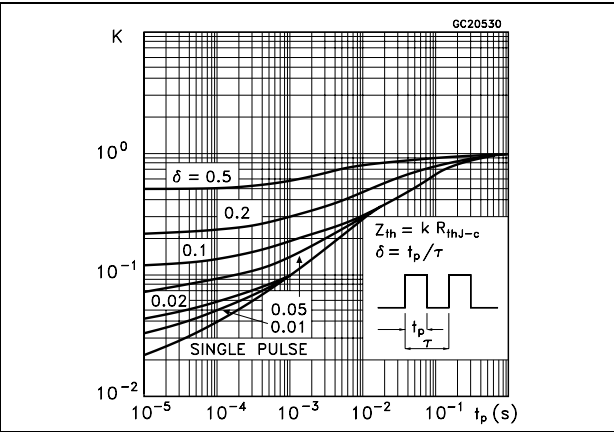
**STB20NM60D**

**2.1 Electrical characteristics (curves)**

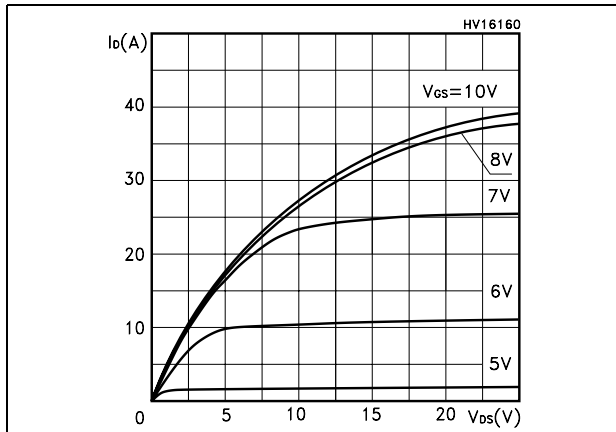
**Figure 1. Safe operating area**



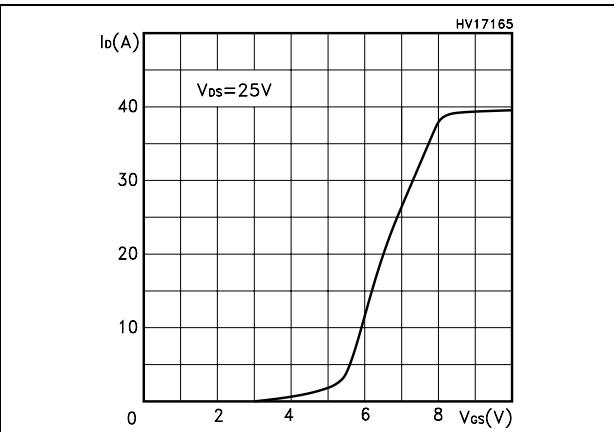
**Figure 2. Thermal impedance**



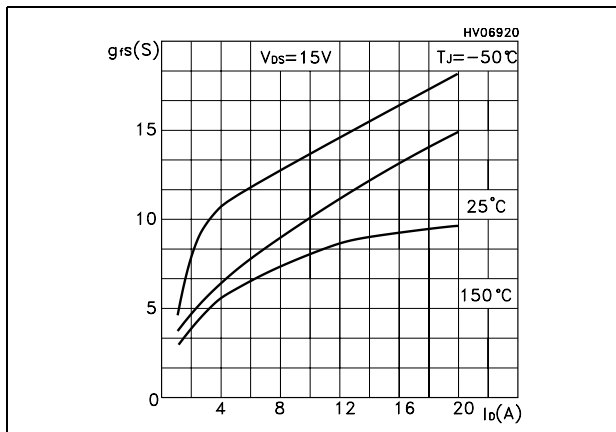
**Figure 3. Output characteristics**



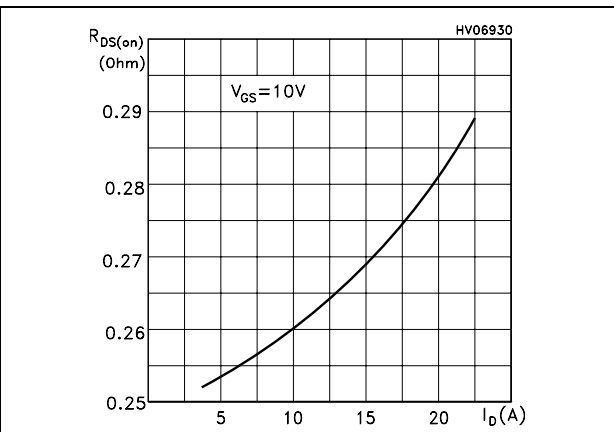
**Figure 4. Transfer characteristics**



**Figure 5. Transconductance**



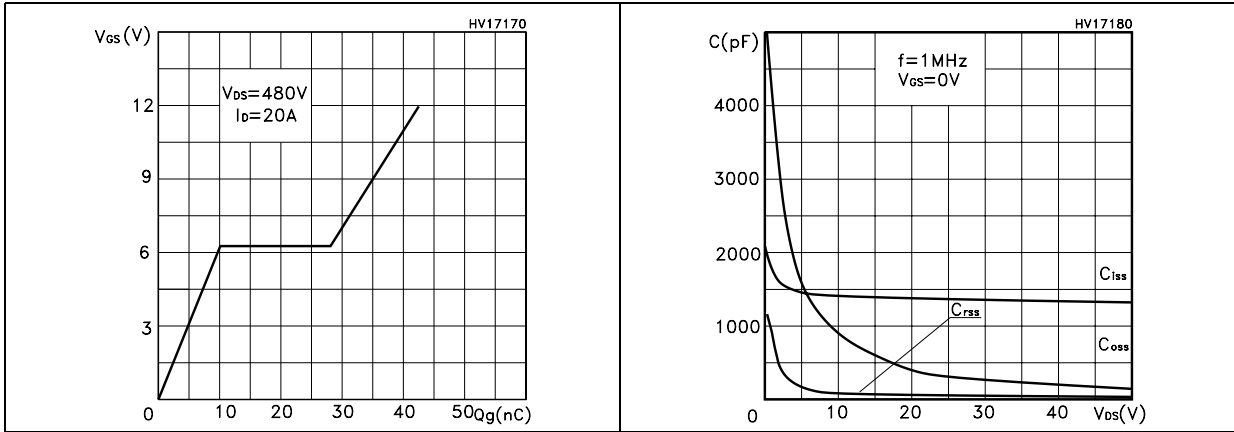
**Figure 6. Static drain-source on resistance**



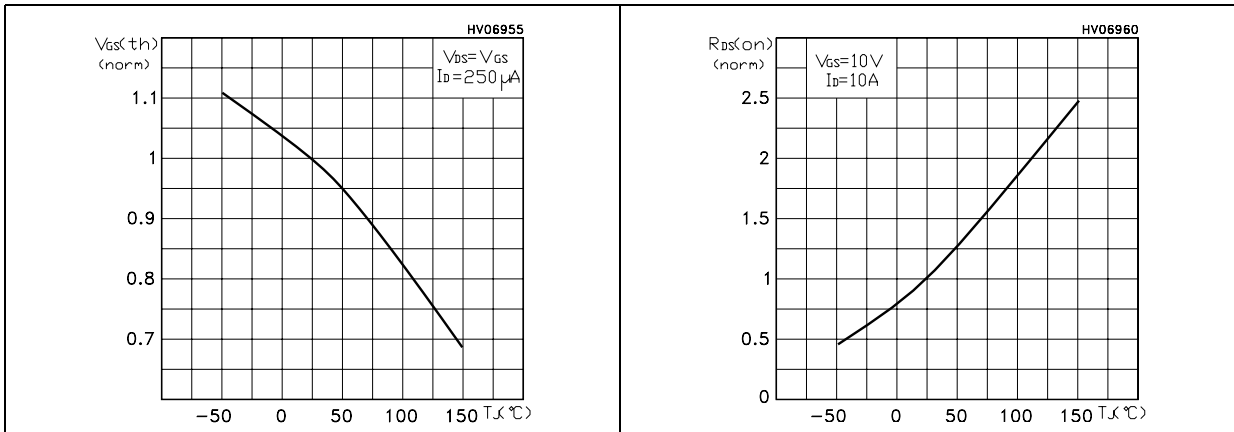
**STB20NM60D**

**Electrical characteristics**

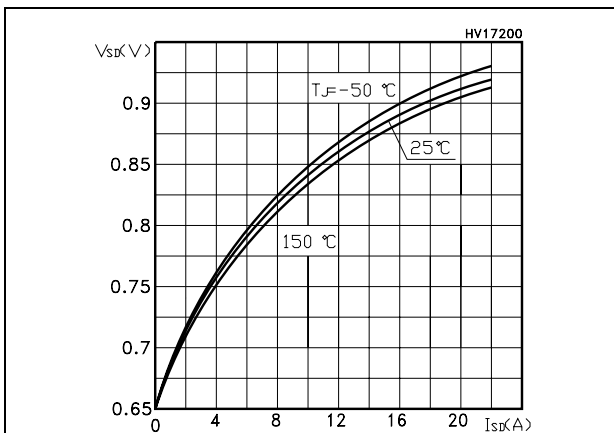
**Figure 7. Gate charge vs gate-source voltage**   **Figure 8. Capacitance variations**



**Figure 9. Normalized gate threshold voltage vs temperature**   **Figure 10. Normalized on resistance vs temperature**



**Figure 11. Source-drain diode forward characteristics**



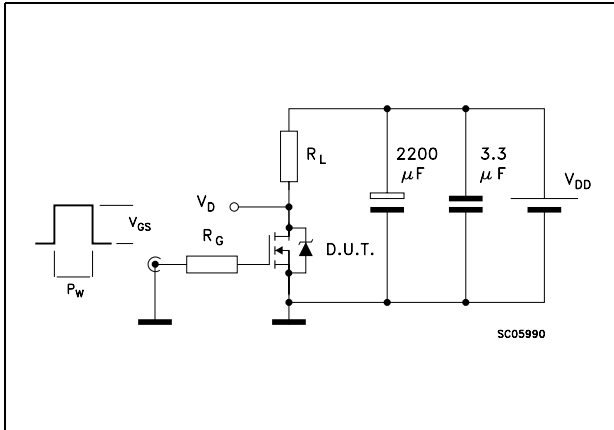


Test circuit

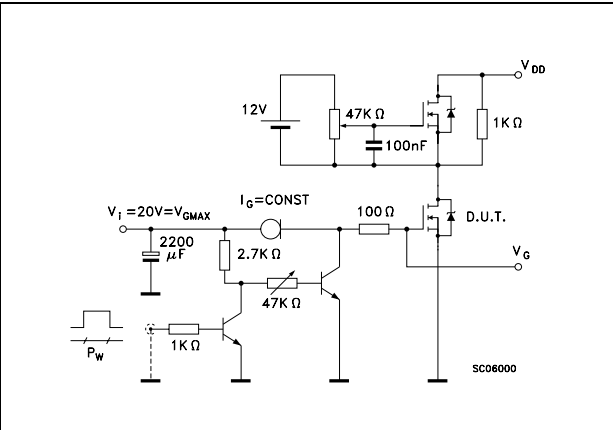
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**3 Test circuit**

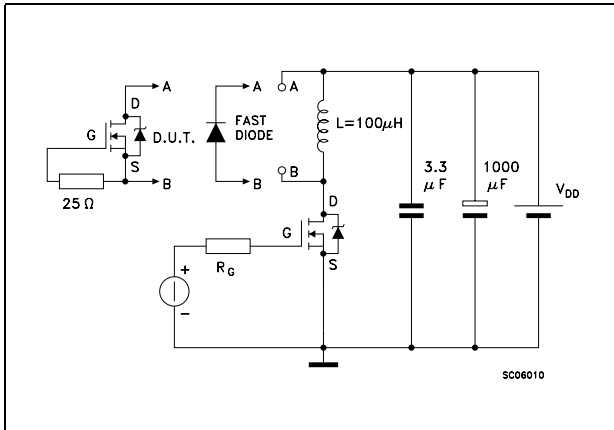
**Figure 12. Switching times test circuit for resistive load**



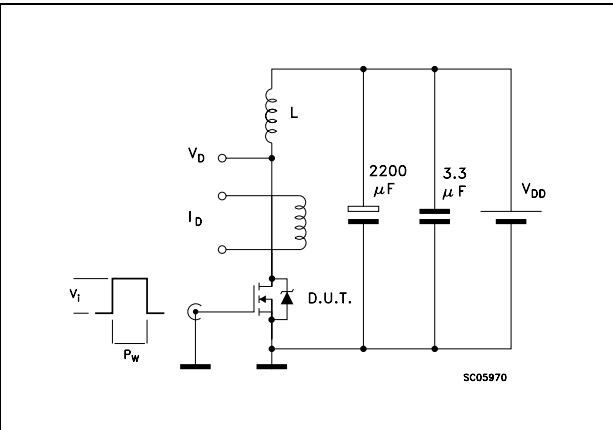
**Figure 13. Gate charge test circuit**



**Figure 14. Test circuit for inductive load switching and diode recovery times**

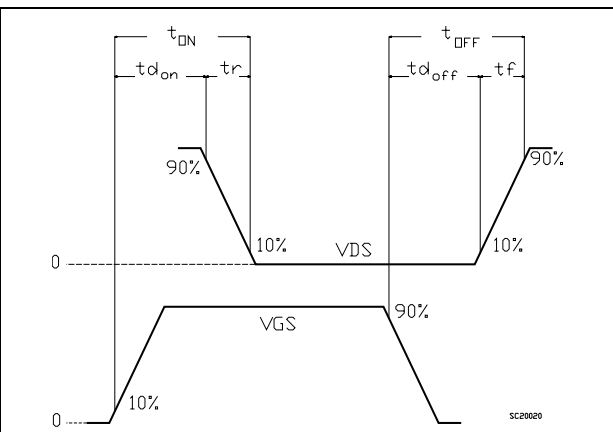
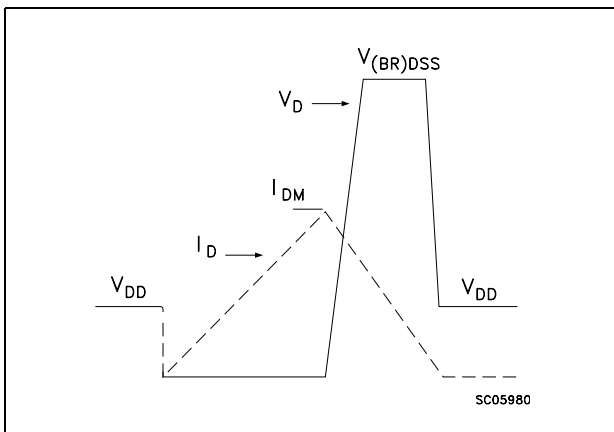


**Figure 15. Unclamped inductive load test circuit**



**Figure 16. Unclamped inductive waveform**

**Figure 17. Switching time waveform**



## 4 Package mechanical data

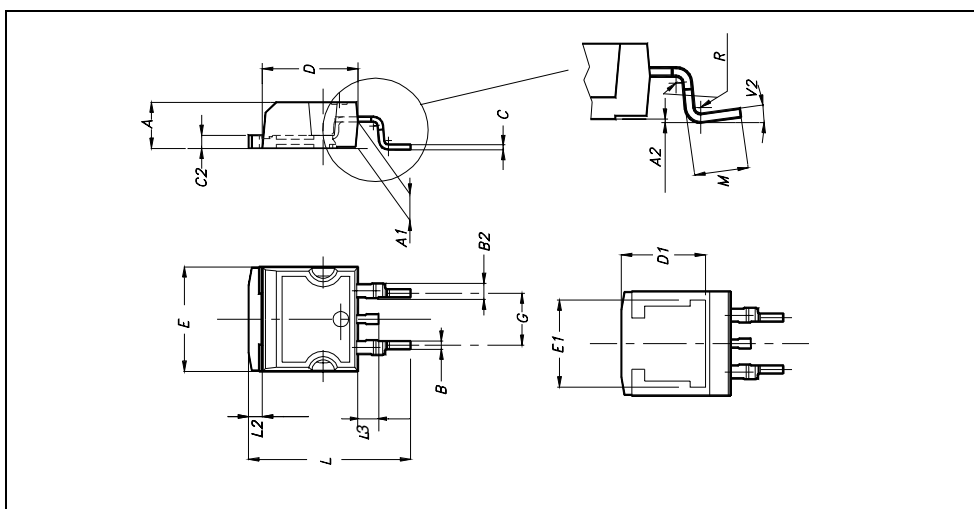
In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect . The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: [www.st.com](http://www.st.com)

**Package mechanical data**

**STB20NM60D**

**D<sup>2</sup>PAK MECHANICAL DATA**

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	4.4		4.6	0.173		0.181
A1	2.49		2.69	0.098		0.106
A2	0.03		0.23	0.001		0.009
B	0.7		0.93	0.027		0.036
B2	1.14		1.7	0.044		0.067
C	0.45		0.6	0.017		0.023
C2	1.23		1.36	0.048		0.053
D	8.95		9.35	0.352		0.368
D1		8			0.315	
E	10		10.4	0.393		
E1		8.5			0.334	
G	4.88		5.28	0.192		0.208
L	15		15.85	0.590		0.625
L2	1.27		1.4	0.050		0.055
L3	1.4		1.75	0.055		0.068
M	2.4		3.2	0.094		0.126
R		0.4			0.015	
V2	0°		4°			

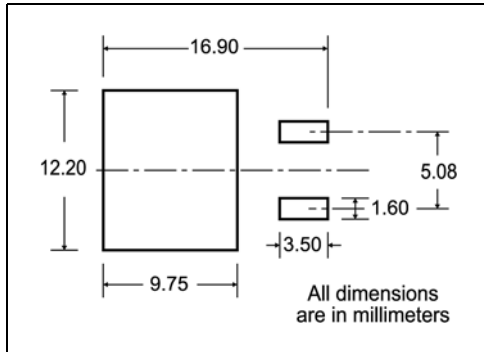


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Packaging mechanical data

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

\* on sales type

## 6 Revision history

Table 8. Revision history

Date	Revision	Changes
08-Jun-2006	1	First release

## STB20NM60D

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