



# STB120NH03L - STI120NH03L STP120NH03L

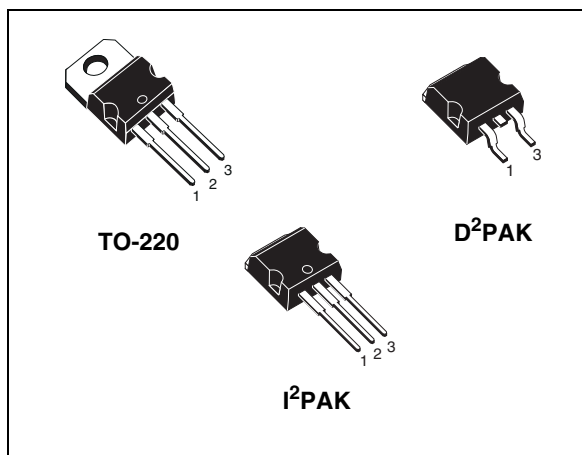
N-channel 30V - 0.005Ω - 60A - TO-220 / D<sup>2</sup>PAK / I<sup>2</sup>PAK  
STripFET™ Power MOSFET for DC-DC conversion

## General features

Type	V <sub>DSS</sub>	R <sub>DS(on)</sub>	I <sub>D</sub>
STB120NH03L	30V	<0.0055Ω	60 <sup>(1)</sup>
STP120NH03L	30V	<0.0055Ω	60 <sup>(1)</sup>
STI120NH03L	30V	<0.0055Ω	60 <sup>(1)</sup>

1. Value limited by wire bonding

- R<sub>DS(on)</sub> \*Q<sub>g</sub> industry's benchmark Low
- Conduction losses reduced
- Switching losses reduced
- Low Threshold device



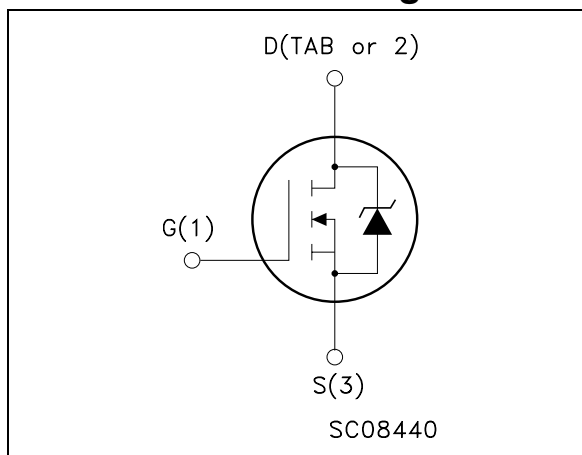
## Description

These devices utilize the latest advanced design rules of ST's proprietary STripFET™ technology. It is ideal in high performance DC-DC converter applications where efficiency is to be achieved at very high output currents.

## Applications

- Switching application

## Internal schematic diagram



## Order codes

Part number	Marking	Package	Packaging
STB120NH03L	B120NH03L	D <sup>2</sup> PAK	Tape & reel
STI120NH03L	120NH03L	I <sup>2</sup> PAK	Tube
STP120NH03L	P120NH03L	TO-220	Tube

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# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{DS}$	Drain-source voltage ( $V_{GS} = 0V$ )	30	V
$V_{GS}$	Gate-source voltage	$\pm 20$	V
$I_D^{(1)}$	Drain current (continuous) at $T_C = 25^\circ C$	60	A
$I_D^{(1)}$	Drain current (continuous) at $T_C = 100^\circ C$	60	A
$I_{DM}^{(2)}$	Drain current (pulsed)	240	A
$P_{TOT}$	Total dissipation at $T_C = 25^\circ C$	110	W
	Derating factor	0.73	W/ $^\circ C$
EAS <sup>(3)</sup>	Single pulse avalanche energy	700	mJ
$T_J$ $T_{stg}$	Operating junction temperature Storage temperature	-55 to 175	$^\circ C$

1. Value limited by wire bonding
2. Pulse width limited by safe operating area
3. Starting  $T_J = 25^\circ C$ ,  $I_D = 30A$ ,  $V_{DD} \leq 30V$

**Table 2. Thermal data**

$R_{thJC}$	Thermal resistance junction-case max	1.30	$^\circ C/W$
$R_{thJA}$	Thermal resistance junction-amb max	62.5	$^\circ C/W$
$T_l$	Maximum lead temperature for soldering purpose	300	$^\circ C$

## 2 Electrical characteristics

( $T_{CASE}=25^{\circ}C$  unless otherwise specified)

**Table 3. On/off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 250\mu A, V_{GS} = 0$	30			V
$I_{DSS}$	Zero gate voltage drain current ( $V_{GS} = 0$ )	$V_{DS} = \text{Max rating},$ $V_{DS} = \text{Max rating},$ $T_C = 125^{\circ}C$			1 10	$\mu A$ $\mu A$
$I_{GSS}$	Gate body leakage current ( $V_{DS} = 0$ )	$V_{GS} = \pm 20V$			$\pm 100$	$\mu A$
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}, I_D = 250\mu A$	1	1.8	3	V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10V, I_D = 30A$ $V_{GS} = 5V, I_D = 30A$		0.005 0.006	0.0055 0.0105	$\Omega$ $\Omega$

**Table 4. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 25V, f = 1MHz,$ $V_{GS} = 0$		4100		pF
$C_{oss}$	Output capacitance			680		pF
$C_{rss}$	Reverse transfer capacitance			70		pF
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 15V, I_D = 30A,$ $R_G = 4.7\Omega, V_{GS} = 10V$ (see <a href="#">Figure 12</a> )		16		ns
$t_r$	Rise time			95		ns
$t_{d(off)}$	Off voltage rise time			48		ns
$t_f$	Fall time			23		ns
$R_g$	Gate input resistance	$f = 1MHz$ gate DC bias=0 test signal level=20mV open drain		1.3		$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 15V, I_D = 60A$ $V_{GS} = 10V$ (see <a href="#">Figure 13</a> )		57	77	nC
$Q_{gs}$	Gate-source charge			12		nC
$Q_{gd}$	Gate-drain charge			7		nC
$Q_{oss}^{(1)}$	Output charge	$V_{DS} = 24V, V_{GS} = 0$		27		ns
$Q_{gls}^{(2)}$	Third-quadrant gate charge	$V_{DS} < 0, V_{GS} = 0V$		55		ns

1.  $Q_{oss} = C_{oss} * \Delta V_{IN}$ ,  $C_{oss} = C_{gd} + C_{ds}$ . See power losses calculation

2. Gate charge for synchronous operation.

**Table 5. Source drain diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$ $I_{SDM}$	Source-drain current Source-drain current (pulsed)				60 240	A A
$V_{SD}^{(1)}$	Forward on voltage	$I_{SD} = 30A, V_{GS} = 0$			1.4	V
$t_{rr}$ $Q_{rr}$ $I_{RRM}$	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_{SD} = 60A,$ $di/dt = 100A/\mu s,$ $V_{DD} = 30V, T_J = 150^\circ C$		46 64 2.8		ns nC A

1. Pulsed: pulse duration = 300 $\mu s$ , duty cycle 1.5%

## 2.1 Electrical characteristics (curves)

Figure 1. Safe operating area

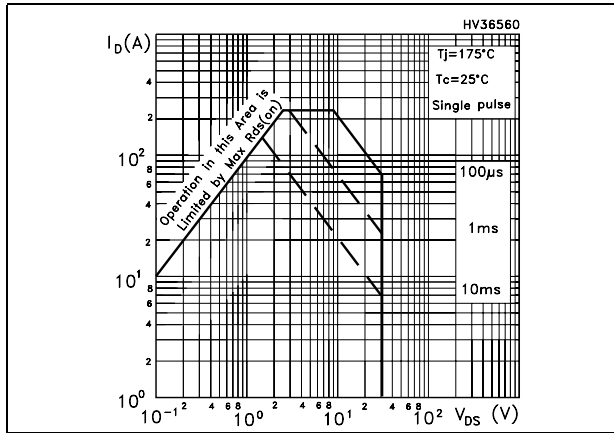


Figure 2. Thermal impedance

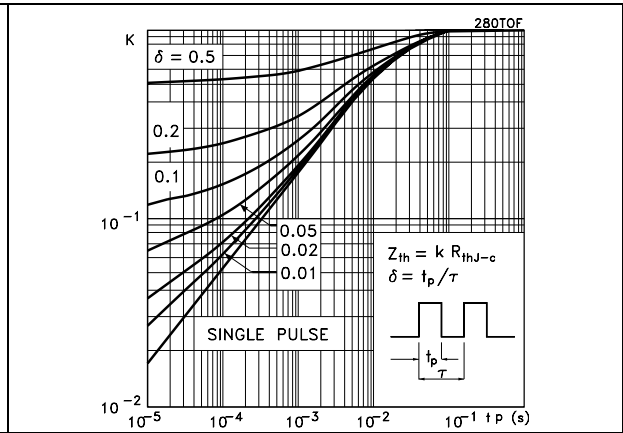


Figure 3. Output characteristics

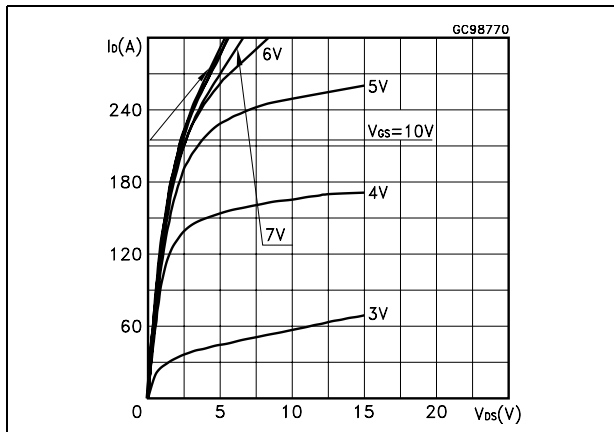


Figure 4. Transfer characteristics

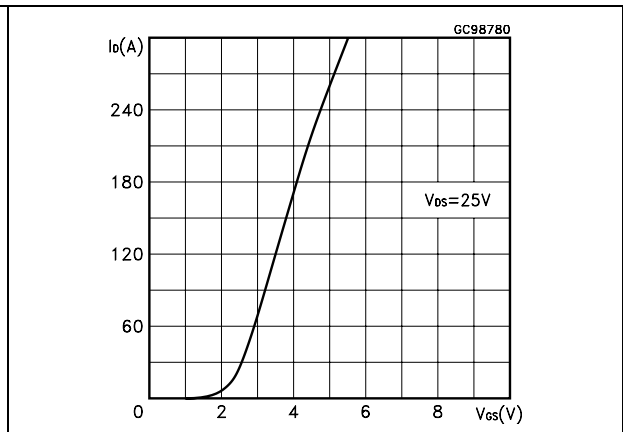


Figure 5. Normalized  $B_{V_{DS}}$  vs temperature

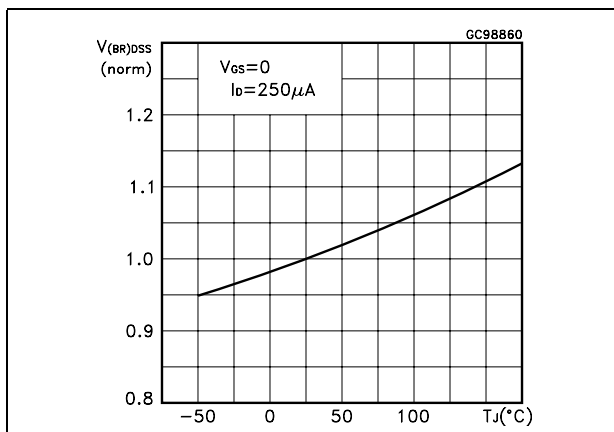


Figure 6. Static drain-source on resistance

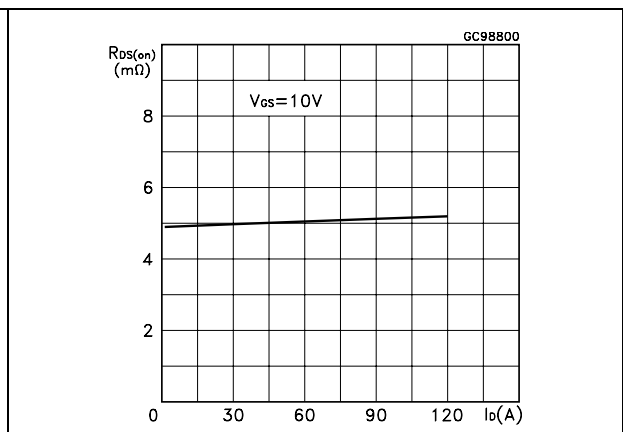


Figure 7. Gate charge vs gate-source voltage Figure 8. Capacitance variations

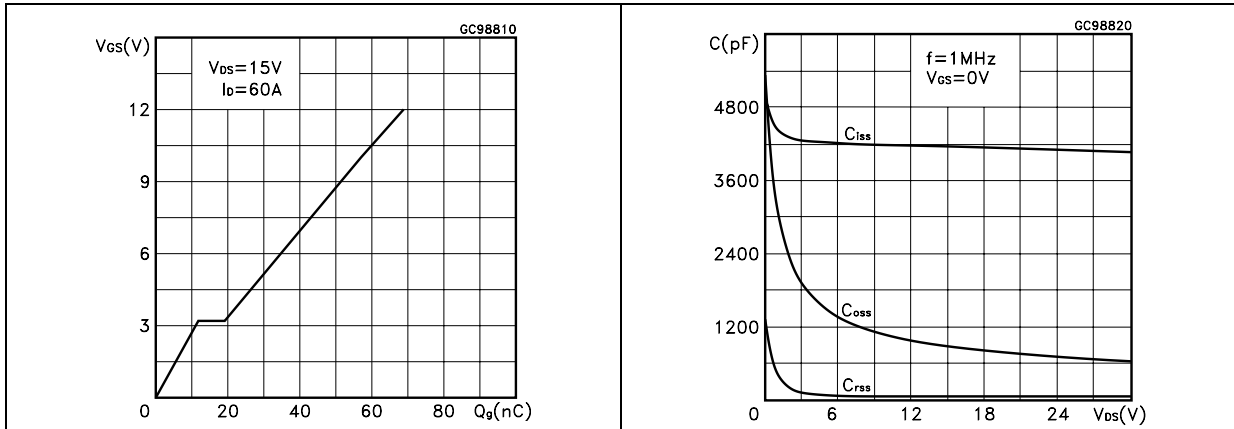


Figure 9. Normalized gate threshold voltage vs temperature Figure 10. Normalized on resistance vs temperature

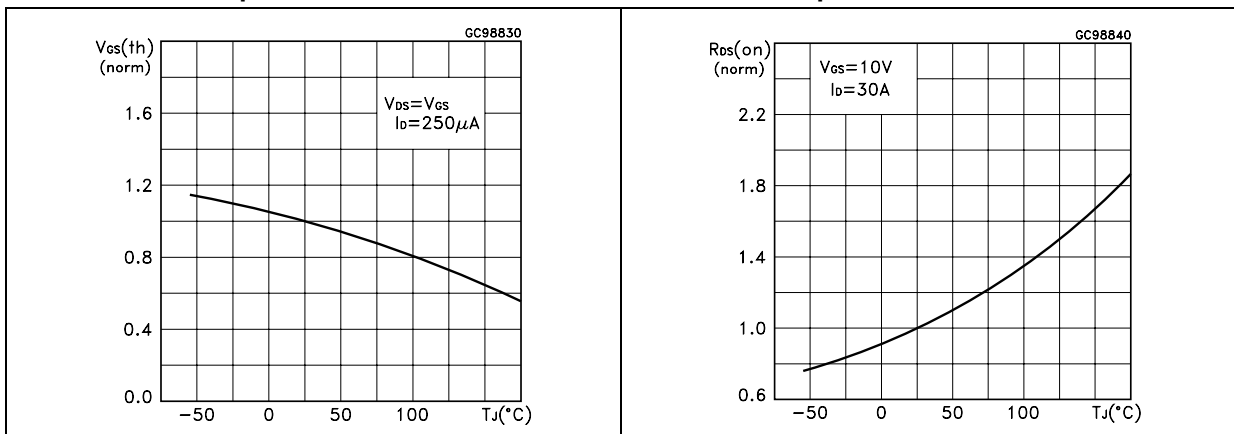
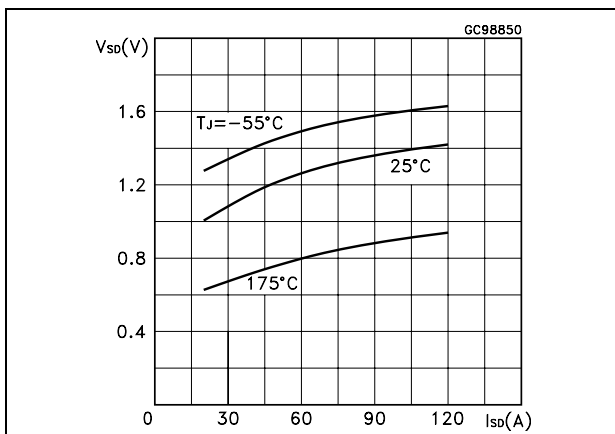


Figure 11. Source-drain diode forward characteristics



### 3 Test circuit

Figure 12. Switching times test circuit for resistive load

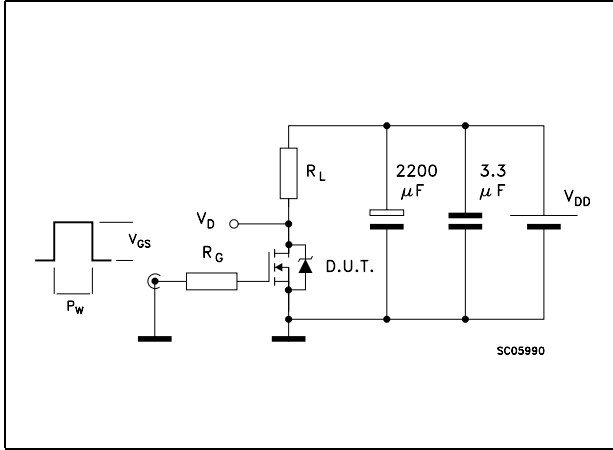


Figure 13. Gate charge test circuit

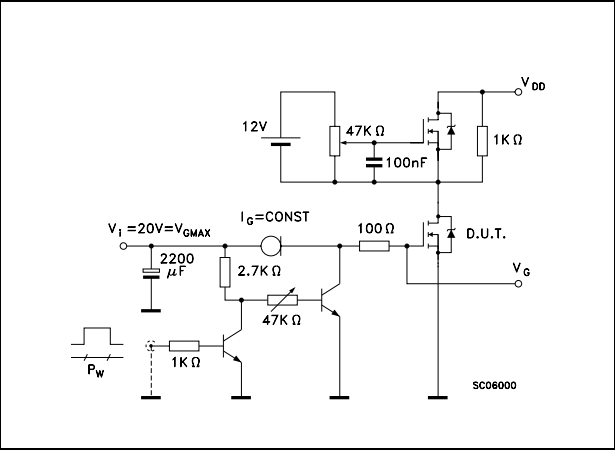


Figure 14. Test circuit for inductive load switching and diode recovery times



Figure 15. Unclamped Inductive load test circuit

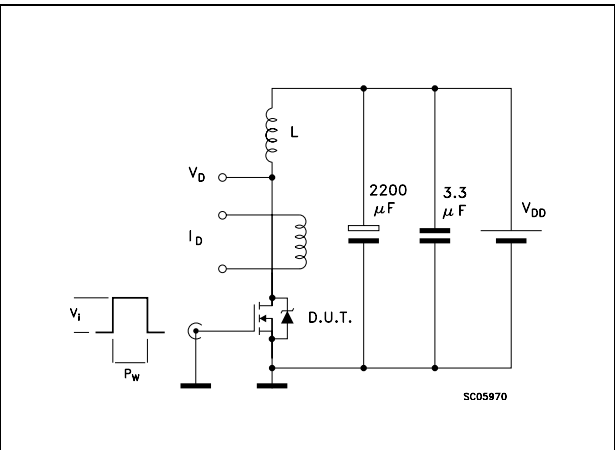
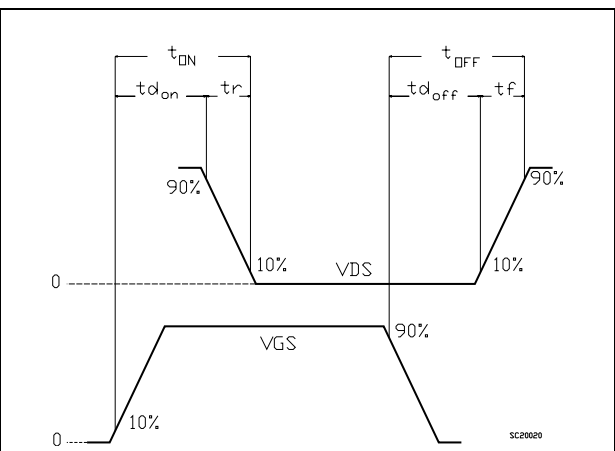


Figure 16. Unclamped inductive waveform



Figure 17. Switching time waveform



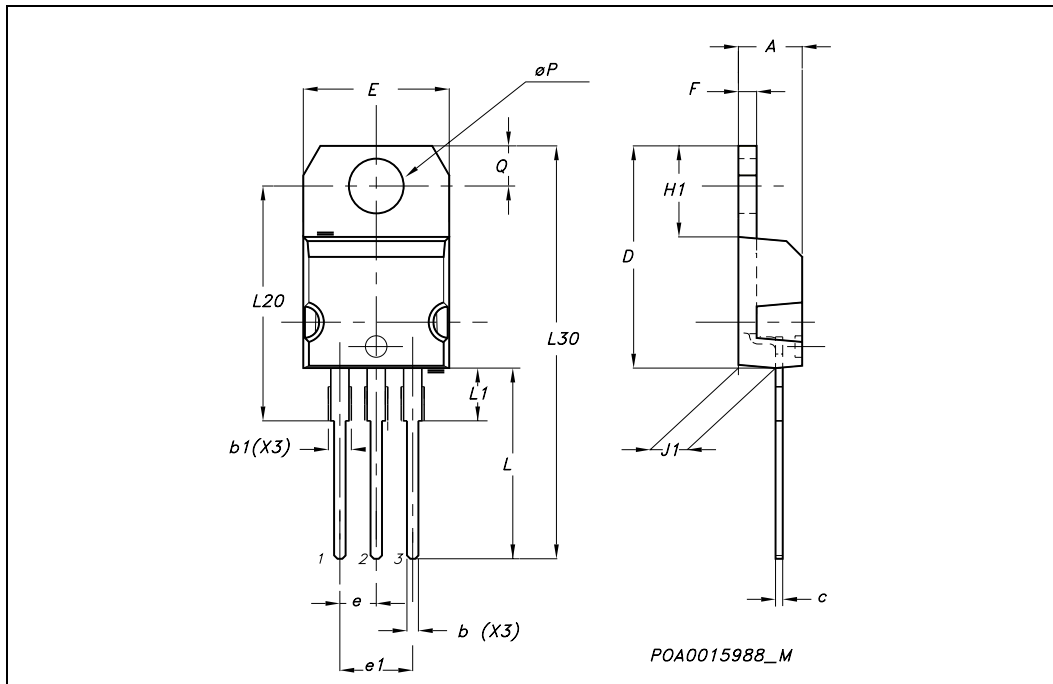


## 4 Package mechanical data

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)

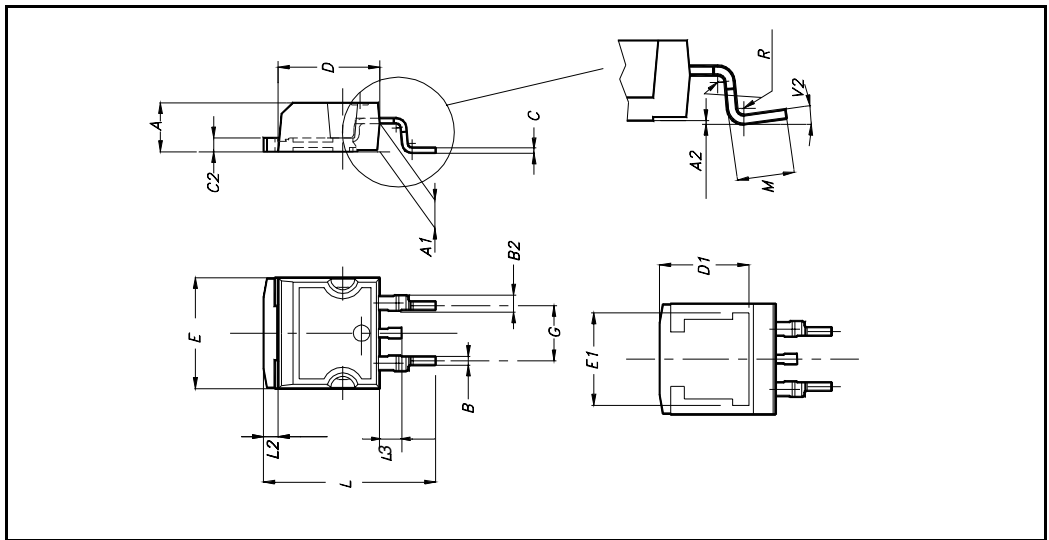
**TO-220 MECHANICAL DATA**

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	1.15		1.70	0.045		0.066
c	0.49		0.70	0.019		0.027
D	15.25		15.75	0.60		0.620
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		0.052
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	
øP	3.75		3.85	0.147		0.151
Q	2.65		2.95	0.104		0.116



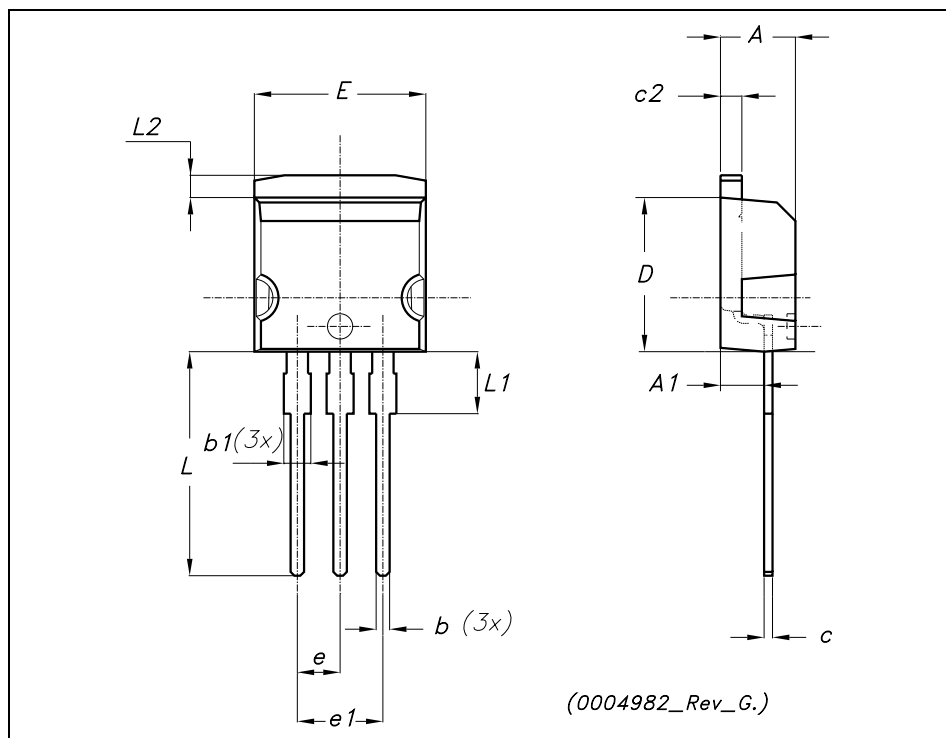
**D<sup>2</sup>PAK MECHANICAL DATA**

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°			



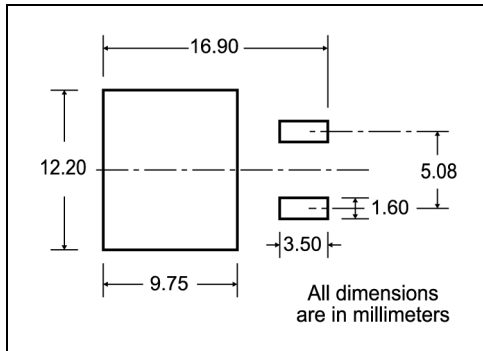
**TO-262 (I<sup>2</sup>PAK) MECHANICAL DATA**

DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.40		4.60	0.173		0.181
A1	2.40		2.72	0.094		0.107
b	0.61		0.88	0.024		0.034
b1	1.14		1.70	0.044		0.066
c	0.49		0.70	0.019		0.027
c2	1.23		1.32	0.048		0.052
D	8.95		9.35	0.352		0.368
e	2.40		2.70	0.094		0.106
e1	4.95		5.15	0.194		0.202
E	10		10.40	0.393		0.410
L	13		14	0.511		0.551
L1	3.50		3.93	0.137		0.154
L2	1.27		1.40	0.050		0.055



# 5 Packing 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

Center line of cavity

User Direction of Feed

FEED DIRECTION

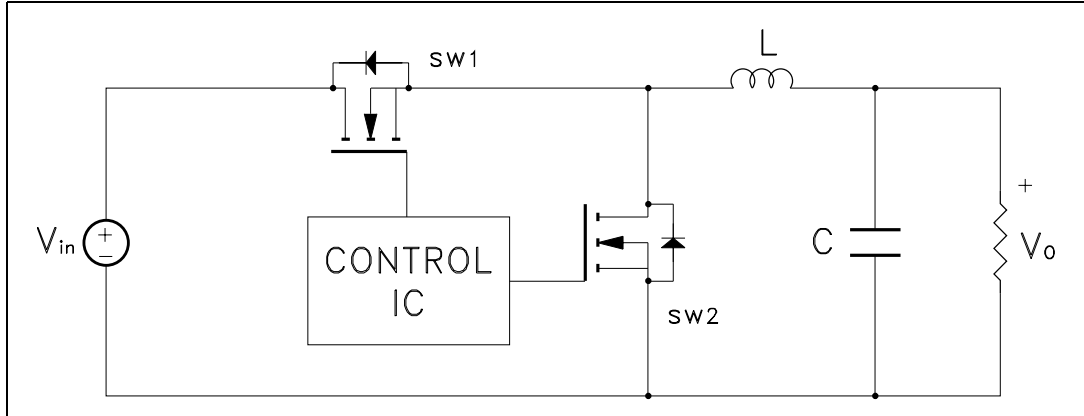
Bending radius

R min.

\* on sales type

## 6 Appendix A

Figure 18. Buck converter: power losses estimation



The power losses associated with the FETs in a synchronous buck converter can be estimated using the equations shown in the table below. The formulas give a good approximation, for the sake of performance comparison, of how different pairs of devices affect the converter efficiency. However a very important parameter, the working temperature, is not considered. The real device behavior is really dependent on how the heat generated inside the devices is removed to allow for a safer working junction temperature.

- The low side (SW2) device requires:
  - Very low  $R_{DS(on)}$  to reduce conduction losses
  - Small  $Q_{gl}$  to reduce the gate charge losses
  - Small  $C_{oss}$  to reduce losses due to output capacitance
  - Small  $Q_{rr}$  to reduce losses on SW1 during its turn-on
  - The  $C_{gd}/C_{gs}$  ratio lower than  $V_{th}/V_{gg}$  ratio especially with low drain to source voltage to avoid the cross conduction phenomenon;
- The high side (SW1) device requires:
  - Small  $R_g$  and  $L_s$  to allow higher gate current peak and to limit the voltage feedback on the gate
  - Small  $Q_g$  to have a faster commutation and to reduce gate charge losses
  - Low  $R_{DS(on)}$  to reduce the conduction losses.

**Table 6. Power losses calculation**

		High side switching (SW1)	Low side switch (SW2)
Pconduction		$R_{DS(on)SW1} * I_L^2 * \delta$	$R_{DS(on)SW2} * I_L^2 * (1 - \delta)$
Pswitching		$V_{in} * (Q_{gsth(SW1)} + Q_{gd(SW1)}) * f * \frac{I_L}{I_g}$	Zero Voltage Switching
Pdiode	Recovery <sup>(1)</sup>	Not applicable	$V_{in} * Q_{rr(SW2)} * f$
	Conduction	Not applicable	$V_{f(SW2)} * I_L * t_{deadtime} * f$
Pgate(Q <sub>G</sub> )		$Q_{g(SW1)} * V_{gg} * f$	$Q_{gls(SW2)} * V_{gg} * f$
P <sub>Qoss</sub>		$\frac{V_{in} * Q_{oss(SW1)} * f}{2}$	$\frac{V_{in} * Q_{oss(SW2)} * f}{2}$

1. Dissipated by SW1 during turn-on

**Table 7. Parameters meaning**

Parameter	Meaning
d	Duty-cycle
Q <sub>gsth</sub>	Post threshold gate charge
Q <sub>gls</sub>	Third quadrant gate charge
Pconduction	On state losses
Pswitching	On-off transition losses
Pdiode	Conduction and reverse recovery diode losses
Pgate	Gate drive losses
P <sub>Qoss</sub>	Output capacitance losses

## 7 Revision history

**Table 8. Revision history**

<b>Date</b>	<b>Revision</b>	<b>Changes</b>
20-Dec-2004	4	First release
20-Dec-2005	5	New device inserted
19-Jun-2006	6	The document has been reformatted
16-Feb-2007	7	Added I <sup>2</sup> PAK package



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