



STP130NH02L

N-channel 24V - 0.0034Ω - 120A - TO-220
STripFET™ Power MOSFET for DC-DC conversion

Features

Type	V _{DSS}	R _{DS(on)}	I _D
STP130NH02L	24V	<0.0044Ω	90 ⁽¹⁾

1. Value limited by wire bonding

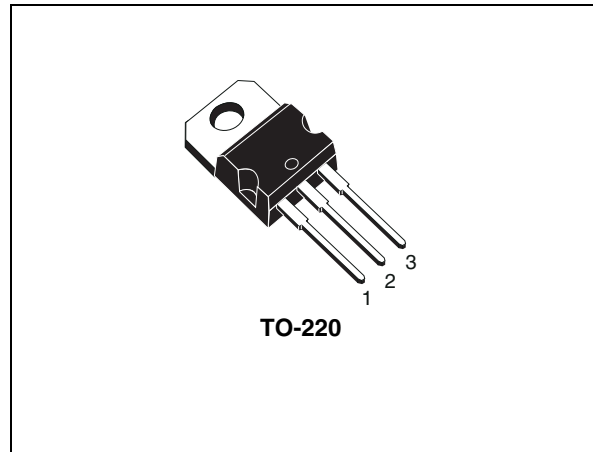
- R_{DS(on)} *Qg industry's benchmark Low
- Conduction losses reduced
- Switching losses reduced
- Low Threshold device

Description

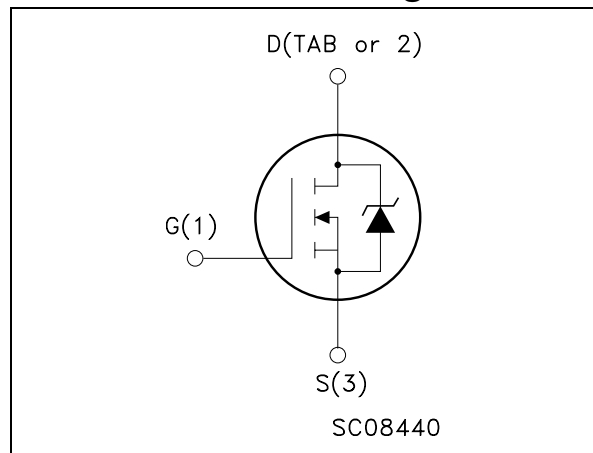
These devices utilizes the latest advanced design rules of ST's proprietary STripFET™ technology. It is ideal in high performance DC-DC converter applications where efficiency is to be achieved at very high output currents.

Application

- Switching application



Internal schematic diagram



Order code

Part number	Marking	Package	Packaging
STP130NH02L	P130NH02L	TO-220	Tube

Contents

1	Electrical ratings	3
2	Electrical characteristics	4
	2.1 Electrical characteristics (curves)	6
3	Test circuit	8
4	Package mechanical data	9
5	Appendix A	11
6	Revision history	13

1 Electrical ratings

Table 1.

Symbol	Parameter	Value	Unit
$V_{\text{spike}}^{(1)}$	Drain-source voltage rating	30	V
V_{DS}	Drain-source voltage ($V_{\text{GS}} = 0$)	24	V
V_{DGR}	Drain-gate voltage ($R_{\text{GS}} = 20 \text{ k}\Omega$)	24	V
V_{GS}	Gate- source voltage	± 20	V
$I_{\text{D}}^{(2)}$	Drain current (continuous) at $T_{\text{C}} = 25^{\circ}\text{C}$	90	A
$I_{\text{D}}^{(2)}$	Drain current (continuous) at $T_{\text{C}} = 100^{\circ}\text{C}$	90	A
$I_{\text{DM}}^{(3)}$	Drain current (pulsed)	360	A
P_{tot}	Total dissipation at $T_{\text{C}} = 25^{\circ}\text{C}$	150	W
	Derating factor	1	W/ $^{\circ}\text{C}$
$E_{\text{AS}}^{(4)}$	Single pulse avalanche energy	900	mJ
T_{stg}	Storage temperature	-55 to 175	$^{\circ}\text{C}$
T_{j}	Max. operating junction temperature		

1. Guaranteed when external $R_{\text{g}}=4.7 \Omega$ and $t_{\text{f}} < t_{\text{fmax}}$

2. Value limited by wire bonding

3. Pulse width limited by safe operating area

4. Starting $T_{\text{J}} = 25^{\circ}\text{C}$, $I_{\text{D}} = 45\text{A}$, $V_{\text{DD}} = 10\text{V}$

Table 2. Thermal data

$R_{\text{thj-case}}$	Thermal resistance junction-case max	1.0	$^{\circ}\text{C}/\text{W}$
$R_{\text{thj-amb}}$	Thermal resistance junction-ambient max	62.5	$^{\circ}\text{C}/\text{W}$
T_{l}	Maximum lead temperature for soldering purpose	300	$^{\circ}\text{C}$

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	$I_D = 25mA$ $V_{GS}=0$	24			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	μA μA
I_{GSS}	Gate body leakage current ($V_{DS} = 0$)	$V_{GS} = \pm 20V$			± 100	μA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}, I_D = 250\mu A$	1			V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10V, I_D = 45A$ $V_{GS} = 5V, I_D = 22.5A$		0.0034 0.005	0.0044 0.008	Ω Ω

Table 4. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$g_{fs}^{(1)}$	Forward transconductance	$V_{DS} = 10V, I_D = 45A$		55		S
C_{iss} C_{oss} C_{rss}	Input capacitance Output capacitance Reverse transfer capacitance	$V_{DS} = 15V, f = 1MHz,$ $V_{GS} = 0$		4450 1126 141		pF pF pF
$t_{d(on)}$ t_r $t_{d(off)}$ t_f	Turn-on delay time Rise time Off voltage rise time Fall time	$V_{DD} = 10V, I_D = 45A,$ $R_G = 4.7\Omega, V_{GS} = 10V$ (see Figure 13)		14 224 69 40		ns ns ns ns
R_g	Gate input resistance	$f = 1MHz$ gate DC bias=0 test signal level=20mV open drain		1.6		Ω
Q_g Q_{gs} Q_{gd}	Total gate charge Gate-source charge Gate-drain charge	$V_{DD}=10V, I_D = 90A$ $V_{GS} = 10V$ (see Figure 14)		69 13 9	93	nC nC nC
$Q_{oss}^{(2)}$	Output charge	$V_{DS} = 16V, V_{GS} = 0$		27		ns
$Q_{gls}^{(3)}$	Third-quadrant gate charge	$V_{DS} < 0, V_{GS} = 10V$		64		ns

1. Pulsed: pulse duration = 300 μs , duty cycle 1.5%
2. $Q_{oss} = C_{oss} \cdot \Delta V_{IN}$, $C_{oss} = C_{gd} + C_{ds}$. See power losses calculation
3. 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)				90 360	A A
$V_{SD}^{(1)}$	Forward on voltage	$I_{SD} = 45A, V_{GS} = 0$			1.3	V
t_{rr} Q_{rr} I_{RRM}	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_{SD} = 90A,$ $di/dt = 100A/\mu s,$ $V_{DD} = 15V, T_J = 150^\circ C$		47 58 2.5		ns nC A

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

2.1 Electrical characteristics (curves)

Figure 1. Safe operating area

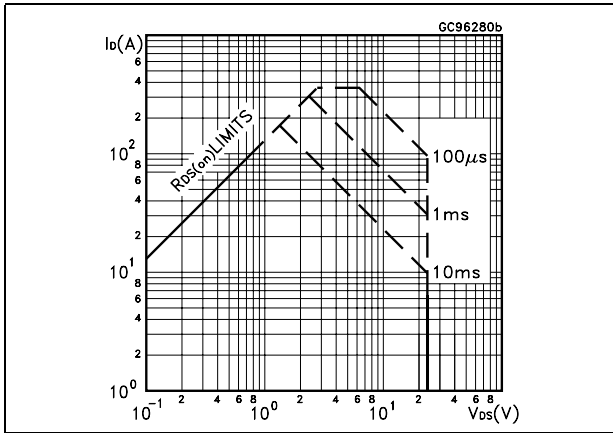


Figure 2. Thermal impedance

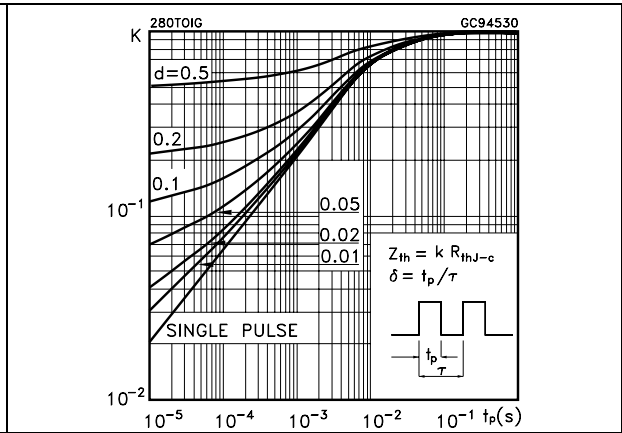


Figure 3. Output characteristics

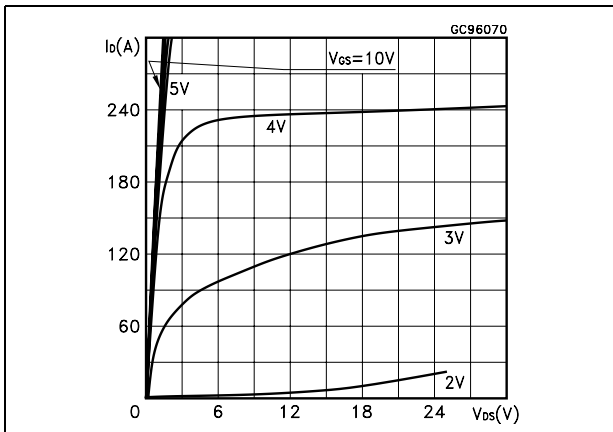


Figure 4. Transfer characteristics

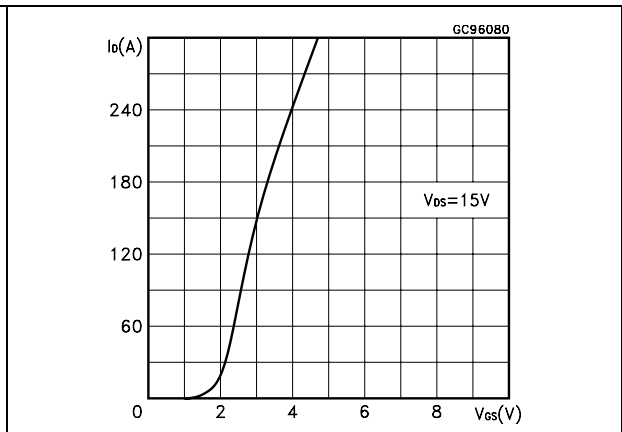


Figure 5. Transconductance

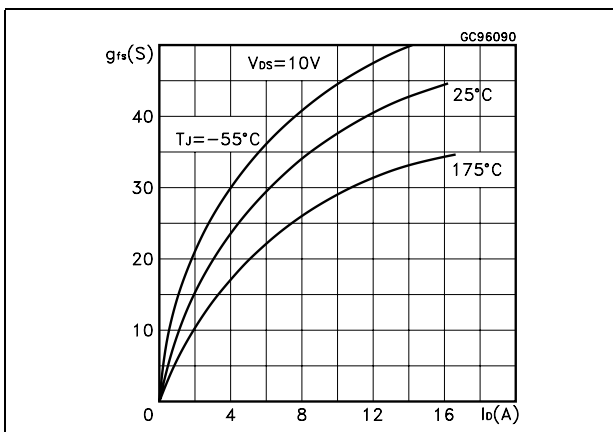


Figure 6. Static drain-source on resistance

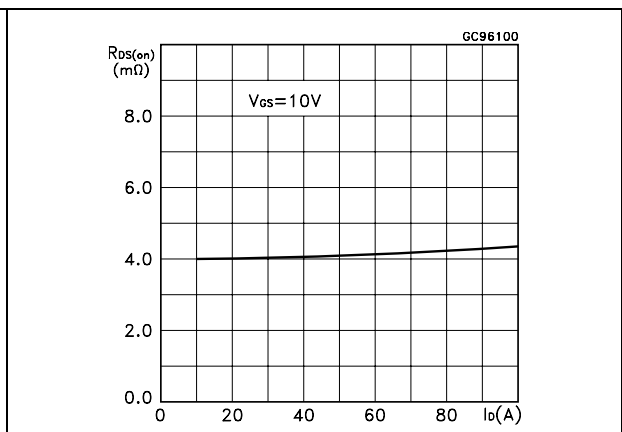


Figure 7. Gate charge vs gate-source voltage Figure 8. Capacitance variations

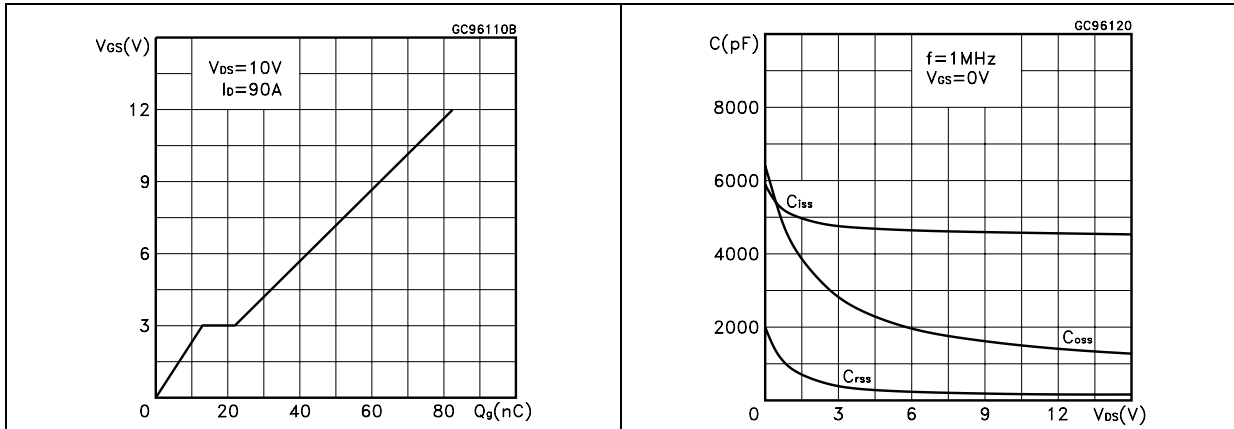


Figure 9. Normalized gate threshold voltage vs temperature Figure 10. Normalized on resistance vs temperature

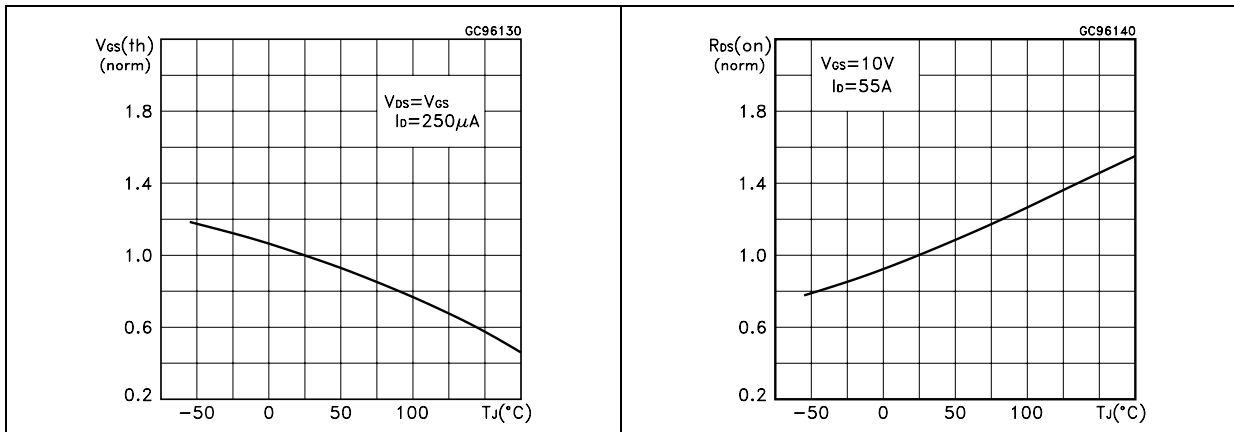
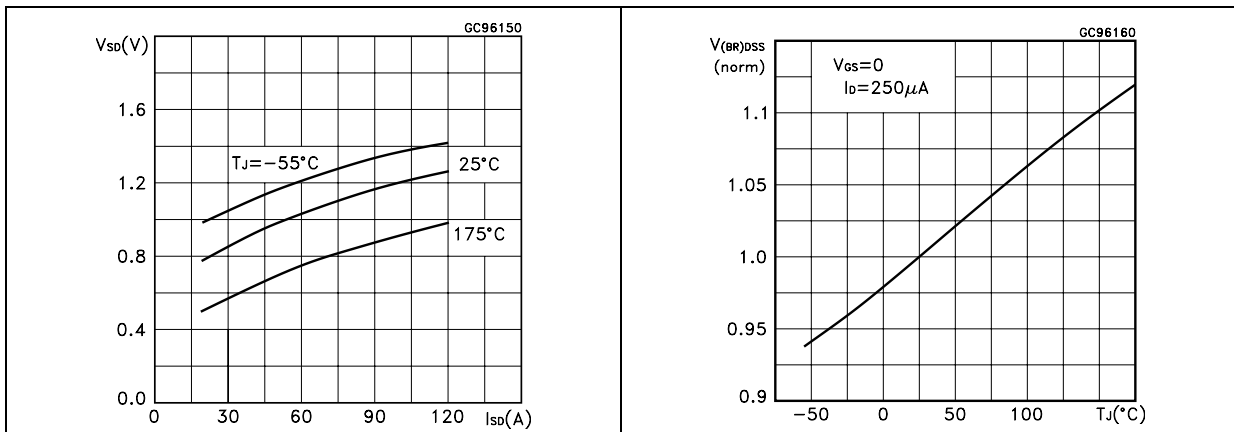


Figure 11. Source-drain diode forward characteristics Figure 12. Normalized $B_{V_{DS}}$ vs temperature



3 Test circuit

Figure 13. Switching times test circuit for resistive load

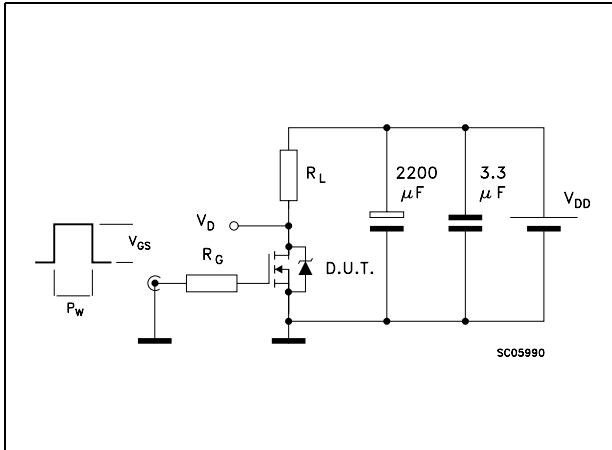


Figure 14. Gate charge test circuit



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

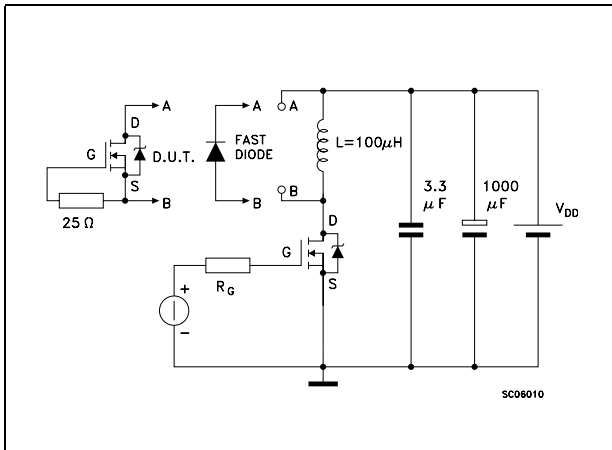


Figure 16. Unclamped Inductive load test circuit



Figure 17. Unclamped inductive waveform

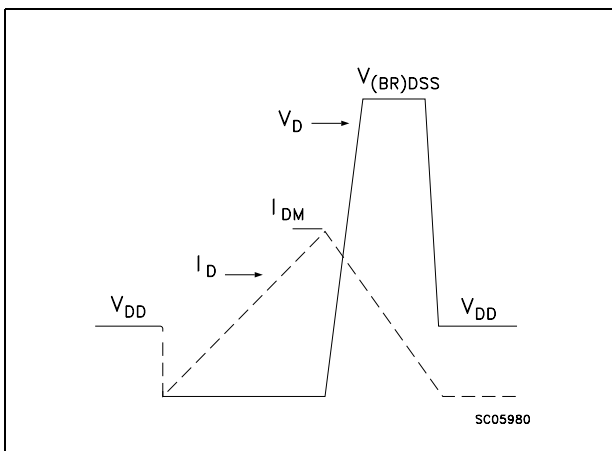


Figure 18. Switching time waveform

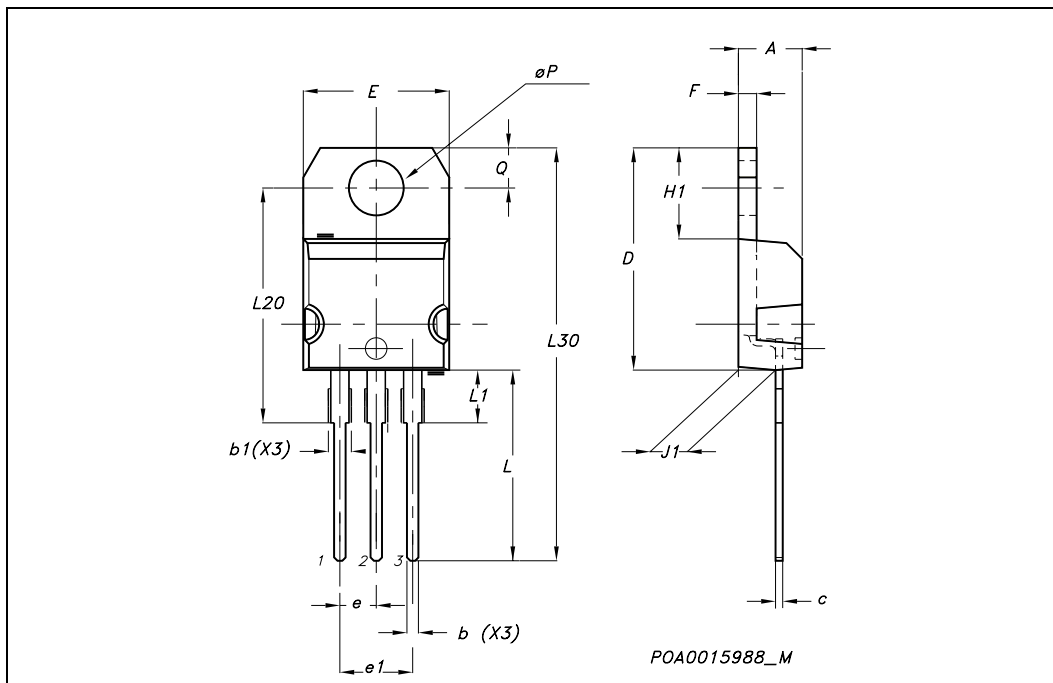


4 Package mechanical data

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

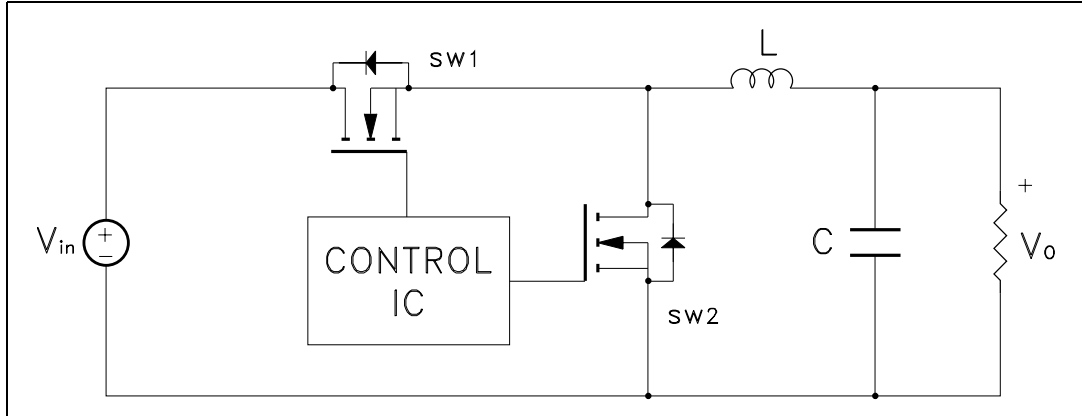
TO-220 MECHANICAL DATA

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



5 Appendix A

Figure 19. 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 (1)	Not applicable	$V_{in} * Q_{rr(SW2)} * f$
	Conduction	Not applicable	$V_{f(SW2)} * I_L * t_{deadtime} * f$
Pgate(QG)		$Q_{g(SW1)} * V_{gg} * f$	$Q_{gls(SW2)} * V_{gg} * f$
PQoss		$\frac{V_{in} * Q_{oss(SW1)} * f}{2}$	$\frac{V_{in} * Q_{oss(SW2)} * f}{2}$

1. Dissipated by SW1 during turn-on

Table 7. Parameters meaning

Parameter	Meaning
d	Duty-cycle
Qgsth	Post threshold gate charge
Qgls	Third quadrant gate charge
Pconduction	On state losses
Pswitching	On-off transition losses
Pdiode	Conduction and reverse recovery diode losses
Pgate	Gate drive losses
PQoss	Output capacitance losses

6 Revision history

Table 8. Revision history

Date	Revision	Changes
14-Mar-2005	4	Preliminary document
24-Mar-2005	5	New package inserted (TO-220)
19-Jun-2006	6	New template, no content change
13-Apr-2007	7	Package removed (D ² PAK)

Please Read Carefully:

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

UNLESS EXPRESSLY APPROVED IN WRITING BY AN AUTHORIZED REPRESENTATIVE OF ST, ST PRODUCTS ARE NOT DESIGNED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS, WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE.

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2007 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

www.st.com