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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

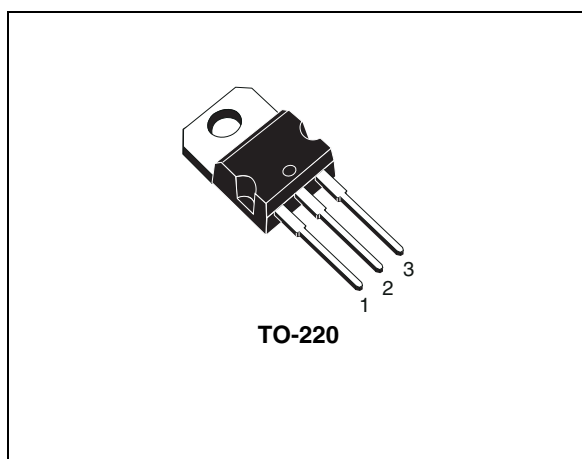
- R_{DS(on)} *Qg industry's benchmark Low
- Conduction losses reduced
- Switching losses reduced
- Low Threshold device

Description

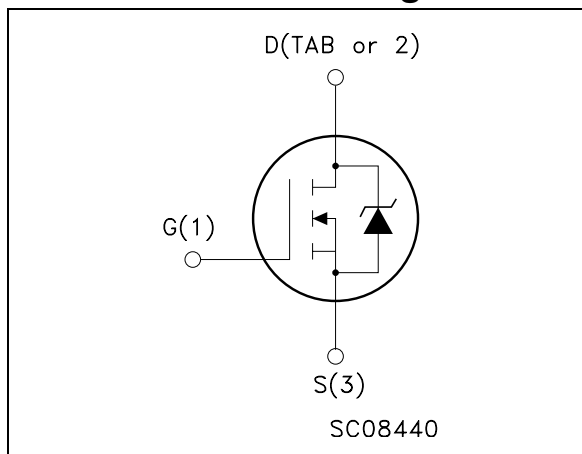
These devices utilizes the latest advanced design rules of ST's proprietary STripFET™ technology. It is ideal in high performance DC-DC converter applications where efficiency is to be achieved at very high output currents.

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

STP130NH02L
Electrical ratings

1 Electrical ratings

Table 1.

Symbol	Parameter	Value	Unit
$V_{spike}^{(1)}$	Drain-source voltage rating	30	V
V_{DS}	Drain-source voltage ($V_{GS} = 0$)	24	V
V_{DGR}	Drain-gate voltage ($R_{GS} = 20\text{ k}\Omega$)	24	V
V_{GS}	Gate- source voltage	± 20	V
$I_D^{(2)}$	Drain current (continuous) at $T_C = 25^\circ\text{C}$	90	A
$I_D^{(2)}$	Drain current (continuous) at $T_C = 100^\circ\text{C}$	90	A
$I_{DM}^{(3)}$	Drain current (pulsed)	360	A
P_{tot}	Total dissipation at $T_C = 25^\circ\text{C}$	150	W
	Derating factor	1	W/ $^\circ\text{C}$
$E_{AS}^{(4)}$	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 $R_g=4.7\ \Omega$ and $t_f < t_{fmax}$

2. Value limited by wire bonding

3. Pulse width limited by safe operating area

 4. Starting $T_J = 25^\circ\text{C}$, $I_D = 45\text{A}$, $V_{DD} = 10\text{V}$
Table 2. Thermal data

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

Electrical characteristics

STP130NH02L

2 Electrical characteristics

(T_{CASE}=25°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} = Max rating, V _{DS} = Max rating, T _C =125°C			1 10	μA μA
I _{GSS}	Gate body leakage current (V _{DS} = 0)	V _{GS} = ±20V			±100	μA
V _{GS(th)}	Gate threshold voltage	V _{DS} = V _{GS} , I _D = 250μA	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 = 4.7Ω, 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 = 300μs, duty cycle 1.5%
2. Q_{oss} = C_{oss}* ΔV_{IN}, C_{oss} = C_{gd} + C_{ds}. See power losses calculation
3. Gate charge for synchronous operation.

STP130NH02L
Electrical characteristics
Table 5. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current				90	A
I_{SDM}	Source-drain current (pulsed)				360	A
$V_{SD}^{(1)}$	Forward on voltage	$I_{SD} = 45A, V_{GS} = 0$			1.3	V
t_{rr}	Reverse recovery time	$I_{SD} = 90A,$ $di/dt = 100A/\mu s,$ $V_{DD} = 15V, T_J = 150^\circ C$		47		ns
Q_{rr}	Reverse recovery charge			58		nC
I_{RRM}	Reverse recovery current			2.5		A

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

Electrical characteristics

STP130NH02L

2.1 Electrical characteristics (curves)

Figure 1. Safe operating area

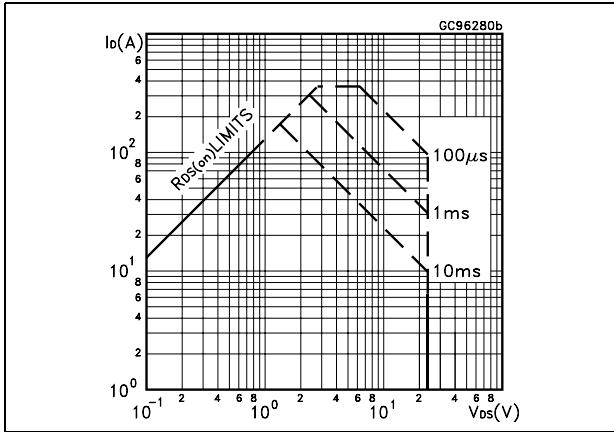


Figure 2. Thermal impedance

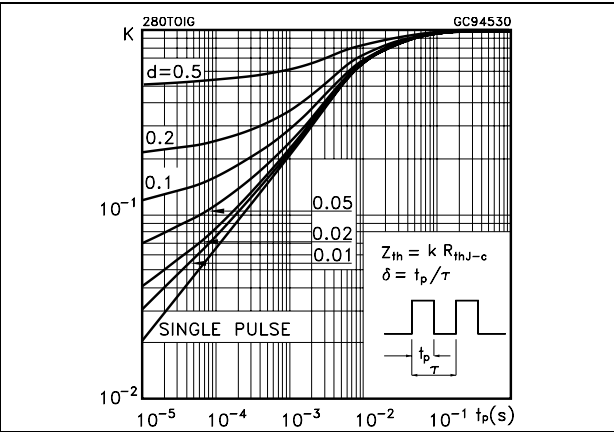


Figure 3. Output characteristics

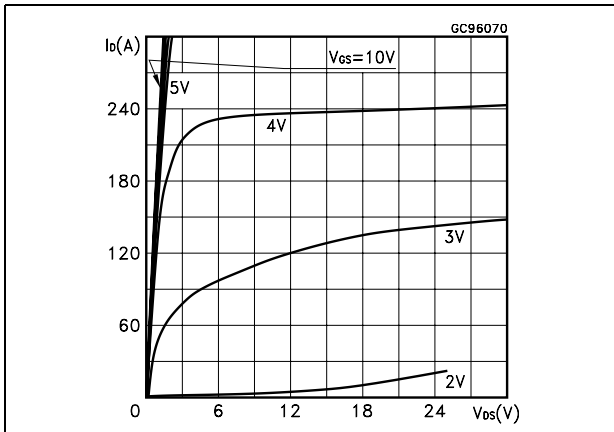


Figure 4. Transfer characteristics

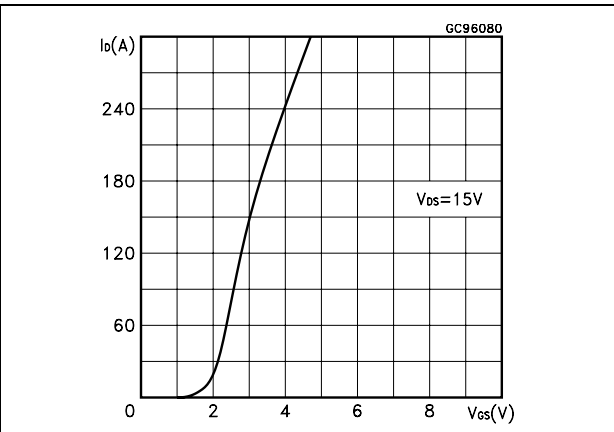


Figure 5. Transconductance

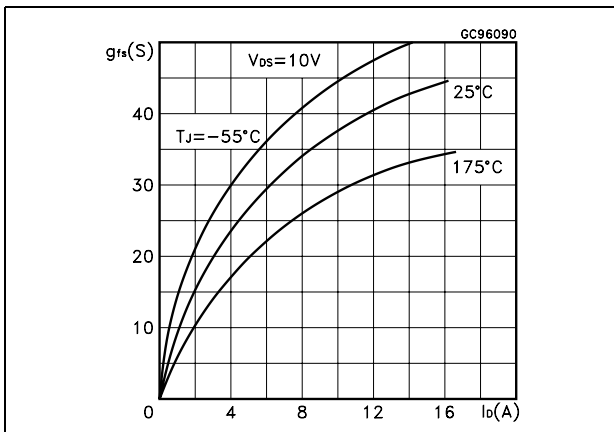
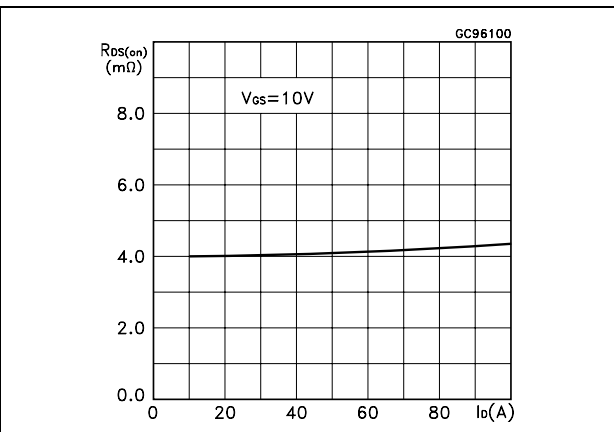


Figure 6. Static drain-source on resistance



STP130NH02L

Electrical characteristics

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

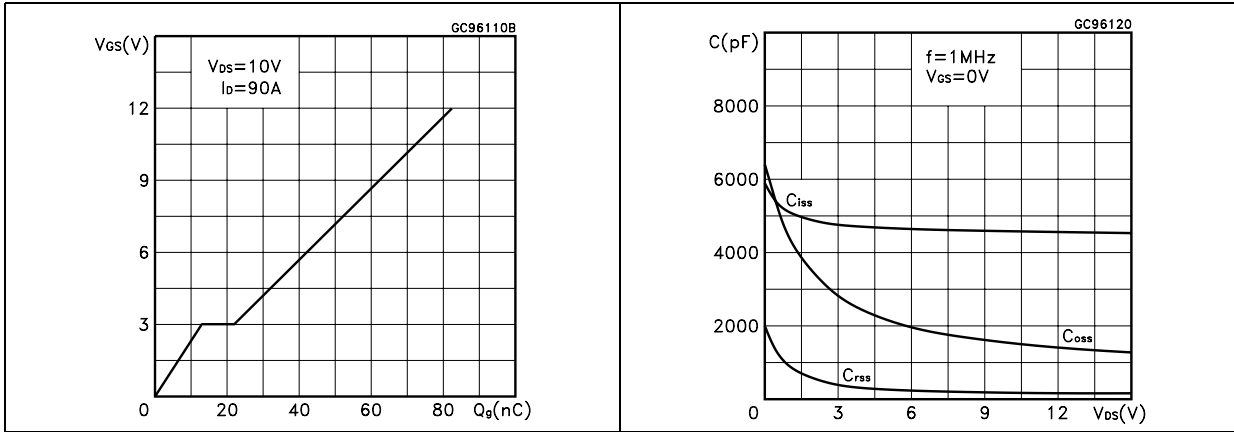


Figure 9. Normalized gate threshold voltage vs temperature **Figure 10. Normalized on resistance vs temperature**

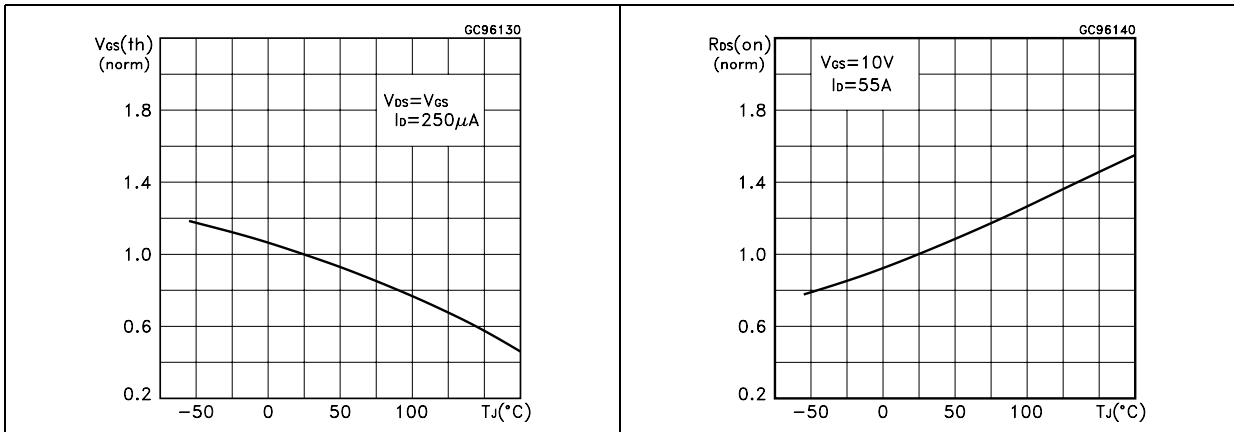
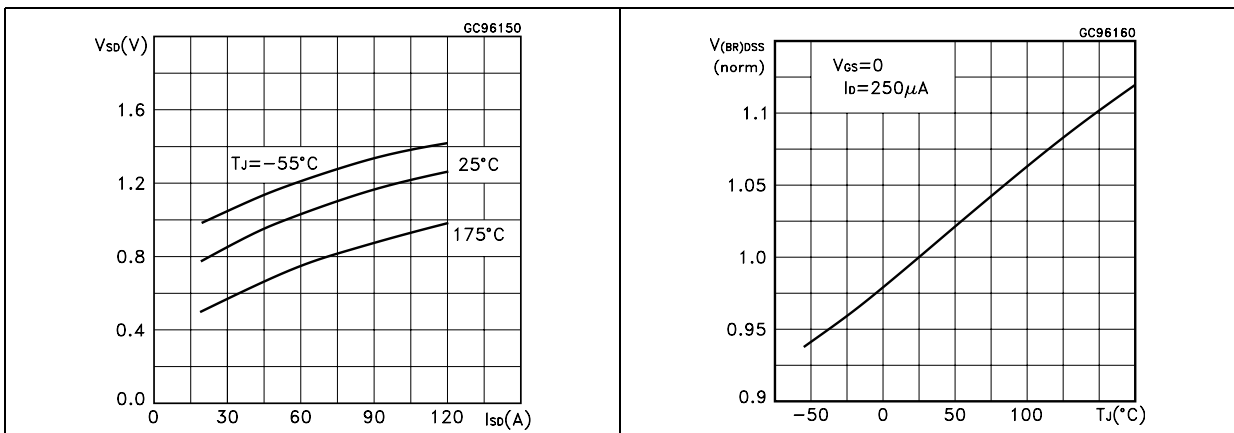


Figure 11. Source-drain diode forward characteristics **Figure 12. Normalized B_{VDS} vs temperature**



Test circuit

STP130NH02L

3 Test circuit

Figure 13. Switching times test circuit for resistive load

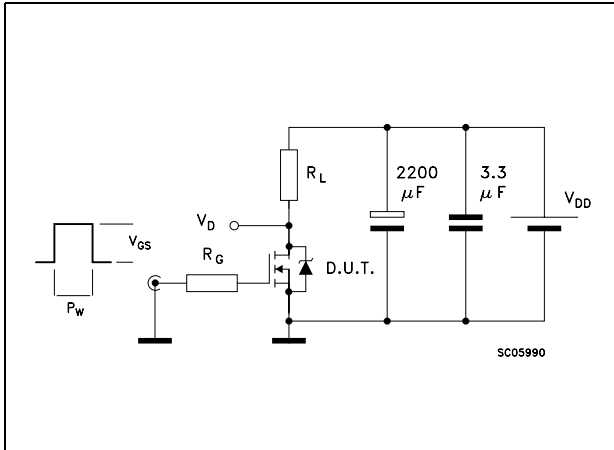


Figure 14. Gate charge test circuit

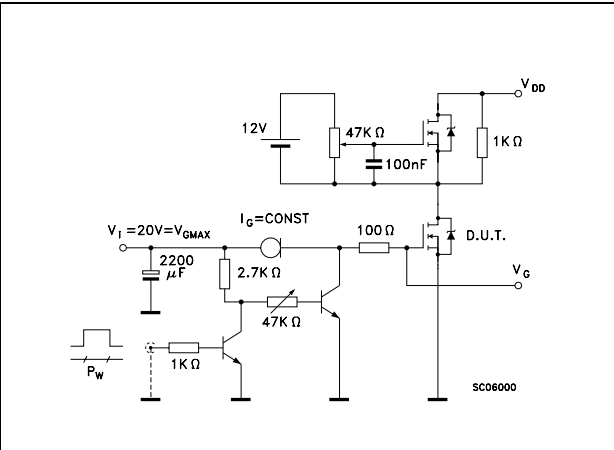


Figure 15. Test circuit for inductive load switching and diode recovery times

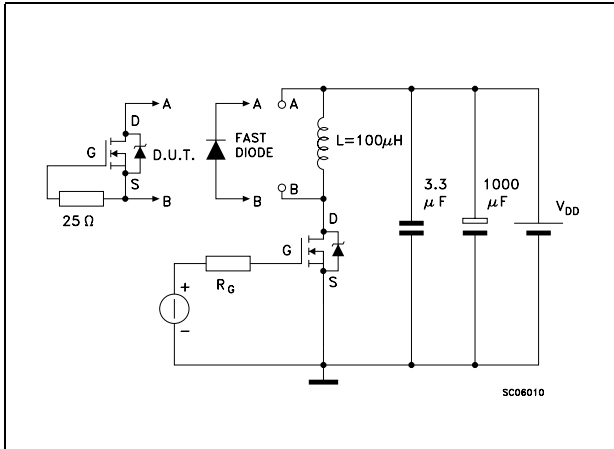


Figure 16. Unclamped Inductive load test circuit

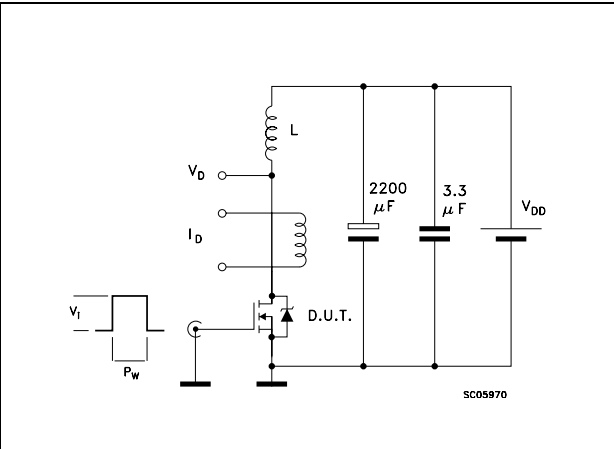


Figure 17. Unclamped inductive waveform

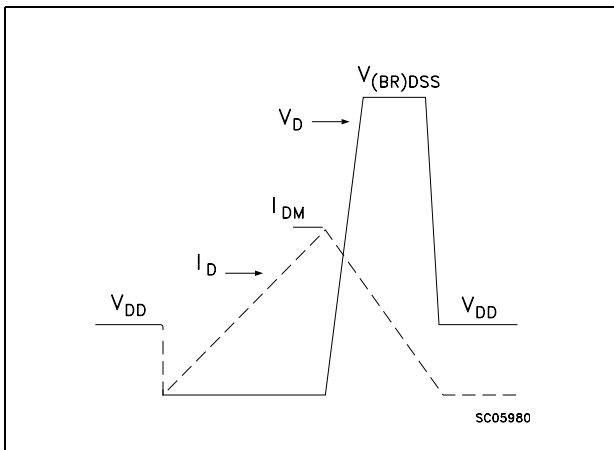
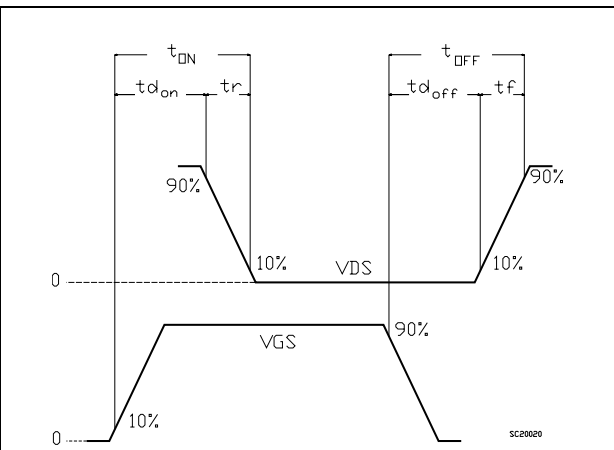


Figure 18. Switching time waveform



4 Package mechanical data

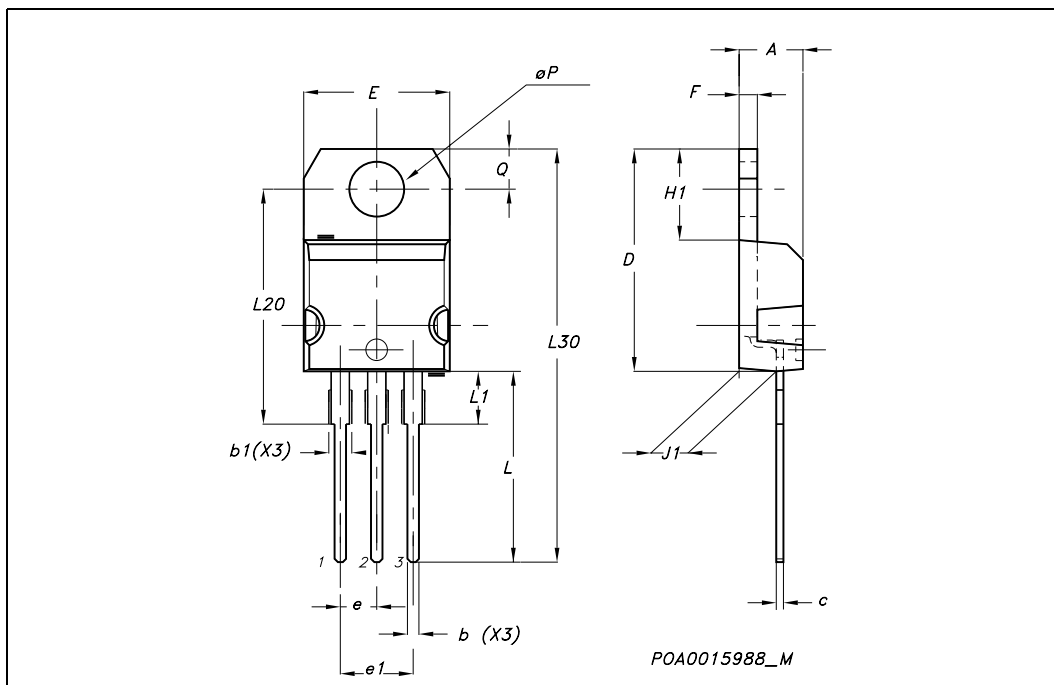
In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings 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

Package mechanical data

STP130NH02L

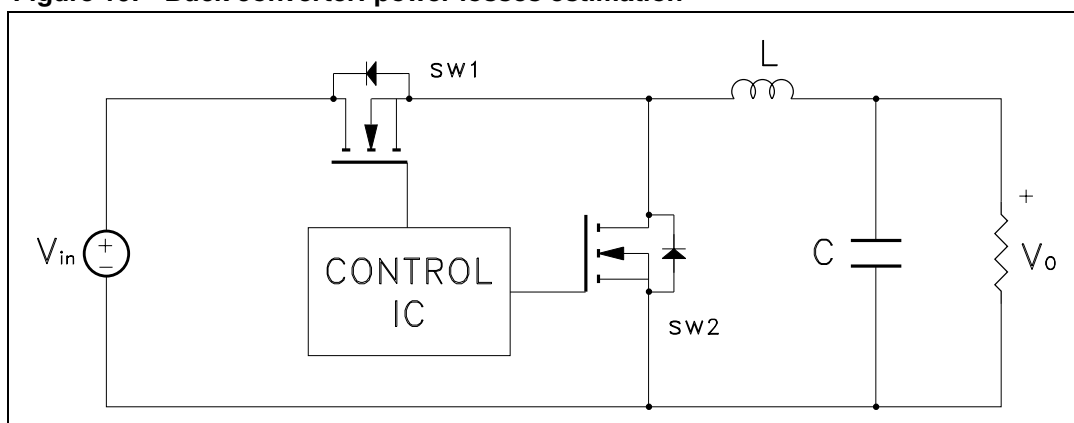
TO-220 MECHANICAL DATA

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.

Appendix A
STP130NH02L
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(Q _G)		$Q_{g(SW1)} * V_{gg} * f$	$Q_{gls(SW2)} * V_{gg} * f$
P _{Qoss}		$\frac{V_{in} * Q_{oss(SW1)} * f}{2}$	$\frac{V_{in} * Q_{oss(SW2)} * f}{2}$

1. Dissipated by SW1 during turn-on

Table 7. Parameters meaning

Parameter	Meaning
d	Duty-cycle
Q _{gsth}	Post threshold gate charge
Q _{gls}	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 _{Qoss}	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)

STP130NH02L

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