



# STP130NH02L

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

## Features

Type	V <sub>DSS</sub>	R <sub>DS(on)</sub>	I <sub>D</sub>
STP130NH02L	24V	<0.0044Ω	90 <sup>(1)</sup>

1. Value limited by wire bonding

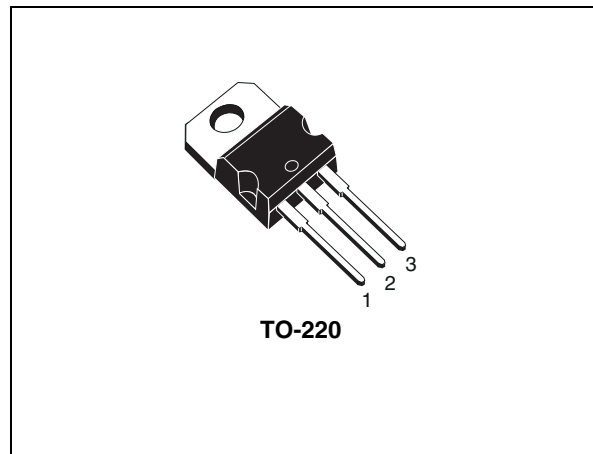
- R<sub>DS(on)</sub> \*Qg industry's benchmark Low
- Conduction losses reduced
- Switching losses reduced
- Low Threshold device

## Description

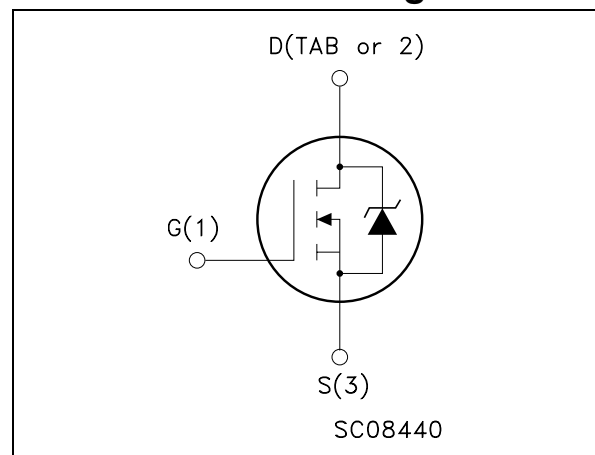
These devices utilizes the latest advanced design rules of ST's proprietary STripFET™ technology. It is ideal in high performance DC-DC converter applications where efficiency is to be achieved at very high output currents.

## Application

- Switching application



## Internal schematic diagram



## Order code

Part number	Marking	Package	Packaging
STP130NH02L	P130NH02L	TO-220	Tube

# Contents

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# 1 Electrical ratings

Table 1.

Symbol	Parameter	Value	Unit
$V_{\text{spike}}^{(1)}$	Drain-source voltage rating	30	V
$V_{\text{DS}}$	Drain-source voltage ( $V_{\text{GS}} = 0$ )	24	V
$V_{\text{DGR}}$	Drain-gate voltage ( $R_{\text{GS}} = 20 \text{ k}\Omega$ )	24	V
$V_{\text{GS}}$	Gate- source voltage	$\pm 20$	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
$P_{\text{tot}}$	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
$T_{\text{stg}}$	Storage temperature	-55 to 175	$^{\circ}\text{C}$
$T_{\text{j}}$	Max. operating junction temperature		

1. Guaranteed when external  $R_{\text{g}}=4.7 \text{ }\Omega$  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	$^{\circ}\text{C}/\text{W}$
$T_{\text{l}}$	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	$\mu A$ $\mu A$
$I_{GSS}$	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			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	$\Omega$ $\Omega$

**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 <a href="#">Figure 13</a> )		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		$\Omega$
$Q_g$ $Q_{gs}$ $Q_{gd}$	Total gate charge Gate-source charge Gate-drain charge	$V_{DD}=10V, I_D = 90A$ $V_{GS} = 10V$ (see <a href="#">Figure 14</a> )		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 $\mu s$ , 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 $\mu$ s, duty cycle 1.5%

## 2.1 Electrical characteristics (curves)

Figure 1. Safe operating area

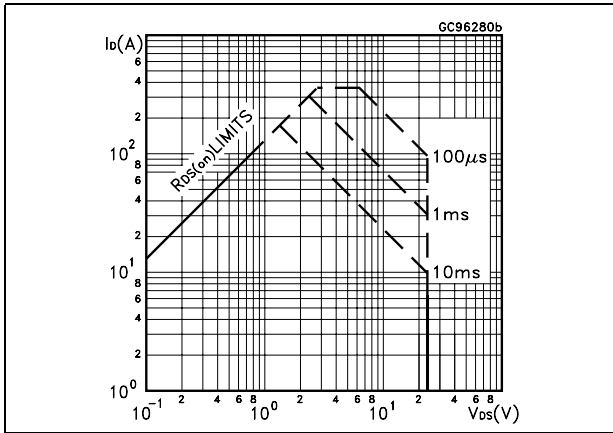


Figure 2. Thermal impedance

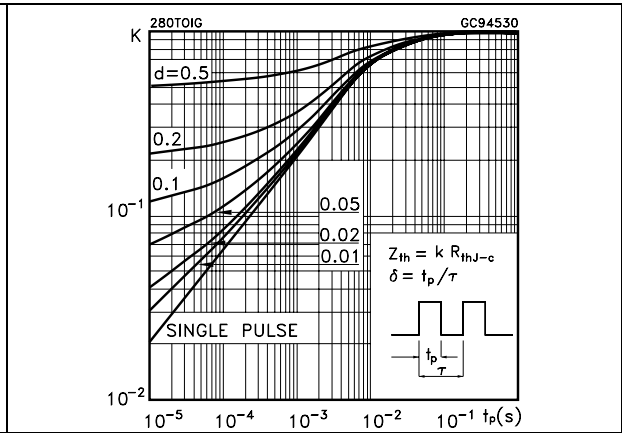


Figure 3. Output characteristics

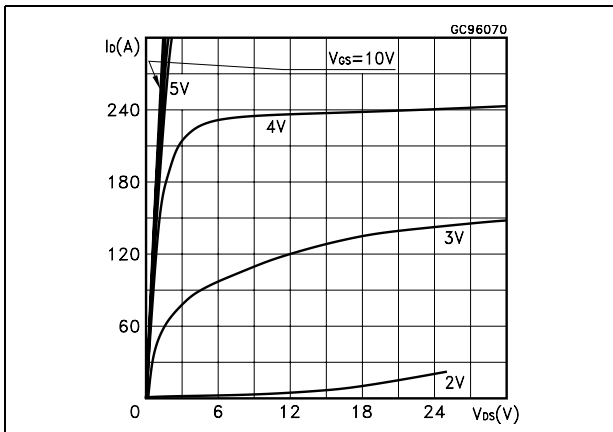


Figure 4. Transfer characteristics

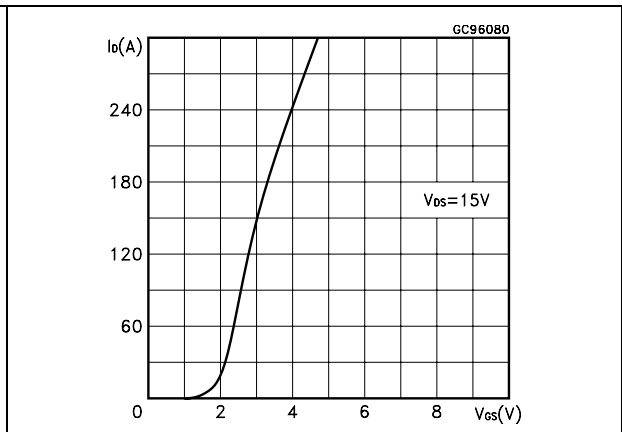


Figure 5. Transconductance

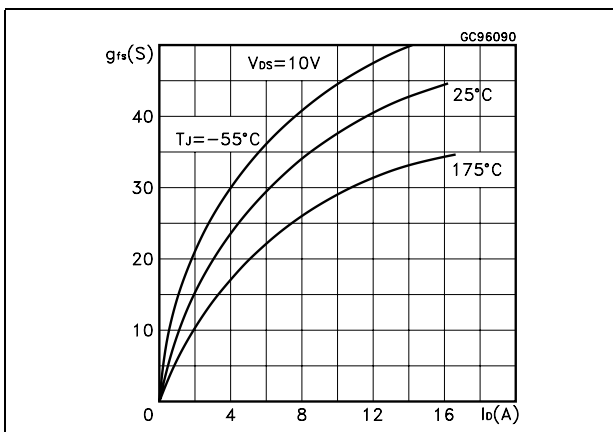


Figure 6. Static drain-source on resistance

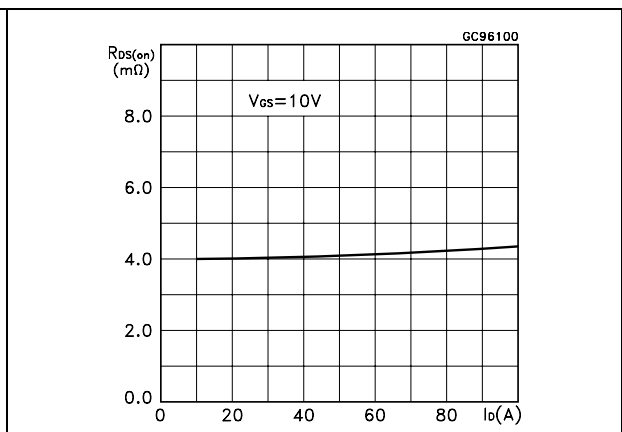


Figure 7. Gate charge vs gate-source voltage Figure 8. Capacitance variations

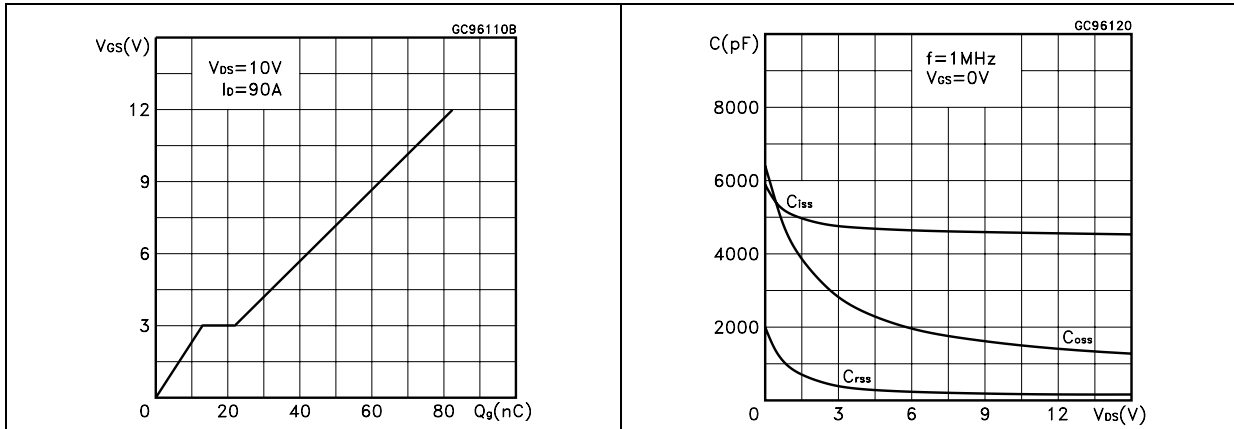


Figure 9. Normalized gate threshold voltage vs temperature Figure 10. Normalized on resistance vs temperature

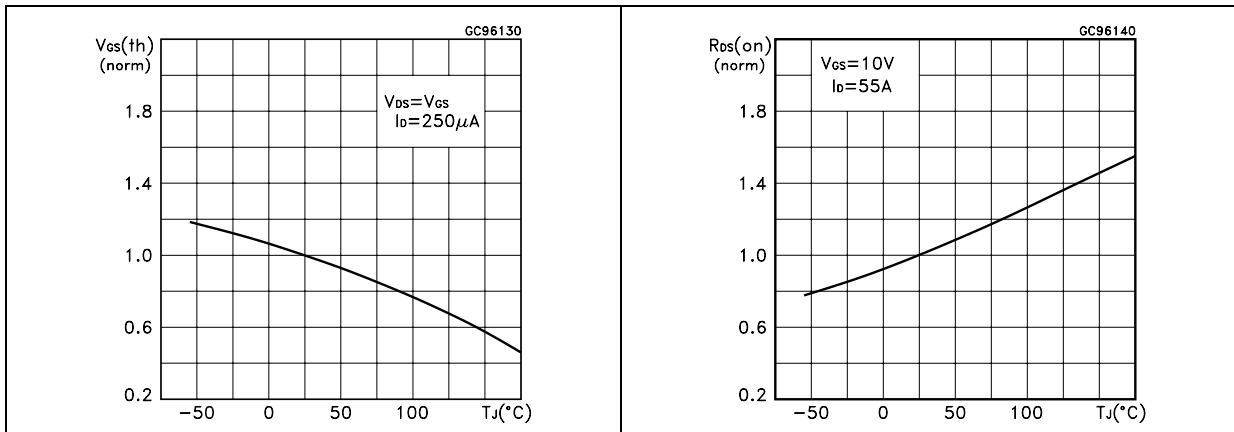
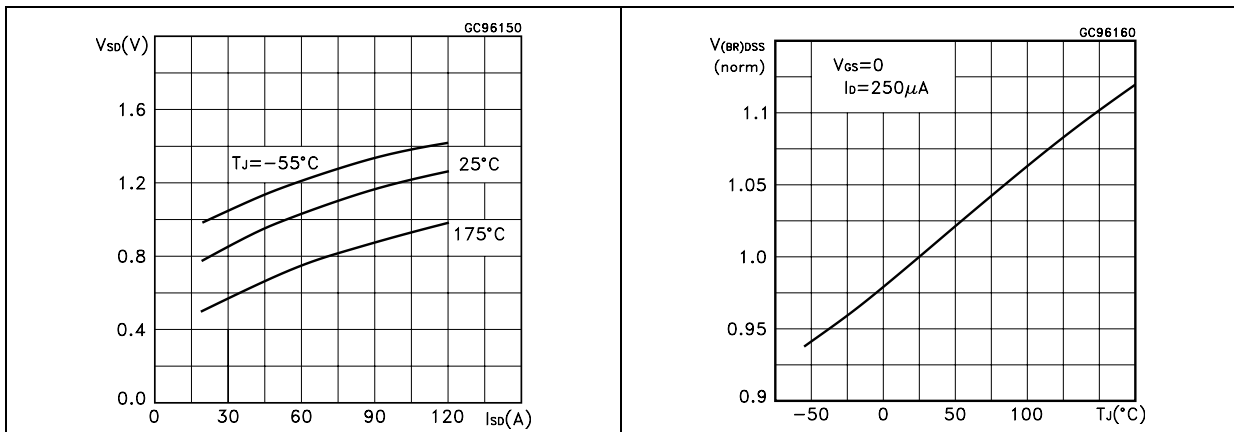


Figure 11. Source-drain diode forward characteristics Figure 12. Normalized  $B_{V_{DS}}$  vs temperature



### 3 Test circuit

Figure 13. Switching times test circuit for resistive load



Figure 14. Gate charge test circuit

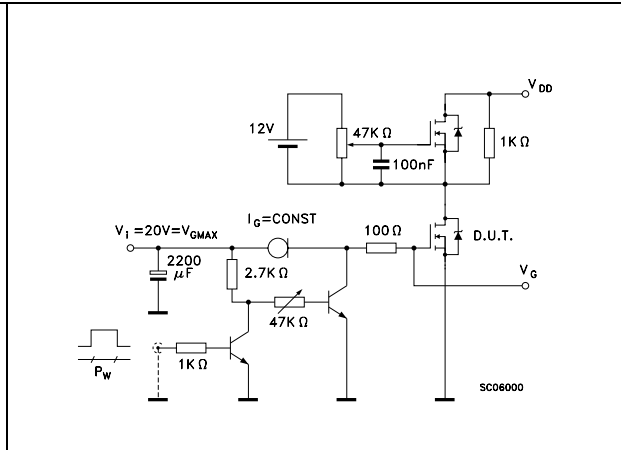


Figure 15. Test circuit for inductive load switching and diode recovery times



Figure 16. Unclamped Inductive load test circuit

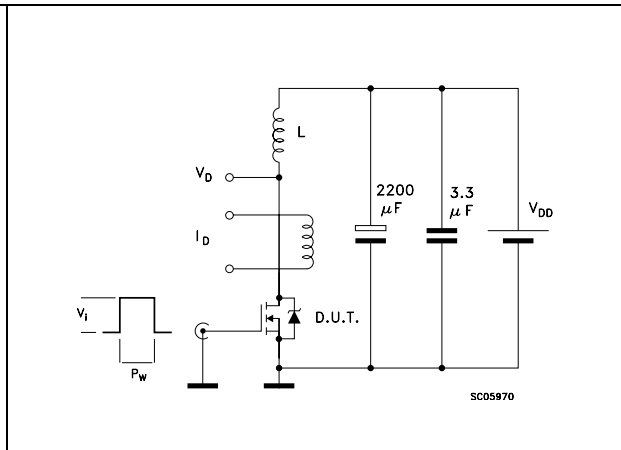
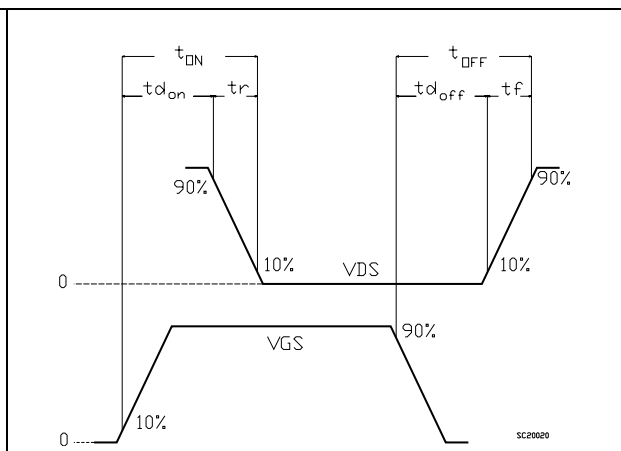


Figure 17. Unclamped inductive waveform



Figure 18. Switching time waveform



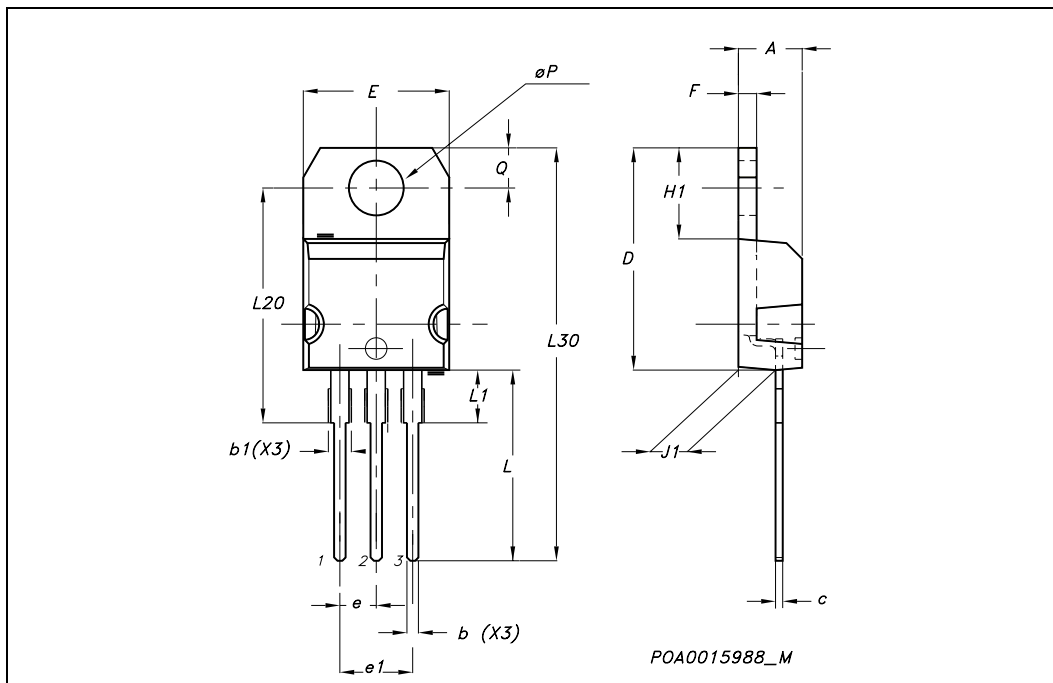


## 4 Package mechanical data

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](http://www.st.com)

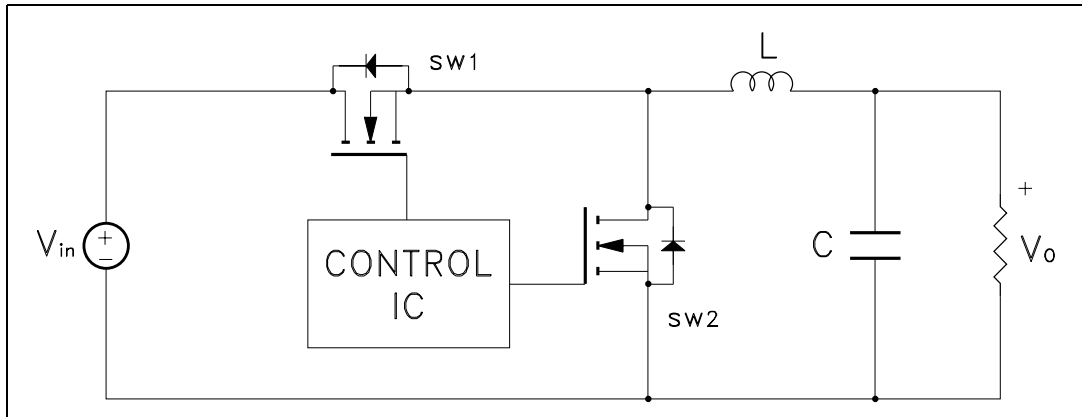
**TO-220 MECHANICAL DATA**

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



## 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**

<b>Date</b>	<b>Revision</b>	<b>Changes</b>
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 <sup>2</sup> PAK)

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