



STD90N03L STD90N03L-1

N-channel 30V - 0.005Ω - 80A - DPAK/IPAK
STripFET™ III Power MOSFET

General features

| Type | V _{DSS} | R _{DS(on)} | I _D |
|-------------|------------------|---------------------|--------------------|
| STD90N03L | 30V | 0.0057Ω | 80A ⁽¹⁾ |
| STD90N03L-1 | 30V | 0.0057Ω | 80A ⁽¹⁾ |

1. Pulse width limited by safe operating area

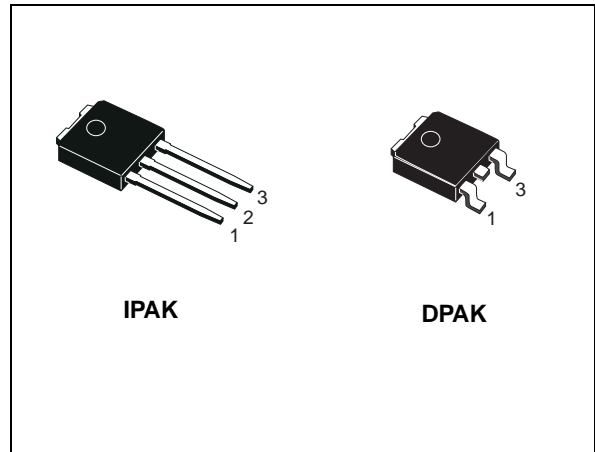
- R_{DS(on)}*Q_g industry's benchmark
- Conduction losses reduced
- Switching losses reduced
- Low threshold device

Description

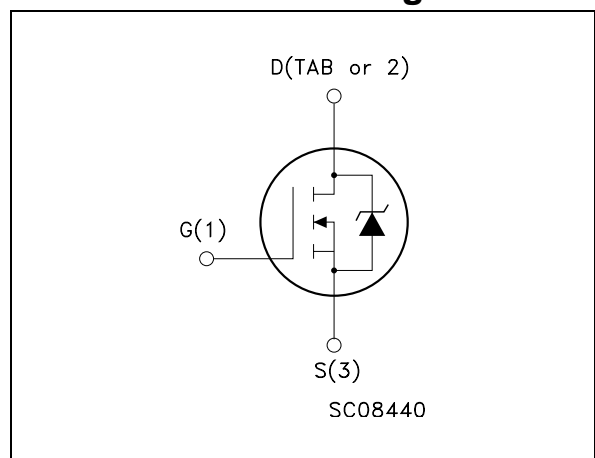
This device utilizes the latest advanced design rules of ST's proprietary STripFET™ technology. This is suitable for the most demanding DC-DC converter application where high efficiency is to be achieved.

Applications

- Switching applications



Internal schematic diagram



Order codes

| Part number | Marking | Package | Packaging |
|-------------|-----------|---------|-------------|
| STD90N03L | D90N03L | DPAK | Tape & reel |
| STD90N03L-1 | D90N03L-1 | IPAK | Tube |

Content

1 **Electrical ratings** 3

2 **Electrical characteristics** 4

 2.1 Electrical characteristics (curves) 6

3 **Test circuit** 8

4 **Package mechanical data** 11

5 **Packaging mechanical data** 14

6 **Revision history** 15

1 Electrical ratings

Table 1. Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|--------------------|---|------------|---------------------|
| V_{DS} | Drain-source voltage ($V_{GS} = 0$) | 30 | V |
| V_{GS} | Gate-source voltage | ± 20 | V |
| $I_D^{(1)}$ | Drain current (continuous) at $T_C = 25^\circ\text{C}$ | 80 | A |
| I_D | Drain current (continuous) at $T_C = 100^\circ\text{C}$ | 64 | A |
| $I_{DM}^{(2)}$ | Drain current (pulsed) | 320 | A |
| P_{TOT} | Total dissipation at $T_C = 25^\circ\text{C}$ | 95 | W |
| | Derating factor | 0.63 | W/ $^\circ\text{C}$ |
| $E_{AS}^{(3)}$ | Single pulse avalanche energy | 350 | mJ |
| T_J T_{stg} | Operating junction temperature Storage temperature | -55 to 175 | $^\circ\text{C}$ |

1. Value limited by wire bonding
2. Pulse width limited by safe operating area
3. Starting $T_J = 25^\circ\text{C}$, $I_D = 40\text{A}$, $V_{DD} = 15\text{V}$

Table 2. Thermal data

| Symbol | Parameter | Value | Unit |
|----------------|--|-------|--------------------|
| $R_{thj-case}$ | Thermal resistance junction-case max | 1.58 | $^\circ\text{C/W}$ |
| $R_{thj-amb}$ | Thermal resistance junction-ambient max | 100 | $^\circ\text{C/W}$ |
| T_J | Maximum lead temperature for soldering purpose | 275 | $^\circ\text{C}$ |

2 Electrical characteristics

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

Table 3. On/off states

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------|--|---|------|----------------|------------------|--------------------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $I_D = 250\mu\text{A}$, $V_{GS} = 0$ | 30 | | | V |
| I_{DSS} | Zero gate voltage drain current ($V_{GS} = 0$) | $V_{DS} = 30\text{V}$ $V_{DS} = 30\text{V}$, $T_C=125^{\circ}\text{C}$ | | | 1 10 | μA μA |
| I_{GSS} | Gate body leakage current ($V_{DS} = 0$) | $V_{GS} = \pm 20\text{V}$ | | | ± 100 | nA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS} = V_{GS}$, $I_D = 250\mu\text{A}$ | 1 | | | V |
| $R_{DS(on)}$ | Static drain-source on resistance | $V_{GS} = 10\text{V}$, $I_D = 40\text{A}$ $V_{GS} = 5\text{V}$, $I_D = 40\text{A}$ | | 0.005 0.007 | 0.0057 0.0011 | Ω Ω |

Table 4. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-------------------------------------|---|---|------|-------------------|------|----------------|
| C_{iss} C_{oss} C_{rss} | Input capacitance Output capacitance Reverse transfer capacitance | $V_{DS} = 25\text{V}$, $f = 1\text{MHz}$, $V_{GS} = 0$ | | 2805 549 76 | | pF pF pF |
| Q_g Q_{gs} Q_{gd} | Total gate charge Gate-source charge Gate-drain charge | $V_{DD} = 15\text{V}$, $I_D = 80\text{A}$ $V_{GS} = 5\text{V}$ (see Figure 13) | | 22 10 7 | 32 | nC nC nC |
| R_G | Gate input resistance | $f = 1\text{MHz}$ Gate Bias Bias=0 Test Signal Level=20mV open drain | | 1.2 | | Ω |

Table 5. Switching times

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------------|----------------------------------|---|------|-----------|------|----------|
| $t_{d(on)}$ t_r | Turn-on delay time Rise time | $V_{DD} = 15\text{V}$, $I_D = 40\text{A}$, $R_G = 4.7\Omega$, $V_{GS} = 5\text{V}$ (see Figure 12) | | 19 135 | | ns ns |
| $t_{d(off)}$ t_f | Turn-off delay time Fall time | $V_{DD} = 15\text{V}$, $I_D = 40\text{A}$, $R_G = 4.7\Omega$, $V_{GS} = 5\text{V}$ (see Figure 12) | | 24 33 | | ns ns |

Table 6. Source drain diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|--|------|------|------|---------|
| I_{SD} | Source-drain current | | | | 80 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | | | 320 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $I_{SD}=40A$, $V_{GS}=0$ | | | 1.3 | V |
| t_{rr} | Reverse recovery time | $I_{SD}=80A$, $di/dt = 100A/\mu s$, $V_{DD}=19V$, $T_j = 150^\circ C$ (see Figure 15) | | 36 | | ns |
| Q_{rr} | Reverse recovery charge | | | 32 | | μC |
| I_{RRM} | Reverse recovery current | | | 1.8 | | A |

1. Pulse width limited by safe operating area

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

2.1 Electrical characteristics (curves)

Figure 1. Safe operating area

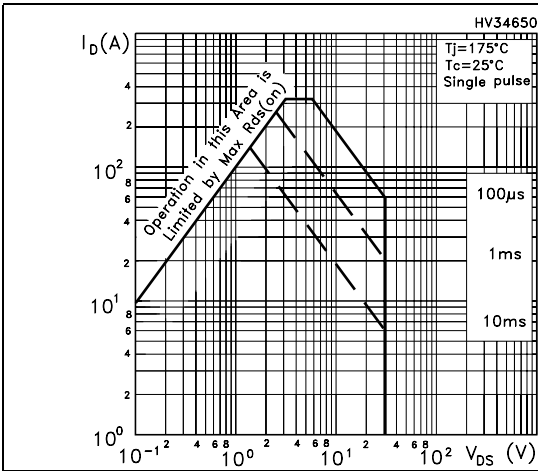


Figure 2. Thermal impedance

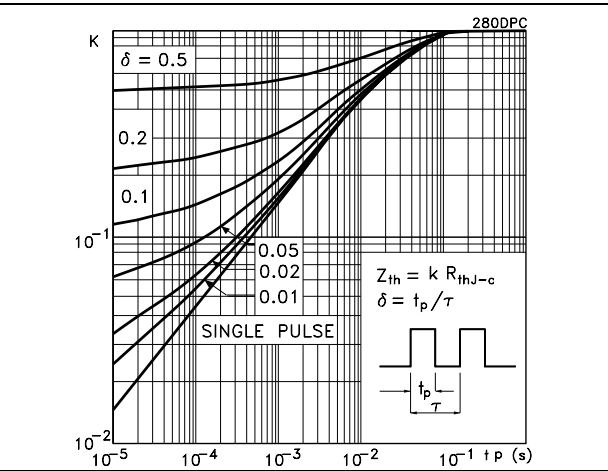


Figure 3. Output characteristics

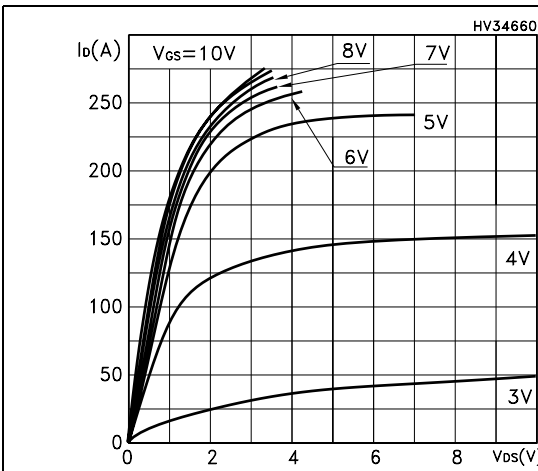


Figure 4. Transfer characteristics

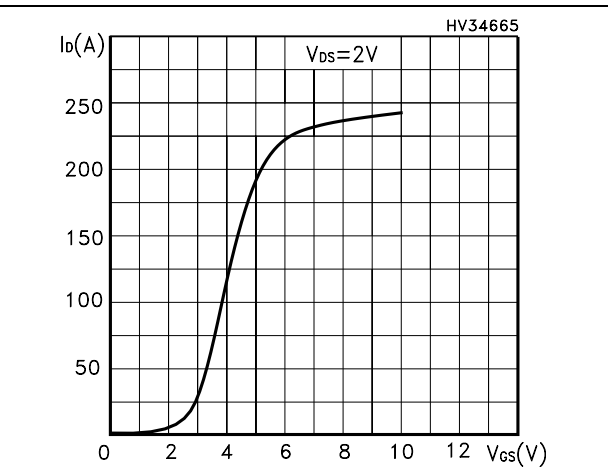


Figure 5. Static drain-source on resistance

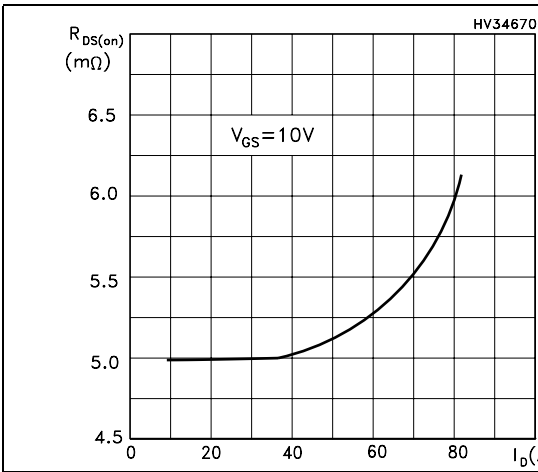


Figure 6. Normalized $B_{V_{DS}}$ vs temperature

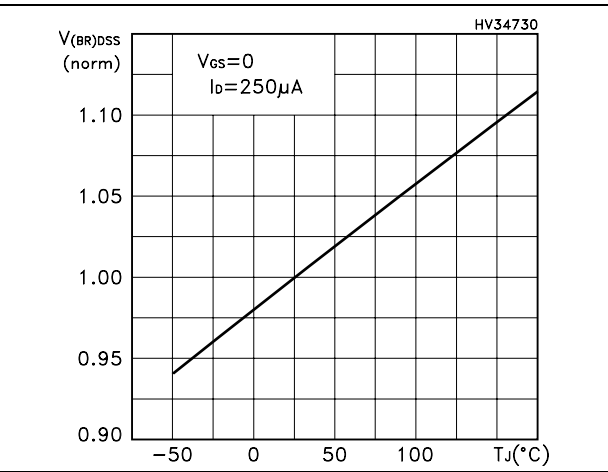


Figure 7. Gate charge vs gate-source voltage Figure 8. Capacitance variations

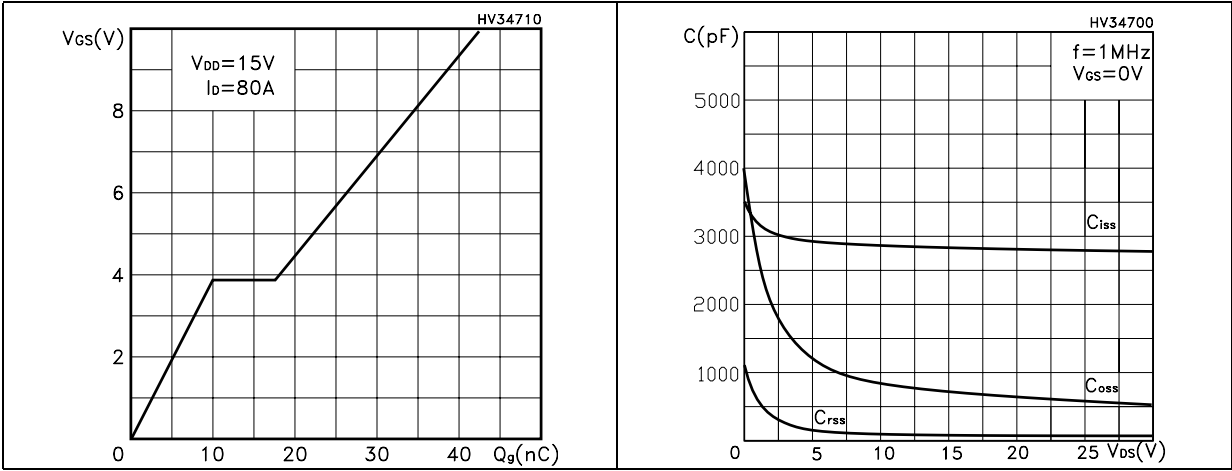


Figure 9. Normalized gate threshold voltage vs temperature Figure 10. Normalized on resistance vs temperature

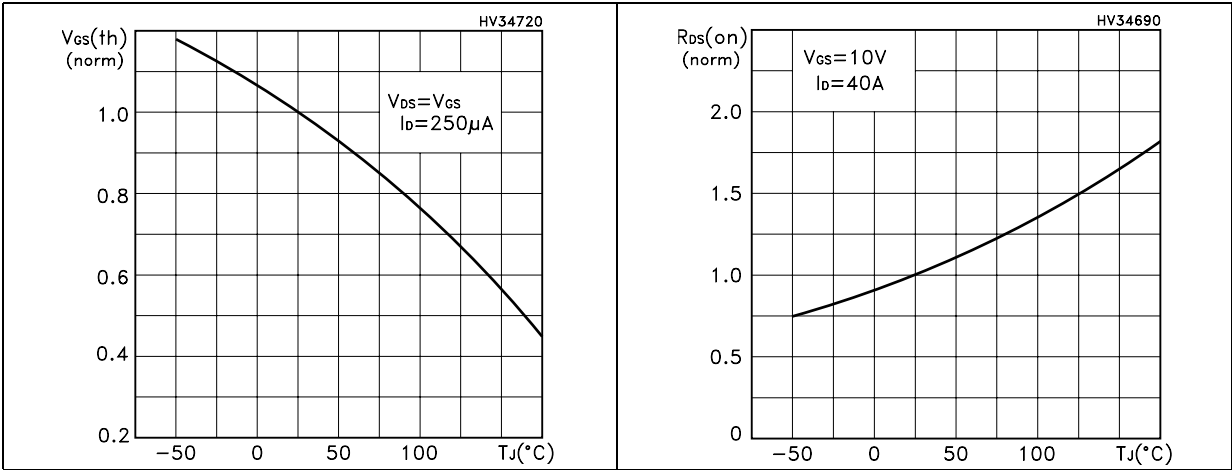
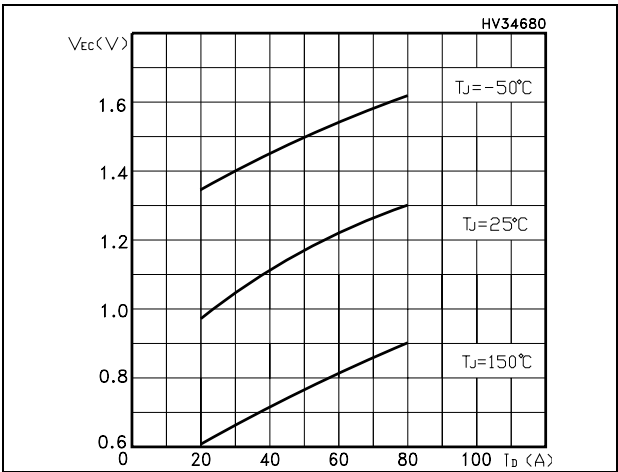


Figure 11. Source-drain diode forward characteristics



3 Test circuit

Figure 12. Switching times test circuit for resistive load

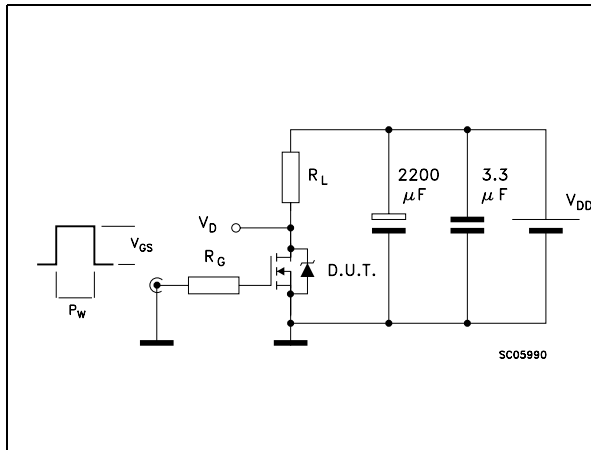


Figure 13. Gate charge test circuit

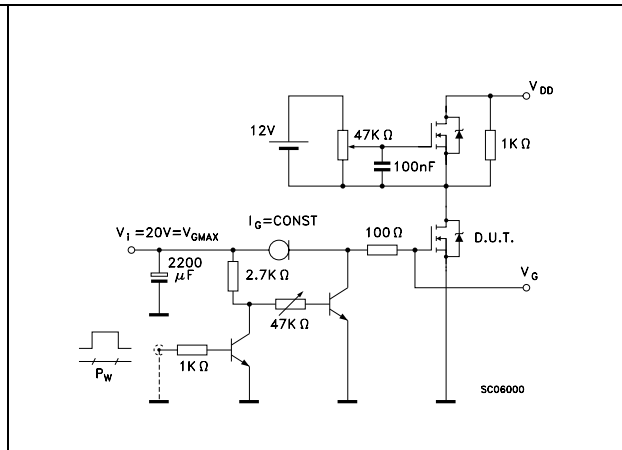


Figure 14. Test circuit for inductive load switching and diode recovery times

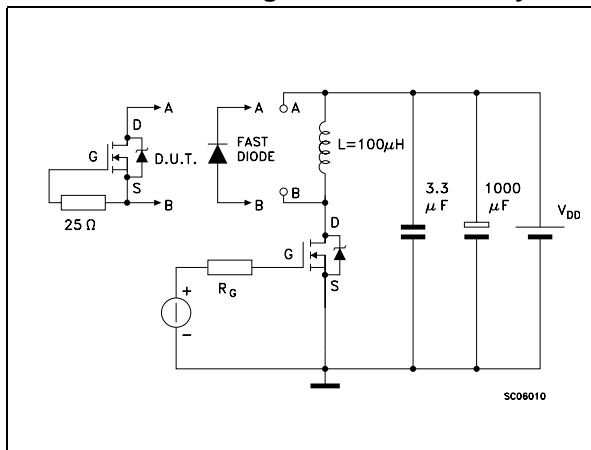
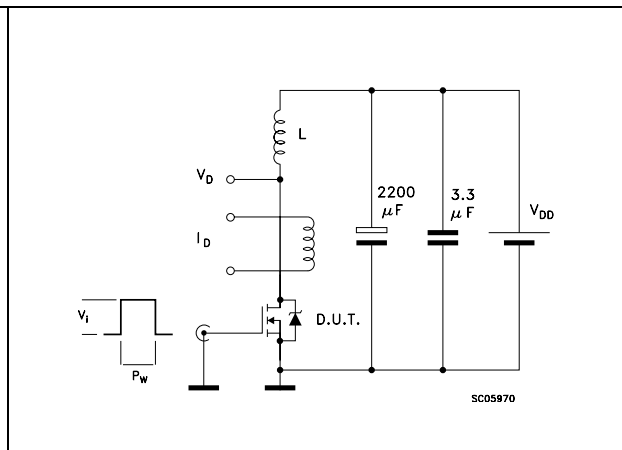
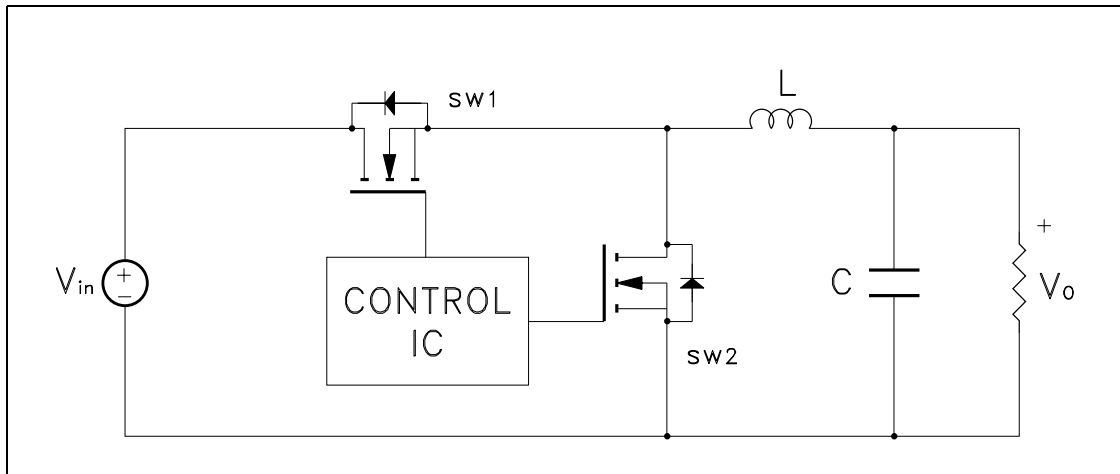


Figure 15. Unclamped Inductive load test circuit



Appendix A

Figure 16. 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 7. Power losses calculation

| | | High Side Switching (SW1) | Low Side Switch (SW2) |
|-------------------------|-----------------|---|---|
| $P_{\text{conduction}}$ | | $R_{\text{DS(on)SW1}} * I_L^2 * \delta$ | $R_{\text{DS(on)SW2}} * I_L^2 * (1 - \delta)$ |
| $P_{\text{switching}}$ | | $V_{\text{in}} * (Q_{\text{gsth(SW1)}} + Q_{\text{gd(SW1)}}) * f * \frac{I_L}{I_g}$ | Zero voltage switching |
| P_{diode} | Recovery (1) | Not applicable | $V_{\text{in}} * Q_{\text{rr(SW2)}} * f$ |
| | Conduction | Not applicable | $V_{\text{f(SW2)}} * I_L * t_{\text{deadtime}} * f$ |
| $P_{\text{gate(QG)}}$ | | $Q_{\text{g(SW1)}} * V_{\text{gg}} * f$ | $Q_{\text{gls(SW2)}} * V_{\text{gg}} * f$ |
| P_{Qoss} | | $\frac{V_{\text{in}} * Q_{\text{oss(SW1)}} * f}{2}$ | $\frac{V_{\text{in}} * Q_{\text{oss(SW2)}} * f}{2}$ |

1. Dissipated by SW1 during turn-on

Table 8. Paramiters meaning

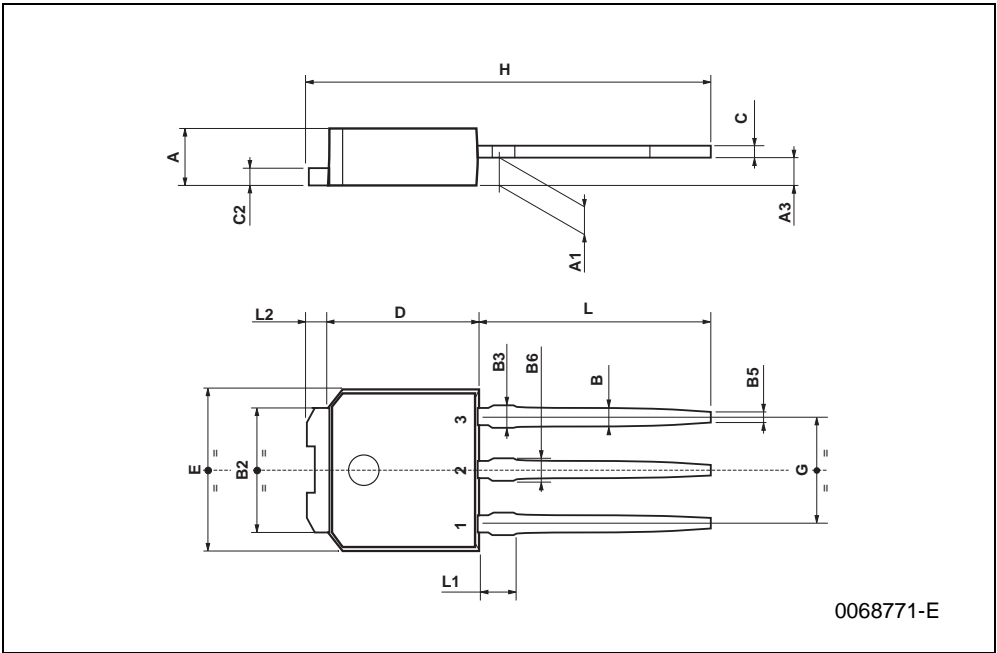
| Parameter | Meaning |
|-------------------------|--|
| d | Duty-cycle |
| Q_{gsth} | Post threshold gate charge |
| Q_{gls} | Third quadrant gate charge |
| $P_{\text{conduction}}$ | On state losses |
| $P_{\text{switching}}$ | On-off transition losses |
| P_{diode} | Conduction and reverse recovery diode losses |
| P_{gate} | Gate drive losses |
| P_{Qoss} | Output capacitance losses |

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-251 (IPAK) MECHANICAL DATA

| DIM. | mm | | | inch | | |
|------|------|------|------|-------|-------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 2.2 | | 2.4 | 0.086 | | 0.094 |
| A1 | 0.9 | | 1.1 | 0.035 | | 0.043 |
| A3 | 0.7 | | 1.3 | 0.027 | | 0.051 |
| B | 0.64 | | 0.9 | 0.025 | | 0.031 |
| B2 | 5.2 | | 5.4 | 0.204 | | 0.212 |
| B3 | | | 0.85 | | | 0.033 |
| B5 | | 0.3 | | | 0.012 | |
| B6 | | | 0.95 | | | 0.037 |
| C | 0.45 | | 0.6 | 0.017 | | 0.023 |
| C2 | 0.48 | | 0.6 | 0.019 | | 0.023 |
| D | 6 | | 6.2 | 0.236 | | 0.244 |
| E | 6.4 | | 6.6 | 0.252 | | 0.260 |
| G | 4.4 | | 4.6 | 0.173 | | 0.181 |
| H | 15.9 | | 16.3 | 0.626 | | 0.641 |
| L | 9 | | 9.4 | 0.354 | | 0.370 |
| L1 | 0.8 | | 1.2 | 0.031 | | 0.047 |
| L2 | | 0.8 | 1 | | 0.031 | 0.039 |

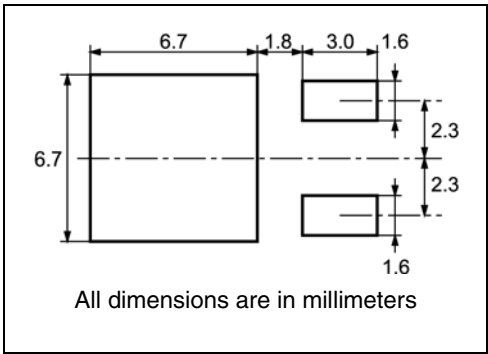


| DPAK MECHANICAL DATA | | | | | | |
|----------------------|------|------|------|-------|-------|-------|
| DIM. | mm. | | | inch | | |
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 2.2 | | 2.4 | 0.086 | | 0.094 |
| A1 | 0.9 | | 1.1 | 0.035 | | 0.043 |
| A2 | 0.03 | | 0.23 | 0.001 | | 0.009 |
| B | 0.64 | | 0.9 | 0.025 | | 0.035 |
| b4 | 5.2 | | 5.4 | 0.204 | | 0.212 |
| C | 0.45 | | 0.6 | 0.017 | | 0.023 |
| C2 | 0.48 | | 0.6 | 0.019 | | 0.023 |
| D | 6 | | 6.2 | 0.236 | | 0.244 |
| D1 | | 5.1 | | | 0.200 | |
| E | 6.4 | | 6.6 | 0.252 | | 0.260 |
| E1 | | 4.7 | | | 0.185 | |
| e | | 2.28 | | | 0.090 | |
| e1 | 4.4 | | 4.6 | 0.173 | | 0.181 |
| H | 9.35 | | 10.1 | 0.368 | | 0.397 |
| L | 1 | | | 0.039 | | |
| (L1) | | 2.8 | | | 0.110 | |
| L2 | | 0.8 | | | 0.031 | |
| L4 | 0.6 | | 1 | 0.023 | | 0.039 |
| R | | 0.2 | | | 0.008 | |
| V2 | 0° | | 8° | 0° | | 8° |

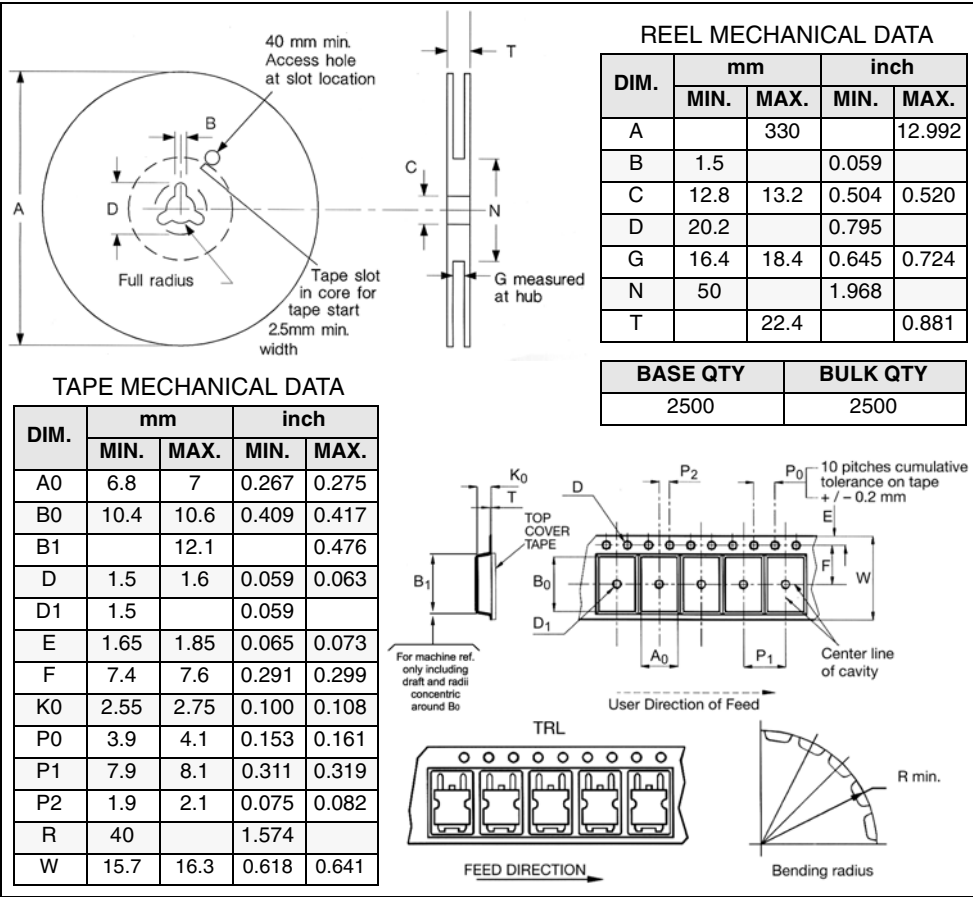
0068772-F

5 Packaging mechanical data

DPAK FOOTPRINT



TAPE AND REEL SHIPMENT



6 Revision history

Table 9. Revision history

| Date | Revision | Changes |
|-------------|----------|------------------|
| 20-Oct-2006 | 1 | Initial release. |

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 ST REPRESENTATIVE, ST PRODUCTS ARE NOT RECOMMENDED, 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. ST PRODUCTS WHICH ARE NOT SPECIFIED AS "AUTOMOTIVE GRADE" MAY ONLY BE USED IN AUTOMOTIVE APPLICATIONS AT USER'S OWN RISK.

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.

© 2006 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