



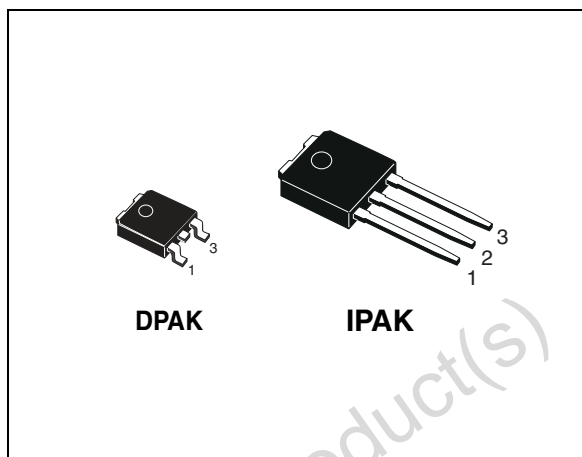
STD90N02L STD90N02L-1

N-channel 25V - 0.0052Ω - 60A - DPAK - IPAK
STripFET™ III Power MOSFET

Features

| Type | V _{DSS} | R _{DS(on)} Max | I _D |
|-------------|------------------|----------------------------|----------------|
| STD90N02L | 25V | <0.006Ω | 60A |
| STD90N02L-1 | 25V | <0.006Ω | 60A |

- R_{DS(ON)} * Qg industry's benchmark
- Conduction losses reduced
- Switching losses reduced
- Low threshold device
- In compliance with the 2002/95/ec european directive



Application

- Switching applications

Description

This series of products 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.

Figure 1. Internal schematic diagram

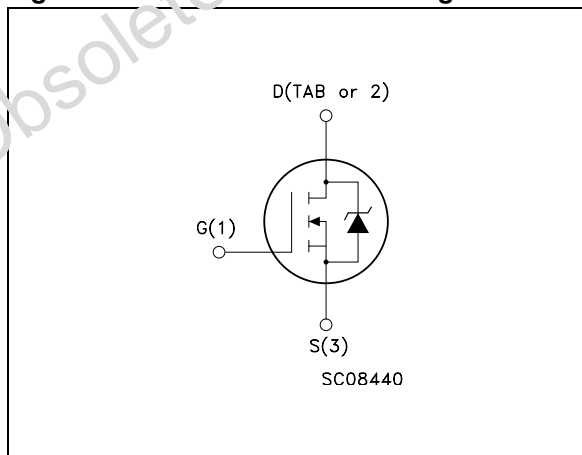


Table 1. Device summary

| Order codes | Marking | Package | Packaging |
|-------------|---------|---------|-------------|
| STD90N02L-1 | D90N02L | IPAK | Tube |
| STD90N02L | D90N02L | DPAK | Tape & reel |

Contents

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Obsolete Product(s) - Obsolete Product(s)

1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|------------------------------------|--|------------|-----------------------|
| $V_{\text{spike}}^{(1)}$ | Drain-source voltage rating | 30 | V |
| V_{DS} | Drain-source voltage ($V_{\text{GS}} = 0$) | 25 | V |
| V_{DGR} | Drain-gate voltage ($R_{\text{GS}} = 20\text{k}\Omega$) | 25 | V |
| V_{GS} | Gate-source voltage | ± 20 | V |
| $I_{\text{D}}^{(2)}$ | Drain current (continuous) at $T_{\text{C}} = 25^{\circ}\text{C}$ | 60 | A |
| I_{D} | Drain current (continuous) at $T_{\text{C}} = 100^{\circ}\text{C}$ | 42 | A |
| $I_{\text{DM}}^{(3)}$ | Drain current (pulsed) | 240 | A |
| P_{TOT} | Total dissipation at $T_{\text{C}} = 25^{\circ}\text{C}$ | 70 | W |
| | Derating factor | 0.47 | W/ $^{\circ}\text{C}$ |
| $E_{\text{AS}}^{(4)}$ | Single pulse avalanche energy | 360 | mJ |
| T_{j} T_{stg} | Operating junction temperature Storage temperature | -55 to 175 | $^{\circ}\text{C}$ |

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 $T_{\text{j}} = 25^{\circ}\text{C}$, $I_{\text{D}} = 30\text{A}$, $V_{\text{DD}} = 15\text{V}$

Table 3. Thermal data

| Symbol | Parameter | Value | Unit |
|-----------------------|--|-------|-----------------------------|
| $R_{\text{thj-case}}$ | Thermal resistance junction-case max. | 2.14 | $^{\circ}\text{C}/\text{W}$ |
| $R_{\text{thj-amb}}$ | Thermal resistance junction-amb max. | 100 | $^{\circ}\text{C}/\text{W}$ |
| T_{l} | Maximum lead temperature for soldering purpose | 275 | $^{\circ}\text{C}$ |

2 Electrical characteristics

(T_{case} =25°C unless otherwise specified)

Table 4. On /off states

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|----------------------|---|---|------|-----------------|----------------|----------|
| V _{(BR)DSS} | Drain-source breakdown voltage | I _D = 25mA, V _{GS} = 0 | 25 | | | V |
| I _{DSS} | Zero gate voltage drain current (V _{GS} = 0) | V _{DS} = 20V, V _{DS} = 20V, T _c = 125°C | | | 1 10 | μA μA |
| I _{GSS} | Gate body leakage current (V _{DS} = 0) | V _{GS} = ±20V | | | ±100 | nA |
| V _{GS(th)} | Gate threshold voltage | V _{DS} = V _{GS} , I _D = 250μA | 1 | 1.8 | | V |
| R _{DS(on)} | Static drain-source on resistance | V _{GS} = 10V, I _D = 30A V _{GS} = 5V, I _D = 15A | | 0.0052 0.007 | 0.006 0.011 | Ω Ω |

Table 5. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--|---|--|------|-------------------|------|----------------|
| g _{fs} (1) | Forward transconductance | V _{DS} =10V, I _D = 18A | | 27 | | S |
| C _{iss} C _{oss} C _{rss} | Input capacitance Output capacitance Reverse transfer capacitance | V _{DS} =16V, f=1MHz, V _{GS} =0 | | 2050 545 70 | | pF pF pF |
| Q _g Q _{gs} Q _{gd} | Total gate charge Gate-source charge Gate-drain charge | V _{DD} =10V, I _D = 60A V _{GS} =5V (see Figure 17) | | 17 7.7 3.5 | 22 | nC nC nC |
| R _G | Gate input resistance | f=1MHz Gate DC Bias =0 test signal level =20mV open drain | 0.5 | 1.5 | 3 | Ω |
| Q _{OSS} (2) | Output charge | V _{DS} =10V, V _{GS} =0V | | 14 | | nC |

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

2. Q_{OSS} = C_{oss} * D Vin, C_{oss} = C_{gd} + C_{gd}. (see [Buck converter](#))

Table 6. Switching times

| Symbol | Parameter | Test conditions | Min. | Typ. | Max | Unit |
|--------------|---------------------|--|------|------|-----|------|
| $t_{d(on)}$ | Turn-on delay time | $V_{DD}=10V, I_D=30A,$ $R_G=4.7\Omega, V_{GS}=5V$ <i>(see Figure 16)</i> | | 12 | | ns |
| t_r | Rise time | | | 110 | | ns |
| $t_{d(off)}$ | Turn-off delay time | | | 18 | | ns |
| t_f | Fall time | | | 8 | | ns |

Table 7. Source drain diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|----------------|-------------------------------|--|------|------|------|------|
| I_{SD} | Source-drain current | | | | 60 | A |
| I_{SDM} | Source-drain current (pulsed) | | | | 240 | A |
| $V_{SD}^{(1)}$ | Forward on voltage | $I_{SD}=30A, V_{GS}=0$ | | | 1.3 | V |
| t_{rr} | Reverse recovery time | $I_{SD}=60A, di/dt = 100A/\mu s,$ $V_{DD}=15V, T_j=150^\circ C$ <i>(see Figure 18)</i> | | 36 | | ns |
| Q_{rr} | Reverse recovery charge | | | 65 | | nC |
| I_{RRM} | Reverse recovery current | | | 3.6 | | A |

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

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area

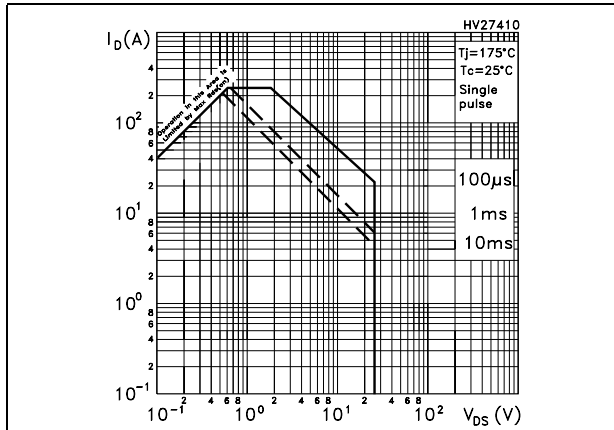


Figure 3. Thermal impedance

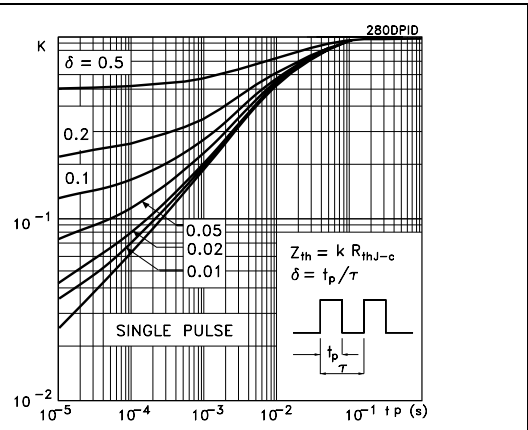


Figure 4. Output characteristics

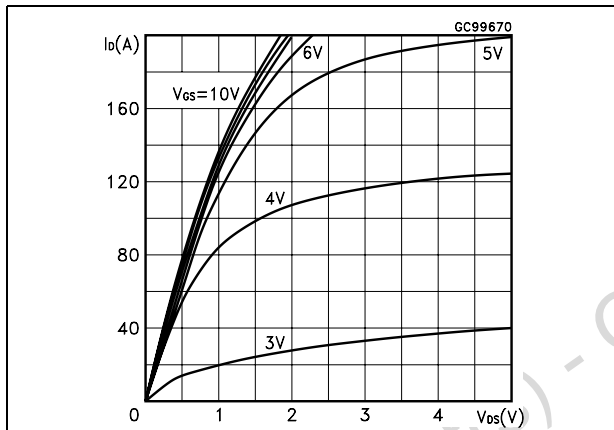


Figure 5. Transfer characteristics

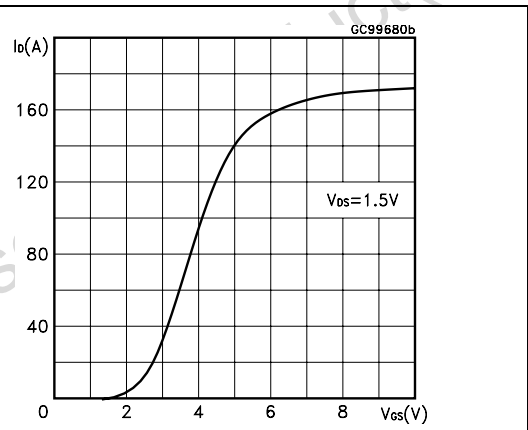


Figure 6. Transconductance

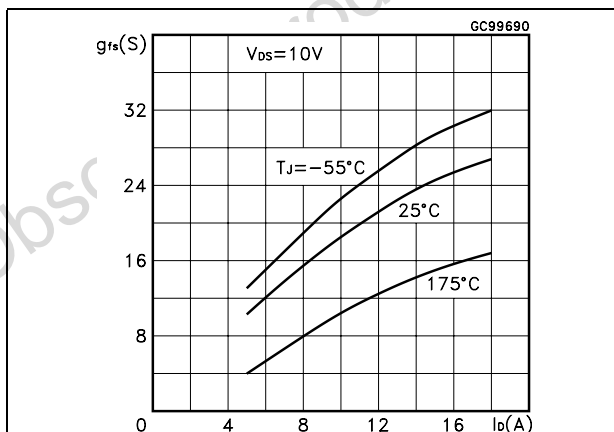


Figure 7. Static drain-source on resistance

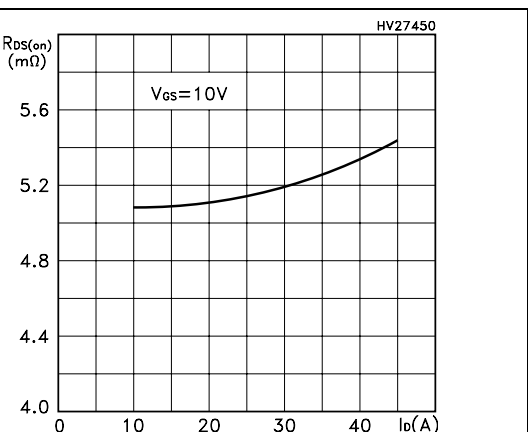


Figure 8. Gate charge vs gate-source voltage Figure 9. Capacitance variations

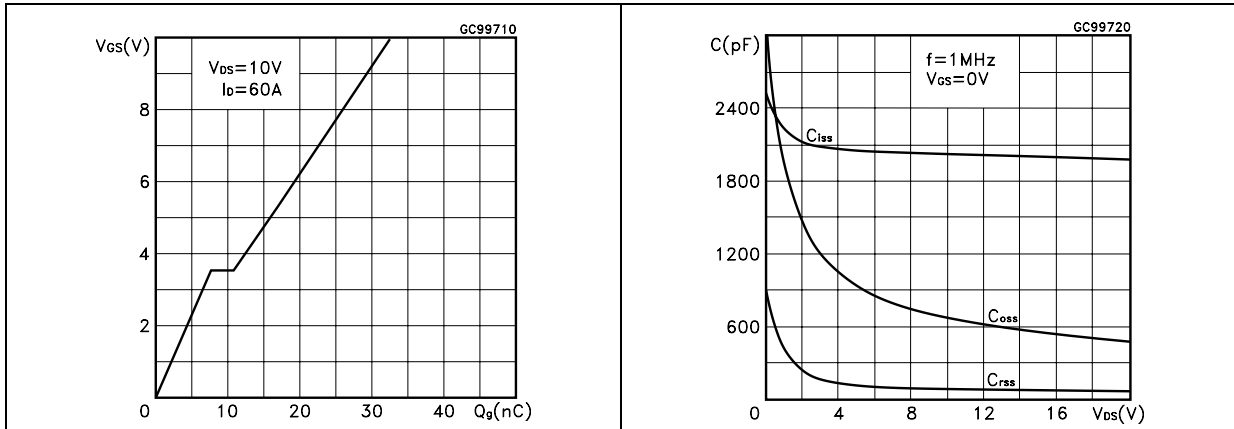


Figure 10. Normalized gate threshold voltage vs temperature Figure 11. Normalized on resistance vs temperature

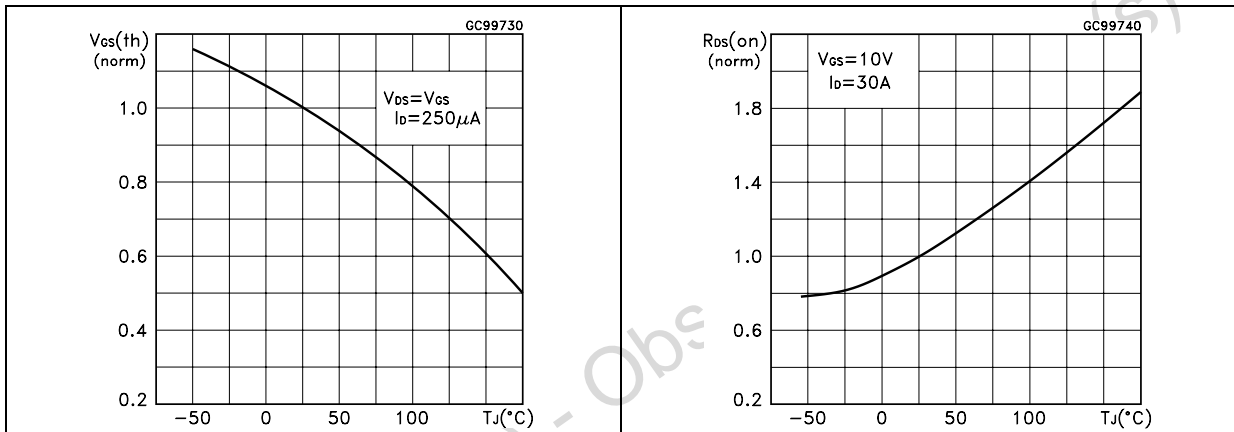


Figure 12. Source-drain diode forward characteristics Figure 13. Normalized $B_{V_{DSS}}$ vs temperature

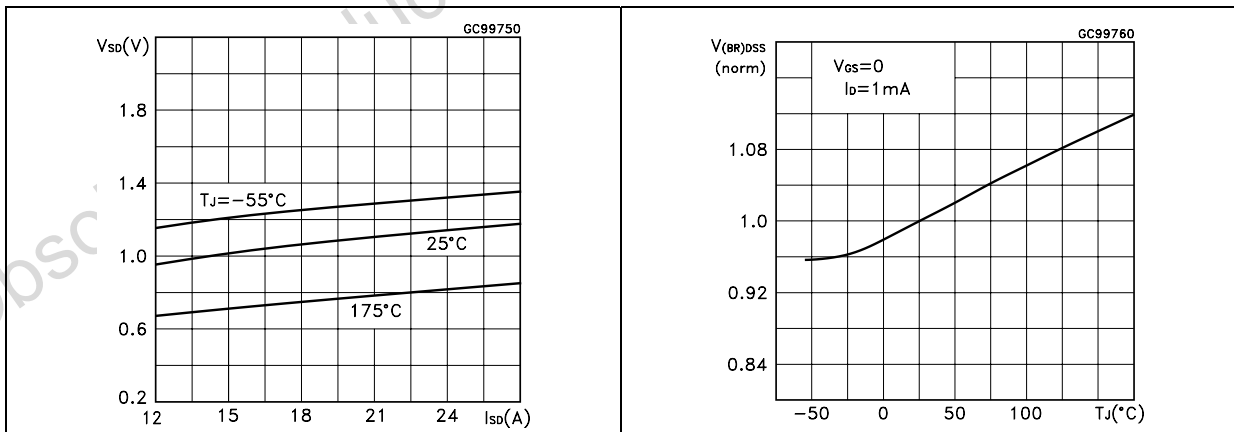
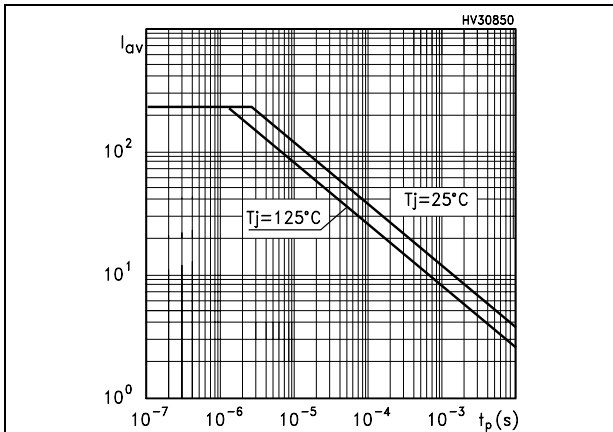


Figure 14. Allowable I_{AV} vs time in avalanche



The previous curve gives the single pulse safe operating area for unclamped inductive loads, under the following conditions:

$$P_{D(AVE)} = 0.5 \cdot (1.3 \cdot B_{VDSS} \cdot I_{AV})$$

$$E_{AS(AR)} = P_{D(AVE)} \cdot t_{AV}$$

Where:

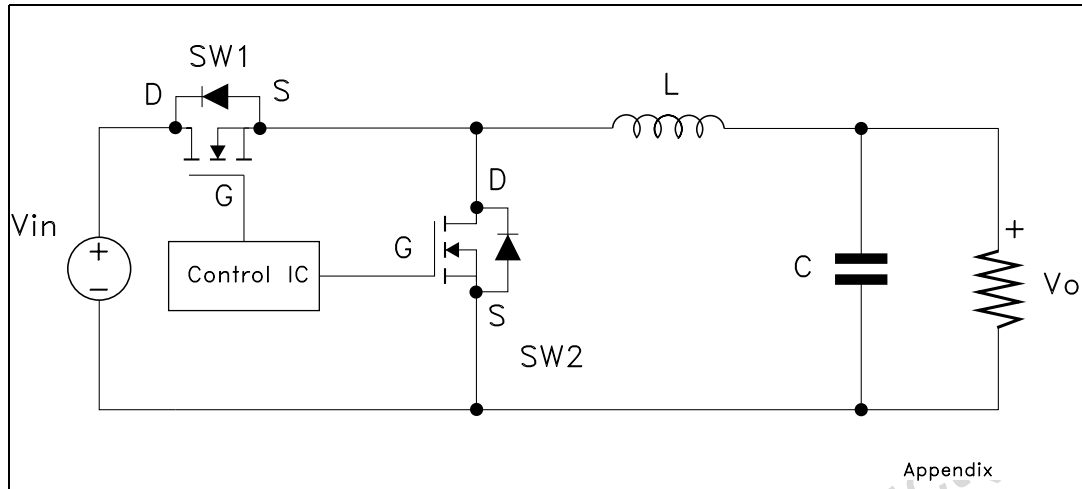
I_{AV} is the allowable current in avalanche

$P_{D(AVE)}$ is the average power dissipation in avalanche (single pulse)

t_{AV} is the time in avalanche

3 Buck converter

Figure 15. Synchronous buck converter



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_{GLS} 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_G 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 8. Power losses

| | | High side switch (SW1) | Low side switch (SW2) |
|-------------------------|------------|--|---|
| P _{conduction} | | $R_{DS(on)} \cdot I_L^2 \cdot \delta$ | $R_{DS(on)} \cdot I_L^2 \cdot (1 - \delta)$ |
| P _{switching} | | $I_{in} \cdot (Q_{gsth(SW1)} + Q_{gd(SW1)}) \cdot f$ | Zero voltage switching |
| P _{diode} | recovery | Not applicable | $V_{in} \cdot Q_{rr(SW2)} \cdot f$ |
| | conduction | Not applicable | $V_{f(SW2)} \cdot I_L \cdot t_{deadtime} \cdot f$ |
| P _{gate(Qg)} | | $Q_{g(SW1)} \cdot V_{gg} \cdot f$ | $Q_{gls(SW2)} \cdot V_{gg} \cdot f$ |
| P _{Qoss} | | $\frac{V_{in} \cdot Q_{oss(SW1)} \cdot f}{2}$ | $\frac{V_{in} \cdot Q_{oss(SW2)} \cdot f}{2}$ |

Table 9. Power losses parameters

| Parameter | Meaning |
|-------------------------|--|
| d | Duty-cycle |
| Q _{gsth} | Post threshold gate charge |
| Q _{gls} | Third quadrant gate charge |
| P _{conduction} | On state losses |
| P _{switching} | On-off transition losses |
| P _{diode} | Conduction and reverse recovery diode losses |
| P _{gate} | Gate driver losses |
| P _{Qoss} | Output capacitance losses |

4 Test circuits

Figure 16. Switching times test circuit for resistive load

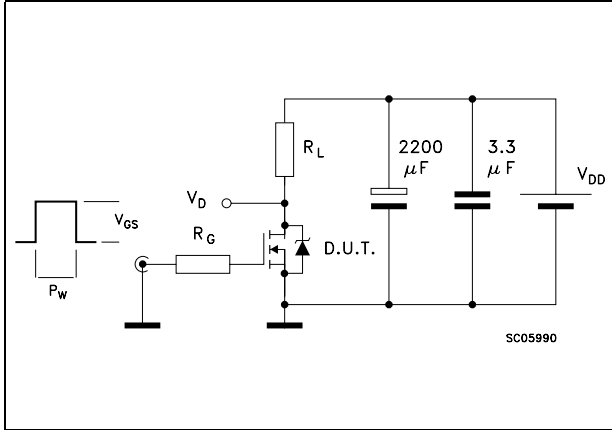


Figure 17. Gate charge test circuit

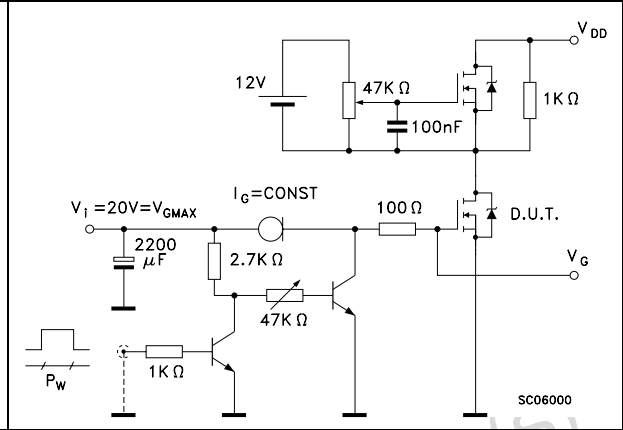


Figure 18. Test circuit for inductive load switching and diode recovery times

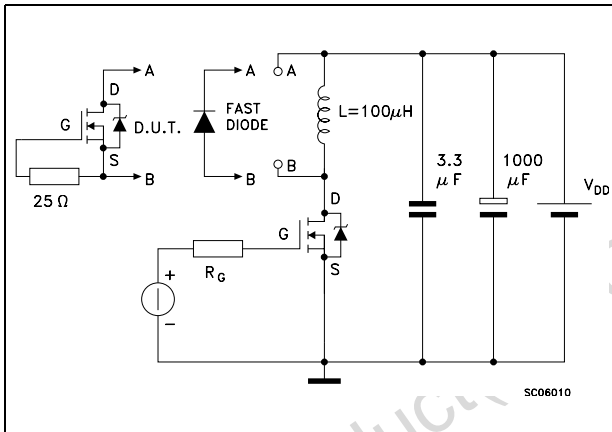


Figure 19. Unclamped inductive load test circuit

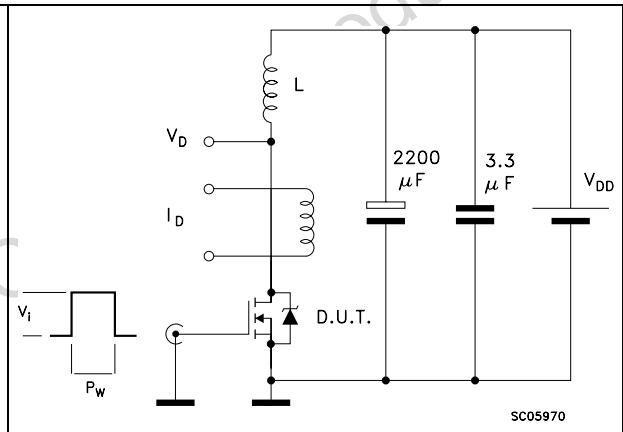


Figure 20. Unclamped inductive waveform

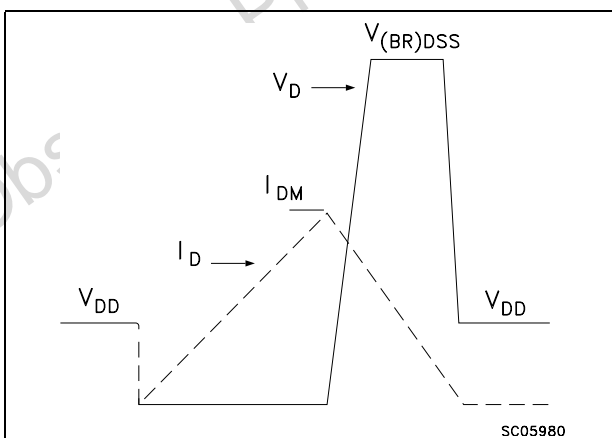
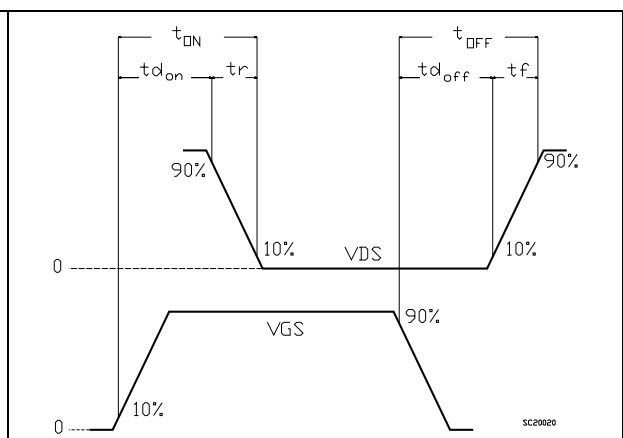


Figure 21. Switching time waveform



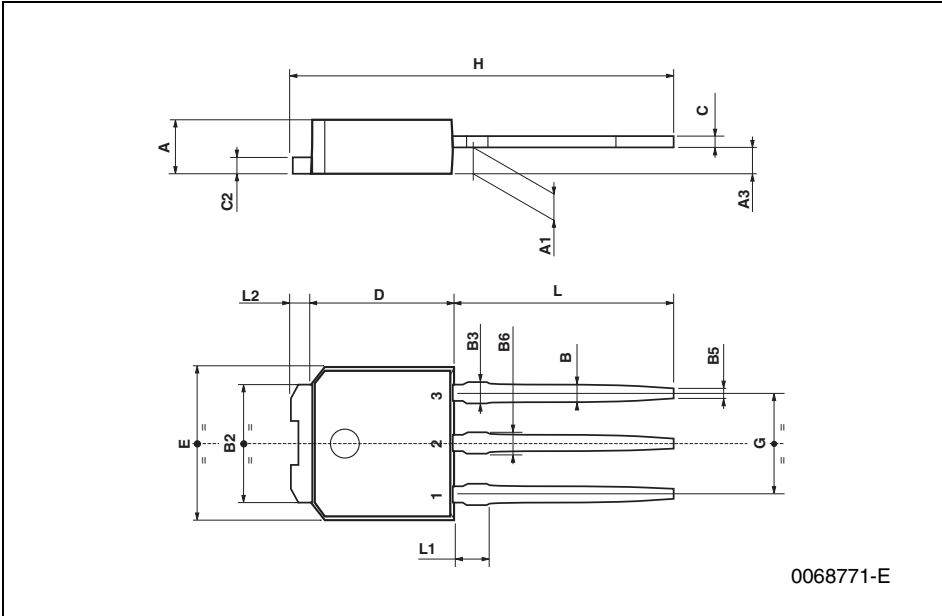
5 Package mechanical data

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

Obsolete Product(s) - Obsolete Product(s)

TO-251 (IPAK) MECHANICAL DATA

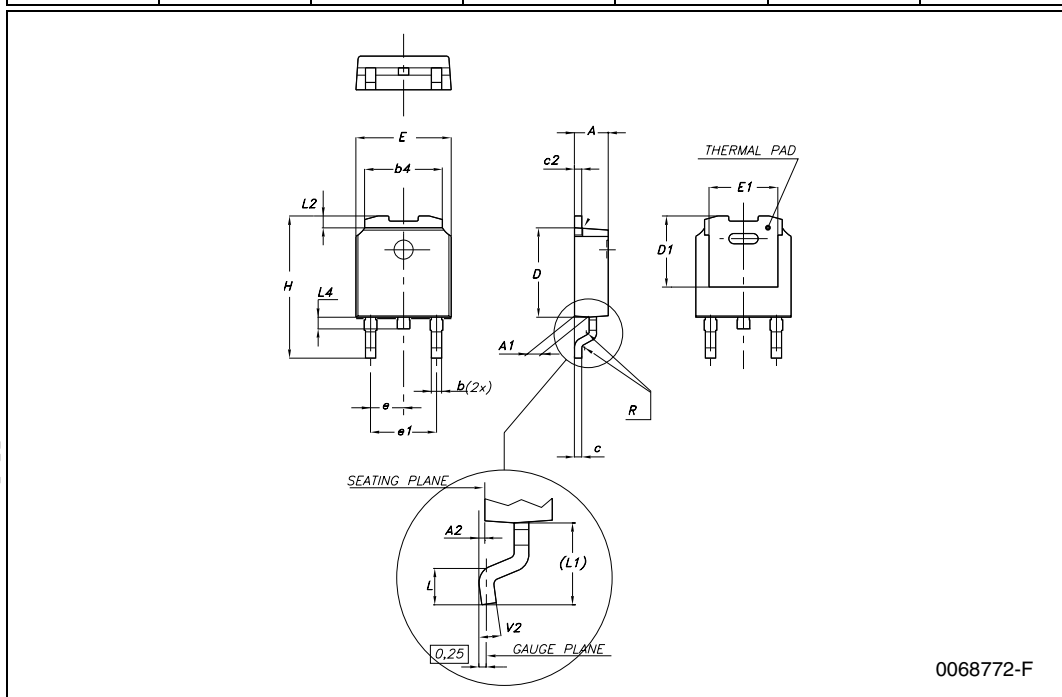
| DIM. | mm | | | inch | | |
|------|------|------|------|-------|-------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 2.2 | | 2.4 | 0.086 | | 0.094 |
| A1 | 0.9 | | 1.1 | 0.035 | | 0.043 |
| A3 | 0.7 | | 1.3 | 0.027 | | 0.051 |
| B | 0.64 | | 0.9 | 0.025 | | 0.031 |
| B2 | 5.2 | | 5.4 | 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 |



Obsole

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

6 Package mechanical data

DPAK FOOTPRINT



TAPE AND REEL SHIPMENT

| 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 | 16.4 | 18.4 | 0.645 | 0.724 |
| N | 50 | | 1.968 | |
| T | | 22.4 | | 0.881 |

| DIM. | mm | | inch | |
|------|------|------|-------|-------|
| | MIN. | MAX. | MIN. | MAX. |
| A0 | 6.8 | 7 | 0.267 | 0.275 |
| B0 | 10.4 | 10.6 | 0.409 | 0.417 |
| B1 | | 12.1 | | 0.476 |
| D | 1.5 | 1.6 | 0.059 | 0.063 |
| D1 | 1.5 | | 0.059 | |
| E | 1.65 | 1.85 | 0.065 | 0.073 |
| F | 7.4 | 7.6 | 0.291 | 0.299 |
| K0 | 2.55 | 2.75 | 0.100 | 0.108 |
| P0 | 3.9 | 4.1 | 0.153 | 0.161 |
| P1 | 7.9 | 8.1 | 0.311 | 0.319 |
| P2 | 1.9 | 2.1 | 0.075 | 0.082 |
| R | 40 | | 1.574 | |
| W | 15.7 | 16.3 | 0.618 | 0.641 |

| BASE QTY | BULK QTY |
|----------|----------|
| 2500 | 2500 |

7 Revision history

Table 10. Document revision history

| Date | Revision | Changes |
|-------------|----------|---|
| 29-Aug-2005 | 1 | First release |
| 07-Apr-2006 | 2 | New template |
| 03-May-2006 | 3 | New value on Table 4 , new curve (<i>see Figure 14</i>) |
| 24-Oct-2007 | 4 | Corrected value on Table 6 , Updated BV_{dss} value |

Obsolete Product(s) - Obsolete Product(s)

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