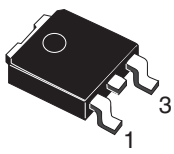
# STD60N3LH5
# STU60N3LH5

## N-channel 30V - 0.0072Ω - 48A - DPAK - IPAK
## STripFET™ V Power MOSFET

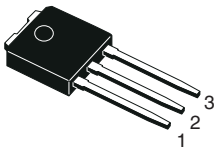
## Features

| Type | $V_{DSS}$ | $R_{DS(on)}$ Max | $I_D$ |
|---|---|---|---|
| STD60N3LH5 | 30V | 0.008Ω | 48A |
| STU60N3LH5 | 30V | 0.0084Ω | 48A |

- $R_{DS(on)}$ * $Q_g$ industry benchmark
- Extremely low on-resistance $R_{DS(on)}$
- Very low switching gate charge
- High avalanche ruggedness
- Low gate drive power losses




DPAK




IPAK

## Application

- Switching applications

## Description

This product utilizes the 5th generation of design rules of ST's proprietary STripFET™ technology. The lowest available $R_{DS(on)}$*$Q_g$, in the standard packages, makes this device suitable for the most demanding DC-DC converter applications, where high power density is to be achieved.

**Figure 1. Internal schematic diagram**

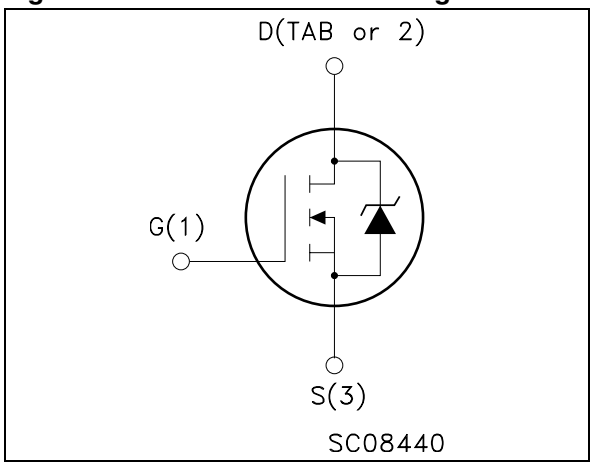



**Table 1. Device summary**

| Order codes | Marking | Package | Packaging |
|---|---|---|---|
| STD60N3LH5 | 60N3LH5 | DPAK | Tape & reel |
| STU60N3LH5 | 60N3LH5 | IPAK | Tube |

# Contents

# 1 Electrical ratings

**Table 2. 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°C | 48 | A |
| $I_D$ | Drain current (continuous) at $T_C$ = 100°C | 42.8 | A |
| $I_{DM}$ (2) | Drain current (pulsed) | 192 | A |
| $P_{TOT}$ | Total dissipation at $T_C$ = 25°C | 60 | W |
| | Derating factor | 0.4 | W/°C |
| $E_{AS}$ (3) | Single pulse avalanche energy | 160 | mJ |
| $T_j$<br>$T_{stg}$ | Operating junction temperature<br>Storage temperature | -55 to 175 | °C |

1. Limited by wire bonding
2. Pulse width limited by safe operating area
3. Starting Tj = 25°C, Id = 24A, Vdd = 12V

**Table 3. Thermal resistance**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| Rthj-case | Thermal resistance junction-case max | 2.5 | °C/W |
| Rthj-amb | Thermal resistance junction-case max | 100 | °C/W |
| $T_j$ | Maximum lead temperature for soldering purpose | 275 | °C |

# 2 Electrical characteristics

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

**Table 4. Static**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{(BR)DSS}$ | Drain-source breakdown Voltage | $I_D$ = 250µA, $V_{GS}$= 0 | 30 | | | V |
| $I_{DSS}$ | Zero gate voltage drain current ($V_{GS}$ = 0) | $V_{DS}$ = 30V<br>$V_{DS}$ = 30V,Tc = 125°C | | | 1<br>10 | µA<br>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 | | | V |
| $R_{DS(on)}$ | Static drain-source on resistance | $V_{GS}$= 10V, $I_D$= 24A<br>SMD version | | 0.0072 | 0.008 | Ω |
| | | $V_{GS}$= 10V, $I_D$= 24A | | 0.0076 | 0.0084 | Ω |
| | | $V_{GS}$= 5V, $I_D$= 24A<br>SMD version | | 0.0088 | 0.011 | Ω |
| | | $V_{GS}$= 5V, $I_D$= 24A | | 0.0092 | 0.0114 | Ω |

**Table 5. Dynamic**

| Symbol | Parameter | Test conditions | Min | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $C_{iss}$<br>$C_{oss}$<br>$C_{rss}$ | Input capacitance<br>Output capacitance<br>Reverse transfer capacitance | $V_{DS}$ =25V, f=1MHz, $V_{GS}$=0 | | 1350<br>265<br>32 | | pF<br>pF<br>pF |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$ | Total gate charge<br>Gate-source charge<br>Gate-drain charge | $V_{DD}$=15V, $I_D$ = 48A<br>$V_{GS}$ =5V<br>*(Figure 14)* | | 8.8<br>4.7<br>2.2 | | nC<br>nC<br>nC |
| $Q_{gs1}$<br>$Q_{gs2}$ | Pre $V_{th}$ gate-to-source charge<br>Post $V_{th}$ gate-to-source charge | $V_{DD}$=15V, $I_D$ = 48A<br>$V_{GS}$ =5V<br>*(Figure 19)* | | 2.2<br>2.5 | | nC<br>nC |
| $R_G$ | Gate input resistance | f=1MHz gate bias<br>Bias= 0 test signal level=20mV<br>open drain | | 1.1 | | Ω |

**Table 6. Switching on/off (resistive load)**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $t_{d(on)}$<br>$t_r$ | Turn-on delay time<br>Rise time | $V_{DD}$=10V, $I_D$= 24A,<br>$R_G$=4.7Ω, $V_{GS}$= 10V<br>*(Figure 13 and Figure 18)* | | 6<br>33 | | ns<br>ns |
| $t_{d(off)}$<br>$t_f$ | Turn-off delay time<br>Fall time | $V_{DD}$=10V, $I_D$= 24A,<br>$R_G$=4.7Ω, $V_{GS}$= 10V<br>*(Figure 13 and Figure 18)* | | 19<br>4.2 | | ns<br>ns |

**Table 7. Source drain diode**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $I_{SD}$<br>$I_{SDM}$ | Source-drain current<br>Source-drain current (pulsed)(1) | | | | 48<br>192 | A<br>A |
| $V_{SD}$ | Forward on voltage | $I_{SD}$=24A, $V_{GS}$=0 | | | 1.1 | V |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | $I_{SD}$=48A, di/dt =100A/µs,<br>$V_{DD}$=20V, Tj = 25°C<br>*(Figure 15)* | | 25<br>18.5<br>1.5 | | ns<br>nC<br>A |

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

## 2.1 Electrical characteristics (curves)

**Figure 2. Safe operating area**

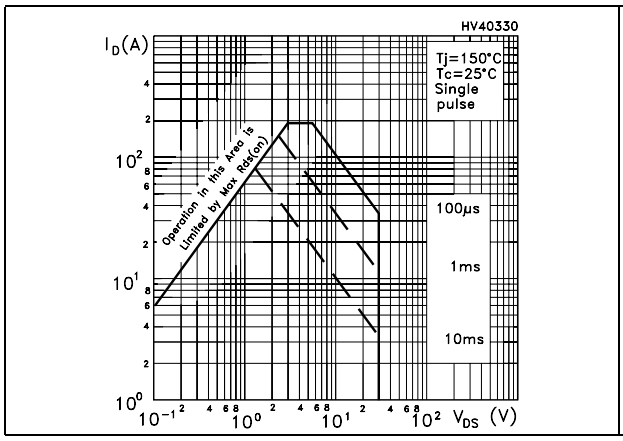



**Figure 3. Thermal impedance**

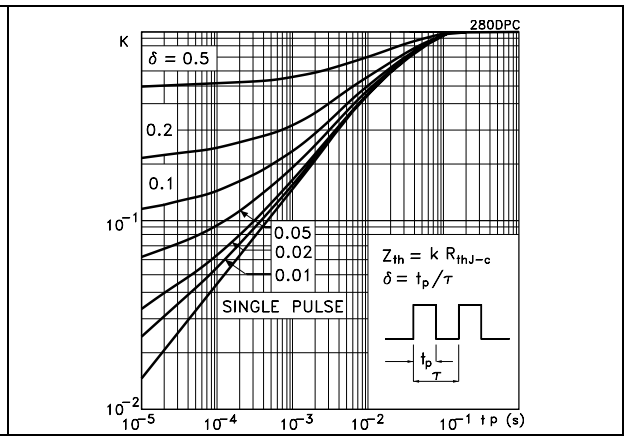



**Figure 4. Output characterisics**

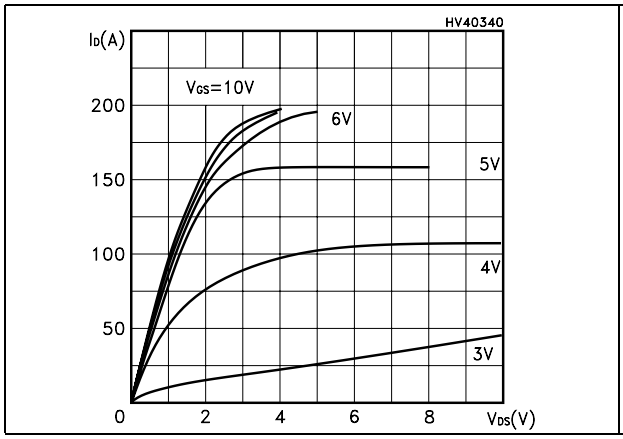



**Figure 5. Transfer characteristics**

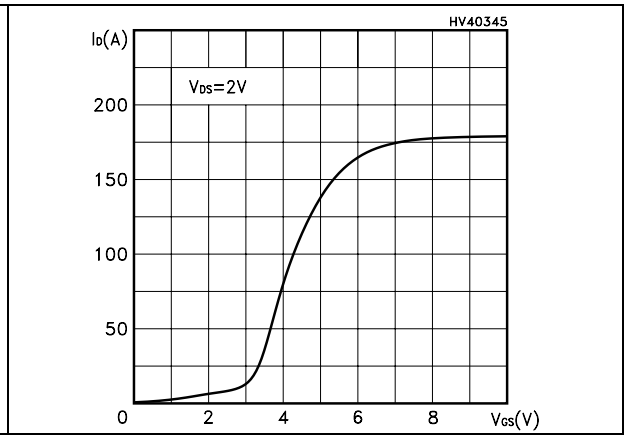



**Figure 6. Normalized $B_{VDSS}$ vs temperature**

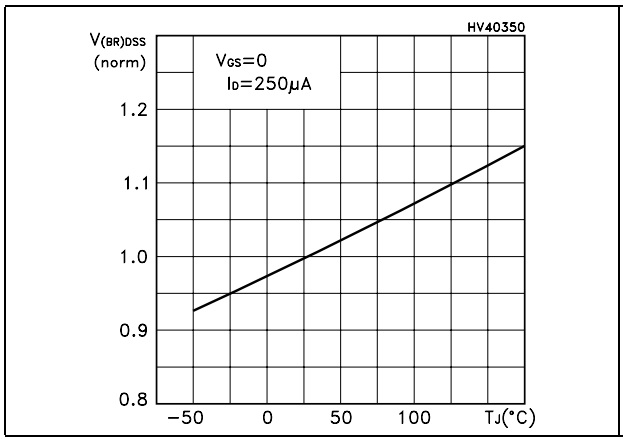



**Figure 7. Static drain-source on resistance**

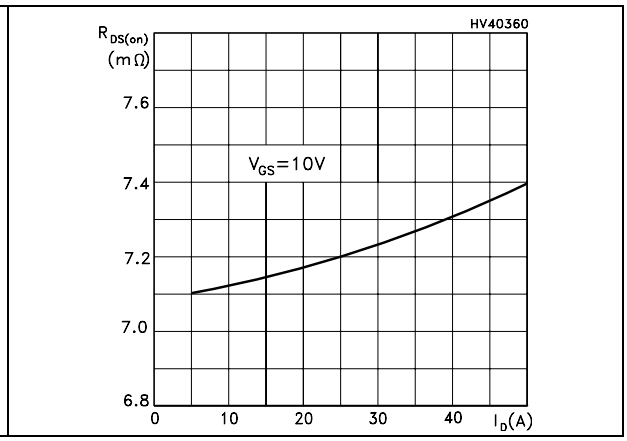


**Figure 8. Gate charge vs gate-source voltage**

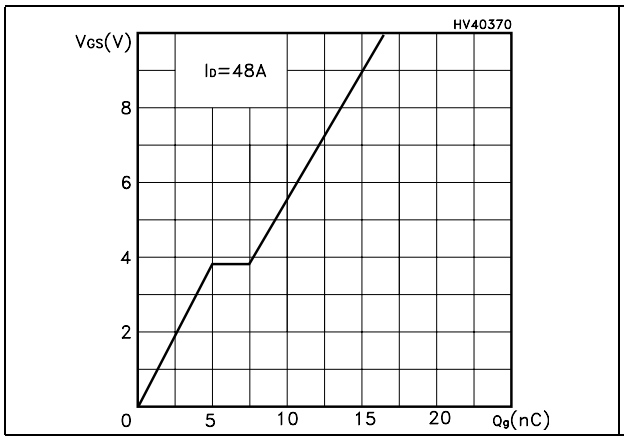



**Figure 9. Capacitance variations**

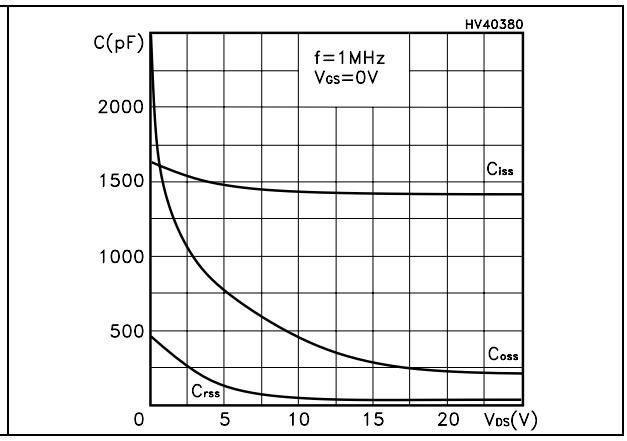



**Figure 10. Normalized gate threshold voltage vs temperature**

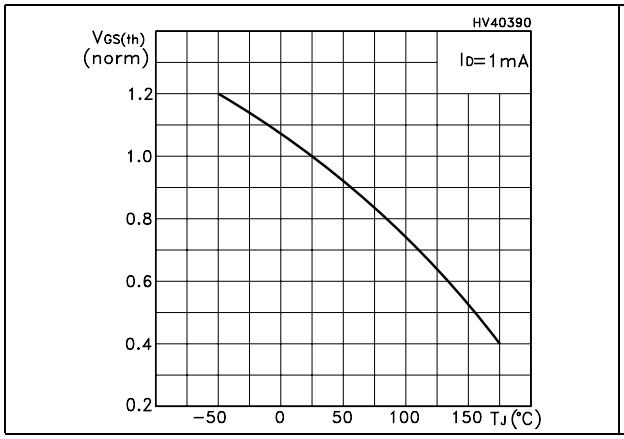



**Figure 11. Normalized on resistance vs temperature**

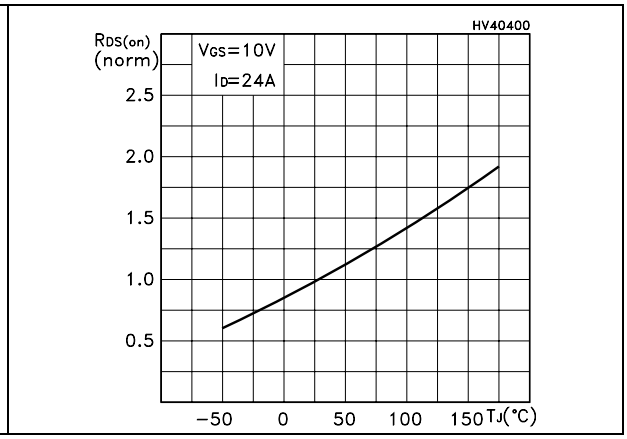
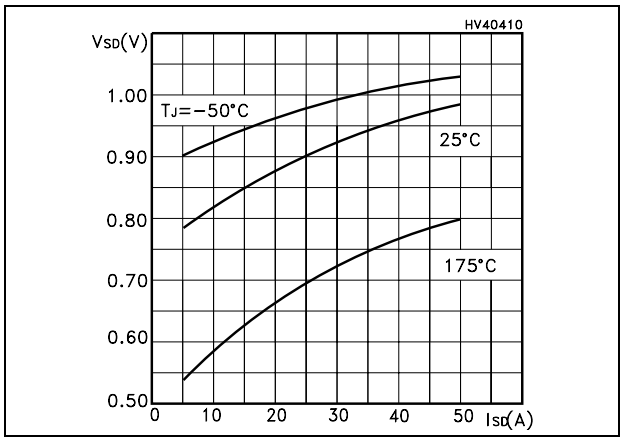



**Figure 12. Source-drain diode forward characteristics**



# 3 Test circuit

**Figure 13. Switching times test circuit for resistive load**

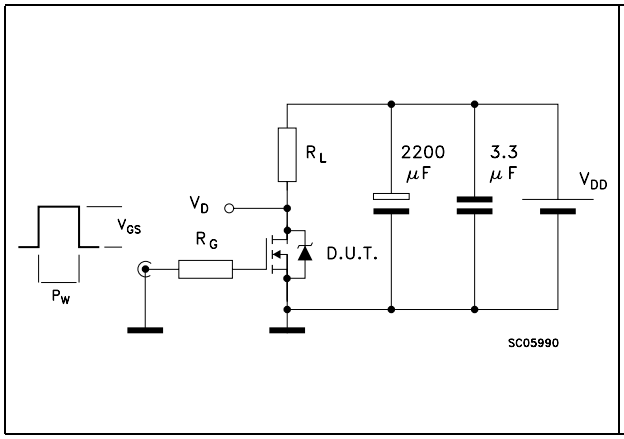



**Figure 14. Gate charge test circuit**

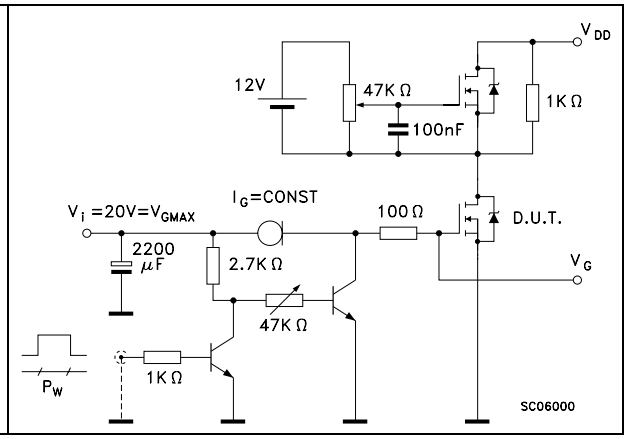



**Figure 15. Test circuit for inductive load switching and diode recovery times**

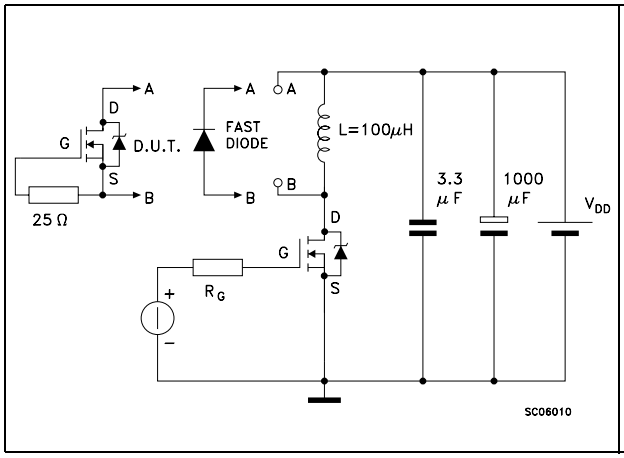



**Figure 16. Unclamped Inductive load test circuit**

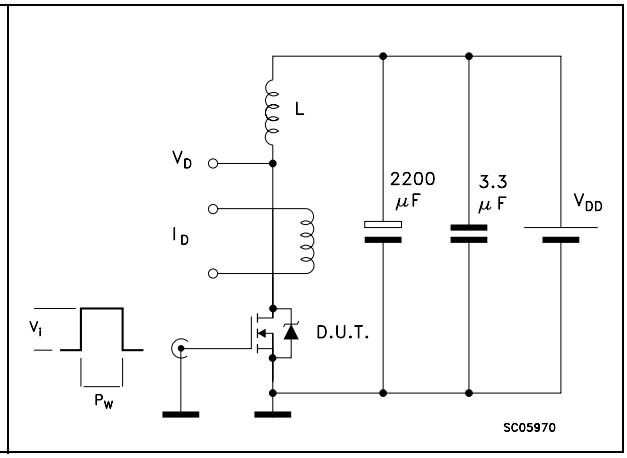



**Figure 17. Unclamped inductive waveform**

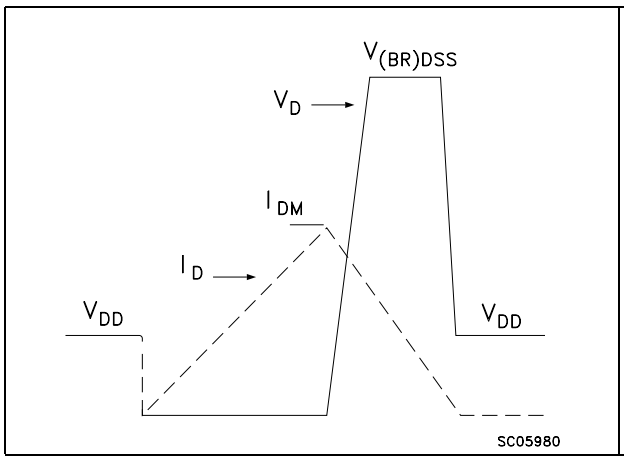



**Figure 18. Switching time waveform**

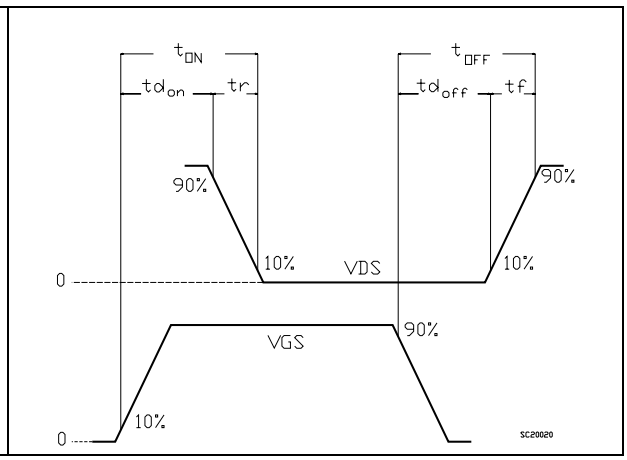
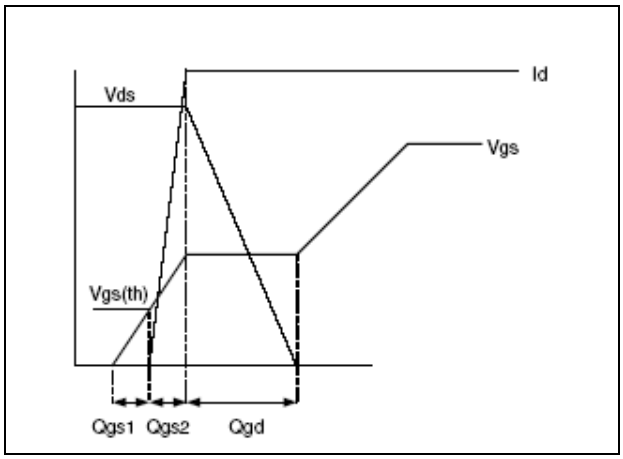


**Figure 19. Gate charge waveform**

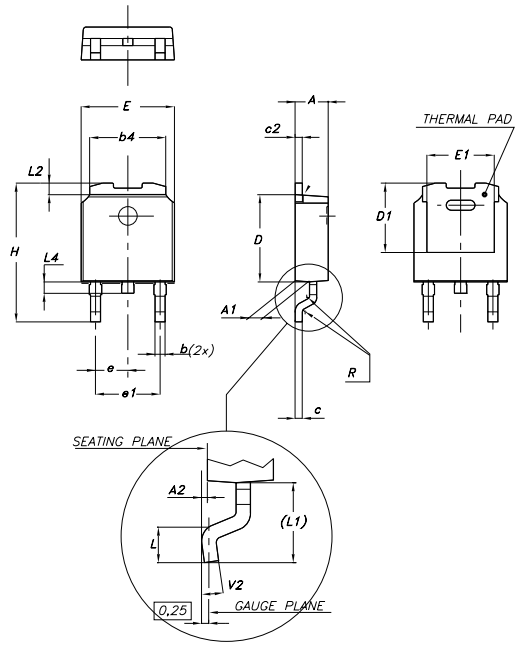


# 4 Package mechanical data

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*

## DPAK MECHANICAL DATA

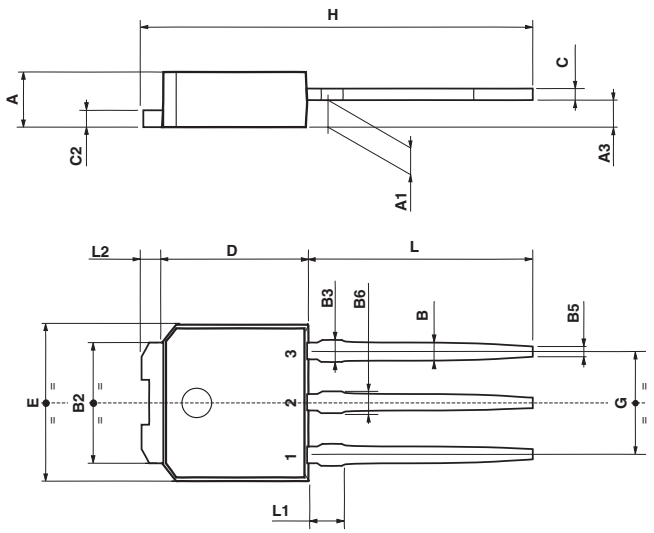
| DIM. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | 2.2 | | 2.4 | 0.086 | | 0.094 |
| A1 | 0.9 | | 1.1 | 0.035 | | 0.043 |
| A2 | 0.03 | | 0.23 | 0.001 | | 0.009 |
| B | 0.64 | | 0.9 | 0.025 | | 0.035 |
| b4 | 5.2 | | 5.4 | 0.204 | | 0.212 |
| 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

## TO-251 (IPAK) MECHANICAL DATA

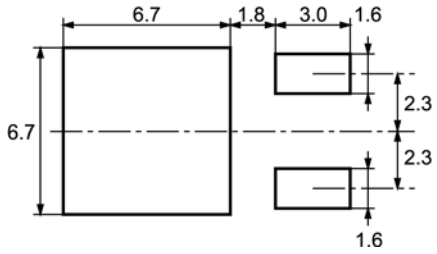
| DIM. | mm | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 2.2 | | 2.4 | 0.086 | | 0.094 |
| A1 | 0.9 | | 1.1 | 0.035 | | 0.043 |
| A3 | 0.7 | | 1.3 | 0.027 | | 0.051 |
| B | 0.64 | | 0.9 | 0.025 | | 0.031 |
| B2 | 5.2 | | 5.4 | 0.204 | | 0.212 |
| 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 |




0068771-E

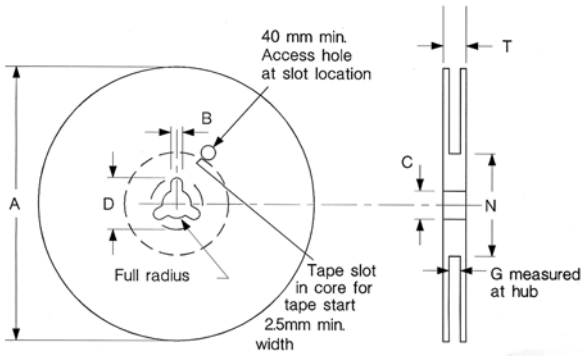
# 5 Packaging mechanical data

### DPAK FOOTPRINT




All dimensions are in millimeters

### TAPE AND REEL SHIPMENT



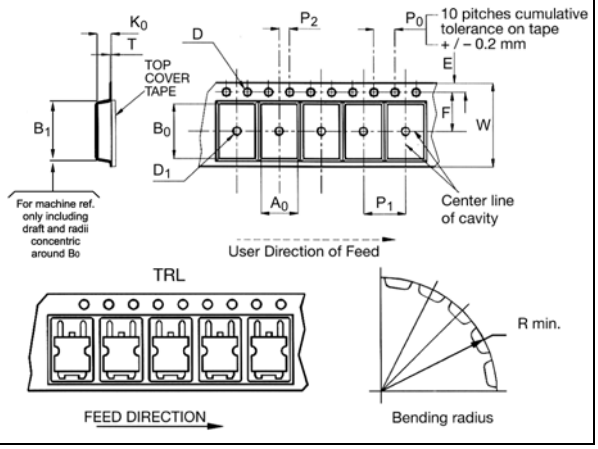

REEL MECHANICAL DATA

| 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 |

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

TAPE MECHANICAL DATA

| 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 |



# 6 Revision history

Table 8. Document revision history

| Date | Revision | Changes |
|---|---|---|
| 19-Oct-2007 | 1 | First release |

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