



# THE DATASHEET OF STB40N20





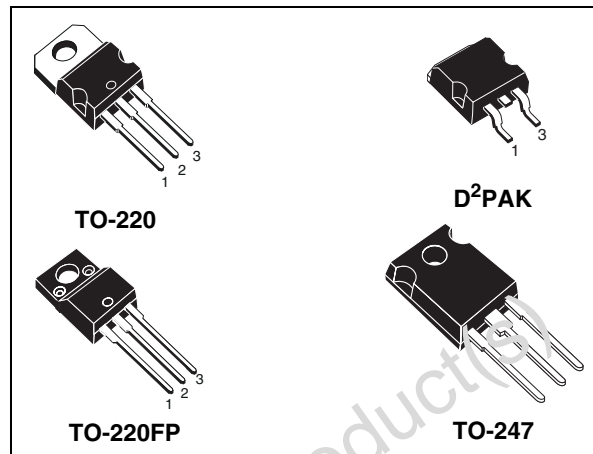
# STP40N20 - STF40N20 STB40N20 - STW40N20

N-channel 200V - 0.038Ω -40A- D<sup>2</sup>PAK/TO-220/TO-220FP/TO-247  
Low gate charge STripFET™ Power MOSFET

## General features

| Type       | V <sub>DSS</sub> | R <sub>DS(on)</sub> | I <sub>D</sub> | P <sub>W</sub> |
|------------|------------------|---------------------|----------------|----------------|
| STB40N20   | 200V             | <0.045Ω             | 40A            | 160W           |
| STP40N20   | 200V             | <0.045Ω             | 40A            | 160W           |
| STP40N20FP | 200V             | <0.045Ω             | 40A            | 160W           |
| STW40N20   | 200V             | <0.045Ω             | 40A            | 40W            |

- Gate charge minimized
- Very low intrinsic capacitances
- Very good manufacturing repeatability
- Excellent figure of merit (R<sub>DS</sub>\*Q<sub>g</sub>)
- 100% avalanche tested



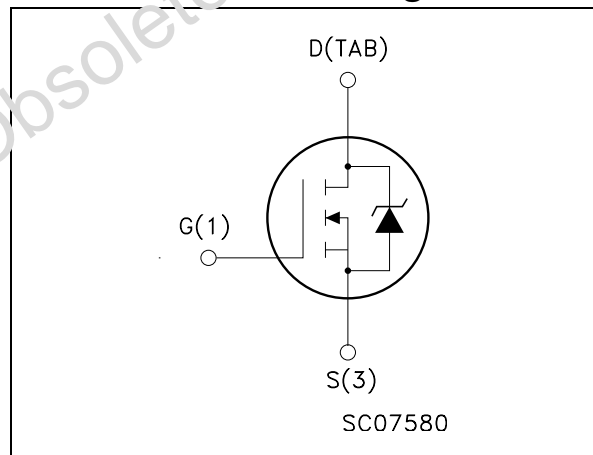
## Description

This MOSFET series realized with STMicroelectronics unique STripFET process has specifically been designed to minimize input capacitance and gate charge. It is therefore suitable as primary switch in advanced high-efficiency isolated DC-DC converters.

## Applications

- Switching application

## Internal schematic diagram



## Order codes

| Part number | Marking | Package            | Packaging   |
|-------------|---------|--------------------|-------------|
| STB40N20    | B40N20  | D <sup>2</sup> PAK | Tape & reel |
| STP40N20    | P40N20  | TO-220             | Tube        |
| STP40N20FP  | P40N20  | TO-220FP           | Tube        |
| STW40N20    | W40N20  | TO-247             | Tube        |

# Contents

|          |   |           |
|----------|---|-----------|
| <b>1</b> | <b>Electrical ratings</b> .....           | <b>3</b>  |
| <b>2</b> | <b>Electrical characteristics</b> .....   | <b>4</b>  |
| 2.1      | Electrical characteristics (curves) ..... | 6         |
| <b>3</b> | <b>Test circuit</b> .....                 | <b>9</b>  |
| <b>4</b> | <b>Package mechanical data</b> .....      | <b>11</b> |
| <b>5</b> | <b>Packaging mechanical data</b> .....    | <b>16</b> |
| <b>6</b> | <b>Revision history</b> .....             | <b>17</b> |

Obsolete Product(s) - Obsolete Product(s)

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol                         | Parameter   | Value                                  |          | Unit |
|--------------------------------|---|--|----------|------|
|                                |   | TO-220<br>D <sup>2</sup> PAK<br>TO-247 | TO-220FP |      |
| V <sub>DS</sub>                | Drain-source voltage (V <sub>GS</sub> = 0)  | 200                                    |          | V    |
| V <sub>GS</sub>                | Gate- source voltage  | ± 20                                   |          | V    |
| I <sub>D</sub> <sup>(1)</sup>  | Drain current (continuous) at T <sub>C</sub> = 25°C   | 40                                     |          | A    |
| I <sub>D</sub> <sup>(1)</sup>  | Drain current (continuous) at T <sub>C</sub> = 100°C  | 25                                     |          | A    |
| I <sub>DM</sub> <sup>(2)</sup> | Drain current (pulsed)  | 160                                    |          | A    |
| P <sub>tot</sub>               | Total dissipation at T <sub>C</sub> = 25°C  | 160                                    | 40       | W    |
|                                | Derating Factor   | 1.28                                   | 0.32     |      |
| dv/dt <sup>(3)</sup>           | Peak diode recovery voltage slope   | 12                                     |          | V/ns |
| V <sub>ISO</sub>               | Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1s; T <sub>c</sub> = 25°C) | --                                     | 2500     | V    |
| T <sub>stg</sub>               | Storage temperature   | -55 to 150                             |          | °C   |
| T <sub>j</sub>                 | Max. operating junction temperature   |  |          |      |

- Value limited by wire bonding
- Pulse width limited by safe operating area.
- I<sub>SD</sub> ≤ 40A, di/dt ≤ 200A/μs, V<sub>DD</sub> ≤ V<sub>(BR)DSS</sub>, T<sub>j</sub> ≤ T<sub>JMAX</sub>

**Table 2. Thermal data**

|                       |   | TO-220<br>D <sup>2</sup> PAK | TO-247 | TO-220FP |      |
|-----------------------|---|------------------------------|--------|----------|------|
| R <sub>thj-case</sub> | Thermal resistance junction-case max                          | 0.78                         |        | 3.1      | °C/W |
| R <sub>thj-amb</sub>  | Thermal resistance junction-ambient max                       | 62.5                         | 50     | 62.5     | °C/W |
| T <sub>J</sub>        | Maximum lead temperature for soldering purpose <sup>(1)</sup> | 300                          |        |          | °C   |

- for 10 sec. 1.6mm from case

**Table 3. Avalanche characteristics**

| Symbol          | Parameter  | Max Value | Unit |
|-----------------|--|-----------|------|
| I <sub>AR</sub> | Avalanche Current, Repetitive or Not-Repetitive (pulse width limited by T <sub>j</sub> max)                                | 40        | A    |
| E <sub>AS</sub> | Single Pulse Avalanche Energy (starting T <sub>j</sub> = 25 °C, I <sub>D</sub> = I <sub>AR</sub> , V <sub>DD</sub> = 50 V) | 230       | mJ   |

## 2 Electrical characteristics

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

**Table 4. On/off states**

| Symbol        | Parameter  | Test conditions  | Min. | Typ.  | Max.      | Unit                           |
|---------------|--|--|------|-------|-----------|--------------------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage                   | $I_D = 1\text{mA}, V_{GS} = 0$   | 200  |       |           | V                              |
| $I_{DSS}$     | Zero gate voltage drain current ( $V_{GS} = 0$ ) | $V_{DS} = \text{max ratings}$<br>$V_{DS} = \text{max ratings},$<br>$T_C = 125^{\circ}\text{C}$ |      |       | 1<br>10   | $\mu\text{A}$<br>$\mu\text{A}$ |
| $I_{GSS}$     | Gate-body leakage current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 20\text{V}$  |      |       | $\pm 100$ | nA                             |
| $V_{GS(th)}$  | Gate threshold voltage                           | $V_{DS} = V_{GS}, I_D = 250\mu\text{A}$  | 2    | 3     | 4         | V                              |
| $R_{DS(on)}$  | Static drain-source on resistance                | $V_{GS} = 10\text{V}, I_D = 20\text{A}$  |      | 0.038 | 0.045     | $\Omega$                       |

**Table 5. Dynamic**

| Symbol  | Parameter   | Test conditions  | Min. | Typ.                 | Max. | Unit                 |
|---|---|--|------|----------------------|------|----------------------|
| $g_{fs}^{(1)}$                                | Forward transconductance  | $V_{DS} = 15\text{V}, I_D = 20\text{A}$  |      | 30                   |      | S                    |
| $C_{iss}$<br>$C_{oss}$<br>$C_{rss}$           | Input capacitance<br>Output capacitance<br>Reverse transfer capacitance | $V_{DS} = 25\text{V}, f = 1\text{MHz},$<br>$V_{GS} = 0$  |      | 2500<br>510<br>78    |      | pF<br>pF<br>pF       |
| $t_{d(on)}$<br>$t_r$<br>$t_{d(off)}$<br>$t_f$ | Turn-on delay time<br>Rise time<br>Turn-off delay time<br>Fall time     | $V_{DD} = 100\text{V}, I_D = 20\text{A}$<br>$R_G = 4.7\Omega, V_{GS} = 10\text{V}$<br>(see <a href="#">Figure 16</a> ) |      | 20<br>44<br>74<br>22 |      | ns<br>ns<br>ns<br>ns |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$                 | Total gate charge<br>Gate-source charge<br>Gate-drain charge            | $V_{DD} = 160\text{V}, I_D = 40\text{A},$<br>$V_{GS} = 10\text{V}$<br>(see <a href="#">Figure 17</a> )                 |      | 75<br>13.2<br>35.5   |      | nC<br>nC<br>nC       |

1. Pulsed: Pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5 %.

Table 6. Source drain diode

| Symbol                            | Parameter  | Test conditions   | Min. | Typ.                | Max.      | Unit          |
|-----------------------------------|--|---|------|---------------------|-----------|---------------|
| $I_{SD}$<br>$I_{SDM}^{(1)}$       | Source-drain current<br>Source-drain current<br>(pulsed)                     |   |      |                     | 40<br>160 | A<br>A        |
| $V_{SD}^{(2)}$                    | Forward on voltage   | $I_{SD} = 20A, V_{GS} = 0$  |      |                     | 1.5       | V             |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | $I_{SD} = 20A,$<br>$di/dt = 100A/\mu s,$<br>$V_{DD} = 25V$<br>(see <a href="#">Figure 18</a> )                    |      | 192<br>922<br>9.6   |           | ns<br>nC<br>A |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | $I_{SD} = 20A,$<br>$di/dt = 100A/\mu s,$<br>$V_{DD} = 25V, T_j = 150^\circ C$<br>(see <a href="#">Figure 18</a> ) |      | 242<br>1440<br>11.9 |           | ns<br>nC<br>A |

1. Pulse width limited by safe operating area.
2. Pulsed: Pulse duration = 300  $\mu s$ , duty cycle 1.5 %

## 2.1 Electrical characteristics (curves)

Figure 1. Safe operating area for TO-220/D<sup>2</sup>PAK

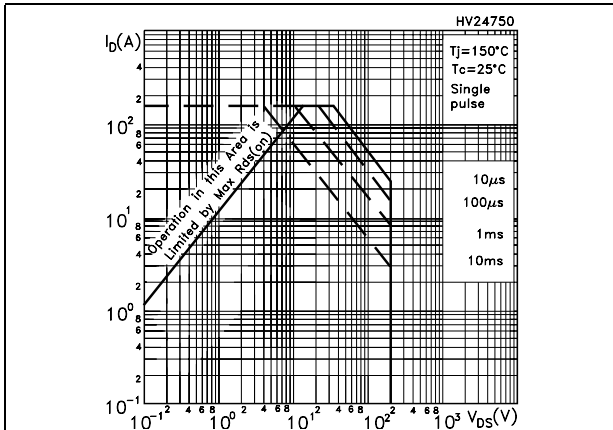


Figure 2. Thermal impedance area for TO-220/D<sup>2</sup>PAK

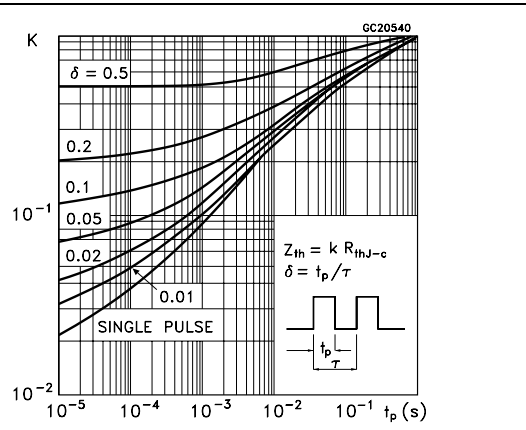


Figure 3. Safe operating area for TO-247

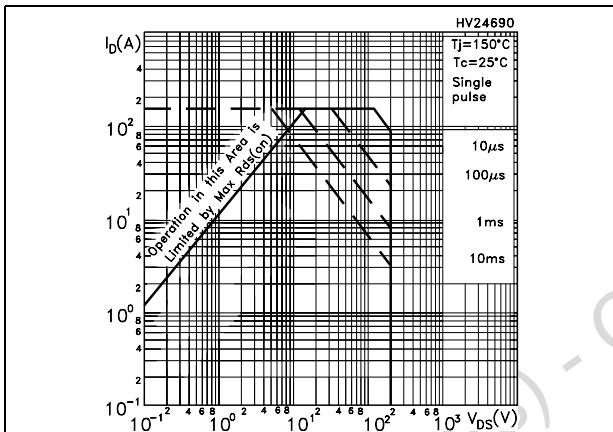


Figure 4. Thermal impedance for TO-247

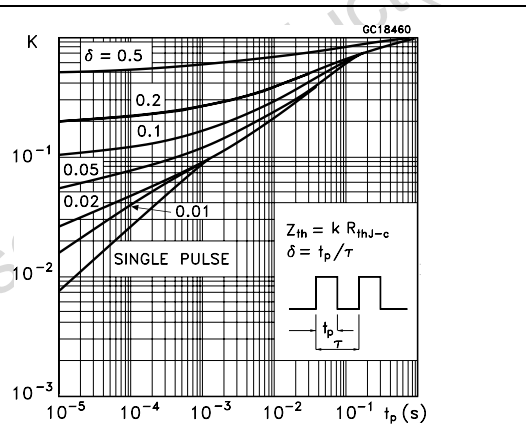


Figure 5. Safe operating area for TO-220FP

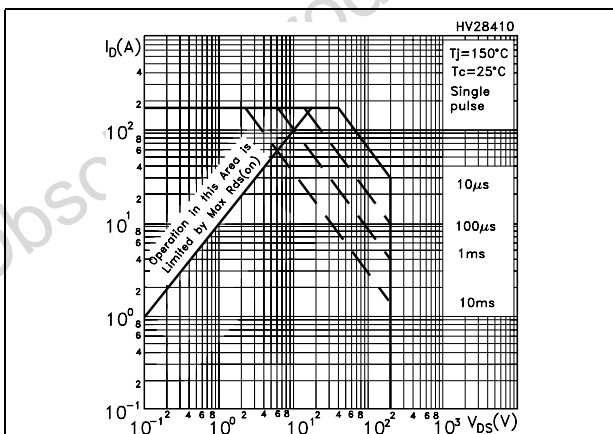


Figure 6. Thermal impedance for TO-220FP

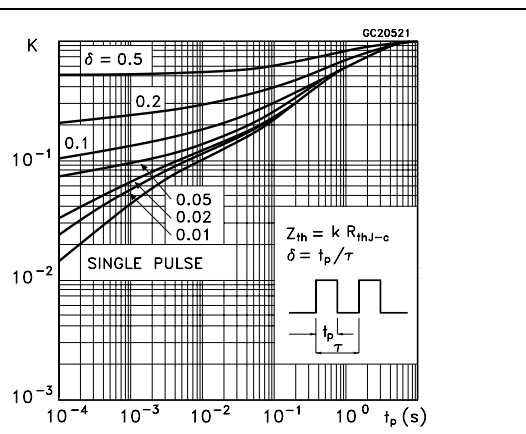


Figure 7. Output characteristics

Figure 8. Transfer characteristics

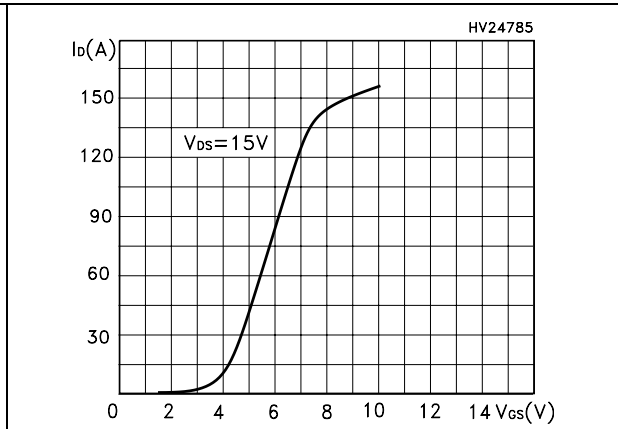
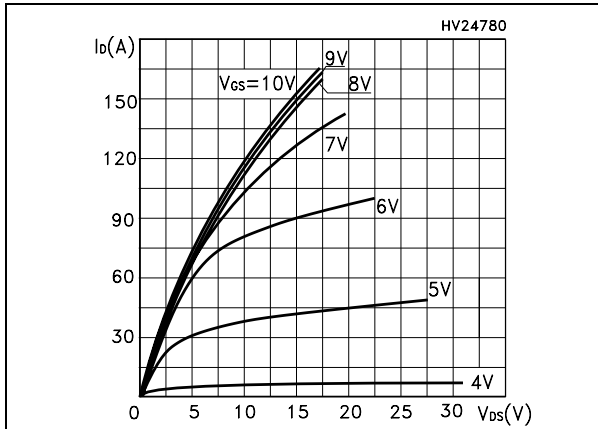


Figure 9. Transconductance

Figure 10. Static drain-source on resistance

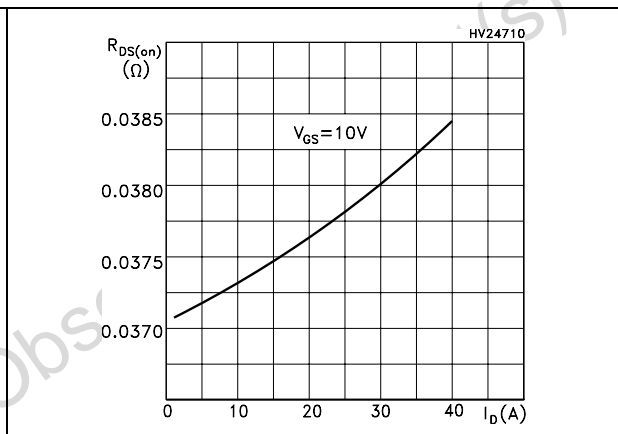
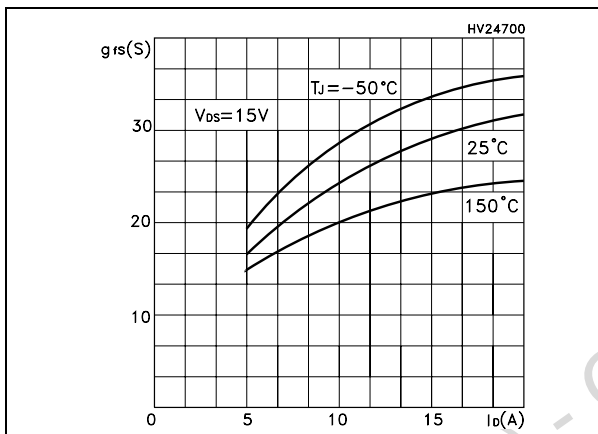


Figure 11. Gate charge vs gate-source voltage Figure 12. Capacitance variations

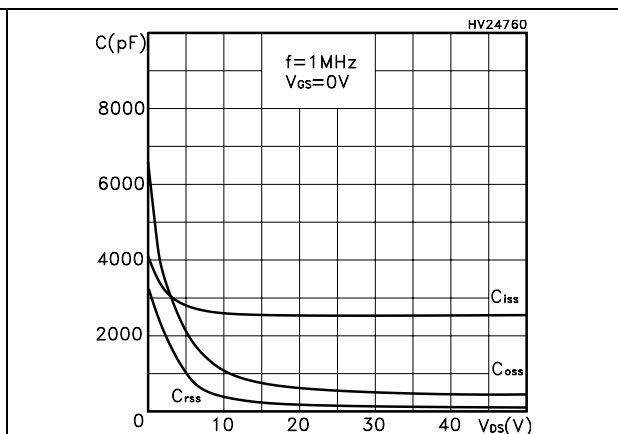
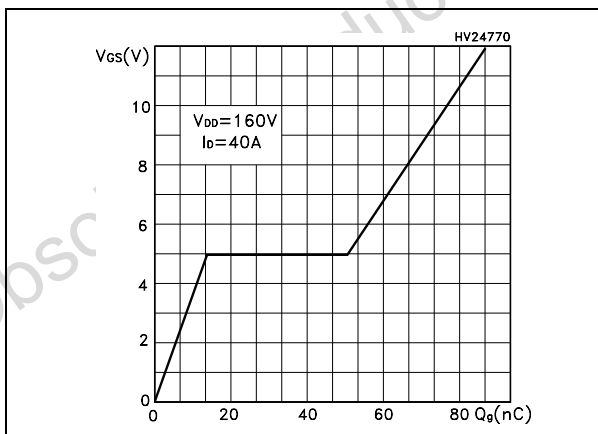


Figure 13. Normalized gate threshold voltage vs temperature

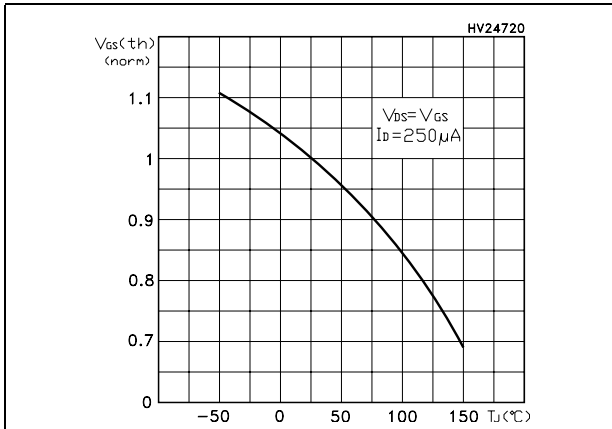


Figure 14. Normalized on resistance vs temperature

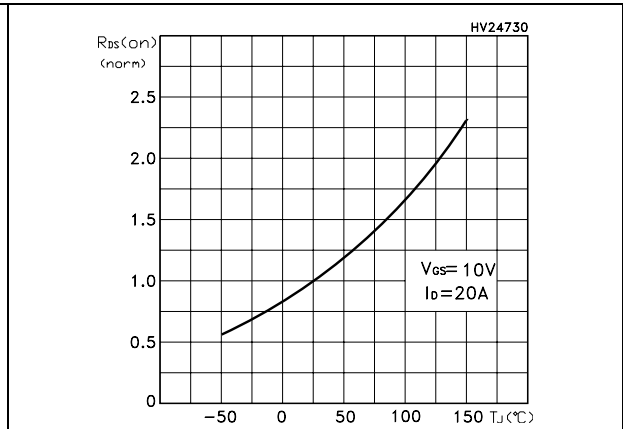
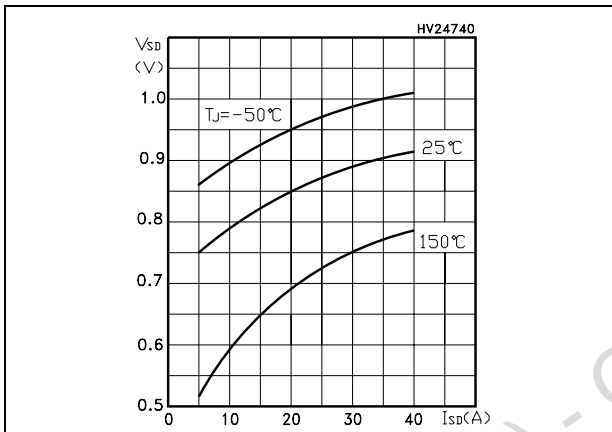


Figure 15. Source-drain diode forward characteristics



### 3 Test circuit

Figure 16. Switching times test circuit for resistive load



Figure 17. Gate charge test circuit

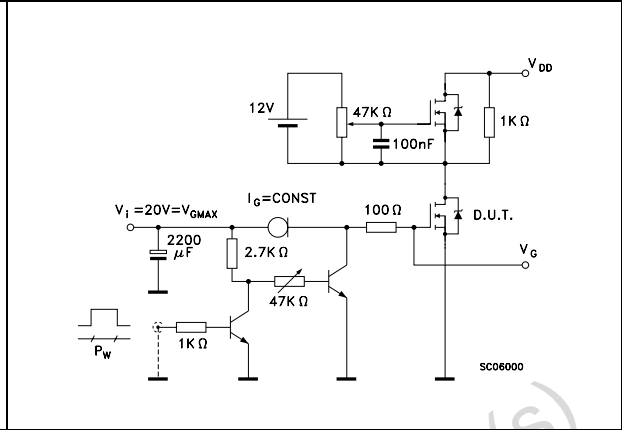


Figure 18. Test circuit for inductive load switching and diode recovery times

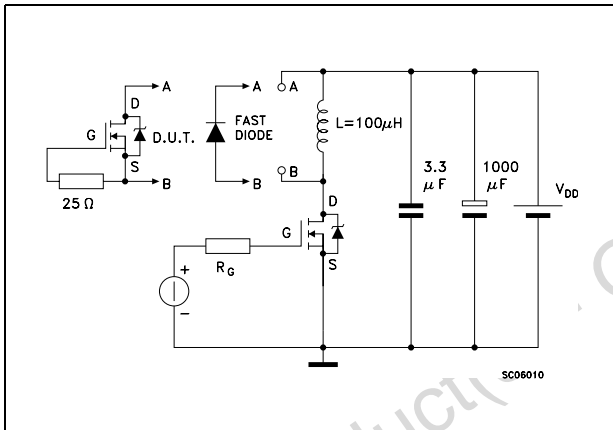


Figure 19. Unclamped Inductive load test circuit

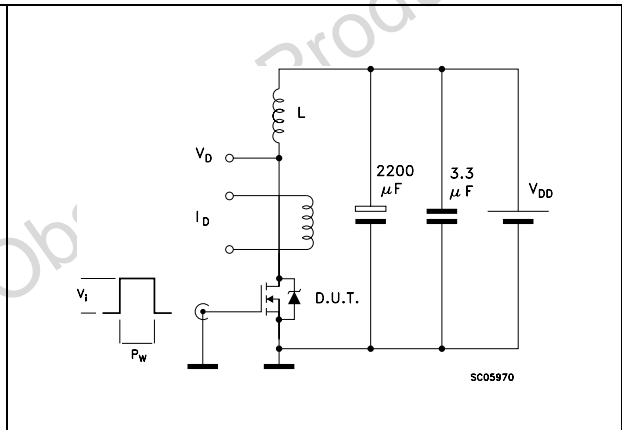


Figure 20. Unclamped inductive waveform

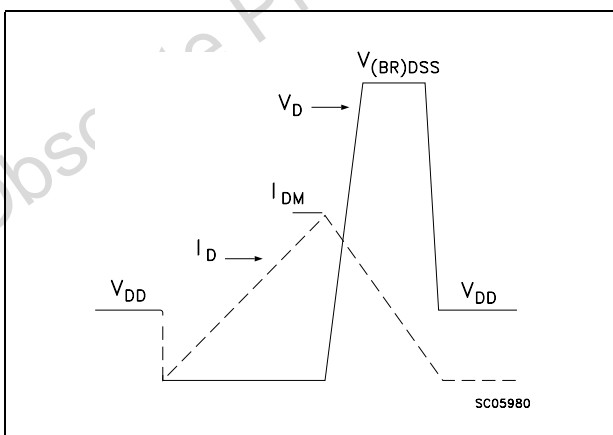


Figure 21. Switching time waveform

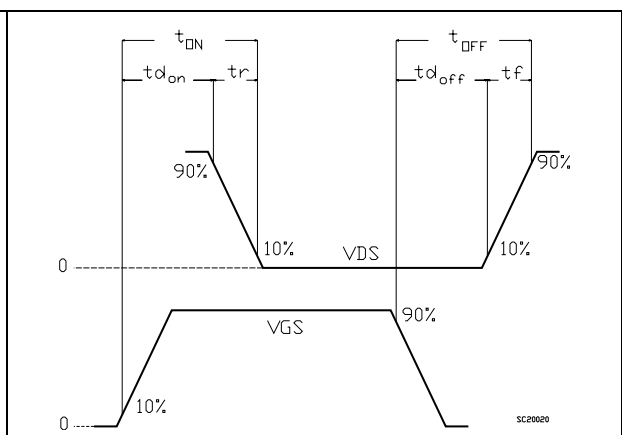
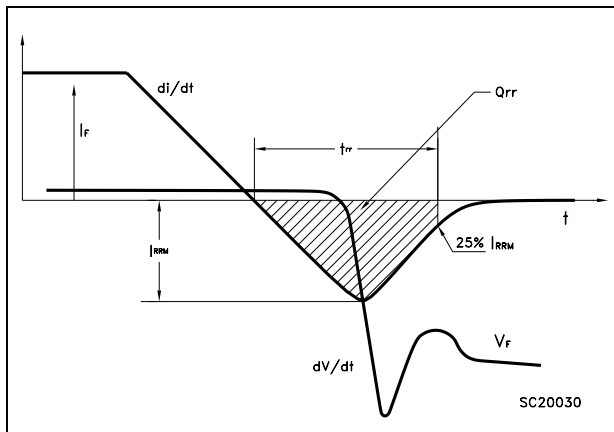


Figure 22. Diode recovery times waveform



Obsolete Product(s) - Obsolete Product(s)

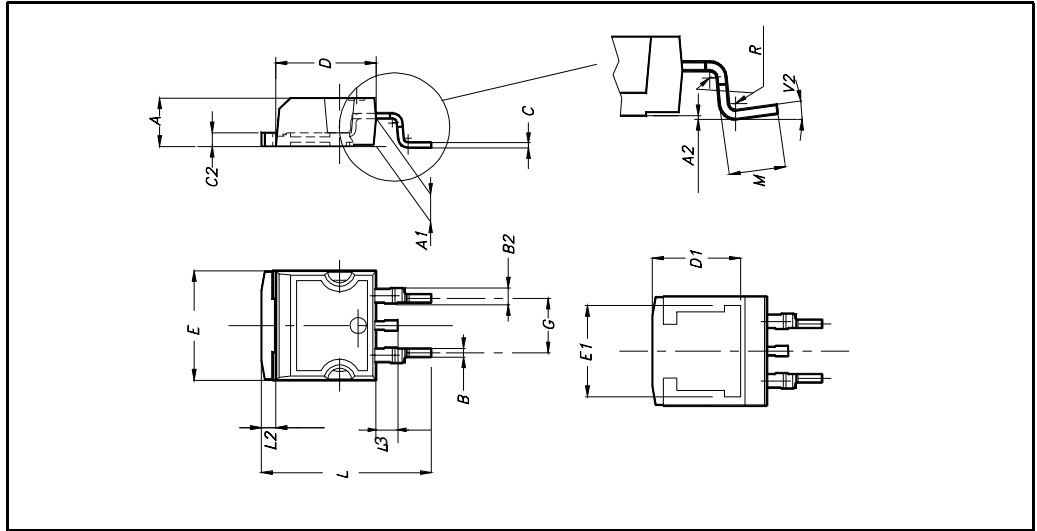
## 4 Package mechanical data

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)

Obsolete Product(s) - Obsolete Product(s)

**D<sup>2</sup>PAK MECHANICAL DATA**

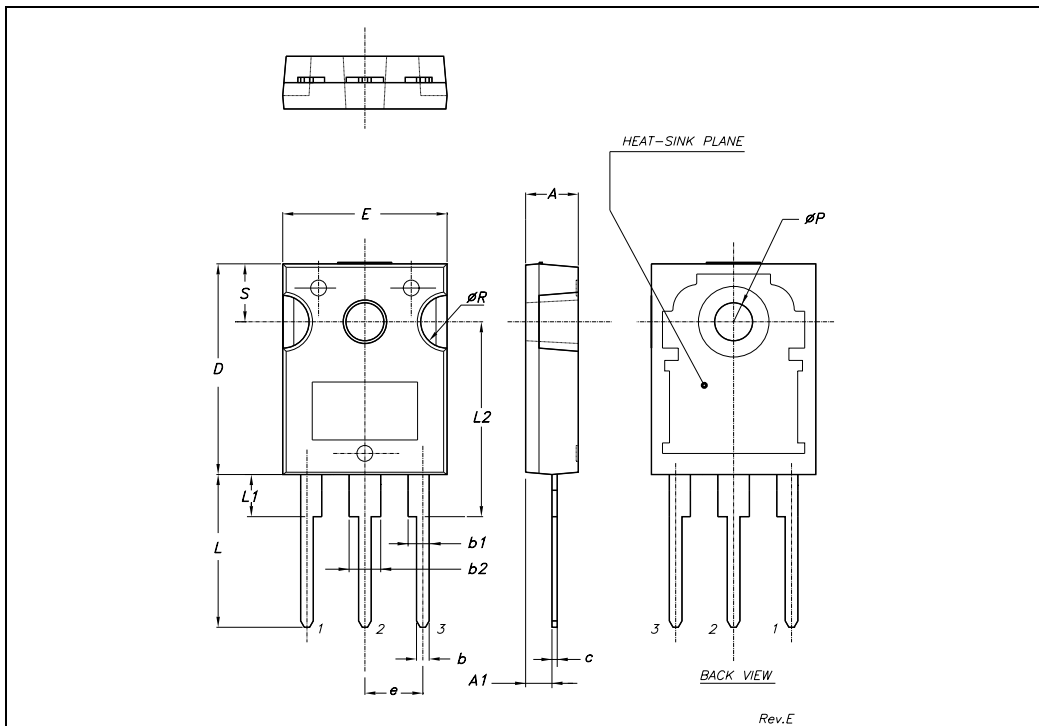
| DIM. | mm.  |      |       | inch  |       |       |
|------|------|------|-------|-------|-------|-------|
|      | MIN. | TYP. | MAX.  | MIN.  | TYP.  | MAX.  |
| A    | 4.4  |      | 4.6   | 0.173 |       | 0.181 |
| A1   | 2.49 |      | 2.69  | 0.098 |       | 0.106 |
| A2   | 0.03 |      | 0.23  | 0.001 |       | 0.009 |
| B    | 0.7  |      | 0.93  | 0.027 |       | 0.036 |
| B2   | 1.14 |      | 1.7   | 0.044 |       | 0.067 |
| C    | 0.45 |      | 0.6   | 0.017 |       | 0.023 |
| C2   | 1.23 |      | 1.36  | 0.048 |       | 0.053 |
| D    | 8.95 |      | 9.35  | 0.352 |       | 0.368 |
| D1   |      | 8    |       |       | 0.315 |       |
| E    | 10   |      | 10.4  | 0.393 |       |       |
| E1   |      | 8.5  |       |       | 0.334 |       |
| G    | 4.88 |      | 5.28  | 0.192 |       | 0.208 |
| L    | 15   |      | 15.85 | 0.590 |       | 0.625 |
| L2   | 1.27 |      | 1.4   | 0.050 |       | 0.055 |
| L3   | 1.4  |      | 1.75  | 0.055 |       | 0.068 |
| M    | 2.4  |      | 3.2   | 0.094 |       | 0.126 |
| R    |      | 0.4  |       |       | 0.015 |       |
| V2   | 0°   |      | 4°    |       |       |       |



Obsole

**TO-247 MECHANICAL DATA**

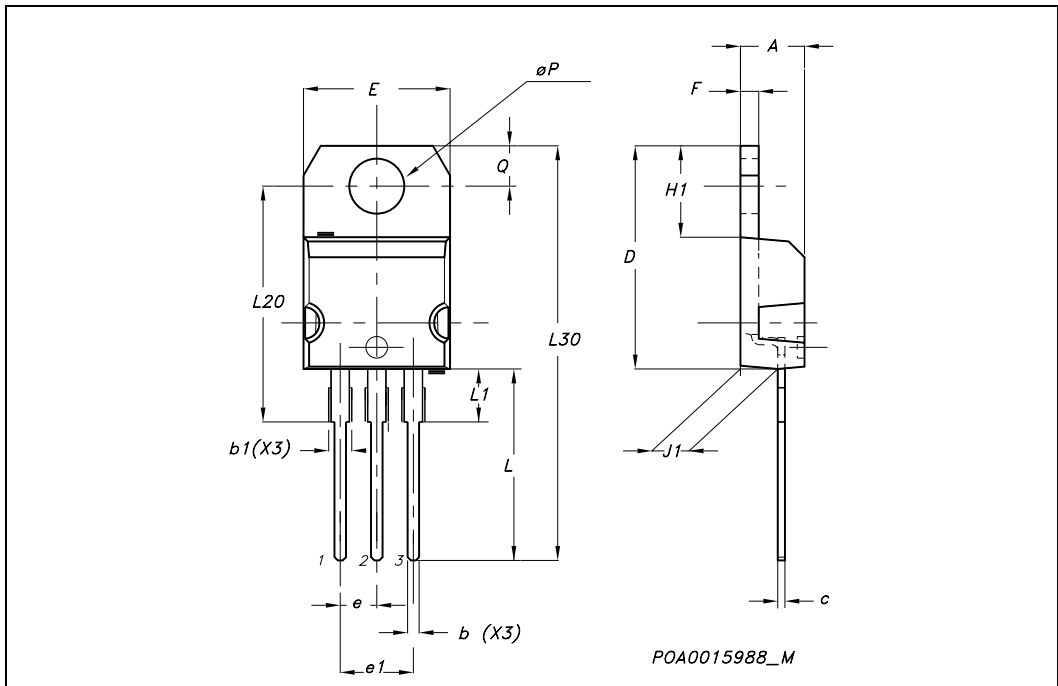
| DIM. | mm.   |       |       | inch  |       |       |
|------|-------|-------|-------|-------|-------|-------|
|      | MIN.  | TYP.  | MAX.  | MIN.  | TYP.  | MAX.  |
| A    | 4.85  |       | 5.15  | 0.19  |       | 0.20  |
| A1   | 2.20  |       | 2.60  | 0.086 |       | 0.102 |
| b    | 1.0   |       | 1.40  | 0.039 |       | 0.055 |
| b1   | 2.0   |       | 2.40  | 0.079 |       | 0.094 |
| b2   | 3.0   |       | 3.40  | 0.118 |       | 0.134 |
| c    | 0.40  |       | 0.80  | 0.015 |       | 0.03  |
| D    | 19.85 |       | 20.15 | 0.781 |       | 0.793 |
| E    | 15.45 |       | 15.75 | 0.608 |       | 0.620 |
| e    |       | 5.45  |       |       | 0.214 |       |
| L    | 14.20 |       | 14.80 | 0.560 |       | 0.582 |
| L1   | 3.70  |       | 4.30  | 0.14  |       | 0.17  |
| L2   |       | 18.50 |       |       | 0.728 |       |
| øP   | 3.55  |       | 3.65  | 0.140 |       | 0.143 |
| øR   | 4.50  |       | 5.50  | 0.177 |       | 0.216 |
| S    |       | 5.50  |       |       | 0.216 |       |



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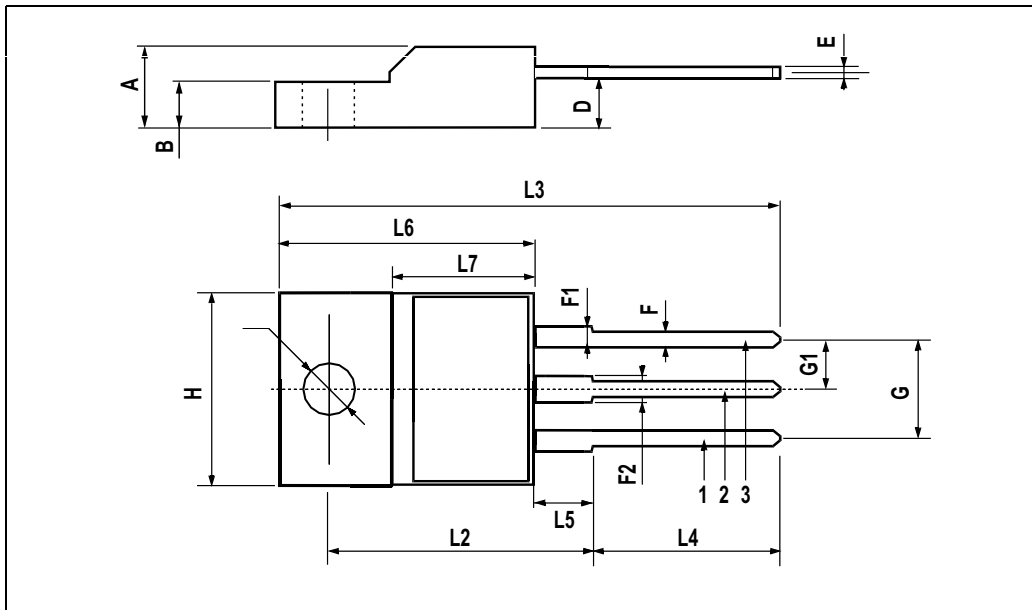
**TO-220 MECHANICAL DATA**

| 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 |



**TO-220FP MECHANICAL DATA**

| DIM. | mm.  |      |      | inch  |       |       |
|------|------|------|------|-------|-------|-------|
|      | MIN. | TYP. | MAX. | MIN.  | TYP.  | MAX.  |
| A    | 4.4  |      | 4.6  | 0.173 |       | 0.181 |
| B    | 2.5  |      | 2.7  | 0.098 |       | 0.106 |
| D    | 2.5  |      | 2.75 | 0.098 |       | 0.108 |
| E    | 0.45 |      | 0.7  | 0.017 |       | 0.027 |
| F    | 0.75 |      | 1    | 0.030 |       | 0.039 |
| F1   | 1.15 |      | 1.7  | 0.045 |       | 0.067 |
| F2   | 1.15 |      | 1.7  | 0.045 |       | 0.067 |
| G    | 4.95 |      | 5.2  | 0.195 |       | 0.204 |
| G1   | 2.4  |      | 2.7  | 0.094 |       | 0.106 |
| H    | 10   |      | 10.4 | 0.393 |       | 0.409 |
| L2   |      | 16   |      |       | 0.630 |       |
| L3   | 28.6 |      | 30.6 | 1.126 |       | 1.204 |
| L4   | 9.8  |      | 10.6 | .0385 |       | 0.417 |
| L5   | 2.9  |      | 3.6  | 0.114 |       | 0.141 |
| L6   | 15.9 |      | 16.4 | 0.626 |       | 0.645 |
| L7   | 9    |      | 9.3  | 0.354 |       | 0.366 |
| Ø    | 3    |      | 3.2  | 0.118 |       | 0.126 |



Obsole

# 5 Packaging mechanical data

## D<sup>2</sup>PAK FOOTPRINT



## TAPE AND REEL SHIPMENT

**TAPE MECHANICAL DATA**

| DIM. | mm   |      | inch   |        |
|------|------|------|--------|--------|
|      | MIN. | MAX. | MIN.   | MAX.   |
| A0   | 10.5 | 10.7 | 0.413  | 0.421  |
| B0   | 15.7 | 15.9 | 0.618  | 0.626  |
| D    | 1.5  | 1.6  | 0.059  | 0.063  |
| D1   | 1.59 | 1.61 | 0.062  | 0.063  |
| E    | 1.65 | 1.85 | 0.065  | 0.073  |
| F    | 11.4 | 11.6 | 0.449  | 0.456  |
| K0   | 4.8  | 5.0  | 0.189  | 0.197  |
| P0   | 3.9  | 4.1  | 0.153  | 0.161  |
| P1   | 11.9 | 12.1 | 0.468  | 0.476  |
| P2   | 1.9  | 2.1  | 0.075  | 0.082  |
| R    | 50   |      | 1.574  |        |
| T    | 0.25 | 0.35 | 0.0098 | 0.0137 |
| W    | 23.7 | 24.3 | 0.933  | 0.956  |

**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    | 24.4 | 26.4 | 0.960 | 1.039  |
| N    | 100  |      | 3.937 |        |
| T    |      | 30.4 |       | 1.197  |

| BASE QTY | BULK QTY |
|----------|----------|
| 1000     | 1000     |

\* on sales type

## 6 Revision history

Table 7. Revision history

| Date        | Revision | Changes                             |
|-------------|----------|-------------------------------------|
| 09-Feb-2005 | 1        | First version                       |
| 09-Jun-2005 | 2        | Complete version with curves        |
| 09-Nov-2005 | 3        | Inserted D <sup>2</sup> PAK package |
| 15-Mar-2006 | 4        | Inserted TO-220FP package           |
| 16-Aug-2006 | 5        | New template, no content change     |

Obsolete Product(s) - Obsolete Product(s)

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