



STP10NK80Z, STP10NK80ZFP, STW10NK80Z

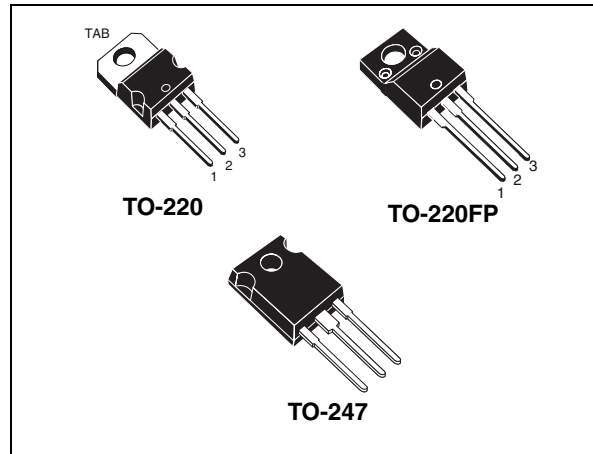
N-channel 800 V, 0.78 Ω , 9 A Zener-protected SuperMESH™ Power MOSFETs in TO-220, TO-220FP and TO-247 packages

Datasheet — production data

Features

| Type | V _{DSS} | R _{DS(on)} | I _D | P _w |
|--------------|------------------|---------------------|----------------|----------------|
| STP10NK80Z | 800V | <0.90 Ω | 9A | 160 W |
| STP10NK80ZFP | 800V | <0.90 Ω | 9A | 40 W |
| STW10NK80Z | 800V | <0.90 Ω | 9A | 160 W |

- Extremely high dv/dt capability
- 100% avalanche tested
- Gate charge minimized
- Very low intrinsic capacitances
- Very good manufacturing repeability



Applications

- Switching application

Description

These devices are N-channel Zener-protected Power MOSFETs developed using STMicroelectronics' SuperMESH™ technology, achieved through optimization of ST's well established strip-based PowerMESH™ layout. In addition to a significant reduction in on-resistance, this device is designed to ensure a high level of dv/dt capability for the most demanding applications.

Figure 1. Internal schematic diagram



Table 1. Device summary

| Part number | Marking | Package | Packaging |
|--------------|------------|----------|-----------|
| STP10NK80Z | P10NK80Z | TO-220 | Tube |
| STP10NK80ZFP | P10NK80ZFP | TO-220FP | Tube |
| STW10NK80Z | W10NK80Z | TO-247 | Tube |

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1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | | Unit |
|----------------------|---|----------------|------------|---------------------|
| | | TO-220/ TO-247 | TO-220FP | |
| V_{DSS} | Drain-source voltage ($V_{GS} = 0$) | 800 | | V |
| V_{DGR} | Drain-gate voltage ($R_{GS} = 20k\Omega$) | 800 | | V |
| V_{GS} | Gate-source voltage | ± 30 | | V |
| I_D | Drain current (continuous) at $T_C = 25^\circ\text{C}$ | 9 | $9^{(1)}$ | A |
| I_D | Drain current (continuous) at $T_C = 100^\circ\text{C}$ | 6 | $6^{(1)}$ | A |
| $I_{DM}^{(2)}$ | Drain current (pulsed) | 36 | $36^{(1)}$ | A |
| P_{TOT} | Total dissipation at $T_C = 25^\circ\text{C}$ | 160 | 40 | W |
| | Derating factor | 1.28 | 0.32 | W/ $^\circ\text{C}$ |
| Vesd(G-S) | G-S ESD (HBM C=100pF, R=1.5k Ω) | 4 | | kV |
| dv/dt ⁽³⁾ | Peak diode recovery voltage slope | 4.5 | | V/ns |
| V_{ISO} | Insulation withstand voltage (DC) | -- | 2500 | V |
| T_J T_{stg} | Operating junction temperature Storage temperature | -55 to 150 | | $^\circ\text{C}$ |

1. Limited by maximum junction temperature.
2. Pulse width limited by safe operating area.
3. $I_{SD} \leq 9\text{ A}$, $di/dt \leq 200\text{ A}/\mu\text{s}$, $V_{DD} \leq V_{(BR)DSS}$, $T_J \leq T_{JMAX}$

Table 3. Thermal data

| Symbol | Parameter | Value | | | Unit |
|----------------|---|--------|----------|--------|---------------------------|
| | | TO-220 | TO-220FP | TO-247 | |
| $R_{thj-case}$ | Thermal resistance junction-case Max | 0.78 | 3.1 | 0.78 | $^\circ\text{C}/\text{W}$ |
| R_{thj-a} | Thermal resistance junction-ambient Max | 62.5 | | 50 | $^\circ\text{C}/\text{W}$ |

Table 4. Avalanche characteristics

| Symbol | Parameter | Value | Unit |
|----------|---|-------|------|
| I_{AS} | Avalanche current, repetitive or not-repetitive (pulse width limited by T_J Max) | 9 | A |
| E_{AS} | Single pulse avalanche energy (starting $T_J = 25^\circ\text{C}$, $I_d = I_{AS}$, $V_{DD} = 50\text{V}$) | 290 | mJ |

2 Electrical characteristics

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

Table 5. On/off states

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------|--|--|------|------|----------|--------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $I_D = 1mA, V_{GS} = 0$ | 800 | | | V |
| I_{DSS} | Zero gate voltage drain current ($V_{GS} = 0$) | $V_{DS} = 800V$ $V_{DS} = 800V, T_C = 125^{\circ}C$ | | | 1 50 | μA μA |
| I_{GSS} | Gate body leakage current ($V_{DS} = 0$) | $V_{GS} = \pm 20V$ | | | ± 10 | μA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS} = V_{GS}, I_D = 100\mu A$ | 3 | 3.75 | 4.5 | V |
| $R_{DS(on)}$ | Static drain-source on resistance | $V_{GS} = 10V, I_D = 4.5A$ | | 0.78 | 0.9 | Ω |

Table 6. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-------------------------------------|---|--|------|-------------------|------|----------------|
| $g_{fs}^{(1)}$ | Forward transconductance | $V_{DS} = 15V, I_D = 4.5A$ | - | 9.6 | - | S |
| C_{iss} C_{oss} C_{rss} | Input capacitance Output capacitance Reverse transfer capacitance | $V_{DS} = 25V, f = 1 MHz, V_{GS} = 0$ | - | 2180 205 38 | - | pF pF pF |
| $C_{oss eq}^{(2)}$ | Equivalent output capacitance | $V_{GS} = 0, V_{DS} = 0V \text{ to } 640V$ | - | 105 | - | pF |
| Q_g Q_{gs} Q_{gd} | Total gate charge Gate-source charge Gate-drain charge | $V_{DD} = 640V, I_D = 9A$ $V_{GS} = 10V$ See Figure 20 | - | 72 12.5 37 | - | nC nC nC |

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

2. $C_{oss eq}$ is defined as a constant equivalent capacitance giving the same charging time as C_{oss} when V_{DS} increases from 0 to 80% V_{DSS}

Table 7. Switching times

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------------|----------------------------------|---|------|----------|------|----------|
| $t_{d(on)}$ t_r | Turn-on delay time Rise time | $V_{DD}=400\text{ V}$, $I_D=4.5\text{ A}$, $R_G=4.7\Omega$, $V_{GS}=10\text{ V}$ See Figure 21 | | 30 20 | | ns ns |
| $t_{d(off)}$ t_f | Turn-off delay Time Fall time | $V_{DD}=400\text{ V}$, $I_D=4.5\text{ A}$, $R_G=4.7\Omega$, $V_{GS}=10\text{ V}$ See Figure 21 | | 65 17 | | ns ns |

Table 8. Gate-source zener diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|------------------|-------------------------------|--|------|------|------|------|
| $BV_{GSO}^{(1)}$ | Gate-source breakdown voltage | $I_{GS}=\pm 1\text{ mA}$ (open drain) | 30 | | | V |

- The built-in back-to-back Zener diodes have specifically been designed to enhance not only the device's ESD capability, but also to make them safely absorb possible voltage transients that may occasionally be applied from gate to source. In this respect the Zener voltage is appropriate to achieve an efficient and cost-effective intervention to protect the device's integrity. These integrated Zener diodes thus avoid the usage of external components.

Table 9. Source drain diode

| Symbol | Parameter | Test conditions | Min | Typ. | Max | Unit |
|-----------------------------------|--|---|-----|------------------|-----|--------------------------|
| I_{SD} | Source-drain current | | - | | 9 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | - | | 36 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $I_{SD}=9\text{ A}$, $V_{GS}=0$ | - | | 1.6 | V |
| t_{rr} Q_{rr} I_{RRM} | Reverse recovery time Reverse recovery charge Reverse recovery current | $I_{SD}=9\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD}=45\text{ V}$, $T_j=150^\circ\text{C}$ | - | 645 6.4 20 | | ns μC A |

- Pulse width limited by safe operating area
- Pulsed: pulse duration=300 μs , duty cycle 1.5%

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for TO-220

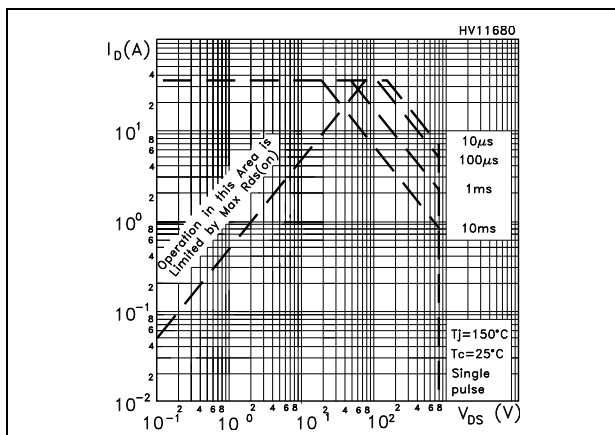


Figure 3. Thermal impedance for TO-220

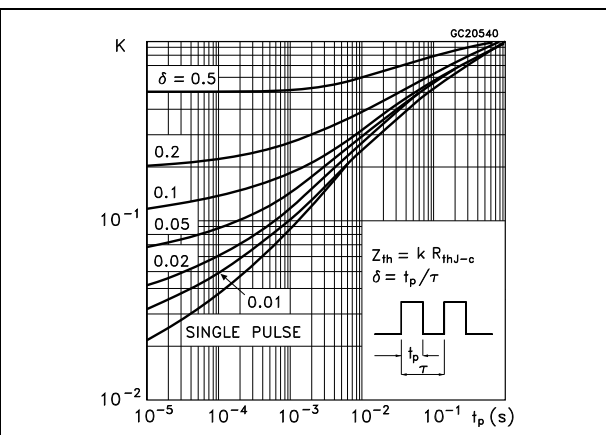


Figure 4. Safe operating area for TO-220FP

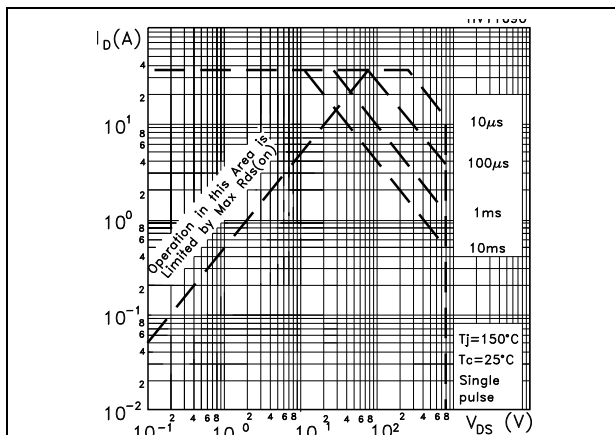


Figure 5. Thermal impedance for TO-220FP

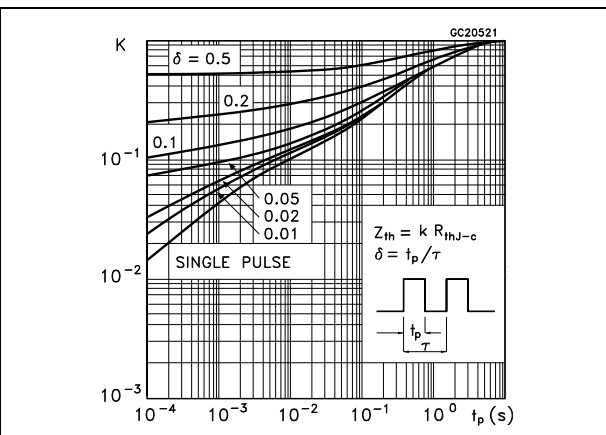


Figure 6. Safe operating area for TO-247

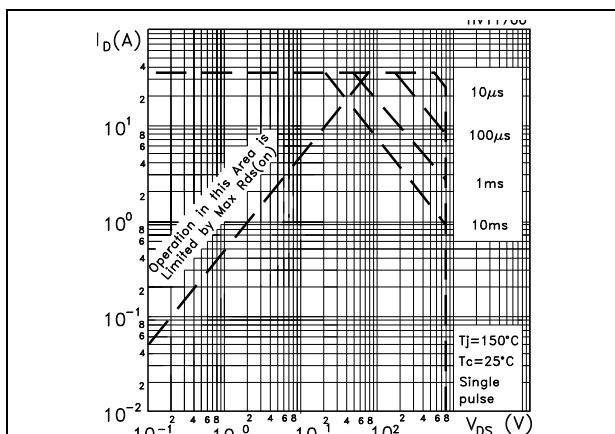


Figure 7. Thermal impedance for TO-247

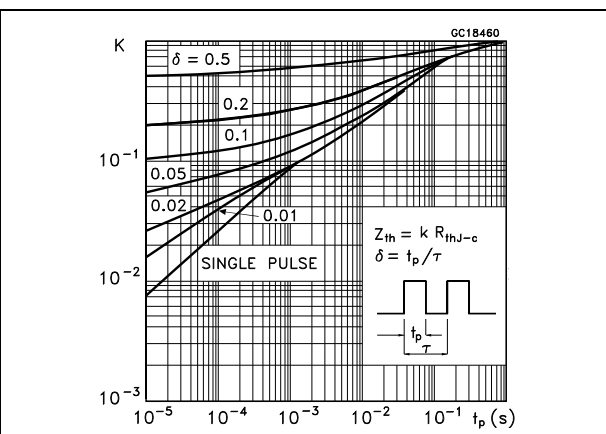


Figure 8. Output characteristics

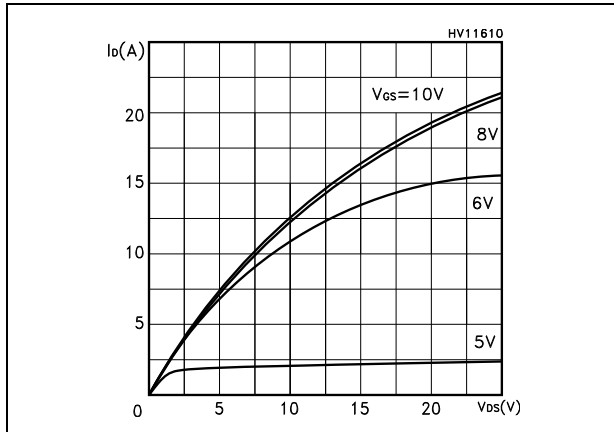


Figure 9. Transfer characteristics

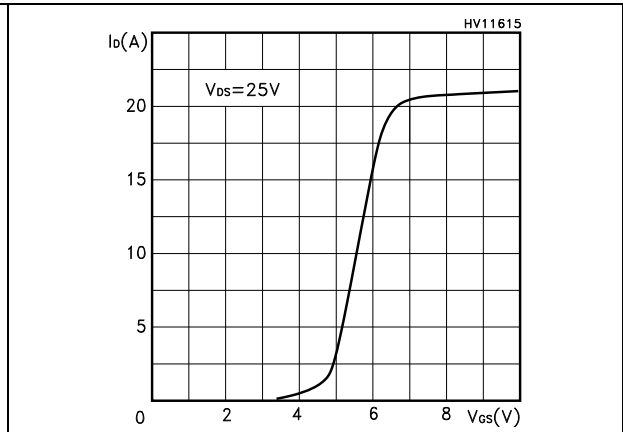


Figure 10. Transconductance

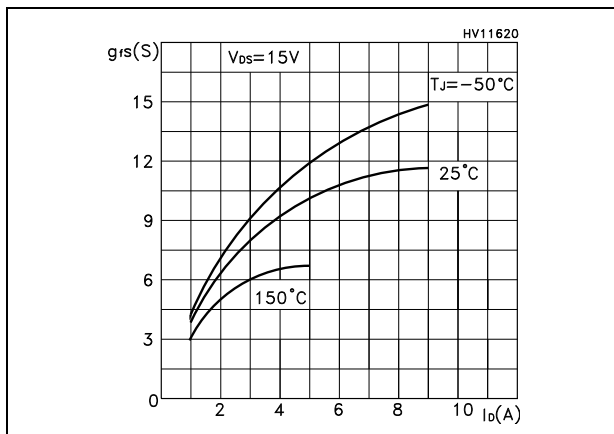


Figure 11. Static drain-source on resistance

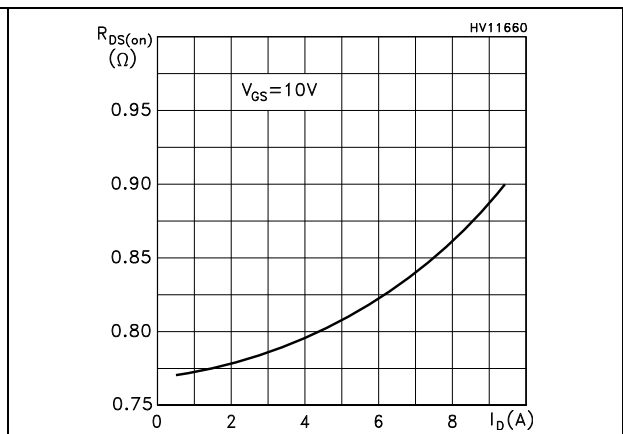


Figure 12. Gate charge vs gate-source voltage

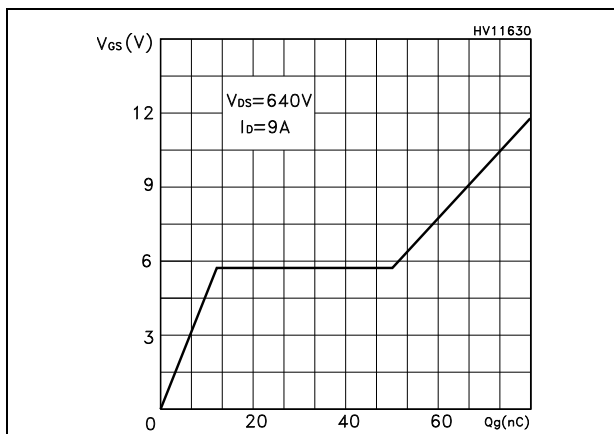


Figure 13. Capacitance variations

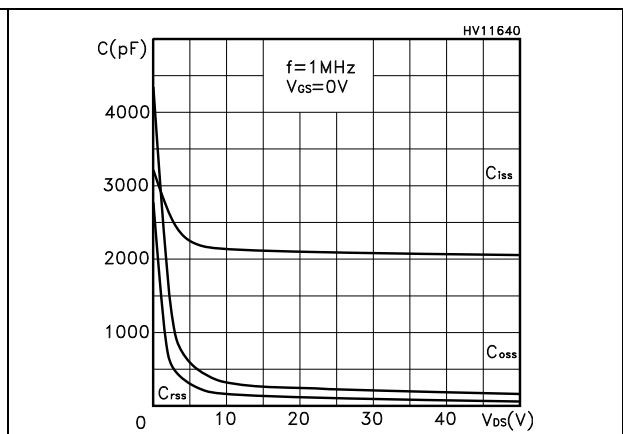


Figure 14. Normalized gate threshold voltage vs temperature

Figure 15. Normalized on resistance vs temperature

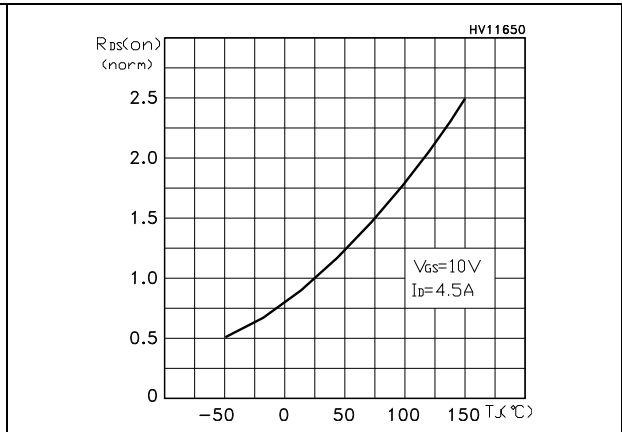
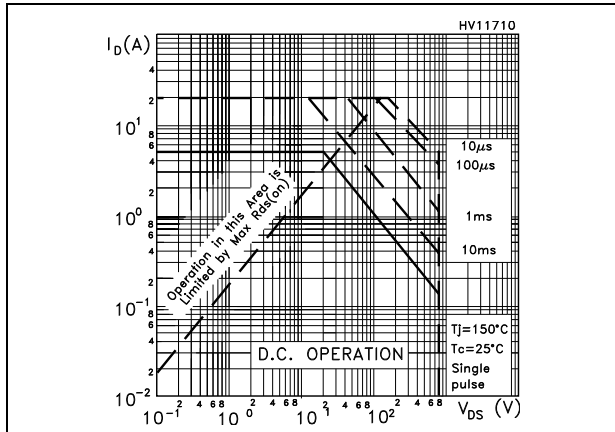


Figure 16. Source-drain diode forward characteristics

Figure 17. Normalized BV_{DSS} vs temperature

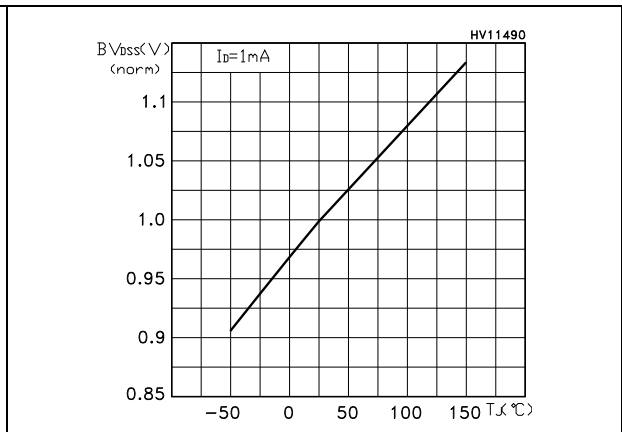
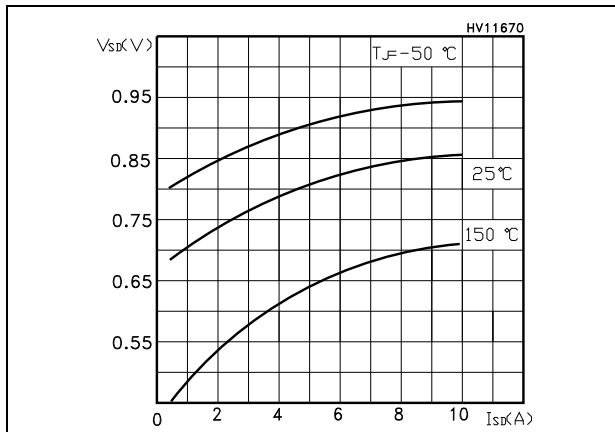
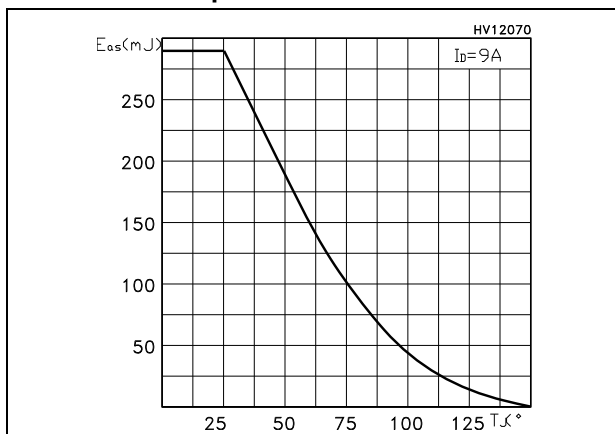


Figure 18. Maximum avalanche energy vs temperature



3 Test circuit

Figure 19. Switching times test circuit for resistive load

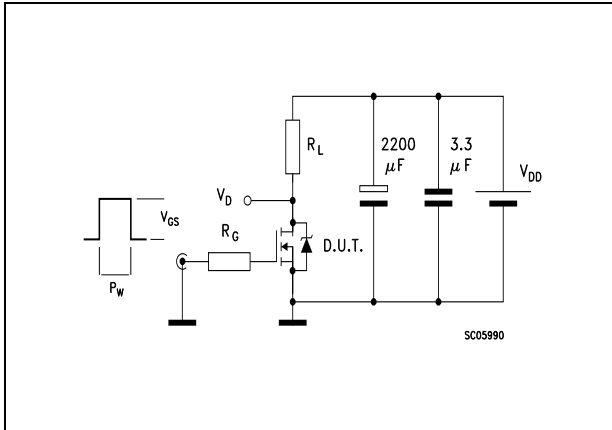


Figure 20. Gate charge test circuit

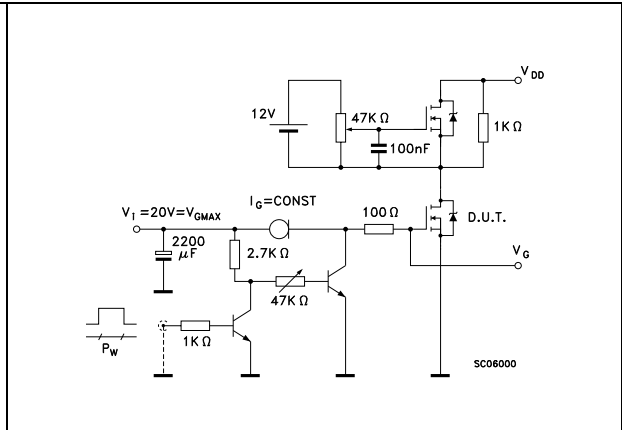


Figure 21. Test circuit for inductive load switching and diode recovery times

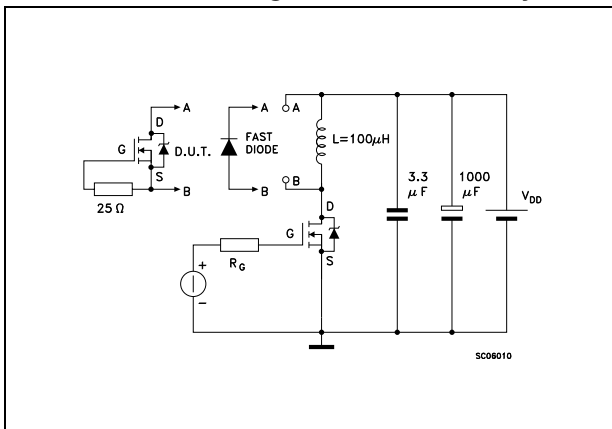


Figure 22. Unclamped Inductive load test circuit

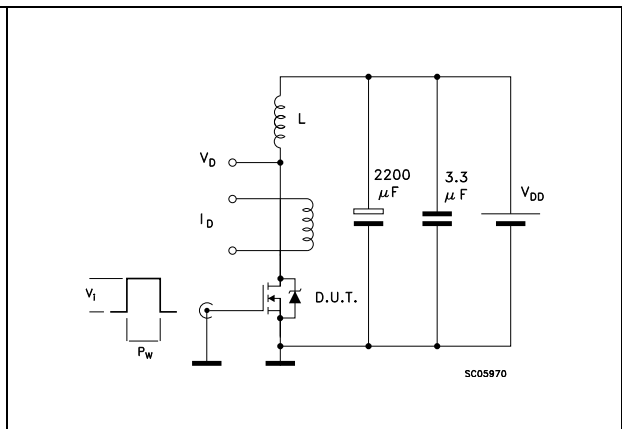


Figure 23. Unclamped inductive waveform

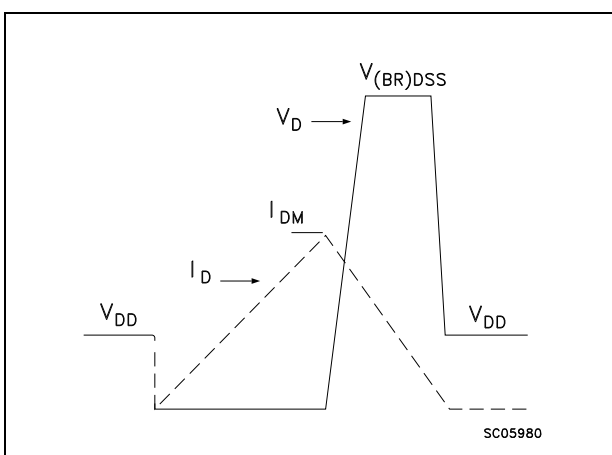
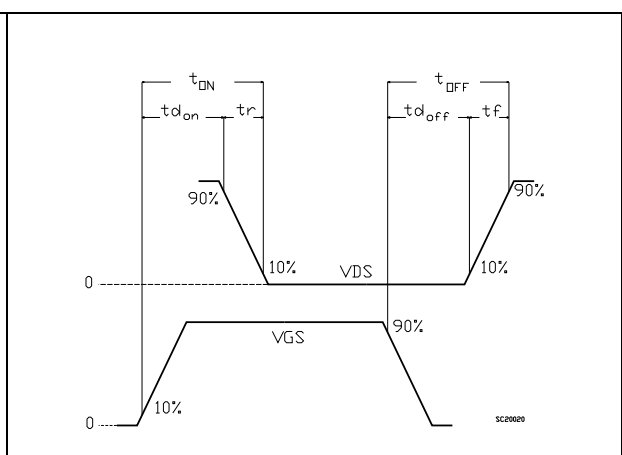


Figure 24. Switching time waveform



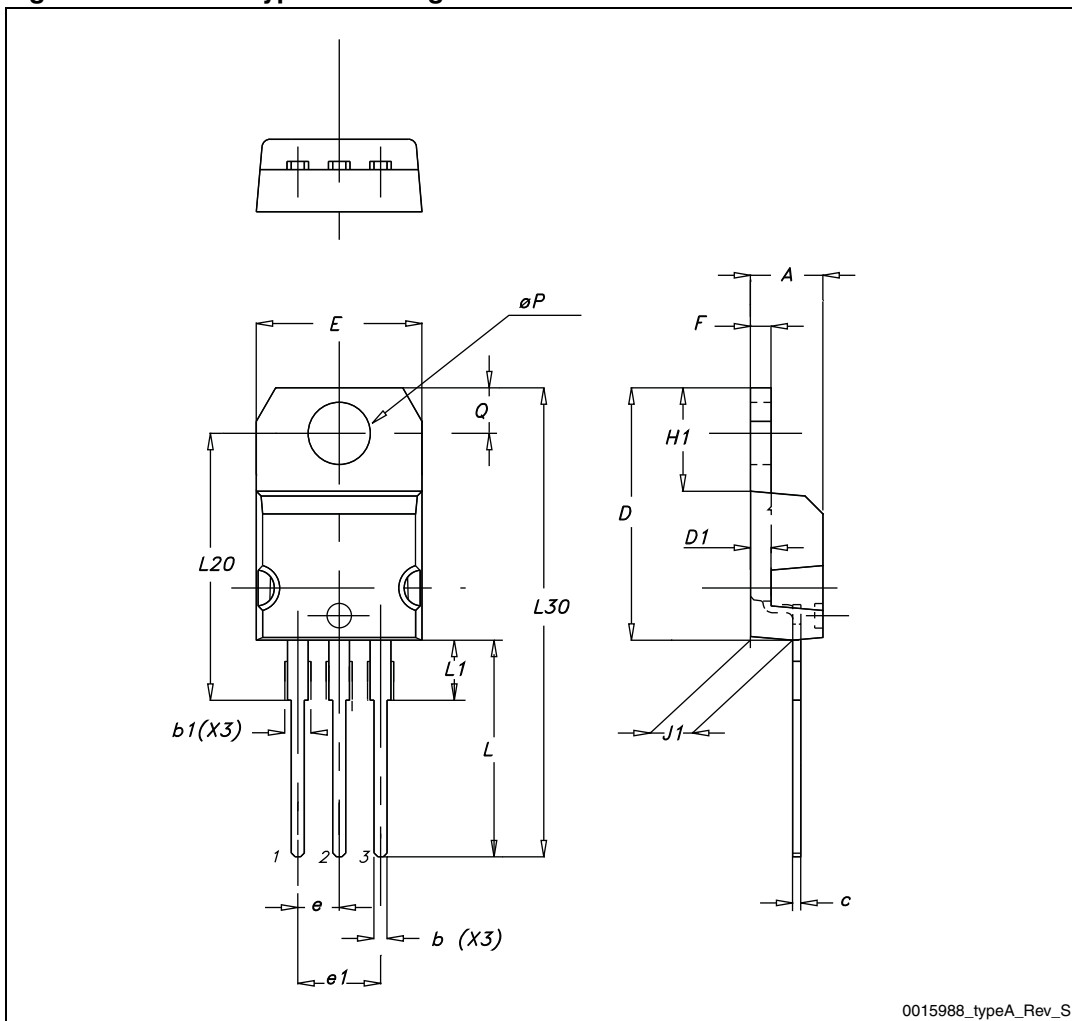
4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: www.st.com. ECOPACK is an ST trademark.

Table 10. TO-220 type A mechanical data

| Dim. | mm | | |
|------|-------|-------|-------|
| | Min. | Typ. | Max. |
| A | 4.40 | | 4.60 |
| b | 0.61 | | 0.88 |
| b1 | 1.14 | | 1.70 |
| c | 0.48 | | 0.70 |
| D | 15.25 | | 15.75 |
| D1 | | 1.27 | |
| E | 10 | | 10.40 |
| e | 2.40 | | 2.70 |
| e1 | 4.95 | | 5.15 |
| F | 1.23 | | 1.32 |
| H1 | 6.20 | | 6.60 |
| J1 | 2.40 | | 2.72 |
| L | 13 | | 14 |
| L1 | 3.50 | | 3.93 |
| L20 | | 16.40 | |
| L30 | | 28.90 | |
| ØP | 3.75 | | 3.85 |
| Q | 2.65 | | 2.95 |

Figure 25. TO-220 type A drawing



0015988_typeA_Rev_S

Table 11. TO-220FP mechanical data

| Dim. | mm | | |
|------|------|------|------|
| | Min. | Typ. | Max. |
| A | 4.4 | | 4.6 |
| B | 2.5 | | 2.7 |
| D | 2.5 | | 2.75 |
| E | 0.45 | | 0.7 |
| F | 0.75 | | 1 |
| F1 | 1.15 | | 1.70 |
| F2 | 1.15 | | 1.70 |
| G | 4.95 | | 5.2 |
| G1 | 2.4 | | 2.7 |
| H | 10 | | 10.4 |
| L2 | | 16 | |
| L3 | 28.6 | | 30.6 |
| L4 | 9.8 | | 10.6 |
| L5 | 2.9 | | 3.6 |
| L6 | 15.9 | | 16.4 |
| L7 | 9 | | 9.3 |
| Dia | 3 | | 3.2 |

Figure 26. TO-220FP drawing

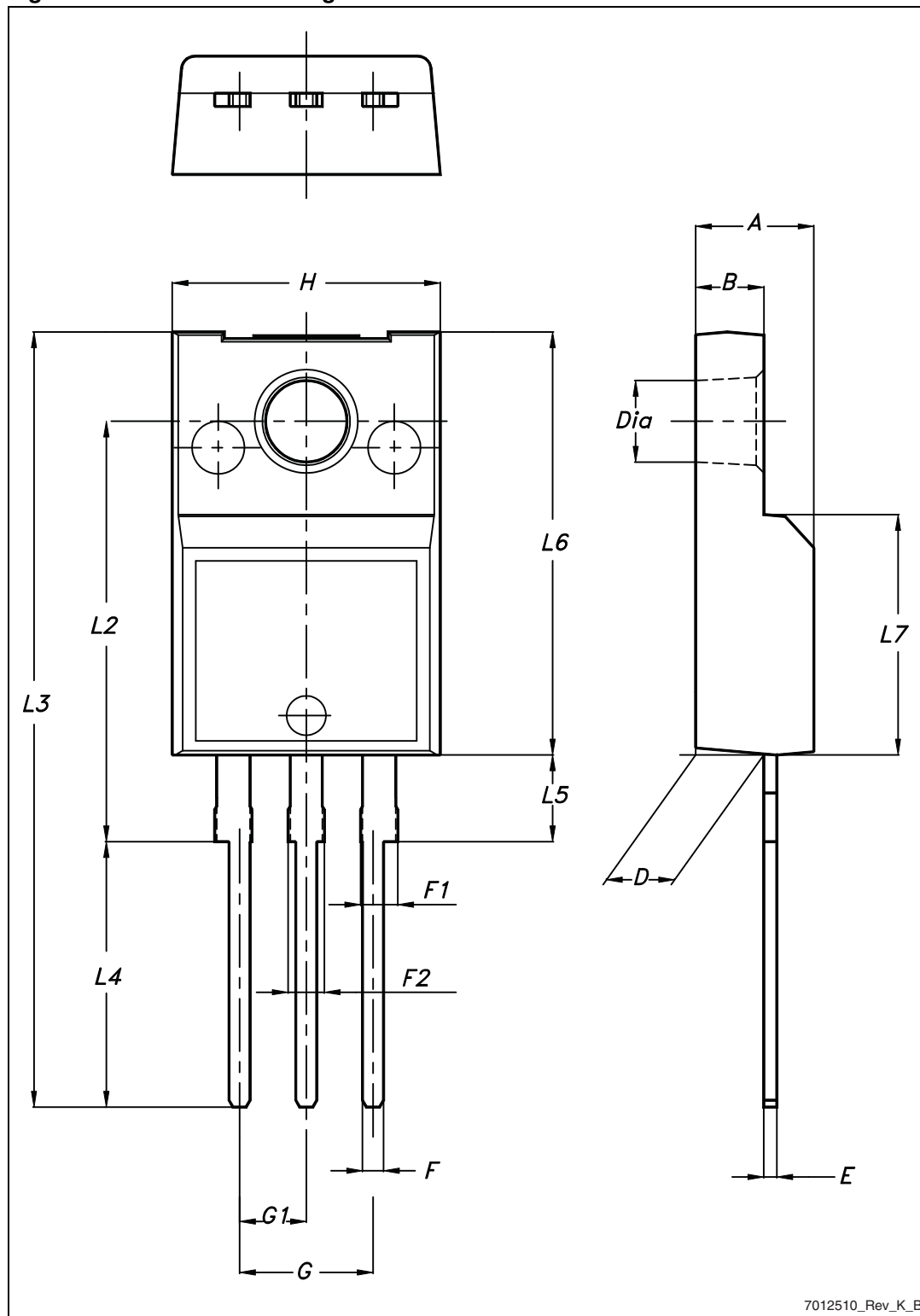
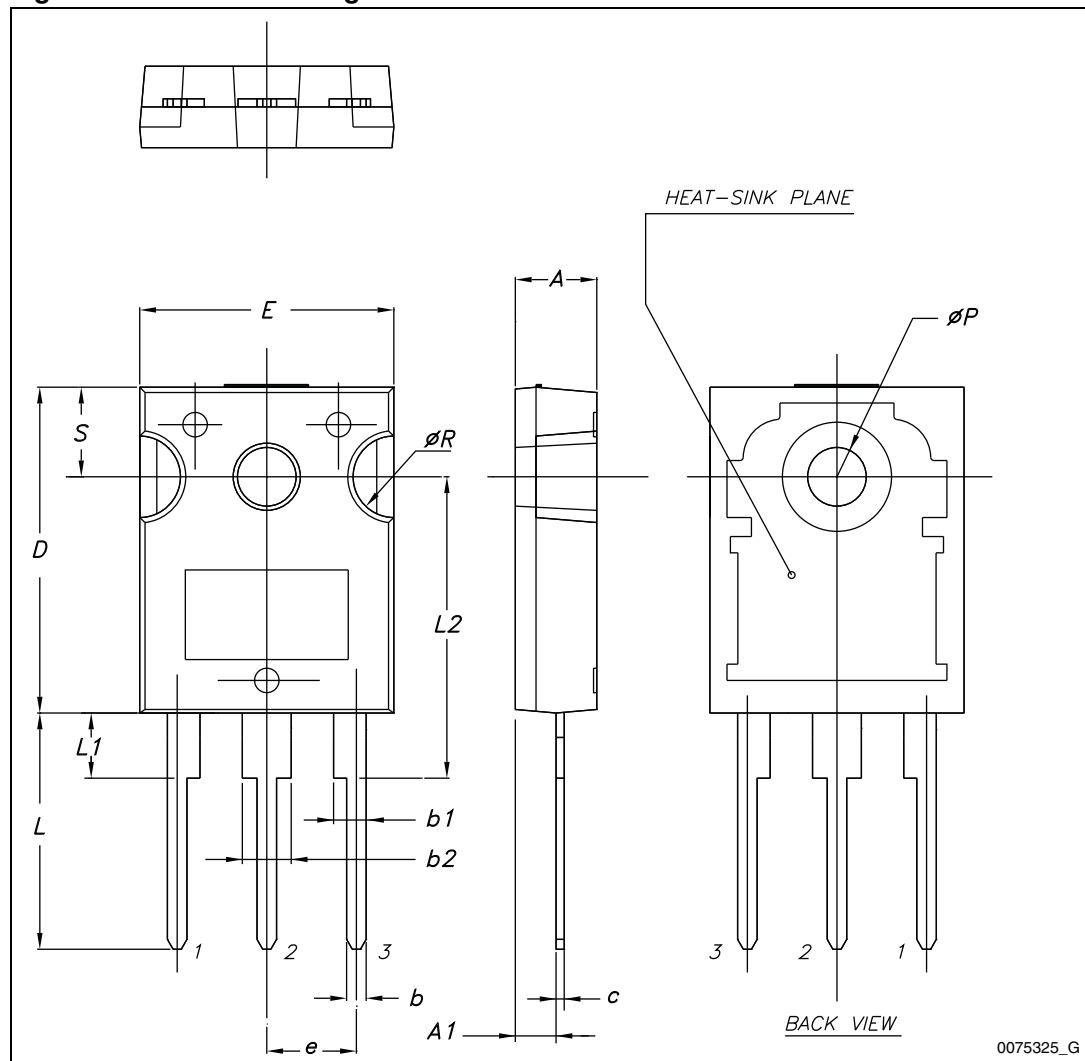


Table 12. TO-247 mechanical data

| Dim. | mm. | | |
|------|-------|-------|-------|
| | Min. | Typ. | Max. |
| A | 4.85 | | 5.15 |
| A1 | 2.20 | | 2.60 |
| b | 1.0 | | 1.40 |
| b1 | 2.0 | | 2.40 |
| b2 | 3.0 | | 3.40 |
| c | 0.40 | | 0.80 |
| D | 19.85 | | 20.15 |
| E | 15.45 | | 15.75 |
| e | 5.30 | 5.45 | 5.60 |
| L | 14.20 | | 14.80 |
| L1 | 3.70 | | 4.30 |
| L2 | | 18.50 | |
| ØP | 3.55 | | 3.65 |
| ØR | 4.50 | | 5.50 |
| S | 5.30 | 5.50 | 5.70 |

Figure 27. TO-247 drawing



5 Revision history

Table 13. Document revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 08-Sep-2005 | 4 | Complete document |
| 10-Mar-2006 | 5 | Inserted ecopack indication |
| 28-Sep-2005 | 6 | New template, no content change |
| 15-Mar-2012 | 7 | Content reworked to improve readability. Minor text changes in cover page. Updated Table 5 . Updated Section 4: Package mechanical data . |

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