

N-channel 600 V, 0.45 Ω typ., 13.5 A SuperMESH™
Power MOSFETs in I²PAK, TO-220 and TO-247 packages

Datasheet - obsolete product

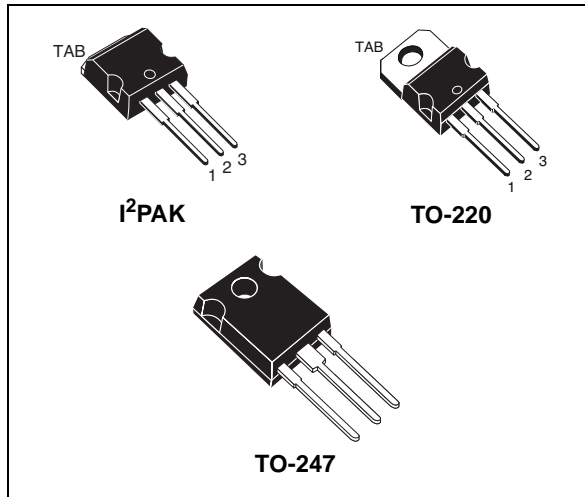
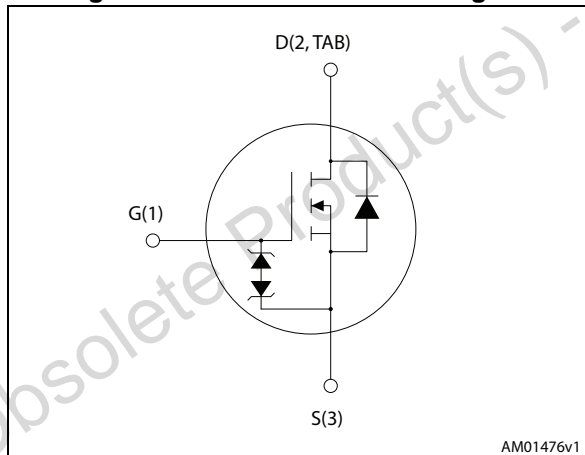


Figure 1. Internal schematic diagram



Features

| Order codes | V _{DS} | R _{DS(on)} max. | I _D | P _{TOT} |
|--------------|-----------------|-----------------------------|----------------|------------------|
| STB14NK60Z-1 | 600 V | 0.5 Ω | 13.5 A | 160 W |
| STP14NK60Z | | | | |
| STW14NK60Z | | | | |

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

Applications

- Switching applications

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.

Table 1. Device summary

| Order codes | Marking | Package | Packaging |
|--------------|----------|--------------------|-----------|
| STB14NK60Z-1 | B14NK60Z | I ² PAK | Tube |
| STP14NK60Z | P14NK60Z | TO-220 | |
| STW14NK60Z | W14NK60Z | TO-247 | |

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Obsolete Product(s) - Obsolete Product(s)



1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|--------------------|--|------------|---------------------|
| V_{DS} | Drain-source voltage | 600 | V |
| V_{DGR} | Drain-gate voltage ($R_{GS} = 20 \text{ k}\Omega$) | 600 | V |
| V_{GS} | Gate-source voltage | ± 30 | V |
| I_D | Drain current (continuous) at $T_C = 25^\circ\text{C}$ | 13.5 | A |
| I_D | Drain current (continuous) at $T_C = 100^\circ\text{C}$ | 8.5 | A |
| $I_{DM}^{(1)}$ | Drain current (pulsed) | 54 | A |
| P_{TOT} | Total dissipation at $T_C = 25^\circ\text{C}$ | 160 | W |
| | Derating factor | 1.28 | W/ $^\circ\text{C}$ |
| ESD | Gate-source human body model ($R = 1.5 \text{ k}\Omega$, $C = 100 \text{ pF}$) | 4 | kV |
| $dv/dt^{(2)}$ | Peak diode recovery voltage slope | 4.5 | V/ns |
| T_J T_{stg} | Operating junction temperature Storage temperature | -55 to 150 | $^\circ\text{C}$ |

1. Pulse width limited by safe operating area
2. $I_{SD} \leq 13.5 \text{ A}$, $di/dt \leq 200 \text{ A}/\mu\text{s}$, $V_{DD} \leq V_{(BR)DSS}$, $T_J \leq T_{JMAX}$.

Table 3. Thermal data

| Symbol | Parameter | Value | Unit |
|----------------|---|-------|---------------------------|
| $R_{thj-case}$ | Thermal resistance junction-case max | 0.78 | $^\circ\text{C}/\text{W}$ |
| $R_{thj-amb}$ | Thermal resistance junction-ambient max | 62.5 | $^\circ\text{C}/\text{W}$ |

Table 4. Avalanche characteristics

| Symbol | Parameter | Value | Unit |
|----------|---|-------|------|
| I_{AS} | Avalanche current, repetitive or not-repetitive (pulse width limited by T_{jmax}) | 12 | A |
| E_{AS} | Single pulse avalanche energy (starting $T_J = 25^\circ\text{C}$, $I_D = I_{AR}$, $V_{DD} = 50 \text{ V}$) | 300 | 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 | $I_D = 1 \text{ mA}, V_{GS} = 0$ | 600 | | | V |
| I_{DSS} | Zero gate voltage drain current ($V_{GS} = 0$) | $V_{DS} = 600 \text{ V}$ | | | 1 | μA |
| | | $V_{DS} = 600 \text{ V}, T_C = 125^{\circ}C$ | | | 50 | μA |
| I_{GSS} | Gate body leakage current ($V_{DS} = 0$) | $V_{GS} = \pm 30 \text{ V}$ | | | ± 10 | μA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS} = V_{GS}, I_D = 100 \mu\text{A}$ | 3 | 3.75 | 4.5 | V |
| $R_{DS(on)}$ | Static drain-source on resistance | $V_{GS} = 10 \text{ V}, I_D = 6 \text{ A}$ | | 0.45 | 0.5 | Ω |

Table 6. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|----------------------------|-------------------------------|---|------|------|------|------|
| C_{iss} | Input capacitance | $V_{DS} = 25 \text{ V}, f = 1 \text{ MHz}, V_{GS} = 0$ | - | 2220 | - | pF |
| C_{oss} | Output capacitance | | - | 240 | - | pF |
| C_{rss} | Reverse transfer capacitance | | - | 57 | - | pF |
| $C_{oss \text{ eq}}^{(1)}$ | Equivalent output capacitance | $V_{GS} = 0, V_{DS} = 0 \text{ V to } 480 \text{ V}$ | - | 122 | - | pF |
| Q_g | Total gate charge | $V_{DD} = 480 \text{ V}, I_D = 12 \text{ A}, V_{GS} = 10 \text{ V}$ | - | 75 | - | nC |
| Q_{gs} | Gate-source charge | | - | 13.2 | - | nC |
| Q_{gd} | Gate-drain charge | | - | 38.6 | - | nC |

1. $C_{oss \text{ eq}}^{(1)}$ 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 |
|---------------|-----------------------|--|------|------|------|------|
| $t_{d(on)}$ | Turn-on delay time | $V_{DD}=300\text{ V}$, $I_D=6\text{ A}$, $R_G=4.7\ \Omega$, $V_{GS}=10\text{ V}$ (see Figure 17) | - | 26 | - | ns |
| t_r | Rise time | | - | 18 | - | ns |
| $t_{d(off)}$ | Turn-off delay time | | - | 62 | - | ns |
| t_f | Fall time | | - | 13 | - | ns |
| $t_{r(Voff)}$ | Off-voltage rise time | $V_{DD}=480\text{ V}$, $I_D=12\text{ A}$, $R_G=4.7\ \Omega$, $V_{GS}=10\text{ V}$ (see Figure 19) | - | 12 | - | ns |
| t_f | Fall time | | - | 9.5 | - | ns |
| t_c | Cross-over time | | - | 22 | - | ns |

Table 8. Source drain diode

| Symbol | Parameter | Test conditions | Min | Typ. | Max | Unit |
|-----------------|-------------------------------|--|-----|------|-----|---------------|
| I_{SD} | Source-drain current | | - | | 12 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | - | | 48 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $I_{SD}=12\text{ A}$, $V_{GS}=0$ | - | | 1.6 | V |
| t_{rr} | Reverse recovery time | $I_{SD}=12\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD}=50\text{ V}$ | - | 490 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 4.7 | | μC |
| I_{RRM} | Reverse recovery current | | - | 19.3 | | A |
| t_{rr} | Reverse recovery time | $I_{SD}=12\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD}=50\text{ V}$, $T_j=150\text{ }^\circ\text{C}$ | - | 664 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 6.8 | | μC |
| I_{RRM} | Reverse recovery current | | - | 20.5 | | A |

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

Table 9. Gate-source Zener diode

| Symbol | Parameter | Test conditions | Min | Typ. | Max. | Unit |
|---------------|-------------------------------|-------------------------------------|-----|------|------|------|
| $V_{(BR)GSO}$ | Gate-source breakdown voltage | $I_{GS} = \pm 1\text{mA}$, $I_D=0$ | 30 | - | - | V |

The built-in back-to-back Zener diodes have specifically been designed to enhance the device's ESD capability. 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.

Obsolete Product(s) - Obsolete Product(s)

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for I²PAK and TO-220

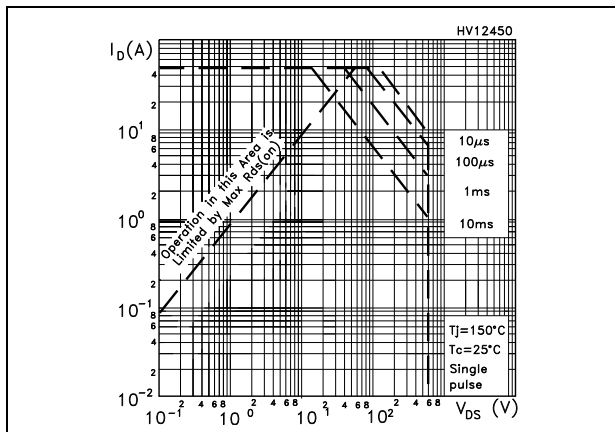


Figure 3. Thermal impedance for I²PAK and TO-220

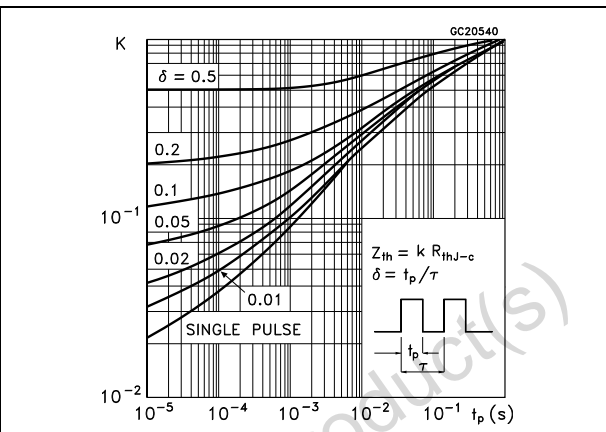


Figure 4. Safe operating area for TO-247

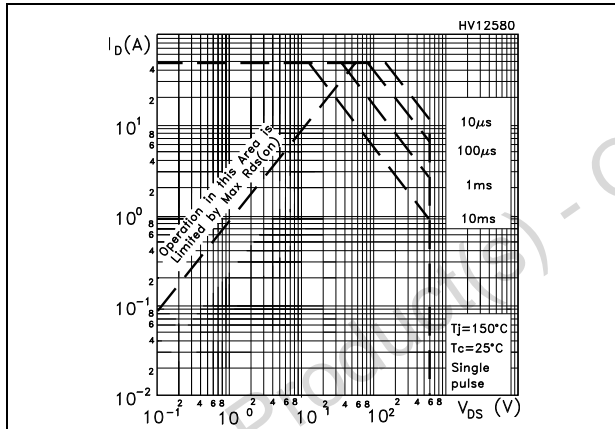


Figure 5. Thermal impedance for TO-247

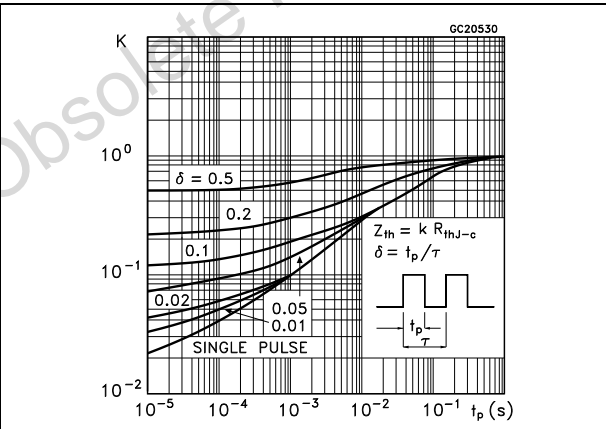


Figure 6. Output characteristics

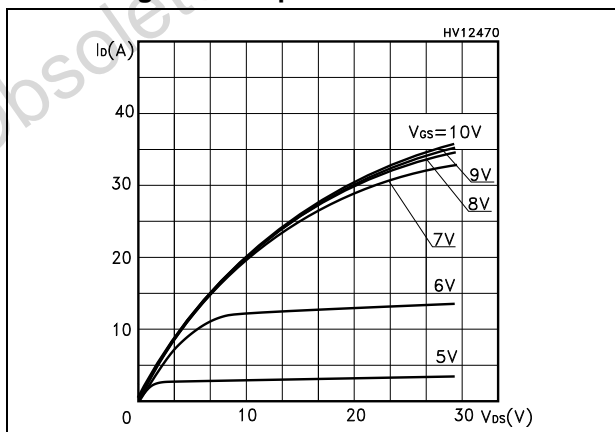


Figure 7. Transfer characteristics

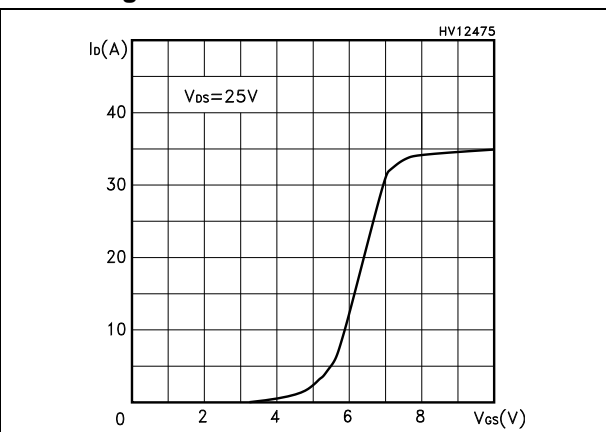


Figure 8. Transconductance

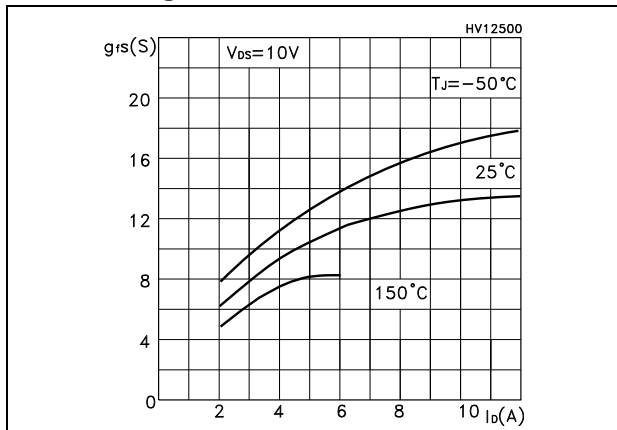


Figure 9. Static drain-source on-resistance

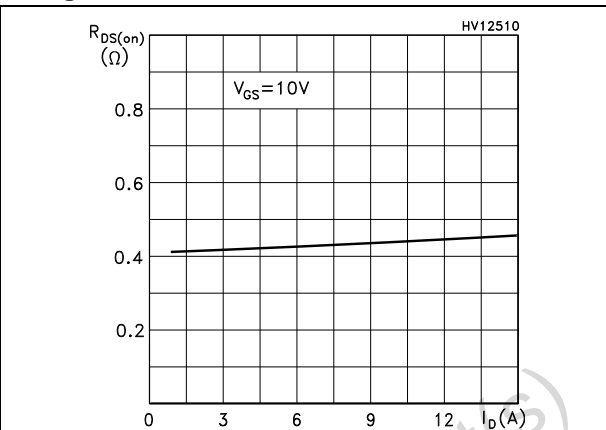


Figure 10. Gate charge vs gate-source voltage

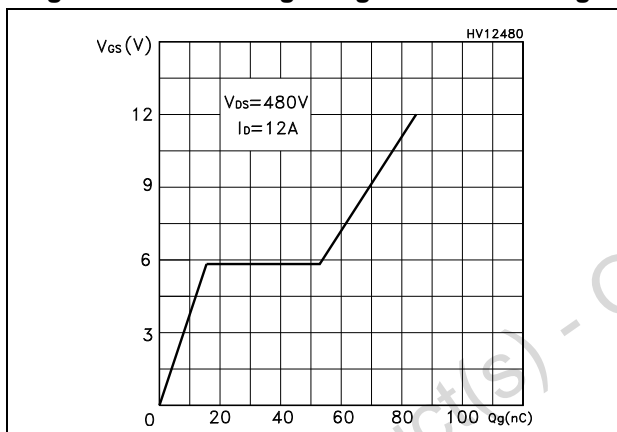


Figure 11. Capacitance variations

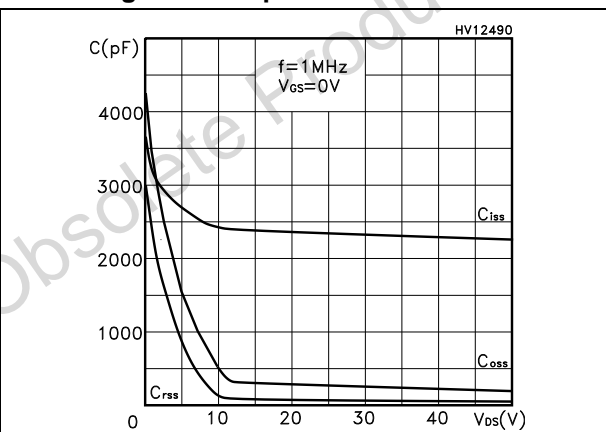


Figure 12. Normalized gate threshold voltage vs temperature

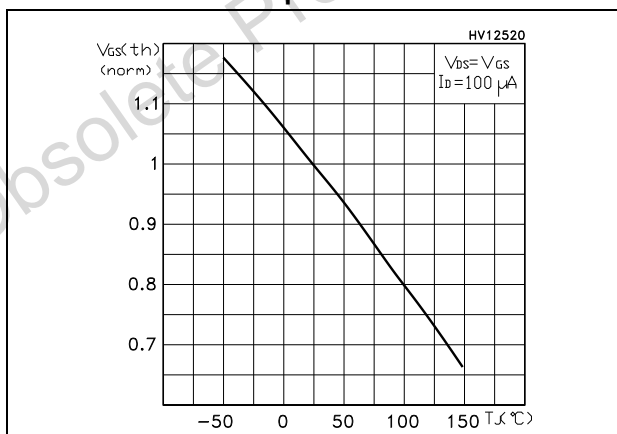


Figure 13. Normalized on-resistance vs temperature

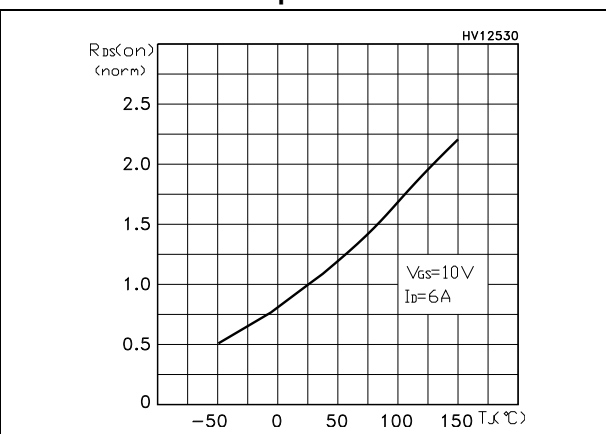


Figure 14. Source-drain diode forward characteristics

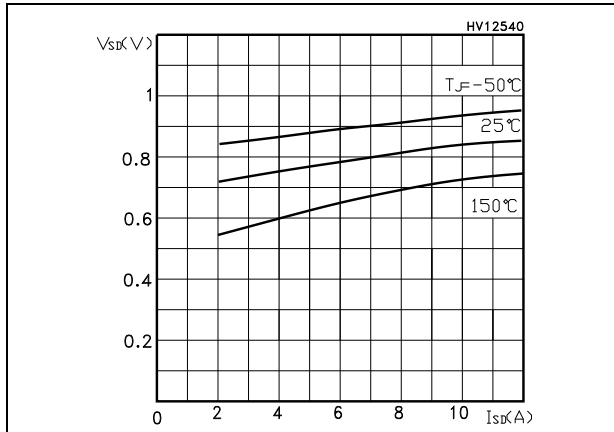


Figure 15. Normalized $V_{(BR)DSS}$ vs temperature

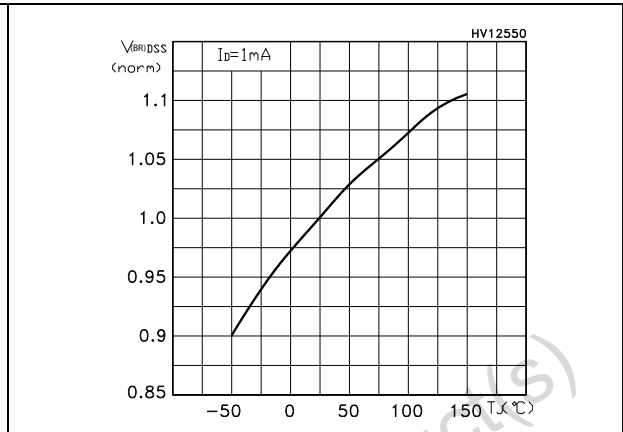
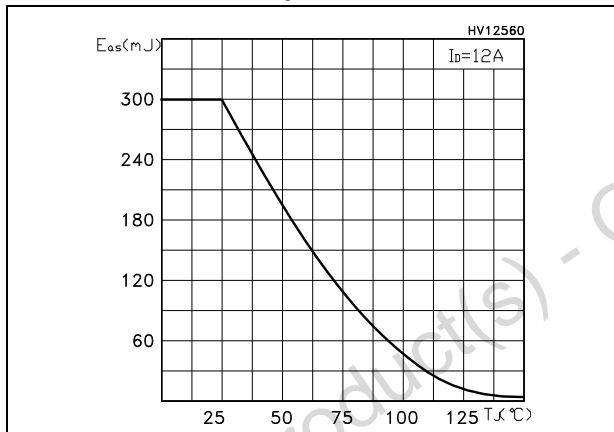
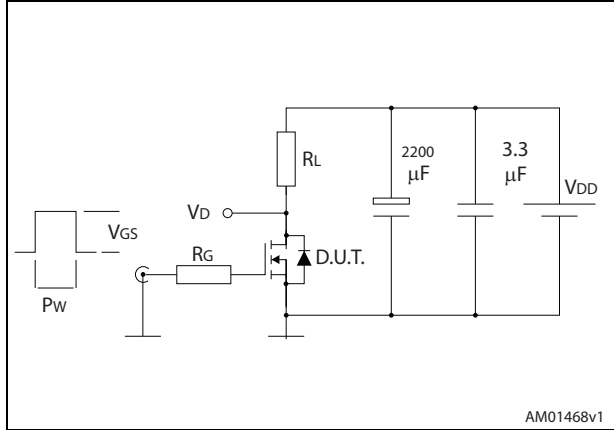


Figure 16. Maximum avalanche energy vs temperature



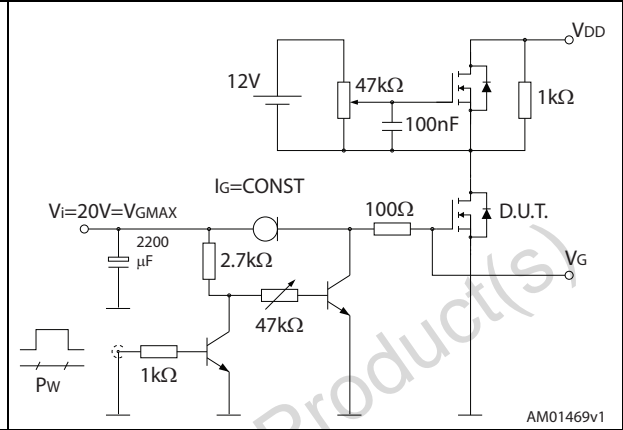
3 Test circuits

Figure 17. Switching times test circuit for resistive load



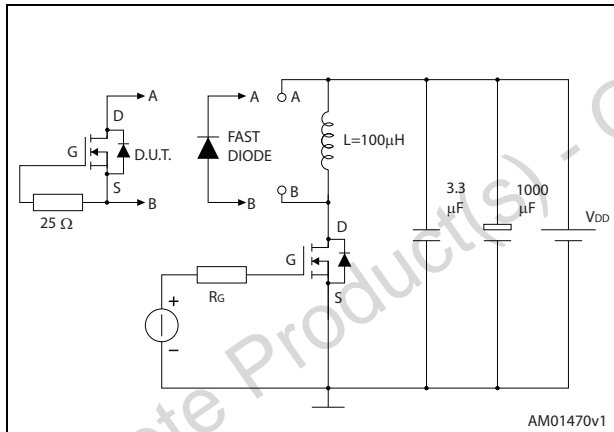
AM01468v1

Figure 18. Gate charge test circuit



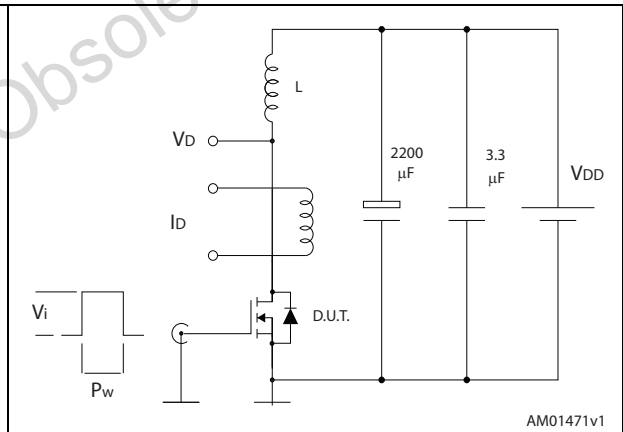
AM01469v1

Figure 19. Test circuit for inductive load switching and diode recovery times



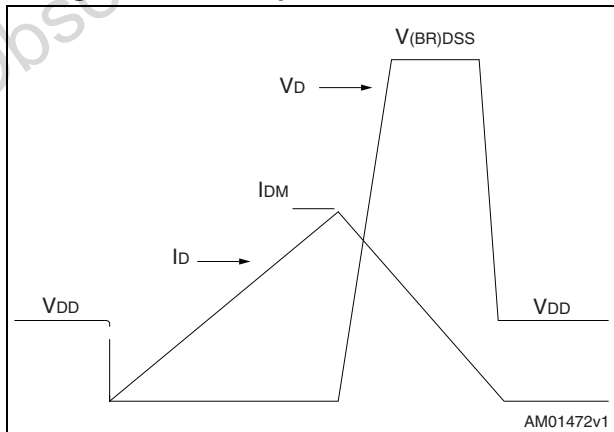
AM01470v1

Figure 20. Unclamped inductive load test circuit



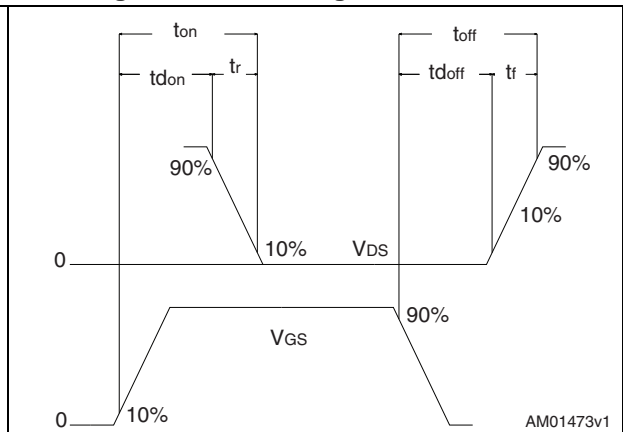
AM01471v1

Figure 21. Unclamped inductive waveform



AM01472v1

Figure 22. Switching time waveform



AM01473v1

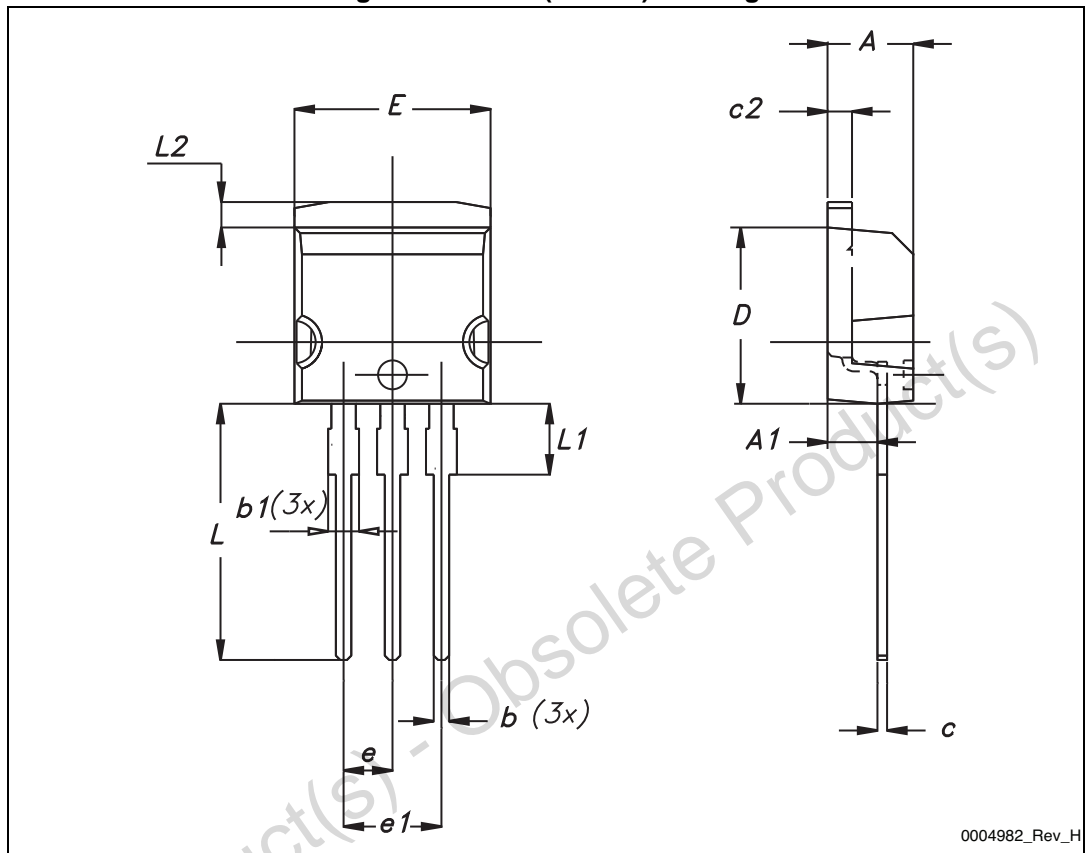
4 Package mechanical data

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.

Obsolete Product(s) - Obsolete Product(s)

4.1 I²PAK, STB14NK60Z

Figure 23. I²PAK (TO-262) drawing



0004982_Rev_H

Table 10. I²PAK (TO-262) mechanical data

| DIM. | mm. | | |
|------|------|-----|-------|
| | min. | typ | max. |
| A | 4.40 | | 4.60 |
| A1 | 2.40 | | 2.72 |
| b | 0.61 | | 0.88 |
| b1 | 1.14 | | 1.70 |
| c | 0.49 | | 0.70 |
| c2 | 1.23 | | 1.32 |
| D | 8.95 | | 9.35 |
| e | 2.40 | | 2.70 |
| e1 | 4.95 | | 5.15 |
| E | 10 | | 10.40 |
| L | 13 | | 14 |
| L1 | 3.50 | | 3.93 |
| L2 | 1.27 | | 1.40 |

4.2 TO-220, STP14NK60Z

Figure 24. TO-220 type A drawing

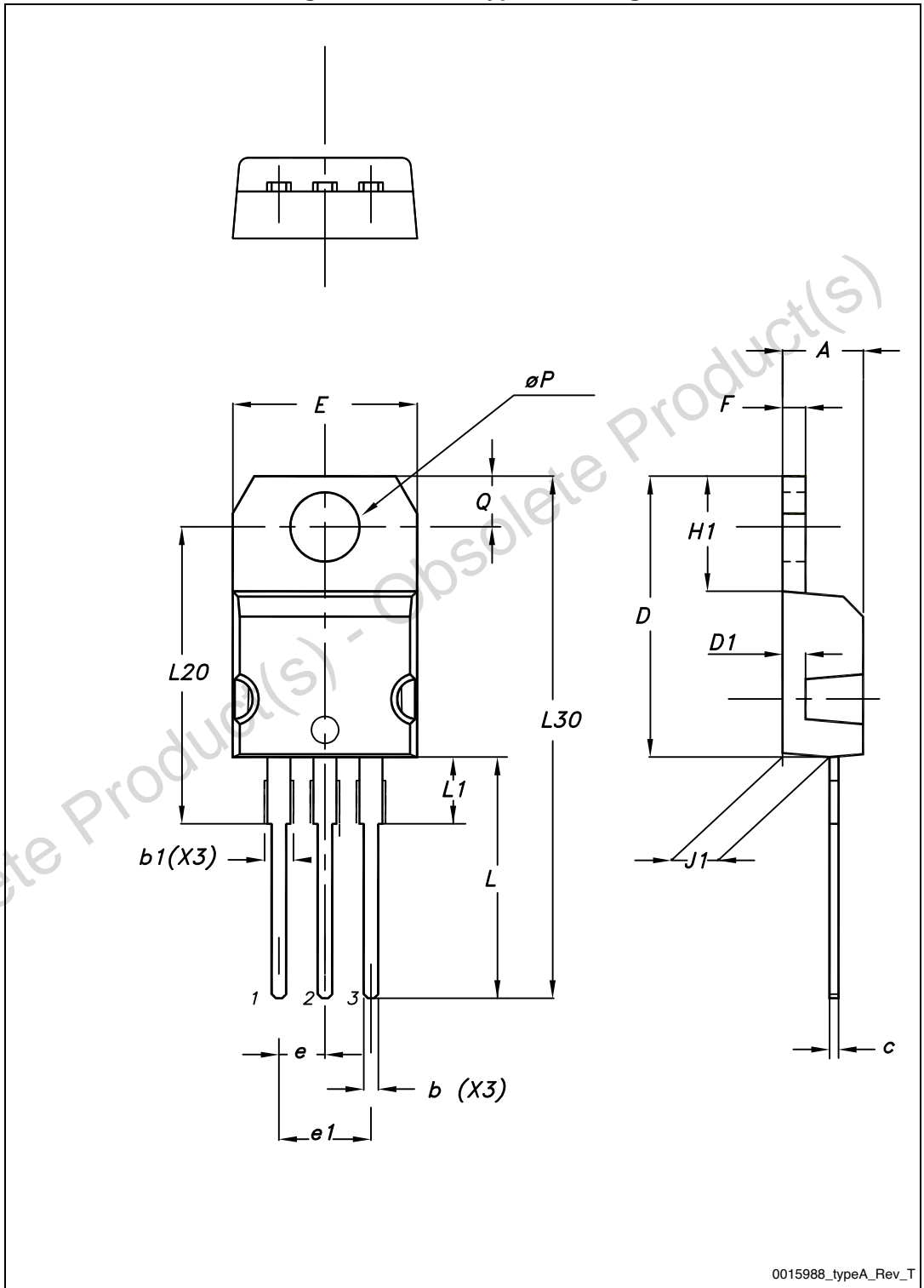


Table 11. TO-220 type A mechanical data

| 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 |

4.3 TO-247, STW14NK60Z

Figure 25. TO-247 drawing

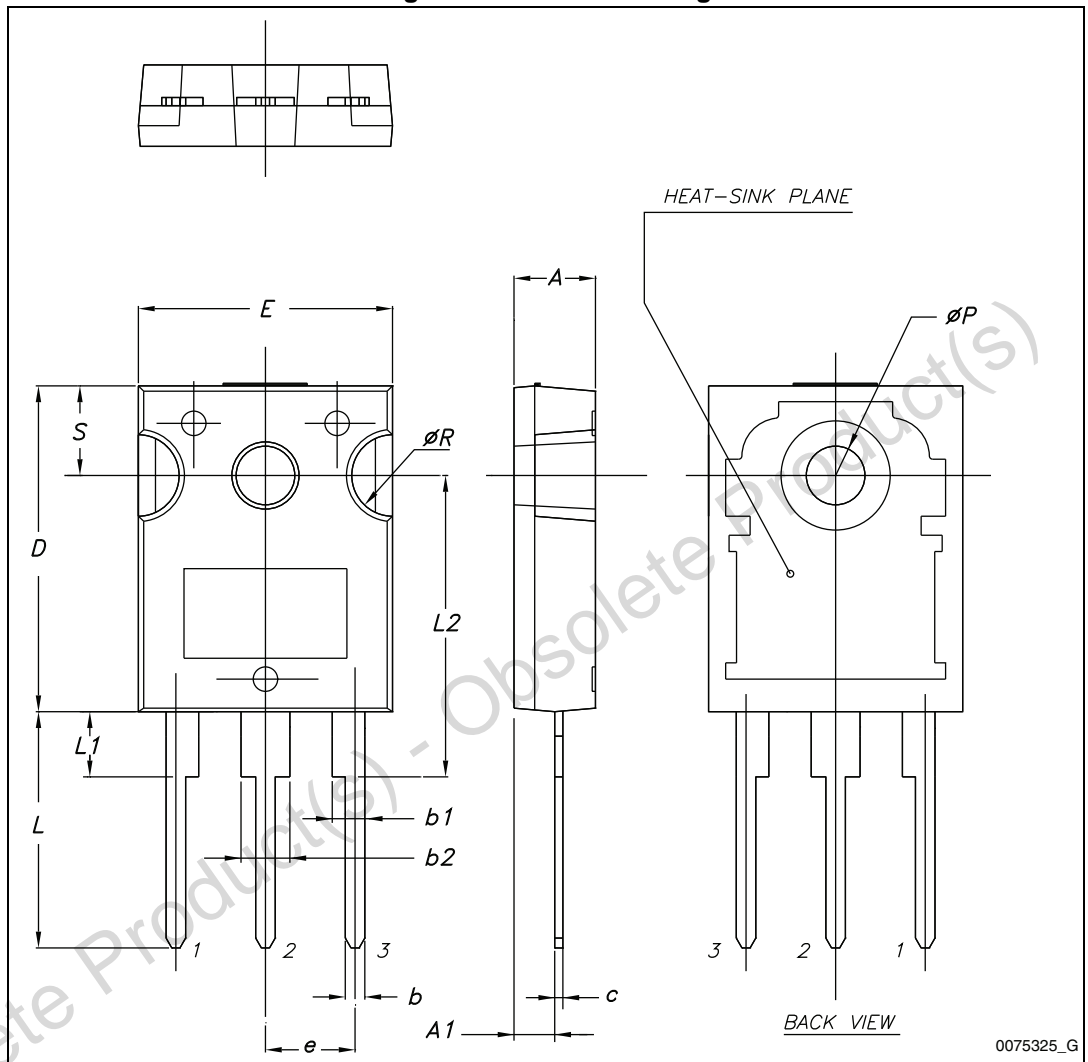


Table 12. TO-247 mechanical data

| 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 |

5 Revision history

Table 13. Document revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 30-Aug-2004 | 3 | Preliminary version |
| 17-Aug-2005 | 4 | Complete version with curves |
| 08-Sep-2005 | 5 | Inserted ecopack indication |
| 14-Oct-2005 | 6 | New package inserted: TO-247 |
| 26-Jul-2006 | 7 | New template, no content change |
| 06-May-2014 | 8 | <ul style="list-style-type: none">– Updated: Figure 17, 18, 19 and 20– Updated: Section 4: Package mechanical data– Minor text changes– The part number STP14NK60ZFP has been moved to a separate datasheet |

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