



STF7N95K3 STP7N95K3, STW7N95K3

N-channel 950 V, 1.1 Ω , 7.2 A, TO-220, TO-220FP, TO-247
Zener-protected SuperMESH3™ Power MOSFET

Features

| Type | V _{DSS} | R _{DS(on) max} | I _D | P _w |
|-----------|------------------|-------------------------|----------------|----------------|
| STF7N95K3 | 950 V | < 1.35 Ω | 7.2 A | 35 W |
| STP7N95K3 | 950 V | < 1.35 Ω | 7.2 A | 150 W |
| STW7N95K3 | 950 V | < 1.35 Ω | 7.2 A | 150 W |

- 100% avalanche tested
- Extremely large avalanche performance
- Gate charge minimized
- Very low intrinsic capacitances
- Zener-protected

Application

- Switching applications

Description

The new SuperMESH3™ series is obtained through the combination of a further fine tuning of ST's well established strip-based PowerMESH™ layout with a new optimized vertical structure. In addition to pushing on-resistance significantly down, special attention has been taken to ensure a very good dynamic performances coupled with a very large avalanche capability for the most demanding application.

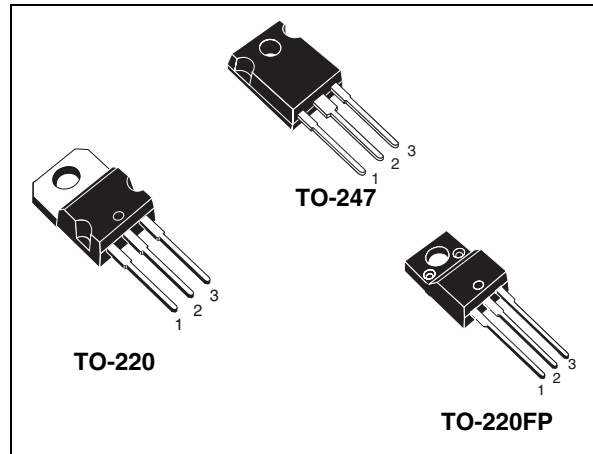


Figure 1. Internal schematic diagram

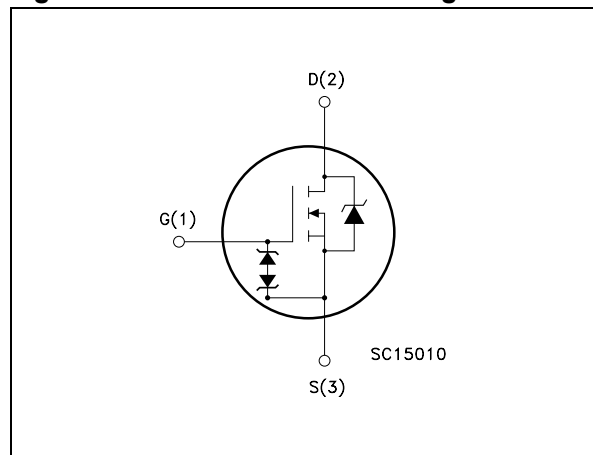


Table 1. Device summary

| Order codes | Marking | Package | Packaging |
|-------------|---------|----------|-----------|
| STF7N95K3 | 7N95K3 | TO-220FP | Tube |
| STP7N95K3 | 7N95K3 | TO-220 | Tube |
| STW7N95K3 | 7N95K3 | 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_{GS} | Gate-source voltage | ± 30 | | V |
| I_D | Drain current (continuous) at $T_C = 25\text{ °C}$ | 7.2 | 7.2 ⁽¹⁾ | A |
| I_D | Drain current (continuous) at $T_C = 100\text{ °C}$ | 4.5 | 4.5 ⁽¹⁾ | A |
| I_{DM} ⁽²⁾ | Drain current (pulsed) | 28.8 | 28.8 ⁽¹⁾ | A |
| P_{TOT} | Total dissipation at $T_C = 25\text{ °C}$ | 150 | 35 | W |
| I_{AR} | Max current during repetitive or single pulse avalanche (pulse width limited by T_{JMAX}) | 9 | | A |
| E_{AS} | Single pulse avalanche energy ⁽³⁾ | 220 | | mJ |
| | Derating factor | 1.12 | 0.24 | W/°C |
| dv/dt ⁽⁴⁾ | Peak diode recovery voltage slope | 6 | | V/ns |
| V_{ISO} | Insulation withstand voltage (RMS) from all three leads to external heat sink ($t=1\text{ s}; T_C=25\text{ °C}$) | | 2000 | V |
| T_j T_{stg} | Operating junction temperature Storage temperature | -55 to 150 | | °C |

- Limited by package
- Pulse width limited by safe operating area
- Starting $T_j = 25\text{ °C}$, $I_D = I_{AR}$, $V_{DD} = 50\text{ V}$
- $I_{SD} \leq 7.2\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{Peak} < V_{(BR)DSS}$

Table 3. Thermal data

| Symbol | Parameter | TO-220 | TO-247 | TO-220FP | Unit |
|----------------|--|--------|--------|----------|------|
| $R_{thj-case}$ | Thermal resistance junction-case max | 0.83 | | 3.57 | °C/W |
| $R_{thj-amb}$ | Thermal resistance junction-ambient max | 62.5 | 50 | 62.5 | °C/W |
| T_l | Maximum lead temperature for soldering purpose | 300 | | | °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 = 1 mA, V _{GS} = 0 | 950 | | | V |
| I _{DSS} | Zero gate voltage drain current (V _{GS} = 0) | V _{DS} = Max rating V _{DS} = Max rating, T _C =125 °C | | | 1 50 | μA μA |
| I _{GSS} | Gate-body leakage current (V _{DS} = 0) | V _{GS} = ± 20 V | | | 10 | μA |
| V _{GS(th)} | Gate threshold voltage | V _{DS} = V _{GS} , I _D = 100 μA | 3 | 4 | 5 | V |
| R _{DS(on)} | Static drain-source on resistance | V _{GS} = 10 V, I _D = 3.6 A | | 1.1 | 1.35 | Ω |

Table 5. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--|---|--|------|-------------------|------|----------------|
| g _{fs} ⁽¹⁾ | Forward transconductance | V _{DS} = 15 V, I _D = 3.6 A | | 5 | | S |
| C _{iss} C _{oss} C _{rss} | Input capacitance Output capacitance Reverse transfer capacitance | V _{DS} = 100 V, f = 1 MHz, V _{GS} = 0 | | 1031 79 0.9 | | pF pF pF |
| C _{o(tr)} ⁽²⁾ | Equivalent capacitance time related | V _{DS} = 0 to 760 V, V _{GS} = 0 | | 60 | | pF |
| C _{o(er)} ⁽³⁾ | Equivalent capacitance energy related | V _{DS} = 0 to 760 V, V _{GS} = 0 | | 36 | | pF |
| R _G | Gate input resistance | f=1 MHz Gate DC Bias=0 Test signal level = 20 mV open drain | | 2.4 | | Ω |
| Q _g Q _{gs} Q _{gd} | Total gate charge Gate-source charge Gate-drain charge | V _{DD} = 760 V, I _D = 7.2 A, V _{GS} = 10 V (see Figure 20) | | 34 6 20 | | nC nC nC |

1. Pulsed: pulse duration = 300 μs, duty cycle 1.5%
2. C_{oss eq} time related 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}
3. C_{oss eq} energy related is defined as a constant equivalent capacitance giving the same stored energy as C_{oss} when V_{DS} increases from 0 to 80% V_{DSS}

Table 6. Switching times

| Symbol | Parameter | Test conditions | Min. | Typ. | Max | Unit |
|--------------|---------------------|--|------|------|-----|------|
| $t_{d(on)}$ | Turn-on delay time | $V_{DD} = 475 \text{ V}$, $I_D = 3.6 \text{ A}$, $R_G = 4.7 \Omega$, $V_{GS} = 10 \text{ V}$ (see Figure 19) | | 14 | | ns |
| t_r | Rise time | | | 9 | | ns |
| $t_{d(off)}$ | Turn-off-delay time | | | 36 | | ns |
| t_f | Fall time | | | 23 | | ns |

Table 7. Source drain diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|--|------|------|------|---------------|
| I_{SD} | Source-drain current | | | | 7.2 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | | | 28.8 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $I_{SD} = 7.2 \text{ A}$, $V_{GS} = 0$ | | | 1.6 | V |
| t_{rr} | Reverse recovery time | $I_{SD} = 7.2 \text{ A}$, $di/dt = 100 \text{ A}/\mu\text{s}$ $V_{DD} = 60 \text{ V}$ (see Figure 24) | | 450 | | ns |
| Q_{rr} | Reverse recovery charge | | | 6 | | μC |
| I_{RRM} | Reverse recovery current | | | 28 | | A |
| t_{rr} | Reverse recovery time | $I_{SD} = 7.2 \text{ A}$, $di/dt = 100 \text{ A}/\mu\text{s}$ $V_{DD} = 60 \text{ V}$, $T_j = 150 \text{ }^\circ\text{C}$ (see Figure 24) | | 550 | | ns |
| Q_{rr} | Reverse recovery charge | | | 8 | | μC |
| I_{RRM} | Reverse recovery current | | | 28 | | A |

1. Pulse width limited by safe operating area

2. Pulsed: Pulse duration = 300 μs , duty cycle 1.5%

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 |

1. 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

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for TO-220

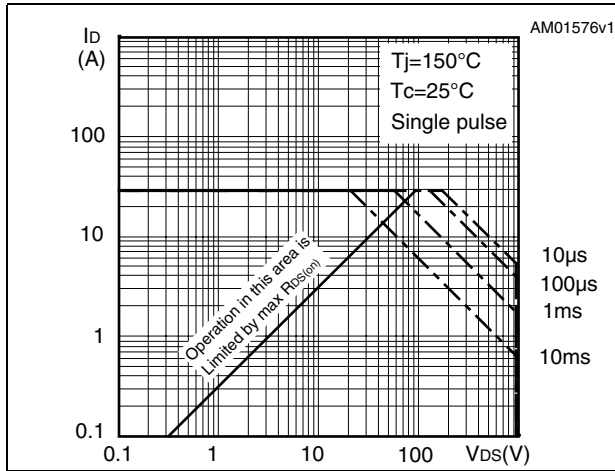


Figure 3. Thermal impedance for TO-220

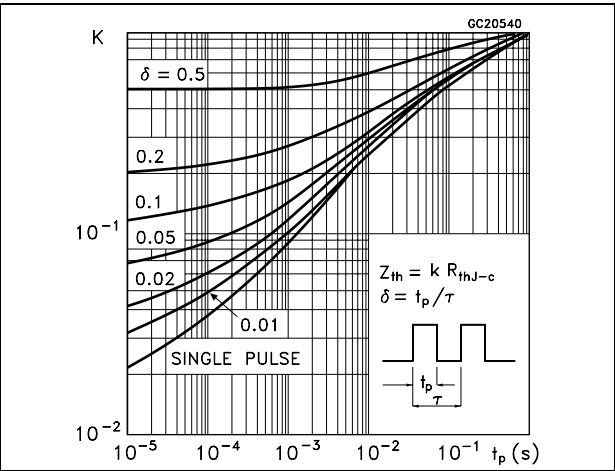


Figure 4. Safe operating area for TO-220FP

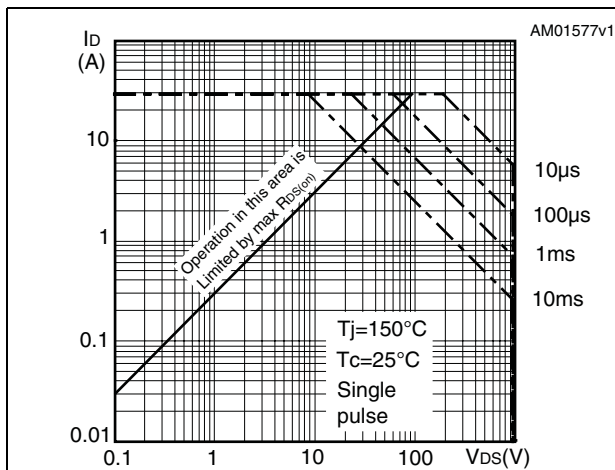


Figure 5. Thermal impedance for TO-220FP

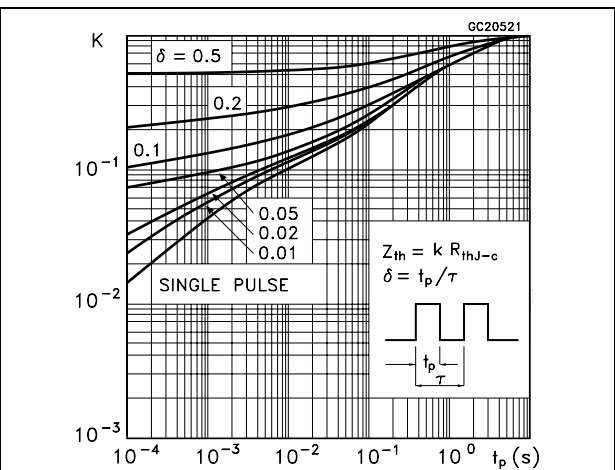


Figure 6. Safe operating area for TO-247

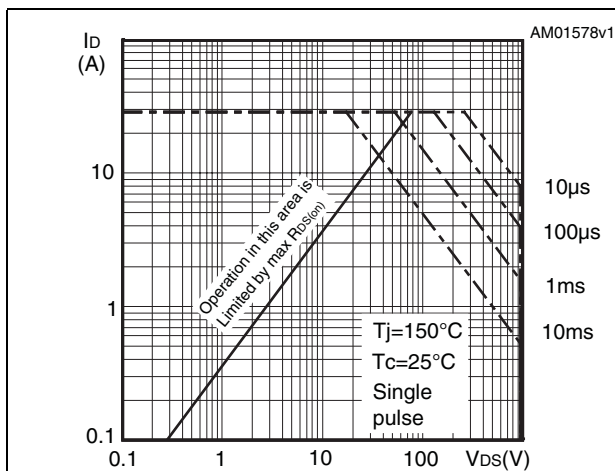


Figure 7. Thermal impedance for TO-247

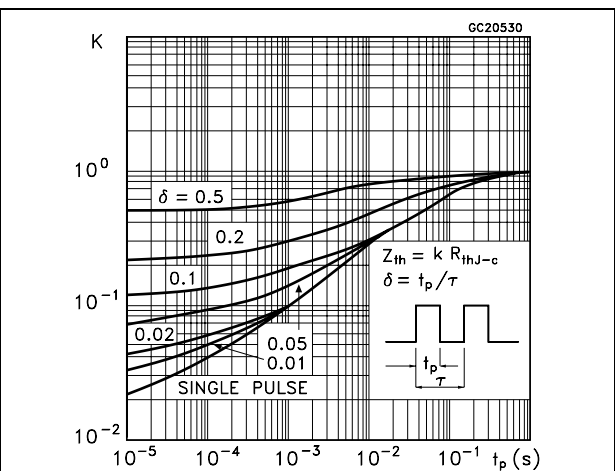


Figure 8. Output characteristics

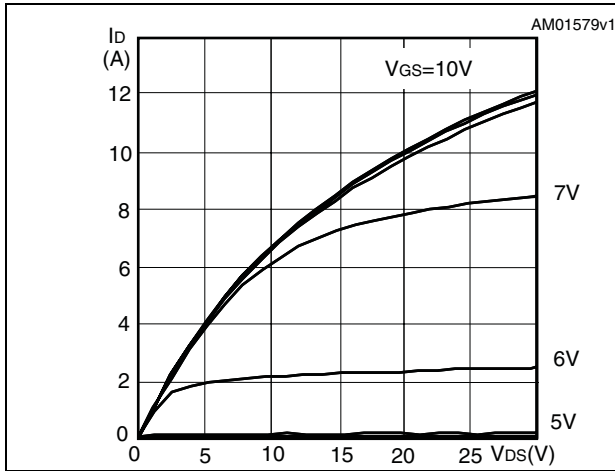


Figure 9. Transfer characteristics

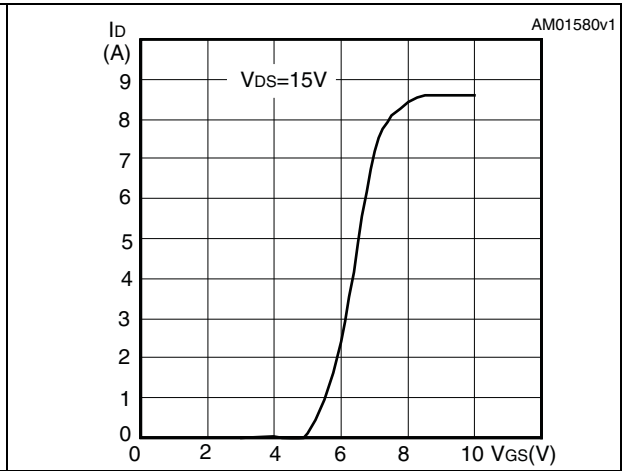


Figure 10. Normalized B_{VDSS} vs temperature

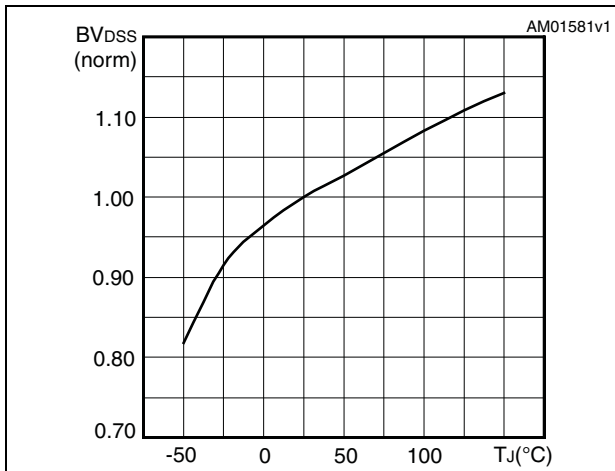


Figure 11. Static drain-source on resistance

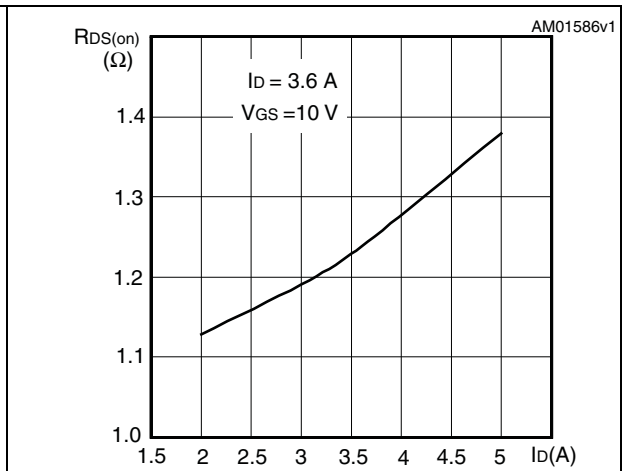


Figure 12. Gate charge vs gate-source voltage

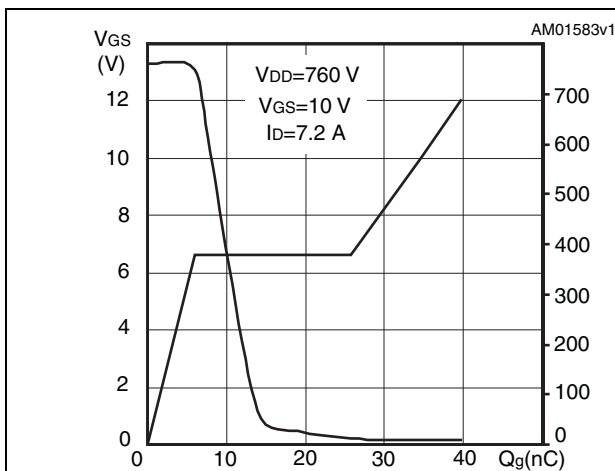


Figure 13. Capacitance variations

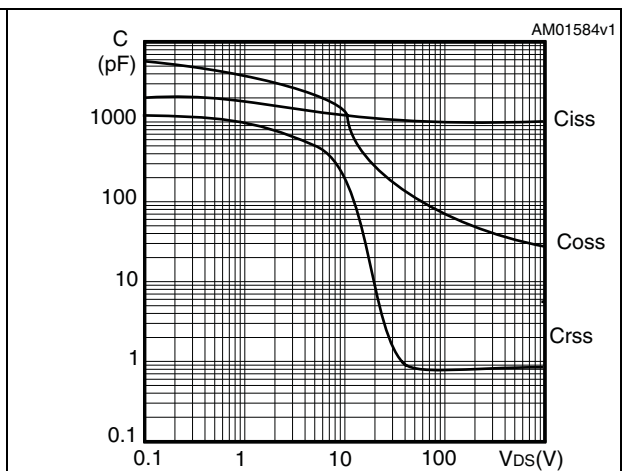


Figure 14. Output capacitance stored energy

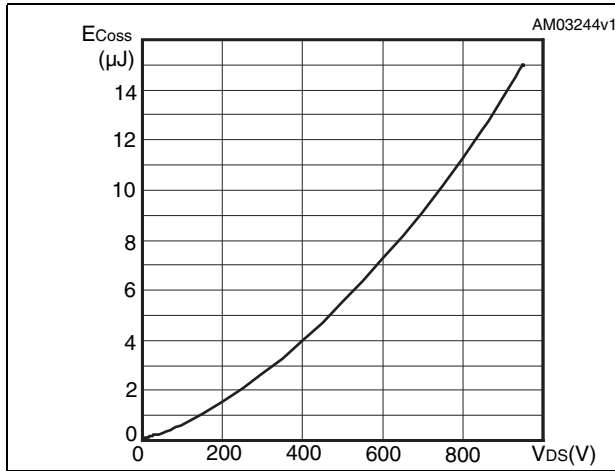


Figure 15. Normalized on resistance vs temperature

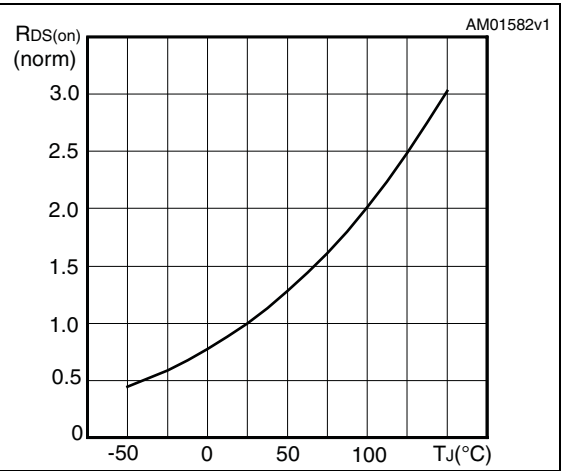


Figure 16. Source-drain diode forward characteristics

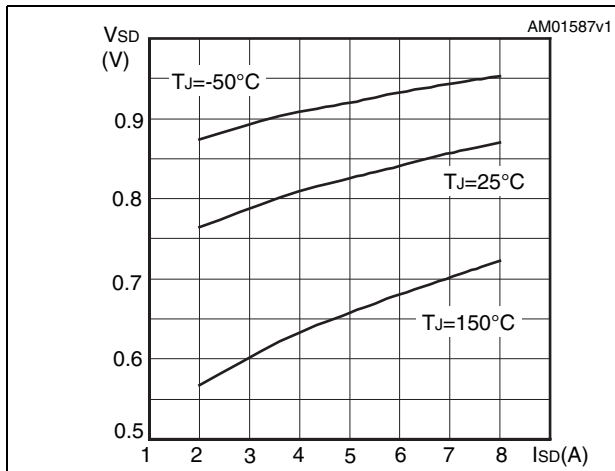


Figure 17. Normalized gate threshold voltage vs temperature

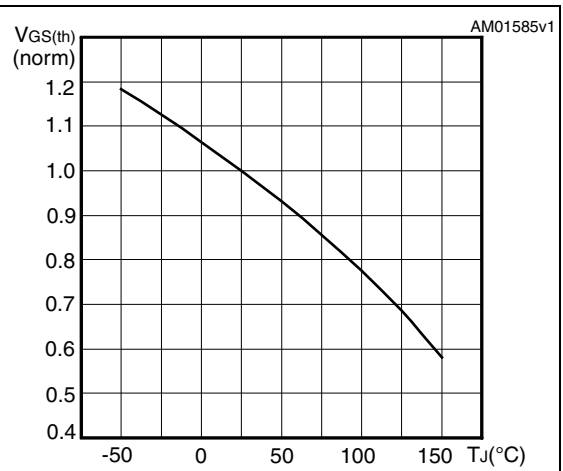
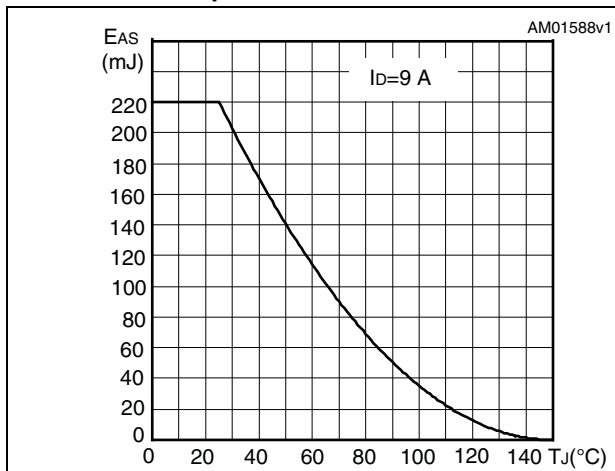
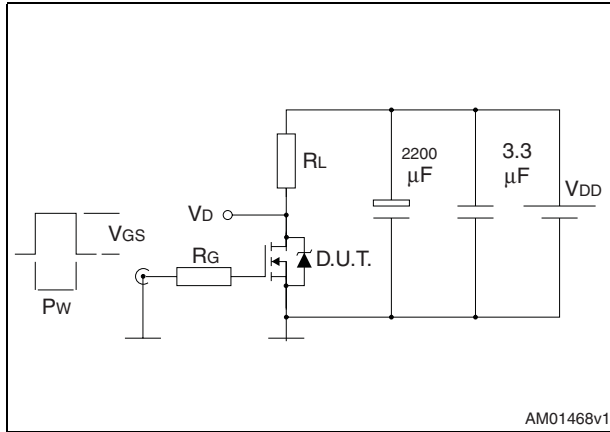


Figure 18. Maximum avalanche energy vs temperature



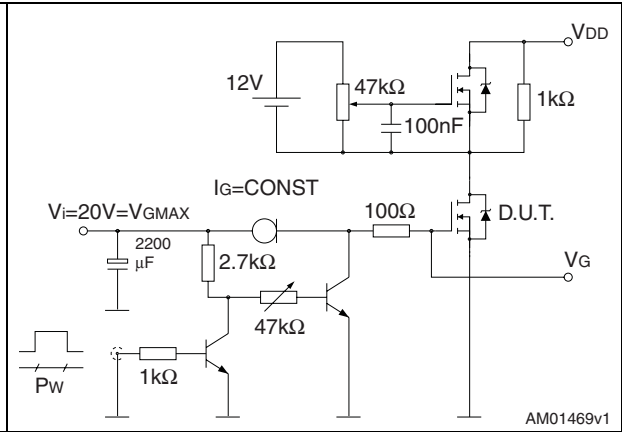
3 Test circuits

Figure 19. Switching times test circuit for resistive load



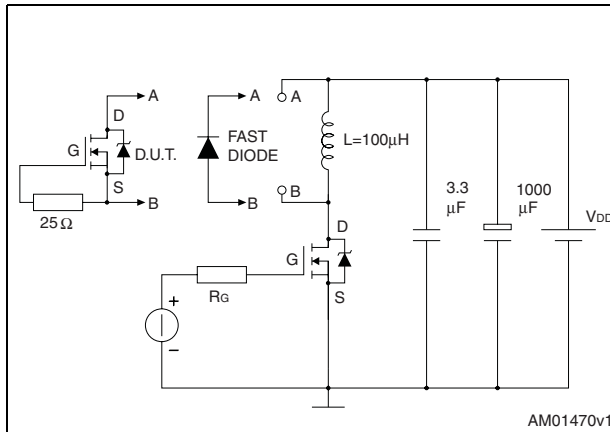
AM01468v1

Figure 20. Gate charge test circuit



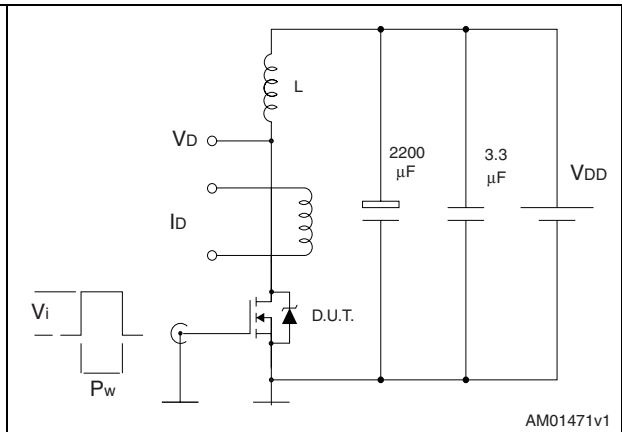
AM01469v1

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



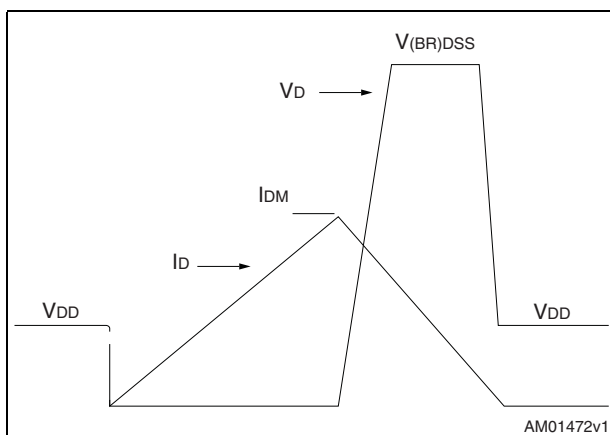
AM01470v1

Figure 22. Unclamped inductive load test circuit



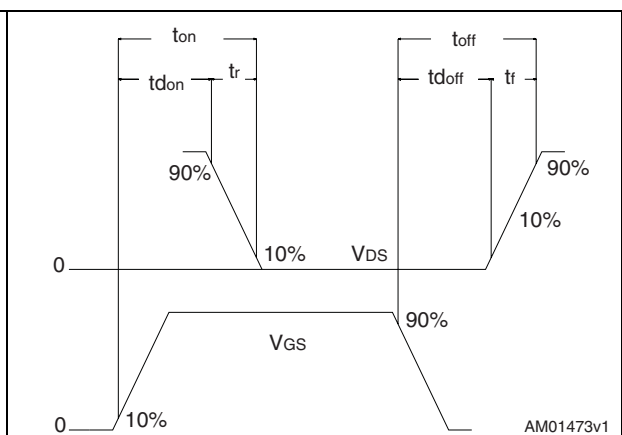
AM01471v1

Figure 23. Unclamped inductive waveform



AM01472v1

Figure 24. Switching time waveform



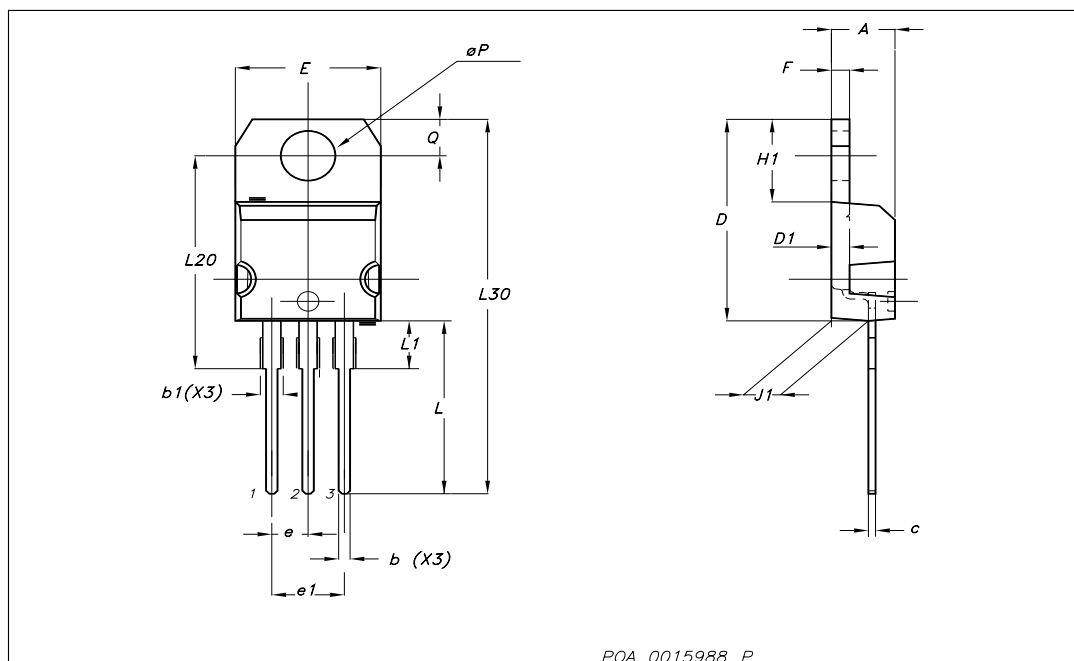
AM01473v1

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.

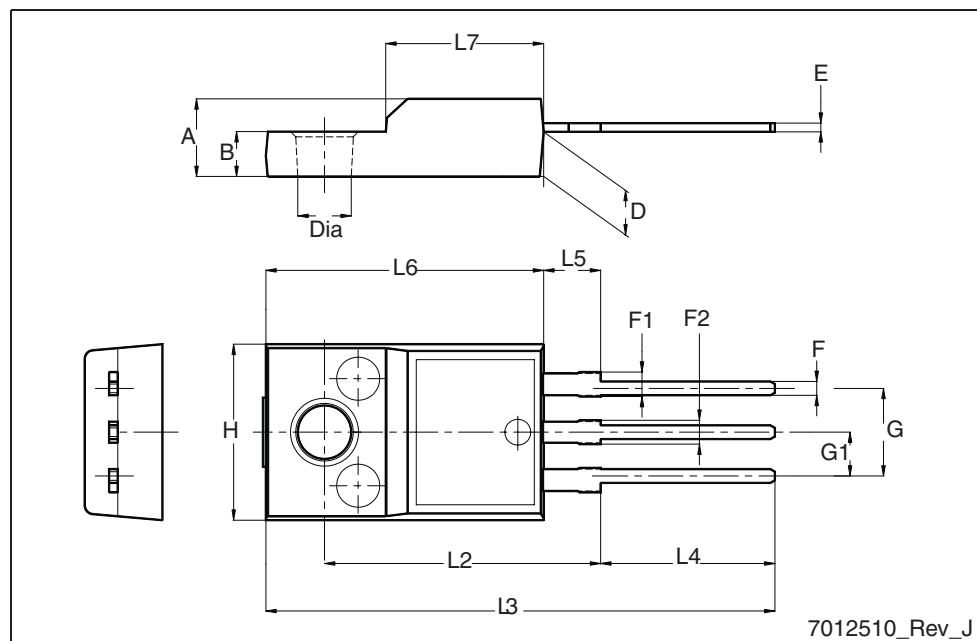
TO-220 mechanical data

| 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 | 1.14 | | 1.70 | 0.044 | | 0.066 |
| c | 0.49 | | 0.70 | 0.019 | | 0.027 |
| D | 15.25 | | 15.75 | 0.6 | | 0.62 |
| D1 | | 1.27 | | | 0.050 | |
| 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 | | 0.051 |
| 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 | |
| ∅P | 3.75 | | 3.85 | 0.147 | | 0.151 |
| Q | 2.65 | | 2.95 | 0.104 | | 0.116 |



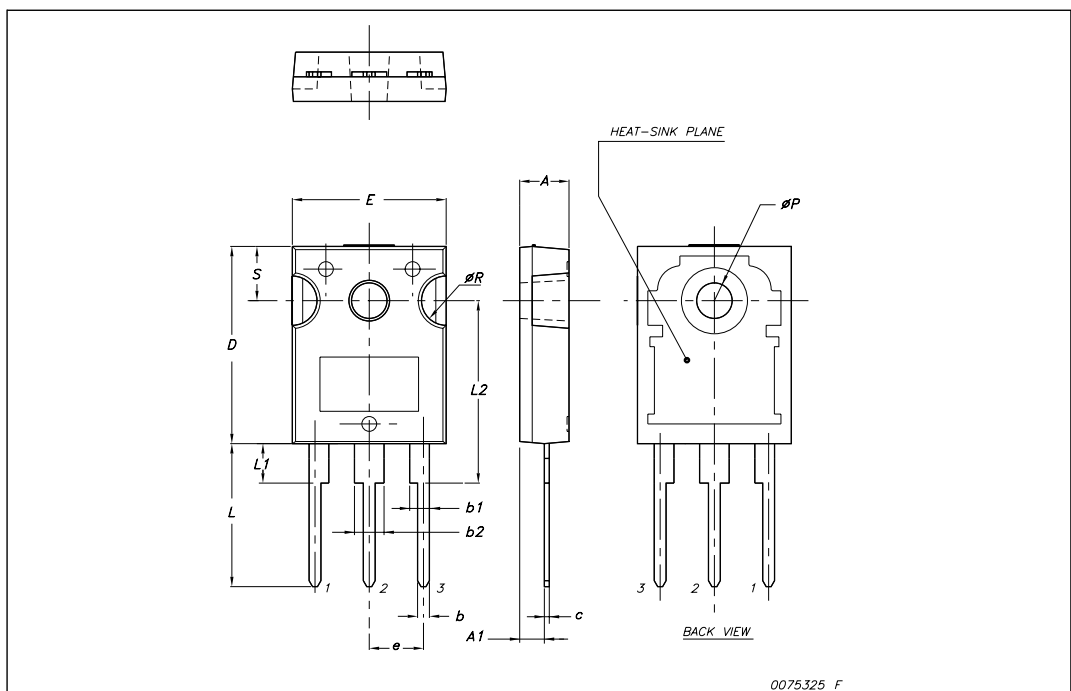
TO-220FP mechanical data

| 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 | | 1.5 |
| 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 |



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 | | 5.45 | |
| L | 14.20 | | 14.80 |
| L1 | 3.70 | | 4.30 |
| L2 | | 18.50 | |
| øP | 3.55 | | 3.65 |
| øR | 4.50 | | 5.50 |
| S | | 5.50 | |



5 Revision history

Table 9. Document revision history

| Date | Revision | Changes |
|-------------|----------|---------------|
| 27-Jan-2009 | 1 | First release |

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