



STF15N65M5, STFI15N65M5, STP15N65M5

N-channel 650 V, 0.308 Ω typ., 11 A MDmesh™ V Power MOSFET in TO-220FP, I²PAKFP and TO-220 packages

Datasheet — production data

Features

| Order codes | V _{DS} @ T _{Jmax} | R _{DS(on)} max | I _D |
|-------------|-------------------------------------|-------------------------|----------------|
| STF15N65M5 | 710 V | < 0.34 Ω | 11 A |
| STFI15N65M5 | | | |
| STP15N65M5 | | | |

- Worldwide best R_{DS(on)} * area
- Higher V_{DSS} rating and high dv/dt capability
- Excellent switching performance
- 100% avalanche tested

Applications

- Switching applications

Description

These devices are N-channel MDmesh™ V Power MOSFETs based on an innovative proprietary vertical process technology, which is combined with STMicroelectronics' well-known PowerMESH™ horizontal layout structure. The resulting product has extremely low on-resistance, which is unmatched among silicon-based Power MOSFETs, making it especially suitable for applications which require superior power density and outstanding efficiency.

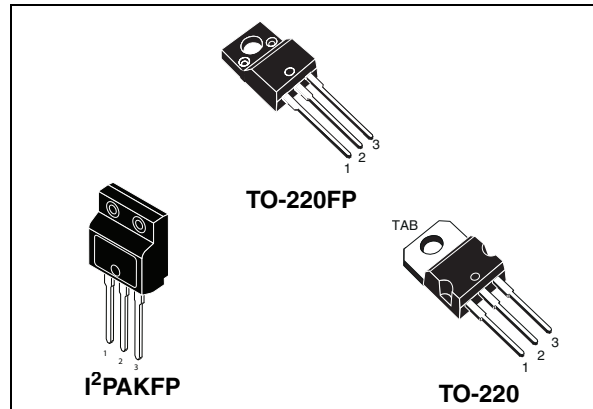


Figure 1. Internal schematic diagram

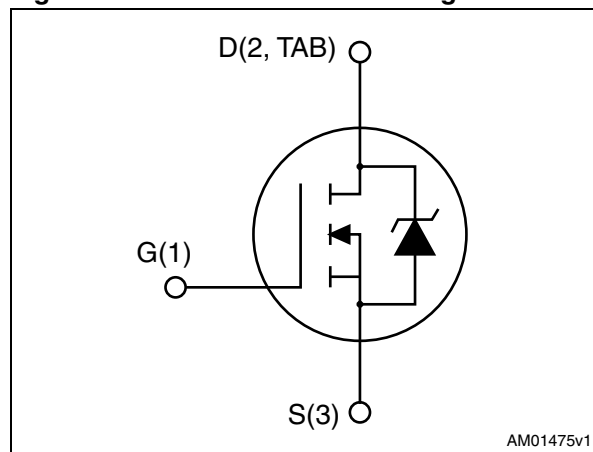


Table 1. Device summary

| Order codes | Marking | Package | Packaging |
|-------------|---------|----------------------|-----------|
| STF15N65M5 | 15N65M5 | TO-220FP | Tube |
| STFI15N65M5 | | I ² PAKFP | |
| STP15N65M5 | | TO-220 | |

Contents

| | | |
|----------|---|-----------|
| 1 | Electrical ratings | 3 |
| 2 | Electrical characteristics | 4 |
| | 2.1 Electrical characteristics (curves) | 6 |
| 3 | Test circuits | 9 |
| 4 | Package mechanical data | 10 |
| 5 | Revision history | 16 |

1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | | Unit |
|--------------------------------|---|-------------|----------------------------------|------|
| | | TO-220 | TO-220FP I ² PAKFP | |
| V _{GS} | Gate-source voltage | ± 25 | | V |
| I _D | Drain current (continuous) at T _C = 25 °C | 11 | 11 ⁽¹⁾ | A |
| I _D | Drain current (continuous) at T _C = 100 °C | 6.9 | 6.9 ⁽¹⁾ | A |
| I _{DM} ⁽¹⁾ | Drain current (pulsed) | 44 | 44 ⁽¹⁾ | A |
| P _{TOT} | Total dissipation at T _C = 25 °C | 85 | 25 | W |
| dv/dt ⁽²⁾ | Peak diode recovery voltage slope | 15 | | V/ns |
| V _{ISO} | Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; T _C = 25 °C) | | 2500 | V |
| T _{stg} | Storage temperature | - 55 to 150 | | °C |
| T _j | Max. operating junction temperature | 150 | | °C |

1. Limited by maximum junction temperature.

2. I_{SD} ≤ 11 A, di/dt ≤ 400 A/μs; V_{DD} = 400 V, V_{DS(peak)} < V_{(BR)DSS}

Table 3. Thermal data

| Symbol | Parameter | Value | | Unit |
|-----------------------|---|----------------------------------|--------|------|
| | | TO-220FP I ² PAKFP | TO-220 | |
| R _{thj-case} | Thermal resistance junction-case max | 5 | 1.47 | °C/W |
| R _{thj-amb} | Thermal resistance junction-ambient max | 62.5 | | °C/W |

Table 4. Avalanche characteristics

| Symbol | Parameter | Value | Unit |
|-----------------|---|-------|------|
| I _{AR} | Avalanche current, repetitive or not repetitive (pulse width limited by T _{jmax}) | 2.5 | A |
| E _{AS} | Single pulse avalanche energy (starting t _j = 25°C, I _D = I _{AR} ; V _{DD} = 50 V) | 160 | mJ |

2 Electrical characteristics

($T_C = 25\text{ °C}$ unless otherwise specified)

Table 5. On /off states

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------|--|--|------|-------|-----------|--------------------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $I_D = 1\text{ mA}$, $V_{GS} = 0$ | 650 | | | V |
| I_{DSS} | Zero gate voltage drain current ($V_{GS} = 0$) | $V_{DS} = 650\text{ V}$ $V_{DS} = 650\text{ V}$, $T_C = 125\text{ °C}$ | | | 1 100 | μA μA |
| I_{GSS} | Gate-body leakage current ($V_{DS} = 0$) | $V_{GS} = \pm 25\text{ V}$ | | | ± 100 | nA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS} = V_{GS}$, $I_D = 250\text{ }\mu\text{A}$ | 3 | 4 | 5 | V |
| $R_{DS(on)}$ | Static drain-source on-resistance | $V_{GS} = 10\text{ V}$, $I_D = 5.5\text{ A}$ | | 0.308 | 0.34 | Ω |

Table 6. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-------------------|---------------------------------------|--|------|------|------|----------|
| C_{iss} | Input capacitance | $V_{DS} = 100\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0$ | - | 816 | - | pF |
| C_{oss} | Output capacitance | | | 23 | | pF |
| C_{rss} | Reverse transfer capacitance | | | 2.6 | | pF |
| $C_{o(tr)}^{(1)}$ | Equivalent capacitance time related | $V_{DS} = 0\text{ to }520\text{ V}$, $V_{GS} = 0$ | - | 70 | - | pF |
| $C_{o(er)}^{(2)}$ | Equivalent capacitance energy related | | | 21 | | pF |
| R_G | Intrinsic gate resistance | $f = 1\text{ MHz}$ open drain | - | 5 | - | Ω |
| Q_g | Total gate charge | $V_{DD} = 520\text{ V}$, $I_D = 5.5\text{ A}$, $V_{GS} = 10\text{ V}$ (see Figure 18) | - | 22 | - | nC |
| Q_{gs} | Gate-source charge | | | 5.5 | | nC |
| Q_{gd} | Gate-drain charge | | | 11 | | nC |

1. 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}
2. 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 7. Switching times

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--------------|--------------------|---|------|------|------|------|
| $t_{d(V)}$ | Voltage delay time | $V_{DD} = 400\text{ V}$, $I_D = 7\text{ A}$, $R_G = 4.7\ \Omega$, $V_{GS} = 10\text{ V}$ (see Figure 19 and Figure 22) | | 30 | | ns |
| $t_r(V)$ | Voltage rise time | | - | 8 | - | ns |
| $t_f(I)$ | Current fall time | | 11 | | | ns |
| $t_{c(off)}$ | Crossing time | | 12.5 | | | ns |

Table 8. Source drain diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|--|------|------|------|---------------|
| I_{SD} | Source-drain current | | - | | 11 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | | | 44 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $I_{SD} = 11\text{ A}$, $V_{GS} = 0$ | - | | 1.5 | V |
| t_{rr} | Reverse recovery time | $I_{SD} = 11\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 100\text{ V}$ (see Figure 22) | - | 247 | | ns |
| Q_{rr} | Reverse recovery charge | | | 2.4 | | μC |
| I_{RRM} | Reverse recovery current | | | 19.5 | | A |
| t_{rr} | Reverse recovery time | $I_{SD} = 11\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 100\text{ V}$, $T_j = 150\text{ }^\circ\text{C}$ (see Figure 22) | - | 312 | | ns |
| Q_{rr} | Reverse recovery charge | | | 3 | | μC |
| I_{RRM} | Reverse recovery current | | | 19 | | A |

1. Pulse width limited by safe operating area.

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

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for TO-220FP and I²PAKFP

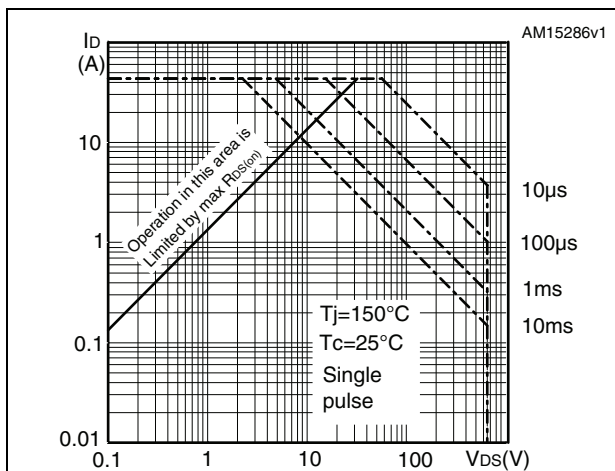


Figure 3. Thermal impedance for TO-220FP and I²PAKFP

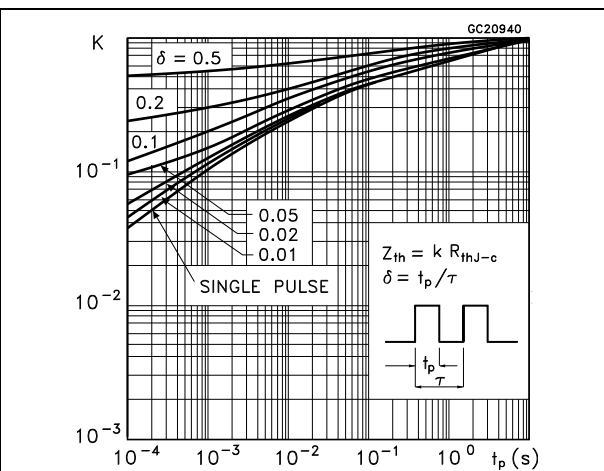


Figure 4. Safe operating area for TO-220

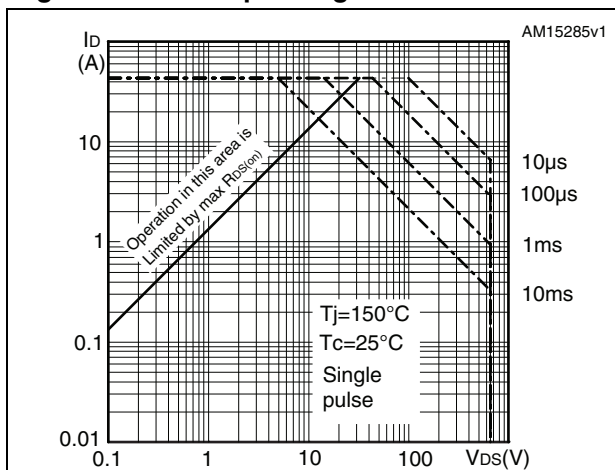


Figure 5. Thermal impedance for TO-220

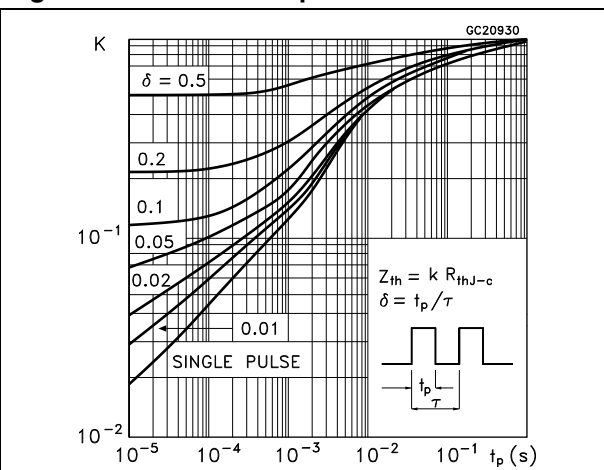


Figure 6. Output characteristics

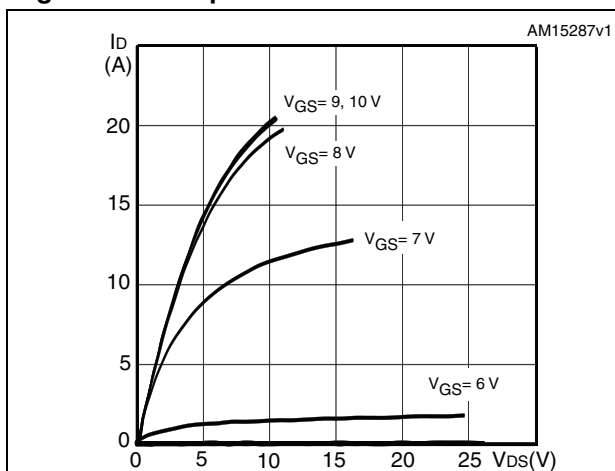


Figure 7. Transfer characteristics

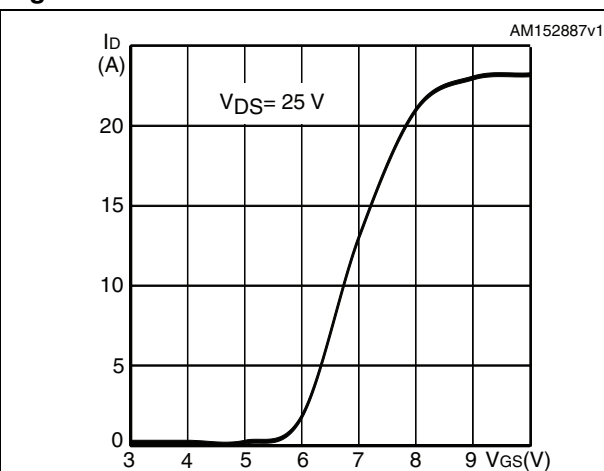


Figure 8. Gate charge vs gate-source voltage Figure 9. Static drain-source on-resistance

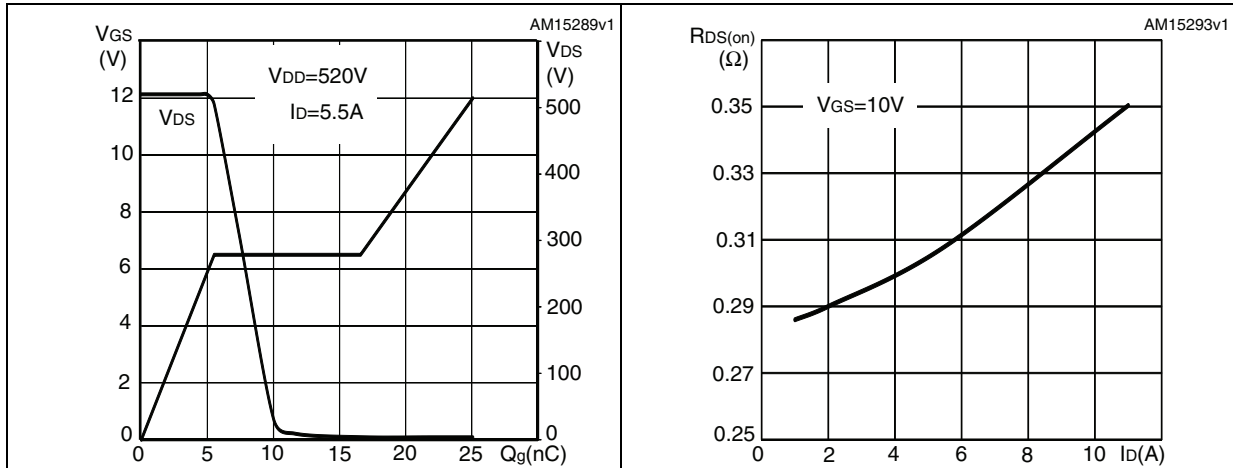


Figure 10. Capacitance variations Figure 11. Output capacitance stored energy

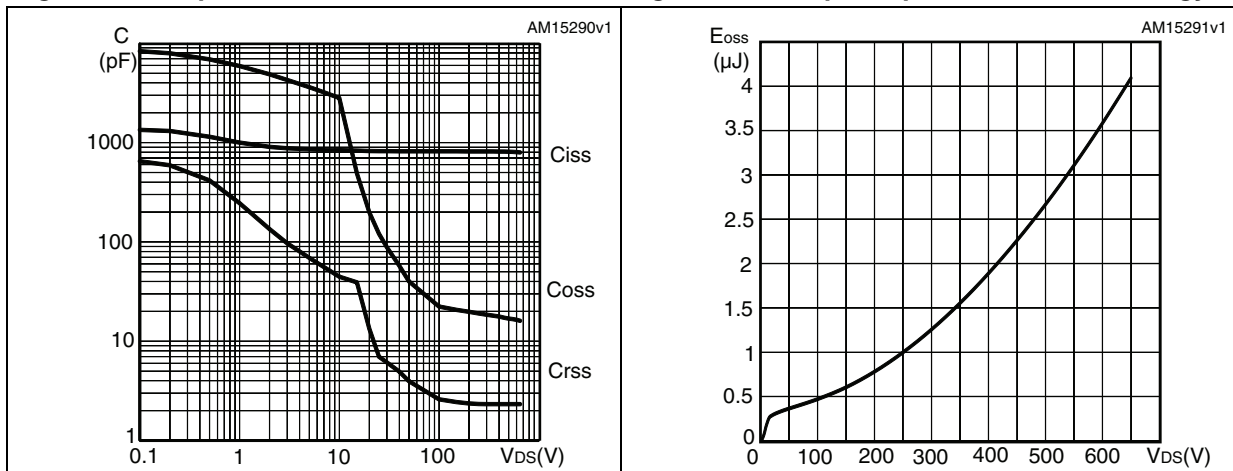


Figure 12. Normalized gate threshold voltage vs temperature Figure 13. Normalized on-resistance vs temperature

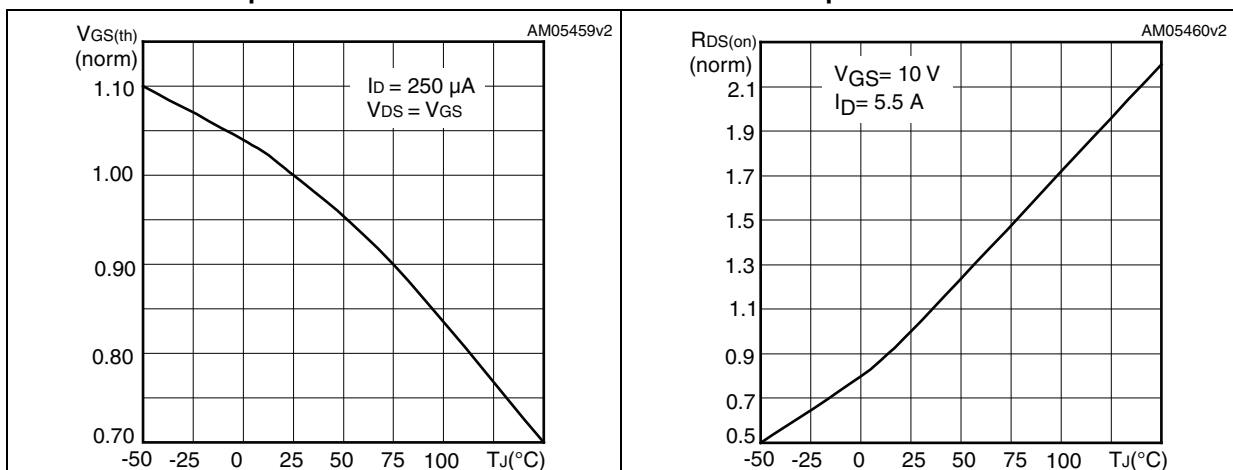


Figure 14. Source-drain diode forward characteristics

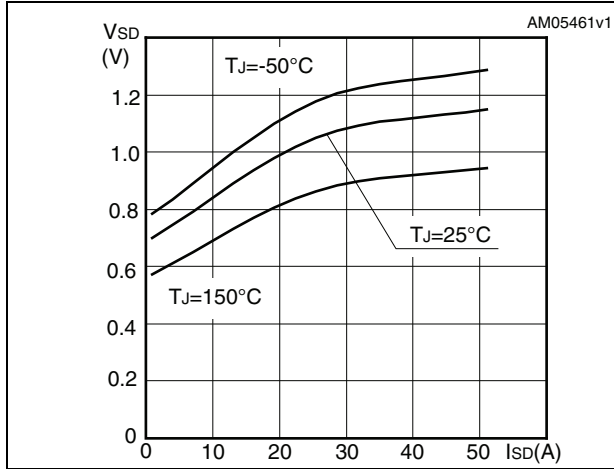


Figure 15. Normalized B_{VDSS} vs temperature

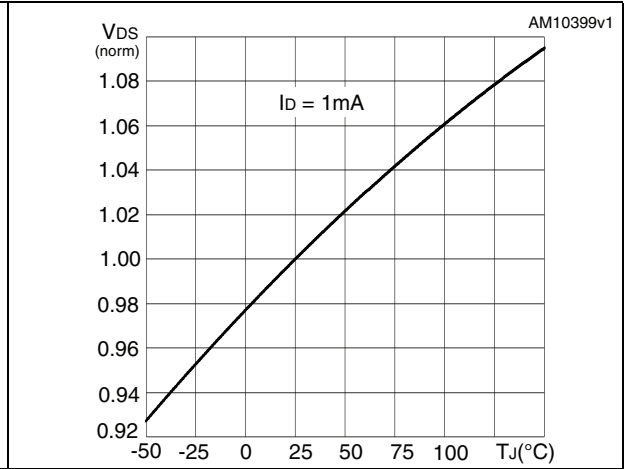
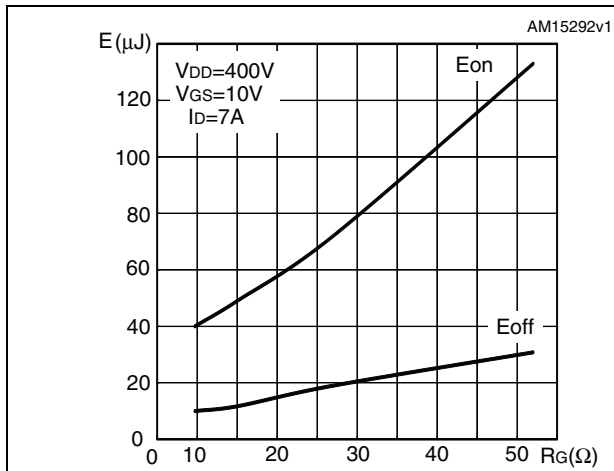


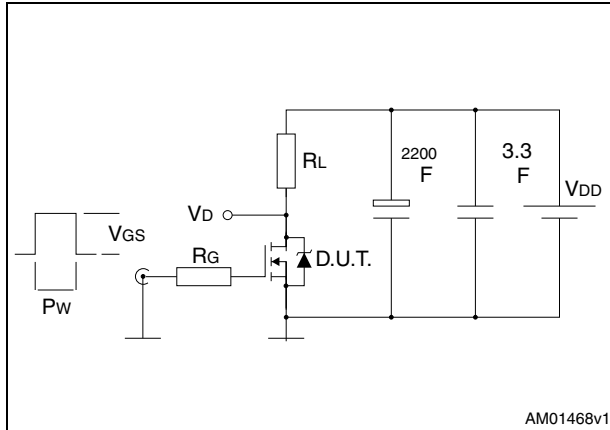
Figure 16. Switching losses vs gate resistance (1)



1. E_{on} including reverse recovery of a SiC diode

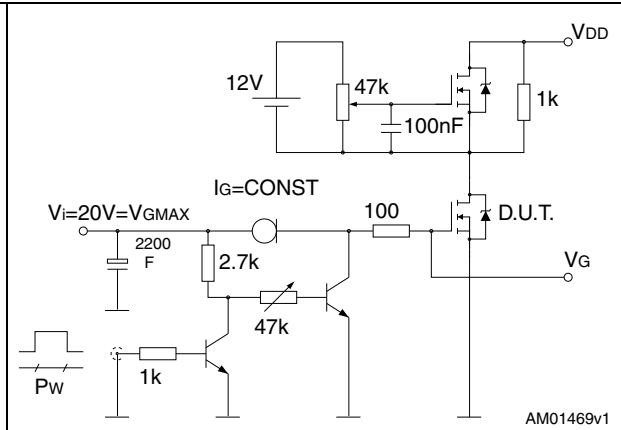
3 Test circuits

Figure 17. Switching times test circuit for resistive load



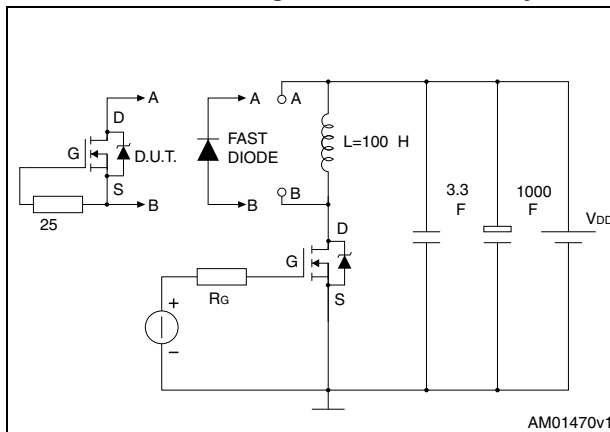
AM01468v1

Figure 18. Gate charge test circuit



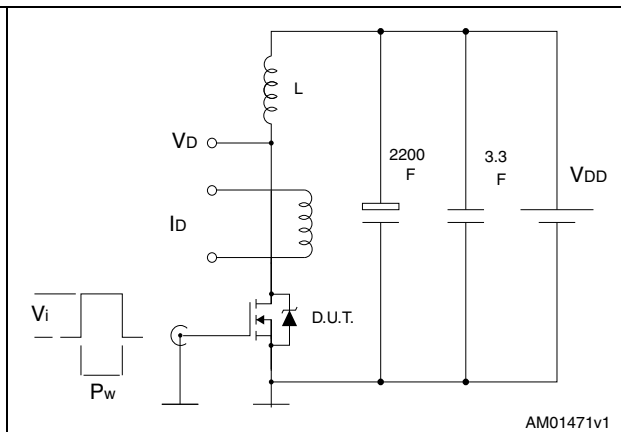
AM01469v1

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



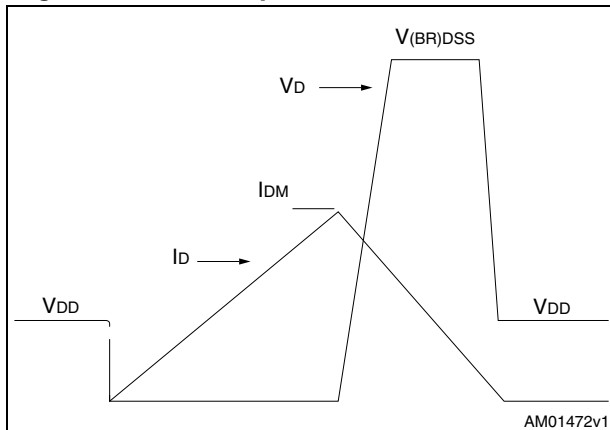
AM01470v1

Figure 20. Unclamped inductive load test circuit



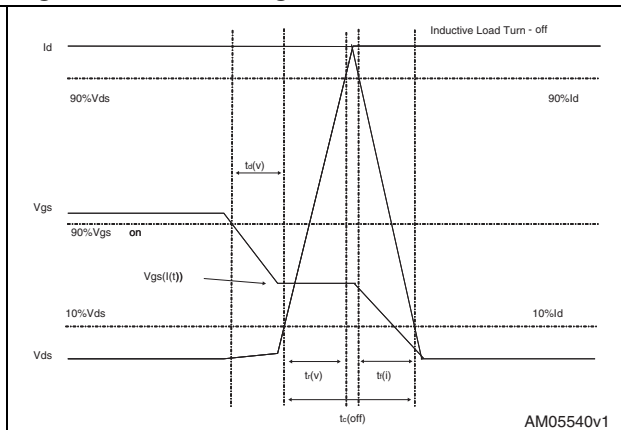
AM01471v1

Figure 21. Unclamped inductive waveform



AM01472v1

Figure 22. Switching time waveform



AM05540v1

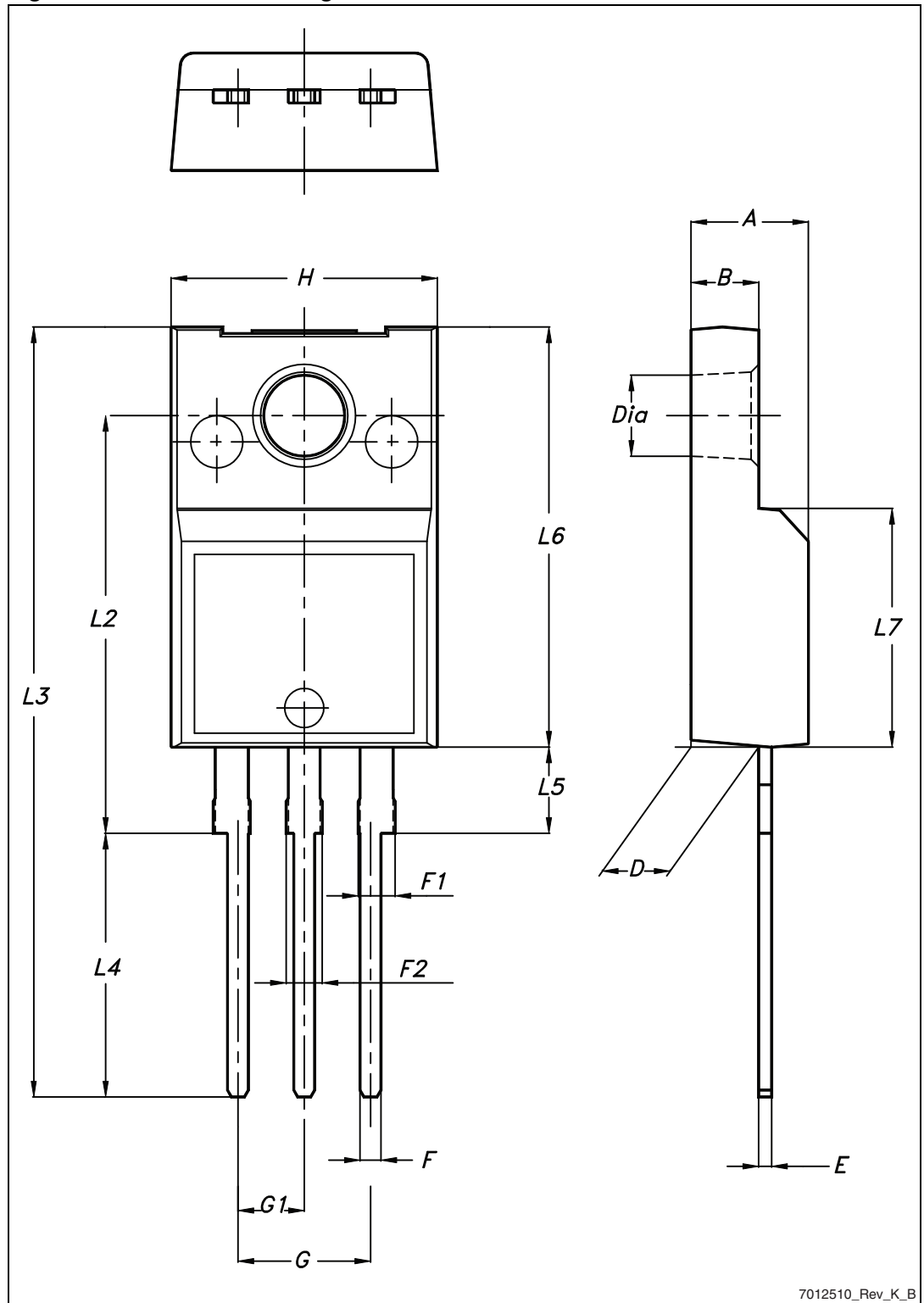
4 Package mechanical data

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 9. 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 23. TO-220FP drawing

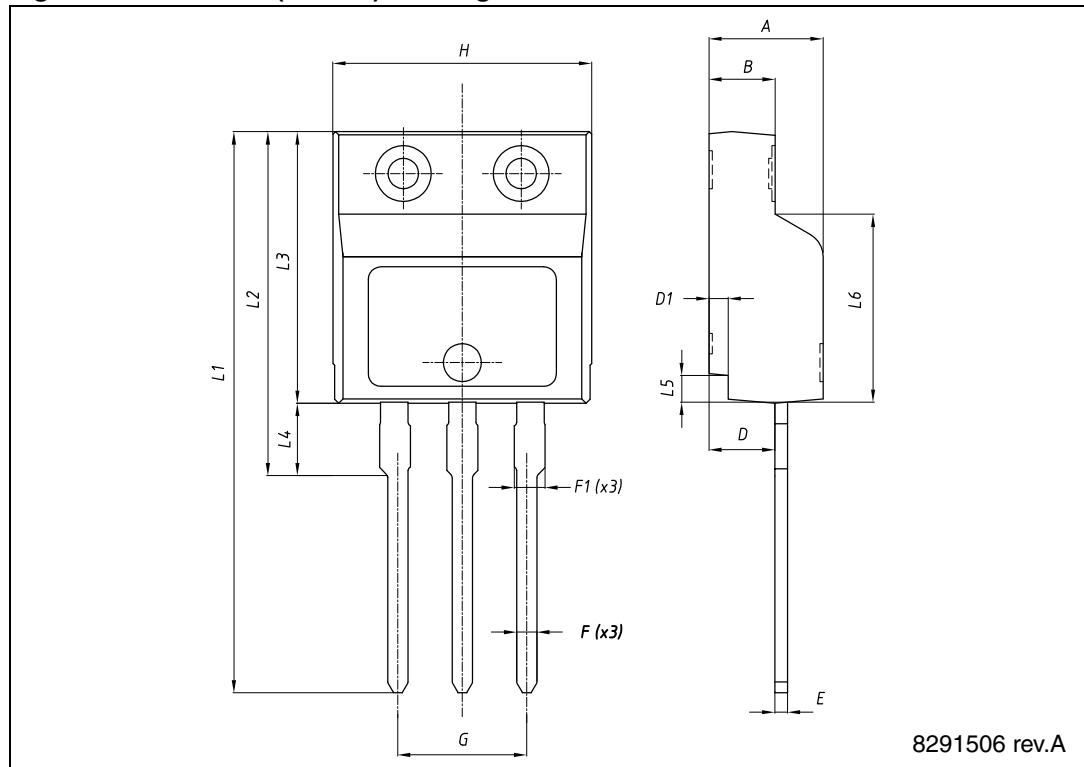


7012510_Rev_K_B

Table 10. I²PAKFP (TO-281) mechanical data

| Dim. | mm | | |
|------|-------|------|-------|
| | Min. | Typ. | Max. |
| A | 4.40 | | 4.60 |
| B | 2.50 | | 2.70 |
| D | 2.50 | | 2.75 |
| D1 | 0.65 | | 0.85 |
| E | 0.45 | | 0.70 |
| F | 0.75 | | 1.00 |
| F1 | | | 1.20 |
| G | 4.95 | - | 5.20 |
| H | 10.00 | | 10.40 |
| L1 | 21.00 | | 23.00 |
| L2 | 13.20 | | 14.10 |
| L3 | 10.55 | | 10.85 |
| L4 | 2.70 | | 3.20 |
| L5 | 0.85 | | 1.25 |
| L6 | 7.30 | | 7.50 |

Figure 24. I²PAKFP (TO-281) drawing

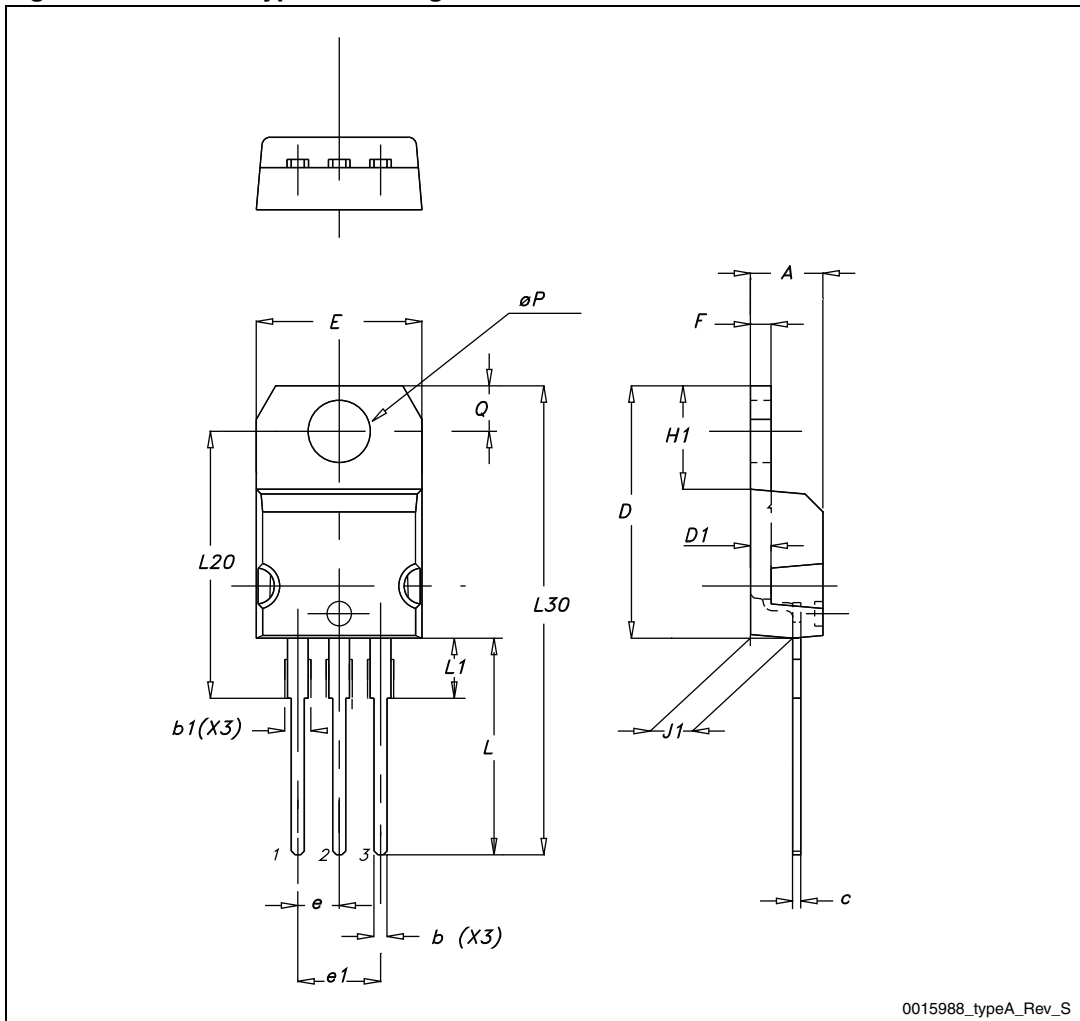


8291506 rev.A

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 |

Figure 25. TO-220 type A drawing



5 Revision history

Table 12. Document revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 05-Mar-2012 | 1 | First release. |
| 09-Nov-2012 | 2 | <ul style="list-style-type: none">– The part number STB15N65M5 has been moved to a separate datasheet.– Added Section 2.1: Electrical characteristics (curves).– Minor text changes. |

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