

N-channel 500 V, 0.28  $\Omega$  typ., 12 A MDmesh™ II Power MOSFETs  
in TO-220FP, I<sup>2</sup>PAK and TO-220 packages

Datasheet - production data

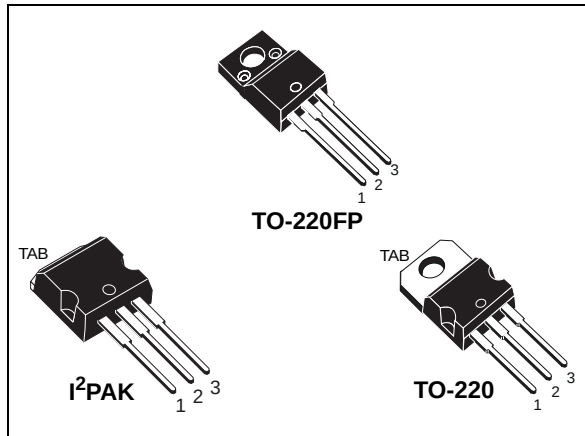
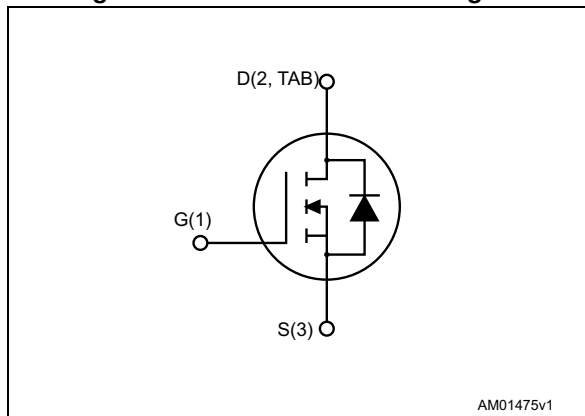


Figure 1. Internal schematic diagram



## Features

| Order codes | $V_{DS} @ T_{Jmax}$ | $R_{DS(on) max}$ | $I_D$ |
|-------------|---------------------|------------------|-------|
| STF14NM50N  | 550 V               | 0.32 $\Omega$    | 12 A  |
| STI14NM50N  |                     |                  |       |
| STP14NM50N  |                     |                  |       |

- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance

## Applications

- Switching applications

## Description

These devices are N-channel Power MOSFET developed using the second generation of MDmesh™ technology. This revolutionary Power MOSFET associates a vertical structure to the company's strip layout to yield one of the world's lowest on-resistance and gate charge. It is therefore suitable for the most demanding high efficiency converters.

Table 1. Device summary

| Order codes | Marking | Package            | Packaging |
|-------------|---------|--------------------|-----------|
| STF14NM50N  | 14NM50N | TO-220FP           | Tube      |
| STI14NM50N  |         | I <sup>2</sup> PAK |           |
| STP14NM50N  |         | TO-220             |           |

## 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 circuits</b>                | <b>9</b>  |
| <b>4</b> | <b>Package mechanical data</b>      | <b>10</b> |
| 4.1      | TO-220FP, STF14NM50N                | 11        |
| 4.2      | I <sup>2</sup> PAK, STI14NM50N      | 13        |
| 4.3      | TO-220, STP14NM50N                  | 15        |
| <b>5</b> | <b>Revision history</b>             | <b>17</b> |

# 1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol                         | Parameter                                                                                                       | Value                      |                   | Unit |
|--------------------------------|-----------------------------------------------------------------------------------------------------------------|----------------------------|-------------------|------|
|                                |                                                                                                                 | I <sup>2</sup> PAK, TO-220 | TO-220FP          |      |
| V <sub>DS</sub>                | Drain-source voltage                                                                                            | 500                        |                   | V    |
| V <sub>GS</sub>                | Gate-source voltage                                                                                             | ± 25                       |                   | V    |
| I <sub>D</sub>                 | Drain current (continuous) at T <sub>C</sub> = 25 °C                                                            | 12                         | 12 <sup>(1)</sup> | A    |
| I <sub>D</sub>                 | Drain current (continuous) at T <sub>C</sub> = 100 °C                                                           | 8                          | 8 <sup>(1)</sup>  | A    |
| I <sub>DM</sub> <sup>(2)</sup> | Drain current (pulsed)                                                                                          | 48                         | 48 <sup>(1)</sup> | A    |
| P <sub>TOT</sub>               | Total dissipation at T <sub>C</sub> = 25 °C                                                                     | 90                         | 25                | W    |
| dv/dt <sup>(3)</sup>           | Peak diode recovery voltage slope                                                                               | 15                         |                   | V/ns |
| V <sub>ISO</sub>               | Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; 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                                                                             | 150                        |                   | °C   |

1. Limited by maximum junction temperature
2. Pulse width limited by safe operating area
3.  $I_{SD} \leq 12$  A,  $di/dt \leq 400$  A/s,  $V_{DS\ peak} \leq V_{(BR)DSS}$ ,  $V_{DD} = 80\% V_{(BR)DSS}$

Table 3. Thermal data

| Symbol                | Parameter                               | Value    |                    |        | Unit |
|-----------------------|-----------------------------------------|----------|--------------------|--------|------|
|                       |                                         | TO-220FP | I <sup>2</sup> PAK | TO-220 |      |
| R <sub>thj-case</sub> | Thermal resistance junction-case max    | 5        | 1.39               |        | °C/W |
| R <sub>thj-amb</sub>  | Thermal resistance junction-ambient max | 62.5     |                    |        | °C/W |

Table 4. Avalanche data

| Symbol          | Parameter                                                                                                                 | Value | Unit |
|-----------------|---------------------------------------------------------------------------------------------------------------------------|-------|------|
| I <sub>AR</sub> | Avalanche current, repetitive or not-repetitive (pulse width limited by T <sub>j</sub> max)                               | 4     | 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) | 172   | mJ   |

## 2 Electrical characteristics

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

**Table 5. On /off states**

| Symbol        | Parameter                                        | Test conditions                                                                          | Min. | Typ. | Max.      | Unit                           |
|---------------|--------------------------------------------------|------------------------------------------------------------------------------------------|------|------|-----------|--------------------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage                   | $I_D = 1\text{ mA}$ , $V_{GS} = 0$                                                       | 500  |      |           | V                              |
| $I_{DSS}$     | Zero gate voltage drain current ( $V_{GS} = 0$ ) | $V_{DS} = 500\text{ V}$<br>$V_{DS} = 500\text{ V}$ , $T_C = 125\text{ }^{\circ}\text{C}$ |      |      | 1<br>100  | $\mu\text{A}$<br>$\mu\text{A}$ |
| $I_{GSS}$     | Gate-body leakage current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 25\text{ V}$                                                               |      |      | $\pm 100$ | nA                             |
| $V_{GS(th)}$  | Gate threshold voltage                           | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$                                       | 2    | 3    | 4         | V                              |
| $R_{DS(on)}$  | Static drain-source on-resistance                | $V_{GS} = 10\text{ V}$ , $I_D = 6\text{ A}$                                              |      | 0.28 | 0.32      | $\Omega$                       |

**Table 6. Dynamic**

| Symbol                              | Parameter                                                               | Test conditions                                                                                            | Min. | Typ.           | Max. | Unit           |
|-------------------------------------|-------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|------|----------------|------|----------------|
| $C_{iss}$<br>$C_{oss}$<br>$C_{rss}$ | Input capacitance<br>Output capacitance<br>Reverse transfer capacitance | $V_{DS} = 50\text{ V}$ , $f = 1\text{ MHz}$ ,<br>$V_{GS} = 0$                                              | -    | 816<br>60<br>3 | -    | pF<br>pF<br>pF |
| $C_{oss\text{ eq.}}^{(1)}$          | Equivalent output capacitance                                           | $V_{DS} = 0\text{ to }50\text{ V}$ , $V_{GS} = 0$                                                          | -    | 157            | -    | pF             |
| $R_G$                               | Intrinsic gate resistance                                               | $f = 1\text{ MHz}$ open drain                                                                              | -    | 4.5            | -    | $\Omega$       |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$       | Total gate charge<br>Gate-source charge<br>Gate-drain charge            | $V_{DD} = 400\text{ V}$ , $I_D = 12\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$ (see <a href="#">Figure 16</a> ) | -    | 27<br>5<br>15  | -    | nC<br>nC<br>nC |

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

**Table 7. Switching times**

| Symbol       | Parameter           | Test conditions                                                                                                                           | Min. | Typ. | Max. | Unit |
|--------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $t_{d(on)}$  | Turn-on delay time  | $V_{DD} = 400\text{ V}$ , $I_D = 12\text{ A}$ ,<br>$R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 17</a> ) | -    | 12   | -    | ns   |
| $t_r$        | Rise time           |                                                                                                                                           |      | 16   |      | ns   |
| $t_{d(off)}$ | Turn-off-delay time |                                                                                                                                           |      | 42   |      | ns   |
| $t_f$        | Fall 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         | $I_{SD} = 12\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 60\text{ V}$<br>(see <a href="#">Figure 20</a> )                                     | -    | 252  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                 |      | 2.8  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                 |      | 22   |      | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 12\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 60\text{ V}$ , $T_J = 150\text{ }^\circ\text{C}$<br>(see <a href="#">Figure 20</a> ) | -    | 300  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                 |      | 3.3  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                 |      | 22.2 |      | A             |

1. Pulse width limited by safe operating area.

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

## 2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for I<sup>2</sup>PAK, TO-220 Figure 3. Thermal impedance for I<sup>2</sup>PAK, TO-220

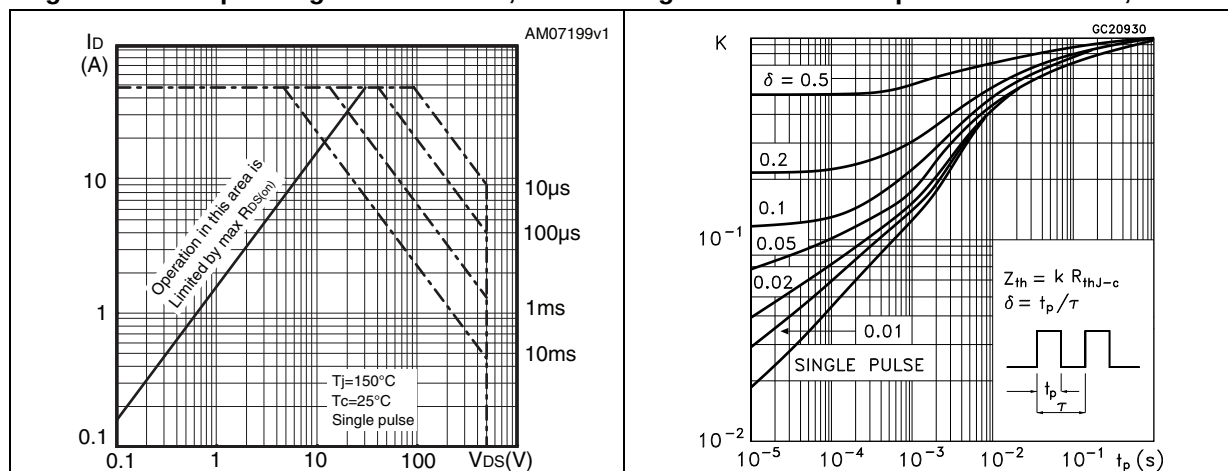


Figure 4. Safe operating area for TO-220FP

Figure 5. Thermal impedance for TO-220FP

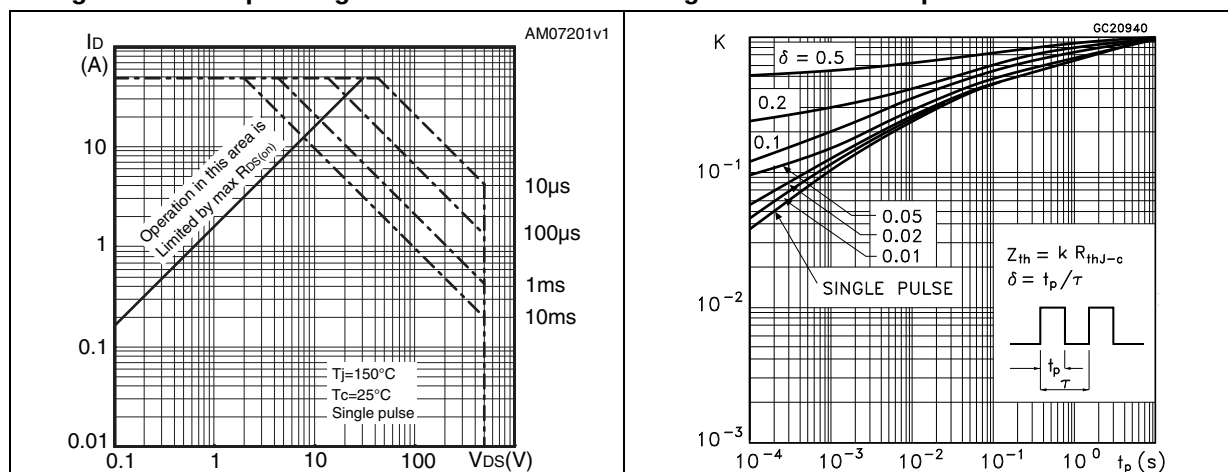


Figure 6. Output characteristics

Figure 7. Transfer characteristics

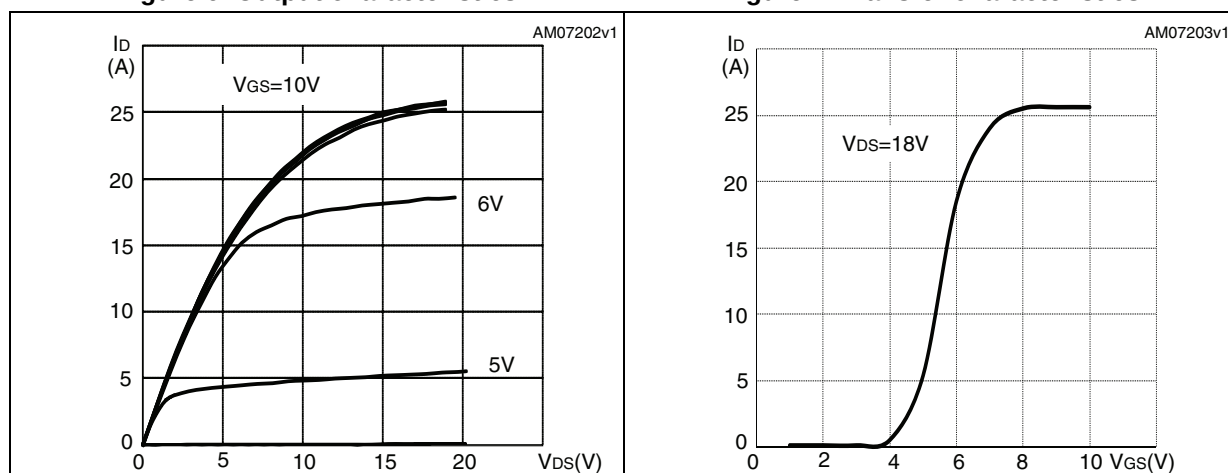


Figure 8. Normalized  $V_{(BR)DSS}$  vs temperature

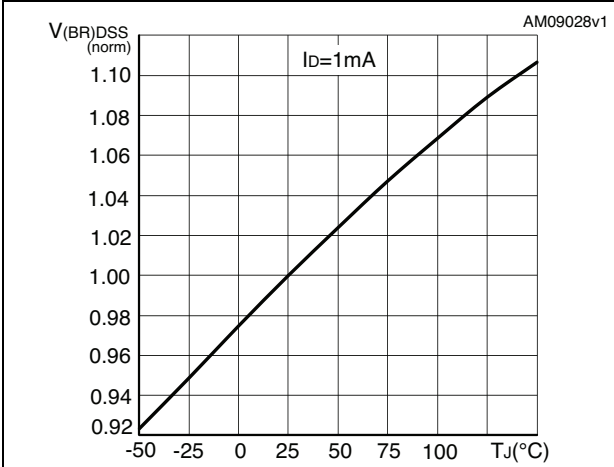


Figure 9. Static drain-source on-resistance

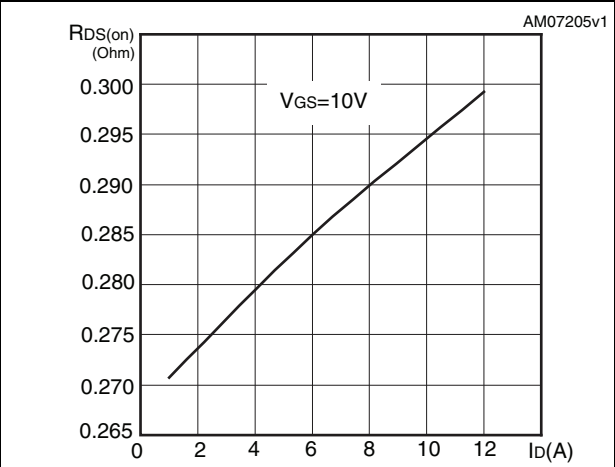


Figure 10. Capacitance variations

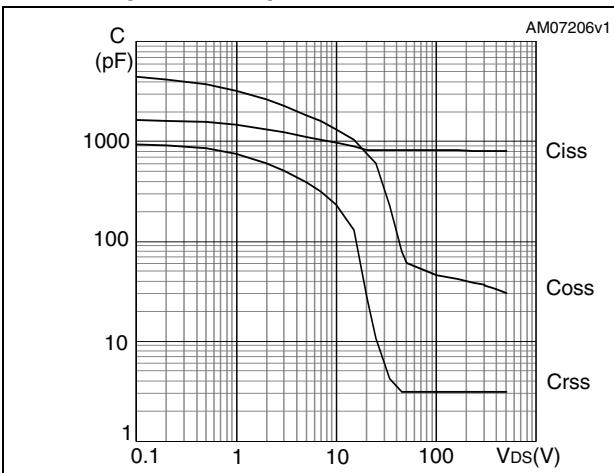


Figure 11. Gate charge vs gate-source voltage

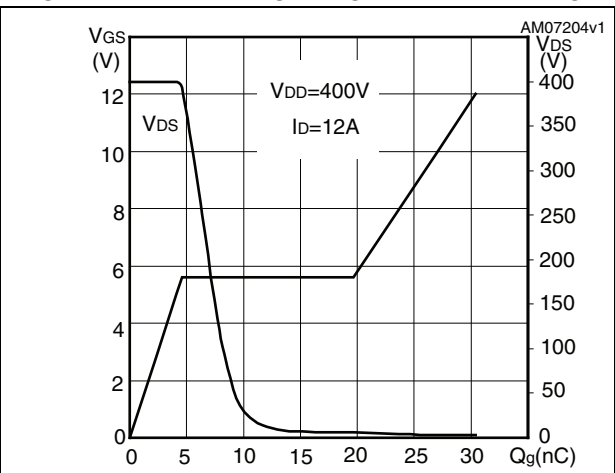


Figure 12. Normalized gate threshold voltage vs temperature

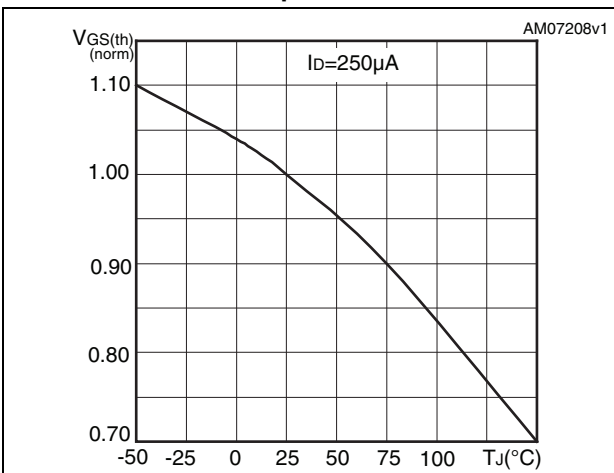


Figure 13. Normalized on-resistance vs temperature

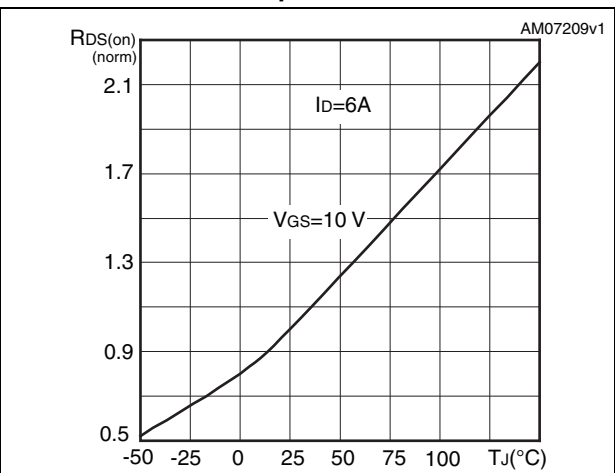
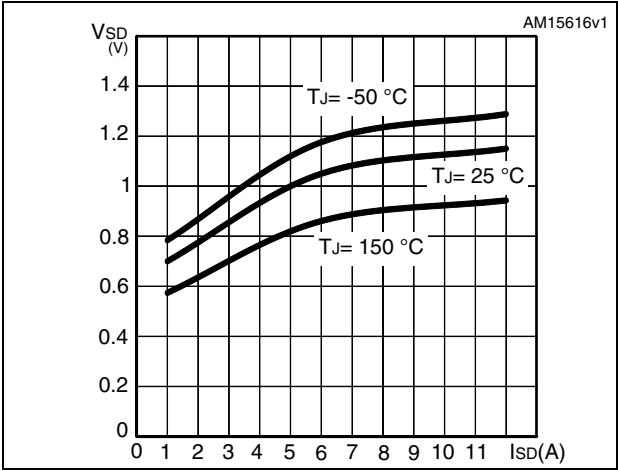


Figure 14. Source-drain diode forward characteristics





### 3 Test circuits

Figure 15. Switching times test circuit for resistive load

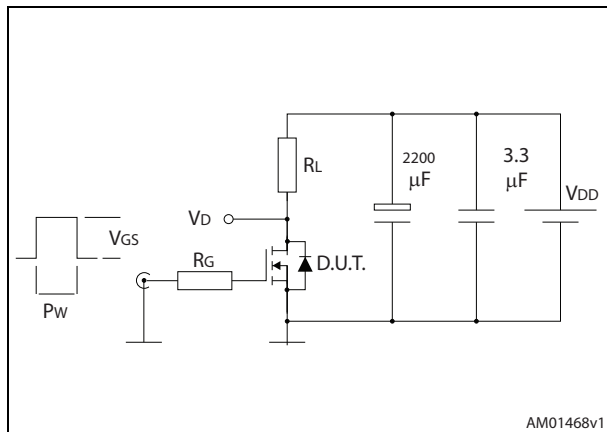


Figure 16. Gate charge test circuit

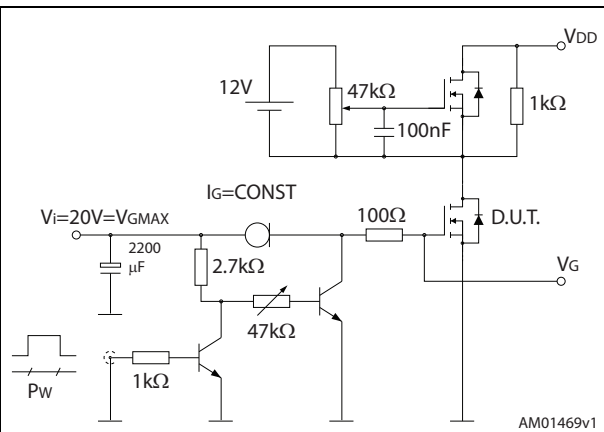


Figure 17. Test circuit for inductive load switching and diode recovery times

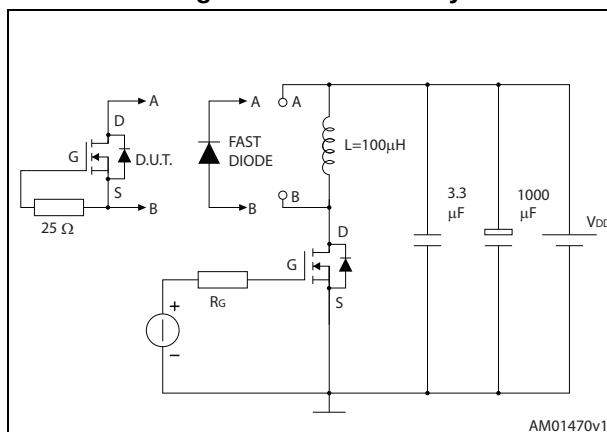


Figure 18. Unclamped inductive load test circuit

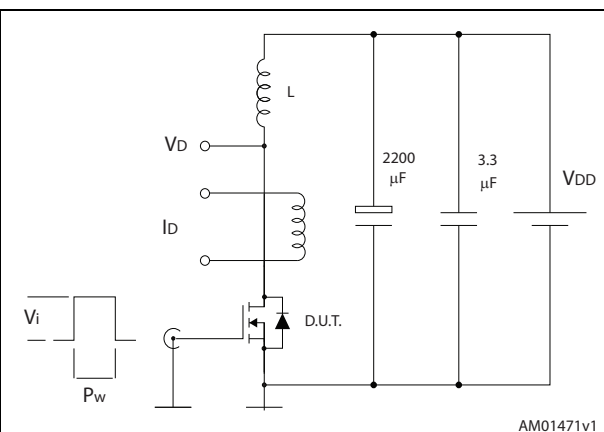


Figure 19. Unclamped inductive waveform

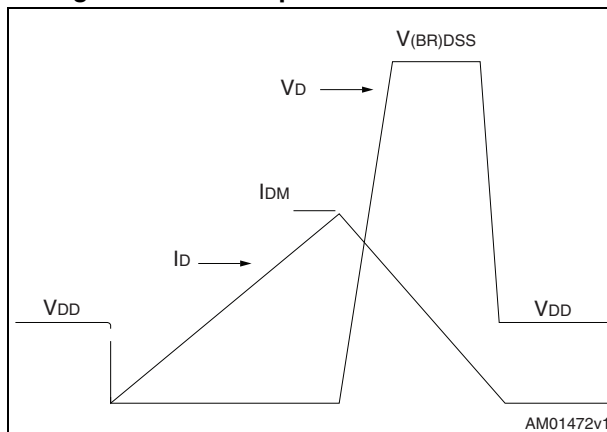
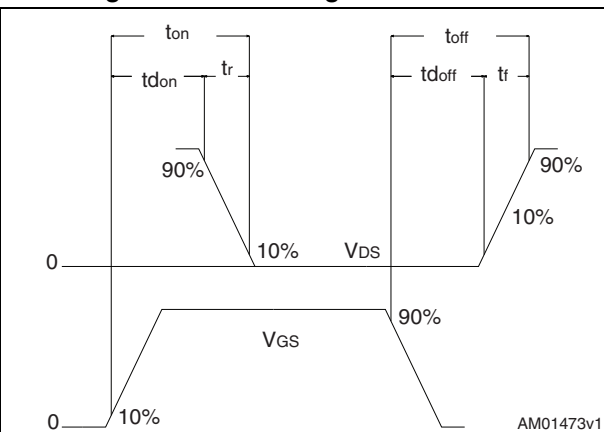


Figure 20. Switching time waveform

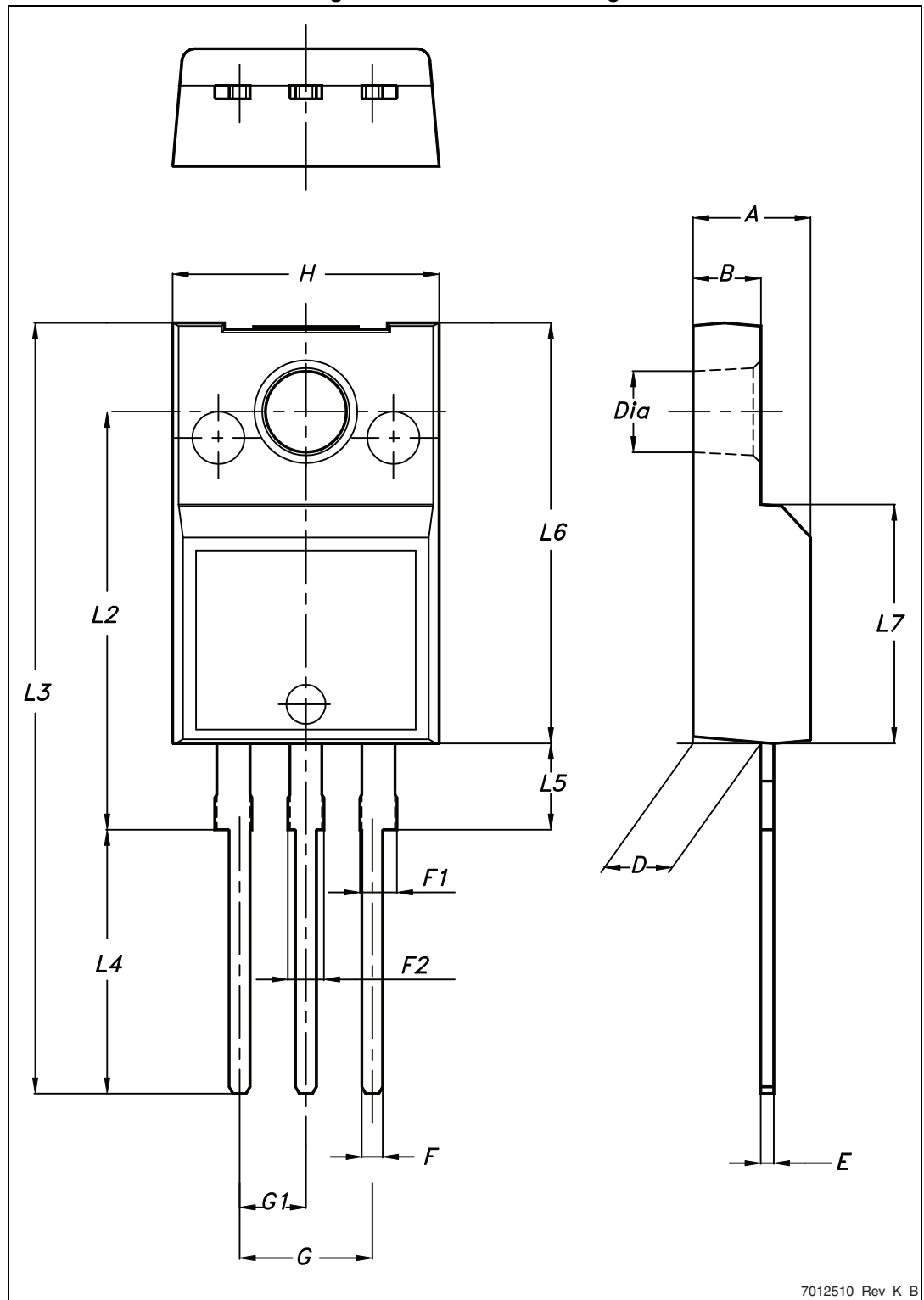


## 4 Package mechanical data

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

## 4.1 TO-220FP, STF14NM50N

Figure 21. TO-220FP drawing



7012510\_Rev\_K\_B

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  |

## 4.2 I<sup>2</sup>PAK, STI14NM50N

Figure 22. I<sup>2</sup>PAK (TO-262) drawing

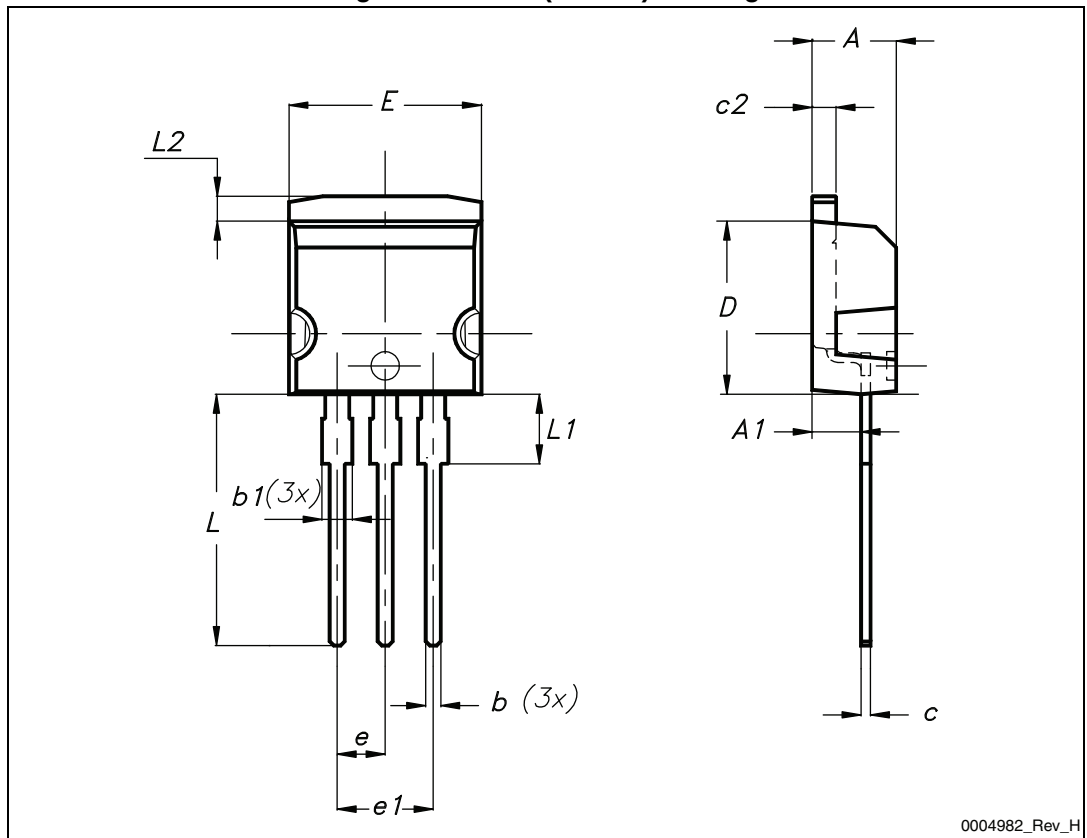


Table 10. I<sup>2</sup>PAK (TO-262) mechanical data

| 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  |

## 4.3 TO-220, STP14NM50N

Figure 23. TO-220 type A drawing

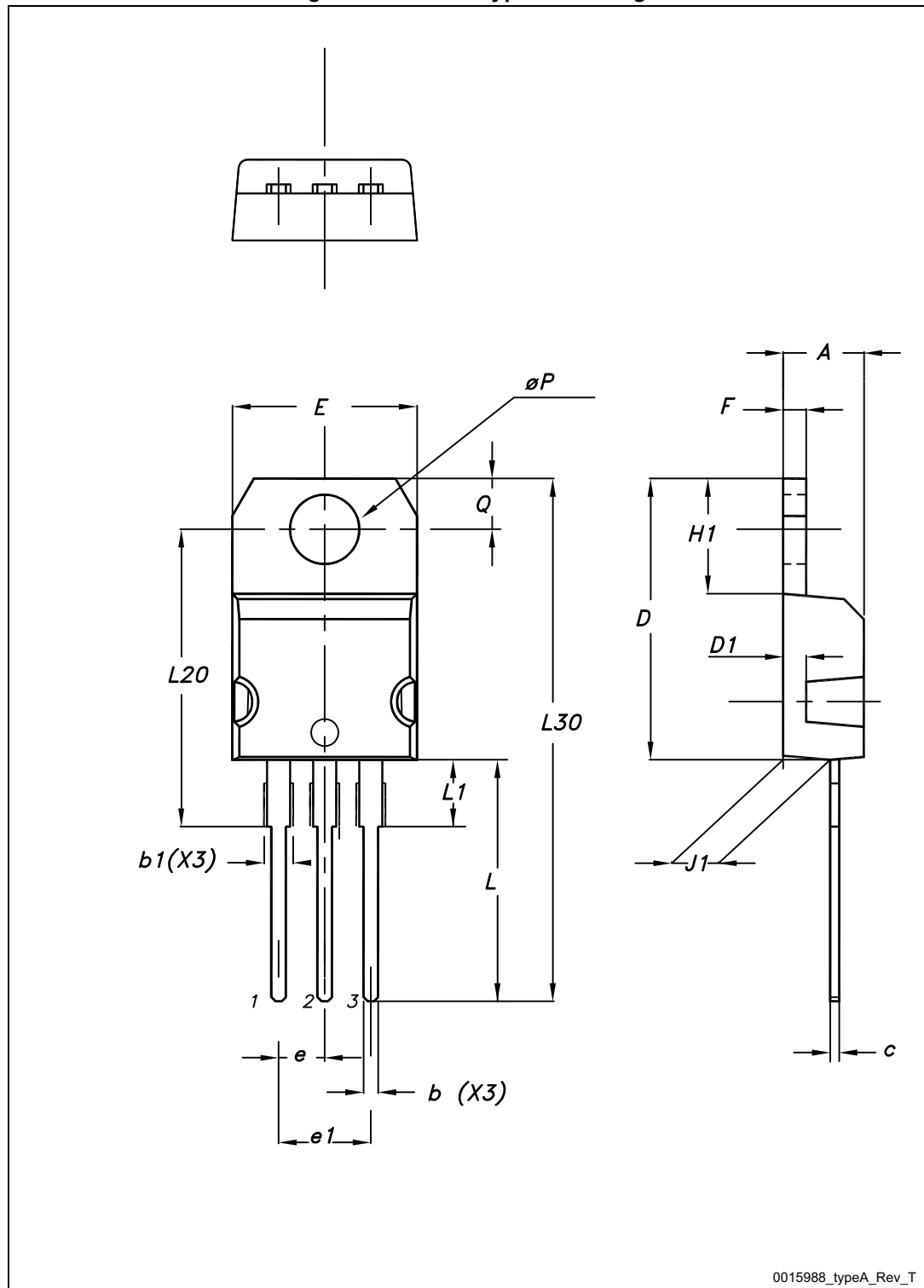


Table 11. TO-220 type A mechanical data

| 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  |



## 5 Revision history

Table 12. Document revision history

| Date        | Revision | Changes                                                                                                                                                                                                                                                                                                                               |
|-------------|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 26-Nov-2009 | 1        | First release.                                                                                                                                                                                                                                                                                                                        |
| 02-Dec-2009 | 2        | Inserted table footnote <a href="#">Table 3: Thermal data</a> .                                                                                                                                                                                                                                                                       |
| 22-Jul-2010 | 3        | Document status promoted from preliminary data to datasheet.                                                                                                                                                                                                                                                                          |
| 06-Apr-2011 | 4        | Updated $E_{AS}$ in <a href="#">Table 2</a> .                                                                                                                                                                                                                                                                                         |
| 30-Oct-2012 | 5        | Updated <a href="#">Figure 1: Internal schematic diagram</a> , <a href="#">Table 1: Device summary</a> , <a href="#">Table 2: Absolute maximum ratings</a> , <a href="#">Table 3: Thermal data</a> , <a href="#">Table 5: On /off states</a> .<br>Updated <a href="#">Section 4: Package mechanical data</a> .<br>Minor text changes. |
| 07-Feb-2013 | 6        | – Minor text changes<br>– Added: <a href="#">Figure 14</a><br>– Updated: <a href="#">Section 4: Package mechanical data</a> only for DPAK package                                                                                                                                                                                     |
| 05-Jun-2014 | 7        | – The root part numbers STB14NM50N and STD14NM50N have been moved to a separate datasheet<br>– Updated Coss eq. in <a href="#">Table 6: Dynamic</a><br>– Updated: <a href="#">Section 4.3: TO-220, STP14NM50N</a><br>– Minor text changes                                                                                             |

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