

N-channel 600 V, 0.35  $\Omega$  typ., 11 A MDmesh II Plus™ low  $Q_g$   
Power MOSFETs in TO-220, IPAK and TO-247 packages

Datasheet – production data

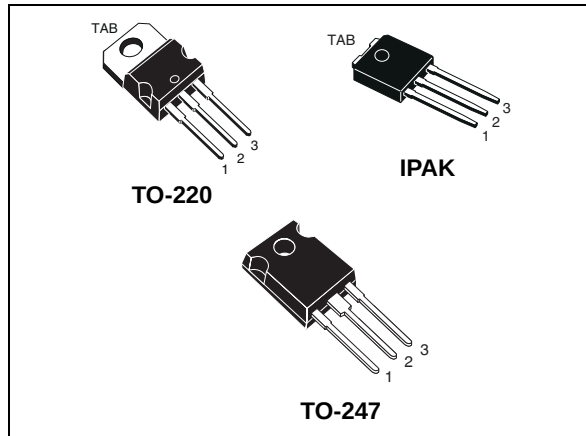
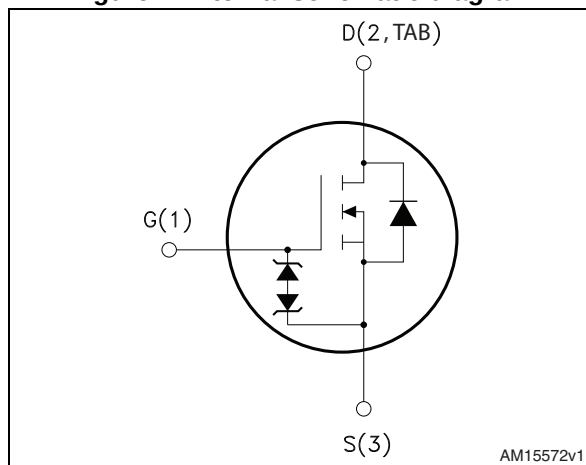


Figure 1. Internal schematic diagram



## Features

| Order codes | $V_{DS} @ T_{Jmax}$ | $R_{DS(on)} max$ | $I_D$ |
|-------------|---------------------|------------------|-------|
| STP13N60M2  | 650 V               | 0.38 $\Omega$    | 11 A  |
| STU13N60M2  |                     |                  |       |
| STW13N60M2  |                     |                  |       |

- Extremely low gate charge
- Lower  $R_{DS(on)}$  x area vs previous generation
- Low gate input resistance
- 100% avalanche tested
- Zener-protected

## Applications

- Switching applications

## Description

These devices are N-channel Power MOSFETs developed using a new generation of MDmesh™ technology: MDmesh II Plus™ low  $Q_g$ . These revolutionary Power MOSFETs associate a vertical structure to the company's strip layout to yield one of the world's lowest on-resistance and gate charge. They are therefore suitable for the most demanding high efficiency converters.

Table 1. Device summary

| Order codes | Marking | Package | Packaging |
|-------------|---------|---------|-----------|
| STP13N60M2  | 13N60M2 | TO-220  | Tube      |
| STU13N60M2  |         | IPAK    |           |
| STW13N60M2  |         | TO-247  |           |

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol         | Parameter                                                         | Value       | Unit               |
|----------------|-------------------------------------------------------------------|-------------|--------------------|
| $V_{GS}$       | Gate-source voltage                                               | $\pm 25$    | V                  |
| $I_D$          | Drain current (continuous) at $T_C = 25\text{ }^{\circ}\text{C}$  | 11          | A                  |
| $I_D$          | Drain current (continuous) at $T_C = 100\text{ }^{\circ}\text{C}$ | 7           | A                  |
| $I_{DM}^{(1)}$ | Drain current (pulsed)                                            | 44          | A                  |
| $P_{TOT}$      | Total dissipation at $T_C = 25\text{ }^{\circ}\text{C}$           | 110         | W                  |
| $dv/dt^{(2)}$  | Peak diode recovery voltage slope                                 | 15          | V/ns               |
| $dv/dt^{(3)}$  | MOSFET $dv/dt$ ruggedness                                         | 50          | V/ns               |
| $T_{stg}$      | Storage temperature                                               | - 55 to 150 | $^{\circ}\text{C}$ |
| $T_j$          | Max. operating junction temperature                               |             |                    |

1. Pulse width limited by safe operating area.

2.  $I_{SD} \leq 11\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ;  $V_{DS\text{ peak}} < V_{(BR)DSS}$ ,  $V_{DD}=400\text{ V}$ .

3.  $V_{DS} \leq 480\text{ V}$

**Table 3. Thermal data**

| Symbol         | Parameter                               | Value  |      |        | Unit                        |
|----------------|-----------------------------------------|--------|------|--------|-----------------------------|
|                |                                         | TO-220 | IPAK | TO-247 |                             |
| $R_{thj-case}$ | Thermal resistance junction-case max    | 1.14   |      |        | $^{\circ}\text{C}/\text{W}$ |
| $R_{thj-amb}$  | Thermal resistance junction-ambient max | 62.5   | 100  | 50     | $^{\circ}\text{C}/\text{W}$ |

**Table 4. Avalanche characteristics**

| Symbol   | Parameter                                                                                       | Value | Unit |
|----------|-------------------------------------------------------------------------------------------------|-------|------|
| $I_{AR}$ | Avalanche current, repetitive or not repetitive (pulse width limited by $T_{jmax}$ )            | 2.8   | A    |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_j=25^{\circ}\text{C}$ , $I_D=I_{AR}$ , $V_{DD}=50$ ) | 125   | 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                   | $I_D = 1\text{ mA}$ , $V_{GS} = 0$                                                       | 600  |      |          | V                              |
| $I_{DSS}$     | Zero gate voltage drain current ( $V_{GS} = 0$ ) | $V_{DS} = 600\text{ V}$<br>$V_{DS} = 600\text{ V}$ , $T_C = 125\text{ }^{\circ}\text{C}$ |      |      | 1<br>100 | $\mu\text{A}$<br>$\mu\text{A}$ |
| $I_{GSS}$     | Gate-body leakage current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 25\text{ V}$                                                               |      |      | $\pm 10$ | $\mu\text{A}$                  |
| $V_{GS(th)}$  | 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                | $V_{GS} = 10\text{ V}$ , $I_D = 5.5\text{ A}$                                            |      | 0.35 | 0.38     | $\Omega$                       |

**Table 6. Dynamic**

| Symbol                     | Parameter                     | Test conditions                                                                                            | Min. | Typ. | Max. | Unit     |
|----------------------------|-------------------------------|------------------------------------------------------------------------------------------------------------|------|------|------|----------|
| $C_{iss}$                  | Input capacitance             | $V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ ,<br>$V_{GS} = 0$                                             | -    | 580  | -    | pF       |
| $C_{oss}$                  | Output capacitance            |                                                                                                            | -    | 32   | -    | pF       |
| $C_{rss}$                  | Reverse transfer capacitance  |                                                                                                            | -    | 1.1  | -    | pF       |
| $C_{oss\text{ eq.}}^{(1)}$ | Equivalent output capacitance | $V_{DS} = 0\text{ to }480\text{ V}$ , $V_{GS} = 0$                                                         | -    | 120  | -    | pF       |
| $R_G$                      | Intrinsic gate resistance     | $f = 1\text{ MHz}$ open drain                                                                              | -    | 6.6  | -    | $\Omega$ |
| $Q_g$                      | Total gate charge             | $V_{DD} = 480\text{ V}$ , $I_D = 11\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$ (see <a href="#">Figure 17</a> ) | -    | 17   | -    | nC       |
| $Q_{gs}$                   | Gate-source charge            |                                                                                                            | -    | 2.5  | -    | nC       |
| $Q_{gd}$                   | Gate-drain charge             |                                                                                                            | -    | 9    | -    | 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%  $V_{DSS}$

**Table 7. Switching times**

| Symbol       | Parameter           | Test conditions                                                                                                                                                   | Min. | Typ. | Max. | Unit |
|--------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $t_{d(on)}$  | Turn-on delay time  | $V_{DD} = 300\text{ V}$ , $I_D = 5.5\text{ A}$ ,<br>$R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$ (see<br><a href="#">Figure 16</a> and <a href="#">21</a> ) | -    | 11   | -    | ns   |
| $t_r$        | Rise time           |                                                                                                                                                                   | -    | 10   | -    | ns   |
| $t_{d(off)}$ | Turn-off delay time |                                                                                                                                                                   | -    | 41   | -    | ns   |
| $t_f$        | Fall time           |                                                                                                                                                                   | -    | 9.5  | -    | 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            | $I_{SD} = 11\text{ A}$ , $V_{GS} = 0$                                                                                                                         | -    |      | 1.6  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 11\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 60\text{ V}$ (see <a href="#">Figure 18</a> )                                        | -    | 297  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                               | -    | 2.8  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                               | -    | 18.5 |      | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 11\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 60\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$<br>(see <a href="#">Figure 18</a> ) | -    | 394  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                               | -    | 3.8  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                               | -    | 19   |      | 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 TO-220 and TO-247

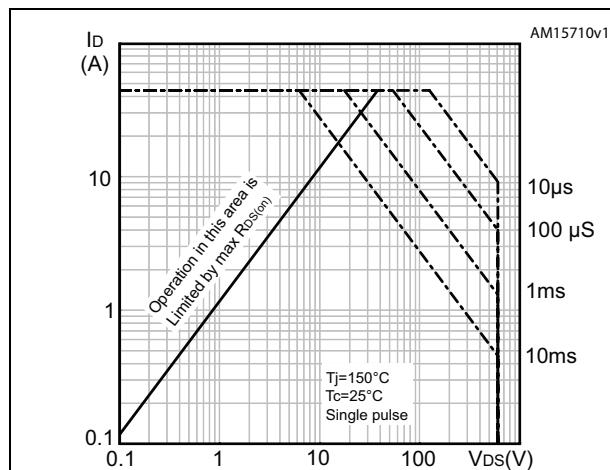


Figure 3. Thermal impedance for TO-220 and TO-247

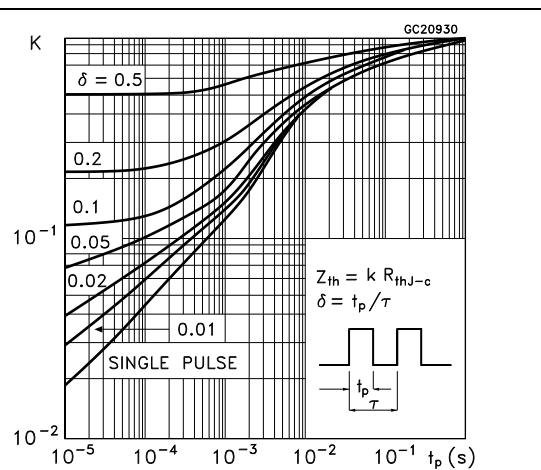


Figure 4. Safe operating area for IPAK

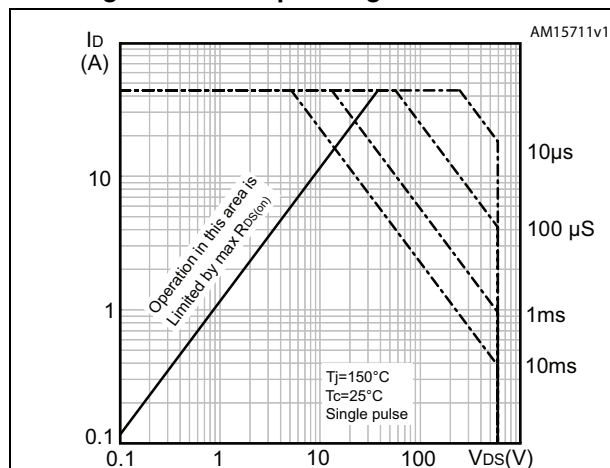


Figure 5. Thermal impedance for IPAK

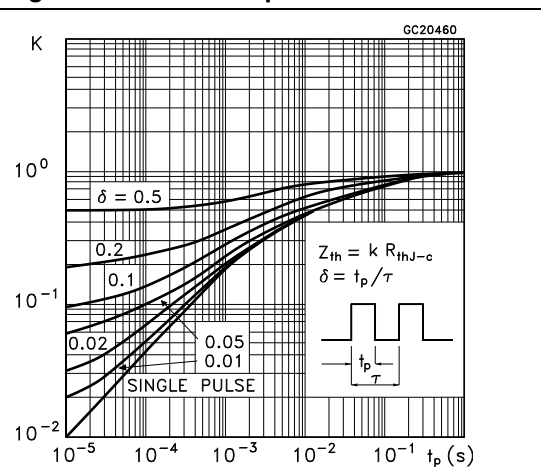


Figure 6. Output characteristics

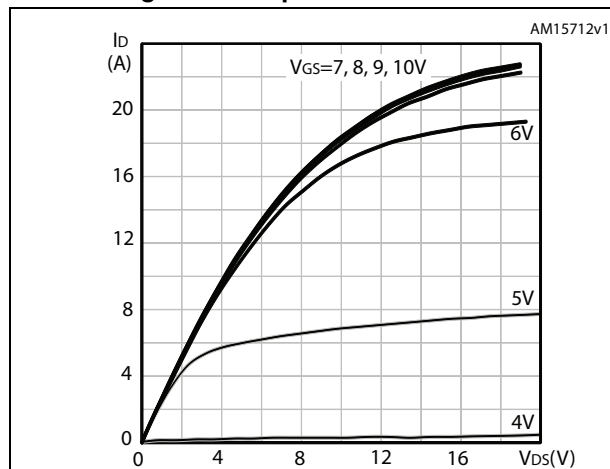


Figure 7. Transfer characteristics

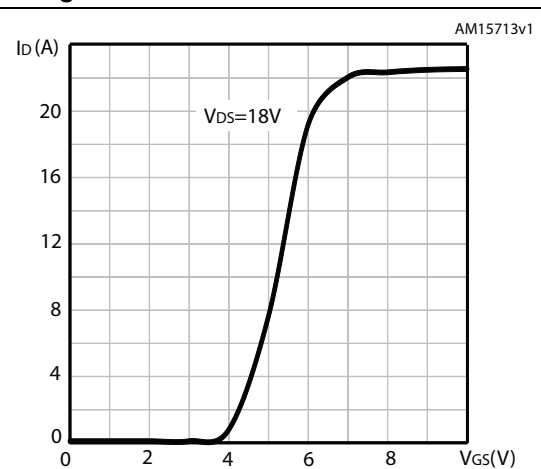


Figure 8. Normalized  $V_{(BR)DSS}$  vs temperature

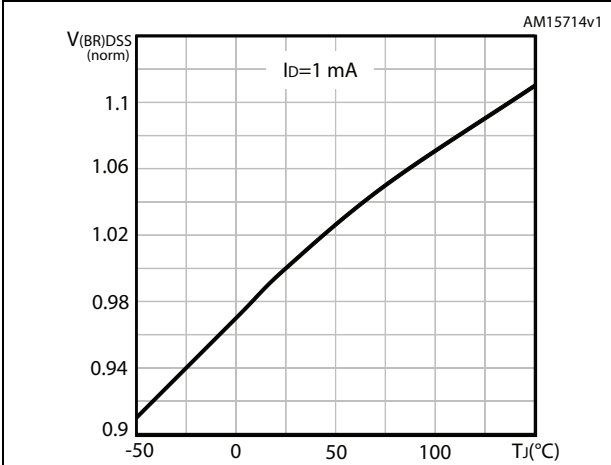


Figure 9. Static drain-source on-resistance

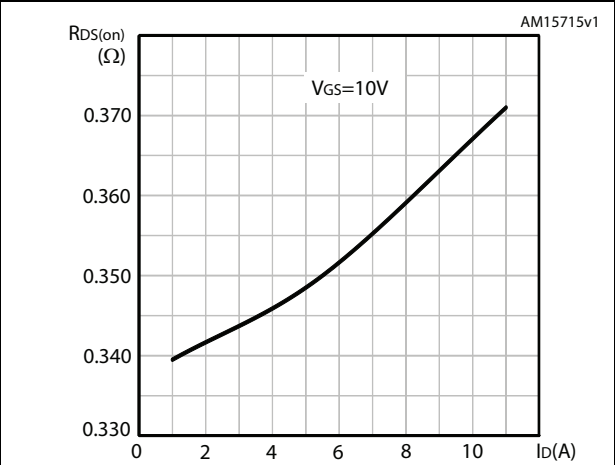


Figure 10. Gate charge vs gate-source voltage

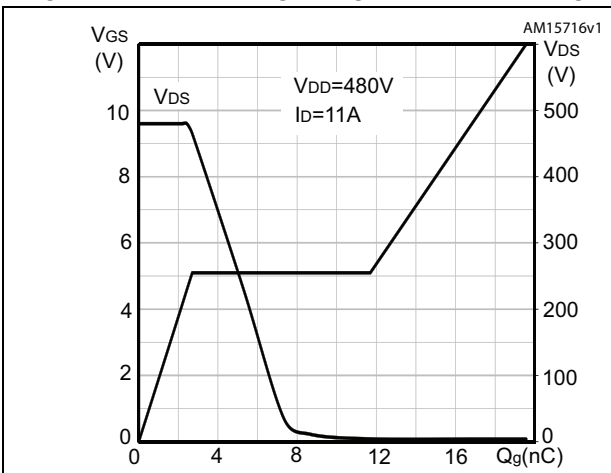


Figure 11. Capacitance variations

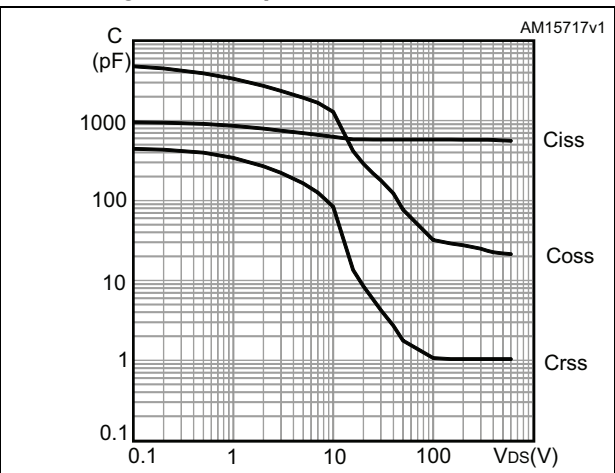


Figure 12. Normalized gate threshold voltage vs temperature

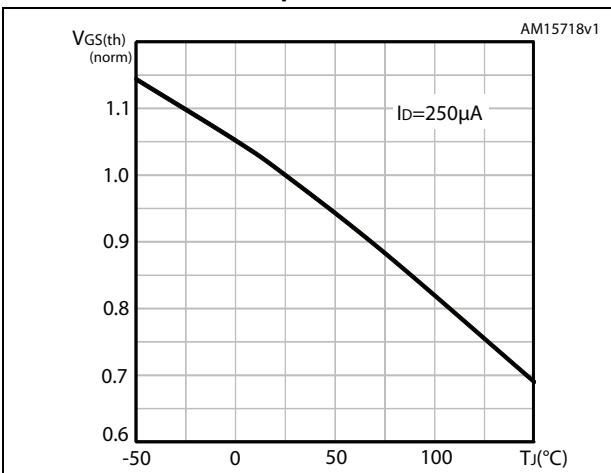


Figure 13. Normalized on-resistance vs temperature

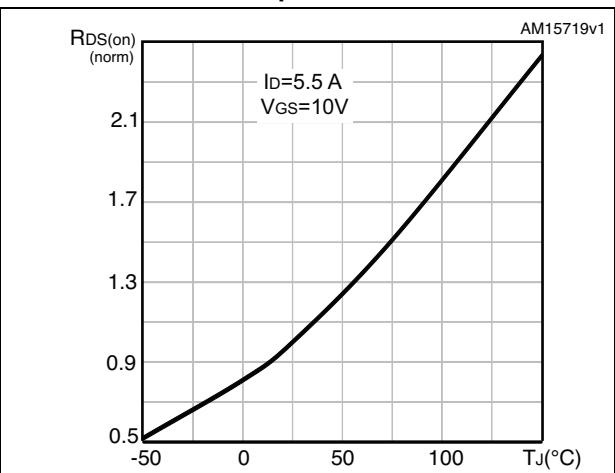


Figure 14. Source-drain diode forward characteristics

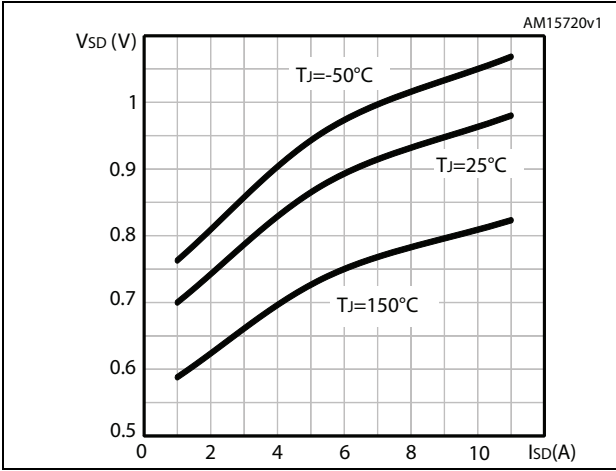
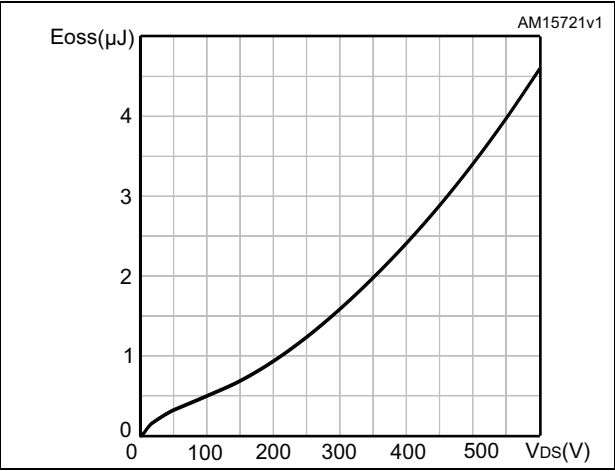


Figure 15. Output capacitance stored energy





### 3 Test circuits

Figure 16. Switching times test circuit for resistive load

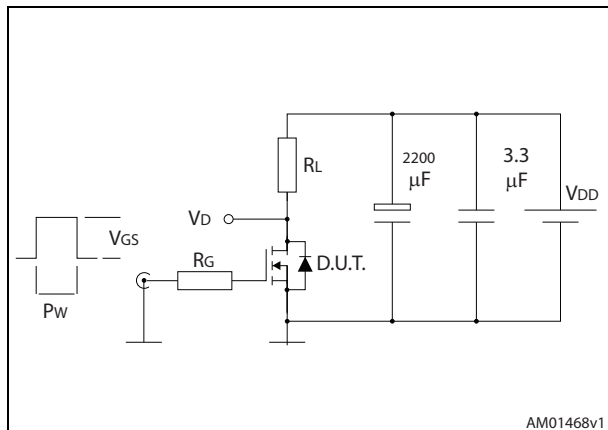


Figure 17. Gate charge test circuit

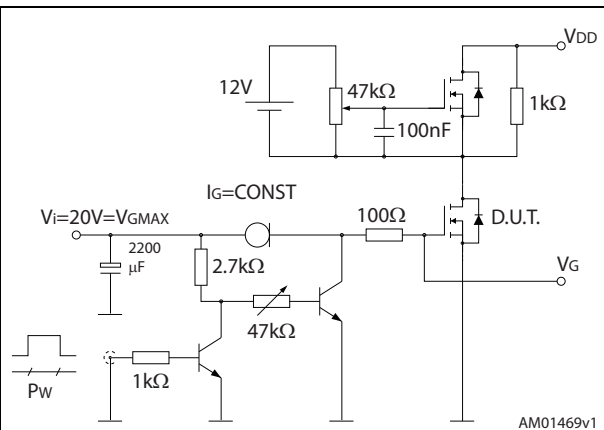


Figure 18. Test circuit for inductive load switching and diode recovery times

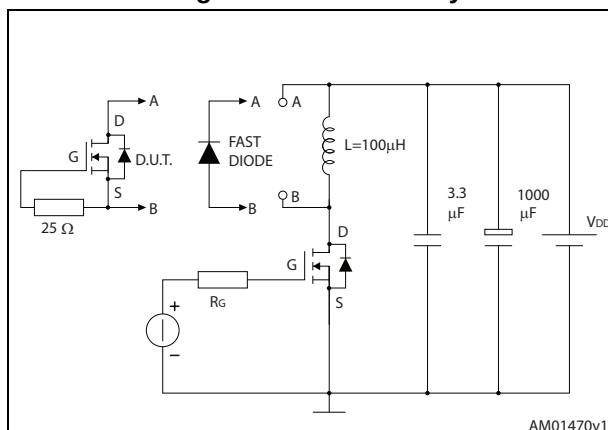


Figure 19. Unclamped inductive load test circuit

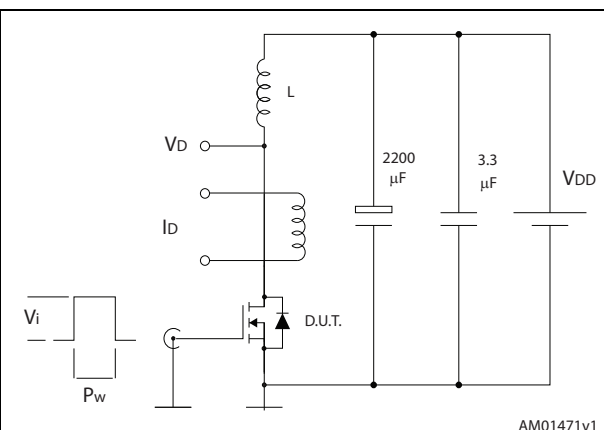


Figure 20. Unclamped inductive waveform

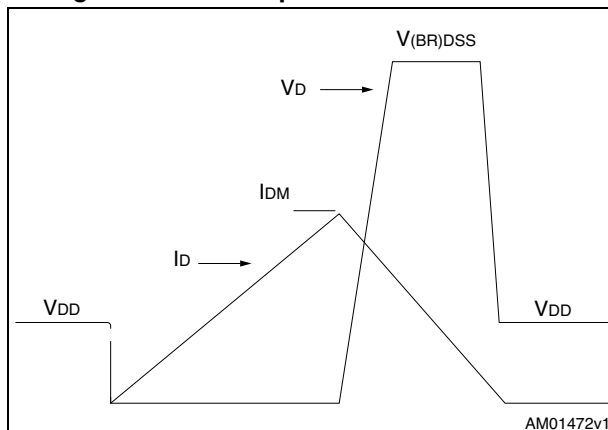
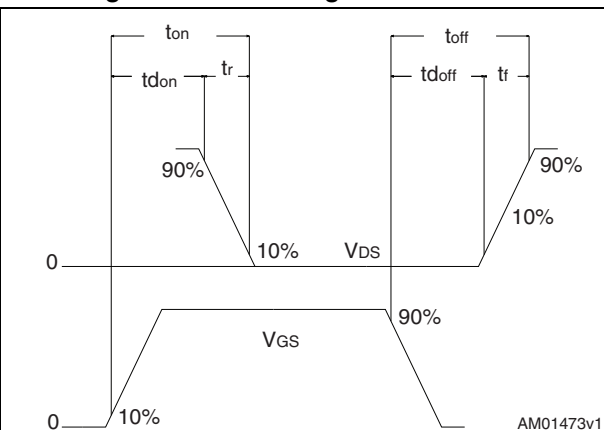


Figure 21. Switching time waveform



## 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.

Figure 22. TO-220 type A drawing

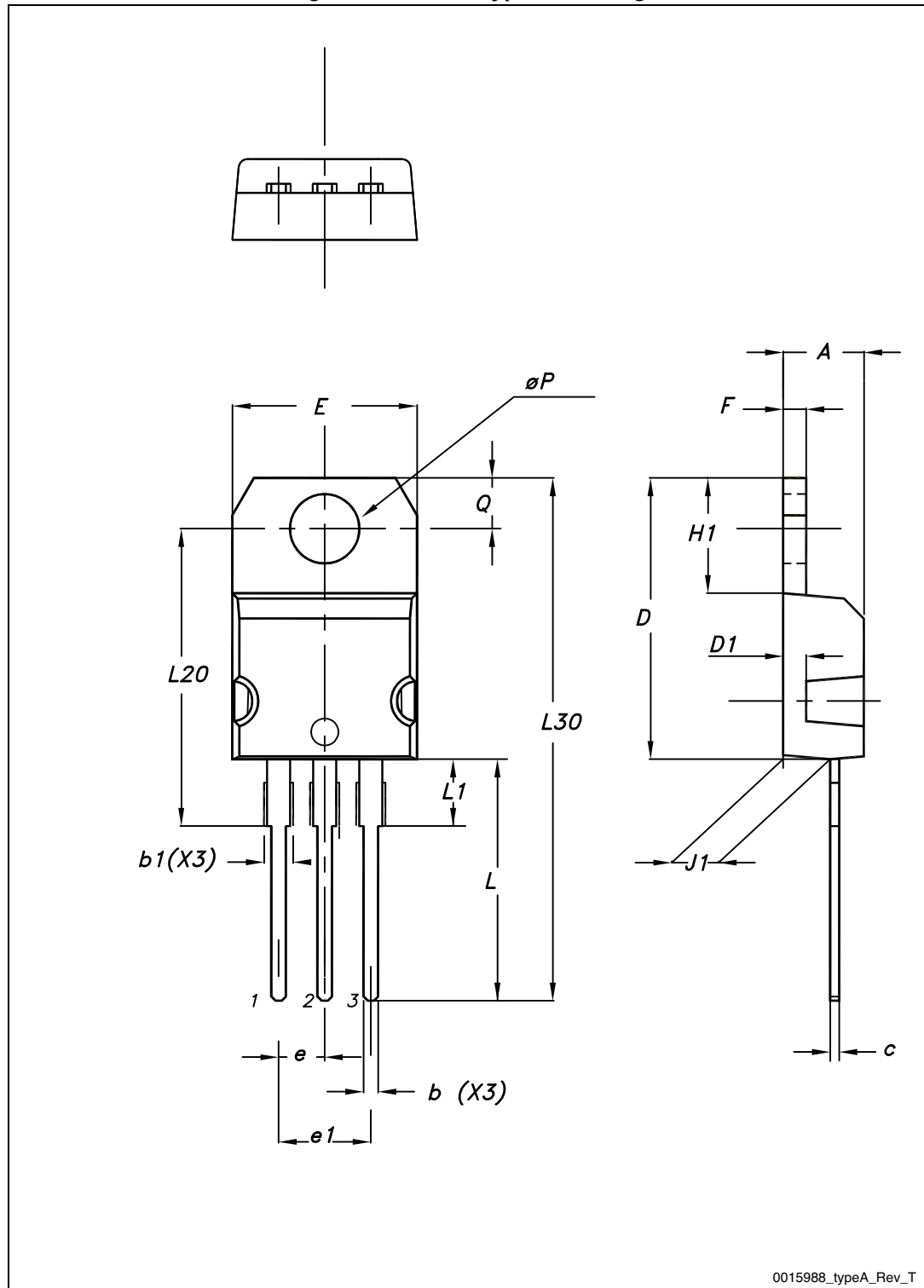


Table 9. TO-220 type A mechanical data

| 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 23. IPAK (TO-251) drawing

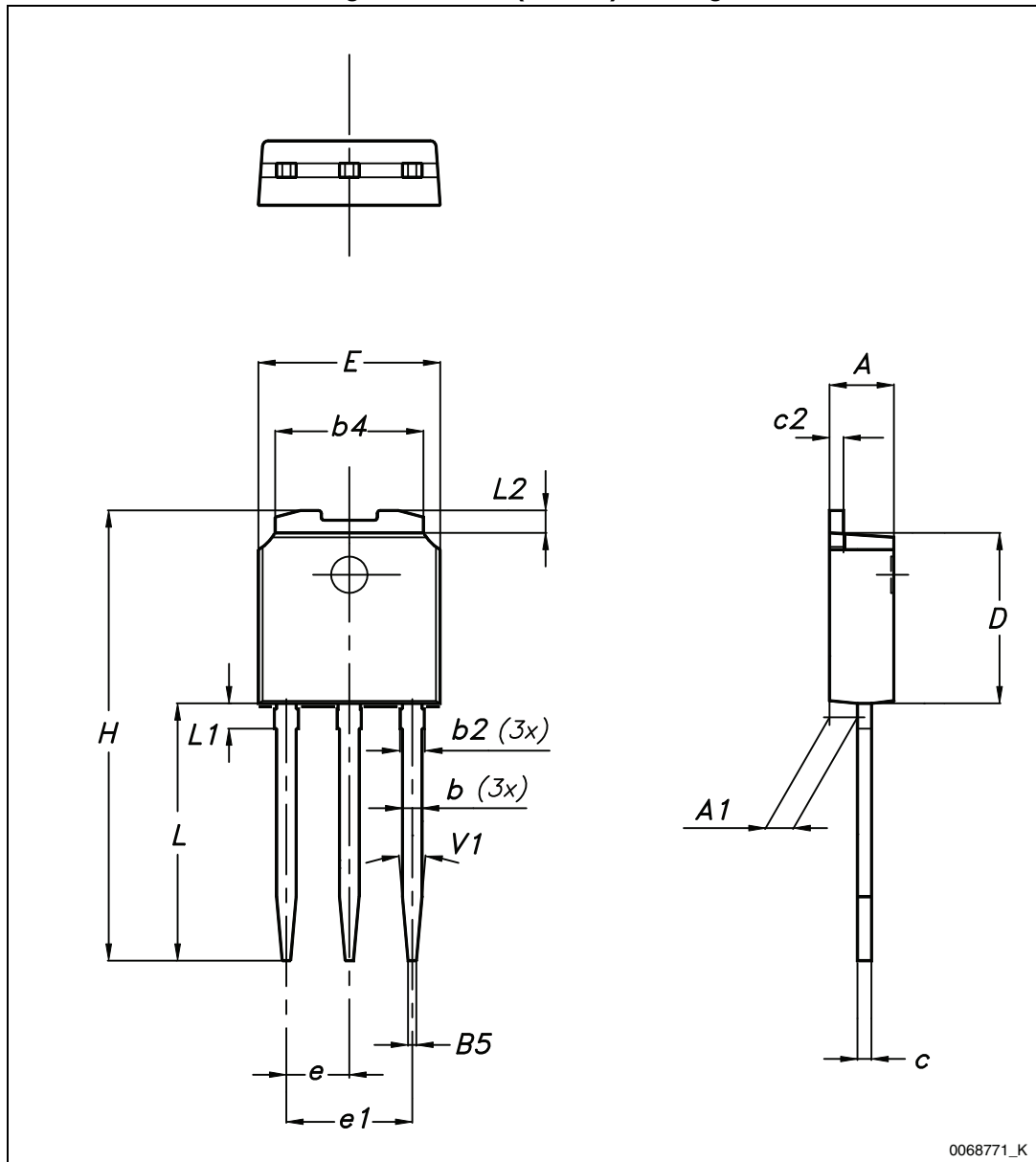


Table 10. IPAK (TO-251) mechanical data

| DIM | mm.  |       |      |
|-----|------|-------|------|
|     | min. | typ.  | max. |
| A   | 2.20 |       | 2.40 |
| A1  | 0.90 |       | 1.10 |
| b   | 0.64 |       | 0.90 |
| b2  |      |       | 0.95 |
| b4  | 5.20 |       | 5.40 |
| B5  |      | 0.30  |      |
| c   | 0.45 |       | 0.60 |
| c2  | 0.48 |       | 0.60 |
| D   | 6.00 |       | 6.20 |
| E   | 6.40 |       | 6.60 |
| e   |      | 2.28  |      |
| e1  | 4.40 |       | 4.60 |
| H   |      | 16.10 |      |
| L   | 9.00 |       | 9.40 |
| L1  | 0.80 |       | 1.20 |
| L2  |      | 0.80  | 1.00 |
| V1  |      | 10°   |      |

Figure 24. TO-247 drawing

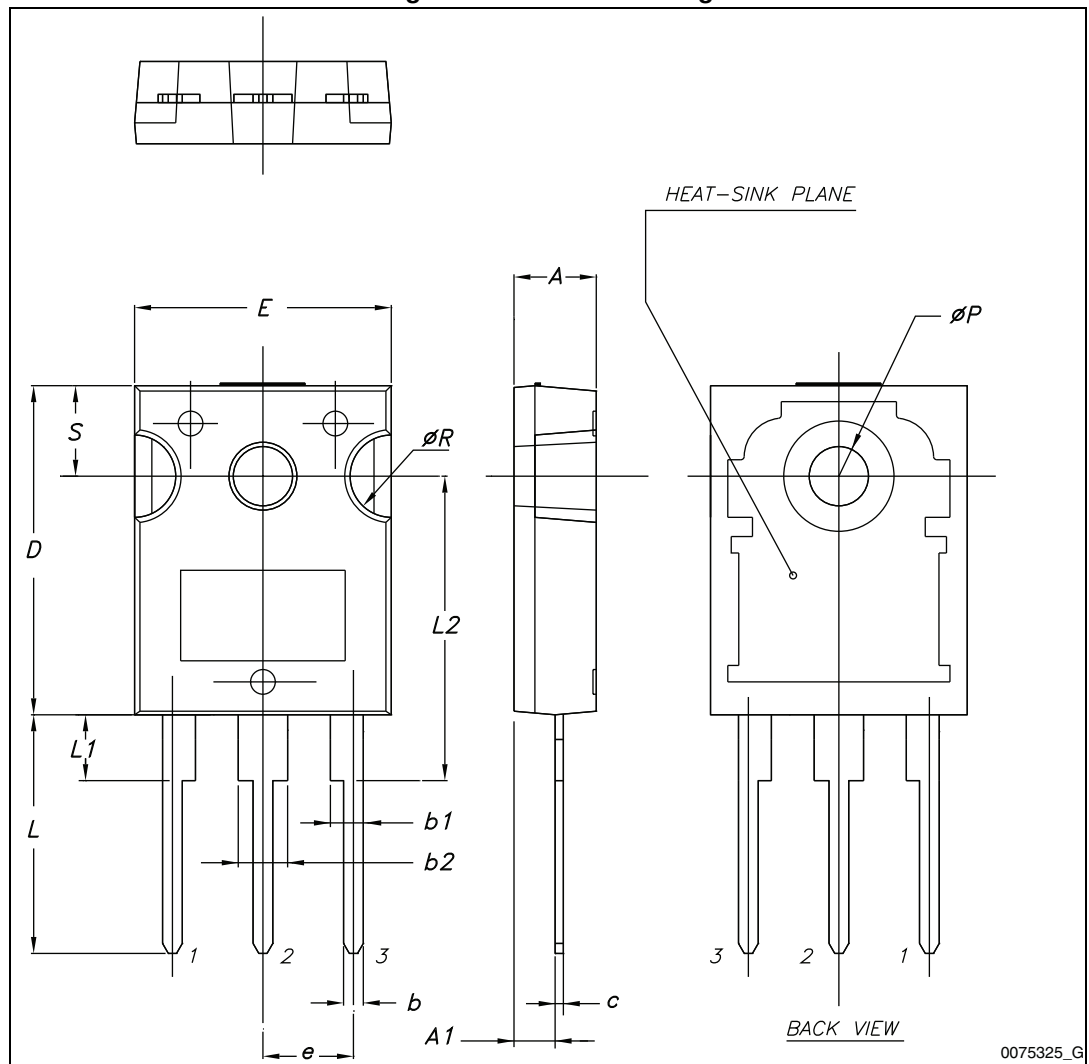


Table 11. TO-247 mechanical data

| 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 12. Document revision history

| Date        | Revision | Changes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 18-Dec-2012 | 1        | First release.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 11-Apr-2013 | 2        | <ul style="list-style-type: none"> <li>– Added: <a href="#">note 3</a> in <a href="#">Table 2</a></li> <li>– Modified: <math>I_D</math> value on <a href="#">Table 2</a>, <math>I_{AR}</math>, <math>I_{AS}</math> on <a href="#">Table 4</a>, <math>R_{DS(on)}</math> on <a href="#">Table 5</a></li> <li>– Updated: typical values for <a href="#">Table 6</a>, <a href="#">7</a> and <a href="#">8</a></li> <li>– Modified: <a href="#">Figure 1</a></li> <li>– The part number STD13N60M2 has been moved to a separate datasheet</li> <li>– Added: <a href="#">Section 2.1: Electrical characteristics (curves)</a></li> </ul> |
| 17-Apr-2013 | 3        | <ul style="list-style-type: none"> <li>– Modified: <math>R_{thj-case}</math> value on <a href="#">Table 3</a>, <math>t_{rr}</math>, <math>q_{rr}</math> values, and <math>t_{rr}</math> for <math>T_J = 150\text{ °C}</math> on <a href="#">Table 8</a></li> <li>– Minor text changes</li> </ul>                                                                                                                                                                                                                                                                                                                                   |
| 28-Jun-2013 | 4        | <ul style="list-style-type: none"> <li>– Document status promoted from preliminary data to production data</li> <li>– Minor text changes</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 28-Feb-2014 | 5        | <ul style="list-style-type: none"> <li>– Updated: <a href="#">Figure 22</a> and <a href="#">Table 9</a></li> <li>– Minor text changes</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

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- Поставка оригинальных импортных электронных компонентов напрямую с производств Америки, Европы и Азии, а так же с крупнейших складов мира;
- Широкая линейка поставок активных и пассивных импортных электронных компонентов (более 30 млн. наименований);
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Помощь Конструкторского Отдела и консультации квалифицированных инженеров;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Поставка электронных компонентов под контролем ВП;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- При необходимости вся продукция военного и аэрокосмического назначения проходит испытания и сертификацию в лаборатории (по согласованию с заказчиком);
- Поставка специализированных компонентов военного и аэрокосмического уровня качества (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Actel, Aeroflex, Peregrine, VPT, Syfer, Eurofarad, Texas Instruments, MS Kennedy, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Компания «Океан Электроники» является официальным дистрибьютором и эксклюзивным представителем в России одного из крупнейших производителей разъемов военного и аэрокосмического назначения «JONHON», а так же официальным дистрибьютором и эксклюзивным представителем в России производителя высокотехнологичных и надежных решений для передачи СВЧ сигналов «FORSTAR».



## JONHON

«JONHON» (основан в 1970 г.)

Разъемы специального, военного и аэрокосмического назначения:

(Применяются в военной, авиационной, аэрокосмической, морской, железнодорожной, горно- и нефтедобывающей отраслях промышленности)

«FORSTAR» (основан в 1998 г.)

ВЧ соединители, коаксиальные кабели,  
кабельные сборки и микроволновые компоненты:

(Применяются в телекоммуникациях гражданского и специального назначения, в средствах связи, РЛС, а так же военной, авиационной и аэрокосмической отраслях промышленности).



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