



## VND5N07

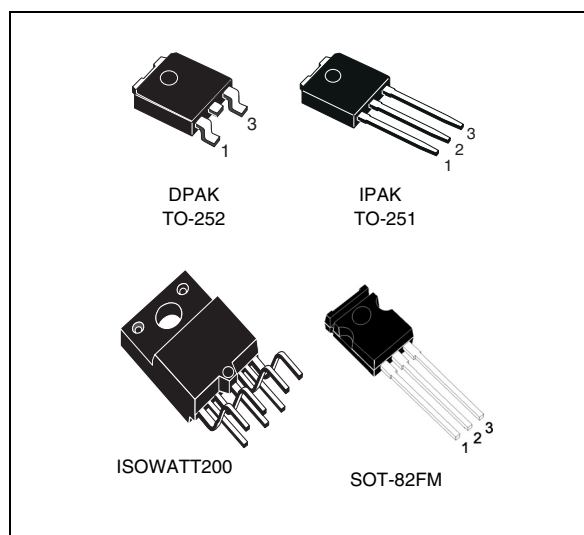
### OMNIFET II

#### fully autoprotected Power MOSFET

## Features

|                                    |              |              |
|------------------------------------|--------------|--------------|
| Max. on-state resistance (per ch.) | $R_{DS(on)}$ | 0.2 $\Omega$ |
| Current limitation (typ)           | $I_{LIMH}$   | 5 A          |
| Drain-Source clamp voltage         | $V_{CLAMP}$  | 70V          |

- Linear current limitation
- Thermal shutdown
- Short circuit protection
- Integrated clamp
- Low current drawn from input pin
- Diagnostic feedback through input pin
- ESD protection
- Direct access to the gate of the power mosfet (analog driving)
- Compatible with standard Power MOSFET



## Description

The VND5N07 is a monolithic device designed in STMicroelectronics VIPower M0 technology, intended for replacement of standard Power MOSFETs from DC to 50KHz applications. Built in thermal shutdown, linear current limitation and overvoltage clamp protect the chip in harsh environments.

Fault feedback can be detected by monitoring the voltage at the input pin.

**Table 1. Device summary**

| Package    | Order codes |               |
|------------|-------------|---------------|
|            | Tube        | Tape and reel |
| DPAK       | VND5N07     | VND5N0713TR   |
| IPAK       | VND5N07-1   |               |
| ISOWATT220 | VNP5N07FI   |               |
| SOT-82FM   | VNK5N07FM   |               |

# Contents

|          |                                              |           |
|----------|----------------------------------------------|-----------|
| <b>1</b> | <b>Block diagram and pin description</b>     | <b>5</b>  |
| <b>2</b> | <b>Electrical specifications</b>             | <b>6</b>  |
| 2.1      | Absolute maximum ratings                     | 6         |
| 2.2      | Thermal data                                 | 6         |
| 2.3      | Electrical characteristics                   | 7         |
| 2.4      | Electrical characteristics curves            | 13        |
| <b>3</b> | <b>Protection features</b>                   | <b>17</b> |
| 3.1      | Overvoltage clamp protection                 | 17        |
| 3.2      | Linear current limiter circuit               | 17        |
| 3.3      | Overtemperature and short circuit protection | 17        |
| 3.4      | Status feedback                              | 17        |
| <b>4</b> | <b>Package and packing information</b>       | <b>18</b> |
| 4.1      | ECOPACK® packages                            | 18        |
| 4.2      | DPAK mechanical data                         | 18        |
| 4.3      | IPAK mechanical data                         | 20        |
| 4.4      | ISOWATT220 mechanical data                   | 21        |
| 4.5      | SOT-82FM mechanical data                     | 22        |
| <b>5</b> | <b>Revision history</b>                      | <b>23</b> |

## List of tables

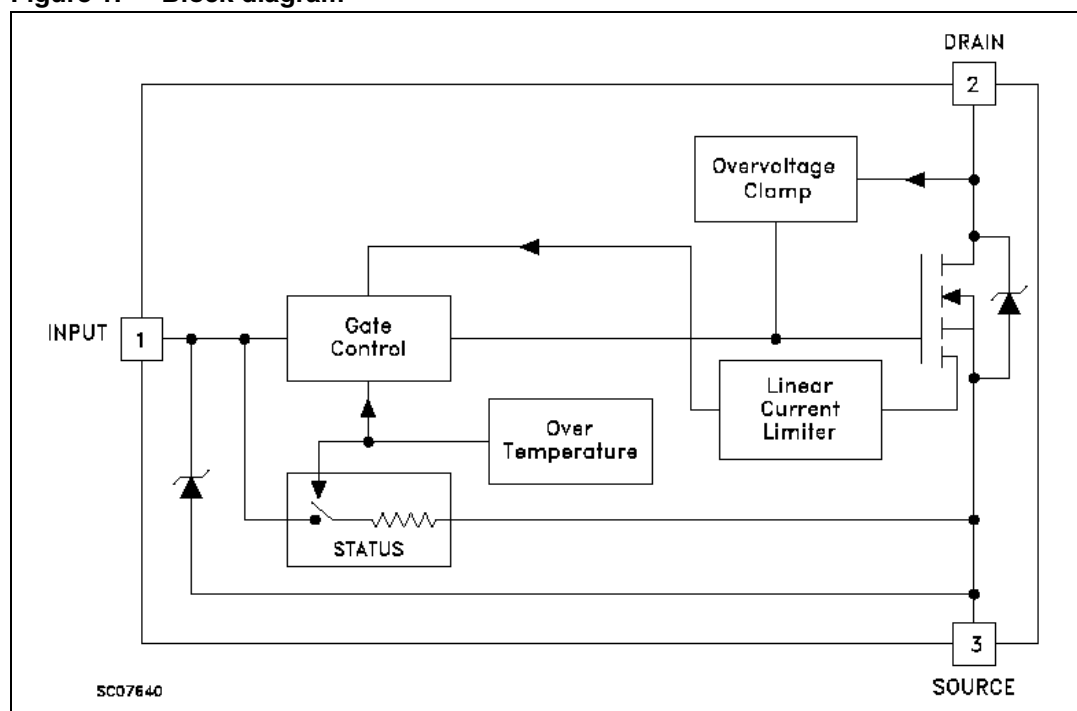
|           |                                                                                    |    |
|-----------|------------------------------------------------------------------------------------|----|
| Table 1.  | Device summary . . . . .                                                           | 1  |
| Table 2.  | Absolute maximum ratings . . . . .                                                 | 6  |
| Table 3.  | Thermal data. . . . .                                                              | 6  |
| Table 4.  | Off . . . . .                                                                      | 7  |
| Table 5.  | On . . . . .                                                                       | 7  |
| Table 6.  | Dynamic . . . . .                                                                  | 7  |
| Table 7.  | Switching . . . . .                                                                | 8  |
| Table 8.  | Source Drain diode . . . . .                                                       | 8  |
| Table 9.  | Protections (-40°C < T <sub>j</sub> < 150°C, unless otherwise specified) . . . . . | 8  |
| Table 10. | DPAK mechanical data . . . . .                                                     | 19 |
| Table 11. | IPAK mechanical data . . . . .                                                     | 20 |
| Table 12. | ISOWATT220 mechanical data . . . . .                                               | 21 |
| Table 13. | SOT-82FM mechanical data . . . . .                                                 | 22 |
| Table 14. | Document revision history . . . . .                                                | 23 |

## List of figures

|            |                                                               |    |
|------------|---------------------------------------------------------------|----|
| Figure 1.  | Block diagram . . . . .                                       | 5  |
| Figure 2.  | Switching time test circuit for resistive load . . . . .      | 9  |
| Figure 3.  | Test circuit for diode recovery times . . . . .               | 9  |
| Figure 4.  | Unclamped inductive load test circuits . . . . .              | 10 |
| Figure 5.  | Input charge test circuit. . . . .                            | 10 |
| Figure 6.  | Unclamped inductive waveforms . . . . .                       | 11 |
| Figure 7.  | Switching waveforms . . . . .                                 | 11 |
| Figure 8.  | Thermal impedance for ISOWATT220 . . . . .                    | 12 |
| Figure 9.  | Thermal impedance for DPAK / IPAK . . . . .                   | 12 |
| Figure 10. | Source-Drain diode forward characteristics . . . . .          | 13 |
| Figure 11. | Static Drain-Source on resistance . . . . .                   | 13 |
| Figure 12. | Derating curve . . . . .                                      | 13 |
| Figure 13. | Static Drain-Source on resistance vs. input voltage . . . . . | 13 |
| Figure 14. | Normalized on resistance Vs temperature . . . . .             | 13 |
| Figure 15. | Transconductance . . . . .                                    | 13 |
| Figure 16. | Static Drain-Source on resistance Vs. Id . . . . .            | 14 |
| Figure 17. | Switching time resistive load. . . . .                        | 14 |
| Figure 18. | Turn-on current slope . . . . .                               | 14 |
| Figure 19. | Turn-on current slope . . . . .                               | 14 |
| Figure 20. | Input voltage Vs. input charge . . . . .                      | 14 |
| Figure 21. | Turn-off Drain source voltage slope . . . . .                 | 14 |
| Figure 22. | Turn-off Drain-Source voltage slope. . . . .                  | 15 |
| Figure 23. | Capacitance variations . . . . .                              | 15 |
| Figure 24. | Switching time resistive load. . . . .                        | 15 |
| Figure 25. | Step response current limit. . . . .                          | 15 |
| Figure 26. | Output characteristics . . . . .                              | 15 |
| Figure 27. | Normalized on resistance Vs. temperature. . . . .             | 15 |
| Figure 28. | Normalized Input threshold voltage Vs. temperature . . . . .  | 16 |
| Figure 29. | Normalized current limit Vs. junction temperature . . . . .   | 16 |
| Figure 30. | DPAK package dimensions . . . . .                             | 18 |
| Figure 31. | IPAK mechanical data and package outline . . . . .            | 20 |
| Figure 32. | ISOWATT220 mechanical data and package outline . . . . .      | 21 |
| Figure 33. | SOT-82FM mechanical data and package outline . . . . .        | 22 |

# 1 Block diagram and pin description

Figure 1. Block diagram



## 2 Electrical specifications

### 2.1 Absolute maximum ratings

Stressing the device above the rating listed in the “Absolute maximum ratings” table may cause permanent damage to the device. These are stress ratings only and operation of the device at these or any other conditions above those indicated in the operating sections of this specification is not implied. Exposure to Absolute maximum rating conditions for extended periods may affect device reliability. Refer also to the STMicroelectronics SURE program and other relevant quality document.

**Table 2. Absolute maximum ratings**

| Symbol    | Parameter                                                     | Value              |            |          | Unit       |
|-----------|---------------------------------------------------------------|--------------------|------------|----------|------------|
|           |                                                               | DPAK / IPAK        | ISOWATT220 | SOT-82FM |            |
| $V_{DSn}$ | Drain-Source voltage ( $V_{INn} = 0V$ )                       | Internally clamped |            |          | V          |
| $V_{INn}$ | Input voltage                                                 | 18                 |            |          | V          |
| $I_{Dn}$  | Drain current                                                 | Internally limited |            |          | A          |
| $I_{Rn}$  | Reverse DC output current                                     | -7                 |            |          | A          |
| $V_{ESD}$ | Electrostatic discharge ( $R = 1.5K\Omega$ ,<br>$C = 100pF$ ) | 2000               |            |          | V          |
| $P_{tot}$ | Total dissipation at $T_c = 25^\circ C$                       | 60                 | 24         | 9        | W          |
| $T_j$     | Operating junction temperature                                | Internally limited |            |          | $^\circ C$ |
| $T_c$     | Case operating temperature                                    | Internally limited |            |          | $^\circ C$ |
| $T_{stg}$ | Storage temperature                                           | -55 to 150         |            |          | $^\circ C$ |

### 2.2 Thermal data

**Table 3. Thermal data**

| Symbol         | Parameter                           | Max. value  |            |          | Unit         |
|----------------|-------------------------------------|-------------|------------|----------|--------------|
|                |                                     | DPAK / IPAK | ISOWATT220 | SOT-82FM |              |
| $R_{thj-case}$ | Thermal resistance junction-case    | 3.75        | 5.2        | 14       | $^\circ C/W$ |
| $R_{thj-amb}$  | Thermal resistance junction-ambient | 100         | 62.5       | 100      | $^\circ C/W$ |

## 2.3 Electrical characteristics

T<sub>case</sub> = 25°C unless otherwise stated.

**Table 4. Off**

| Symbol             | Parameter                                              | Test conditions                                                                             | Min. | Typ. | Max.      | Unit     |
|--------------------|--------------------------------------------------------|---------------------------------------------------------------------------------------------|------|------|-----------|----------|
| V <sub>CLAMP</sub> | Drain-Source clamp voltage                             | V <sub>IN</sub> = 0V; I <sub>D</sub> = 200mA                                                | 60   | 70   | 80        | V        |
| V <sub>CLTH</sub>  | Drain-Source threshold voltage                         | V <sub>IN</sub> = 0V; I <sub>D</sub> = 2mA                                                  | 55   |      |           | V        |
| I <sub>ISS</sub>   | Supply current from input pin                          | V <sub>DS</sub> = 0V; V <sub>IN</sub> = 10V                                                 |      | 250  | 500       | μA       |
| V <sub>INCL</sub>  | Input-Source reverse clamp voltage                     | I <sub>IN</sub> = 1mA                                                                       | -1.0 |      | -0.3      | V        |
| I <sub>DSS</sub>   | Zero input voltage drain current (V <sub>IN</sub> =0V) | V <sub>DS</sub> = 13V; V <sub>IN</sub> = 0V;<br>V <sub>DS</sub> = 25V; V <sub>IN</sub> = 0V |      |      | 50<br>200 | μA<br>μA |

**Table 5. On<sup>(1)</sup>**

| Symbol              | Parameter                         | Test conditions                                                                              | Min. | Typ. | Max.       | Unit |
|---------------------|-----------------------------------|----------------------------------------------------------------------------------------------|------|------|------------|------|
| R <sub>DS(on)</sub> | Static Drain-Source on resistance | V <sub>IN</sub> = 10V; I <sub>D</sub> = 2.5A;<br>V <sub>IN</sub> = 5V; I <sub>D</sub> = 2.5A |      |      | 200<br>280 | mΩ   |
| V <sub>IN(th)</sub> | Input threshold voltage           | V <sub>DS</sub> = V <sub>in</sub> ; I <sub>D</sub> + I <sub>in</sub> = 1 mA                  | 0.8  |      | 3          | V    |

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

**Table 6. Dynamic**

| Symbol                         | Parameter                | Test conditions                                       | Min. | Typ. | Max. | Unit |
|--------------------------------|--------------------------|-------------------------------------------------------|------|------|------|------|
| g <sub>fs</sub> <sup>(1)</sup> | Forward transconductance | V <sub>DS</sub> = 13V; I <sub>D</sub> = 2.5A          | 3    | 4    |      | S    |
| C <sub>OSS</sub>               | Output capacitance       | V <sub>DS</sub> = 13V; f = 1MHz; V <sub>IN</sub> = 0V |      | 200  | 300  | pF   |

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

**Table 7. Switching<sup>(1)</sup>**

| Symbol         | Parameter             | Test conditions                                                   | Min. | Typ. | Max. | Unit       |
|----------------|-----------------------|-------------------------------------------------------------------|------|------|------|------------|
| $t_{d(on)}$    | Turn-on delay time    | $V_{DD} = 15V; I_D = 2.5A$<br>$V_{gen} = 10V; R_{gen} = 10\Omega$ |      | 50   | 100  | ns         |
| $t_r$          | Rise time             |                                                                   |      | 60   | 100  | ns         |
| $t_{d(off)}$   | Turn-off delay time   |                                                                   |      | 150  | 300  | ns         |
| $t_f$          | Fall time             |                                                                   |      | 40   | 80   | ns         |
| $t_{d(on)}$    | Turn-on delay time    | $V_{DD} = 15V; I_D = 2.5A$<br>$V_{gen} = 10V; R_{gen} = 1k\Omega$ |      | 150  | 250  | ns         |
| $t_r$          | Rise time             |                                                                   |      | 400  | 600  | ns         |
| $t_{d(off)}$   | Turn-off delay time   |                                                                   |      | 3900 | 5000 | ns         |
| $t_f$          | Fall time             |                                                                   |      | 1100 | 1600 | ns         |
| $(dl/dt)_{on}$ | Turn-on current slope | $V_{DD} = 15V; I_D = 2.5A$<br>$V_{in} = 10V; R_{gen} = 10\Omega$  |      | 80   |      | A/ $\mu$ S |
| $Q_i$          | Total input charge    | $V_{DD} = 12V; I_D = 2.5A; V_{IN} = 10V$                          |      | 18   |      | nC         |

1. Parameters guaranteed by design / characterization.

**Table 8. Source Drain diode**

| Symbol          | Parameter                | Test conditions                                         | Min. | Typ. | Max. | Unit    |
|-----------------|--------------------------|---------------------------------------------------------|------|------|------|---------|
| $V_{SD}^{(1)}$  | Forward On voltage       | $I_{SD} = 2.5A; V_{IN} = 0V$                            |      |      | 1.6  | V       |
| $t_{rr}^{(2)}$  | Reverse recovery time    | $I_{SD} = 2.5A; dl/dt = 100 A/\mu s$<br>$V_{DD} = 30V;$ |      | 150  |      | ns      |
| $Q_{rr}^{(2)}$  | Reverse recovery charge  |                                                         |      | 0.3  |      | $\mu$ C |
| $I_{RRM}^{(2)}$ | Reverse recovery current |                                                         |      | 5.7  |      | A       |

1. Pulsed: pulse duration = 300 $\mu$ s, duty cycle 1.5%.

2. Parameters guaranteed by design / characterization.

**Table 9. Protections (-40°C < T<sub>j</sub> < 150°C, unless otherwise specified)**

| Symbol           | Parameter                     | Test conditions                                                                          | Min.       | Typ.     | Max.     | Unit               |
|------------------|-------------------------------|------------------------------------------------------------------------------------------|------------|----------|----------|--------------------|
| $I_{lim}$        | Drain current limit           | $V_{IN} = 10V; V_{DS} = 13V$<br>$V_{IN} = 5V; V_{DS} = 13V$                              | 3.5<br>3.5 | 5<br>5   | 7<br>7   | A<br>A             |
| $t_{dlim}^{(1)}$ | Step response current limit   | $V_{IN} = 10V;$<br>$V_{IN} = 5V$                                                         |            | 15<br>40 | 20<br>60 | $\mu$ S<br>$\mu$ S |
| $T_{jsh}^{(1)}$  | Overtemperature shutdown      |                                                                                          | 150        |          |          | °C                 |
| $T_{jrs}^{(1)}$  | Overtemperature reset         |                                                                                          | 135        |          |          | °C                 |
| $I_{gf}^{(1)}$   | Fault sink current            | $V_{IN} = 10V; V_{DS} = 13V;$<br>$V_{IN} = 5V; V_{DS} = 13V$                             |            | 50<br>20 |          | mA<br>mA           |
| $E_{as}^{(1)}$   | Single pulse avalanche energy | Starting $T_j = 25^\circ C; V_{DD} = 20V$<br>$V_{IN} = 10V R_{gen} = 1k\Omega; L = 10mH$ | 0.2        |          |          | J                  |

1. Parameters guaranteed by design / characterization.

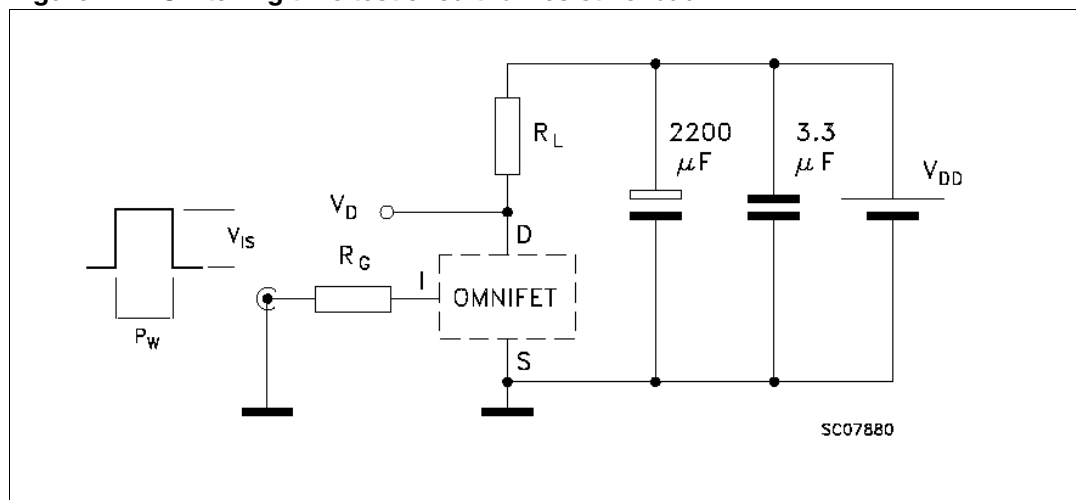
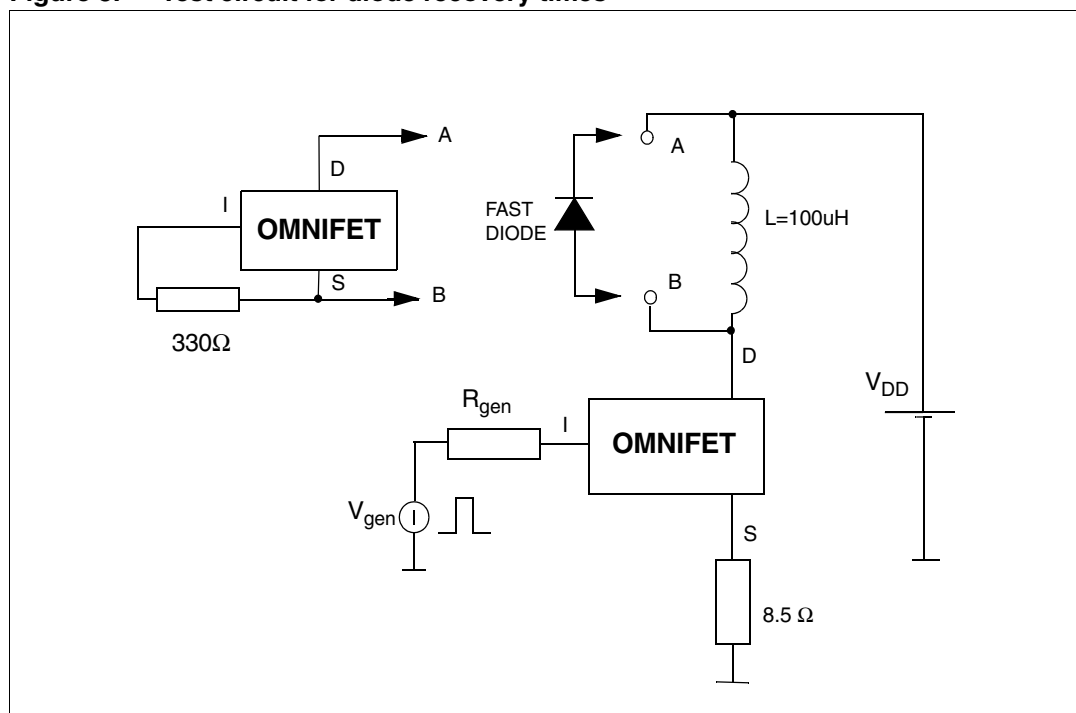
**Figure 2. Switching time test circuit for resistive load****Figure 3. Test circuit for diode recovery times**

Figure 4. Unclamped inductive load test circuits

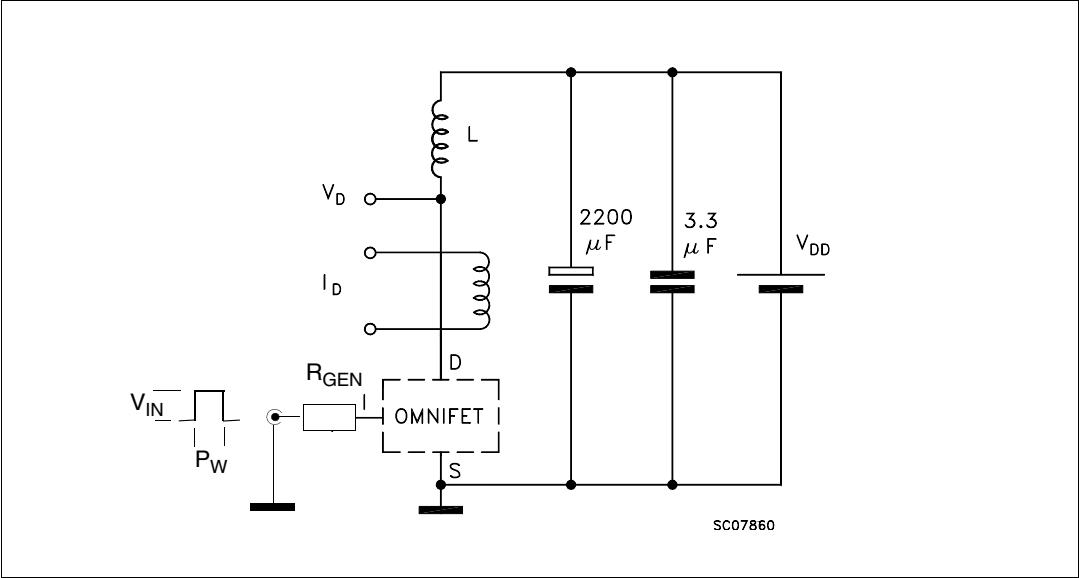


Figure 5. Input charge test circuit

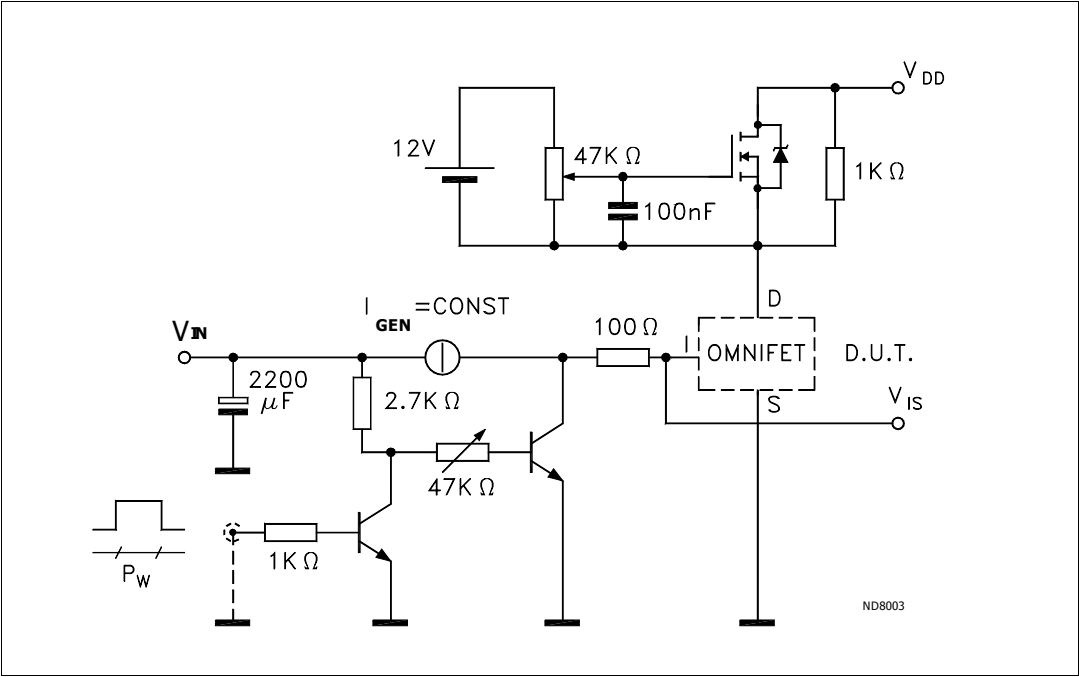


Figure 6. Unclamped inductive waveforms

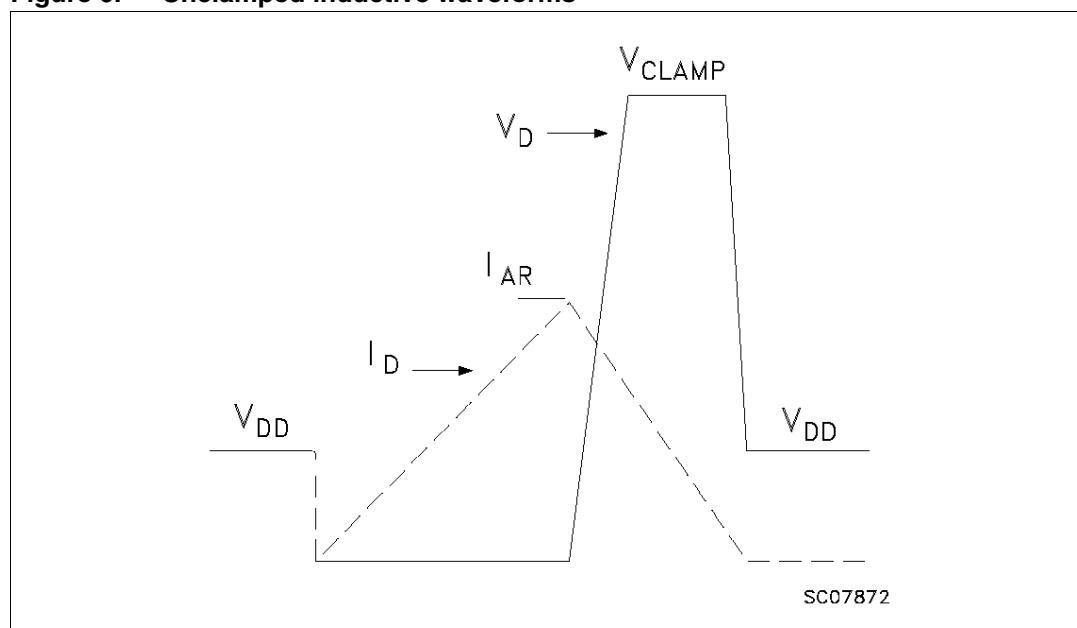


Figure 7. Switching waveforms

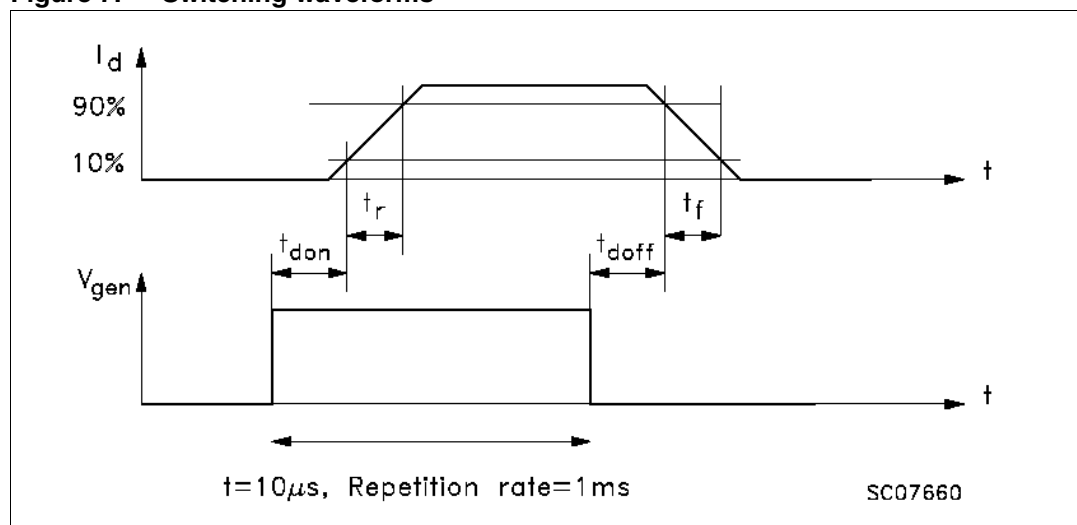


Figure 8. Thermal impedance for ISOWATT220

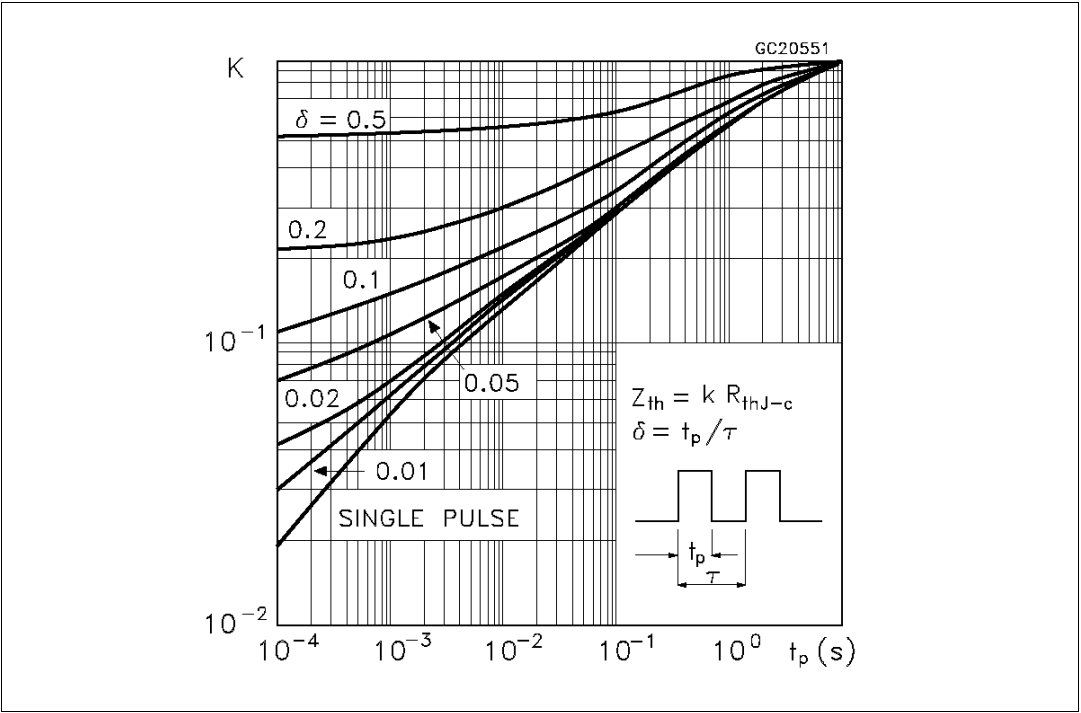
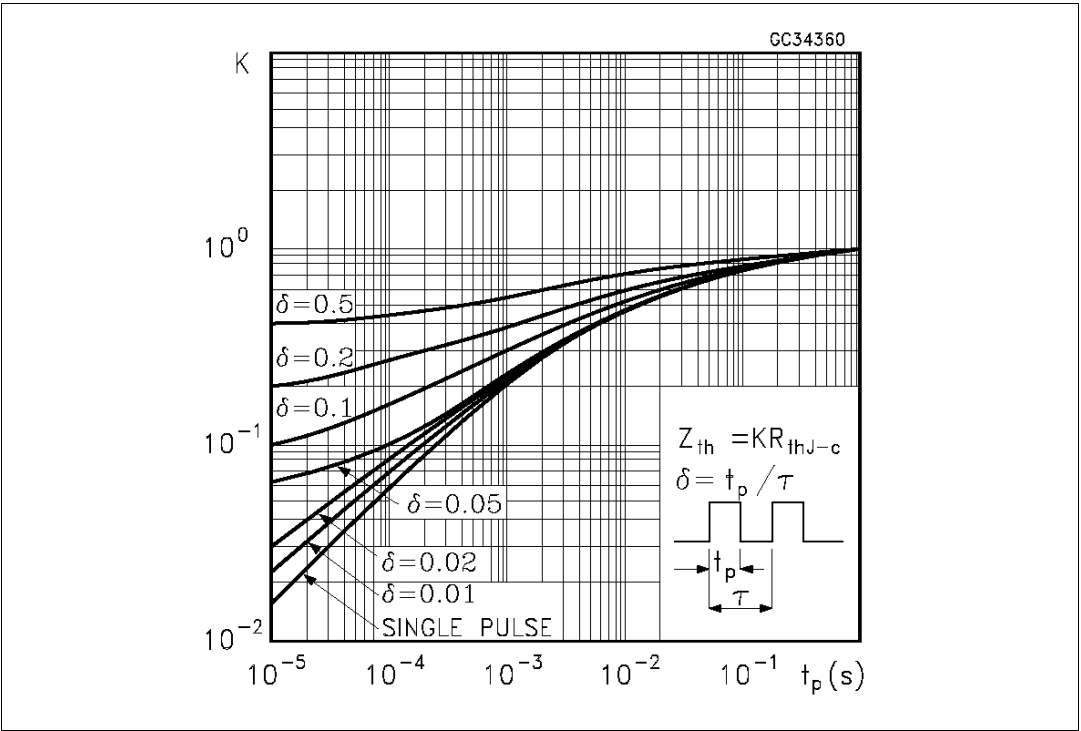


Figure 9. Thermal impedance for DPAK / IPAK



# 2.4 Electrical characteristics curves

Figure 10. Source-Drain diode forward characteristics

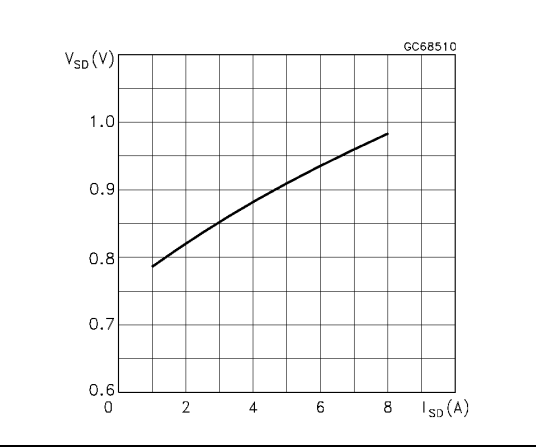


Figure 11. Static Drain-Source on resistance

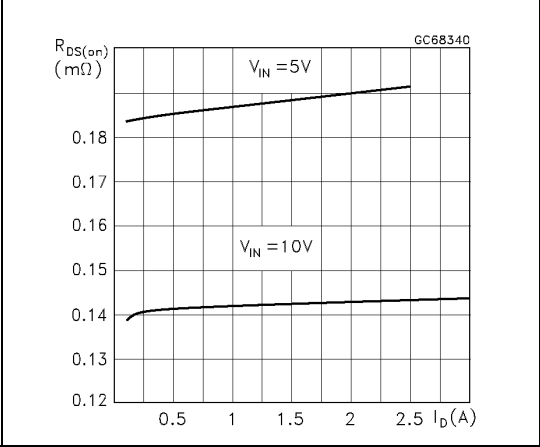


Figure 12. Derating curve

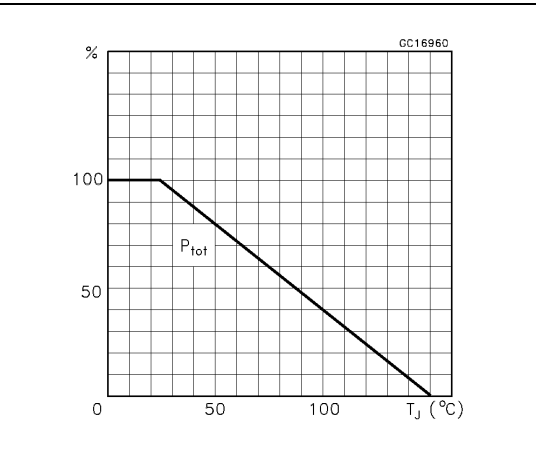


Figure 13. Static Drain-Source on resistance vs. input voltage

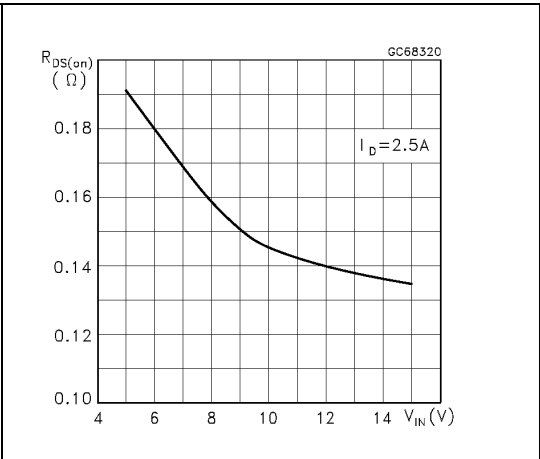


Figure 14. Normalized on resistance Vs temperature

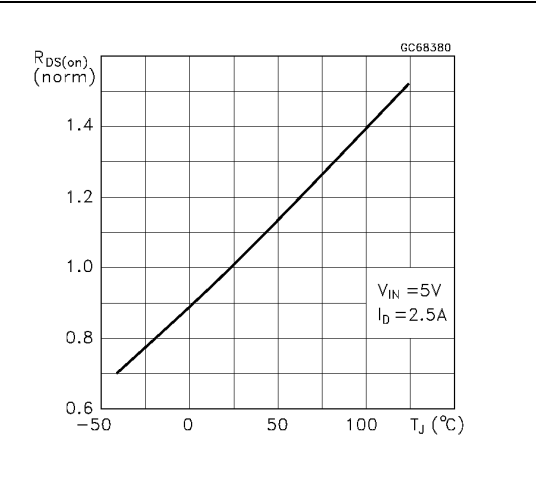


Figure 15. Transconductance

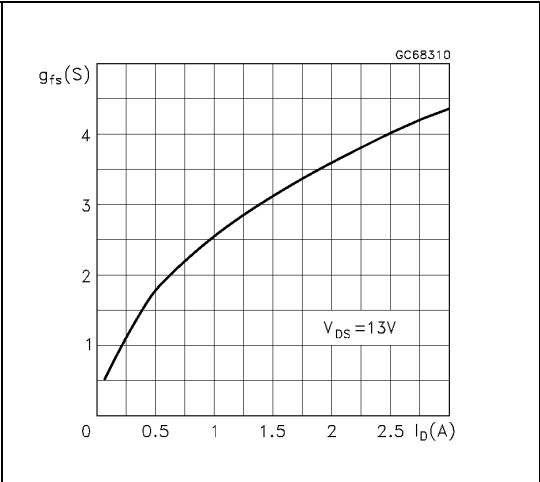


Figure 16. Static Drain-Source on resistance Vs. Id

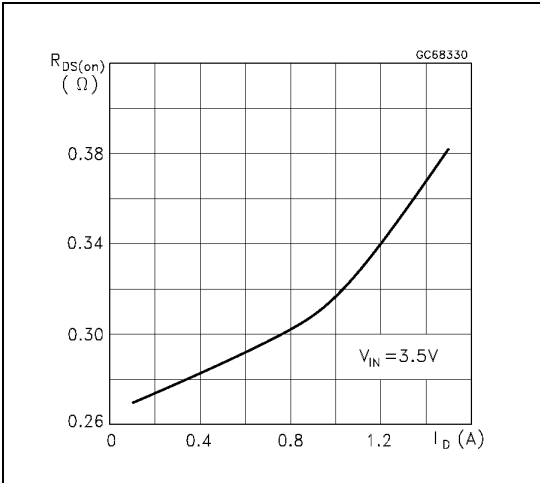


Figure 17. Switching time resistive load

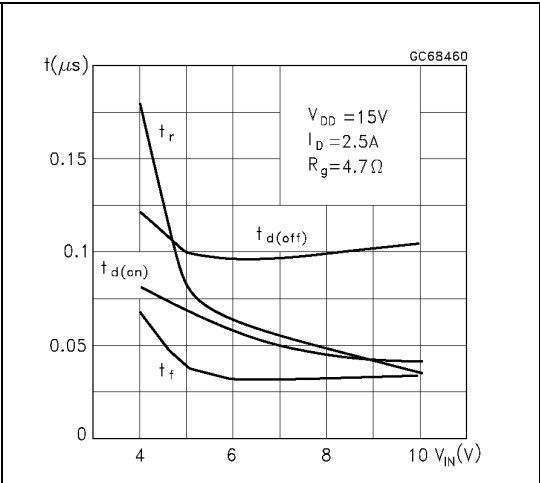


Figure 18. Turn-on current slope ( $V_{IN} = 10V$ )

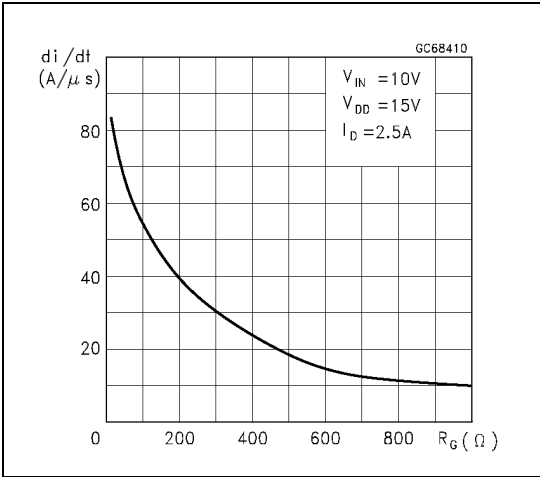


Figure 19. Turn-on current slope ( $V_{IN} = 5V$ )

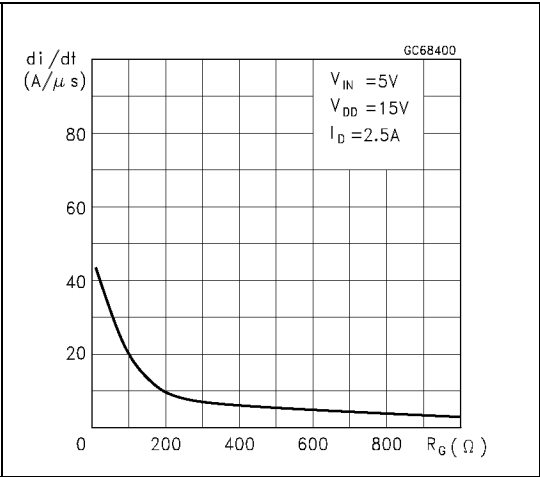


Figure 20. Input voltage Vs. input charge

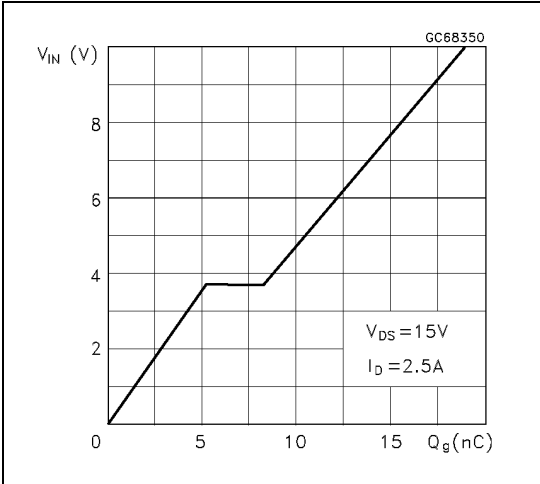
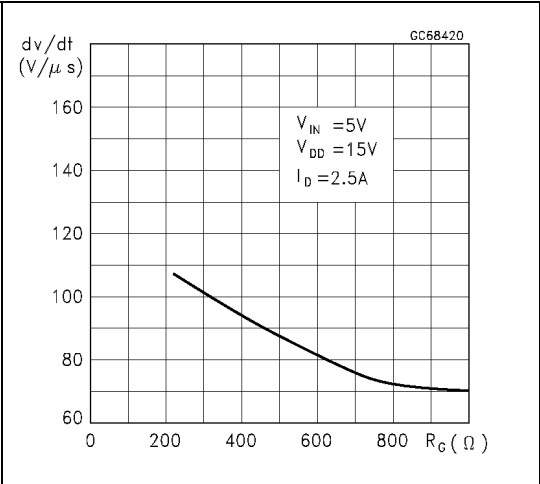
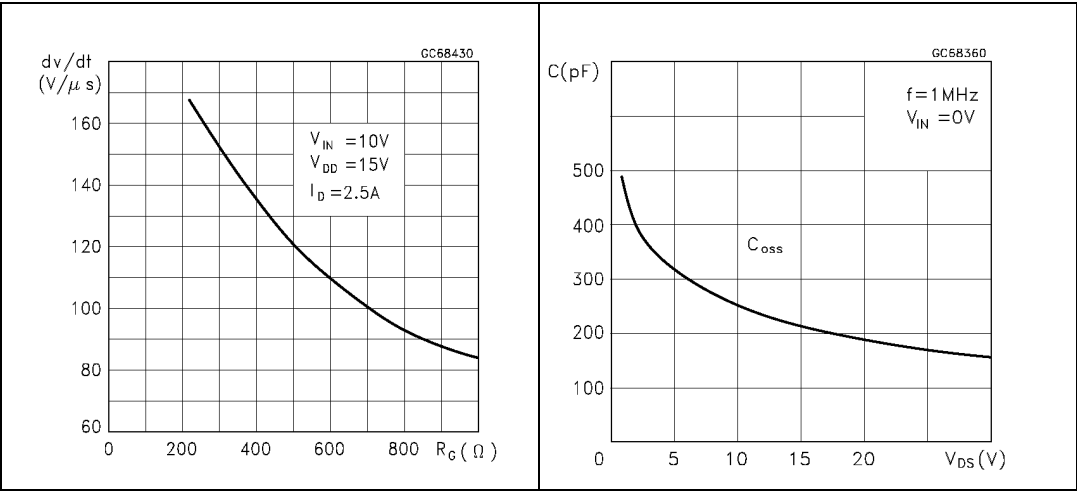


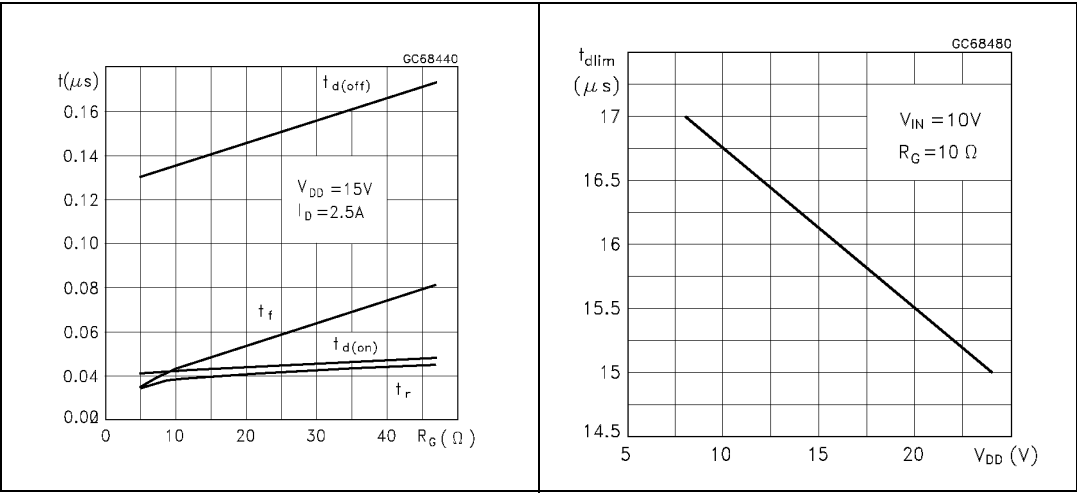
Figure 21. Turn-off Drain Source voltage slope



**Figure 22. Turn-off Drain-Source voltage slope** **Figure 23. Capacitance variations**



**Figure 24. Switching time resistive load** **Figure 25. Step response current limit**



**Figure 26. Output characteristics** **Figure 27. Normalized on resistance Vs. temperature**

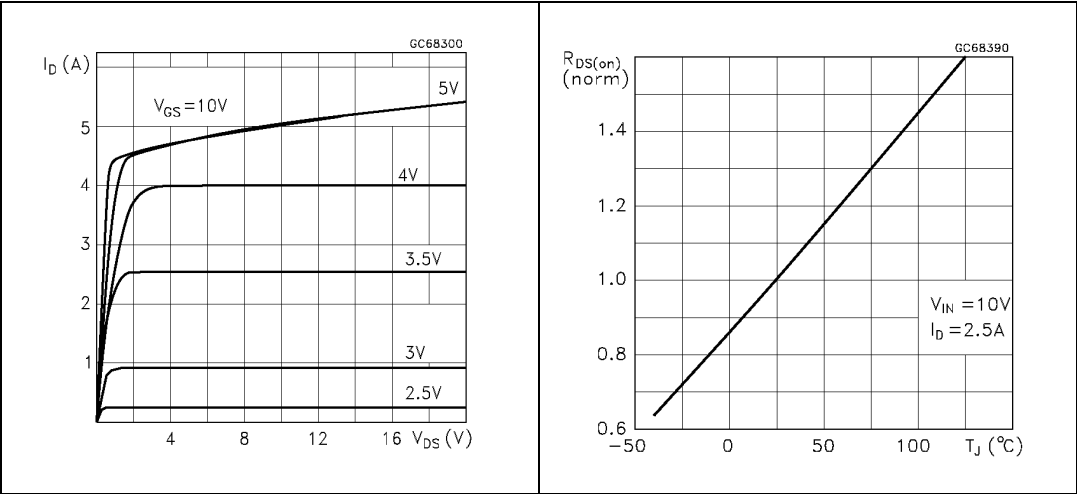


Figure 28. Normalized Input threshold voltage Vs. temperature

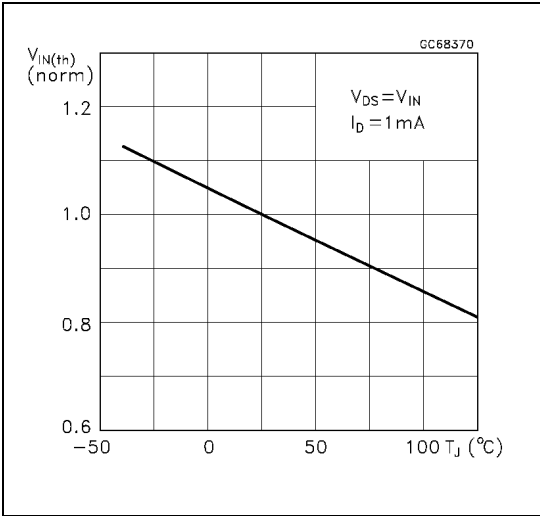
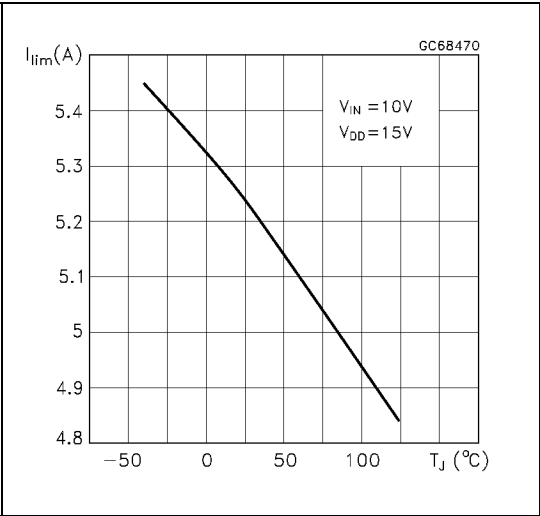


Figure 29. Normalized current limit Vs. junction temperature



## 3 Protection features

During normal operation, the INPUT pin is electrically connected to the gate of the internal power MOSFET.

The device then behaves like a standard power MOSFET and can be used as a switch from DC to 50KHz. The only difference from the user's standpoint is that a small DC current  $I_{ISS}$  flows into the INPUT pin in order to supply the internal circuitry.

The device integrates:

### 3.1 Overvoltage clamp protection

Internally set at 70V, along with the rugged avalanche characteristics of the Power MOSFET stage give this device unrivalled ruggedness and energy handling capability. This feature is mainly important when driving inductive loads.

### 3.2 Linear current limiter circuit

Limits the drain current  $I_D$  to  $I_{lim}$  whatever the INPUT pin voltages. When the current limiter is active, the device operates in the linear region, so power dissipation may exceed the capability of the heatsink. Both case and junction temperatures increase, and if this phase lasts long enough, junction temperature may reach the overtemperature threshold  $T_{jsh}$ .

### 3.3 Overtemperature and short circuit protection

These are based on sensing the chip temperature and are not dependent on the input voltage. The location of the sensing element on the chip in the power stage area ensures fast, accurate detection of the junction temperature. Overtemperature cutout occurs at minimum 150 °C. The device is automatically restarted when the chip temperature falls below 135 °C .

### 3.4 Status feedback

In the case of an overtemperature fault condition, a Status Feedback is provided through the Input pin. The internal protection circuit disconnects the input from the gate and connects it instead to ground via an equivalent resistance of 100  $\Omega$ . The failure can be detected by monitoring the voltage at the Input pin, which will be close to ground potential.

Additional features of this device are ESD protection according to the Human Body model and the ability to be driven from a TTL Logic circuit (with a small increase in  $R_{DS(on)}$ ).

## 4 Package and packing information

### 4.1 ECOPACK® packages

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](http://www.st.com). ECOPACK® is an ST trademark.

### 4.2 DPAK mechanical data

Figure 30. DPAK package dimensions

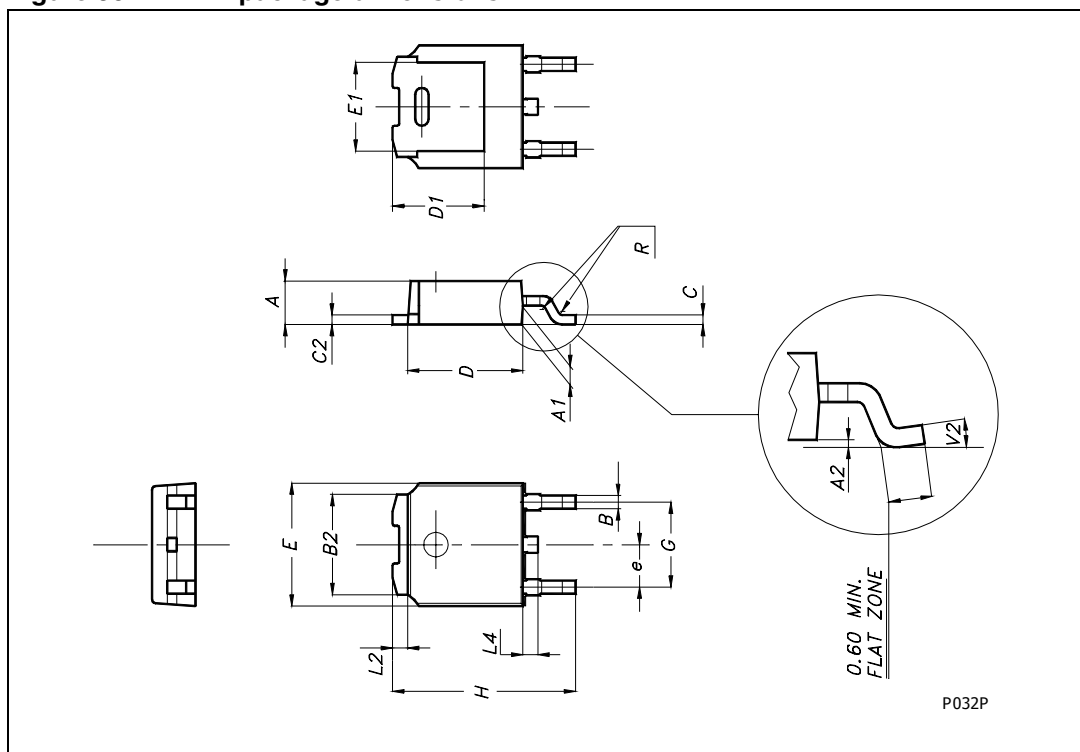


Table 10. DPAK mechanical data

| Dim.           | mm       |      |       |
|----------------|----------|------|-------|
|                | Min.     | Typ. | Max.  |
| A              | 2.20     |      | 2.40  |
| A1             | 0.90     |      | 1.10  |
| A2             | 0.03     |      | 0.23  |
| B              | 0.64     |      | 0.90  |
| B2             | 5.20     |      | 5.40  |
| C              | 0.45     |      | 0.60  |
| C2             | 0.48     |      | 0.60  |
| D              | 6.00     |      | 6.20  |
| D1             |          | 5.1  |       |
| E              | 6.40     |      | 6.60  |
| E1             |          | 4.7  |       |
| e              |          | 2.28 |       |
| G              | 4.40     |      | 4.60  |
| H              | 9.35     |      | 10.10 |
| L2             |          | 0.8  |       |
| L4             | 0.60     |      | 1.00  |
| R              |          | 0.2  |       |
| V2             | 0°       | 8°   |       |
| Package weight | Gr. 0.29 |      |       |

### 4.3 IPAK mechanical data

Figure 31. IPAK mechanical data and package outline

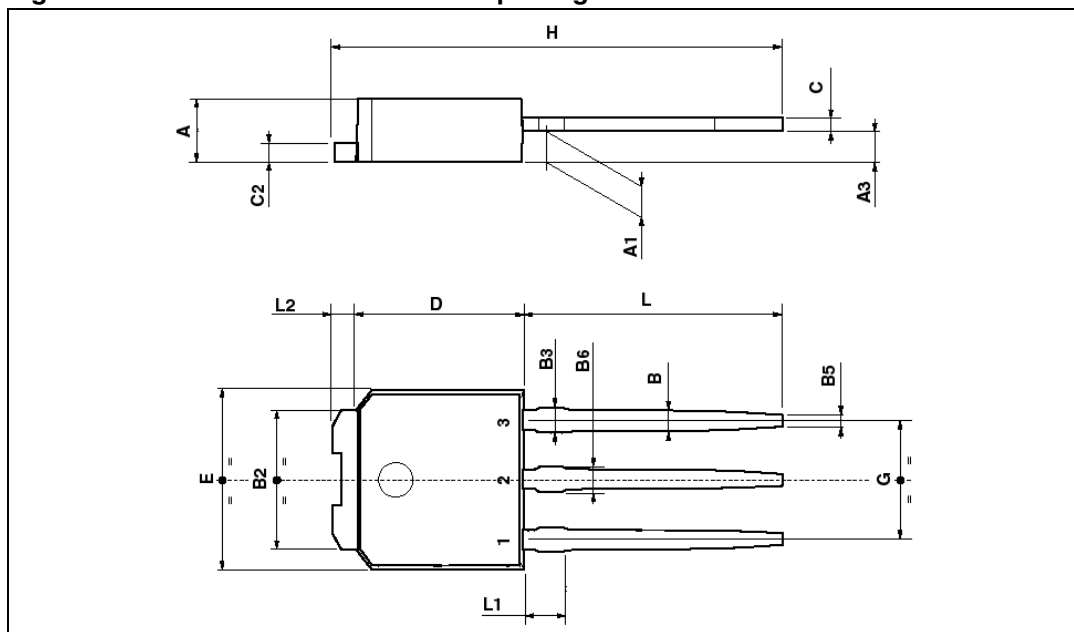


Table 11. IPAK mechanical data

| Symbol | mm   |      |      |
|--------|------|------|------|
|        | Min. | Typ. | Max. |
| A      | 2.2  |      | 2.4  |
| A1     | 0.9  |      | 1.1  |
| A3     | 0.7  |      | 1.3  |
| B      | 0.64 |      | 0.9  |
| B2     | 5.2  |      | 5.4  |
| B3     |      |      | 0.85 |
| B5     |      | 0.3  |      |
| B6     |      |      | 0.95 |
| C      | 0.45 |      | 0.6  |
| C2     | 0.48 |      | 0.6  |
| D      | 6    |      | 6.2  |
| E      | 6.4  |      | 6.6  |
| G      | 4.4  |      | 4.6  |
| H      | 15.9 |      | 16.3 |
| L      | 9    |      | 9.4  |
| L1     | 0.8  |      | 1.2  |
| L2     |      | 0.8  | 1    |

## 4.4 ISOWATT220 mechanical data

Figure 32. ISOWATT220 mechanical data and package outline

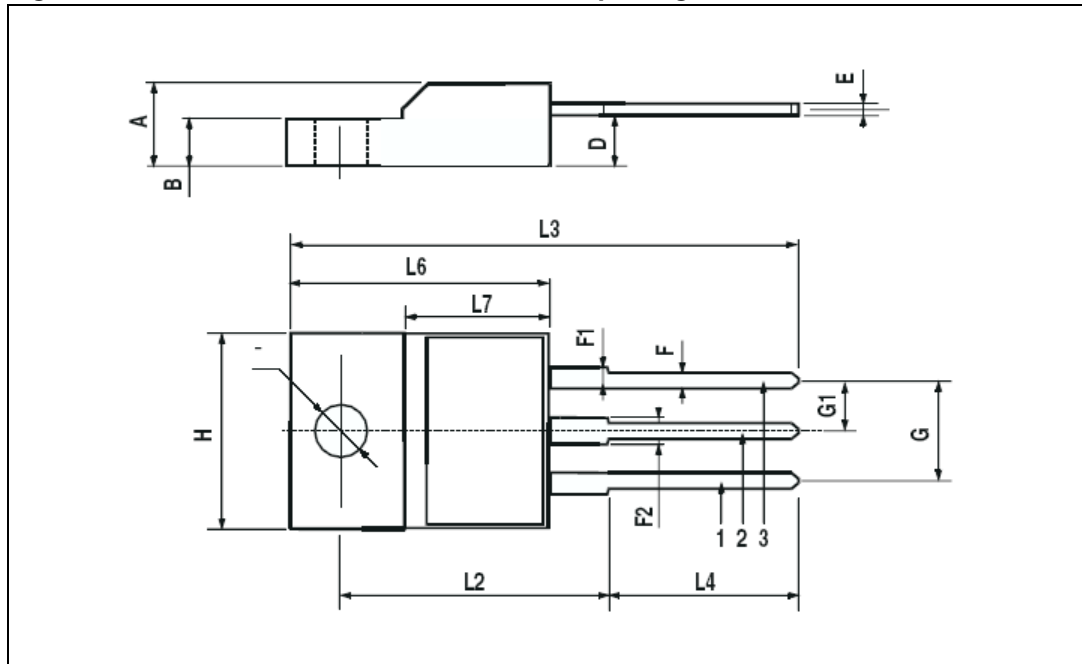


Table 12. ISOWATT220 mechanical data

| Symbol | mm   |      |      |
|--------|------|------|------|
|        | Min. | Typ. | Max. |
| A      | 4.4  |      | 4.6  |
| B      | 2.5  |      | 2.7  |
| D      | 2.5  |      | 2.75 |
| E      | 0.4  |      | 0.7  |
| F      | 0.75 |      | 1    |
| F1     | 1.15 |      | 1.7  |
| F2     | 1.15 |      | 1.7  |
| 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 |
| L6     | 15.9 |      | 16.4 |
| L7     | 9    |      | 9.3  |
|        | 3    |      | 3.2  |

## 4.5 SOT-82FM mechanical data

Figure 33. SOT-82FM mechanical data and package outline

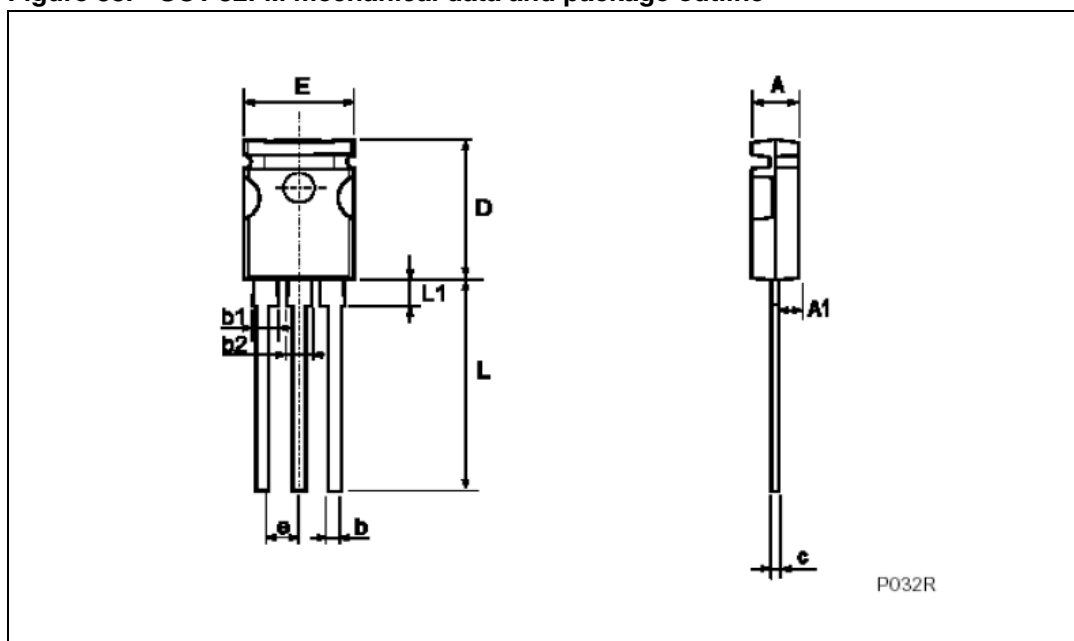


Table 13. SOT-82FM mechanical data

| Symbol | mm     |      |      |
|--------|--------|------|------|
|        | Min.   | Typ. | Max. |
| A      | 2.85   |      | 3.05 |
| A1     | 1.47   |      | 1.67 |
| b      | 0.40   |      | 0.60 |
| b1     | 1.4    |      | 1.6  |
| b2     | 1.3    |      | 1.5  |
| c      | 0.45   |      | 0.6  |
| D      | 10.5   |      | 10.9 |
| e      | 2.2    |      | 2.8  |
| E      | 7.45   |      | 7.75 |
| L      | 15.5   |      | 15.9 |
| L      | 1 1.95 |      | 2.35 |

## 5 Revision history

Table 14. Document revision history

| Date        | Revision | Changes                                                                                          |
|-------------|----------|--------------------------------------------------------------------------------------------------|
| 09-Sep-2004 | 1        | Initial release.                                                                                 |
| 17-Dec-2007 | 2        | Stylesheet update. No content change.                                                            |
| 11-Dec-2008 | 3        | Document restructured and reformatted.<br>Added <i>ECOPACK<sup>®</sup> packages</i> information. |

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