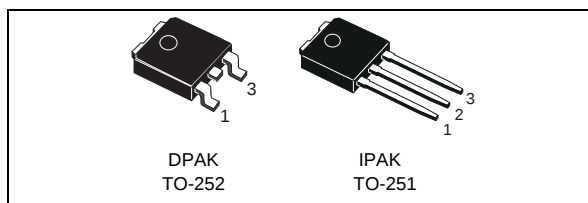


## OMNIFET II fully autoprotected Power MOSFET

Datasheet - production data



### Description

The VND5N07-E is a monolithic device designed using STMicroelectronics® VIPower® M0 technology, intended for replacement of standard Power MOSFETs from DC to 50 KHz 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.

### Features

|                                    |              |      |
|------------------------------------|--------------|------|
| Max. on-state resistance (per ch.) | $R_{DS(on)}$ | 0.2Ω |
| 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

Table 1. Device summary

| Package | Order codes |               |
|---------|-------------|---------------|
|         | Tube        | Tape and reel |
| DPAK    | VND5N07-E   | VND5N07TR-E   |
| IPAK    | VND5N07-1-E |               |

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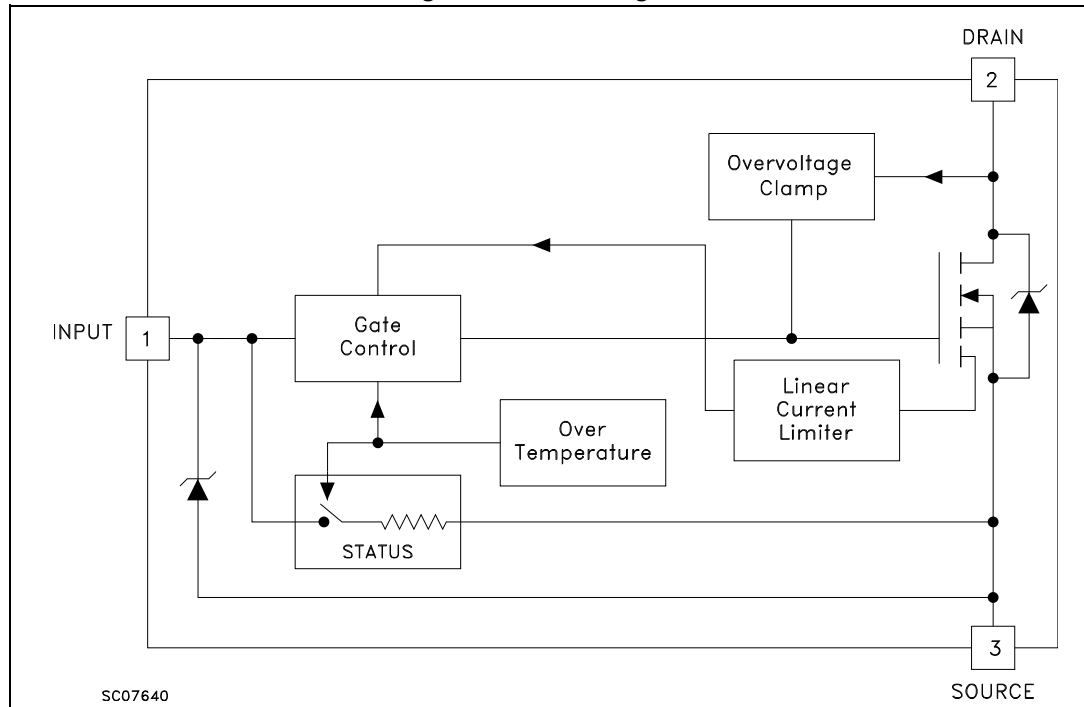
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# 1 Block diagram and pin description

Figure 1. Block diagram



## 2 Electrical specifications

### 2.1 Absolute maximum ratings

Stressing the device above the rating listed in [Table 2](#) 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.

**Table 2. Absolute maximum ratings**

| Symbol    | Parameter                                                                  | Value              | Unit             |
|-----------|----------------------------------------------------------------------------|--------------------|------------------|
| $V_{DSn}$ | Drain-Source voltage ( $V_{INn} = 0\text{ V}$ )                            | 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 ( $R = 1.5\text{ K}\Omega$ , $C = 100\text{ pF}$ ) | 2000               | V                |
| $P_{tot}$ | Total dissipation at $T_c = 25^\circ\text{C}$                              | 60                 | W                |
| $T_j$     | Operating junction temperature                                             | Internally limited | $^\circ\text{C}$ |
| $T_c$     | Case operating temperature                                                 | Internally limited | $^\circ\text{C}$ |
| $T_{stg}$ | Storage temperature                                                        | -55 to 150         | $^\circ\text{C}$ |

### 2.2 Thermal data

**Table 3. Thermal data**

| Symbol         | Parameter                           | Max. value | Unit               |
|----------------|-------------------------------------|------------|--------------------|
| $R_{thj-case}$ | Thermal resistance junction-case    | 3.75       | $^\circ\text{C/W}$ |
| $R_{thj-amb}$  | Thermal resistance junction-ambient | 100        | $^\circ\text{C/W}$ |

## 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> = 0 V; I <sub>D</sub> = 200 mA | 60   | 70   | 80   | V    |
| V <sub>CLTH</sub>  | Drain-Source threshold voltage                           | V <sub>IN</sub> = 0 V; I <sub>D</sub> = 2 mA   | 55   |      |      | V    |
| I <sub>ISS</sub>   | Supply current from input pin                            | V <sub>DS</sub> = 0 V; V <sub>IN</sub> = 10 V  |      | 250  | 500  | μA   |
| V <sub>INCL</sub>  | Input-Source reverse clamp voltage                       | I <sub>IN</sub> = 1 mA                         | -1.0 |      | -0.3 | V    |
| I <sub>DSS</sub>   | Zero input voltage drain current (V <sub>IN</sub> = 0 V) | V <sub>DS</sub> = 13 V; V <sub>IN</sub> = 0 V  |      |      | 50   | μA   |
|                    |                                                          | V <sub>DS</sub> = 25 V; V <sub>IN</sub> = 0 V  |      |      | 200  | 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> = 10 V; I <sub>D</sub> = 2.5 A                              |      |      | 200  | mΩ   |
|                     |                                   | V <sub>IN</sub> = 5 V; I <sub>D</sub> = 2.5 A                               |      |      | 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 = 300 μs, 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> = 13 V; I <sub>D</sub> = 2.5 A           | 3    | 4    |      | S    |
| C <sub>OSS</sub>               | Output capacitance       | V <sub>DS</sub> = 13 V; f = 1 MHz; V <sub>IN</sub> = 0 V |      | 200  | 300  | pF   |

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

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

| Symbol              | Parameter           | Test conditions                                                                                     | Min. | Typ. | Max. | Unit |
|---------------------|---------------------|-----------------------------------------------------------------------------------------------------|------|------|------|------|
| t <sub>d(on)</sub>  | Turn-on delay time  | V <sub>DD</sub> = 15 V; I <sub>D</sub> = 2.5 A;<br>V <sub>gen</sub> = 10 V; R <sub>gen</sub> = 10 Ω |      | 50   | 100  | ns   |
| t <sub>r</sub>      | Rise time           |                                                                                                     |      | 60   | 100  | ns   |
| t <sub>d(off)</sub> | Turn-off delay time |                                                                                                     |      | 150  | 300  | ns   |
| t <sub>f</sub>      | Fall time           |                                                                                                     |      | 40   | 80   | ns   |

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

| Symbol         | Parameter             | Test conditions                                                                                    | Min. | Typ. | Max. | Unit       |
|----------------|-----------------------|----------------------------------------------------------------------------------------------------|------|------|------|------------|
| $t_{d(on)}$    | Turn-on delay time    | $V_{DD} = 15\text{ V}; I_D = 2.5\text{ A};$<br>$V_{gen} = 10\text{ V}; R_{gen} = 1\text{ k}\Omega$ |      | 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         |
| $(di/dt)_{on}$ | Turn-on current slope | $V_{DD} = 15\text{ V}; I_D = 2.5\text{ A};$<br>$V_{in} = 10\text{ V}; R_{gen} = 10\text{ }\Omega$  |      | 80   |      | A/ $\mu$ S |
| $Q_i$          | Total input charge    | $V_{DD} = 12\text{ V}; I_D = 2.5\text{ A};$<br>$V_{IN} = 10\text{ V}$                              |      | 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       | $I_{SD} = 2.5\text{ A}; V_{IN} = 0\text{ V}$                                         |      |      | 1.6  | V       |
| $t_{rr}^{(2)}$  | Reverse recovery time    | $I_{SD} = 2.5\text{ A}; di/dt = 100\text{ A}/\mu\text{s};$<br>$V_{DD} = 30\text{ V}$ |      | 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 ( $-40^\circ\text{C} < T_j < 150^\circ\text{C}$ , unless otherwise specified)

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

1. Parameters guaranteed by design / characterization.

Figure 2. Switching time test circuit for resistive load

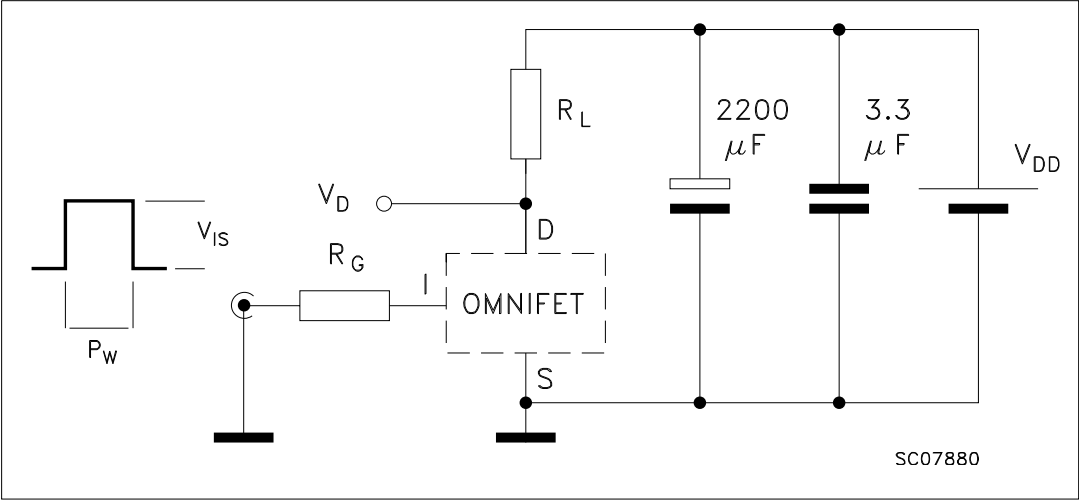


Figure 3. Test circuit for diode recovery times

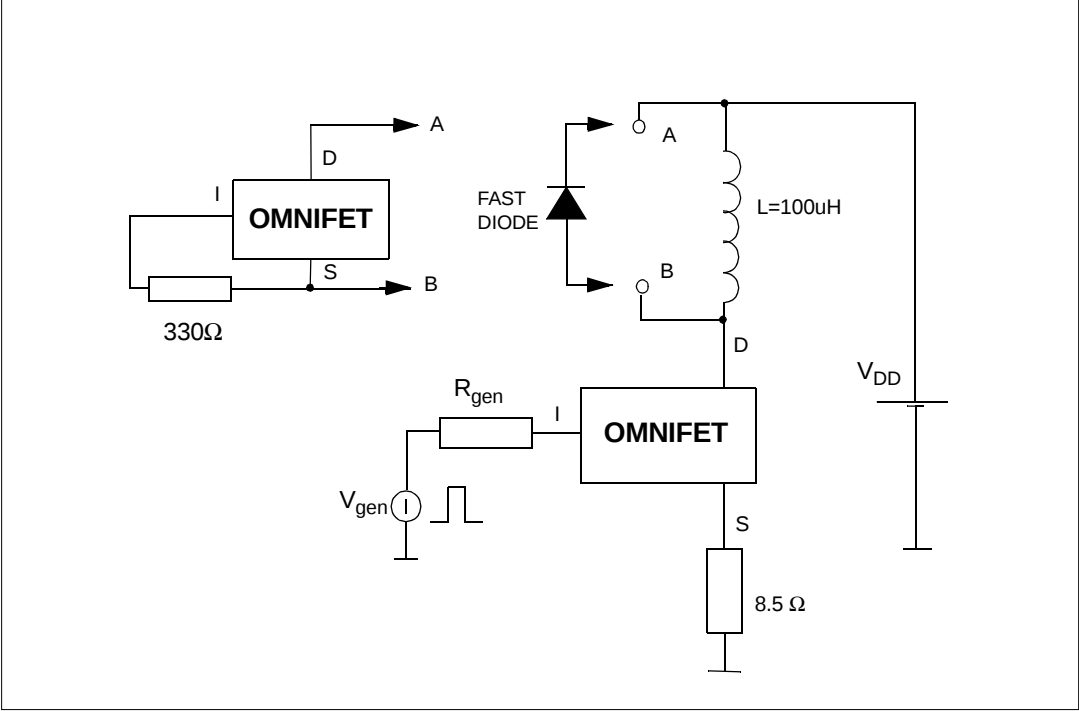


Figure 4. Unclamped inductive load test circuits

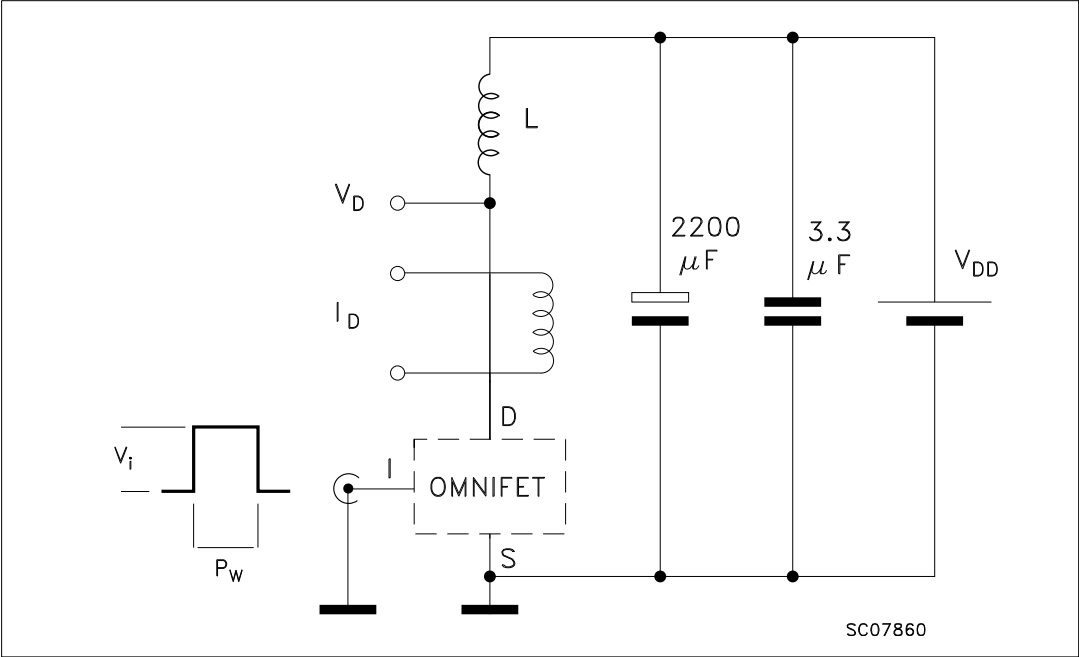


Figure 5. Input charge test circuit

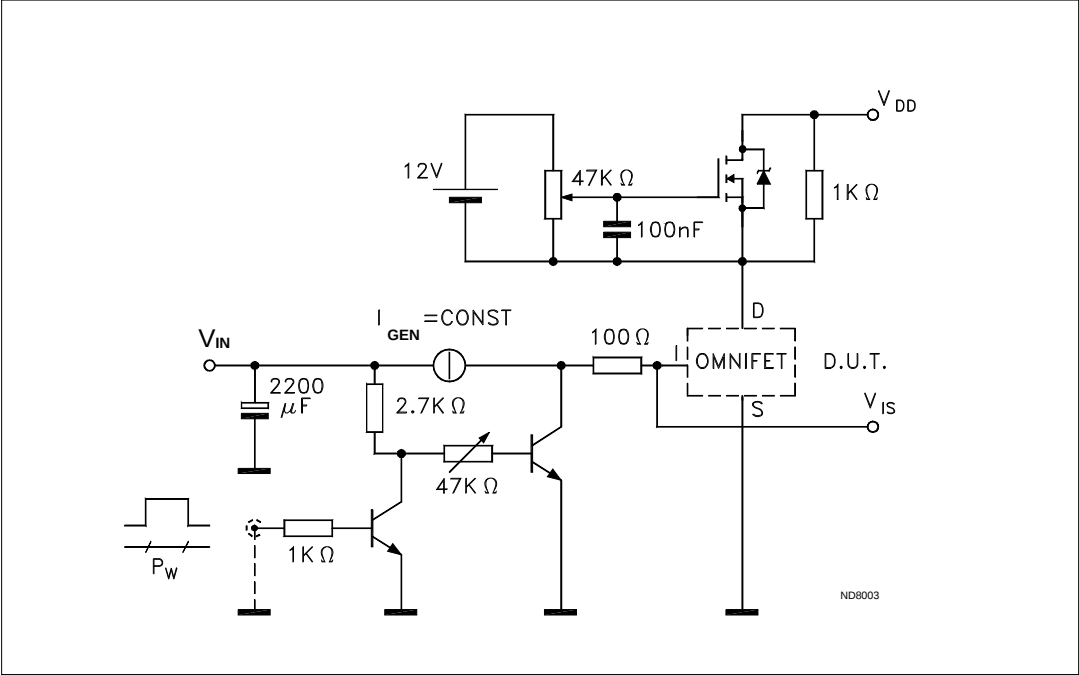


Figure 6. Unclamped inductive waveforms

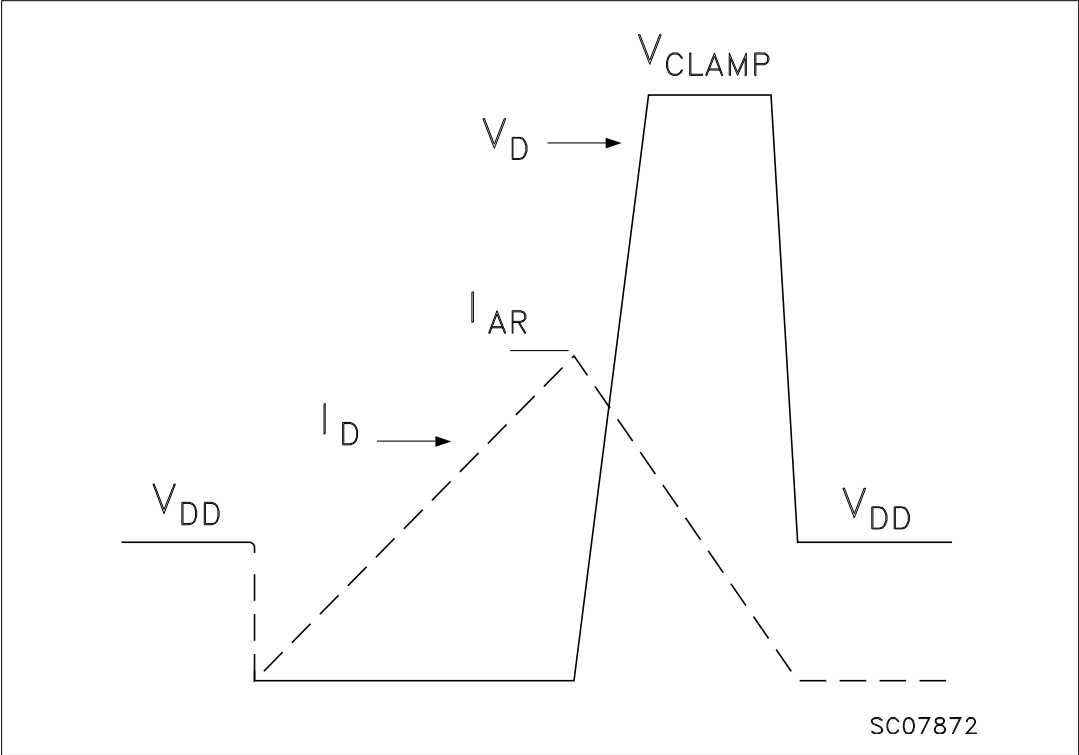


Figure 7. Switching waveforms

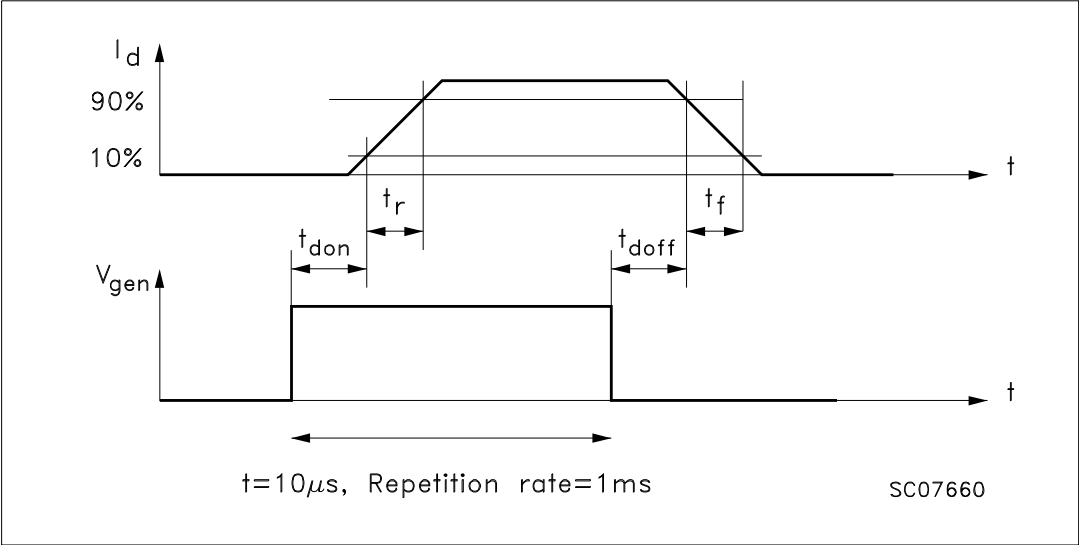
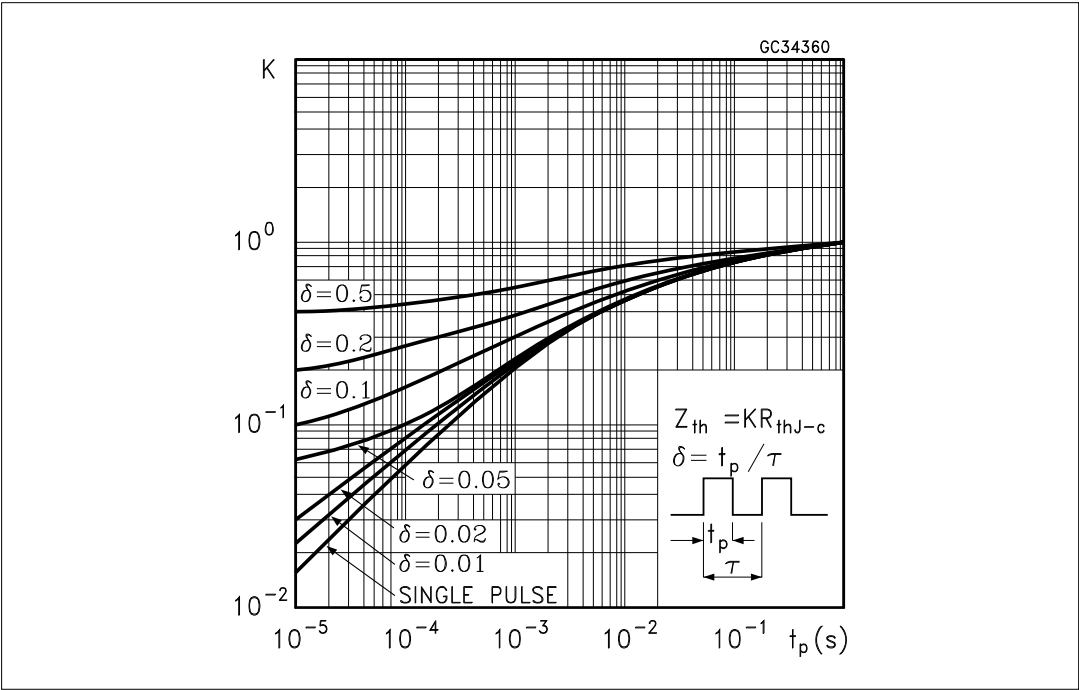


Figure 8. Thermal impedance for DPAK / IPAK



# 2.4 Electrical characteristics curves

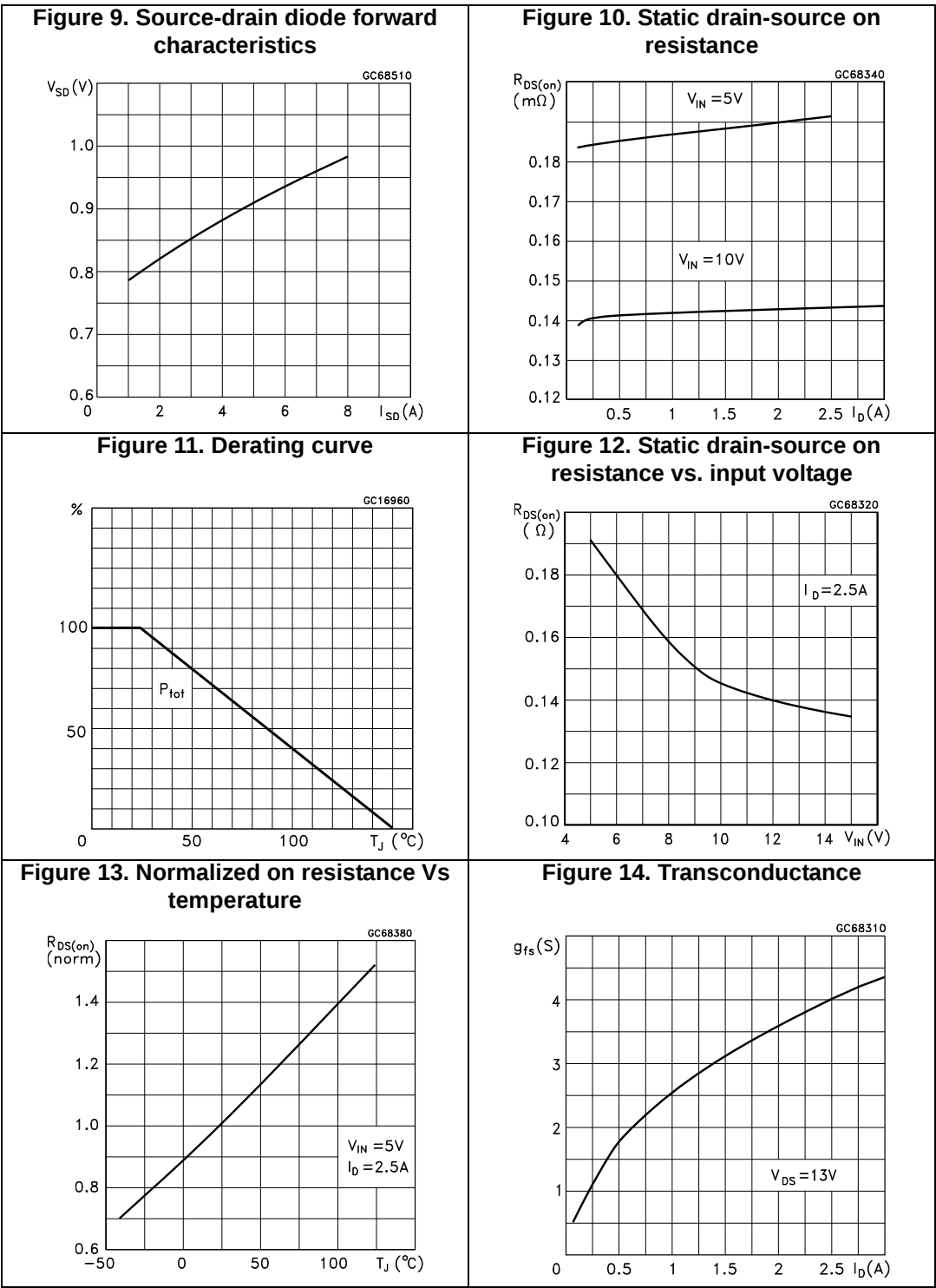


Figure 15. Static drain-source on resistance Vs. Id

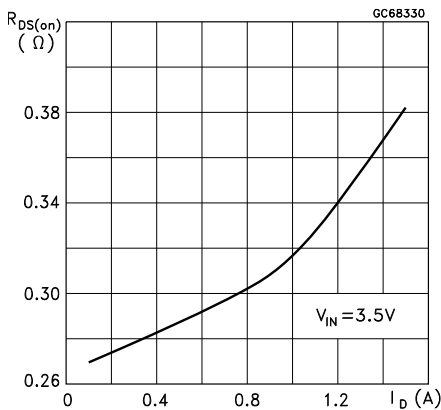


Figure 16. Switching time resistive load

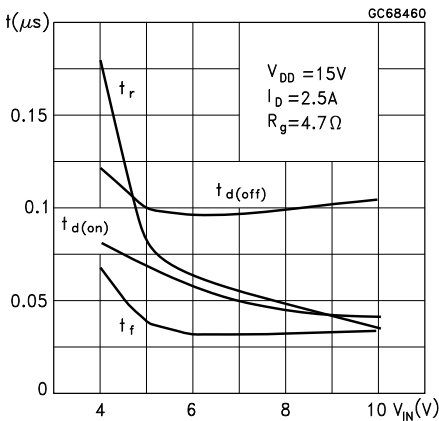


Figure 17. Turn-on current slope ( $V_{IN} = 10V$ )

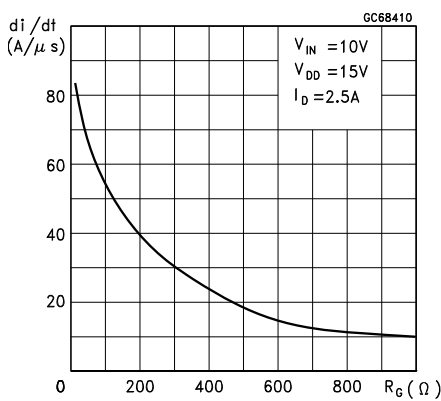


Figure 18. Turn-on current slope ( $V_{IN} = 5V$ )

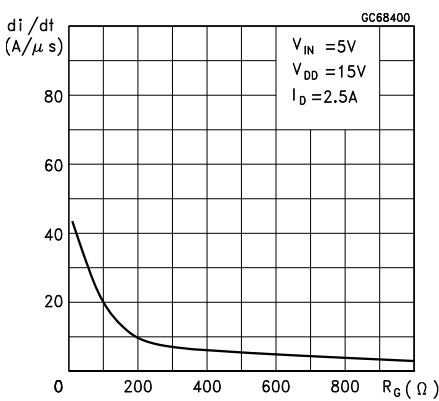


Figure 19. Input voltage vs. input charge

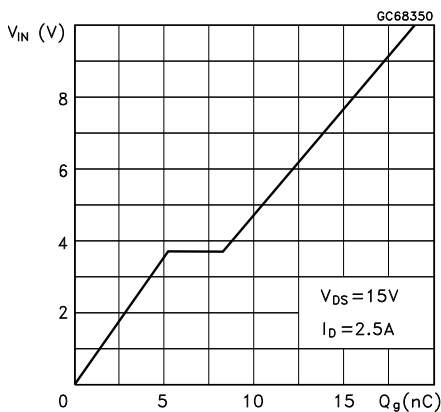
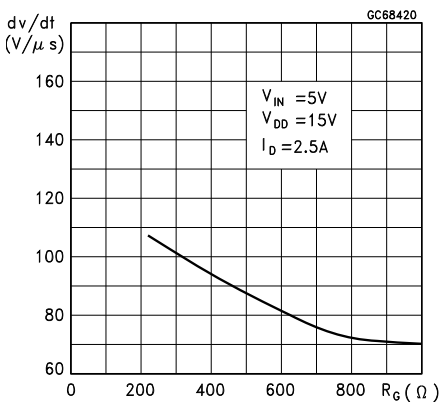
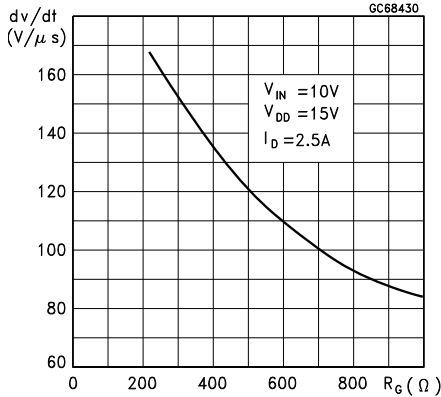


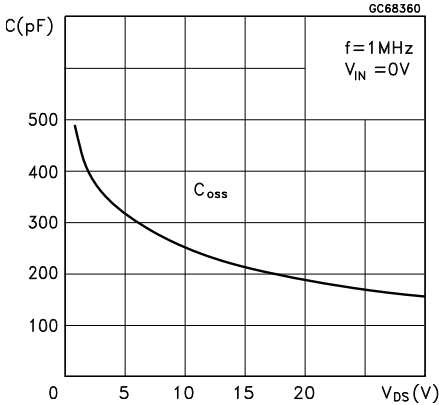
Figure 20. Turn-off drain source voltage slope



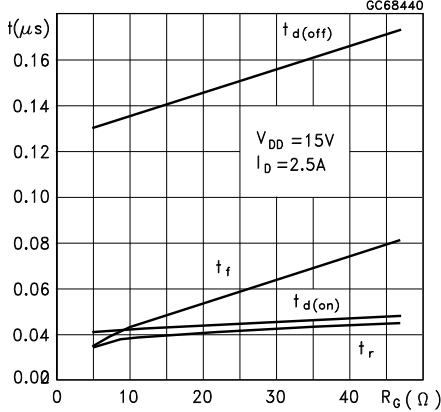
**Figure 21. Turn-off drain-source voltage slope**



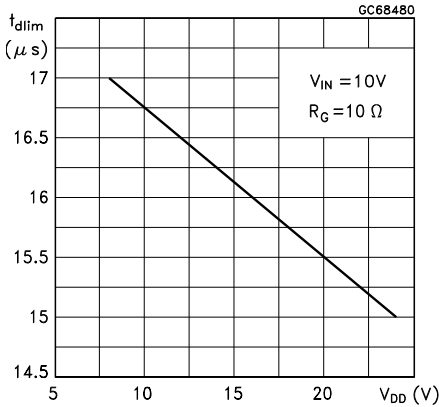
**Figure 22. Capacitance variations**



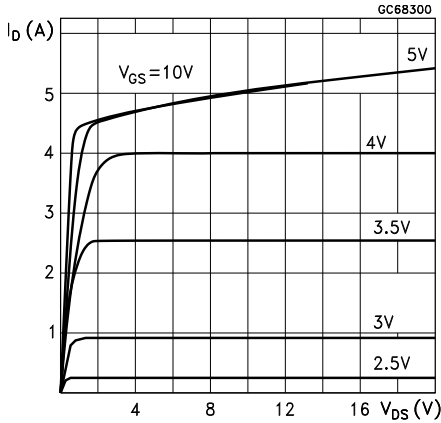
**Figure 23. Switching time resistive load**



**Figure 24. Step response current limit**



**Figure 25. Output characteristics**



**Figure 26. Normalized on resistance vs. temperature**

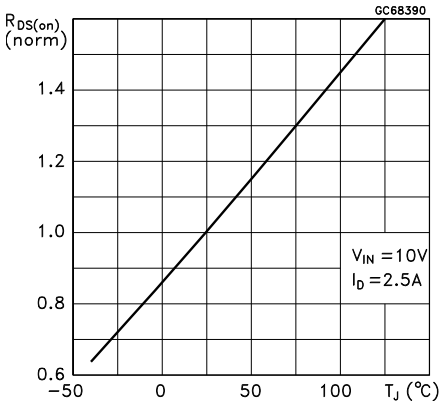


Figure 27. Normalized input threshold voltage vs. temperature

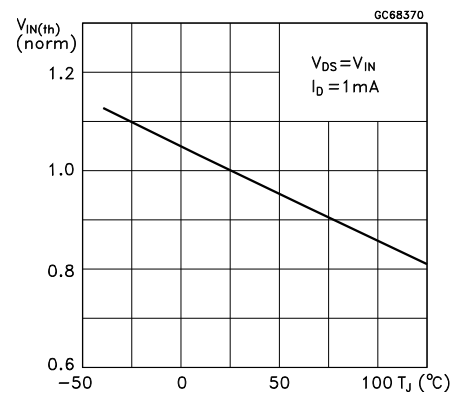
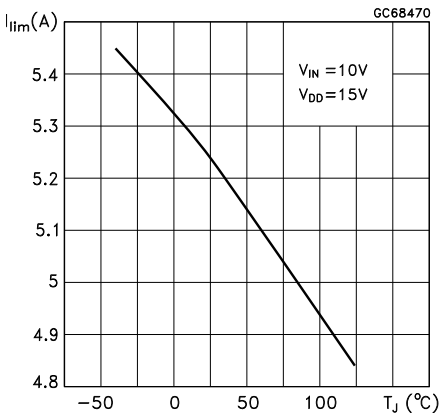


Figure 28. Normalized current limit vs. junction temperature



## 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 70 V, along with the rugged avalanche characteristics of the Power MOSFET stage give this device unrivaled 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 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<sup>®</sup> packages

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.

### 4.2 DPAK mechanical data

Figure 29. DPAK package dimensions

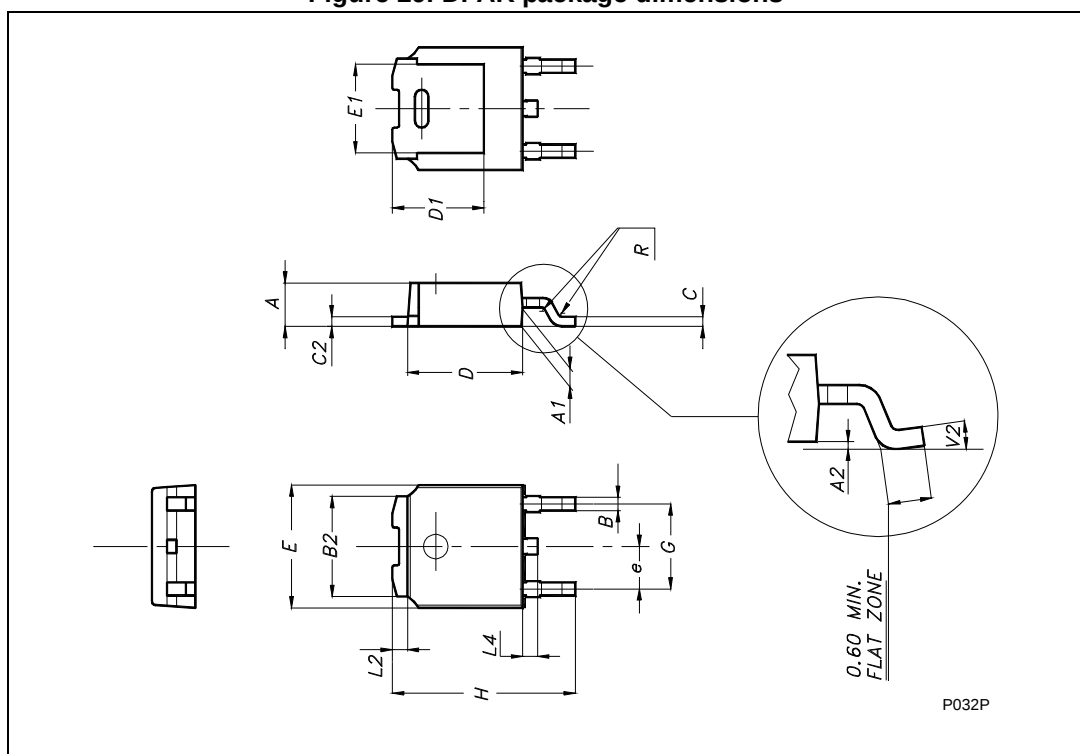


Table 10. DPAK mechanical data

| 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 30. IPAK mechanical data and package outline

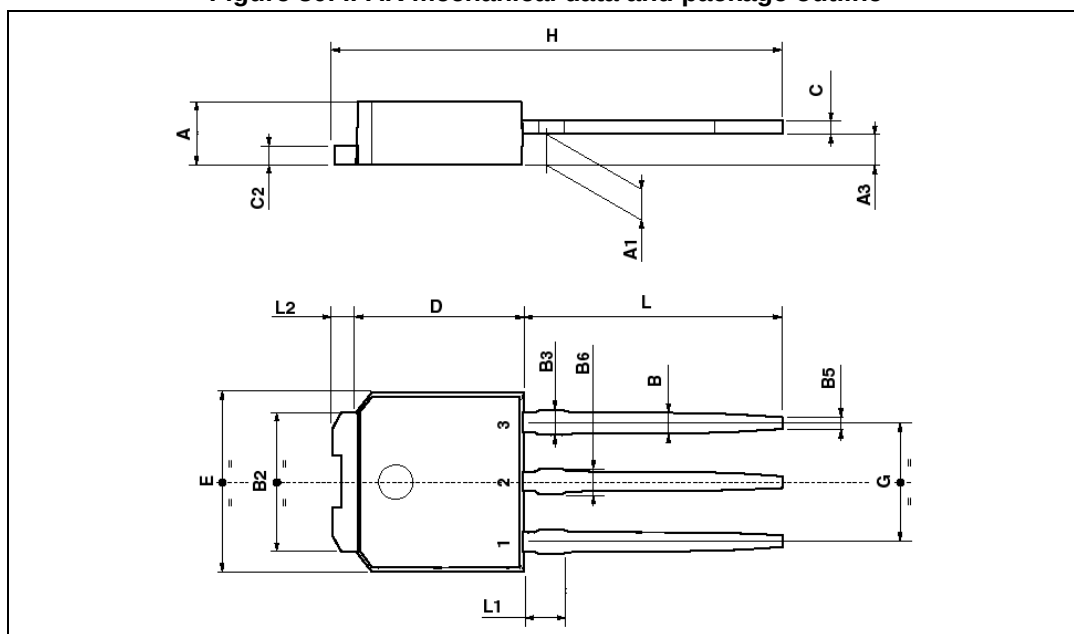


Table 11. IPAK mechanical data

| 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    |

## 5 Revision history

**Table 12. Document revision history**

| Date        | Revision | Changes             |
|-------------|----------|---------------------|
| 01-Aug-2013 | 1        | Initial release.    |
| 16-Sep-2013 | 2        | Updated disclaimer. |

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