



# VNW100N04

## "OMNIFET": FULLY AUTOPROTECTED POWER MOSFET

**Table 1. General Features**

| Type      | V <sub>clamp</sub> | R <sub>DS(on)</sub> | I <sub>lim</sub> |
|-----------|--------------------|---------------------|------------------|
| VNW100N04 | 42 V               | 0.012 Ω             | 100 A            |

- LINEAR CURRENT LIMITATION
- THERMAL SHUT DOWN
- 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
- STANDARD TO-247 PACKAGE

### DESCRIPTION

The VNW100N04 is a monolithic device made using STMicroelectronics ViPower M0 Technology, intended for replacement of standard power MOSFETS in DC to 50 kHz applications. Built-in thermal shut-down, 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 2. Order Codes**

| Package | Tube      | Tape and Reel |
|---------|-----------|---------------|
| TO-247  | VNW100N04 | —             |

**Figure 1. Package**

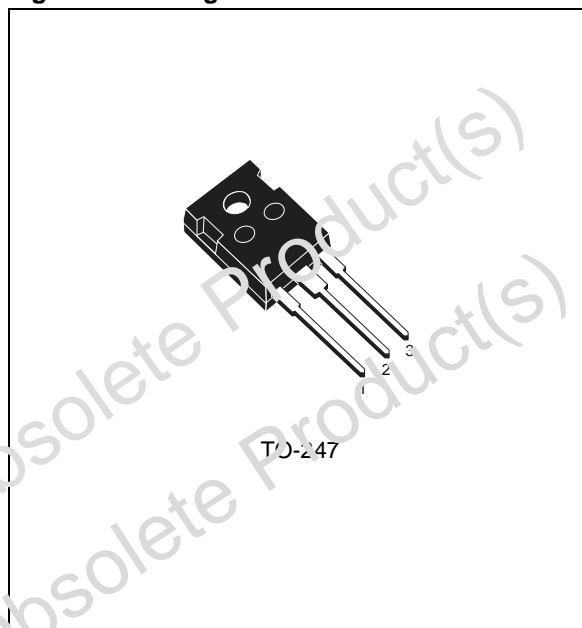


Figure 2. Block Diagram

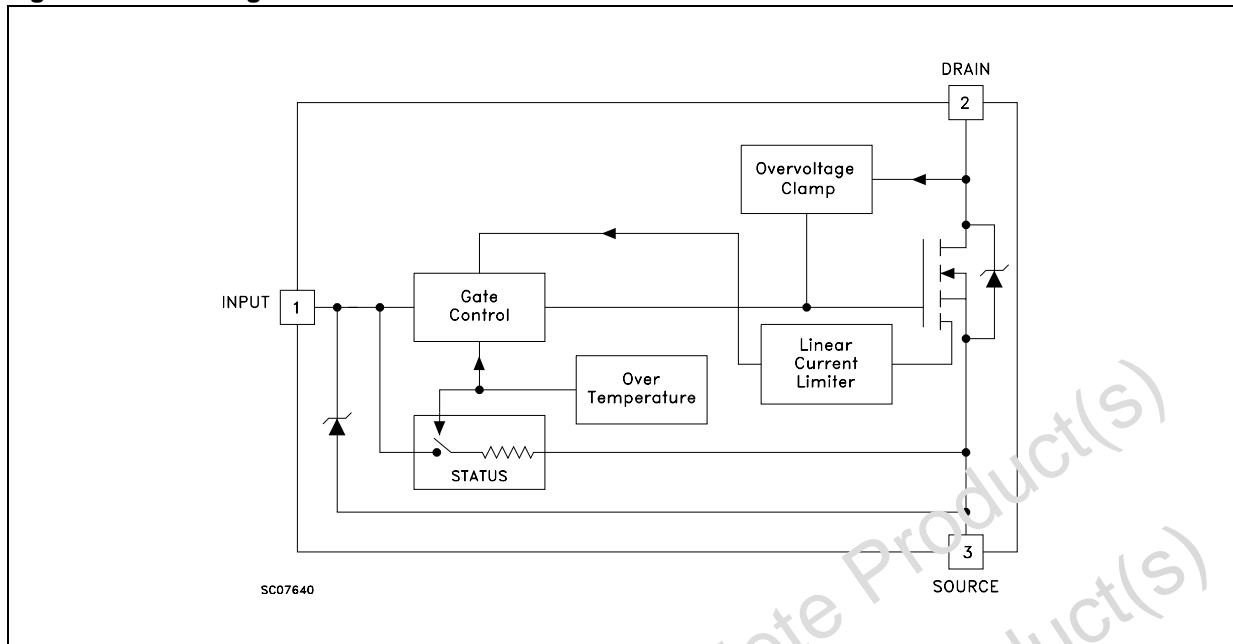


Table 3. Absolute Maximum Ratings

| Symbol    | Parameter  | Value              | Unit |
|-----------|--|--------------------|------|
| $V_{DS}$  | Drain-Source Voltage ( $V_{in} = 0$ )                          | Internally Clamped | V    |
| $V_{IN}$  | Input Voltage  | 18                 | V    |
| $I_D$     | Drain Current  | Internally Limited | A    |
| $I_R$     | Reverse DC Output Current                                      | -100               | A    |
| $V_{esd}$ | Electrostatic Discharge ( $C = 100$ pF, $R = 1.5$ K $\Omega$ ) | 2000               | V    |
| $P_{tot}$ | Total Dissipation at $T_c = 25$ °C                             | 208                | W    |
| $T_j$     | Operating Junction Temperature                                 | Internally Limited | °C   |
| $T_c$     | Case Operating Temperature                                     | Internally Limited | °C   |
| $T_{stg}$ | Storage Temperature  | -55 to 150         | °C   |

Table 4. Thermal Data

| Symbol         | Parameter                               | Value | Unit |
|----------------|---|-------|------|
| $R_{thj-case}$ | Thermal Resistance Junction-case Max    | 0.6   | °C/W |
| $R_{thj-amb}$  | Thermal Resistance Junction-ambient Max | 30    | °C/W |

**ELECTRICAL CHARACTERISTICS** ( $T_{\text{case}} = 25^{\circ}\text{C}$  unless otherwise specified)**Table 5. Off**

| Symbol             | Parameter   | Test Conditions  | Min. | Typ. | Max.      | Unit                           |
|--------------------|---|--|------|------|-----------|--------------------------------|
| $V_{\text{CLAMP}}$ | Drain-source Clamp Voltage                                  | $I_{\text{D}} = 50 \text{ A}; V_{\text{in}} = 0$   | 36   | 42   | 48        | V                              |
| $V_{\text{CLTH}}$  | Drain-source Clamp Threshold Voltage                        | $I_{\text{D}} = 2 \text{ mA}; V_{\text{in}} = 0$   | 35   |      |           | V                              |
| $V_{\text{INCL}}$  | Input-Source Reverse Clamp Voltage                          | $I_{\text{in}} = -1 \text{ mA}$  | -1   |      | -0.3      | V                              |
| $I_{\text{DSS}}$   | Zero Input Voltage<br>Drain Current ( $V_{\text{in}} = 0$ ) | $V_{\text{DS}} = 13 \text{ V}; V_{\text{in}} = 0$<br>$V_{\text{DS}} = 25 \text{ V}; V_{\text{in}} = 0$ |      |      | 50<br>200 | $\mu\text{A}$<br>$\mu\text{A}$ |
| $I_{\text{ISS}}$   | Supply Current from Input Pin                               | $V_{\text{DS}} = 0 \text{ V}; V_{\text{in}} = 10 \text{ V}$  |      | 250  | 500       | $\mu\text{A}$                  |

**Table 6. On <sup>(1)</sup>**

| Symbol              | Parameter                         | Test Conditions   | Min. | Typ. | Max.           | Unit                 |
|---------------------|-----------------------------------|---|------|------|----------------|----------------------|
| $V_{\text{IN(th)}}$ | Input Threshold Voltage           | $V_{\text{DS}} = V_{\text{in}}; I_{\text{D}} + I_{\text{in}} = 1 \text{ mA}$  | 0.8  |      | 3              | V                    |
| $R_{\text{DS(on)}}$ | Static Drain-source On Resistance | $V_{\text{in}} = 10 \text{ V}; I_{\text{D}} = 50 \text{ A}$<br>$V_{\text{in}} = 5 \text{ V}; I_{\text{D}} = 50 \text{ A}$ |      |      | 0.012<br>0.015 | $\Omega$<br>$\Omega$ |

Note: 1. Pulsed: Pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5 %**Table 7. Dynamic**

| Symbol                         | Parameter                | Test Conditions  | Min. | Typ. | Max. | Unit |
|--------------------------------|--------------------------|--|------|------|------|------|
| $g_{\text{fs}}$ <sup>(2)</sup> | Forward Transconductance | $V_{\text{DS}} = 13 \text{ V}; I_{\text{D}} = 50 \text{ A}$          | 40   | 60   |      | S    |
| $C_{\text{OSS}}$               | Output Capacitance       | $V_{\text{DS}} = 13 \text{ V}; f = 1 \text{ MHz}; V_{\text{in}} = 0$ |      | 2000 | 3000 | pF   |

Note: 2. Pulsed: Pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5 %.**Table 8. Switching <sup>(3)</sup>**

| Symbol                | Parameter             | Test Conditions   | Min. | Typ. | Max. | Unit             |
|-----------------------|-----------------------|---|------|------|------|------------------|
| $t_{\text{d(on)}}$    | Turn-on Delay Time    | $V_{\text{DD}} = 15 \text{ V}; I_{\text{d}} = 50 \text{ A};$  |      | 110  | 250  | ns               |
| $t_{\text{r}}$        | Rise Time             | $V_{\text{gen}} = 10\text{V}; R_{\text{gen}} = 10 \Omega$   |      | 500  | 900  | ns               |
| $t_{\text{d(off)}}$   | Turn-off Delay Time   | (see Figure 27)   |      | 1000 | 1800 | ns               |
| $t_{\text{f}}$        | Fall Time             |   |      | 600  | 1000 | ns               |
| $t_{\text{d(on)}}$    | Turn-on Delay Time    | $V_{\text{DD}} = 15 \text{ V}; I_{\text{d}} = 50 \text{ A};$  |      | 2.2  | 3.5  | $\mu\text{s}$    |
| $t_{\text{r}}$        | Rise Time             | $V_{\text{gen}} = 10\text{V}; R_{\text{gen}} = 1000 \Omega$   |      | 3.5  | 6    | $\mu\text{s}$    |
| $t_{\text{d(off)}}$   | Turn-off Delay Time   | (see Figure 27)   |      | 22   | 30   | $\mu\text{s}$    |
| $t_{\text{f}}$        | Fall Time             |   |      | 12   | 18   | $\mu\text{s}$    |
| $(di/dt)_{\text{on}}$ | Turn-on Current Slope | $V_{\text{DD}} = 15 \text{ V}; I_{\text{D}} = 50 \text{ A}$<br>$V_{\text{in}} = 10 \text{ V}; R_{\text{gen}} = 10 \Omega$ |      | 55   |      | A/ $\mu\text{s}$ |
| $Q_{\text{i}}$        | Total Input Charge    | $V_{\text{DD}} = 15 \text{ V}; I_{\text{D}} = 50 \text{ A}; V_{\text{in}} = 10 \text{ V}$                                 |      | 190  |      | nC               |

Note: 3. Parameters guaranteed by design/characterization.

**ELECTRICAL CHARACTERISTICS** (cont'd)

**Table 9. Source Drain Diode**

| Symbol          | Parameter                | Test Conditions   | Min. | Typ. | Max. | Unit          |
|-----------------|--------------------------|---|------|------|------|---------------|
| $V_{SD}^{(4)}$  | Forward On Voltage       | $I_{SD} = 50\text{ A}; V_{in} = 0$  |      |      | 1.6  | V             |
| $t_{rr}^{(5)}$  | Reverse Recovery Time    | $I_{SD} = 50\text{ A}; di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 30\text{ V}; T_j = 25\text{ }^\circ\text{C}$<br>(see test circuit, Figure 29) |      | 800  |      | ns            |
| $Q_{rr}^{(5)}$  | Reverse Recovery Charge  |   |      | 5    |      | $\mu\text{C}$ |
| $I_{RRM}^{(5)}$ | Reverse Recovery Current |   |      | 15   |      | A             |

Note: 4. Pulsed: Pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5 %  
5. Parameters guaranteed by design/characterization.

**Table 10. Protection**

| Symbol           | Parameter                     | Test Conditions   | Min. | Typ. | Max. | Unit             |
|------------------|-------------------------------|---|------|------|------|------------------|
| $I_{lim}$        | Drain Current Limit           | $V_{in} = 10\text{ V}; V_{DS} = 13\text{ V}$  | 35   | 50   | 65   | A                |
|                  |                               | $V_{in} = 5\text{ V}; V_{DS} = 13\text{ V}$   | 35   | 50   | 65   | A                |
| $t_{dlim}^{(6)}$ | Step Response Current Limit   | $V_{in} = 10\text{ V}$  |      | 50   | 80   | $\mu\text{s}$    |
|                  |                               | $V_{in} = 5\text{ V}$   |      | 130  | 200  | $\mu\text{s}$    |
| $T_{jsh}^{(6)}$  | Overtemperature Shutdown      |   | 170  |      |      | $^\circ\text{C}$ |
| $T_{jrs}^{(6)}$  | Overtemperature Reset         |   | 155  |      |      | $^\circ\text{C}$ |
| $I_{gf}^{(6)}$   | 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               |
| $E_{as}^{(6)}$   | Single Pulse Avalanche Energy | starting $T_j = 25\text{ }^\circ\text{C}; V_{DD} = 20\text{ V}$<br>$V_{in} = 10\text{ V}; R_{gen} = 1\text{ K}\Omega; L = 10\text{ mH}$ | 4    |      |      | J                |

Note: 6. Parameters guaranteed by design/characterization.

**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 50 KHz. The only difference from the user's standpoint is that a small DC current ( $I_{in}$ ) flows into the Input pin in order to supply the internal circuitry.

The device integrates:

- **OVERVOLTAGE CLAMP PROTECTION:** internally set at 42V, 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.
- **LINEAR CURRENT LIMITER CIRCUIT:** limits the drain current  $I_d$  to  $I_{lim}$  whatever the Input pin voltage. 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  $T_{jsh}$ .

- **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 170 $^\circ\text{C}$ . The device is automatically restarted when the chip temperature falls below 155 $^\circ\text{C}$ .

- **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  $R_{DS(on)}$ ).

Figure 3. Thermal Impedance

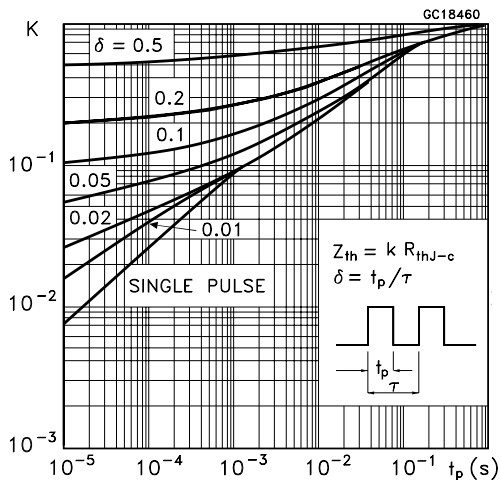


Figure 4. Derating Curve

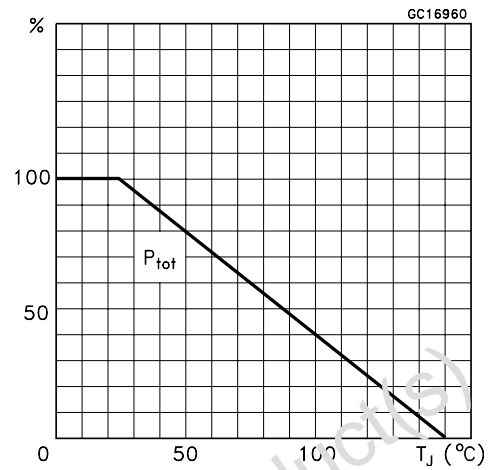


Figure 5. Output Characteristics

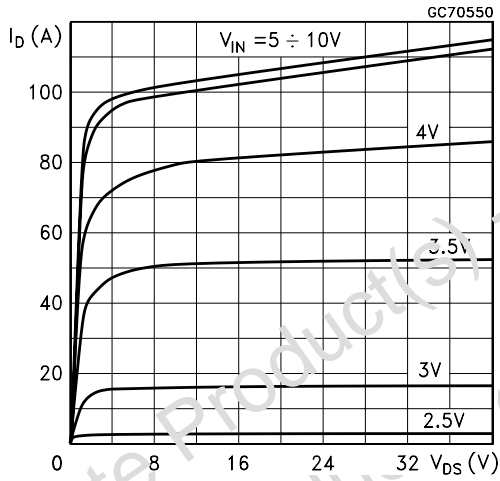


Figure 6. Transconductance

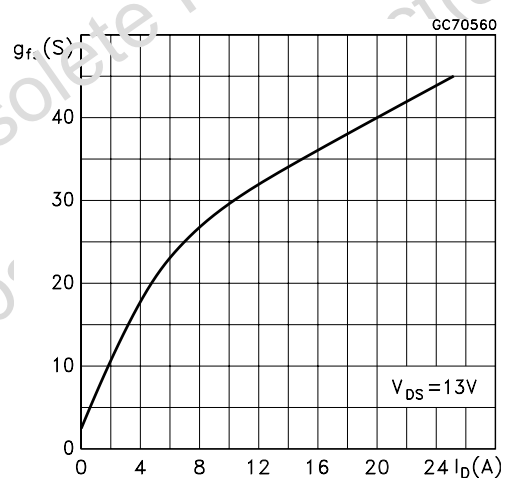


Figure 7. Static Drain-Source On Resistance vs Input Voltage

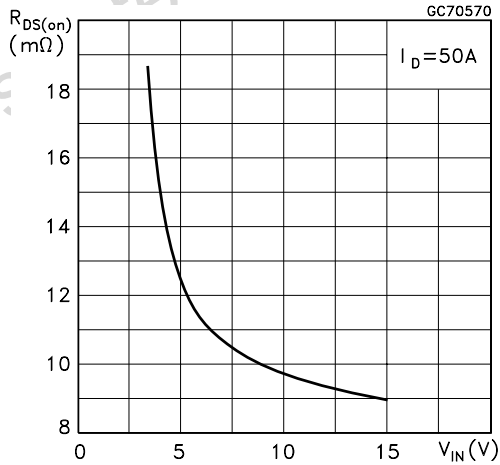


Figure 8. Static Drain-Source On Resistance

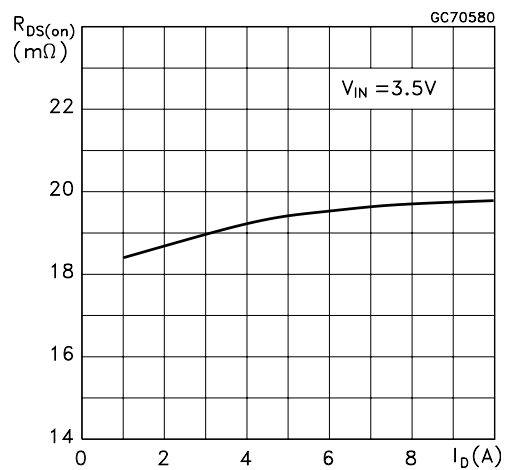


Figure 9. Static Drain-Source On Resistance

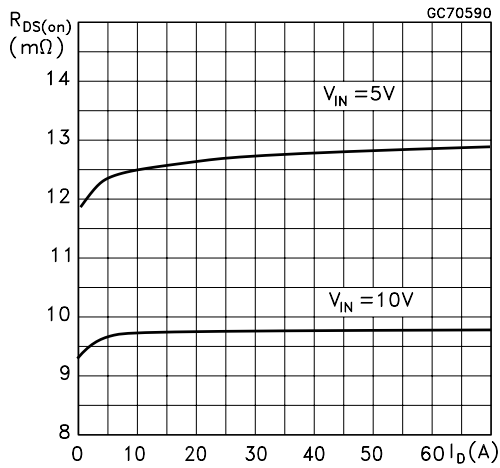


Figure 10. Input Charge vs Input Voltage

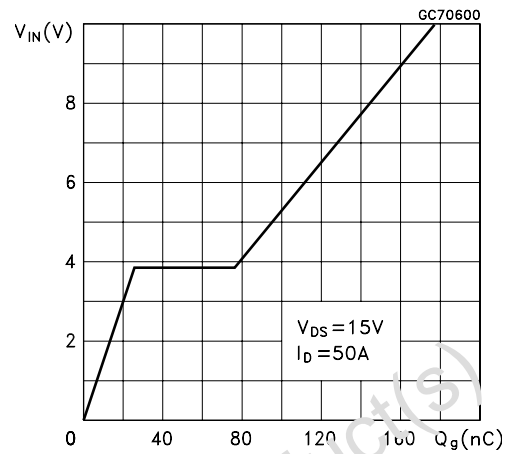


Figure 11. Capacitance Variations

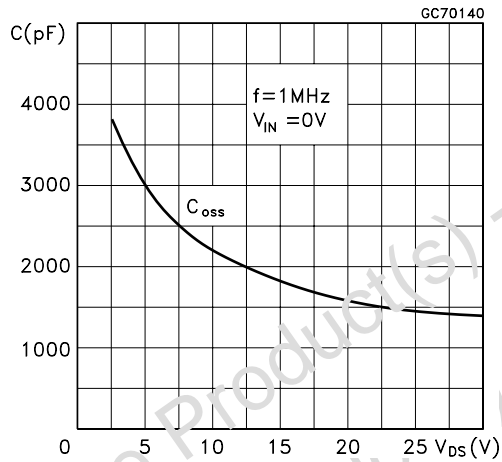


Figure 12. Normalized Input Threshold Voltage vs Temperature

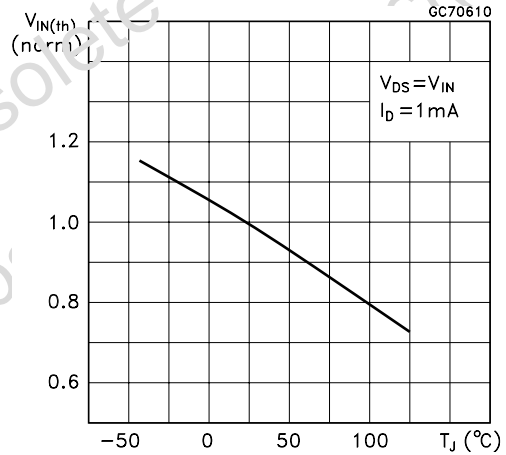


Figure 13. Normalized On Resistance vs Temperature

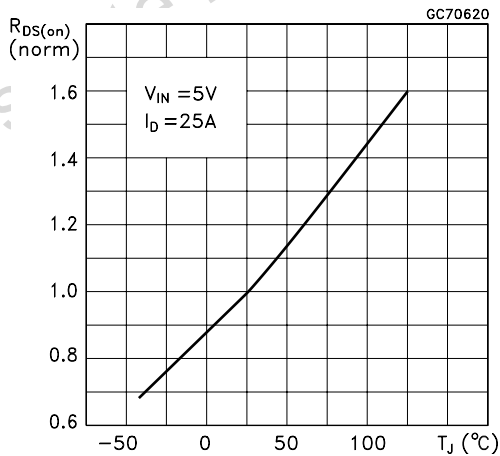


Figure 14. Normalized On Resistance vs Temperature

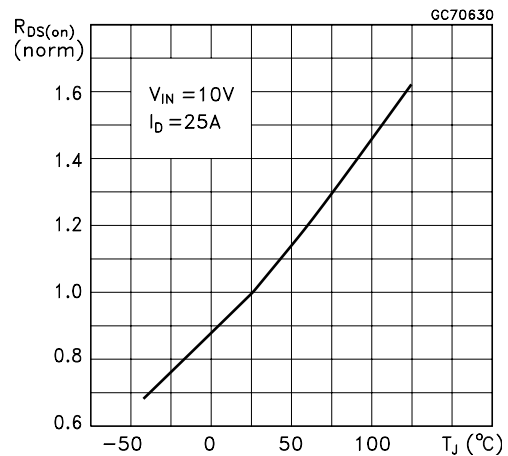


Figure 15. Turn-on Current Slope

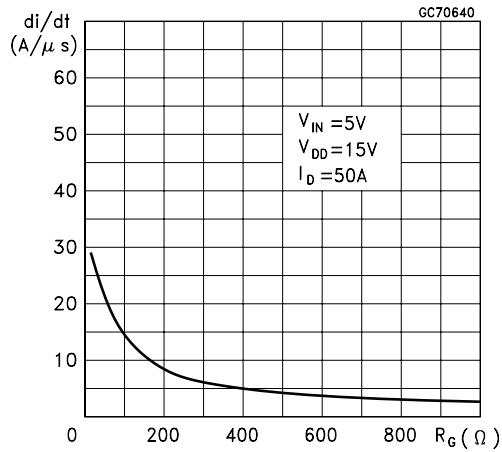


Figure 16. Turn-on Current Slope

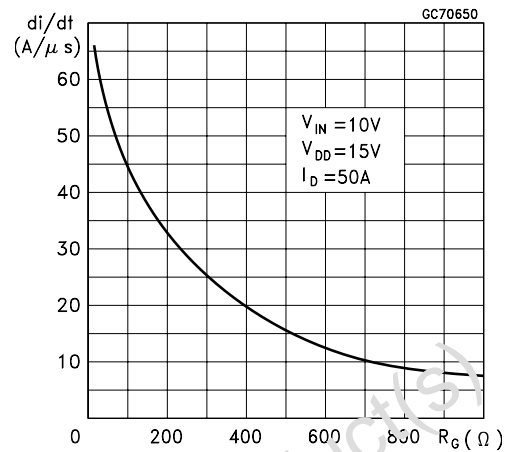


Figure 17. Turn-off Drain-Source Voltage Slope

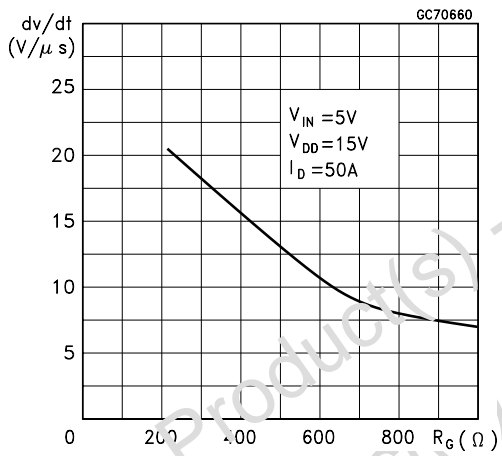


Figure 18. Turn-on Drain-Source Voltage Slope

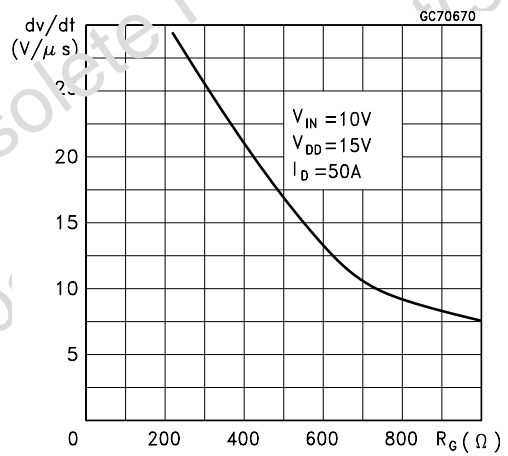


Figure 19. Switching Time Resistive Load

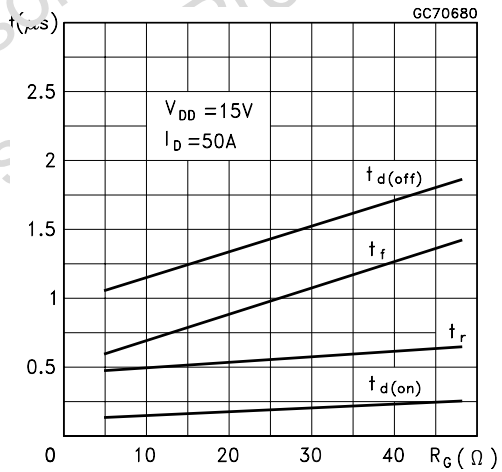


Figure 20. Switching Time Resistive Load

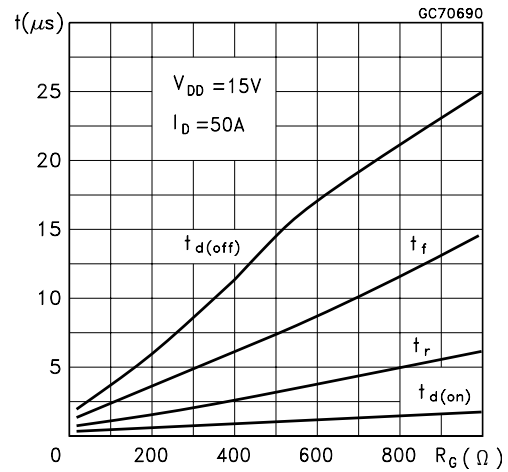


Figure 21. Switching Time Resistive Load

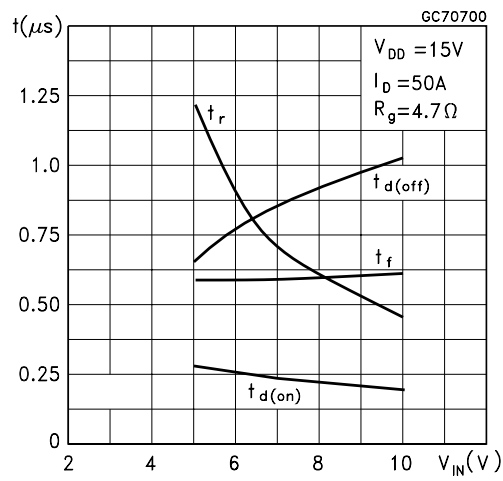


Figure 22. Current Limit vs Junction Temperature

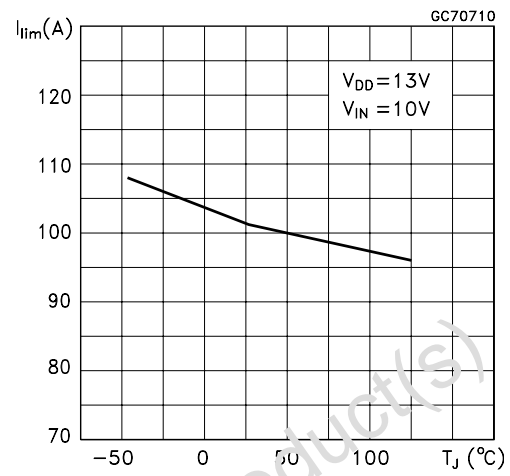


Figure 23. Step Response Current Limit

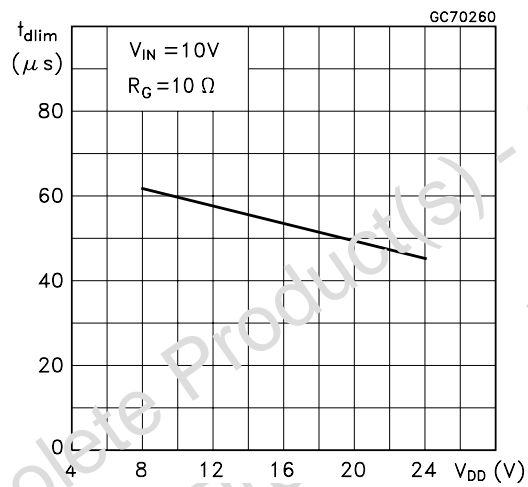


Figure 24. Source Drain Diode Forward Characteristics

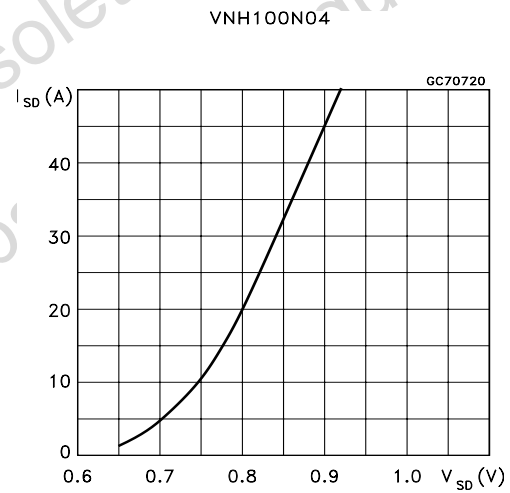




Figure 25. Unclamped Inductive Load Test Circuits

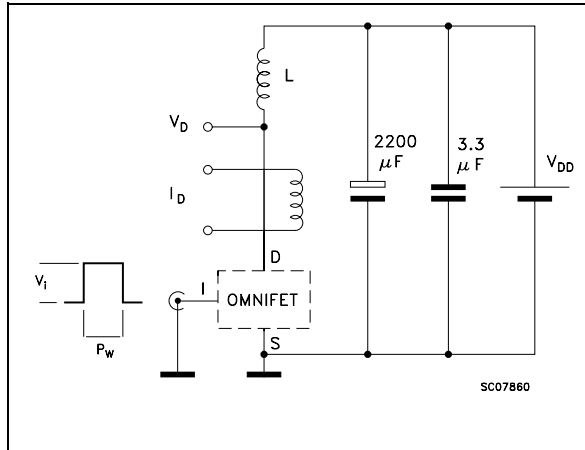


Figure 26. Unclamped Inductive Waveforms

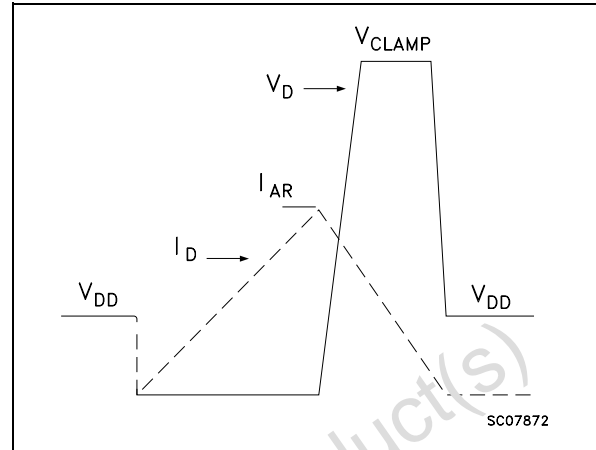


Figure 27. Switching Times Test Circuits For Resistive Load

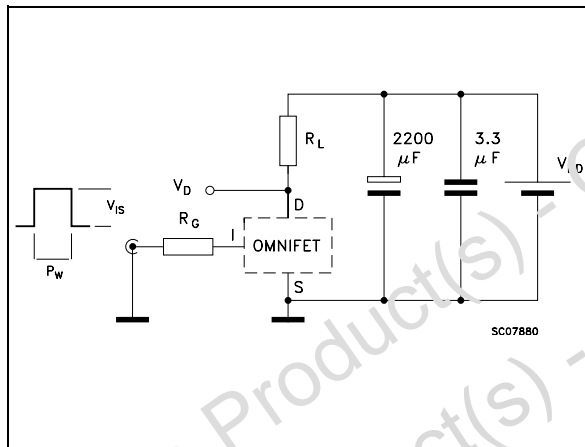


Figure 28. Input Charge Test Circuit

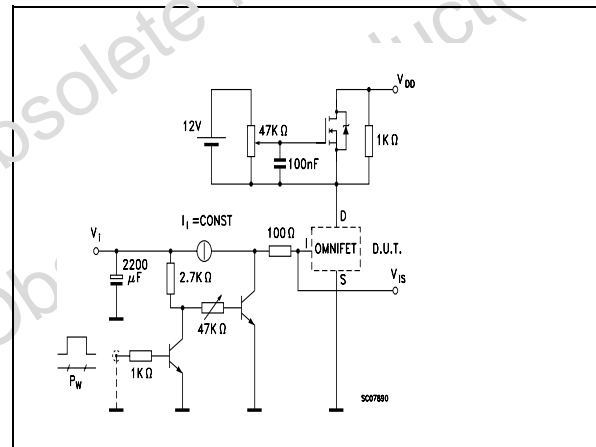


Figure 29. Test Circuit For Inductive Load Switching And Diode Recovery Times

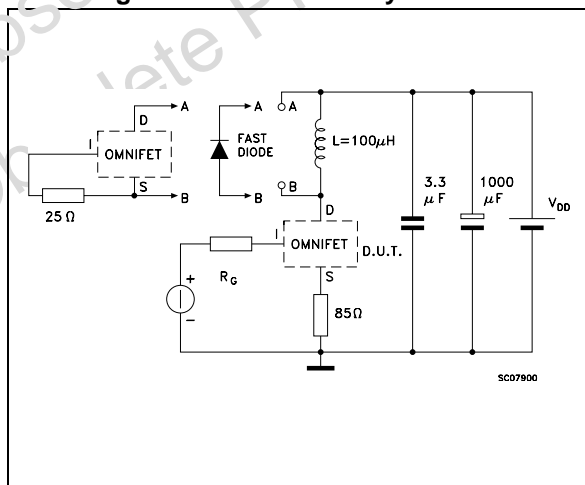
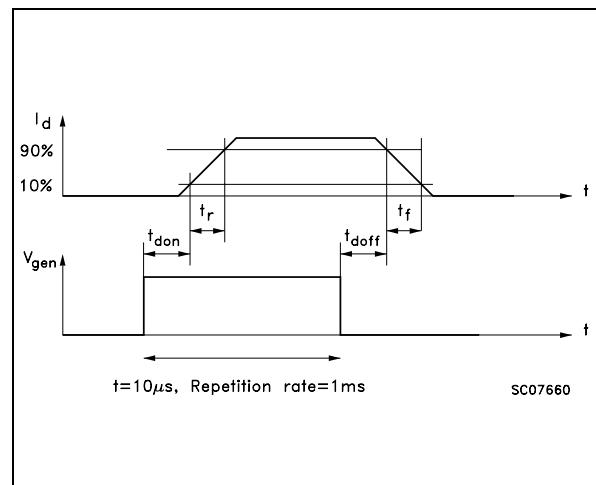


Figure 30. Waveforms

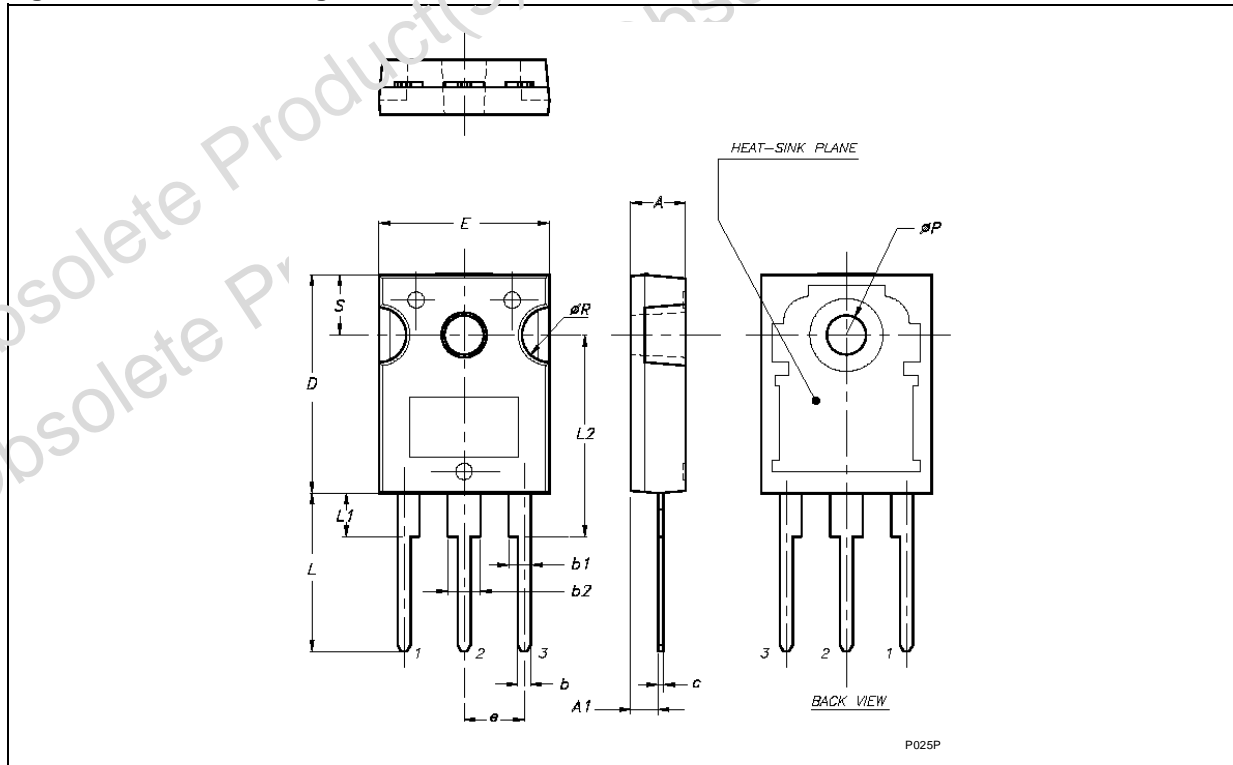


PACKAGE MECHANICAL

Table 11. TO-247 Mechanical Data

| Symbol         | millimeters |          |       |
|----------------|-------------|----------|-------|
|                | 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              |             | 5.45     |       |
| L              | 14.20       |          | 14.80 |
| L1             | 3.70        |          | 4.30  |
| L2             |             | 18.50    |       |
| ∅P             | 3.55        |          | 3.65  |
| ∅R             | 4.50        |          | 5.50  |
| S              |             | 5.50     |       |
| Package Weight |             | Gr. 4.43 |       |

Figure 31. TO-247 Package Dimensions



Note: Drawing is not to scale.

**REVISION HISTORY****Table 12. Revision History**

| <b>Date</b>    | <b>Revision</b> | <b>Description of Changes</b>         |
|----------------|-----------------|---------------------------------------|
| September-1996 | 1               | First Issue                           |
| 18-June-2004   | 2               | Stylesheet update. No content change. |

Obsolete Product(s) - Obsolete Product(s)  
Obsolete Product(s) - Obsolete Product(s)

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