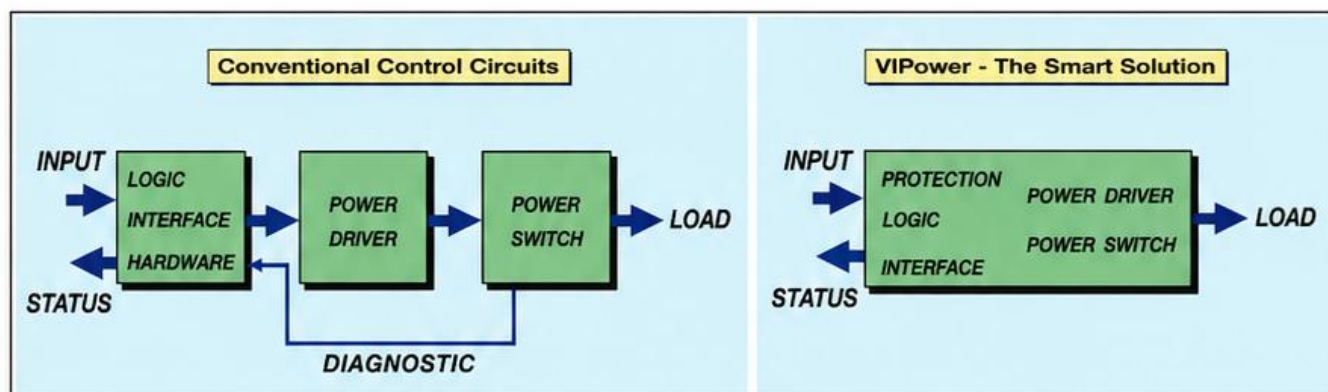


BENEFITS OF VIPower



Power semiconductors are generally required to operate in hostile environments; the ability to withstand thermal cycling, power cycling and electrical overstress are commonplace requirements.

When faults occur in a power circuit, considerable surges of energy can result and may cause damage to the system and to the semiconductors in particular.

Until the arrival of VIPower comprehensive protection circuitry was frequently discarded for being impractical, or too expensive.

Using VIPower, it is possible to integrate within the power semiconductor device, not only a

control circuit, but also protection circuits and, if required, a diagnostic output to signal a fault condition to the system controller, allowing the system to be altered or shut down in a controlled manner in the event of a fault.

The benefits of using a smart power solution can be as many and as varied as the number of potential applications. For example, VIPower devices' reduced worst-case power dissipation may allow operation without heatsinks. By doing this, not only will the heatsink costs be saved, but, perhaps the assembly could be made surface mount instead of through-hole, further decreasing system size and cost while increasing reliability.

VIPower Advantages Over Equivalent Discretes

- ▶ Reduced component count. Lower component and assembly costs.
- ▶ Smaller circuit boards for more flexible design.
- ▶ Higher system reliability (fewer solder joints and more protection features).
- ▶ Faster design cycle time results in increased competitiveness.

PROTECTION FEATURES

Some of the popular protection features in VIPower devices include:

► Thermal Overload Protection

Turns off the power device when the junction temperature exceeds an internally set threshold and prevents the device from being switched on again while the junction temperature remains unacceptably high.

► Current Overload Protection

The circuit either switches off the device on detection of a current overload, or decreases the drive until the transistor goes into the active region, maintaining the current $I_{C(max)}$ at a constant level.

► Overvoltage Protection

Voltage transients caused by fast switching of inductive loads are a common problem. The protection circuit allows the transient energy to be discharged in a safe manner, avoiding breakdown and potentially the failure of the switching device.

► Staying Inside The Safe Operating Area

The occurrence of current and voltage at the same instant through the power switch could cause transistor breakdown. By limiting the rate of change of drive, it is possible to limit the instantaneous power through the transistor.

► Short Circuit Protection

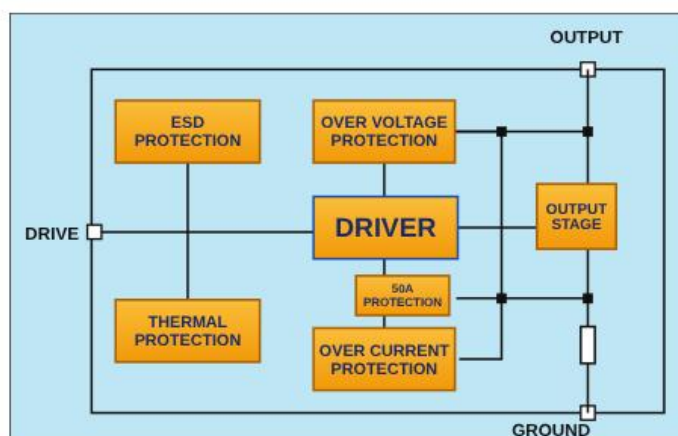
This normally works by detecting a short circuited load. The protection circuit overrides the control input and switches off the device in order to protect it.

► High Inrush Current Loads

It is common practice to allow a timed current surge to occur when the switch is activated in order to accommodate loads such as filament lamps which take a few milliseconds to reach a steady state operating condition.

► Electrostatic Discharge Protection

Power MOSFETs are susceptible to puncture of the gate oxide and consequent destruction due to electrostatic discharge. Adding zener diode protection circuits on all input pins decreases the susceptibility to ESD damage. VIPower devices are designed to withstand industry standard human body model and machine model ESD tests.



▶ VIPower APPLICATIONS

VIPower technologies can be used in a wide range of power applications. The devices developed can be classified into three areas:

- 1) custom devices, often for large automotive customers
- 2) application-specific devices, and
- 3) general purpose devices designed as protected drop-in replacements for existing transistors.

All devices are available in standard packages and die form for hybrid assembly.

Since the automotive market is of the greatest importance to VIPower circuits this is covered in detail on the following page.

▶ *Industrial Applications*

Industrial uses for VIPower circuits are widespread. Motor speed controllers (especially PWM controllers) and switched mode power supplies are the most important. For example, a custom VIPower device with a 50A current rating and comprehensive protection features has been developed for driving the motor of battery operated handtools such as portable drills and screw drivers.

▶ *Process Control*

The market for industrial process controllers is an important one for VIPower and is discussed in detail on page 30.

▶ *Consumer Applications*

Potential high volume applications are expected in consumer equipment such as colour TVs and home appliances (washing machines, etc.).

Fluorescent lamp ballasts could use the excellent reliability of protected intelligent transistors.

▶ *Replacing Discrete Transistors*

Devices such as the 3-pin OMNIFET can be used wherever a MOSFET is used, to provide a higher level of reliability.

Others devices, such as the VB921Z, are 3-pin devices designed to replace transistors in specific applications.

▶ *Portable Computer and*

▶ *Communications Equipment*

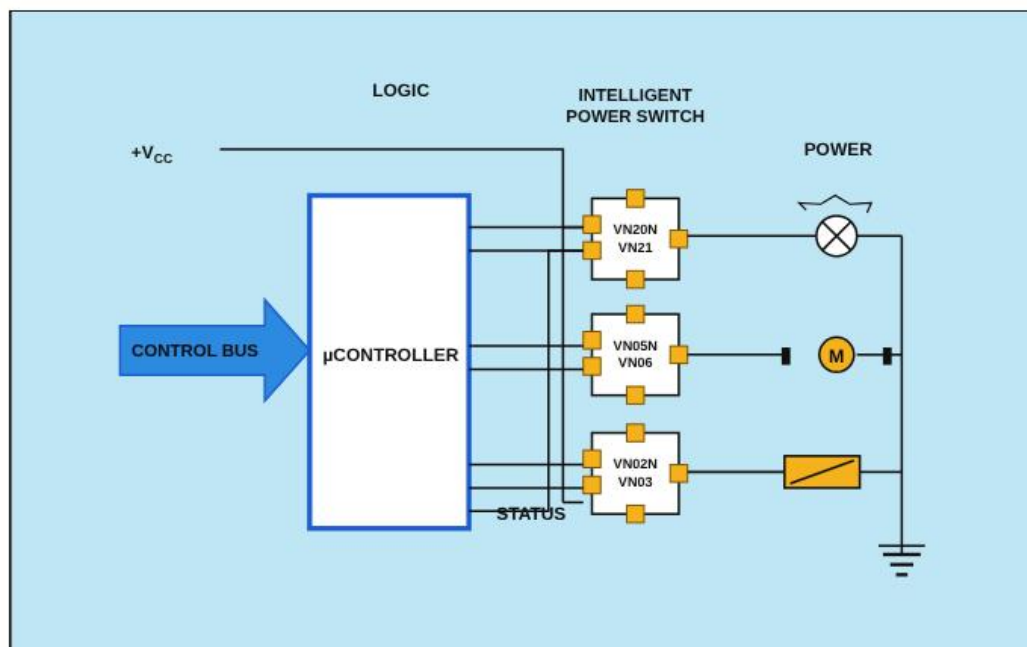
Low voltage, low power versions of VIPower circuits could find uses in the fast growing mobile battery powered equipment.

INTELLIGENT HIGH SIDE DRIVERS

The VIPower M0 technology used for making these High Side Drivers produces a monolithic silicon chip which combines control and protection circuitry with a standard power MOSFET structure, where the power stage current flows vertically. High Side Drivers are used mainly in automotive and industrial process control applications. The VN series of High Side Drivers are logic driven, fully protected switches (short circuit, over-temperature protection, etc.) with diagnostic digital feedback.

Benefits

- ▶ Compact, easy to use
- ▶ Saves PC board space
- ▶ Protects load in fault conditions
- ▶ Range of max. current, packages
- ▶ Choice of different diagnostic features



High Side Drivers Interface Between Control Logic and Power Load

The VN series offers designers a highly attractive method of controlling a variety of inductive and resistive loads.

The option of using a selection of extra features such as fast demagnetization,

status filtering, etc., makes them equally suitable for general or specialised use, typically in the automotive, consumer and industrial environments.

Multiplexed automotive systems are becoming increasingly popular because of the weight, labour and cost reduction as well as the increased reliability promised by this technology. High Side Drivers (HSDs) will replace automotive relays because of their diagnostic features and system reliability advantages.

High Side Drivers Families

The high side drivers designed specifically for automotive applications fall into four families:

- 1) The standard series, for example the VN05N and VN20N.
- 2) The ISO series. This meets the interim industry standard for high side drivers as proposed by the International Standards Organization. eg. VN06, VN21 etc.
- 3) The new multiple high side drivers implemented in the second generation VIPower M0 technology eg. VND05B, VND10B etc.

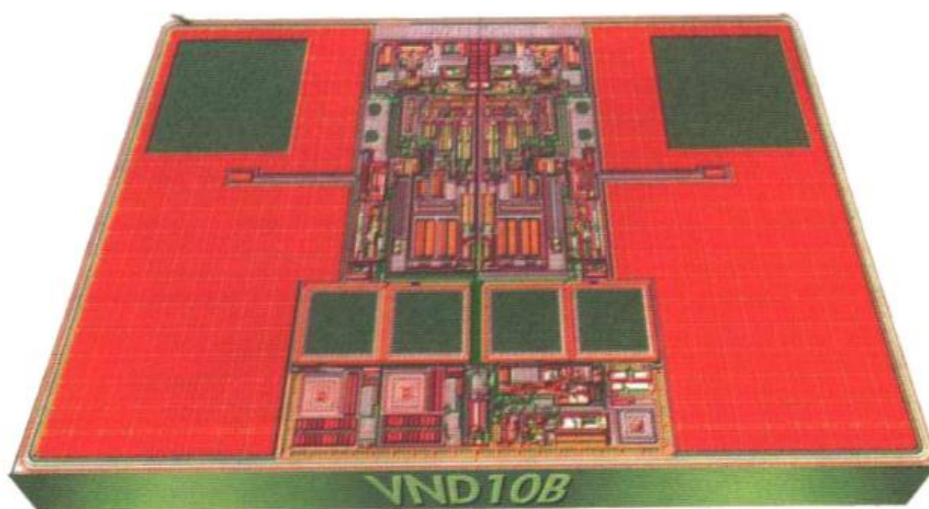
- 4) The "H" series designed also for truck/bus and other 24V automotive battery applications. eg. the VN02H.

Low Side Drivers

In addition to the high side drivers, low side drivers complementing certain high side drivers are also available. An example is the VN121SP, the low side equivalent to the VN21SP.

Automotive High Side Drivers have certain characteristic protection features such as off-state load status detection etc. For example, let us suppose a lamp controlled by the HSD has a broken filament. Even if the lamp is not turned on, this information will be conveyed by the HSD to a microcontroller making a periodic diagnostic check of all systems. This type of diagnostic feature is particularly useful in critical systems such as braking systems.

Some of the High Side Drivers have built-in fast demagnetizing circuits for inductive loads.



VND10B - A New Monolithic Dual High Side Driver

2ND GENERATION DUAL HIGH SIDE DRIVERS

The success of the VN High Side Driver family has led SGS-THOMSON to the implementation of a program of increased cost effectiveness and improved performance together with higher quality and reliability levels.

The first step in this continuous improvement program is to introduce the second generation M0 technology.

With this technology a new family of High Side Drivers has been developed, providing not only a much lower specific $R_{DS(on)}$ but also a reduction in the minimum transistor area.

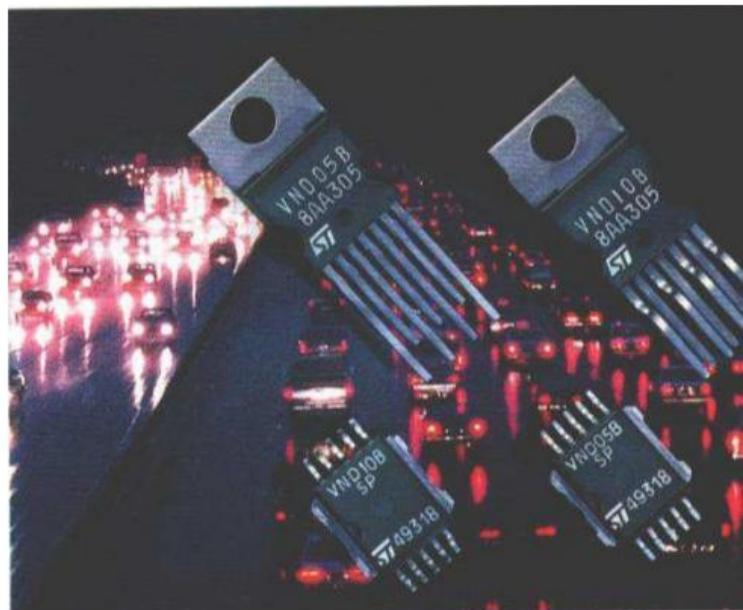
A global die size reduction of about 40%, with respect to the first generation devices has been obtained.

We can offer, in HEPTAWATT, PENTAWATT or PowerSO-10, the following options implemented monolithically:

a single 30mΩ driver,
a dual channel driver (70mΩ each)
a quad channel driver (160mΩ each)

At present, in production, we have three High Side Drivers manufactured with the second generation M0 technology.

VND05B	200mΩ	40V	HEPTAWATT/PowerSO-10
VND10B	100mΩ	40V	HEPTAWATT/PowerSO-10
VN16B	60mΩ	40V	PENTAWATT/PowerSO-10



Features

- ▶ 5V logic level compatible input
- ▶ thermal shut-down independent for each channel
- ▶ under voltage protection
- ▶ fast demagnetization of inductive load
- ▶ open load detection in off-state and in on-state condition
- ▶ "stuck-on to V_{CC} " detection

This family of devices is ideal for applications where it is necessary to drive a high number of medium and high power loads concentrating the fully protected High Side Drivers and their associated circuitry on a small PCB reaching at the same time state - of - the - art reliability and performance levels.

INDUSTRIAL & PROCESS CONTROL

The industrial control market for smart power products is another area where intelligent power circuits have tremendous potential. Many process control and numerical control applications use low voltage dc (typically 24V batteries) to drive actuators. In this market, reliability at a system level is very important. The low voltage dc process and industrial control equipment often consists of a specialized computer that controls a series of loads. The end user is given the flexibility of choosing the load on each output.

Replacing Relays

Traditionally relays are used for this application. Intelligent power high side drivers used in place of the relays can feed the status of the load back to the computer controlling the loads. For example, if there is a short circuit on one load, this information could be very

useful to the entire system. One important family of high side drivers designed specifically for this application is the VNxxAN/VN220 series of single high side drivers.

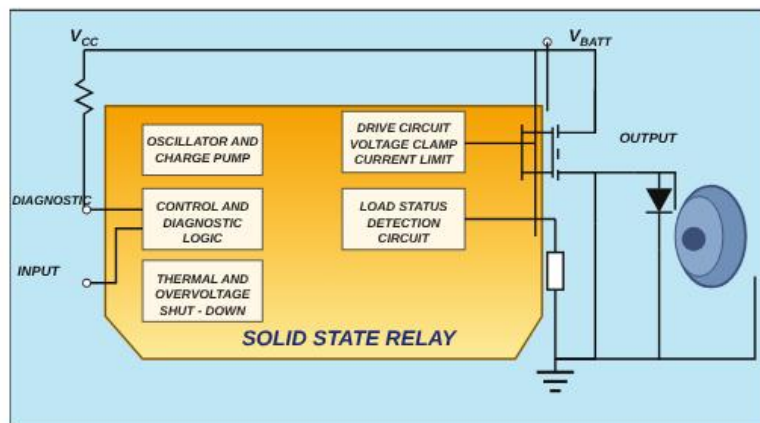
Minimizing Off-State Losses

Since these applications use several high side drivers on a single board, minimizing the power dissipated in the logic section during the off-stage is important for use of the high side switches without heatsinks.

Monolithic Multiple HSDs

Other parts in the introduction phase are the four channel high side drivers, the VN330SP / VN340SP. These devices, housed in the PowerSO-10 package, can significantly increase the system reliability. By using two channels per load, the user can provide fail-safe operation. In the unlikely event that one switch fails to actuate, the second switch can be used. This significantly increases the system reliability. The VN340SP offers thermal shutdown status feedback on the input pin for each channel.

The drastic reduction of the system cost per channel, the sophisticated protection and status features used, the versatile PowerSO-10 package, all contribute to the process control system designer preferring our multiple high side drivers over any other solution.



VIpower technology is revolutionizing solid state switches!

One single chip takes the place of traditional bulky electromechanical relays and its control circuits.

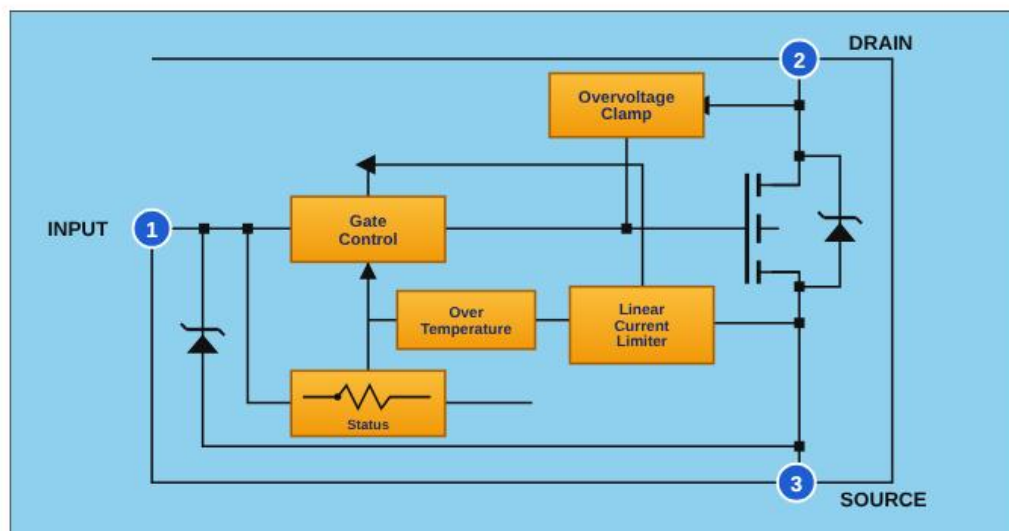
OMNIFET

Fully Autoprotected Power MOSFET



OMNIFET, the new family of fully autoprotected MOSFETs can be used in various applications. These three pin devices can directly replace TO-220 MOSFETs in existing designs. They offer comprehensive protection during abnormal operating conditions but function just like a 'dumb' MOSFET during normal operation. The OMNIFET concept has been developed using the VIPower second generation MO technology, allowing the construction of both a sophisticated NMOS logic control

stage and a high-density vertical DMOS power stage on the same chip. The resulting devices have all the advantages of a conventional discrete power MOSFET, but incorporate a wide range of logic and protection features that make them ideal replacements in dc-to-50 kHz applications where high reliability and safety levels are required. Using the OMNIFET, the system designer can realize a higher level of reliability at lower prices than possible with equivalent discrete components.



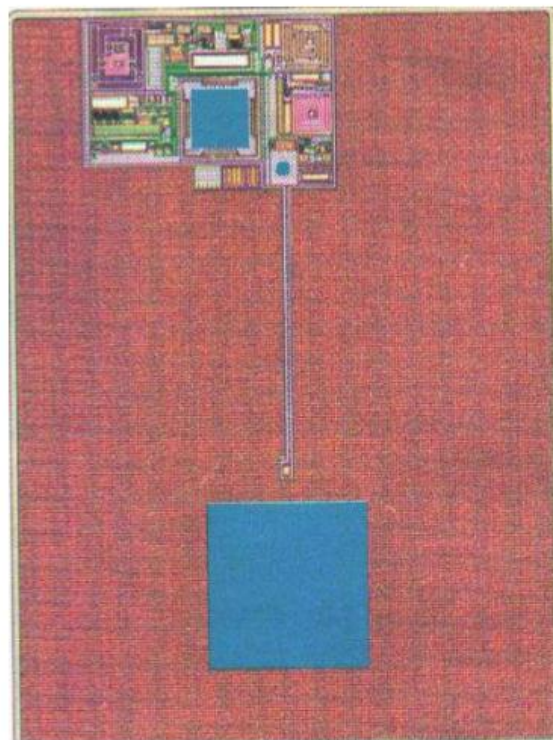
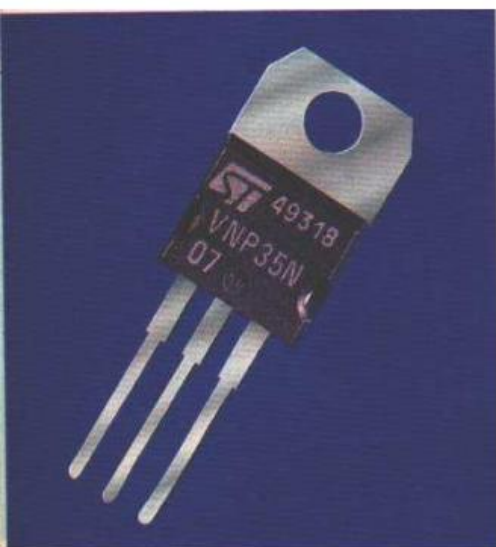
OMNIFET Block Diagram

The versatility and ease of use make OMNIFETs ideal power switches for use in all markets.

Features

- ▶ Short circuit protection.
 - ▶ Overtemperature protection.
 - ▶ Logic -Level Operation is possible.
 - ▶ ESD protection.
 - ▶ Current limit internally set.
 - ▶ Direct access to the gate of the Power MOSFET (analog driving).
 - ▶ Fast source - drain diode.
 - ▶ Status feedback reported through the input pin.
 - ▶ No external components required.
 - ▶ Very low DC supply current from the gate pin.
 - ▶ Power MOSFET avalanche energy rated.
 - ▶ Protection features (such as over temp. shutdown) work even when the device gate voltage goes to zero
-
- ▶ Overvoltage clamp handles 2 Joules for the VNP35N07

VNP35N07 - Chip Layout



OMNIFETs Available for Sampling

Type	V _{clamp} V	I _D A	R _{DS(on)} mΩ	Package
VNP35N07	70	35	28	TO-220
VNP35N07FI	70	35	28	ISOWATT220
VNV35N07	70	35	28	PowerSO-10
*VNP10N06	60	10	150	TO-220

* No status feedback; Schmitt trigger on input

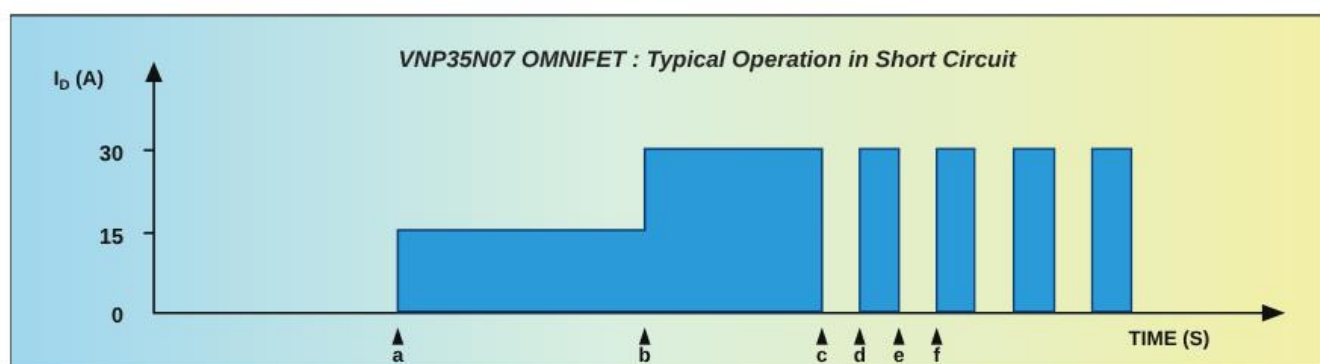
Other OMNIFET devices at clamp voltages of 70V and 42V as well as lower voltages will follow through 1994.

OMNIFET PROTECTION FEATURES

Overtemperature and Short Circuit Protection are based on sensing of the chip temperature and are not dependent on the input voltage. The location of the sensing element, in the area of the power stage, ensures fast, accurate detection of the junction temperature, a feature difficult to implement with discrete MOSFETs.

Overtemperature cut-out occurs in the range of 140°C to 180°C, with 160°C being a typical level. In case of overtemperature fault condition, the device is shut-down and **Status Feedback** is activated. The gate and source pins are connected internally by a 100Ω equivalent resistor. During normal operation, the gate current drawn by the OMNIFET is about 200 microamperes. This changes to several milliamperes during thermal shutdown. This way, shutdown can be detected by monitoring the drive power to the OMNIFET. The device is **automatically restarted** when the chip temperature falls below 125°C.

Overvoltage Clamp Protection, internally set at 70V, the VNP35N07 offers an unrivalled energy handling capability of up to 2 Joules (single pulse). This feature is mainly important when driving inductive loads. A **linear Current Limit** is also provided. Using the sensefet technique, the drain current is compared with a built-in reference. If the maximum current is exceeded, the gate drive is reduced till the current falls below the max. limit also provided. This makes the OMNIFET particularly suited to handling current spikes. An additional feature of this device is **ESD Protection** of the input pin according the Human Body Model and machine models. **Logic Level Operation** from a TTL driver circuit is also possible with a 20% increase in $R_{DS(on)}$. The intrinsic body drain diode is rated at the same current as the Power MOSFET, and it is fast enough to be used as a freewheeling diode when required by the application.



- a) Normal operation , device turned on
- b) Hard short circuit occurs. Current internally limited to 30A.
- c) Junction temperature exceeds 145°C. Device shuts down
- d) Junction temperature falls below 135°C. Device turns on again.
- e) and f) same as c) and d) respectively. Device "hiccups" till short circuit is removed.