



VNN3NV04 / VNS3NV04 VND3NV04 / VND3NV04-1

“OMNIFET II”: FULLY AUTOPROTECTED POWER MOSFET

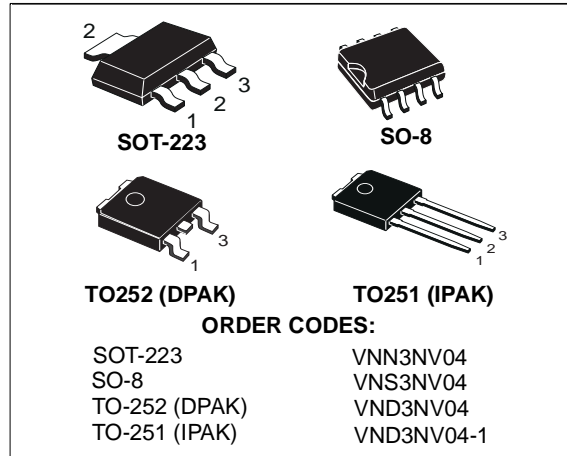
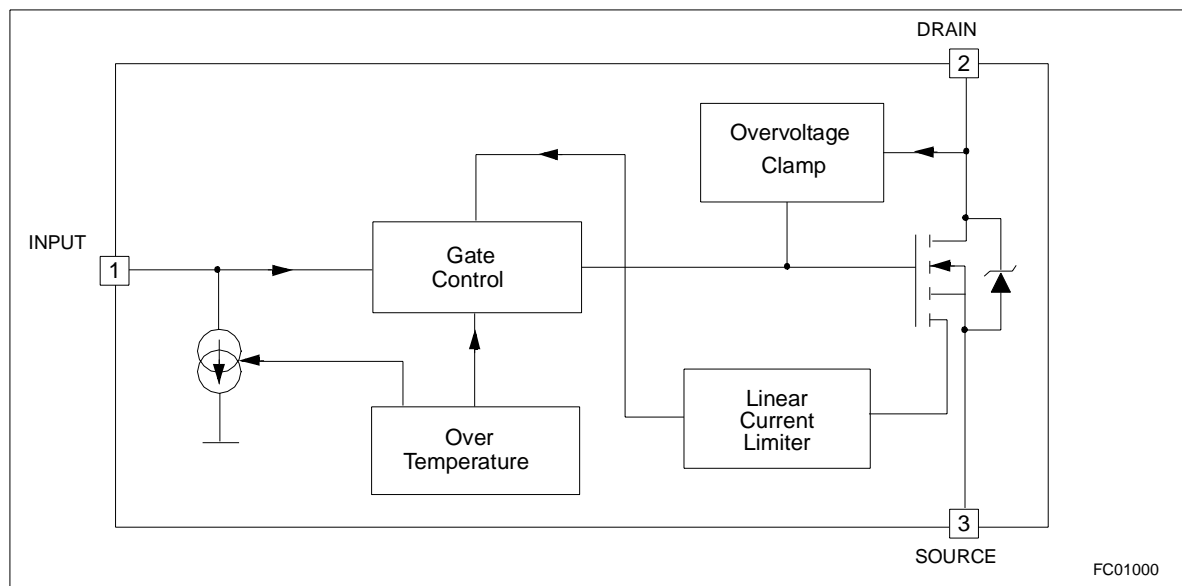
| TYPE | $R_{DS(on)}$ | I_{lim} | V_{clamp} |
|------------|--------------|-----------|-------------|
| VNN3NV04 | 120 mΩ | 3.5 A | 40 V |
| VNS3NV04 | | | |
| VND3NV04 | | | |
| VND3NV04-1 | | | |

- 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

DESCRIPTION

The VNN3NV04, VNS3NV04, VND3NV04 VND3NV04-1, are monolithic devices designed in STMicroelectronics VIPower M0-3 Technology,

BLOCK DIAGRAM



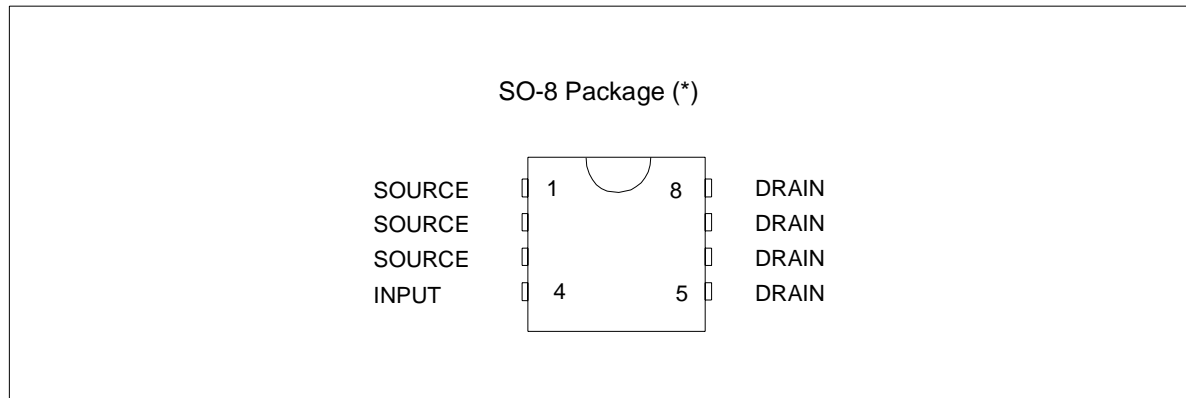
intended for replacement of standard Power MOSFETS from DC up to 50KHz applications. Built in thermal shutdown, linear current limitation and overvoltage clamp protect the chip in harsh environments.

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

ABSOLUTE MAXIMUM RATING

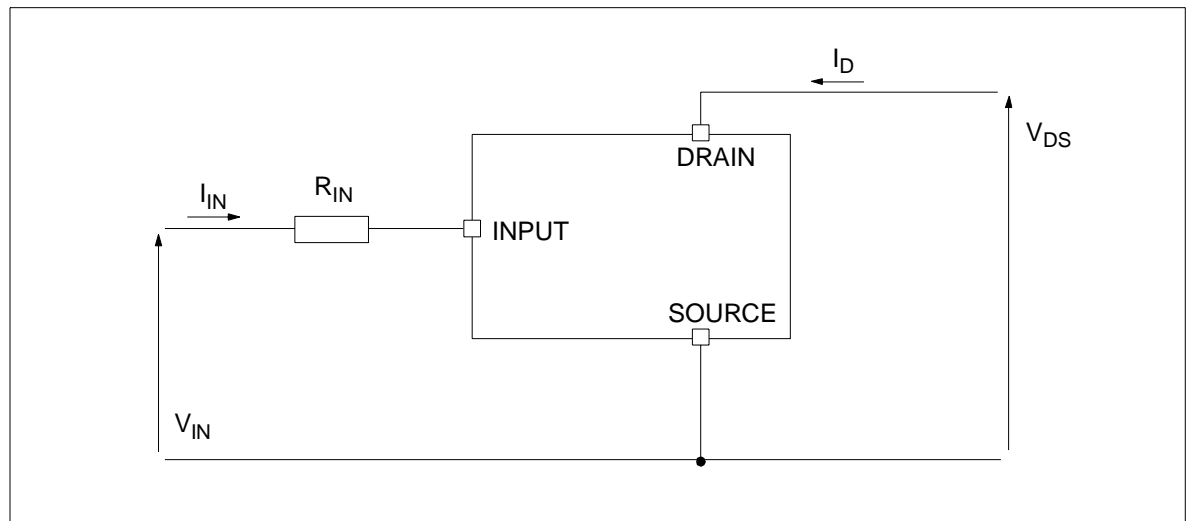
| Symbol | Parameter | Value | | | Unit |
|---------------|---|--------------------|------|-----------|------------|
| | | SOT-223 | SO-8 | DPAK/IPAK | |
| V_{DS} | Drain-source Voltage ($V_{IN}=0V$) | Internally Clamped | | | V |
| V_{IN} | Input Voltage | Internally Clamped | | | V |
| I_{IN} | Input Current | +/-20 | | | mA |
| $R_{IN\ MIN}$ | Minimum Input Series Impedance | 220 | | | Ω |
| I_D | Drain Current | Internally Limited | | | A |
| I_R | Reverse DC Output Current | -5.5 | | | A |
| V_{ESD1} | Electrostatic Discharge (R=1.5K Ω , C=100pF) | 4000 | | | V |
| V_{ESD2} | Electrostatic Discharge on output pin only (R=330 Ω , C=150pF) | 16500 | | | V |
| P_{tot} | Total Dissipation at $T_c=25^\circ C$ | 7 | 8.3 | 35 | 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 | | | $^\circ C$ |

CONNECTION DIAGRAM (TOP VIEW)



(*) For the pins configuration related to SOT-223, DPAK, IPAK see outlines at page 1.

CURRENT AND VOLTAGE CONVENTIONS



THERMAL DATA

| Symbol | Parameter | Value | | | | Unit |
|-----------------------|---|---------|-------|-------|------|------|
| | | SOT-223 | SO-8 | DKPAK | IPAK | |
| R _{thj-case} | Thermal Resistance Junction-case MAX | 18 | | 3.5 | 3.5 | °C/W |
| R _{thj-lead} | Thermal Resistance Junction-lead MAX | | 15 | | | °C/W |
| R _{thj-amb} | Thermal Resistance Junction-ambient MAX | 70(*) | 65(*) | 54(*) | 100 | °C/W |

(*) When mounted on a standard single-sided FR4 board with 50mm² of Cu (at least 35 μm thick) connected to all DRAIN pins.

ELECTRICAL CHARACTERISTICS (-40°C < T_j < 150°C, unless otherwise specified)

OFF

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Unit |
|--------------------|--|--|-----------|-----|-----------|------|
| V _{CLAMP} | Drain-source Clamp Voltage | V _{IN} =0V; I _D =1.5A | 40 | 45 | 55 | V |
| V _{CLTH} | Drain-source Clamp Threshold Voltage | V _{IN} =0V; I _D =2mA | 36 | | | V |
| V _{INTH} | Input Threshold Voltage | V _{DS} =V _{IN} ; I _D =1mA | 0.5 | | 2.5 | V |
| I _{ISS} | Supply Current from Input Pin | V _{DS} =0V; V _{IN} =5V | | 100 | 150 | μA |
| V _{INCL} | Input-Source Clamp Voltage | I _{IN} =1mA I _{IN} =-1mA | 6 -1.0 | 6.8 | 8 -0.3 | V |
| I _{DSS} | Zero Input Voltage Drain Current (V _{IN} =0V) | V _{DS} =13V; V _{IN} =0V; T _j =25°C V _{DS} =25V; V _{IN} =0V | | | 30 75 | μA |

ON

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Unit |
|---------------------|-----------------------------------|--|-----|-----|------------|------|
| R _{DS(on)} | Static Drain-source On Resistance | V _{IN} =5V; I _D =1.5A; T _j =25°C V _{IN} =5V; I _D =1.5A | | | 120 240 | mΩ |

VNN3NV04 / VNS3NV04 / VND3NV04 / VND3NV04-1

ELECTRICAL CHARACTERISTICS (continued) ($T_j=25^\circ\text{C}$, unless otherwise specified)

DYNAMIC

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Unit |
|------------|--------------------------|--|-----|-----|-----|------|
| g_{fs}^* | Forward Transconductance | $V_{DD}=13\text{V}; I_D=1.5\text{A}$ | | 5.0 | | S |
| C_{OSS} | Output Capacitance | $V_{DS}=13\text{V}; f=1\text{MHz}; V_{IN}=0\text{V}$ | | 150 | | pF |

SWITCHING

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Unit |
|----------------|-----------------------|--|-----|------|------|------------------|
| $t_{d(on)}$ | Turn-on Delay Time | $V_{DD}=15\text{V}; I_D=1.5\text{A}$ | | 90 | 300 | ns |
| t_r | Rise Time | | | 250 | 750 | ns |
| $t_{d(off)}$ | Turn-off Delay Time | $V_{gen}=5\text{V}; R_{gen}=R_{IN\ MIN}=220\Omega$ (see figure 1) | | 450 | 1350 | ns |
| t_f | Fall Time | | | 250 | 750 | ns |
| $t_{d(on)}$ | Turn-on Delay Time | $V_{DD}=15\text{V}; I_D=1.5\text{A}$ | | 0.45 | 1.35 | μs |
| t_r | Rise Time | | | 2.5 | 7.5 | μs |
| $t_{d(off)}$ | Turn-off Delay Time | $V_{gen}=5\text{V}; R_{gen}=2.2\ \text{K}\Omega$ (see figure 1) | | 3.3 | 10.0 | μs |
| t_f | Fall Time | | | 2.0 | 6.0 | μs |
| $(di/dt)_{on}$ | Turn-on Current Slope | $V_{DD}=15\text{V}; I_D=1.5\text{A}$ $V_{gen}=5\text{V}; R_{gen}=R_{IN\ MIN}=220\Omega$ | | 4.7 | | A/ μs |
| Q_i | Total Input Charge | $V_{DD}=12\text{V}; I_D=1.5\text{A}; V_{IN}=5\text{V}$ $I_{gen}=2.13\text{mA}$ (see figure 5) | | 8.5 | | nC |

SOURCE DRAIN DIODE

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Unit |
|------------|--------------------------|--|-----|-----|-----|---------------|
| V_{SD}^* | Forward On Voltage | $I_{SD}=1.5\text{A}; V_{IN}=0\text{V}$ | | 0.8 | | V |
| t_{rr} | Reverse Recovery Time | $I_{SD}=1.5\text{A}; di/dt=12\text{A}/\mu\text{s}$ | | 107 | | ns |
| Q_{rr} | Reverse Recovery Charge | $V_{DD}=30\text{V}; L=200\mu\text{H}$ | | 37 | | μC |
| I_{RRM} | Reverse Recovery Current | (see test circuit, figure 2) | | 0.7 | | A |

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 | $V_{IN}=5\text{V}; V_{DS}=13\text{V}$ | 3.5 | 5 | 7 | A |
| t_{dlim} | Step Response Current Limit | $V_{IN}=5\text{V}; V_{DS}=13\text{V}$ | | 10 | | μs |
| T_{jsh} | Overtemperature Shutdown | | 150 | 175 | 200 | $^\circ\text{C}$ |
| T_{jrs} | Overtemperature Reset | | 135 | | | $^\circ\text{C}$ |
| I_{gf} | Fault Sink Current | $V_{IN}=5\text{V}; V_{DS}=13\text{V}; T_j=T_{jsh}$ | 10 | 15 | 20 | mA |
| E_{as} | Single Pulse Avalanche Energy | starting $T_j=25^\circ\text{C}; V_{DD}=24\text{V}$ $V_{IN}=5\text{V}; R_{gen}=R_{IN\ MIN}=220\Omega; L=24\text{mH}$ (see figures 3 & 4) | 100 | | | mJ |

(*) Pulsed: Pulse duration = 300 μs , duty cycle 1.5%

PROTECTION FEATURES

During normal operation, the INPUT pin is electrically connected to the gate of the internal power MOSFET through a low impedance path.

The device then behaves like a standard power MOSFET and can be used as a switch from DC up to 50KHz. The only difference from the user's standpoint is that a small DC current I_{SS} (typ. 100 μ A) flows into the INPUT pin in order to supply the internal circuitry.

The device integrates:

- OVERVOLTAGE CLAMP PROTECTION:

internally set at 45V, 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 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} .

- 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 in the range 150 to 190 °C, a typical value being 170 °C. The device is automatically restarted when the chip temperature falls of about 15°C below shut-down temperature.

- STATUS FEEDBACK:

in the case of an overtemperature fault condition ($T_j > T_{jsh}$), the device tries to sink a diagnostic current I_{gf} through the INPUT pin in order to indicate fault condition. If driven from a low impedance source, this current may be used in order to warn the control circuit of a device shutdown. If the drive impedance is high enough so that the INPUT pin driver is not able to supply the current I_{gf} , the INPUT pin will fall to 0V. **This will not however affect the device operation: no requirement is put on the current capability of the INPUT pin driver except to be able to supply the normal operation drive current I_{SS} .**

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.

Fig.1: Switching Time Test Circuit for Resistive Load

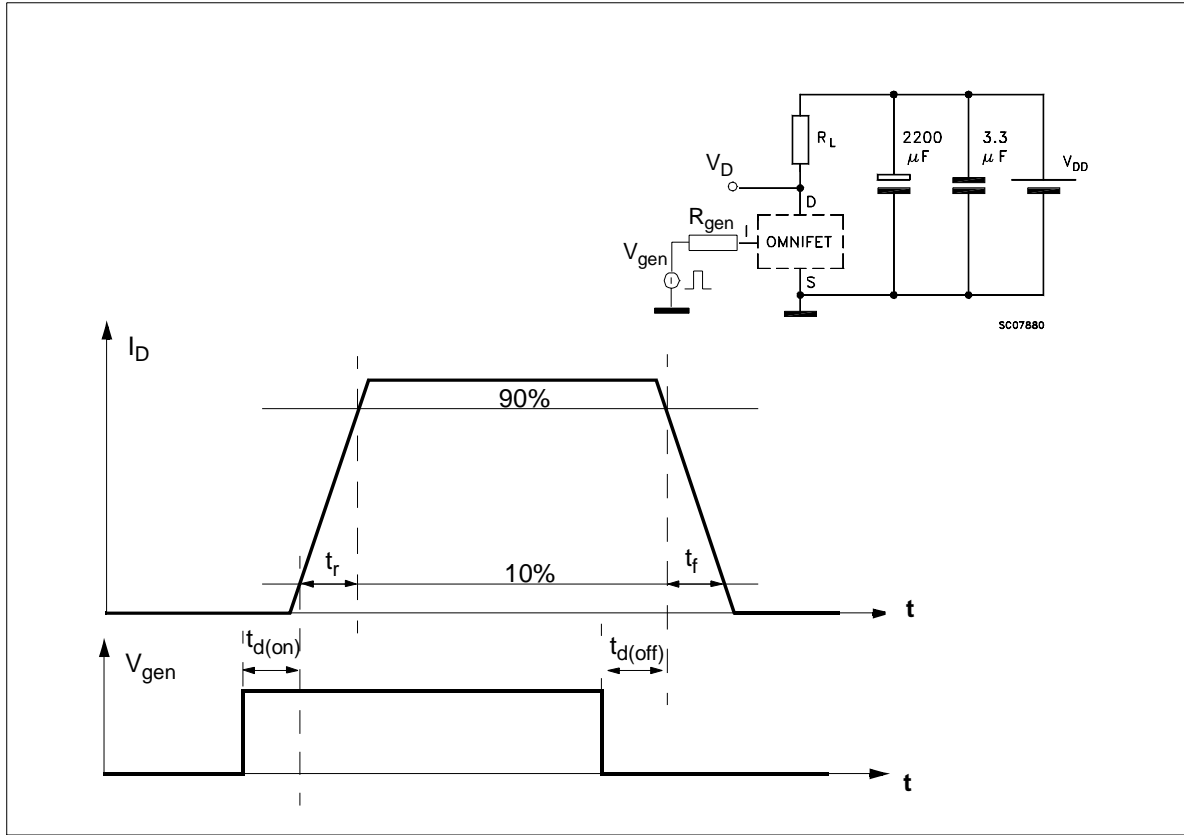
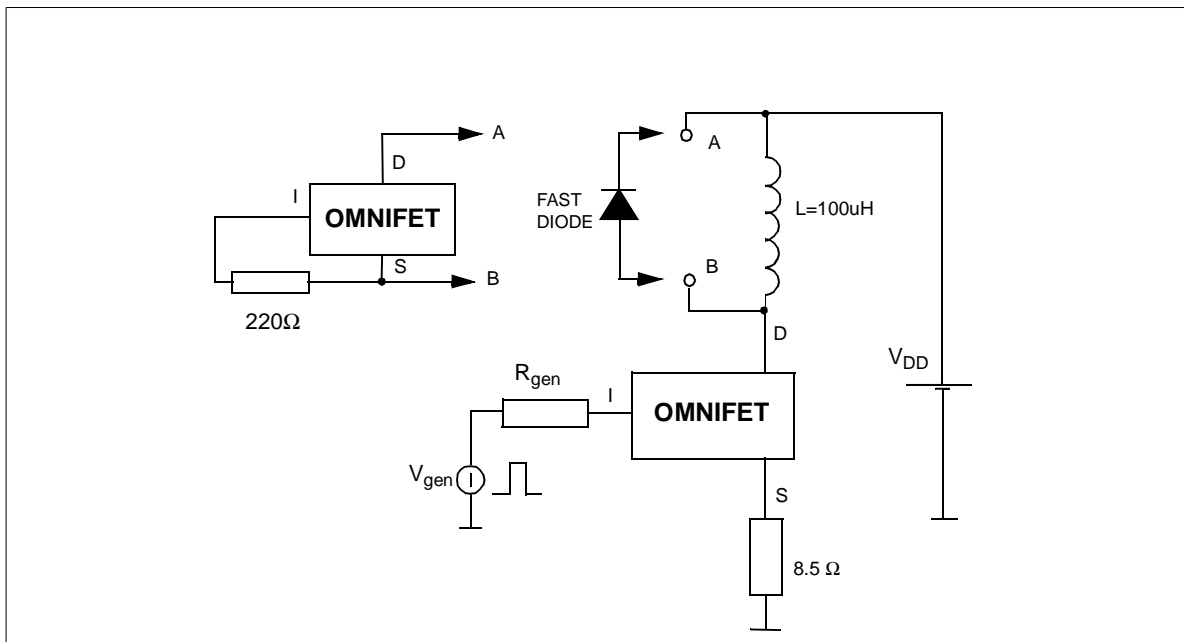
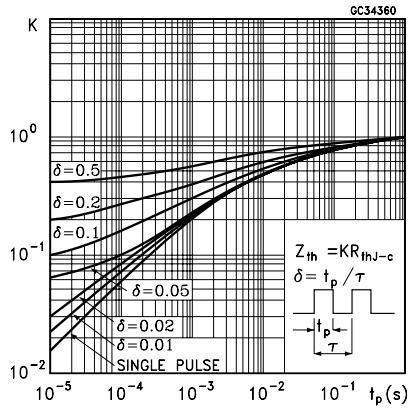


Fig.2: Test Circuit for Diode Recovery Times



Thermal Impedance for DPAK/IPAK



Thermal Impedance for SOT-223

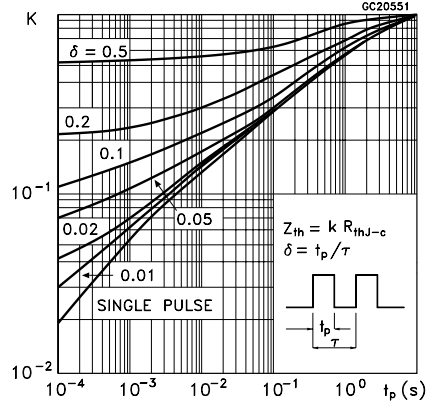


Fig. 3: Unclamped Inductive Load Test Circuits

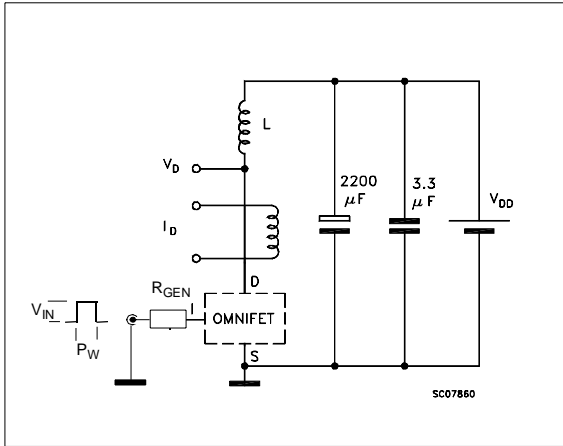


Fig. 4: Unclamped Inductive Waveforms

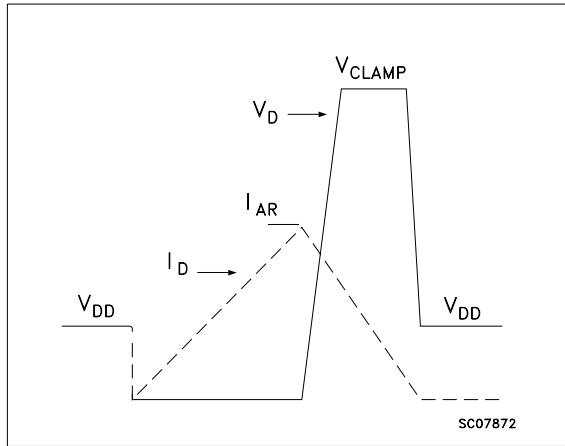
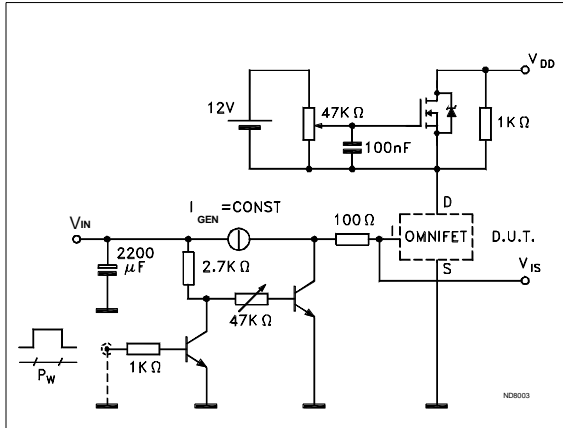
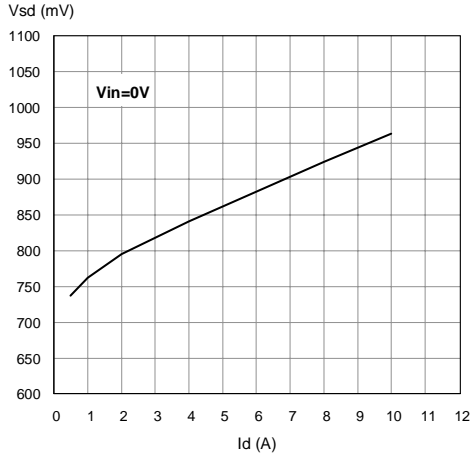


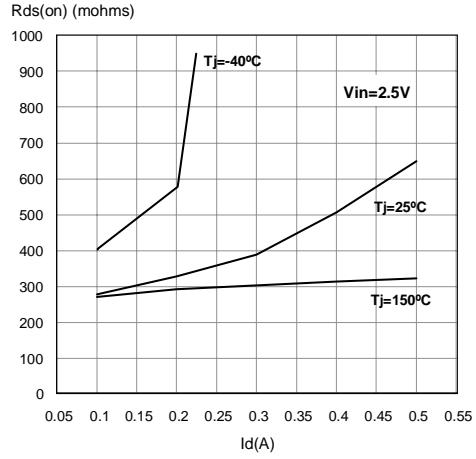
Fig. 5: Input Charge Test Circuit



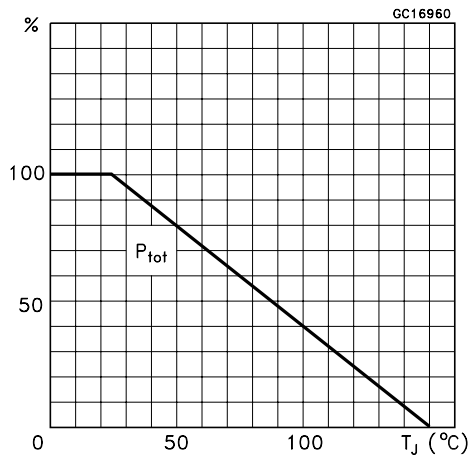
Source-Drain Diode Forward Characteristics



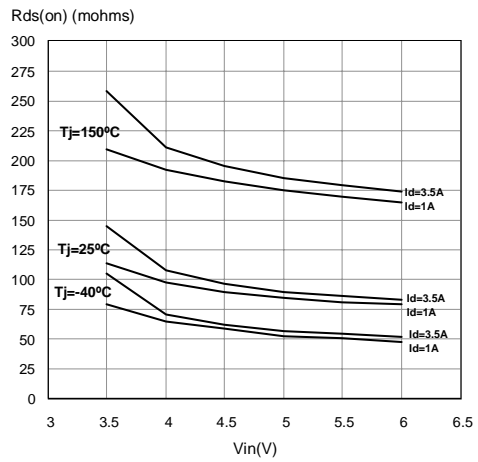
Static Drain Source On Resistance



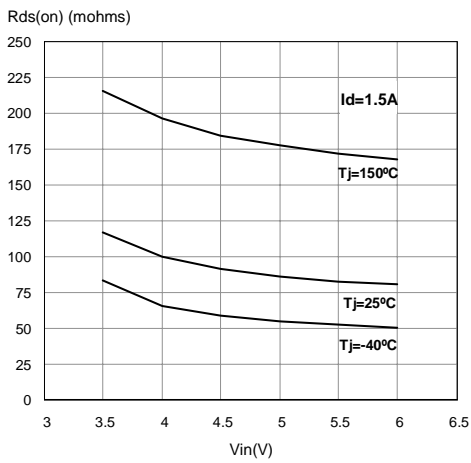
Derating Curve



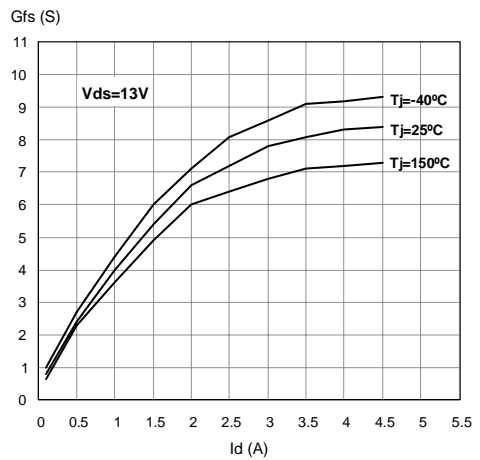
Static Drain-Source On resistance Vs. Input Voltage



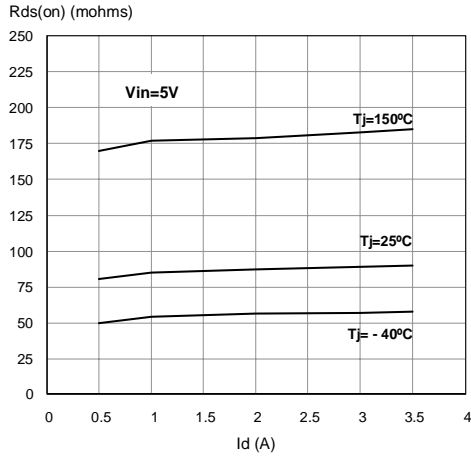
Static Drain-Source On resistance Vs. Input Voltage



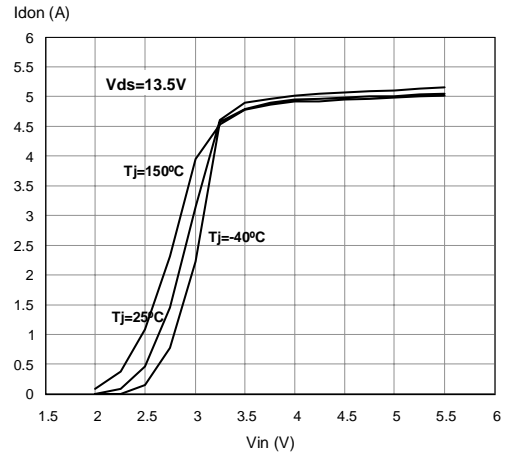
Transconductance



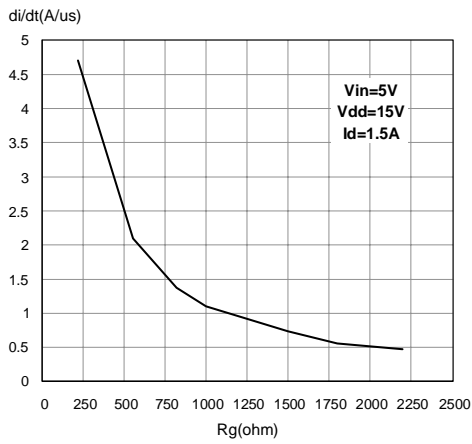
Static Drain-Source On Resistance Vs. Id



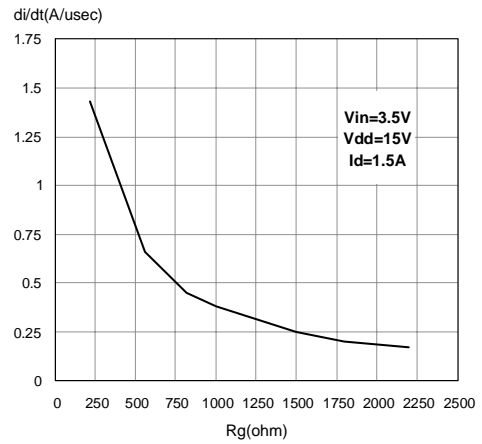
Transfer Characteristics



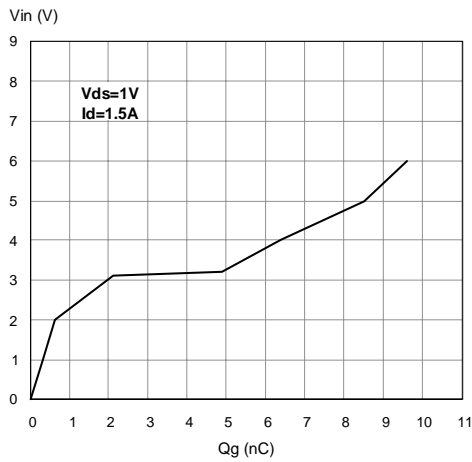
Turn On Current Slope



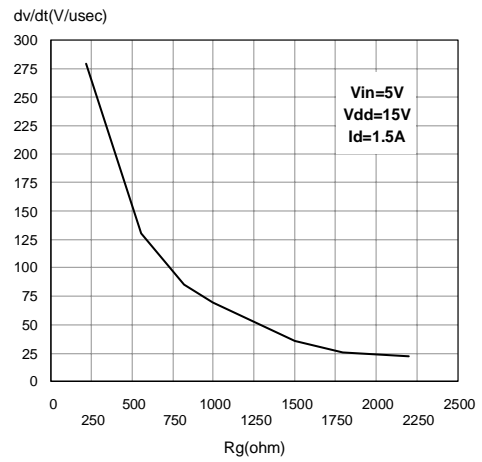
Turn On Current Slope



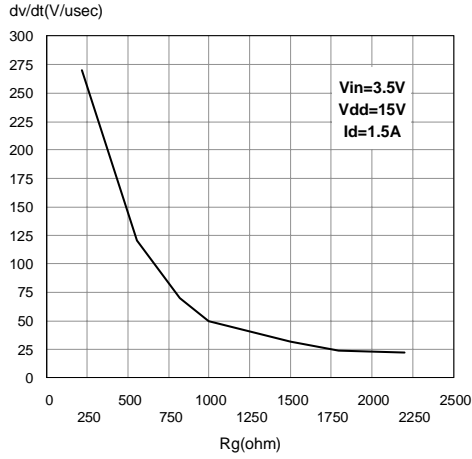
Input Voltage Vs. Input Charge



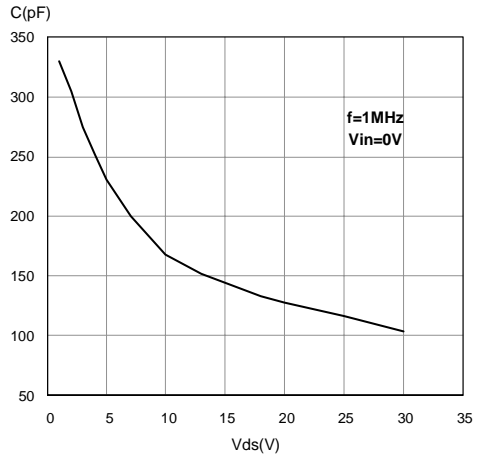
Turn off drain source voltage slope



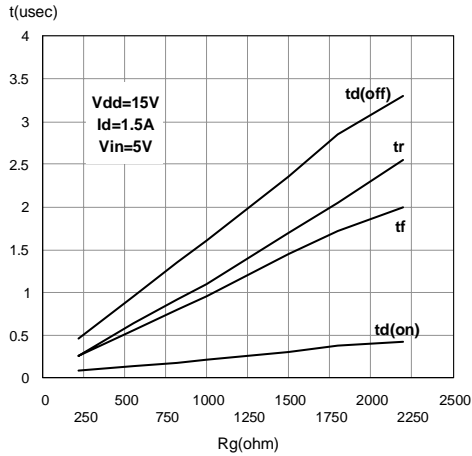
Turn Off Drain-Source Voltage Slope



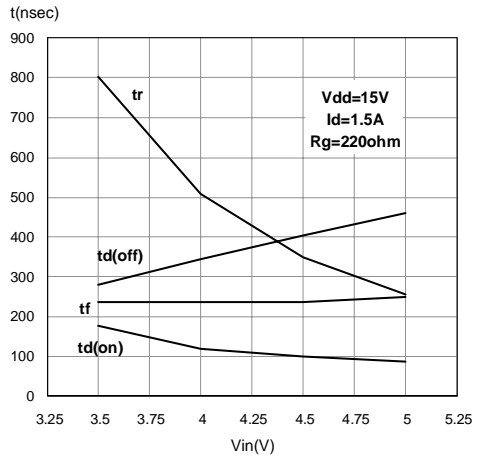
Capacitance Variations



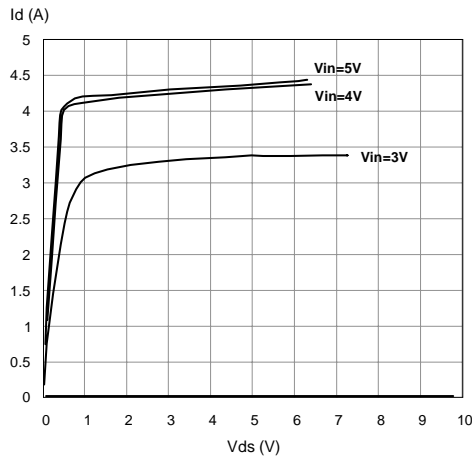
Switching Time Resistive Load



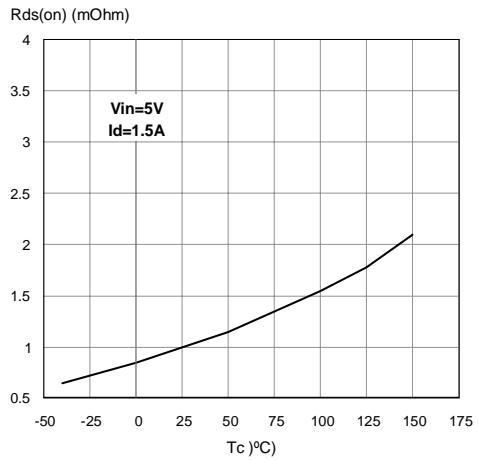
Switching Time Resistive Load



Output Characteristics

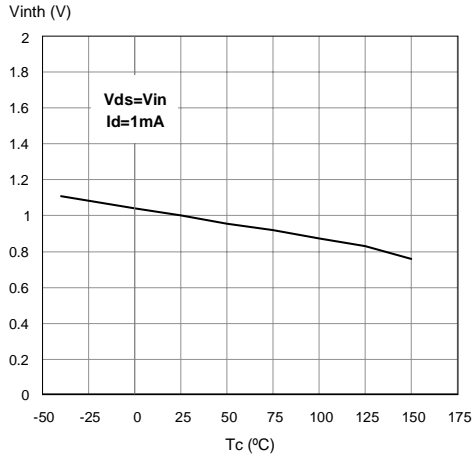


Normalized On Resistance Vs. Temperature

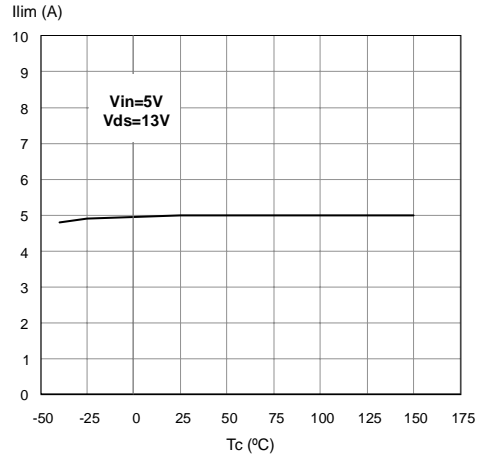


VNN3NV04 / VNS3NV04 / VND3NV04 / VND3NV04-1

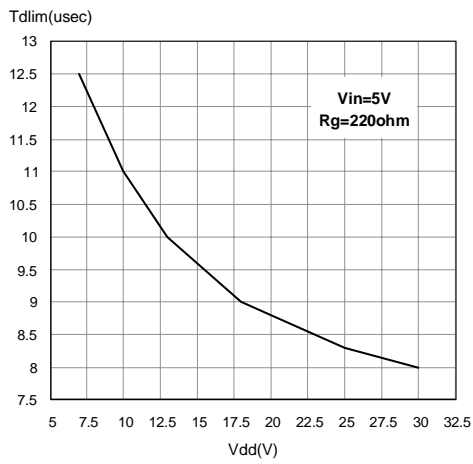
Normalized Input Threshold Voltage Vs. Junction Temperature



Normalized Current Limit Vs. Junction Temperature

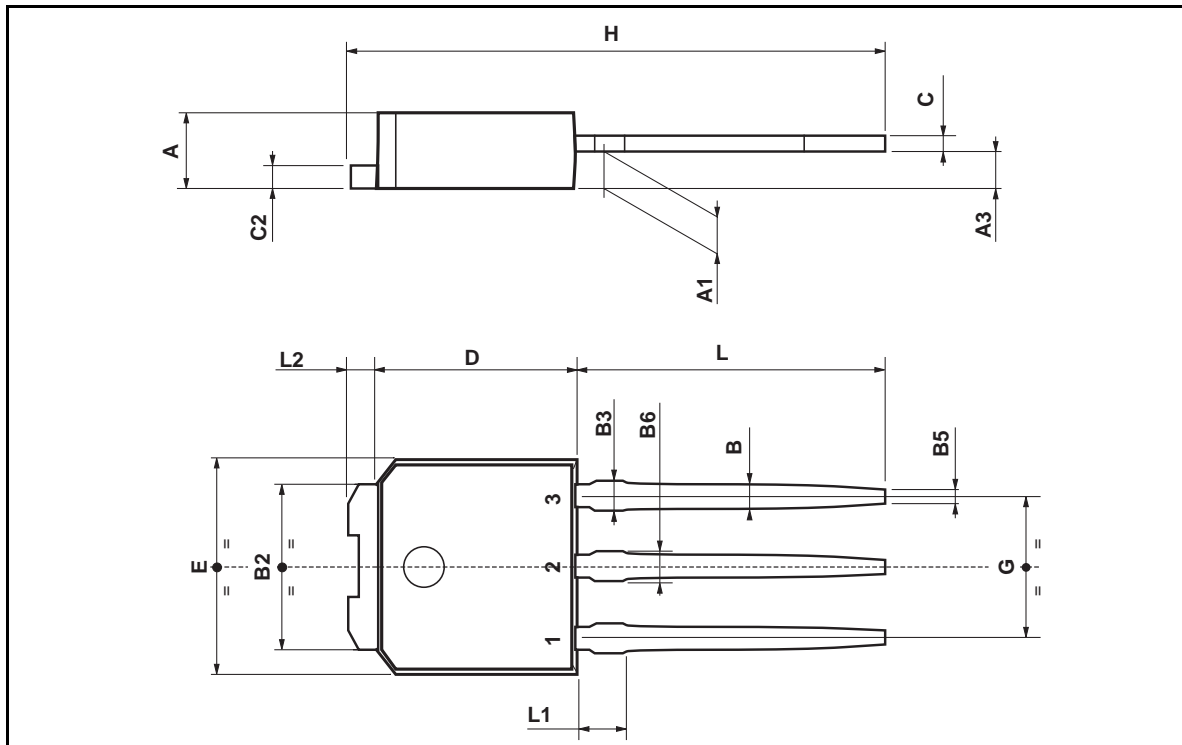


Step Response Current Limit



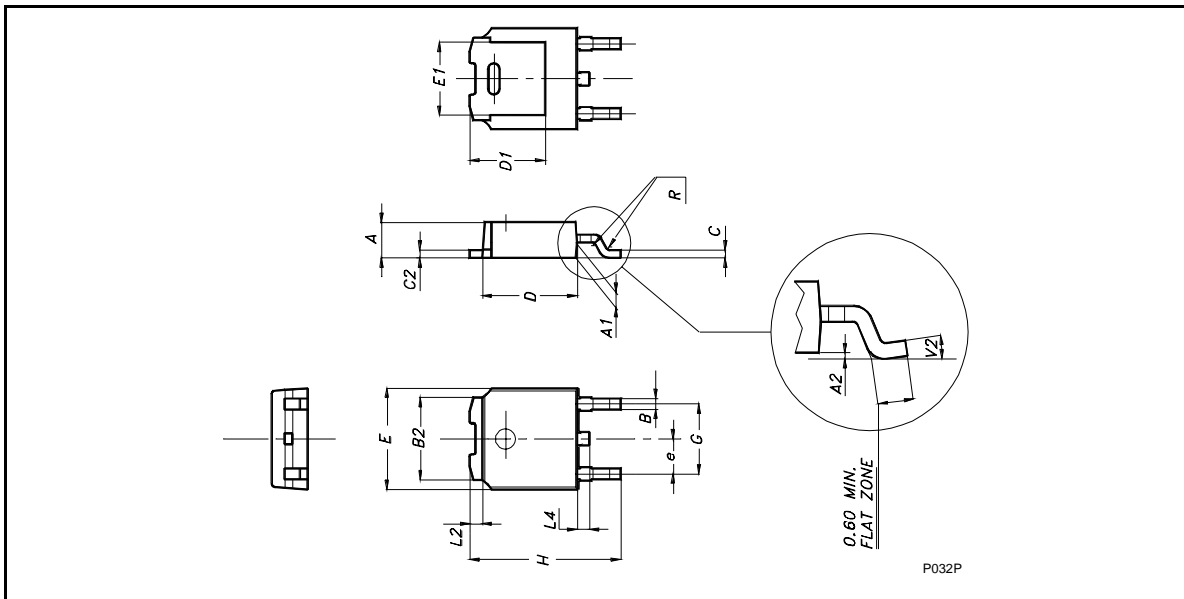
TO-251 (IPAK) MECHANICAL DATA

| DIM. | mm. | | | inch | | |
|------|------|-----|------|-------|-------|-------|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | 2.2 | | 2.4 | 0.086 | | 0.094 |
| A1 | 0.9 | | 1.1 | 0.035 | | 0.043 |
| A3 | 0.7 | | 1.3 | 0.027 | | 0.051 |
| B | 0.64 | | 0.9 | 0.025 | | 0.031 |
| B2 | 5.2 | | 5.4 | 0.204 | | 0.212 |
| B3 | | | 0.85 | | | 0.033 |
| B5 | | 0.3 | | | 0.012 | |
| B6 | | | 0.95 | | | 0.037 |
| C | 0.45 | | 0.6 | 0.017 | | 0.023 |
| C2 | 0.48 | | 0.6 | 0.019 | | 0.023 |
| D | 6 | | 6.2 | 0.236 | | 0.244 |
| E | 6.4 | | 6.6 | 0.252 | | 0.260 |
| G | 4.4 | | 4.6 | 0.173 | | 0.181 |
| H | 15.9 | | 16.3 | 0.626 | | 0.641 |
| L | 9 | | 9.4 | 0.354 | | 0.370 |
| L1 | 0.8 | | 1.2 | 0.031 | | 0.047 |
| L2 | | 0.8 | 1 | | 0.031 | 0.039 |



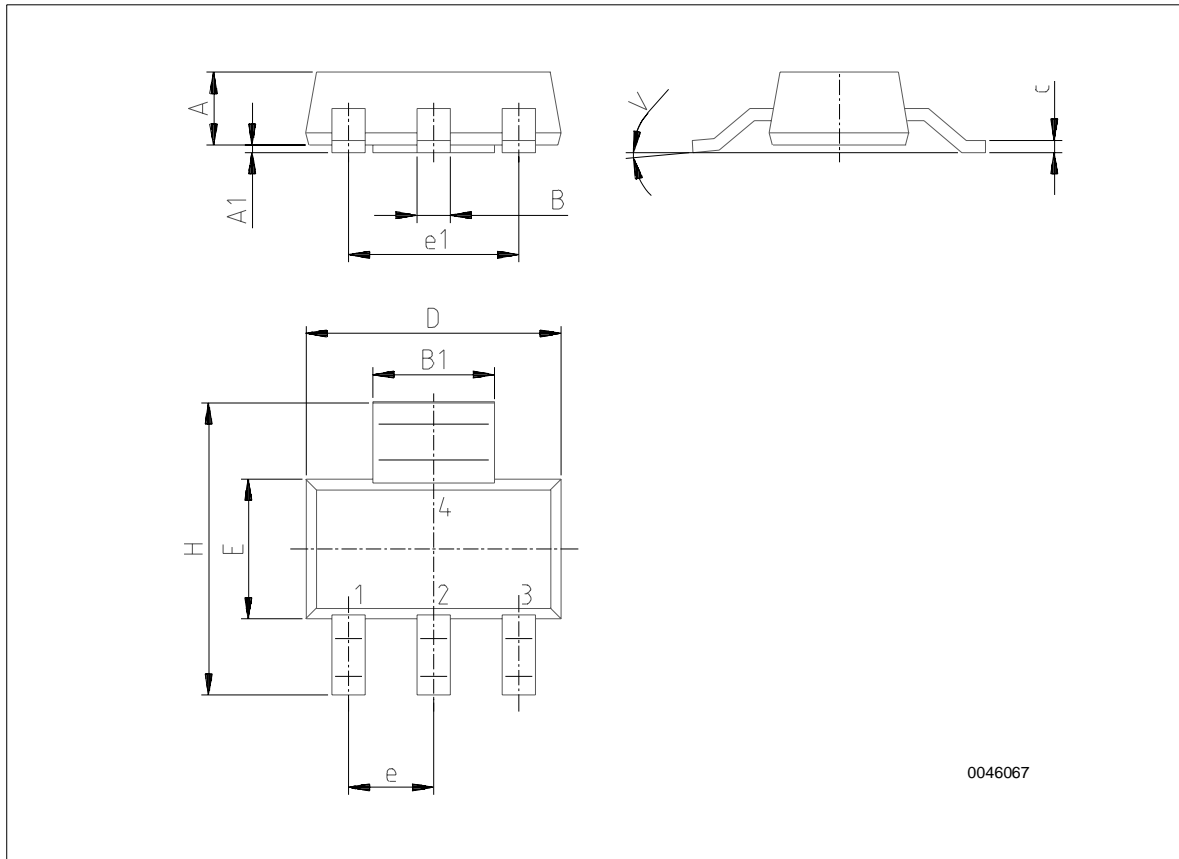
TO-252 (DPAK) MECHANICAL DATA

| 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 | | |



SOT-223 MECHANICAL DATA

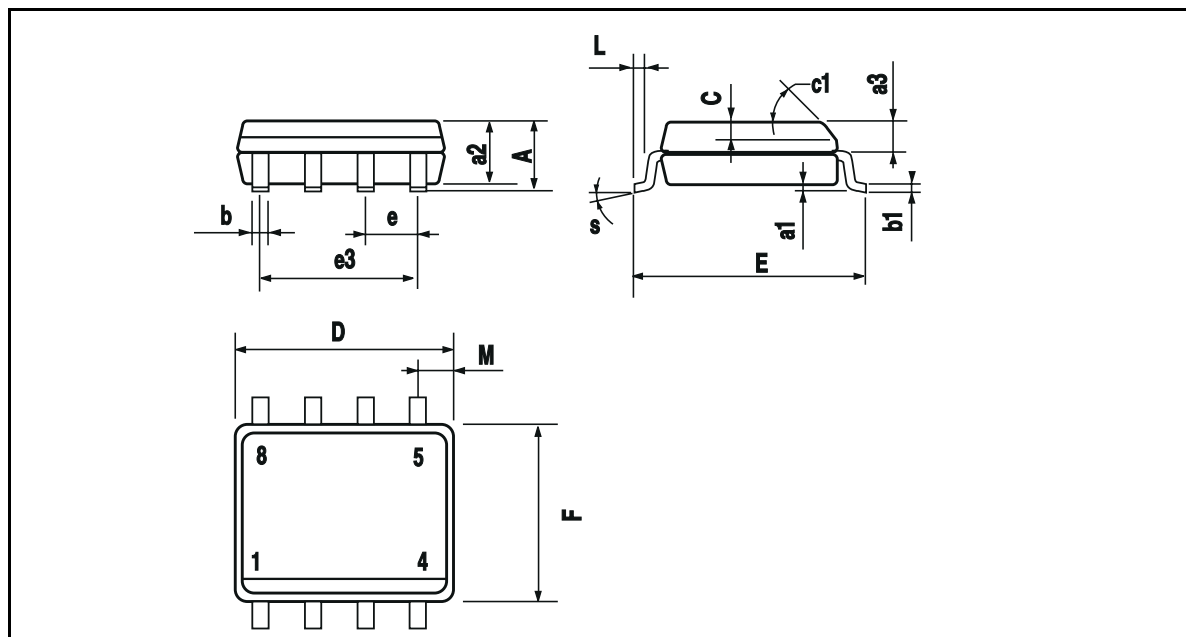
| DIM. | mm. | | | inch | | |
|------|----------|------|------|--------|-------|-------|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | | | 1.8 | | | 0.071 |
| B | 0.6 | 0.7 | 0.85 | 0.024 | 0.027 | 0.033 |
| B1 | 2.9 | 3 | 3.15 | 0.114 | 0.118 | 0.124 |
| c | 0.24 | 0.26 | 0.35 | 0.009 | 0.01 | 0.014 |
| D | 6.3 | 6.5 | 6.7 | 0.248 | 0.256 | 0.264 |
| e | | 2.3 | | | 0.09 | |
| e1 | | 4.6 | | | 0.181 | |
| E | 3.3 | 3.5 | 3.7 | 0.13 | 0.138 | 0.146 |
| H | 6.7 | 7 | 7.3 | 0.264 | 0.276 | 0.287 |
| V | 10 (max) | | | | | |
| A1 | 0.02 | | 0.1 | 0.0008 | | 0.004 |



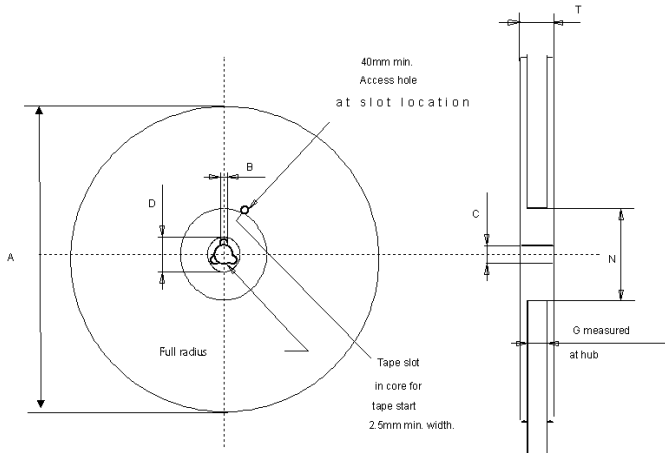
0046067

SO-8 MECHANICAL DATA

| DIM. | mm. | | | inch | | |
|------|-----------|------|------|-------|-------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | | | 1.75 | | | 0.068 |
| a1 | 0.1 | | 0.25 | 0.003 | | 0.009 |
| a2 | | | 1.65 | | | 0.064 |
| a3 | 0.65 | | 0.85 | 0.025 | | 0.033 |
| b | 0.35 | | 0.48 | 0.013 | | 0.018 |
| b1 | 0.19 | | 0.25 | 0.007 | | 0.010 |
| C | 0.25 | | 0.5 | 0.010 | | 0.019 |
| c1 | 45 (typ.) | | | | | |
| D | 4.8 | | 5.0 | 0.188 | | 0.196 |
| E | 5.8 | | 6.2 | 0.228 | | 0.244 |
| e | | 1.27 | | | 0.050 | |
| e3 | | 3.81 | | | 0.150 | |
| F | 3.8 | | 4.0 | 0.14 | | 0.157 |
| L | 0.4 | | 1.27 | 0.015 | | 0.050 |
| M | | | 0.6 | | | 0.023 |
| F | 8 (max.) | | | | | |



SOT-223 TAPE AND REEL SHIPMENT (suffix "13TR")



REEL DIMENSIONS

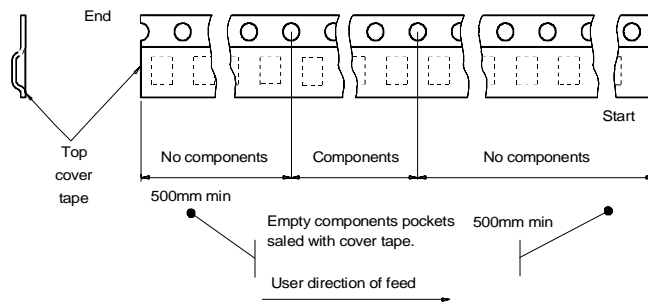
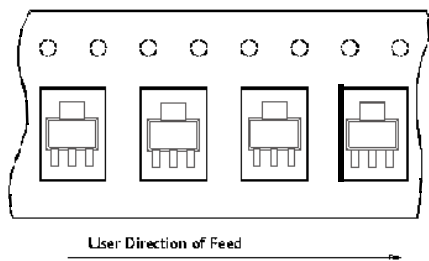
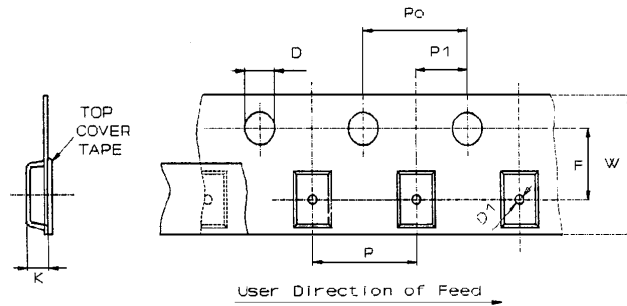
| | |
|-----------------|------|
| Base Q.ty | 1000 |
| Bulk Q.ty | 1000 |
| A (max) | 330 |
| B (min) | 1.5 |
| C (± 0.2) | 13 |
| F | 20.2 |
| G (+ 2 / -0) | 12.4 |
| N (min) | 60 |
| T (max) | 18.4 |

TAPE DIMENSIONS

According to Electronic Industries Association (EIA) Standard 481 rev. A, Feb. 1986

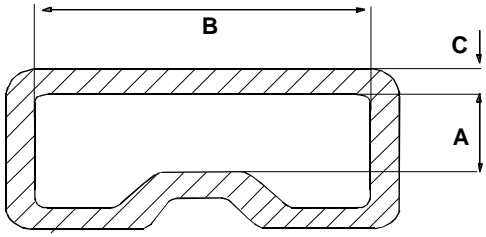
| | | |
|-------------------|--------------------|-----|
| Tape width | W | 12 |
| Tape Hole Spacing | P0 (± 0.1) | 4 |
| Component Spacing | P | 8 |
| Hole Diameter | D ($\pm 0.1/-0$) | 1.5 |
| Hole Diameter | D1 (min) | 1.5 |
| Hole Position | F (± 0.05) | 5.5 |
| Compartment Depth | K (max) | 4.5 |
| Hole Spacing | P1 (± 0.1) | 2 |

All dimensions are in mm.



VNN3NV04 / VNS3NV04 / VND3NV04 / VND3NV04-1

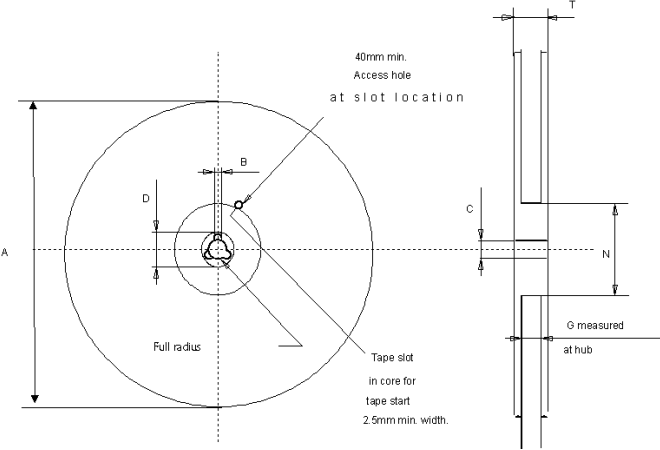
SO-8 TUBE SHIPMENT (no suffix)



| | |
|---------------------------|------|
| Base Q.ty | 100 |
| Bulk Q.ty | 2000 |
| Tube length (± 0.5) | 532 |
| A | 3.2 |
| B | 6 |
| C (± 0.1) | 0.6 |

All dimensions are in mm.

TAPE AND REEL SHIPMENT (suffix "13TR")



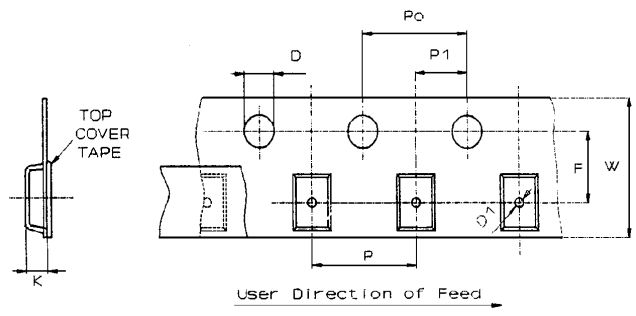
| | |
|-----------------|------|
| Base Q.ty | 2500 |
| Bulk Q.ty | 2500 |
| A (max) | 330 |
| B (min) | 1.5 |
| C (± 0.2) | 13 |
| F | 20.2 |
| G (+ 2 / -0) | 12.4 |
| N (min) | 60 |
| T (max) | 18.4 |

All dimensions are in mm.

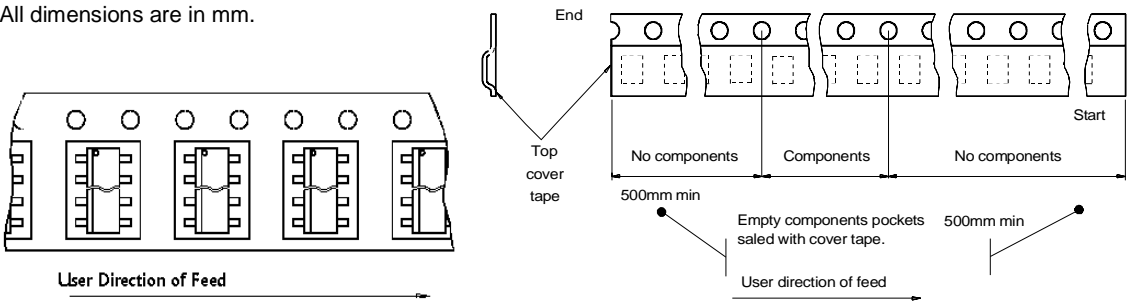
TAPE DIMENSIONS

According to Electronic Industries Association (EIA) Standard 481 rev. A, Feb 1986

| | | |
|-------------------|--------------------|-----|
| Tape width | W | 12 |
| Tape Hole Spacing | P0 (± 0.1) | 4 |
| Component Spacing | P | 8 |
| Hole Diameter | D ($\pm 0.1/-0$) | 1.5 |
| Hole Diameter | D1 (min) | 1.5 |
| Hole Position | F (± 0.05) | 5.5 |
| Compartment Depth | K (max) | 4.5 |
| Hole Spacing | P1 (± 0.1) | 2 |



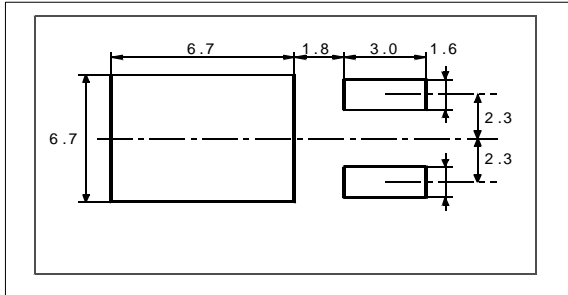
All dimensions are in mm.



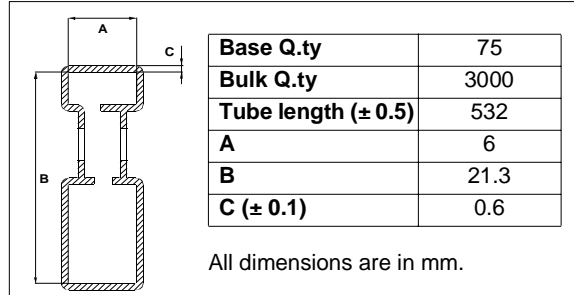
User Direction of Feed

User direction of feed

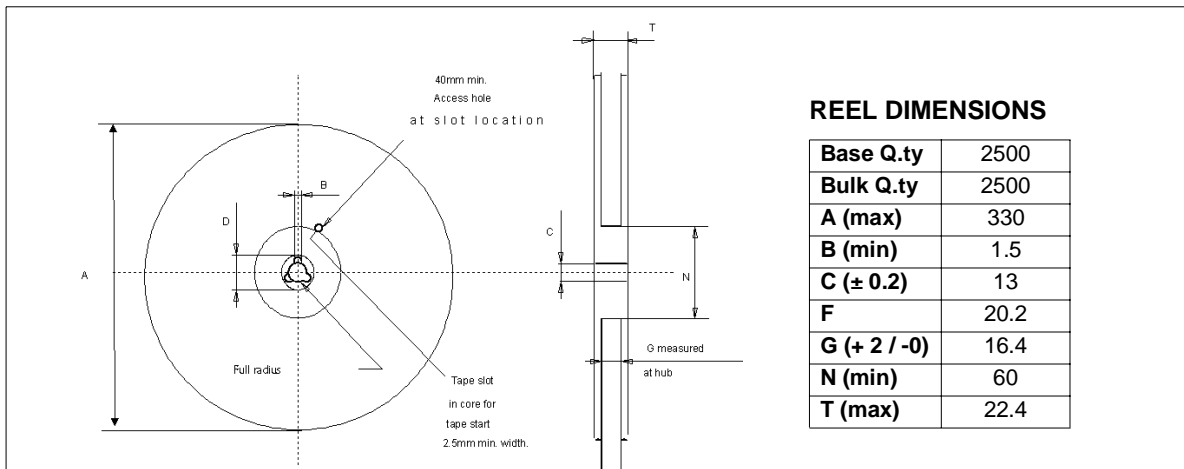
DPAK FOOTPRINT



TUBE SHIPMENT (no suffix)



TAPE AND REEL SHIPMENT (suffix "13TR")

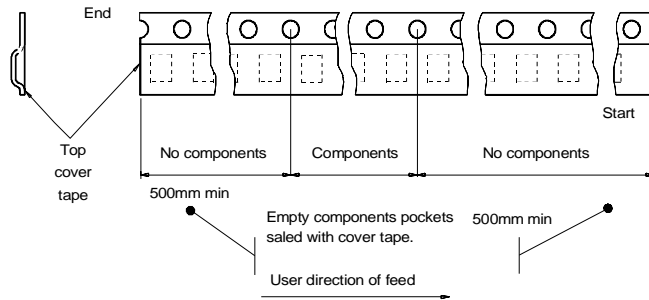
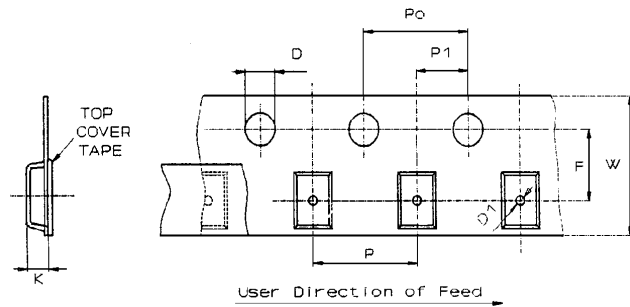
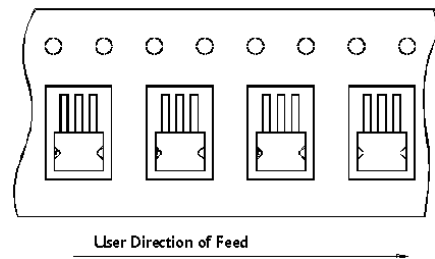


TAPE DIMENSIONS

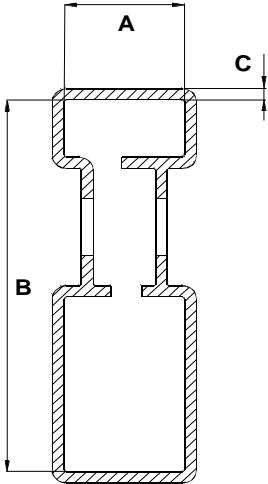
According to Electronic Industries Association (EIA) Standard 481 rev. A, Feb 1986

| | | |
|-------------------|--------------------|-----|
| Tape width | W | 16 |
| Tape Hole Spacing | P0 (± 0.1) | 4 |
| Component Spacing | P | 8 |
| Hole Diameter | D ($\pm 0.1/-0$) | 1.5 |
| Hole Diameter | D1 (min) | 1.5 |
| Hole Position | F (± 0.05) | 7.5 |
| Compartment Depth | K (max) | 6.5 |
| Hole Spacing | P1 (± 0.1) | 2 |

All dimensions are in mm.



IPAK TUBE SHIPMENT (no suffix)



| | |
|---------------------------|------|
| Base Q.ty | 75 |
| Bulk Q.ty | 3000 |
| Tube length (± 0.5) | 532 |
| A | 6 |
| B | 21.3 |
| C (± 0.1) | 0.6 |

All dimensions are in mm.

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