# VP2106

## P-Channel Enhancement-Mode Vertical DMOS FET

### Features

- Free from Secondary Breakdown
- Low Power Drive Requirement
- Ease of Paralleling
- Low $C_{ISS}$ and Fast Switching Speeds
- Excellent Thermal Stability
- Integral Source-Drain Diode
- High Input Impedance and High Gain

### Applications

- Motor Controls
- Converters
- Amplifiers
- Switches
- Power Supply Circuits
- Drivers (Relays, Hammers, Solenoids, Lamps, Memories, Displays, Bipolar Transistors, etc.)

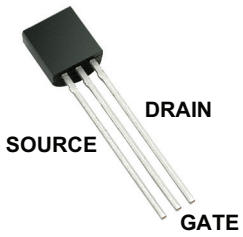
### General Description

The VP2106 Enhancement-mode (normally-off) transistors use a vertical DMOS structure and a well-proven silicon-gate manufacturing process. This combination produces a device with the power handling capabilities of bipolar transistors and the high input impedance and positive temperature coefficient inherent in MOS devices. Characteristic of all MOS structures, these devices are free from thermal runaway and thermally induced secondary breakdown.

Microchip's vertical DMOS FETs are ideally suited for a wide range of switching and amplifying applications where very low threshold voltage, high breakdown voltage, high input impedance, low input capacitance, and fast switching speeds are desired.

### Package Type

**3-lead TO-92**
(Top view)




See Table 3-1 for pin information.

## 1.0 ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings†

Drain-to-Source Voltage ..... $BV_{DSS}$
Drain-to-Gate Voltage ..... $BV_{DGS}$
Gate-to-Source Voltage ..... ±20V
Operating Ambient Temperature, $T_A$ ..... –55°C to +150°C
Storage Temperature, $T_S$ ..... –55°C to +150°C

**† Notice:** Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only, and functional operation of the device at those or any other conditions above those indicated in the operational sections of this specification is not intended. Exposure to maximum rating conditions for extended periods may affect device reliability.

## DC ELECTRICAL CHARACTERISTICS

**Electrical Specifications:** $T_A$ = 25°C unless otherwise specified. All DC parameters are 100% tested at 25°C unless otherwise stated. Pulse test: 300 µs pulse, 2% duty cycle

| Parameter | Sym. | Min. | Typ. | Max. | Unit | Conditions |
|---|---|---|---|---|---|---|
| Drain-to-Source Breakdown Voltage | $BV_{DSS}$ | –60 | — | — | V | $V_{GS}$ = 0V, $I_D$ = –1 mA |
| Gate Threshold Voltage | $V_{GS(th)}$ | –1.5 | — | –3.5 | V | $V_{GS}$ = $V_{DS}$, $I_D$ = –1 mA |
| Change in $V_{GS(th)}$ with Temperature | $\Delta V_{GS(th)}$ | — | 5.8 | 6.5 | mV/°C | $V_{GS}$ = $V_{DS}$, $I_D$ = –1 mA (**Note 1**) |
| Gate Body Leakage Current | $I_{GSS}$ | — | –1 | –100 | nA | $V_{GS}$ = ±20V, $V_{DS}$ = 0V |
| Zero-Gate Voltage Drain Current | $I_{DSS}$ | — | — | –10 | µA | $V_{GS}$ = 0V, $V_{DS}$ = Maximum rating |
| | | — | — | –1 | mA | $V_{DS}$ = 0.8 Maximum rating, $V_{GS}$ = 0V, $T_A$ = 125°C (**Note 1**) |
| On-State Drain Current | $I_{D(ON)}$ | –0.5 | –1 | — | A | $V_{GS}$ = –10V, $V_{DS}$ = –25V |
| Static Drain-to-Source On-State Resistance | $R_{DS(ON)}$ | — | 11 | 15 | Ω | $V_{GS}$ = –5V, $I_D$ = –100 mA |
| | | — | 9 | 12 | Ω | $V_{GS}$ = –10V, $I_D$ = –500 mA |
| Change in $R_{DS(ON)}$ with Temperature | $\Delta R_{DS(ON)}$ | — | 0.55 | 1 | %/°C | $V_{GS}$ = –10V, $I_D$ = –500 mA (**Note 1**) |

**Note 1:** Specification is obtained by characterization and is not 100% tested.

## AC ELECTRICAL CHARACTERISTICS

| **Electrical Specifications:** $T_A$ = 25°C unless otherwise specified. All AC parameters are not 100% sample tested. | | | | | | |
|---|---|---|---|---|---|---|
| **Parameter** | **Sym.** | **Min.** | **Typ.** | **Max.** | **Unit** | **Conditions** |
| Forward Transconductance | $G_{FS}$ | 150 | 200 | — | mmho | $V_{DS}$ = –25V, $I_D$ = –500 mA |
| Input Capacitance | $C_{ISS}$ | — | 45 | 60 | pF | $V_{GS}$ = 0V, $V_{DS}$ = –25V, f = 1 MHz |
| Common-Source Output Capacitance | $C_{OSS}$ | — | 22 | 30 | pF | |
| Reverse Transfer Capacitance | $C_{RSS}$ | — | 3 | 8 | pF | |
| Turn-On Delay Time | $t_{d(ON)}$ | — | 4 | 5 | ns | $V_{DD}$ = –25V, $I_D$ = –500 mA, $R_{GEN}$ = 25Ω |
| Rise Time | $t_r$ | — | 5 | 8 | ns | |
| Turn-Off Delay Time | $t_{d(OFF)}$ | — | 5 | 9 | ns | |
| Fall Time | $t_f$ | — | 4 | 8 | ns | |
| **DIODE PARAMETER** | | | | | | |
| Diode Forward Voltage Drop | $V_{SD}$ | — | –1.2 | –2 | V | $V_{GS}$ = 0V, $I_{SD}$ = –500 mA (**Note 1**) |
| Reverse Recovery Time | $t_{rr}$ | — | 400 | — | ns | $V_{GS}$ = 0V, $I_{SD}$ = –500 mA |

**Note 1:** Unless otherwise stated, all DC parameters are 100% tested at 25°C. Pulse test: 300 µs pulse, 2% duty cycle

## TEMPERATURE SPECIFICATIONS

| **Parameter** | **Sym.** | **Min.** | **Typ.** | **Max.** | **Unit** | **Conditions** |
|---|---|---|---|---|---|---|
| **TEMPERATURE RANGE** | | | | | | |
| Operating Ambient Temperature | $T_A$ | –55 | — | +150 | °C | |
| Storage Temperature | $T_S$ | –55 | — | +150 | °C | |
| **PACKAGE THERMAL RESISTANCE** | | | | | | |
| 3-lead TO-92 | $\theta_{JA}$ | — | 132 | — | °C/W | |

## THERMAL CHARACTERISTICS

| **Package** | **$I_D$ (Note 1) (Continuous) (mA)** | **$I_D$ (Pulsed) (mA)** | **Power Dissipation at $T_A$ = 25°C (W)** | **$I_{DR}$ (Note 1) (mA)** | **$I_{DRM}$ (mA)** |
|---|---|---|---|---|---|
| 3-lead TO-92 | –250 | –800 | 1 | –250 | –800 |

**Note 1:** $I_D$ (continuous) is limited by maximum rated $T_J$.

## 2.0 TYPICAL PERFORMANCE CURVES

**Note:** The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g. outside specified power supply range) and therefore outside the warranted range.

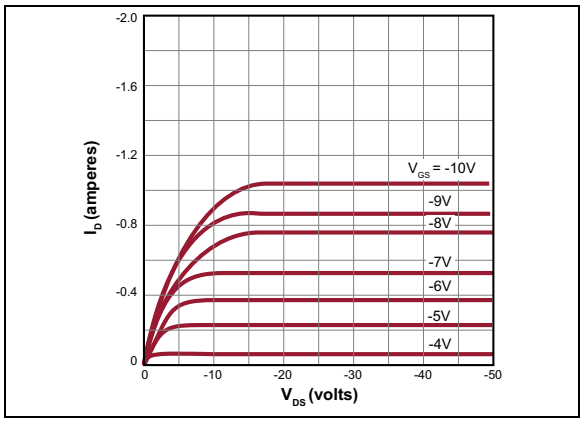



***FIGURE 2-1:*** *Output Characteristics.*

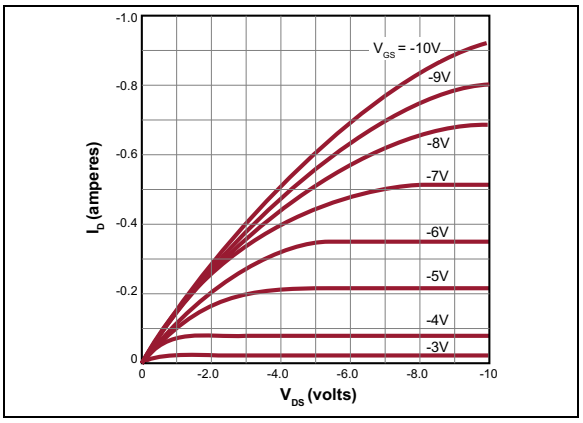



***FIGURE 2-4:*** *Saturation Characteristics.*

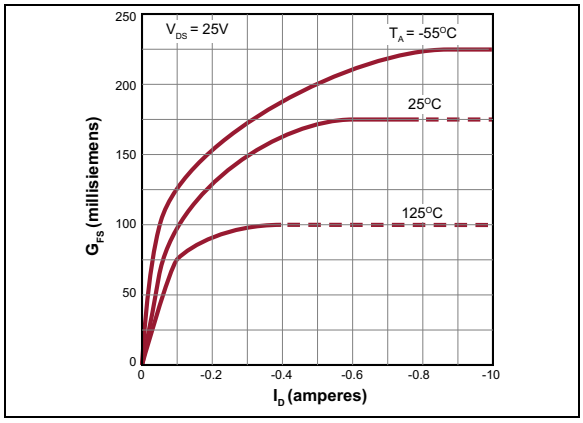



***FIGURE 2-2:*** *Transconductance vs. Drain Current.*

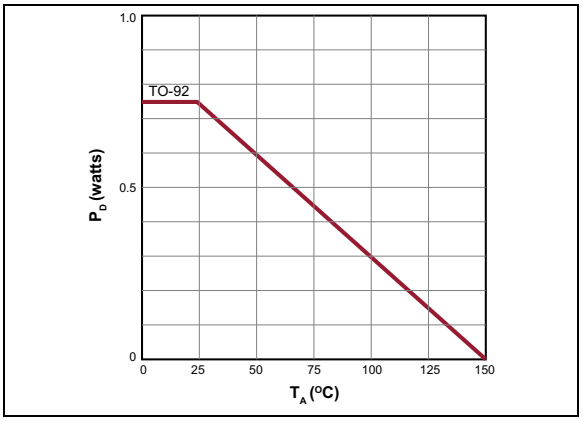



***FIGURE 2-5:*** *Power Dissipation vs. Ambient Temperature.*

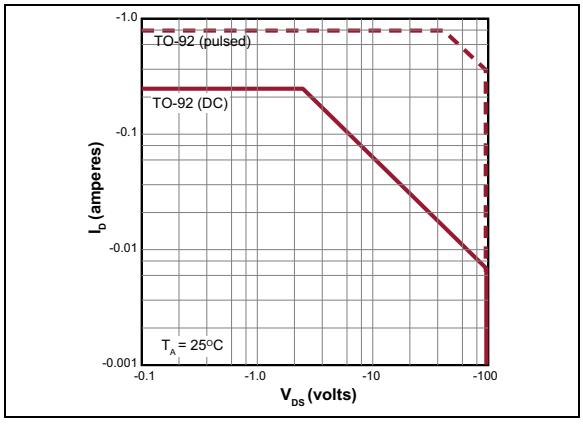



***FIGURE 2-3:*** *Maximum Rated Safe Operating Area.*

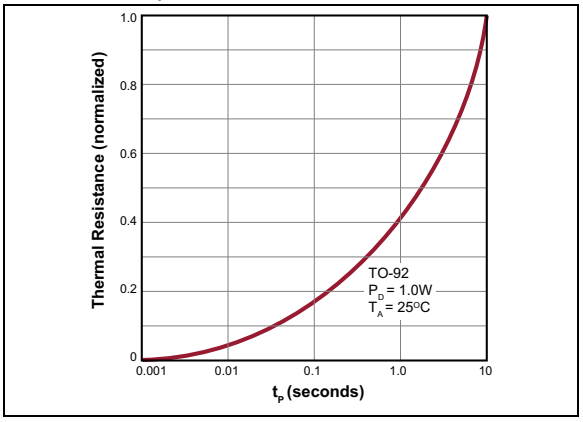



***FIGURE 2-6:*** *Thermal Response Characteristics.*

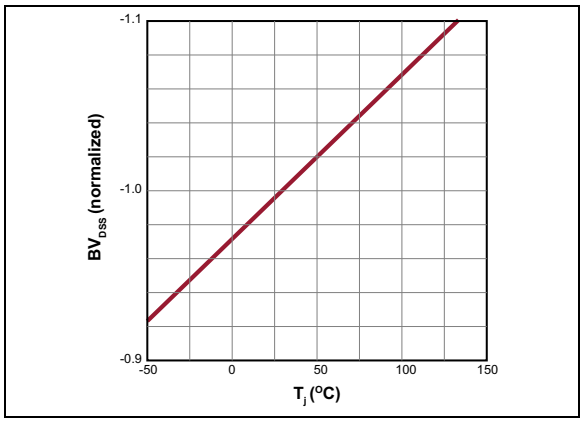



***FIGURE 2-7:*** *$BV_{DSS}$ Variation with Temperature.*

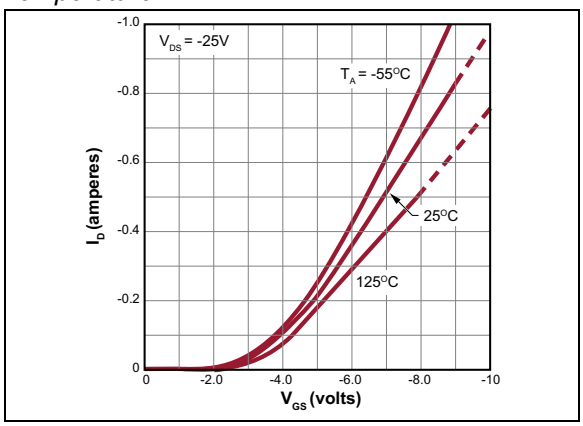



***FIGURE 2-8:*** *Transfer Characteristics.*

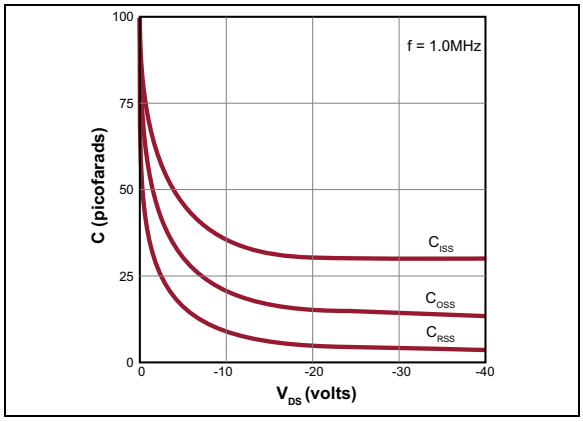



***FIGURE 2-9:*** *Capacitance vs. Drain-to-Source Voltage.*

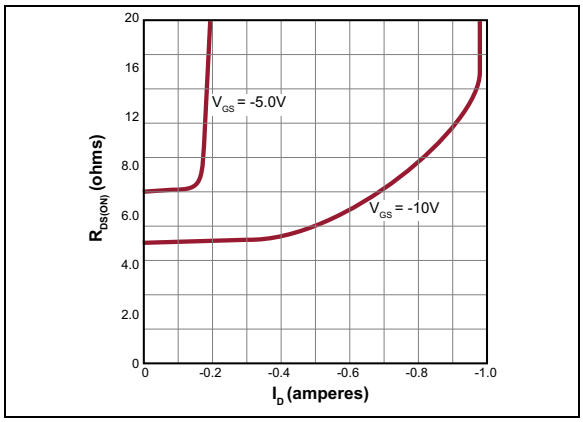



***FIGURE 2-10:*** *On-Resistance vs. Drain Current.*

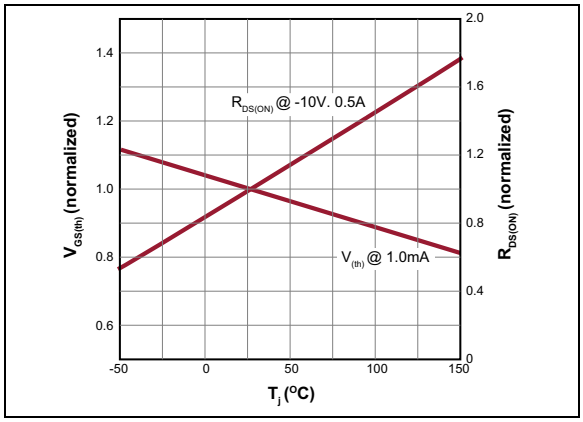



***FIGURE 2-11:*** *$V_{(th)}$ and $R_{DS}$ Variation with Temperature.*

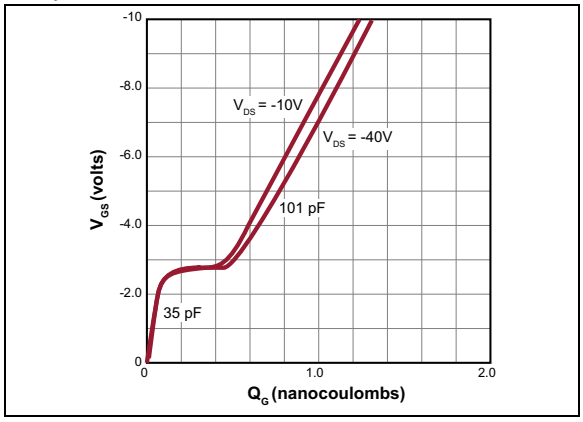



***FIGURE 2-12:*** *Gate Drive Dynamic Characteristics.*

## 3.0 PIN DESCRIPTION

The details on the pins of VP2106 are listed in Table 3-1. Refer to **Package Type** for the location of pins.

**TABLE 3-1: 3-LEAD TO-92 PIN FUNCTION TABLE**

| Pin Number | Pin Name | Description |
|---|---|---|
| 1 | Source | Source |
| 2 | Gate | Gate |
| 3 | Drain | Drain |

## 4.0 FUNCTIONAL DESCRIPTION

Figure 4-1 illustrates the switching waveforms and test circuit for VP2106.

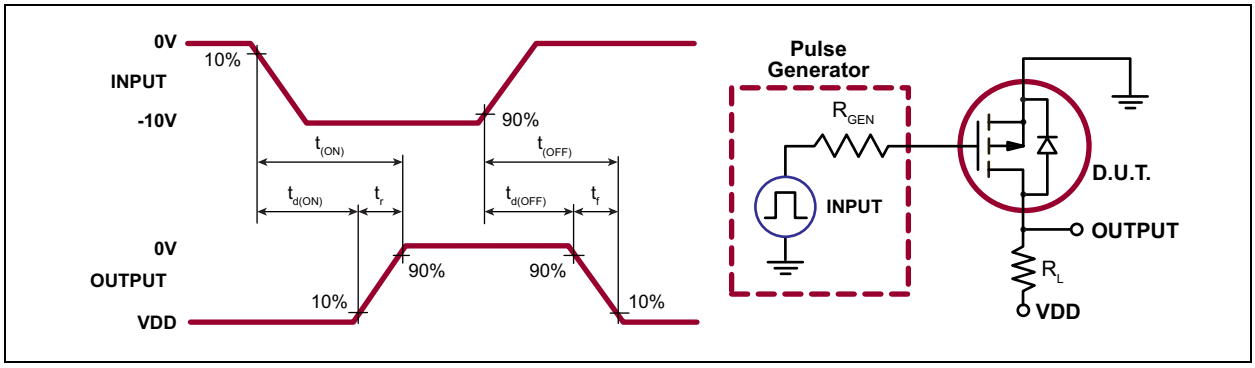


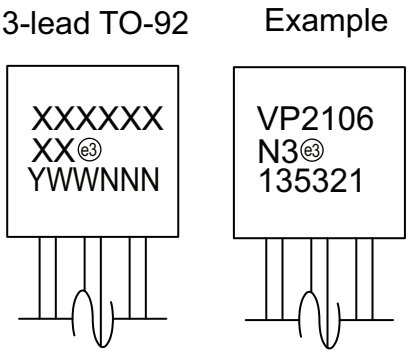

***FIGURE 4-1:*** *Switching Waveforms and Test Circuit.*

**TABLE 4-1: PRODUCT SUMMARY**

| Device | $BV_{DSS}/BV_{DGS}$ (V) | $R_{DS(ON)}$ (Maximum) (Ω) | $I_{D(ON)}$ (Minimum) (mA) |
|---|---|---|---|
| VP2106 | –60 | 12 | –500 |

## 5.0 PACKAGING INFORMATION

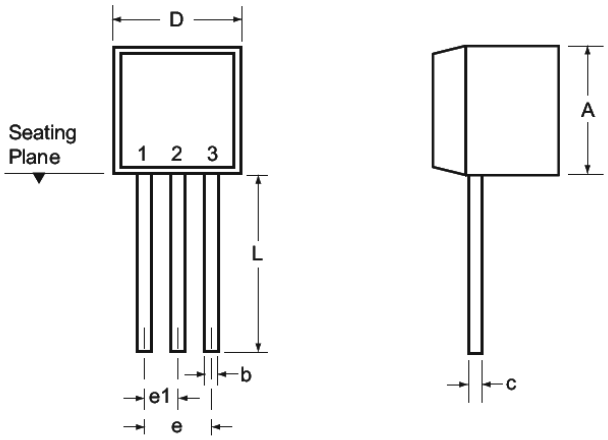
### 5.1 Package Marking Information



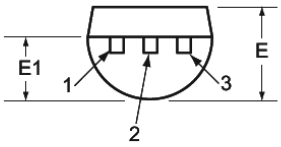

| | | |
|---|---|---|
| **Legend:** | XX...X | Product Code or Customer-specific information |
| | Y | Year code (last digit of calendar year) |
| | YY | Year code (last 2 digits of calendar year) |
| | WW | Week code (week of January 1 is week ‘01’) |
| | NNN | Alphanumeric traceability code |
| | (e3) | Pb-free JEDEC® designator for Matte Tin (Sn) |
| | * | This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package. |

**Note**: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for product code or customer-specific information. Package may or not include the corporate logo.

## 3-Lead TO-92 Package Outline (L/LL/N3)




**Front View** **Side View**




**Bottom View**

Note: For the most current package drawings, see the Microchip Packaging Specification at www.microchip.com/packaging.

| Symbol | | A | b | c | D | E | E1 | e | e1 | L |
|---|---|---|---|---|---|---|---|---|---|---|
| Dimensions (inches) | MIN | .170 | .014† | .014† | .175 | .125 | .080 | .095 | .045 | .500 |
| | NOM | - | - | - | - | - | - | - | - | - |
| | MAX | .210 | .022† | .022† | .205 | .165 | .105 | .105 | .055 | .610* |

*JEDEC Registration TO-92.*
****** This dimension is not specified in the JEDEC drawing.***
*† This dimension differs from the JEDEC drawing.*
***Drawings not to scale.***

**NOTES:**

# APPENDIX A: REVISION HISTORY

## Revision A (December 2021)

- Converted Supertex Doc# DSFP-VP2106 to Microchip DS20006007A
- Changed the package marking format
- Removed the 3-Lead TO-92 N3 P002, P003, P005, P013, and P014 media types to align packaging specifications with the actual BQM
- Added sections to comply with Microchip formatting standards
- Made minor text changes throughout the document

## PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, contact your local Microchip representative or sales office.

| PART NO. | XX | - | X | - | X |
|---|---|---|---|---|---|
| Device | Package Options | | Environmental | | Media Type |

| | | | |
|---|---|---|---|
| Device: | VP2106 | = | P-Channel Enhancement-Mode Vertical DMOS FET |
| Package: | N3 | = | 3-lead TO-92 |
| Environmental: | G | = | Lead (Pb)-free/RoHS-compliant Package |
| Media Type: | (blank) | = | 1000/Bag for an N3 Package |

**Example:**

a) VP2106N3-G: P-Channel Enhancement-Mode, Vertical DMOS FET, 3-lead TO-92, 1000/Bag

**Note the following details of the code protection feature on Microchip products:**

- Microchip products meet the specifications contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is secure when used in the intended manner, within operating specifications, and under normal conditions.
- Microchip values and aggressively protects its intellectual property rights. Attempts to breach the code protection features of Microchip product is strictly prohibited and may violate the Digital Millennium Copyright Act.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of its code. Code protection does not mean that we are guaranteeing the product is “unbreakable”. Code protection is constantly evolving. Microchip is committed to continuously improving the code protection features of our products.



*For information regarding Microchip’s Quality Management Systems, please visit www.microchip.com/quality.*



ISBN: 978-1-5224-9516-1

# Worldwide Sales and Service


## AMERICAS

**Corporate Office**
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200
Fax: 480-792-7277
Technical Support:
http://www.microchip.com/support
Web Address:
www.microchip.com

**Atlanta**
Duluth, GA
Tel: 678-957-9614
Fax: 678-957-1455

**Austin, TX**
Tel: 512-257-3370

**Boston**
Westborough, MA
Tel: 774-760-0087
Fax: 774-760-0088

**Chicago**
Itasca, IL
Tel: 630-285-0071
Fax: 630-285-0075

**Dallas**
Addison, TX
Tel: 972-818-7423
Fax: 972-818-2924

**Detroit**
Novi, MI
Tel: 248-848-4000

**Houston, TX**
Tel: 281-894-5983

**Indianapolis**
Noblesville, IN
Tel: 317-773-8323
Fax: 317-773-5453
Tel: 317-536-2380

**Los Angeles**
Mission Viejo, CA
Tel: 949-462-9523
Fax: 949-462-9608
Tel: 951-273-7800

**Raleigh, NC**
Tel: 919-844-7510

**New York, NY**
Tel: 631-435-6000

**San Jose, CA**
Tel: 408-735-9110
Tel: 408-436-4270

**Canada - Toronto**
Tel: 905-695-1980
Fax: 905-695-2078

## ASIA/PACIFIC

**Australia - Sydney**
Tel: 61-2-9868-6733

**China - Beijing**
Tel: 86-10-8569-7000

**China - Chengdu**
Tel: 86-28-8665-5511

**China - Chongqing**
Tel: 86-23-8980-9588

**China - Dongguan**
Tel: 86-769-8702-9880

**China - Guangzhou**
Tel: 86-20-8755-8029

**China - Hangzhou**
Tel: 86-571-8792-8115

**China - Hong Kong SAR**
Tel: 852-2943-5100

**China - Nanjing**
Tel: 86-25-8473-2460

**China - Qingdao**
Tel: 86-532-8502-7355

**China - Shanghai**
Tel: 86-21-3326-8000

**China - Shenyang**
Tel: 86-24-2334-2829

**China - Shenzhen**
Tel: 86-755-8864-2200

**China - Suzhou**
Tel: 86-186-6233-1526

**China - Wuhan**
Tel: 86-27-5980-5300

**China - Xian**
Tel: 86-29-8833-7252

**China - Xiamen**
Tel: 86-592-2388138

**China - Zhuhai**
Tel: 86-756-3210040

## ASIA/PACIFIC

**India - Bangalore**
Tel: 91-80-3090-4444

**India - New Delhi**
Tel: 91-11-4160-8631

**India - Pune**
Tel: 91-20-4121-0141

**Japan - Osaka**
Tel: 81-6-6152-7160

**Japan - Tokyo**
Tel: 81-3-6880- 3770

**Korea - Daegu**
Tel: 82-53-744-4301

**Korea - Seoul**
Tel: 82-2-554-7200

**Malaysia - Kuala Lumpur**
Tel: 60-3-7651-7906

**Malaysia - Penang**
Tel: 60-4-227-8870

**Philippines - Manila**
Tel: 63-2-634-9065

**Singapore**
Tel: 65-6334-8870

**Taiwan - Hsin Chu**
Tel: 886-3-577-8366

**Taiwan - Kaohsiung**
Tel: 886-7-213-7830

**Taiwan - Taipei**
Tel: 886-2-2508-8600

**Thailand - Bangkok**
Tel: 66-2-694-1351

**Vietnam - Ho Chi Minh**
Tel: 84-28-5448-2100

## EUROPE

**Austria - Wels**
Tel: 43-7242-2244-39
Fax: 43-7242-2244-393

**Denmark - Copenhagen**
Tel: 45-4485-5910
Fax: 45-4485-2829

**Finland - Espoo**
Tel: 358-9-4520-820

**France - Paris**
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79

**Germany - Garching**
Tel: 49-8931-9700

**Germany - Haan**
Tel: 49-2129-3766400

**Germany - Heilbronn**
Tel: 49-7131-72400

**Germany - Karlsruhe**
Tel: 49-721-625370

**Germany - Munich**
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

**Germany - Rosenheim**
Tel: 49-8031-354-560

**Israel - Ra'anana**
Tel: 972-9-744-7705

**Italy - Milan**
Tel: 39-0331-742611
Fax: 39-0331-466781

**Italy - Padova**
Tel: 39-049-7625286

**Netherlands - Drunen**
Tel: 31-416-690399
Fax: 31-416-690340

**Norway - Trondheim**
Tel: 47-7288-4388

**Poland - Warsaw**
Tel: 48-22-3325737

**Romania - Bucharest**
Tel: 40-21-407-87-50

**Spain - Madrid**
Tel: 34-91-708-08-90
Fax: 34-91-708-08-91

**Sweden - Gothenberg**
Tel: 46-31-704-60-40

**Sweden - Stockholm**
Tel: 46-8-5090-4654

**UK - Wokingham**
Tel: 44-118-921-5800
Fax: 44-118-921-5820