

Tiny 500 mA, High-Speed Power MOSFET Driver

Features

- High Peak Output Current: 500 mA (typ.)
- Wide Input Supply Voltage Operating Range:
 - 4.5V to 18V
- Low Shoot-Through/Cross-Conduction Current in Output Stage
- High Capacitive Load Drive Capability:
 - 470 pF in 19 ns (typ.)
 - 1000 pF in 34 ns (typ.)
- Short Delay Times: 35 ns (typ.)
- Matched Rise/Fall Times
- Low Supply Current:
 - With Logic '1' Input – 850 mA (typ.)
 - With Logic '0' Input – 100 mA (typ.)
- Latch-Up Protected: Will Withstand 500 mA Reverse Current
- Logic Input Will Withstand Negative Swing Up To 5V
- Space-saving 5L SOT-23 Package

Applications

- Switch Mode Power Supplies
- Pulse Transformer Drive
- Line Drivers
- Motor and Solenoid Drive

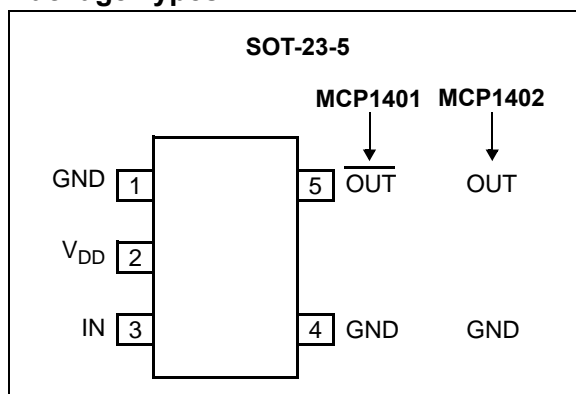
General Description

The MCP1401/02 are high speed MOSFET drivers capable of providing 500 mA of peak current. The inverting or non-inverting single channel output is directly controlled from either TTL or CMOS (3V to 18V). These devices also feature low shoot-through current, matched rise/fall times and propagation delays which make them ideal for high switching frequency applications.

The MCP1401/02 devices operate from a 4.5V to 18V single power supply and can easily charge and discharge 470 pF gate capacitance in under 19 ns (typ). They provide low enough impedances in both the on and off states to ensure the MOSFETs intended state will not be affected, even by large transients.

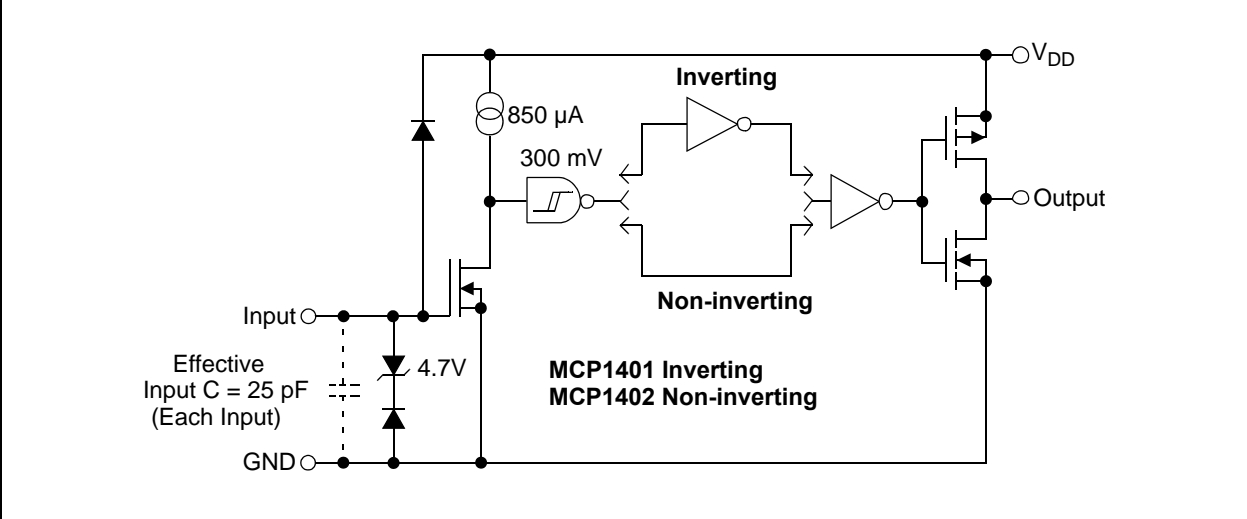
These devices are highly latch-up resistant under any conditions within their power and voltage ratings. They are not subject to damage when up to 5V of noise spiking (of either polarity) occurs on the ground pin. They can accept, without damage or logic upset, up to 500 mA of reverse current being forced back into their outputs. All terminals are fully protect against Electrostatic Discharge (ESD) up to 3 kV (HBM) and 400V (MM).

Package Types



MCP1401/02

Functional Block Diagram



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

| | |
|--|--|
| Supply Voltage | +20V |
| Input Voltage | (V _{DD} + 0.3V) to (GND – 5V) |
| Input Current (V _{IN} >V _{DD})..... | 50 mA |
| Package Power Dissipation (T _A = 50°C) | |
| 5L SOT23 | 0.39W |

† **Notice:** Stresses above those listed under "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 CHARACTERISTICS (NOTE 2)

| Electrical Specifications: Unless otherwise indicated, T _A = +25°C, with 4.5V ≤ V _{DD} ≤ 18V. | | | | | | |
|---|------------------|-------------------------|------|----------------------|-------|--|
| Parameters | Sym | Min | Typ | Max | Units | Conditions |
| Input | | | | | | |
| Logic '1', High Input Voltage | V _{IH} | 2.4 | 1.5 | — | V | |
| Logic '0', Low Input Voltage | V _{IL} | — | 1.3 | 0.8 | V | |
| Input Current | I _{IN} | -1 | — | 1 | μA | 0V ≤ V _{IN} ≤ V _{DD} |
| Input Voltage | V _{IN} | -5 | — | V _{DD} +0.3 | V | |
| Output | | | | | | |
| High Output Voltage | V _{OH} | V _{DD} – 0.025 | — | — | V | DC Test |
| Low Output Voltage | V _{OL} | — | — | 0.025 | V | DC Test |
| Output Resistance, High | R _{OH} | — | 12 | 18 | Ω | I _{OUT} = 10 mA, V _{DD} = 18V |
| Output Resistance, Low | R _{OL} | — | 10 | 16 | Ω | I _{OUT} = 10 mA, V _{DD} = 18V |
| Peak Output Current | I _{PK} | — | 0.5 | — | A | V _{DD} = 18V (Note 2) |
| Latch-Up Protection Withstand Reverse Current | I _{REV} | — | >0.5 | — | A | Duty cycle ≤ 2%, t ≤ 300 μs |
| Switching Time (Note 1) | | | | | | |
| Rise Time | t _R | — | 19 | 25 | ns | Figure 4-1 , Figure 4-2 C _L = 470 pF |
| Fall Time | t _F | — | 15 | 20 | ns | Figure 4-1 , Figure 4-2 C _L = 470 pF |
| Delay Time | t _{D1} | — | 35 | 40 | ns | Figure 4-1 , Figure 4-2 |
| Delay Time | t _{D2} | — | 35 | 40 | ns | Figure 4-1 , Figure 4-2 |
| Power Supply | | | | | | |
| Supply Voltage | V _{DD} | 4.5 | — | 18.0 | V | |
| Power Supply Current | I _S | — | 0.85 | 1.1 | mA | V _{IN} = 3V |
| | I _S | — | 0.10 | 0.20 | mA | V _{IN} = 0V |

Note 1: Switching times ensured by design.

2: Tested during characterization, not production tested.

MCP1401/02

DC CHARACTERISTICS (OVER OPERATING TEMPERATURE RANGE)

| Electrical Specifications: Unless otherwise indicated, operating temperature range with $4.5V \leq V_{DD} \leq 18V$. | | | | | | |
|---|----------|------------------|------|--------------|----------|--|
| Parameters | Sym | Min | Typ | Max | Units | Conditions |
| Input | | | | | | |
| Logic '1', High Input Voltage | V_{IH} | 2.4 | — | — | V | |
| Logic '0', Low Input Voltage | V_{IL} | — | — | 0.8 | V | |
| Input Current | I_{IN} | -10 | — | +10 | μA | $0V \leq V_{IN} \leq V_{DD}$ |
| Input Voltage | V_{IN} | -5 | — | $V_{DD}+0.3$ | V | |
| Output | | | | | | |
| High Output Voltage | V_{OH} | $V_{DD} - 0.025$ | — | — | V | DC TEST |
| Low Output Voltage | V_{OL} | — | — | 0.025 | V | DC TEST |
| Output Resistance, High | R_{OH} | — | 12 | 18 | Ω | $I_{OUT} = 10 \text{ mA}, V_{DD} = 18V$ |
| Output Resistance, Low | R_{OL} | — | 10 | 16 | Ω | $I_{OUT} = 10 \text{ mA}, V_{DD} = 18V$ |
| Switching Time (Note 1) | | | | | | |
| Rise Time | t_R | — | 20 | 30 | ns | Figure 4-1, Figure 4-2 $C_L = 470 \text{ pF}$ |
| Fall Time | t_F | — | 18 | 28 | ns | Figure 4-1, Figure 4-2 $C_L = 470 \text{ pF}$ |
| Delay Time | t_{D1} | — | 40 | 51 | ns | Figure 4-1, Figure 4-2 |
| Delay Time | t_{D2} | — | 40 | 51 | ns | Figure 4-1, Figure 4-2 |
| Power Supply | | | | | | |
| Supply Voltage | V_{DD} | 4.5 | — | 18.0 | V | |
| Power Supply Current | I_S | — | 0.90 | 1.10 | mA | $V_{IN} = 3V$ |
| | | — | 0.11 | 0.20 | mA | $V_{IN} = 0V$ |

Note 1: Switching times ensured by design.

Note 2: Tested during characterization, not production tested.

TEMPERATURE CHARACTERISTICS

| Electrical Specifications: Unless otherwise noted, all parameters apply with $4.5V \leq V_{DD} \leq 18V$. | | | | | | |
|--|---------------|-----|-----|------|---------------|------------|
| Parameters | Sym | Min | Typ | Max | Units | Conditions |
| Temperature Ranges | | | | | | |
| Specified Temperature Range | T_A | -40 | — | +125 | $^{\circ}C$ | |
| Maximum Junction Temperature | T_J | — | — | +150 | $^{\circ}C$ | |
| Storage Temperature Range | T_A | -65 | — | +150 | $^{\circ}C$ | |
| Package Thermal Resistances | | | | | | |
| Thermal Resistance, 5L-SOT23 | θ_{JA} | — | 256 | — | $^{\circ}C/W$ | |

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.

Note: Unless otherwise indicated, $T_A = +25^\circ\text{C}$ with $4.5\text{V} \leq V_{DD} \leq 18\text{V}$.

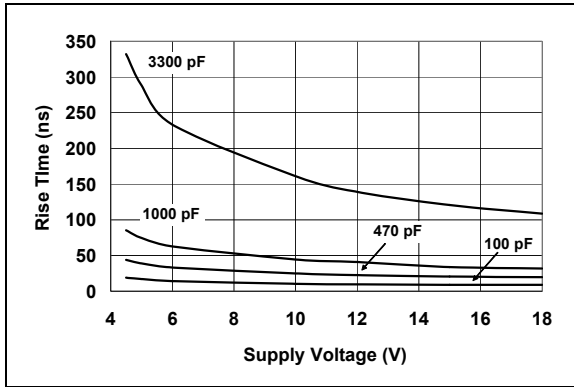


FIGURE 2-1: Rise Time vs. Supply Voltage.

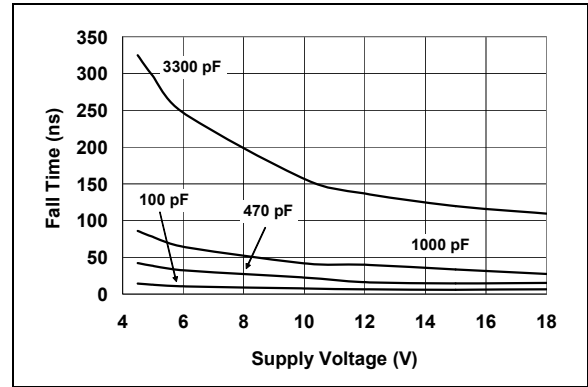


FIGURE 2-4: Fall Time vs. Supply Voltage.

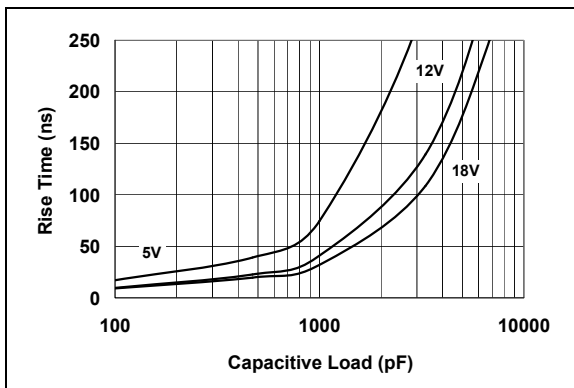


FIGURE 2-2: Rise Time vs. Capacitive Load.

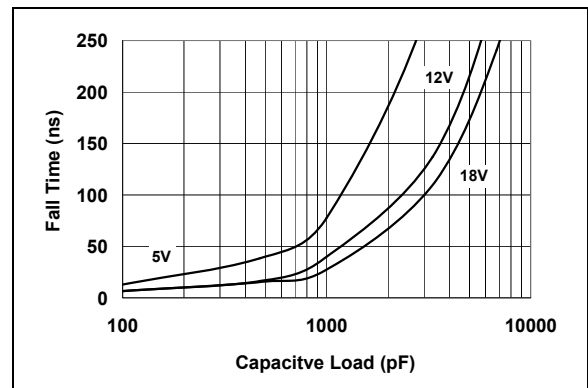


FIGURE 2-5: Fall Time vs. Capacitive Load.

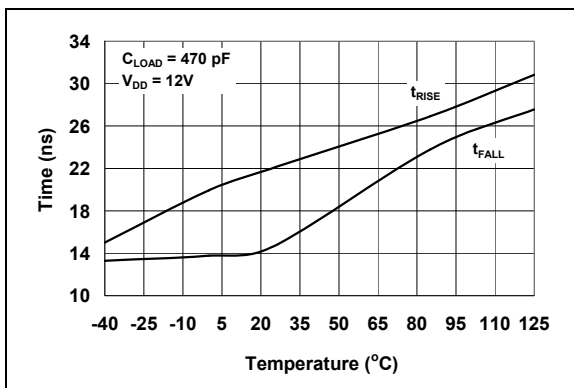


FIGURE 2-3: Rise and Fall Times vs. Temperature.

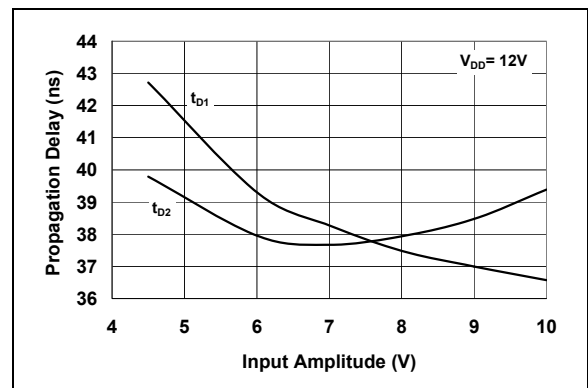


FIGURE 2-6: Propagation Delay vs. Input Amplitude.

MCP1401/02

Typical Performance Curves (Continued)

Note: Unless otherwise indicated, $T_A = +25^\circ\text{C}$ with $4.5\text{V} \leq V_{DD} \leq 18\text{V}$.

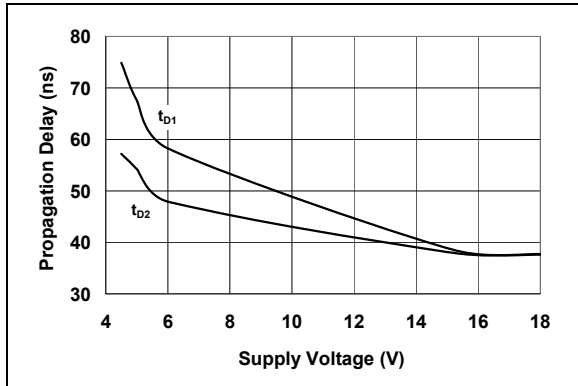


FIGURE 2-7: Propagation Delay Time vs. Supply Voltage.

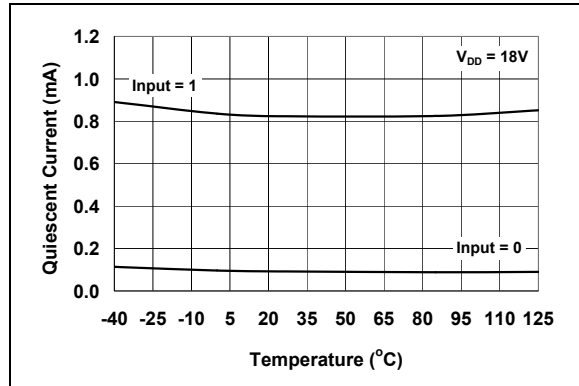


FIGURE 2-10: Quiescent Current vs. Temperature.

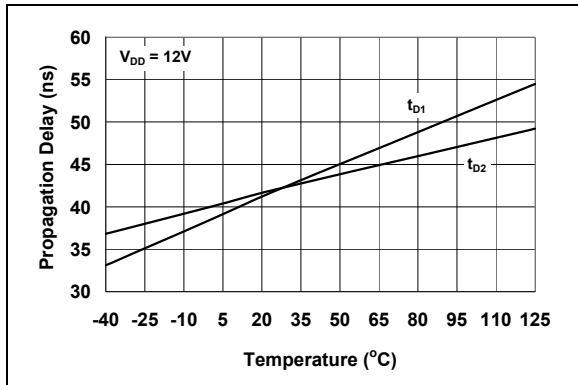


FIGURE 2-8: Propagation Delay Time vs. Temperature.

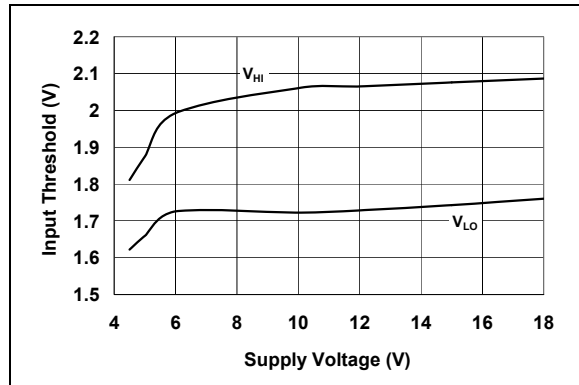


FIGURE 2-11: Input Threshold vs. Supply Voltage.

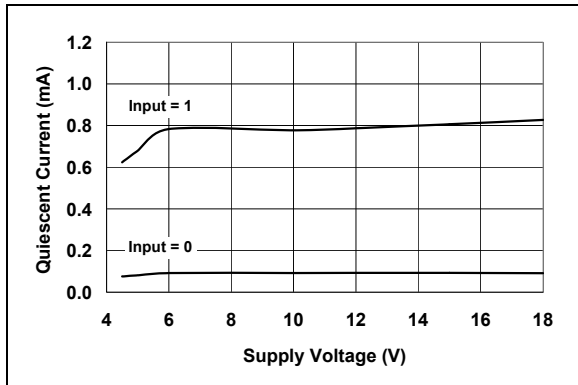


FIGURE 2-9: Quiescent Current vs. Supply Voltage.

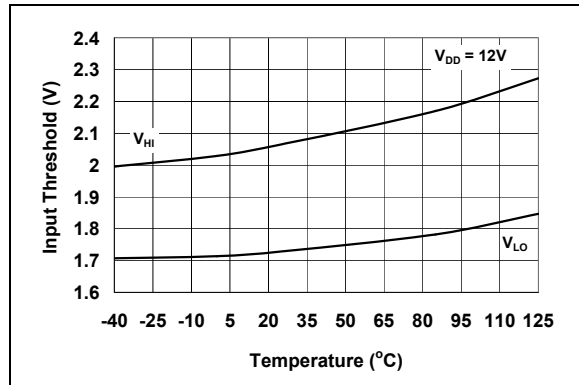


FIGURE 2-12: Input Threshold vs. Temperature.

Typical Performance Curves (Continued)

Note: Unless otherwise indicated, $T_A = +25^\circ\text{C}$ with $4.5\text{V} \leq V_{DD} \leq 18\text{V}$.

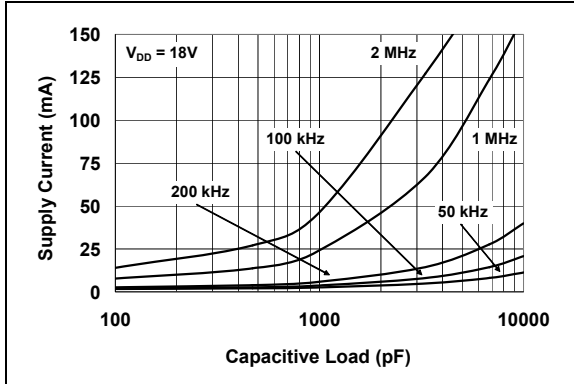


FIGURE 2-13: Supply Current vs. Capacitive Load.

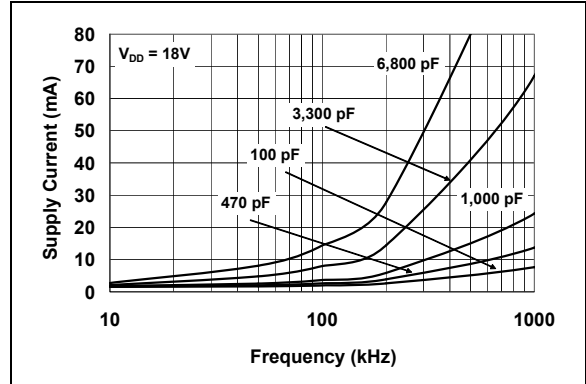


FIGURE 2-16: Supply Current vs. Frequency.

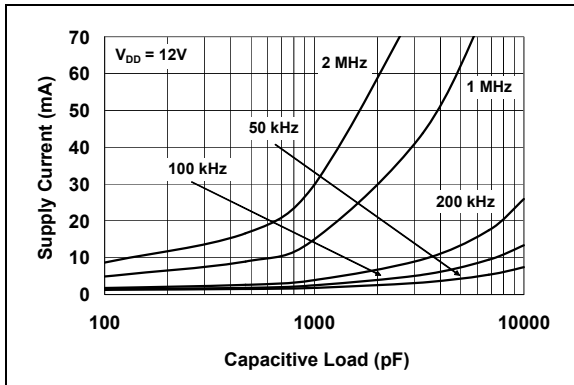


FIGURE 2-14: Supply Current vs. Capacitive Load.

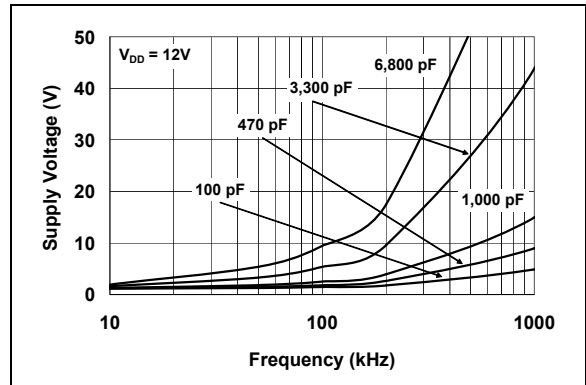


FIGURE 2-17: Supply Current vs. Frequency.

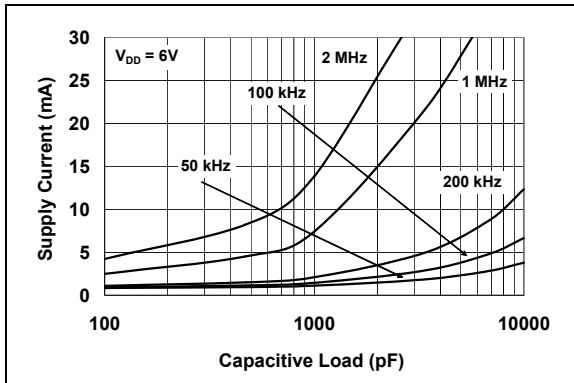


FIGURE 2-15: Supply Current vs. Capacitive Load.

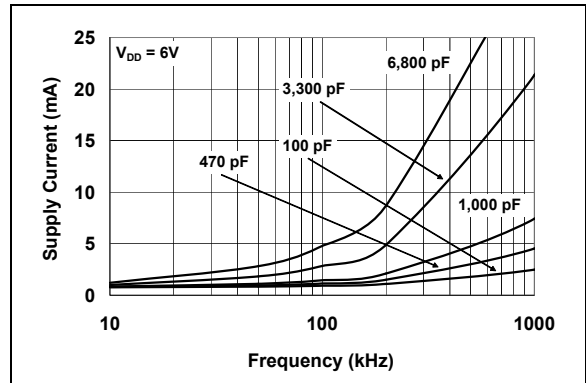


FIGURE 2-18: Supply Current vs. Frequency.

MCP1401/02

Typical Performance Curves (Continued)

Note: Unless otherwise indicated, $T_A = +25^\circ\text{C}$ with $4.5\text{V} \leq V_{DD} \leq 18\text{V}$.

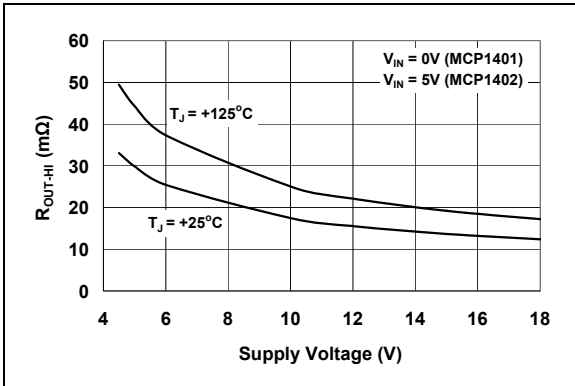


FIGURE 2-19: Output Resistance (Output High) vs. Supply Voltage.

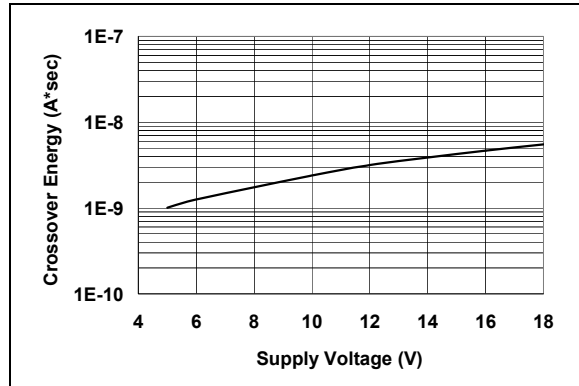


FIGURE 2-21: Crossover Energy vs. Supply Voltage

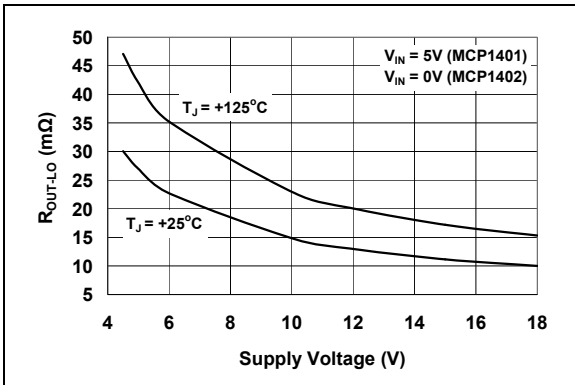


FIGURE 2-20: Output Resistance (Output Low) vs. Supply Voltage

3.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in [Table 3-1](#).

TABLE 3-1: PIN FUNCTION TABLE (1)

| SOT-23-5 | Symbol | Description |
|----------|-----------------|---------------|
| 1 | GND | Ground |
| 2 | V _{DD} | Supply Input |
| 3 | IN | Control Input |
| 4 | GND | Ground |
| 5 | OUT | Output |

Note 1: Duplicate pins must be connected for proper operation.

3.1 Supply Input (V_{DD})

V_{DD} is the bias supply input for the MOSFET driver and has a voltage range of 4.5V to 18V. This input must be decoupled to ground with a local capacitor. This bypass capacitor provides a localized low-impedance path for the peak currents that are to be provided to the load.

3.2 Control Input (IN)

The MOSFET driver input is a high-impedance, TTL/CMOS-compatible input. The input also has hysteresis between the high and low input levels, allowing them to be driven from slow rising and falling signals, and to provide noise immunity.

3.3 Ground (GND)

Ground is the device return pin. The ground pin should have a low impedance connection to the bias supply source return. High peak currents will flow out the ground pin when the capacitive load is being discharged.

3.4 Output (OUT)

The output is a CMOS push-pull output that is capable of sourcing and sinking 0.5A of peak current (V_{DD} = 18V). The low output impedance ensures the gate of the external MOSFET will stay in the intended state even during large transients. This output also has a reverse current latch-up rating of 0.5A.

MCP1401/02

4.0 APPLICATION INFORMATION

4.1 General Information

MOSFET drivers are high-speed, high current devices which are intended to source/sink high peak currents to charge/discharge the gate capacitance of external MOSFETs or IGBTs. In high frequency switching power supplies, the PWM controller may not have the drive capability to directly drive the power MOSFET. A MOSFET driver like the MCP1401/02 family can be used to provide additional source/sink current capability.

4.2 MOSFET Driver Timing

The ability of a MOSFET driver to transition from a fully off state to a fully on state are characterized by the drivers rise time (t_R), fall time (t_F), and propagation delays (t_{D1} and t_{D2}). The MCP1401/02 family of drivers can typically charge and discharge a 470 pF load capacitance in 19 ns along with a typical matched propagation delay of 35 ns. Figure 4-1 and Figure 4-2 show the test circuit and timing waveform used to verify the MCP1401/02 timing.

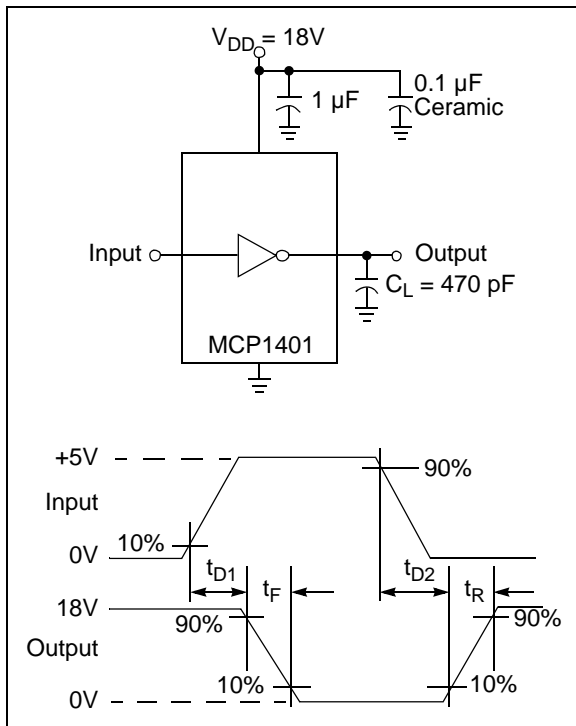


FIGURE 4-1: Inverting Driver Timing Waveform.

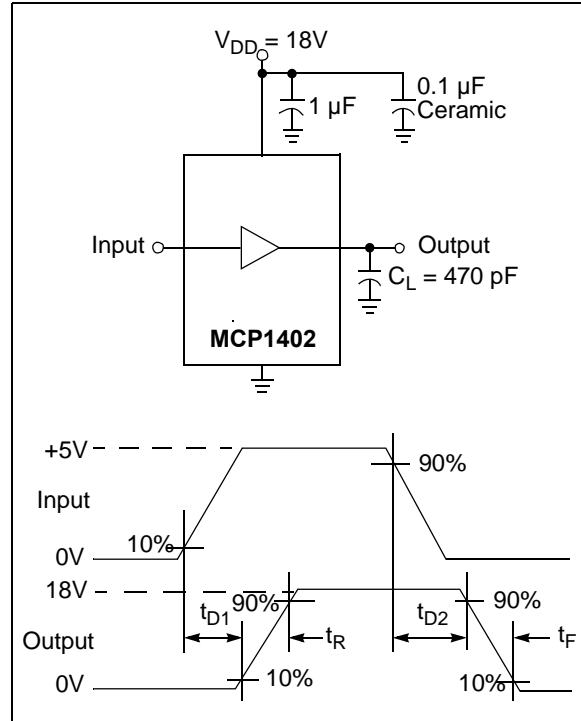


FIGURE 4-2: Non-Inverting Driver Timing Waveform.

4.3 Decoupling Capacitors

Careful layout and decoupling capacitors are highly recommended when using MOSFET drivers. Large currents are required to charge and discharge capacitive loads quickly. For example, approximately 550 mA are needed to charge a 470 pF load with 18V in 15 ns.

To operate the MOSFET driver over a wide frequency range with low supply impedance, a ceramic and low ESR film capacitor is recommended to be placed in parallel between the driver V_{DD} and GND. A 1.0 μF low ESR film capacitor and a 0.1 μF ceramic capacitor placed close to the driver to minimized circuit board parasitics and provide a local source for the required current.

4.4 PCB Layout Considerations

Proper PCB layout is important in a high current, fast switching circuit to provide proper device operation and robustness of design. PCB trace loop area and inductance should be minimized by the use of ground planes or trace under MOSFET gate drive signals, separate analog and power grounds, and local driver decoupling.

Placing a ground plane beneath the MCP1401/02 will help as a radiated noise shield as well as providing some heat sinking for power dissipated within the device.

4.5 Power Dissipation

The total internal power dissipation in a MOSFET driver is the summation of three separate power dissipation elements.

EQUATION 4-1:

$$P_T = P_L + P_Q + P_{CC}$$

Where:

| | | |
|----------|---|-----------------------------|
| P_T | = | Total power dissipation |
| P_L | = | Load power dissipation |
| P_Q | = | Quiescent power dissipation |
| P_{CC} | = | Operating power dissipation |

4.5.1 CAPACITIVE LOAD DISSIPATION

The power dissipation caused by a capacitive load is a direct function of frequency, total capacitive load, and supply voltage. The power lost in the MOSFET driver for a complete charging and discharging cycle of a MOSFET is shown in [Equation 4-2](#).

EQUATION 4-2:

$$P_L = f \times C_T \times V_{DD}^2$$

Where:

| | | |
|----------|---|------------------------------|
| f | = | Switching frequency |
| C_T | = | Total load capacitance |
| V_{DD} | = | MOSFET driver supply voltage |

4.5.2 QUIESCENT POWER DISSIPATION

The power dissipation associated with the quiescent current draw depends upon the state of the input pin. The MCP1401/02 devices have a quiescent current draw when the input is high of 850 mA (typ) and 100 mA (typ) when the input is low. The quiescent power dissipation is shown in [Equation 4-3](#).

EQUATION 4-3:

$$P_Q = (I_{QH} \times D + I_{QL} \times (1 - D)) \times V_{DD}$$

Where:

| | | |
|----------|---|-------------------------------------|
| I_{QH} | = | Quiescent current in the high state |
| D | = | Duty cycle |
| I_{QL} | = | Quiescent current in the low state |
| V_{DD} | = | MOSFET driver supply voltage |

4.5.3 OPERATING POWER DISSIPATION

The operating power dissipation occurs each time the MOSFET driver output transitions because for a very short period of time both MOSFETs in the output stage are on simultaneously. This cross-conduction current leads to a power dissipation described in [Equation 4-4](#).

EQUATION 4-4:

$$P_{CC} = CC \times f \times V_{DD}$$

Where:

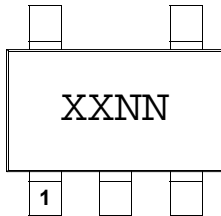
| | | |
|----------|---|-----------------------------------|
| CC | = | Cross-conduction constant (A*sec) |
| f | = | Switching frequency |
| V_{DD} | = | MOSFET driver supply voltage |

MCP1401/02

5.0 PACKAGING INFORMATION

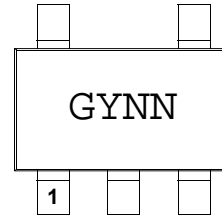
5.1 Package Marking Information (Not to Scale)

5-Lead SOT-23



| Standard Markings for SOT-23 | |
|------------------------------|------|
| Part Number | Code |
| MCP1401T-E/OT | GYNN |
| MCP1402T-E/OT | GZNN |

Example:

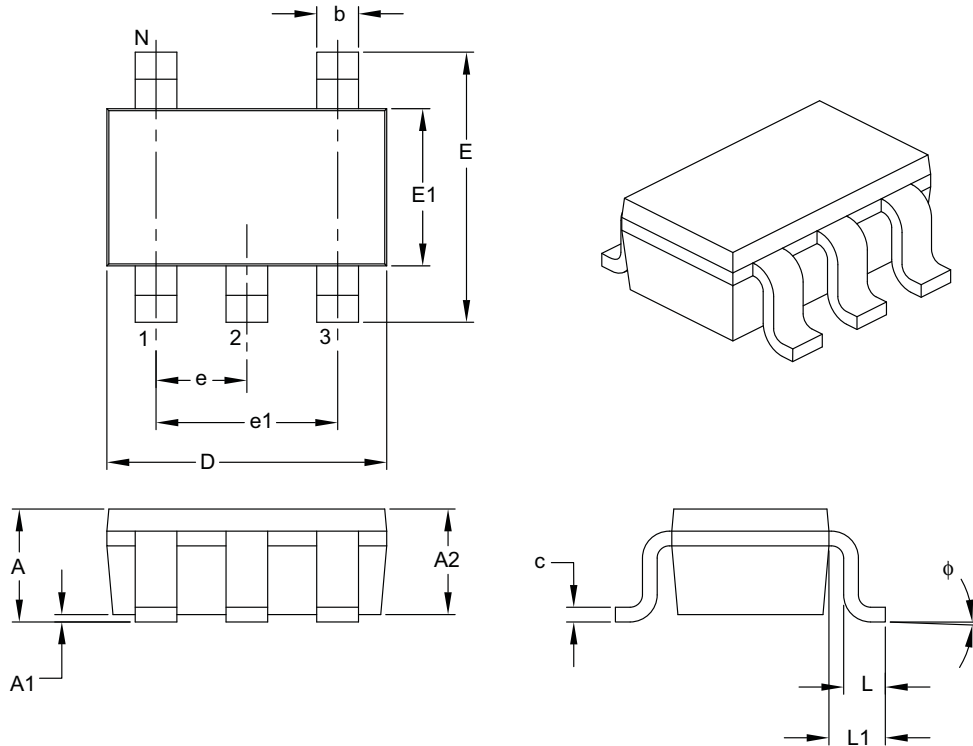


| | | |
|----------------|--------|--|
| Legend: | XX...X | Customer-specific information |
| | Y | Year code (last digit of calendar year) |
| | YY | Year code (last 2 digits of calendar year) |
| | WW | Week code (week of January 1 is week '01') |
| | NNN | Alphanumeric traceability code |
| | (e3) | 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 customer-specific information.

5-Lead Plastic Small Outline Transistor (OT) [SOT-23]

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



| Dimension Limits | Units | MILLIMETERS | | |
|--------------------------|--------|-------------|-----|------|
| | | MIN | NOM | MAX |
| Number of Pins | N | 5 | | |
| Lead Pitch | e | 0.95 BSC | | |
| Outside Lead Pitch | e1 | 1.90 BSC | | |
| Overall Height | A | 0.90 | - | 1.45 |
| Molded Package Thickness | A2 | 0.89 | - | 1.30 |
| Standoff | A1 | 0.00 | - | 0.15 |
| Overall Width | E | 2.20 | - | 3.20 |
| Molded Package Width | E1 | 1.30 | - | 1.80 |
| Overall Length | D | 2.70 | - | 3.10 |
| Foot Length | L | 0.10 | - | 0.60 |
| Footprint | L1 | 0.35 | - | 0.80 |
| Foot Angle | ϕ | 0° | - | 30° |
| Lead Thickness | c | 0.08 | - | 0.26 |
| Lead Width | b | 0.20 | - | 0.51 |

Notes:

- Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.127 mm per side.
- Dimensioning and tolerancing per ASME Y14.5M.

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing C04-091B

MCP1401/02

NOTES:

APPENDIX A: REVISION HISTORY

Revision A (June 2007)

- Original Release of this Document.

MCP1401/02

NOTES:

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.

| <u>PART NO.</u> | X | X | XX |
|--------------------|---|-------------------|---------|
| Device | Tape & Reel Range | Temperature Range | Package |
| Device: | MCP1401: 500 mA MOSFET Driver, Inverting MCP1402: 500 mA MOSFET Driver, Non-Inverting | | |
| Tape and Reel | T = Tape and Reel | | |
| Temperature Range: | E = -40°C to +125°C | | |
| Package: * | OT = Plastic Thin Small Outline Transistor (OT) , 5-Lead * All package offerings are Pb Free (Lead Free) | | |

Examples:

- a) MCP1401T-E/OT: 500 mA Inverting MOSFET Driver, 5LD SOT-23 package.
- a) MCP1402T-E/OT: 500 mA Non-Inverting, MOSFET Driver, 5LD SOT-23 package.

MCP1401/02

NOTES:

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Information contained in this publication regarding device applications and the like is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION, INCLUDING BUT NOT LIMITED TO ITS CONDITION, QUALITY, PERFORMANCE, MERCHANTABILITY OR FITNESS FOR PURPOSE. Microchip disclaims all liability arising from this information and its use. Use of Microchip devices in life support and/or safety applications is entirely at the buyer's risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights.

Trademarks

The Microchip name and logo, the Microchip logo, Accuron, dsPIC, KEELOQ, KEELOQ logo, microID, MPLAB, PIC, PICmicro, PICSTART, PRO MATE, rfPIC and SmartShunt are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.


AmpLab, FilterLab, Linear Active Thermistor, Migratable Memory, MXDEV, MXLAB, SEEVAL, SmartSensor and The Embedded Control Solutions Company are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Analog-for-the-Digital Age, Application Maestro, CodeGuard, dsPICDEM, dsPICDEM.net, dsPICworks, ECAN, ECONOMONITOR, FanSense, FlexROM, fuzzyLAB, In-Circuit Serial Programming, ICSP, ICEPIC, Mindi, MiWi, MPASM, MPLAB Certified logo, MPLIB, MPLINK, PICkit, PICDEM, PICDEM.net, PICLAB, PICtail, PowerCal, PowerInfo, PowerMate, PowerTool, REAL ICE, rfLAB, Select Mode, Smart Serial, SmartTel, Total Endurance, UNI/O, WiperLock and ZENA are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

All other trademarks mentioned herein are property of their respective companies.

© 2007, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

 Printed on recycled paper.

QUALITY MANAGEMENT SYSTEM
CERTIFIED BY DNV
== ISO/TS 16949:2002 ==

Microchip received ISO/TS-16949:2002 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company's quality system processes and procedures are for its PIC® MCUs and dsPIC® DSCs, KEELOQ® code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.



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://support.microchip.com>
Web Address:
www.microchip.com

Atlanta

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

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

Farmington Hills, MI
Tel: 248-538-2250
Fax: 248-538-2260

Kokomo

Kokomo, IN
Tel: 765-864-8360
Fax: 765-864-8387

Los Angeles

Mission Viejo, CA
Tel: 949-462-9523
Fax: 949-462-9608

Santa Clara

Santa Clara, CA
Tel: 408-961-6444
Fax: 408-961-6445

Toronto

Mississauga, Ontario,
Canada
Tel: 905-673-0699
Fax: 905-673-6509

ASIA/PACIFIC

Asia Pacific Office

Suites 3707-14, 37th Floor
Tower 6, The Gateway
Harbour City, Kowloon
Hong Kong
Tel: 852-2401-1200
Fax: 852-2401-3431

Australia - Sydney

Tel: 61-2-9868-6733
Fax: 61-2-9868-6755

China - Beijing

Tel: 86-10-8528-2100
Fax: 86-10-8528-2104

China - Chengdu

Tel: 86-28-8665-5511
Fax: 86-28-8665-7889

China - Fuzhou

Tel: 86-591-8750-3506
Fax: 86-591-8750-3521

China - Hong Kong SAR

Tel: 852-2401-1200
Fax: 852-2401-3431

China - Qingdao

Tel: 86-532-8502-7355
Fax: 86-532-8502-7205

China - Shanghai

Tel: 86-21-5407-5533
Fax: 86-21-5407-5066

China - Shenyang

Tel: 86-24-2334-2829
Fax: 86-24-2334-2393

China - Shenzhen

Tel: 86-755-8203-2660
Fax: 86-755-8203-1760

China - Shunde

Tel: 86-757-2839-5507
Fax: 86-757-2839-5571

China - Wuhan

Tel: 86-27-5980-5300
Fax: 86-27-5980-5118

China - Xian

Tel: 86-29-8833-7252
Fax: 86-29-8833-7256

ASIA/PACIFIC

India - Bangalore

Tel: 91-80-4182-8400
Fax: 91-80-4182-8422

India - New Delhi

Tel: 91-11-4160-8631
Fax: 91-11-4160-8632

India - Pune

Tel: 91-20-2566-1512
Fax: 91-20-2566-1513

Japan - Yokohama

Tel: 81-45-471-6166
Fax: 81-45-471-6122

Korea - Daegu

Tel: 82-53-744-4301
Fax: 82-53-744-4302

Korea - Seoul

Tel: 82-2-554-7200
Fax: 82-2-558-5932 or
82-2-558-5934

Malaysia - Penang

Tel: 60-4-646-8870
Fax: 60-4-646-5086

Philippines - Manila

Tel: 63-2-634-9065
Fax: 63-2-634-9069

Singapore

Tel: 65-6334-8870
Fax: 65-6334-8850

Taiwan - Hsin Chu

Tel: 886-3-572-9526
Fax: 886-3-572-6459

Taiwan - Kaohsiung

Tel: 886-7-536-4818
Fax: 886-7-536-4803

Taiwan - Taipei

Tel: 886-2-2500-6610
Fax: 886-2-2508-0102

Thailand - Bangkok

Tel: 66-2-694-1351
Fax: 66-2-694-1350

EUROPE

Austria - Wels

Tel: 43-7242-2244-39
Fax: 43-7242-2244-393

Denmark - Copenhagen

Tel: 45-4450-2828
Fax: 45-4485-2829

France - Paris

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

Germany - Munich

Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

Italy - Milan

Tel: 39-0331-742611
Fax: 39-0331-466781

Netherlands - Drunen

Tel: 31-416-690399
Fax: 31-416-690340

Spain - Madrid

Tel: 34-91-708-08-90
Fax: 34-91-708-08-91

UK - Wokingham

Tel: 44-118-921-5869
Fax: 44-118-921-5820

06/25/07