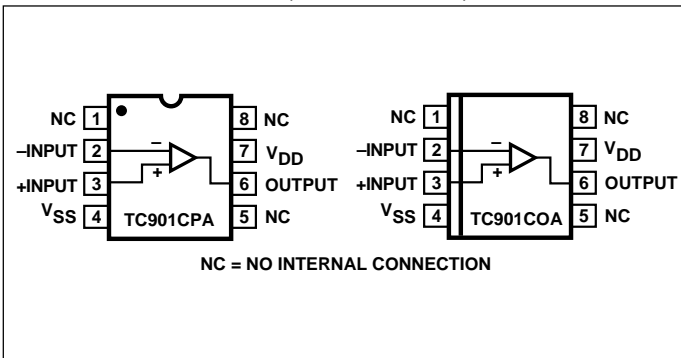


Dual Auto-Zeroed Operational Amplifiers

FEATURES

- Second-Generation Monolithic, Chopper-Stabilized Op Amp
- No External Capacitors Required
- Single-Supply Operation $\pm 15\text{V}$ or 5V to 32V
- Supply Current $450\mu\text{A}$ at 15V , Typ
- Input Offset Voltage $7\mu\text{V}$, Typ
- Common-Mode Rejection Ratio 140dB , Typ
- Open-Loop Gain 140dB Into 10k Load, Typ
- Input Noise $5\mu\text{V}$ at 10Hz Bandwidth
- Pinout Compatible With ICL7650
- Lowest Parts Count Chopper Op Amp

PIN CONFIGURATION (DIP and SOIC)



GENERAL DESCRIPTION

The TC901 is a monolithic, auto-zeroed operational amplifier. It is a second-generation design of the TC91X CMOS chopper-stabilized op-amps with on-chip capacitors.

Elimination of the external capacitors allows the designer to increase reliability, lower cost, and simplify design by lowering parts count.

Since the TC901 is an auto-zeroing op amp, input offset voltage is very low. More important, there is almost zero drift with time. This eliminates production line adjustments, as well as periodic calibration.

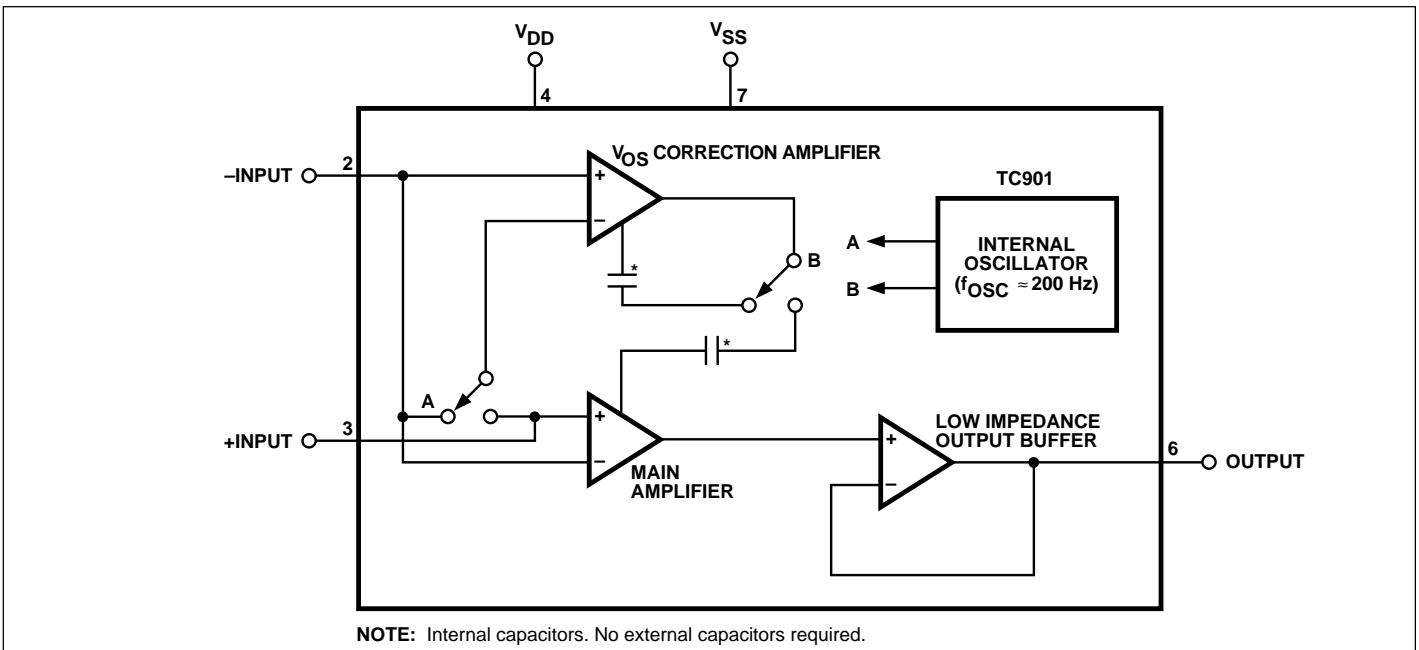
Notable electrical characteristics are low supply current ($450\mu\text{A}$, typical), single-supply operation (5V to 32V), low input offset voltage ($7\mu\text{V}$, typical), low noise ($<5\mu\text{V}_{\text{P-P}}$, typical, for a 10Hz bandwidth), and fast recovery from saturation without the use of external clamp circuitry.

This device is supplied in 8-pin plastic DIP and plastic SOIC packages. It is pin compatible with bipolar, CMOS, JFET and other chopper-stabilized op-amps using the industry-standard 741 pinout.

ORDERING INFORMATION

Part No.	Package	Temperature Range
TC901COA	8-Pin SOIC	0°C to $+70^{\circ}\text{C}$
TC901CPA	8-Pin Plastic DIP	0°C to $+70^{\circ}\text{C}$

FUNCTIONAL BLOCK DIAGRAM



Dual Auto-Zeroed Operational Amplifiers

TC901

ABSOLUTE MAXIMUM RATINGS*

Total Supply Voltage (V_{DD} to V_{SS})	+36V
Input Voltage ($V_{DD} + 0.3V$) to ($V_{SS} - 0.3V$)	
Current Into Any Pin	10mA
While Operating	100 μ A
Storage Temperature Range	-65°C to +150°C
Lead Temperature (Soldering, 10 sec)	+300°C
Operating Temperature Range	
C Device	0°C to +70°C

Package Power Dissipation ($T_A \leq 70^\circ\text{C}$)

Plastic DIP	730mW
Plastic SOIC	470mW

*Static-sensitive device. Appropriate precautions should be taken when handling, shipping, or storing these devices. Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the devices. These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied.

ELECTRICAL CHARACTERISTICS: $V_S \pm 15V$, $T_A = +25^\circ\text{C}$, unless otherwise indicated.

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
V_{OS}	Input Offset Voltage (Figure 2)	$T_A = +25^\circ\text{C}$	—	7	15	μV
TCV_{OS}	Average Temperature Coefficient of Input Offset Voltage	$0^\circ\text{C} \leq T_A \leq +70^\circ\text{C}$ (Note 1)	—	0.05	0.15	$\mu\text{V}/^\circ\text{C}$
I_{BIAS}	Average Input Bias Current	$T_A = +25^\circ\text{C}$ $0^\circ\text{C} \leq T_A \leq +70^\circ\text{C}$ $-25^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$	—	30 0.2 0.2	50 10 10	pA nA nA
I_{OS}	Average Input Offset Current	$T_A = +25^\circ\text{C}$ $T_A = +85^\circ\text{C}$	—	50 —	100 1	pA nA
e_N	Input Voltage Noise (Figure 1B)	0.1 to 1Hz, $R_S \leq 100\Omega$	—	1.2	—	μV_{P-P}
e_N	Input Voltage Noise (Figure 1A)	0.1 to 10Hz, $R_S \leq 100\Omega$	—	5	—	μV_{P-P}
CMRR	Common-Mode Rejection Ratio	$V_{SS} \leq V_{CM} \leq V_{DD} - 2V$	120	140	—	dB
CMVR	Common-Mode Voltage Range	$V_S = \pm 5V$ to $\pm 15V$	V_{SS}	—	$V_{DD} - 2$	V
A_{OL}	Open-Loop Voltage Gain	$R_L = 10k\Omega$, $V_S = \pm 15V$	120	140	—	dB
V_{OUT}	Output Voltage Swing	$R_L = 10k\Omega$	$V_{SS} + 1$	—	$V_{DD} - 1.2$	V
BW	Closed-Loop Bandwidth (Figure 7)	Closed-Loop Gain = +1	—	0.8	—	MHz
SR	Slew Rate	$R_L = 10k\Omega$, $C_L = 50pF$	—	2	—	V/ μsec
PSRR	Power Supply Rejection Ratio	$V_S = \pm 5V$ to $\pm 15V$	120	140	—	dB
V_S	Operating Supply Voltage Range	Note 2	± 3	—	± 16	V
I_S	Quiescent Supply (Figure 2)	$V_S = \pm 15V$	—	0.45	0.6	mA

- NOTES:** 1. Characterized; not 100% tested.
2. Single supply operation: $V_{DD} = +5V$ to $+32V$.

Overload Recovery

The TC901 recovers quickly from output saturation. Typical recovery time from positive output saturation is 20 msec. Negative output saturation recovery time is typically msec.

Thermocouple Errors

Heating a junction made from two different metallic wires causes current flow. This is known as the Seebeck effect. An open-circuit voltage (Seebeck voltage) can be measured across the junction. Junction temperature and metal type determine the magnitude. Typical values are $0.1\mu\text{V}/^\circ\text{C}$ to $10\mu\text{V}/^\circ\text{C}$. Thermal-induced voltages can be many times larger than the TC901's offset voltage drift. Unless unwanted thermocouple potentials can be controlled, system performance will be less than optimum.

Unwanted thermocouple junctions are created when leads are soldered or sockets/connectors are used. Low thermoelectric coefficient solder can reduce errors. A 60% Cd/40% Sn Pb solder has one-tenth the thermal voltage of common 64% Sn/36% Pb solder at a copper junction.

The number and type of dissimilar metallic junctions in the input circuit loop should be balanced. If the junctions are kept at the same temperature, their summation will add to zero, canceling errors (Figure 7).

Shielding precision analog circuits from air currents — especially those caused by power dissipating components and fans — will minimize temperature gradients and minimize thermocouple-induced errors.

Avoiding Latch-Up

Larger voltages can turn the p-n-p-n device on, causing excessive device power supply current and excessive power dissipation. TC901's power supply should be established at the same time (or before) input signals are applied. If this is not possible, input current should be limited to $100\mu\text{A}$ to avoid triggering the p-n-p-n structure.

Pin Compatibility

The CMOS TC901 is pin compatible with other chopper-stabilized amplifiers, such as the 7650, 7652 and 1052. Amplifiers such as the 7650 require $0.1\mu\text{F}$ external capacitors connected to pins 1 and 8. The TC901 includes the chopper capacitors on-chip, so external capacitors are not required. Since pins 1, 5 and 8 of the TC901 are not connected, the TC901 can directly replace other chopper-stabilized amplifiers in existing circuits.

The TC901 pinout also matches many popular bipolar and JFET op amps, such as the OP-07, OP-20, LM101, LM108, 356 and 741. In many applications that operate from $\pm 15\text{V}$ power supplies, the TC901 offers superior electrical performance and is a functional pin-compatible replacement. Offset voltage correction potentiometers, compensation capacitors, and chopper-stabilization capacitors can be removed when retrofitting existing equipment designs. System parts count, assembly time, and system cost are reduced, while reliability and performance are improved.

Overload Recovery

The TSC90X Series recovers quickly from output saturation. Typical recovery time from positive output saturation is 20msec. Negative output saturation recovery time is typically 5msec.

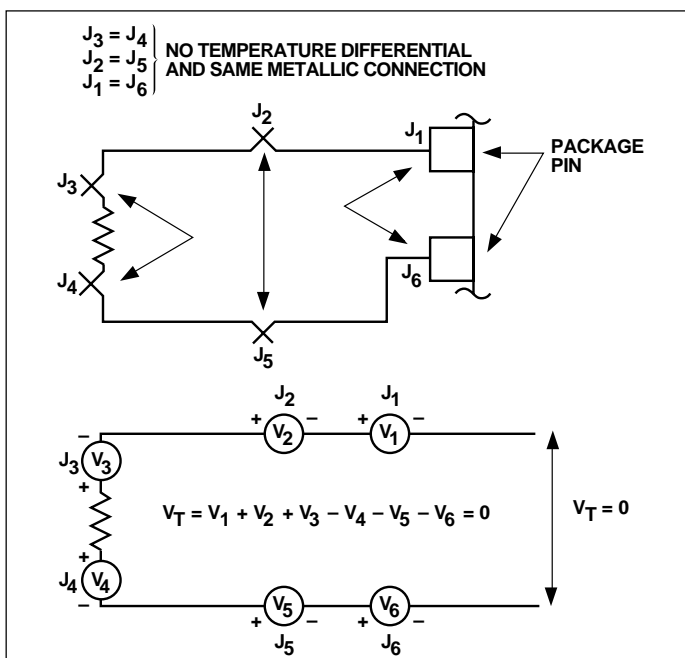


Figure 7. Unwanted Thermocouple Errors Eliminated by Reducing Thermal Gradients and Balancing Junctions

TC901

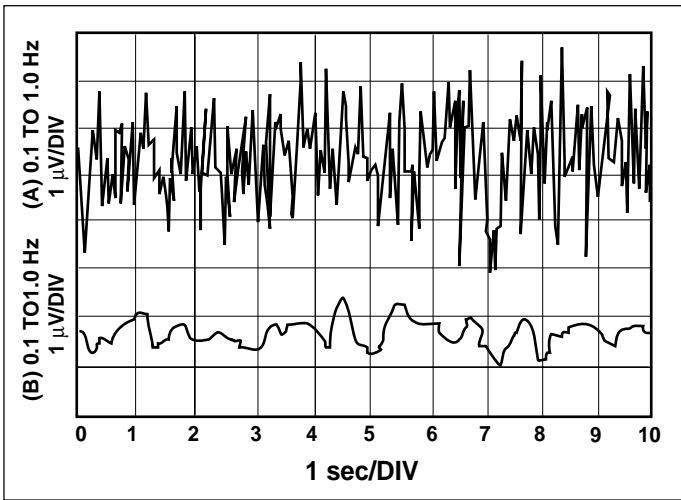


Figure 1. Input Voltage Noise

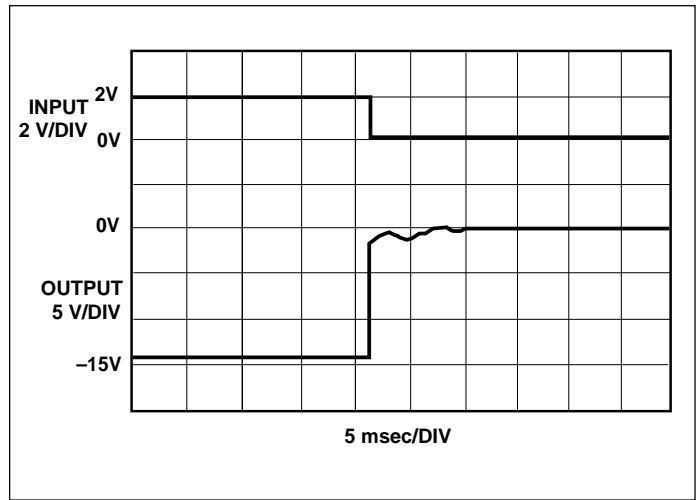


Figure 3. Recovery From Negative Saturation

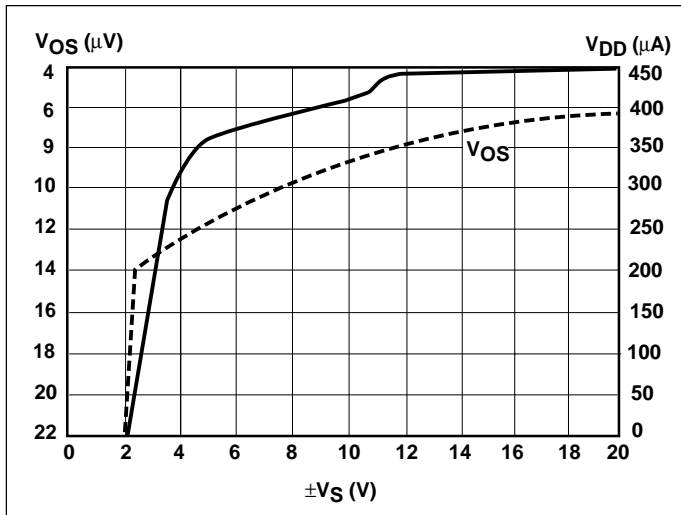


Figure 2. V_{OS} and I_{DD} vs Supply Voltage

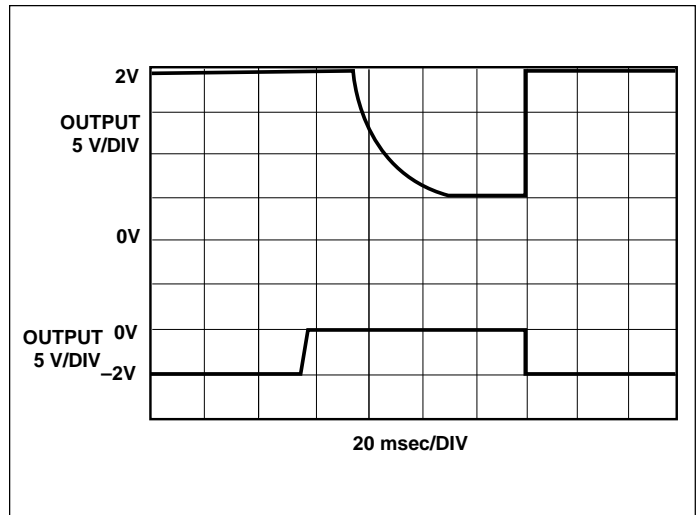


Figure 4. Recovery From Positive Saturation

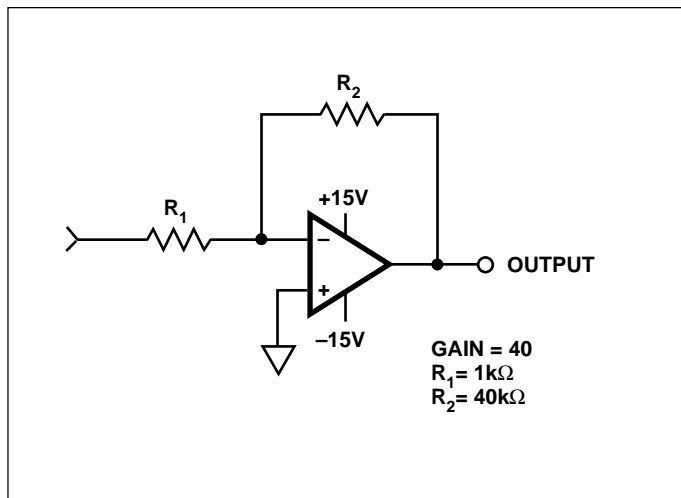


Figure 5. Saturation Test Circuit

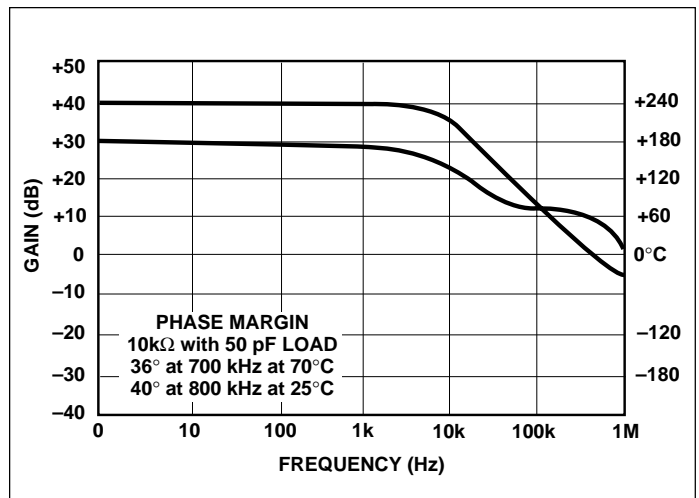
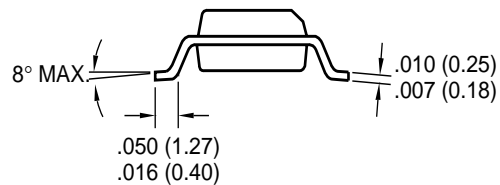
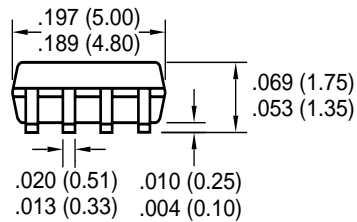
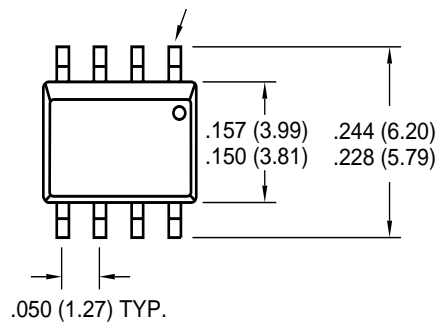


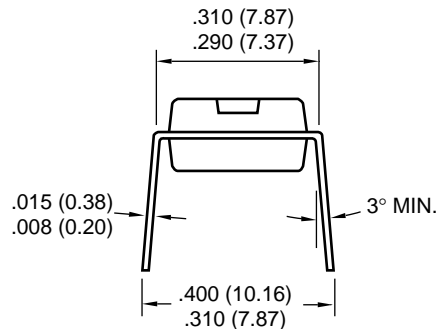
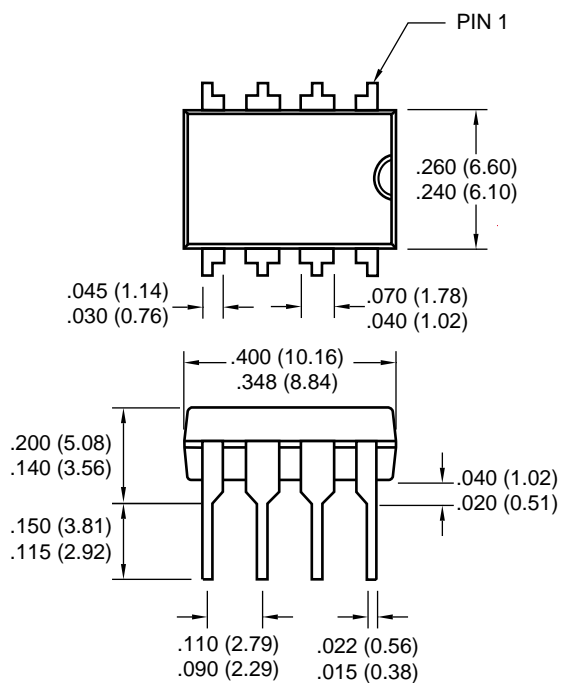
Figure 6. Phase-Gain

PACKAGE DIMENSIONS

8-Pin SOIC Narrow



8-Pin Plastic Dip



Dimensions: inches (mm)



WORLDWIDE SALES AND SERVICE

AMERICAS

Corporate Office

2355 West Chandler Blvd.
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Dallas

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Addison, TX 75001
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Dayton

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Tel: 937-291-1654 Fax: 937-291-9175

Detroit

Tri-Atria Office Building
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Tel: 248-538-2250 Fax: 248-538-2260

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Analog Product Sales
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New York

150 Motor Parkway, Suite 202
Hauppauge, NY 11788
Tel: 631-273-5305 Fax: 631-273-5335

San Jose

Microchip Technology Inc.
2107 North First Street, Suite 590
San Jose, CA 95131
Tel: 408-436-7950 Fax: 408-436-7955

Toronto

6285 Northam Drive, Suite 108
Mississauga, Ontario L4V 1X5, Canada
Tel: 905-673-0699 Fax: 905-673-6509

ASIA/PACIFIC

China - Beijing

Microchip Technology Beijing Office
Unit 915
New China Hong Kong Manhattan Bldg.
No. 6 Chaoyangmen Beidajie
Beijing, 100027, No. China
Tel: 86-10-85282100 Fax: 86-10-85282104

China - Shanghai

Microchip Technology Shanghai Office
Room 701, Bldg. B
Far East International Plaza
No. 317 Xian Xia Road
Shanghai, 200051
Tel: 86-21-6275-5700 Fax: 86-21-6275-5060

Hong Kong

Microchip Asia Pacific
RM 2101, Tower 2, Metroplaza
223 Hing Fong Road
Kwai Fong, N.T., Hong Kong
Tel: 852-2401-1200 Fax: 852-2401-3431

India

Microchip Technology Inc.
India Liaison Office
Divyasree Chambers
1 Floor, Wing A (A3/A4)
No. 11, O'Shaughnessey Road
Bangalore, 560 025, India
Tel: 91-80-2290061 Fax: 91-80-2290062

Japan

Microchip Technology Intl. Inc.
Benex S-1 6F
3-18-20, Shinyokohama
Kohoku-Ku, Yokohama-shi
Kanagawa, 222-0033, Japan
Tel: 81-45-471- 6166 Fax: 81-45-471-6122

Korea

Microchip Technology Korea
168-1, Youngbo Bldg. 3 Floor
Samsung-Dong, Kangnam-Ku
Seoul, Korea
Tel: 82-2-554-7200 Fax: 82-2-558-5934

ASIA/PACIFIC (continued)

Singapore

Microchip Technology Singapore Pte Ltd.
200 Middle Road
#07-02 Prime Centre
Singapore, 188980
Tel: 65-334-8870 Fax: 65-334-8850

Taiwan

Microchip Technology Taiwan
11F-3, No. 207
Tung Hua North Road
Taipei, 105, Taiwan
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EUROPE

Australia

Microchip Technology Australia Pty Ltd
Suite 22, 41 Rawson Street
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Australia
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Denmark

Microchip Technology Denmark ApS
Regus Business Centre
Lautrup høj 1-3
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France

Arizona Microchip Technology SARL
Parc d'Activite du Moulin de Massy
43 Rue du Saule Trapu
Batiment A - 1er Etage
91300 Massy, France
Tel: 33-1-69-53-63-20 Fax: 33-1-69-30-90-79

Germany

Arizona Microchip Technology GmbH
Gustav-Heinemann Ring 125
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Tel: 49-89-627-144 0 Fax: 49-89-627-144-44

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Tel: 49-89-895650-0 Fax: 49-89-895650-22

Italy

Arizona Microchip Technology SRL
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20041 Agrate Brianza
Milan, Italy
Tel: 39-039-65791-1 Fax: 39-039-6899883

United Kingdom

Arizona Microchip Technology Ltd.
505 Eskdale Road
Winkersley Triangle
Wokingham
Berkshire, England RG41 5TU
Tel: 44 118 921 5869 Fax: 44-118 921-5820

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