

100mA Charge Pump Voltage Converter with Shutdown

Features

- Optional High-Frequency Operation Allows Use of Small Capacitors
- Low Operating Current (FC = GND)
 - 50µA
- High Output Current (100mA)
- Converts a 2.4V to 5.5V Input Voltage to a Corresponding Negative Output Voltage (Inverter Mode)
- Uses Only 2 Capacitors; No Inductors Required
- Selectable Oscillator Frequency
 - 10kHz to 200kHz
- Power-Saving Shutdown Input
- Available in 8-Pin MSOP, 8-Pin PDIP and 8-Pin Small Outline (SOIC) Packages

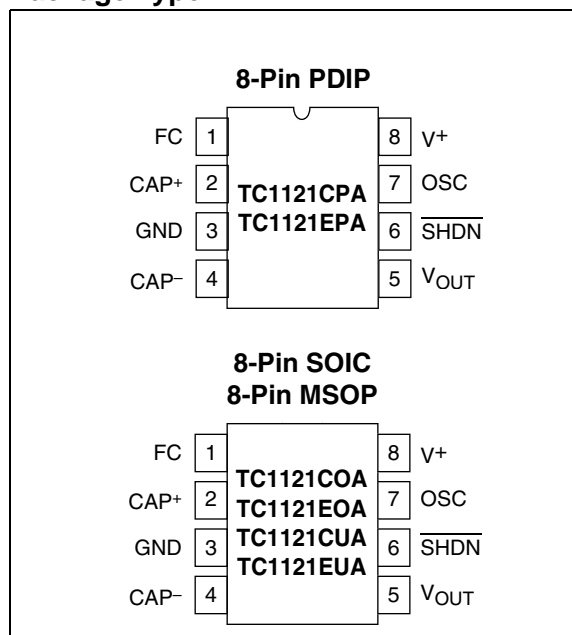
Applications

- Laptop Computers
- Medical Instruments
- Disk Drives
- µP-Based Controllers
- Process Instrumentation

Device Selection Table

Part Number	Package	Operating Temp. Range
TC1121COA	8-Pin SOIC	0°C to +70°C
TC1121CPA	8-Pin PDIP	0°C to +70°C
TC1121CUA	8-Pin MSOP	0°C to +70°C
TC1121EOA	8-Pin SOIC	-40°C to +85°C
TC1121EPA	8-Pin PDIP	-40°C to +85°C
TC1121EUA	8-Pin MSOP	-40°C to +85°C

Package Type



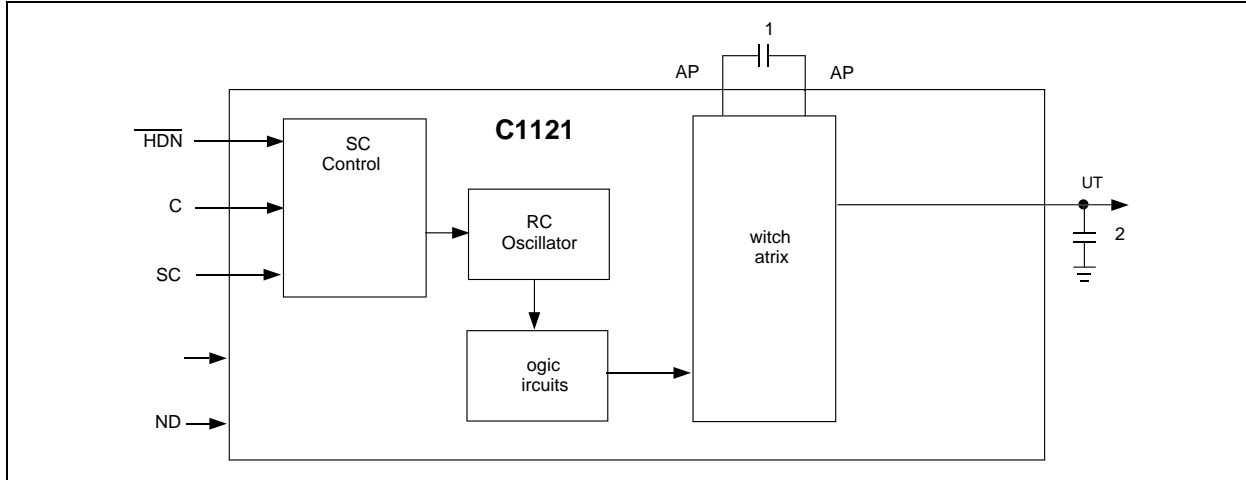
General Description

The TC1121 is a charge pump converter with 100mA output current capability. It converts a 2.4V to 5.5V input to a corresponding negative output voltage. As with all charge pump converters, the TC1121 uses no inductors saving cost, size and EMI.

An on-board oscillator operates at a typical frequency of 10kHz (at V⁺ = 5V) when the frequency control input (FC) is connected to ground. The oscillator frequency increases to 200kHz when FC is connected to V⁺, allowing the use of smaller capacitors. Operation at sub-10kHz frequencies results in lower quiescent I_{NS}current and is accomplished with the addition of an external capacitor from OSC (pin 7) to ground. The TC1121 also can be driven from an external clock NSconnected OSC. Typical supply current at 10kHz is 50µA, and falls to less than 1µA when the shutdown input is brought low, whether the internal or an external clock is used. The TC1121 is available in 8-pin SOIC, MSOP and PDIP packages.

TC1121

Functional Block Diagram



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings*

Supply Voltage (V_{DD})6V
OSC, FC, $\overline{\text{SHDN}}$ Input Voltage-0.3V to ($V^+ + 0.3V$)
Output Short Circuit Duration 10 Sec.
Package Power Dissipation ($T_A \leq 70^\circ\text{C}$)	
8-Pin PDIP 730mW
8-Pin SOIC 470mW
8-Pin MSOP 333mW
Operating Temperature Range	
C Suffix 0°C to $+70^\circ\text{C}$
E Suffix -40°C to $+85^\circ\text{C}$
Storage Temperature Range -65°C to $+150^\circ\text{C}$

*Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operation sections of the specifications is not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability.

TC1121 ELECTRICAL SPECIFICATIONS

Electrical Characteristics: $T_A = 0^\circ\text{C}$ to 70°C (C suffix), -40°C to $+85^\circ\text{C}$ (E suffix), $V^+ = 5V \pm 10\%$ $C_{OSC} = \text{Open}$, $C1, C2 = 10\mu\text{F}$, $\text{FC} = V^+$, $\overline{\text{SHDN}} = V_{IH}$, typical values are at $T_A = 25^\circ\text{C}$ unless otherwise noted.						
Symbol	Parameter	Min	Typ	Max	Units	Test Conditions
I_{DD}	Active Supply Current	—	50	100	μA	$R_L = \text{Open}$, $\text{FC} = \text{Open or GND}$
		—	0.6	1	mA	
$I_{SHUTDOWN}$	Shutdown Supply Current	—	0.2	1.0	μA	$\overline{\text{SHDN}} = 0V$
V^+	Supply Voltage	2.4	—	5.5	V	
V_{IH}	$\overline{\text{SHDN}}$ Input Logic High	$V_{DD} \times 0.8$	—	—	V	
V_{IL}	$\overline{\text{SHDN}}$ Input Logic Low	—	—	0.4	V	
I_{IN}	Input Leakage Current	-1	—	1	μA	$\overline{\text{SHDN}}$, OSC FC pin
		-4	—	4		
R_{OUT}	Output Source Resistance	—	12	20	Ω	$I_{OUT} = 60\text{mA}$
I_{OUT}	Output Current	60	100			$V_{OUT} = \text{more negative than } -3.75V$
F_{OSC}	Oscillator Frequency	5	10	—	kHz	Pin 7 Open, Pin 1 Open or GND $\overline{\text{SHDN}} = V_{IH}$, Pin 1 = V^+
		100	200	—		
P_{EFF}	Power Efficiency	—	—	—	%	FC = GND for all $R_L = 2k$ between V^+ and V_{OUT} $R_L = 1k\Omega$ between V_{OUT} and GND $I_L = 60\text{mA}$ to GND
		93	97	—		
		94	97	—		
		—	92	—		
V_{EFF}	Voltage Conversion Efficiency	99	99.9	—	%	$R_L = \text{Open}$

Note 1: Connecting any input terminal to voltages greater than V^+ or less than GND may cause destructive latch-up. It is recommended that no inputs from sources operating from external supplies be applied prior to "power up" of the TC1121.

TC1121

2.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in Table 2-1.

TABLE 2-1: PIN FUNCTION TABLE

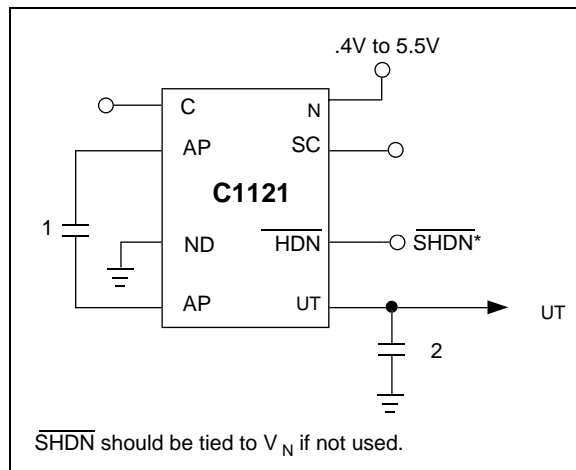
Pin No. (8-Pin MSOP, PDIP, SOIC)	Symbol	Description
1	FC	Frequency control for internal oscillator, FC = open, $F_{OSC} = 10\text{kHz typ}$; FC = V^+ , $F_{OSC} = 200\text{kHz typ}$; FC has no effect when OSC pin is driven externally.
2	CAP ⁺	Charge-pump capacitor, positive terminal.
3	GND	Power-supply ground input.
4	CAP ⁻	Charge-pump capacitor, negative terminal.
5	OUT	Output, negative voltage.
6	$\overline{\text{SHDN}}$	Shutdown.
7	OSC	Oscillator control input. An external capacitor can be added to slow the oscillator. Take care to minimize stray capacitance. An external oscillator also may be connected to overdrive OSC.
8	V^+	Power-supply positive voltage input.

3.0 APPLICATIONS

3.1 Negative Voltage Converter

The TC1121 is typically used as a charge-pump voltage inverter. C1 and C2 are the only two external capacitors used in the operating circuit (Figure 3-1).

FIGURE 3-1: CHARGE PUMP INVERTER



The TC1121 is not sensitive to load current changes, although its output is not actively regulated. A typical output source resistance of 11.8Ω means that an input of +5V results in -5V output voltage under light load, and only decreases to -3.8V typ with a 100mA load.

The supplied output current is from capacitor C2 during one-half the charge-pump cycle. This results in a peak-to-peak ripple of:

$$V_{\text{RIPPLE}} = I_{\text{OUT}}/2(f_{\text{PUMP}}) (C2) + I_{\text{OUT}} (ESR_{C2})$$

Where f_{PUMP} is 5kHz (one half the nominal 10kHz oscillator frequency), and $C2 = 150\mu\text{F}$ with an ESR of 0.2Ω, ripple is about 90mV with a 100mA load current. If C2 is raised to 390μF, the ripple drops to 45mV.

3.2 Changing Oscillator Frequency

The TC1121's clock frequency is controlled by four modes:

TABLE 3-1: OSCILLATOR FREQUENCY MODES

FC	OSC	Oscillator Frequency
Open	Open	10kHz
FC = V ⁺	Open	200kHz
Open or FC = V ⁺	External Capacitor	See Typical Operating Characteristics
Open	External Clock	External Clock Frequency

The oscillator runs at 10kHz (typical) when FC and OSC are not connected. The oscillator frequency is lowered by connecting a capacitor between OSC and GND, but FC can still multiply the frequency by 20 times in this mode.

An external clock source that swings within 100mV of V⁺ and GND may overdrive OSC in the inverter mode. OSC can be driven by any CMOS logic output. When OSC is overdriven, FC has no effect.

Note that the frequency of the signal appearing at CAP⁺ and CAP⁻ is half that of the oscillator. In addition, by lowering the oscillator frequency, the effective output resistance of the charge-pump increases. To compensate for this, the value of the charge-pump capacitors may be increased.

Because the 5kHz output ripple frequency may be low enough to interfere with other circuitry, the oscillator frequency can be increased with the use of the FC pin or an external oscillator. The output ripple frequency is half the selected oscillator frequency. Although the TC1121's quiescent current will increase if the clock frequency is increased, it allows smaller capacitance values to be used for C1 and C2.

3.3 Capacitor Selection

In addition to load current, the following factors affect the TC1121 output voltage drop from its ideal value 1) output resistance, 2) pump (C1) and reservoir (C2) capacitor ESRs and 3) C1 and C2 capacitance.

The voltage drop is the load current times the output resistance. The loss in C2 is the load current times C2's ESR; C1's loss is larger because it handles currents greater than the load current during charge-pump operation. Therefore, the voltage drop due to C1 is about four times C1's ESR multiplied by the load current, and a low (or high) ESR capacitor has a greater impact on performance for C1 than for C2.

In general, as the TC1121's pump frequency increases, capacitance values needed to maintain comparable ripple and output resistance diminish proportionately.

TC1121

3.4 Cascading Devices

To produce greater negative magnitudes of the initial supply voltage, the TC1121 may be cascaded (see Figure 3-2). Resulting output resistance is approximately equal to the sum of individual TC1121 R_{OUT} values. The output voltage (where n is an integer representing the number of devices cascaded) is defined by $V_{OUT} = -n (V_{IN})$.

3.5 Paralleling Devices

To reduce output resistance, multiple TC1121s may be paralleled (see Figure 3-3). Each device needs a pump capacitor $C1$, but the reservoir capacitor $C2$ serves all devices. The value of $C2$ should be increased by a factor of n (the number of devices).

FIGURE 3-2: CASCADING TC1121s TO INCREASE OUTPUT VOLTAGE

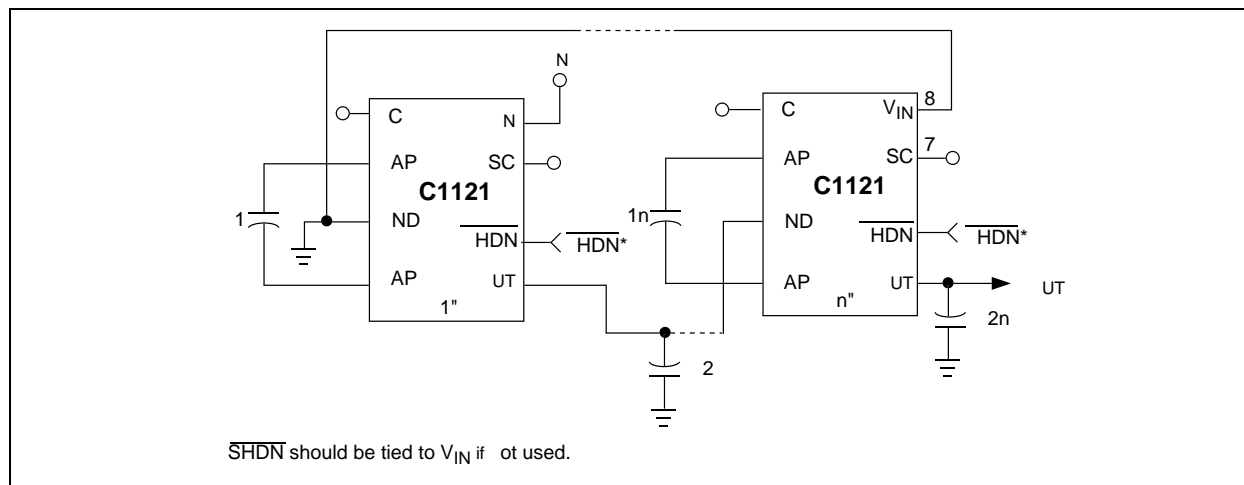
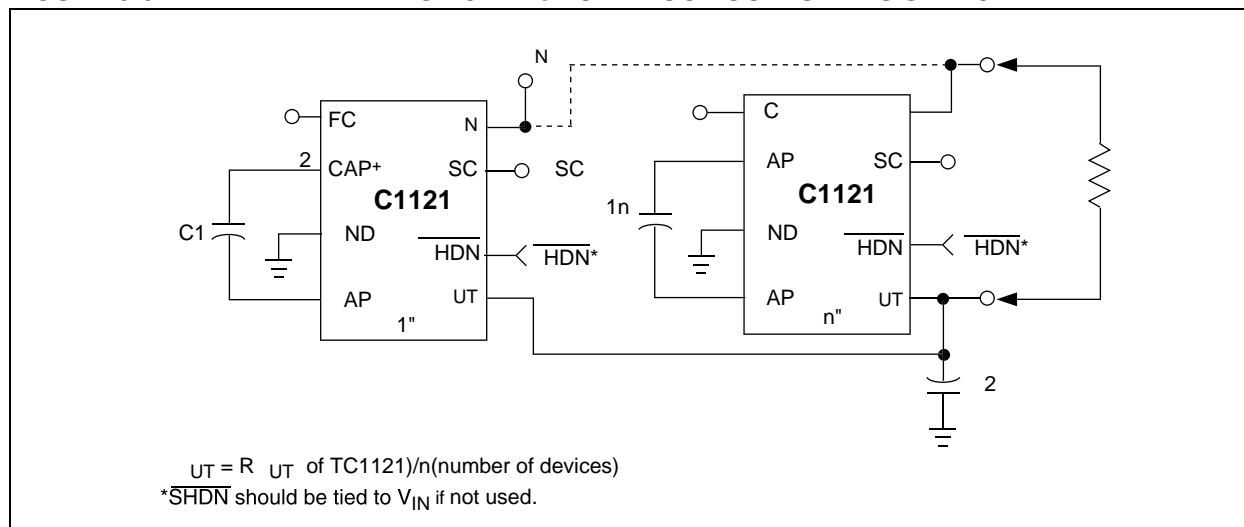


FIGURE 3-3: PARALLELING TC1121s TO REDUCE OUTPUT RESISTANCE

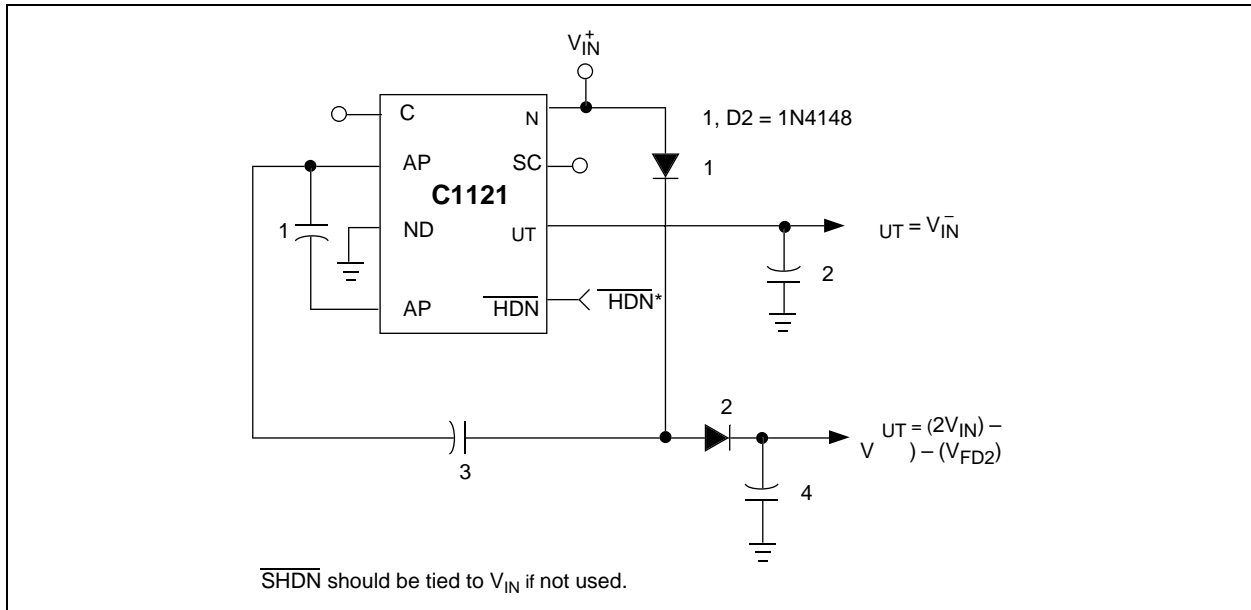


3.6 Combined Positive Supply Multiplication and Negative Voltage Conversion

Figure 3-4 shows this dual function circuit, in which capacitors C1 and C2 perform pump and reservoir functions to generate negative voltage. Capacitors C3

and C4 are the respective capacitors for multiplied positive voltage. This particular configuration leads to higher source impedances of the generated supplies due to the finite impedance of the common charge-pump driver.

FIGURE 3-4: COMBINED POSITIVE MULTIPLIER AND NEGATIVE CONVERTER



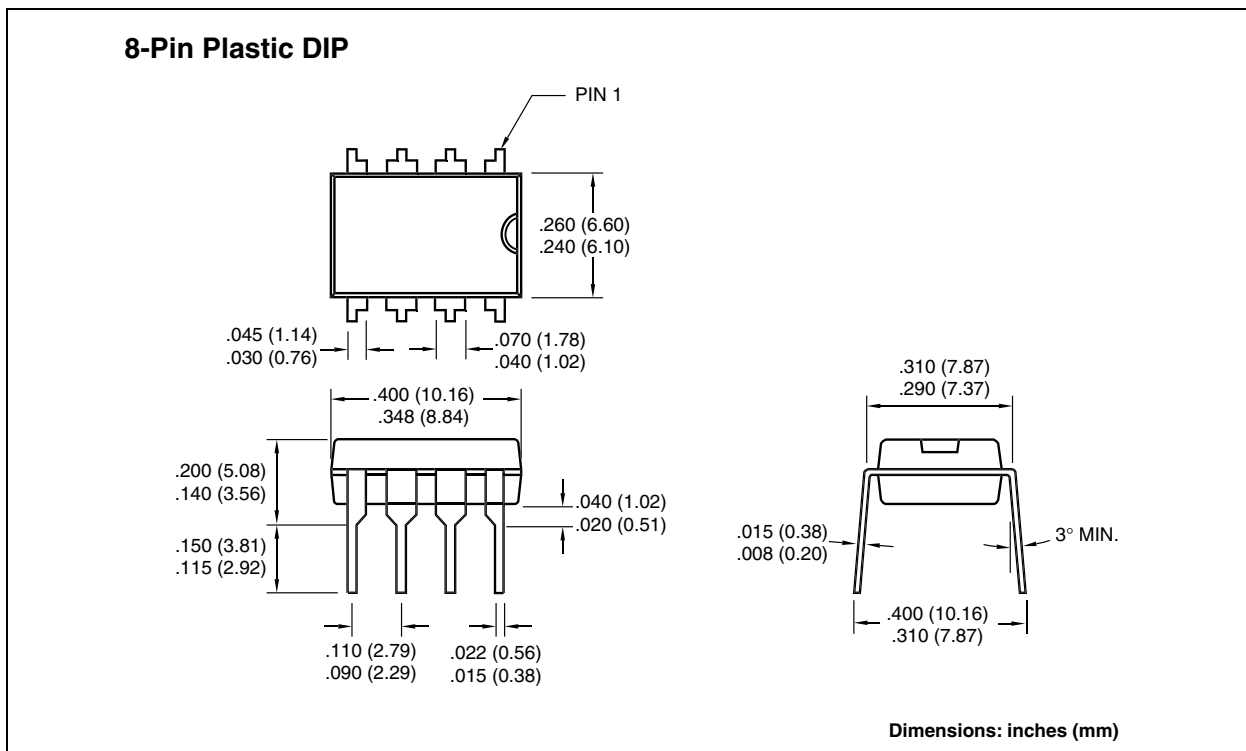
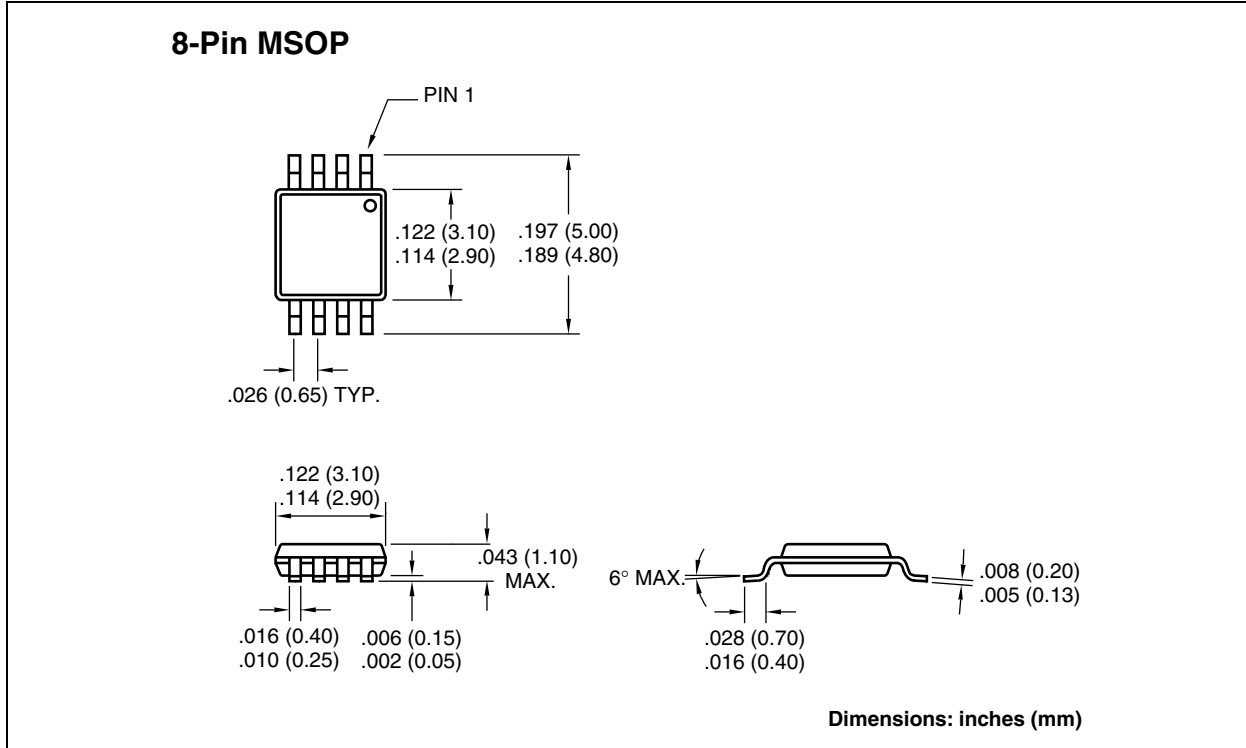
TC1121

4.0 PACKAGING INFORMATION

4.1 Package Marking Information

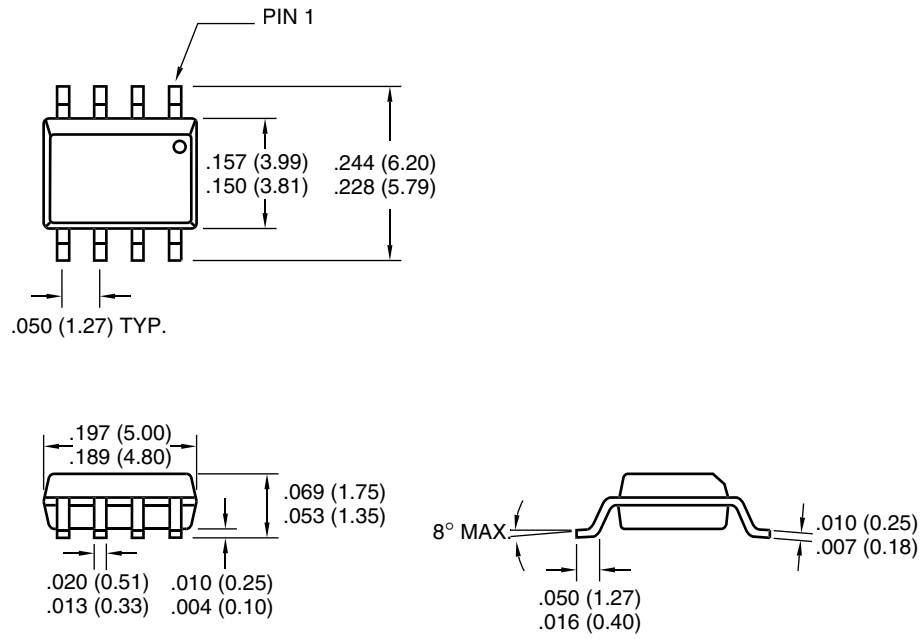
Package marking data not available at this time.

4.2 Package Dimensions



Package Dimensions (Continued)

8-Pin SOIC



Dimensions: inches (mm)

TC1121

NOTES:

Sales and Support

Data Sheets

Products supported by a preliminary Data Sheet may have an errata sheet describing minor operational differences and recommended workarounds. To determine if an errata sheet exists for a particular device, please contact one of the following:

1. Your local Microchip sales office
2. The Microchip Corporate Literature Center U.S. FAX: (480) 792-7277
3. The Microchip Worldwide Site (www.microchip.com)

Please specify which device, revision of silicon and Data Sheet (include Literature #) you are using.

New Customer Notification System

Register on our web site (www.microchip.com/cn) to receive the most current information on our products.

TC1121

NOTES:

Information contained in this publication regarding device applications and the like is intended through suggestion only and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. No representation or warranty is given and no liability is assumed by Microchip Technology Incorporated with respect to the accuracy or use of such information, or infringement of patents or other intellectual property rights arising from such use or otherwise. Use of Microchip's products as critical components in life support systems is not authorized except with express written approval by Microchip. No licenses are conveyed, implicitly or otherwise, under any intellectual property rights.

Trademarks


The Microchip name and logo, the Microchip logo, FilterLab, KEELOQ, microID, MPLAB, PIC, PICmicro, PICMASTER, PICSTART, PRO MATE, SEEVAL and The Embedded Control Solutions Company are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

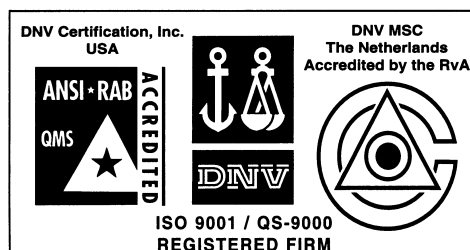
dsPIC, ECONOMONITOR, FanSense, FlexROM, fuzzyLAB, In-Circuit Serial Programming, ICSP, ICEPIC, microPort, Migratable Memory, MPASM, MPLIB, MPLINK, MPSIM, MXDEV, PICC, PICDEM, PICDEM.net, rfPIC, Select Mode and Total Endurance are trademarks of Microchip Technology Incorporated in the U.S.A.

Serialized Quick Turn Programming (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.

© 2002, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

 Printed on recycled paper.



Microchip received QS-9000 quality system certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona in July 1999 and Mountain View, California in March 2002. The Company's quality system processes and procedures are QS-9000 compliant for its PICmicro® 8-bit MCUs, KEELOQ® code hopping devices, Serial EEPROMs, microperipherals, non-volatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001 certified.



MICROCHIP

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: 480-792-7627
Web Address: <http://www.microchip.com>

Rocky Mountain

2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7966 Fax: 480-792-7456

Atlanta

500 Sugar Mill Road, Suite 200B
Atlanta, GA 30350
Tel: 770-640-0034 Fax: 770-640-0307

Boston

2 Lan Drive, Suite 120
Westford, MA 01886
Tel: 978-692-3848 Fax: 978-692-3821

Chicago

333 Pierce Road, Suite 180
Itasca, IL 60143
Tel: 630-285-0071 Fax: 630-285-0075

Dallas

4570 Westgrove Drive, Suite 160
Addison, TX 75001
Tel: 972-818-7423 Fax: 972-818-2924

Detroit

Tri-Atria Office Building
32255 Northwestern Highway, Suite 190
Farmington Hills, MI 48334
Tel: 248-538-2250 Fax: 248-538-2260

Kokomo

2767 S. Albright Road
Kokomo, Indiana 46902
Tel: 765-864-8360 Fax: 765-864-8387

Los Angeles

18201 Von Karman, Suite 1090
Irvine, CA 92612
Tel: 949-263-1888 Fax: 949-263-1338

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

Australia

Microchip Technology Australia Pty Ltd
Suite 22, 41 Rawson Street
Epping 2121, NSW
Australia
Tel: 61-2-9868-6733 Fax: 61-2-9868-6755

China - Beijing

Microchip Technology Consulting (Shanghai)
Co., Ltd., Beijing Liaison Office
Unit 915
Bei Hai Wan Tai Bldg.
No. 6 Chaoyangmen Beidajie
Beijing, 100027, No. China
Tel: 86-10-85282100 Fax: 86-10-85282104

China - Chengdu

Microchip Technology Consulting (Shanghai)
Co., Ltd., Chengdu Liaison Office
Rm. 2401, 24th Floor,
Ming Xing Financial Tower
No. 88 TIDU Street
Chengdu 610016, China
Tel: 86-28-6766200 Fax: 86-28-6766599

China - Fuzhou

Microchip Technology Consulting (Shanghai)
Co., Ltd., Fuzhou Liaison Office
Unit 28F, World Trade Plaza
No. 71 Wusi Road
Fuzhou 350001, China
Tel: 86-591-7503506 Fax: 86-591-7503521

China - Shanghai

Microchip Technology Consulting (Shanghai)
Co., Ltd.
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

China - Shenzhen

Microchip Technology Consulting (Shanghai)
Co., Ltd., Shenzhen Liaison Office
Rm. 1315, 13/F, Shenzhen Kerry Centre,
Renminnan Lu
Shenzhen 518001, China
Tel: 86-755-2350361 Fax: 86-755-2366086

Hong Kong

Microchip Technology Hongkong Ltd.
Unit 901-6, 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'Shaugnessey Road
Bangalore, 560 025, India
Tel: 91-80-2290061 Fax: 91-80-2290062

Japan

Microchip Technology Japan K.K.
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 135-882
Tel: 82-2-554-7200 Fax: 82-2-558-5934

Singapore

Microchip Technology Singapore Pte Ltd.
200 Middle Road
#07-02 Prime Centre
Singapore, 188980
Tel: 65-6334-8870 Fax: 65-6334-8850

Taiwan

Microchip Technology Taiwan
11F-3, No. 207
Tung Hua North Road
Taipei, 105, Taiwan
Tel: 886-2-2717-7175 Fax: 886-2-2545-0139

EUROPE

Denmark

Microchip Technology Nordic ApS
Regus Business Centre
Lautrup høj 1-3
Ballerup DK-2750 Denmark
Tel: 45 4420 9895 Fax: 45 4420 9910

France

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

Microchip Technology GmbH
Gustav-Heinemann Ring 125
D-81739 Munich, Germany
Tel: 49-89-627-144 0 Fax: 49-89-627-144-44

Italy

Microchip Technology SRL
Centro Direzionale Colleoni
Palazzo Taurus 1 V. Le Colleoni 1
20041 Agrate Brianza
Milan, Italy
Tel: 39-039-65791-1 Fax: 39-039-6899883

United Kingdom

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

03/01/02

