

Inverting Voltage Doubler

Features:

- 99.9% Voltage Conversion Efficiency
- 92% Power Conversion Efficiency
- Wide Input Voltage Range:
 - +2.4V to +5.5V
- Only 3 External Capacitors Required
- 185 μ A Supply Current
- Space-Saving 8-Pin SOIC and 8-Pin PDIP Packages

Applications:

- -10V from +5V Logic Supply
- -6V from a Single 3V Lithium Cell
- Portable Handheld Instruments
- Cellular Phones
- LCD Display Bias Generator
- Panel Meters
- Operational Amplifier Power Supplies

Device Selection Table

Part Number	Package	Operating Temp. Range
TC682COA	8-Pin SOIC	0°C to +70°C
TC682CPA	8-Pin PDIP	0°C to +70°C
TC682EOA	8-Pin SOIC	-40°C to +85°C
TC682EPA	8-Pin PDIP	-40°C to +85°C

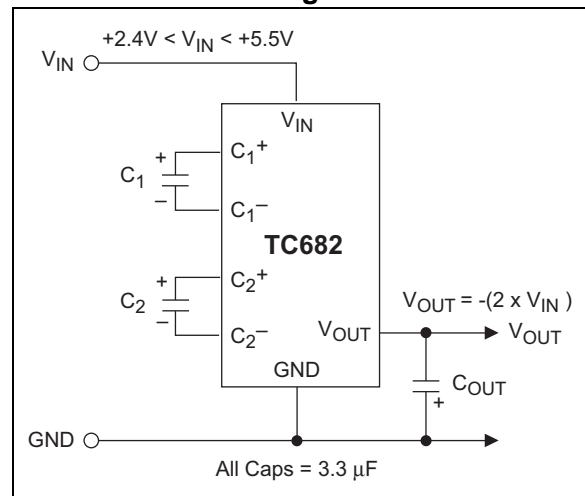
General Description:

The TC682 is a CMOS charge pump converter that provides an inverted doubled output from a single positive supply. An on-board 12 kHz (typical) oscillator provides the clock and only 3 external capacitors are required for full circuit implementation.

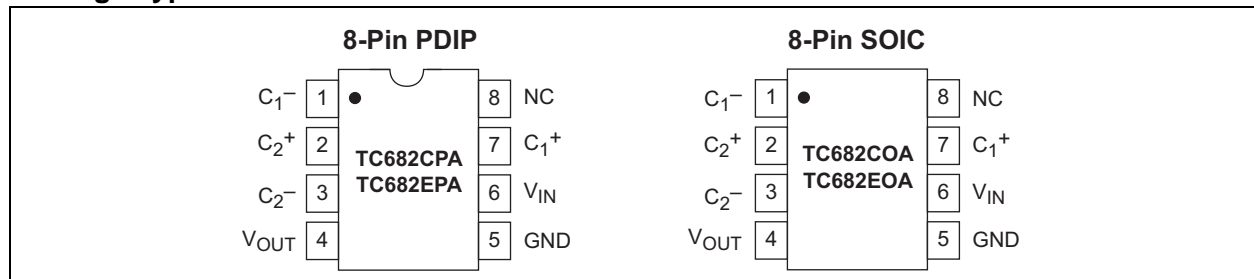
Low output source impedance (typically 140 Ω), provides output current up to 10 mA. The TC682 features low quiescent current and high efficiency, making it the ideal choice for a wide variety of applications that require a negative voltage derived from a single positive supply (for example: generation of -6V from a 3V lithium cell or -10V generated from a +5V logic supply).

The minimum external parts count and small physical size of the TC682 make it useful in many medium-current, dual voltage analog power supplies.

Functional Block Diagram



Package Type



TC682

1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings*

V_{IN}	+5.8V
V_{IN} dV/dT	1V/ μ sec
V_{OUT}	-11.6V
Short-Circuit Duration - V_{OUT}	Continuous
Power Dissipation ($T_A \leq 70^\circ\text{C}$)	
8-Pin PDIP	730 mW
8-Pin SOIC	470 mW
Operating Temperature Range.....	-40°C to +85°C
Storage Temperature (Unbiased)	-65°C to +150°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.

TC682 ELECTRICAL SPECIFICATIONS

Electrical Characteristics: Over operating temperature range, $V_{IN} = +5V$, test circuit Figure 3-1 unless otherwise noted.						
Symbol	Parameter	Min	Typ	Max	Units	Test Conditions
V_{IN}	Supply Voltage Range	2.4	—	5.5	V	$R_L = 2\text{ k}\Omega$
I_{IN}	Supply Current	—	185	300	μ A	$R_L = \infty, T_A = 25^\circ\text{C}$ $R_L = \infty$
R_{OUT}	V_{OUT} Source Resistance	—	140	180	Ω	$I_L^- = 10\text{ mA}, T_A = 25^\circ\text{C}$ $I_L^- = 10\text{ mA}$ $I_L^- = 5\text{ mA}, V_{IN} = 2.8V$
F_{OSC}	Oscillator Frequency	—	12	—	kHz	
P_{EFF}	Power Efficiency	90	92	—	%	$R_L = 2\text{ k}\Omega, T_A = 25^\circ\text{C}$
V_{OUTEFF}	Voltage Conversion Efficiency	99	99.9	—	%	$V_{OUT}, R_L = \infty$

2.0 PIN DESCRIPTION

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

TABLE 2-1: PIN FUNCTION TABLE

Pin No. (8-Pin PDIP, SOIC)	Symbol	Description
1	C1-	Input. Capacitor C1 negative terminal.
2	C2+	Input. Capacitor C2 positive terminal.
3	C2-	Input. Capacitor C2 negative terminal.
4	V _{OUT}	Output. Negative output voltage (-2V _{IN}).
5	GND	Input. Ground.
6	V _{IN}	Input. Power supply voltage.
7	C1+	Input. Capacitor C1 positive terminal.
8	NC	No connection.

TC682

3.0 DETAILED DESCRIPTION

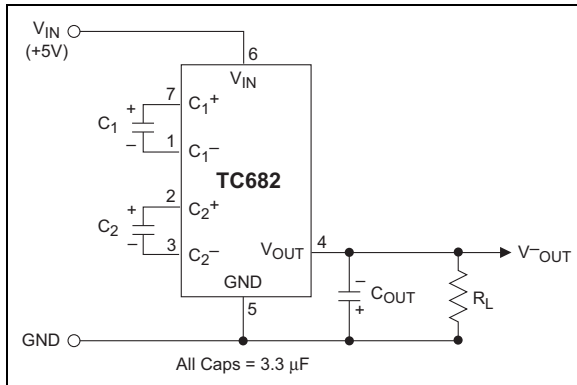


FIGURE 3-1: TC682 Test Circuit

3.1 Phase 1

V_{SS} charge storage – before this phase of the clock cycle, capacitor C_1 is already charged to +5V. C_1^+ is then switched to ground and the charge in C_1^- is transferred to C_2^- . Since C_2^+ is at +5V, the voltage potential across capacitor C_2 is now -10V.

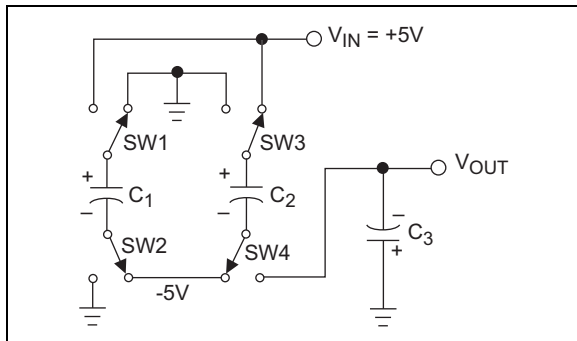


FIGURE 3-2: Charge Pump – Phase 1

3.2 Phase 2

V_{SS} transfer – phase two of the clock connects the negative terminal of C_2 to the negative side of reservoir capacitor C_3 and the positive terminal of C_2 to ground, transferring the generated -10V to C_3 . Simultaneously, the positive side of capacitor C_1 is switched to +5V and the negative side is connected to ground. C_2 is then switched to V_{CC} and GND and Phase 1 begins again.

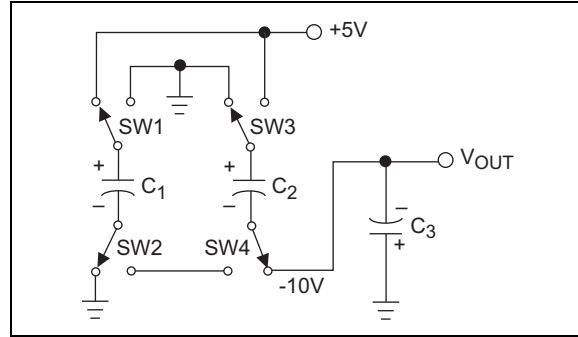


FIGURE 3-3: Charge Pump – Phase 2

3.3 Maximum Operating Limits

The TC682 has on-chip Zener diodes that clamp V_{IN} to approximately 5.8V, and V_{OUT} to -11.6V. Never exceed the maximum supply voltage or excessive current will be shunted by these diodes, potentially damaging the chip. The TC682 will operate over the entire operating temperature range with an input voltage of 2V to 5.5V.

3.4 Efficiency Considerations

Theoretically a charge pump voltage multiplier can approach 100% efficiency under the following conditions:

- The charge pump switches have virtually no offset and are extremely low on resistance.
- Minimal power is consumed by the drive circuitry.
- The impedances of the reservoir and pump capacitors are negligible.

For the TC682, efficiency is as shown below:

$$\begin{aligned} \text{Voltage Efficiency} &= V_{OUT} / (-2V_{IN}) \\ V_{OUT} &= -2V_{IN} + V_{DROP} \\ V_{DROP} &= (I_{OUT}) (R_{OUT}) \end{aligned}$$

$$\text{Power Loss} = I_{OUT} (V_{DROP})$$

There will be a substantial voltage difference between V_{OUT} and $-2V_{IN}$ if the impedances of the pump capacitors C_1 and C_2 are high with respect to their respective output loads.

Larger values of reservoir capacitor C_3 will reduce output ripple. Larger values of both pump and reservoir capacitors improve the efficiency. See **Section 4.2 “Capacitor Selection”** “Capacitor Selection”.

4.0 TYPICAL APPLICATIONS

4.1 Negative Doubling Converter

The most common application of the TC682 is as a charge pump voltage converter which provides a negative output of two times a positive input voltage (Figure 4-1).

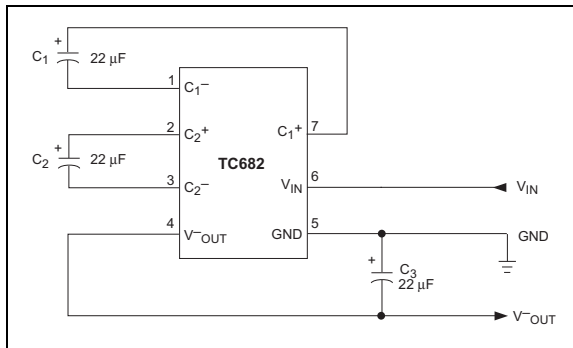


FIGURE 4-1: Inverting Voltage Doubler

4.2 Capacitor Selection

The output resistance of the TC682 is determined, in part, by the ESR of the capacitors used. An expression for R_{OUT} is derived as shown below:

$$R_{OUT} = 2(R_{SW1} + R_{SW2} + ESR_{C1} + R_{SW3} + R_{SW4} + ESR_{C2}) + 2(R_{SW1} + R_{SW2} + ESR_{C1} + R_{SW3} + R_{SW4} + ESR_{C2}) + 1/(f_{PUMP} \times C1) + 1/(f_{PUMP} \times C2) + ESR_{C3}$$

Assuming all switch resistances are approximately equal:

$$R_{OUT} = 16R_{SW} + 4ESR_{C1} + 4ESR_{C2} + ESR_{C3} + 1/(f_{PUMP} \times C1) + 1/(f_{PUMP} \times C2)$$

R_{OUT} is typically 140Ω at +25°C with $V_{IN} = +5V$ and 3.3 µF low ESR capacitors. The fixed term ($16R_{SW}$) is about 80-90Ω. It can be seen easily that increasing or decreasing values of C1 and C2 will affect efficiency by changing R_{OUT} . However, be careful about ESR. This term can quickly become dominant with large electrolytic capacitors. Table 4-1 shows R_{OUT} for various values of C1 and C2 (assume 0.5Ω ESR). C1 must be rated at 6VDC or greater while C2 and C3 must be rated at 12VDC or greater.

Output voltage ripple is affected by C3. Typically the larger the value of C3 the less the ripple for a given load current. The formula for p-p V_{RIPPLE} is given below:

$$V_{RIPPLE} = \{1/[2(f_{PUMP} \times C3)] + 2(ESR_{C3})\} (I_{OUT})$$

For a 10 µF (0.5Ω ESR) capacitor for C3, $f_{PUMP} = 10$ kHz and $I_{OUT} = 10$ mA the peak-to-peak ripple voltage at the output will be less than 60 mV. In most applications ($I_{OUT} < 10$ mA) a 10-20 µF capacitor and 1-5 µF pump capacitors will suffice. Table 4-2 shows V_{RIPPLE} for different values of C3 (assume 1Ω ESR).

TABLE 4-1: OUTPUT RESISTANCE VS. C1, C2

C1, C2 (µF)	$R_{OUT}(\Omega)$
0.05	4085
0.10	2084
0.47	510
1.00	285
3.30	145
5.00	125
10.00	105
22.00	94
100.00	87

TABLE 4-2: V_{RIPPLE} PEAK-TO-PEAK VS. C3 ($I_{OUT} 10mA$)

C3 (µF)	$V_{RIPPLE} (mV)$
0.50	1020
1.00	520
3.30	172
5.00	120
10.00	70
22.00	43
100.00	25

4.3 Paralleling Devices

Paralleling multiple TC682s reduces the output resistance of the converter. The effective output resistance is the output resistance of a single device divided by the number of devices. As illustrated in Figure , each requires separate pump capacitors C_1 and C_2 , but all can share a single reservoir capacitor.

4.4 -5V Regulated Supply From A Single 3V Battery

Figure 4-3 shows a -5V power supply using one 3V battery. The TC682 provides -6V at V_{OUT} , which is regulated to -5V by the negative LDO. The input to the TC682 can vary from 3V to 5.5V without affecting regulation appreciably. A TC54 device is connected to the battery to detect undervoltage. This unit is set to detect at 2.7V. With higher input voltage, more current can be drawn from the outputs of the TC682. With 5V at V_{IN} , 10 mA can be drawn from the regulated output. Assuming 150Ω source resistance for the converter, with $I_L^- = 10$ mA, the charge pump will droop 1.5V.

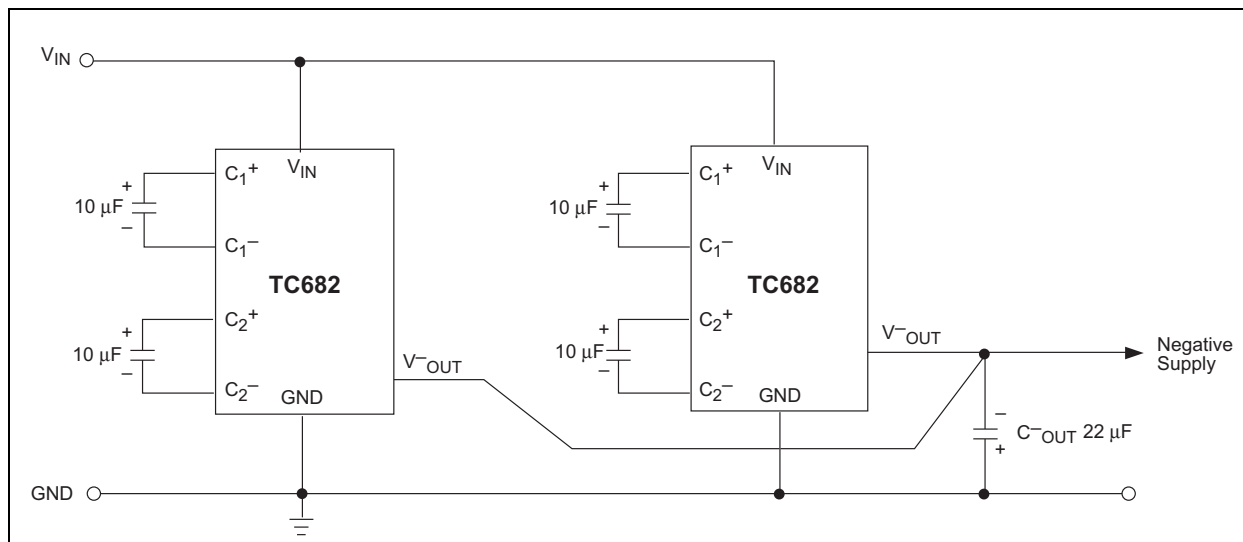


FIGURE 4-2: Paralleling TC682 for Lower Output Source Resistance

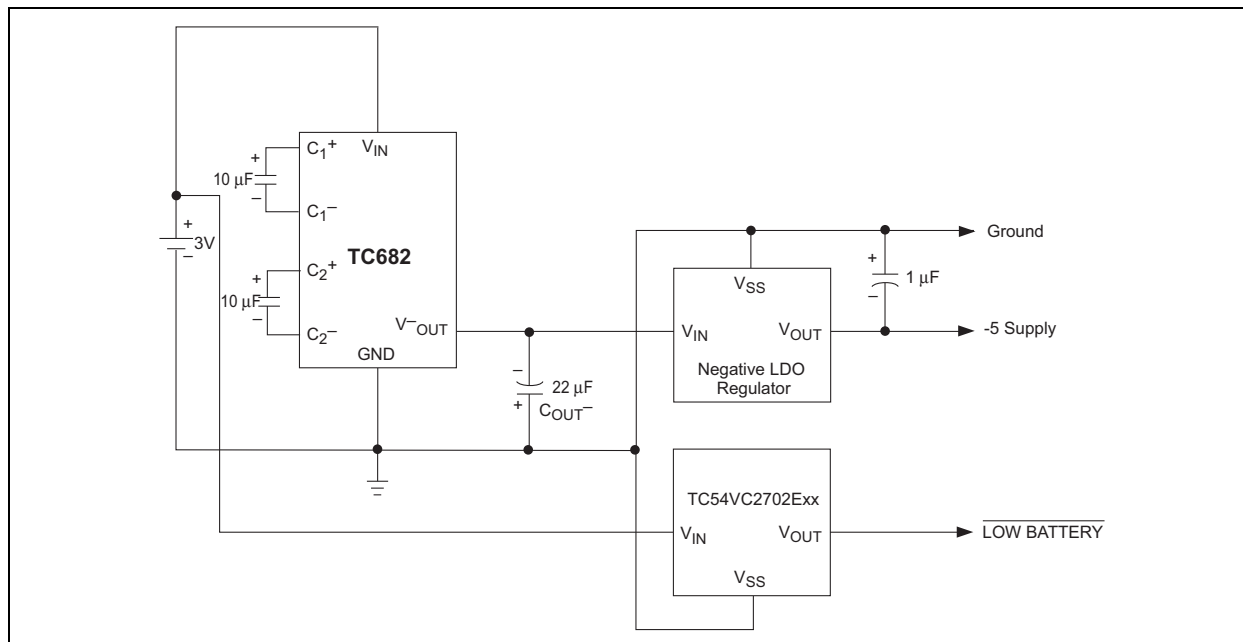
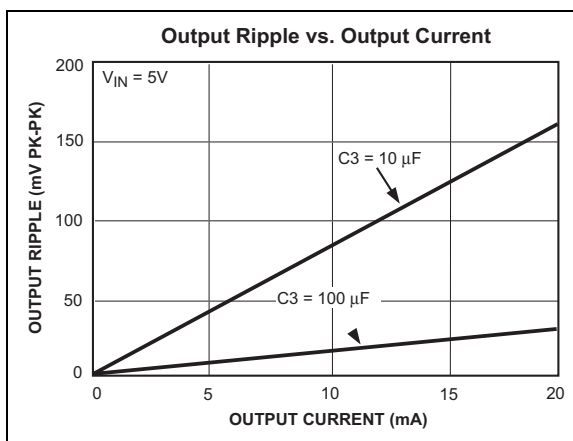
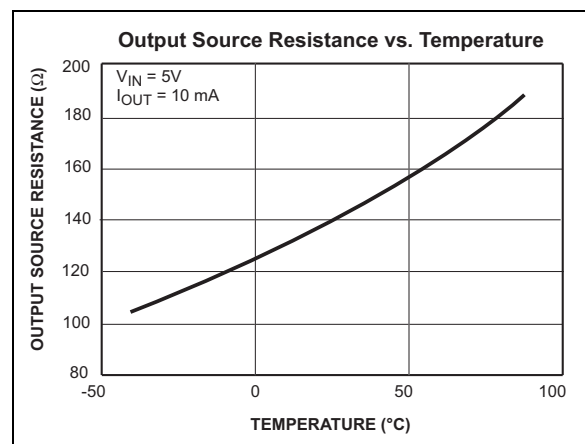
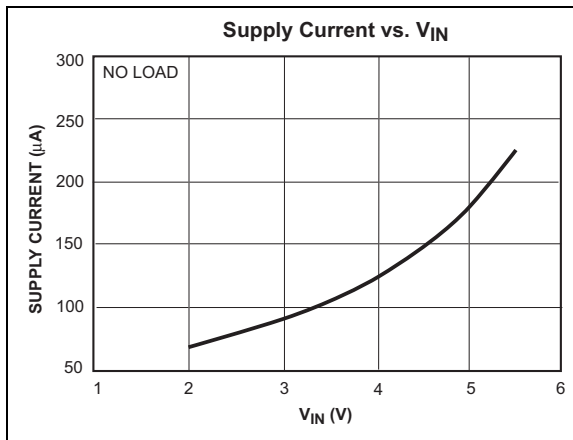
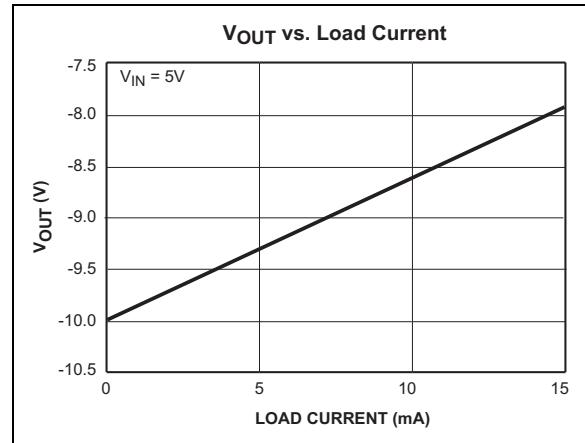
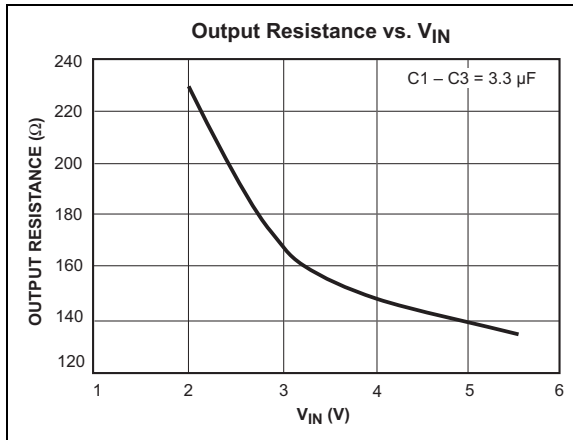


FIGURE 4-3: Negative Supply Derived from 3V Battery

5.0 TYPICAL CHARACTERISTICS

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.

Circuit of Figure 3-1, $C_1 = C_2 = C_{OUT} = 3.3 \mu\text{F}$, $T_A = 25^\circ\text{C}$ unless otherwise noted.



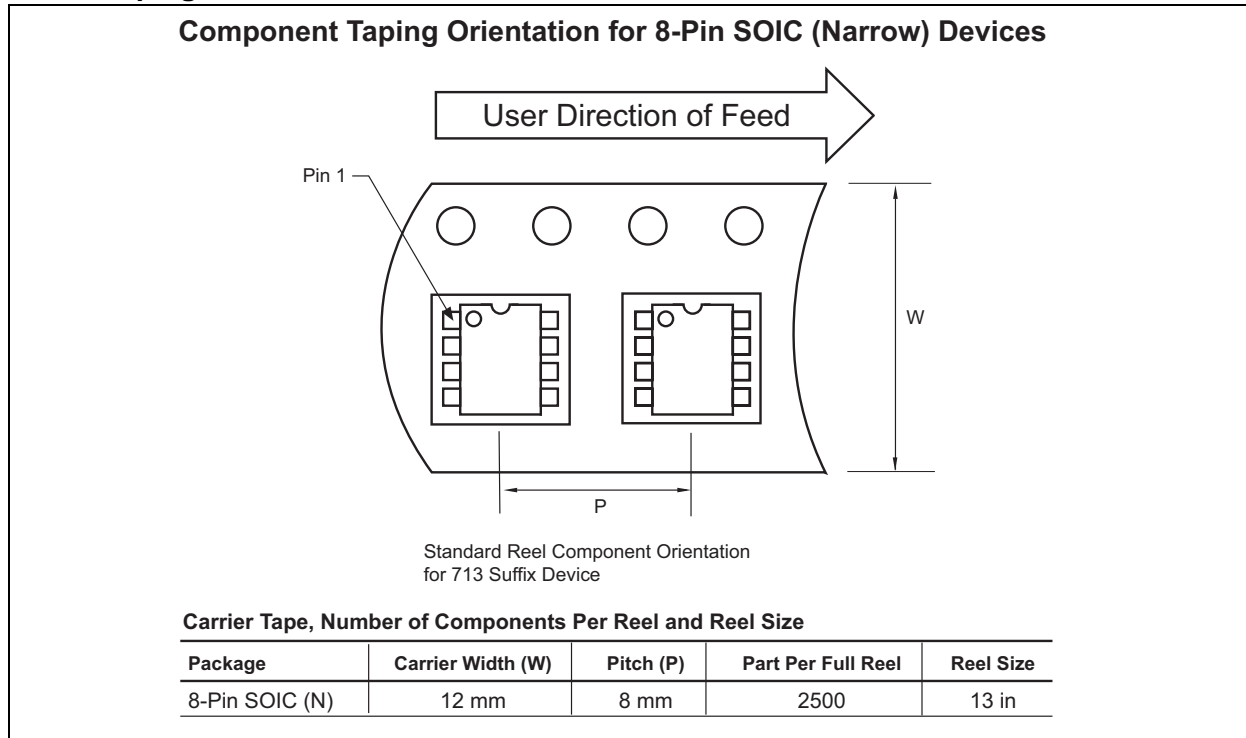
TC682

6.0 PACKAGING INFORMATION

6.1 Package Marking Information

Package marking data not available at this time.

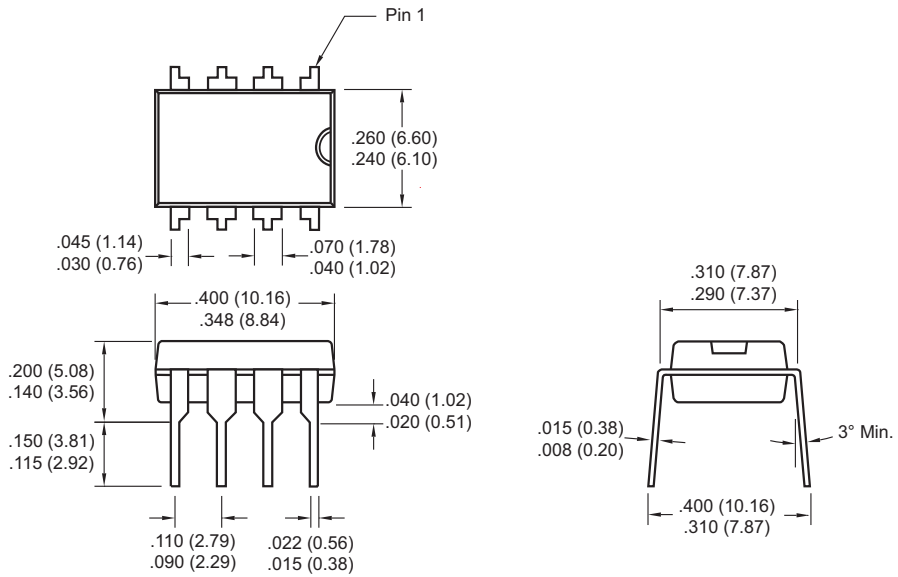
6.2 Taping Form



6.3 Package Dimensions

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

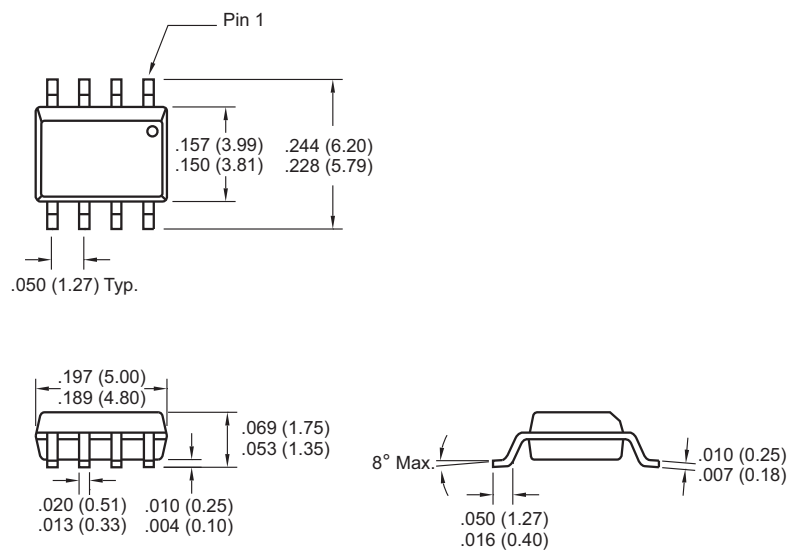
8-Pin Plastic DIP



Dimensions: inches (mm)

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

8-Pin SOIC



Dimensions: inches (mm)

7.0 REVISION HISTORY

Revision D

Added a note to each package outline drawing.

THE MICROCHIP WEB SITE

Microchip provides online support via our WWW site at www.microchip.com. This web site is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the web site contains the following information:

- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **General Technical Support** – Frequently Asked Questions (FAQ), technical support requests, online discussion groups, Microchip consultant program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

CUSTOMER CHANGE NOTIFICATION SERVICE

Microchip's customer notification service helps keep customers current on Microchip products. Subscribers will receive e-mail notification whenever there are changes, updates, revisions or errata related to a specified product family or development tool of interest.

To register, access the Microchip web site at www.microchip.com. Under "Support", click on "Customer Change Notification" and follow the registration instructions.

CUSTOMER SUPPORT

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

Customers should contact their distributor, representative or field application engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

Technical support is available through the web site at: <http://microchip.com/support>

READER RESPONSE

It is our intention to provide you with the best documentation possible to ensure successful use of your Microchip product. If you wish to provide your comments on organization, clarity, subject matter, and ways in which our documentation can better serve you, please FAX your comments to the Technical Publications Manager at (480) 792-4150.

Please list the following information, and use this outline to provide us with your comments about this document.

TO: Technical Publications Manager Total Pages Sent _____

RE: Reader Response

From: Name _____

Company _____

Address _____

City / State / ZIP / Country _____

Telephone: (_____) _____ - _____ FAX: (_____) _____ - _____

Application (optional):

Would you like a reply? Y N

Device: TC682

Literature Number: DS21453D

Questions:

1. What are the best features of this document?

2. How does this document meet your hardware and software development needs?

3. Do you find the organization of this document easy to follow? If not, why?

4. What additions to the document do you think would enhance the structure and subject?

5. What deletions from the document could be made without affecting the overall usefulness?

6. Is there any incorrect or misleading information (what and where)?

7. How would you improve this document?

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, dsPIC, FlashFlex, KEELOQ, KEELOQ logo, MPLAB, PIC, PICmicro, PICSTART, PIC³² logo, rPIC, SST, SST Logo, SuperFlash and UNI/O are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

FilterLab, Hampshire, HI-TECH C, Linear Active Thermistor, MTP, SEEVAL and The Embedded Control Solutions Company are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Silicon Storage Technology is a registered trademark of Microchip Technology Inc. in other countries.

Analog-for-the-Digital Age, Application Maestro, BodyCom, chipKIT, chipKIT logo, CodeGuard, dsPICDEM, dsPICDEM.net, dsPICworks, dsSPEAK, ECAN, ECONOMONITOR, FanSense, HI-TIDE, In-Circuit Serial Programming, ICSP, Mindi, MiWi, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, mTouch, Omniclient Code Generation, PICC, PICC-18, PICDEM, PICDEM.net, PICkit, PICtail, REAL ICE, rLAB, Select Mode, SQI, Serial Quad I/O, Total Endurance, TSHARC, UniWinDriver, WiperLock, ZENA and Z-Scale 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.

GestIC and ULPP are registered trademarks of Microchip Technology Germany II GmbH & Co. & KG, a subsidiary of Microchip Technology Inc., in other countries.

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

© 2002-2012, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

 Printed on recycled paper.

ISBN: 9781620768341

Microchip received ISO/TS-16949:2009 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.

**QUALITY MANAGEMENT SYSTEM
CERTIFIED BY DNV
= ISO/TS 16949 =**



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:
<http://www.microchip.com/support>
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

Cleveland
Independence, OH
Tel: 216-447-0464
Fax: 216-447-0643

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

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

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

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: 86-10-8569-7000
Fax: 86-10-8528-2104

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

China - Chongqing
Tel: 86-23-8980-9588
Fax: 86-23-8980-9500

China - Hangzhou
Tel: 86-571-2819-3187
Fax: 86-571-2819-3189

China - Hong Kong SAR
Tel: 852-2943-5100
Fax: 852-2401-3431

China - Nanjing
Tel: 86-25-8473-2460
Fax: 86-25-8473-2470

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: 86-755-8864-2200
Fax: 86-755-8203-1760

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

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

China - Xiamen
Tel: 86-592-2388138
Fax: 86-592-2388130

China - Zhuhai
Tel: 86-756-3210040
Fax: 86-756-3210049

ASIA/PACIFIC

India - Bangalore
Tel: 91-80-3090-4444
Fax: 91-80-3090-4123

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 - Osaka
Tel: 81-6-6152-7160
Fax: 81-6-6152-9310

Japan - Tokyo
Tel: 81-3-6880-3770
Fax: 81-3-6880-3771

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 - Kuala Lumpur
Tel: 60-3-6201-9857
Fax: 60-3-6201-9859

Malaysia - Penang
Tel: 60-4-227-8870
Fax: 60-4-227-4068

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: 886-3-5778-366
Fax: 886-3-5770-955

Taiwan - Kaohsiung
Tel: 886-7-213-7828
Fax: 886-7-330-9305

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

11/29/12



Компания «ЭлектроПласт» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Оперативные поставки широкого спектра электронных компонентов отечественного и импортного производства напрямую от производителей и с крупнейших мировых складов;
- Поставка более 17-ти миллионов наименований электронных компонентов;
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- Лицензия ФСБ на осуществление работ с использованием сведений, составляющих государственную тайну;
- Поставка специализированных компонентов (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Aeroflex, Peregrine, Syfer, Eurofarad, Texas Instrument, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Помимо этого, одним из направлений компании «ЭлектроПласт» является направление «Источники питания». Мы предлагаем Вам помощь Конструкторского отдела:

- Подбор оптимального решения, техническое обоснование при выборе компонента;
- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



Как с нами связаться

Телефон: 8 (812) 309 58 32 (многоканальный)

Факс: 8 (812) 320-02-42

Электронная почта: org@eplast1.ru

Адрес: 198099, г. Санкт-Петербург, ул. Калинина, дом 2, корпус 4, литера А.