

MC1121

100mA Charge Pump Voltage Converter with Shutdown

The MC1121 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 MC1121 uses no inductors saving cost, size, and reducing EMI.

An on-board oscillator operates at a typical frequency of 10kHz (at $V_{DD} = 5V$) when the frequency control input (FC) is connected to ground. The oscillator frequency increases to 200kHz when FC is connected to V_{DD} , allowing the use of smaller capacitors. Operation at sub-10kHz frequencies results in lower quiescent current and is accomplished with the addition of an external capacitor from OSC (pin 7) to ground. The MC1121 can be driven from an external clock connected OSC. Typical supply current at 10kHz is 50 μ A, and falls to less than 1 μ A when the shutdown input is brought low, whether the internal or an external clock is used. The MC1121 is available in a Micro-8 package.

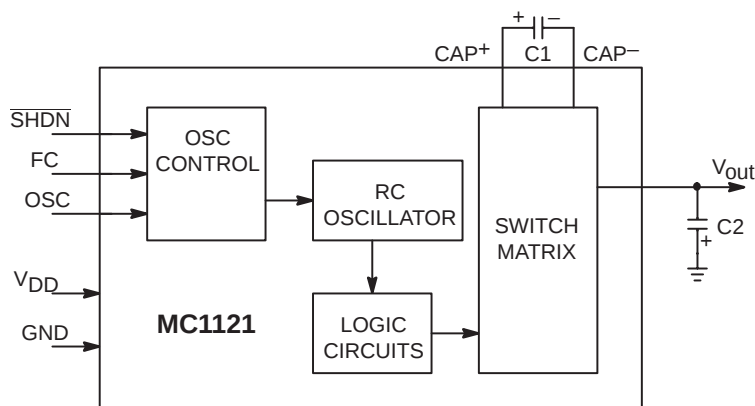
Features

- Converts a 2.4V to 5.5V Input Voltage to a Corresponding Negative Output Voltage (Inverter Mode)
- Uses Only 2 Capacitors; No Inductors Required!
- High Output Current: 100mA
- Selectable Oscillator Frequency: 10kHz to 200kHz
- Power-Saving Shutdown Input
- Optional High-Frequency Operation Allows Use of Small Capacitors
- Low Operating Current (FC = GND): 50 μ A
- Tested Operating Temperature Range: -40°C to +85°C

Typical Applications

- Laptop Computers
- Medical Instruments
- Disk Drives
- μ P-Based Controllers
- Process Instrumentation

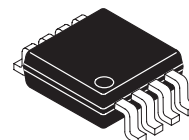
FUNCTIONAL BLOCK DIAGRAM



ON Semiconductor

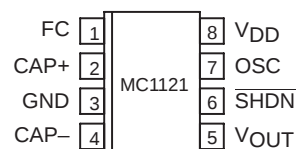
Formerly a Division of Motorola

<http://onsemi.com>



Micro8
DM SUFFIX
CASE TBD
PRELIMINARY INFORMATION

PIN CONFIGURATION (Top View)



ORDERING INFORMATION

Device	Package	Shipping
MC1121DMR2	Micro-8	2500 Tape/Reel

PIN DESCRIPTION

Pin No.	Symbol	Description
1	FC	Frequency control for internal oscillator, FC = open, F _{OSC} = 10kHz typ; FC = V _{DD} , F _{OSC} = 200kHz 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	V _{OUT}	Output, negative voltage
6	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 _{DD}	Power-supply positive voltage input

ABSOLUTE MAXIMUM RATINGS*

Parameter	Value	Unit
V _{DD} Supply Voltage	6.0	V
Operating Temperature Range	-40 to +85	°C
OSC, FC, SHDN Input Voltage	-0.3 to (V _{DD} + 0.3)	V
Output Short Circuit Duration	10	Sec
Storage Temperature Range	-65 to +150	°C
Package Power Dissipation (T _A ≤ 70°C) Micro8 Derate by 4mW/°C for T _A > 70°C	333	mW
Lead Temperature (Soldering, 10 Seconds)	+300	°C

* Maximum Ratings are those values beyond which damage to the device may occur.

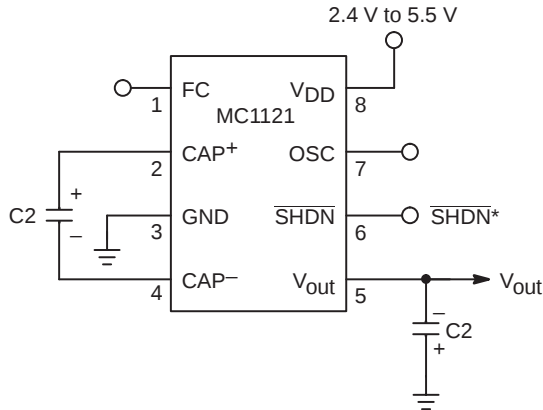
ELECTRICAL CHARACTERISTICS (T_A = -40°C to +85°C, V_{DD} = 5V ±10% C_{OSC} = OPEN, C1, C2 = 10μF, FC = V_{DD}, SHDN = V_{IH}, unless otherwise noted. Typical values are at T_A = 25°C.)

Symbol	Characteristic	Min	Typ	Max	Unit
I _{DD}	Active Supply Current R _L = Open, FC = Open or GND R _L = Open, FC = V _{DD}	— —	50 0.6	100 1.0	μA mA
I _{DD} (SHDN)	Shutdown Supply Current (SHDN = 0V)	—	0.2	1.0	μA
V _{DD}	Supply Voltage	2.4	—	5.5	V
V _{IH}	SHDN Logic High Input Voltage	V _{DD} × 0.8	—	—	V
V _{IL}	SHDN Logic Low Input Voltage	—	—	0.4	V
I _{IN}	Input Leakage Current SHDN, OSC FC Pin	-1.0 -4.0	— —	1.0 4.0	μA
R _{OUT}	Output Source Resistance (I _{OUT} = 60 mA)	—	12	20	Ω
I _{OUT}	Output Current (V _{OUT} more negative than -3.75V)	60	100	—	mA
F _{OSC}	Oscillator Frequency OSC Open, FC = Open or GND SHDN = V _{IH} , FC = V _{DD}	5.0 100	10 200	— —	kHz
P _{EFF}	Power Efficiency (FC = GND) R _L = 2kΩ between V _{DD} and V _{OUT} R _L = 1 kΩ between V _{OUT} and GND I _L = 60 mA to GND	93 94 —	97 97 92	— — —	%
V _{EFF}	Voltage Conversion Efficiency (R _L = OPEN)	99	99.9	—	%

APPLICATIONS INFORMATION

Negative Voltage Converter

The MC1121 is typically used as a charge-pump voltage inverter. C1 and C2 are the only two external capacitors used in the operating circuit (see Figure 1).



NOTES: *SHDN should be tied to VDD if not used.

Figure 1. Charge Pump Inverter

The MC1121 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:

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

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.

Changing Oscillator Frequency

The MC1121's clock frequency is controlled by four modes:

FC	OSC	Oscillator Frequency
Open	Open	10kHz
FC = VDD	Open	200kHz
Open or FC = VDD	External Capacitor	Reduced from 10kHz or 200kHz depending on FC state
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 VDD 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 MC1121's quiescent current will increase if the clock frequency is increased, it allows smaller capacitance values to be used for C1 and C2.

Capacitor Selection

In addition to load current, the following factors affect the MC1121 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 MC1121's pump frequency increases, capacitance values needed to maintain comparable ripple and output resistance diminish proportionately.

Cascading Devices

To produce greater negative magnitudes of the initial supply voltage, the MC1121 may be cascaded (see Figure 2). The resulting output resistance is approximately equal to the sum of individual MC1121 R_{OUT} values. The output voltage (where n is an integer representing the number of devices cascaded) is defined by

$$V_{\text{OUT}} = -n(V_{\text{IN}}).$$

MC1121

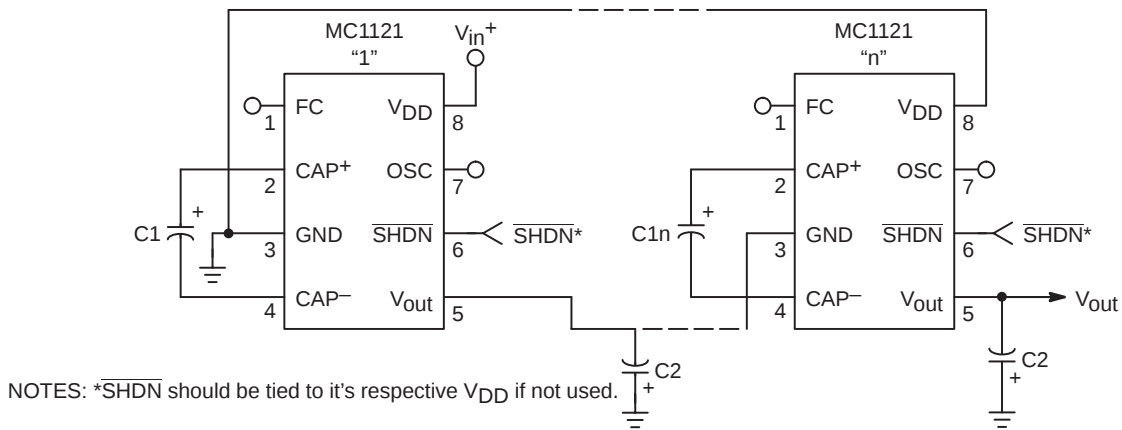


Figure 2. Cascading MC1121s to Increase Output Voltage

Paralleling Devices

To reduce output resistance, multiple MC1121s may be paralleled (see Figure 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).

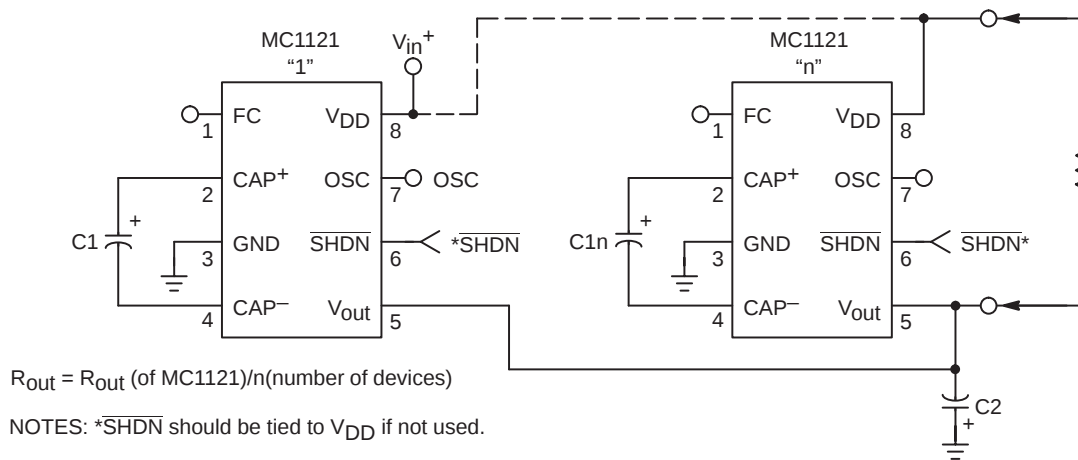


Figure 3. Paralleling MC1121s to Reduce Output Resistance

Combined Positive Supply Multiplication and Negative Voltage Conversion

Figure 4 shows this dual function circuit, in which capacitors C1 and C2 perform pump and reservoir functions to generate the negative voltage. Capacitors C2 and C4 are the respective capacitors for the 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.

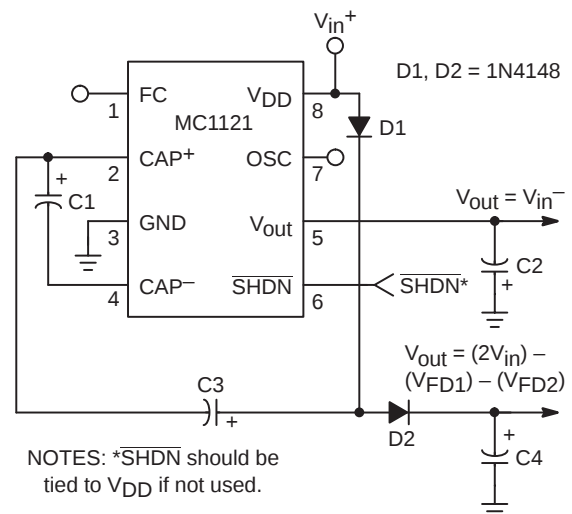
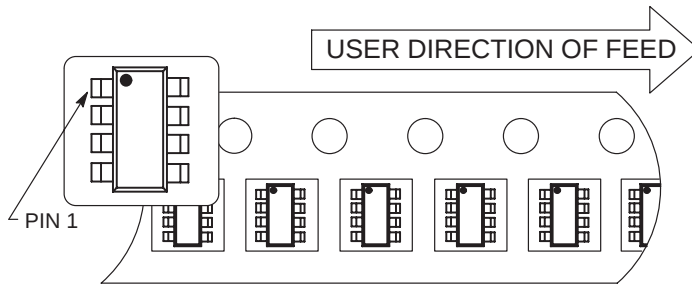


Figure 4. Combined Positive Multiplier and Negative Converter

MC1121

TAPE AND REEL INFORMATION

Component Taping Orientation for Micro-8 Devices



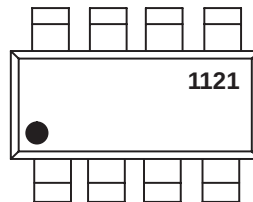
Standard Reel Component Orientation
for R2 Suffix Device
(Mark Right Side Up)

Tape & Reel Specifications Table

Package	Tape Width (W)	Pitch (P)	Part Per Full Reel	Diameter
Micro-8	12 mm	4 mm	2500	13 inches

MARKING

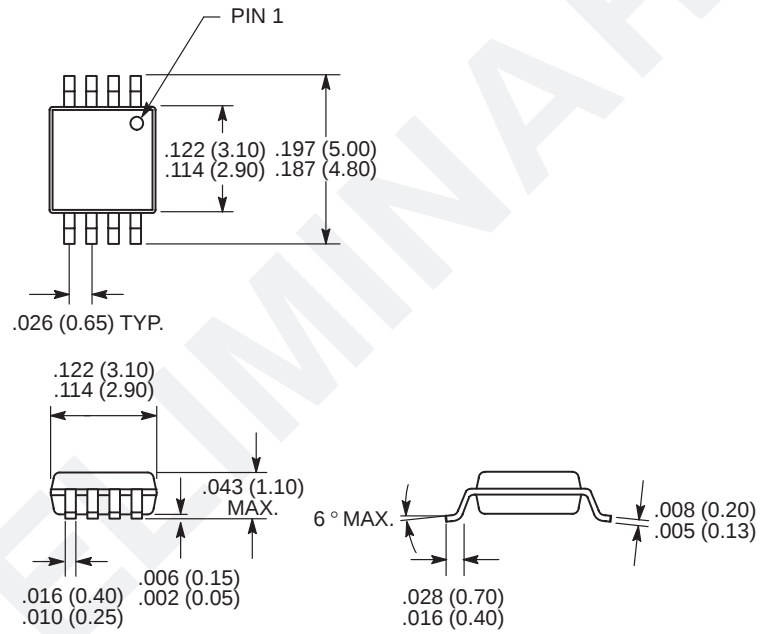
MC1121DMR2



MC1121

PACKAGE DIMENSIONS

Micro8
PLASTIC PACKAGE
CASE TBD
ISSUE TBD



Dimensions: inches (mm)

Notes

ON Semiconductor and  are trademarks of Semiconductor Components Industries, LLC (SCILLC). SCILLC reserves the right to make changes without further notice to any products herein. SCILLC makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does SCILLC assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. "Typical" parameters which may be provided in SCILLC data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. SCILLC does not convey any license under its patent rights nor the rights of others. SCILLC products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the SCILLC product could create a situation where personal injury or death may occur. Should Buyer purchase or use SCILLC products for any such unintended or unauthorized application, Buyer shall indemnify and hold SCILLC and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that SCILLC was negligent regarding the design or manufacture of the part. SCILLC is an Equal Opportunity/Affirmative Action Employer.

PUBLICATION ORDERING INFORMATION

NORTH AMERICA Literature Fulfillment:

Literature Distribution Center for ON Semiconductor
P.O. Box 5163, Denver, Colorado 80217 USA
Phone: 303-675-2175 or 800-344-3860 Toll Free USA/Canada
Fax: 303-675-2176 or 800-344-3867 Toll Free USA/Canada
Email: ONlit@hibbertco.com
Fax Response Line: 303-675-2167 or 800-344-3810 Toll Free USA/Canada

N. American Technical Support: 800-282-9855 Toll Free USA/Canada

EUROPE: LDC for ON Semiconductor – European Support

German Phone: (+1) 303-308-7140 (M–F 1:00pm to 5:00pm Munich Time)
Email: ONlit-german@hibbertco.com
French Phone: (+1) 303-308-7141 (M–F 1:00pm to 5:00pm Toulouse Time)
Email: ONlit-french@hibbertco.com
English Phone: (+1) 303-308-7142 (M–F 12:00pm to 5:00pm UK Time)
Email: ONlit@hibbertco.com

EUROPEAN TOLL-FREE ACCESS*: 00-800-4422-3781

*Available from Germany, France, Italy, England, Ireland

CENTRAL/SOUTH AMERICA:

Spanish Phone: 303-308-7143 (Mon–Fri 8:00am to 5:00pm MST)
Email: ONlit-spanish@hibbertco.com

ASIA/PACIFIC: LDC for ON Semiconductor – Asia Support

Phone: 303-675-2121 (Tue–Fri 9:00am to 1:00pm, Hong Kong Time)
Toll Free from Hong Kong & Singapore:
001-800-4422-3781
Email: ONlit-asia@hibbertco.com

JAPAN: ON Semiconductor, Japan Customer Focus Center
4-32-1 Nishi-Gotanda, Shinagawa-ku, Tokyo, Japan 141-8549
Phone: 81-3-5740-2745
Email: r14525@onsemi.com

ON Semiconductor Website: <http://onsemi.com>

For additional information, please contact your local Sales Representative.