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MC1121

100 mA Charge Pump Voltage Converter with Shutdown

The MC1121 is a charge pump converter with 100 mA output current capability. It converts a 2.4 V to 5.5 V 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 10 kHz (at $V_{DD} = 5.0$ V) when the frequency control input (FC) is connected to ground. The oscillator frequency increases to 200 kHz when FC is connected to V_{DD} , allowing the use of smaller capacitors. Operation at sub-10 kHz 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 10 kHz is 50 μ A, and falls to less than 1.0 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 2.4 V to 5.5 V Input Voltage to a Corresponding Negative Output Voltage (Inverter Mode)
- Uses Only 2 Capacitors; No Inductors Required!
- High Output Current: 100 mA
- Selectable Oscillator Frequency: 10 kHz to 200 kHz
- 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

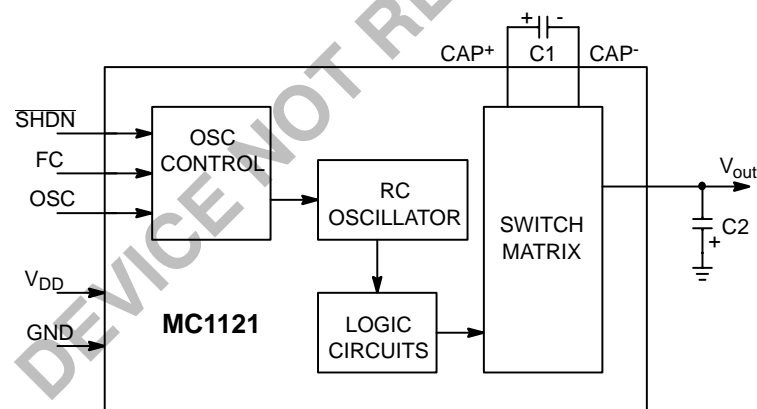
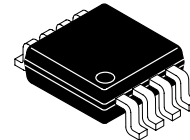


Figure 1. Functional Block Diagram



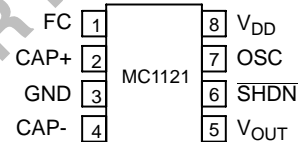
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Micro8
DM SUFFIX
CASE TBD
PRELIMINARY INFORMATION

PIN CONFIGURATION



(Top View)

ORDERING INFORMATION

Device	Package	Shipping
MC1121DMR2	Micro-8	2500 Tape/Reel

MC1121

PIN DESCRIPTION

Pin No.	Symbol	Description
1	FC	Frequency control for internal oscillator, FC = open, $F_{OSC} = 10 \text{ kHz typ}$; FC = V_{DD} , $F_{OSC} = 200 \text{ kHz typ}$, 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	V_{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_{DD}	Power-supply positive voltage input

ABSOLUTE MAXIMUM RATINGS*

Rating	Value	Unit
V_{DD} Supply Voltage	6.0	V
Operating Temperature Range	-40 to +85	°C
OSC, FC, $\overline{\text{SHDN}}$ 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 ($T_A \leq 70^\circ\text{C}$) Micro8 Derate by 4.0 mW/°C for $T_A > 70^\circ\text{C}$	333	mW
Lead Temperature (Soldering, 10 Seconds)	+300	°C

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

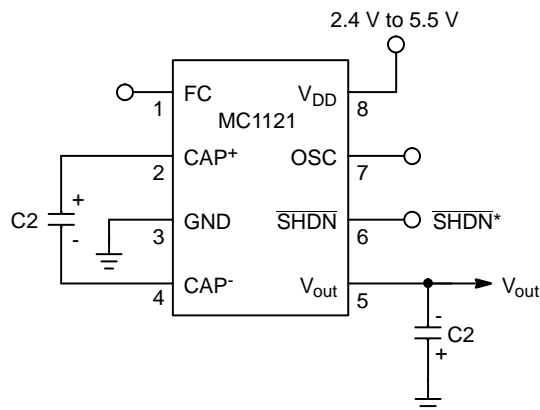
ELECTRICAL CHARACTERISTICS ($T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$, $V_{DD} = 5.0 \text{ V} \pm 10\%$, $C_{OSC} = \text{OPEN}$, C1, C2 = 10 μF , FC = V_{DD} , $\overline{\text{SHDN}} = V_{IH}$, unless otherwise noted. Typical values are at $T_A = 25^\circ\text{C}$.)

Characteristic	Symbol	Min	Typ	Max	Unit
Active Supply Current $R_L = \text{Open}$, FC = Open or GND $R_L = \text{Open}$, FC = V_{DD}	I_{DD}	- -	50 0.6	100 1.0	μA mA
Shutdown Supply Current ($\overline{\text{SHDN}} = 0 \text{ V}$)	$I_{DD}(\overline{\text{SHDN}})$	-	0.2	1.0	μA
Supply Voltage	V_{DD}	2.4	-	5.5	V
$\overline{\text{SHDN}}$ Logic High Input Voltage	V_{IH}	$V_{DD} \times 0.8$	-	-	V
$\overline{\text{SHDN}}$ Logic Low Input Voltage	V_{IL}	-	-	0.4	V
Input Leakage Current SHDN, OSC FC Pin	I_{IN}	-1.0 -4.0	- -	1.0 4.0	μA
Output Source Resistance ($I_{OUT} = 60 \text{ mA}$)	R_{OUT}	-	12	20	Ω
Output Current (V_{OUT} more negative than -3.75 V)	I_{OUT}	60	100	-	mA
Oscillator Frequency OSC Open, FC = Open or GND $\overline{\text{SHDN}} = V_{IH}$, FC = V_{DD}	F_{OSC}	5.0 100	10 200	- -	kHz
Power Efficiency (FC = GND) $R_L = 2.0 \text{ k}\Omega$ between V_{DD} and V_{OUT} $R_L = 1.0 \text{ k}\Omega$ between V_{OUT} and GND $I_L = 60 \text{ mA}$ to GND	P_{EFF}	93 94 -	97 97 92	- - -	%
Voltage Conversion Efficiency ($R_L = \text{OPEN}$)	V_{EFF}	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 2).



NOTE: *SHDN should be tied to V_{DD} if not used.

Figure 2. Charge Pump Inverter

The MC1121 is not actively regulated. A typical output source resistance of 11.8 Ω means that an input of +5.0 V results in -5.0 V output voltage under light load, and only decreases to -3.8 V (typ) with a 100 mA 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 5.0 kHz (one half the nominal 10 kHz oscillator frequency), and $C2 = 150 \mu\text{F}$ with an ESR of 0.2 Ω ripple is about 90 mV with a 100 mA load current. If C2 is raised to 390 μF, the ripple drops to 45 mV.

Changing Oscillator Frequency

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

FC	OSC	Oscillator Frequency
Open	Open	10 kHz
FC = V _{DD}	Open	200 kHz
Open or FC = V _{DD}	External Capacitor	Reduced from 10 kHz or 200 kHz depending on FC state
Open	External Clock	External Clock Frequency

The oscillator runs at 10 kHz (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 100 mV of V_{DD} 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 5.0 kHz 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 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.

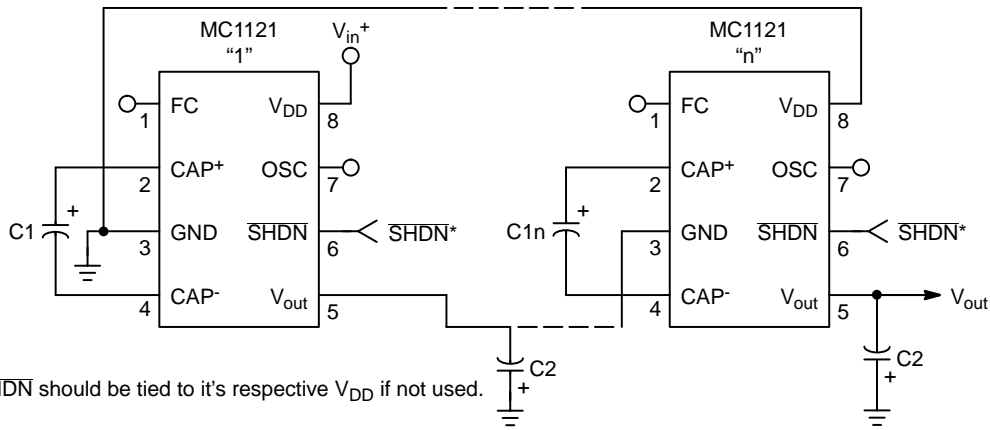
In general, as the MC1121's pump frequency increases, capacitance values needed to maintain comparable ripple and output resistance diminish proportionately.

Cascading Devices

To produce greater negative magnitudes of the initial supply voltage, the MC1121 may be cascaded (see Figure 3). 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



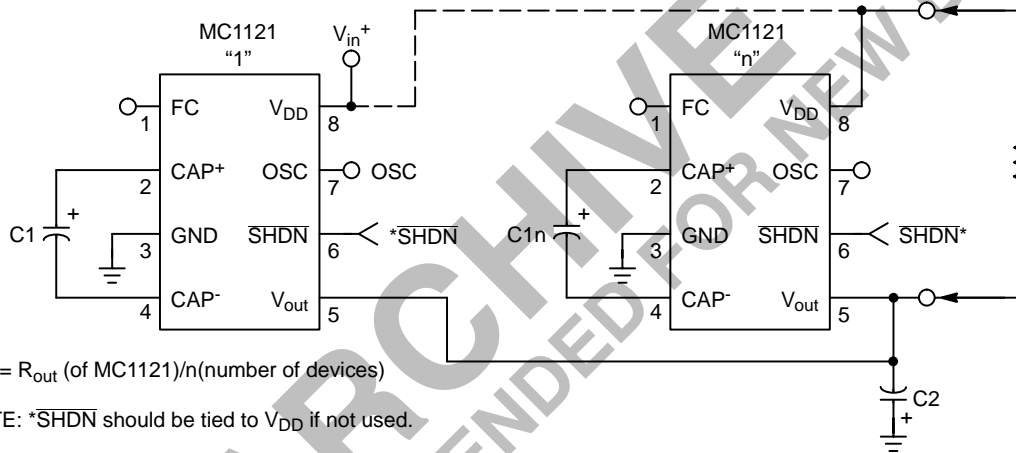
NOTE: *SHDN should be tied to its respective V_{DD} if not used.

Figure 3. Cascading MC1121s to Increase Output Voltage

Paralleling Devices

To reduce output resistance, multiple MC1121s may be paralleled (see Figure 4). 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).



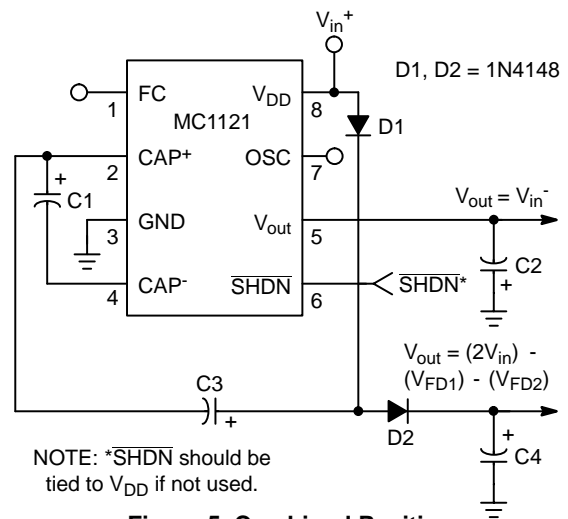
$$R_{out} = R_{out} \text{ (of MC1121)}/n(\text{number of devices})$$

NOTE: *SHDN should be tied to V_{DD} if not used.

Figure 4. Paralleling MC1121s to Reduce Output Resistance

Combined Positive Supply Multiplication and Negative Voltage Conversion

Figure 5 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.



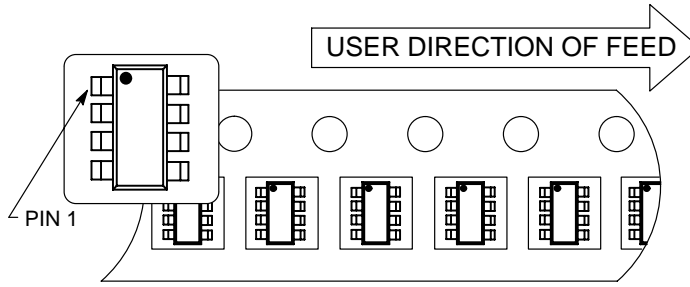
NOTE: *SHDN should be tied to V_{DD} if not used.

Figure 5. Combined Positive Multiplier and Negative Converter

MC1121

TAPE AND REEL INFORMATION

Component Taping Orientation for Micro-8 Devices



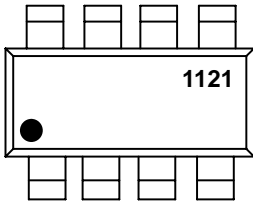
Standard Reel Component Orientation
for R2 Suffix Device
(Mark Right Side Up)

Tape & Reel Specifications Table

Package	Tape Width (W)	Pitch (P)	Part Per Full Reel	Diameter
Micro-8	12 mm	4.0 mm	2500	13 inches

MARKING

MC1121DMR2

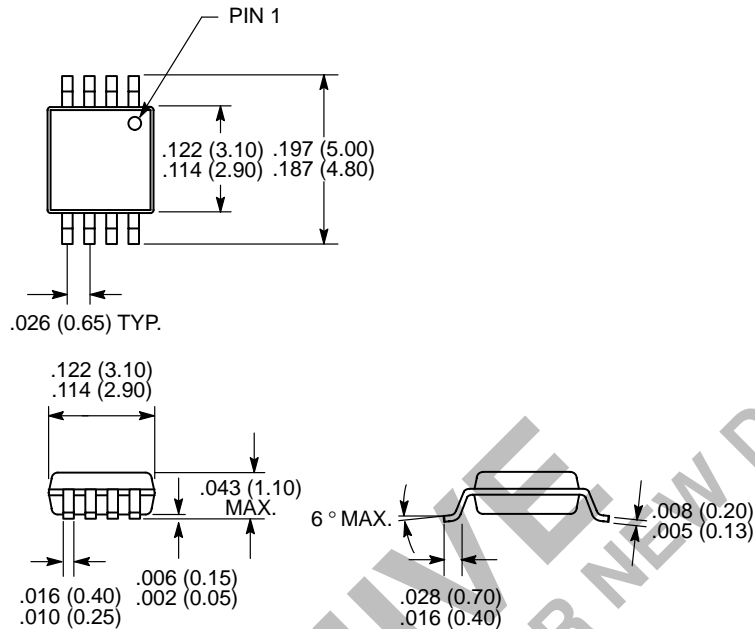


ARCHIVE
DEVICE NOT RECOMMENDED FOR NEW DESIGN


MC1121

PACKAGE DIMENSIONS

Micro8
PLASTIC PACKAGE
CASE TBD
ISSUE TBD



Dimensions: inches (mm)

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