MC7660 Charge Pump DC-DC Voltage Converter

MC7660 is a charge pump dc-to-dc voltage converter using AL-gate CMOS technology and optimization design. It converters a +2.5V to +10V input to a corresponding -2.5V to -10V output using only two external capacitors, eliminating inductors and their associated cost, size and EMI. The on-board oscillator operates at a nominal frequency of 10KHz. Operation below 10 KHz (for lower supply current applications) is possible by connecting an external capacitor from OSC to ground.

Features

- Converts +5V Logic supply to $\pm$ 5V
- Wide input voltage range: 2.5V~10V
- Efficient voltage conversion: 99.9%
- Good power efficiency: 98%
- Low power supply: 40uA @5V input
- Easy to use: only two external capacitors required
- Compatible with RS232 negative powersupply standard
- High ESD protection: up to 3kV
- No Dx diode needed for high voltage operation
- Package : SOP8, DIP8

Applications

- LCD Display Module
- Specially designed LCD display module
- Instrument product

Pin Configuration
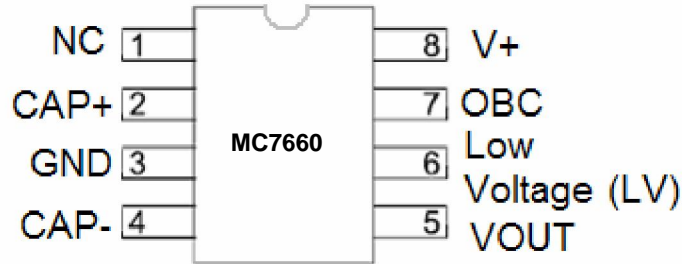
Pin Assigment

PIN Number		PIN NAME	FUNCTION
SOP8	DIP8		
1	1	NC	No connection
2	2	CAP$^+$	Connecting external capacitor(+) pin
3	3	GND	Ground pin
4	4	CAP$^-$	Connecting external capacitor(-) pin
5	5	Vout	Voltage output pin
6	6	Low Voltage	Low voltage selection pin
7	7	OSC	Connecting oscillation capacitor pin
8	8	V$^+$	Power supply pin

Block Diagram
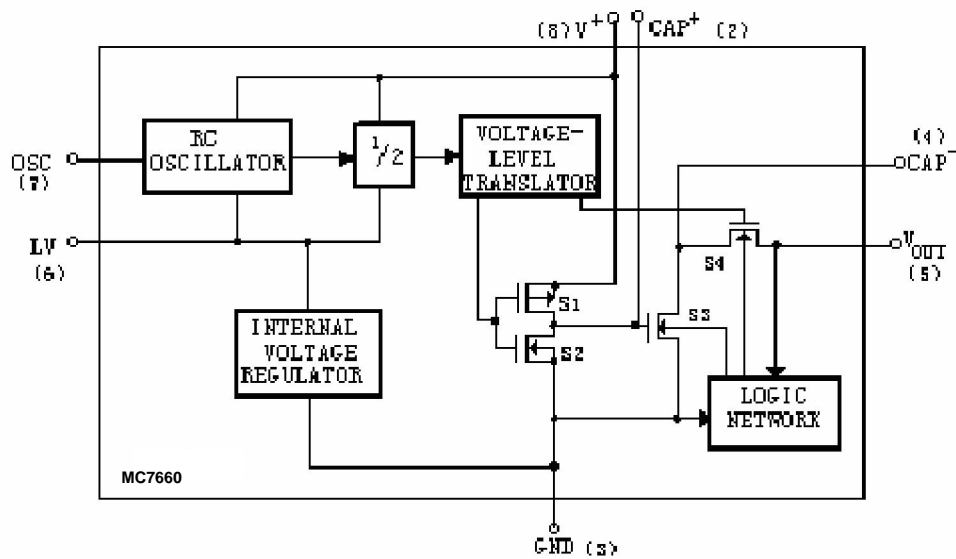
Block of function module in chip

Absolute Maximum Ratings

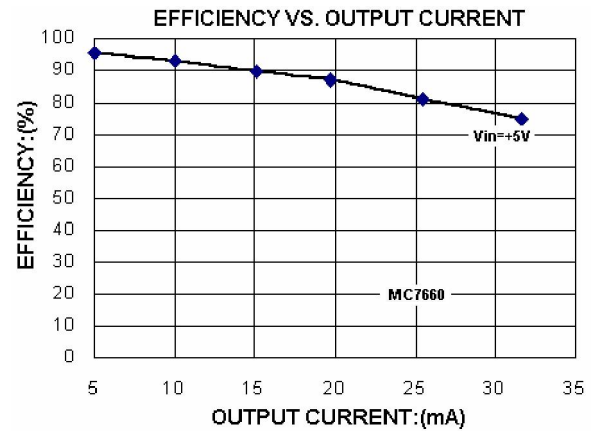| PARAMETER	SYMBAL	RATINGS	UNITS
Input voltage	V_{IN}	+10.5V	V
LV PIN input voltage	V_{LX}	-0.3 (V^++0.3) if V^+<5.5V	V
OSC PIN input voltage	V_{OSC}	(V^+-5.5V) (V^++0.3V) if V^+>5.5V	
LV PIN input voltage	I_{LV}	20 if V+>3.5V	µA
Output Short Duration (Vsupply 5.5V)			
ContinuousTotal Power Dissipation T_A 75	SOP8	Pd	470	mW
	DIP8	Pd	730	mW
Operating Ambient Temperature	T_{Opr}	-40~+85	
Storage Temperature	T_{stg}	-65~+150	
Soldering temperature and time	T_{solder}	260 , 10s	

Electrical Characteristics(V^+=5V,C_{OSC}=0)

Symbol	Item	Conditions	Min	Typ	Max	Unit
I^+	Supply Current	R_L=	—	40	100	µA
V^+_H	Supply Voltage, High	LV Open	3.5	—	10	V
V^+_L	Supply Voltage, Low	LV to GND	2.5	—	3.5	V
R_{OUT}	Output Resistance	I_{OUT}=20mA T_A=25		70		
		I_{OUT}=5mA V+=3V T_A=25		120		
F_{OSC}	Oscillator Frequency	Pin 7 open	—	10	—	kHz
P_{EFF}	Power Efficiency	R_L=5k	95	98	—	%
$V_{OUT}E_{FF}$	Voltage Conversion Efficiency	R_L=	98	99.9	—	%

Test Circuits

Type Characteristics

OUTPUT RESISTANCE VS. INPUT VOLTAGE

MC7660

Io=5mA

OUTPUT RESISTANCE VS. OUTPUT CURRENT

Vin=+5V

MC7660

OUTPUT VOLTAGE VS. OUTPUT CURRENT

MC7660

Vin=+5V

EFFICIENCY VS. OUTPUT CURRENT

Vin=+5V
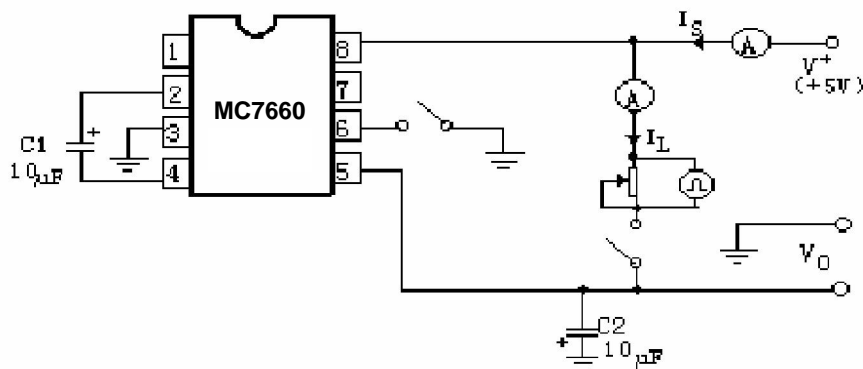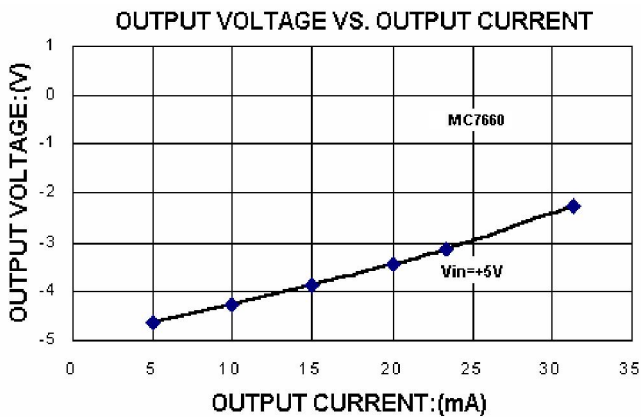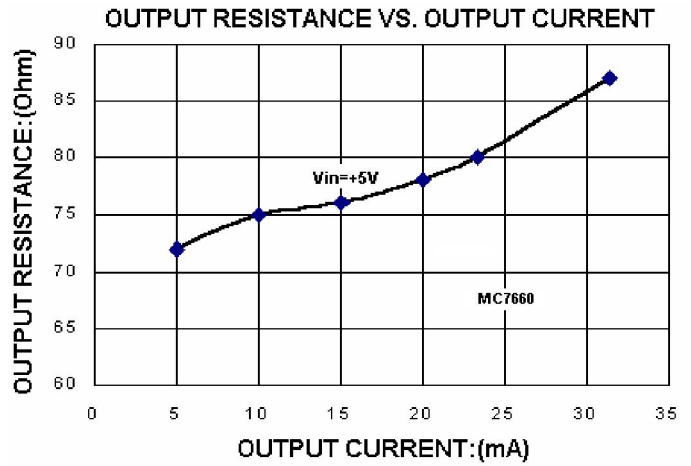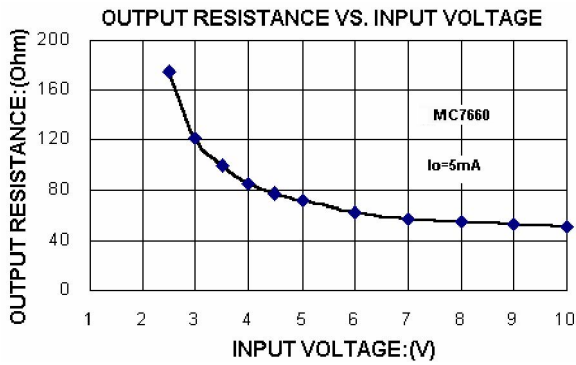
MC7660

Operation

MC7660 together with two external capacitors C1 C2 complement a voltage Inverter. Capacitor C1 is charged to a voltage V^+, for the first half cycle when switches S1 and S3 are closed (while switches S2 and S4 are open during this half cycle); During the second half cycle of operation, switches S2 and S4 are closed, with S1 and S3 open, thereby shifting capacitor C2 negatively to -V^+.

The voltage regulator portion of the chip is an integral part of the anti-latch-up circuitry. Its inherent voltage drop can degrade operation at low voltages. To improve low-voltage operation, the LV pin should be connected to GND, disabling the regulator. For supply voltages greater than 3.5V, the LV terminal must be left open to ensure latch-up-proof operation.
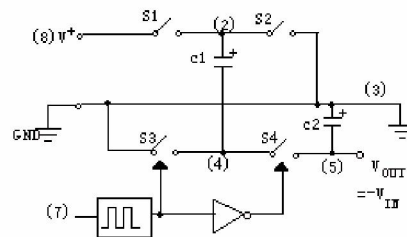
Charge Pump Voltage Converter operating process

Theoretical Power Efficiency Considerations

In theory, a capacitive charge pump can approach 100% efficiency if certain conditions are met:

1   The drive circuitry consumes no power.

2   The output switches have extremely low ON resistance and no offset when operation.

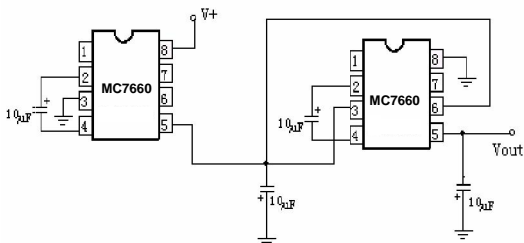3   The impedances of the pump and reservoir capacitors are negligible at the pump frequency.

Notes:

1   Supply voltage should not exceed maximum rating;

2   Do not connect LV terminal to GND for supply voltages greater than 3.5V;

3   Do not short circuit the output to V^+ supply for voltages above 5.5V for extended periods;

4   Polarized capacitors should be connected as the figure above.
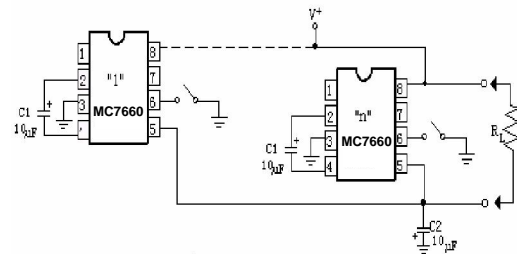
Typical Application
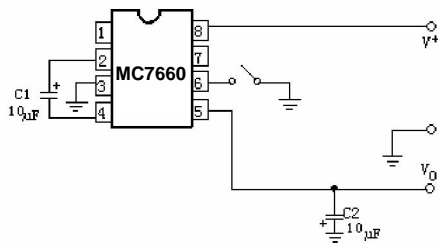
Above figure is the basic application circuit to provide a negative supply from -2.5V~ -10V while a positive supply from +2.5V ~ +10V is available. When V^+=+5V, the output resistance is about 70 ; The output voltage is –4V while the load current is 10mA.

MC7660 may be paralleled to reduce output resistance (see the above   figure)
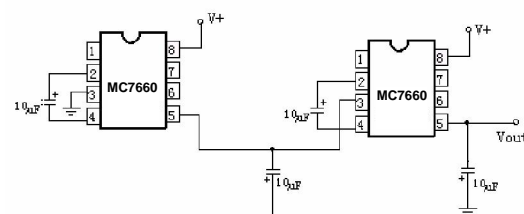
Rout=Rout(of MC7660)/n(number of devices)

MC7660 may be cascaded as shown above to produce larger negative output voltage (-10V). However, The output resistance is approximately two of a single chip resistance.
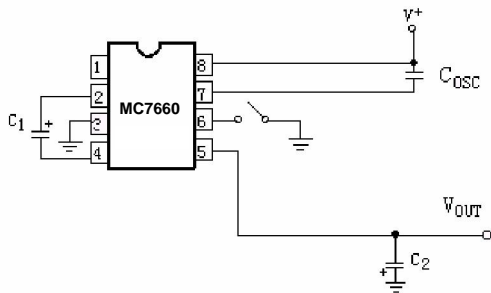

MC7660 may be cascaded as shown above to produce larger negative output voltage (-15V). However, The output resistance is approximately two of a single chip resistance.

To increase the conversion efficiency, the oscillator frequency may be lowered by connecting a capacitor from pin 7 and pin 8 as shown above.

This reduces the switching losses. However, lowering the oscillator frequency will cause an undesirable increase in the impedance of the pump and reservoir capacitors. So, the values of C1 and C2 should be increased by the same factor that the
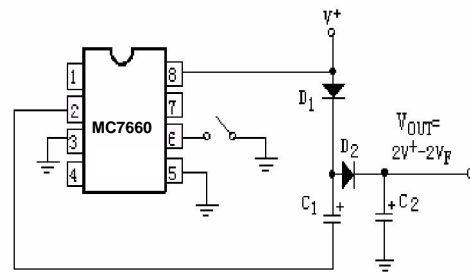
MC7660 may be applied to achieve positive voltage multiplication using the circuit shown in the above figure
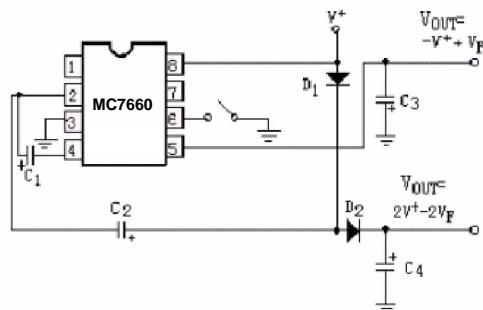
In above figure, C1　C3 are the pump and reservoir capacitors respectively for the generation of the negative voltage; C2　C4 are the pump and reservoir capacitors respectively for the multiplied positive voltage. When +5V supply is provided, +9V and -5V can be generated.
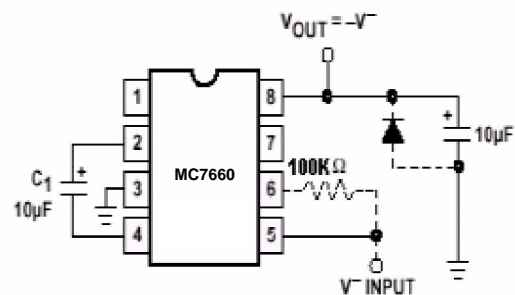
Since the switches that allow the charge pumping operation are bi-directional, the charge transfer can be performed backwards as easily as forwards. In the above figure, MC7660 transforming –5V to +5V. The only problem hear is that the internal clock and switch-drive section will not operate until some positive voltage has been generated. An initial inefficient pump, as show in left figure, could be used to start this circuit up, after which it will bypass the other (D1 and D2　in left figure would never turn on),or else the diode and resistor show dotted in above figure can used to "force" the internal regulator on.
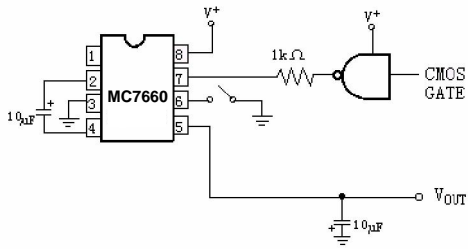
In some applications due to noise, it may be desirable to increase the oscillator frequency. This can be achieved by overdriving the oscillator from an external clock as shown in the above figure. The external clock output should connect a 1k   resistor to prevent device latch-up. Besides, the pump frequency will be half of the clock frequency because of the internal circuit

Important statement:

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