

# Switched-Capacitor Voltage Converter

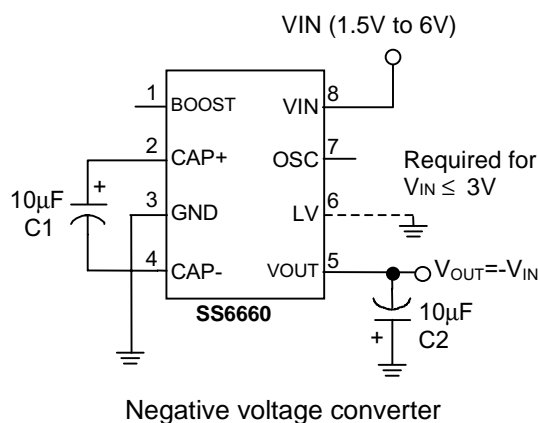
## FEATURES

- Low output impedance (typ.  $35\Omega$  at  $V_{IN}=5V$ )
- Improved direct replacement for 7660
- Operation from 1.5V to 6V
- No external diode required
- Simple conversion from +5V to -5V
- Low quiescent current (typ.  $36\mu A$  at  $V_{IN}=5V$ )
- High power efficiency (typ. 98%)
- Boost pin for higher switching frequency
- Improved SCR latchup protection

## APPLICATIONS

- RS-232 Power Supplies
- Handheld Instruments
- Data Acquisition Systems
- Supply Splitter  $V_{OUT} = \pm V_{IN}/2$
- Operational Amplifier Supplies
- Panel Meter

## TYPICAL APPLICATION CIRCUIT



## DESCRIPTION

The SS6660 is a monolithic CMOS switched-capacitor voltage converter. Designed to be an improved direct replacement for the popular 7660 and LTC1044, the main function of the SS6660 is to convert a positive input voltage in the range of 1.5V to 6V to the corresponding negative output voltage in the range of 11.5V to -6V. The input voltage can also be doubled ( $V_{OUT} = 2V_{IN}$ ), divided ( $V_{OUT} = V_{IN}/2$ ), or multiplied ( $V_{OUT} = \pm nV_{IN}$ ) as shown in the application examples.

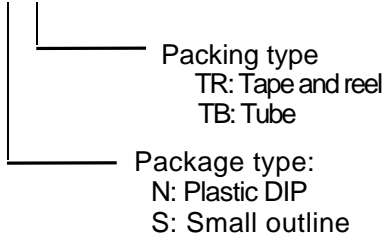
The chip contains a series DC power supply regulator, oscillator, control circuitry and four output power MOSFET switches. The frequency of the oscillator can be lowered by the addition of an external capacitor to the OSC pin, or the oscillator may be over-driven by an external clock.

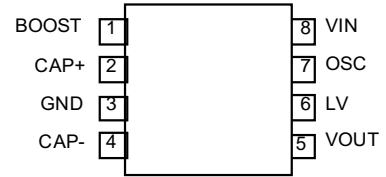
This boost function is available to raise the oscillator frequency to optimize performance in specific applications. The "LV" terminal may be tied to GND to improve low input-voltage ( $V_{IN} \leq 3V$ ) operation, or be left floating for input voltages larger than 3V to improve power dissipation.

The SS6660 provides performance superior to previous designs by combining low output impedance, low quiescent current with high efficiency and by eliminating losses from diode voltage drops. The only external components required are two low-cost electrolytic capacitors.

**ORDERING INFORMATION**

SS6660CXXX


**PIN CONFIGURATION**

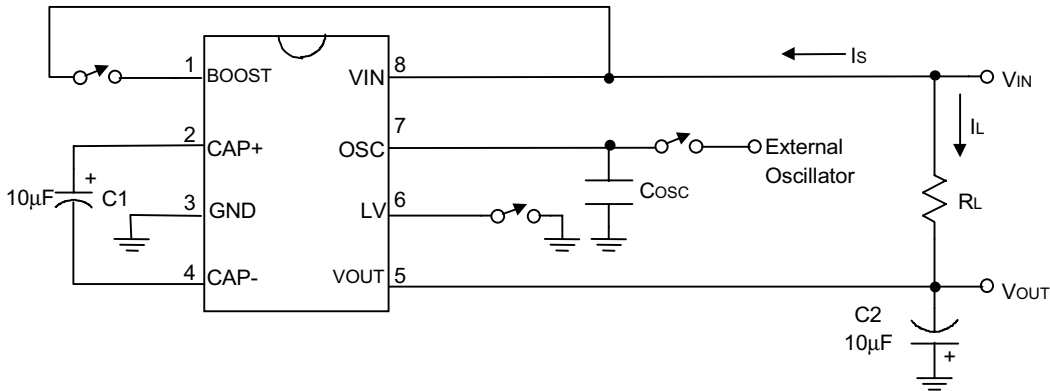
 DIP-8  
 SO-8  
 TOP VIEW


Example: SS6660CSTR  
 in SO-8 package shipped on tape and reel.

Please note that CN is only available in tubes.

**ABSOLUTE MAXIMUM RATINGS**

Supply Voltage (VIN to GND, or GND to VOUT) .....	6.0V
Input Voltage on Pin 1, 6 and 7 .....	-0.3V ~VIN + 0.3V
Operating Temperature Range .....	-40°C~+85°C
Storage Temperature Range.....	-65°C~150°C

**TEST CIRCUIT**


**ELECTRICAL CHARACTERISTICS** ( $V_{IN} = 5.0V$ ,  $T_A = 25^\circ C$ ,  $OSC = OPEN$ , unless otherwise specified.)

PARAMETER	TEST CONDITIONS	SYMBOL	MIN	TYP	MAX	UNIT
Supply Current	$R_L = \infty$	$I_S$		36	70	$\mu A$
Minimum Supply Voltage	$R_L = \infty$	$V_{INL}$	1.5			V
Maximum Supply Voltage	$R_L = \infty$	$V_{INH}$			6	V
Output Resistance	$I_L = 20mA$ , $F_{OSC} = 10kHz$	$R_{OUT}$		35	70	$\Omega$
Oscillator Frequency	$C_{OSC} = 0$ Pin 1 Floating or GND Pin 1 = $V_{IN}$	$F_{OSC}$		10 50		KHz
Power Efficiency	$R_L = 5K$ , $F_{OSC} = 10kHz$	$\eta$	96	98		%
Voltage Conversion Efficiency	$R_L = \infty$	$V_{OUTEFF}$	98	99.9		%

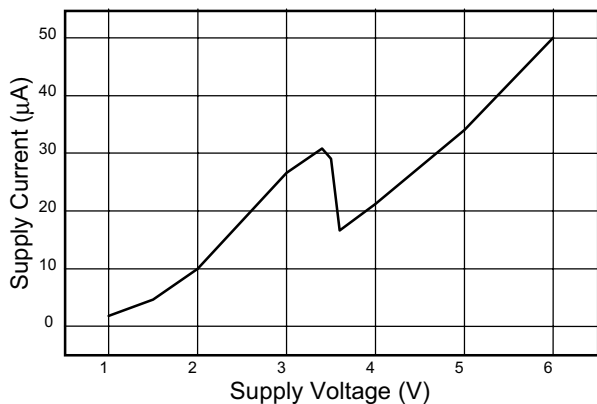
**TYPICAL PERFORMANCE CHARACTERISTICS** ( $T_A = 25^\circ C$ )


Fig. 1 Supply Current vs. Supply Voltage

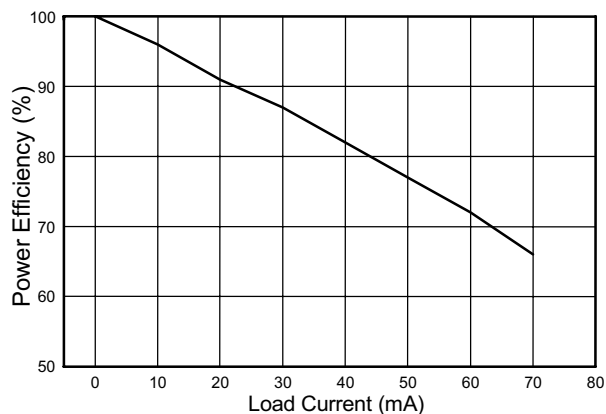


Fig. 2 Power Efficiency vs. Load Current

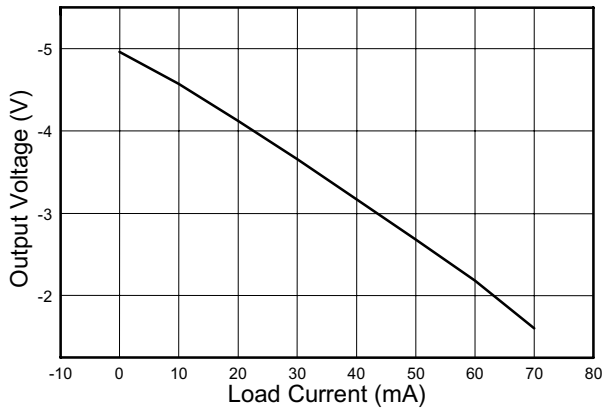
**TYPICAL PERFORMANCE CHARACTERISTICS (cont.)**


Fig. 3 Output Voltage vs. Load Current

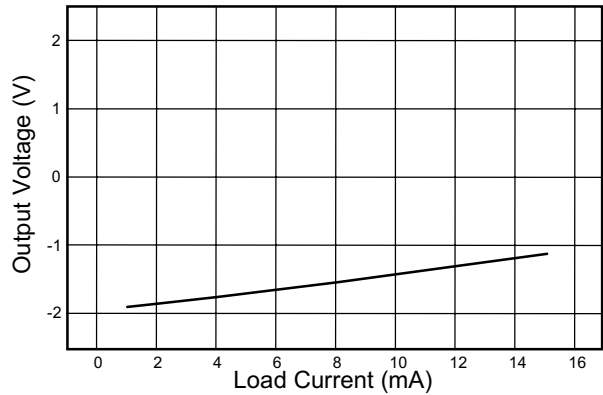
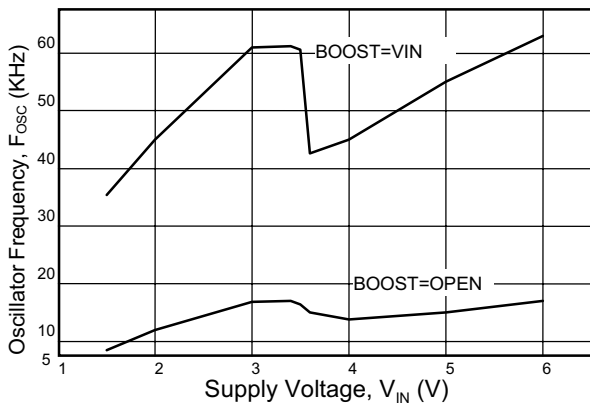

 Fig. 4 Output Voltage vs. Load Current ( $V_{IN}=2V$ )


Fig. 5 Oscillator Frequency vs. Supply Voltage

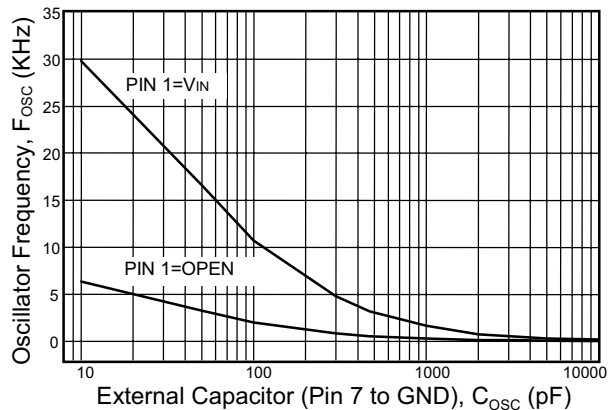
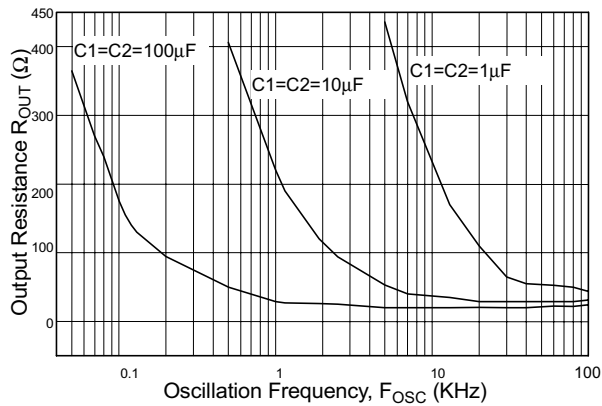
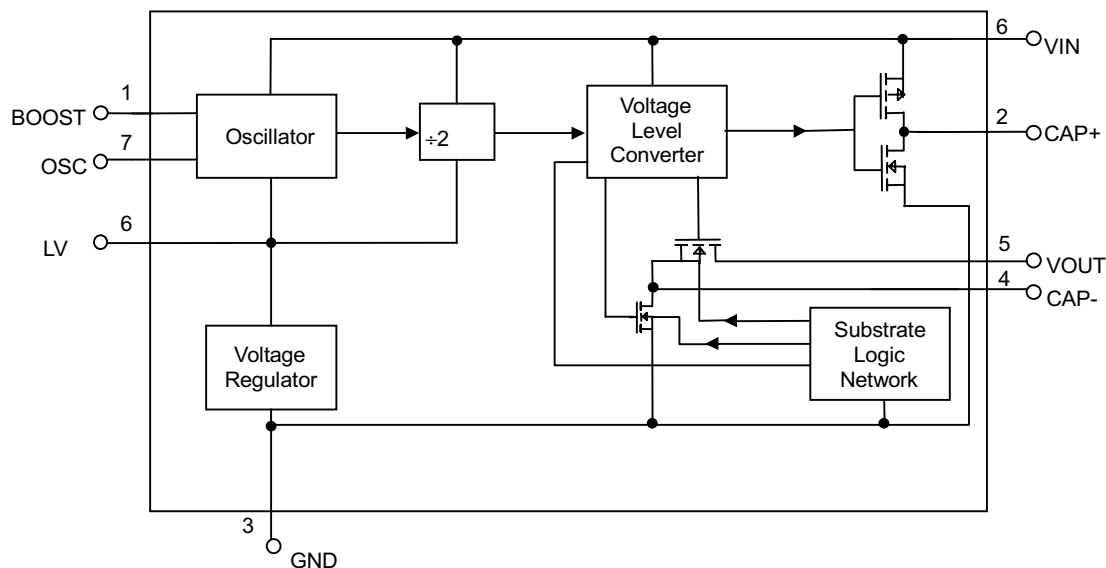

 Fig. 6 Oscillator Frequency vs. Value of  $C_{OSC}$ 


Fig. 7 Output Resistance vs. Oscillation Frequency

**BLOCK DIAGRAM**

**PIN DESCRIPTIONS**

PIN 1: BOOST- The frequency of oscillator will be 5 times if boost pin is connected to  $V_{IN}$ .

PIN 2: CAP+ - To be connected to the positive side of the flying capacitor.

PIN 3: GND - Ground

PIN 4: CAP- - To be connected to the negative side of flying capacitor.

PIN 5: VOUT - Negative output voltage, typically connected to a  $10\mu\text{F}$  capacitor.

PIN 6: LV - If  $V_{IN}$  is below 3V, LV should be tied to GND. For  $V_{IN}$  larger than 3V, LV can be floating.

PIN 7: OSC - The frequency of oscillator can be lowered by the addition of an external capacitor to the OSC pin. Or the oscillator may be over-driven by an external clock.

PIN 8: VIN - Input supply.

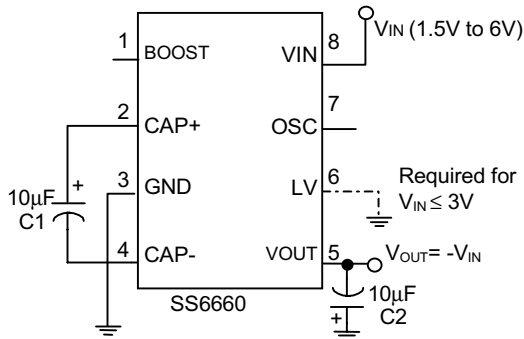
**APPLICATION EXAMPLES**

**Fig. 8 Negative Voltage Converter**

Fig. 8 shows a typical connection, which will provide a negative supply from an available positive supply without the need of any external diodes. The LV pin should connect to ground for  $V_{IN} \leq 3V$ , or may be "floated" for  $V_{IN} > 3V$ .

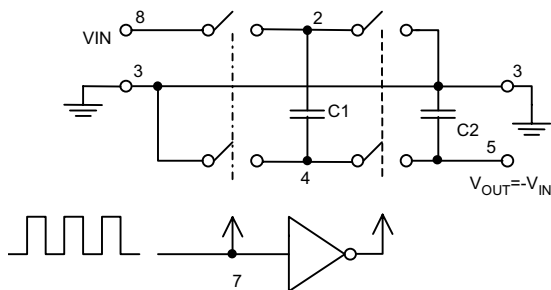

**Fig. 9 Idealized Negative Voltage Converter**

Fig. 9 shows the idealized negative voltage converter.

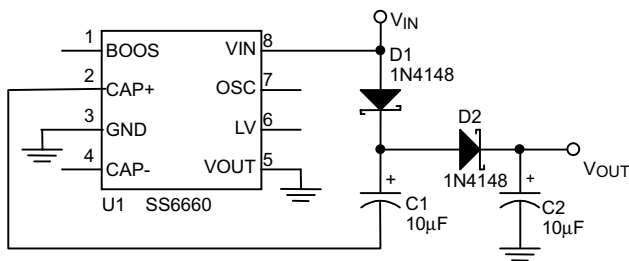
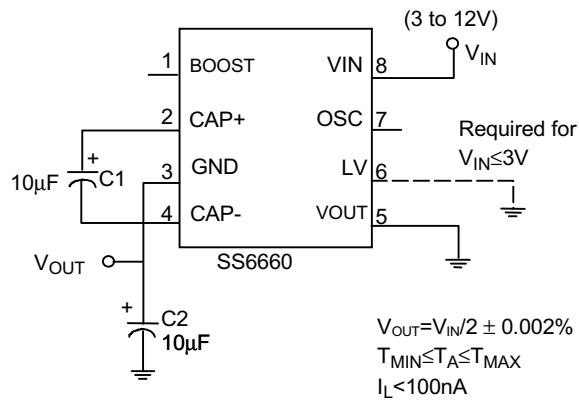
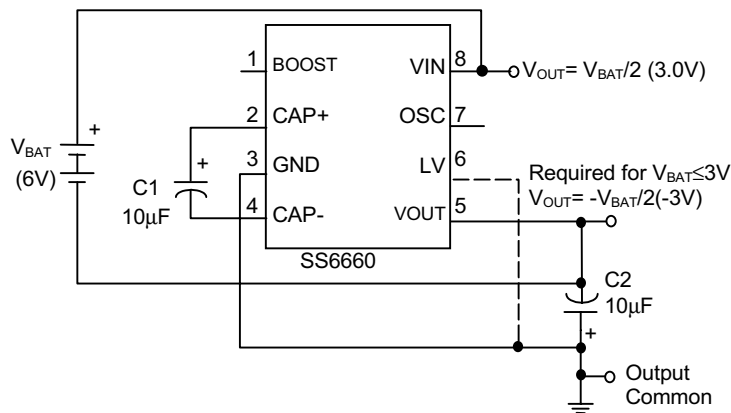

**Fig. 10 Voltage Doubling**

Fig. 10 shows a method of voltage doubling.  $V_{OUT} = 2V_{IN} - 2V_D$ . To reduce the voltage drops across diodes, use Schottky diodes.

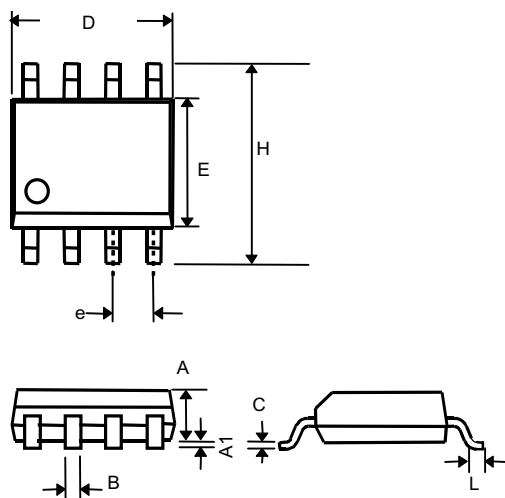
**APPLICATION EXAMPLES (cont.)**


An ultra precision voltage divider is shown in Fig. 11. To achieve the 0.002% accuracy as indicated, the load current should be kept below 100nA. However, with a slight loss in accuracy, the load current can be increased.

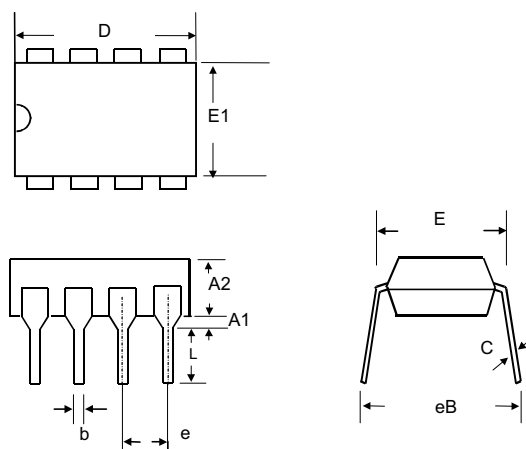
**Fig. 11 Ultra Precision Voltage Divider**


A common need in many systems is to obtain (+) and (-) supplies from a single battery or power supply system. Where current requirements are low, the circuit shown in Fig. 12 is a simple solution.

**Fig. 12 Battery Splitter**

**PHYSICAL DIMENSIONS**
**8 Lead plastic SO (units: mm)**


SYMBOL	MIN	MAX
A	1.35	1.75
A1	0.10	0.25
B	0.33	0.51
C	0.19	0.25
D	4.80	5.00
E	3.80	4.00
e	1.27(TYP)	
H	5.80	6.20
L	0.40	1.27

**8 Lead plastic DIP (units: mm)**


SYMBOL	MIN	MAX
A1	0.381	—
A2	2.92	4.96
b	0.35	0.56
C	0.20	0.36
D	9.01	10.16
E	7.62	8.26
E1	6.09	7.12
e	2.54 (TYP)	
eB	—	10.92
L	2.92	3.81

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