

SCI7661CoA/MoA

Low Voltage
Operation
Products

DC-DC Converter

- 95% Typical Power Efficiency
- Doubled or Tripled Output Voltage
- Internal Voltage Regulator

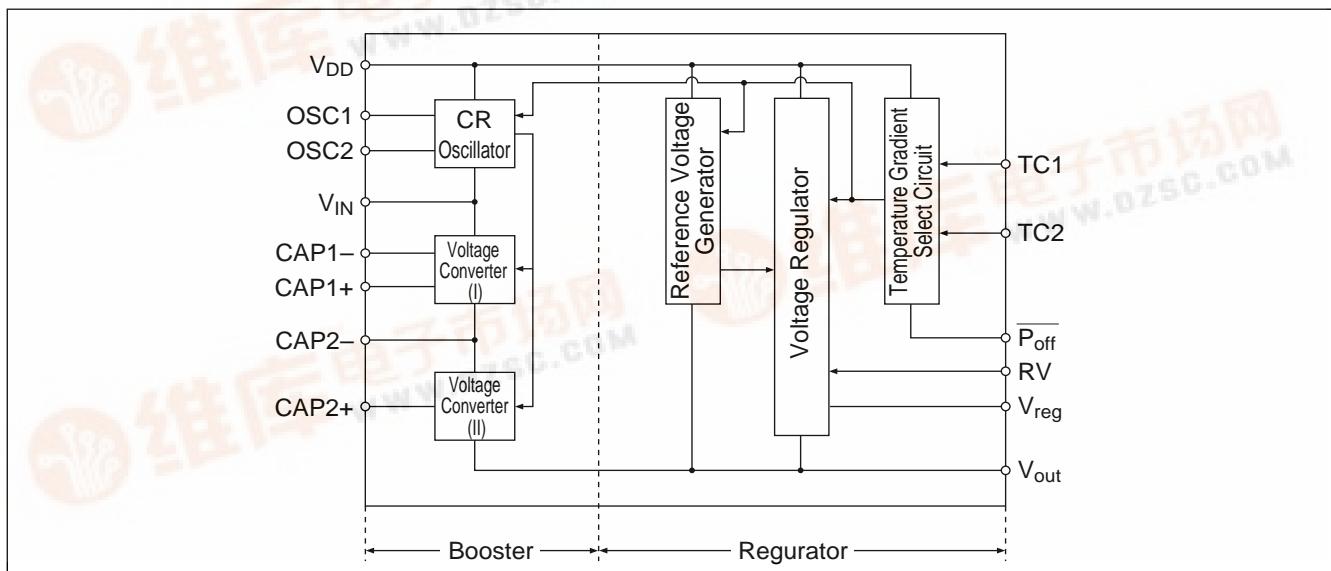
■ DESCRIPTION

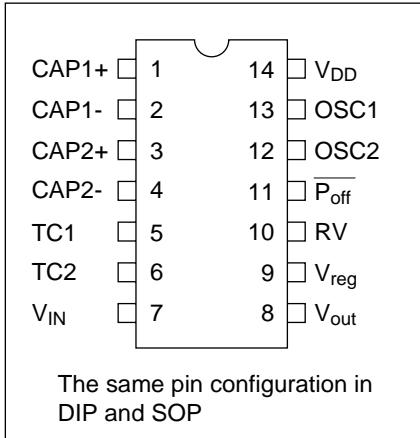
The SCI7661CoA/MoACMOS DC-DC Converter features high operational performance with low power dissipation. It consists of two major parts: the booster circuitry and the regulator circuitry. The booster generates a doubled output voltage (-2.4 to -12V) or tripled output voltage (-3.6 to -18V) from the input (-1.2 to -6V). The regulator is capable of setting the output to any desired voltage. The regulated voltage can be given one of the three threshold temperature gradients.

■ FEATURES

- High performance with low power dissipation
- Simple conversion of V_{IN} (-5V) to $|V_{IN}|$ (+5V),
2 $|V_{IN}|$ (+10V), 2 V_{IN} (-10V) or 3 V_{IN} (-15V)
- On-chip output voltage regulator
- Power conversion efficiency-Typ. 95%
- Temperature gradient for LCD power supply – 0.1% / °C, 0.4%/°C or 0.6%/ °C
- Power off by external signals – Stationary current at power off – Max. 2 μ A
- Cascade connection–two device connected:
 $V_{IN}=-5V$, $V_{OUT}=-20V$
- On-chip C'-R oscillator
- Package SCI7661C₀A: DIP-14pin(plastic)
SCI7661M₀A: SOP5-14pin(plastic)
SCI7661M_{AA}: SSOP2-16pin(plastic)

■ BLOCK DIAGRAM



■ PIN CONFIGURATION**■ PIN DESCRIPTION**

Pin name	No.	Function
CAP1+, CAP1-	1, 2	Terminal for connection of capacitor for doubler
CAP2+, CAP2-	3, 4	Terminal for connection of capacitor for tripler
TC1, TC2	5, 6	Temperature gradient selection terminal
V _{IN}	7	Power supply terminal(negative, system supply GND)
V _{OUT}	8	Output terminal at tripling
V _{reg}	9	Regulated voltage output terminal
R _V	10	Regulated voltage control terminal
P _{off}	11	V _{reg} output ON/OFF control terminal
OSC2, OSC1	12, 13	Oscillation resistor connection terminal
V _{DD}	14	Power supply terminal(positive system supply VCC)

■ ABSOLUTE MAXIMUM RATINGS(V_{DD}=0V)

Rating	Symbol	Min.	Max.	Unit	Remark
Input supply voltage	V _I	-20/N	0.5	V	N=2 : Doubler N=3 : Tripler
Input terminal voltage	V _I	V _{IN} -0.5	0.5	V	OSC1, P _{off}
		V _{OUT} -0.5	0.5	V	TC1, TC2, RV
Output voltage	V _O	-20.0		V	
Allowable loss	P _d		300	mW	
Operating temperature	T _{opr}	-30	85	°C	Plastic package
Storage temperature	T _{stg}	-55	150	°C	
Soldering temperature and time	T _{sol}	260°C, 10s(at lead)		-	

Note: When this IC is soldered in the solder-reflow process, be sure to maintain the reflow furnace at the curve shown in "Fig. 1-5 Reflow Furnace Temperature Curve" of this DATA BOOK. And this IC can not be exposed to high temperature of the solder dipping.

■ ELECTRICAL CHARACTERISTICS(V_{DD} = 0V, V_{IN}=-5V, Ta=-30 to 85°C)

Characteristic	Symbol	Min.	Typ.	Max.	Unit	Condition
Input supply voltage	V _I	-6.0		-1.2	V	
Output voltage	V _O	-18.0			V	
	V _{reg}	-18		-2.6	V	R _L =∞, R _{RV} =1MΩ, V _O =-18V
Regulator operating voltage	V _{OUT}	-18.0		-3.2	V	
Booster current consumption	I _{opr1}		60	100	μA	R _L =∞, R _{OSC} =1MΩ
Regulator current consumption	I _{opr2}		50	12.0	μA	R _L =∞, R _{RV} =1MΩ, V _{OUT} =-15V
Stationary current	I _Q			2.0	μA	TC2=TC1=V _{OUT} , R _L =∞
Oscillation frequency	f _{osc}	16	20	24	kHz	R _{OSC} =1MΩ
Output impedance	R _{OUT}		150	200	Ω	I _{OUT} =10mA
Booster power conversion efficiency	P _{eff}	90	95		%	I _{OUT} =5mA
Regulated output voltage fluctuation	$\frac{\Delta V_{reg}}{\Delta V_{OUT} \cdot V_{reg}}$		0.2		%/V	-18V < V _{OUT} < -8V, V _{reg} =-8V, R _L =∞, Ta=25°C

Characteristic	Symbol	Min.	Typ.	Max.	Unit	Condition
Regulated output load fluctuation	$\frac{\Delta V_{\text{reg}}}{\Delta I_{\text{OUT}}}$		5		Ω	$V_{\text{OUT}}=-15V, V_{\text{reg}}=-8V,$ $T_a=25^\circ\text{C}$ $0 < I_{\text{OUT}} < 10\text{mA}, \text{TC1}=V_{\text{DD}}$ $\text{TC2}=V_{\text{OUT}}$
Regulated output saturation resistance	R_{SAT}		5		Ω	$R_{\text{SAT}}=D(V_{\text{reg}}-V_{\text{OUT}})/I_{\text{OUT}}$ $0 < I_{\text{OUT}} < 10\text{mA}, RV=V_{\text{DD}},$ $T_a=25^\circ\text{C}$
Reference voltage	V_{RV0} V_{RV1} V_{RV2}	-2.3 -1.7 -1.1	-1.5 -1.3 -0.9	-1.0 -1.1 -0.8	V	$\text{TC2}=V_{\text{OUT}}, \text{TC1}=V_{\text{DD}}, T_a=25^\circ\text{C}$ $\text{TC2}=\text{TC1}=V_{\text{OUT}}, T_a=25^\circ\text{C}$ $\text{TC2}=V_{\text{DD}}, \text{TC1}=V_{\text{OUT}}, T_a=25^\circ\text{C}$
Temperature Gradient	CT^0 CT^4 CT^2	-0.25 -0.5 -0.7	-0.1 -0.4 -0.6	-0.06 -0.3 -0.5	$^{\circ}/\text{C}$	$CT = \frac{ V_{\text{reg}}(50^\circ\text{C}) - V_{\text{reg}}(0^\circ\text{C}) }{50^\circ\text{C}-0^\circ\text{C}}$ $\times \frac{1}{ V_{\text{reg}}(25^\circ\text{C}) } \times 100$
Input leakage current	I_L			2.0	μA	$P_{\text{off}}, \text{TC1}, \text{TC2}, \text{OSC1}, RV$ pins

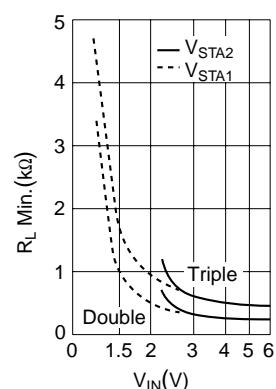
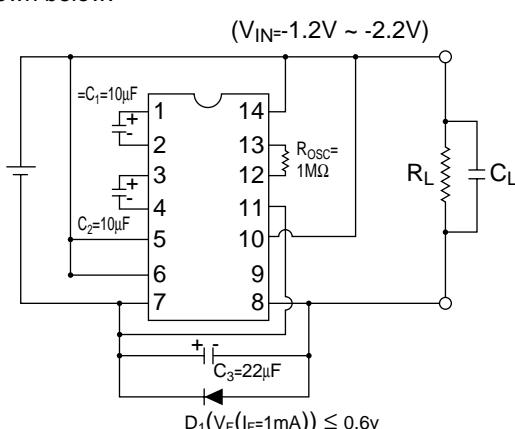
■ RECOMMENDED OPERATING CONDITIONS

(Ta=-30 to 85°C)

Condition	Symbol	Min.	Max.	Unit	Remark
Booster start voltage	V_{STA1}		-1.2	V	$R_{\text{OSC}}=1\text{M}\Omega, C_3 \geq 10\mu\text{F}^{\ast 1}$ $C_L/C_3 \leq 1/20, T_a=-20 \text{ to } 85^\circ\text{C}$
	V_{STA2}		-2.2	V	$R_{\text{OSC}}=1\text{M}\Omega$
Booster stop voltage	V_{STP}	-1.2		V	$R_{\text{OSC}}=1\text{M}\Omega$
Output load resistance	R_L	R_L Min.* ²		Ω	
Output load current	I_{OUT}		20	mA	
Oscillation frequency	f_{OSC}	10	30	kHz	
External resistance for oscillation	R_{OSC}	680	2000	k Ω	
Capasitor for booster	C_1, C_2, C_3	3.3		μF	
Regulated output adjustable resistance	R_{RV}	100	1000	k Ω	

*1: Recommended circuitry in low voltage operation is shown below.

*2: R_L Min. depends on input voltage as shown below.



■ PERFORMANCE CURVES

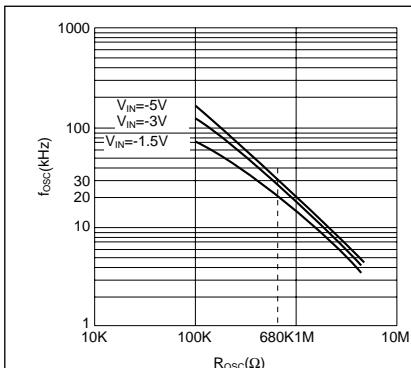


Fig.1 Oscillation Frequency(f_{osc})vs. External-Resistance(R_{osc})

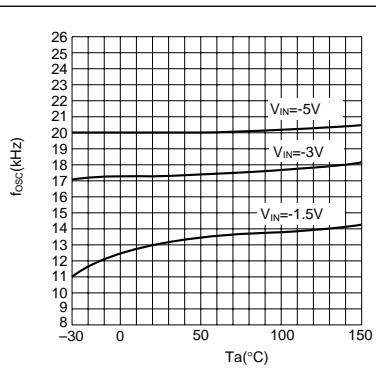


Fig.2 Oscillation Frequency(f_{osc})vs. Temperature(T_a)

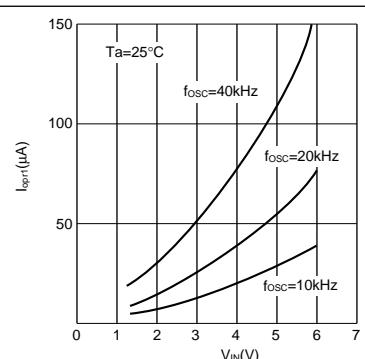


Fig.3 Input Voltage(V_{IN})vs. Booster Current Consumption(I_{opr1})

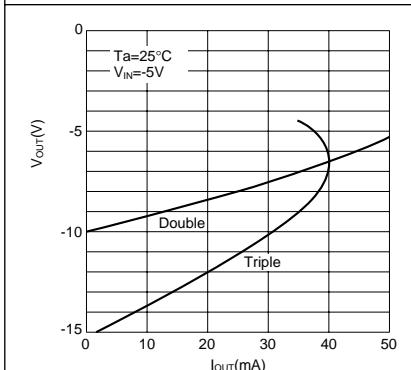


Fig.4 Output Voltage(V_{OUT})vs. Output Current(I_{OUT})

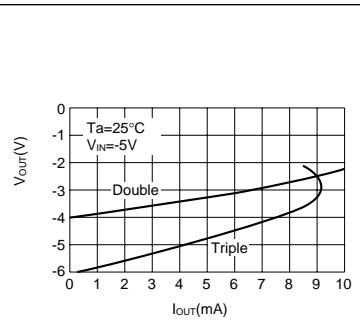


Fig.5 Output Voltage(V_{OUT})vs. Output Current(I_{OUT})

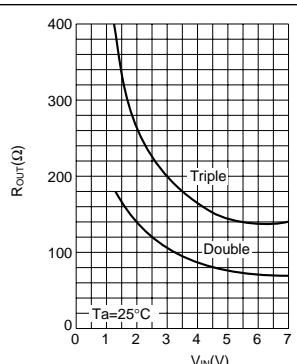


Fig.6 Output Impedance(R_{OUT})vs. Input Voltage(V_{IN})

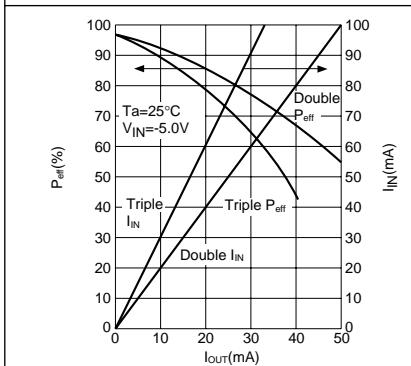


Fig.7 Power Conversion Efficiency (P_{eff})/Input Current(I_{IN})vs. Output Current(I_{OUT})

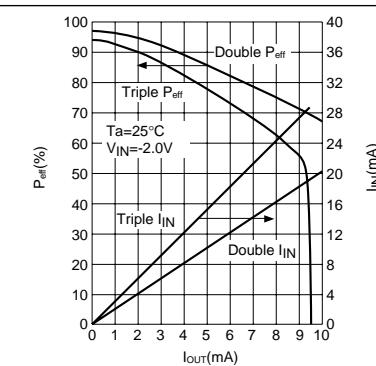


Fig.8 Power Conversion Efficiency (P_{eff})/Input Current(I_{IN})vs. Output Current(I_{OUT})

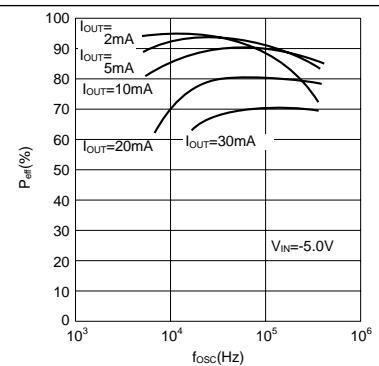


Fig.9 Power Conversion Efficiency (P_{eff})vs. Oscillation Frequency (f_{osc})

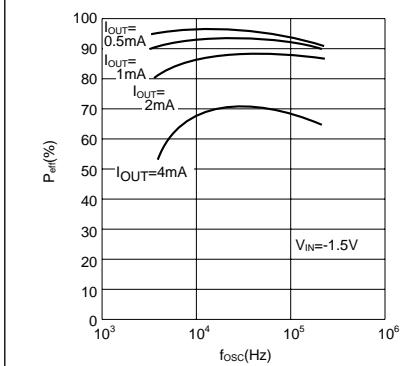


Fig.10 Power Conversion Efficiency(P_{eff}) vs. Oscillation Frequency(f_{osc})

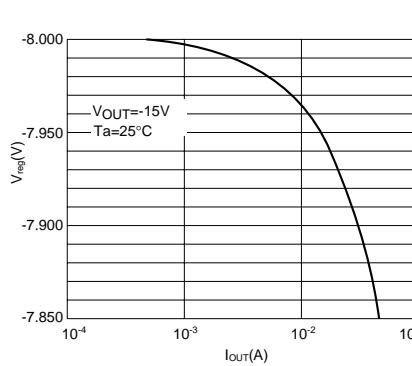


Fig.11 Output Voltage(V_{reg})vs. Output Current(I_{OUT})

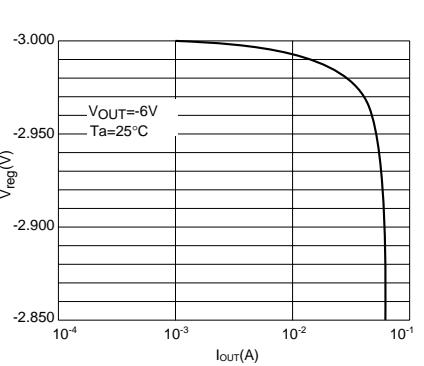
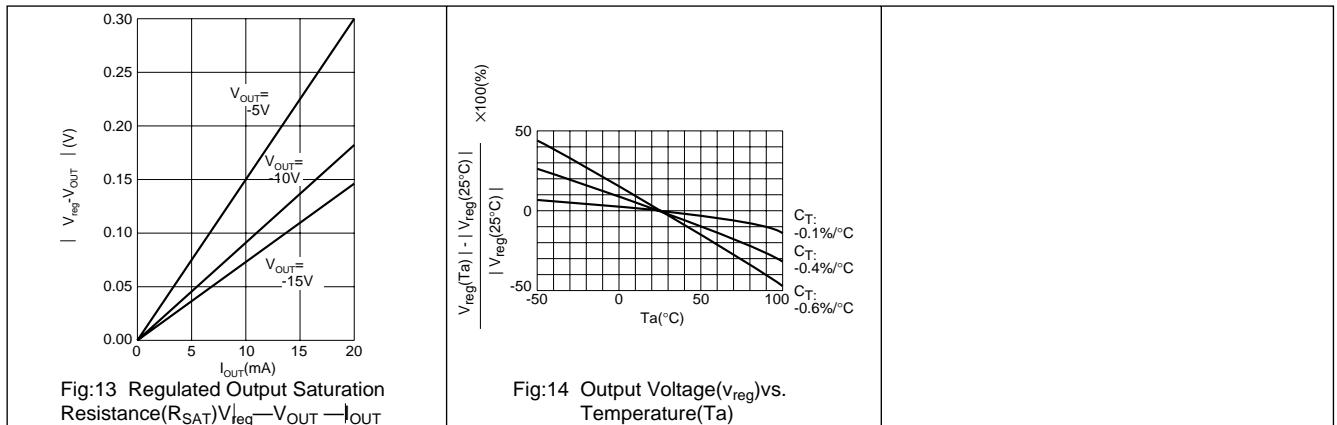


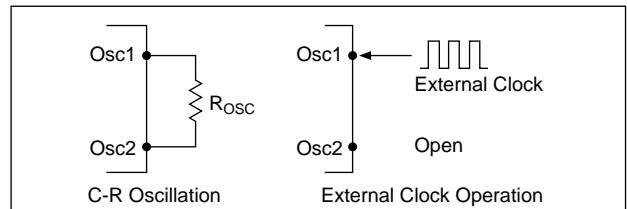
Fig.12 Output Voltage(V_{reg})vs. Output Current(I_{OUT})



■ CIRCUIT DESCRIPTION

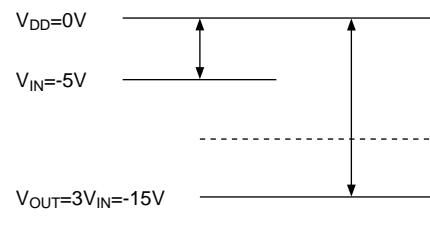
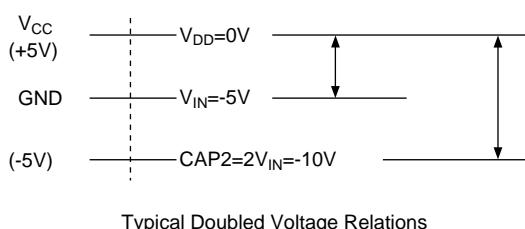
● C-R Oscillator

The SCI7661C/M contains a C-R oscillator for internal oscillation. It consists of an external resistor R_{osc} connected between the OSC1 pin and OSC2 pin.



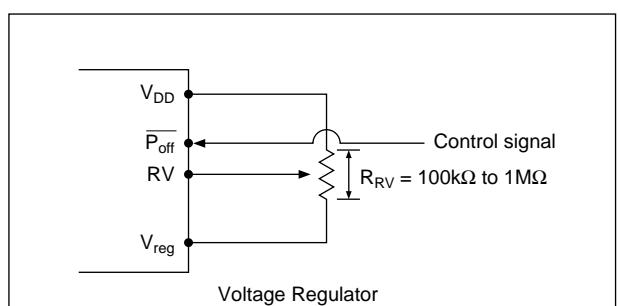
● Voltage Converters

The voltage converters double/triple the input supply voltage (V_{IN}) using clocks generated by the C-R oscillator.



● Reference Voltage Generator and Voltage Regulator

The reference voltage generator produces reference voltage needed for operation of regulator circuit. The voltage regulator is used to regulate a boosted output voltage and its circuit contains a power-off function which uses signals from the system for on-off control of the V_{reg} output.



● Temperature Gradient Selector Circuit

The SCI7661C/M provides the V_{reg} output with a temperature gradient suitable for LCD driving.

● Temperature Gradient Assignment

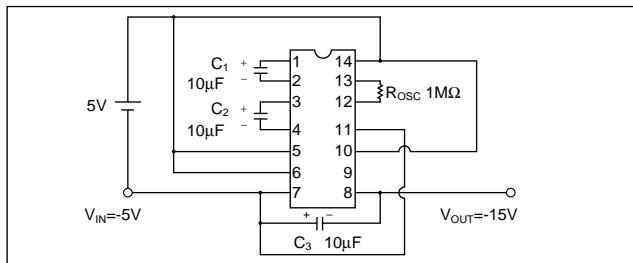
P _{off}	TC2	TC1	Temp. Gradient	V _{reg} Output	CR oscillation	Remarks
1(V _{DD})	L(V _{OUT})	L(V _{OUT})	-0.4%/°C	ON	ON	Cascade connection
1	L	H(V _{DD})	-0.1%/°C	ON	ON	
1	H(V _{DD})	L	-0.6%/°C	ON	ON	
1	H	H	-0.6%/°C	ON	OFF	
0(V _{IN})	L	L	-	OFF(Hi-Z)	OFF	
0	L	H	-	OFF(Hi-Z)	OFF	
0	H	L	-	OFF(Hi-Z)	OFF	
0	H	H	-	OFF(Hi-Z)	ON	Without regulation

NOTE: The potential at Low level is different between the P_{off} pin and the TC1/TC2 pin.

■ BASIC EXTERNAL CONNECTION

● Voltage Doubler and Tripler

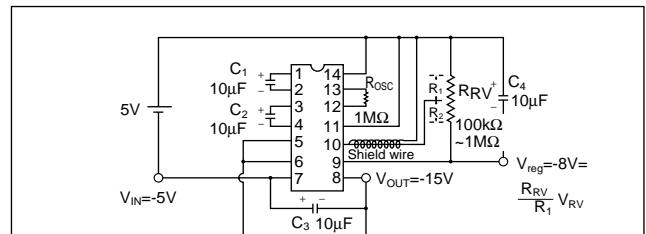
A doubled voltage can be obtained at V_{OUT}(CAP2-) by disconnecting capacitor C₂ from the tripler configuration and shorting CAP2-(pin4) and V_{OUT} (pin 8).



Voltage Tripler

● Voltage Tripler+Regulator

V_{reg} output is given a temperature gradient, after boosted output V_{OUT} regulated. In this connection, both V_{OUT} and V_{reg} can be taken out at the same time.

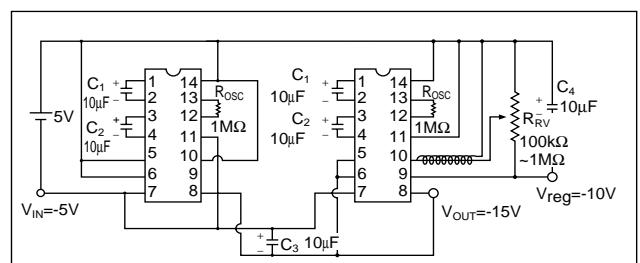


Tripler+Regulator
(-0.4%/°C selected as temperature gradient)

● Parallel Connection

Parallel connection of n circuits can reduce R_{OUT} to about 1/n, that output impedance R_{OUT} can be reduced by connecting serial configuraion. A single smoothing capacitor C₃ can be used commonly for all parallelly connected circuit.

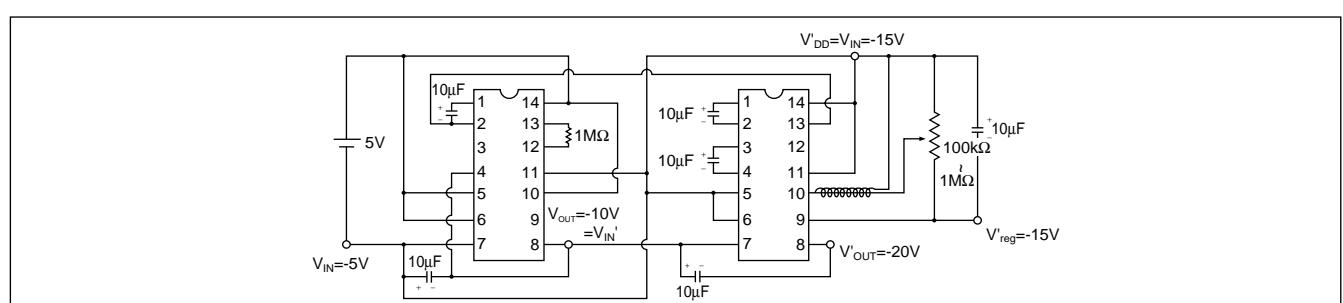
In parallel connection, a regulated output can be obtained by applying the regulation circuit to only one of the n parallelly connected circuit.



Parallel Connection

● Cascade Connection

Cascade connection of SCI7661C/M (by connecting V_{IN} and V_{OUT} of one stage to V_{DD} and V_{IN} respectively of the next stage) further increase the output voltage. Note, however, that the serial connection increases the output impedance.

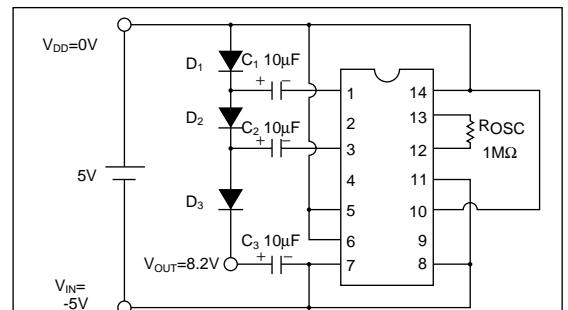


Serial Connection

● Positive Voltage Conversion

The input voltage can be doubled or tripled toward the positive side. (In the doubler configuration, capacitor C_2 and diode D_3 are disconnected and the diode D_3 shorted at the both ends.) In this case, however, the output voltage decrease by V_F (forward voltage)

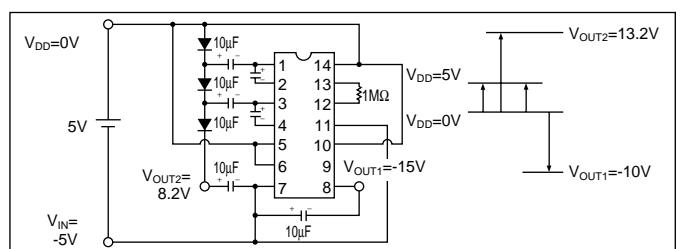
For example $V_{DD}=0V$, $V_{IN}=-5V$ and $V_F=0.6V$, then $V_{OUT}=10V-3\times0.6V=8.2V$ (if doubled, $5V-2\times0.6V=3.8V$)



Positive Voltage Conversion D₁, D₂, D₃;: Shottky diodes with small V_F are recommended.

● Negative Voltage Conversion + Positive Voltage Conversion

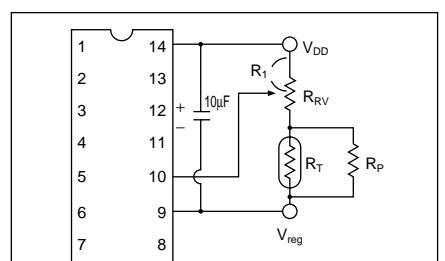
This circuit produces outputs of $-15V$ and $+8.2V$ from the $-5V$ input. Note that this configuration causes higher output impedance than in a single function (negative or positive voltage converter).



Negative Voltage Conversion +Positive Voltage Conversion

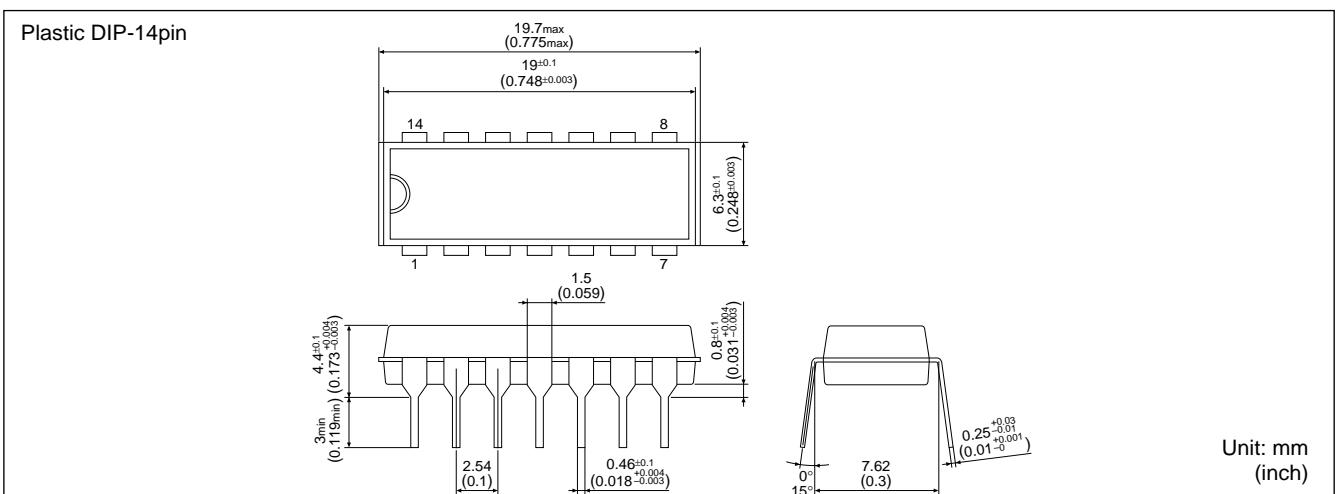
● Changing the Temperature Gradient through Use of External Temperature Sensor (Thermistor)

The SCI7661C/M has a temperature gradient selector circuit in its regulator. It selects any one of the three gradients: $-0.1\% / ^\circ C$, $-0.4\% / ^\circ C$ and $-0.6\% / ^\circ C$. It is necessary that the temperature gradient can be changed to any other value by connecting a thermistor in series to the output voltage control resistor R_{RV} .



Example of Change of Temperature Gradient

■ PACKAGE DIMENSIONS

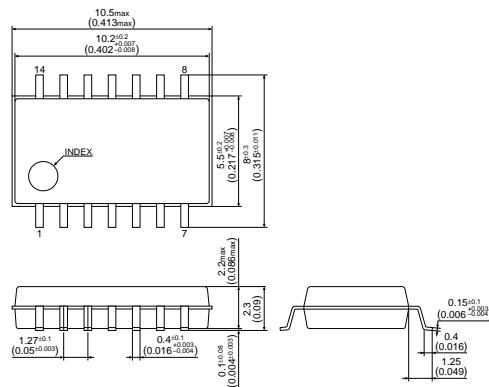


Unit: mm
(inch)

EPSON

SCI7661CoA/MoA

Plastic SOP5-14pin



Unit: mm
(inch)

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