

SCI7661C/M

CMOS DC/DC CONVERTER

J-57-11

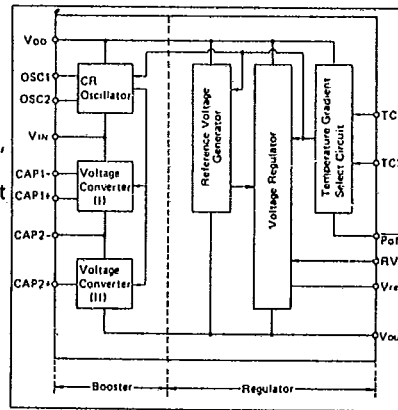
DESCRIPTION

The SCI7661C CMOS 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 (-2.4V to -12V) or tripled output voltage (-3.6V 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.

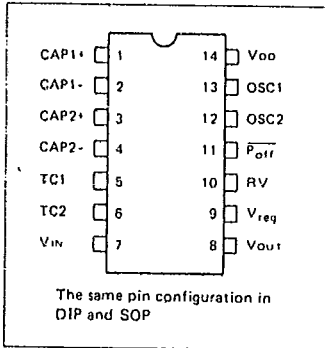
FEATURES

- High performance with low power dissipation
- Simple conversion of V_{IN} (-5V) to $|V_{IN}|$ (+5V), $2|V_{IN}|$ (+10V), $2V_{IN}$ (-10V) or $3V_{IN}$ (-15V)
- On-chip output voltage regulator
- Power conversion efficiency – Typ95%
- 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 2μA
- Cascade connection – two device connected: $V_{IN} = -5V$, $V_{OUT} = -20V$
- On-chip C-R oscillator
- Package..... SCI7661C14-pinDIP (plastic)
SCI7661M14-pinSOP (plastic)

BLOCK DIAGRAM



PIN CONFIGURATION



PIN DESCRIPTION

Terminal	No.	Functions
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
RV	10	Regulated voltage control terminal
Poff	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 V _{CC})

ABSOLUTE MAXIMUM RATINGS

(V_{DD} = 0V)

Parameter	Symbol	Ratings		Unit	Remarks
		Min	Max		
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, Poff
		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	

ELECTRICAL CHARACTERISTICS

(V_{DD} = 0V, V_{IN} = -5V, T_a = -30 to 85°C)

Parameter	Symbol	Ratings			Unit	Conditions
		Min	Typ	Max		
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}		5.0	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	$\frac{\Delta V_{reg}}{\Delta V_{OUT} + V_{reg}}$		0.2		%/V	-18V < V _{OUT} < -8V, V _{reg} = -8V, R _L = ∞, T _a = 25°C
Regulated output load fluctuation	$\frac{\Delta V_{reg}}{\Delta I_{OUT}}$		5		Ω	V _{OUT} = -15V, V _{reg} = -8V, T _a = 25°C 0 < I _{OUT} < 10mA, TC1 = V _{DD} TC2 = V _{OUT}
Regulated output saturation resistance	R _{SAT}		8		Ω	R _{SAT} = Δ(V _{reg} - V _{OUT}) / ΔI _{OUT} 0 < I _{OUT} < 10mA, R _V = V _{DD} , T _a = 25°C
Reference voltage	VRV0	-2.3	-1.5	-1.0	V	TC2 = V _{OUT} , TC1 = V _{DD} , T _a = 25°C
	VRV1	-1.7	-1.3	-1.1	V	TC2 = TC1 = V _{OUT} , T _a = 25°C
	VRV2	-1.1	-0.9	-0.8	V	TC2 = V _{DD} , TC1 = V _{OUT} , T _a = 25°C
Temperature Gradient	CT0	-0.25	-0.1	-0.06	%/°C	$CT = \frac{ V_{reg}(50°C) - V_{reg}(0°C) }{50°C - 0°C}$ $\times \frac{1}{ V_{reg}(25°C) } \times 100$
	CT1	-0.5	-0.4	-0.3	%/°C	
	CT2	-0.7	-0.6	-0.5	%/°C	
Input leakage current	I _L			2.0	μA	Poff, TC1, TC2, OSC1, RV pins

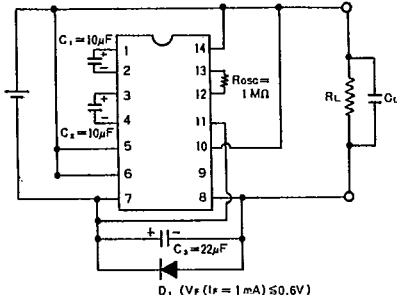
RECOMMENDED OPERATING CONDITIONS

(Ta = -30 ~ 85°C)

Parameter	Symbol	Ratings		Unit	Remarks
		Min	Max		
Booster start voltage	V _{STA1}		-1.2	V	R _{osc} = 1MΩ, C ₁ ≥ 10μF *2 C _L /C ₁ ≤ 1/20, Ta = -20 to 85°C
	V _{STA2}		-2.2	V	R _{osc} = 1 MΩ
Booster stop voltage	V _{STP}	-1.2		V	R _{osc} = 1 MΩ
Output load resistance	R _L	R _L min *3		Ω	
Output load current	I _{OUT}		20	mA	
Oscillation frequency	f _{osc}	10	30	kHz	
External resistance for oscillation	R _{osc}	680	2000	kΩ	
Capacitor for booster	C ₁ , C ₂ , C ₃	3.3		μF	
Regulated output adjustable resistance	R _{RV}	100	1000	kΩ	

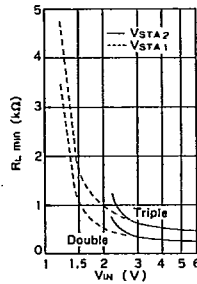
*1 V_{DD} = 0V

*2 Recommended circuitry in low voltage operation is shown below (V_{IN} = -1.2V ~ -2.2V)

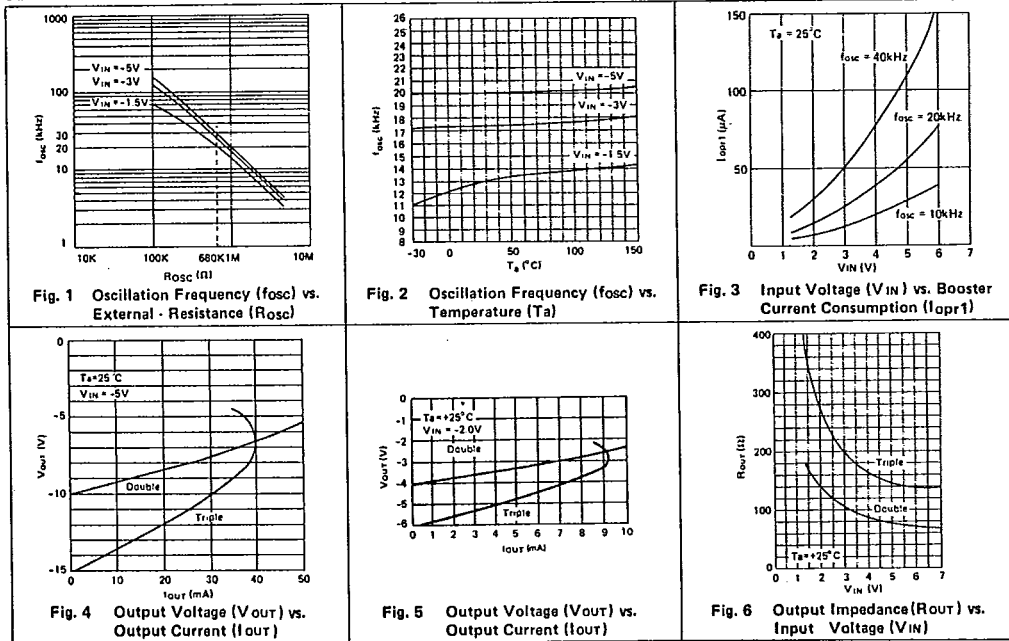


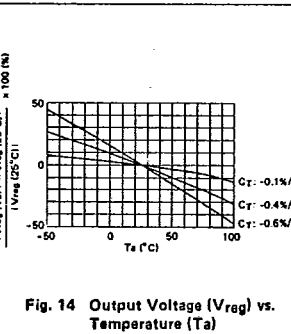
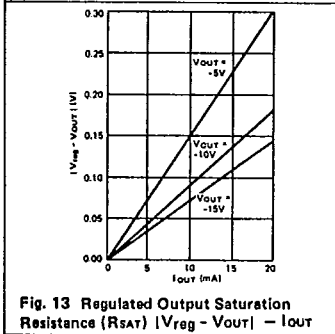
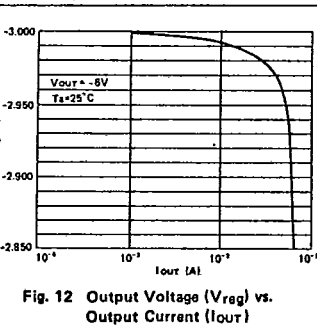
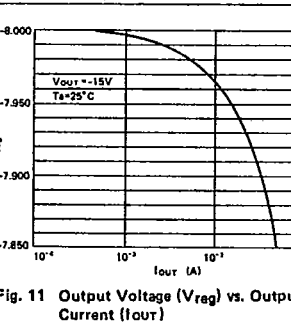
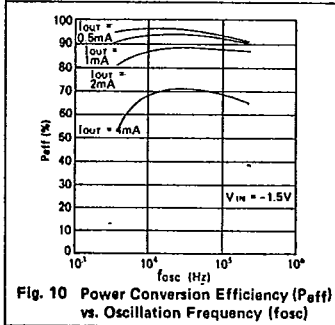
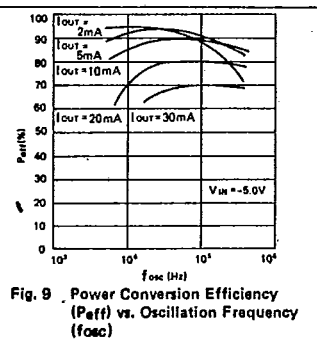
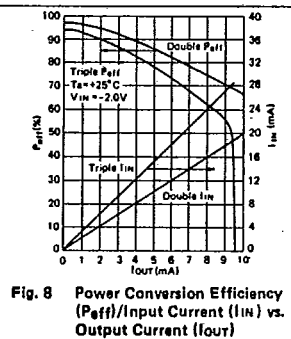
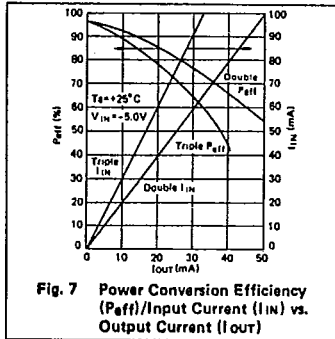
D₁ (V_F (I_F = 1 mA) ≤ 0.6V)

*3 R_L min depends on input voltage as shown below.



PERFORMANCE CURVES

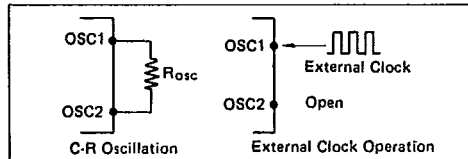




CIRCUIT DESCRIPTION

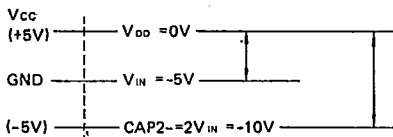
C-R Oscillator

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

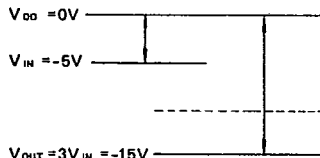


Voltage Converters

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



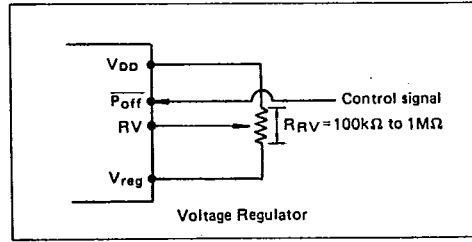
Typical Doubled Voltage Relations



Typical Tripled Voltage Relations

● 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 provides the V_{reg} output with a temperature gradient suitable for LCD driving.

● Temperature Gradient Assignment

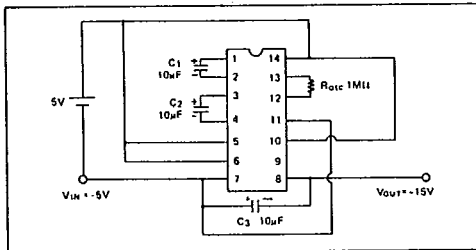
$\overline{P_{off}}$	TC2	TC1	Temp. Gradient	V_{reg} Output	CR oscillation	Remarks
1 (V_{DD})	L (V_{OUT})	L (V_{OUT})	-0.4%/°C	ON	ON	
1	L	H (V_{DD})	-0.1%/°C	ON	ON	
1	H (V_{DD})	L	-0.6%/°C	ON	ON	
1	H	H	-0.6%/°C	ON	OFF	
0 (V_{IN})	L	L	-	OFF (Hi-Z)	OFF	Without regulation
0	L	H	-	OFF (Hi-Z)	OFF	
0	H	L	-	OFF (Hi-Z)	OFF	
0	H	H	-	OFF (Hi-Z)	ON	

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

■ EXAMPLE OF APPLICATIONS

● Voltage Doubler and Tripler

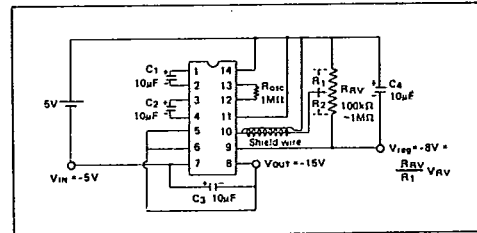
A doubled voltage can be obtained at V_{OUT} (CAP2-) by disconnecting capacitor C_2 from the tripler configuration and shorting CAP2- (pin 4) and V_{OUT} (pin 8).



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.

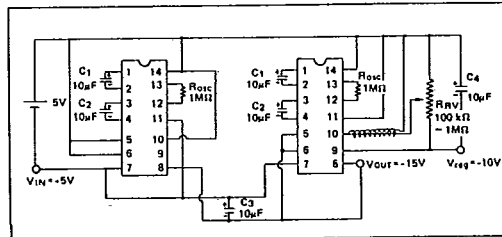


Tripler + Regulator
(-0.4%/°C selected as temperature gradient)

● 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 configuration. A single smoothing capacitor C_3 can be used commonly for all parallelly connected circuit.

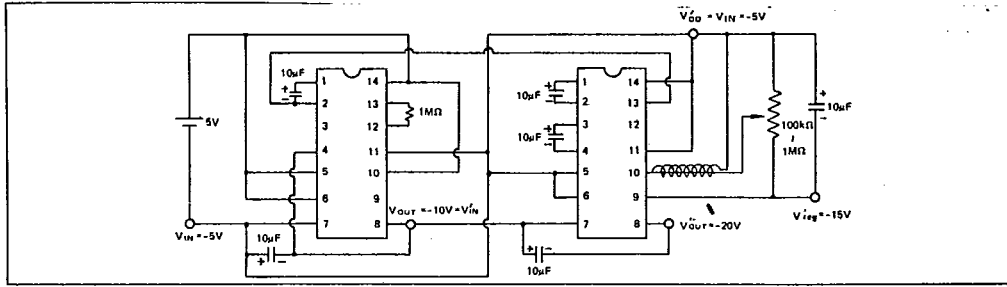
In parallelly connection, a regulated output can be obtained by applying the regulation circuit to only one of the n parallelly connected circuit.



Parallel Connection

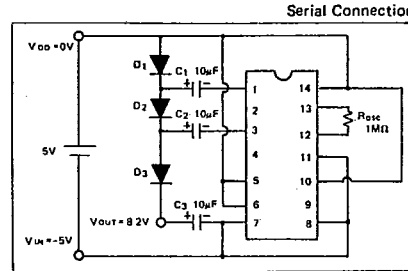
● Cascade Connection

Cascade connection of SCI7661C (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.



● Positive Voltage Conversion

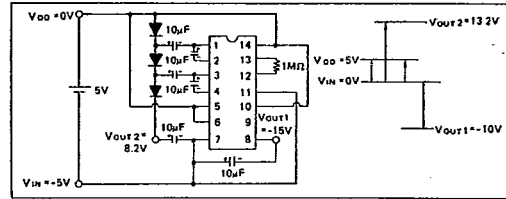
The input voltage can be doubled or tripled toward the positive side. (In the doubler configuration, capacitor C₂ and diode D₃ are disconnected and the diode D₃ shorted at the both ends.) In this case, however, the output voltage decrease by V_F (forward voltage). For example V_{DD} = 0V, V_{IN} = -5V and V_F = 0.6V, then V_{OUT} = 10V - 3 × 0.6V = 8.2V (if doubled, 5V - 2 × 0.6V = 3.8V)



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

● Negative Voltage Conversion + Positive Voltage Conversion

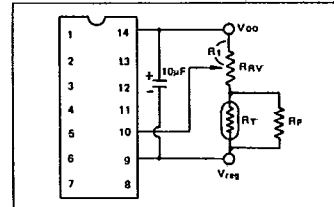
This circuit produces outputs of -15V and +8.2V from the -5V input. Note that this configuration causes higher output impedance than in a single function (negative or positive voltage converter).



Negative Voltage Conversion + Positive Voltage Conversion

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

The SCI7661C has a temperature gradient selector circuit in its regulator. It selects any one of the three gradients: -0.1%/°C, -0.4%/°C and -0.6%/°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

