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S1F76600M1E
Technical Manual

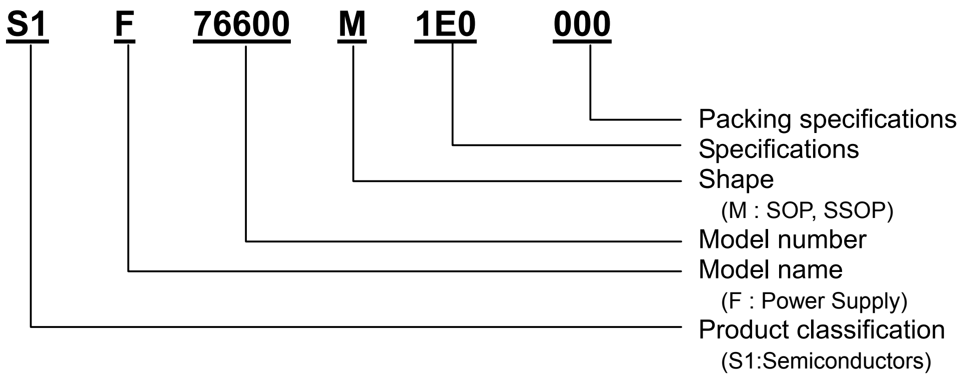
SEIKO EPSON CORPORATION

Rev.1.2

NOTICE

Configuration of product number

● DEVICES



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1. DESCRIPTION

The S1F76600 is a CMOS DC-DC converter with high efficiency and low power consumption.
It assures double boosting output (V_{OUT} = -3.0 to -16V) for input voltage (V_{IN} = -1.5 to -8V).
The S1F76600 enables you to drive an IC (liquid crystal driver, analog IC, etc.), that would usually require another power supply in addition to the logic main power, using a single power supply. Therefore, it is suitable for supplying micro-power to compact electrical devices such as hand-held computers with low power consumption.

2. FEATURES

(1) CMOS DC-DC converter with high efficiency and low power consumption
(2) Easy conversion from input voltage V_{IN} (-5V) to positive or negative voltage
    Output + | V_{IN} | (+5V) and 2V_{IN} (-10V) from input V_{IN} (-5V)
(3) Output current: Max. 30 mA (V_{IN} = -5V)
(4) Power conversion efficiency: Typ. 95%
(5) Serial connection enabled (V_{IN} = -5V, V_{OUT} = -15V using two ICs)
(6) Low voltage operation: Appropriate for battery drive
(7) CR oscillation circuit built-in
(8) SOP3A - 8 pin

3. BLOCK DIAGRAM

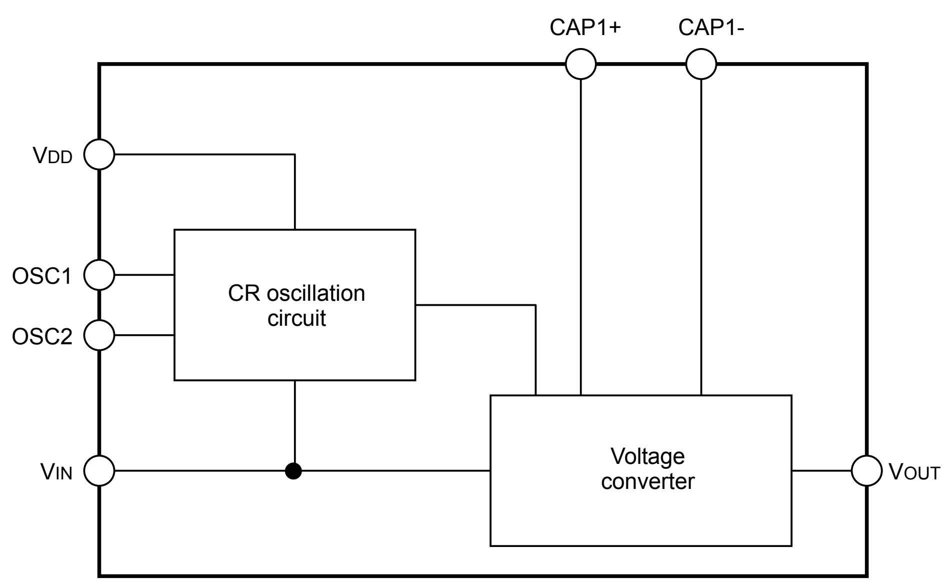


Fig.3.1 Block diagram

4. PIN DESCRIPTION

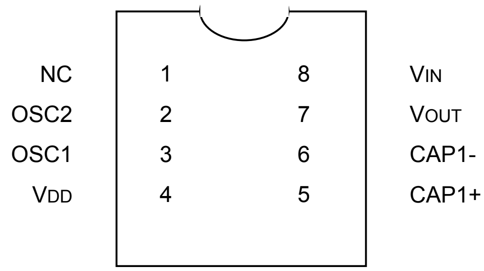


Fig.4.1 Pin assignment

Table 4.1 Pin functions

Pin name	Pin No.	Function
(N.C.)	1	—
OSC2	2	Pin connected to oscillation resistor; opened for external clock operation
OSC1	3	Pin connected to oscillation resistor; functions as a clock input pin for external clock operation
V_{DD}	4	Power supply pin (Positive side, system V_{CC})
CAP1+	5	Positive pin connected to pump-up capacitor for double boosting
CAP1-	6	Negative pin connected to pump-up capacitor for double boosting
V_{OUT}	7	Output pin for double boosting
V_{IN}	8	Power supply pin (Negative side, system GND)

5. FUNCTIONAL DESCRIPTION

5.1 CR Oscillation Circuit

The S1F76600 is equipped with a CR oscillation circuit as an internal oscillation circuit, connecting external resistor R_{OSC} for oscillation between the OSC1 and OSC2 pins.

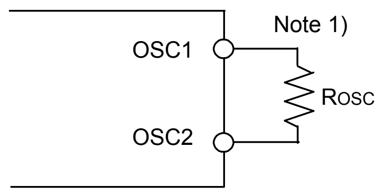


Fig.5.1

Note 1) The oscillation frequency varies depending on the wiring capacity, so the wire between OSC1, OSC2, and R_{OSC} must be short as much as possible.

To set the external resistor R_{OSC}, first obtain the oscillation frequency f_{OSC} to get the maximum efficiency in Fig.6.4.9 and 6.4.10, and then obtain R_{OSC} corresponding to the f_{OSC}. The relation between R_{OSC} and f_{OSC} shown in Fig.6.4.1 is expressed with the following formula, concerning only the straight part (500kΩ<R_{OSC}<2MΩ).

$R_{OSC}=A\cdot(1/f_{OSC})$ (A = Constant: V_{DD}=0V,V_I=-5V →A ≒ 2.0×10^{10} (Ω·Hz))

Therefore, the Rosc value is obtained from the relational expression above
(Recommended oscillation frequency: 10kHz to 30kHz (R_{OSC}: 2MΩ to 680kΩ))

For external clock operation, as shown below, open the OSC2 pin and input external clocks (duty 50%) from the OSC1 pin.

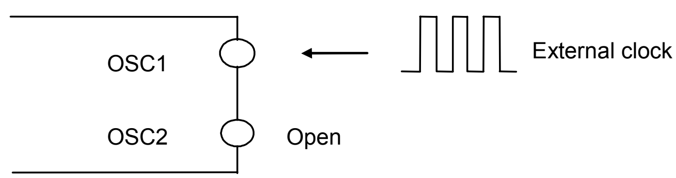


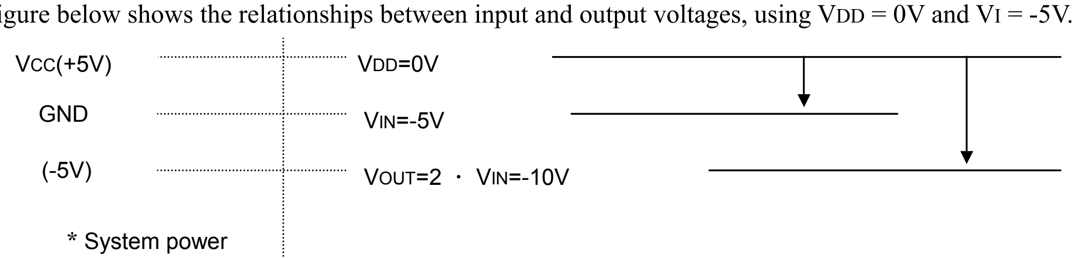
Fig.5.2

5.2 Voltage Converter

Voltage converter performs double boosting for input power voltage V_I using clocks generated in the CR oscillation circuit

For double boosting, the double input voltage ($2V_I$) is obtained from the V_O pin by connecting a pump-up capacitor between CAP1+ and CAP2- and an external smoothing capacitor between V_I and V_O.

The figure below shows the relationships between input and output voltages, using V_{DD} = 0V and V_I = -5V.



*) For connection with the system power, V_{OUT} = -5V is obtained as double boosting output by setting V_{IN} = system power GND; V_{DD} = system power; and V_{CC} = +5V.

6. ELECTRICAL CHARACTERISTICS

(1) Absolute maximum ratings

Table 6.1

(T_a=-40 to +85°C)

Item	Symbol	Standard value		Unit	Remarks
		Min.	Max.		
Input power voltage	V_{IN}	-10.0	V_{DD}+0.3	V	—
Input pin voltage	V_I	V_I - 0.3	V_{DD}+0.3	V	OSC1, OSC2
Output voltage	V_{OUT}	-20.0	V_{DD}+0.3	V	V_O
Output power voltage	V_{CAP+}	V_I - 0.3	V_{DD}+0.3	V	CAP+
Output pin voltage	V_{CAP-}	V_O - 0.3	V_{DD}+0.3	V	CAP-
Allowable dissipation	P_D	—	150	mW	SOP3A-8pin
Operating temperature	T_{opr}	-40	85	°C	—
Storage temperature	T_{stg}	-65	150	°C	—

Note 1) Exceeding the absolute maximum ratings above may cause permanent destruction of the IC.
A long-term operation with the absolute maximum ratings may cause a significant reduction in reliability.

(2) Recommended operating conditions

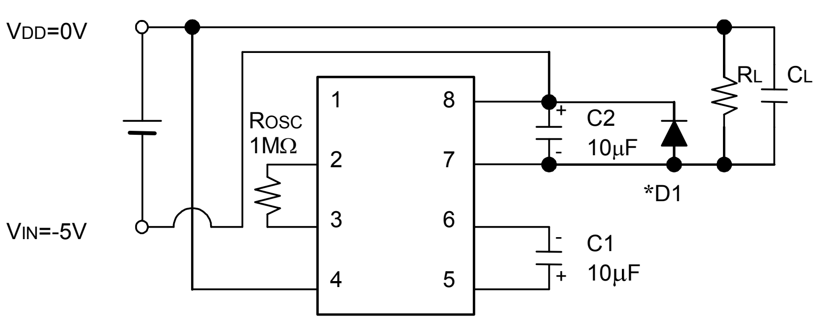
Table 6.2

(T_a=-40 to +85°C)

Item	Symbol	Standard value		Remarks	Unit
		Min.	Max.		
Boosting start voltage	V_{STA1}	—	-1.5	V	R_{OSC}=1MΩ C2≤10µF Note 2) CL/C2≤1/20
	V_{STA2}	—	-2.2		R_{OSC}=1MΩ
Boosting stop voltage	V_{STP}	-1.5	—	V	—
Output load current	I_{OUT}	—	30	mA	—
Oscillation frequency	f_{OSC}	10	30	kHz	—
External resistor for oscillation	R_{OSC}	680	2000	kΩ	—
Boosting capacitor	C1, C2	3.3	—	µF	—

Note 1) All the voltages are based on V_{DD} = 0V.

Note 2) For low-voltage (V_{IN} = -1.5 to -2.2V) operation, the recommended circuit is as follows.



* D1 (V_F (I_F = 1mA) ≤ 0.6V recommended)

Fig.6.1 Recommended circuit

(3) Electrical characteristics

Table 6.3

(V_I=-5V, T_a=-40 to +85°C)

Item	Symbol	Standard value			Unit	Remarks
		Min.	Typ.	Max.		
Input power voltage	V_{IN}	-8.0	—	-1.5	V	—
Output voltage	V_{OUT}	-16.0	—	—	V	—
Booster current consumption	I_{OPR}	—	20	30	µA	R_{OSC}=1MΩ
Static current	I_Q	—	—	5	µA	—
Oscillation frequency	f_{OSC}	16	20	24	kHz	R_{OSC}=1MΩ
Output impedance	R_{OUT}	—	60	80	Ω	I_O=10mA
Boosting power conversion efficiency	Peff	90	95	—	%	I_O= 5mA
Input leak current	I_{LK}	—	—	2.0	µA	OSC1 pin

Note 1) All the voltages are based on V_{DD} = 0V.

(4) Measuring circuits

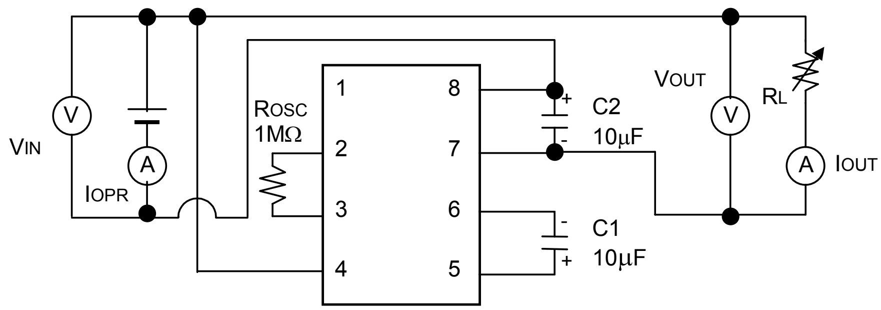


Fig.6.2

7. CHARACTERISTIC DATA SHEETS

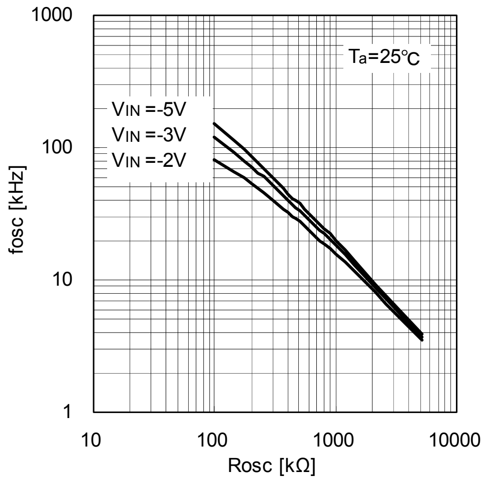


Fig.7.1 Oscillation frequency - External resistor for oscillation

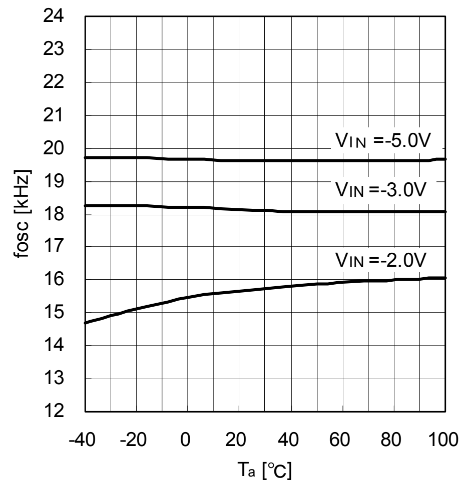


Fig.7.2 Oscillation frequency - Temperature

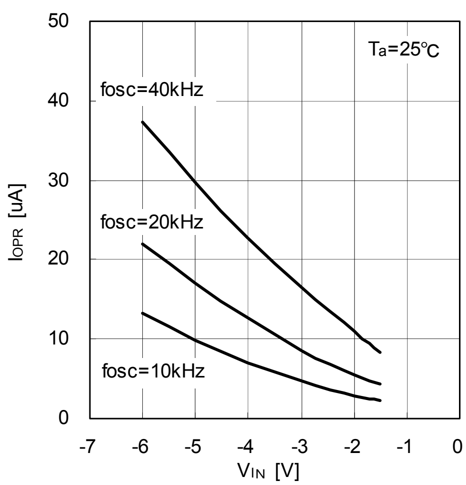


Fig.7.3 Booster current consumption - Input voltage

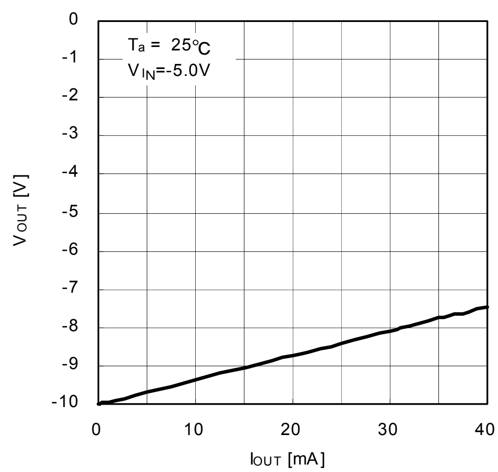


Fig.7.4 Output voltage - Output current

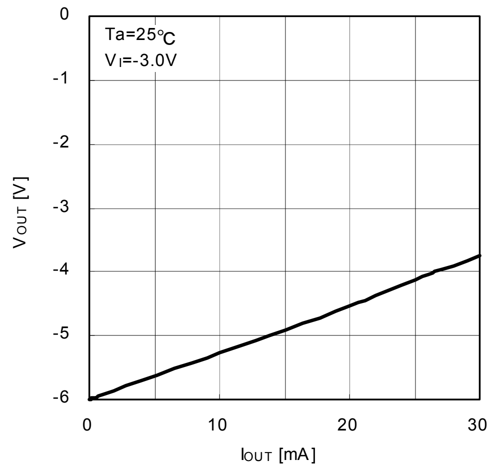


Fig.7.5 Output voltage - Output current

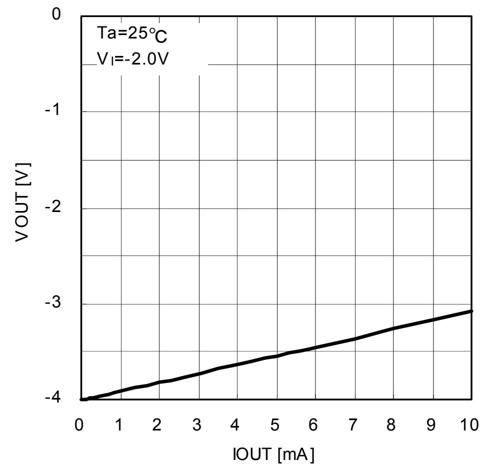


Fig.7.6 Output voltage - Output current

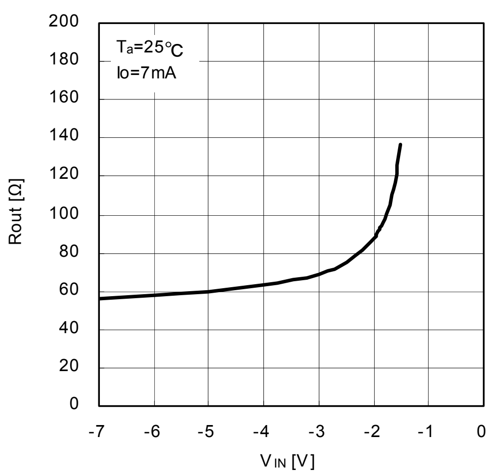


Fig.7.7 Output impedance - Input voltage

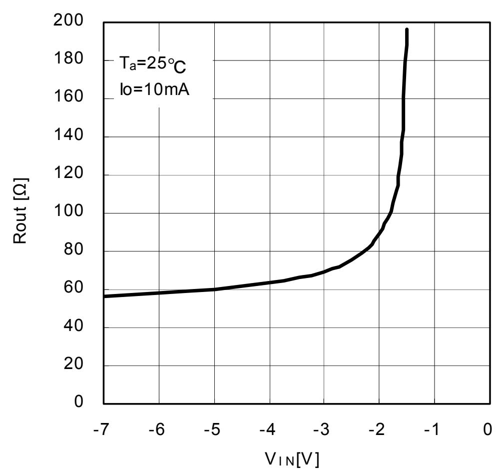


Fig.7.8 Output impedance - Input voltage

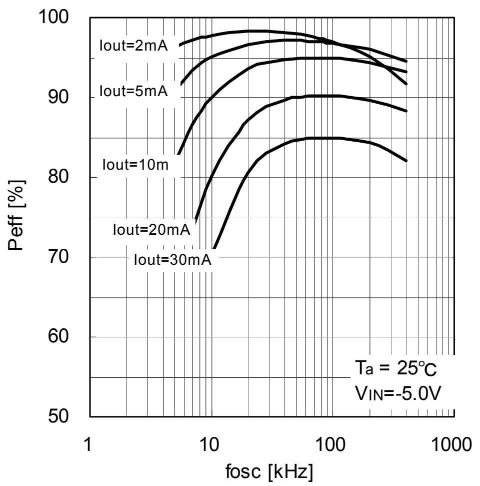


Fig.7.9 Power conversion efficiency - Oscillation frequency

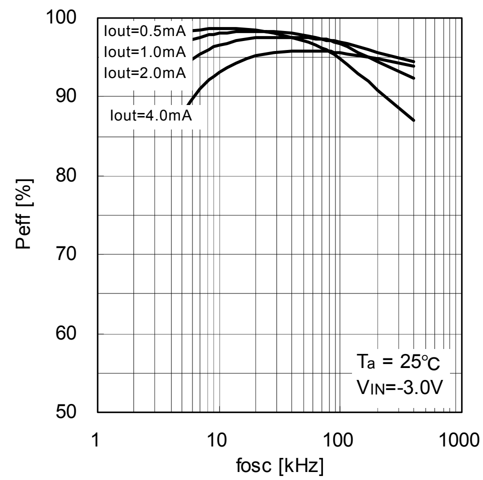


Fig.7.10 Power conversion efficiency - Oscillation frequency

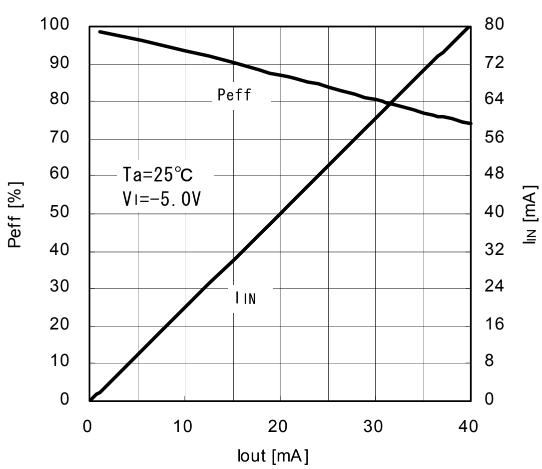


Fig.7.11 Power conversion efficiency - Output current
Input current - Output current

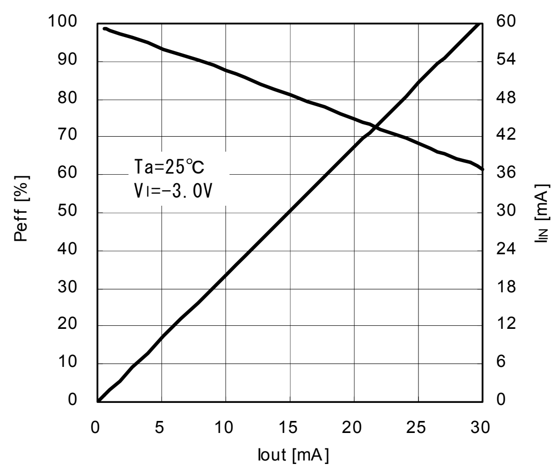


Fig.7.12 Power conversion efficiency - Output current
Input current - Output current

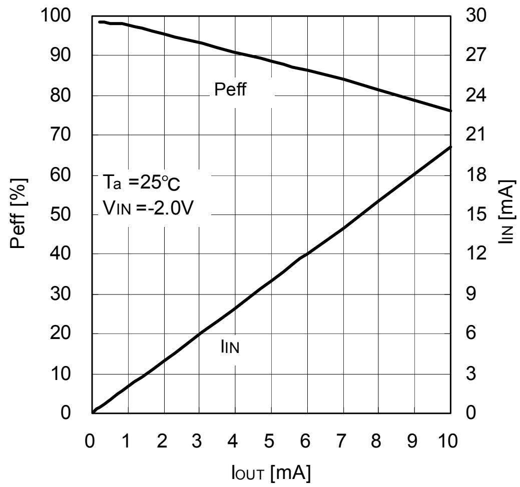


Fig.7.13 Power conversion efficiency - Output current
Input current - Output current

8. APPLIED CIRCUIT EXAMPLES

(1) Double boosting

The connection shown in Fig.8.1 enables double boosting output (2 × VIN) from VO.

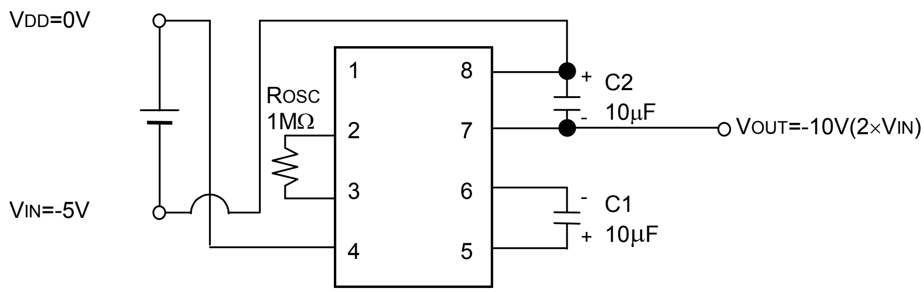


Fig.8.1 Double boosting

(2) Parallel connection

As shown in Fig.8.2, multi-connection reduces output impedance RO.
Therefore, n parallel connections lowers RO to 1/n.
Smoothing capacitor C2, which is a single device, is shared by those connections.

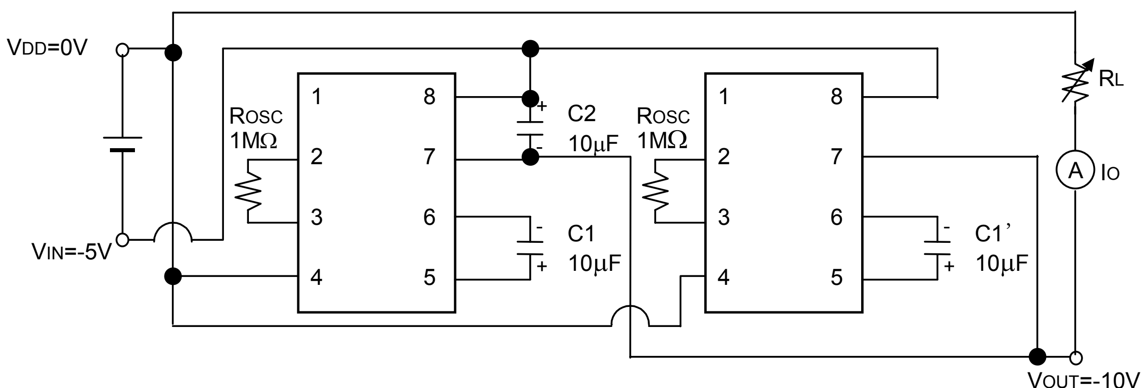


Fig.8.2 Parallel connection

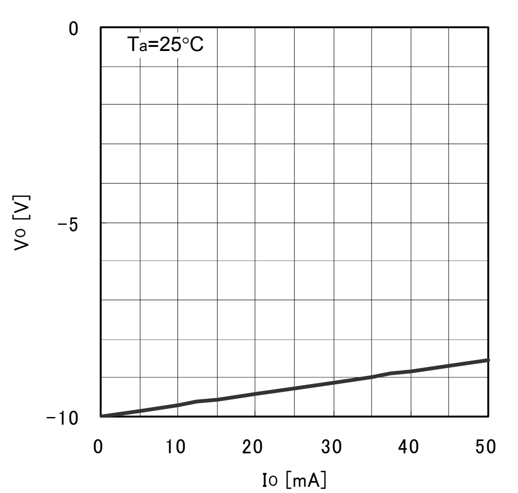


Fig.8.3 Output voltage - Output current

(3) Serial connection

The serial connection for the S1F76600 (connecting VI and VO in the pre-stage to VDD and VI in the next stage respectively) further increases output voltage.

However, the serial connection raises output impedance.

Fig.8.4 shows a serial connection example for obtaining VO = -15V from VI = -5V.

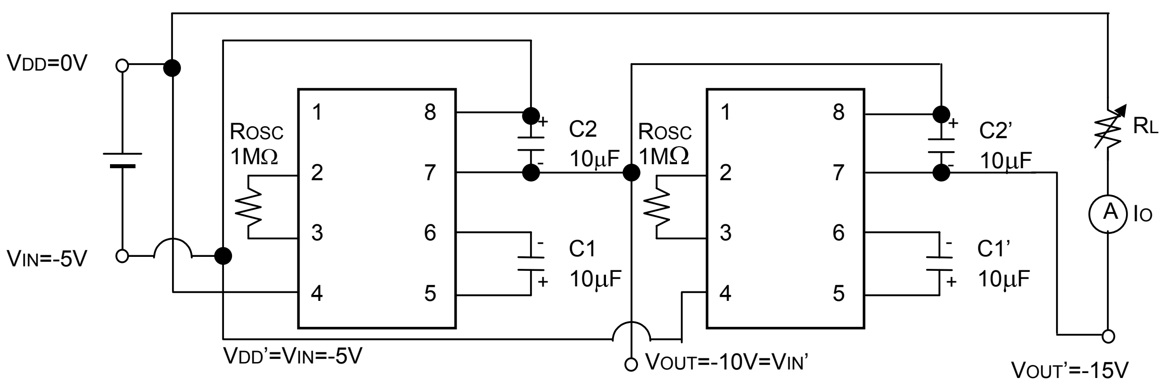


Fig.8.4 Serial connection

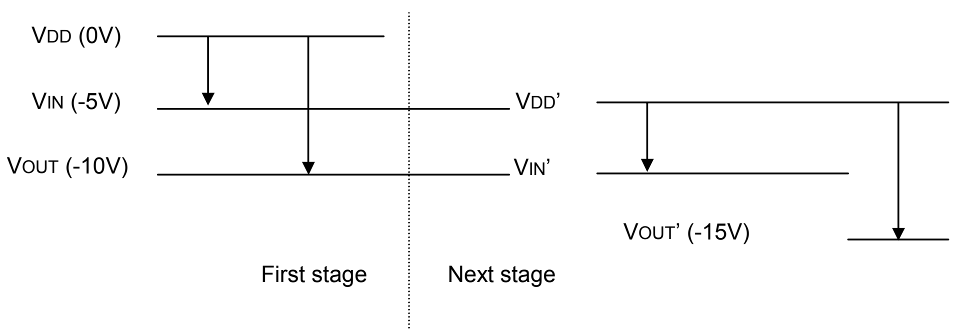


Fig.8.5 Voltage relation in serial connection (1)

Note) In serial connection, if the next-stage input voltage is within the standard (VDD' - VI' ≤ 8V), the first-stage output (VDD - VO) can be used as the next-stage input (VDD - VI). (See Fig.7.5.)

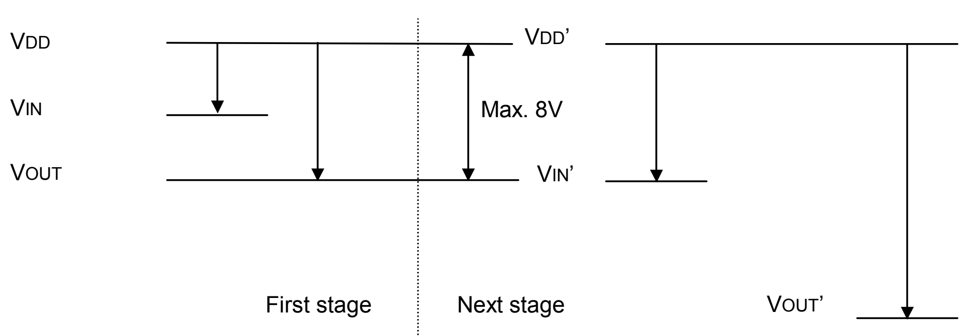


Fig.8.6 Voltage relation in serial connection (2)

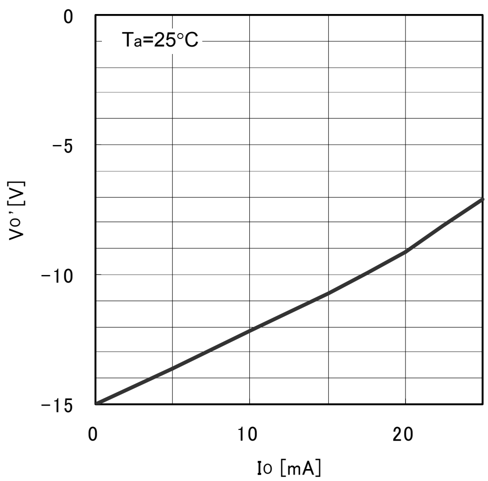


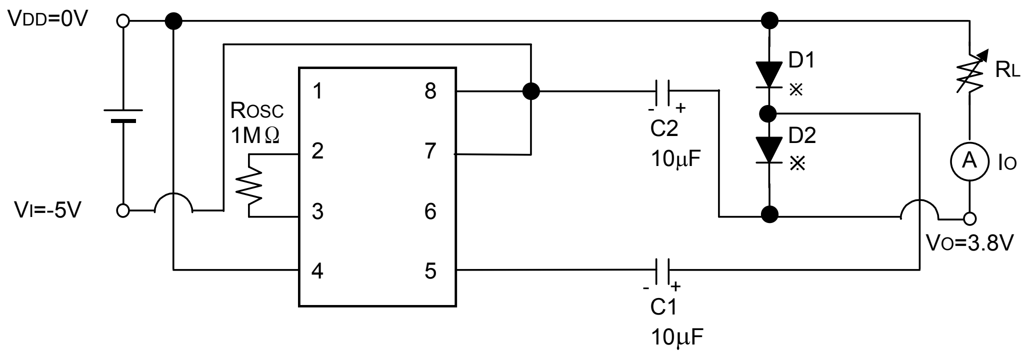
Fig.8.7 Output voltage - Output current

(4) Positive voltage conversion

The S1F76600 converts input voltage to positive voltage for double boosting through the circuit shown in Fig.8.8.

However, the output voltage lowers by forward voltage VF of the diode.

For example, as shown in Fig.8.8, V_{DD} = 0V; V_I = -5V; and VF = 0.6V results in V_O = 5V – 2 × 0.6V = 3.8V.



※: The Schottky diode with a low VF value is recommended for D1 and D2.

Fig.8.8 Positive-voltage conversion

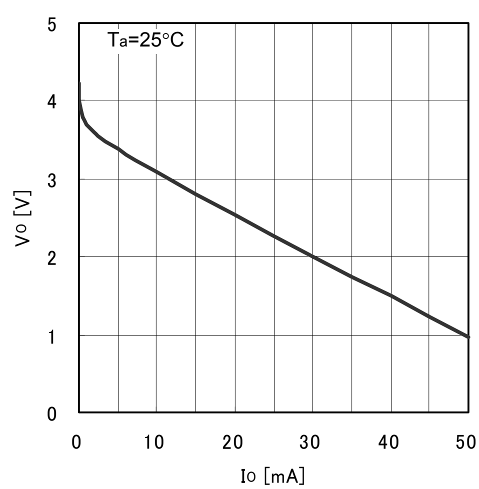


Fig.8.9 Output voltage - Output current

(5) Negative-voltage conversion + Positive-voltage conversion

Combining the double boosting (Fig.8.1) with the positive voltage conversion (Fig.8.8) generates the circuit shown in Fig.8.10, and outputs -10V and +3.8V from 5V input. In this case, the output impedance is higher than that for negative voltage conversion only or positive voltage conversion only.

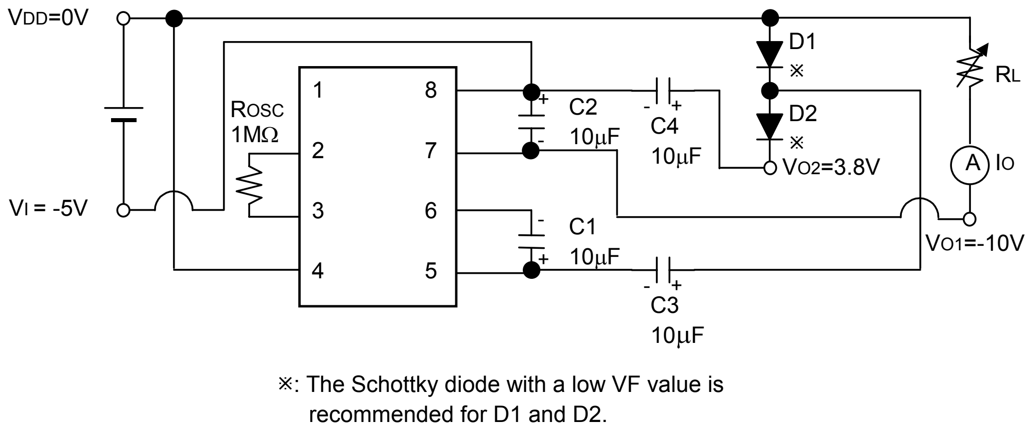


Fig.8.10 Negative-voltage conversion + Positive-voltage conversion

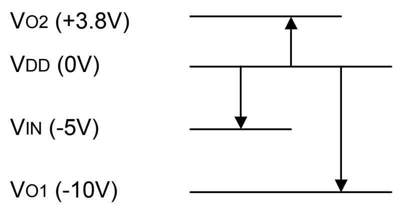


Fig.8.11 Voltage relations at VDD = 0V and VI = -5V

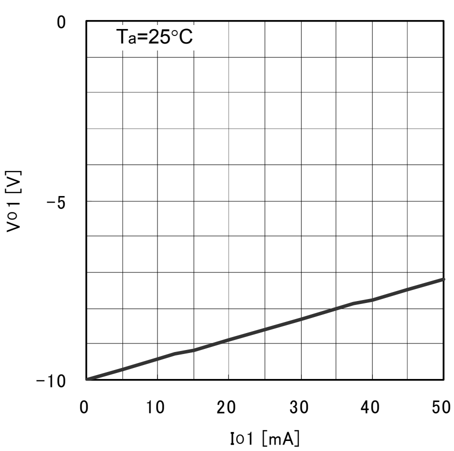


Fig.8.12 Output voltage - Output current

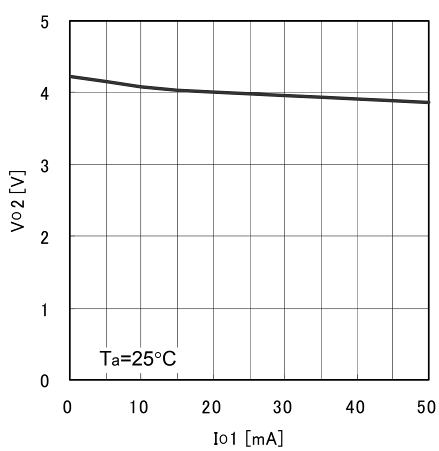


Fig.8.13 Output voltage - Output current

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