

R1250VXX1A

■ OUTLINE

The R1250Vxx1A Series are Negative Output Charge Pump Regulator ICs which can be developed as a controller of local power supply for portable appliances and small electric appliances used with batteries, with low supply current by CMOS process.

Each of these ICs consists of an oscillator, a control circuit, a reference voltage unit, an error amplifier, an output driver circuit. The R1250Vxx1A can be easily supply negative voltage, or regulated setting output voltage in the range from -2V to -4V .

The chip enable function works to shut down the internal circuit and reduces supply current at the stand-by mode, therefore the R1250Vxx1A is very suitable for the application such as portable systems that require low supply current.

Since the package for this IC is TSSOP8 package (TSOP8 in EIAJ standard), high density mounting of the ICs on board is possible.

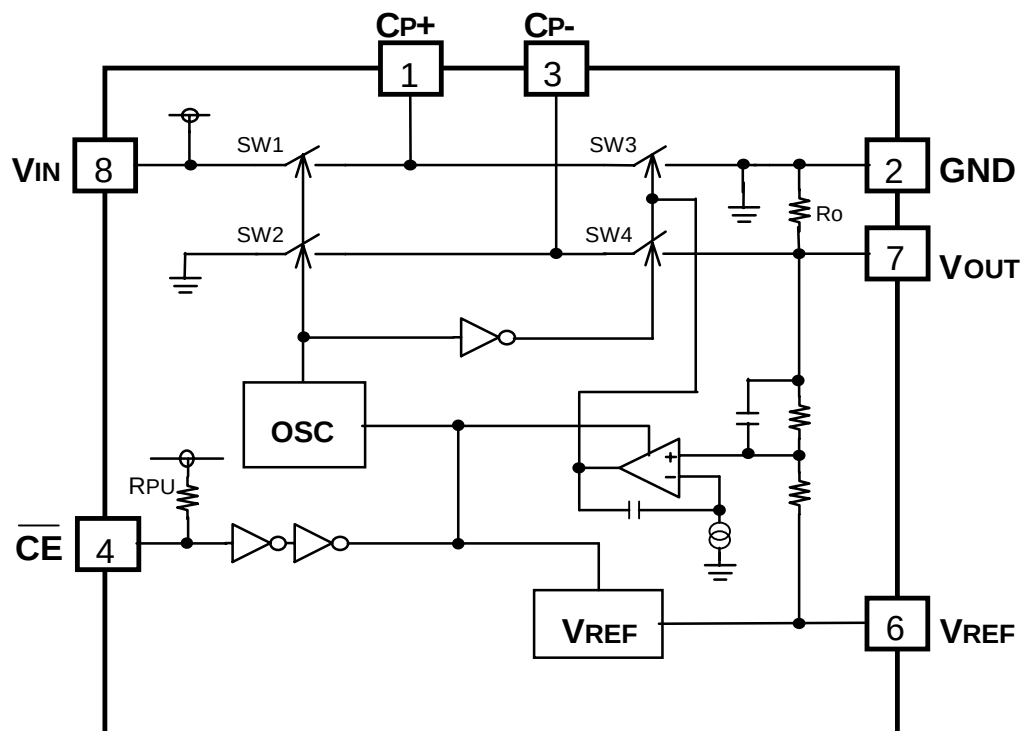
■ FEATURES

- Output Current 100mA (MAX. at $V_{IN}=5.0\text{V}$, $C_{IN}=C_P=C_{OUT}=4.7\mu\text{F}$,
Set Output Voltage= -3.0V)
- Output Voltage Accuracy • $\pm 3.0\%$ ($V_{IN}=5.0\text{V}$, $C_{IN}=C_P=C_{OUT}=4.7\mu\text{F}$, Set Output Voltage= -3.0V , $I_{OUT}=0\text{mA}/10\text{mA}$)
 $\pm 9.0\%$ ($V_{IN}=5.0\text{V}$, $C_{IN}=C_P=C_{OUT}=4.7\mu\text{F}$, Set Output Voltage= -3.0V , $I_{OUT}=50\text{mA}$)
- Output Voltage Stepwise setting with a step of 0.1V in the range from -2.0V
to -4.0V is possible.
- Range of Input Voltage $|V_{OUT}|$ to $+5.5\text{V}$ (Set Output Voltage= -4.0V to -2.8V)
 $+2.7$ to $+5.5\text{V}$ (Set Output Voltage= -2.7V to -2.0V)
- Oscillator Frequency TYP. 280kHz
- Chip Enable Function (Active at "L")
- Package TSSOP8

■ APPLICATIONS

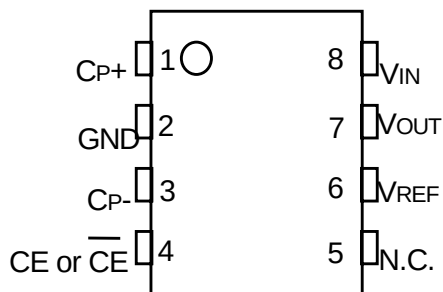
- Power source for Disk Drives.
- Power source for hand-held communication equipment and battery-powered equipment.
- Power source for PC peripherals and ADD-ON cards.
- Power source for portable audio-visual appliances such as cameras.
- Local power source for small electrical appliances.

■ BLOCK DIAGRAM

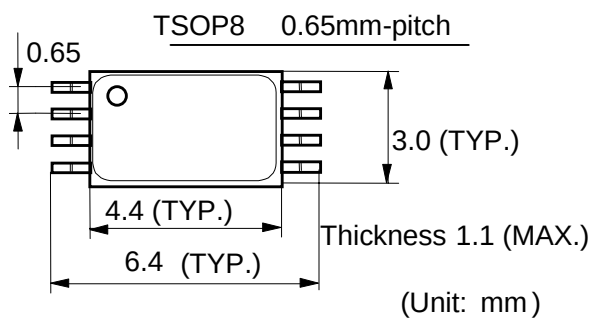


■ PIN CONFIGURATION

● TSSOP8



■ PACKAGE DIMENSION



■ PIN DESCRIPTION

Pin No.	Symbol	Description
1	CP+	CP (Capacitor for Charge Pump) Positive Power Supply Pin
2	GND	Ground Pin
3	CP-	CP(Capacitor for Charge Pump) Negative Power Supply Pin
4	$\overline{\text{CE}}$	Chip Enable Pin (active at "L")
5	NC	No Connection Pin
6	VREF	Output Pin for Reference Voltage(*Note1)
7	VOUT	Output Pin for Negative Regulator
8	VIN	Power Supply Pin

*Note1 VREF is just a monitoring pin, therefore remain open. Do not connect any load. Refer to Technical Notes.

□ ABSOLUTE MAXIMUM RATINGS

(GND=0V)

Symbol	Item	Rating	Unit
VIN	VIN Supply Voltage	-0.3 to 7.5	V
VCE	$\overline{\text{CE}}$ Pin Input Voltage	-0.3 to VIN+0.3	V
VP+	CP+ Pin Input Voltage	-0.3 to VIN+0.3	V
VREF	VREF Pin Voltage	-0.3 to VIN+0.3	V
VP-	CP- Pin Input Voltage	VIN-12 to +0.3	V
VOUT	VOUT Pin Voltage	VIN-12 to +0.3	V
IOUT	Output Current	200	mA
PD	Power Dissipation*NOTE1	490	mW
Topt	Operating Temperature Range	-40 to +85	°C
Tstg	Storage Temperature Range	-55 to +125	°C

*Note1: Power dissipation is specified under our specified condition.

Conditions;

Evaluation Board Dimensions: 50mm×50mm×1.6mm

Material: Glass Epoxy (FR-4)

Reverse side of the evaluation board: Plane Copper

Surface of the evaluation board: Land pattern and Wiring

■ SELECTION GUIDE

The output voltage and the active type for the ICs can be selected at the user's request.

The selection can be made with designating the part number as shown below;

R1250V~~xx~~1A-~~xx~~

↑ ↑ ↑

a b c

Code	Contents
a	Setting Output Voltage xx : The absolute value of Output Voltage Stepwise setting with a step of 0.1V in the range of –2.0V to –4.0V is possible.
b	Designation of Active Type of the Chip Enable Circuit: A (fixed) : “L” active type
c	Designation of Packing Type E2 : E2 1reel=2000pcs

ELECTRICAL CHARACTERISTICS

●R1250Vxx1A

(Unless otherwise provided, $V_{IN}=5.0V$, $T_{opt}=25^{\circ}C$, C_P , C_{OUT} = Ceramic 4.7 μF)

Symbol	Item	Conditions	MIN.	TYP.	MAX.	Unit
V_{IN}	Operating Input Voltage	Set Output Voltage = $-2.7V$ to $-2.0V$	2.7		5.5	V
		Set Output Voltage = $-4.0V$ to $-2.8V$ $\square$ Set V_{OUT}				
I_{SS}	Supply Current	Operation: Active, for IC itself*Note1	$-2.4V$ to $-2.0V$	1.50	2.30	mA
			$-2.9V$ to $-2.5V$	1.60	2.55	
			$-3.4V$ to $-3.0V$	1.70	2.75	
			$-4.0V$ to $-3.5V$	1.80	3.00	
I_{STB}	Shut-down Current	Operation: Shut-down, for IC itself*Note2		0.1	1	$\square A$
V_{OUT}	Output Voltage	$I_{OUT}=0mA/10mA$	$-2.4V$ to $-2.0V$	$\square 0.95$	$\square 1.05$	V
			$-2.9V$ to $-2.5V$	$\square 0.96$	$\square 1.04$	
			$-3.4V$ to $-3.0V$	$\square 0.97$	$\square 1.03$	
			$-4.0V$ to $-3.5V$	$\square 0.97$	$\square 1.03$	
		$I_{OUT}=50mA$	$-2.4V$ to $-2.0V$	$\square 0.88$	$\square 1.12$	
		$I_{OUT}=75mA$	$-2.9V$ to $-2.5V$	$\square 0.89$	$\square 1.11$	
			$-3.4V$ to $-3.0V$	$\square 0.91$	$\square 1.09$	
			$-4.0V$ to $-3.5V$	$\square 0.92$	$\square 1.08$	
V_{REF}	Reference Voltage(Note 3)	No load		$\square V_{OUT}$		V
$\square V_{OUT}/\square I_{OUT}$	Load Regulation	$I_{OUT}=10mA$ to $50mA$	$-2.4V$ to $-2.0V$	0.7		mV/mA
		$I_{OUT}=10mA$ to $75mA$	$-4.0V$ to $-2.5V$			
f_{osc}	Oscillator Frequency	Output Frequency	238	280	322	kHz
$\square f_{osc}/\square T$	Oscillator Frequency Temperature Coefficient			$\square 0.25$		kHz/ $^{\circ}C$
DUTY	Oscillator Duty Cycle	At no Load		50		%
V_{SDH}	CE "H" Input Voltage		1.5			V
V_{SDL}	CE "L" Input Voltage				0.25	V
RPU	CE Pull-up Resistance		0.68	1.25	3.00	M $\square$
R_O	Resistance between V_{OUT} and GND			5		k $\square$

*Note1: Refer to Test Circuit 1.

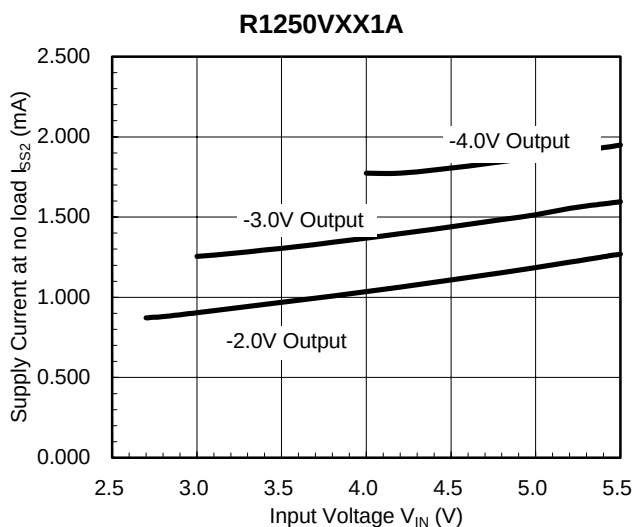
*Note2: Refer to Test Circuit 6.

*Note3: Do not connect ant load. Refer to Technical Notes.

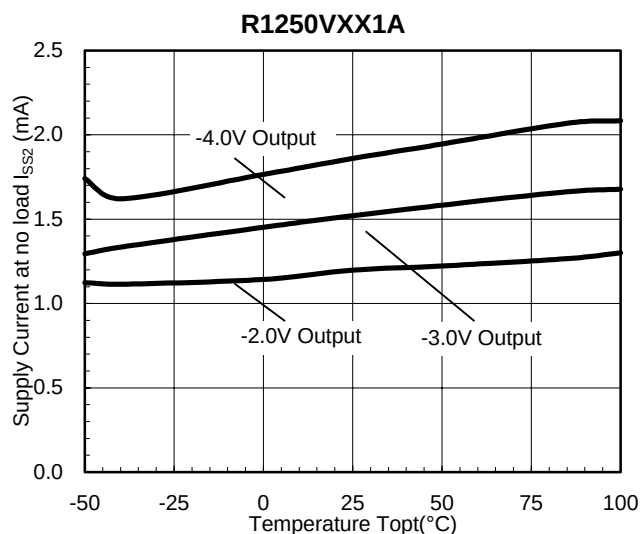
*Use Ceramic Capacitors with low ESR. Capacitors with high ESR could have bad effect on the performance of this IC.

□ TYPICAL CHARACTERISTICS

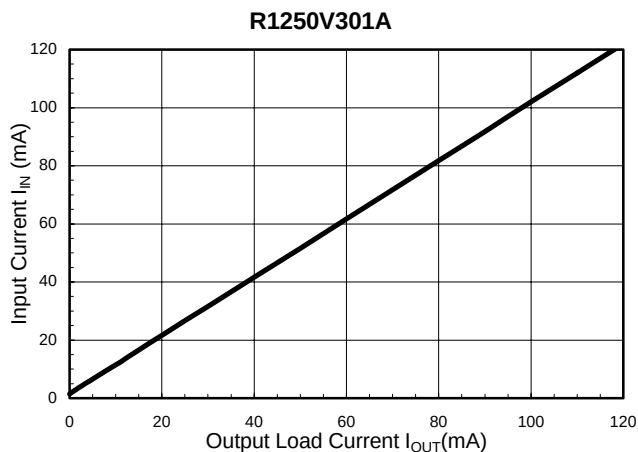
1) Supply Current at no load vs. Input Voltage



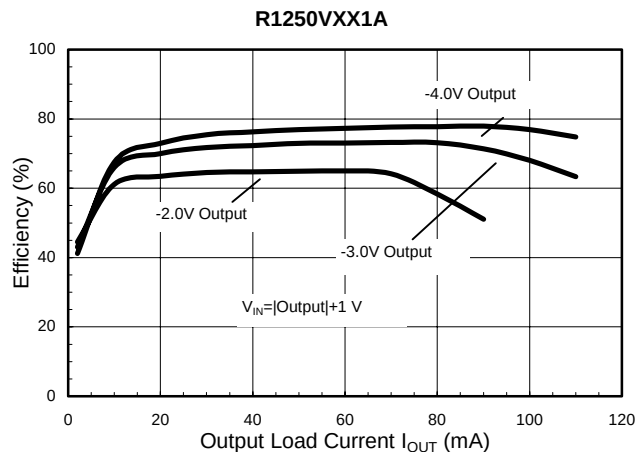
2) Supply Current at no load vs. Temperature



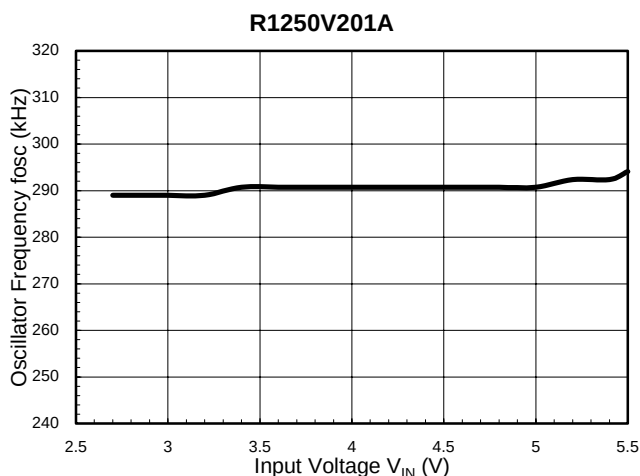
3) Input Current vs. Output Load Current



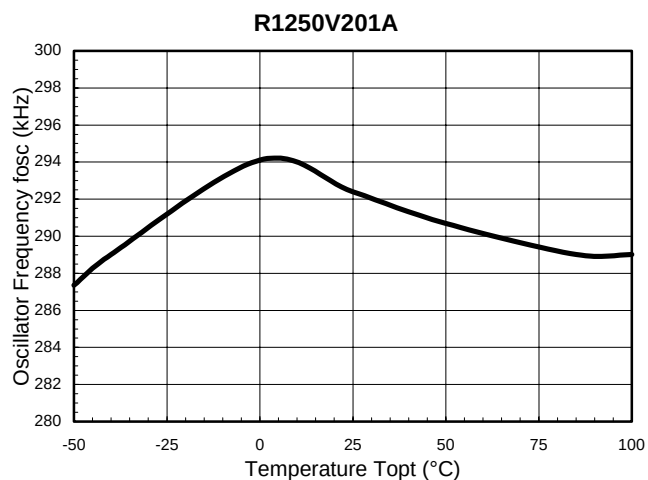
4) Efficiency vs. Load Current



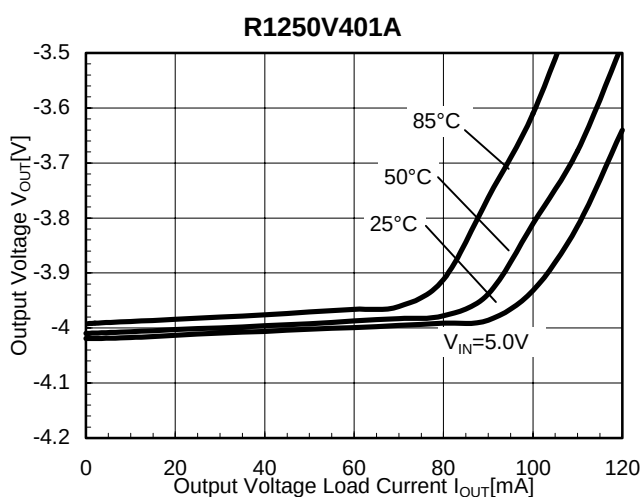
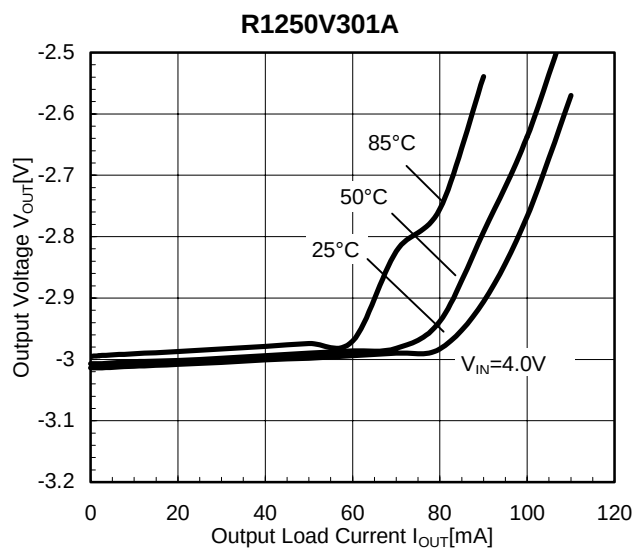
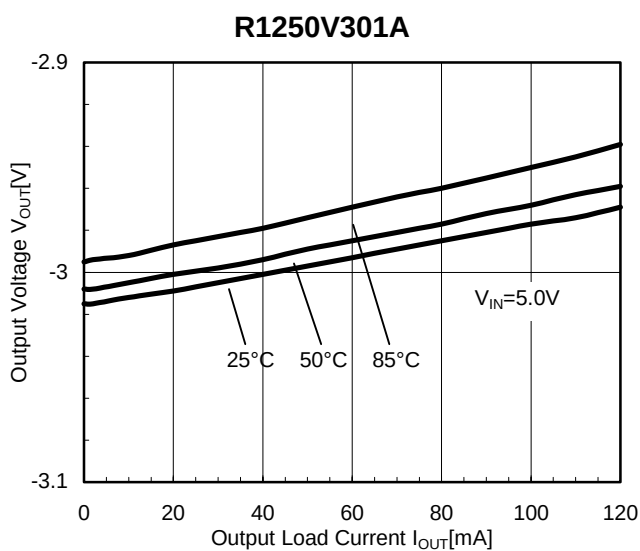
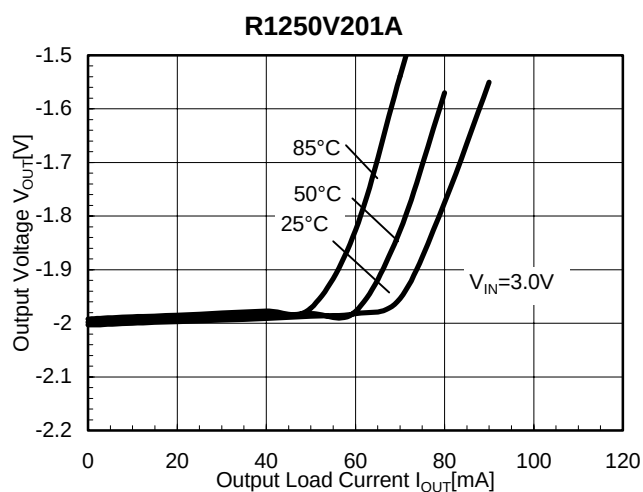
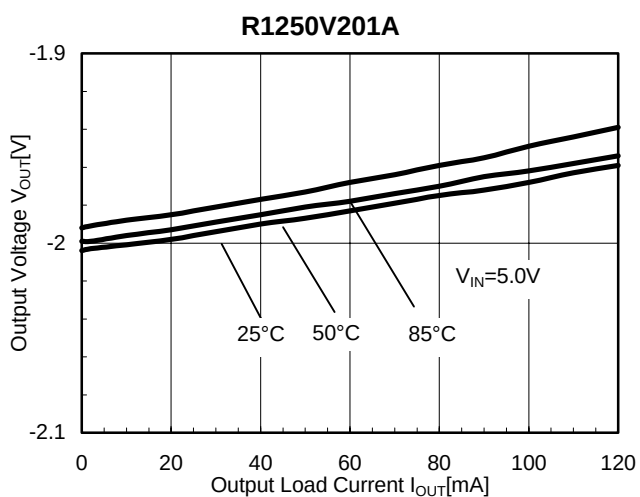
5) Oscillator Frequency vs. Input Voltage



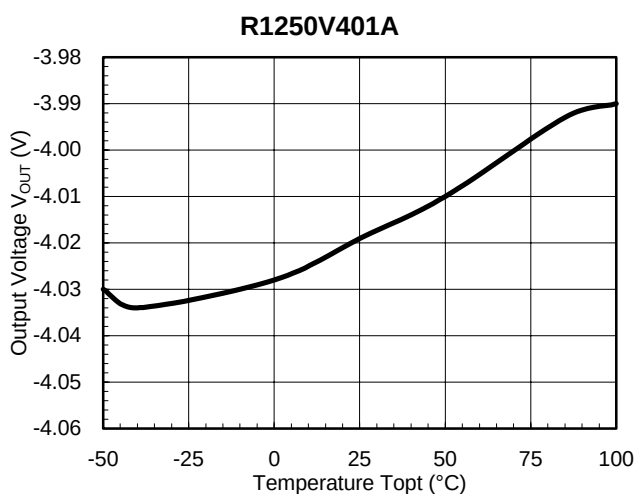
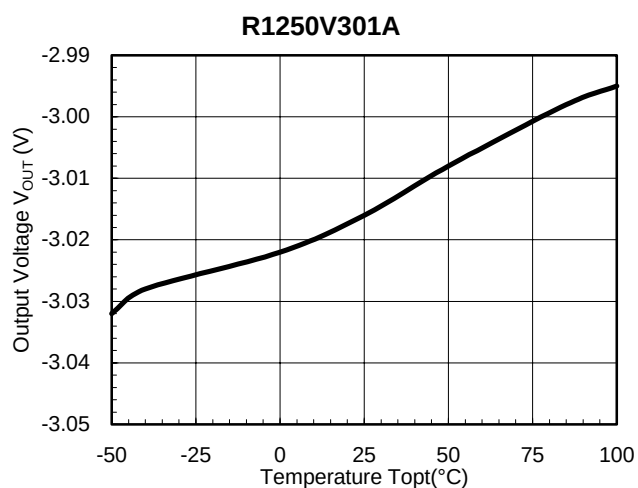
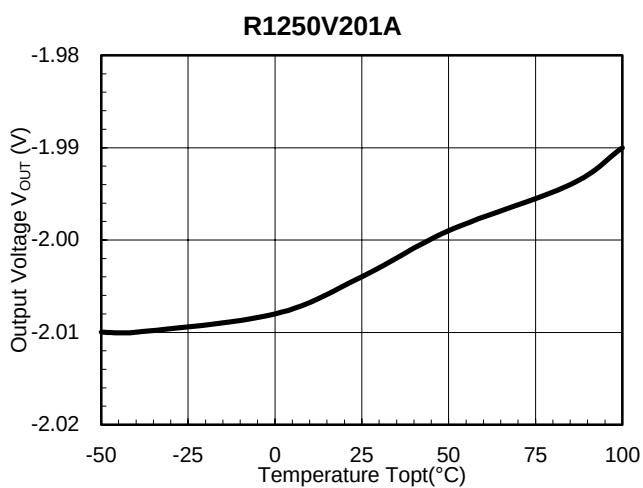
6) Oscillator Frequency vs. Temperature



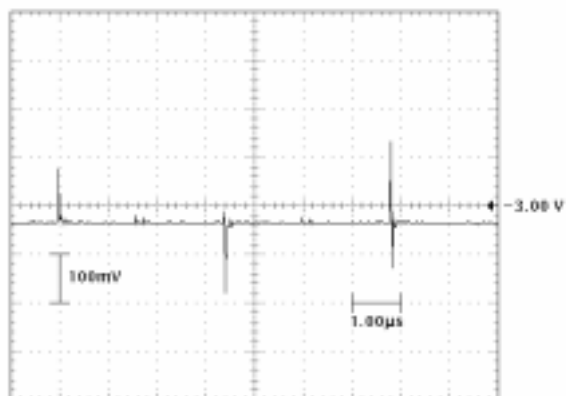
7) Output Voltage vs. Output Load Current



8) Output Voltage vs. Temperature



9) Output Voltage Waveform



Unless otherwise provided, conditions are as follows;

Sample: R1250V301A

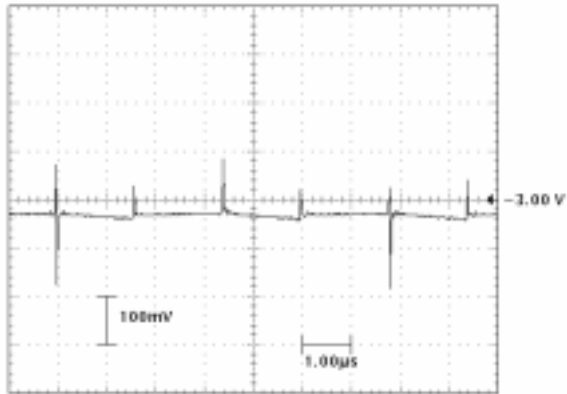
V_{IN}=5.0V

C_{IN}=C_P=C_{OUT}=4.7μF

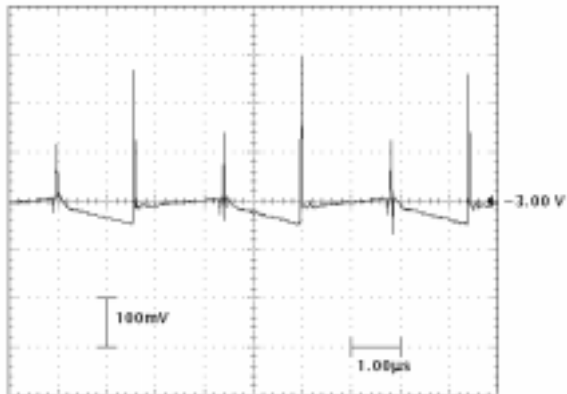
I_{OUT}=0mA

BW=20MHz

$I_{OUT}=10\text{mA}$



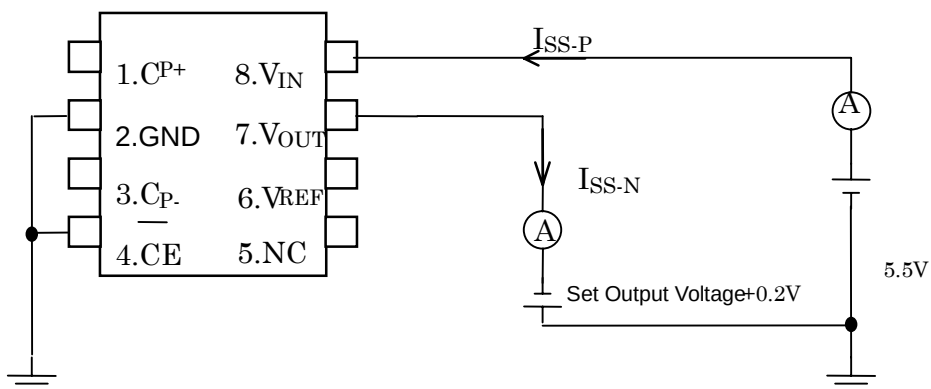
$I_{OUT}=50\text{mA}$



□ TEST CIRCUITS

- Test Circuit 1) Supply Current 1
- Test Circuit 2) Typical Characteristics 1), 2)
- Test Circuit 3) Typical Characteristics 3), 4), 7), 8)
- Test Circuit 4) Typical Characteristics 5), 6)
- Test Circuit 5) Typical Characteristics 9)
- Test Circuit 6) Standby Current

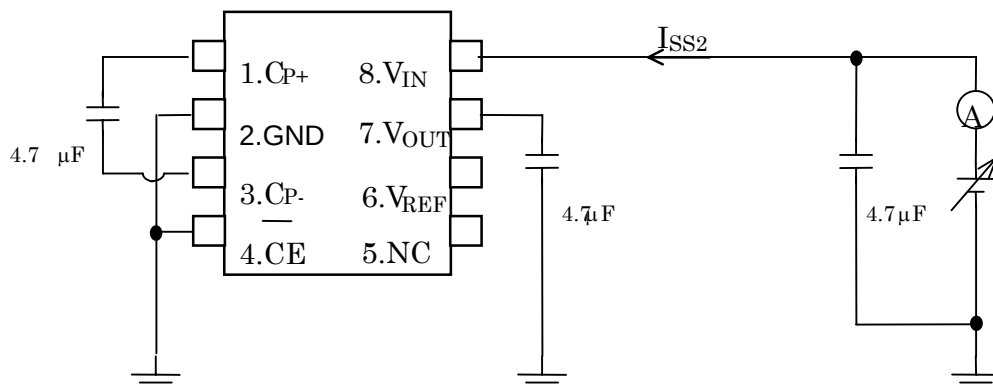
1) Test Circuit 1



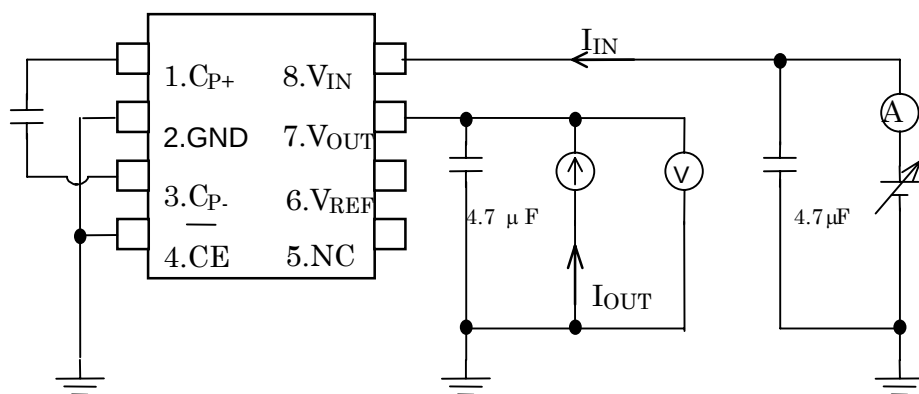
<Definition> $I_{SS1}=I_{SS-P}+I_{SS-N}$

(*) To stabilize voltage, a few μF bypass capacitors are applied to VOUT pin and VIN pin.

2) Test Circuit 2

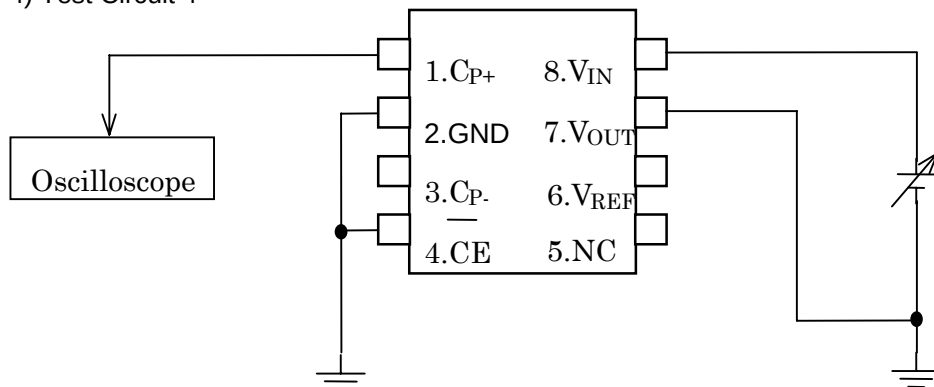


3) Test Circuit 3



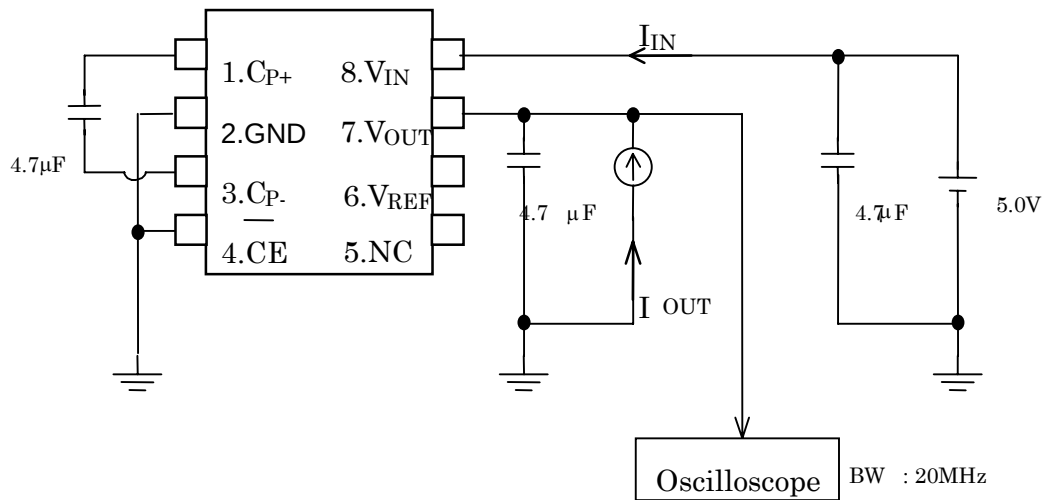
<Definition> $\eta (|V_{OUT}| \times I_{OUT}) / (V_{IN} \times I_{IN}) \times 100(\%)$

4) Test Circuit 4

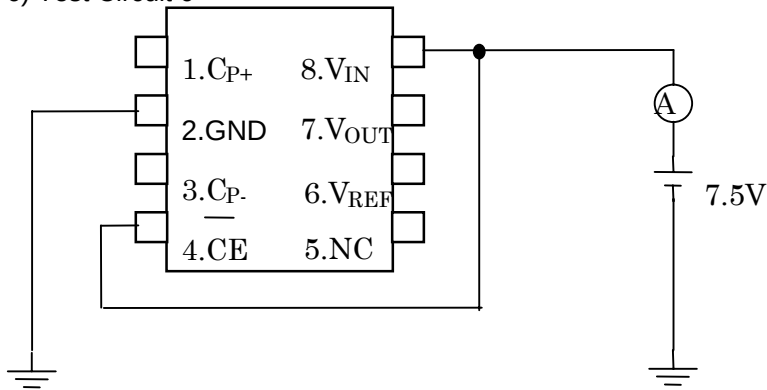


(*) To stabilize voltage, a few μF bypass capacitor is applied to VIN pin.

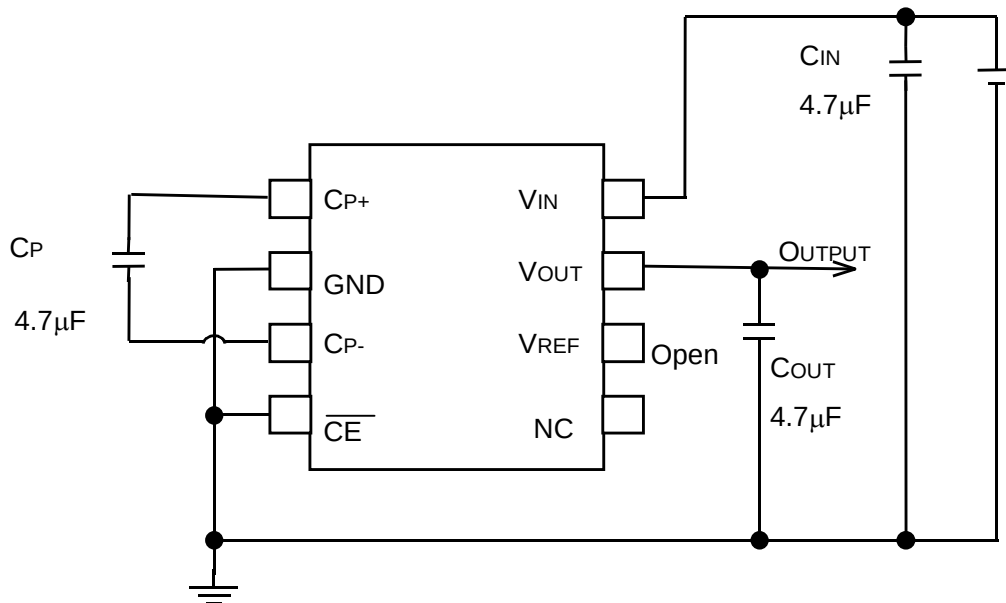
5) Test Circuit 5



6) Test Circuit 6



□ TYPICAL APPLICATION



(*) VREF pin should not be wired. Refer to Technical Notes.

■ OPERATION

1) Basic Operation

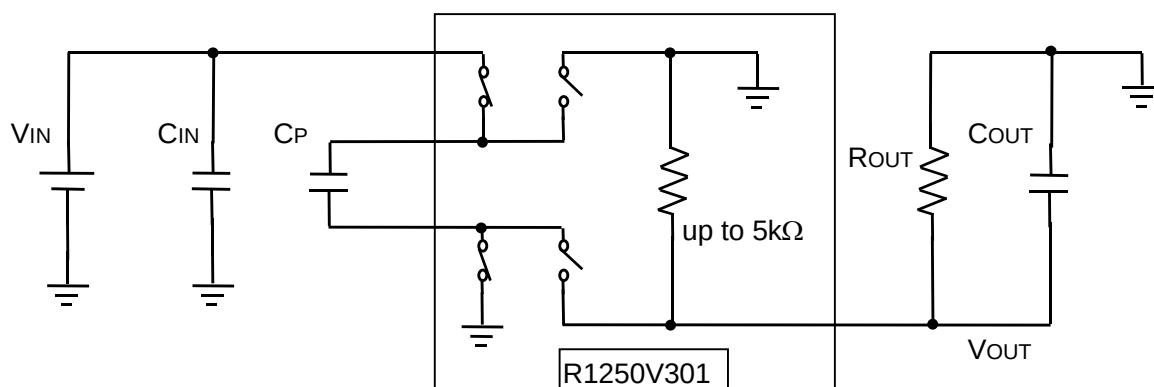
The R1250Vxx1A Series make SW1 through SW4 ON and OFF by the clock generated by internal oscillator (OSC) with fixed frequency, and operate as a inverting charge pump with the capacitor CP and the capacitor COUT.

The Output Voltage is feedback and the voltage between the Output Voltage and Reference Voltage ($V_{REF} = |V_{OUT}|$ V) is divided half, and it is compared with the GND (=0V) level by an internal operational amplifier.

By this action, the impedance of SW3 is controlled to correspond with its load current and Output Voltage keeps "Set VOUT" level.

2) Status of Internal Circuits at Standby mode and Standby Current

At Standby mode, R1250V Series keep the voltage of CP as shown below:



When you design a system with using this IC, consider the following subjects;

2-(1) If very small leakage current would be a critical, the leakage current of both CIN and CP should be considered.

2-(2) Because the voltage level of CP keeps as much as VDD level, the speed for start-up from stand-by mode is faster than the start-up by power-on.

2-(3) VOUT is internally pulled down through 5kΩ to GND. Time constant "τ" of transient response (turn-off speed) of VOUT can be calculated as follows:

$$\tau \cong (5[k\Omega] \parallel R_{OUT}) \times C_{OUT} \text{ (ROUT: Output load resistance)}$$

2-(4) Load current should be OFF synchronously with this IC if the load is electronic or connected between VIN and VOUT. If some charge is continuously flown to the Output VOUT at the "OFF" state, the voltage level of VOUT will rise and could be beyond 0V. And if the voltage will be +0.3V (that is designated as absolute maximum rating.), this IC might be break down.

3) Ripple Voltage

Ripple voltage of Output waveform can be roughly calculated as follows:

$$V_{\text{ripple}} [\text{mVp-p}] \cong 0.5 \times (I_{\text{OUT}} [\text{mA}] + \text{Supply Current at no load} [\text{mA}]) / (\text{Oscillator Frequency: } 280000 [\text{Hz}] / C_{\text{OUT}} [\text{F}])$$

$$\text{Supply Current at no load} [\text{mA}] \cong \text{Supply Current } 1 [\text{mA}]$$

4) Power Consumption

Power Consumption at large load current of this IC can be calculated as follows:

$$W_{\text{chip}} [\text{mW}] \cong (V_{\text{IN}} [\text{V}] - \text{Set Output Voltage } V) \times (I_{\text{OUT}} [\text{mA}])$$

■ TECHNICAL NOTES

To use this IC, the following things should be considered.

1) Short Protection function for each pin is not included in this IC.

2) Use capacitors with low equivalent series resistor (ESR) for CIN, CP, COUT pins. Capacitors with large ESR make this IC's performance worse.

3) Make wiring of GND, VIN, CP+, CP- secure enough and decrease impedance. High impedance could be a cause of unstable operation of this IC.

4) When this IC is used with large load current, consider its radiation of heat.

5) Basically, VREF pin can be used for soldering to the mount pad of PCB. Do not make it wiring.

6) Load type is electronic or setting between VIN and VOUT, in cases of OFF-state of this IC and start-up state of this IC, make sure not to raise VOUT level on positive voltage side. If the voltage level is beyond +0.3V, which is

designated as the absolute maximum rating, this IC could be broken.