Negative Output Charge Pump Regulator (100mA)

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.

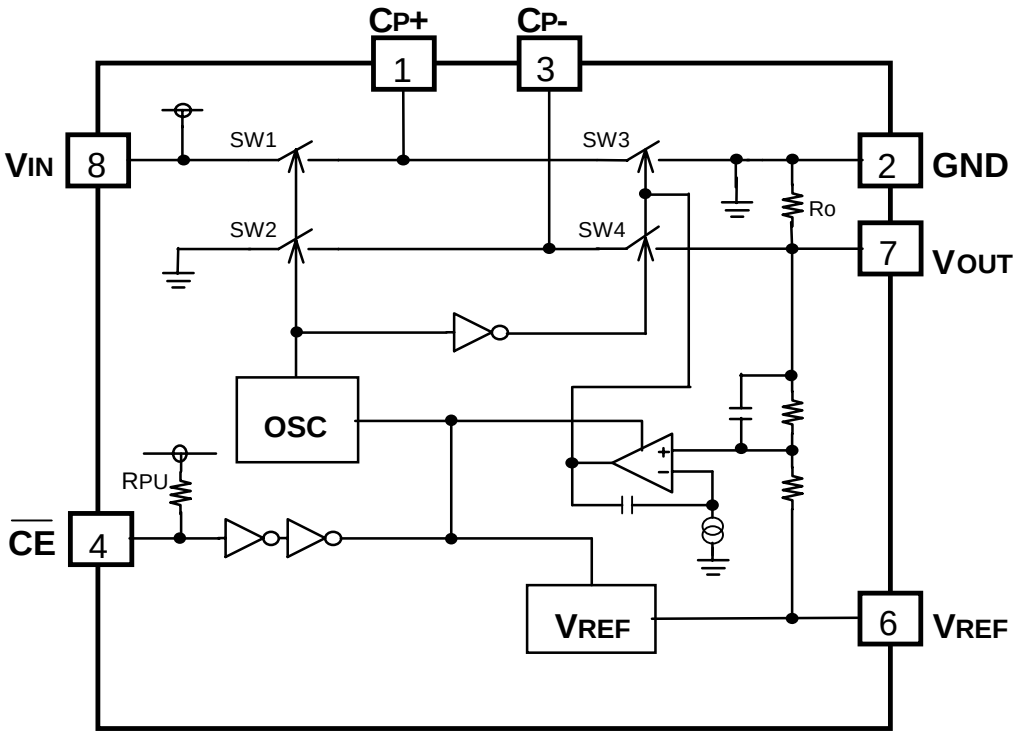
■ FEATURES

- Output Current ..... 100mA (MAX. at V_{IN}=5.0V, C_{IN}=C_P=C_{OUT}=4.7μF, Set Output Voltage=-3.0V)
- Output Voltage Accuracy ..... ±3.0%(V_{IN}=5.0V, C_{IN}=C_P=C_{OUT}=4.7μF, Set Output Voltage=-3.0V, I_{OUT}=0mA/10mA)
  ±9.0%(V_{IN}=5.0V, C_{IN}=C_P=C_{OUT}=4.7μF, Set Output Voltage=-3.0V, I_{OUT}=50mA)
- 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 +5.5V(Set Output Voltage=-4.0V to -2.8V)
  +2.7 to +5.5V(Set Output Voltage=-2.7V to –2.0V)
- Oscillator Frequency ..... TYP. 280kHz
- Chip Enable Function (Active at "L")
- Package TSSOP8

■ APPLICATIONS

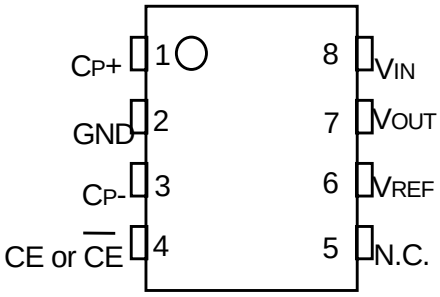
- Power source for Disk Drives.
- Power source for hand-held communication equipment and battery-powered equipment.
- Power source for PC peripherals and ADD-ON cards.
- Power source for portable audio-visual appliances such as cameras.
- Local power source for small electrical appliances.

■ BLOCK DIAGRAM

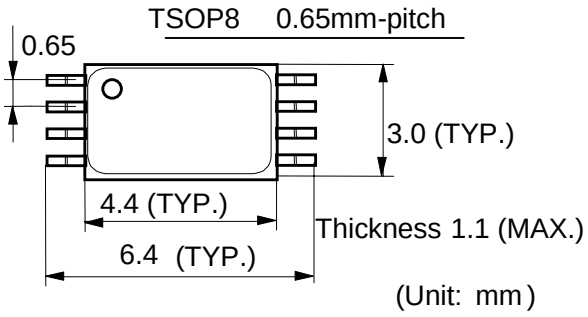


■ PIN CONFIGURATION

● TSSOP8



■ PACKAGE DIMENSION



■ PIN DESCRIPTION

Pin No.	Symbol	Description
1	C_{P+}	C_P (Capacitor for Charge Pump) Positive Power Supply Pin
2	GND	Ground Pin
3	C_{P-}	C_P(Capacitor for Charge Pump) Negative Power Supply Pin
4	$\overline{CE}$	Chip Enable Pin (active at “L”)
5	NC	No Connection Pin
6	V_{REF}	Output Pin for Reference Voltage(*Note1)
7	V_{OUT}	Output Pin for Negative Regulator
8	V_{IN}	Power Supply Pin

*Note1 V_{REF} 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
V_{IN}	V_{IN} Supply Voltage	-0.3 to 7.5	V
V_{CE}	$\overline{CE}$ Pin Input Voltage	-0.3 to V_{IN}+0.3	V
V_{P+}	C_{P+} Pin Input Voltage	-0.3 to V_{IN}+0.3	V
V_{REF}	V_{REF} Pin Voltage	-0.3 to V_{IN}+0.3	V
V_{P-}	C_{P-} Pin Input Voltage	V_{IN}-12 to +0.3	V
V_{OUT}	V_{OUT} Pin Voltage	V_{IN}-12 to +0.3	V
I_{OUT}	Output Current	200	mA
P_D	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××1A-××

↑ ↑ ↑

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, Topt=25°C, C_P, C_{OUT} = Ceramic 4.7μF)

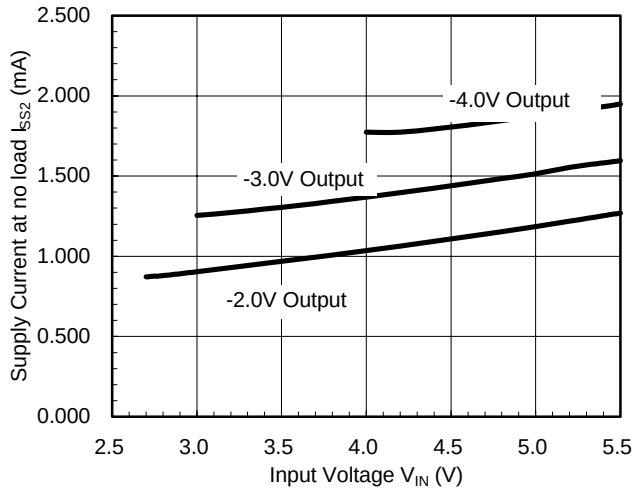
Symbol	Item	Conditions		MIN.	TYP.	MAX.	Unit
V_{IN}	Operating Input Voltage	Set Output Voltage = –2.7V to –2.0V		2.7		5.5	V
		Set Output Voltage = -4.0V to –2.8V		□Set V_{OUT}□			
Iss	Supply Current	Operation: Active, for IC itself*Note1	-2.4V to –2.0V		1.50	2.30	mA
			-2.9V to –2.5V		1.60	2.55	
			-3.4V 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	□A
V_{OUT}	Output Voltage	I_{OUT}=0mA/10mA	-2.4V to –2.0V	□0.95		□1.05	V
			-2.9V to –2.5V	□0.96		□1.04	
			-3.4V to –3.0V	□0.97		□1.03	
			-4.0V to –3.5V	□0.97		□1.03	
		I_{OUT}=50mA	-2.4V to –2.0V	□0.88		□1.12	
		I_{OUT}=75mA	-2.9V to –2.5V	□0.89		□1.11	
			-3.4V to –3.0V	□0.91		□1.09	
			-4.0V to –3.5V	□0.92		□1.08	
V_{REF}	Reference Voltage(Note 3)	No load			□V_{OUT}□		V
□V_{OUT}/ □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				
fosc	Oscillator Frequency	Output Frequency		238	280	322	kHz
□f_{OSC}/ □T	Oscillator Frequency Temperature Coefficient				□0.25		kHz/□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
R_{PU}	CE Pull-up Resistance			0.68	1.25	3.00	M□
R_O	Resistance between V_{OUT} and GND				5		k□

*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

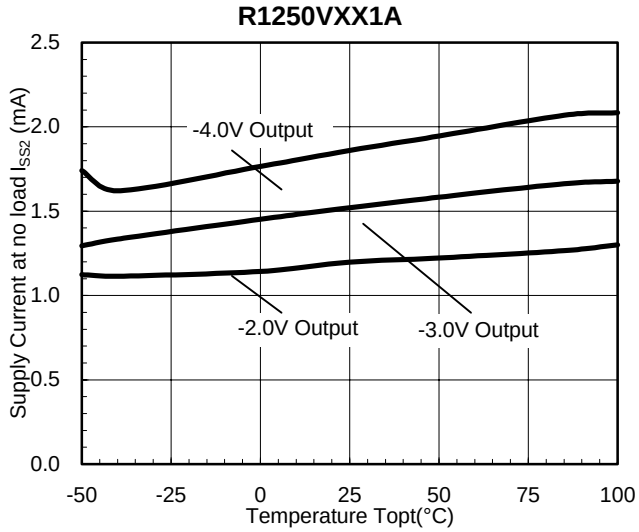
1)Supply Current at no load vs. Input Voltage

R1250VXX1A



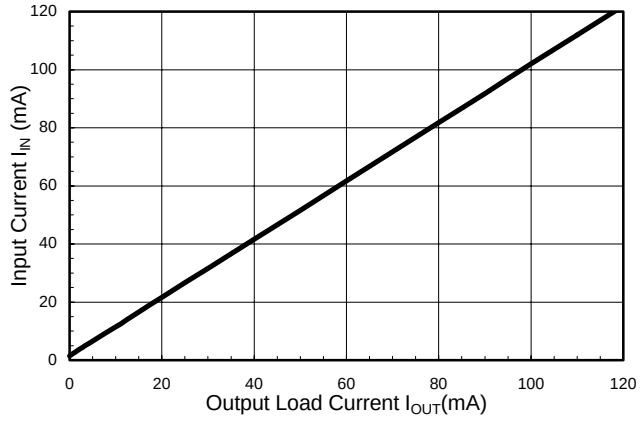
2)Supply Current at no load vs. Temperature

R1250VXX1A



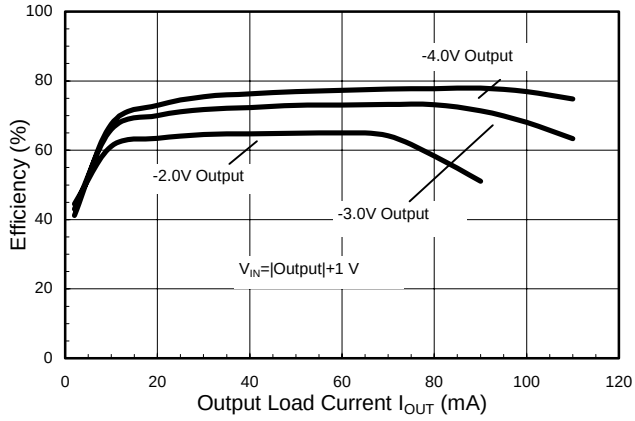
3) Input Current vs. Output Load Current

R1250V301A



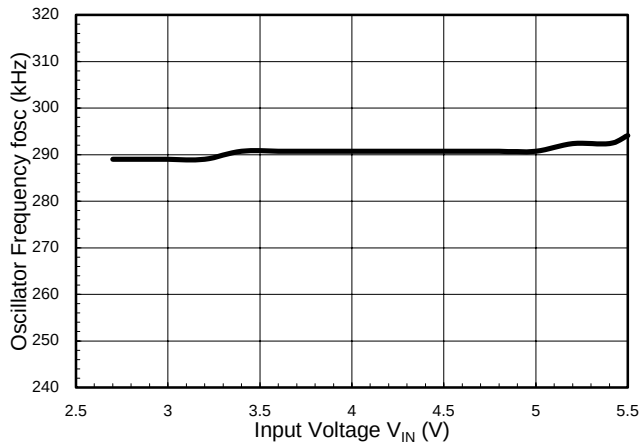
4) Efficiency vs. Load Current

R1250VXX1A



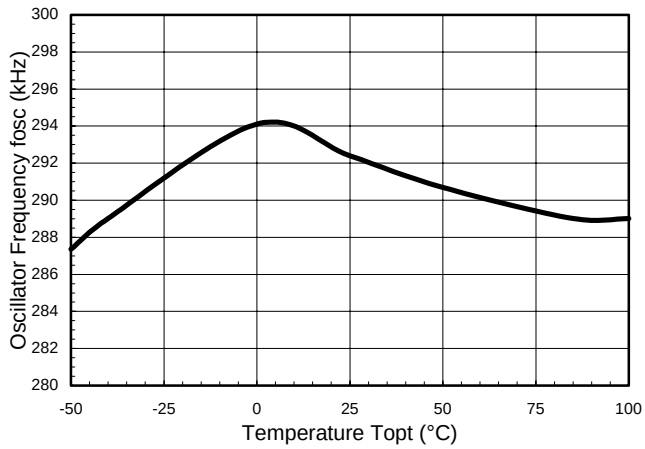
5) Oscillator Frequency vs. Input Voltage

R1250V201A



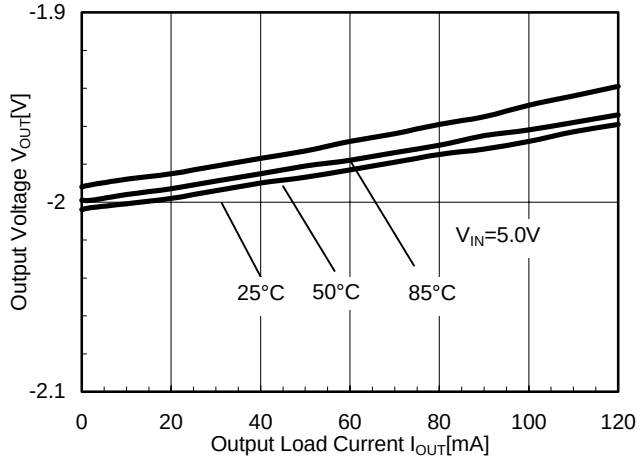
6) Oscillator Frequency vs. Temperature

R1250V201A

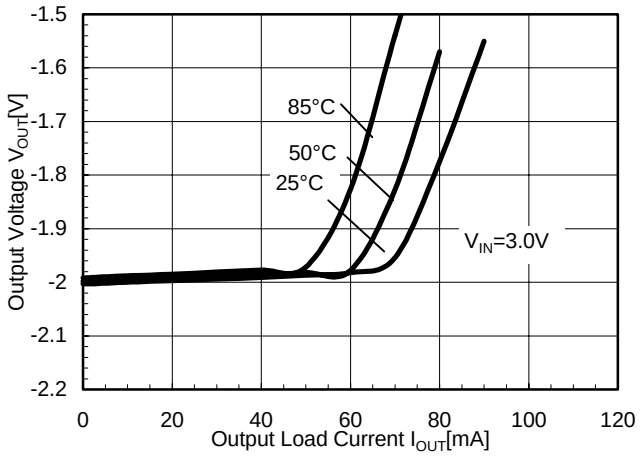


7) Output Voltage vs. Output Load Current

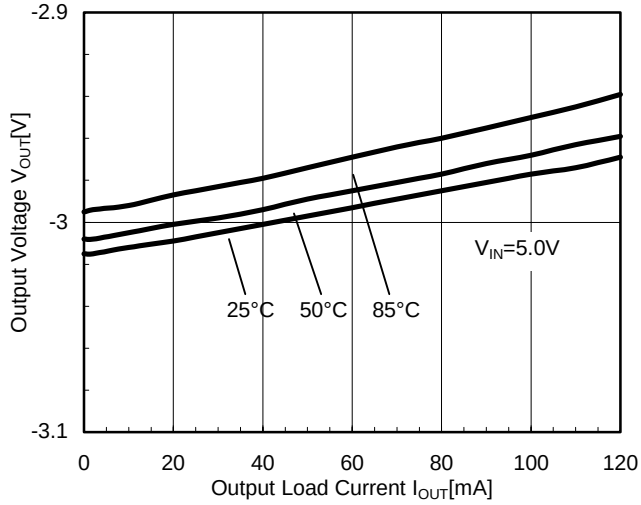
R1250V201A



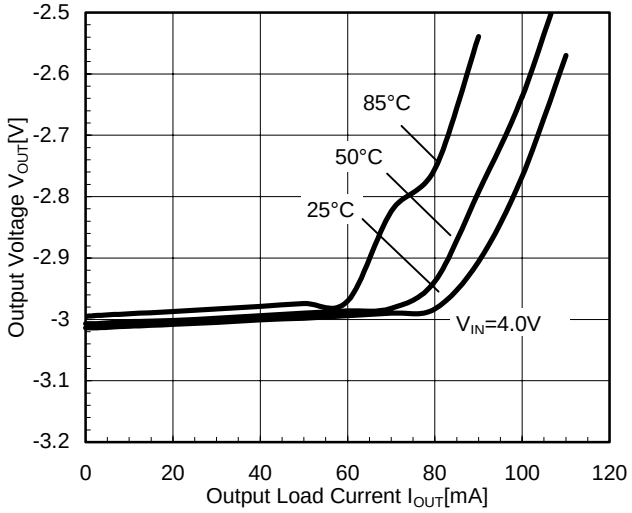
R1250V201A



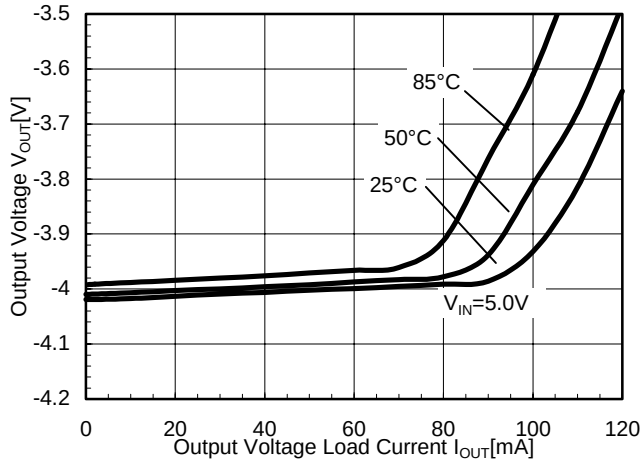
R1250V301A



R1250V301A

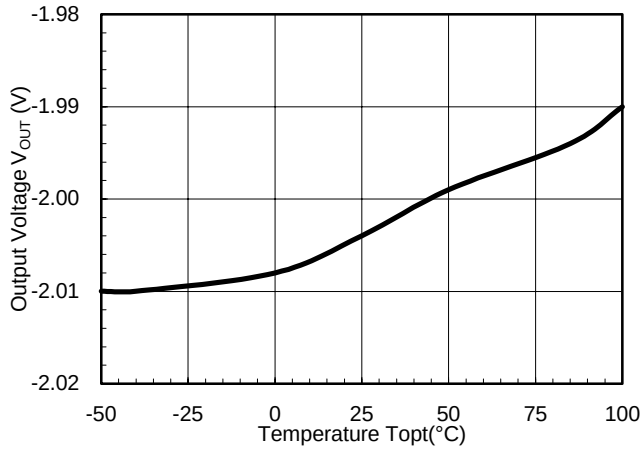


R1250V401A

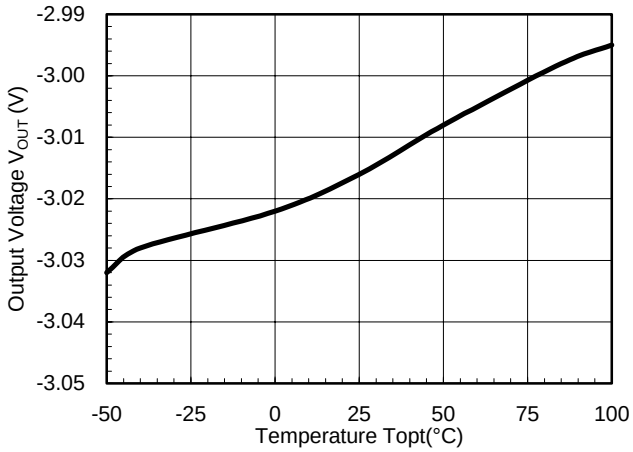


8)Output Voltage vs. Temperature

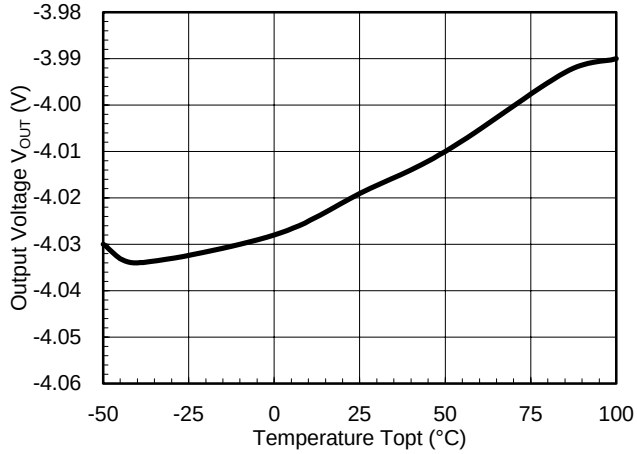
R1250V201A



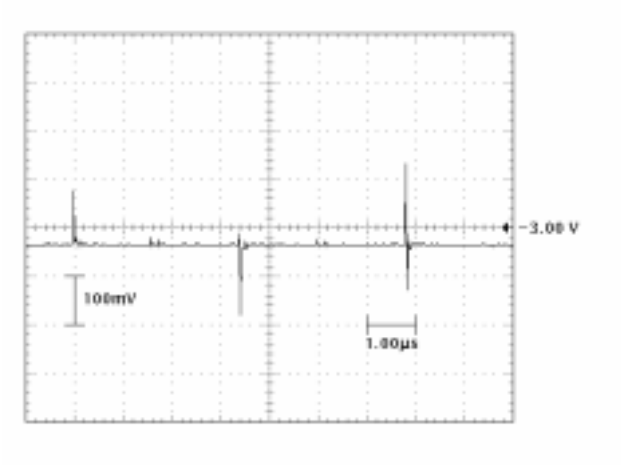
R1250V301A



R1250V401A

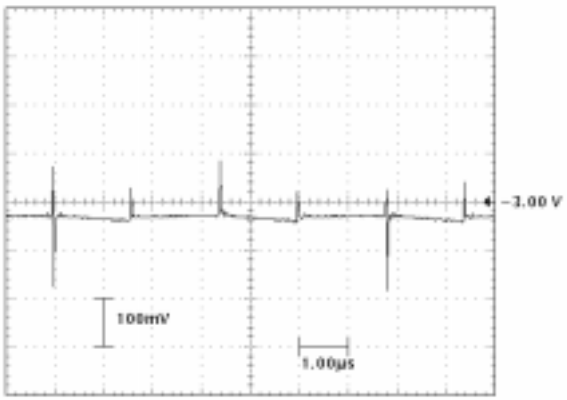


9) Output Voltage Waveform

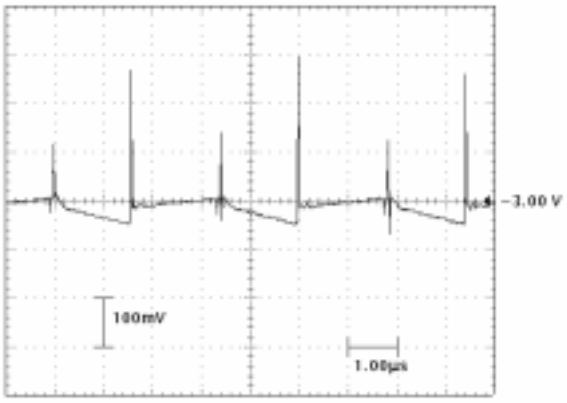


Unless otherwise provided, conditions are as follows;
Sample: R1250V301A
V_{IN}=5.0V
C_{IN}=C_P=C_{OUT}=4.7µF
I_{OUT}=0mA
BW=20MHz

I_{OUT}=10mA



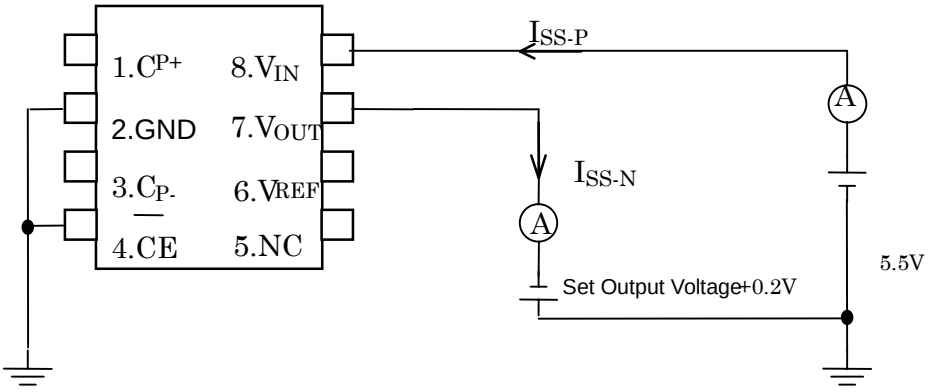
I_{OUT}=50mA



□ TEST CIRCUITS

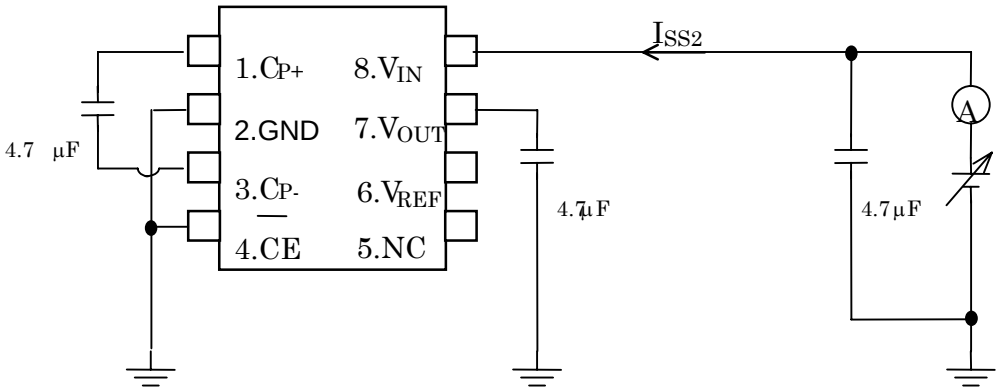
Test Circuit 1) Supply Current 1
Test Circuit 2) Typical Characteristics 1), 2)
Test Circuit 3) Typical Characteristics 3), 4), 7), 8)
Test Circuit 4) Typical Characteristics 5), 6)
Test Circuit 5) Typical Characteristics 9)
Test Circuit 6) Standby Current

1) Test Circuit 1

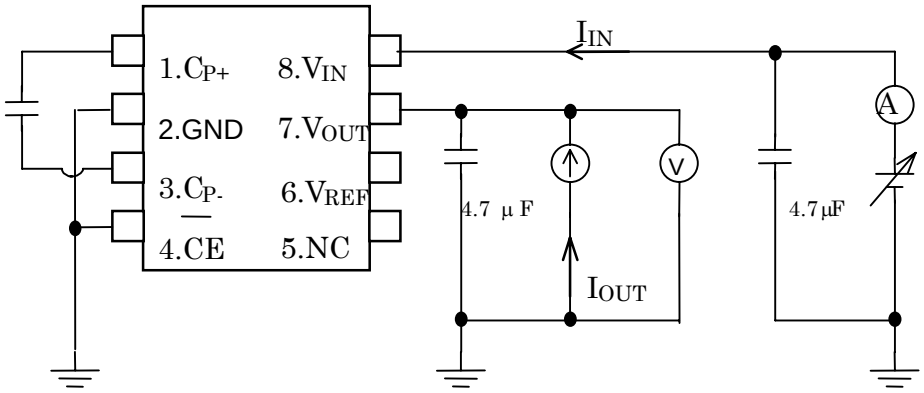


<Definition> I_{SS1}=I_{SS-P}+I_{SS-N}
(*) To stabilize voltage, a few µF bypass capacitors are applied to V_{OUT} pin and V_{IN} pin.

2) Test Circuit 2

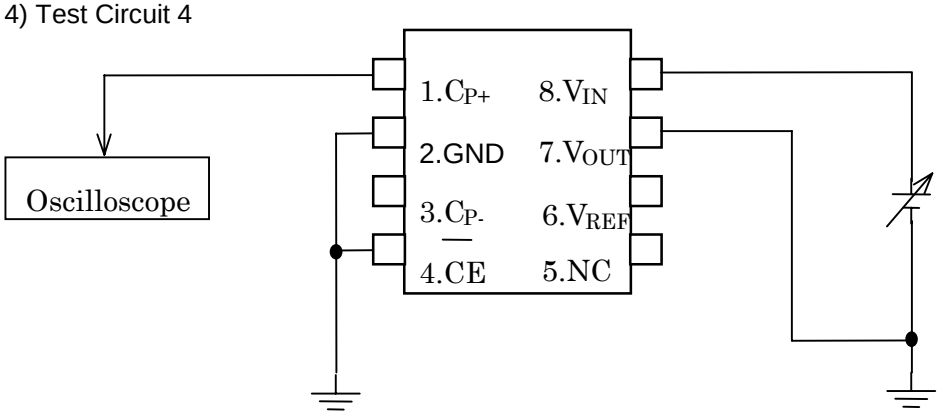


3) Test Circuit 3



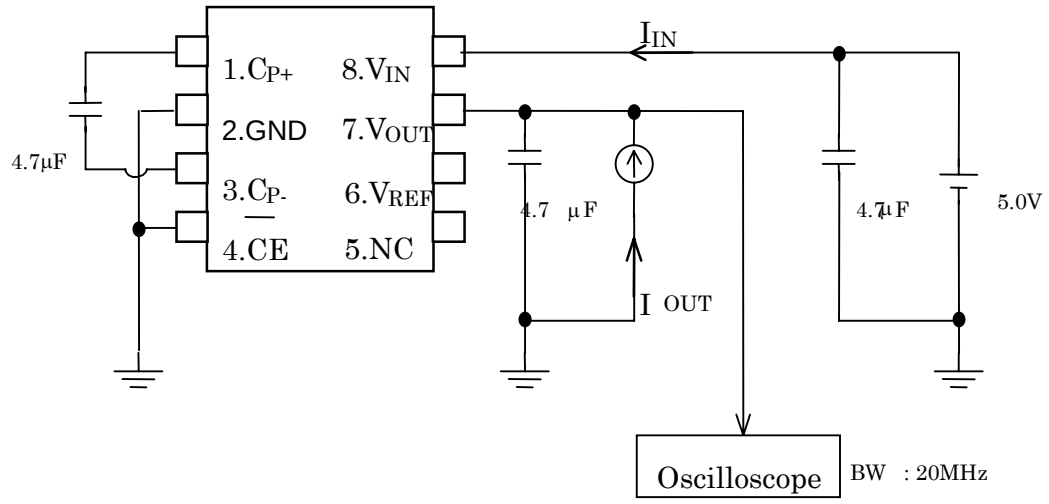
<Definition> η(|VOUT|×IOUT)/(VIN×IIN)×100(%)

4) Test Circuit 4

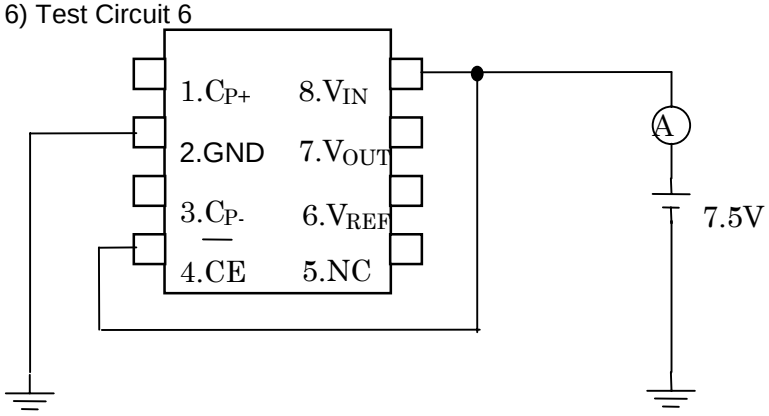


(*) To stabilize voltage, a few µF bypass capacitor is applied to VIN pin.

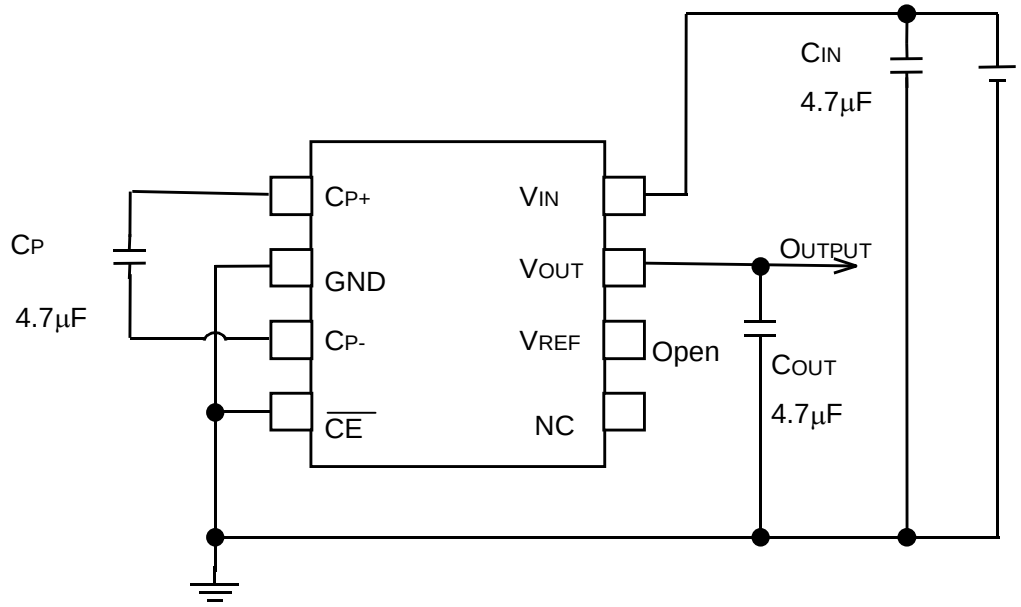
5) Test Circuit 5



6) Test Circuit 6



□ TYPICAL APPLICATION



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

■ OPERATION

1) Basic Operation

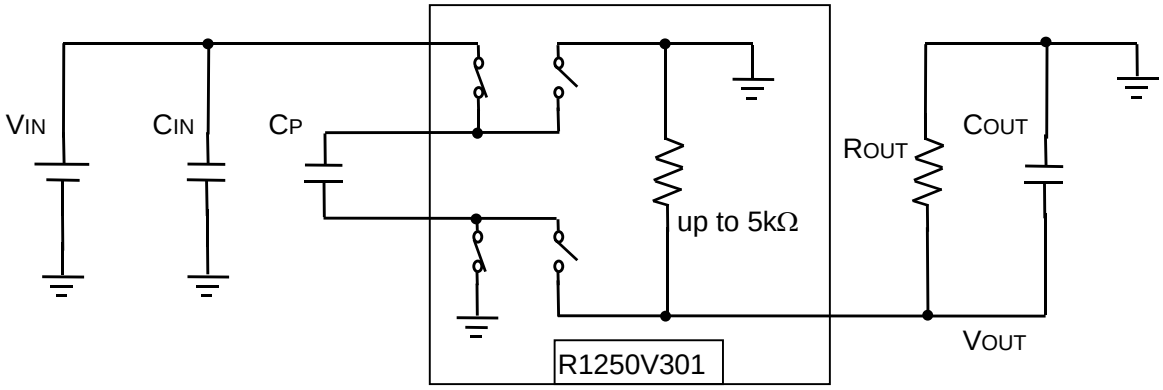
The R1250Vxx1A Series make SW1 through SW4 ON and OFF by the clock generated by internal oscillator (OSC) with fixed frequency, and operate as a inverting charge pump with the capacitor C_P and the capacitor C_{OUT}.

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 V_{OUT}" level.

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

At Standby mode, R1250V Series keep the voltage of C_P 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 C_{IN} and C_P should be considered.

2-(2) Because the voltage level of C_P keeps as much as V_{DD} level, the speed for start-up from stand-by mode is faster than the start-up by power-on.

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

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

2-(4) Load current should be OFF synchronously with this IC if the load is electronic or connected between V_{IN} and V_{OUT}. If some charge is continuously flown to the Output V_{OUT} at the "OFF" state, the voltage level of V_{OUT} 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:

Vripple [mVp-p] ≅ 0.5× (I_{OUT} [mA] + Supply Current at no load [mA]) / (Oscillator Frequency: 280000 [Hz]) / C_{OUT} [F]

Supply Current at no load [mA] ≅ Supply Current 1 [mA]

4) Power Consumption

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

Wchip[mW] ≅ (V_{IN}[V]-| Set Output Voltage |) × (I_{OUT}[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 C_{IN}, C_P, C_{OUT} pins. Capacitors with large ESR make this IC's performance worse.

3) Make wiring of GND, V_{IN}, C_{P+}, C_{P-} 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, V_{REF} 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 V_{IN} and V_{OUT}, in cases of OFF-state of this IC and start-up state of this IC, make sure not to raise V_{OUT} 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.