



# LV5256GP

## Bi-CMOS LSI Operating Mode Switching Type Step-Up/Down Converter

### Overview

The LV5256GP is an operating mode switching type step-up/step-down converter that can switch the operating mode by using the external signal.

### Functions

- Built-in Pch gate drive power supply
- Output short-circuit detection by monitoring the input side of the error amplifier
- OCP timer function
- Software start function
- Support for tracking function
- Built-in thermal protection circuit
- Built-in UVLO
- ON/OFF function: Off-time input current smaller than 1 $\mu$ A
- Oscillation frequency : 300kHz to 1.5MHz Oscillation frequency can be set by an external resistor

### Specifications

Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum input voltage	V <sub>IN</sub> max		12	V
	V <sub>DD</sub> max		3.6	V
Maximum output voltage	V <sub>O</sub> max		16	V
Maximum output current	I <sub>O</sub> max	Between OUT and SW	650	mA
Allowable input pin voltage	V <sub>CONT</sub> max	RT, FB, IN, OCP, SS, ONOFF, TRAC_IN, DU_SEL, OPC_SEL pins	V <sub>DD</sub>	V
Allowable power dissipation	P <sub>d</sub> max	Mounted on a specified board *	0.8	W
Operating temperature	T <sub>opr</sub>		-20 to +85	°C
Storage temperature	T <sub>stg</sub>		-40 to +125	°C

\* Specified board : 50mm × 40mm × 0.8mm, glass epoxy 4-layer circuit board (2S2P).

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## Recommended Operating Conditions at Ta = 25°C

Parameter		Symbol	Conditions	Ratings	Unit
Input voltage range		V <sub>IN</sub>		4.5 to 10	V
		V <sub>DD</sub>		2.9 to 3.1	V
Output voltage range	Step-down	V1	When in normal operation mode	1.0 to V <sub>IN</sub>	V
		V2	When in tracking operation mode	0 to V <sub>IN</sub>	V
	Step-up	V <sub>OUT1</sub>	When in normal operation mode	5.3 to 14	V
		V <sub>OUT2</sub>	When in tracking operation mode	V <sub>IN</sub> to	V
Output current		I <sub>O</sub>		600	mA

## Electrical Characteristics at Ta = 25°C, V<sub>DD</sub> = 3.0V, V<sub>IN</sub> = 6.0V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
<b>Reference voltage</b>						
Reference voltage for comparison	V <sub>ref</sub>		-1%	1.0	-1%	V
<b>Error amplifier</b>						
Input voltage range	V <sub>range</sub>		0		1.5	V
Open loop voltage gain	A <sub>v</sub>		60	110		dB
Unity-gain bandwidth	F <sub>t</sub>		2	8		MHz
Output source current	I <sub>fboL</sub>	I <sub>N</sub> = 2.0V, F <sub>B</sub> = 1.0V	2			mA
Output sink current	I <sub>fboH</sub>	I <sub>N</sub> = 0V, F <sub>B</sub> = 0V	100			μA
I <sub>N</sub> pin source current	I <sub>iniL</sub>	I <sub>N</sub> = 0V		100	300	nA
F <sub>B</sub> pin output range	R <sub>fb</sub>		0.1			V
TRAC_I <sub>N</sub> pin source current	I <sub>tracL</sub>	I <sub>N</sub> = 0 to V <sub>ref</sub>		100	300	nA
TRAC_I <sub>N</sub> pin input operation range	R <sub>trac</sub>		0.1		V <sub>ref</sub> -0.1	V
<b>Logic input pin block 1 (ONOFF)</b>						
Input voltage H level	V <sub>oniH</sub>		2.8			V
Input voltage L level	V <sub>oniL</sub>				0.5	V
Input current H level	I <sub>oniH</sub>	ONOFF = 3.3V		0		μA
Input current L level	I <sub>oniL</sub>	ONOFF = 0V		0		μA
<b>Logic input pin block 2 (DU_SEL)</b>						
Input voltage H level	V <sub>duiH</sub>		2.8			V
Input voltage L level	V <sub>duiL</sub>				0.5	V
Input pull-down resistance	R <sub>du</sub>			200		kΩ
<b>Logic input pin block 3 (OCP_SEL)</b>						
Input voltage H level	V <sub>ocpiH</sub>		2.8			V
Input voltage L level	V <sub>ocpiL</sub>				0.5	V
Input pull-down resistance	R <sub>ocp</sub>			100		kΩ
<b>Soft start</b>						
Soft start source current	I <sub>ssH</sub>	SS = 0V	7	10	13	μA
Soft start sink current	I <sub>ssL</sub>	When reset, SS = 1.0V		1		mA
<b>Short-circuit protection, SCP</b>						
Short-circuit protection detection voltage 1	V <sub>sc1</sub>	OCP_SEL=GND/OPEN *1		× 0.8		V
Short-circuit protection detection voltage 2	V <sub>sc2</sub>	OCP_SEL=REG_0 *1		× 0.4		V
SCP comparator offset voltage	SCPosf	TRAC_I <sub>N</sub> = 0.7V, operation starts from 0.9V.	-40		40	mV
OCP pin source current	I <sub>ocpH</sub>	When in short-circuit protection detection mode		10		μA
OCP pin sink current	I <sub>ocpL</sub>	When in normal operation mode, OCP = 1.0V	0.3	1	3	mA
OCP timer latch voltage	V <sub>ocp</sub>		1.1	1.2	1.3	V

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Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
<b>Thermal protection, UVLO</b>						
Thermal protection operating temperature	Tot	Design guarantee value *2		175		°C
Thermal protection hysteresis	Dot	Design guarantee value *2		20		°C
UVLO lock release voltage 1	VuvloH	REG_O monitored		2.8		V
UVLO lock voltage 1	VuvloL	REG_O monitored		2.5		V
UVLO lock release voltage 2	VuvloH2	V <sub>IN</sub> pin voltage		3.8		V
UVLO lock voltage 2	VuvloL2	V <sub>IN</sub> pin voltage		3.5		V
<b>Oscillator</b>						
Oscillation frequency	F	RT = 100kΩ	0.8	1	1.2	MHz
Oscillation frequency range	R_F		0.3		1.5	MHz
Triangular wave lower-side threshold value	VtriL	RT = 100kΩ		0.5		V
Triangular wave upper-side threshold value	VtriH	RT = 100kΩ		1.0		V
<b>Power supply pin block</b>						
Current drain	Ivin1	V <sub>IN</sub> pin, when converter is in 1MHz operation mode.		2	4	mA
	Ivin2	V <sub>IN</sub> pin, when in ONOFF stop mode.			1.0	μA
	Ivdd1	V <sub>DD</sub> pin, when in ONOFF stop mode.			1.0	μA
<b>Vout-5V Regulator</b>						
Output voltage	Voutm5	Vout-5V regulator, V <sub>OUT</sub> = 10.0V	VOUT-4.5	VOUT-5	VOUT-5.5	V
Drooping current	Ivoutm5	Vout-5V regulator		20		mA
<b>Internal 3.3V Regulator</b>						
Output voltage	Vreg_o	Ireg_o = 2.0mA	3.0	3.3	3.6	V
Drooping current	Ireg_o	Vreg_o = 2V, V <sub>IN</sub> = 5V		10		mA
<b>Output characteristics</b>						
Main switch on resistance (Pch)	RonH	V <sub>IN</sub> = 5V		0.7		Ω
Main switch on resistance (Nch)	RonL	V <sub>IN</sub> = 5V		0.7		Ω
Through current prevention dead time	Tdead			25		ns
Maximum on-duty (step-down)	DMAX1	RT = 100kΩ		100		%
Maximum on-duty (step-up)	DMAX2	RT = 100kΩ		85		%
<b>Converter characteristics</b>						
Efficiency	Step-down	η1	V <sub>IN</sub> = 5.0V, V = 4.6V, I <sub>O</sub> = 200mA		93	%
	Step-up	η2	V <sub>IN</sub> = 5.0V, V <sub>OUT1</sub> = 6.6V, I <sub>O</sub> = 200mA		93	%
Line regulation	Step-down	ΔV1/V <sub>IN</sub>	V <sub>IN</sub> = 4.5 to 8.6V, V1 = 4.6V, I <sub>O</sub> = 200mA	0		%
	Step-up	ΔV <sub>OUT1</sub> /V <sub>IN</sub>	V <sub>IN</sub> = 4.5 to 5.5V, V <sub>OUT1</sub> = 6.6V, I <sub>O</sub> = 200mA	0		%
Load regulation	Step-down	ΔV1/I <sub>O</sub>	V <sub>IN</sub> = 8.4V, V1 = 4.6V, I <sub>O</sub> = 0 to 200mA	0		
	Step-up	ΔV <sub>OUT1</sub> /I <sub>O</sub>	V <sub>IN</sub> = 5.0, V <sub>OUT1</sub> = 6.6V, I <sub>O</sub> = 200mA	0		

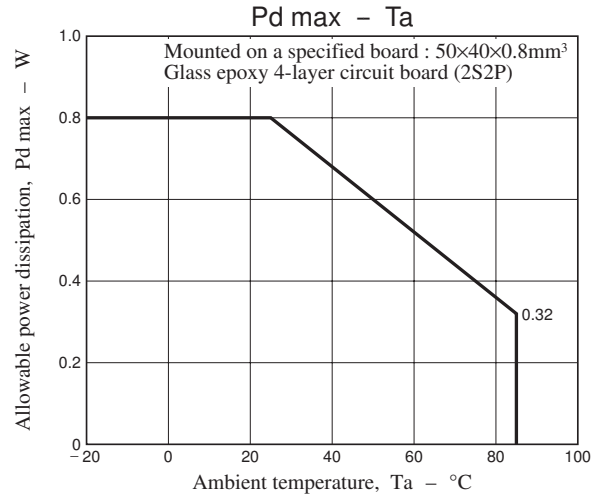
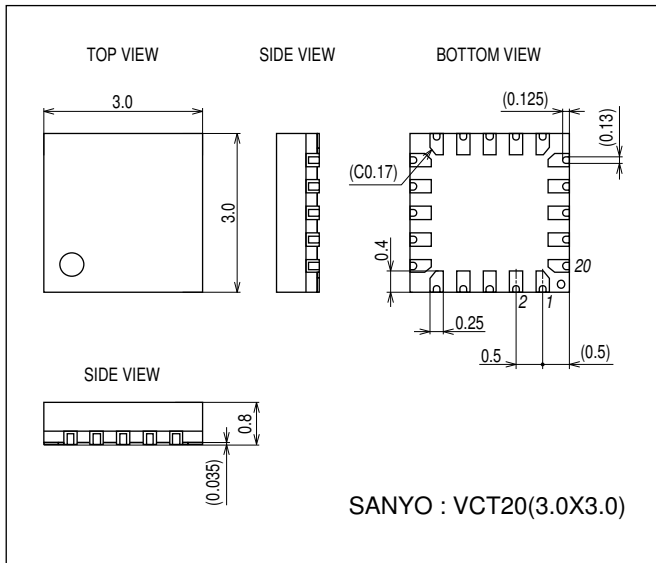
\*1 IN pin voltage is the detection point. The lowest voltage among Vref, TRAC\_IN, and SS is used.

\*2 Design guarantee value, and no measurement is performed.

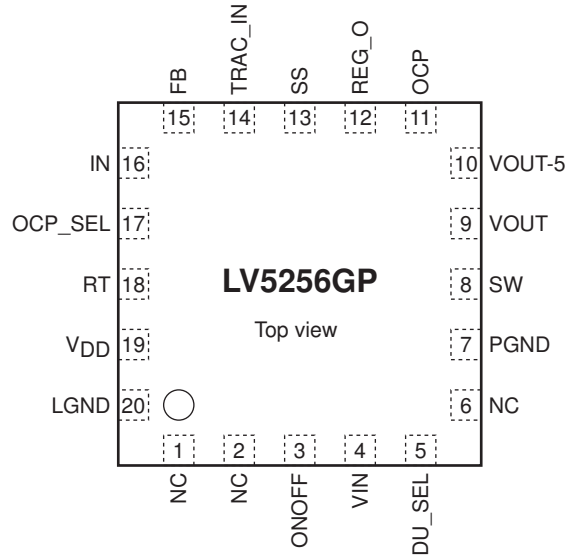
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## Package Dimensions

unit : mm (typ)  
3368

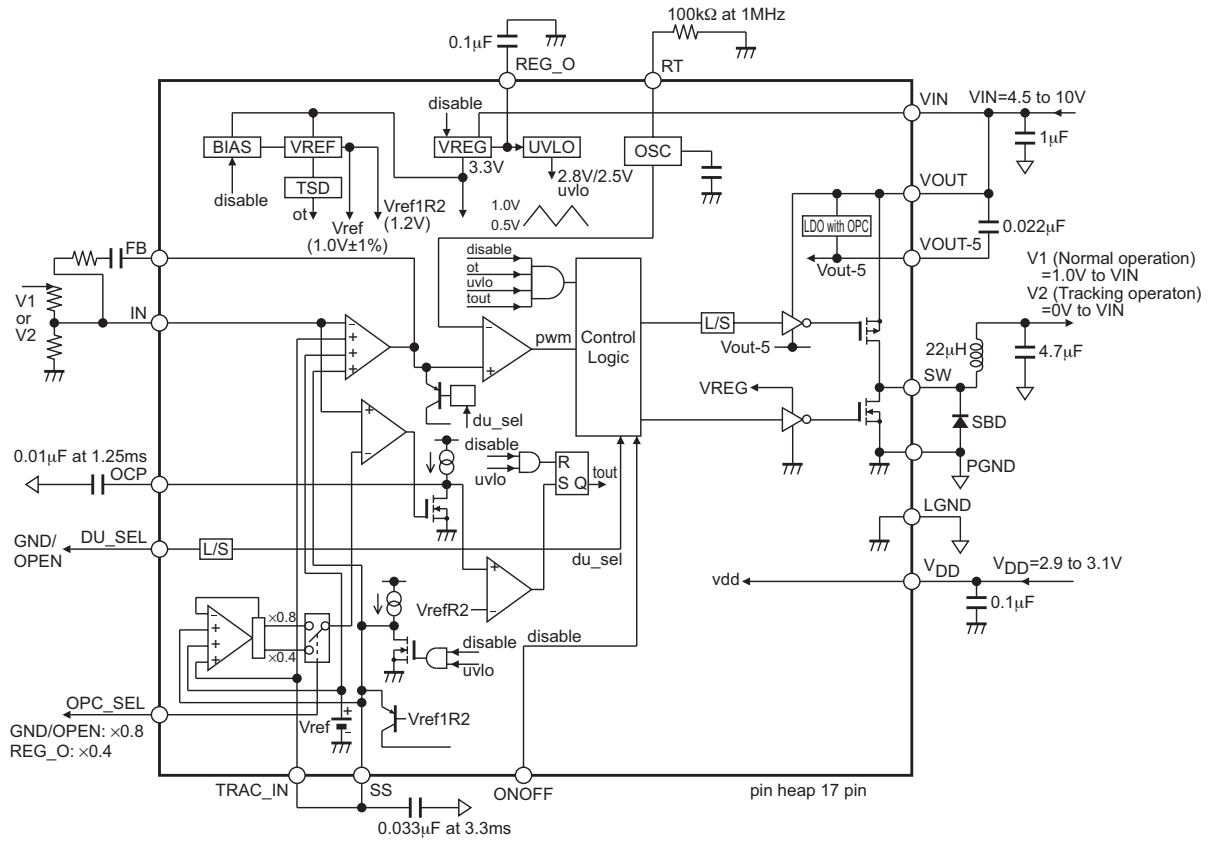


## Pin Assignment

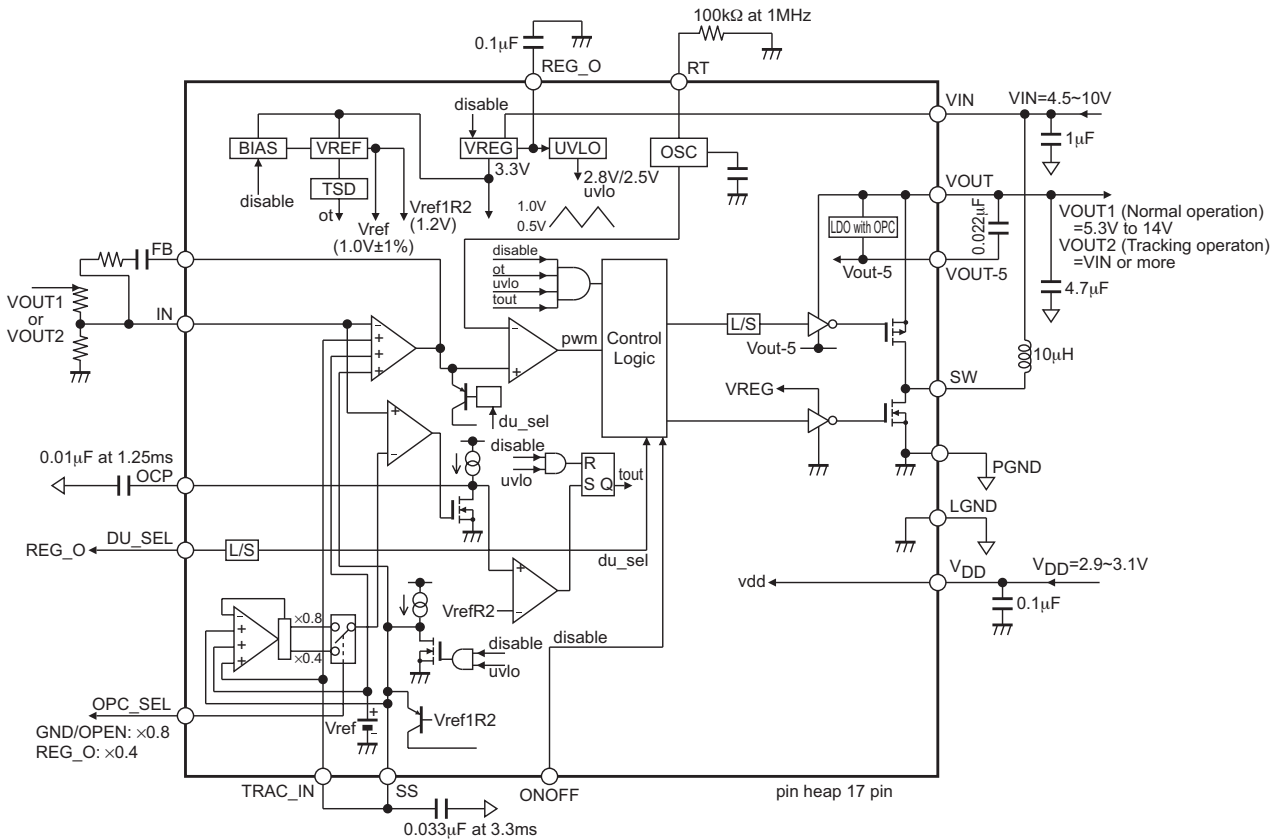


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## Block Diagrams and Sample Application Circuit 1 (Step-down)



## Sample Application Circuit 2 (Step-up)



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## Pin Functions

Pin No.	Pin Name	Description	Equivalent Circuit
1 2 6	NC	No connection. Must be kept open.	
3	ONOFF	ON/OFF signal input pin. Threshold level is TTL level. Maximum withstand voltage is $V_{DD}$ .	
4	VIN	Power supply pin of the IC. Apply the input voltage.	
5	DU_SLE	Step-up/down switching pin. The IC goes in step-up mode by connecting this pin to REG_O pin, and in step-down mode by connecting this pin to GND or leaving this pin open. An internal pull-down resistor (200kΩ) is provided between DU_SEL and GND pins.	
7	PGND	Power ground pin. The source of the output transistor (Nch-MOSFET) is connected.	
8	SW	Switching element. A 0.7Ω (typ) Nch switch is inserted between this pin and PGND, and a 0.7Ω (typ) Pch switch is connected between this pin and VOUT. In step-down mode, insert an inductor between the switching node and power supply output, and in step-up mode insert an inductor between this pin and power supply input.	
9	VOUT	Source potential of the internal Pch-MOSFET. In step-down mode, apply the input voltage. In step-up mode, apply the power supply voltage.	
10	VOUT-5	Internal Pch-MOSFET gate supply voltage generation pin. Used to generate a voltage with a level equal to VOUT pin voltage-5V by the internal LDO with OCP.	
11	OCP	Overcurrent detection timer setup pin. Connect a capacitor between this pin and ground to define the time interval between the beginning of the overcurrent state and the IC latches off. The capacitor is charged by the 10μA internal constant current source. If the OCP_SEL pin is kept open or connected to GND, the IC identifies a short-circuit and starts the timer counter when the voltage at the IN pin falls below 0.8 times the voltage of Vref, TRAC_IN or SS, whichever is lower. If the OCP_SEL pin is connected to REG_O, the IC compares the voltage at the IN pin with 0.4 times the voltage. When the voltage at this pin goes beyond 1.25V, the IC latches off. The latch-off state is reset by the off signal at the ON/OFF pin or the UVLO lock.	
12	REG_O	3.3V regulator output pin.	

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Pin No.	Pin Name	Description	Equivalent Circuit
13	SS	Capacitor connection pin for soft start. The capacitor connected to this pin is charged by the internal 10 $\mu$ A constant current. The interval during which this voltage reaches Vref is called the soft start period. The voltage is clipped to approx. 2V after the soft start. This pin is pulled down to the ground level when ONOFF/UVLO lock mode.	
14	TRAC_IN	Reference voltage input pin for tracking power supply operating. A voltage from 0V up to Vref applied to this pin serves as the reference voltage for determining the output voltage. This pin must be connected to the SS pin when it is not to be used.	
15	FB	Error amplifier output pin. Connect a phase compensation component between this pin and IN pin.	
16	IN	Output voltage input pin. Apply the resistor divided output voltage to this pin.	
17	OCP_SEL	OCP detection voltage switching pin. A 100k $\Omega$ pull-down resistor is provided between OCP_SEL and GND. The IC enters the 0.8 times detection mode when this pin is connected to GND or kept open and enters the 0.4 times detection mode when the pin is connected to the REG_O pin.	

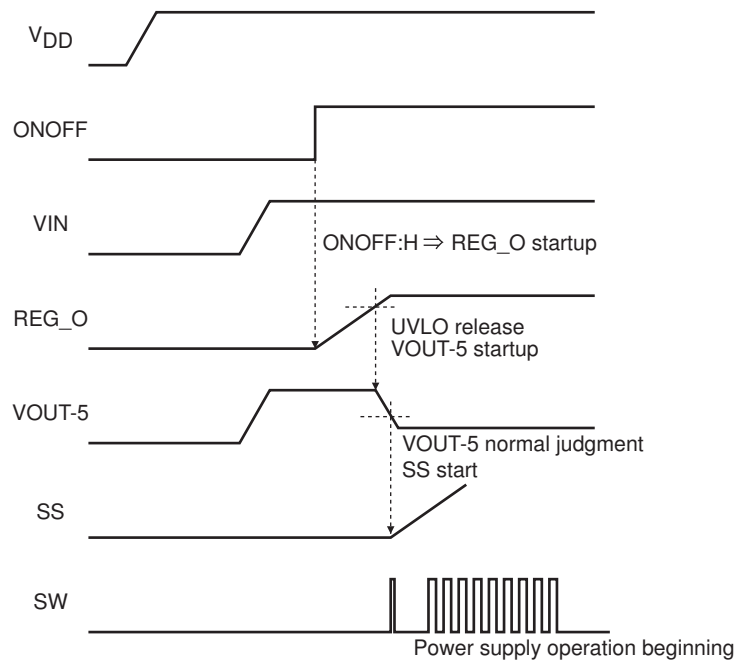
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Pin No.	Pin Name	Description	Equivalent Circuit
18	RT	Oscillation frequency setting pin. Connect a resistor between this pin and GND. A 100kΩ resistor causes the oscillator to oscillate at 1MHz (typ.).	
19	V <sub>DD</sub>	Logic system power supply. Apply 3.0V±0.1V to this pin from an external source.	
20	LGND	Logic system ground pin. All voltages are measured with respect to this voltage level.	

## Startup Sequence

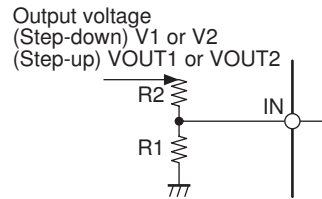


\* Be sure to set the ONOFF to 0V when starts or stops V<sub>DD</sub>. And apply voltage to VIN after V<sub>DD</sub> started up.

## Output Voltage Setting Method

The LV5256GP can produce any arbitrary output voltage. The output voltage is set by the resistor inserted between the IN pin (pin 16) and GND, and IN pin and output voltage.

The calculating formula for setting the output voltage by using the output voltage setup lower-side resistor R1 and the output voltage setup upper-side resistor R2 is as follows:



$$(\text{Output voltage}) = \left(1 + \frac{R2}{R1}\right) \times V_{ref} = 1 + \frac{R2}{R1} \quad \because V_{ref} = 1.00(\text{typ})$$

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