Power Supply IC for Microcomputer

LC201S

General Descriptions

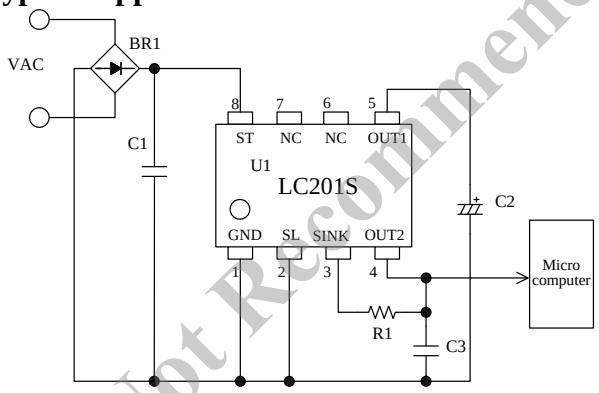
LC201S is the power supply IC for microcomputer of lighting, incorporating a start up circuit and a linear regulator.

There are two outputs. The output voltage of OUT1 can be switched 9 V or 20 V. The output voltage of OUT2 is 5V. The product achieves high cost-performance power supply systems with few external components for microcomputer.

Features

- Built-in startup circuit
- Power dissipation of the startup circuit is zero.
  (When the power of IC is supplied from external power supply)
- OUT1 pin voltage is selectable from 9 V or 20 V by SL pin voltage.
  (When the power of IC is supplied from internal startup circuit)
- OUT2 voltage is fixed to 5V
- Current Sink Function
  (In case OUT1 pin voltage decreases, OUT2 pin is fixed to Low state)

Typical Application Circuit



Package

SOP8

Not to scale

Applications

- Various lighting fixtures
  Fluorescent lamp, ceiling light, street light and down light, etc.
- Electronic equipment with microcomputer

CONTENTS

1. Absolute Maximum Ratings

- The polarity value for current specifies a sink as "+," and a source as "−," referencing the IC.
- Unless otherwise specified T_A = 25 °C

Characteristic	Symbol	Test Conditions	Pins	Rating	Units
ST Pin Voltage	V_{ST}		1−8	600	V
OUT1 Pin Voltage	V_{OUT1}		1−5	35	V
OUT2 Pin Voltage	V_{OUT2}		1−4	− 0.3 to 7.0	V
SL Pin Voltage	V_{SL}		1−2	− 0.3 to 5.0	V
SINK Pin Voltage	V_{SINK}		1−3	20	V
SINK Pin Sink Current	I_{SINK}		1−3	1.2	mA
OUT1 Pin Sink Current	I_{OUT1}		1−5	1.5	mA
OUT2 Pin Sink Current (without auxiliary winding)	I_{OUT2-N}		1−4	1.5	mA
OUT22 Pin Sink Current (with auxiliary winding)	I_{OUT2-A}		1−4	10	mA
Operating Ambient Temperature	T_{op}		—	− 55 to 125	°C
Storage Temperature	T_{stg}		—	− 55 to 125	°C
Junction Temperature	T_j		—	150	°C

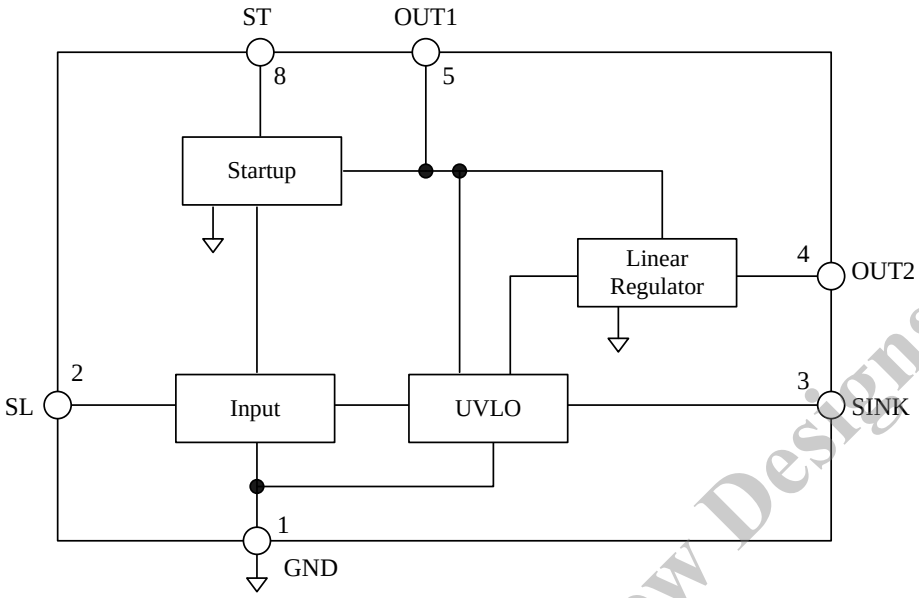
2. Electrical Characteristics

- The polarity value for current specifies a sink as "+," and a source as "−," referencing the IC.
- Unless otherwise specified, T_A = 25 °C

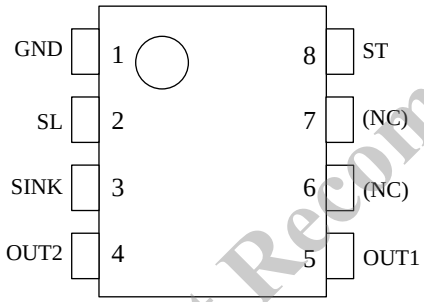
Characteristic	Symbol	Test Conditions	Pins	Rating			Units
				Min.	Typ.	Max.	位
Power Supply Startup Operation							
OUT2 Pin Output Voltage	V_{OUT2}	V_{ST} = 60 V	1 – 4	4.5	5.0	5.5	V
SL Pin High Threshold Voltage	$V_{SL(H)}$		1−2	1.5	—	—	V
SL Pin Low Threshold Voltage	$V_{SL(L)}$		1−2	—	—	0.5	V
Startup Current	I_{ST}		1 – 5	1.5	—	6.5	mA
In case SL pin is Open							
Startup Circuit Operation Voltage	$V_{STON(OP)}$		1 – 8	13	17	21	V
OUT1 Pin Output Voltage	$V_{OUT1(OP)}$	V_{ST} = 60 V	1 – 5	8.0	9.0	10.0	V
UVLO Operation Stop Voltage	$V_{UVH(OP)}$		1 – 3	6.5	8.0	9.5	V
UVLO Operation Start Voltage	$V_{UVL(OP)}$		1 – 3	6.0	7.5	9.0	V
In case SL pin is GND							
Startup Circuit Operation Voltage	$V_{STON(SH)}$		1 – 8	26	30	34	V
OUT1 Pin Output Voltage	$V_{OUT1(SH)}$	V_{ST} = 60 V	1 – 5	18	20	22	V
UVLO Operation Stop Voltage	$V_{UVH(SH)}$		1 – 3	15	18	21	V
UVLO Operation Start Voltage	$V_{UVL(SH)}$		1 – 3	13	16	19	V
Thermal Characteristics							
Junction to Case Thermal Resistance *	θ_{j-C}		—	—	—	45	°C/W

* Case temperature (T_C) measured at the center of the case top surface

3. Functional Block Diagram



4. Pin Configuration Definitions



Pin	Name	Descriptions
1	GND	Ground
2	SL	Switch of OUT1 pin voltage
3	SINK	Sink pin to flow sink current at low input voltage condition. Connect to OUT2 pin.
4	OUT2	5 V (Typ.) output
5	OUT1	9 V (Typ.) or 20 V (Typ.) output. When auxiliary winding is connected to OUT1 pin, OUT1 pin is power supply of the control circuit.
6	(NC)	No function. In order to maintain the distance between high voltage pin and low voltage pin, keep this pin open.
7	(NC)	
8	ST	Startup current input. When auxiliary winding is not connected to OUT1 pin, ST pin is power supply of the control circuit.

5. Typical Application Circuit

Figure 5-1 shows the standalone LC201S operation circuit. The power is supplied to IC via ST pin.

Figure 5-2 shows the LC201S circuit with external power supply. The power is supplied to IC from auxiliary winding of external power supply via OUT1 pin.

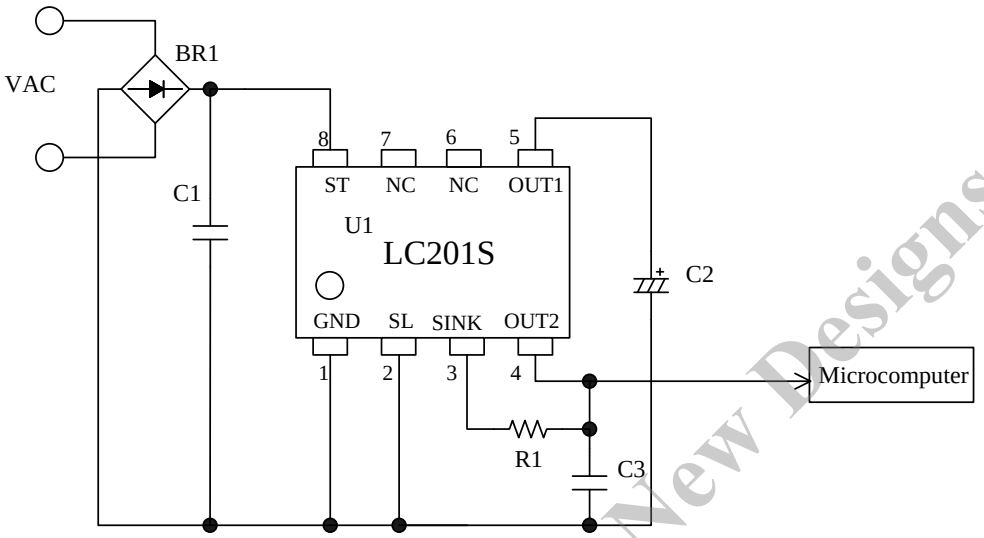


Figure 5-1 Standalone LC201S circuit

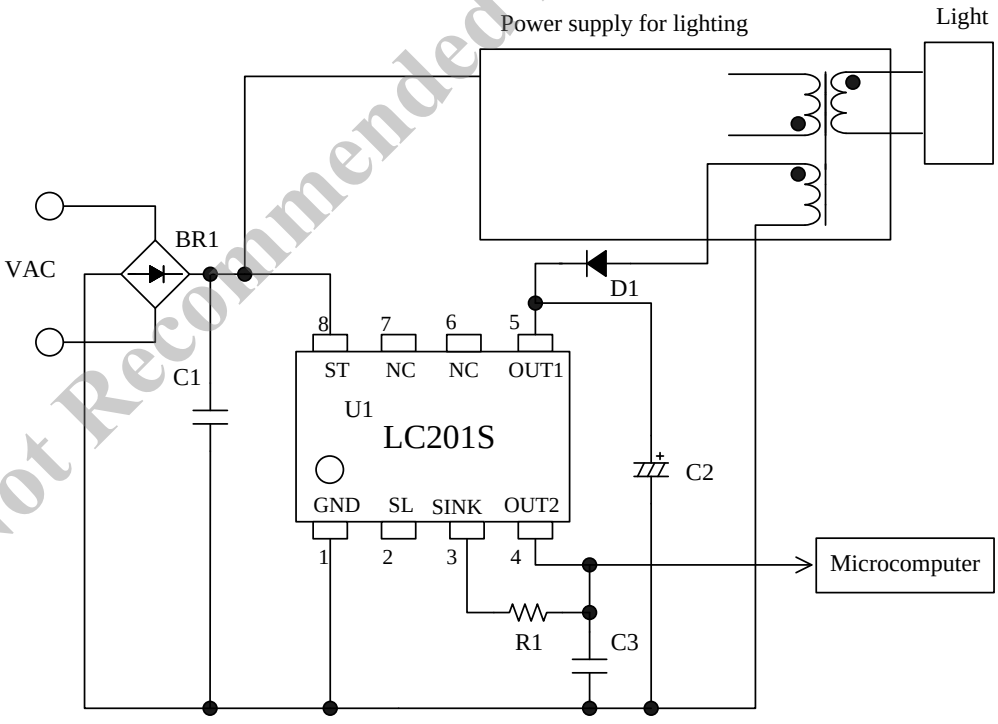
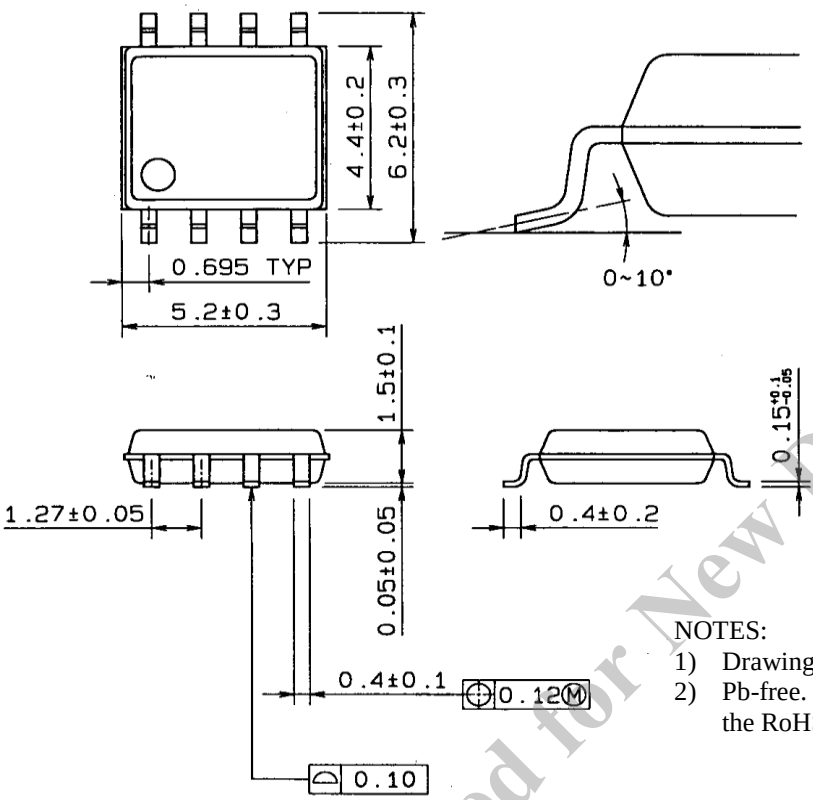


Figure 5-2 LC201 circuit with external power supply.

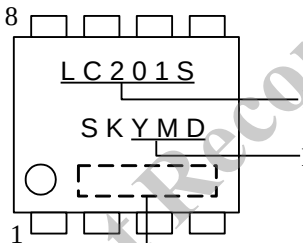
6. Package Outline

- SOP8



NOTES:
1) Drawing is not to scale.
2) Pb-free. Device composition compliant with the RoHS directive

7. Marking Diagram



Part Number

Lot Number

Y is the last digit of the year (0 to 9)

M is the month (1 to 9, O, N or D)

D is a period of days (1 to 3) :

1 : 1st to 10th

2 : 11th to 20th

3 : 21st to 31st

Sanken Control Number

8. Operational Description

- All of the parameter values used in these descriptions are typical values, unless they are specified as minimum or maximum.
- With regard to current direction, "+" indicates sink current (toward the IC) and "–" indicates source current (from the IC).

8.1 Basic Operation

During the startup process, power of IC is spplied via ST pin.

After startup, OUT1 pin can be used as power supply pin instead of ST pin. In this case the OUT1 pin is connected to the auxiliary winding of external power supply.

There are two output pins, OUT1 and OUT2. OUT1 pin voltage is selectable from 9V or 20V. OUT2 pin is fixed to 5V.

In case the power supply after startup of IC is supplied from ST pin, the output voltage of OUT1 pin can be changed as shown in Table 8-1 by the connection method of SL pin as shown in Figure 8-1 (SL pin is open or short with GND pin).

Table 8-1 Relationship between the state of SL pin and the output voltage of OUT1 pin

Parameter	SL = Open ($V_{SL} \geq 1.5$ V)	SL = GND ($V_{SL} \leq 0.5$ V)
OUT1 pin output voltage, V_{OUT1}	9 V	20 V

In case the power supply after startup of IC changes over to the supply from the external power supply, the OUT1 pin after startup of IC is applied to setup voltage of external power supply.

Output voltage of OUT2 pin is 5V constant without relation of the state of SL pin and the supply way of power supply of IC.

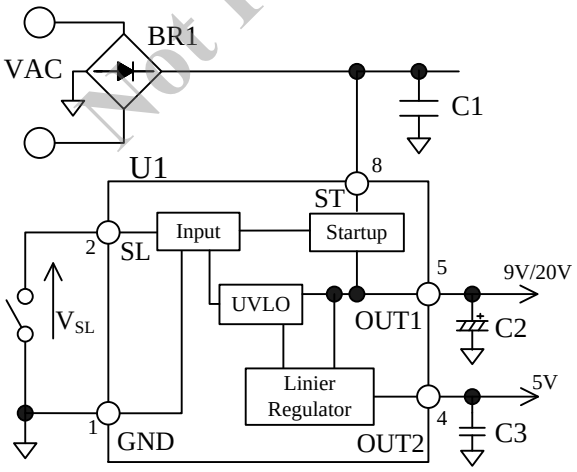


Figure 8-1 SL pin peripheral circuit

8.2 Startup Operation

Figure 8-2 shows ST pin peripheral circuit.

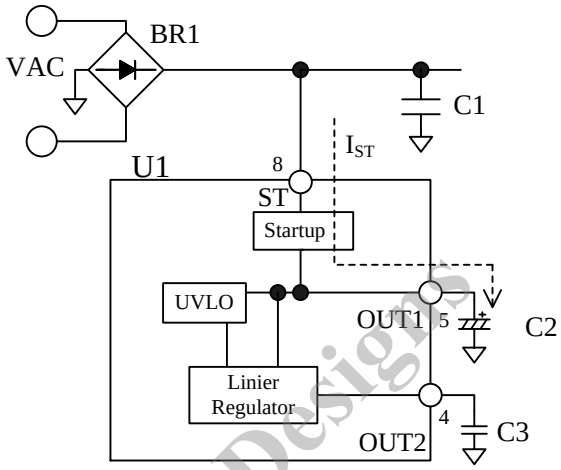


Figure 8-2 ST pin peripheral circuit

When ST pin voltage increases to Startup Circuit Operation Voltage, V_{STON}, the internal startup circuit starts operation, and the C2 connected to OUT1 pin is charged by Startup Current, I_{ST} (about 4 mA).

After that, when OUT1 pin voltage increases to UVLO Operation Stop Voltage, V_{UVH}, the OUT2 pin outputs the voltage of 5 V.

When ST pin voltage decreases and OUT1 pin voltage decreases to UVLO Operation Start Voltage, V_{UVL}, OUT2 pin voltage becomes about 0 V.

The value of V_{STON}, V_{UVH} and V_{UVL} depend on the configuration of SL pin as shown in Table 8-2.

Table 8-2 Relationship between SL pin and the function of OUT1 pin

Parameter	SL = Open	SL = GND
Startup Circuit Operation Voltage, V_{STON}	17 V	30 V
UVLO Operation Stop Voltage, V_{UVH}	8.0 V	18.0V
UVLO Operation Start Voltage, V_{UVL}	7.5 V	16.0V

The startup time until OUT2 pin voltage becomes 5 V depends on capacitance of C2. Figure 8-3 shows reference value of startup time as a function of C2 value.

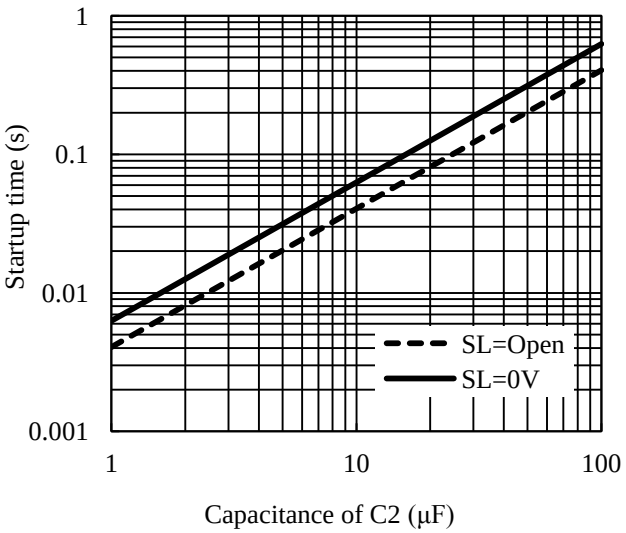


Figure 8-3 The reference startup time of OUT2 pin

After startup, there is two way of suppplying power to IC.

In case the power of IC continues to be supplied via ST pin , OUT1 pin voltage becomes V_{OUT1} (9V or 20V refer to Table 8-1).

In case the power of IC is supplied from external power supply, OUT1 pin is connected to the auxiliary winding of external power supply. Since the power supply pin can be switched from ST pin to OUT1 pin, the power dissipation of the startup circuit can be eliminated after startup process.

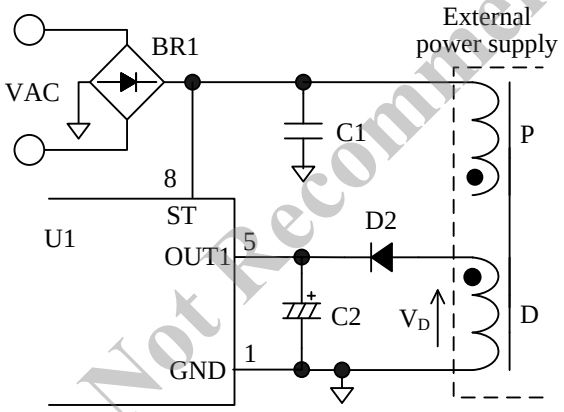


Figure 8-4 In case the power of IC is supplied from external power supply

After external power supply starts, when the auxiliary winding voltage, V_D, is lower than V_{OUT1}, OUT1 pin voltage keeps V_{OUT1}.

When V_D increases and OUT1 pin voltage becomes higher than V_{OUT1}, the startup circuit of IC is cut automatically. Then OUT1 pin voltage becomes the rectified and smoothed V_D voltage.

The number of turns of auxiliary winding D is set such that OUT1 pin voltage, $V_{OUT1(D)}$, becomes within the range of Expression (1) in the specification of the input voltage range and output load range of the power supply.

$$V_{UVH} < V_{OUT1(D)} < 35V \quad (1)$$

Where, V_{UVH} is UVLO Operation Stop Voltage. V_{UVH} depends on the setting of SL pin (refer to Table 8-2).

The diode D2 should be a fast recovery diode since a high frequency switching current flows to D2.

8.3 Current Sink Function

When the output voltage of OUT2 pin is OFF, the Current Sink Function prevents the output voltage of OUT2 pin from varying by external factor.

When this function is used, SINK pin is connected to OUT2 pin as shown in Figure 8-5.

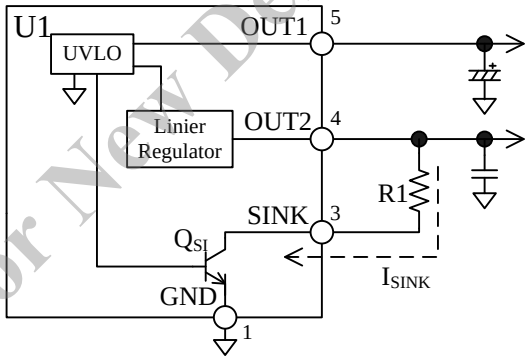


Figure 8-5 SINK pin peripheral circuit

Figure 8-6 shows Current Sink Function operational waveforms.

When OUT1 pin voltage decreases UVLO Operation Stop Voltage, $V_{UVL,}$ the output of OUT2 pin becomes Low state. At the same time, Q_{SI} turns on and the sink current flows into SINK pin. Thus the output of OUT2 pin is fixed Low state immediately.

When OUT1 pin voltage increases to UVLO Operation Start Voltage, $V_{UVH,}$ or more, Q_{SI} turns off and OUT2 pin outputs V_{OUT2} = 5 V.

The value of R1 connected between SINK pin and OUT2 pin should be selected considering the range of the absolute maximum ratings of SINK pin current.

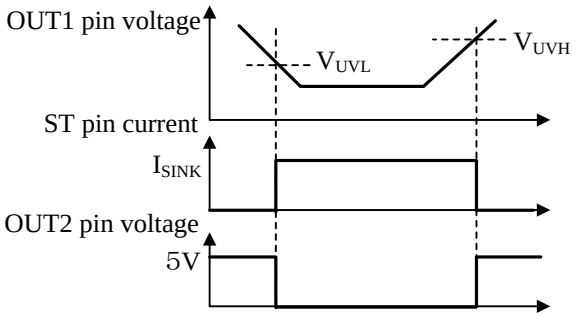


Figure 8-6 Current Sink Function operational waveforms.

9. Design Notes

PCB circuit trace design and component layout significantly affects operation, EMI noise, and power dissipation. Therefore, pay extra attention to these designs.

Because the linear regulator has a positive thermal coefficient of R_{ON}, consider it when preparing a thermal design.

Figure 9-1 shows the circuit design example.

The input capacitor C1 and the output capacitor C2 and C3 are connected to each functional pin (ST pin, OUT1 pin and OUT2 pin) and GND pin as close as possible.

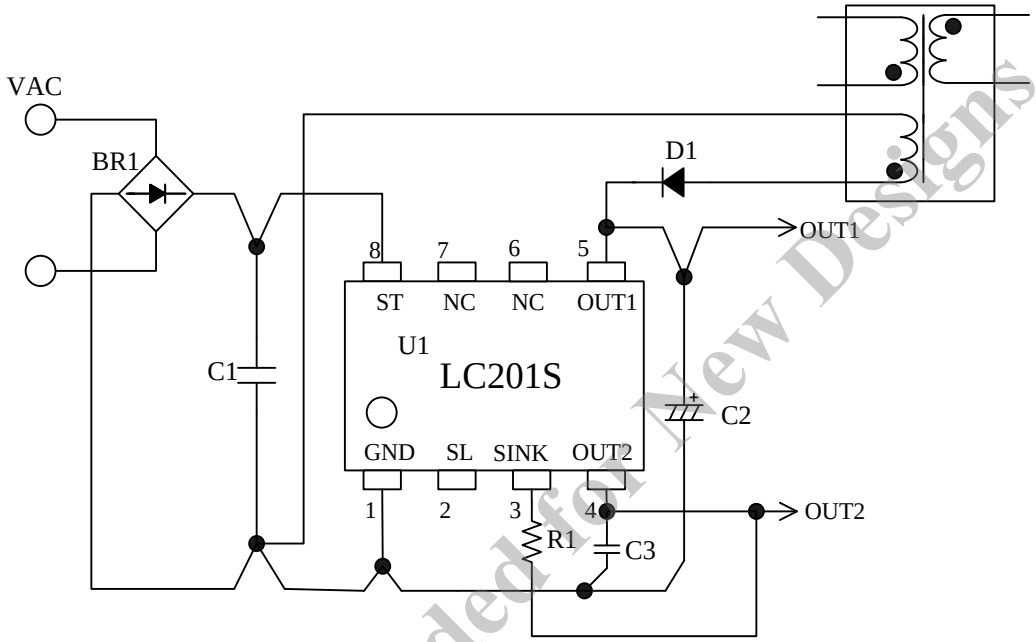
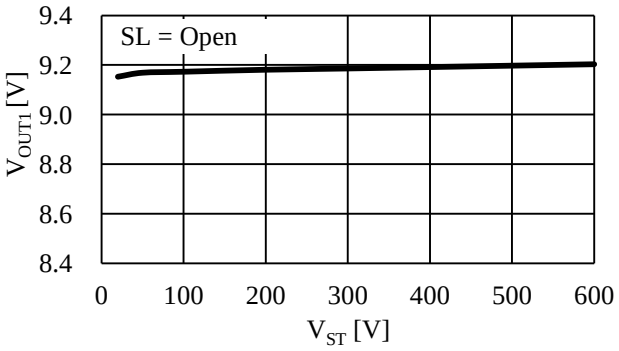


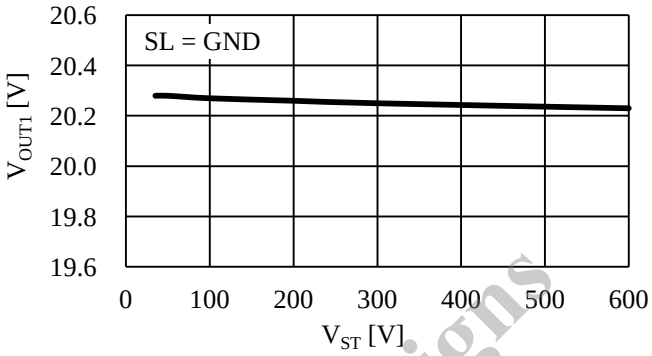
Figure 9-1 The circuit design example

10. Performance Curves

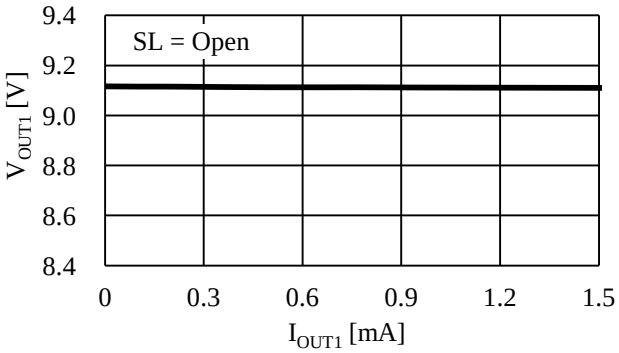
10.1 Regulation Curves of OUT1 Pin

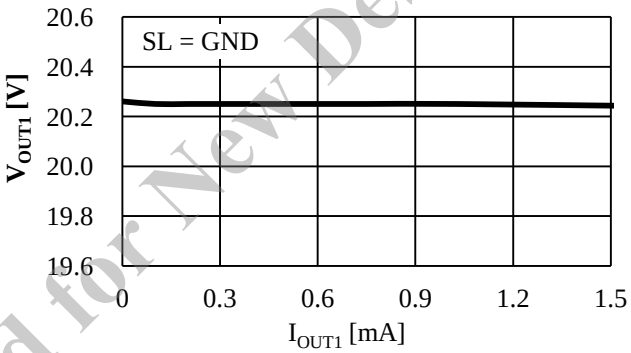
- **Relationship between V_{ST} and V_{OUT1} (I_{OUT1} = 0 mA)**





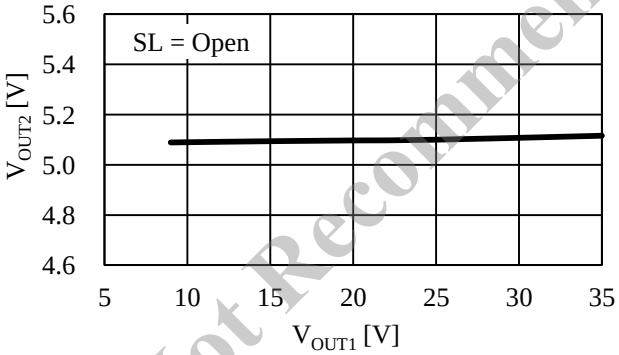
- **Relationship between V_{OUT1} and I_{OUT1} (V_{ST} = 60 V)**

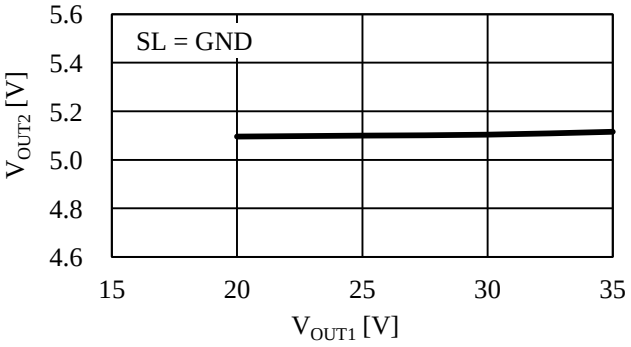




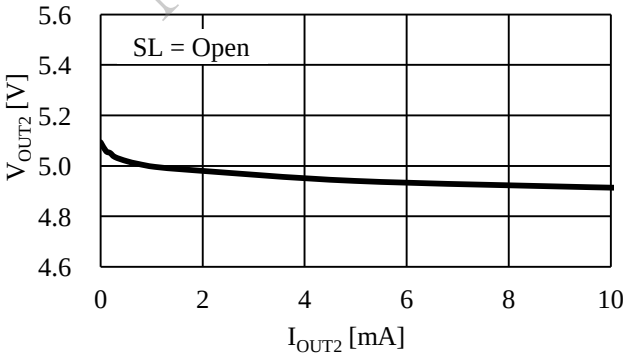
10.2 Regulation Curves of OUT2 Pin

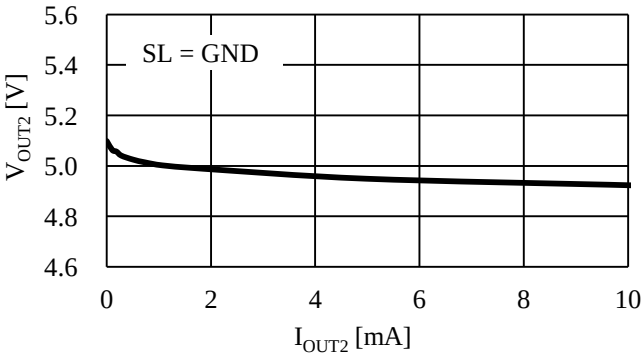
- **Relationship between V_{OUT1} and V_{OUT2} (I_{OUT2} = 0 mA)**





- **Relationship between V_{OUT2} and I_{OUT2}**

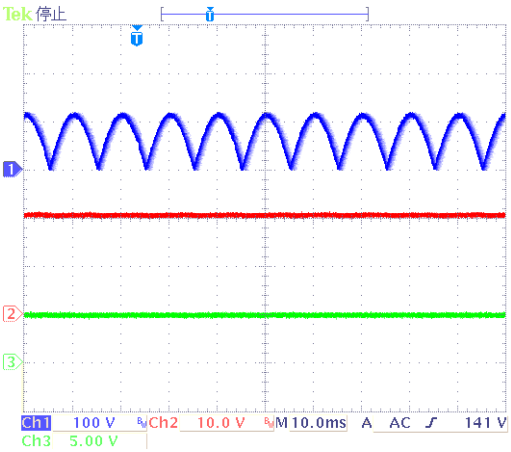




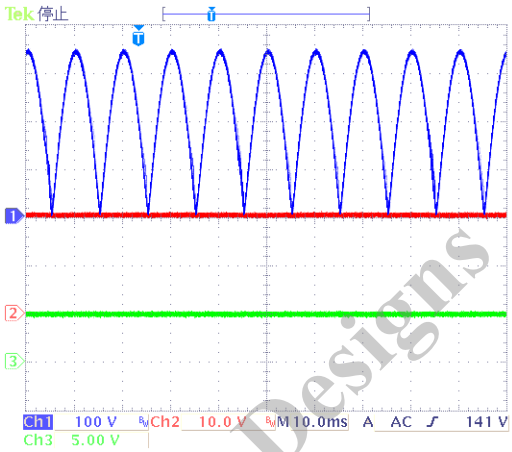
10.3 Typcal Operation Waveform

- **Normal Operation Waveform**

AC 80 V (SL = GND)
(Ch1: AC, Ch2: OUT1, Ch3: OUT2)

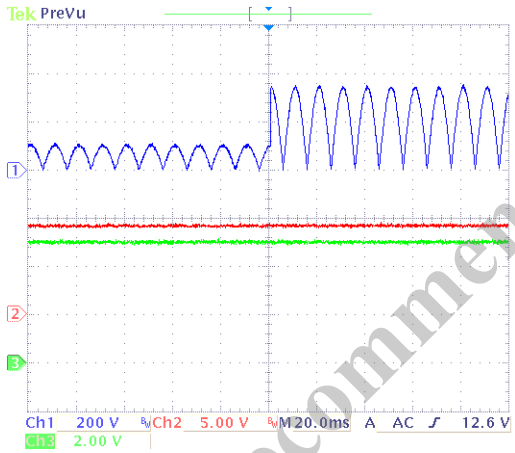


AC 265 V (SL = GND)
(Ch1: AC, Ch2: OUT1, Ch3: OUT2)

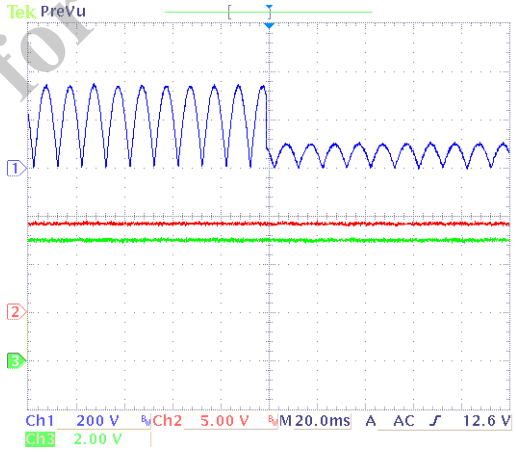


- **Operation Waveform when Input Voltage is Varied**

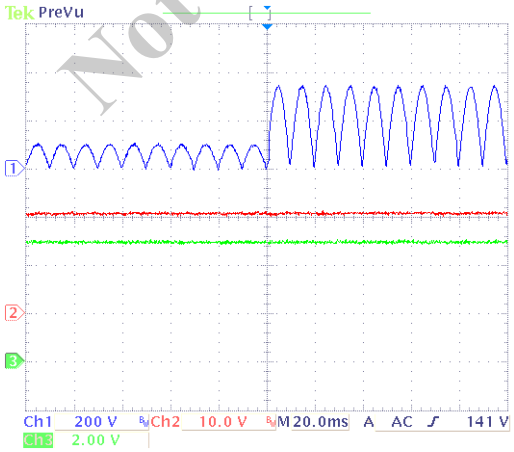
AC 80 V→AC 265 V (SL = Open)
(Ch1: AC, Ch2: OUT1, Ch3: OUT2)



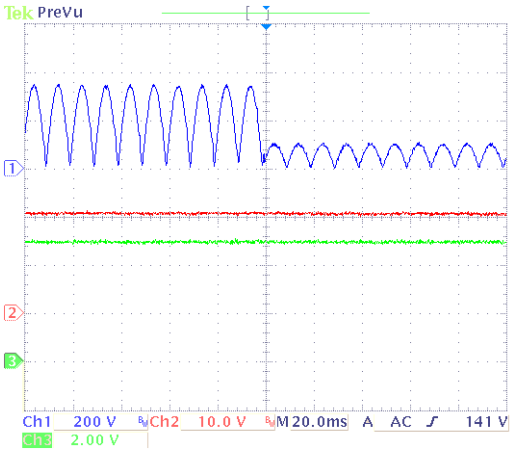
AC 265V→AC 80 V (SL = Open)
(Ch1: AC, Ch2: OUT1, Ch3: OUT2)



AC 80 V→AC 265 V (SL = GND)
(Ch1: AC, Ch2: OUT1, Ch3: OUT2)

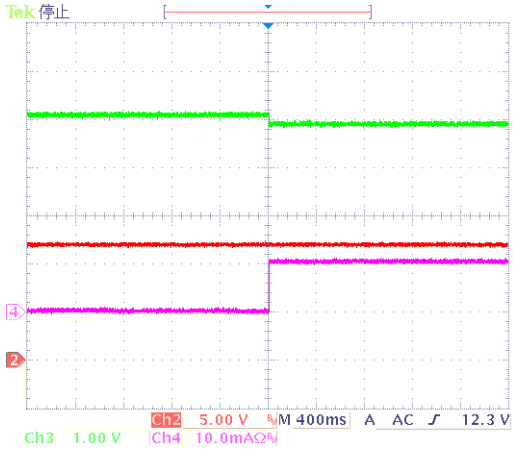


AC 265V→AC 80 V (SL = GND)
(Ch1: AC, Ch2: OUT1, Ch3: OUT2)

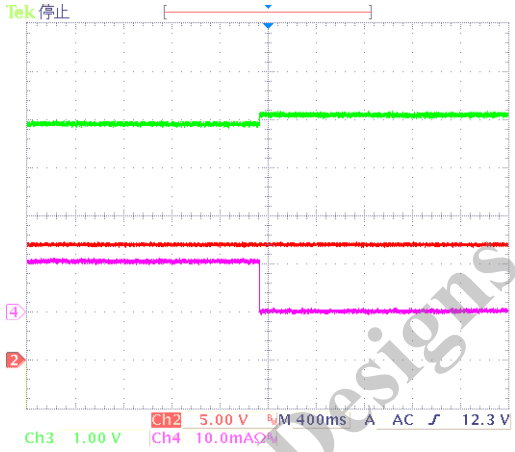


● **Operation Waveform when the Load of OUT2 Pin is Varied**

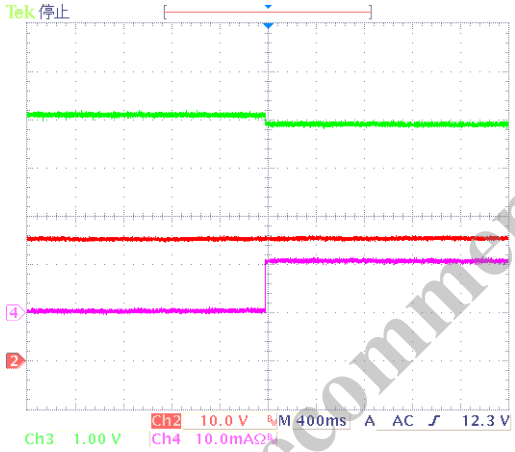
I_{OUT} = 0 mA→10 mA (SL = Open)
(Ch2: OUT1, Ch3: OUT2, Ch4: I_{OUT2})



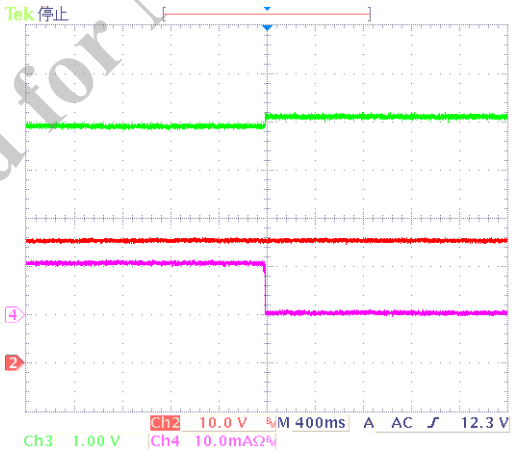
I_{OUT} = 10 mA→0 mA (SL = Open)
(Ch1: OUT1, Ch2: OUT1, Ch3: I_{OUT2})



I_{OUT} = 0 mA→10 mA (SL = GND)
(Ch2: OUT1, Ch3: OUT2, Ch4: I_{OUT2})



I_{OUT} = 10 mA→0 mA (SL = GND)
(Ch1: OUT1, Ch2: OUT1, Ch3:I_{OUT2})



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