

CN274-BBGASPP0CZ

Power Supply with Supercapacitor

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Rev.1.0

Sep. 03, 2020

Description

The CN274-BBGASPP0CZ Power Supply with Supercapacitor board is the application of supercapacitor as backup power supply. The board allows quick evaluation of the ISL85403 in the 2-Stage Boost Buck configuration and ISL9001A Low Dropout linear regulator. It is a cost-effective solution for the low-power, wide input voltage range point-of-load application where both stepping up and stepping down voltage capabilities are required.

Specifications

The design specifications of the CN274-BBGASPP0CZ Power Supply with Supercapacitor are shown in Table 1.

TABLE 1. SPECIFICATIONS

Parameters	Values
Input Voltage (V_{IN})	12V to 14V
ISL85403 Output Voltage (V_{OUT})	3.3V
ISL9001A Output Voltage (V_{LDO})	1.8V
Max. Output Current (ISL85403 I_{OUT_MAX})	2.5A
Supercapacitor Voltage (V_{CAP})	2.5V

Key Features

- Flexible design
- Very high discharge efficiency
- Double channel power output
- Convenient power connection

References

[ISL85403](#) Datasheet

[ISL9001A](#) Datasheet

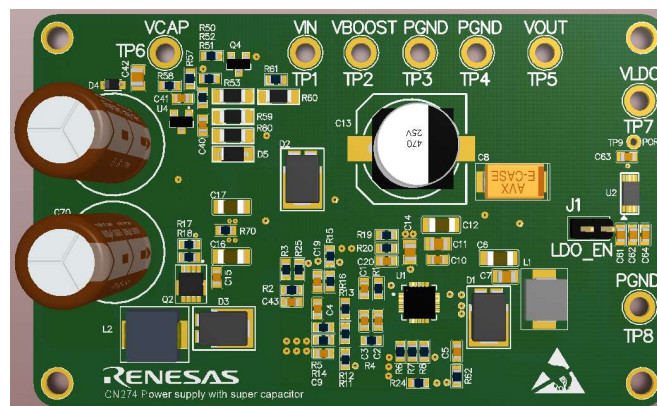


Figure1 Top View

CN274-BBGASPOCZ Power Supply with Supercapacitor

Functional Description

The ISL85403 is a flexible switching regulator with an integrated 127mΩ high-side MOSFET. It can be used as a synchronous buck converter, a 2-stage boost-buck converter or a noninverting buck-boost converter. ISL9001A is a high-performance Low Dropout linear regulator capable of sourcing 300mA current.

The CN274-BBGASPOCZ board demonstrates the operations of the ISL85403 in the 2-stage boost-buck configuration.

When the board connected external power supply, the ISL85403 is in the Buck mode and monitor the boost input voltage. At the same time, the external power supply will charge the supercapacitor.

When the external power supply is disconnected, the supercapacitor discharges and ISL85403 activates the 2-stage Boost-Buck mode, which can fully extract the power of super capacitor (can be as low as 0.3V), providing a stable output of 3.3V until supercapacitor has insufficient power.

The CN274-BBGASPOCZ board is shown in Figures 1. The schematic is shown on page 3, bill of materials on page 4, and PCB layers for reference start on page 5.

Quick Test Setup

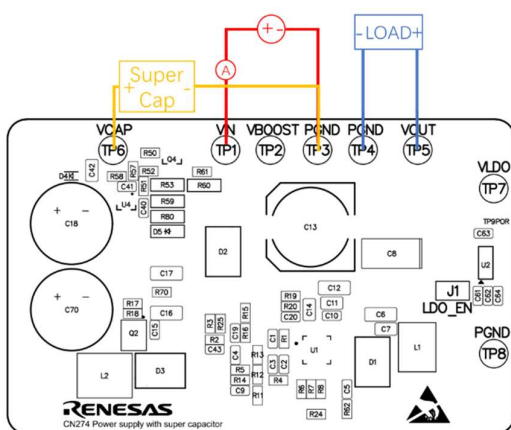


Figure 2 Charger and Buck mode

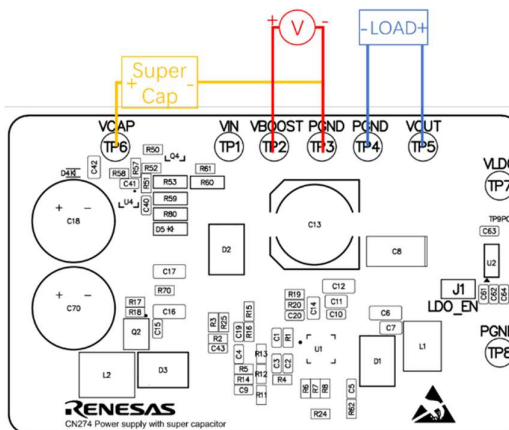


Figure 3 Discharger and 2-stage Boost-Buck mode

- 1, Connect the power supply to the input terminals VIN (TP1) and GND (TP3). Connect the load terminals to the output VOUT (TP5) and GND (TP4). Make sure the setup is correct prior to applying any power or load to the board. Refer to Figure2.
- 2, Adjust the power supply to 12V to 14V and turn it on. The ISL85403 in the Buck mode and supercapacitor in the charger mode.
- 3, Verify the output voltage is 3.3V and use oscilloscope to monitor the supercapacitor voltage. Refer to Figure 2.
- 4, When the charging voltage of the ultracapacitor reaches the set value, make sure the voltage does not increase. At this point, connect the oscilloscope to the VBOOST (TP2) and GND(TP3) and disconnect the power supply. Refer to Figure 3.
- 5, Verify the output voltage is 3.3V and use oscilloscope to monitor the supercapacitor voltage. Refer to Figure 3.

Test Environment

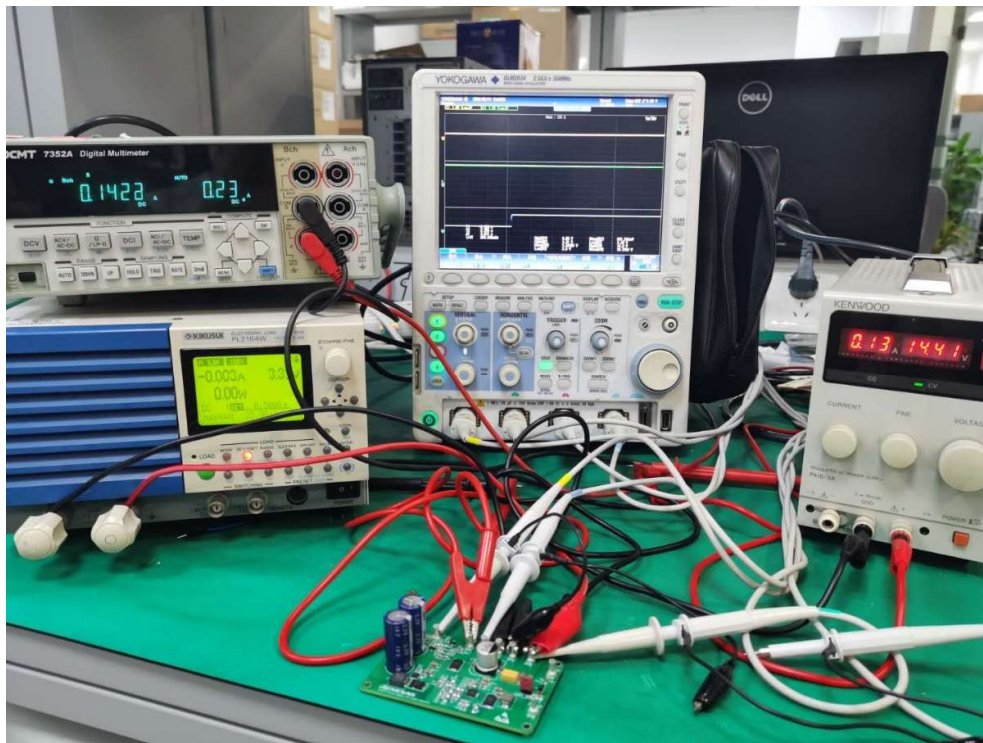


Figure 5 Test Environment

Test Example

- DC-DC Power-On : ISL85403 buck mode
- Supercapacitor Charging & Normal output voltage
- Charging voltage: $V_{in}=13V$, Charging current limiting res = 100R
- Charging cut-off: 2.5V, Charging time: 442.5s

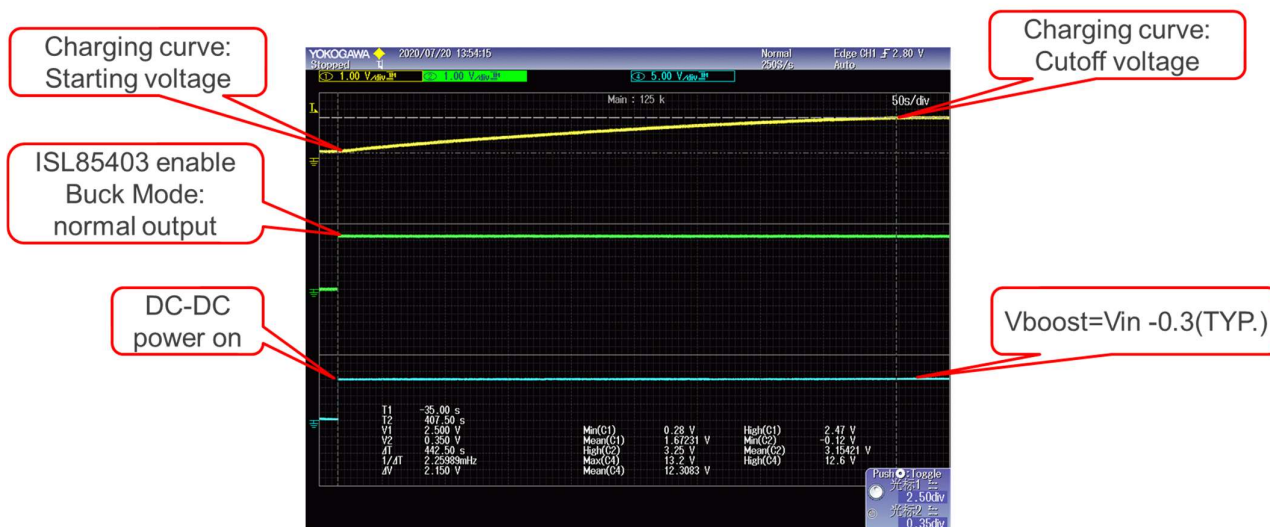


Figure 6 Charging

CN274-BBGASPPOCZ Power Supply with Supercapacitor

- **DC-DC Power-Off : ISL85403 Boost & buck mode**
- Supercapacitor Discharging & Normal output voltage: Electronic load set to CC mode(100mA)
- Discharger time:156.2s, Efficiency: $3.3 \times 0.1 \times 156.2 / (0.5 \times 2 \times 10 \times 2.5 \times 2.5) = 82.4\%$



Figure 7 Discharging in CC Mode(100mA)

- **DC-DC Power-Off:ISL85403 Boost & buck mode**
- Supercapacitor Discharging & Normal output voltage: Electronic load set to CC mode(200mA)
- Discharger time:75.1s, Efficiency: $3.3 \times 0.2 \times 75.1 / (0.5 \times 2 \times 10 \times 2.5 \times 2.5) = 79.3\%$

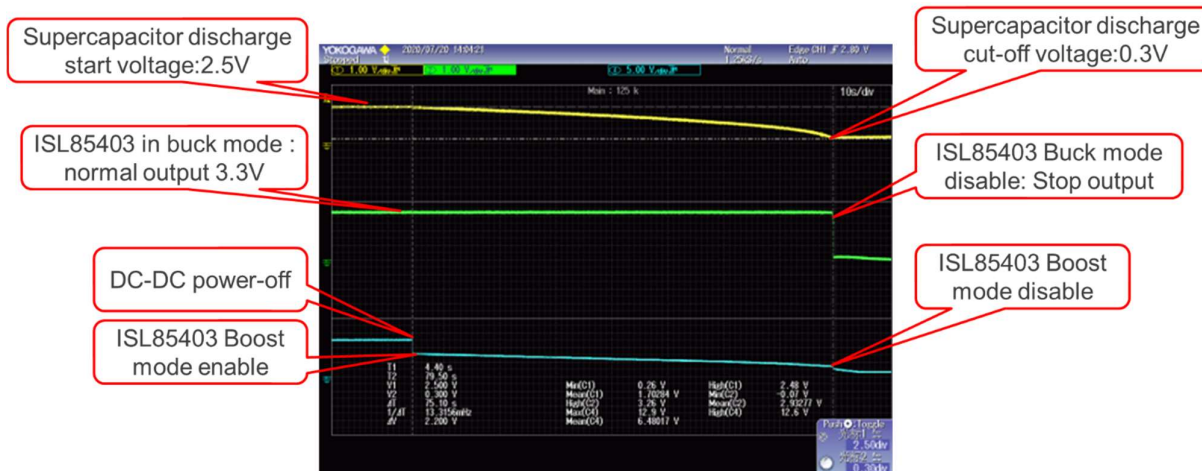


Figure 8 Discharging in CC Mode(200mA)

CN274-BBGASPOCZ Power Supply with Supercapacitor

- **DC-DC Power-Off:ISL85403 Boost & buck mode**
- Supercapacitor Discharging & Normal output voltage: Electronic load set to CC mode(500mA)
- Discharger time:24s, Efficiency: $3.3 \times 0.5 \times 24 / (0.5 \times 2 \times 10 \times 2.5 \times 2.5) = 63.36\%$

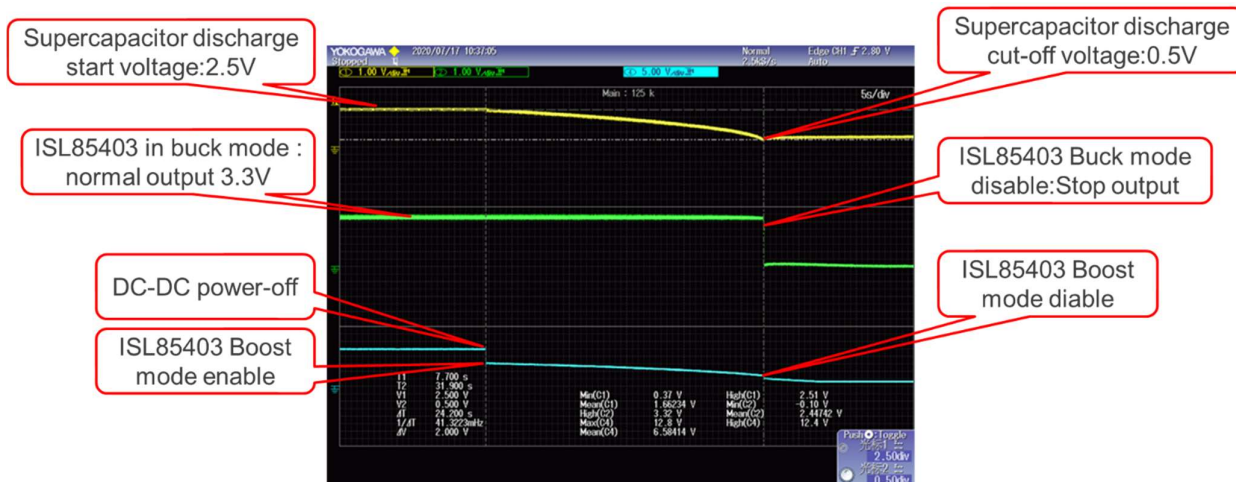


Figure 9 Discharging in CC Mode(500mA)

- **DC-DC Power-Off:ISL85403 Boost & buck mode**
- Supercapacitor Discharging & Normal output voltage: Electronic load set to CC mode(1000mA)
- Discharger time:10.14s, Efficiency: $3.3 \times 1 \times 10.14 / (0.5 \times 2 \times 10 \times 2.5 \times 2.5) = 53.5\%$

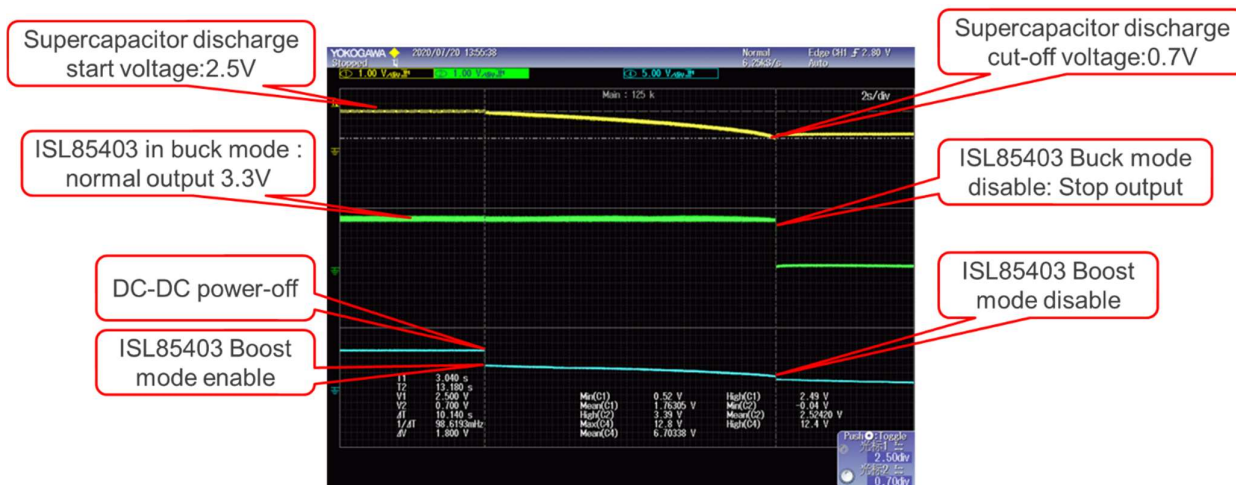


Figure 10 Discharging in CC Mode(1000mA)

CN274-BBGASPOCZ Power Supply with Supercapacitor

CN274-BBGASPOCZ Power Supply with Supercapacitor Circuit Schematic

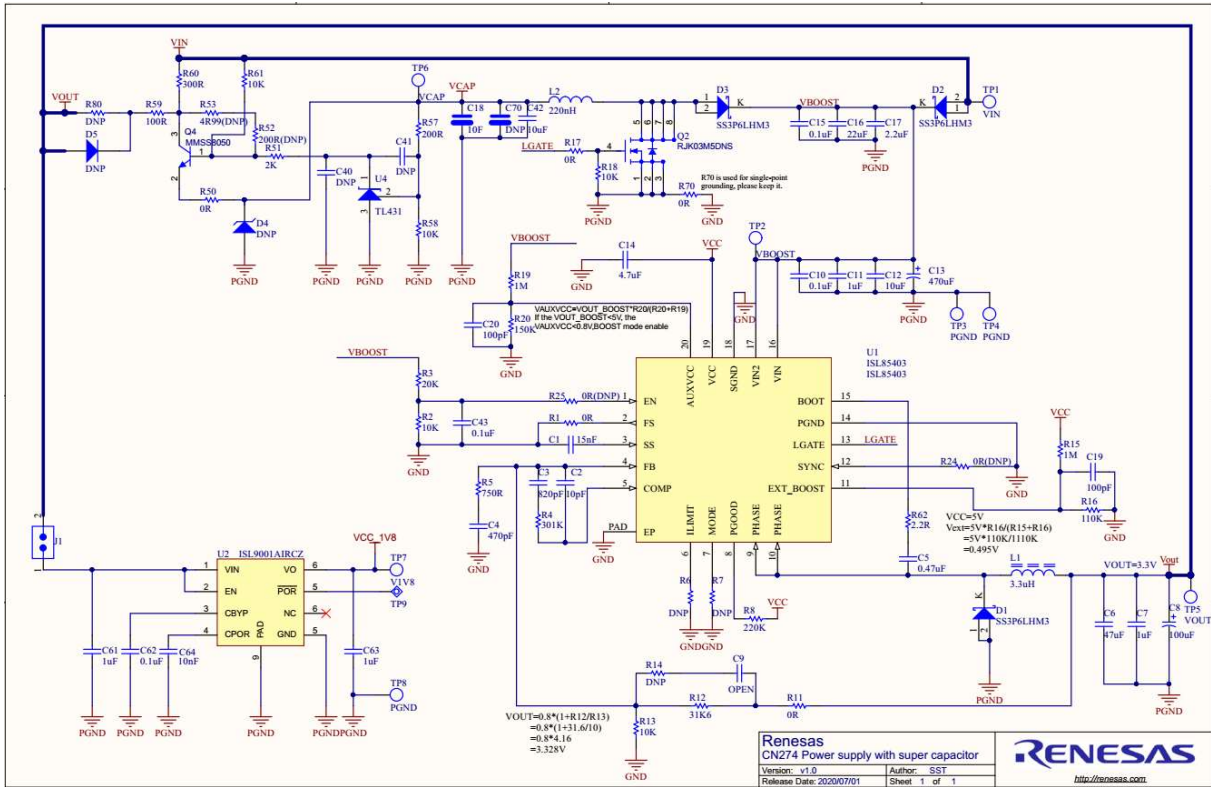


Figure 11 Circuit Schematic

CN274-BBGASPOCZ Power Supply with Supercapacitor

Bill of Materials

TABLE 2. BOM List

Designator	Mfg Part Number	QTY	Description	Manufacturer
C1	CL10B153KB8NNNC	1	Ceramic Chip Capacitor 0603 15nF 50V	Samsung
C2	GRM1885C1H100JA01J	1	Ceramic Chip Capacitor 0603 10pF 50V	Murata
C3	GRM1555C1H821JA01D	1	Ceramic Chip Capacitor 0603 820pF 50V	MURATA
C4	GRM1885C1H471JA01J	1	Ceramic Chip Capacitor 0603 470pF 50V	Murata
C5	GRM188R71E474KA12D	1	Ceramic Chip Capacitor 0603 0.47uF 25V	MURATA
C6	GRM31CR61A476KE15L	1	Ceramic Chip Capacitor 1206 47uF 10V	MURATA
C7, C11	CC0805KX7R7BB105	2	Ceramic Chip Capacitor 0805 1uF 16V	YAGEO
C8	TBJE107K016CBDZ0H23	1	Tantalum Capacitor 7343100uF 16V	AVX
C9,C40, C41		0	DNP	
C10, C15, C43, C62	GCM188L81H104KA57D	4	Ceramic Chip Capacitor 0603 0.1uF 50V	MURATA
C12	GRM31CR71E106KA12L	1	Ceramic Chip Capacitor 1206 10uF 25V	MURATA
C13	EEE-FN1C471V	1	Electrolytic Capacitors 8*10 470uF 163V	Panasonic
C14	GRM21BR61H475KE51L	1	Ceramic Chip Capacitor 0805 4.7uF 50V	MURATA
C16	GRM31CC81E226KE11L	1	Ceramic Chip Capacitor 1206 22uF 25V	MURATA
C17	GCM31CR71H225KA55L	1	Ceramic Chip Capacitor 1206 2.2uF 25V	MURATA
C18, C70	SCCS30B106PRBLE	2	SCC 10F +100%/-0% 2.7VDC 25mOhms	AVX
C19, C20, C64	GCD188R71H103KA01D	3	Ceramic Chip Capacitor 0603 10nF 50V	MURATA
C42	GRM21BR61C106KE15L	1	Ceramic Chip Capacitor 0805 10uF 16V	MURATA
C61, C63	GRT188R61H105KE13D	2	Ceramic Chip Capacitor 0603 1uF 50V	MURATA
D1, D2, D3	SS3P6LHM3	3	Schottky DIODE 60V 3A TO-227A	VISHAY
D4,D5		0	DNP	Microsemi
J1	67997-402HLF	1	FCI Header 0.1" pitch 2pos 1x2	FCI
L1	IHLP2020CZER3R3M01	1	FIXED IND 3.3UH 5A 54.7 MOHM SMD	Vishay
L2	IHLM2525CZERR47M01	1	FIXED IND 470NH 17.5A 4.2 MOHM	Vishay
Q2	RJK03M5DNS	1	MOSFET BEAM2 Series FET, 30V, HWSON3030-8	Renesas
Q4	MMSS8050-H-TP	1	TRANS NPN 25V 1.5A SOT23	Micro
R1, R11, R17, R50, R62, R70	RC0603FR-070RL	8	Chip Resistor Thick Film 0603 0R 1% 1/10W	YAGEO
R2, R3, R6, R7, R14, R24, R25		0	DNP	
R4	RC0603FR-07301KL	1	Chip Resistor Thick Film 0603 301K 1% 1/10W	YAGEO
R5	RC0603FR-10750RL	1	Chip Resistor Thick Film 0603 750R 1% 1/10W	YAGEO
R8	RC0603FR-07220KL	1	Chip Resistor Thick Film 0603 220K 1% 1/10W	YAGEO
R12	RC0603FR-0731K6L	1	Chip Resistor Thick Film 0603 31K6 1% 1/10W	YAGEO
R13, R18	RC0603FR-0710KL	2	Chip Resistor Thick Film 0603 10K 1% 1/10W	YAGEO
R15, R19	RC0603FR-071ML	2	Chip Resistor Thick Film 0603 1M 1% 1/10W	YAGEO
R16	RC0603FR-07110KL	1	Chip Resistor Thick Film 0603 110K 1% 1/10W	YAGEO
R20	RC0603FR-07150KL	1	Chip Resistor Thick Film 0603 150K 1% 1/10W	YAGEO
R51, R57	RC0603FR-072KL	2	Chip Resistor Thick Film 0603 2K 1% 1/10W	YAGEO
R52	RC0603FR-07200RL	1	Chip Resistor Thick Film 0603 200R 1% 1/10W	YAGEO
R53	RC1206FR-074R99L	1	Chip Resistor Thick Film 1206 4R99 1% 1/10W	YAGEO
R58	RC0603FR-07100KL	1	Chip Resistor Thick Film 0603 100K 1% 1/10W	YAGEO
R59, R60, R80	RT1206BRB07100RL	3	Chip Resistor Thick Film 1206100R 1% 1/10W	YAGEO
R61	RC0603FR-0720KL	1	Chip Resistor Thick Film 0603 20K 1% 1/10W	YAGEO
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9		1	High current test terminal Hole 2.5mm	
U1	ISL85403	1	IC Reg w/FET f/ Synch Buck or Boost/Buck QFN20_4x4	Renesas
U2	ISL9001A	1	LDO with Low ISUPPLY, High PSRR 8 LD DFN	Renesas
U4	TL431	1	Auto Cat Low-Vltg Adj Prec Shunt Regulator 0.5% 2.55V SOT-23	TI

Board Layout

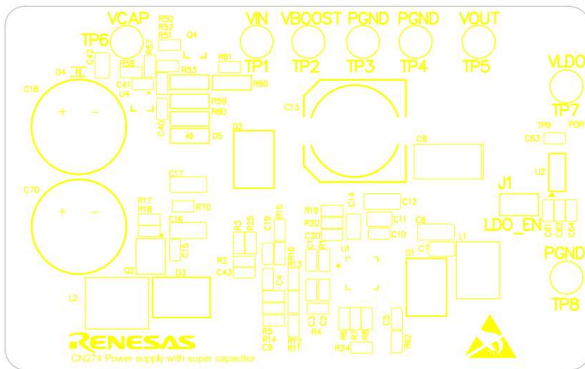


Figure 12 Silkscreen TOP

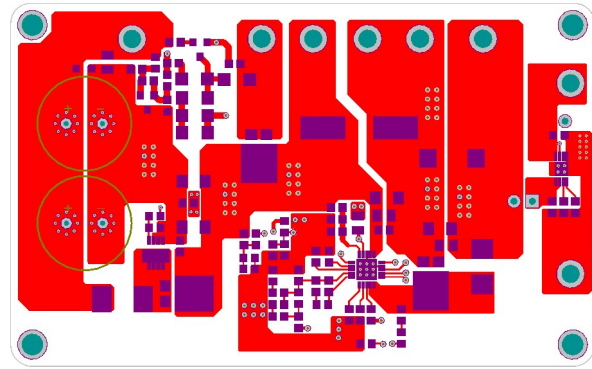


Figure 13 Top Layer

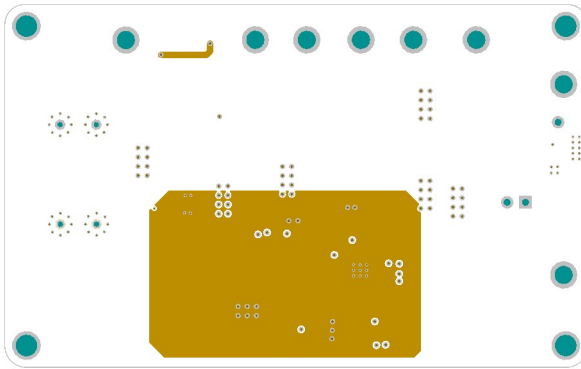


Figure 14 2nd Layer

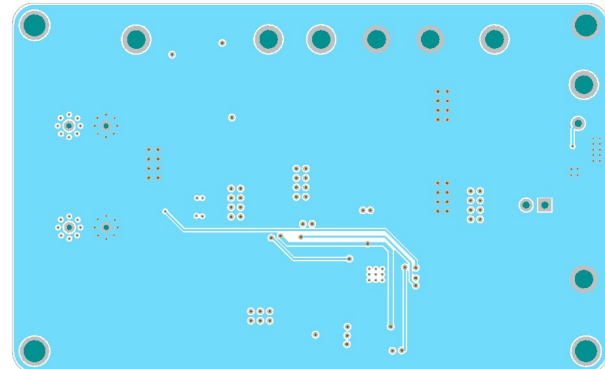


Figure 15 3rd Layer

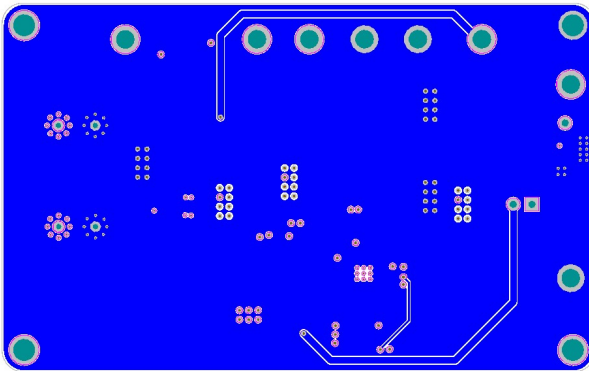


Figure 16 Bottom Layer

Revision History

Rev.	Date	Description	
		Page	Summary
0.1	Sep. 03, 2020	—	First edition issued
0.2	Sep. 14, 2020	3-5	Add test environment and test example
0.3	Sep. 15, 2020	—	Modify header and footer

General Precautions in the Handling of Micro processing Unit and Microcontroller Unit Products

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1. Precaution against Electrostatic Discharge (ESD)

A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.

2. Processing at power-on

The state of the product is undefined at the time when power is supplied. The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the time when power is supplied. In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the time when power is supplied until the reset process is completed. In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the time when power is supplied until the power reaches the level at which resetting is specified.

3. Input of signal during power-off state

Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.

4. Handling of unused pins

Handle unused pins in accordance with the directions given under handling of unused pins in the manual. The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced near the LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible.

5. Clock signals

After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is stabilized. When the clock signal is generated with an external resonator or from an external oscillator during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Additionally, when switching to a clock signal produced with an external resonator or by an external oscillator while program execution is in progress, wait until the target clock signal is stable.

6. Voltage application waveform at input pin

Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (Max.) and V_{IH} (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (Max.) and V_{IH} (Min.).

7. Prohibition of access to reserved addresses

Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.

8. Differences between products

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(Rev.4.0-1 November 2017)

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TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
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