User's Manual

CN299-1-ISL9122A

High Efficiency IoT Battery System

Rev.1.0
Mar. 12, 2021

Description

The CN299-1-ISL9122A High Efficiency IoT Battery System is the application of optimize battery power supply. The board allows quick evaluation of the low dropout linear regulator ISL9001A and the ultra-low IQ buck-boost regulator ISL9122A, whose output voltage can be adjusted by using I2C interface bus. It is a cost-effective solution for the low-power, seamless PWM/PFM and buck/boost transition application where both stepping up and stepping down voltage capabilities are required.

Specifications

The design specifications of the CN299-1-ISL9122A High Efficiency IoT Battery System are shown in Table 1.

TABLE 1. SPECIFICATIONS

Parameters	Values
Input Voltage (VIN)	1.8V to 5.5V
ISL9122 Output Voltage (VOUT)	1.8V to 5.375V
ISL9001A Input Voltage (VLDO_IN)	2.3V to 6.5V
ISL9001A Output Voltage (VLDO)	1.8V
Max. Output Current (ISL9122A IOUT_MAX)	500mA

Key Features

- 1300nA quiescent current
- Seamless PWM/PFM and buck/boost transition
- IIC Control and voltage adjustability
- 97% peak efficiency
- PC terminal via USB control output

References

ISL9122A Datasheet

ISL9001A Datasheet

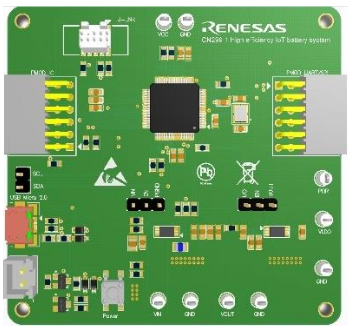

Figure1 Top View

Functional Description

The ISL9122A is a highly integrated non-inverting buck-boost switching regulator that accepts input voltages both above or below the regulated output voltage. It features an extremely low quiescent current consumption of 1300nA in Regulation mode, 120nA in Forced Bypass mode, and 8nA in Shutdown mode. It provides 80% efficiency at 10µA load and has a peak efficiency more than 97%. It supports input voltages from 1.8V to 5.5V.

The ISL9122A supports 3.3V default output voltage at Power-On Reset (POR). After POR, the output voltage can be adjusted in the range of 1.8V to 5.375V controlled by MCU through IIC.

When the system is powered by a battery, the ISL9122A output voltage can be switched by pressing the key. There are 5 levels.

Once connecting the CN299-1-ISL9122A board to the PC, an ISL9122 Demo GUI is available to set the output voltage. And the output voltage and the battery voltage can be monitored in real time on the GUI.

Quick Test Setup

- **ISL9122A default output 3.3V and ISL9001A fixed output 1.8V**

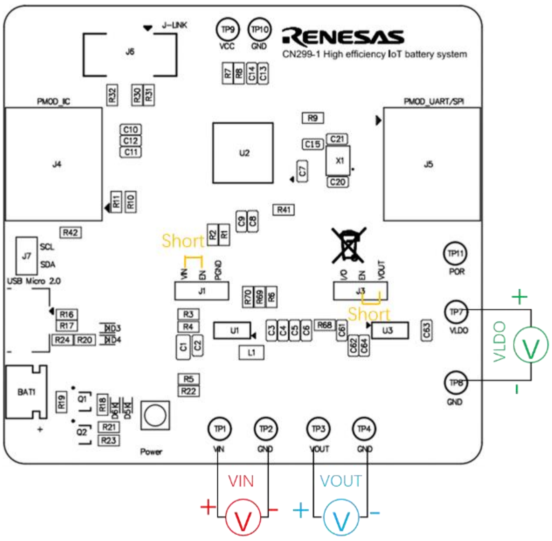

Figure 2 The Connection of the Default Output

1. Connect the power supply to the input terminals VIN (TP1) and GND (TP2). Connect the load to the output VOUT (TP3) and GND (TP4). Short VIN and EN on J1, and EN and VOUT on J3. Make sure the setup is correct prior to applying any power or load to the board. Refer to Figure 2.
2. Adjust the power supply to 1.8V to 5.5V and turn it on.
3. Verify the output voltage is 3.3V(VOUT) and 1.8V(VLDO). Refer to Figure 2.

- **Adjust the ISL9122A output by the keys and ISL9001A fixed output 1.8V**

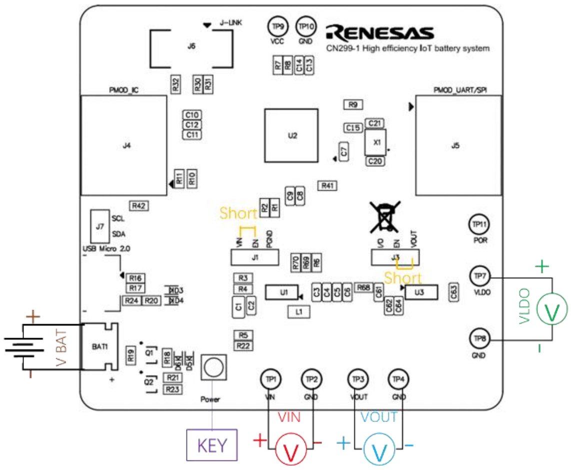

Figure 3 The Connection of Adjust the Output by keys

1. Connect the battery to BAT1. Connect the load to the output VOUT (TP3) and GND (TP4). Short VIN and EN on J1, and EN and VOUT on J3. Make sure the setup is correct prior to applying any power or load to the board. Refer to Figure 2.
2. Press and hold the KEY for 3s to power on the system power.
3. Verify the output voltage is 3.3V(VOUT) and 1.8V(VLDO). Refer to Figure 2.
4. Press the key for a short time to switch the output voltage of ISL9122A. There are 5 voltage levels.

- **Adjust the ISL9122A output by PC and ISL9001A fixed output 1.8V**

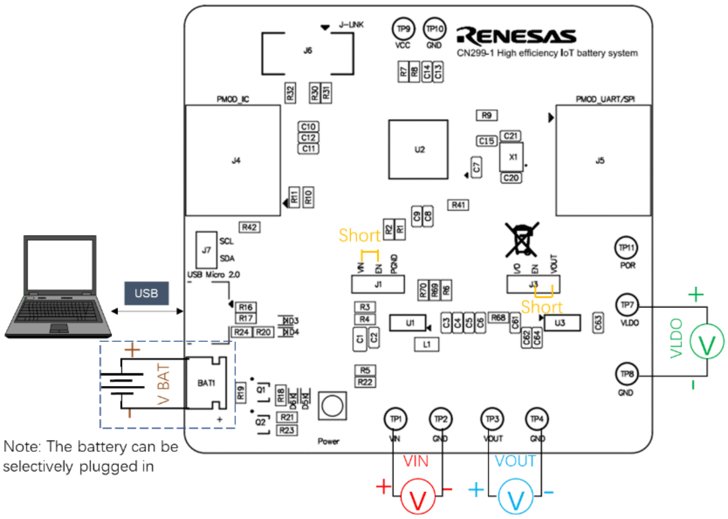

Figure 4 The Connection of Adjust the Output by PC

1. Connect PC to CN299-1-ISL9122A board using USB cable. Connect the load terminals to the output VOUT (TP3) and GND (TP4). Short VIN and EN on J1, and EN and VOUT on J3. Make sure the setup is correct prior to applying any power or load to the board. Refer to Figure 2.
2. Verify the output voltage is 3.3V(VOUT) and 1.8V(VLDO). Refer to Figure 2.
3. Open the GUI. Click the "Connect" button.
4. Use the GUI to adjust the output of the ISL9122A (Adjustable range from 1.8V to 5.375V).

GUI Screenshot

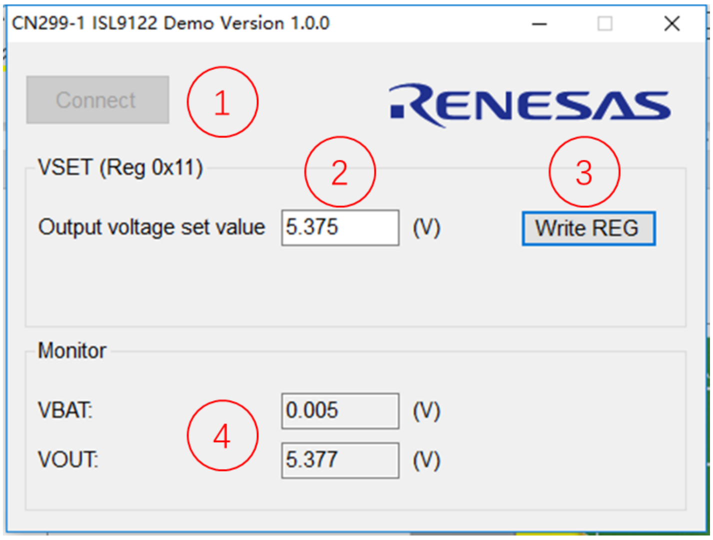

Figure 5 GUI Screenshot

1. Click the "Connect" button to connect the CN299-1-ISL9122A board.
2. Type the setting voltage value.
3. Click the "Write REG" button to send the setting value to MCU.
4. Display the voltage values in real time.

Test Environment

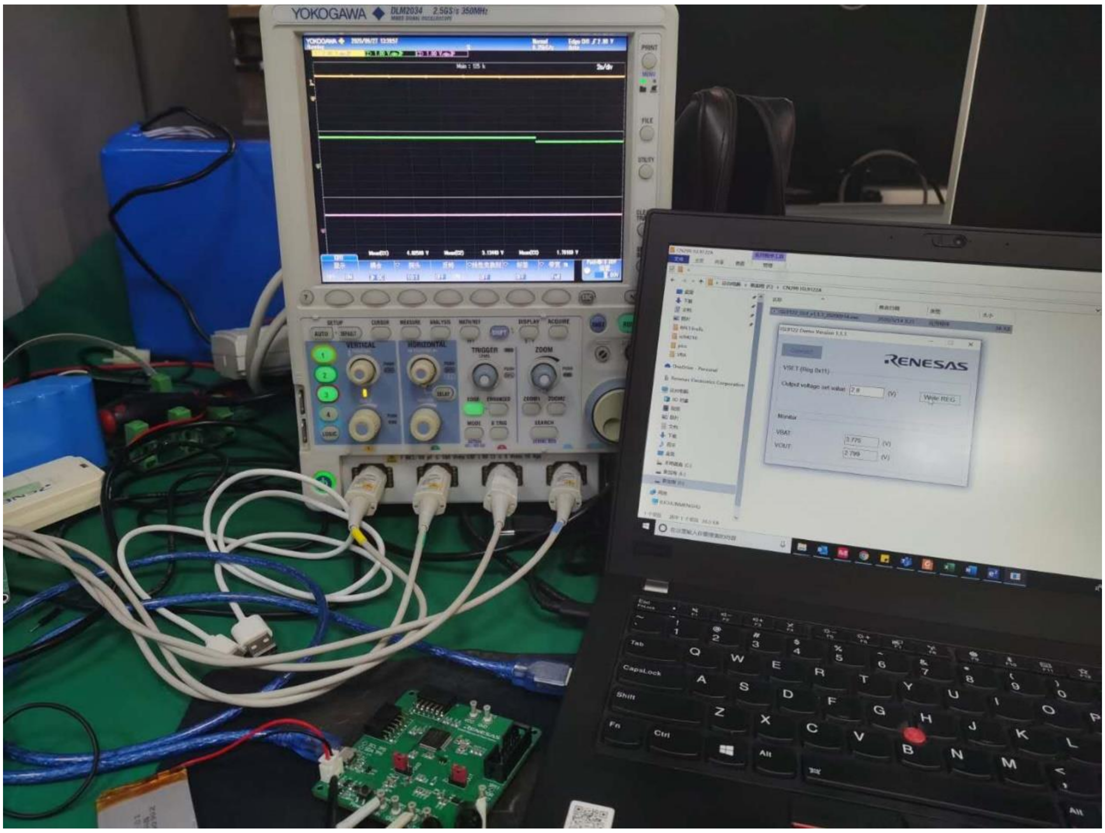

Figure 6 Test Environment

Test Example

- **Default Output**
- Battery powered.
- ISL9122A default output 3.3V, ISL9001A fixed output 1.8V

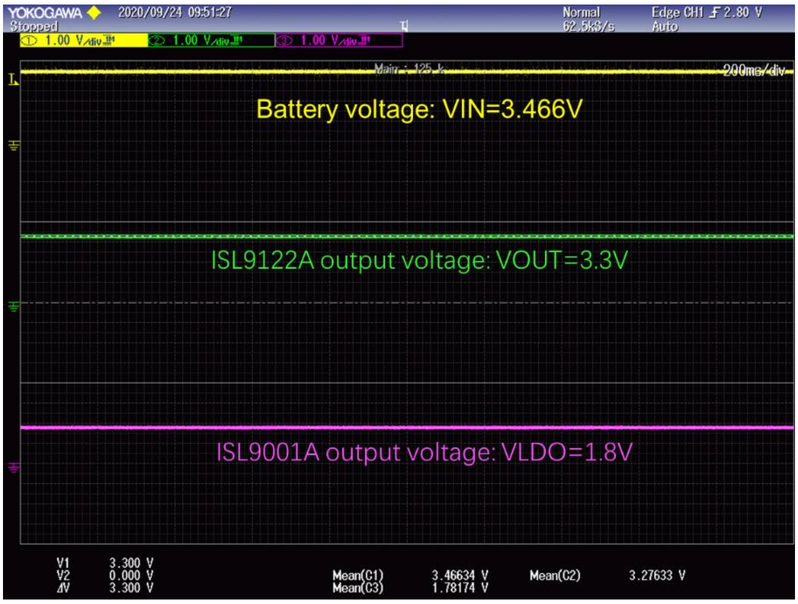

Figure 7 Test of Default Output

- **Adjust the Output by Keys**
- Battery powered
- Adjust the ISL9122A output voltage by Keys
- ISL9001A fixed output 1.8V

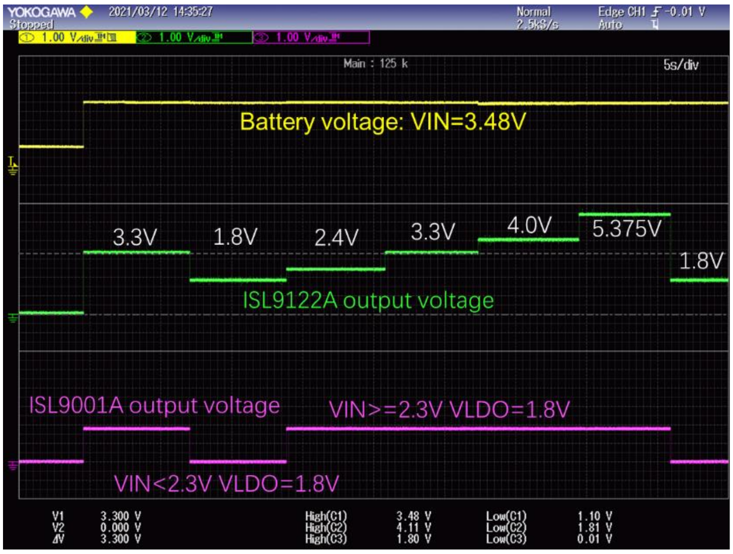

Figure 8 Test of Adjust the Output by Keys

- **Adjust Output by PC**
- USB(PC) powered
- Adjust the ISL9122A output
- ISL9001A fixed output 1.8V

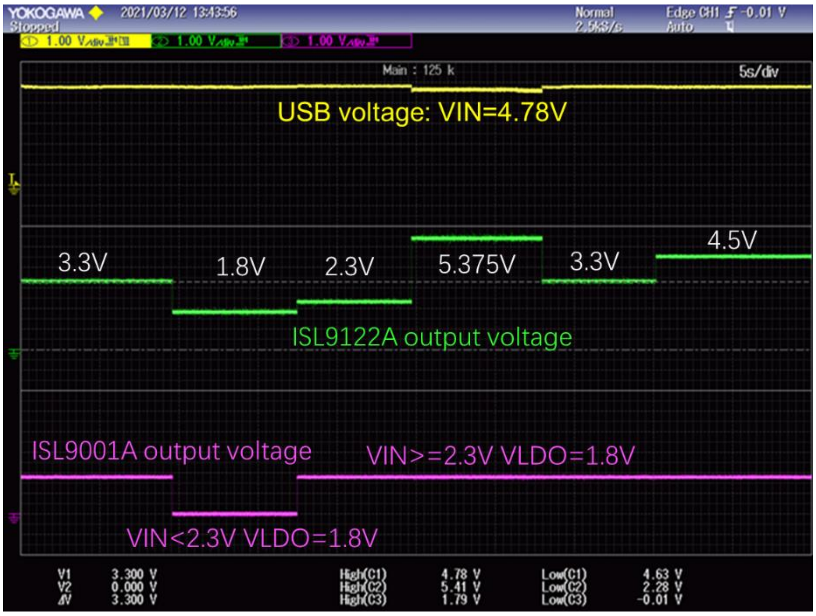

Figure 9 Test of Adjust the Output by PC

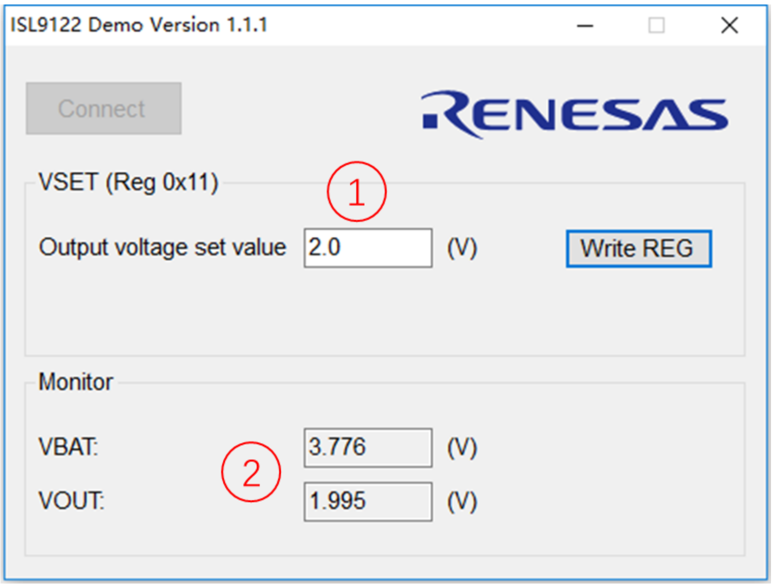

Figure 10 GUI window

1. Set output voltage.
2. Display the battery voltage and output voltage values in real time.

CN299-1-ISL9122A High Efficiency IoT Battery System Circuit Schematic

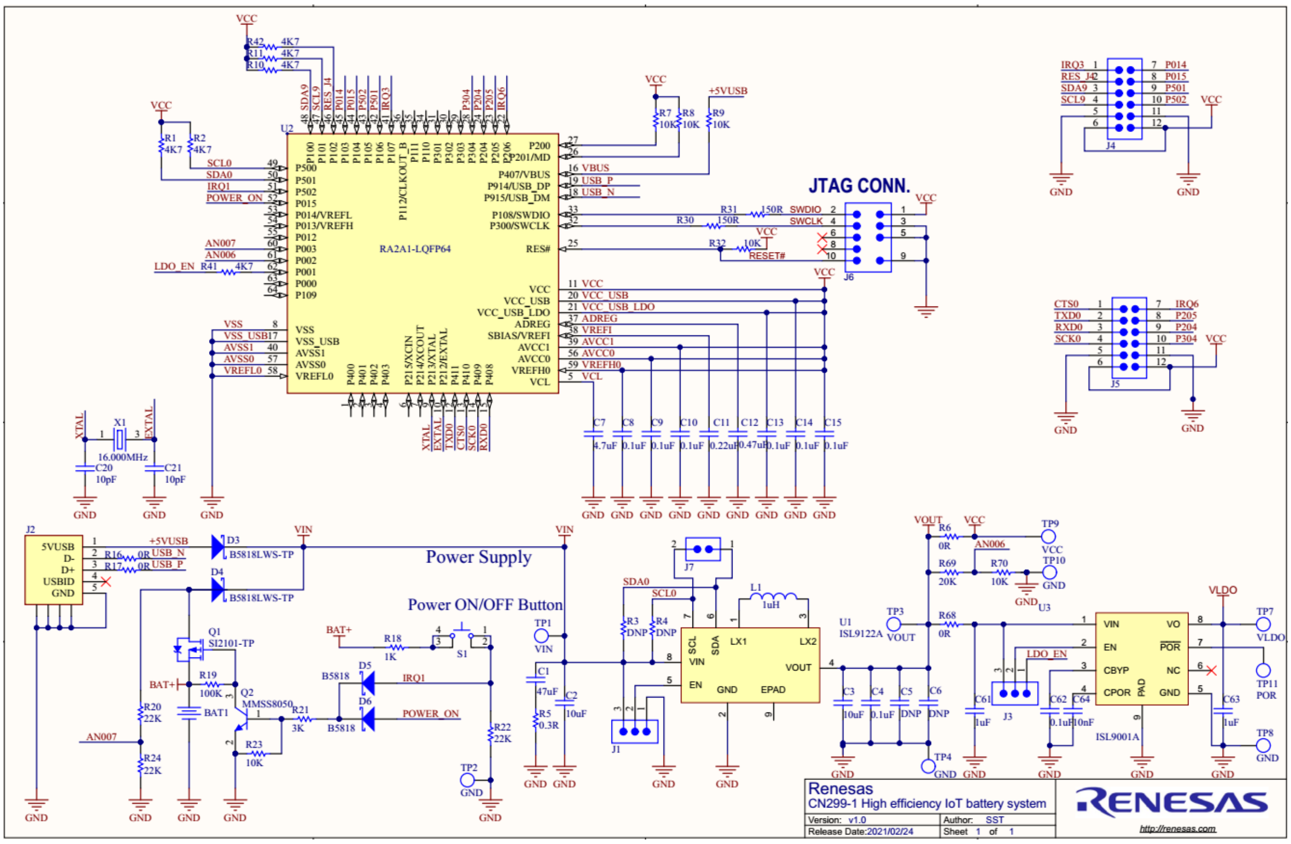

Figure 11 Circuit Schematic

Bill of Materials

TABLE 2. BOM List(1/2)

Designator	Description	Manufacturer	Mfg Part Number	QTY
BAT1	CONN HEADER VERT 2POS 2.5MM	JST	B2B-XH-A(LF)(SN)	1
C1	Ceramic Chip Capacitor 0805 47uF 10V	TDK	C2012X5R1A476M125AC	1
C2, C3	Ceramic Chip Capacitor 0603 10uF 6.3V	Samsung	CL10A106MQ8NNNC	2
C4, C8, C9, C10, C13, C14, C15, C62	Ceramic Chip Capacitor 0603 0.1uF 50V	MURATA	GCM188L81H104KA57D	8
C5, C6	DNP			2
C7	Ceramic Chip Capacitor 0603 4.7uF 6.3V	TDK	CGA3E1X5R0J475K080AC	1
C11	Ceramic Chip Capacitor 0603 0.22uF 50V	MURATA	GCM188R71H224KA64D	1
C12	Ceramic Chip Capacitor 0603 0.47uF 25V	MURATA	GRM188R71E474KA12D	1
C20, C21	Ceramic Chip Capacitor 0603 10pF 50V	Murata	GRM1885C1H100JA01J	2
C61, C63	Ceramic Chip Capacitor 0603 1uF 50V	MURATA	GRT188R61H105KE13D	2
C64	Ceramic Chip Capacitor 0603 10nF 50V	MURATA	GCD188R71H103KA01D	1
D3, D4, D5, D6	Schottky Diode 30V 1A SC-76	MCC	B5818LWS-TP	4
J1, J3	Header 0.1" pitch 3pos 1x3	FCI	77311-818-03LF	2
J2	Connector,MicroUSB B port,5 Position,Right Angle,Gold Flash 1u,black,SMD	FCI	10118192-0001LF	1
J4, J5	Female Header 0.1" pitch 2x6 Male	Sullins	PPTC062LFBN-RC	2
J6	Pin header,RA,male,1.27pitch,2X5p,3H,2.5MM, GF 10u,Getrid 8th pin,Dip	Samtec	FTSH-105-01-L-DV-007-K	1
J7	FCI Header 0.1" pitch 2pos 1x2	FCI	67997-402HLF	1
L1	FIXED IND 1UH 1.5A 125MOHM 0806	Murata	LQM2MPN1R0MEHL	1
Q1	Mosfet,P-Channel,20V,1.4A,SOT-23,SMD	MCC	SI2101-TP	1
Q2	TRANS NPN 25V 1.5A SOT23	MCC	MMSS8050-H-TP	1
R1, R2, R10, R11, R41, R42	Chip Resistor Thick Film 0603 4K7 1% 1/10W	YAGEO	RC0603FR-074K7L	6
R3, R4	DNP			2
R5	Chip Resistor Thick Film 0603 R30 1% 1/10W	YAGEO	RL0603FR-070R3L	1
R6, R16, R17, R68	Chip Resistor Thick Film 0603 0R 1% 1/10W	YAGEO	RC0603FR-070RL	4
R7, R8, R9, R23, R32, R70	Chip Resistor Thick Film 0603 10K 1% 1/10W	YAGEO	RC0603FR-0710KL	6
R18	Chip Resistor Thick Film 0603 1K 1% 1/10W	YAGEO	RC0603FR-071KL	1
R19	Chip Resistor Thick Film 0603 100K 1% 1/10W	YAGEO	RC0603FR-07100KL	1
R20, R22, R24	Chip Resistor Thick Film 0603 22K 1% 1/10W	YAGEO	RC0603FR-0722KL	3
R21	Chip Resistor Thick Film 0603 3K 1% 1/10W	YAGEO	RC0603FR-103KL	1
R30, R31	Chip Resistor Thick Film 0603 150R 1% 1/10W	YAGEO	RC0603FR-07150RL	2
R69	Chip Resistor Thick Film 0603 20K 1% 1/10W	YAGEO	RC0603FR-0720KL	1
S1	Push Button Switch 6 x 6mm 4.3mm High	C&K	PTS645SM43SMTR92 LFS	1
TP1, TP3, TP7, TP9	PCB RED TEST POINT Silver Plating 0.063" (1.60mm) Hole Diameter Mounting Type	KE	5010	1
TP2, TP4, TP8, TP10	PCB BLACK TEST POINT Silver Plating 0.063" (1.60mm) Hole Diameter Mounting Type	KE	5011	4
TP11	PCB WHITE TEST POINT Silver Plating 0.063" (1.60mm) Hole Diameter Mounting Type	KE	5012	1

TABLE 3. BOM List(2/2)

Designator	Description	Manufacturer	Mfg Part Number	QTY
U1	Ultra-Low IQ Buck-Boost Regulator With Bypass	Renesas	ISL9122A	1
U2	Renesas RA2A1 32-Bit 48MHz Cortex-M23 MCU LQFP64	Renesas	R7FRA2A1	1
U3	LDO with Low ISUPPLY, High PSRR 8 LD DFN	Renesas	ISL9001A	1
X1	TXC 7V Crystal 16MHz 10pF	TXC Corp	7V16070008	1

Board Layout

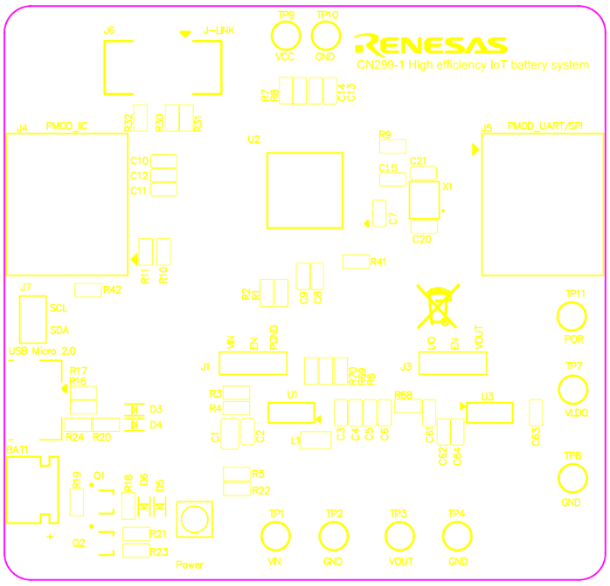

Figure 12 Silkscreen TOP

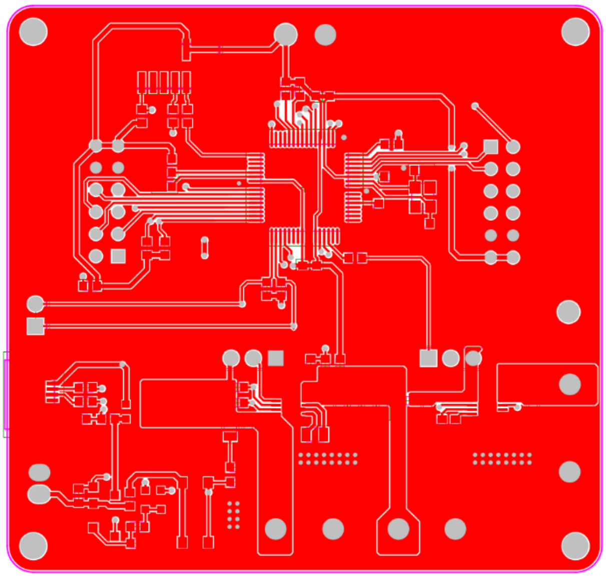

Figure 13 Top Layer

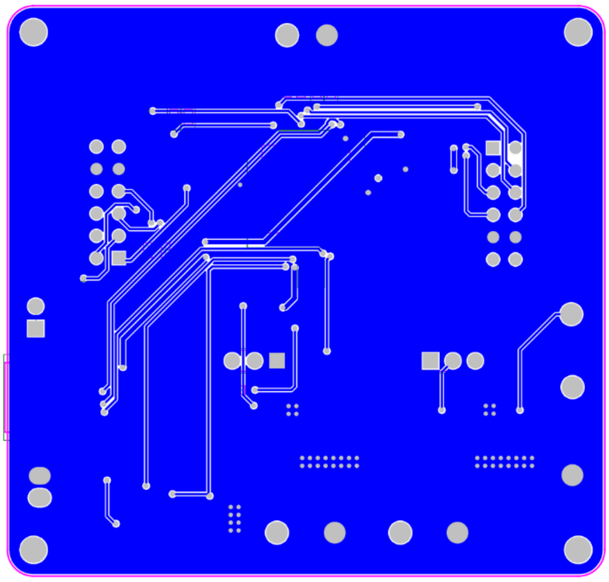

Figure 14 Bottom Layer

Revision History

Rev.	Date	Description	
		Page	Summary
0.1	Mar. 12, 2021	—	First edition issued

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

   Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a micro processing unit or microcontroller unit products in the same group but having a different part number might differ in terms of internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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