RA2L2 group
RA2L2 MCUs USB Type-C Reference Design

Introduction

This user's manual provides an overview and specifications of the RA2L2 MCUs USB Type-C Reference Design.

Contents

1. Overview

1.1 Description

The RA2L2 MCU USB Type-C reference design is a solution for small battery applications with USB Type-C, such as USB data loggers, TWS charging cases, and PC peripherals. In this reference design, the RA2L2 32-bit MCU is used as the main CPU to control peripheral devices such as the charging IC, sensor devices, and the LCD to manage the entire system. Each of the three demonstration use cases allows users to easily experience the RA2L2's features, such as USB Type-C detection, USB 2.0 Full-Speed communication, rich serial communication, and low power.

1.2 Features

- Demonstrates main functions of the RA2L2 MCU close to real application operation
  - RA2L2 (R7FA2L2093CFM)
  - Flash: 128KB, RAM: 16KB, Data Flash: 4KB, Package: 64-pin QFP
- USB Type-C detection, USB 2.0 Full-Speed (FS) communications, rich connectivity, low power
- Compact, single board with battery and small color LCD display
- Supports three demo use cases and two demo modes like real applications
  - Three demo Use Cases: Stand-alone (battery running), connecting to a charger, connecting to a PC
  - Two demo Modes: Low consumption sensing demo mode, mouse demo mode
- Supports two power supplies and charging circuits
  - Two power supplies: 1-cell lithium-ion battery, USB bus power
  - Charging circuit using DA9168 (charger IC)

1.3 RA2L2 MCUs USB Type-C Reference Design composition

This reference design is composed of the following items: Refer to Table 1-1 below.

No	Item	Description
1	RA2L2 USB-C Demonstration Board	Single demo board with RA2L2.. This board is not for sale, so if you would like to use it, please contact our sales team.
2	PCB design files	PCB design data for the RA2L2 USB-C demo board including schematic, BOM list, Gerber data, and artwork files. It is available from the reference design web page.
3	Sample code	Sample code for this reference design. We are currently preparing to open the web page to the public.
4	Application note	This application note describes the details of hardware specifications and sample code. We are currently preparing to open the web page to the public.
5	PC demonstration application	PC demo application to be used with the Demonstration Board. Receives sensor data from the board and displays it graphically on the PC. We are currently preparing to open the web page to the public.

Table 1-1. Reference design composition

1.4 Appearance of the Board and Description of Each Part

Figure 1-1 shows the appearance of the RA2L2 USB-C demonstration board.

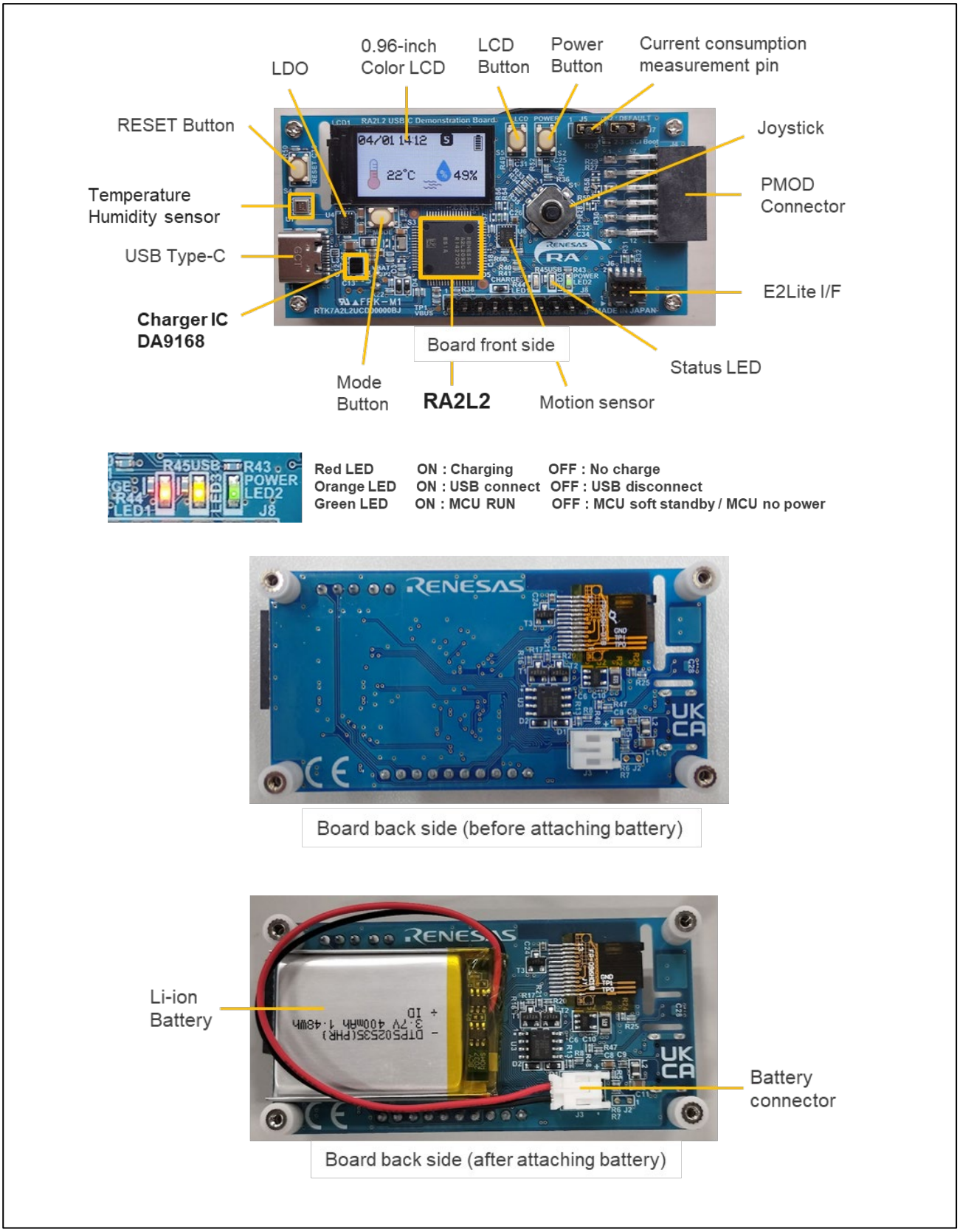


Figure 1-1. Appearance of the board

2. Hardware Specifications

This chapter describes the hardware specifications of the RA2L2 USB-C demonstration board.

2.1 Hardware Specifications Outline

Table 2-1 provides an outline of the board's hardware specifications.

Item	Specifications
Board Part No	RTK7A2L2UCD00000BJ
MCU	RA2L2:R7FA2L2093CFM (Flash:128KB, RAM:16KB, DataFlash:4KB, PKG:64pinQFP)
Sensor	Temperature and humidity sensor ×1 I3C Motion Sensor (TDK: ICM-42688-P) ×1
Button/Switch	Joystick (4-direction + center push) ×1 Power button, Demo mode button, LCD display button, Reset button
LED	Power LED, charging LED, USB communication LED
Display	0.96-inch color LCD
I/F	USB Type-C ×1 Serial I/F external PIN PMOD I/F ×1 E2 Lite debug I/F ×1 SCI boot I/F x1
Charger IC	DA9168 (1cell Li-ion battery charger IC with PMIC)
Power supply	1cell Li-ion battery (Data Power Technology Ltd.: DTP502535 400mAh) USB bus power
External dimensions	35 x 70mm

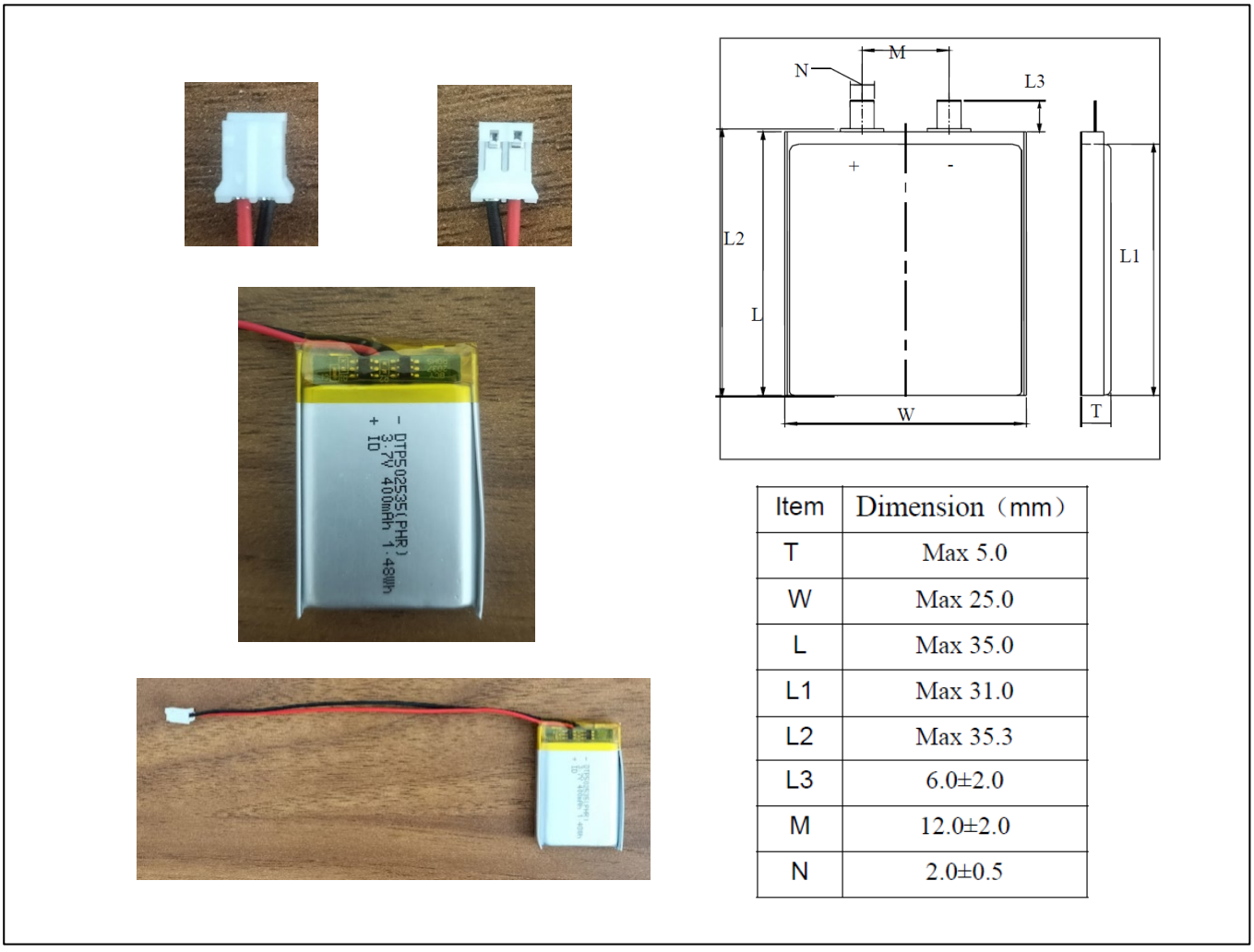
Table 2-1. Hardware specifications Outline

2.2 Battery Specifications Outline

This demonstration board uses 1 cell Li-ion battery (model name: DTP502535) of Data Power Technology Ltd. Table 2-2 shows the battery specifications outline. Figure 2-1 shows the battery dimensions.

Item	Specifications
Battery Type	Polymer Li-ion Recharged Battery
Rated Capacity	400mAh
Normal Voltage	3.70V
Charge Limited Voltage	4.20V
Discharge Cut-off Voltage	2.80V
Maximum Continuous Charge Current	1C (400mA)
Maximum Continuous Discharge Current	1C (400mA)
Operating Temperature Range	Charge: 0~45℃ Discharge: -20~60℃
Storage Temperature Range	-20~60℃
Operating and Storage Humidity Range	65 ± 20%RH

Table 2-2. Battery Specifications Outline



Item	Dimension（mm）
T	Max 5.0
W	Max 25.0
L	Max 35.0
L1	Max 31.0
L2	Max 35.3
L3	6.0±2.0
M	12.0±2.0
N	2.0±0.5

Figure 2-1. Battery dimensions

2.3 RA2L2 specification overview

Table 3-3 shows the specifications of MCU (RA2L2) used in this demonstration board. The Parts number used in this demonstration board is R7FA2L2093CFM.

Parts number		R7FA2L209xCFM	R7FA2L207xCFM	R7FA2L209xCFL R7FA2L209xCNE	R7FA2L207xCFL R7FA2L207xCNE	R7FA2L209xCFJ R7FA2L209xCNH	R7FA2L207xCFJ R7FA2L207xCNH
Pin count		64		48		32	
Package		LQFP		LQFP/HWQFN		LQFP/HWQFN	
Code flash memory		128 KB	64 KB	128 KB	64 KB	128 KB	64 KB
Data flash memory		4 KB		4 KB		4 KB	
SRAM(Parity)		16 KB		16 KB		16 KB	
System	CPU clock	48 MHz		48 MHz		48 MHz	
	Sub clock oscillator	Yes		Yes		Yes	
	ICU	Yes		Yes		Yes	
	KINT	8		5		4	
Event control	ELC	Yes		Yes		Yes	
DMA	DTC	Yes		Yes		Yes	
Timers	GPT32	1 (PWM outputs: 2)		1 (PWM outputs: 2)		1 (PWM outputs: 2)	
	GPT16	6 (PWM outputs: 12)		6 (PWM outputs: 12)		6 (PWM outputs: 7)	
	AGT	2		2		2	
	RTC	Yes		Yes		Yes	
	WDT/IWDT	Yes		Yes		Yes	
Communication	SCI	4		4		3	
	I3C	1		1		1	
	SPI	1		1		1	
	CAN	1		1		1	
	SSIE	1		1		1	
	UARTA	2		2		2	
	USBFS	1		1		1	
	USBCC	1		1		1	
Analog	ADC12	17		13		10	
	TSN	Yes		Yes		Yes	
Data processing	CRC	Yes		Yes		Yes	
	DOC	Yes		Yes		Yes	
Security		TRNG		TRNG		TRNG	
I/O ports	I/O pins	51		35		21	
	Input pins	3		3		3	
	Pull-up resistors	51		35		21	
	N-ch open-drain outputs	38		24		13	
	5-V tolerance	7		7		5	

Table 2-3. RA2L2 specifications outline

2.4 System Diagram

The system block diagram of this demonstration board is shown in Figure 2-2.

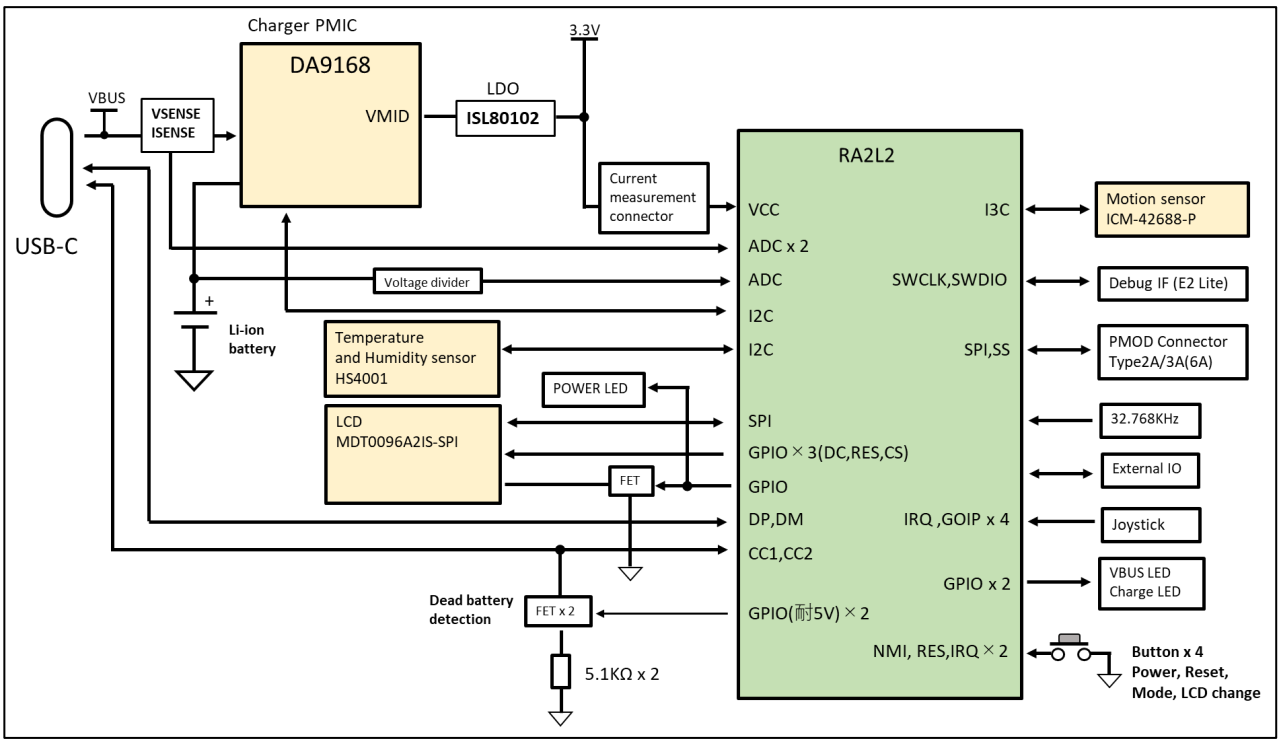


Figure 2-2. System block diagram

3. Software Specifications

This chapter describes the software specifications of the RA2L2 MCUs USB Type-C reference design.

3.1 Software used

The software used for developing MCU software is described in Table 3-1 below.

Integrated development environment	e^2 studio Version 2024-07 (24.7.0)
C compiler	GCC Arm Embedded 13.2.1.arm-13-7
FSP	V5.9.0

Table 3-1. Software to be used

3.2 Software configuration

Figure 3-1 shows the software configuration of MCU sample code used in this reference design.

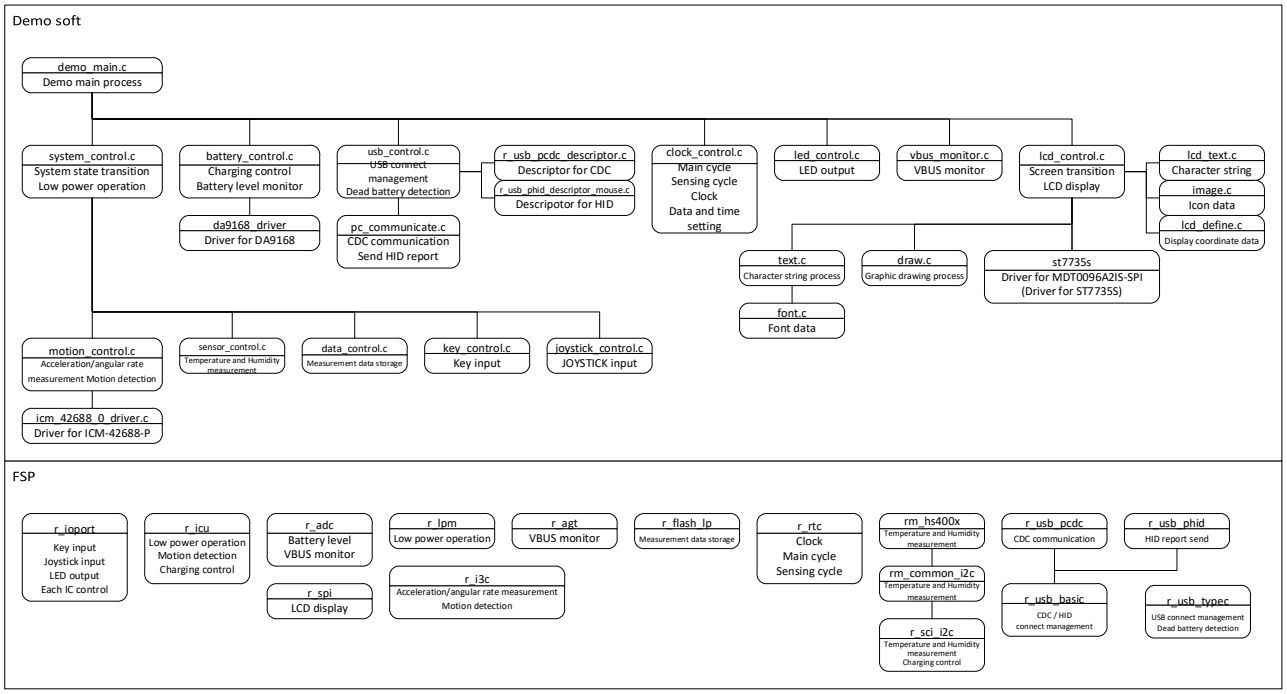


Figure 3-1. Software configuration

3.3 State transition

Figure 3-2 shows the status transitions of MCU sample code used in this reference design.

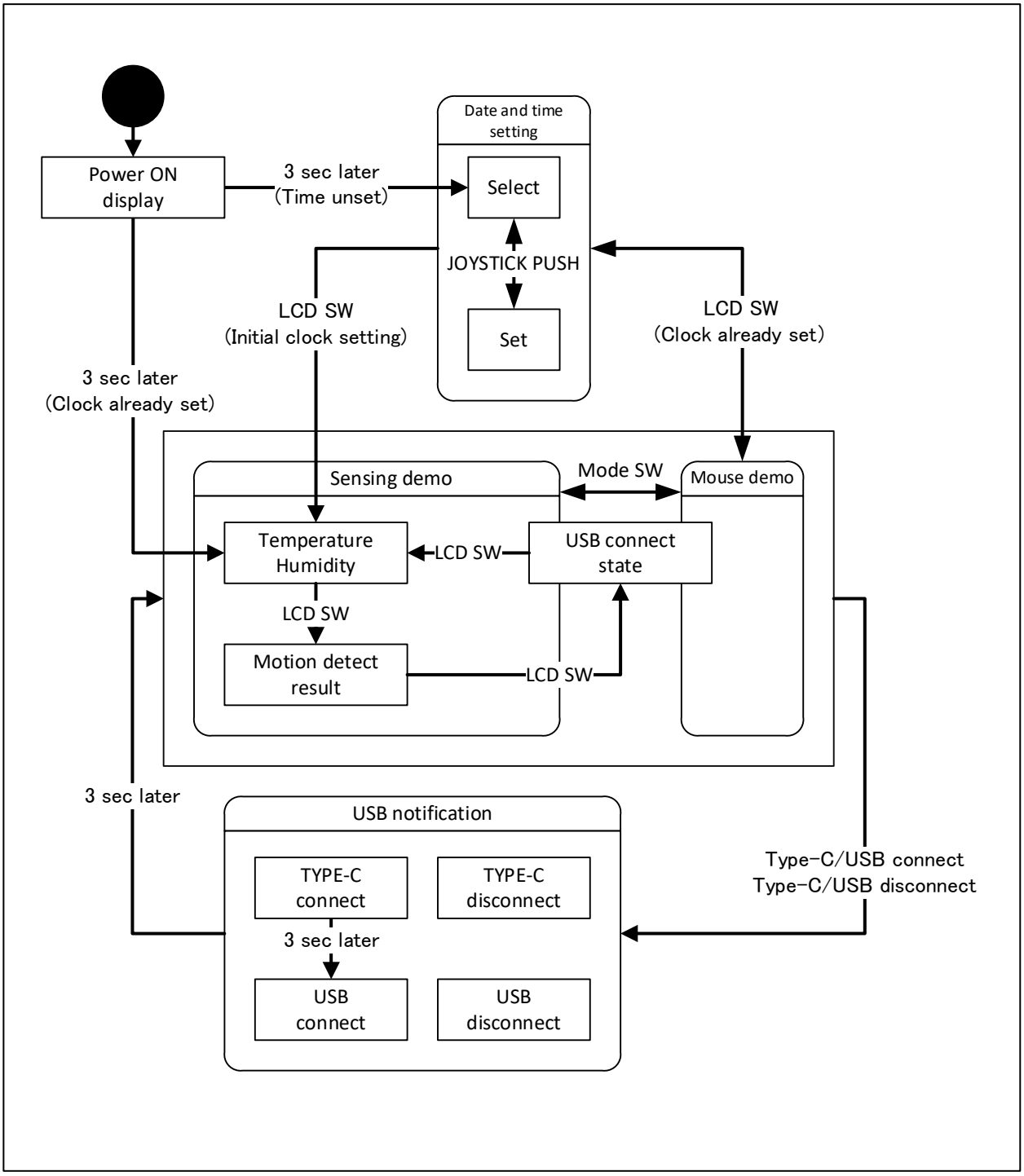


Figure 3-2. State transition diagram

3.4 List of MCU Pin Assignments and Pin Settings

Table 3-2 shows MCU pin assignments and pin settings for this reference design.

Pin No.	Pin name	Selection function	I/O	Active	Function
1	P400	GPIO	O	L	External Rd control for CC1 (OD output)
2	P401	GPIO	O	L	External Rd control for CC2 (OD output)
3	P402	GPIO	I	L	LCD indication selector
4	P403	GPIO	-	-	Free (connected to spare connector)
5	VCL	-	-	-	Capacitor 4.7uF
6	P215	XCIN	-	-	Sub clock
7	P214	XCOUT	-	-	Sub clock
8	VSS	-	-	-	VSS
9	P213	SDA1_A	-	-	Charge IC-SDA
10	P212	SCL1_A	-	-	Charge IC-SCL
11	VCC	-	-	-	VCC
12	P411	GPIO	O	L	Charge IC-CHG_EN
13	P410	IRQ5	I	L	Charge IC-INT
14	P409	GPIO	O	H	Charge IC-EN (reserve)
15	P408	IRQ7	I	L	Motion sensor-INT2(or INT1)
16	USB_DM	USB_DM	-	-	USB communication
17	USB_DP	USB_DP	-	-	USB communication
18	P913	USB_CC1	-	-	Type-C CC detected (CC1)
19	P912	USB_CC2	-	-	Type-C CC detected (CC2)
20	P407	USB_VBUS	-	-	VBUS discovery
21	P207	GPIO	-	-	PMOD (#1) - CS/CTS/-
22	P206	MISO0_D RXD0_D SCL0_D	-	-	PMOD (#3) - MISO/RXD/SCL
23	P205	MOSI0_D TXD0_D SDA0_D	-	-	PMOD (#2) - MOSI/TXD/- PMOD (#4) - SDA
24	P204	SCK0_D	-	-	PMOD (#4) - SCK/RTS
25	RES	-	-	-	Debuggers (#10)-SWD/JTAG Reset button Charging IC-RIN_N
26	P201/MD	MD	-	-	Debuggers (#4)-SWD/JTAG Connected to the spare connector (for SCI boot)
27	P200	GPIO	-	-	-
28	P304	GPIO	O	H	USB power supply LED
29	P303	GPIO	O	H	Charge status LED
20	P302	SDA2_A	-	-	Temperature/humidity sensor-SDA
31	P301	SCL2_A	-	-	Temperature/humidity sensor-SCL
32	P300	SWCLK	-	-	Debuggers (#4)-SWD/JTAG
33	P108	SWDIO	-	-	Debuggers (#2)-SWD/JTAG
34	P109	SCL0_B	-	-	Motion-Sensor-SCL Connected to the spare connector. (/TXD9_B)) for SCI boot)
35	P110	SDA0_B	-	-	Motion Sensor-SDA Connected to the spare connector. (/RXD9_B)) for SCI boot)
36	P111	IRQ4	I	L	Motion Sensor-INT1(or INT2)
37	P112	GPIO	-	-	PMOD (#10) - GPIO

Pin No.	Pin name	Selection function	I/O	Active	Function
38	P113	GPIO	-	-	PMOD (#9) - GPIO
39	VCC	-	-	-	VCC
40	VSS	-	-	-	VSS
41	P107	GPIO			PMOD (#8) - GPIO
42	P106	GPIO			PMOD (#7) - GPIO
43	P105	GPIO	O	L	Color LCD-RESET
44	P104	GPIO	O	-	Color LCD-D/C
45	P103	SSLA0_A	-	-	Color LCD-CS
46	P102	RSPCKA_A	-	-	Color LCD-SCL(CLOCK)
47	P101	MOSIA_A	-	-	Color LCD-SDA(DI)
48	P100	MISOA_A	-	-	Color LCD-SDA(DO)
49	P500	GPIO	O	H	Powered LED Color LCD-Backlight
50	P501	GPIO	O	-	Motion-Sensor-AD0
51	P502	GPIO	I	L	Joystick-Center
52	P015	RXDA1_A	-	-	Reserved (USB-serial convert)
53	P014	TXDA1_A	-	-	Reserved (USB-serial convert)
54	P013	GPIO	I	L	Joystick-A
55	P012	GPIO	I	L	Joystick-B
56	AVCC0	-	-	-	VCC
57	AVSS0	-	-	-	VSS
58	P011	GPIO	I	L	Joystick-C
59	P010	GPIO	I	L	Joystick-D
60	P004	GPIO	I	L	Demo mode select button
61	P003	AN003	I	-	Battery level
62	P002	AN002	I	-	VBUS monitor-ISENSE
63	P001	AN001	I	-	VBUS monitor-VSENSE
64	P000	IRQ6	I	L	Power ON Standby button

Table 3-2. MCU Pin Assignments and Pin Settings

Revision record

Rev.	Issue Date	Details of revision	
		Page	Point
1.0	2025.5.12	-	First edition

General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

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 in the vicinity of 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.).
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   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 microprocessing 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 produ

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