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32-BIT MICROCONTROLLER
FM3 family Application Note

Wireless System Board

User Manual

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Revision History

Rev	Date	Remark
1.0	Aug.24,2011	First Edition
2.0	Feb.6,2012	Updated to latest format Deleted about FW and GUI part

Table of Contents

Target products

This application note is described about below products;

(TYPE0)

Series	Product Number (not included Package suffix)
MB9B500B	MB9BF504NB,MB9BF505NB,MB9BF506NB MB9BF504RB,MB9BF505RB,MB9BF506RB
MB9B400B	MB9BF404NB,MB9BF405NB,MB9BF406NB MB9BF404RB,MB9BF405RB,MB9BF406RB
MB9B300B	MB9BF304NB,MB9BF305NB,MB9BF306NB MB9BF304RB,MB9BF305RB,MB9BF306RB
MB9B100B	MB9BF102NB,MB9BF104NB,MB9BF105NB,MB9BF106NB MB9BF102RB,MB9BF104RB,MB9BF105RB,MB9BF106RB

1 INTRODUCTION

This user manual describes how to use and the specifications of the wireless system board.

2 NOTES

The hardware used in this wireless system board and the software that controls the microcontroller have been certified as compliant with the technical standards in the Radio Law of Japan. If you make any modifications or changes to the hardware or software in the system, you should check the law and take the appropriate measures to ensure that you do not infringe the Radio Law of Japan.

Furthermore, all of the countries around the world have established various rules and regulations regarding safety, electromagnetic interference, and radio waves.

You should comply with these rules and regulations when using or designing this wireless system board.

Please understand that Fujitsu will bear absolutely no liability for any damages arising from the use of this wireless system board.

3 OVERVIEW OF THE WIRELESS SYSTEM BOARD

The wireless system board has two demo operation modes as follows.

① Sensor Logger Mode

The slave devices read the measurement values from the hygro-thermometer and illumination sensor and send them to the host device by wireless communication.

Communication is possible with up to 4 slave devices for each host device. (Communication is possible with up to a maximum of 15 devices by expanding the system)

The host device sends the data received from the slave devices to a PC via UART.

② Remote Control Mode

The slave devices read the measurement value of the accelerometer at an interval of 200 milliseconds, and send the value to the host device by wireless communication.

Communication is between one slave device for each host device.

The host device sends the data received from the slave device to a PC via UART.

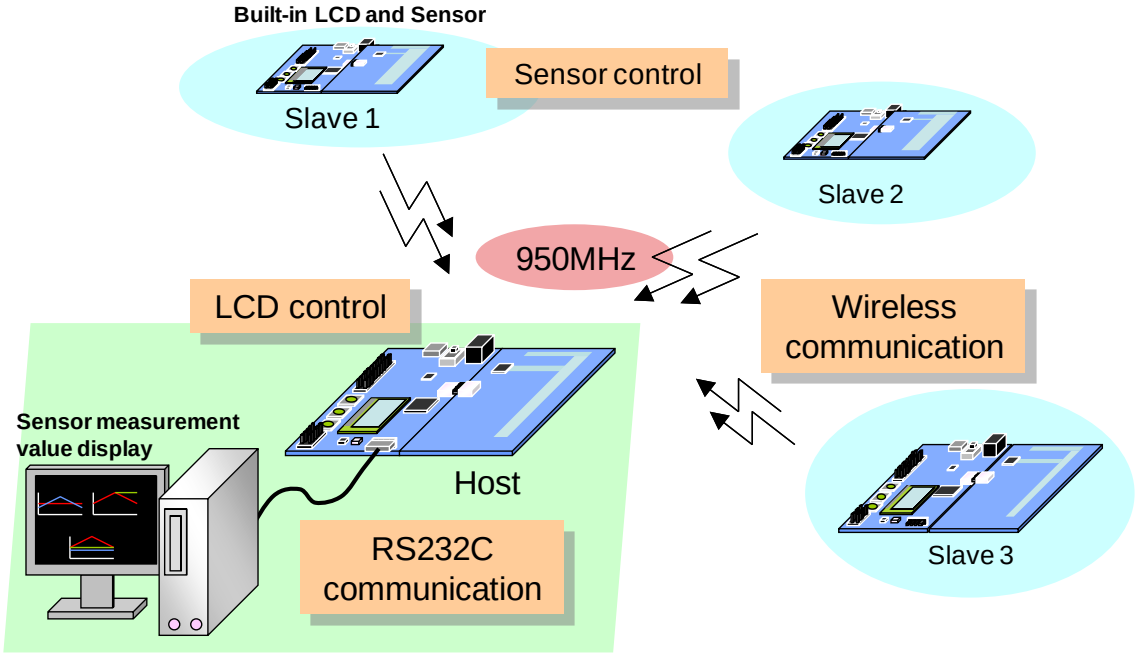

Figure 1 System overview diagram

4 PREPARING THE DEVICE

4.1 Items Included with the Product

A list of the items included with the wireless system board is shown in Table 1, a photograph of the external appearance of the host and slave wireless system boards is shown in Figure 2, and a photograph of the external appearance of the RS232C communication conversion cable is shown in Figure 3.

Table 1 List of Items in the Package

No.	Name	Qty.	Remarks
1	Host wireless system board	1	The hardware is the same as No.2
2	Slave wireless system board	1	The hardware is the same as No.1
3	RS232C communication conversion cable	1	RS232C cable that connects between No.1 and the PC

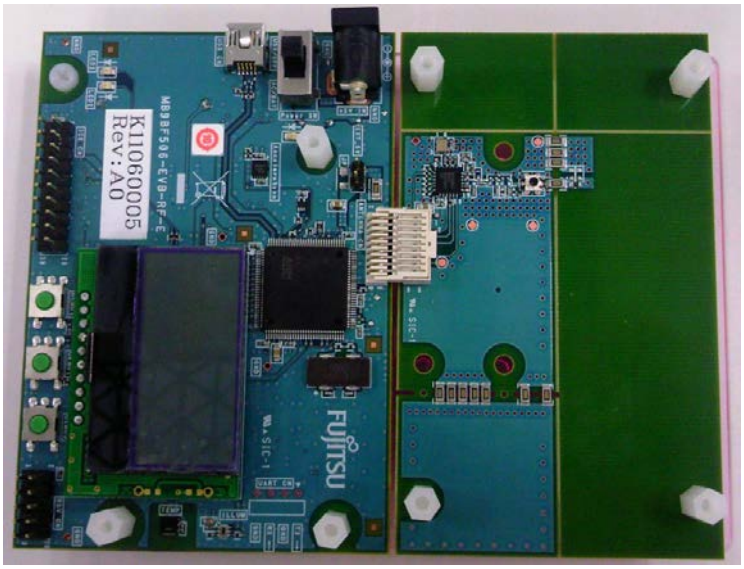

Figure 2 Host and slave wireless system boards

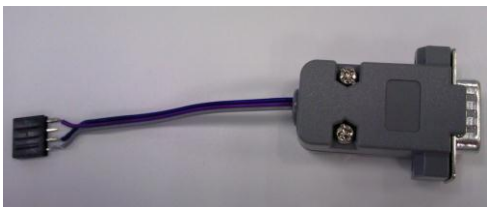

Figure 3 RS232C communication conversion cable

4.2 Required Equipment Not Included with the Product

A list of required equipment that is not included with the product is shown in Table 2, and a list of equipment that can be used if needed is shown in Table 3.

Table 2 List of Required Equipment Not Included with the Product

No.	Name		Qty.	Remarks
1	PC		1	
2	Application executable file		1	Application software that runs on the PC Can be downloaded from the WEB
3	RS232C cable		1	Cross cable
4	Power supply device			Select depending on the power supply method
	(1)	AAA battery	4	Used when power supplied by battery
	(2)	USB cable	1	Cable with TypeA-miniB connector

Table 3 List of Equipment to be used if needed

No.	Name	Qty.	Remarks
1	ICE	1	Required when performing software debugging

4.3 External Appearance of the Wireless System Board

Photographs of the external appearance of the host and slave wireless system boards are shown in Figure 4 and Figure 5.

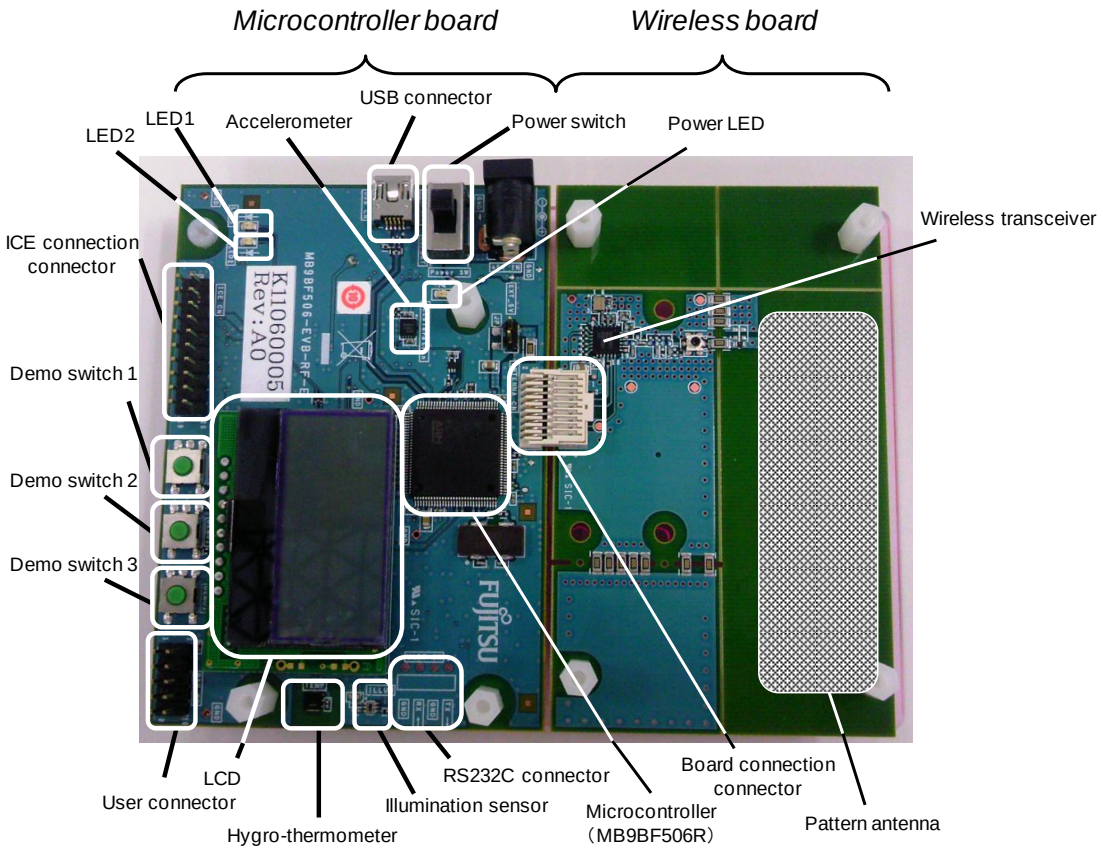

Figure 4 External appearance of the wireless system boards (front surface)

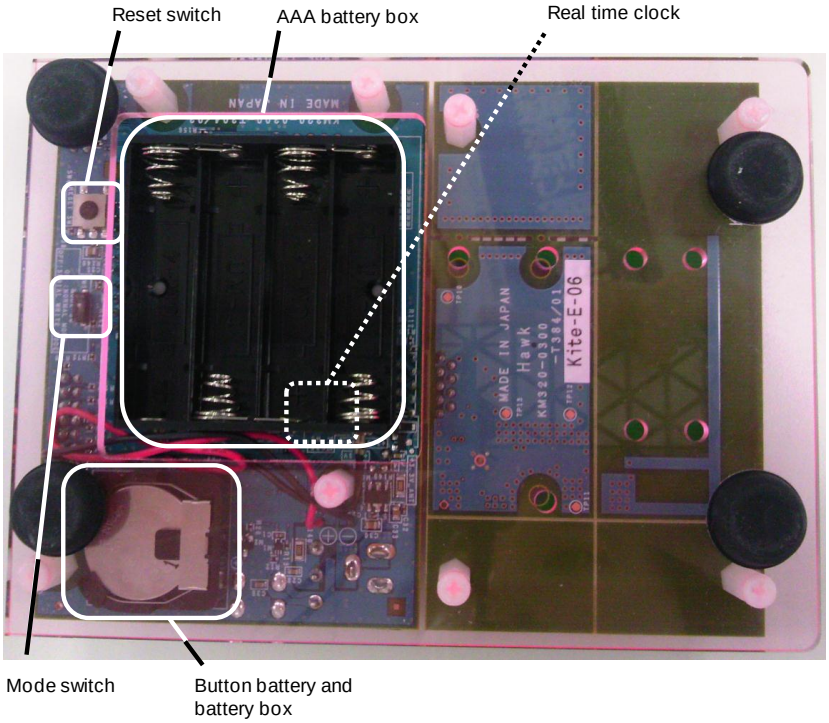

Figure 5 External appearance of the wireless system boards (rear surface)

4.4 Connecting the RS232C Communication Conversion Cable

A diagram inserting the RS232C communication conversion cable that is used for connection the host wireless system board to a PC is shown in Figure 6.

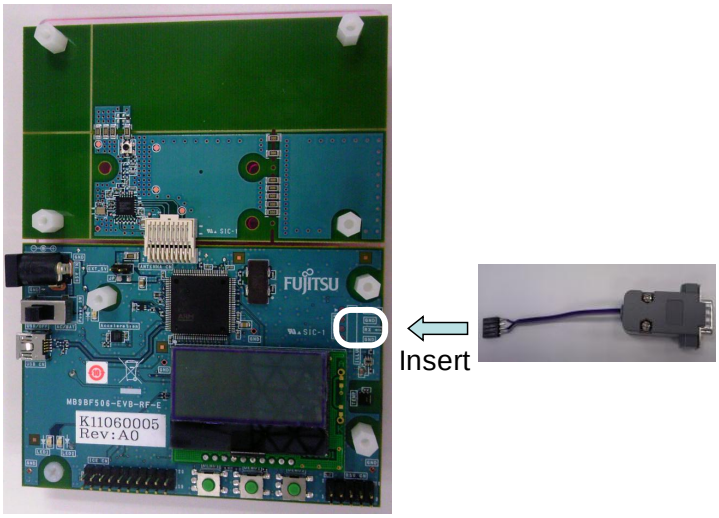

Figure 6 Connecting the wireless system board and RS232C communication conversion cable

4.5 Setting up the PC

GUI is used for demonstration. In this chapter, the explanation of GUI is omitted.

5 POWER SUPPLY METHOD

There are two different ways of supplying power to the wireless system boards.

5.1 Power Supply by Battery

Insert four AAA batteries into the battery box on the rear side of the wireless system board as shown in Figure 7.

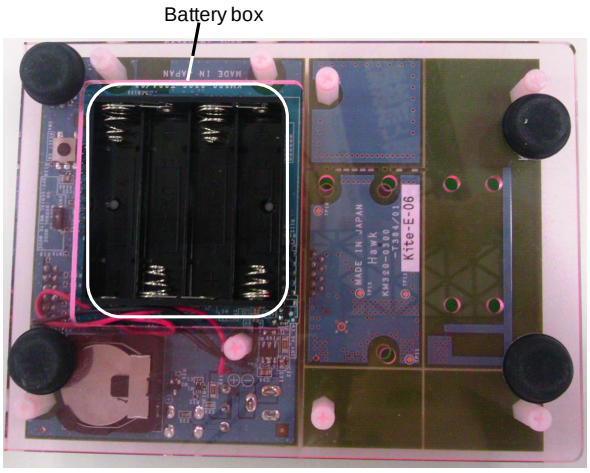

Figure 7 Photograph of the rear side of the wireless system board

Power is supplied by turning on the power switch as shown in Figure 8.

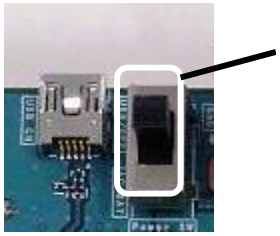

Figure 8 Power Supply When Using Batteries

5.2 Power supply by USB bus power

Connect a USB cable between the USB connector and PC as shown in Figure 9.

Power is supplied by turning on the power switch as shown in Figure 9.

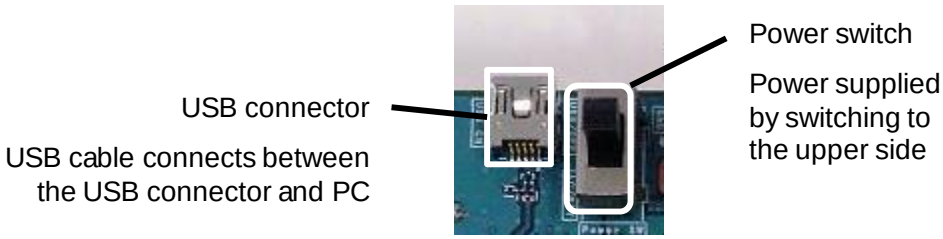

Figure 9 Power supply when using USB bus power

6 OPERATIONS

6.1 Wireless System Board Operations

6.1.1 Overview

6.1.1.1 CPU Operation Modes

The wireless system boards have three CPU operation modes as shown in Table 4.

Host devices have mode 1 and mode 2, and slave devices have mode 1, mode 2, and mode 3.

Table 4 CPU Operation Modes

CPU operation mode	Microcontroller operation state	Host devices	Slave devices
1	CPU regular operation (PLL oscillator) CPU CLK=80MHz Peripheral CLK=40MHz	○	○
2	CPU regular operation (PLL oscillator) CPU CLK=60MHz Peripheral CLK=30MHz	○	○
3	CPU intermittent operation (PLL oscillator/CR oscillator) When active: PLL oscillator CPU CLK=80MHz Peripheral CLK=40MHz When standby: CR oscillator CPU CLK=Stopped Peripheral CLK=4MHz	—	○

6.1.1.2 Overview of Operating the Application

A block diagram showing an overview of the operation of the wireless system board application is shown in Figure 10.

At startup, you can choose between “Sensor Logger Mode” and “Remote Control Mode”, and in “Sensor Logger Mode”, you can also choose the CPU operation mode while running.

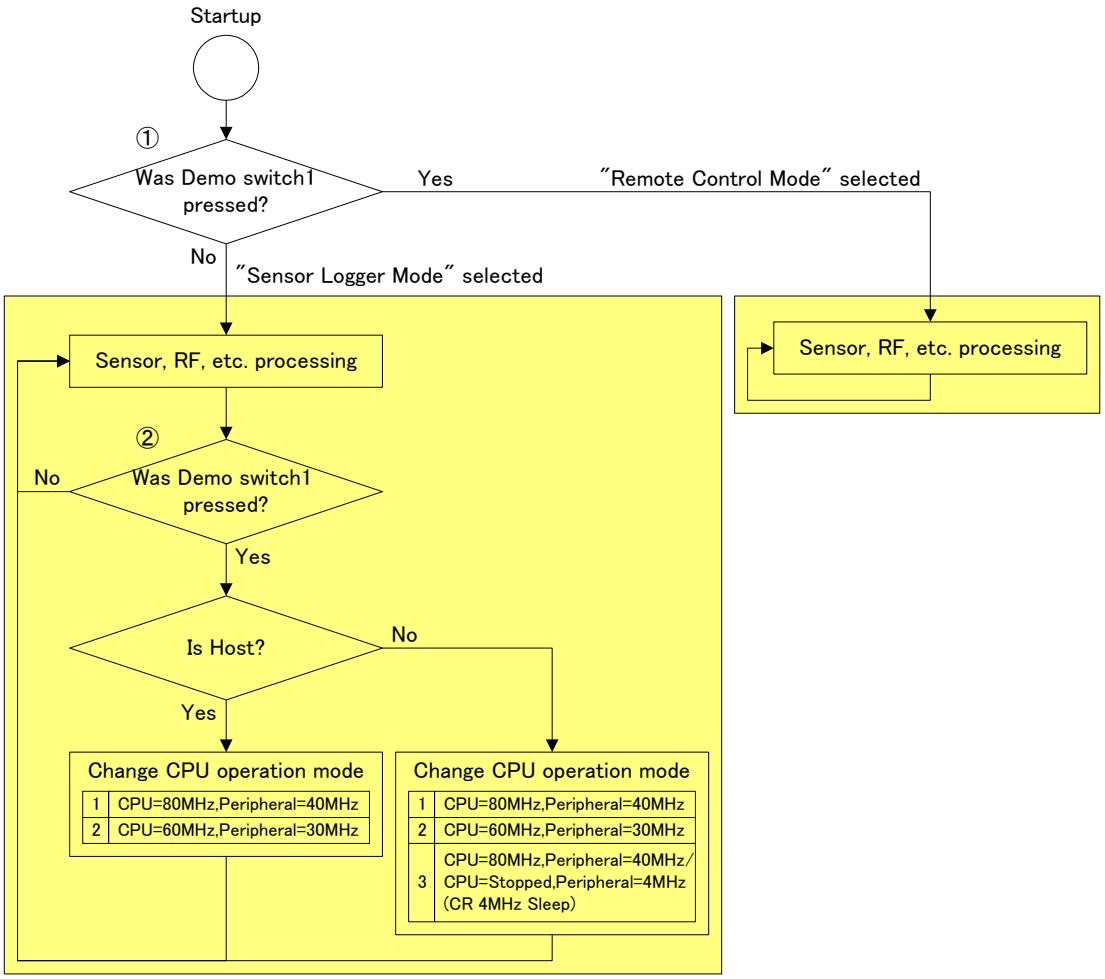

Figure 10 Block diagram showing an overview of the operation of the wireless system board application

◆ LCD display after entering each mode

（1） Remote Control Mode in the host devices and slave devices

Figure 11 LCD display when host device or slave device is in Remote Control Mode

（2） Host device Sensor Logger Mode

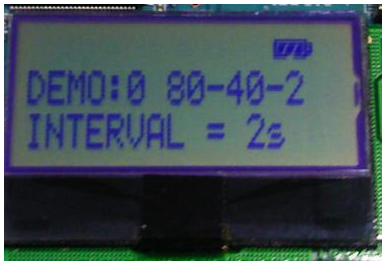

Figure 12 LCD display when host device is in Sensor Logger Mode

（3） Slave device Sensor Logger Mode

Figure 13 LCD display when slave device is in Sensor Logger Mode

6.1.2 Operation

① Select between “Sensor Logger Mode” and “Remote Control Mode” (① in Figure 10)

The mode is selected by the pressed status of demo switch 1 on the wireless system board when the power is turned on.

- Not pressed -> Selects “Sensor Logger Mode”
- Pressed continuously until LED1 goes out -> Selects “Remote Control Mode”

② Select the CPU operation mode when in “Sensor Logger Mode” (② in Figure 10)

When running in “Sensor Logger Mode”, the CPU operation mode is selected by pressing demo switch 1 on the wireless system board.

Although there are three CPU operation modes, the selection of the CPU operation mode differs between host devices and slave devices.

- On host devices

  The selection toggles between mode 1 and mode 2 when demo switch 1 is pressed.
- On slave devices

  The selection cycles through the sequence mode 1 -> mode 2 -> mode 3 -> mode 1 … when demo switch 1 is pressed.

6.2 PC Operation

6.2.1 Overview

The following shows the structural overview of the operation of the PC application.

Upon starting, the TOP screen is displayed, and either the Sensor Logger Mode or the Remote Control Mode can be selected from the TOP screen. You should set the mode selected on the PC application to the same as the mode selected on the board.

The PC application is exited by selecting "×" from the TOP screen.

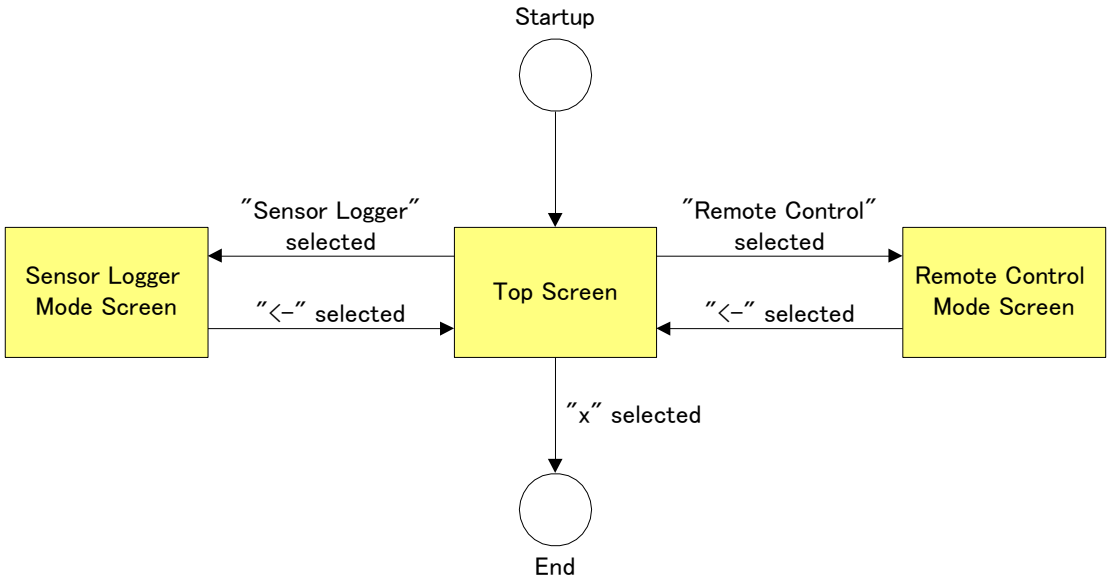

Figure 14 Block diagram showing an overview of the PC application operation

6.2.2 Operation

6.2.2.1 Setting the Port Number

Before running the PC application, the port number that the host device is connected to needs to be set. The port number is configured by editing “Config.ini”. “Config.ini” has the following structure, with the port number configured by changing the numeric value part on the right side of the parameter.

```
[setting]
COM port number = COM1 ―  Set the port number by changing the number
```

Figure 15 Structure of “Config.ini”

6.2.2.2 TOP Screen

After configuring the port number, run “PC_DEMO_APL.exe”. When it is run, the TOP screen shown in Figure 24 is displayed. To switch to the Sensor Logger Mode screen, press the “Sensor Logger” button, and to switch to the Remote Control Mode Screen, press the “Remote Control” button. To exit the PC application, press the “×” button.

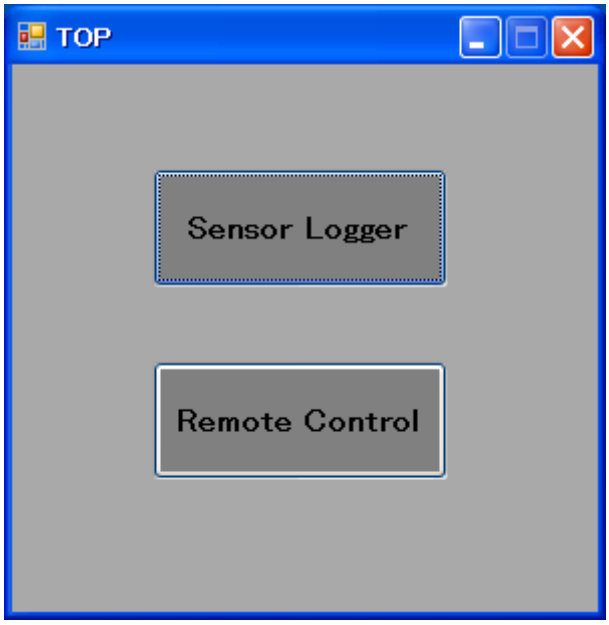

Figure 16 TOP screen

6.2.2.3 Sensor Logger Mode Screen

Press the “Sensor Logger” button in the TOP screen to display the Sensor Logger Mode screen. This mode displays the measurement values of the temperature, humidity, and illumination sensors sent from a maximum of 4 slave devices. The text boxes above each of the graphs display the latest measurement values from each of the sensors as sent from the slave devices.

To return to the TOP screen, press the “<-” button.

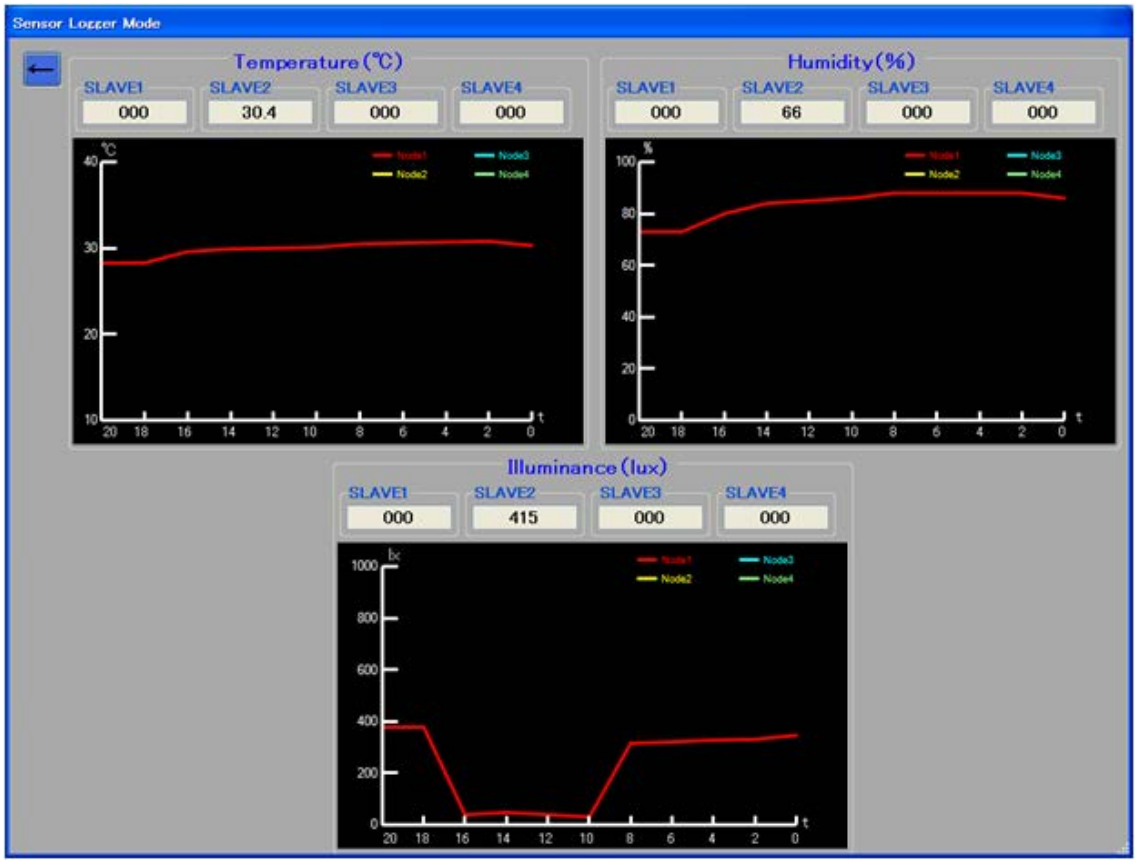

Figure 17 Sensor Logger Mode screen

6.2.2.4 Remote Control Mode Screen

Press the “Remote Control” button in the TOP screen to display the Remote Control Mode Screen. This mode displays a 3D model tilted by the accelerometer measurement values (in each of the three X/Y/Z directions) as sent from a single slave device. The text boxes at the top of the screen display the accelerometer measurement values (X/Y/Z) as sent from the slave device.

To return to the TOP screen, press the “<-” button.

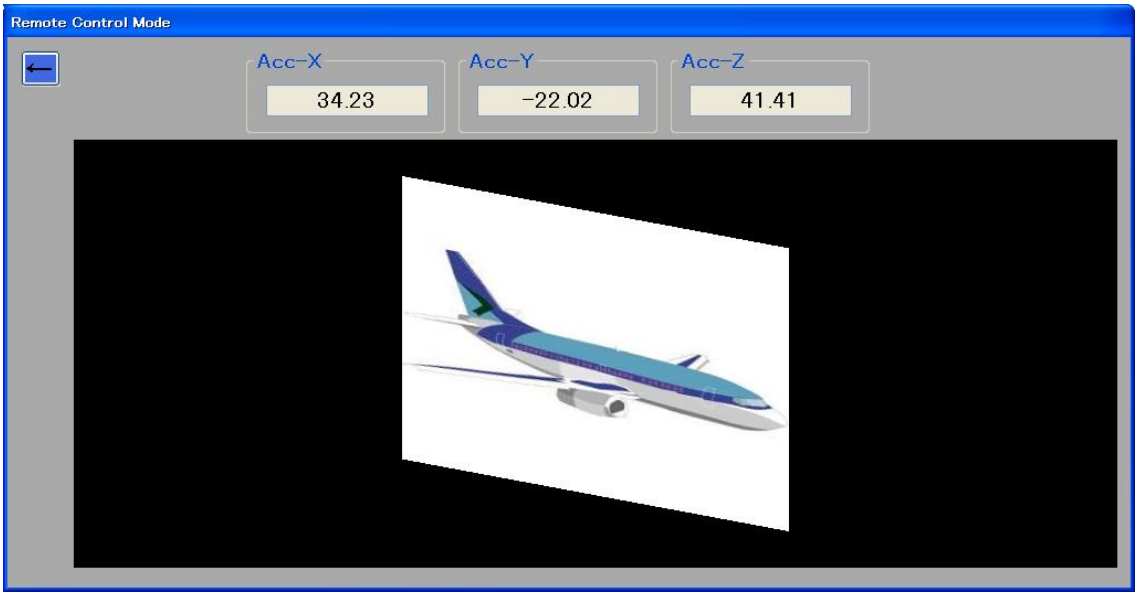

Figure 18 Remote Control Mode Screen

7 SPECIFICATIONS

7.1 Hardware

7.1.1 General Specifications

The general specifications of the wireless system board are shown in Table 5.

Table 5 General Specifications

No.	Item		Details	Remarks
1	Microcontroller		Fujitsu Semiconductor MB9BF506R	
2	External input power supply		DC+5V (+4.5 to +6.5V)	
3	Power consumption	Microcontroller board	150mA (typ.)	Design value
4		Wireless board	When sending: 33mA (typ.) When receiving: 17mA (typ.) When idle: 0.1uA (typ.)	Design value
5	Sensors	Hygro-thermometer	Measurable temperature: -40 to +125℃ Measurable humidity: 0 to 100%RH	Datasheet values
6		Illumination sensor	Measurable range: 1 to 32,768lux	Datasheet values
7		Accelerometer	3-axis, sensitivity: ±1.5g	Datasheet values
8	Switches	Key input switch	Push switch × 3	Green
9		Reset switch	Push switch × 1	Black
10	Display units	LCD panel	16 character × 2 row display	
11		LED	Power on indicator × 1 (red) Demo indicators × 2 (one each orange and green)	
12	Real time clock		Calendar and watch function	
13	Power supply monitor		Detection voltage: +4.2V	
14	External I/F	USB I/F	USB miniB×1ch	
15		RS232C I/F	4-pin connector for conversion cable × 1ch	
16		ICE I/F	20-pin connector for ICE connection × 1ch	
17		User I/F	10-pin connector for user × 1ch	
18	Battery case	For AAA batteries	AAA batteries × 4 pieces	

19		For button battery	CR2032 × 1 piece	For real time clock
20	Operating environment	Temperature	-5℃ to +45℃	Design value
		Humidity	0 to 85%	Design value
21	Environmental conformance		European RoHS, Chinese RoHS	
22	External dimensions (W×D)		100×135mm	
23	Weight (g)		145g	

7.1.2 Wireless Specifications

The wireless specifications of the wireless system board are shown in Table 6.

Table 6 Wireless Specifications

No.	Item	Details	Remarks
1	Standard	Designated low-power wireless station 950MHz band wireless equipment for telemetry, telecontrol, and data transmission	Certified compliant with technical standards
2	Communication mode	Simplex communication	
3	Number of channels used simultaneously	Uses 3 simplex channel simultaneously	The bandwidth used is 3 channels wide
4	Number of channels	7ch	CH18 to 24
5	Frequencies used	954.4 to 955.6MHz	Spacing of 200kHz
6	Modulation type	FSK	
7	Transmission power	Greater than 1mW, less than 10mW	
8	Transmission speed	100kbps MAX	

7.1.3 Hardware Block Diagram

The hardware block diagram is shown in Figure 19.

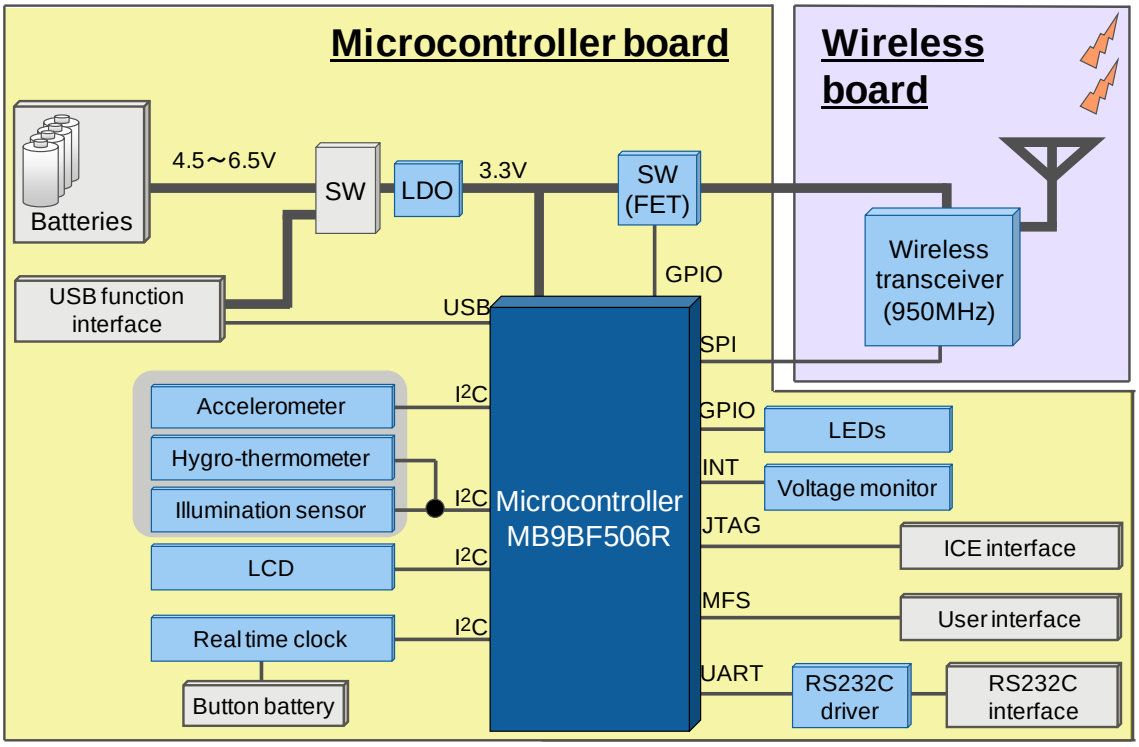

Figure 19 Hardware block diagram

7.1.4 Main Components

The main components of the microcontroller board and wireless board are shown in Table 7 and Table 8.

Table 7 Microcontroller Board Main Component List

No.	Part name	Qty.	Part number	Mfr.	Remarks
1	Microcontroller	1	MB9BF506R	Fujitsu Semiconductor	
2	Illumination sensor	1	ISL29023IROZ-T7	INTERSIL	
3	Hygro-thermometer	1	SHT21	SENSIRION	
4	Accelerometer	1	MMA7660FC	Freescale	
5	RS232C driver	1	MAX3232CUE+	MAXIM	
6	LDO	1	S-1170B33UC-OTSTFU	SII	
7	Voltage monitor	1	BU4842FVE	Rohm	
8	Real time clock	1	RX-8564LC	Epson Toyocom	
9	LCD	1	SB1602B	Strawberry Linux	
10	Quartz oscillator	1	CX1255GB0400H0PESZZ	Kyocera	
11	LED	3	SML-210 series	ROHM	One each red, green, orange
12	Demo switch	3	SKHMQLE010	ALPS	Green
13	Reset switch	1	SKHMQKE010	ALPS	Black
14	Microcontroller mode selection switch	1	CHS-01A	Copal Electronics	
15	Power switch	1	MS-12AAP1	NKK Switches	
16	Board connection connector	1	09P-1.25FJ	JST Connector	
17	User connector	1	FFC-10BMEP1B	Honda Connectors	
18	USB miniB connector	1	E48F-005-8902A	Mitsumi	
19	ICE connection connector	1	FFC-20BMEP1B	Honda Connectors	
20	AAA battery box	1	MP-4-4	Takachi	
21	Button battery box	1	BCR20H5	Takachi	

Table 8 Wireless Board Main Component List

No.	Part name	Qty.	Part number	Mfr.	Remarks
1	Wireless transceiver	1	SX1233IMLTRT	SEMTECH	Version: V2b
2	Quartz oscillator	1	TTS27NSC-A7 32MHz	Tokyo Denpa	TCXO
3	High frequency coaxial connector	1	MM8430-2610	Murata Manufacturing	
4	Board connection connector	1	09R-1.25FJ	JST Connector	

7.1.5 Microcontroller

A list of microcontroller pin connections is shown in Table 9.

Table 9 Microcontroller Pin Connection List

Pin no.	Pin name (Function used)	Connects to	I/O	Remarks
01	VCC	+3.3V power supply	—	
02	INT00_0	Demo switch 1	I	
03	INT01_0	Demo switch 2	I	
04	INT02_0	Demo switch 3	I	
05	INT07_2	Real time clock (INT)	I	
06	SOT6	Real time clock (SDA)	I/O	I^2C communication
07	SCK6	Real time clock (SCL)	I/O	I^2C communication
08	(Not used)	User connector (No.1)	I	
09	(Not used)	User connector (No.3)	I	
10	(Not used)	User connector (No.5)	I	
11	(Not used)	User connector (No.7)	I	
12	(Not used)	User connector (No.9)	I	
13	(Not used)	User connector (No.10)	I	
14	(Not used)	User connector (No.8)	I	
15	(Not used)	User connector (No.6)	I	
16	(Not used)	—	I	
17	(Not used)	—	I	
18	(Not used)	—	I	
19	(Not used)	—	I	
20	(Not used)	—	I	
21	(Not used)	—	I	
22	(Not used)	—	I	
23	(Not used)	—	I	
24	(Not used)	—	I	
25	(Not used)	—	I	
26	(Not used)	—	I	
27	(Not used)	—	I	

Pin no.	Pin name (Function used)	Connects to	I/O	Remarks
28	P3E	LED1 orange	O	
29	P3F	LED2 green	O	
30	VSS	GND	—	
31	VCC	+3.3V power supply	—	
32	(Not used)	—	I	
33	(Not used)	—	I	
34	(Not used)	—	I	
35	(Not used)	—	I	
36	(Not used)	—	I	
37	(Not used)	—	I	
38	C	Capacitor 4.7 μ F	—	
39	VSS	GND	—	
40	VCC	+3.3V power supply	—	
41	(Not used)	—	I	
42	(Not used)	—	I	
43	INTX	Reset switch	I	
44	(Not used)	—	I	
45	SOT3_2	LCD(SDA)	I/O	I^2C communication
46	SCK3_2	LCD(SCL)	I/O	I^2C communication
47	(Not used)	—	I	
48	SCK7_1	Hygro-thermometer (SCL)	I/O	I^2C communication
49	SOT7_1	Hygro-thermometer (SDA)	I/O	I^2C communication
50	(Not used)	—	I	
51	(Not used)	—	I	
52	(Not used)	—	I	
53	(Not used)	—	I	
54	(Not used)	—	I	
55	(Not used)	—	I	
56	MD1	GND	—	
57	MD0	Microcontroller mode selection switch	I	
58	X0	Quartz oscillator (4MHz)	I	

Pin no.	Pin name (Function used)	Connects to	I/O	Remarks
59	X1	Quartz oscillator (4MHz)	I/O	
60	VSS	GND	—	
61	VCC	+3.3V power supply	—	
62	(Not used)	—	I	
63	(Not used)	—	I	
64	(Not used)	—	I	
65	(Not used)	—	I	
66	INT03_1	Wireless transceiver (INT)	I	
67	P15	Wireless transceiver (XCS)	O	
68	P16	Wireless transceiver (RESET)	O	
69	SIN2_2	Wireless transceiver (SIN)	I	SPI communication
70	AVCC	+3.3V power supply	—	
71	AVRH	+3.3V power supply	—	
72	AVSS	GND	—	
73	SOT2_2	Wireless transceiver (SOT)	O	SPI communication
74	SCK2_2	Wireless transceiver (SCK)	O	SPI communication
75	P1A	FET (GATE) (Wireless mode power on/off selection)	O	L:ON, H:OFF
76	(Not used)	—	I	
77	(Not used)	—	I	
78	(Not used)	—	I	
79	(Not used)	—	I	
80	(Not used)	—	I	
81	(Not used)	—	I	
82	(Not used)	—	I	
83	(Not used)	—	I	
84	(Not used)	—	I	
85	(Not used)	—	I	
86	(Not used)	—	I	
87	SOT0_0	RS232C driver (TIN)	O	UART communication
88	SIN0_0	RS232C driver (ROUT)	I	UART communication

Pin no.	Pin name (Function used)	Connects to	I/O	Remarks
89	(Not used)	—	I	
90	VSS	GND	—	
91	VCC	+3.3V power supply	—	
92	TRSTX	ICE connector (TRSTX)	I	
93	TCK	ICE connector (TCK)	I	
94	TDI	ICE connector (TDI)	I	
95	TMS	ICE connector (TMS)	I/O	
96	TDO	ICE connector (TDO)	O	
97	(Not used)	—	I	
98	(Not used)	—	I	
99	(Not used)	—	I	
100	(Not used)	—	I	
101	(Not used)	—	I	
102	(Not used)	—	I	
103	SOT4_0	Accelerometer (SDA)	I/O	I^2C communication
104	SCK4_0	Accelerometer (SCK)	I/O	I^2C communication
105	(Not used)	—	I	
106	(Not used)	—	I	
107	(Not used)	—	I	
108	INT12_2	Accelerometer (INT)	I	
109	(Not used)	—	I	
110	(Not used)	—	I	
111	(Not used)	—	I	
112	INT10_2	Voltage monitor IC (Vout)	I	+5V line monitor
113	(Not used)	—	I	
114	(Not used)	—	I	
115	UHCONX	FET (GATE) (USB D+ pull-up on/off selection)	O	L:ON, H:OFF
116	INT15_1	USB bus power detection	I	
117	USBVCC	+3.3V power supply	—	
118	UDM0	USBminiB connector (USB D-)	I/O	
119	UDP0	USBminiB connector (USB D+)	I/O	

Pin no.	Pin name (Function used)	Connects to	I/O	Remarks
120	VSS	GND	—	

7.1.6 Sensors

The microcontroller board is equipped with an accelerometer, hygro-thermometer, and illumination sensor. These sensors are connected to the microcontroller, and the functions of each sensor can be controlled by the microcontroller. The external appearance and schematic connection diagram of each sensor are shown in Figure 20, and the specifications are shown in Table 10. Refer to the data sheet of the corresponding product for the detailed specifications of each sensor.

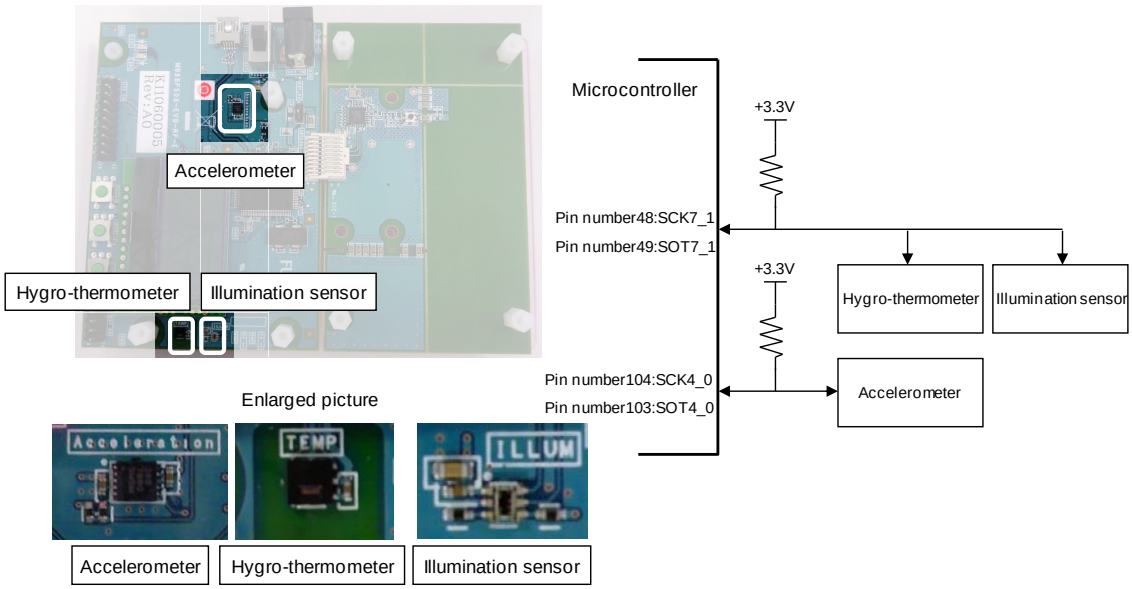

Figure 20 External appearance and schematic connection diagram of each sensor

Table 10 Sensor Specifications

No.	Item	Part number (Mfr.)	Specifications	Microcontroller connection
1	Hygro-thermometer	SHT21 (Sensirion)	Measurable temperature: -40 to +85℃ Measurable humidity: 0 to 100%RH I^2C connection: Address 0x40	Pin number 48: SCK7_1 Pin number 49: SOT7_1

2	Illumination sensor	ISL29023IROZ-T7 (INTERSIL)	Measurable range: 1 to 32,768lux I^2C connection: Address 0x44	
3	Accelerometer	MMA7660FC (Freescale)	3-axis, sensitivity: ± 1.5g I^2C connection: Address 0x4C	Pin number 104: SCK4_0 Pin number 103: SOT4_0

7.1.7 Switches

7.1.7.1 Demo Switch

The microcontroller board is equipped with three demo switches. The external appearance and schematic connection diagram of the demo switches are shown in Figure 21.

Refer to section 6.1.2 for details on the operation when using the demo switches.

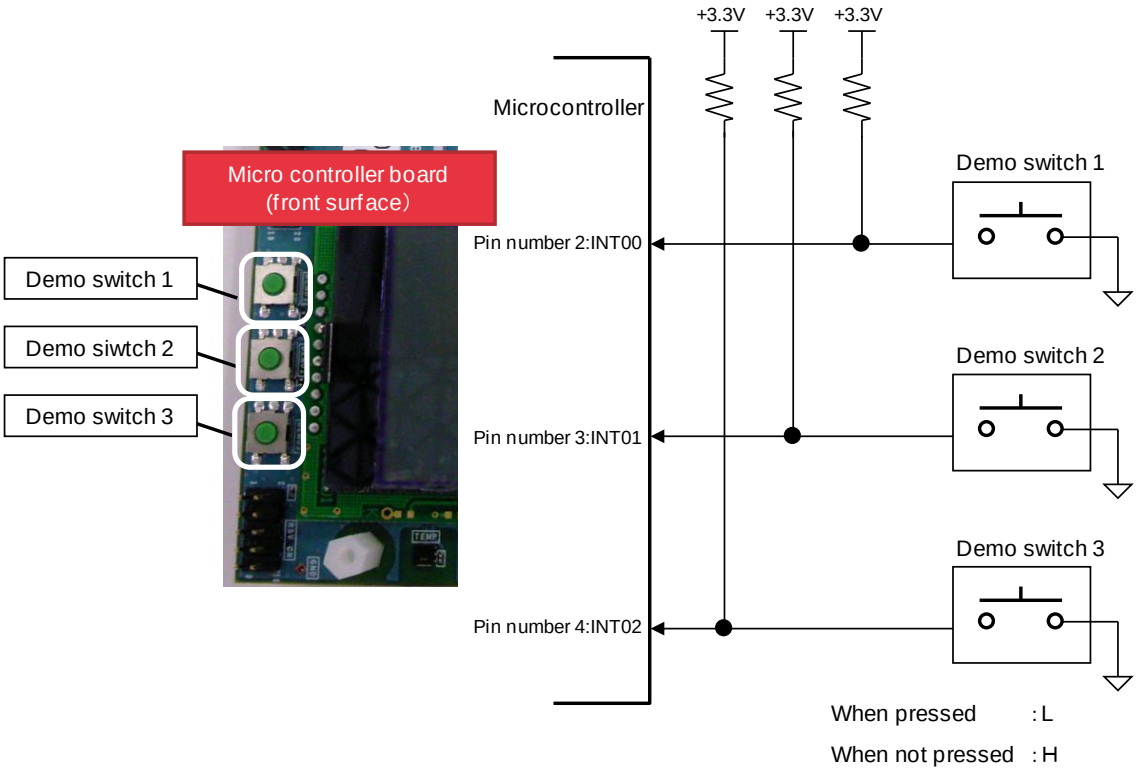

Figure 21 External appearance and schematic connection diagram of demo switches

7.1.7.2 Reset Switch

The microcontroller board is equipped with a reset switch. The external appearance and schematic connection diagram of the reset switch are shown in Figure 22.

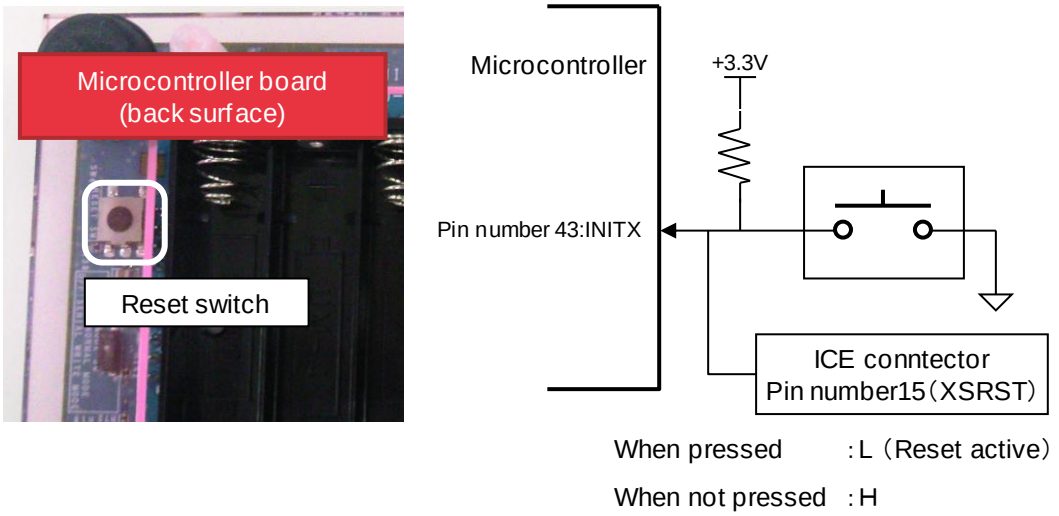

Figure 22 External appearance and schematic connection diagram of the reset switch

7.1.7.3 Microcontroller Mode Selection Switch

The microcontroller board is equipped with a microcontroller mode selection switch. The external appearance and schematic connection diagram of the microcontroller mode selection switch are shown in Figure 23.

Refer to the microcontroller hardware manual for details on the microcontroller modes.

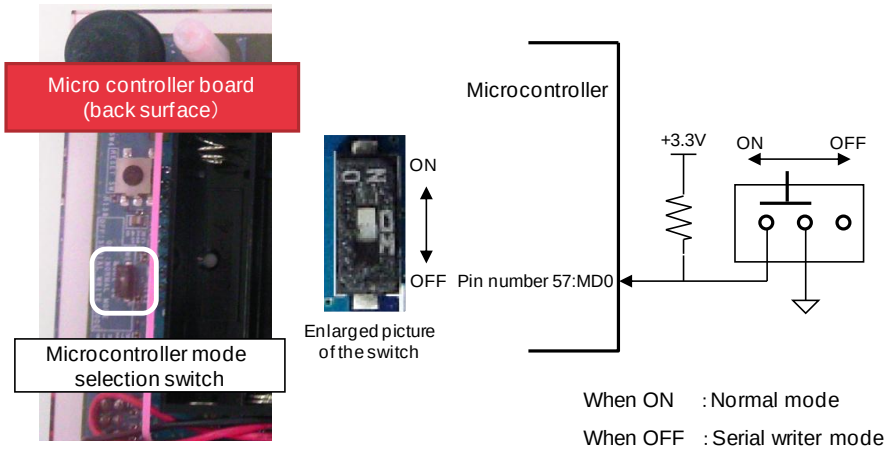

Figure 23 Microcontroller mode selection switch external appearance and schematic connection diagram

7.1.7.4 Power Switch

The microcontroller board is equipped with a power switch. The external appearance and schematic connection diagram of the power switch are shown in Figure 24.

Refer to chapter 5 for details on the power supply methods.

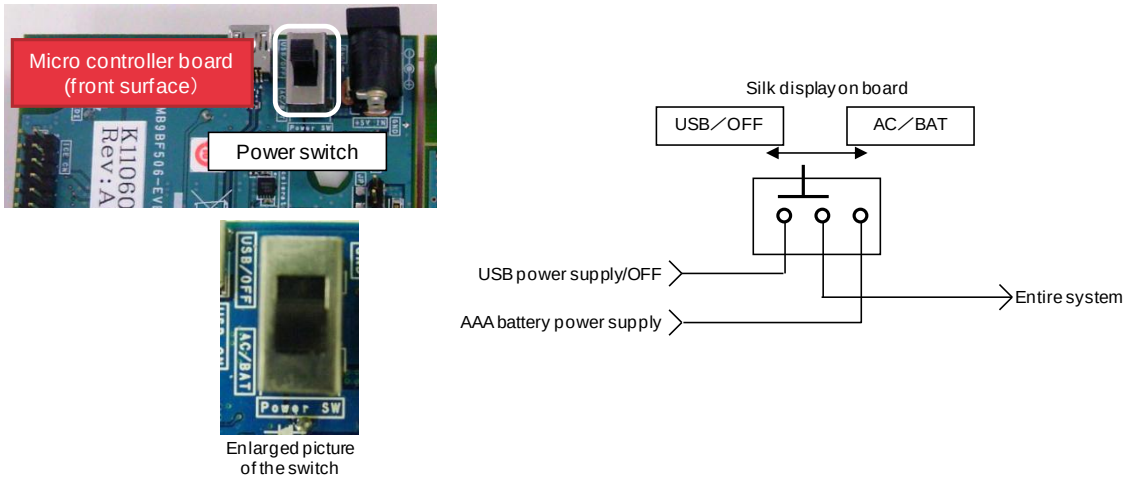

Figure 24 Power switch external appearance and schematic connection diagram

7.1.8 Display Device Specifications

7.1.8.1 Power LED

The microcontroller board is equipped with a power LED that indicates the power supply status. The external appearance of the power LED is shown in Figure 25, and the specifications are shown in Table 11.

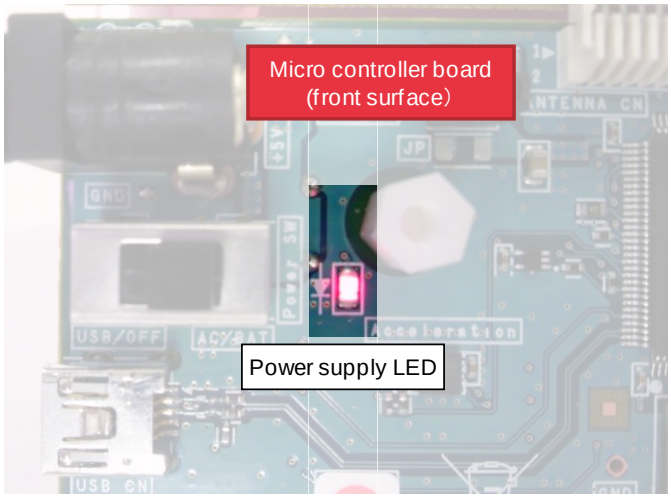

Figure 25 Power LED external appearance

Table 11 Power LED Specifications

No.	Item	Color	Specifications	Connects to
1	Power LED	Red	Power on: Alight Power off: Dark	+5V power supply

7.1.8.2 Demo LED

The microcontroller board is equipped with two demo LEDs that are connected to the microcontroller. The external appearance and schematic connection diagram of the demo LEDs is shown in Figure 26, and the specifications are shown in Table 12.

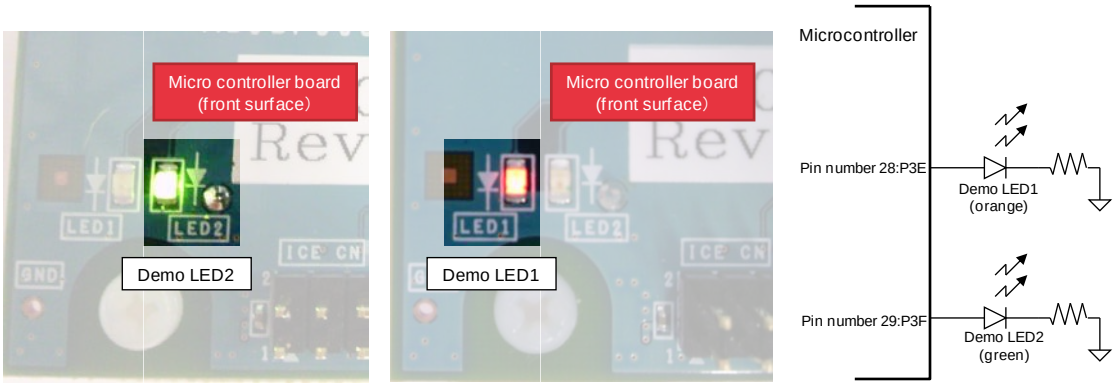

Figure 26 Demo LED external appearance and schematic connection diagram

Table 12 Demo LED Specifications

No.	Item	Color	Microcontroller connection	Specifications
1	Demo LED1	Orange	Pin number 28: P3E	Microcontroller H output: Alight Microcontroller L output: Dark
2	Demo LED2	Green	Pin number 29: P3F	Microcontroller H output: Alight Microcontroller L output: Dark

7.1.8.3 LCD

The microcontroller board is equipped with an LCD that is connected to the microcontroller. The external appearance and schematic connection diagram of the LCD are shown in Figure 27, and the specifications are shown in Table 13. Refer to the data sheet of the corresponding product for the detailed specifications of the LCD.

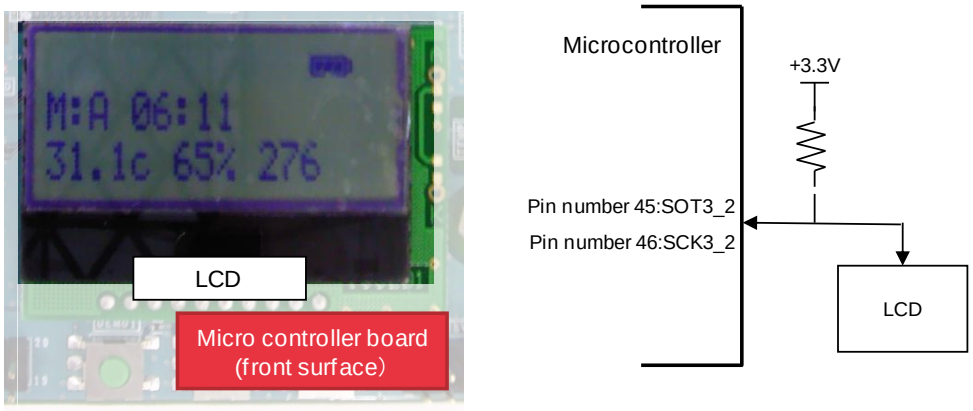

Figure 27 LCD external appearance and schematic connection diagram

Table 13 LCD Specifications

No.	Item	Part number (Mfr.)	Specifications	Microcontroller connection
1	LCD	SB1602B (Strawberry Linux)	16 character × 2 row display I^2C connection: Address 0x3E	Pin number 45: SOT3_2 Pin number 46: SCK3_2

7.1.9 Real Time Clock

A schematic connection diagram of the real time clock on the microcontroller board is shown in Figure 28, and the specifications are shown in Table 14. The real time clock performs data communication with the microcontroller via I^2C. Furthermore, it also supports receiving interrupt signals generated by the register settings of the real time clock.

Refer to the data sheet of the corresponding product for the detailed specifications of the real time clock.

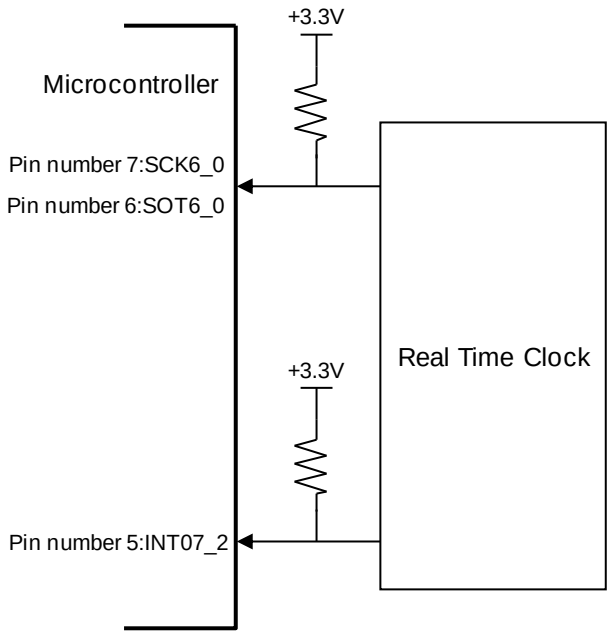

Figure 28 Real time clock schematic connection diagram

Table 14 Real Time Clock Schematic Connection Diagram

No.	Part name	Part number (Mfr.)	Specifications	Microcontroller connection
1	Real time clock	RX-8564LC (Epson Toyocom)	I^2C connection: Address 0x51	Pin number 7: SCK6_0 Pin number 6: SOT6_0
			Interrupt active: L	Pin number 5: INT07_2

7.1.10 Voltage Monitor IC

A schematic connection diagram of the voltage monitor IC on the microcontroller board is shown in Figure 29, and the specifications are shown in Table 15.

The voltage monitor IC monitors the system power supply (＋5V). The microcontroller receives the detection signal when the voltage monitor IC detects a voltage drop as an interrupt signal.

Refer to the data sheet of the corresponding product for the detailed specifications of the voltage monitor IC.

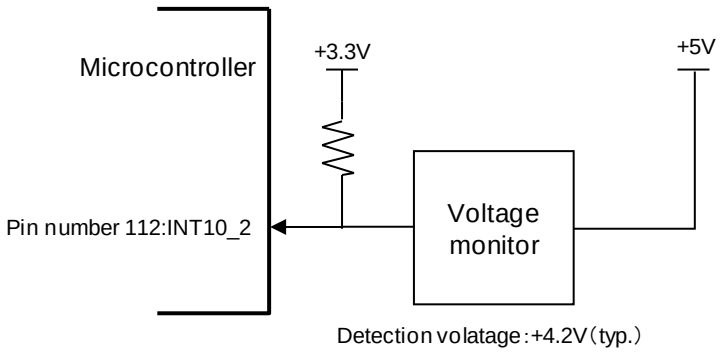

Figure 29 Voltage monitor IC schematic connection diagram

Table 15 Real Time Clock Specifications

No.	Part name	Part number (Mfr.)	Specifications	Microcontroller connection
1	Voltage monitor IC	BU4842FVE (ROHM)	Detection voltage: 4.2V (TYP) Open drain output On detection: L output	Pin number 112: INT10_2

7.1.11 Power Supply Jumper

A schematic connection diagram of the power supply jumper on the microcontroller board is shown in Figure 30. The +3.3V power supply created on the board is connected to the VCC, AVCC, AVRH, and USBVCC pins on the microcontroller via the power supply jumper.

When the power supply jumper is not fitted, no power is supplied to the microcontroller.

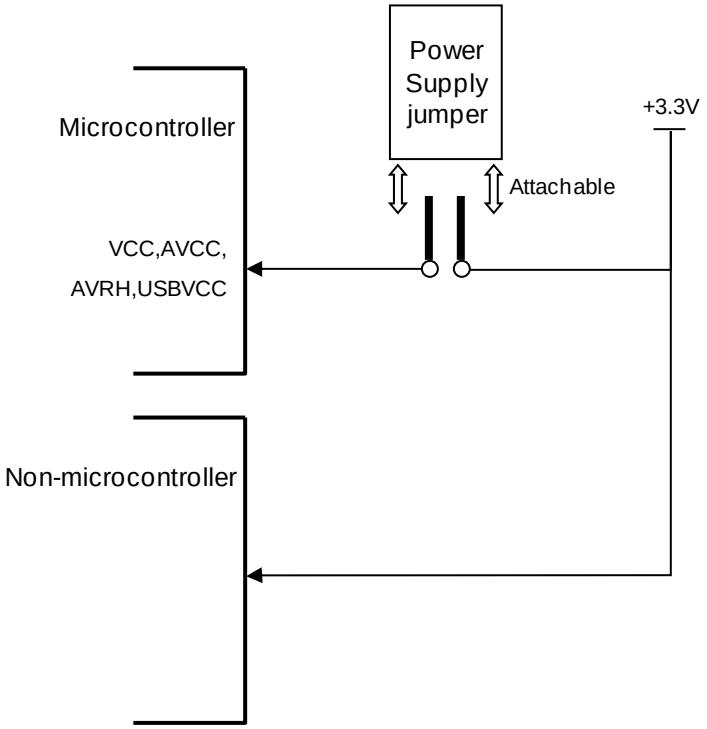

Figure 30 Power Supply Jumper Schematic Connection Diagram

7.1.12 Interface Specifications

7.1.12.1 Board Connection Connector

The pin layout of the board connection connectors that connect the microcontroller board to the wireless board is shown in Figure 31, and the electrical specifications are shown in Table 16.

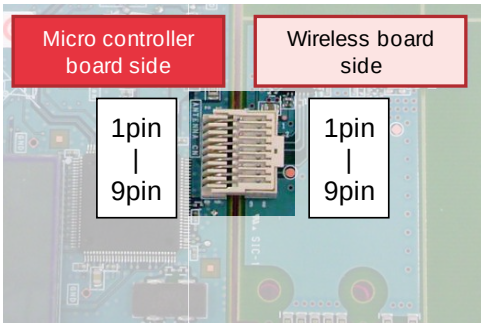

Figure 31 Board connection connector pin layout

Table 16 Board Connection Connector Electrical Specifications (VSS=0V)

Microcontroller board side						Pin no.	Wireless board side				
I/O	Microcontroller connection		Rated value				I/O	Wireless transceiver connection	Rated value		
	Pin no.	Signal name	Item	Min.	Max.				Item	Min.	Max.
—	—	+3.3V	—	—	—	1	—	+3.3V	—	—	—
O	68	P17	VOH	Vcc-0.5	Vcc	2	I	RESET	VIH	VDD*0.8	—
			VOL	Vss	0.4				VIL	—	VDD*0.2
I	69	SIN2_2	VIH	Vcc*0.8	Vcc+0.3	3	O	MISO	VOH	VDD*0.9	—
			VIL	Vss-0.3	Vcc*0.2				VOL	—	VDD*0.1
O	73	SOT2_2	VOH	Vcc-0.5	Vcc	4	I	MOSI	VIH	VDD*0.8	—
			VOL	Vss	0.4				VIL	—	VDD*0.2
O	74	SCK2_2	VOH	Vcc-0.5	Vcc	5	I	SCK	VIH	VDD*0.8	—
			VOL	Vss	0.4				VIL	—	VDD*0.2
O	67	P15	VOH	Vcc-0.5	Vcc	6	I	NSS	VIH	VDD*0.8	—
			VOL	Vss	0.4				VIL	—	VDD*0.2
I	65	P13 (not in use)	VIH	Vcc*0.8	Vcc+0.3	7	—	(N.C.)	—	—	—
			VIL	Vss-0.3	Vcc*0.2						
I	66	INT03_1	VIH	Vcc*0.8	Vcc+0.3	8	O	DIO1	VOH	VDD*0.9	—

			VIL	Vss-0.3	Vcc*0.2				VOL	—	VDD*0.1
—	—	GND	—	—	—	9	—	GND	—	—	—

Furthermore, the +3.3V power supply line that passes through the board connection connectors can be controlled by a switch (FET). A schematic connection diagram of this switch is shown in Figure 32, and the power supply specifications are shown in Table 17.

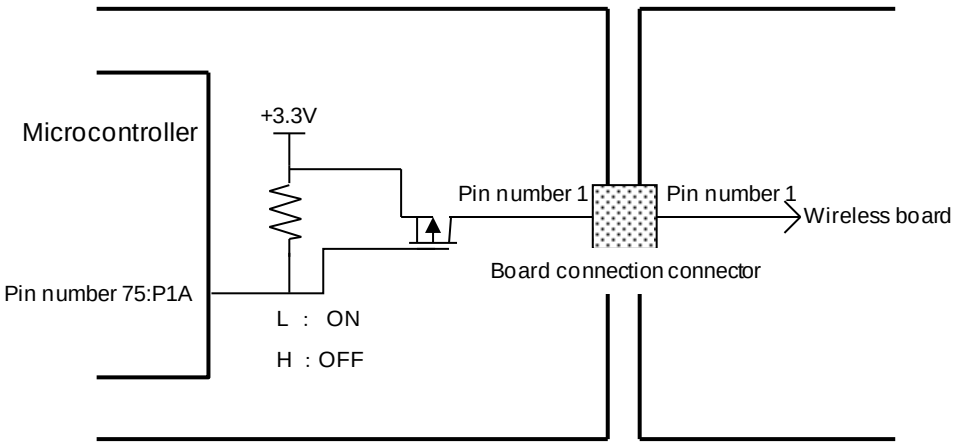

Figure 32 Board connection connector +3.3V power supply line switch schematic connection diagram

Table 17 Board Connection Connector Power Supply Specifications (value in wireless board connected state)

No.	Item	Rated value			Units
		Min.	Typ.	Max.	
01	Power supply Vcc	+3.15	+3.3	+3.45	V
02	Vcc rise time at power on tR	—	—	500	ns
03	Vcc fall time at power off tF	—	—	50	ms

7.1.12.2 User Connector

The microcontroller board is equipped with a user connector that allows the user to use MFS. The pin layout of the user connector is shown in Figure 33 and Table 18, and the electrical specifications are shown in Table 19.

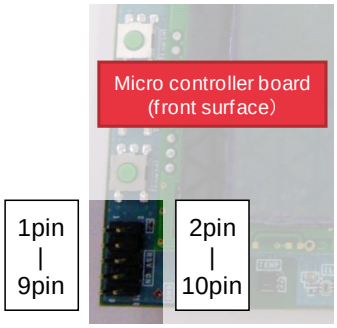

Figure 33 User connector pin layout

Table 18 User Connector Pin Layout

Microcontroller connection		I/O (*)	Pin no.		I/O (*)	Microcontroller connection	
Pin no.	Signal name					Pin no.	Signal name
8	SIN1_0	I	1	2	—	—	VCC (+3.3V)
9	SOT1_0	O	3	4	—	—	GND
10	SCK1_0	O	5	6	I/O	15	P31
11	P59	O	7	8	I/O	14	P30
12	P5A	I/O	9	10	I/O	13	P5B

* I/O as viewed from the microcontroller.

Table 19 User Connector Electrical Specifications (VSS=0V)

No.	Item			Rated value			Units
				Min	Typ	Max	
01	Power supply voltage Vcc			+3.15	+3.3	+3.45	V
02	Power supply current Icc			—	—	20	mA
03 (*)	Input	VIH	—	VCC×0.8	—	VCC+0.3	V
		VIL	—	VSS−0.3	—	VCC×0.2	
04	Outp	VOH	I_{OH} = −2mA	VCC−0.5	—	VCC+0.3	

(*)	ut	VOL	I_{OL} = 2mA	VSS－0.3	－	0.4	

* External load conditions for items 03 and 04: Load resistance = 1kΩ, Load capacitance = 50pF

7.1.12.3 USB miniB Connector

The microcontroller board is equipped with a USB miniB connector for connecting a USB cable. The pin layout of the USB miniB connector is shown in Figure 34 and Table 20.

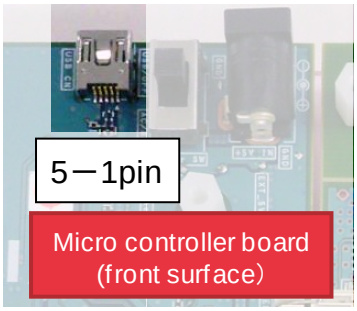

Figure 34 USB miniB connector pin layout

Table 20 USB miniB Connector Pin Layout

Pin no.	I/O (*)	Microcontroller connection	
		Pin no.	Signal name
1	—	—	+5V（VBUS）
2	I/O	118	UDM0（D-）
3	I/O	119	UDP0（D+）
4	—	—	(N.C.)
5	—	—	GND

* I/O as viewed from the microcontroller.

7.1.12.4 RS232C Connector

The microcontroller board is equipped with an RS232C interface connector. A pin layout d7iagram and schematic connection diagram of the RS232C connector are shown in Figure 35, and the pin layout chart is shown in Table 21.

To connect this board to a PC using an RS232C cable, use the RS232C communication conversion cable included in RS232C connector shown in Figure 35.

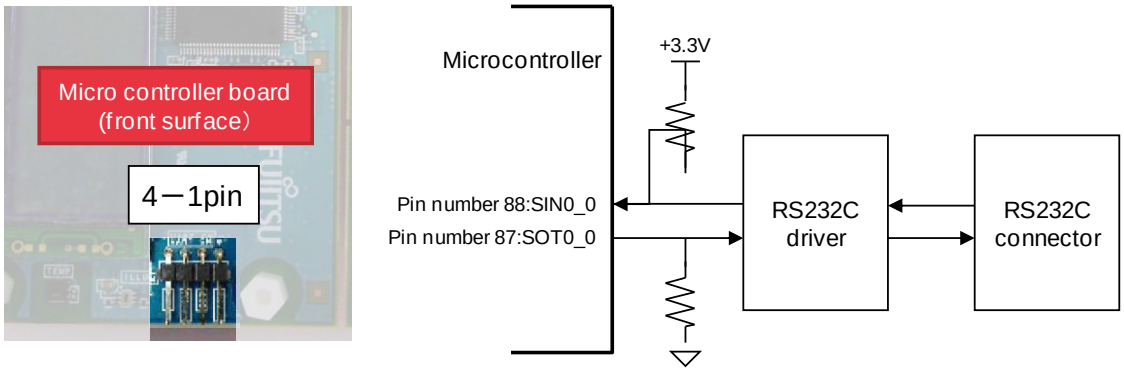

Figure 35 RS232C connector pin layout and schematic connection diagram

Table 21 RS232C Connector Pin Layout

Pin no.	I/O (*)	Microcontroller connection	
		Pin no.	Signal name
1	O	87	SOT0_0
2	—	—	GND
3	I	88	SIN0_0
4	—	—	GND

* I/O as viewed from the microcontroller.

7.1.12.5 ICE Connector

The microcontroller board is equipped with an ICE connector for connecting an ICE. The pin layout diagram of the ICE connector is shown in Figure 36 and the pin layout chart is shown in Table 22.

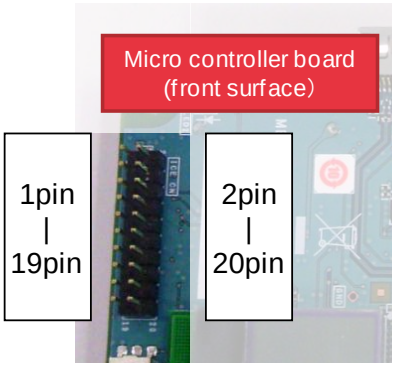

Figure 36 ICE connector pin layout

Table 22 ICE Connector Pin Layout

Microcontroller connection		I/O (*)	Pin no.		I/O (*)	Microcontroller connection	
Pin no.	Signal name					Pin no.	Signal name
—	+3.3V	—	1	2	—	—	(N.C.)
92	TRSTX	I	3	4	—	—	GND
94	TDI	I	5	6	—	—	GND
95	TMS	I/O	7	8	—	—	GND
93	TCK	I	9	10	—	—	GND
(10K pull-down)	—	—	11	12	—	—	GND
96	TDO	O	13	14	—	—	GND
(Reset switch)	XSRST	I	15	16	—	—	GND
(10K pull-down)	—	—	17	18	—	—	GND
(10K pull-down)	—	—	19	20	—	—	GND

* I/O as viewed from the microcontroller.

7.2 Software

7.2.1 Software Block Diagram

A block diagram of the software is shown in Figure 37.

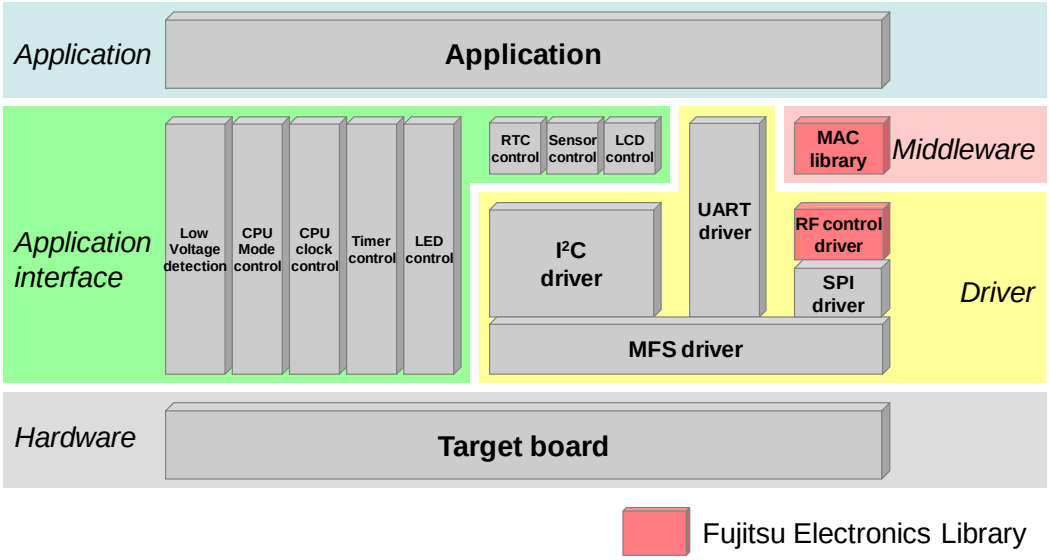

Figure 37 Software block diagram

#Note:

"Fujitsu Electronics Library" is developed for only this demonstration, not for business.

So it is not given to the customers. When they want to make the same system, they will prepare the programs for their hardware system by themselves.

7.2.2 System Specifications

7.2.2.1 Microcontroller System Specifications

The microcontroller system specifications are shown in Table 23.

Table 23 Microcontroller System Specifications

Item	Details	Remarks
Operating clock	CPU: 80MHz Peripheral: 40MHz	High-speed PLL oscillator Internal 20x frequency multiplier CPU operation mode 1, CPU operation mode 3/Active
	CPU: 60MHz Peripheral: 30MHz	High-speed PLL oscillator Internal 15x frequency multiplier, CPU operation mode 2
	CPU: Stopped Peripheral: 4MHz	CR oscillator CPU operation mode 3/Standby
CPU operation mode	Mode 1	Continuous high-speed PLL oscillator 80MHz operation
	Mode 2	Continuous high-speed PLL oscillator 60MHz operation
	Mode 3	When active, high-speed PLL oscillator 80MHz operation When standby, CR oscillator 4MHz operation
MFS(*)	6ch used	Used by UART, I^2C(4ch), and SPI communication Refer to “7.2.2.3 MFS” for details
Timer	Dual timer ch1	For timeout, 1 ms period
External interrupt	INT10	Low voltage detection

* Multi Function Serial (MFS) Interface

7.2.2.2 Memory Map

The memory map of the ROM (FLASH) and RAM is shown in Figure 38.

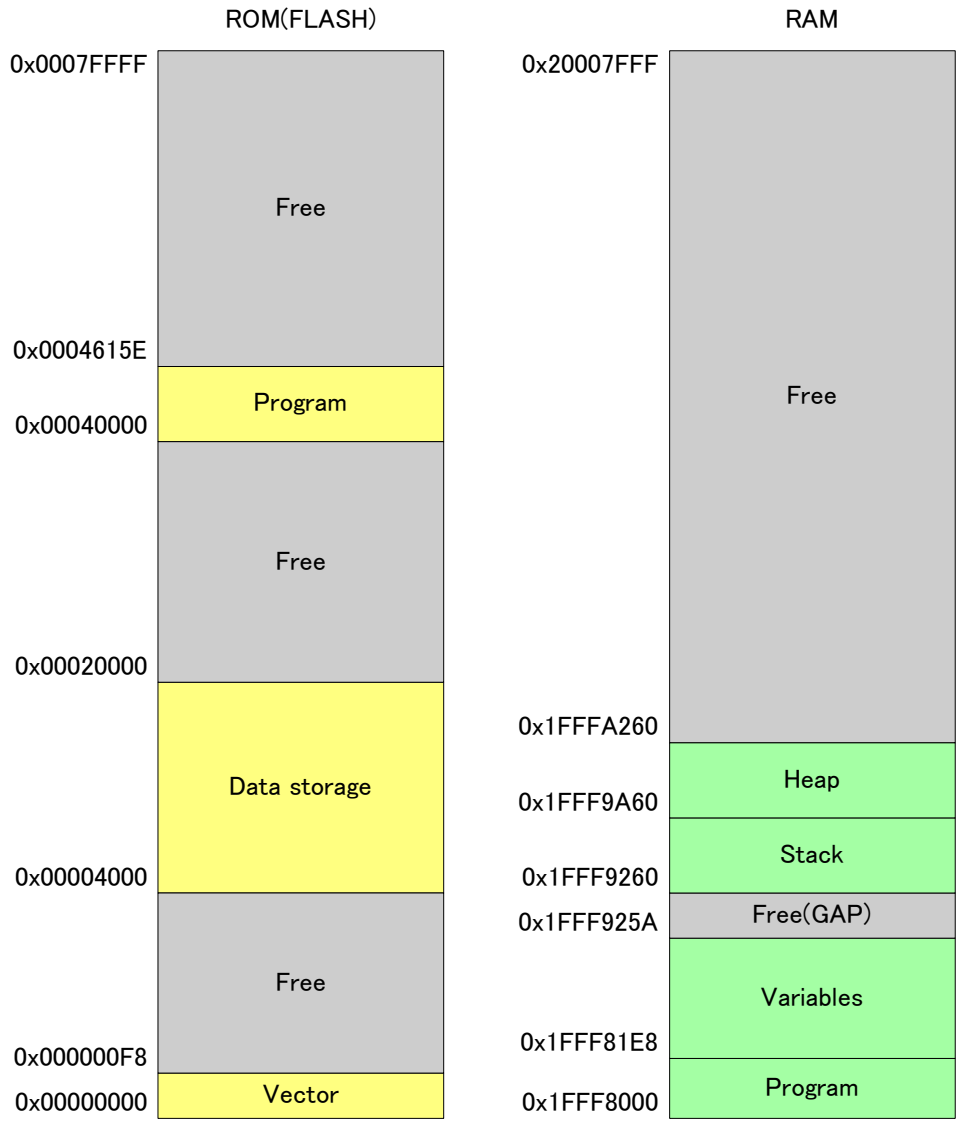

Figure 38 ROM (FLASH) and RAM memory map

7.2.2.3 MFS System Specifications

Table 24 Multi Function Serial System Specifications

Ch no.	Function	Baud rate	Remarks
0	UART	115.2kbps	For RS232C communication with the PC of the sensor data received by the wireless
1	—	—	Not used
2	SPI	1Mbps	For wireless transceiver control
3	I^2C	400kbps	For LCD control
4	I^2C	400kpbs	For accelerometer control
5	—	—	Not used
6	I^2C	400kbps	For real time clock control
7	I^2C	400kbps	For hygro-thermometer and illumination sensor control

7.2.2.4 Interrupt System Specifications

Table 25 Interrupt System Specifications

Interrupt source	Function	Vector no.	Remarks
Reset	Reset_Handler	#01	—
External interrupt 10	EXTI8_15_IRQHandler	#21	Used by low voltage detection
Dual timer 1 interrupt	DT_QDU_IRQHandler	#22	Performs interrupt processing at a period of 1ms.
MFS ch.0 Rx/Tx	MFS0_IRQHandler	#23 #24	Used by UART interrupt (sending to PC) The receive side (#23) does no processing
MFS ch.2 Rx/Tx	MFS2_IRQHandler	#27 #28	Used by SPI interrupt (wireless transceiver control)
MFS ch.3 Rx/Tx	MFS3_IRQHandler	#29 #30	Used by I^2C interrupt (LCD control)
MFS ch.4 Rx/Tx	MFS4_IRQHandler	#31 #32	Used by I^2C interrupt (accelerometer control)
MFS ch.6 Rx/Tx	MFS6_IRQHandler	#35 #36	Used by I^2C interrupt (real time clock control)

MFS ch.7 Rx/Tx	MFS7_IRQHandler	#37 #38	Used by I^2C interrupt (hygro-thermometer and illumination sensor control)

7.2.3 Operating Conditions

This sample program operates under the following conditions.

Host device: Device number 0

When the device number is set to 0, the device operates as the host device.

Slave device: Device numbers 1 to 4

When the device number is set in the range of 1 to 4, the device operates as a slave device.

7.2.4 Overall Application Operating Flow

7.2.4.1 Operation From Startup to Demo Mode Selected

① When the power is turned on, the pressed status of demo switch 1 is detected.

② If demo switch 1 was not pressed, the device enters Sensor Logger Mode.

③ If demo switch 1 was pressed, the device enters Remote Control Mode.

The operation up to this point is common to the host device and slave device.

The above flow is shown in Figure 39.

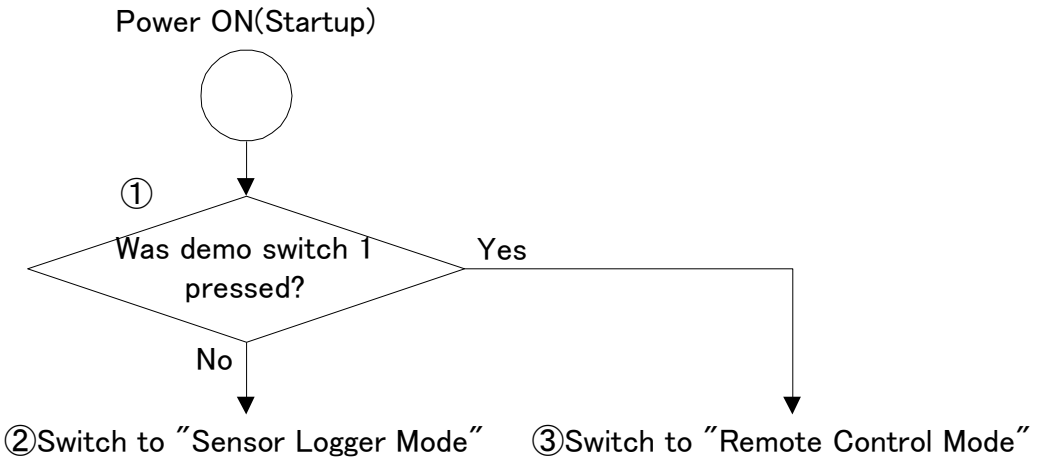

Figure 39 Operation from startup to demo mode selected

7.2.4.2 Operation of Host Device in Sensor Logger Mode and Remote Control Mode

The host device has the same operation in both Sensor Logger Mode and Remote Control Mode.

① Presses of demo switch 1 are detected.

② If a press of demo switch 1 is detected, the CPU operation mode changes.
The CPU operation mode is initially mode 1, and toggles between mode 1 and mode 2.

③ A check is performed for whether there is a valid wireless reception from a slave device.

④ If there is a valid wireless reception from a slave device, the received data is sent to the PC via RS232C.

The above flow is shown in Figure 40.

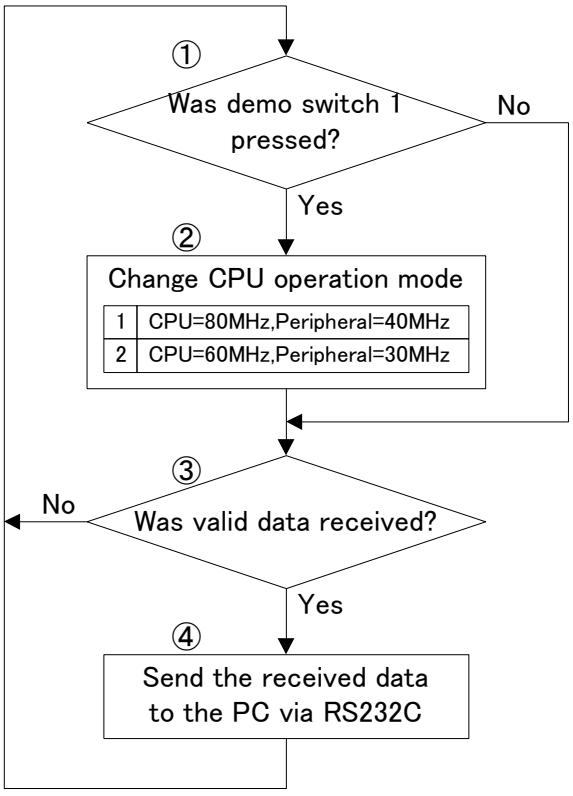

Figure 40 Operation of host devices in Sensor Logger Mode and Remote Control Mode

7.2.4.3 Operation of Slave Devices in Sensor Logger Mode

① Presses of demo switch 1 are detected.

② If a press of demo switch 1 is detected, the CPU operation mode changes.
The CPU operation mode is initially mode 1, and changes cyclically as mode 1 -> mode 2 -> mode 3 -> mode 1 …

③ A check is performed of whether it is the periodic time to get the sensor measurement values.

④ If it is the periodic time to get the sensor measurement values, the measurement values are got from the hygro-thermometer and illumination sensor, and the got measurement values are sent by wireless. The program then waits for the sending to finish.

⑤ Once the sending is complete, a check is performed for whether the standby conditions are met. The standby condition is that the CPU operation mode is mode 3.

⑥ For the standby conditions, the CPU clock changes to the CR oscillator (4MHz).

⑦ A check is performed for whether the standby time has elapsed. The standby time is the value of the sensor measurement value getting period minus the time taken to get the measurement values from the sensors and the time to send by wireless.

⑧ Once the standby time has elapsed, the CPU clock is changed to the PLL oscillator (80MHz).

The above flow is shown in Figure 41.

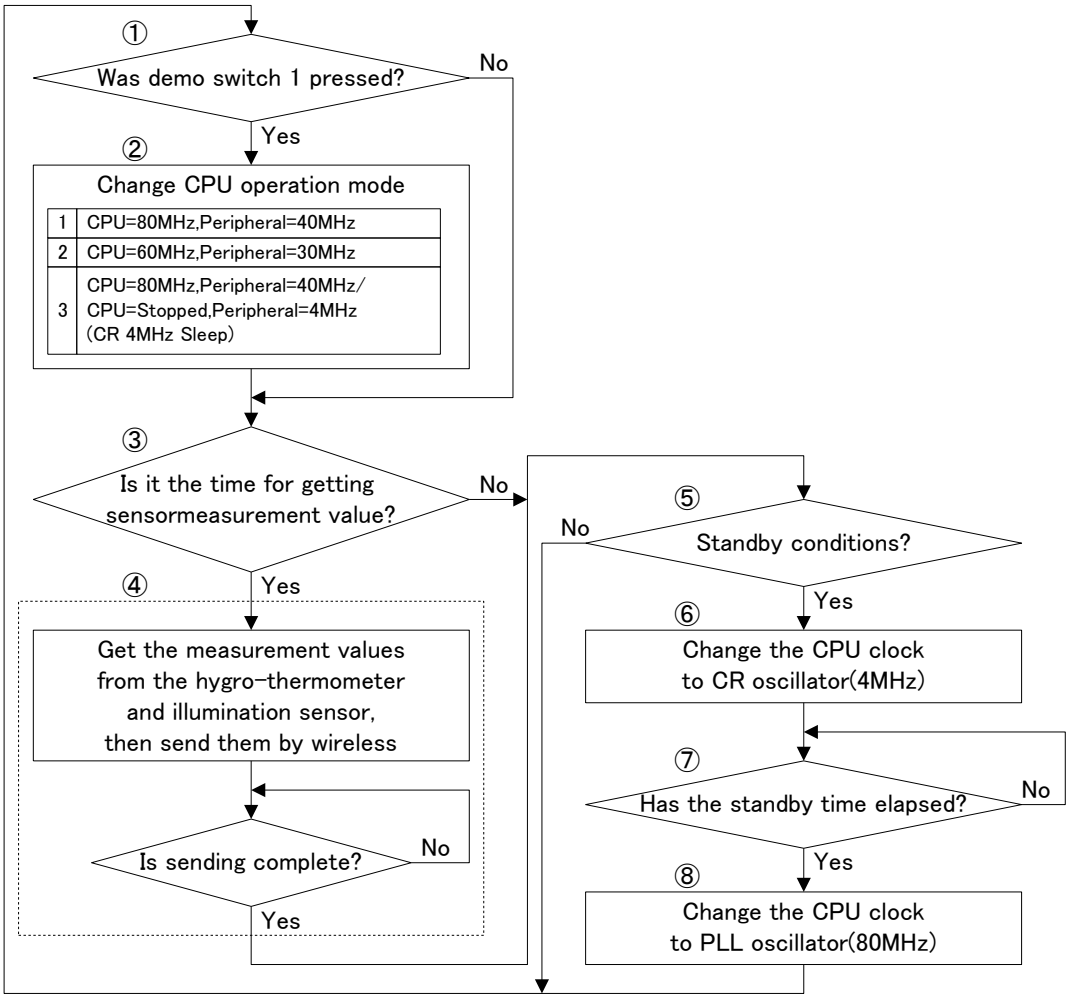

Figure 41 Operation of slave devices in Sensor Logger Mode

7.2.4.4 Operation of Slave Devices in Remote Control Mode

① Presses of demo switch 1 are detected.

② If a press of demo switch 1 is detected, the CPU operation mode changes.
The CPU operation mode is initially mode 1, and changes cyclically as mode 1 -> mode 2 -> mode 3 -> mode 1 ⋯. Note that in Remote Control Mode, the operation of mode 3 is the same as mode 1.

③ A check is performed of whether it is the periodic time to get the sensor measurement values.

④ If it is the periodic time to get the sensor measurement values, the measurement values are got from the accelerometer, the got measurement values are sent by wireless, and the program then waits for the sending to finish.

The above flow is shown in Figure 42.

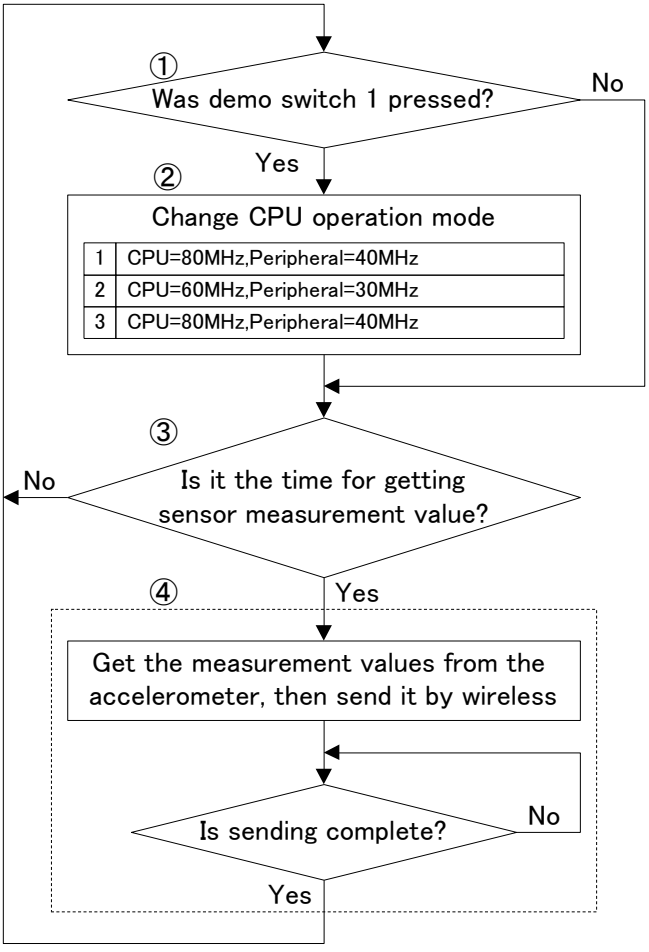

Figure 42 Operation of slave devices in Remote Control Mode

7.2.5 Application State Transitions

7.2.5.1 State Transitions from Startup to Standby State

The state transitions from the host device and slave devices starting to entering standby state are shown in Figure 43.

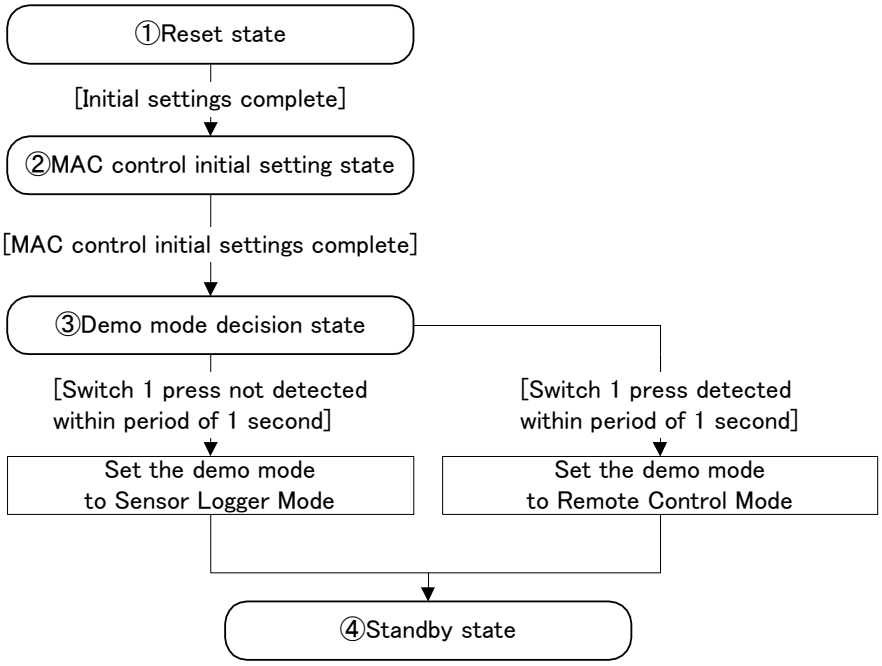

Figure 43 State transitions from startup to standby state

7.2.5.2 Host Device State Transitions

The host device operates in two states in both Sensor Logger Mode and Remote Control Mode, a standby state and a send data to PC state.

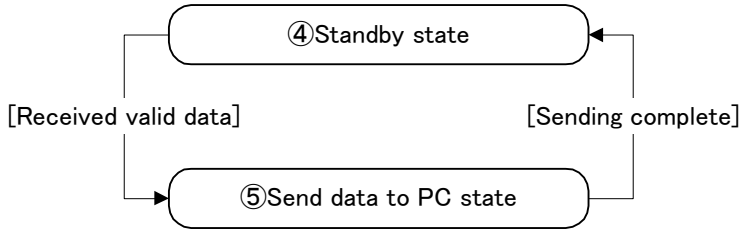

Figure 44 State transitions of the host device

7.2.5.3 Slave Device State Transitions

The slave devices operate in five states, Standby state, Preparing to sleep state, Sleep state, Sensor measurement value read state, and Sensor data send state.

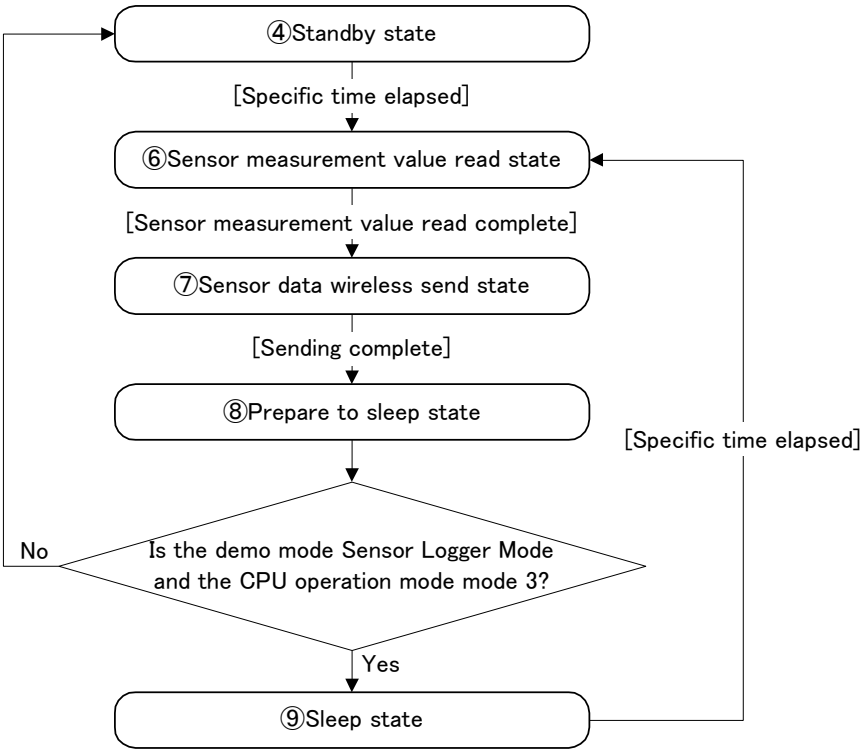

Figure 45 Slave device state transitions

7.2.6 Relationship Between Demo Modes and CPU Operation Modes in Each Application State

The relationship between the demo modes and CPU operation modes in each application state are shown in Table 26.

Table 26 Relationship between the Demo Mode and CPU Operation Mode in each Application state

Device	Application state	Demo mode	CPU operation mode Value in ( ) is CPU/peripheral clock
Common to host device and slave devices	①Reset state	—	Mode 1 (PLL 80/40MHz)
	②MAC library initial setting state	—	Mode 1 (PLL 80/40MHz)
	③Demo mode judgment state	—	Mode 1 (PLL 80/40MHz)
	④Standby state	Sensor Logger Mode	Mode 1 (PLL 80/40MHz)
		Remote Control Mode	Mode 2 (PLL 60/30MHz)
			Mode 3 (PLL 80/40MHz)
Host device	⑤Send data to PC state	Sensor Logger Mode	Mode 1 (PLL 80/40MHz)
		Remote Control Mode	Mode 2 (PLL 60/30MHz)
Slave devices	⑥ Sensor measurement value read state	Sensor Logger Mode	Mode 1 (PLL 80/40MHz)
		Remote Control Mode	Mode 2 (PLL 60/30MHz)
			Mode 3 (PLL 80/40MHz)
	⑦ Sensor data wireless send state	Sensor Logger Mode	Mode 1 (PLL 80/40MHz)
		Remote Control Mode	Mode 2 (PLL 60/30MHz)
			Mode 3 (PLL 80/40MHz)
	⑧Preparing to sleep state	Sensor Logger Mode	Mode 1 (PLL 80/40MHz)
		Remote Control Mode	Mode 2 (PLL 60/30MHz)
			Mode 3 (PLL 80/40MHz)
	⑨Sleep state	Sensor Logger Mode	Mode 3 (CR Stopped/4MHz)

7.2.7 Application States

The nine states shown in “7.2.5 Application State Transitions” are described below.

① Reset state

This state is common to host devices and slave devices, and is the state immediately after turning the power on and immediately after the reset switch is pressed.

The reset state performs software internal initialization processing.

The operating clock is the high-speed PLL (CPU: 80MHz/Peripheral: 40MHz).

② MAC library initial setting state

This state is common to host devices and slave devices, and is the MAC library initial setting state after the software internal initialization processing is complete.

It performs initialization of the MAC library.

The operating clock is the high-speed PLL (CPU: 80MHz/Peripheral: 40MHz).

③ Demo mode decision state

This state is common to host devices and slave devices, and is the demo mode decision state after the MAC library initial setting state.

It detects switch 1 pressed within a period of one second.

If switch 1 pressed is not detected within a period of one second, the demo mode is set to Sensor Logger Mode, and if switch 1 pressed is detected, it is set to Remote Control Mode.

The operating clock is the high-speed PLL (CPU: 80MHz/Peripheral: 40MHz).

④ Standby state

This state is common to host devices and slave devices, and is common to Sensor Logger Mode and Remote Control Mode.

On the host device, it waits to receive wireless from the slave devices, and when it receives valid data, it switches to the send data to PC state.

On slave devices, if it performs no processing for a fixed period of time, and when the specified time elapses, it switches to the sensor measurement value read state.

The operating clock is the high-speed PLL (CPU: 80MHz/Peripheral: 40MHz or CPU: 60MHz/Peripheral: 30MHz).

⑤ Send data to PC state

This is a host device state, and is common to Sensor Logger Mode and Remote Control Mode.

It sends the data received by wireless from the slave devices to the PC via the UART.

Once the sending is complete, it switches to the standby state.

Data is still received from the slave devices while in the send to PC state, and if valid data is received while in this state, it switches to the standby state and then performs the processing.

The operating clock is the high-speed PLL (CPU: 80MHz/Peripheral: 40MHz or CPU: 60MHz/Peripheral: 30MHz).

⑥ Sensor measurement value read state

This is a slave device state which reads the measurement values from the sensors.

If the demo mode is Sensor Logger Mode, the measured data is read from the hygro-thermometer, illumination sensor, and accelerometer, if the demo is mode is Remote Control Mode, the data is read from the accelerometer.

Once reading the sensor measurement values has finished, it switches to the sensor data wireless send state.

The operating clock is the high-speed PLL (CPU: 80MHz/Peripheral: 40MHz or CPU: 60MHz/Peripheral: 30MHz).

⑦ Sensor data wireless send state

This is a slave device state which sends the measurement values read from the sensor by wireless communication.

Once the sending is finished, it switches to the prepare to sleep state.

The operating clock is the high-speed PLL (CPU: 80MHz/Peripheral: 40MHz or CPU: 60MHz/Peripheral: 30MHz).

⑧ Prepare to sleep state

This is a slave device state, and if the CPU operation mode is intermittent operation mode, it stops the CPU clock, changes the peripheral clock to the 4MHz CR, and switches to the sleep state. When not in intermittent operation mode, it switches to the standby (high-speed PLL CPU: 80MHz/Peripheral: 40MHz or CPU: 60MHz/Peripheral: 30MHz) state.

⑨ Sleep state

This is a slave device state that performs nothing for a fixed period of time. It operates with the CPU clock stopped and the peripheral clock set to 4MHz CR.

Once the specific period of time has elapsed, the clock changes to the high-speed PLL (CPU: 80MHz/Peripheral: 40MHz), and it switches to the sensor measurement value read state.

7.2.8 Operation Flowcharts

The meanings of the function call points in the flowchart are shown in Figure 46.

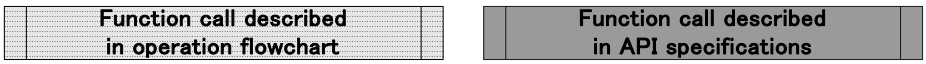

Figure 46 Meanings of function call points

7.2.8.1 Main Processing Function

The flowchart of the main processing function (main) is shown in Figure 47.

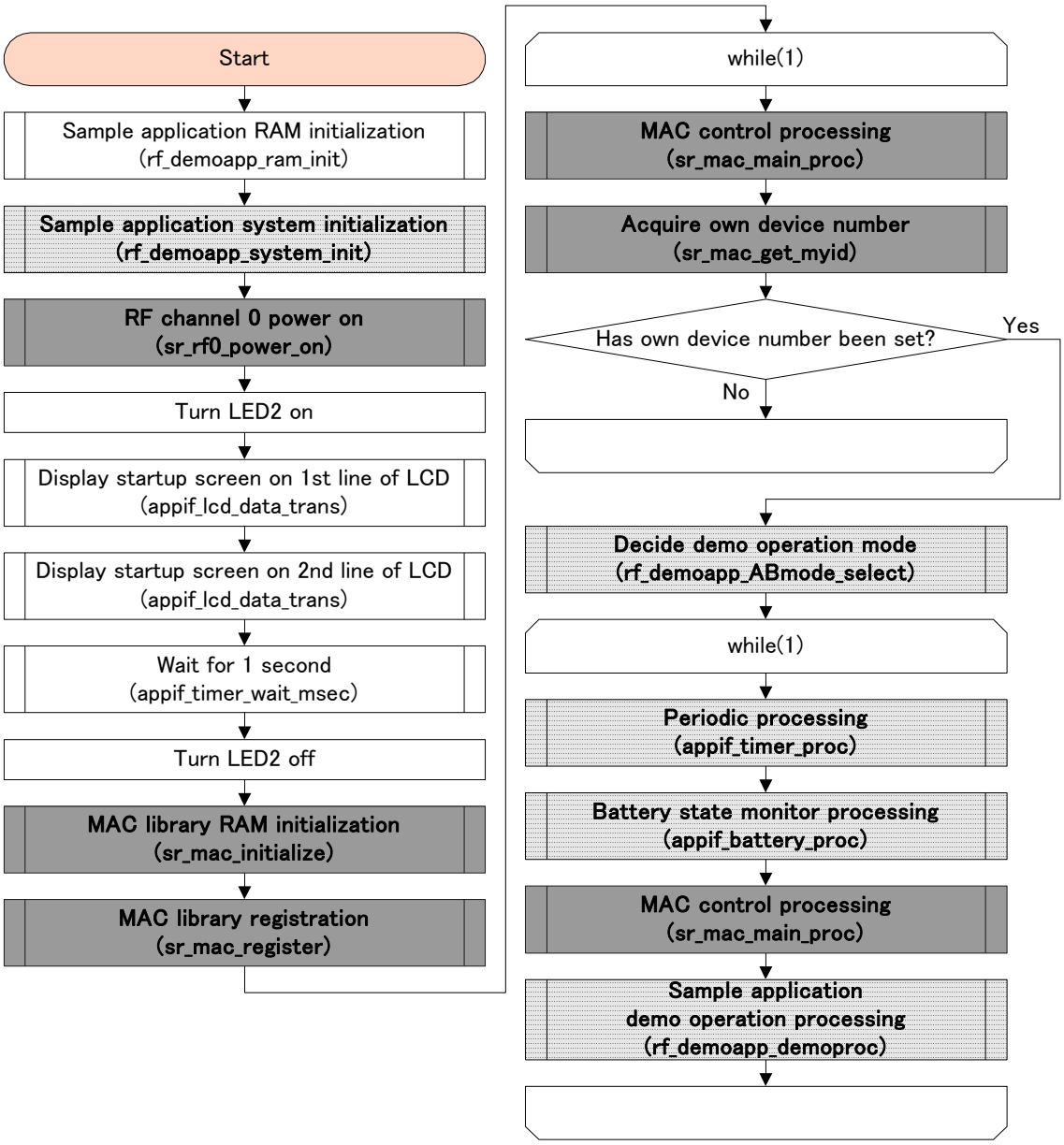

Figure 47 Main function flowchart

7.2.8.2 Sample Application System Initialization Function

This function initializes the clocks, IO ports, serial such as UART, timers, LEDs, LCDs, sensors, etc. (rf_demoapp_system_init)

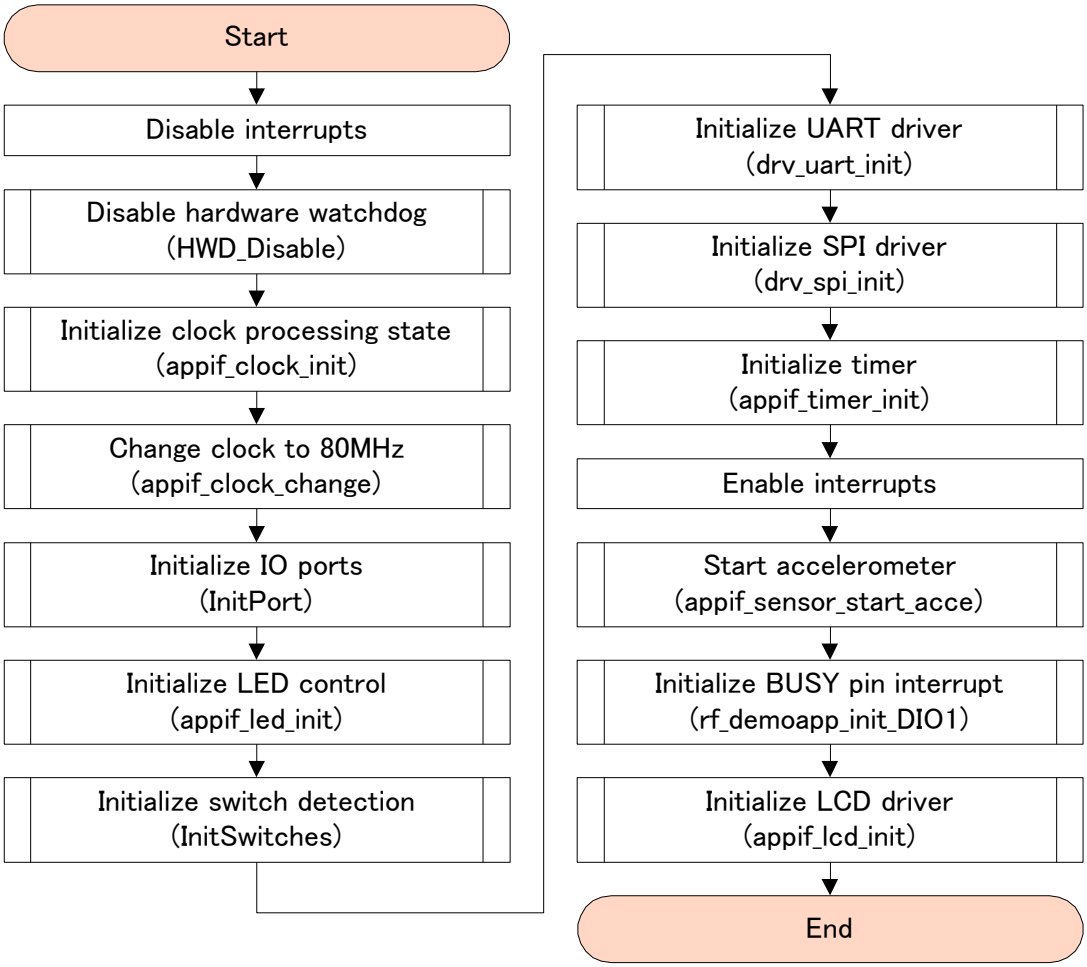

Figure 48 Sample application system initialization function flowchart

7.2.8.3 Demo Operation Mode Decision Function

This function decides whether to operate in Sensor Logger Mode or Remote Control Mode. (rf_demoapp_ABmode_select)

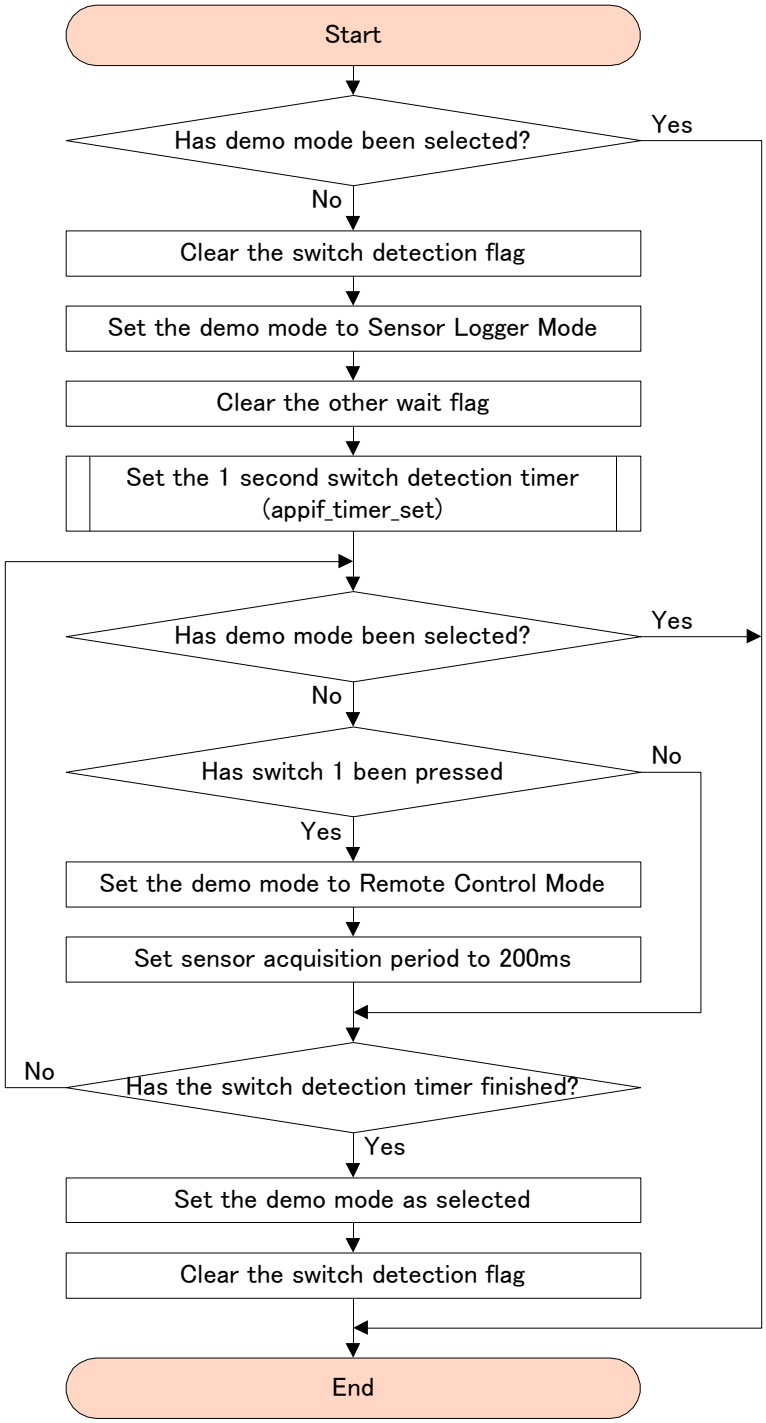

Figure 49 Demo operation mode decision function flowchart

7.2.8.4 Sample Application Demo Operation Function

This function performs the demo operation of the sample application. (rf_demoapp_demoproc)

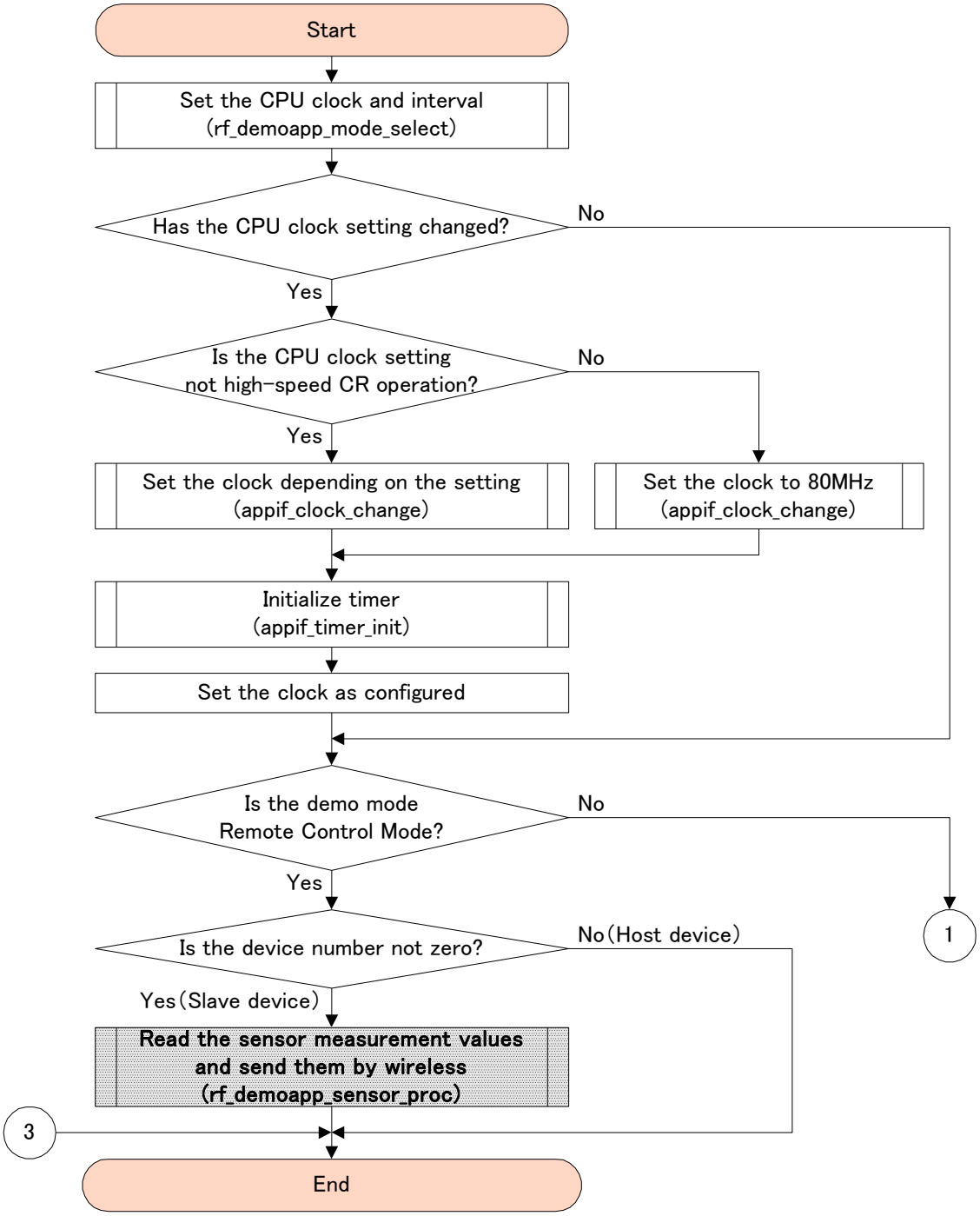

Figure 50 Sample application demo operation function flowchart (1)

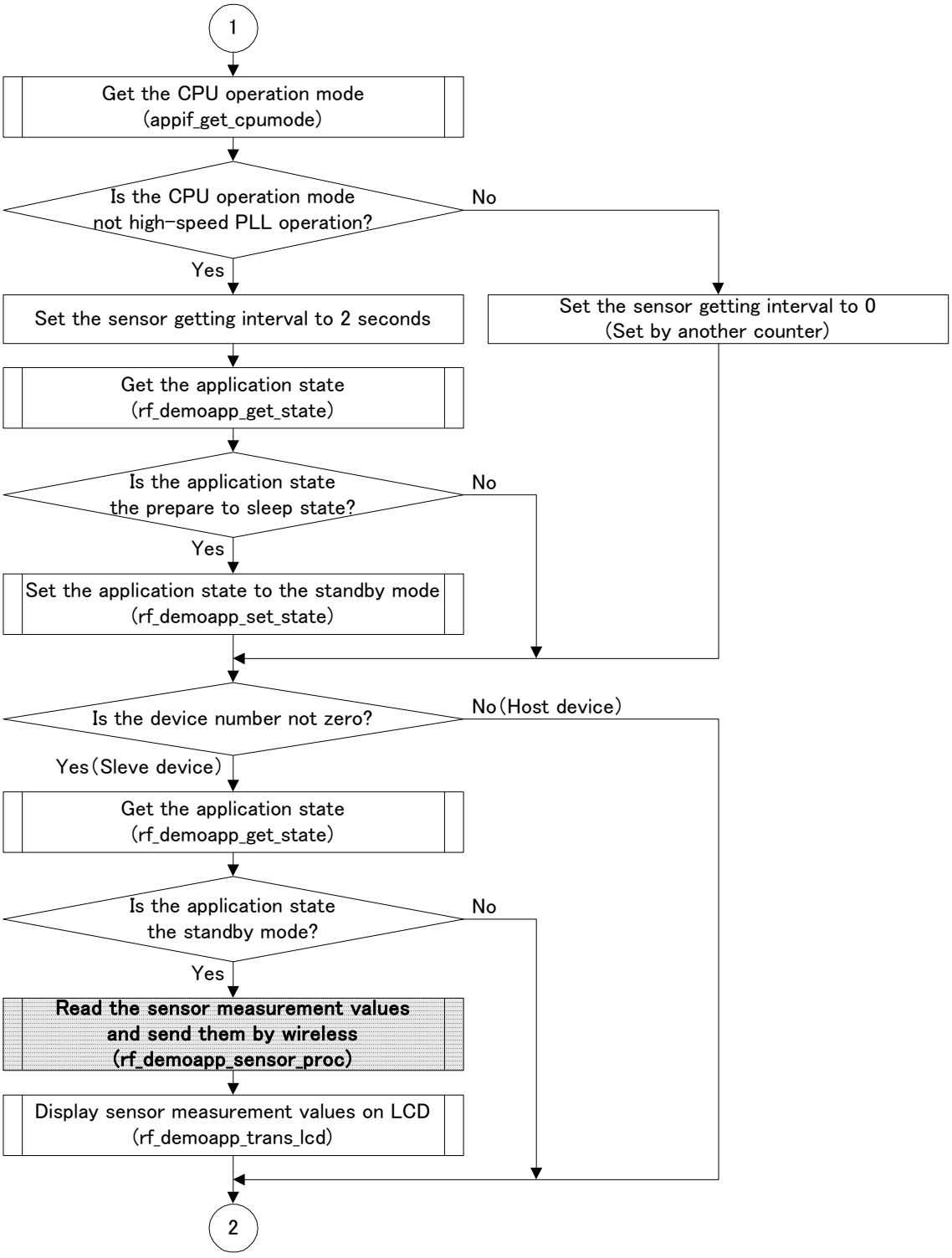

Figure 51 Sample application demo operation function flowchart (2)

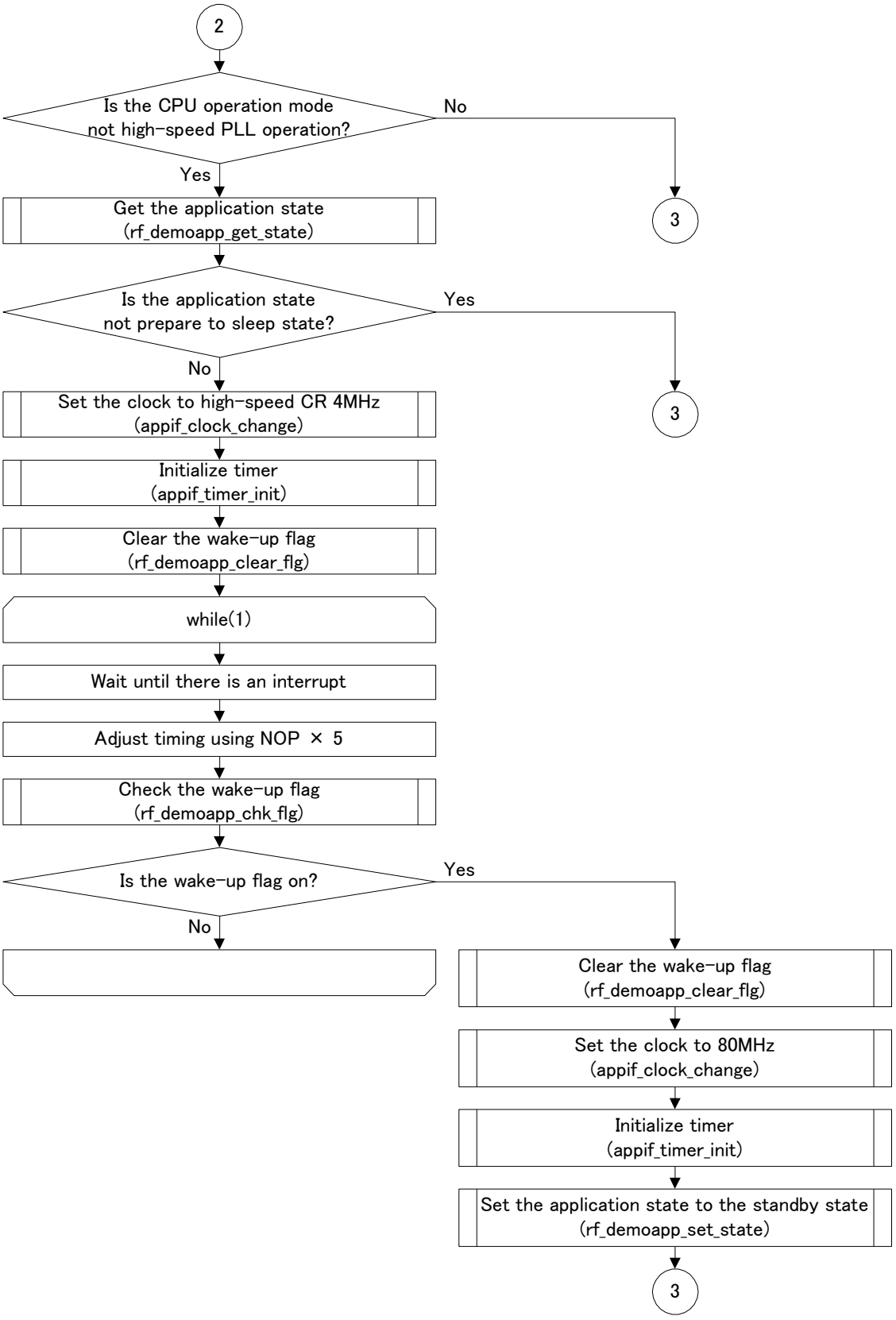

Figure 52 Sample application demo operation function flowchart (3)

7.2.8.5 Sensor Measurement Value Read and Sensor Measurement Value Wireless Send Function

This function reads the sensor measurement values and sends the read sensor measurement values by wireless communication on slave devices where the demo operation mode is Sensor Logger Mode. (rf_demoapp_sensor_proc)

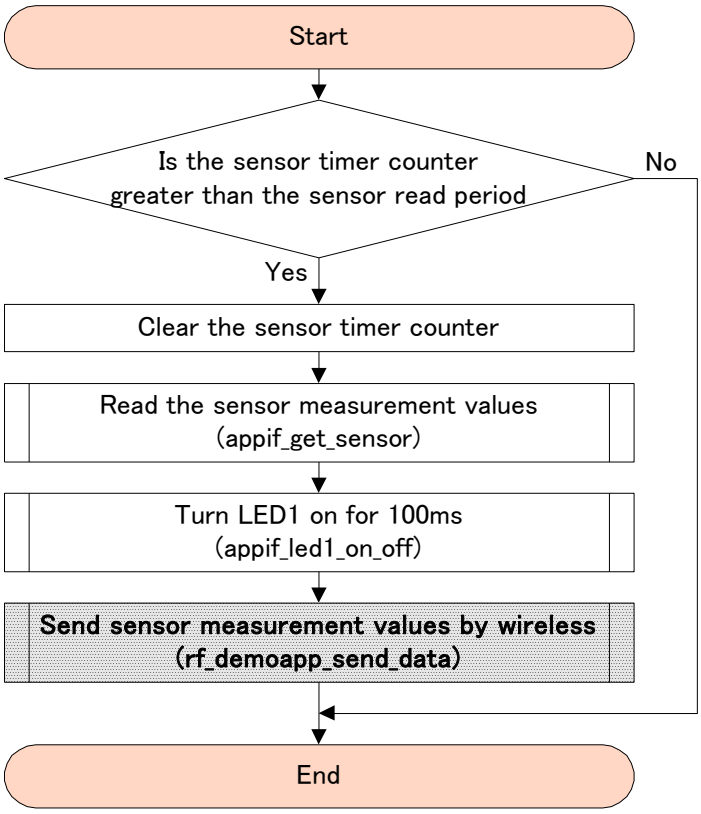

Figure 53 Sensor measurement value read and sensor measurement value wireless send function flowchart

7.2.8.6 Sensor Measurement Value Wireless Send Function

This function sends the measurement values read from the sensors by wireless communication. (rf_demoapp_send_data)

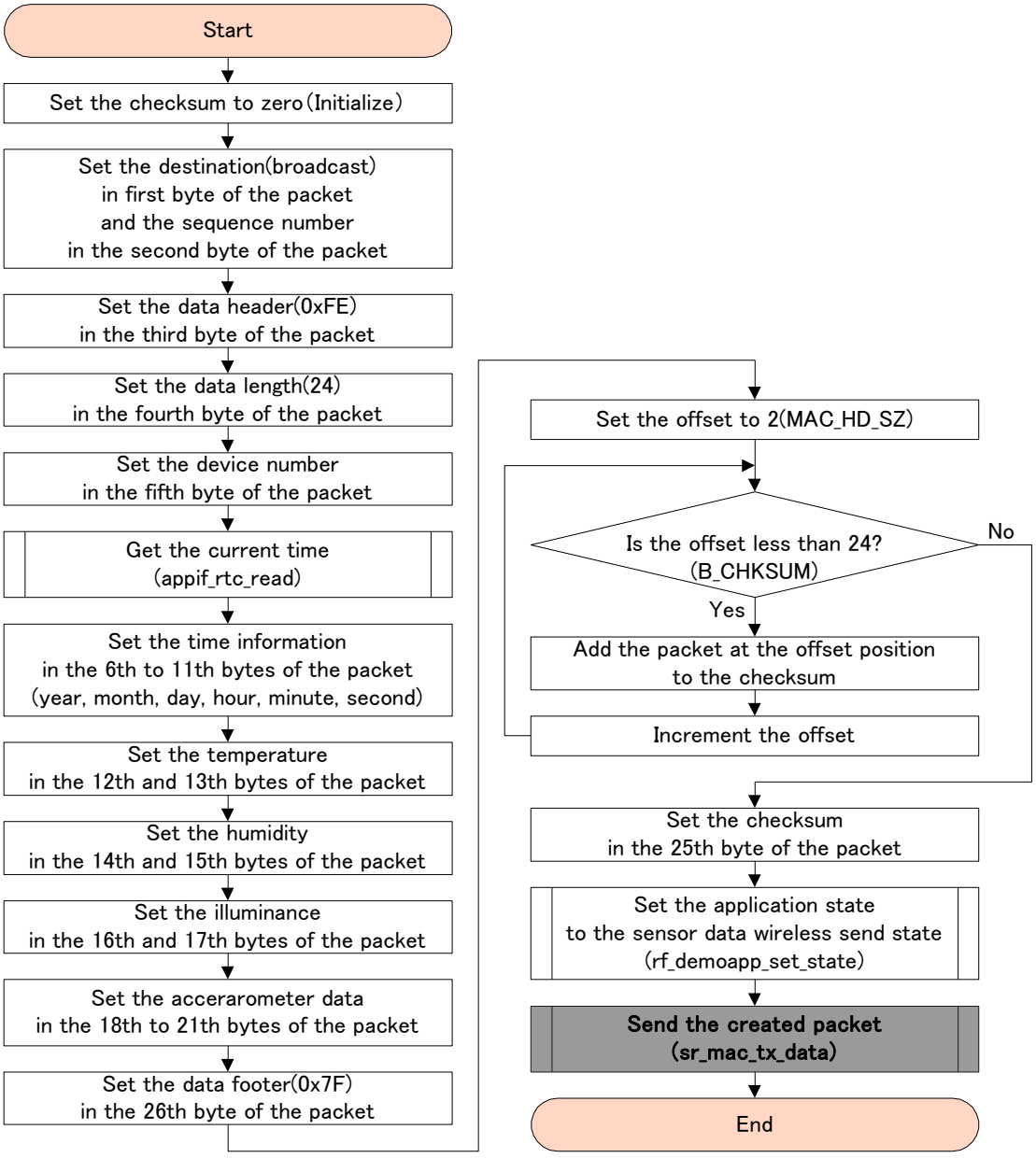

Figure 54 Sensor measurement value wireless send function flowchart

7.2.8.7 Data Wireless Receive Notification Function

This function is called when valid data is received by wireless from the remote device in MAC control. (rf_demoapp_recv_data)

This function is registered by passing it as the first parameter of the registration function in the MAC library (sr_mac_register), and is called from within the MAC control function (sr_mac_main_proc) when valid data is received.

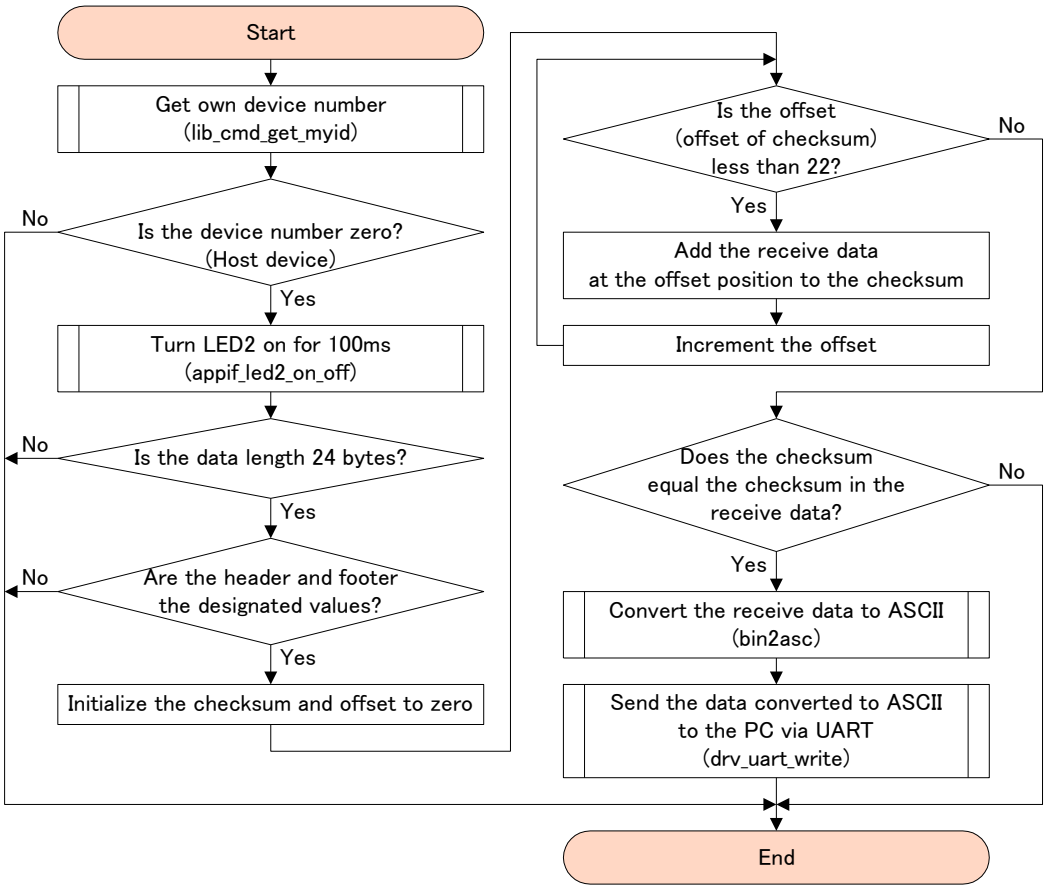

Figure 55 Data wireless receive notification function flowchart

7.2.8.8 Data Wireless Send Complete Notification Function

This function is called when sending data by wireless finishes in the MAC control.

(rf_demoapp_send_complete)

This function is registered by passing it as the second parameter of the MAC library registration function (sr_mac_register), and is called from within the MAC control function (sr_mac_main_proc) when sending data by wireless is complete.

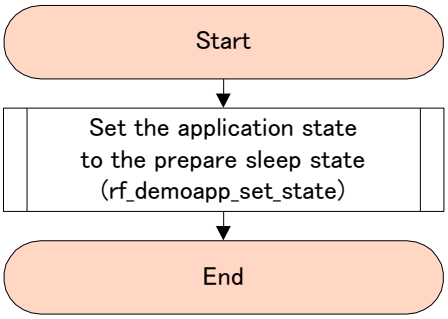

Figure 56 Data wireless send complete notification function flowchart

7.2.8.9 Periodic Processing Function

This function performs processing at a period of 1 ms. (appif_timer_proc)

The difference between the interrupt counter that is incremented by the 1 ms period interrupt processing function and the periodic counter of this function is monitored, and if a difference occurs, the MAC control periodic processing function (sr_mac_cyclic_proc) is called by passing the length of time found by multiplying the difference by the length of the period (1ms) as a parameter.

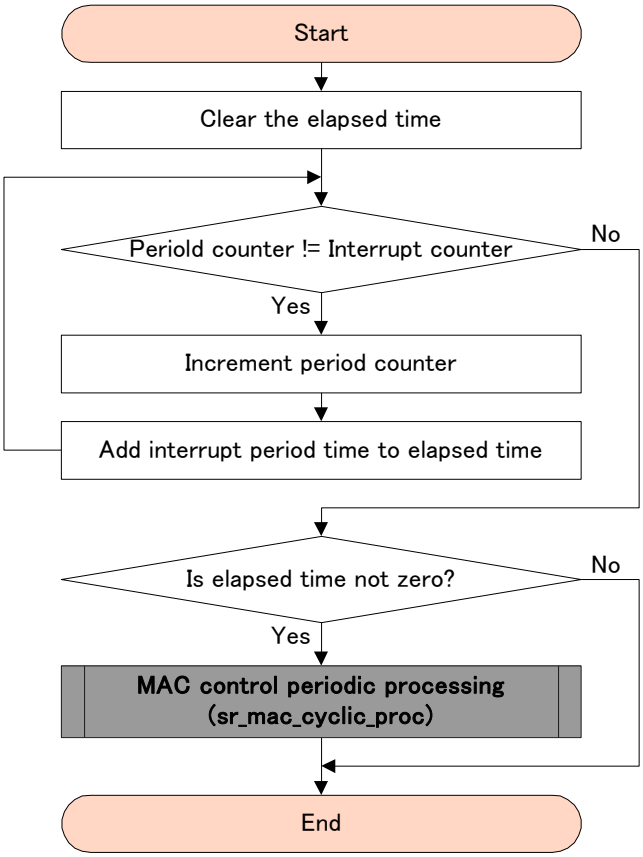

Figure 57 Periodic processing function flowchart

7.2.8.10 Battery Status Monitoring Function

This function monitors the battery detection status, and if there is a change, it sets the LCD display depending on the detected status. (appif_battery_proc)

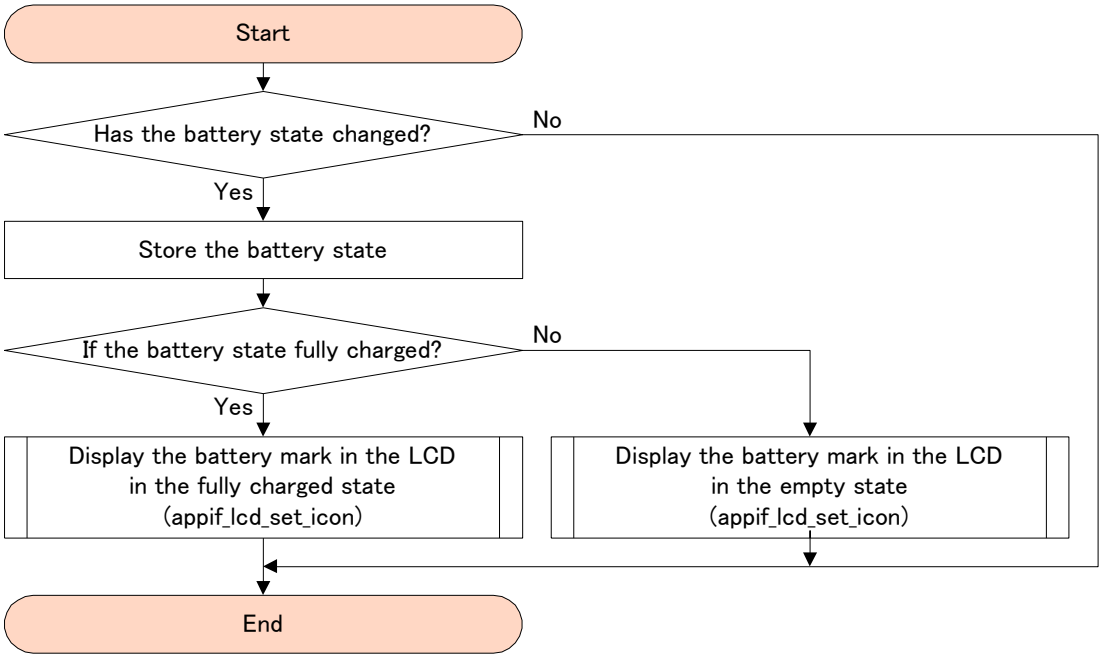

Figure 58 Battery status monitoring function flowchart

-End-