Zero Carbon LoRa[®] Evaluation Board (PC-1570001)

Software Development Procedures

Introduction

These application notes for the Zero Carbon LoRa[®] Evaluation Board describe an application that uses the ultralow power consumption of the RE01 MCU to implement combined Wi-Fi scanning and proprietary indoor/outdoor tracking functionality. These application notes are accompanied by sample code.

Chapter 1: Introduction explains the system information of the LoRa[®] LR1110 module. Chapter 2: Setup Procedure and Application Behavior explains the setup procedures in detail, and subsequent chapters explain the operating conditions, hardware and software settings, and the behavior of the supplied sample code.

Supplied sample project

Prepare the sample project with reference to section 5.3 onward.

Key devices

- Renesas RE01-256KB Group: https://www.renesas.com/re01-256kb
- SEMTECH LR1110:
- https://www.semtech.com/products/wireless-rf/lora-edge/lr1110
 Renesas Low IQ High RSPP LDO ISL9007: https://www.renesas.com/products/power-power-management/linear-regulators-Ido/isl9007-high-current-Ido-low-ig-and-high-psrr
- Renesas High Performance Temperature Sensor HS3001: https://www.renesas.com/products/sensor-products/humidity-sensors/hs3001-high-performance-relative-humidity-and-temperature-sensor

Related Documents

- RE01 Group Products with 256KB Flash Memory User's Manual: Hardware
- https://www.renesas.com/ip/ja/document/mah/re01-group-products-256-kb-flash-memory-users-manual- hardware?language=ja&r=1321781 - LR1110 User Manual
- https://semtech.my.salesforce.com/sfc/p/#E0000000JelG/a/2R000000UmS7/pGnZPdqyilcVrUDwZJcBFzIL_9XoIHV8.tZnE70mv3E
 Zero Carbon LoRa[®] Evaluation Board Tutorial https://github.com/ZeroCarbon-LoRaEva/document/blob/main/ZeroCarbon-LoRaEva_Tutorial.md
- Zero Carbon LoRa[®] Evaluation Board User's Manual <u>https://tachibana-denshi-solutions.co.jp/lora_document.php</u>

Notes regarding the use of RF transceivers

The use of radio receivers and transmitters is subject to international standards and domestic regulations. Ensure that use of the product complies with the standards and regulations of the country in which it is used.

CAUTION

Before applying these application notes to another device, modify the software to suit the specifications of the device and thoroughly evaluate its operation.

LEGEND

File and folder names are highlighted as follows:

・ダウンロードした r01an5753xx0100-re-lora.zip を解凍↔ ※フォルダパスに空白文字や全角文字が含まれているとビルドエラーになる為、解凍先に注意。↔

Application operations and commands are highlighted as follows:

ZeroCarbonProject_WS - 0	e² studio		-	
ファイル(F) 編集(E) ソース(S)	リファクタリング(T) ナビゲート(N) 検索(A) プロジェクト(P) Ren	esas Views 実行(R) ウィンドウ	(W) ヘルプ(H)
ಕ 🚳 ಕ್ರಾಂಕ 🛤			∆ ⇔ ⇔	A A 🗏
RENESAS	Welcome to e ² studio			-

Contents

1.	Introduction	5
1.1.	System overview	6
1.2.	Pins used	6
1.3.	Required components	7
2.	Setup Procedure and Application Behavior	8
2.1.	Setup procedure	8
2.2.	Application behavior	. 10
3.	Operation Check Conditions	.11
4.	Hardware Configuration	.12
4.1.	Board settings	
4.1.1	. Common to board A/B: RFP Zero Carbon board firmware flash mode	
4.1.2	. Common to board A/B: LoRa [®] LR1110 device firmware flash mode	. 13
4.1.3	. Zero Carbon board A (edge) mode	. 13
4.1.4	. Zero Carbon board B (GW access) mode	. 13
4.2.	Connecting a solar panel	
4.3.	Connecting an external GNSS antenna	. 14
4.4.	Connecting an external LoRa® communication antenna	
4.5.	Connecting Pmod modules	. 15
5.	Software Operation	.16
5.1.	Folder structure	
5.2.	File structure	. 17
5.3.	Creating the development environment	. 18
5.3.1	. Link destinations	. 18
5.3.2	. Downloading and extracting Github archives	. 18
5.3.3	. Downloading the base project	. 18
5.3.4	. Applying patch data	. 19
5.3.5	. Overwriting with downloaded code	. 22
5.3.5	.1. Folder created by extracting downloaded file: 2 re-driver-package-master	. 22
5.3.5	.2. Folder created by extracting downloaded file: ③Ir1110_evk_demo_app-master	. 22
5.3.5	.3. Folder created by extracting downloaded file: ④lr1110_driver-Branch_v3.0.0_kai	. 22
5.3.5	.4. Folder created by extracting downloaded file: ^[5] Ir1110_modem_driver-Branch_v2.0.1_kai	. 22
5.3.6	. Installing the e ² studio integrated development environment	. 22
5.3.7	. Importing and building ZeroCarbonProject	. 23
5.4.	Hardware resources	. 31
5.5.	List of constants	. 31
5.5.1	. Board-specific constants	. 31
5.6.	Flowchart	
	. Zero Carbon board A (edge)	
	. Zero Carbon board B (GW access)	
5.6.3	. GW	. 34

Zero Carbon LoRa[®] Evaluation Board Software Development Procedures v1.00

5.7.	Block diagrams	. 35
5.8.	LoRa [®] communication settings	. 36
5.8.1	. LoRa [®] communication packet modulation parameter settings	. 37
5.8.2	. Power amplifier configuration settings	. 38
5.8.3	. TX power and power amplifier ramping time parameter settings	. 39
5.8.4	. Frequency settings	. 40
5.9.	Zero Carbon board A (edge) with additional sensor	. 41
5.9.1	. On the Zero Carbon board A (edge)	. 42
5.9.2	. On the Zero Carbon board B (GW access)	. 44
5.9.3	. On the GW	. 45
6.	Debugging (when using E2Lite)	.47
6.1.	Debugging in e ² studio	. 47
7.	Acquiring a Manage Token from LoRa [®] Cloud	.58
7.1.	Acquiring a Manage Token	. 58
8.	Current Measurement Method and Current Consumption	.59
8.1.	Current measurement method	. 59
8.2.	Current consumption	. 61
9.	Troubleshooting	.64
10.	Precautions for Use	.65
11.	Disclaimer	.66
Revi	sion History	.67

1. Introduction

Before using the sample application, ensure that you have read and understood the Zero Carbon LoRa[®] Evaluation Board Tutorial (ZeroCarbon-LoRaEva_Tutorial.md).

The sample application uses a private LoRa[®] network that incorporates each vendor's proprietary communication protocol at the MAC layer. It is customizable for various applications and uses, while enabling optimization of communication networks.

A disadvantage is the need for each user to purchase and set up their own gateways.

However, the greatest advantage is that the costs associated with wireless communication between devices and gateways is eliminated.

(There is no need to subscribe to a wireless communication provider.)

In addition to the ultralow power consumption and energy harvesting functions of the RE01 MCU, the sample application shows how the LoRaEdgeTMLR1110 module can be used in remote sensing applications. In these application notes, pressing the trigger switch on a Zero Carbon board A (edge) triggers the acquisition of location data (from a Wi-Fi access point (hereinafter *AP*) or GNSS satellite information) and temperature and humidity data by a RE01 MCU-based LoRaEdgeTMLR1110. This data is then sent by LoRa[®] communication to LoRa[®] Cloud via a Zero Carbon board B (GW access) and a gateway (or a PC, hereinafter *GW*), and used to determine the location of the device.

The Zero Carbon board A uses the energy harvesting functionality of the RE01 MCU to charge its rechargeable battery using power supplied from a USB power supply or a solar panel. When the application is not transmitting, the device is placed in standby mode until the next transmission.



Figure 1 shows the overall setup.

■ Contact information for LoRaWAN[®] inquiries

1-13-25 Nishi-honmachi, Nishi-ku, Osaka 550-8555, Japan

Tachibana Electronic Solutions Co., Ltd.

TEL: 06(7222)8211 E-mail: tcs_info@tachibana.co.jp

1.1. System overview

The system has four components: A Zero Carbon board A (edge), a Zero Carbon board B (GW access), a GW, and LoRa[®] Cloud.

The Zero Carbon board A (edge) and Zero Carbon board B (GW access) are based on the same board.

- The components of the common Zero Carbon boards are a Renesas RE01 MCU, a LoRa[®]LR1110 device, an HS3001 sensor, a rechargeable battery, a GNSS external antenna I/F, an external LoRa[®] communication antenna I/F, and a solar panel I/F. The jumper and switch settings and the firmware written to the RE01 MCU determine which is board A and which is board B.
- The components of the Zero Carbon board A (edge) are a common Zero Carbon board, a GNSS external antenna, a LoRa[®] external antenna (can be substituted with an internal antenna), and a solar panel (can be substituted with a USB power supply).
- The components of the Zero Carbon board B (GW access) are a common Zero Carbon board and a USB serial connector (for connecting a USB power supply and communicating with the GW).
- The GW sends Wi-Fi AP information or data received from the GNSS to LoRa[®] Cloud and receives results in the form of location information. The GW requires an internet connection.
- LoRa[®] Cloud determines location information based on the received Wi-Fi AP information or GNSS data.

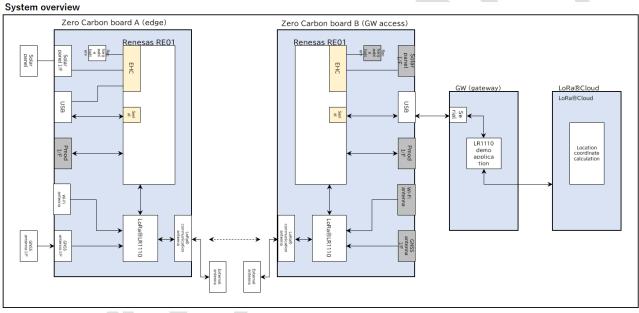


Figure 1-1 System overview

1.2. Pins used

The sample code does not use any MCU pins.

1.3. Required components

Table 1-3 lists the components required to execute the sample application. A barebones setup requires components 1 to 3 in the table.

No.	Description	Part number	Made by
1	Zero Carbon board × 2	Zero Carbon	Tokyo Communication
		LoRa [®] Evaluation Board	Equipment
			Manufacturing Co.,
			Ltd. (Sold by
			Tachibana Electronic
			Solutions Co., Ltd.)
2	GNSS antenna	AA.170.301111	Taoglas Limited
3	USB Type-A to Micro-B cable × 2	-	General consumer
			product
4	Solar panel (for outdoor use)	AM-1815CA	Panasonic
5	Solar panel (for indoor use)	BCS4430B6	TDK
6	LoRa [®] dipole antenna	ANT-916-CW-HWR-RPS-ND	Linx Technologies Inc.
7	Connector conversion cable for dipole	CSBMS156C-AND-125N	Antenna Technology
	antenna		Inc.

Table	1-3	List	of com	ponents
rabie	1-0	LISU		Jonenia

2. Setup Procedure and Application Behavior

2.1. Setup procedure

This section explains how to set up the sample application.

- Step 1: Set up a LoRa[®] Cloud account and acquire a MANAGE TOKEN. See the following resource:
 - Zero Carbon LoRa® Evaluation Board Tutorial "3. Setting up a LoRa® Cloud Account"
- Step 2: Set up the application environment on the **GW** side. See the following resource: Zero Carbon LoRa® Evaluation Board Tutorial
 - "4. Setting up the Application Environment on the PC"
- Step 3: Set up the environment for the Zero Carbon board A (edge).
 First, update the firmware on the Zero Carbon board A (edge).
 See the following resource:

Zero Carbon LoRa® Evaluation Board Tutorial

"7. Updating the Renesas RE01 Firmware (Common to Zero Carbon boards A and B)"

Next, set the jumpers and switches and other settings to suit the environment. See the following resource:

Zero Carbon LoRa® Evaluation Board Tutorial

"5. Zero Carbon LoRa[®] Evaluation Board Jumper and Switch Layout Diagram" When powered by solar panel: "a. Settings when using energy harvesting devices" When powered by USB: "b. Settings when using USB fast charging " or "c. Settings w

When powered by USB: "b. Settings when using USB fast charging " or "c. Settings when using a USB power supply "

Connect the external GNSS antenna and, if needed, the external LoRa[®] communication antenna. If board A is USB-powered, connect it to a power bank or a PC by a USB cable.

Step 4: Set up the environment for the Zero Carbon board B (GW access).

First, update the firmware on the Zero Carbon board B (GW access).

See the following resource:

Zero Carbon LoRa® Evaluation Board Tutorial

"7. Updating the Renesas RE01 Firmware (Common to Zero Carbon boards A and B)"

Next, set the jumpers, switches, and other settings to suit the environment.

See the following resource:

Zero Carbon LoRa® Evaluation Board Tutorial

- "5. Zero Carbon LoRa[®] Evaluation Board Jumper and Switch Layout Diagram"
- "f. Settings when using USB to communicate and using a power supply"

Use a USB cable to connect board B to the GW.

• Step 5: Confirm that each board is running.

Confirm that the LEDs (green) are lit on the Zero Carbon board A (edge) and Zero Carbon board B (GW access).

• Step 6: Start the application on the **GW** side.

See the following resource:

Zero Carbon LoRa® Evaluation Board Tutorial

"10-1. Change the current directory to the LR1110 directory created in *4. Setting up the Application Environment on the PC,* and execute the following command"

• Step 7: Operate the system.

Acquire temperature/humidity and latitude/longitude information. See the following resource: Zero Carbon LoRa® Evaluation Board Tutorial "10-2. Operate the Zero Carbon board A (edge)" 2.2. Application behavior

Figure 2-2 shows the behavior of the sample application after launch.

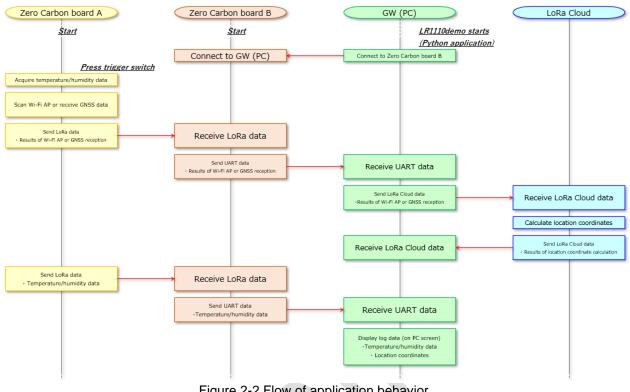


Figure 2-2 Flow of application behavior

3. Operation Check Conditions

The operation of the sample code supplied with these application notes was checked under the conditions in the following table.

Item		Description		
Microcontroller used		R7F0E01182DNG (RE01 256KB Group)		
Operating frequency Main External Oscillator		32MHz crystal oscillator		
	Sub External Oscillator	32.768kHz crystal oscillator		
Operating voltage	•	3.3V		
Target board		Zero Carbon LoRa [®] Evaluation Board		
Integrated development GCC		Renesas e ² studio Version 2021-04 (21.4.0)		
environment				
C compiler	GCC	GNU ARM Embedded Version 6.3.1.20170620		
Debugger		E2 lite		
CMSIS driver package ve	ersion	Ver 1.20		
Sample version	document	2022-04-25 11:02 JST		
	ZeroCarbonProjectPatch	2022-04-25 13:47 JST		
	lr1110_evk_demo_app	2022-04-25 11:03 JST		
	lr1110_modem_driver	2022-01-08 10:38 JST		
	lr1110_driver	2022-01-08 9:57 JST		
	2022-01-06 19:57 JST			

Table 3	Operation	check	conditions
	operation	CHICCK	contaitions

4. Hardware Configuration

This section explains in detail the hardware setup associated with the Zero Carbon board A (edge) and the Zero Carbon board B (GW access).

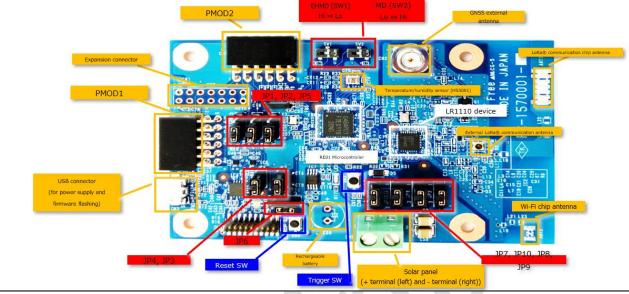


Figure 4 illustrates the layout of the jumpers, switches, and other elements.

Figure 4 Layout of jumpers and switches

4.1. Board settings

•

The Zero Carbon board A (edge) and Zero Carbon board B (GW access) operate in the following modes: Common to both boards (when USB powered):

- Zero Carbon board firmware flash mode implemented by Renesas Flash Programmer
- LoRa[®]LR1110 device firmware flash mode
- Zero Carbon board A (edge) mode (when powered by USB or solar panel)
- Zero Carbon board B (GW access) mode (when powered by USB)

4.1.1. Common to board A/B: RFP Zero Carbon board firmware flash mode

For details about the board setup, see the following resource:

Zero Carbon LoRa® Evaluation Board Tutorial

- "5. Zero Carbon LoRa® Evaluation Board Jumper and Switch Layout Diagram"
- "d. Settings when flashing the RE01 from RFP and using a power supply "

For details about how to use Renesas Flash Programmer (RFP), see the following resource: Zero Carbon LoRa® Evaluation Board Tutorial

"7. Updating the Renesas RE01 Firmware (Common to Zero Carbon boards A and B)"

4.1.2. Common to board A/B: LoRa[®]LR1110 device firmware flash mode

For details about the board setup, see the following resource:

Zero Carbon LoRa® Evaluation Board Tutorial

"5. Zero Carbon LoRa® Evaluation Board Jumper and Switch Layout Diagram"

"e. Settings when flashing the LR1110 FW (USB communication) and using a power supply"

For details about how to flash the LoRa®LR1110 device firmware, see the following resource: Zero Carbon LoRa® Evaluation Board Tutorial

"6. Updating the LoRa[®] LR1110 Firmware (Common to Zero Carbon boards A and B)"

4.1.3. Zero Carbon board A (edge) mode

For details about the board setup, see the following resource:

Zero Carbon LoRa® Evaluation Board Tutorial

"5. Zero Carbon LoRa® Evaluation Board Jumper and Switch Layout Diagram" When powered by solar panel: "a. Settings when using energy harvesting devices" When powered by USB: "b. Settings when using USB fast charging"

4.1.4. Zero Carbon board B (GW access) mode

For details about the board setup, see the following resource: Zero Carbon LoRa® Evaluation Board Tutorial

"5. Zero Carbon LoRa® Evaluation Board Jumper and Switch Layout Diagram"

"f. Settings when using USB to communicate and using a power supply"

4.2. Connecting a solar panel

Connect the solar panel to the connection point shown in Figure 4-2.



Figure 4-2 Solar panel connection point

4.3. Connecting an external GNSS antenna

Connect the GNSS antenna to the connection point shown in Figure 4-3.

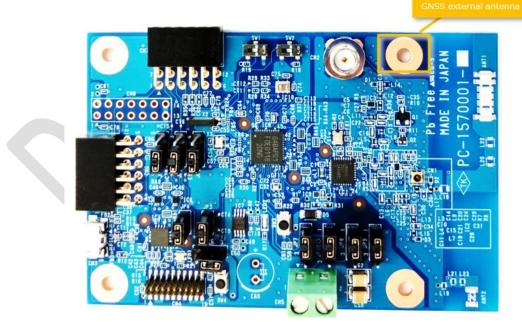


Figure 4-3 GNSS antenna connection point

4.4. Connecting an external LoRa® communication antenna

When using an external LoRa[®] communication antenna, use an antenna connector adapter cable to connect the antenna to the connection point shown in Figure 4-4.

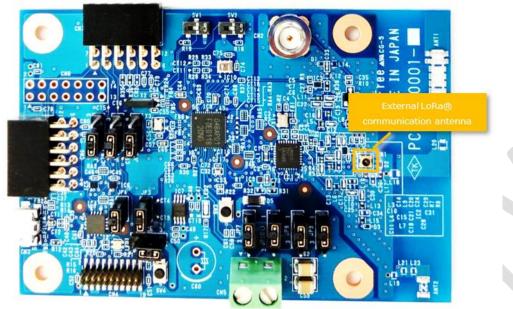


Figure 4-4 External LoRa® communication antenna connection point

4.5. Connecting Pmod modules

Connect Pmod[#] modules to the Pmod connectors shown in Figure 4-5.

#: Pmod is a standard defined by Diligent for connecting low-frequency, low-I/O pin count peripheral modules to host FPGA controller boards. For details about the Pmod standard, see the Digilent website.

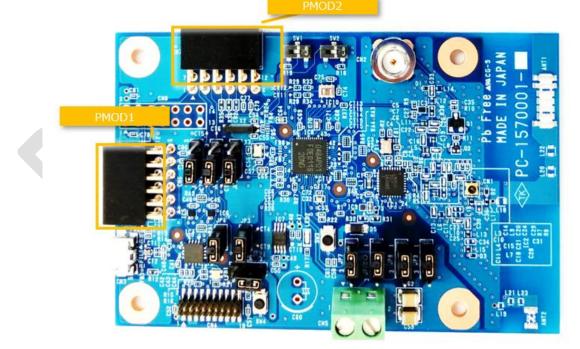


Figure 4-5 Pmod connectors

5. Software Operation

This chapter explains the software specifications of the sample code.

5.1. Folder structure

Figure 5-1 shows the folder structure of the sample code. This sample code was prepared based on "Application Note RE01 256KB".





5.2. File structure

Table 5-2 lists the application files added to or changed from the "Application Note RE01 256KB" group files.

File name	Overview of processing or	Remarks
	settings	
config_mode.h	Definition of Zero Carbon board	Send/receive/update settings,
	configuration	connected antenna/server
		transmission settings
configuration.h	LR1110 EVK settings	LR1110 device environment
		settings
main.c	Main processing	Main application group
hs300x.c	Acquisition of HS300x sensor data	Sensor read requests, data
hs300x.h	Definition of HS300x sensor	acquisition processing
1155004.11	settings	
lr1110 firmware update.c	LR1110 firmware update	
	processing	
lr1110 firmware update.h	LR1110 firmware update definitions	
transceiver almanac.c	Acquisition and setting of almanac	For LoRa® transceiver
—	data	
transceiver_almanac.h	Definition of almanac data	For LoRa® transceiver
transceiver_gnss.c	Acquisition and setting of GNSS	For LoRa® transceiver
	data	-
transceiver_gnss.h	Definition of GNSS data	For LoRa® transceiver
transceiver_power.c	Application of LR1110 power	For LoRa® transceiver
	source settings	
transceiver_power.h	Definition of LR1110 power source	For LoRa® transceiver
	settings	
transceiver_radio.c	Application of LR1110 initial	For LoRa® transceiver
turnarainan madia h	settings and send/receive settings	Fan La Da® transmission
transceiver_radio.h	Definition of LR1110 initial settings and send/receive settings	For LoRa® transceiver
transceiver_rtc.c	Application of date and time	For LoRa® transceiver
	correction	
transceiver rtc.h	Definition of date and time	For LoRa® transceiver
	correction	
transceiver wifi scan.c	Wi-Fi MAC address scanning	For LoRa® transceiver
transceiver wifi scan.h	Settings for Wi-Fi MAC address	For LoRa® transceiver
	scanning	
lib_additional.c	Processing of shared library	-
lib_additional.h	Definition of shared library	-
lr1110_modem_common.h	Common definition of modem	-
	drivers for LR1110	

Table 5-2 File structure

5.3. Creating the development environment

This section explains how to create the project.

5.3.1. Link destinations

Table 5-3-1 contains links to the resources required to create the development environment.

	I able 5-3-1 Link destinations			
No.	Target	Link destination		
1	ZeroCarbonProject Patch data	https://github.com/ZeroCarbon-LoRaEva/ZeroCarbonProjectPatch		
2	Renesas driver package	https://github.com/ZeroCarbon-LoRaEva/re-driver-package		
3	LoRa [®] Ir1110 EVK demo application	https://github.com/ZeroCarbon-LoRaEva/Ir1110_evk_demo_app		
4	LoRa [®] Ir1110 driver	https://github.com/ZeroCarbon-		
		LoRaEva/lr1110_driver/tree/Branch_v3.0.0_kai		
5	LoRa [®] Ir1110 modem driver	https://github.com/ZeroCarbon-		
		LoRaEva/lr1110_modem_driver/tree/Branch_v2.0.1_kai		

5.3.2. Downloading and extracting Github archives

Download the necessary files from the Github repositories in *5.3.1. Link destinations* by selecting Download ZIP from the Code drop-down menu on each page.

The following folders are created when the files are extracted:

- ① ZeroCarbonProjectPatch-main
- 2 re-driver-package-master
- ③ Ir1110_evk_demo_app-master
- ④ Ir1110_driver-Branch_v3.0.0_kai
- ⑤ Ir1110_modem_driver-Branch_v2.0.1_kai

5.3.3. Downloading the base project

Download and extract the file on which the project is based from the Renesas website.

- Download the file from the following URL: <u>Application Note RE01 256KB Group Battery Maintenance Free LoRaWAN® Sensor Energy</u> <u>Harvesting</u>
- Unzip the file r01an5753xx0100-re-lora.zip you downloaded.
 Note: A build error will occur if the folder path contains spaces or fullwidth characters. Check the destination path before extracting the file.

📔 r01an5753_re_lora.zip	2021/02/24 16:55	ZIP ファイル	1,322 KB
🛃 r01an5753ej0100-re-lora.pdf	2021/02/25 14:04	Adobe Acroba 文書	4,173 KB
🛓 r01an5753jj0100-re-lora.pdf	2021/02/25 13:54	Adobe Acroba 文書	4,490 KB

Extract the file r01an5753_re_lora.zip

Zero Carbon LoRa® Evaluation Board Software Development Procedures v1.00

へ 名前	更新日時	種類	サイズ ^
	2021/02/20 11:15		
settings	2021/02/20 11:15	ファイル フォルダー	
boards	2021/02/20 11:15	ファイル フォルダー	
CMSIS	2021/02/20 11:15	ファイル フォルダー	
config	2021/02/20 11:15	ファイル フォルダー	
Device	2021/02/20 11:15	ファイル フォルダー	
Flash Debug	2021/02/24 16:52	ファイル フォルダー	
HardwareDebug	2021/02/24 16:54	ファイル フォルダー	
A mac	2021/02/20 11:15	ファイル フォルダー	
📙 radio	2021/02/20 11:15	ファイル フォルダー	
Resource	2021/02/20 11:15	ファイル フォルダー	
script	2021/02/20 11:15	ファイル フォルダー	
SVD	2021/02/20 11:15	ファイル フォルダー	
system	2021/02/20 11:15	ファイル フォルダー	
DE .cproject	2021/02/24 16:53	CPROJECT ファイル	45 KB
IDE .project	2021/01/29 21:23	PROJECT ファイル	1 KB
📒 agt0_timer.c	2021/01/22 16:04	C ファイル	6 KB
🔚 agt0_timer.h	2020/10/27 16:08	Η ファイル	3 KB
🔚 agt1.c	2020/10/27 16:08	C ファイル	7 KB
🔚 agt1.h	2020/10/27 16:08	Η ファイル	3 KB
Commissioning.h	2021/02/24 16:50	Η ファイル	6 KB
🔚 error.h	2020/10/27 16:08	Η ファイル	3 KB
🔚 hs300x.c	2021/01/28 16:35	C ファイル	6 KB
🔚 hs300x.h	2021/01/28 17:49	Η ファイル	3 KB
🔚 lcd.c	2021/01/12 15:48	C ファイル	31 KB
🔛 lcd.h	2020/12/21 16:41	Η ファイル	5 KB
🔛 lvd_lvdbat.c	2021/01/20 19:45	C ファイル	34 KB
🔛 lvd_lvdbat.h	2020/12/21 16:41	Η ファイル	6 KB
🔚 main.c	2021/02/24 13:49	C ファイル	60 KB
🔚 main.h	2021/02/24 10:32	Н ファイル	13 KB
mip_display.c	2020/12/23 16:32	C ファイル	11 KB 🗸

Rename the folder.
 r01an5753_re_lora → ZeroCarbonProject

5.3.4. Applying patch data

Apply the patch data to the ZeroCarbonProject folder.

- Download extraction folder: ①ZeroCarbonProjectPatch-main
- Application target folder: ZeroCarbonProject
- Patch data files: 0001-FileAndFolder-delete.patch 0002-ZeroCarbon-Custom.patch

Copy the patch data files to the same level as the ZeroCarbonProject folder.

📕 ZeroCarbonProject	2022/03/30 10:55	ファイル フォルダー	
₽ 0001-FileAndFolder-delete.patch	2022/03/16 13:59	Patch File	2,611 KB
₽ 0002-ZeroCarbon-Custom.patch	2022/03/16 13:59	Patch File	668 KB

1. Prepare the patch command.

Because Windows has no patch command by default, you need to install it separately. You can obtain the patch command for Windows from websites like the following:

Download				
Description	Download	Size	Last change	Md5sum
Complete package, except sources	Setup	507466	15 May 2007	49fcf947ae8974b4a1046c8b15f0d63d
Sources	Setup	Click th	is link to dow	vnload
Binaries	Zip	126248	15 May 2007	b9c8b31d62f4b2e4f1887bbb63e8a905
	10.1	102022	15 May 2007	2c9cb3ff535077755a81fb43883a71a5
Documentation	Zip	127677	15 May 2007	200000110000110000001100

Extract the downloaded zip file to a folder of your choice.

Due to Windows constraints, you must execute the patch command from a Command Prompt with administrator privileges.

Before running the patch command, you must first execute the following command to register the path of the patch.exe file.

set PATH=%PATH%;"folder-containing-extracted-patch-command¥patch-2.5.9-7-bin¥bin"

Example:

Folder containing extracted command file: E:¥ZeroCarbonProject¥patch-2.5.9-7-bin¥bin Path registration command: set PATH=%PATH%;"E:¥ZeroCarbonProject¥patch-2.5.9-7-bin¥bin"

2. Open Command Prompt and use the cd command to change the current folder to the folder containing the ZeroCarbonProject folder.



3. Execute the following command. patch --directory=ZeroCarbonProject -p1 --verbose --remove-empty-files < 0001-FileAndFolder-. delete.patch



■ 管理者: コマンド プロンプト	-	×
diffgit a/system/uart.h b/system/uart.h deleted file mode 100644 index 7796a210000000 a/system/uart.h +++ /dex/null		^
Patching file system/uart.h using Plan A Humk #l succeeded at 1. Removing file system/uart.h Removed empty directory system Hmm Ignoring the trailing garbage. done		
E:¥Trial>_		~

patch --directory=ZeroCarbonProject -p1 --verbose --remove-empty-files < 0002-ZeroCarbon-Custom.patch

◎ 管理者: コマンド ブロンプト	-		\times
E:¥Trial>patchdirectory=ZeroCarbonProject -p1verboseremove-empty-files < 0002-ZeroCarbon-C	Custom.patc	h_	~
If command execution is successful, the window appears as follows:			
國 管理者: コマンド ブロンプト	-		×
Hmm The next patch looks like a unified diff to me The text leading up to this was:			
diffgit a/transceiver_wifi_scan.h b/transceiver_wifi_scan.h new file mode 100644 index 00000005ede241 /dev/null +++ b/transceiver_wifi_scan.h			
Patching file transceiver_wifi_scan.h using Plan A Hunk #1 succeeded at 1. Hmm Ignoring the trailing garbage. done			

E:¥Trial>_ 5

5.3.5. Overwriting with downloaded code

Replace the files and folders in the ZeroCarbonProject folder with the downloaded code.

5.3.5.1. Folder created by extracting downloaded file: 2 re-driver-packagemaster

re-driver-package-master¥SDK_RE01_256KB¥RE01_256KB_DFP

Overwrite the following folders in the ZeroCarbonProject folder by copying the equivalent folders in the preceding folder to the ZeroCarbonProject folder.

- CMSIS
- config
- Device
- script
- SVD

5.3.5.2. Folder created by extracting downloaded file: ③ Ir1110_evk_demo_app-master

Ir1110_evk_demo_app-master¥embedded

Overwrite the following folders in the ZeroCarbonProject folder by copying the equivalent folders in the preceding folder to the ZeroCarbonProject folder.

- application
- demo
- system

5.3.5.3. Folder created by extracting downloaded file: ④ Ir1110_driver-Branch_v3.0.0_kai

lr1110 driver-Branch v3.0.0 kai

Copy the preceding folder to the ZeroCarbonProject folder, and rename it as follows:

Ir1110_driver

5.3.5.4. Folder created by extracting downloaded file: 5lr1110_modem_driver-Branch_v2.0.1_kai

lr1110_modem_driver-Branch_v2.0.1_kai

Copy the preceding folder to the ZeroCarbonProject folder, and rename it as follows:

Ir1110_modem_driver

5.3.6. Installing the e² studio integrated development environment

Download and install the e² studio environment from the following section of the Renesas website: Resources - RE Family Development Environment <u>https://www.renesas.com/re01-256kb</u> 5.3.7. Importing and building ZeroCarbonProject

Import ZeroCarbonProject into the e² studio integrated development environment and build the project. Start e² studio.

• Specify the workspace directory and then click Launch.

•

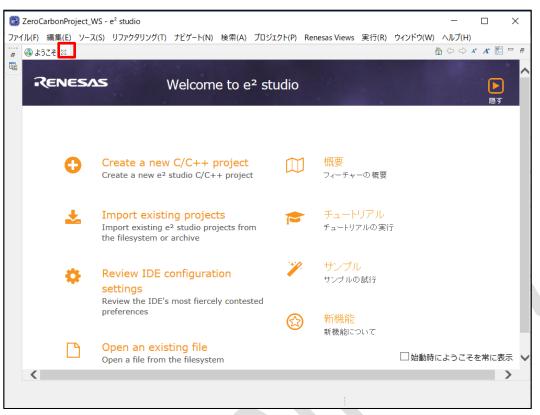
② e² studio ランチャー	×	
ティレクトリーをワークスペースとして選択 e ² studio は、ワークスペースディレクトリを使用して、環境設定と開発成果物を保存します。		
ワークスペース(W): [●] E¥Trial¥ZeroCarbonProject_WS ~ 参照(B)		
□この選択をデフォルトとして使用し、今後この質問を表示しない(U) ▶ 最近のワークスペース(R) 起勤(L) キャンセル		

• In the Collect log/usage data dialog box, click the Cancel button.

>

	×
ログノ使用状況テータ収集	RENESAS
e2 studioは、使用状況を記録したログを許諾に基づいてRene このデータは、製品とサービスの向上、およびサポートとメンテナンス この設定は、設定ウィンドウにもあります。許諾を戴いた後も、設 収集する情報について	スの向上を目的として使用されます。
<u>ブライパシーポリシー</u> □ データ収集を有効にする(詳細な内容が表示されます)	
サポートに役立てるため、e2 studioは問題の調査に有効な使用 このデータはワークスペースに記録され、Renesasには送信されませ □ 詳細なログを有効にする	
	Apply キャンセル

Click the x on the Welcome tab of the Renesas Welcome to e² studio window.



In the Project Explorer area, click Import Projects.

ZeroCarbonProject_WS - e ² studi	io						-		×
ファイル(F) 編集(E) ソース(S) リファク	タリング(T) ナビゲート(N) 検索(A)	プロジェクト(P)	Renesas View	s 実行(R) ウイン	ッドウ(W) ヘルプ(H)		
	V No Launch Cor	figurations	~ オン:		∨ ☆	-		- % -	1019
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⋬╺╗╺╬┽╎							Q	et Fe	C/C++
Ъ プロジェクト・エクスプロ 🛛 🗖 🗖							語 アウトライ	ン 🛙	- 0
E 🕏 7 🕴									
ワークスペースにプロジェクトがありません。 プロジェクトを追加するには:							アウトラインス ブなエディタ		
Synergy C/C++ Project									
Create a new Makefile project in a directory containing existing code									
C <u>または C++ プロジェクトを</u> 新規作成									
📑 プロジェクトを作成									
<u> ♪ □ ジェクトをインボート…</u>									
	🔝 問題 🛛 旦 コン	ノール 🦦 スマー	ト・ブラウザー	גב=רי-א-רא	Рル			7	3 - 0
	0 項目								
	記述/説明	^			リソース	パス		1	コケーション
	<								>
0項目が選択されました。									

Under the General node, select Existing Projects into Workspace and then click Next.

3 インポート −		×	
選択 アーカイブ・ファイルまたはディレクトリーから新規プロジェクトを作成します。		2	
インポート・ウィザードの選択(S):			
7ィルタ入力			
 ・一般 CMSIS Pack CMSIS Pack GNUARM-NONE/RZ(DS-5) project conversion to GCC ARM Embedded GNUARM-NONE/RZ(DS-5) project conversion to GCC ARM Embedded GNUARM-NONE/RZ(DS-5) project conversion to GCC ARM Embedded 		< >	
次へ(N) > 終了(F)	キャンセ	ll	

Click the Browse button beside the Select root directory field, select the project folder you created (which appears as LR1110_GNSS_256KB_Transceiver in the Projects area), and then click the Finish button.

📴 インポート			_		×	
プロジェクトをインボート 既存の Eclipse プロジェクトを検索す	るディレクトリーを選択します。					
◉ ルート・ディレクトリーの選択(T): E	::¥Trial¥ZeroCarbonProject		~	参照((R)	
○ アーカイブ・ファイルの選択(A):			~	参照((R)	
プロジェクト(P):						
LR1110_GNSS_256KB_Trai	nsceiver(E:¥Trial¥ZeroCarbo	nProject)		すべて選打	択(S)	
			運	【択をすべて	解除(D)	
				更新(E)	
オプション						
□ ネストしたプロジェクトを検索(H)						
□ プロジェクトをワークスペースにコピー						
 完了次第、新しくインポートしたフ ワークスペースに既に存在するプロ 						
ワーキング・セット						
ワーキング・セットにプロジェクトを	追加(T)			新規(W)	
ワーキング・セット(O):			/	選択(E)		
? < 戻	る(B) 次へ(N) >	終了(F)		キャン	セル	

Select LR1110_GNSS_256KB_Transceiver in the Project Explorer area, and from the Project menu, select Change Device.

				~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~		
📴 Z	eroCarbonProject_V	VS - e ² studio				– 🗆 X
ファイル	/(F) 編集(E) ソース	(S) リファクタ	リング(T) ナビゲート(N) 検索(A)	プロジェクト(P) Renesas Vie	ws 実行(R) ウィンドウ(W) ヘルプ(H)
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Q. 2	8 💸 + 💁 +	0. 🗸 😽 🛙	• 💷 😭 🕹 🕹 👘 📲 🥖	アロジェクトを閉じる(S)		
🕹 👻	A ▲ 42 43 40 ▲	⇒ - 🖻		Open Synergy Configu Open FSP Configuratio		९ 🖻 िि C/C++
Pa 🕹 🕹	ジェクト・エクスプロ	×		■ すべてビルド(A)	Ctrl+Alt+B	🏗 アウトライン 🛛 🗌 🗖
	LR1110_GNSS_256K			ビルド構成	CUITAILTB >	
1		b_iransceive		プロジェクトのビルド(B)	Ctrl+B	アウトラインを提供するアクティ ブなエディターはありません。
				ワーキング・セットのビルド(W) >	
				クリーン(N) 自動的にビルド(M)		
				ビルド・ターゲット	>	-
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		1	Synergy	一 ナベマの法方関係を更新	Alt+D	
				Change Device		
				C/C++ Project Setting	s Ctrl+Alt+P	
				プロパティ(P)		
<	_	>	1			×
		,				
😂 LR1	110_GNSS_256KB_	Fransceiver				
Click the	button to	the righ	it of the Target Dev	<mark>/ice</mark> field.		
	🗐 リファクタリング					
	Change Device	•				
	Select the new d	evice for LR1	110_GNSS_256KB_Transceiver			
	Current Device: R	7F0E01182CF	P			
	Custom					
	Target Board:	Custom			~	
	ターゲット・デバイス	P7F0F01PP				
	9-995-9713	K/FOEDTBE		=		
				2	<u>バイスのアンロック</u>	
	?		< 戻る(B) 次へ (N)	> 終了(F)	キャンセル	

• In the Device Selection dialog box, select R7F0E01182DNG and then click OK.

					\times
Device Selection					
You can filter devices by regular	expression				
Search Device					
Device	RAM	ROM	Pin		^
✓ REO					
> RE01B					
> RE01_1500KB					
✓ RE01_256KB					
> R7F0E01082DNG - 56p					
 R7F0E01182DNG - 56pi 					
R7F0E01182DNG	128 KB	256 KB	56		
- K7F0E01082CFIVI - 04pr					
> R7F0E01182CFM - 64pi					
> R7F0E01082DBR - 72pi					
> R7F0E01182DBR - 72pi					
> R7F0E01082CFP - 100p					
> R7F0E01082DBH - 100p					
> R7F0E01182CFP - 100pi					
D7E0E01102DBU100					~
?		OK		キャンセル	

Click Next.

📴 אַראָלידע – 🗆 X
Change Device 下のリストに示されている情報を確認してください。'次へ >' をクリックして次の項目を表示するか、'終了' をクリ ックします。
検出された問題 🔱 🗘
This change cannot be undone. Please make sure you backup this project before continuing.
使用可能なコンテキスト情報はありません
? < 戻る(B) 次へ(N) > 終了(F) キャンセル

 In the Changes to be performed list, clear the check box beside HardwareDebug_IAR and then click Finish.

📴 リファクタリング			\times	
Change Device リファクタリングを実行するには、以下の変更が必要です。				
実行される変更 ● 包 Change Device for LR1110_GNSS_256KB_1 ● 包 Build Settings ● 2 A HardwareDebug ● Device name > 2 名 HardwareDebug_IAR	ransceiver	₽	∀ •	
> 🗸 🖄 Project Files Device name			~	
New 1 R7F0E01182DNG	Current 1 R7F0E01182CFP	2	· ·	
? < 戻る(B)	次へ(N) > 終了(F)	キャンセ	IL	

 In the Project Explorer area, right-click LR1110_GNSS_256KB_Transceiver and select Build Project from the context menu.

					_
ZeroCarbonPro		次ヘジャンプ(1)		X	
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		ローカル・ターミナルで表示	>		1
 > ∰ 		コピー(C)	Cui+C		
\$2 ▼ 13 ▼ 13 ▼ 13	Ē.	貼り付け(P)	Ctrl+V	Q i 🖻 🔤 C/C++	
陷 プロジェクト・エクス:	×	削除(D) ソース	削除	□ 1 2 アウトライン 22 「	1
	٦	移動(∨)	, ,		
ER1110_GNSS_	J	名前を変更(M)	F2	アウトラインを提供するアクティ	(
	è	インポート(1)		プなエディターはありません。	
		1 ノホート(I) エクスポート(O)			
	L	ブロジェクトのビルト(6) 選択	されたプロジェクトをインクリ		
	ഭി	更新(F)	F5	ラウザー і♀ スマート・マニュアル 🔋 💀 🖻 ▼ 🖻 ▼ 🗅 □	1
		プロジェクトを閉じる(S)			
		無関係なプロジェクトを閉じる(し)		
		ビルド・ターゲット	>		
		インデックス	>		
		ビルド構成	>		
	0	実行(R)	>		
	蓉	デバッグ(D)	>		
		ローカル履歴から復元(Y)			
		MISRA-C	>		
	N	C/C++ Project Settings	Ctrl+Alt+P		
		Save build settings report			
	-140	Change Device			
<	N	C/C++ コード解析を実行 Team	>	>	-
		Compare With	>		-
😂 LR1110_GNSS_25			,		
	_				_

• The build is successful if **Build Finished 0 error**, **0 warnings** appears on the **Console** tab at the bottom right of the window.

ZeroCarbonProject_WS - e ² studi	0	_			
ファイル(F) 編集(E) ソース(S) リファクタリング(T) ナビゲート(N) 検索(A) プロジェクト(P) Renesas Views 実行(R) ウィンドウ(W) ヘルプ(H)					
🔦 🏘 🔳 🎋 デバッグ(B)	✓ Can4950_gpio_re_256kb Hart ✓ 禁 オン: ✓ 禁 ご ▼		- 🖏 🔮		
	▼!№ □ 11 !₽! ∞ !@!% ☆ ▼ \$ ~ !% ▼ * !% ■ 00 * * 8 & & !%				
		٩ 🛛			
🎦 プロジェクト・エクスプロ 🛛 🗖 🗖		🏗 アウトライン			
ا 🛱 🛱 ا⊟ 🕞 🕞 📄 > 🕼 LR1110 GNSS 256KB Transceive		アウトラインたち	提供するアクティ		
		ブなエディター			
	◎ 問題 □ コンソール ※ ● スマート・ブラウザー □ スマート・マニュアル				
	× ◆ 全 名 量 = ● ● = ■ CDT ビルド・コンソール [LR1110_GNSS_256KB_Transceiver]				
	arm-none-eabi-gcc -mcpu=cortex-m0plus -march=armv6-m -mthumb -mlittle-endian -mfl				
	arm-none-eabi-gcc -mcpu=cortex-m0plus -march=armv6-m -mthumb - arm-none-eabi-gcc -mcpu=cortex-m0plus -march=armv6-m -mthumb -				
	arm-none-eabi-gcc -mcpu=cortex-m0plus -march=armv6-m -mthumb -	mlittle-en	dian -mfl		
	arm-none-eabi-gcc -mcpu=cortex-m0plus -march=armv6-m -mthumb - arm-none-eabi-gcc -mcpu=cortex-m0plus -march=armv6-m -mthumb -				
	arm-none-eabi-objcopy -0 ihex "LR1110_GNSS_256KB_Transceiver.e	lf" "LR11	10_GNSS_2		
	arm-none-eabi-sizeformat=berkeley "LR1110_GNSS_256KB_Transc text data bss dec hex filename	eiver.elf"			
	170767 476 19968 191211 2eaeb LR1110_GNSS_256KB_Tran	sceiver.el	f		
	4:15:03 Build Finished. 0 errors, 0 warnings. (took 6s.174ms)				
< >	<		>		

The .hex file for the project is generated in the following folder: ZeroCarbonProject¥HardwareDebug¥LR1110_GNSS_256KB_Transceiver.hex

•

5.4. Hardware resources

Table 5-4 shows the hardware interrupt used by the sample code.

Table	5-4 Hardware resources

Used for	Interrupt name	Description
Trigger switch	IRQ3_IRQHandler	An interrupt used to wake from standby mode. This interrupt is always enabled.

5.5. List of constants

The following explains the constants used in the sample code.

5.5.1. Board-specific constants

The following table shows the board-specific constant used in the project. This constant is declared in the file ZeroCarbonProject/config_mode.h.

Table 5-6-1 Board-specific constants

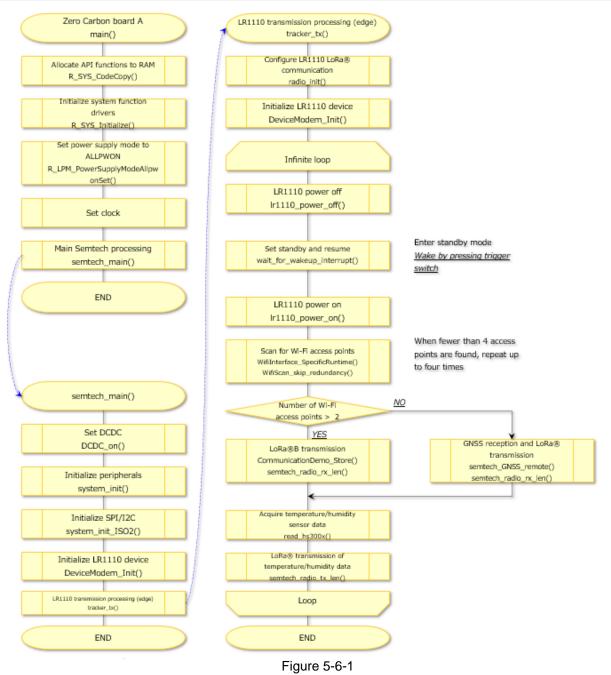
Constant name	Zero Carbon board A (edge) Note: This is the default value	Zero Carbon board B (GW access)
TRACKER_RX_TX_UPDATE (for switching between boards A and B)	2	1

5.6. Flowchart

The following flowcharts show the operation of the sample code.

5.6.1. Zero Carbon board A (edge)

Figure 5-6-1 is a flowchart for Zero Carbon board A (edge).



5.6.2. Zero Carbon board B (GW access)

Figure 5-6-2 is a flowchart for Zero Carbon board B (GW access).

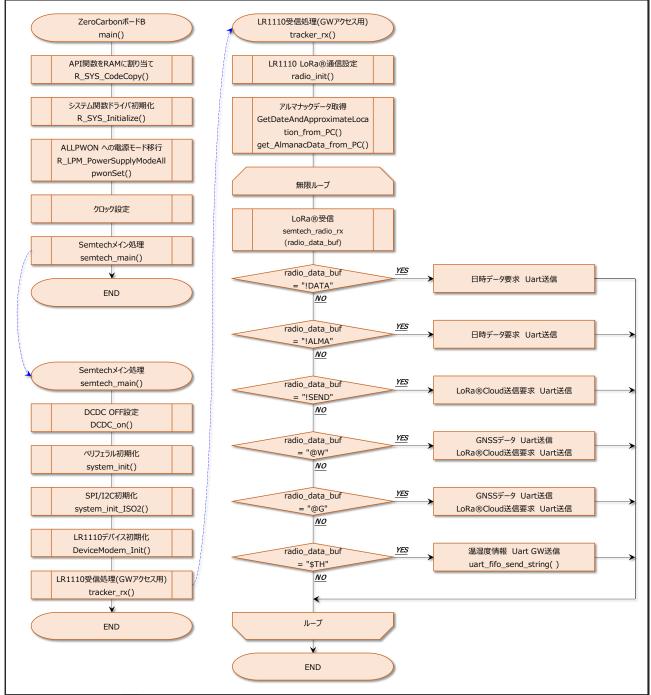
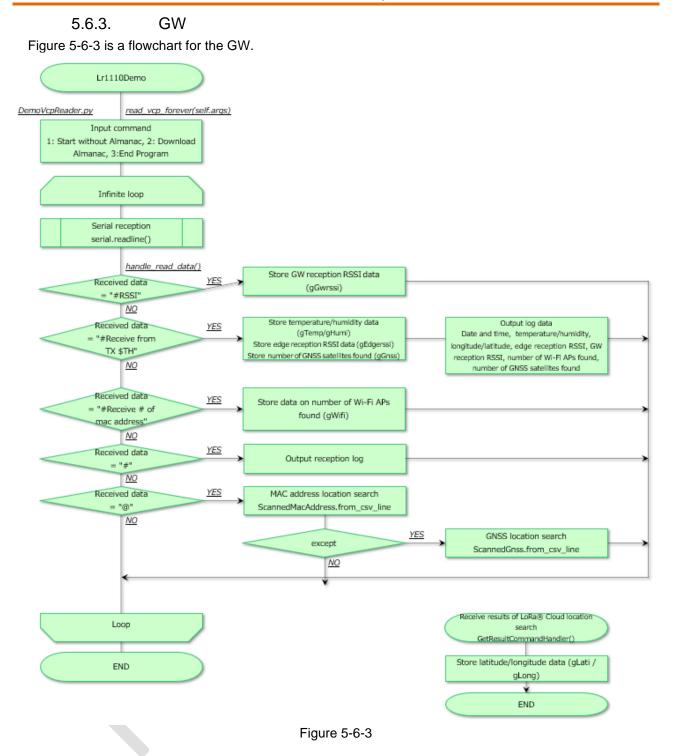


Figure 5-6-2



5.7. Block diagrams

Figure 5-7 illustrates the software layers.

Zero Carbon board A (edge)							
Demo Application (Bare metal)	Delay API LoRa@LR1110 API						
Device Interface Layer							
RE01 MCU CMSIS-Driver, Vendor defined Drivers							
RE01 MCU CMSIS-Core (Startup, vector, IO definitions, etc.)							
RE01 MCU RTC	AGT Timer SPI I2C, SPI, ADC						
	↓ ↓						
	LR1110 LoRa® chip Sensors						
Semtech and Renesas Renesas Provided							
·							
Zero Carbon board B (GW access)	↓ ↓						
	LR1110 LoRa® chip						
	<u></u>						
RE01 MCU	SPI UART						
RE01 MCU CMSIS-Core (Startup, vector, IO definitions, etc.)							
RE01 MCU CMSIS-Driver, Vendor defined Drivers							
Device Interface Layer	¥ ¥						
Demo Application (Bare metal)	LoRa®LR1110 API						
GW (PC: phtyon)	¥						
	UART						
	Ŷ						
Demo Application LoRa®Cloud	Modem and Geolocation						
	[
LoRa®Cloud	¥						
Modem and Geolocation Services							
Figure 5-7 Bloc	k diagrams						
Figure 5-7 Block diagrams							

5.8. LoRa[®] communication settings

Note: <u>Applying the settings in this section incorrectly might result in violation of radio</u> <u>communication laws. Exercise care when applying these settings.</u>

With reference to the following sections, set the LoRa[®] communication settings of the **Zero Carbon board A (edge)** and **Zero Carbon board B (GW access)**. Use the same settings for both boards.

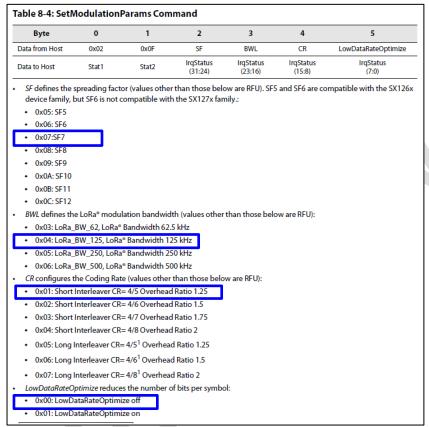
5.8.1. LoRa[®] communication packet modulation parameter settings

See the following resource for details on modulation parameter settings.

LR1110 Transceiver User Manual (UserManual_LR1110_V1_2.pdf)

"8.3.1 SetModulationParams"

The blue boxes in the following figure indicate the initial settings of the sample code.





🖺 tran	seeiver_radio.c - sakura 2.4.12849 — 🗆 🗙
158 in) 編集(E) 変換(C) 検索(S) ツール(T) 設定(O) ウインドウ(W) ヘルプ(H)
161 162 ↔	^ uint16_t i;↔ modem_result= radio_init_sub();↔
163 164	modem_result = lr1110_radio_set_pkt_type(&lr1110, LR1110_RADIO_PKT_TYPE_LORA);+
165 166 167 168 169 170	modulation_lora_sf = LR110_RADIO_LORA_SF7;~ modulation_lora.bw = LR110_RADIO_LORA_SF7;~ modulation_lora.cr = LR110_RADIO_LORA_CR_4_5;~ modulation_lora.ldr = 0;~ modem_result= lr110_radio_set_lora_mod_params(&lr1110, &modulation_lora);~
171 ↑ 172 ↑ 173 ↑ 174 ↑ 175 ↑ 176 ↑	packet_lora.preamble_len_in_symb = 8;** packet_lora.header_type = LR1110_RADI0_LORA_PKT_EXPLICIT; // = DEMO_RADI0_LORA_HDR_DEFAULT;** packet_lora.crc = LR1110_RADI0_LORA_C&C_OFF; // = DEMO_RADI0_LORA_C&C_DEFAULT;** packet_lora.iq = LR1110_RADI0_LORA_I0_STANDARD; // = DEMO_RADI0_LORA_I0_DEFAULT;** modem_result = Ir1110_radio_set_lora_pkt_params(&Ir1110, &packet_lora);**
178 179 e	modem_result= lr1110_radio_set_rf_freq(&lr1110, RF_FREQUENCY); e
179 € 180 0 181 0 182 0 183 // 184 0 185 0 186 €	pa_configuration.pa_sel = LR1110_RADIO_PA_SEL_LP; // =DEMO_RADIO_PA_SEL_DEFAULT; Low-power Power Amplifier* pa_configuration.pa_duty_cycle = DEMO_RADIO_PA_DUTY_VREG; // = DEMO_RADIO_PA_REG_SUPPLY_DEFAULT; Power amplifier supplied by the main regulator* pa_configuration.pa_duty_cycle = DEMO_RADIO_PA_DUTY_VREG_DEFAULT; // = 4* pa_configuration.pa_duty_cycle = DEMO_RADIO_PA_HDYE_DEFAULT; // = 4* pa_configuration.pa_duty_cycle = DEMO_RADIO_PA_HDYE_DEFAULT; // = 4* pa_configuration.pa_duty_cycle = DEMO_RADIO_PA_HDYE_DEFAULT; // = 4* pa_configuration.pa_be_sel = DEMO_RADIO_PA_HDYE_DEFAULT; // = 0** modem_result = lr1110_radio_set_pa_cfg(&lr1110, &pa_configuration);*
180 × 187 // 188 1 189 190 191 192 ←	<pre>(* modem_result= irl110_radio_set_tx_params(&irl110, DEMO_RADIO_TX_POWER_DEFAULT, LR1110_RADIO_RAWP_240_UB>);** modem_result= irl110_system_set_dio_irg_params(&irl110, POWER_DOEDWULT, LR1110_RADIO_RAWP_80_UB>);** modem_result= irl110_system_set_dio_irg_params(&irl110,** LR1110_SYSTEM_IRO_GMSS_SCAL_NOWE!LR110_SYSTEM_IRO_TX_DOWE LR1110_SYSTEM_IRO_TX_DOWE LR1110_SYSTEM_IRO_TX_DOWE LR110_SYSTEM_IRO_TX_DOWE SYSTEM_IRO_TX_DOWE LR110_SYSTEM_IRO_TX_DOWE SYSTEM_IRO_TX_DOWE SYSTEM_IRO_TX_DOWE</pre>
193	return 0:4
194]• 195 ↔	·
_ <	

Figure 5-8-1-2 Location of modulation parameter settings

5.8.2. Power amplifier configuration settings

See the following resource for details on power amplifier configuration settings: LR1110 Transceiver User Manual (UserManual_LR1110_V1_4.pdf)

"9.5.1 SetPaConfig"

1 (F) 編集(

return 0;«

The blue boxes in the following figure indicate the initial settings of the sample code.

mocm_result = Inilio_radio_set_lora_pkt_params(&Irilio, &packet_lora); mocm_result = Inilio_radio_set_lora, &packet_lora, &pa

modem_result= Ir1110_radio_set_rf_freq(&|r1110, RF_FREQUENCY);↔ L D1110

		1	2	3	4	5	
Data from Host	0x02	0x15	PaSel	RegPaSupply	PaDutyCycle	PaHPSel	
Data to Host	Stat1	Stat2	IrqStatus (31:24)	IrqStatus (23:16)	IrqStatus (15:8)	IrqStatus (7:0)	
 PaSel selects the 	e PA:						
0x00: Select:	the low power	PA.					
 0x01: Selects 	s the high powe	r PA.					
 RegPaSupply se 	lects the PA pov	ver source:	_				
		e internal regulat					
				<i>ly</i> = 0x01 wheneve	r TxPower > 14.		
PaDutyCycle controls the duty cycle of the high and low power PAs.							
Fable 9-4: DutyCycle Parameter 0x04							
Low Power PA							
Control			DutyCycle	= 20% + 4%*PaDuty	/Cycle		
		20% <dutycycle<48%< td=""><td colspan="3">20%<dutycycle<36%< td=""></dutycycle<36%<></td></dutycycle<48%<>			20% <dutycycle<36%< td=""></dutycycle<36%<>		
Allowed Ran	ge	0 <padu< td=""><td>tyCycle<7</td><td></td><td>0<padutycycle<< td=""><td><6</td></padutycycle<<></td></padu<>	tyCycle<7		0 <padutycycle<< td=""><td><6</td></padutycycle<<>	<6	
Default valu	e		_	DutyCycle=36%			
DellDCelesetes		high power PA.	, –)×00			
Fiç	gure 5-8-3	2-1 Powei	r amplifier	configura	tion setting	IS	
kura 2.4.1.2849					~		
:) 検索(S) ツール(T) 設定							
it()←		5 ! 16 !	17			12	
ب = radio_init_sub	();∉						
t = Ir1110_radio_set	_pkt_type(& r1	110, LR1110_RADIO	_PKT_TYPE_LORA);	÷			

Figure 5-8-2-2 Location of power amplifier configuration settings

pa_configuration.pa_cst_supply = LR1110_RADIO_PA_SEL_LP___/__PENUO_PADIO_PA_SEL_DETENUT.L_SUPPLY_DEFAULT; Power amplifier supplied by
pa_configuration.pa_duty_cvcle = DEMO_RADIO_PA_REG_SUPPLY_WREG; // = 4+
pa_configuration.pa_duty_cvcle = DEMO_RADIO_PA_DUTY_CYCLE_DEFAULT; // = 4+
pa_configuration.pa_duty_cvcle = DEMO_RADIO_PA_DUTY_CYCLE_DEFAULT; // = 4+
modem_result = Ir1110_radio_set_pa_cfg(&Ir1110, & Radio_spa_configuration);++++

modem_result: Iffio_faulo_set_tx_params(&frillo, beno_haplo_fx_pomer_beraolt, Entito_haplo_fx_m__tx_outo_fx_m modem_result: Iffilo_system_set_dio_fra_params(&frillo, beno_fx_pomer_ber_bown, Entito_Fx_pomer_base_faulo_fx_m LRTIO_SYSTEM_IRO_GNSS_SCAN_DONE | LRTITO_SYSTEM_RO_TX_DONE | LRTITO_SYSTEM_IRO_FX_DONE | LRTITO_SYSTEM_IRO_TIMEOUT, 0);+ modem_result = Iffilo_system_clear_ira_status(&frillo, LRTITO_SYSTEM_IRO_AL_MASK_);+

[CRLF] 158:20

he main regulator

5.8.3. TX power and power amplifier ramping time parameter settings

See the following resource for details on power amplifier configuration settings. LR1110 Transceiver User Manual (UserManual_LR1110_V1_2.pdf)

"9.5.2 SetTxParams"

The blue boxes in the following figure indicate the initial settings of the sample code.

Byte	0	1	2	3
ta from Host	0x02	0x11	TxPower	RampTime
ita to Host	Stat1	Stat2	IrqStatus(31:24)	IrqStatus(23:16
 17 dBm (0xEF) to + 9 dBm (0xF7) to +22 If <i>TxPower</i> > +14 dBn <i>RampTime</i> defines the P 	tput power in dBm in a ra 14 dBm (0x0E) by steps of 2 dBm(0x16) by steps of 1 n, the user must select th 14 power ramping time, w	f 1 dB if the hig I dB if the high pov e VBAT supply for t	he PA using the SetPaCor	-
ble 9-6: RampTime	Values	Ramp	Time in µs	
SET_RAMP_16U	0x00		16	
SET_RAMP_32U	0x01		32	
SET_RAMP_48U	0x02		48	
SET_RAMP_64U	0x03		64	
SET_RAMP_80U	0x04		80	
SET_RAMP_96U	0x05		96	
SET_RAMP_112U	0x06		112	
SET_RAMP_128U	0x07		128	
SET_RAMP_144U	0x08		144	
			160	
SET_RAMP_160U	0x09			
SET_RAMP_160U SET_RAMP_176U	0x09 0x0A		176	
			176 192	
SET_RAMP_176U	0x0A			
SET_RAMP_176U SET_RAMP_192U	0x0A 0x0B		192	
SET_RAMP_176U SET_RAMP_192U SET_RAMP_208U	0x0A 0x0B 0x0C		192 208	

Figure 5-8-3-1 TX power and power amplifier ramping time parameter settings

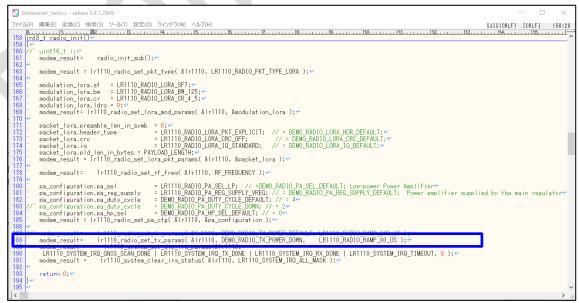


Figure 5-8-3-2 Location of TX power and power amplifier ramping time parameter settings

5.8.4. Frequency settings

See the following resource for details on frequency settings:

LR1110 Transceiver User Manual (UserManual_LR1110_V1_2.pdf)

"7.2.1 SetRfFrequency"

The frequency settings in this section conform to Japanese standards as explained at the following URL: <u>https://www.arib.or.jp/kikaku/kikaku_tushin/desc/std-t108.html</u>

The blue box in the following figure indicates the initial settings of the sample code.

Byte	0	1	2	3	4	5
Data from Host	0x02	0x0B	RfFreq (31:24)	RfFreq (23:16)	RfFreq (15:8)	RfFreq (7:0)
Data to Host	Stat1	Stat2	IrqStatus	IrqStatus	IrqStatus	IrqStatus

RfFreq: RF Frequency of the sub-GHz radio in Hz. All frequency dependent parameter by the LR1110 firmware when processing this command.



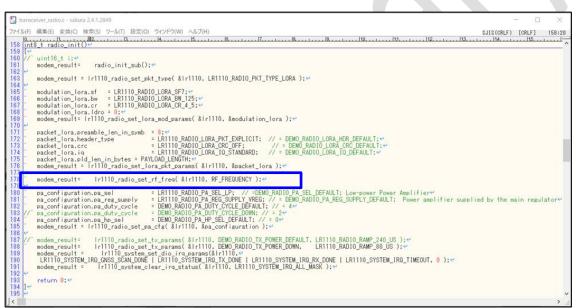


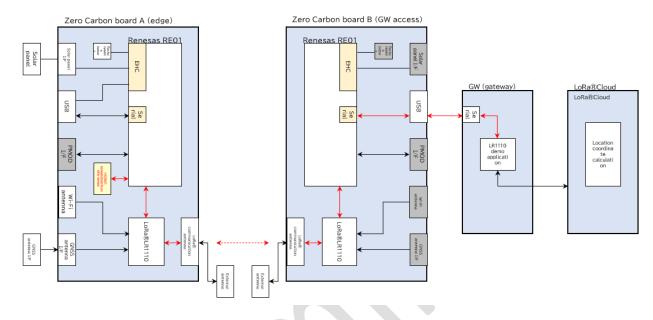
Figure 5-8-4-2 Location of frequency settings

5.9. Zero Carbon board A (edge) with additional sensor

The following explains the steps required on the Zero Carbon board A (edge), Zero Carbon board B (GW access) and GW in a system where a sensor is added to the Zero Carbon board A (edge).

Note: The following uses the example of the HS3001 (I²C communication temperature and humidity sensor) that the Zero Carbon board currently incorporates.

In the following overall system diagram, the output of the HS3001 (temperature and humidity sensor) is passed to the gateway by serial communication via the LR1110 (the route shown in red in the following figure).



Development languages:

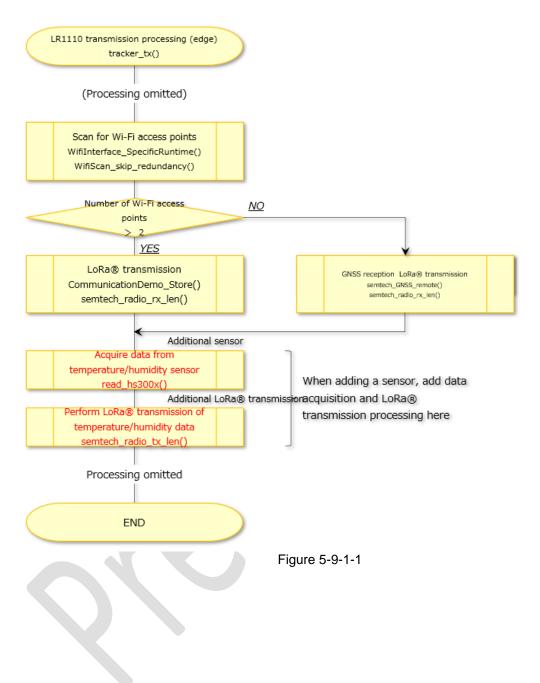
- Zero Carbon board A (edge)
- Zero Carbon board B (GW access)
 - : c : python

: c

- GW

5.9.1. On the Zero Carbon board A (edge)

The software acquires the output of the HS3001 temperature and humidity sensor and uses LoRa[®] communication to send the data to the Zero Carbon board B (GW access).



Zero Carbon LoRa® Evaluation Board Software Development Procedures v1.00

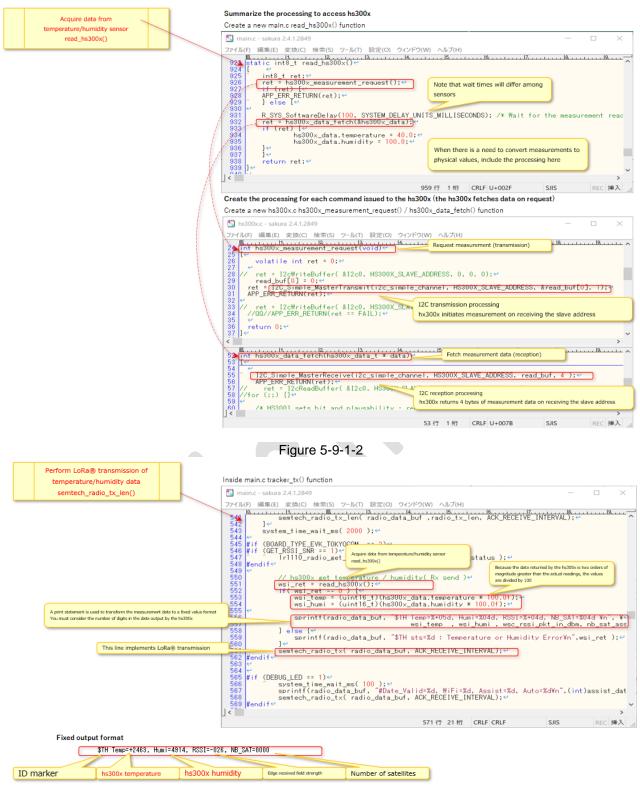
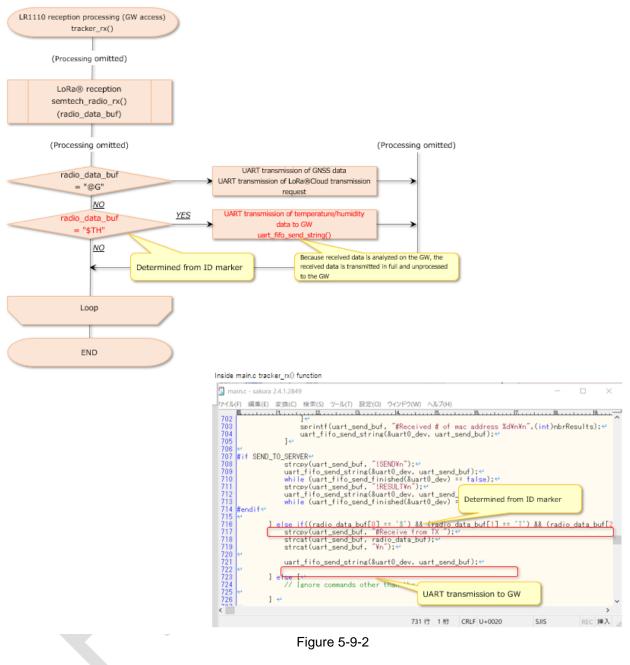


Figure 5-9-1-3

5.9.2. On the Zero Carbon board B (GW access)

The software uses UART communication to send the temperature and humidity data of the HS3001 sensor received by LoRa[®] communication to the GW.



5.9.3. On the GW

The software stores the temperature and humidity data of the HS3001 sensor received by UART communication in variables and outputs the values as log data.

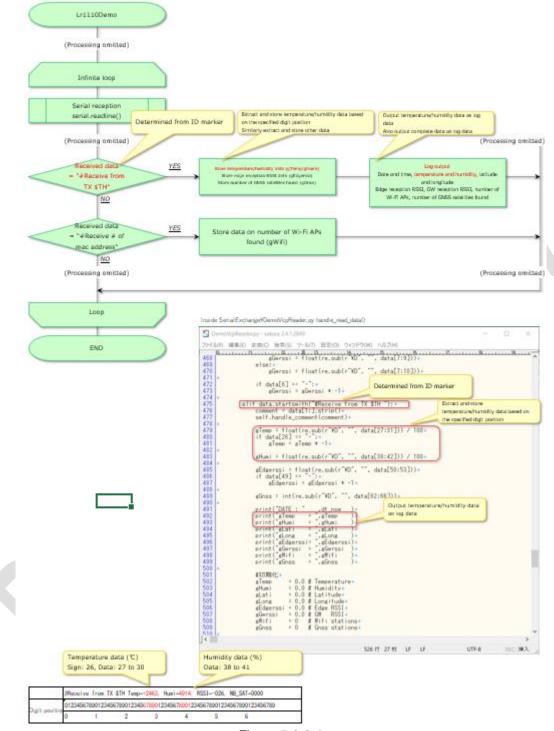


Figure 5-9-3-1

The log output is as follows:

Execution results

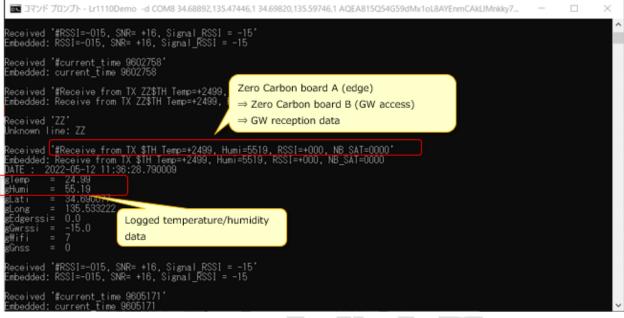


Figure 5-9-3-2

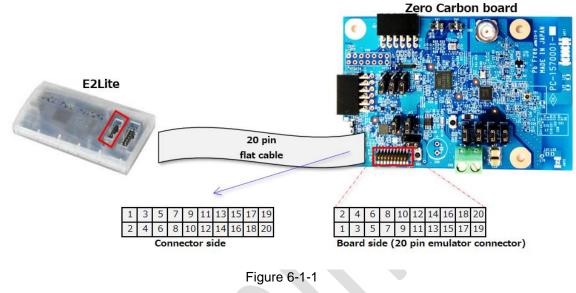
6. Debugging (when using E2Lite)

This chapter explains how to debug the software using Renesas' E2 Emulator Lite (hereinafter E2Lite).

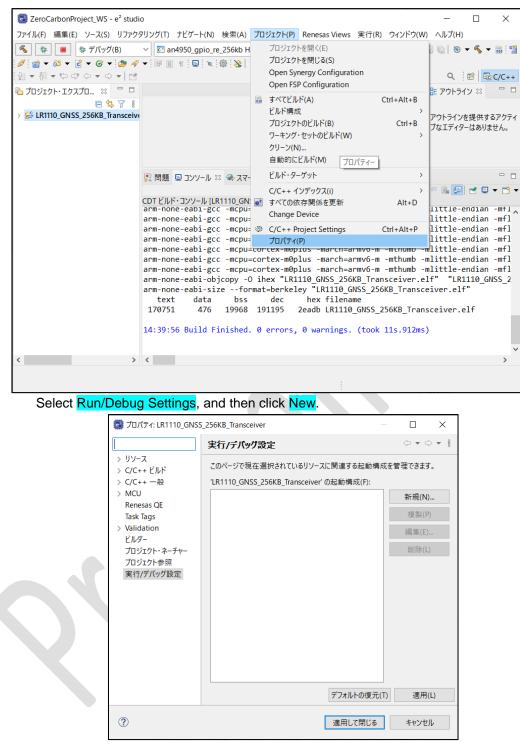
6.1. Debugging in e^2 studio

• Step1: Connecting the Zero Carbon board A (edge) and the E2Lite

Connect a flat cable to connectors indicated by the red boxes in Figure 6-1-1, paying attention to the orientation of the pins.



 Step 2: Run/debug settings From the Project menu, select Properties.





Select Renesas GDB Hardware Debugging, and then click OK.

On the Debugger tab, select E2lite (ARM) from the Debug hardware drop-down list.

📴 構成の編集				_		×	
起動構成プロパティ	の編集				C	Ì.	
■ メイン 参 Debug Debug hardware: GDB Settings Cc GDB 接続設定: ● ローカル GDB ○ リモート GDB GDB	COM Port (RL78) E1 (RH850) E1 (RX) E1/E20 (RL78) E2 (ARM) E2 (RH850)	围(C) 🦆 ソース	: R7F701002xA ドレス: localhos		. 変数.		
		前回保管	管した状態に戻す	(V)	適用(Y)		
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							l

Click the ... button beside the Target Device field.

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名前(N): LR1110_GNSS_256KB_Transce	-				
Debug hardware: E2 Lite (ARM)		CF /			
GDB Settings Connection Settings GDB 接続設定: ・ ローカル GDB サーパーを自動起動		ost			
○リモート GDB サーバーへ接続 GDB	GDB ポート番号: 61234				
GDB コマンド: arm-none-eabi-ge Step Mode	lb	参照	変数		
	前回保管した状態に戻	す(V)	適用(Y)		
?	OK		キャンセル		

In the Device Selection dialog box, click Device, RE, RE/RE_256KB, and R7F0E01182DNG, and then click OK.

Image: Selection Selection You can filter devices by regular expression Search Device Device ✓ RE ✓ RE/RE01_256KB R7F0E01082CFM R7F0E01082CFP R7F0E01082DBH R7F0E01082DBH R7F0E01082DBH R7F0E01182CFP R7F0E01182CFP R7F0E01182CFB R7F0E01182DBG R7F0E01182DBH R7F0E01182DBH R7F0E01182DBR R7F0E01182DBR R7F0E01182DBR R7F0E01182DNG > RE/RE01_1500KB > RE/RE01B				
You can filter devices by regular expression Search Device Device V RE/RE01_256KB R7F0E01082CFM R7F0E01082CFP R7F0E01082DBH R7F0E01082DBH R7F0E01082DBR R7F0E01182CFP R7F0E01182CFM R7F0E01182DBR R7F0E01182DBH R7F0E01182DBH R7F0E01182DBH R7F0E01182DBH R7F0E01182DBG PAF0E01182DBG PAF0E01182DBH R7F0E01182DBH R7F0E01182DBH R7F0E01182DBH R7F0E01182DBH R7F0E01182DBH R7F0E01182DBH R7F0E01182DBH R7F0E01182DBH				—
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 ✓ RE ✓ RE/RE01_256KB R7F0E01082CFM R7F0E01082CFP R7F0E01082DBH R7F0E01082DBR R7F0E01182CFM R7F0E01182CFM R7F0E01182DBH R7F0E01182DBR R7F0E01182DBR R7F0E01182DBR R7F0E01182DNG > RE/RE018 	Search De	evice		
 ✓ RE/RE01_256KB R7F0E01082CFM R7F0E01082CFP R7F0E01082DBH R7F0E01082DNG R7F0E01082DNG R7F0E01182CFM R7F0E01182CFP R7F0E01182DBH R7F0E01182DBR R7F0E01182DBR R7F0E01182DBR PRE/RE01_1500KB > RE/RE01B 	Device			
R7F0E01082CFM R7F0E01082CFP R7F0E01082DBR R7F0E01082DNG R7F0E01182CFM R7F0E01182CFM R7F0E01182DBH R7F0E01182DBR R7F0E01182DBR R7F0E01182DNG > RE/RE01_1500KB > RE/RE01_B	✓ RE			
R7F0E01082CFP R7F0E01082DBH R7F0E01082DNG R7F0E01082CFM R7F0E01182CFM R7F0E01182CFP R7F0E01182DBH R7F0E01182DBR R7F0E01182DNG PRF0E01182DNG > RE/RE01_1500KB > RE/RE01B	V RE	/RE01_256KB		
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R7F0E01082DBR R7F0E01082DNG R7F0E01182CFM R7F0E01182CFP R7F0E01182DBH R7F0E01182DBR R7F0E01182DNG > RE/RE01_1500KB > RE/RE01B		R7F0E01082CFP		
R7F0E01082DNG R7F0E01182CFM R7F0E01182CFP R7F0E01182DBH R7F0E01182DBR R7F0E01182DNG > RE/RE01_1500KB > RE/RE01B		R7F0E01082DBH		
R7F0E01182CFM R7F0E01182CFP R7F0E01182DBH R7F0E01182DBR R7F0E01182DNG > RE/RE01_1500KB > RE/RE01B		R7F0E01082DBR		
R7F0E01182CFP R7F0E01182DBH R7F0E01182DBR R7F0E01182DNG > RE/RE01_1500KB > RE/RE01B		R7F0E01082DNG		
R7F0E01182DBH R7F0E01182DBR R7F0E01182DNG > RE/RE01_1500KB > RE/RE01B		R7F0E01182CFM		
R7F0E01182DBR R7F0E01182DNG > RE/RE01_1500KB > RE/RE01B		R7F0E01182CFP		
R7F0E01182DNG > RE/RE01_1500KB > RE/RE01B				
> RE/RE01_1500KB > RE/RE01B				
> RE/RE01B				
DA DA		/RE01B		
	> RE/			

On the Connection Settings tab, select No for the Power setting Power Target from the Emulator (MAX 200mA).

■ 構成の編集		[\times
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名前(N): LR1110_GNSS_256KB_Transceiver HardwareDebug				
🗎 メイン 🅸 Debugger 🕨 Startup 🔲 共通(C) 🦆 ソース				
Debug hardware: E2 Lite (ARM) V Target Device: R7F0E011	82DN(
GDB Settings Connection Settings デバッグ・ツール設定				
内蔵フラッシュ・メモリー書き換え時にクロック・ソースの変更を許可する	はい		~	^
∨ ターゲット・ボードとの接続				
エミュレーター	(Auto)			
タイプ	SWD		~	
接続速度 (kHz)	Auto		~	
~ 電源				
エミュレーターから電源を供給する (MAX 200mA)	いいえ		\sim	
供給電圧 (V)	はい			
✓ 接続	いいえ			
接続時にリセット状態を維持する	はい		\sim	
IDコード (バイト単位)	FFFFFFF	FFFFFF	FFI	
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Click Apply, and then click OK.

6 26 (L) 1 1 1 1				_
	110_GNSS_256KB_Transceiver HardwareDebug			_
🗎 メイン 🅸 [Debugger 🕨 Startup 🔲 共通(C) 🧤 ソース			
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	 > C/C++ ビルド > C/C++ 一般 > MCU Renesas QE Task Tags > Validation ビルダー プロジェクト・ネーチャー プロジェクト・参照 	'LR1110_GNSS_256KB_Transceiver' の起動構成(F): © LR1110_GNSS_256KB_Transceiver HardwareDebu	新規(N) 複製(P) 編集(E) 削除(L)	
	?	適用して閉じる	キャンセル	

Click Apply, and then click OK. This step is now complete.

Step 3: Zero Carbon board A (edge) jumper and switch settings

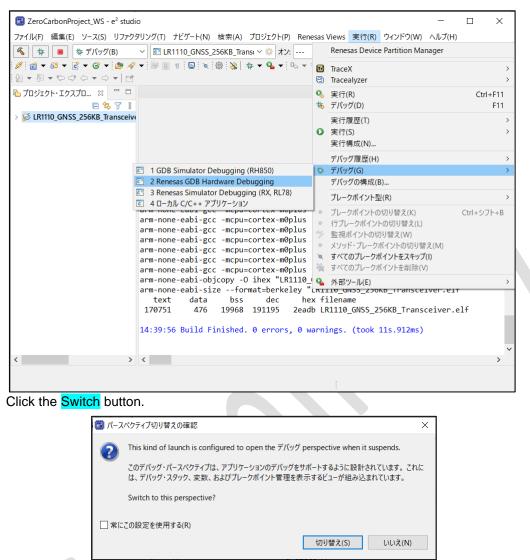
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For details about the board setup when using a USB power supply, see the following resource: Zero Carbon LoRa® Evaluation Board Tutorial

"5. Zero Carbon LoRa® Evaluation Board Jumper and Switch Layout Diagram" When powered by USB: "b. Settings when using USB fast charging"

Note: Because the voltage supplied by energy harvesting devices is unstable, you must power the Zero Carbon board A (edge) with a USB power supply.

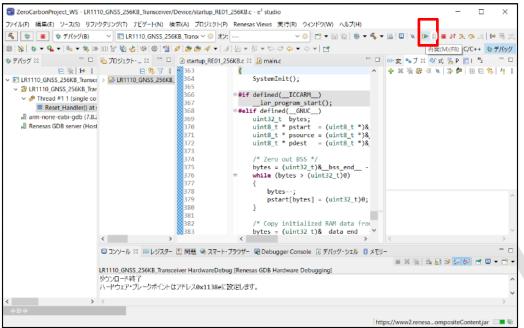
Step 4: Starting the debugger
 From the Run menu, select Debug and then Renesas GDB Hardware Debugging.



Note: If an error message like the following appears, disconnect the USB cable from the E2Lite and the Zero Carbon board A (edge). Then, reconnect the cable, first to the E2Lite and then to the Zero Carbon board A (edge).

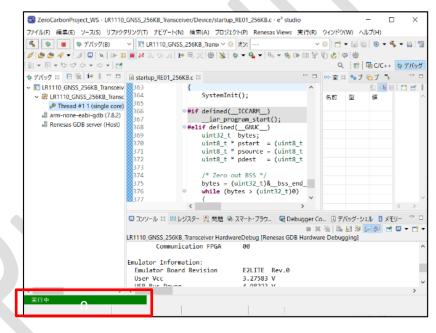
	命的エラー (GDB サーバー):	
4	Error 0x0F000000: エミュレータとの通 (RFWERR_COM)。デパッガを切断し い。その後エミュレータの電源を入れな;	た後、USBケーブルを再接続してくださ

 Step 5: Start debugging Press the F8 key or click the Resume button shown in the red box in the following figure.



Running, Suspended, or Standby appears in the status bar according to the status of the debug



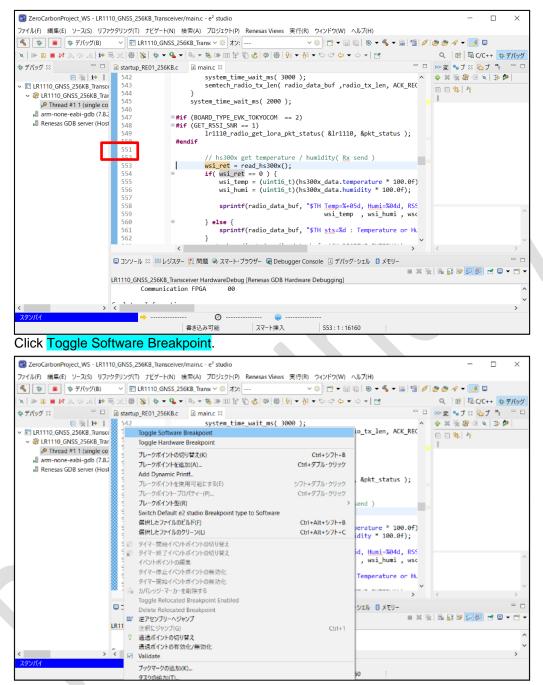


The process will sometimes stop at a hardware breakpoint during the first run. If this occurs, click the **Resume** button again.

Press the trigger switch on the Zero Carbon board A (edge) and confirm that it works.

• Step 6: Setting a breakpoint

Right-click the left of the line of source code where you want to place a break, as indicated by the red box.



ZeroCarbonProject_WS - LR1110_GNSS_256KB_Transceiver/main.c - e² studio × ファイル(F) 編集(E) ソース(S) リファクタリング(T) ナビゲート(N) 検索(A) プロジェクト(P) Renesas Views 実行(R) ウィンドウ(W) ヘルプ(H) 🔏 🎄 🔳 🎄 デバッグ(B) 🗸 🖻 LR1110_GNSS_256KB_Trans(> 🌞 オン: ---Q 🛛 😰 🔤 C/C++ 🎄 デバッグ □ 🗈 startup_RE01_256KB.c 🗟 main.c 🛛 铃 デバッグ ♡ 🗆 🖙 変 🍨 ブ 🛛 🔓 ブ 🦇 E 🙀 ite 🖇 542 556/R Transce 543 🕂 🗙 💥 🥐 🖘 😒 🏇 🔗 system time wait ms(3000); semtech_radio_tx_len(radio_data_buf ,radio_tx_len, ACK_REC
 IR1110_GNSS_256KB_Transce
 IR1110_GNSS_256KB_Transce
 🕀 🕒 😫 🗏 ୟ 544 545 546 547 548 system_time_wait_ms(2000); 🗸 🧬 Thread #1 1 (single co v 🖉 🖉 main.c [行: 553] tracker_tx() at main @#if (BOARD_TYPE_EVK_TOKYOCOM == 2) @#if (GET_RSSI_SNR == 1) semtech_main() at i
 main() at main.c:30. lr1110_radio_get_lora_pkt_status(&lr1110, &pkt_status); 549 #endif 📕 arm-none-eabi-gdb (7.8.2 📕 Renesas GDB server (Host 550 // hs300x get temperature / humidity(<u>Rx</u> send)
wsi_ret = read_hs300x();
if(wsi_ret == 0) {
 wsi_temp = (uintl6_t)(hs300x_data.temperature * 100.0f)
 wsi_humi = (uint16_t)(hs300x_data.humidity * 100.0f); 558 559 560 561 現在の選択では、表示する詳細はあり ません。 } else { sprintf(radio_data_buf, "\$TH sts=%d : Temperature or Hu } 562 < 💷 コンソール 🛛 🚟 レジスター 💱 問題 🧆 スマート・ブラウザー 🗟 Debugger Console 🗓 デバッグ・シェル 🔋 メモリー • × ½ B. I & F. LR1110_GNSS_256KB_Transceiver HardwareDebug [Renesas GDB Hardware Debugging] Warning 0x10040207: (Warning)MCUのスタンバイ状態を解除して、コマンド処理を継続しました。 < 🗿 System Time 0x2000d62a Ø 10413.0 ms スマート挿入 553 : 1 : 16160 書き込み可能

When you press the trigger switch to run the code, execution stops at the specified break point.

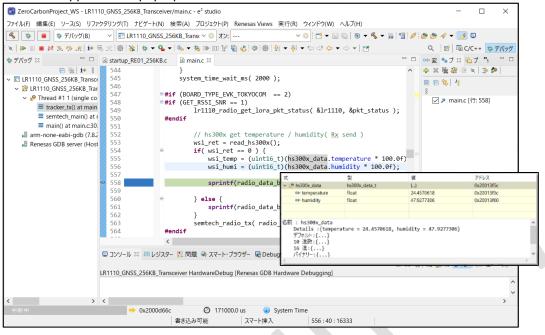
To resume code execution, click the Resume button.

To remove the breakpoint, right-click the location of the breakpoint and then click Toggle Software Breakpoint.

You can also clear a breakpoint by clearing the check box in the Breakpoint window displayed by pressing ALT + Shift + Q, B.

Step 7: Checking variable values

Stop execution by setting a breakpoint in the source code where you want to check the value of a variable, and align the mouse cursor with the variable you want to check. The contents of the variable appears in a pop-up window as follows:



7. Acquiring a Manage Token from LoRa® Cloud

The following explains how to acquire a Manage Token from ${\rm LoRa}^{\rm @}\,{\rm Cloud}.$

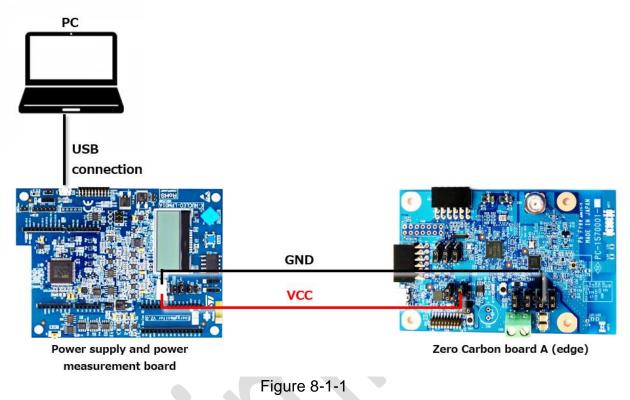
7.1. Acquiring a Manage Token

See the following resource: Zero Carbon LoRa® Evaluation Board Tutorial "3. Setting up a LoRa® Cloud Account"

8. Current Measurement Method and Current Consumption

8.1. Current measurement method

The following shows how to measure the power consumption of the Zero Carbon board A (edge). Figure 8-1-1 shows an overall view of the connections among devices.



The power supply and power measurement board requires the STM32CubeMonitor-Power software together with an ultralow power consumption tool and accompanying software.

For information about how to set up and use this system, visit the following URL: https://www.st.com/resource/en/user_manual/um2202-stm32cubemonitorpower-software-tool-for-power-and-ultralowpower-measurements- stmicroelectronics.pdf

For details about the power supply and power measurement board (X-NUCLEO-LPM01A), visit the following URL:

https://www.st.com/content/st_com/ja/products/evaluation-tools/product-evaluation-tools/stm32-nucleo-expansion-boards/x-nucleo-lpm01a.html

Figure 8-1-2 and Table 8-1-1 show the settings for the Zero Carbon board A (edge).

Regular power supply	
	Zero Carbon board A (edge)
Power source	JP7 JP10 JP8 JP9
VCC	JPG
Power source GND	

Figure 8-1-2

Та	ble 8-1-1
JP/SW	State
JP1	Open
JP2	Open
JP3	Connect VCC power
	source to pin 1
JP4	Open
JP5	Open
JP6	Open
JP7	1-2
JP8	Connect GND of
	power source to pin 1
	1-2
JP9	1-2
JP10	2-3
SW1(EHMD)	Low
SW2(MD)	High

8.2. Current consumption

Total 64 mJ (26mC@2.5V)

The sample code conducts a Wi-Fi scan. If the Wi-Fi scan is unable to obtain enough Wi-Fi Mac addresses (> 4) to determine location, the sample code updates the GNSS almanac data and performs a GNSS scan. You might encounter this scenario when using the system in mountainous areas or in the middle of the ocean where Wi-Fi is out of range.

You can select whether to update almanac data (Assisted Mode/Autonomous Mode). Updating almanac data (Assisted Mode) yields an approximate 7dB improvement in GNSS reception sensitivity (for details, see the SEMTECH <u>Application Notes</u>).

• Results of Wi-Fi tracking current measurement

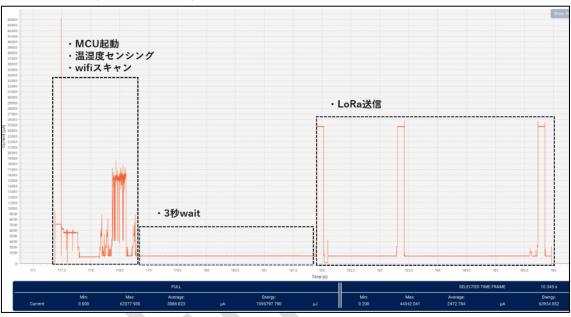


Figure 8-2-1



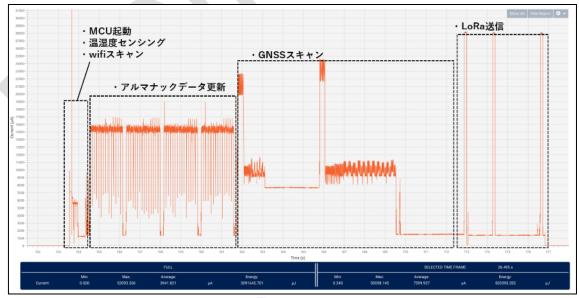


Figure 8-2-2

Zero Carbon LoRa® Evaluation Board Software Development Procedures v1.00

· Dalance between	Balance between energy narvested and consumed						
Solar battery	Size [mm]	Thickness [mm]	Mass [g]	Luminance [lux] (approx.)	Generated current [uA] (values on datasheet)	Charging time [minutes] required to implement one Wi-Fi tracking cycle (26mC)	Charging time [minutes] required to implement one GNSS tracking cycle (201mC)
Solar film For indoor/outdoor use BCS4430B6 (TDK)	44 × 30	0.18	0.2	200 (indoors) (typical room)	30	14.4	Not relevant due to lack of GNSS reception indoors
				500 (indoors) (bright room)	80	5.4	Not relevant due to lack of GNSS reception indoors
				3,000 (outdoors) (full shade)	500	0.9	6.7
				5,000 (outdoors) (full shade)	640	0.7	5.2
Solar panel Indoor luminance specifications AM-1815 (Panasonic)	58.1 × 48.6	1.1	7.8	200 (indoors) (typical room)	45.7	9.5	Not relevant due to lack of GNSS reception indoors
Solar panel Outdoor_ luminance_ specifications AM-5812 (Panasonic)	59.0 × 28.7	1.6	4.6	50,000 (outdoors) (bright overcast sky)	8900	0.05	0.38

· Balance between energy harvested and consumed

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Apr. 28, 2022

9. Troubleshooting

Table 9 lists problems that might occur and the action you need to take when they do.

	Table 9 Troubleshooting				
Related section	Problem	Solution			
2.1	The GW application fails to start	If the version of Python is earlier than 3.5, upgrade to Python version 3.5 or later. If multiple instances of Python are installed, you might not have set the path of the instance you installed most recently. See <i>11.</i> <i>Troubleshooting</i> in the Zero Carbon LoRa® Evaluation Board Tutorial.			
		The port number of the PC port to which the Zero Carbon board B (GW access) is connected is incorrectly set. With board B connected to the port, check the port number in the Ports (COM & LPT) node of Device Manager.			
	A solar powered Zero Carbon board A (edge) does not boot	The microcontroller requires a start-up voltage of approximately 2.6 volts. Either wait a while for the battery to charge, or use USB fast charging to charge the battery before reconnecting the solar panel.			
5.3.4	The Patch command fails	Run the command as a user with administrator privileges.			
		Place the Patch data file at the same level as the ZeroCarbon folder in the folder structure.			
5.3.7	Build does not complete successfully	The Patch command might have failed. Try again by repeating the steps from 5.3.3 onward.			
		The code file downloaded in 5.3.2 might be the wrong version. Download the specified version of the code file and repeat the steps from 5.3.3 onward.			
6.1	Zero Carbon board A (edge) does not connect to E2Lite	When connecting the E2lite to a PC, connect the USB cable to E2Lite first, and then connect the power supply USB cable to the Zero Carbon board A (edge). Alternatively, check the orientation of the flat cable that connects the Zero Carbon board A (edge) to the E2Lite.			
-	The program code does not use GNSS to estimate location	GNSS reception is used to estimate location when a Wi-Fi scan finds fewer than three access points. Either shield the Wi-Fi antenna or modify the code for the Zero Carbon board A (edge) to perform GNSS reception only.			
-	The trigger switch does not function	The Zero Carbon board A (edge) and Zero Carbon board B (GW access) might have been flashed with the wrong firmware. Alternatively, the Zero Carbon board B (GW access) that connects to the GW might have the wrong firmware. Review the setup again. We recommend that you label the Zero Carbon board A (edge) and Zero Carbon board B (GW access) to ensure the correct firmware is flashed to the correct board.			
-	Renesas Knowledge Base (FAQ)	For details about the RE family of microcontrollers, visit the following website: https://ja-support.renesas.com/knowledgeBase#31135			
	1	1			

10. Precautions for Use

Note the following when using the Zero Carbon LoRa® Evaluation Board (model name: PC-1570001):

- The PC-1570001 is a board that embodies the reference design provided by Renesas' Zero Carbon Solution[#] concept. Because its use case lies solely in evaluation, we can make no guarantees regarding its operation or circuit design. The schematics and bill of materials shown in P38 onward of the User's Guide are those of the Zero Carbon Solution[#].
- The circuits and other related information described in resources related to the PC-1570001 board are intended only as examples of the operation and application of semiconductor products. It is the responsibility of the customer to evaluate this information thoroughly when designing their equipment and systems.

Renesas accepts no responsibility for damages resulting from the information in resources related to the PC-1570001 board. This includes damages incurred by the customer or any third party (the same applies hereinafter).

- The PC-1570001 does not represent an ideal reference design for the final product, nor does it satisfy regulatory standards that apply to the final product.
- Tachibana Electronic Solutions makes no warranty and assumes no responsibility for any infringement of patents, copyrights, or other intellectual property rights of third parties or disputes arising from the use of the product data, diagrams, tables, programs, algorithms, application circuit examples, and other information described in related documents.
- The PC-1570001 grants no license to any patent rights, copyrights, or other intellectual property rights of Tachibana Electronic Solutions or any third party.
- Do not, in whole or part, alter, modify, reproduce, reverse engineer, or otherwise improperly use the PC-1570001. Tachibana Electronic Solutions is not liable for any damages caused by any such modification, alteration, reproduction, or reverse engineering.
- The PC-1570001 is not intended for use in equipment or systems that might directly endanger life or limb (such as life-support equipment and items implanted in the human body) or cause significant property damage (such as space equipment, submarine repeaters, nuclear power control systems, aircraft control systems, core plant systems, and military equipment), nor do we anticipate its use in such applications. Tachibana Electronic Solutions is not liable for any damage caused by use of our products for unanticipated applications.
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- If the customer resells or otherwise transfers the PC-1570001 to a third party, the customer is responsible for notifying the third party in advance of these terms and conditions.
- Reproduction or duplication of resources related to the PC-1570001 board, in whole or in part, is prohibited without our prior written consent.
- The PC-1570001 can generate, use, and emit RF energy that can cause harmful interference to radio communications. It can also be affected by EMC considerations.
- Cautionary note regarding the sample program
 The sample program is a product of the open-source community. Conditions of use and compensation are defined by the GitHub website, and any support requests can be submitted to the GitHub community.
- #: Zero Carbon Solution:

https://www.semtech.com/company/press/semtech-ryoden-and-renesas-electronics-launch-zerocarbon-solution-with-the-lora-edge-platform-and-a-re-microcontroller

11. Disclaimer

By using the evaluation board (model name: PC-1570001), the customer agrees to the following terms and conditions:

- The PC-1570001 is not guaranteed to be free of defects. Any risk related to the results and performance of the PC-1570001 is borne entirely by the customer.
- The PC-1570001 is provided as-is without warranty of any kind, either express or implied.
- Such warranties include, but are not limited to, implied warranties of fitness for a particular purpose, salability, and non-infringement of authority and intellectual property rights. Tachibana Electronic Solutions expressly disclaims all such warranties.
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Zero Carbon LoRa® Evaluation Board Software Development Procedures v1.00

Revision History

		Revisions	
Rev.	Publication date	Pages	Description
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Contact Information



1-13-25 Nishi-honmachi, Nishi-ku, Osaka 550-8555, Japan TEL: 06(7222)8211 E-mail: tcs_info@tachibana.co.jp