RL78/G15

Wireless Communication with the XBee ZB 2SC and HS300x (AT Solution)

Introduction

This application note describes a sample program to control the XBee ZB S2C* on the RL78/G15 to perform wireless communication. Humidity and temperature data acquired from the HS300x (humidity and temperature sensor) is communicated wirelessly. This application note also describes how to control the HS300x on the RL78/G15.

Additionally, we will explain the sample program for the module (hereinafter referred to as the receiving wireless module) that controls XBee ZB S2C, receives humidity and temperature data transmitted from the transmission wireless module, and displays it on the LCD module. This application note also describes the method of controlling the LCD module with RL78/G15.

Target Device

RL78/G15

Contents

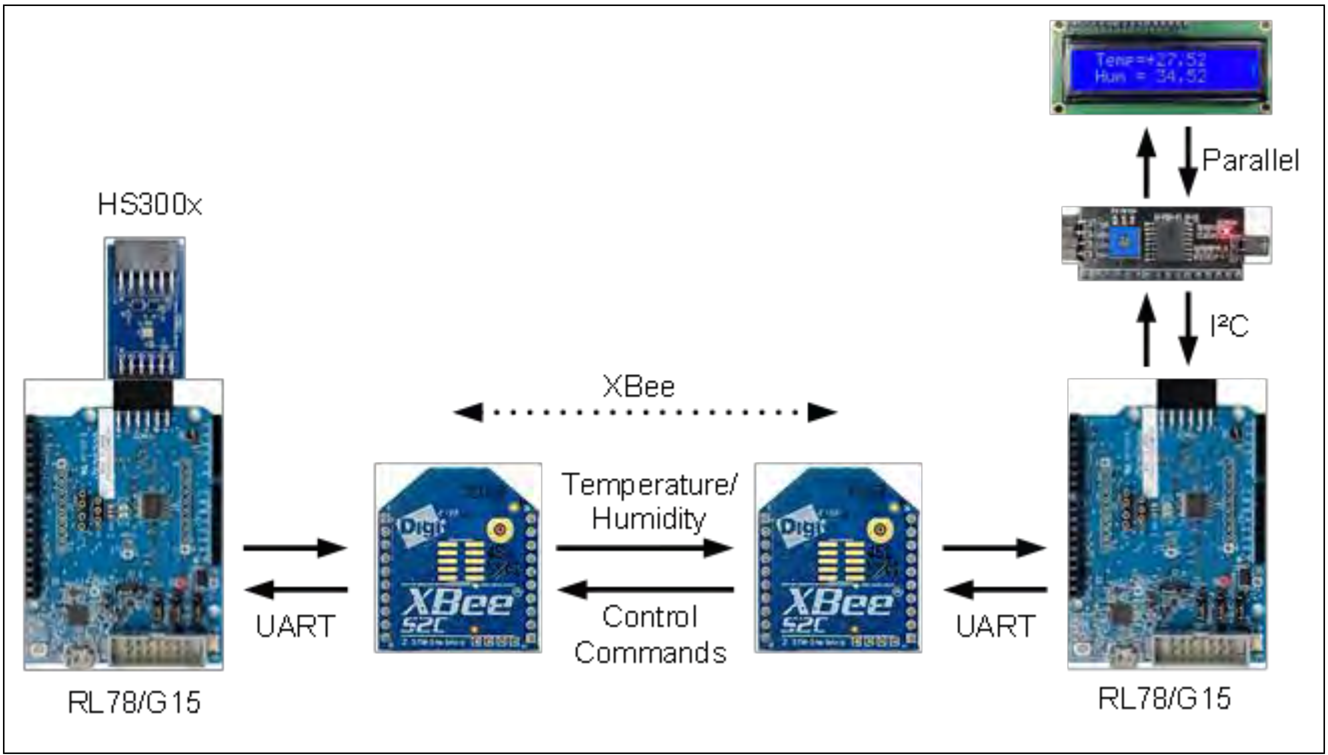
1. Overview

This application note describes how to connect the RL78/G15 with the XBee ZB S2C and wirelessly communicate humidity and temperature data acquired from the HS300x. The sample program uses the XBee ZB S2C by the UART function incorporated into the RL78/G15 to wirelessly communicate humidity and temperature data.

In addition, this application note describes how to acquire and calculate humidity and temperature data from the HS300x humidity and temperature sensor on the RL78/G15. The sample program controls the HS300x by the built-in I2C driver of the RL78/G15, and acquires humidity and temperature ADC data from the HS300x. Additionally, this sample program calculates acquired data on the RL78/G15.

Additionally, we will explain how to connect the RL78/G15 with the receiving wireless module and the LCD module. We will also demonstrate the process of displaying humidity and temperature data received via XBee ZB S2C on the LCD module.

Figure 1-1 Schematic Diagram of the Entire System



2. Operation Confirmation Conditions

The operation of the sample code provided with this application note has been tested under the following conditions.

Table 2-1 Operation Confirmation Conditions

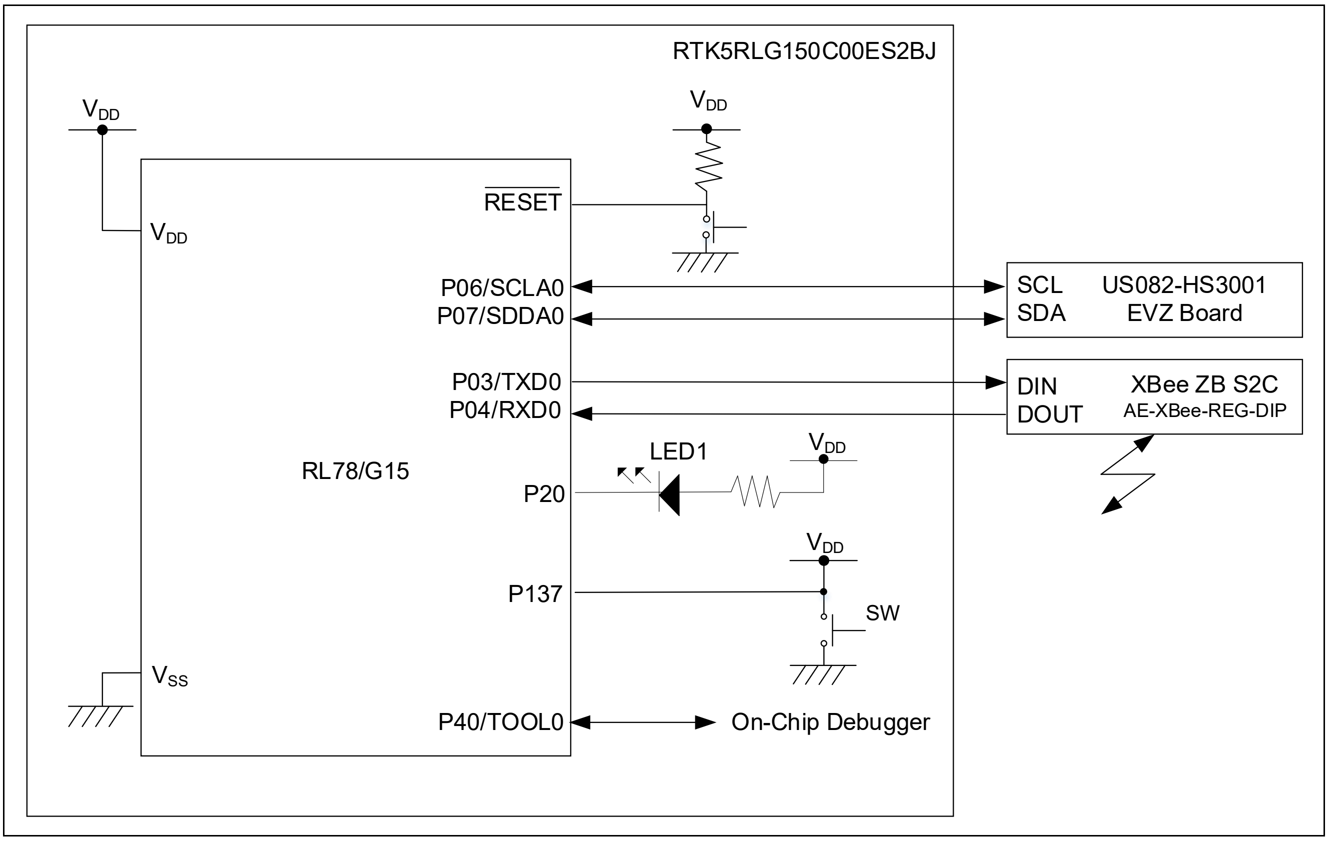
Item	Description
MCU used	RL78/G15 （R5F12068）
Operating frequency	16 MHz
Memory size (memory used)	ROM 8KB （6701 byte used） RAM 1KB （206 byte used）
Operating voltage	2.4V～5.5V SPOR operation At rising edge TYP. 2.57 V (2.44 V to 2.68 V) At falling edge TYP. 2.52 V (2.40 V to 2.62 V)
Integrated development environment (e2studio)	e2 studio V2024-1 from Renesas Electronics Corp.
C compiler (e2studio)	CC-RL V1.13.00 from Renesas Electronics Corp.
Integrated development environment (CS+)	CS+ V8.11.00 from Renesas Electronics Corp.
C compiler (CS+)	CC-RL V1.13.00 from Renesas Electronics Corp.
Integrated development environment (IAR)	IAR Embedded Workbench for Renesas RL78 V5.10.1 from IAR Systems Corp.
C compiler (IAR)	IAR C/C++ Compiler for Renesas RL78 V5.10.1 from IAR Systems Corp.
Smart configurator (SC)	V1.9.0 from Renesas Electronics Corp.
Board support package (BSP)	BSP v1.60
Board used	RL78/G15 Fast Prototyping Board (RTK5RLG150C00ES2BJ)
Temperature/Humidity Sensor Modules	Relative Humidity Sensor Pmod™ Board (US082-HS3001EVZ)
Data transmission module	XBee ZB S2C
Serial to Parallel Conversion Module for LCD Module	PCF8574
LCD Module	LCD1602A

3. Hardware Descriptions

3.1. Example of Hardware Configuration

The following shows an example of the hardware configuration used in the application note.

Figure 3-1 Hardware Configuration (Transmitting Wireless Module)

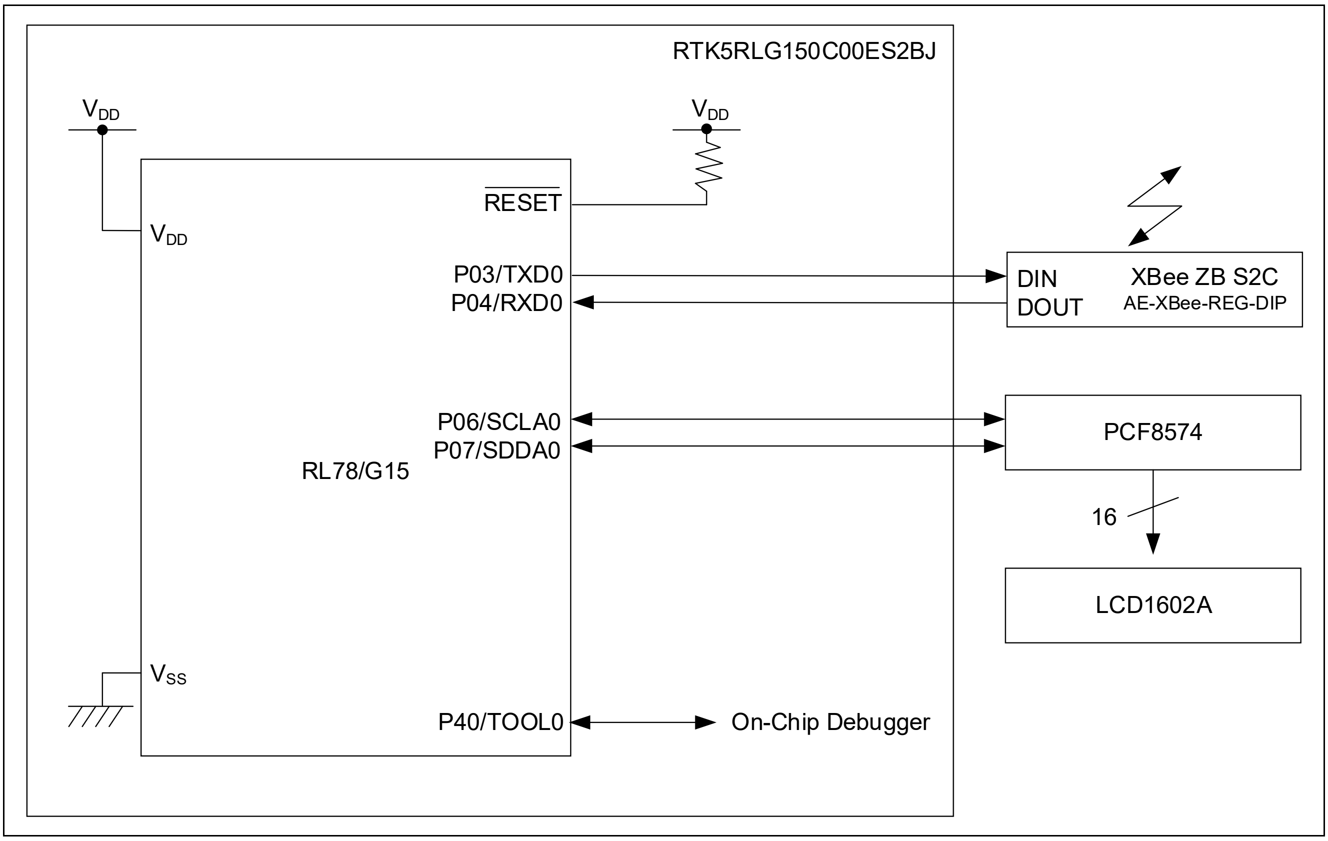


Note 1. This schematic circuit diagram is simplified to show the outline of connections. When creating circuits, design them so that they meet electrical characteristics by properly performing pin processing. (Connect input-only ports to VDD or VSS individually through a resistor.)

Note 2. VDD must not be lower than the reset release voltage (VSPOR) that is specified for the SPOR.

Note 3. When using USB power, the transmitting wireless module may exceed the allowable current during the initial settings, causing operation to stop. Therefore, please power the RL78/G15 Fast Prototyping Board with 3.3V from the external power supply pin for proper operation.

Figure 3-2 Hardware Configuration (Receiving Wireless Module)



Note 1. This schematic circuit diagram is simplified to show the outline of connections. When creating circuits, design them so that they meet electrical characteristics by properly performing pin processing. (Connect input-only ports to VDD or VSS individually through a resistor.)

Note 2. VDD must not be lower than the reset release voltage (VSPOR) that is specified for the SPOR

3.2. List of Pins to be Used

The following lists the pins to be used and their functions.

Table 3-1 Pins to be Used and Their Functions (Transmitting Wireless Module)

Pin name	I/O	Function
P03/TXD0	Output	UART Data transmission pin (Via XBee ZB S2C)
P04/RXD0	Input	UART Data reception pin (From XBee ZB S2C)
P06/SCLA0	Input/Output	IICA serial clock (with HS300x)
P07/SDDA0	Input/Output	IICA serial data bus (with HS300x)
P20	Output	LED1 control pin (Low Active)
P137 / INTP0	Input	Input terminal for the switch (external interrupt request input terminal)

Table3-2 Pins to be Used and Their Functions (Receiving Wireless Module)

Pin name	I/O	Function
P03/TXD0	Output	UART Data transmission pin (Via XBee ZB S2C)
P04/RXD0	Input	UART Data reception pin (From XBee ZB S2C)
P06/SCLA0	Input/Output	IICA serial clock with the LCD module serial/parallel conversion board (SCL of PCF8574).
P07/SDDA0	Input/Output	IICA serial data bus with the LCD module serial/parallel conversion board (SDA of PCF8574).

4. Module Specifications

This section describes the specifications of the XBee ZB S2C and HS300x.

4.1. Specifications of XBee ZB S2C

Table4-1 outlines the specifications of the XBee ZB S2C.

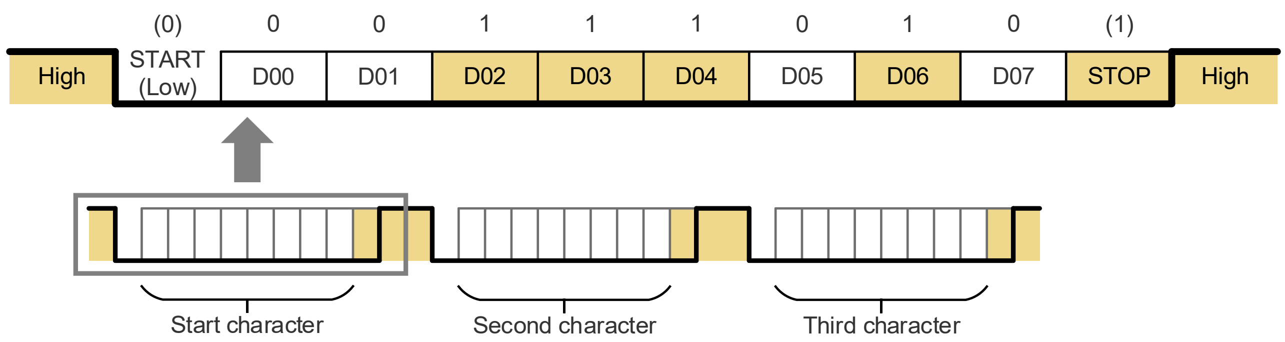
Table 4-1 Specifications of XBee ZB S2C

Item	Description
Data rate	RF 250 Kbps, serial (up to 1 Mbps)
Indoors/urban range	Up to 60 m
Outdoors/expected range	Up to 1,200 m
Transmission power	3.1 mW (+5 dBm) / 6.3 mW (+8 dBm) in boost mode
Receiver sensitivity (1% PER)	-100 dBm / -102 dBm in boost mode
Serial data interface	UART, SPI
Configuration method	API or AT command, local or wireless
Frequency band	ISM 2.4 GHz
Operating voltage	2.7 to 3.6 V
Auxiliary board for connecting MCU	AE-XBee-REG-DIP (2.54-mm pitch conversion board)
Auxiliary board for connecting PC	AE-XBEE-USB (USB interface board)

4.1.1. UART communication interface

The following figure shows the UART format for communicating humidity/temperature data.

Figure 4-1 UART Communication Formal



If " : " (start character[0x3A]) is entered as the first character, the command is judged.
The second character is used to judge whether to acquire data (G) or control LED (L).
The third character determines temperature (T) or humidity (H) or ON (1) or OFF (0).

4.2. Specifications of HS300x

Table 4-2 outlines the specifications of the HS300x humidity and temperature sensor.

Table 4-2 Specifications of HS300x Sensor

Item	Description
Humidity measurement range	0 to 100%RH
Humidity accuracy	±1.5%RH (typ.) (HS3001, 10 to 90%RH, 25℃)
ADC resolution	0.01%RH (typ.), (14 bits)
Measurement resolution	8, 10, 12, 14 bits
RH response speed	1 second (typ.) (with 1 m/s air flow) 4 seconds (typ.) (in a sealed space)
Temperature sensor accuracy	±0.2℃ (typ.) (HS3001, HS3002, -10 to 80℃)
Average current	Average 24.4 uA (14-bit resolution, power supply voltage 3.3 V supplied), 1 RH and temperature measurement per second
Sleep current	-40 to 85℃: 0.6 μA (typ.) -40 to 125℃: 1 μA (typ.)
Power supply voltage	2.3 V to 5.5 V: 3.3 V (typ.)
Extended power supply voltage	1.8 V (-20℃ to +125℃)
Operating temperature	-40℃ to +125℃

Table 4-3 List of Sensor Functions

Item	Description
I^2C communication	Sensor data are transferred through I^2C communication.
Measurement mode	This software operates with the sensor in sleep mode. On completion of measurement triggered by a measurement request, the sensor enters sleep mode.
Measurement request	The sensor in sleep mode is placed in the measurement state upon receiving a measurement request.
Data fetch	At the end of a measurement cycle, valid data can be acquired.
Status bits	The status bits for the results of measurement indicate whether the current data are valid.

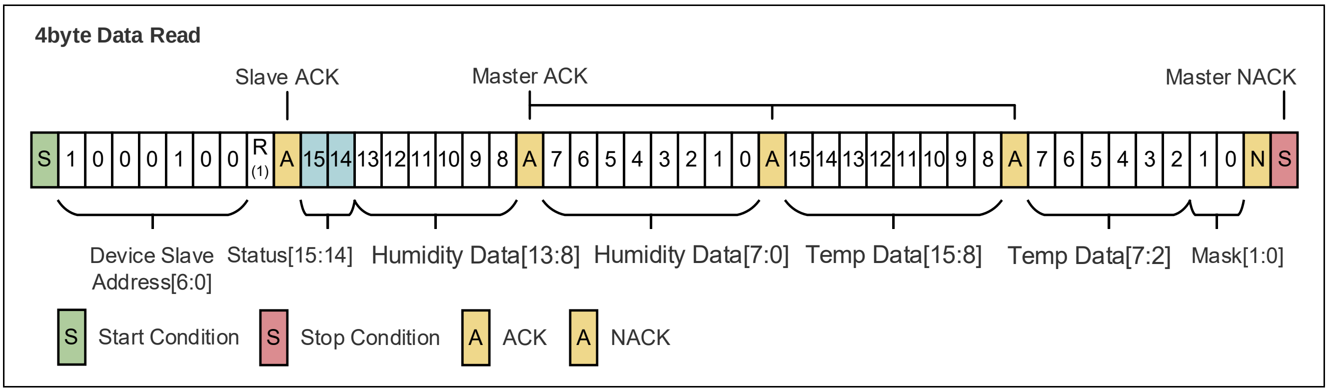
Note: This software does not support the following functions of the HS300x:

- Access to non-volatile memory
- Setting of the measurement resolution
- Reading of the HS300x ID number

4.2.1. I²C Communication Interface

The following figure shows the format of measurement data transferred through I²C communications.

Figure 4-2 Format of I2C Communication



The status bits indicate the state of data as follows.

00B: Valid data acquired at the end of a measurement cycle

01B: Invalid data that have already been acquired

4.2.2. Expressions for Converting Output Value to Humidity and Temperature

The HS300x software converts the acquired ADC data to values for humidity and temperature, and then outputs them.

The humidity conversion expression is as follows.

$$\text{Humidity [\%RH]} = \left(\frac{\text{Humidity}[13:0]}{2^{14}-1}\right) * 100$$

The temperature conversion expression is as follows.

$$\text{Temperature [°C]} = \left(\frac{\text{Temperature}[15:2]}{2^{14}-1}\right) * 165 - 40$$

4.3 LCD Control Method

The LCD display sends data to PCF8574 using the I2C interface from RL78/G15. PCF8574 performs an 8-bit parallel conversion from the serial data received from RL78/G15 and outputs it to LCD1602A. In this application, LCD1602A is used in 4-bit mode, so the upper 4 bits are used as commands or data for LCD1602A, and the lower 4 bits are used as data for the mode setting of LCD1602A.

In addition, the I2C slave address of PCF8574 in this application is 0x27.

The data format for the commands sent to PCF8574 is shown below.

Figure 4-3 The data format for the commands

7	6	5	4	3	2	1	0
cmd/DATA				BL	EN	RW	RS

cmd/DATA	Commands or data to LCD1602A
BL	Back Light 1:ON 0:OFF
EN	Enable bit 1:ON 0:OFF
RW	Read/Write 1:Read 0:Write
RS	Register Select 1:Data Transmission 0:Command Transmission

Table 4-4 Command Codes for LCD1602A Used in This Application

Command	Description
0x28	Function Set 4-bit Mode, LCD Display 2 Lines
0x08	LCD display OFF
0x01	LCD display data clear
0x06	Entry Mode Set
0x0C	LCD display ON

Figure 4-4 LCD Display Example

Xbee ZB S2C Address Display

			4	1	F	D	5	1	7	8					

Temperature and Humidity Display

	T	e	m	p	=	+/-	x	x	.	x	x				
	H	u	m		=	x	x	x	.	x	x				

5. Sample Program

5.1. Sample Program Structure

Figure 5-1 , Figure 5-2 is a block diagram of the sample program structure.

Figure 5-1 Block Diagram of Software (Transmitting Wireless Module)

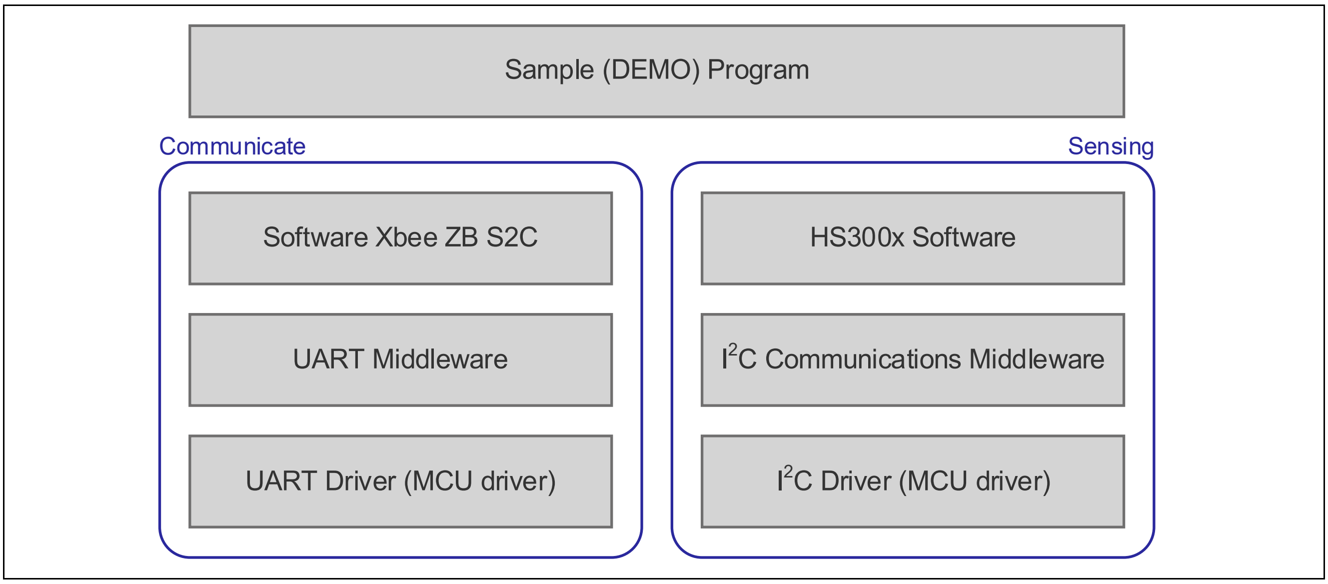
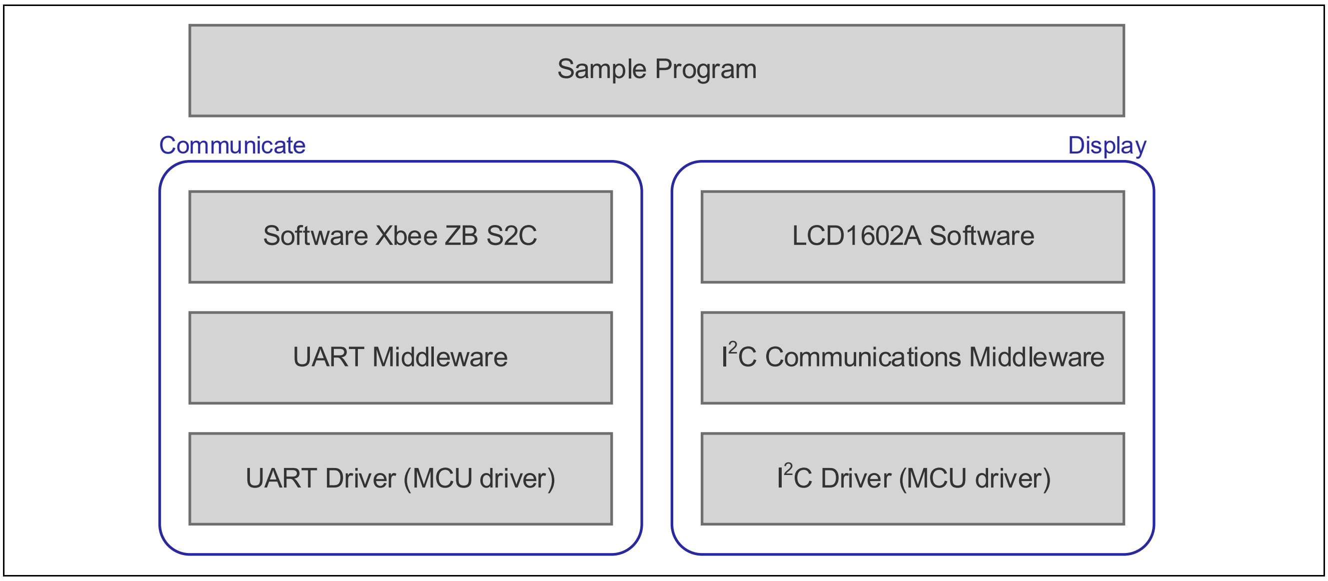


Figure 5-2 Block Diagram of Software (Receiving Wireless Module)



5.2. Specifications of HS300x API Functions

5.2.1. List of HS300x API functions

The following table lists the sensor API functions. For details of the API functions, refer to the separately provided HS300x Sensor API FIT Module application note (R01AN5893) and Renesas Sensor Control Modules Firmware Integration Technology (R01AN5892).

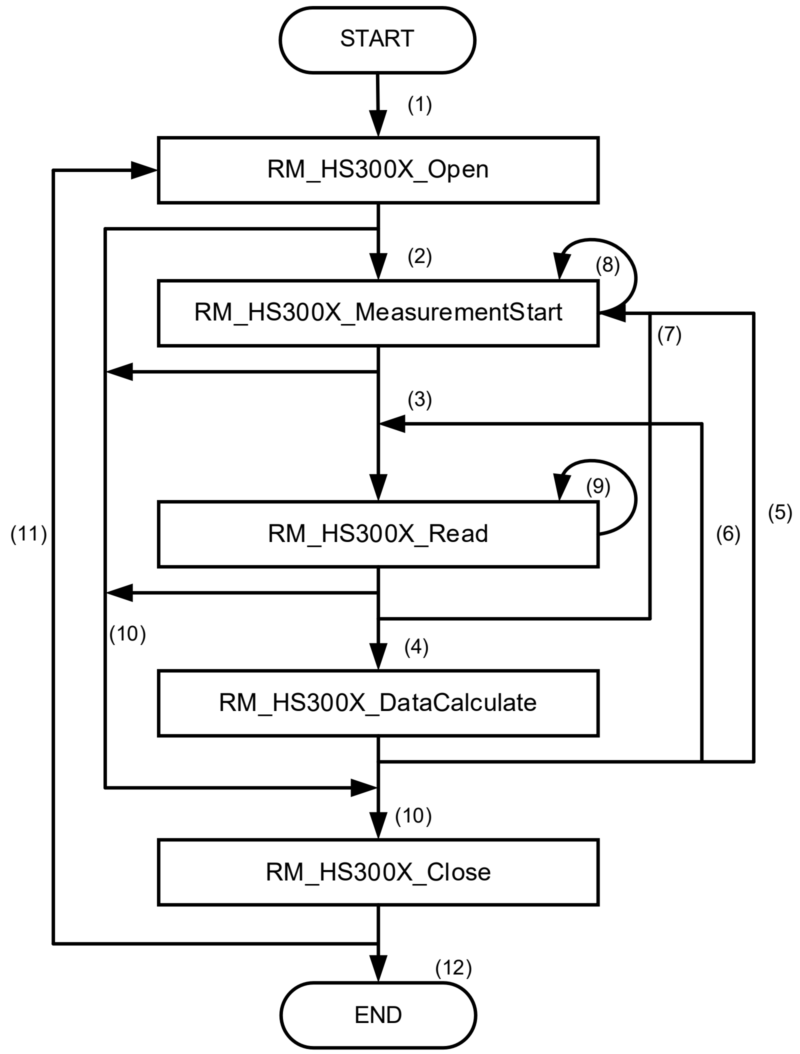
Table 5-1 List of HS300x API Functions

Function	Function
RM_HS300X_Open	Starts control of the sensor.
RM_HS300X_Close	Terminates control of the sensor.
RM_HS300X_MeasurementStart	Starts measurement by the sensor.
RM_HS300X_Read	Acquires data from the sensor.
RM_HS300X_DataCalculate	Calculates values from the data acquired from the sensor.

5.2.2. Guide to Using the API Functions

The following diagram of API function transitions shows the conditions on the usage of the individual HS300x API functions and the expected orders of function calls.

Figure 5-3 Diagram of Transitions between API Function Calls



Flow No.	Function	Transition Case
(1)	Start HS300x	not open HS300x
(2)	Start Measurement HS300x	open success
(3)	ADC Read	Measurement success (callback state success)
(4)	Humidity & Temp. calculate	ADC Read success (callback state success)
(5)	next measurement start	DataCalculate return success and next ADC data Get
(6)	get retry ADC data	User get retry ADC data or DataCalculate return invalid data
(7)	next measurement (Not calculate)	The user requests only ADC data and measures the next data
(8)	Retry Measure Start	Measurement start Waiting for response (callback none and polling)
(9)	Retry ADC Read	Read ADC Waiting for response (callback none and polling)
(10)	Close HS300x	Error state or user stop
(11)	Restart HS300x	Close success and user restart
(12)	Stop HS300x	Close success or Error

The conditions for calling the individual functions are shown below.

・RM_HS300X_Open:	(1) Activation of HS300x, or (11) restart after a call of RM_HS300X_Close
・RM_HS300X_Close:	(10) Successful completion or abnormal end of individual processing
・RM_HS300X_MeasurementStart:	(2) Start of measurement after a call of RM_HS300X_Open, (5) (7) acquisition of the next measured data, or (8) retry after waiting for the response to the measurement start request
・RM_HS300X_Read:	(3) Acquisition of measured data after a call of RM_HS300X_MeasurementStart, or (9) retry after waiting for the response to the data acquisition request
・RM_HS300X_DataCalculate:	(4) Calculation of humidity and temperature data after a call of RM_HS300X_Read

Notes: Since RM_HS300X_Open checks the state of the I^2C driver, the I^2C driver must be opened before the RM_HS300X_Open processing.

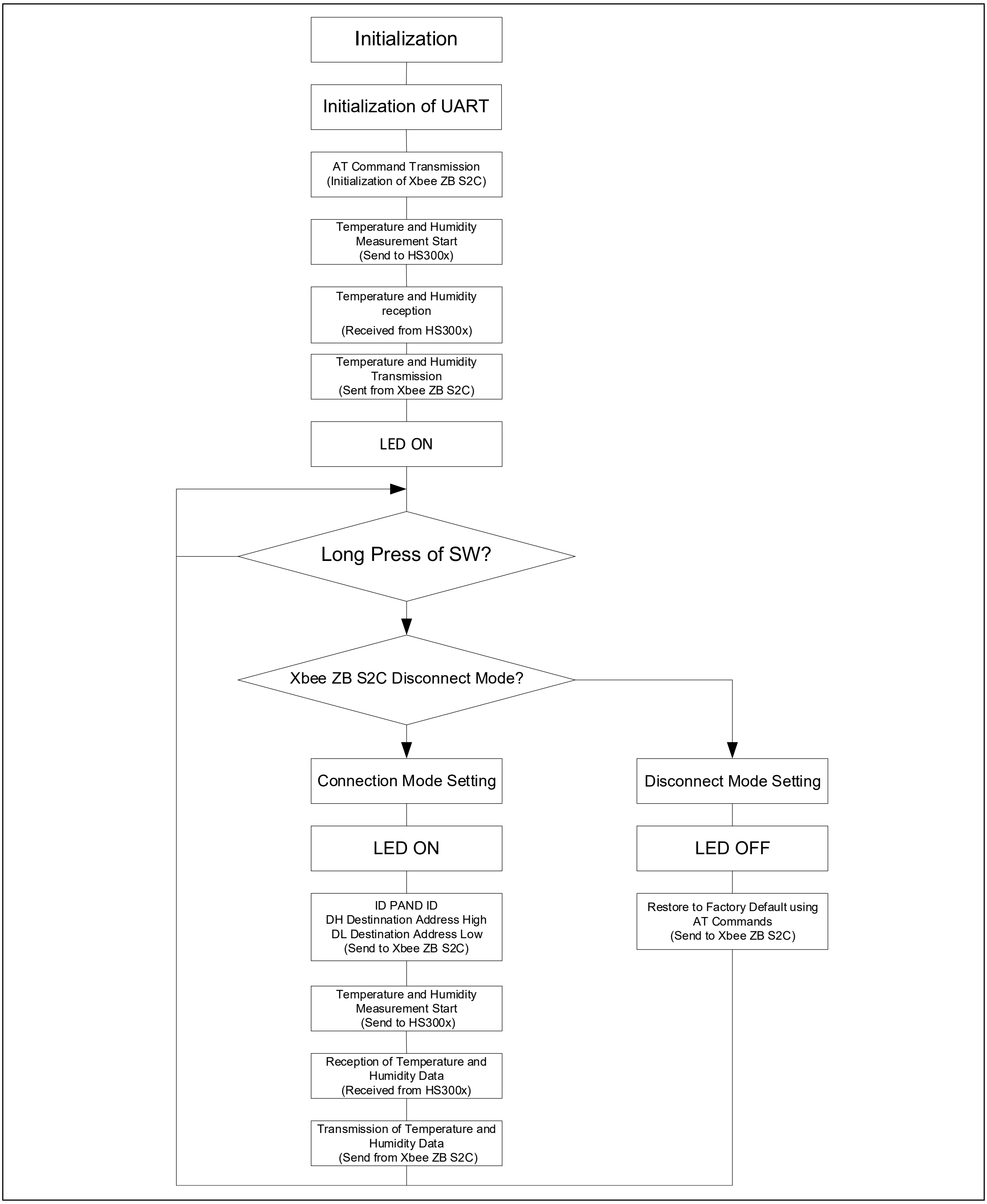
When measurement is started by RM_HS300X_MeasurementStart, the sensor stops measurement after outputting the ADC data. Therefore, RM_HS300X_MeasurementStart must be called at least once every time before RM_HS300X_Read processing.

5.3. Flowcharts

5.3.1. Overall Flowchart (Transmitting Wireless Module)

The following figure shows the overall flowchart (Transmitting Wireless Module).

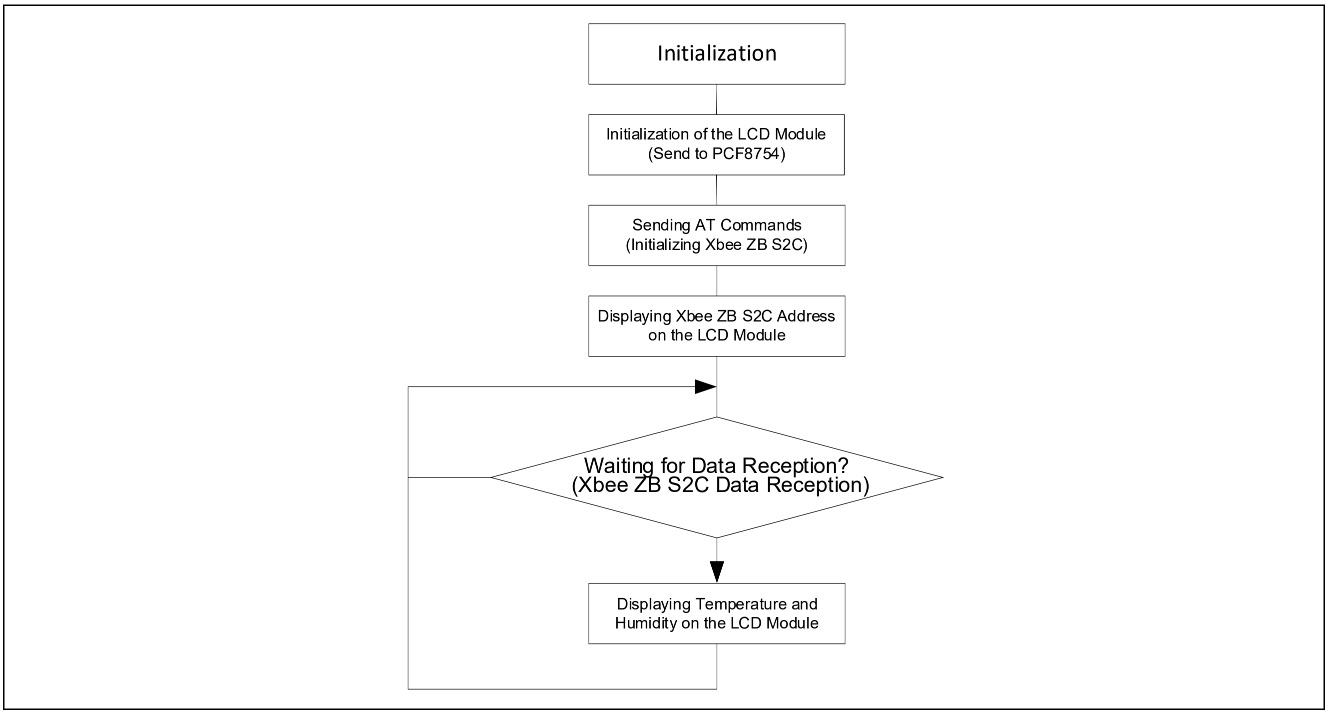
Figure 5-4 Overall Flowchart (Transmitting Wireless Module)



5.3.2. Overall Flowchart (Receiving Wireless Module)

The following figure shows the overall flowchart (Receiving Wireless Module).

Figure 5-5 Overall Flowchart (Receiving Wireless Module)



5.4. Sample Program Structure

5.4.1. Peripheral Functions to Be Used

The following table lists the peripheral functions used in the sample program.

Table 5-2 Peripheral Functions to Be Used (Transmitting Wireless Module)

Peripheral Function	Use
PORT	Used to control LED1 mounted on RL78/G15_FPB.
IICA0	Used for I^2C communication with HS300x and acquisition of humidity and temperature data from HS300x.
UART0	Used for UART communication with XBee ZB S2C, command transmission to XBee ZB S2C, and confirmation of response results returned from XBee ZB S2C.

Table 5-3 Peripheral Functions to Be Used (Receiving Wireless Module)

Peripheral Function	Use
IICA0	Used for I2C communication with PCF8574 to control the display of the LCD module.
UART0	Used for UART communication with XBee ZB S2C, command transmission to XBee ZB S2C, and confirmation of response results returned from XBee ZB S2C.

5.4.2. Settings of Peripheral Functions

The following table lists the settings of Smart Configurator used in the sample program. The items and settings in each table of Smart Configurator Settings are described with the names displayed on the actual setting screen.

Table 5-4 Smart Configurator Settings (1/2)

Category	Item	Settings
Smart Configurator >> Clock		The settings on the [Clock] tab are as follows:
	VDD setting	2.4 V ≦ VDD ≦ 5.5 V
	High-speed on-chip oscillator	Checked Frequency: 16 MHz
	X1 oscillator circuit	Unchecked
	Low-speed on-chip oscillator	15 kHz
	Source selection for main system clock (f_{MAIN})	Select [High-speed on-chip oscillator (f_{IH})]. (f_{MAIN}: 16 MHz)
	Operating clock supply for 12-bit interval timer	Unchecked (f_{IL}: 15 kHz)
Smart Configurator >> System		The settings on the [System] tab are as follows:
	Pseudo RRM/DMM function setting	Not used
	Start/Stop function setting	Not used
	Security ID setting	Set security ID. Security ID "0x00000000000000000000"
	RESET pin setting	Used
	Operation mode setting	2.52 V
Smart Configurator >> Component >> r_bsp		Use the default settings except for the following changes:
	API functions disable(R_BSP_StartClock, R_BSP_StopClock)	Disable
	API functions disable(R_BSP_SetClockSource)	Disable
	API functions disable(R_BSP_ChangeClockSetting)	Disable
	API functions disable(R_BSP_SoftwareDelay)	Disable

Smart Configurator >> Component >> PORT		Use the default settings except for the following changes:
	Port selection	PORT2
	PORT2	P20: Select [Output], [Output 1].
Smart Configurator >> Component >> Config_IICA0		The settings on [Config_IICA0] are as follows:
	Local address	16
	Operation mode setting	Set [Standard] and transfer clock (f_{SCL}): 100000 (bps)
	tR and tF settings	Unchecked
	Interrupt setting	Level 3 (lowest priority)
	Callback function setting	Select [Master transmission end], [Master reception end], and [Master error].
	Callback extension setting	Unchecked

Note.1 PORT settings apply only to the transmit wireless module.

Table 5-5 Smart Configurator Settings (2/2)

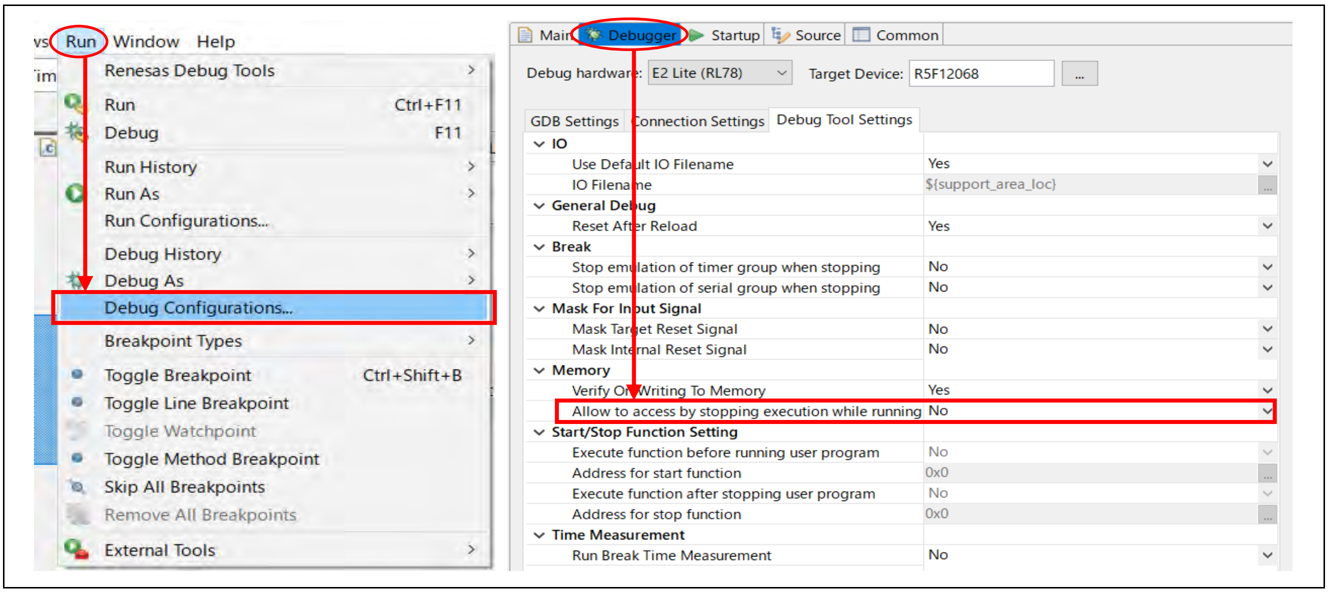
Category	Item		Settings
Smart Configurator >> Component >> Config_UART			The settings on [Config_UART0] are as follows:
	Transmission	UART0 clock setting	Operating clock: CK00 Clock source: f_{CLK}/2^3
		Transfer mode setting	Continuous transfer mode
		Data bit length setting	8 bits
		Data transfer direction setting	LSB
		Parity setting	No parity bit
		Stop bit length setting	1 bit
		Transmit data level setting	Non-inversion (normal)
		Transfer rate	9600 (bps)
		Interrupt setting	Level 3 (lowest priority)
		Callback function setting	End of transmission
	Reception	UART0 clock setting	Operating clock: CK00 Clock source: f_{CLK}/2^3
		Data bit length setting	8 bits
		Data transfer direction setting	LSB
		Parity setting	No parity bit
		Transmit data level setting	Non-inversion (normal)
		Transfer rate	9600 (bps)
		Interrupt setting	Level 3 (lowest priority)
		Callback function setting	Reception end, reception error
Smart Configurator >> Pin			The settings on the [Pin] tab are as follows:
	Serial array unit (SAU0)		SAU00 RxD0: P04 TxD0: P03
	Serial interface IICA (IICA0)		IICA0 SCLA0: P06 SDAA0: P07

5.4.2.1 How to Prevent Memory from being Overwritten

If you use the default debugger settings as is, the debugger will occupy the top address (4 bytes) of the RAM (RRM function). Therefore, you need to change the settings.

As shown in Figure 5-6, select the debugger memory in [Debug configuration] and change [Interrupt execution to access memory] to "No" to stop the RRM function and prevent the first 4 bytes of the RAM from being overwritten.

Figure 5-6 Change Debugger Settings



5.4.3. File Structure

The following table lists the file structure of the sample program.

Table 5-6 File Structure (Transmitting Wireless Module)

Folder name, file name	Explanation
src	Program storage folder
├ command	Command related program storage folder
│ ├ xbee_atcom.c	AT Command related source file
│ └ xbee_atcom.h	AT Command related header file
│ ├ command.c	Command related source file
│ └ command.h	Command related header file
├ r_comms_i2c_rl	I2C communication middleware layer storage folder (the one for G23 is used)
├ r_hs300x	Sensor middleware layer storage folder (the one for G23 is used)
├ smc_gen	Smart Configurator generation folder
│ ├ Config_IICA0	
│ ├ Config_PORT	
│ ├ Config_UART0	
│ ├ general	
│ ├ r_bsp	
│ └ r_config	
├ main.c	Main processing source file
├ rl78_hs300x.c	Sensor software measurement flow source file
└ rl78_hs300x.h	Sensor software measurement flow header file

Table 5-7 File Structure (Receiving Wireless Module)

Folder name, file name	Explanation
src	Program storage folder
├ command	Command related program storage folder
│ ├ xbee_atcom.c	AT Command related source file
│ └ xbee_atcom.h	AT Command related header file
│ ├ command.c	Command related source file
│ └ command.h	Command related header file
├ smc_gen	Smart Configurator generation folder
│ ├ Config_IICA0	
│ ├ Config_PORT	
│ ├ Config_UART0	
│ ├ general	
│ ├ r_bsp	
│ └ r_config	
├ main.c	Main processing source file
├ lcd_1602a.c	Source files related to LCD display
└ lcd_1602a.h	Header files related to LCD display

For details on the I^2C communication middleware layer storage folder, sensor middleware layer storage folder, and Smart Configurator generation folder, refer to the application notes stored in the doc folder in each folder.

6. Description of Software Operation

This sample program uses e2 studio as a tool for developing MCU programs and checking operation, and XCTU as a tool for controlling the XBee ZB S2C and checking its operation.

6.1. Initialization Using the AT Commands

To enable communication between two XBee ZB S2C devices, it is necessary to configure them, as they do not communicate with each other in their default settings. Here, I will explain the method for initializing the XBee ZB S2C devices to enable communication using AT commands.

For the initial configuration of the XBee ZB S2C, you can use the UART interface to send AT commands from a microcontroller and set the parameters related to communication. The settings involve writing parameter values to the XBee ZB S2C using AT commands

Table 6-1 List of AT Commands Used for Configuring XBee ZB S2C

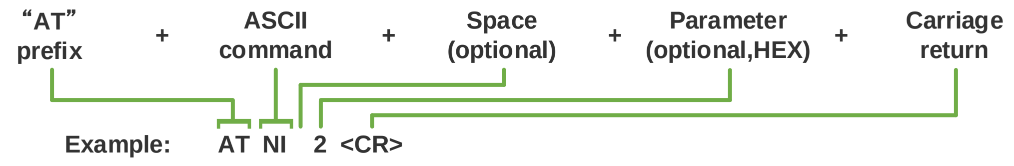
Configuration Items	Configuration Values (Commands)	Description
ID PAN ID	Any value (in the sample program, '5555' is used). *Ensure it is the same for both transmission and reception.	XBee ZB S2C can communicate only with devices having the same ID parameter.
DH Destination Address High	13A200	Specify the upper address of the communication destination. XBee ZB S2C is fixed at '13A200'.
DL Destination Address Low	The values of DL for each other. Please refer to the XBee ZB S2C device itself for this information.	Specify the lower address of the destination. For XBee ZB S2C, you can check the value by connecting to XCTU and confirming the DL value, or by inspecting the device (MAC).
Entering command mode	＋＋＋	Switching XBee ZB S2C to command mode.
Exiting command mode	ATCN	Exiting the command mode of XBee ZB S2C.
RESTORE defaults	ATRE¥R	Restoring XBee ZB S2C to factory default settings.
Reading the address	ATSL	Reading the configured address of XBee ZB S2C.

To enable communication between two XBee ZB S2C modules, you need to configure three settings: ID, DH, and DL. Please configure these values in the following order: ID → DH → DL. Make sure to set each of these values on both XBee ZB S2C modules.

If you enter command mode, make sure to reconfigure ID, DH, and DL.

The format for sending AT commands is as follows:

Figure 6-1 Transmission Format of AT Commands



To control the XBee ZB S2C using the AT commands, it is necessary to enter command mode before sending the AT commands. Refer to the following online manual for details about how to enter command mode and about parameters to be sent for each AT command.

https://www.digi.com/resources/documentation/Digidocs/90001500/Default.htm

6.2 Preparation of Hardware

Connect the transmitting wireless module RL78/G15, XBee ZB S2C, and HS300x as follows. Also, connect the receiving wireless module RL78/G15, XBee ZB S2C, PCF8574, and LCD1602A as follows.

Figure 6-2 Overall View of Connection

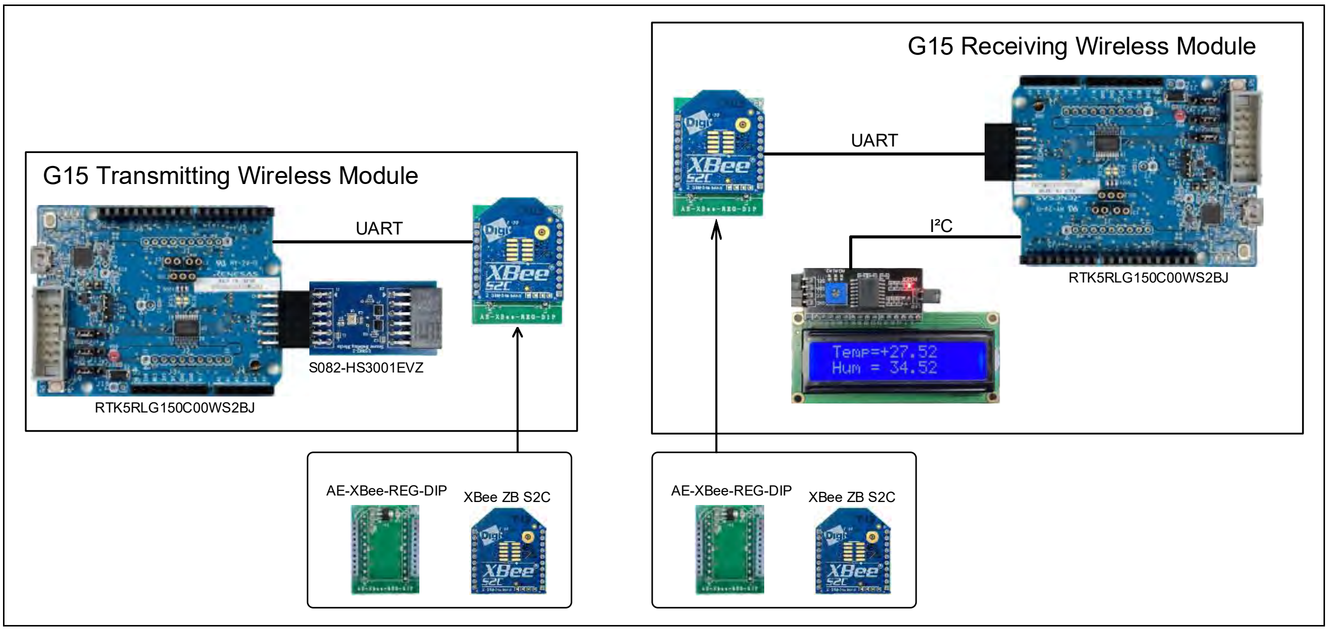


Table 6-2 Pins to which RL78/G15 and XBee ZB S2C Connect

RL78/ G15		XBee ZB S2C		Explanation
Pin number	Name	Pin number	Name	
-	VDD	Pin1	VCC	Power supply from RL78/G15 to XBee ZB S2C
-	GND	Pin10	GND	GND of RL78/G15 and XBee ZB S2C
P03	TXD0	Pin3	DIN	UART transmission from RL78/G15 to XBee ZB S2C
P04	RXD0	Pin2	DOUT	UART Reception from XBee ZB S2C to RL78/G15

Table 6-3 Pins to which RL78/G15 and HS300x Connect

RL78/ G15		HS300x		Explanation
Pin number	Name	Pin number	Name	
-	VDD	Pin4	VDD	Power supply from RL78/G15 to HS300x
-	GND	Pin6	VSS	GND of RL78/G15 and HS300x
P06	SCLA0	Pin1	SCL	I²C clock transmission from RL78/G15 to HS300x
P07	SDDA0	Pin2	SDA	I²C data transmission from RL78/G15 to HS300x

Table 6-4 Pins to which RL78/G15 and PCF8574 Connect

RL78/G15		PCF8574		Explanation
Pin number	Name	Pin number	Name	
-	VDD	16	VDD	Power supply from RL78/G15 to PCF8574
-	GND	8	VSS	GND of RL78/G15 and PCF8574
P06	SCLA0	14	SCL	I[2]C clock transmission from RL78/G15 to PCF8574
P07	SDDA0	15	SDA	I[2]C data transmission from RL78/G15 to PCF8574
-	-	1	A0	I2C address input pin0
-	-	2	A1	I2C address input pin1
-	-	3	A2	I2C address input pin2

Note 1. The address of the PCF8574 used in this application is set to 0x27 (A0, A1, A2 = High)..

Table 6-5 Pins to which PCF8574 and LCD1602A Connect

PCF8574		LCD1602A		Explanation
Pin number	Name	Pin number	Name	
8	VSS	1	VSS	GND of PCF8574 and LCD1602A
16	VDD	2	VDD	Power supply from PCF8574 to LCD1602A
-	-	3	VO	Contrast control from PCF8574 to LCD1602A
4	P0	4	RS	Register Select from PCF8574 to LCD1602A: Specify whether it's a command or data.
5	P1	5	R/W	Read/Write specification from PCF8574 to LCD1602A.
6	P2	6	E	Enable signal from PCF8574 to LCD1602A.
-	-	7	DB0	Data0 from PCF8574 to LCD1602A
-	-	8	DB1	Data1 from PCF8574 to LCD1602A
-	-	9	DB2	Data2 from PCF8574 to LCD1602A
-	-	10	DB3	Data3 from PCF8574 to LCD1602A
9	DB4	11	DB4	Data4 from PCF8574 to LCD1602A
10	DB5	12	DB5	Data5 from PCF8574 to LCD1602A
11	DB6	13	DB6	Data6 from PCF8574 to LCD1602A
12	DB7	14	DB7	Data7 from PCF8574 to LCD1602A
-	-	15	A	Anode for the backlight from PCF8574 to LCD1602A
7	P3	16	K	Cathode for the backlight from PCF8574 to LCD1602A (connected through a transistor).

Note 1. In this application, the LCD1602A is controlled in 4-bit mode, so the DB0 to DB3 terminals of the LCD1602A are not used.

6.3 Operation Confirmation Methods

This sample software allows the control of LED1 on the RL78/G15 Fast Prototyping Board and the HS300x sensor connected to the same board using the transmitting wireless module. It receives temperature and humidity data sent from the transmitting wireless module, and displays the temperature and humidity on the LCD1602A.

(1) Set the power selection header of the receiving wireless module's RL78/G15 Fast Prototyping Board to 3.3V power (short J15 2-3), and supply power to the RL78/G15. At this point, the XBee ZB S2C on the G15 side also receives power, and the XBee ZB S2C address is displayed on the LCD1602.

(2) Set the power selection header of the transmitting wireless module's RL78/G15 Fast Prototyping Board to 3.3V power (short J15 2-3), and supply power to the RL78/G15. At this point, the XBee ZB S2C on the G15 side also receives power, and the preparation is complete.

(3) When the transmitting wireless module receives temperature and humidity data, it is displayed on the LCD1602A through the receiving wireless module. (The LCD display does not change until new temperature and humidity data is received.)

(4) Press and hold the SW on the transmitting wireless module to switch between connecting and disconnecting communication of the XBee ZB S2C. When communication is connected, it sends temperature and humidity data to the receiving wireless module, and when communication is disconnected, it stops sending temperature and humidity data. During communication connection, the LED lights up, and during communication disconnection, the LED turns off.

(5) Repeat steps (3) and beyond in a loop.

Reference Doucuments

・RL78/G15 User’s Manual: Hardware (R01UH0959)

・RL78/G15 Fast Prototyping Board User’s Manual (R12UM0042)

・HS300x Datasheet (R36DS0010EU0701)

・RA Family, RX Family, RL78 Family, RE01 256KB / 1500KB Group, RZ Family　HS300x Sample Software Manual (R01AN5897)

・RA Family, RX Family, RL78 Family, RZ Family Sensor Software Combination Manual (R01AN6591)

・RL78 Family Board Support Package Module Using Software Integration System（R01AN5522）

・RX Family Renesas HS300x Sensor Control Module Firmware Integration Technology (R01AN5893)

・RL78 Family Renesas Sensor Control Modules Software Integration System（R01AN6192）

・RX Family Renesas Sensor Control Modules Firmware Integration Technology（R01AN5892）

・RL78 Family Renesas Sensor I2C Communication Middleware Control Module Software Integration System (R01AN6193）

・RL78 Family Renesas HS300x Sensor Control Module Software Integration System（R01AN6194）

The latest versions can be downloaded from the Renesas Electronics website.

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Jan.9.2023	-	First Edition
1.01	Mar.8.2024	4	Update of operational verification conditions
		15	Correction of errors
		17	Change to using the reset terminal in the Smart Configurator settings

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

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

1. Precaution against Electrostatic Discharge (ESD)

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

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

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

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

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

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

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

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

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