JP202 Sub-GHz still image transmission demo kit

Hardware Use's Guide

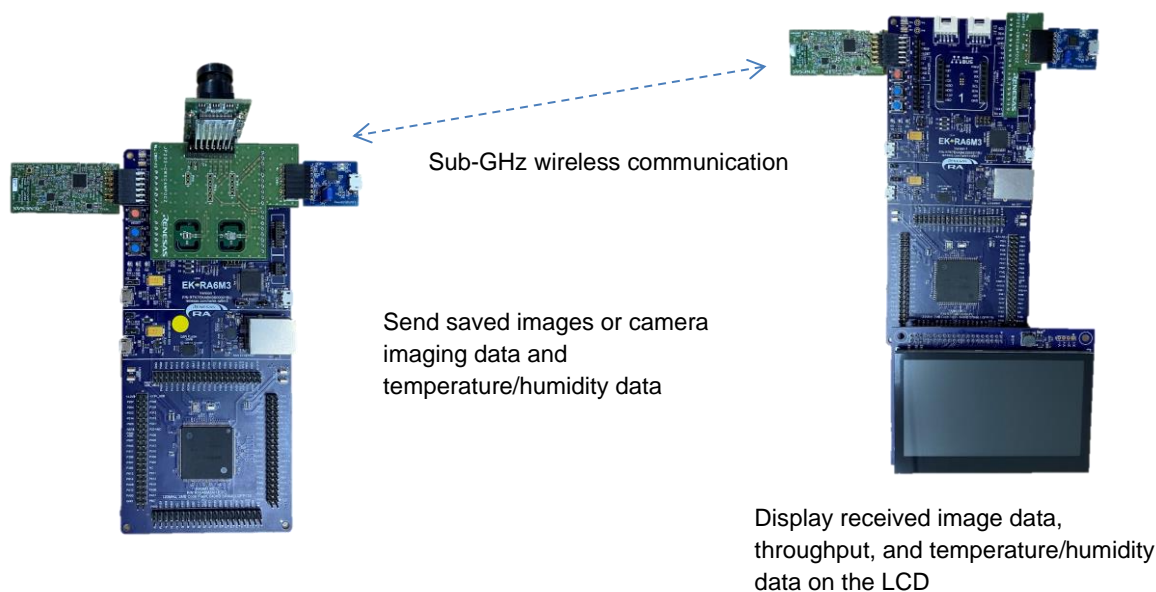## Contents

1. System overview

This system wirelessly transmits either stored still images or captured data from the camera, and data from the temperature/humidity sensor in the Sub-GHz band. The receiver displays the received data on the LCD.
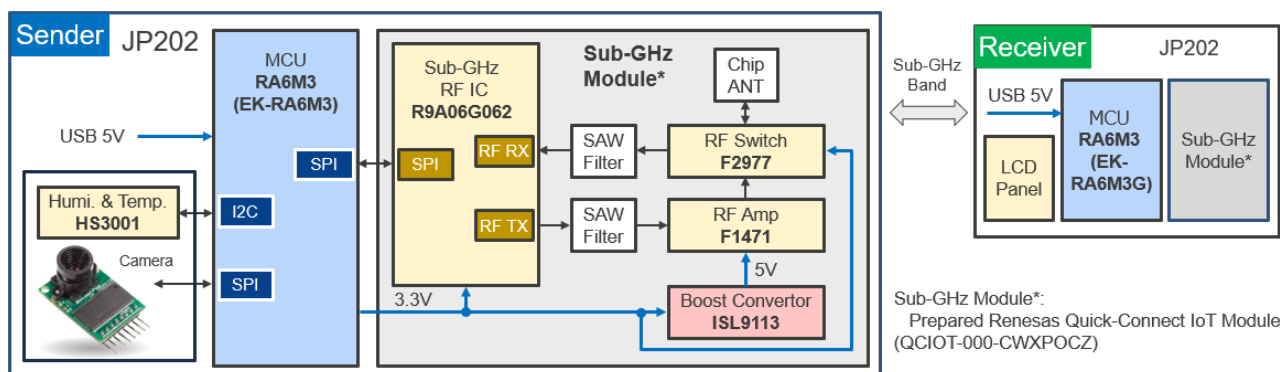
This demo kit consists of 2 pcs of Sub-GHz modules (QCIOT-000-CWXPOCZ), 1 camera sensor kit (JP202-CWXCAMPOCZ) and EK-RA6M3 (for transmitting images and data from cameras, temperature and humidity sensors) / EK-RA6M3G (received images and data display) boards are required. Also, if you want to check the UART command control operation from a PC, you will need 2 pcs Digilent PmodUSBUART and a USB cable.

Figure 1- 1 system overview

Sub-GHz wireless communication

Send saved images or camera imaging data and temperature/humidity data

Display received image data, throughput, and temperature/humidity data on the LCD

There are several power source options for EK-RA6M3 MCU board, option 1, the J10 Debug USB, is the easiest to power the system demo.

Figure 1- 2 JP202 Demo Kit System Block Diagram

The JP202 Sub-GHz Wireless Communication Demo Kit Specifications is shown below.

| Item	Specification
QCIOT-000-CWXPOCZ dimensions	24.0 mm(width) x 50.8 mm (length), connector is not included
Transceiver IC (CWX-M)	R9A06G062GNP (Renesas)
RF AMP	F1471 (Renesas)
RF Switch	F2977 (Renesas)
Power-supply IC for RF AMP	ISL9113ER7Z-T (Renesas)
SAW filter	B39921B2672P810 (Qualcomm)
Antenna	M620720 (Ethertronics/AVX)
Wireless function	Sub-GHz Wireless circuit
	Modulation Method: FSK / OFDM
	North America Band: 902 to 928MHz (FCC)
	Europe Band: 863 to 870MHz (CE)
	Japan Band: 920 to 928MHz (Type certification)
Control Microcomputer board	R7FA6M3AH3CFC (Renesas) on board RA6M3 MCU Graphics Evaluation Kit EK-RA6M3G (for receiver) RA6M3 MCU Evaluation Kit EK-RA6M3 (for sender)
LCD panel	TFT color LCD 480×272 pixel
JP202-CWXCAMPOCZ dimensions	Camara sensor board: 53.0 mm(width) x 67.3 mm (length)
	PMOD adaptor board: 19.08 mm(width) x 53.0 mm (length)
CMOS camera	Arducam-Mini-5MP-Plus Camera element: OV5642 Framebuffer: 512KB Output resolution: 2592×1944、1920×1080、1280×720、640×480、320×240 Output format: RAW、YUV、RGB、JPEG
Temperature and humidity sensor	HS3001
Power-supply	USB connector: 5V input
Operating ambient temperature	-10 to +60°C
Operating humidity	20% to 75%
Power Consumption for Transceiver at SUN-FSK mode 100kbps	Transmission supply current@+15.0 dBm: 62mA (VDD=3.3V)
	Reception supply current@ -95 dBm: 16.7mA (VDD=3.3V)
Power Consumption for Transceiver at SUN-OFDM mode 100kbps	Transmission supply current@+10.0 dBm: 68mA (VDD=3.3V)
	Reception supply current@-95 dBm: 21.5mA (VDD=3.3V)

2.   Hardware setup

This system consists of an evaluation board equipped with a camera module to which a camera and temperature/humidity sensor are connected, and an evaluation board equipped with an LCD. Each setup method is shown below.

### 2.1   Evaluation board with camera module
2.1.1   Board connection for camera module

Connect the camera module and PmodUSBUART board (when using communication with a PC) to the camera module board in the direction shown in the photo.
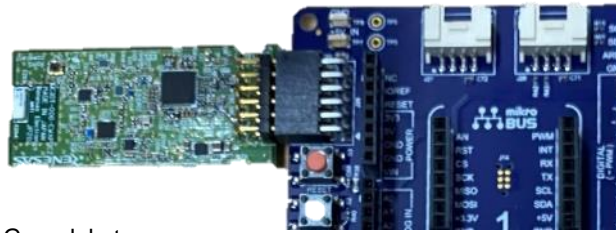
Connect camera module

Connect PmodUSBUART
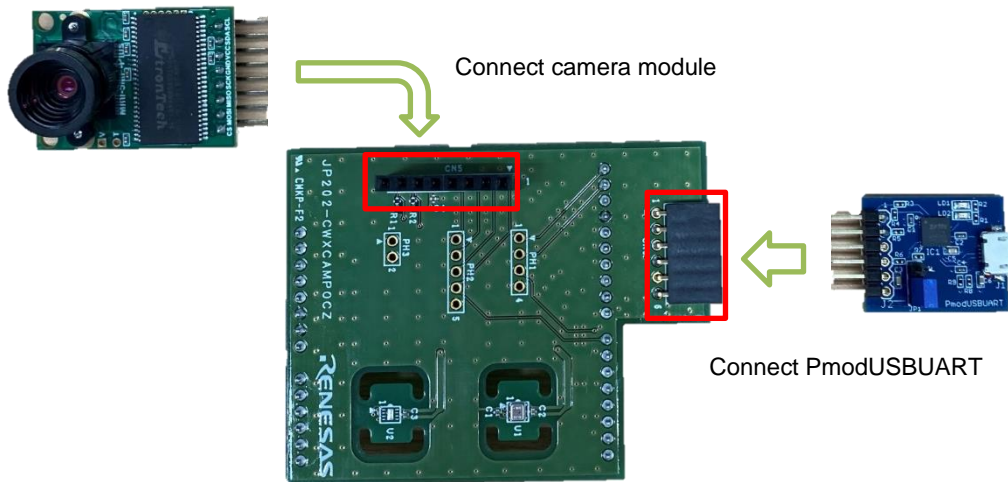
Connect the camera module board to the Arduino connector of the RA6M3 MCU evaluation board.

Connected to camera module board
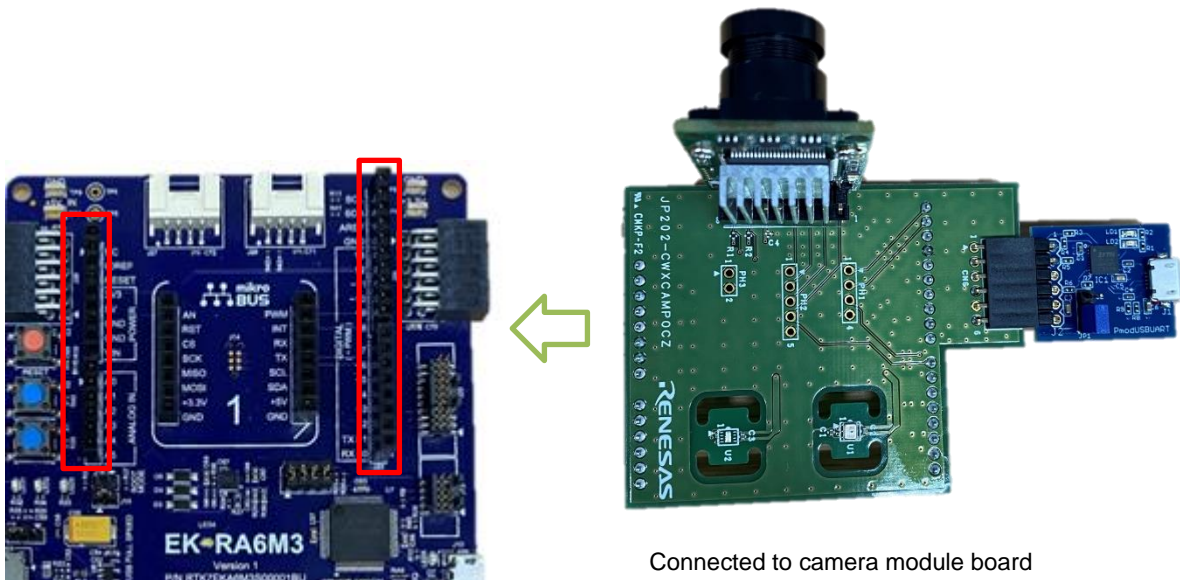
2.1.2 Sub-GHz module connection

Connect the Sub-GHz module to the PMOD1 connector (J26) on the EK-RA6M3 board.

Connect Sub-G module to
PMOD1 connector

2.1.3 User switch operation

The behavior of the user switches on the EK-RA6M3 board is shown below.

SW	behavior
S1	Toggle to switch between OFDM and FSK
S2	[Transmitting saved images] Short press to send pre-stored image data. The image (2 types) switches with each short press. [Transmitting camera images] Press and hold (3 seconds or more) to continuously send data captured by the camera. Short press during transmission to stop transmission

User switch (S2)

User switch (S1)

2.1.4 User LED behavior

The behavior of the user LEDs on the EK-RA6M3 board is shown below.

LED	behavior
LED1(blue)	Lights up in OFDM mode
LED2(green)	Lights up in FSK mode
LED3(red)	Lights up during transmission

User LED1 (blue)   User LED2 (green)   User LED3 (red)

2.2 Evaluation board with LCD

2.2.1 LCD connection

Connect the graphics expansion board that comes with the evaluation kit to J1 of the MCU pin direct access area on the EK-RA6M3 board.

Connect graphics expansion board to J1
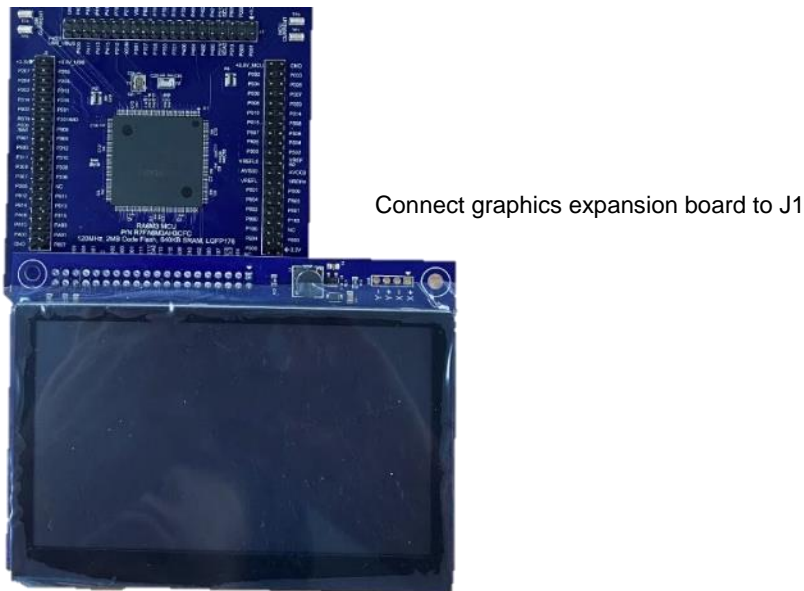
2.2.2 Sub-GHz module connection

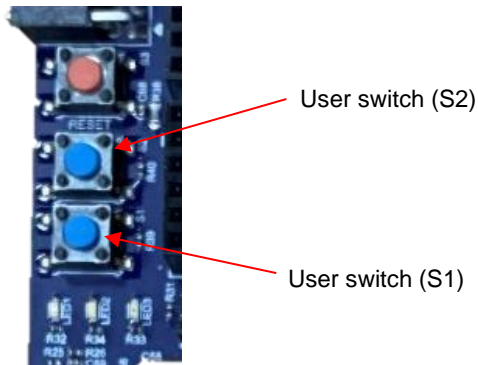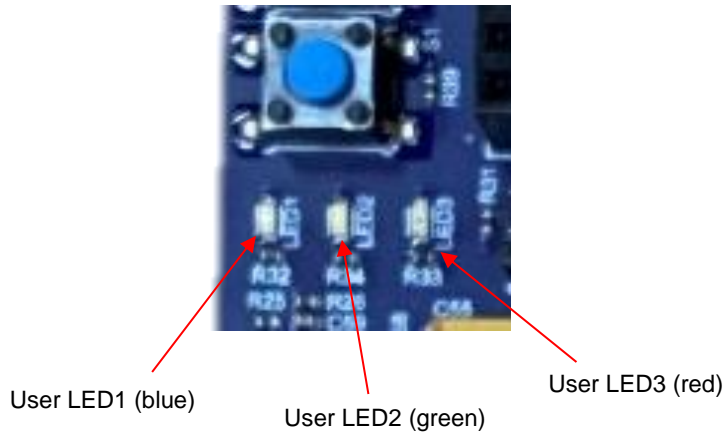Connect the Sub-GHz module to the PMOD1 connector (J26) on the EK-RA6M3 board.

Connect Sub-G module to
PMOD1 connector

2.2.3 PC connection board

Connect the PC connection board to J23 and J24 of the Arduino connector on the RA6M3 MCU evaluation board.
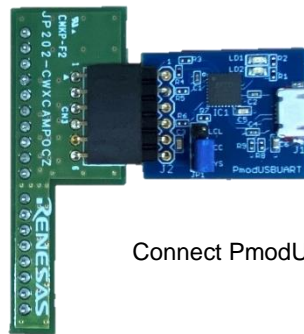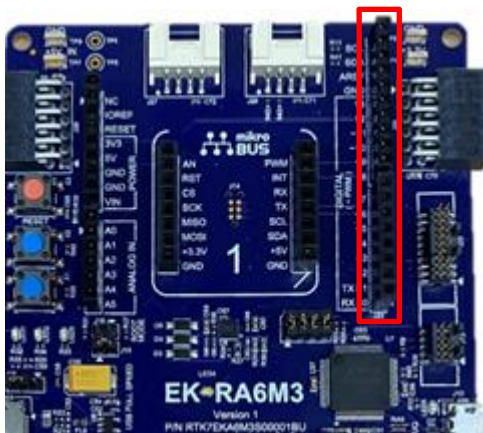
Connect PmodUSBUART

2.2.4 User switch operation

The behavior of the user switches on the EK-RA6M3 board is shown below.

SW	behavior
S1	Toggle to switch between OFDM and FSK

2.2.5 User LED operation

The behavior of the LEDs on the EK-RA6M3 board is shown below.

LED	behavior
LED1(blue)	Lights up in OFDM mode
LED2(green)	Lights up in FSK mode

2.2.6 LCD display

Displays transmitted saved data or camera images, temperature/humidity, and wireless throughput.
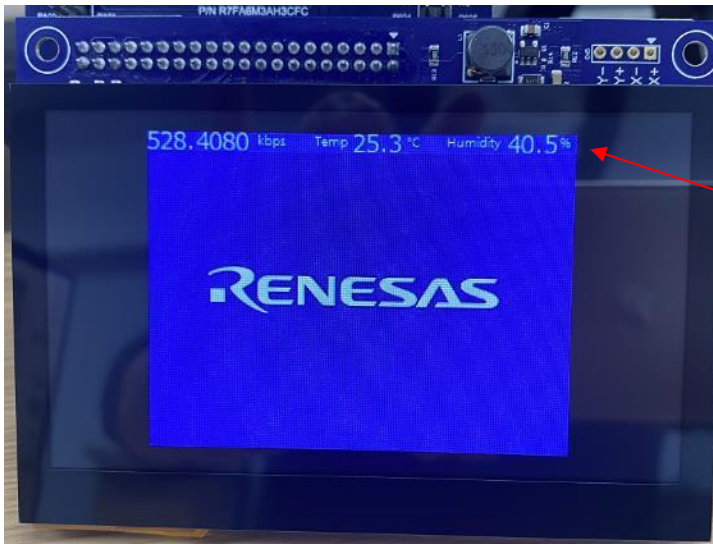
Display of throughput, temperature and humidity

3. Wireless settings

A UART connection enables wireless settings from a PC.

The radio PHY settings can be changed with the characterization program commands. The serial settings of the terminal software are as follows.

Serial settings:

Setting items	Value
Baud rate	500000bps
Data	8bit
Parity	None
Stop bit	1bit
Flow control	None
Line feed code	Receive：LF or AUTO Transmit：LF
Local echo	Enable
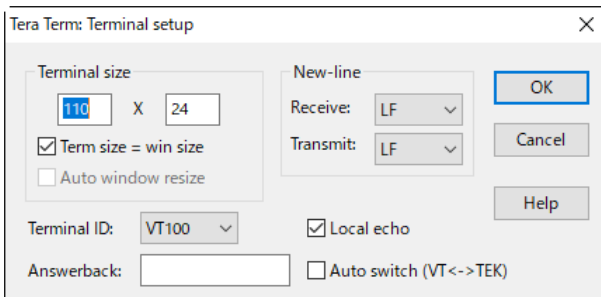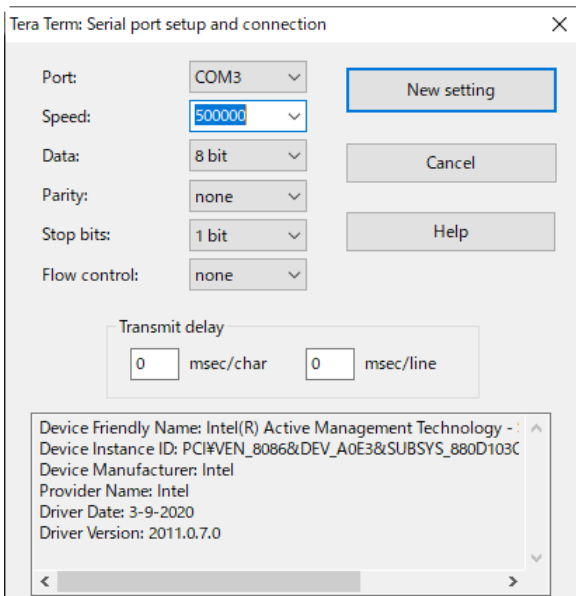
PHY Operation Mode (Sub-GHz Transceiver Transmit/Receive Operation Mode)

i) tope [modulation] [domain (NS/JP/EU/JP)] [phytype] [phymode] [ChanPlanID]

ii) tope [modulation][domain (UD)] [phytype] [phymode] [chspace] [chfreq0]

The default settings (at reset) are as follows.

FSK mode

PhyOperatingMode Setvalue =FSK / JP / 2FSK without FEC / 200Kbps M=1.0 #4b / ChanPlan:23

OFDM mode

PhyOperatingMode Setvalue =OFDM / JP / OFDM Option2 / MCS4 / ChanPlan:24

The default TX power is -17dBm for both FSK/OFDM.

The settings and commands are as follows.

Area	PHY settings	Command
JP	Frequency Band : JP Data rate : 100kbps(m=1) CH PlanID : 22 CH : 922.5MHz TX Power : -9.5dBm (PA Power +13dBm)	tope FSK JP FSKwoFEC 2b 22 tch 4 ttxpowd -9.5
	Frequency Band : JP Data rate : 100kbps(m=1) CH PlanID : 22 CH : 927.7MHz TX Power : -9.5dBm (PA Power +13dBm)	tope FSK JP FSKwoFEC 2b 22 tch 17 ttxpowd -9.5
	Frequency Band : JP Data rate : Option3-MCS6 CH PlanID : 22 CH : 922.5MHz TX Power : -8.5dBm (PA Power +13dBm)	tope OFDM JP op3 m6 22 tch 4 ttxpowd -8.5
	Frequency Band : JP Data rate : Option3-MCS6 CH PlanID : 22 CH : 927.7MHz TX Power : -8.5dBm (PA Power +13dBm)	tope OFDM JP op4 m6 21 tch 17 ttxpowd -8.5
	Frequency Band : JP Data rate : Option4-MCS6 CH PlanID : 21 CH : 922.4MHz TX Power : -8.5dBm (PA Power +13dBm)	tope OFDM JP op4 m6 21 tch 9 ttxpowd -8.5
	Frequency Band : JP Data rate : Option4-MCS6 CH PlanID : 21 CH : 928.0MHz TX Power : -8.5dBm (PA Power +13dBm)	tope OFDM JP op4 m6 21 tch 37 ttxpowd -8.5

Area	PHY settings	Command
EU	Frequency Band : EU Data rate : 50kbps(m=0.5) CH PlanID : 32 CH : 863.1MHz TX Power : -7.5dBm (PA Power +14dBm)	tope FSK EU FSKwoFEC 1a 32 tch 0 ttxpowd -7.5
	Frequency Band : EU Data rate : 50kbps(m=0.5) CH PlanID : 32 CH : 869.9MHz TX Power : -7.5dBm (PA Power +14dBm)	tope FSK EU FSKwoFEC 1a 32 tch 68 ttxpowd -7.5
	Frequency Band : EU Data rate : 100kbps(m=0.5) CH PlanID : 33 CH : 863.1MHz TX Power : -7.5dBm (PA Power +14dBm)	tope FSK EU FSKwoFEC 2a 33 tch 0 ttxpowd -7.5
	Frequency Band : EU Data rate : 100kbps(m=0.5) CH PlanID : 33 CH : 869.9MHz TX Power : -7.5dBm (PA Power +14dBm)	tope FSK EU FSKwoFEC 2a 33 tch 34 ttxpowd -7.5
	Frequency Band : EU Data rate : Option4-MCS6 CH PlanID : 33 CH : 863.1MHz TX Power : -5.5dBm (PA Power +14dBm)	tope OFDM EU op4 m6 33 tch 0 ttxpowd -5.5
	Frequency Band : EU Data rate : Option4-MCS6 CH PlanID : 33 CH : 869.9MHz TX Power : -5.5dBm (PA Power +14dBm)	tope OFDM EU op4 m6 33 tch 34 ttxpowd -5.5

Area	PHY settings	Command
US	Frequency Band : NA Data rate : 50kbps(m=1) CH PlanID : 1 CH : 902.2MHz TX Power : -7.5dBm (PA Power +15dBm)	tope FSK NA FSKwoFEC 1b 1 tch 0 ttxpowd -7.5
	Frequency Band : NA Data rate : 50kbps(m=1) CH PlanID : 1 CH : 927.8MHz TX Power : -7.5dBm (PA Power +15dBm)	tope FSK NA FSKwoFEC 1b 1 tch 128 ttxpowd -7.5
	Frequency Band : NA Data rate : 150kbps(m=0.5) CH PlanID : 2 CH : 902.4MHz TX Power : -7.5dBm (PA Power +15dBm)	tope FSK NA FSKwoFEC 3 2 tch 0 ttxpowd -7.5
	Frequency Band : NA Data rate : 150kbps(m=0.5) CH PlanID : 2 CH : 927.6MHz TX Power : -7.5dBm (PA Power +15dBm)	tope FSK NA FSKwoFEC 3 2 tch 63 ttxpowd -7.5
	Frequency Band : NA Data rate : Option1-MCS6 CH PlanID : 5 CH : 903.2MHz TX Power : -6dBm (PA Power +15dBm)	tope OFDM NA op1 m6 5 tch 0 ttxpowd -6
	Frequency Band : NA Data rate : Option1-MCS6 CH PlanID : 5 CH : 927.2MHz TX Power : -6dBm (PA Power +15dBm)	tope OFDM NA op1 m6 5 tch 20 ttxpowd -6
	Frequency Band : NA Data rate : Option2-MCS6 CH PlanID : 4 CH : 902.8MHz TX Power : -6dBm (PA Power +15dBm)	tope OFDM NA op2 m6 4 tch 0 ttxpowd -6
	Frequency Band : NA Data rate : Option2-MCS6 CH PlanID : 4 CH : 927.6MHz TX Power : -6dBm (PA Power +15dBm)	tope OFDM NA op2 m6 4 tch 31 ttxpowd -6
	Frequency Band : NA Data rate : Option3-MCS6 CH PlanID : 2 CH : 902.4MHz TX Power : -6dBm (PA Power +15dBm)	tope OFDM NA op3 m6 2 tch 0 ttxpowd -6
	Frequency Band : NA Data rate : Option3-MCS6 CH PlanID : 2 CH : 927.6MHz TX Power : -6dBm (PA Power +15dBm)	tope OFDM NA op3 m6 2 tch 63 ttxpowd -6
	Frequency Band : NA Data rate : Option4-MCS6 CH PlanID : 1 CH : 902.2MHz TX Power : -6dBm (PA Power +15dBm)	tope OFDM NA op4 m6 1 tch 0 ttxpowd -6
	Frequency Band : NA Data rate : Option4-MCS6 CH PlanID : 1 CH : 927.8MHz TX Power : -6dBm (PA Power +15dBm)	tope OFDM NA op4 m6 1 tch 128 ttxpowd -6

4. How to change the saved image

Static images for the TX sample project are stored as rgb565 pixel data arrays in the following C header files:

> tx/platform/ra6x/src/ra6m3/src/staticimage1.h
>
> tx/platform/ra6x/src/ra6m3/src/staticimage2.h

To generate new rgb565 header files from a different image use img2rgb565 tool:

> tx/images/img2rgb565.exe

The tools accepts a path to image file as a parameter, for example:

> img2rgb565.exe staticimage1.png

Will generate staticimage1.h file in the current directory. Optionally, destination file name can be specified as a second parameter:

> img2rgb565.exe staticimage1.png ../platform/ra6x/src/ra6m3/src/staticimage1.h

Note that the image file must be named `staticimage1.*` or `staticimage2.*` so that generated .h files have correct variable names (img_staticimage1 and img_staticimage2). The image resolution must be 320x240 pixels. The tool currently supports bmp, png, jpeg and gif file formats.

5. Certification of Compliance

This system complies with the laws and regulations described below.

Radio-Related Laws

North America: FCC ID：2AEMX JP202CWXPZ

Europe: CE (RE)
Japan: Type certification

FCC Regulatory

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

JP202-CWXCAMPOCZ module is for demonstration and evaluation purposes only. This module is not intended to be incorporated into final products. When applying a reference design to a final product, wireless certification must be obtained again by the end user. Every host device would have to be evaluated for spurious emissions, and perhaps other parameters potentially affected by the host.

FCC CAUTION
In accordance with FCC Part 15, QCIOT-000-CWXPOZ is listed as a Modular Transmitter device.

HOST that includes QCIOT-000-CWXPOZ shall have the labeling "Contains Transmitter module FCC ID: 2AEMX JP202CWXPZ".

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This transmitter must not be co-located or operated in conjunction with any other antenna or transmitter.

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment and meets the FCC radio frequency (RF) Exposure Guidelines. This equipment has very low levels of RF energy that it deemed to comply without maximum permissive exposure evaluation (MPE). But it is desirable that it should be installed and operated keeping the radiator at least 20cm or more away from person's body.

This device complies with FCC Part 15.203 because the antenna is not removable from this device.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures.

This equipment has been tested and meets the FCC RF exposure guidelines when used with the Renesas accessories supplied or designated for this product. Use of other accessories may not ensure compliance with FCC RF exposure guidelines.

Revision History

Rev.	Date	Description	
		Page	**Summary**
1.00	July 12, 2023	-	Initial release
1.01	Oct. 4, 2023	1	Added JP202 Demo Kit System Block Diagram
		2	Updated Demo Kit Specifications
		14	Certification of Compliance added

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1. Precaution against Electrostatic Discharge (ESD)

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

2. Processing at power-on

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

3. Input of signal during power-off state

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

4. Handling of unused pins

   Handle unused pins in accordance with the directions given under handling of unused pins in the manual. The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced 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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