QCIOT-RRH47000POCZ

QCIOT-RRH47000POCZ NDIR CO2 Sensor PMOD

Description

The QCIOT-RRH47000POCZ Evaluation Board (RRH47000 EVB) demonstrates the functionality and performance of the RRH47000 NDIR CO_2 sensor. The RRH47000 uses nondispersive infrared (NDIR) technology to accurately measure CO_2. The design of the RRH47000 EVB is generic so that customers can embed the sensor into their specific applications.

The board provides a standard Pmod™ Type 6A (extended I^2C) connection for the onboard sensor to plug into any required MCU evaluation kit with a matching connector. The RRH47000 EVB can be added to the end of a daisy-chained solution with multiple Type 6/6A devices on the same MCU Pmod connector.

The software support included with the Renesas IDE (e² studio) allows for code generation to connect the device and the MCU in order to significantly reduce development time. With its standard connector and software support, the RRH47000 EVB is ideal for the Renesas Quick-Connect IoT to rapidly create an IoT system.

Features

- Accurate CO_2 measurements
- Sensor outputs feature:
  - NDIR CO_2 sensor technology
  - Integrated temperature and humidity sensor
  - CO_2 measurement range: 400ppm to 5000ppm
  - CO_2 Accuracy: ± (30ppm + 3% of reading) for the range 0 to 2000ppm, 0 to 50°C and 50 ±10% RH
- Current consumption: < 50mA at 1s sample time
- I^2C and UART interface
- Long-term stability and long lifetime > 15 years
- Standardized type 6A Pmod connector supports I^2C/SMBUS extended interface
- Software support in e² studio minimizes development time with one-click code generation

Board Contents

- QCIOT-RRH47000POCZ CO_2 Sensor

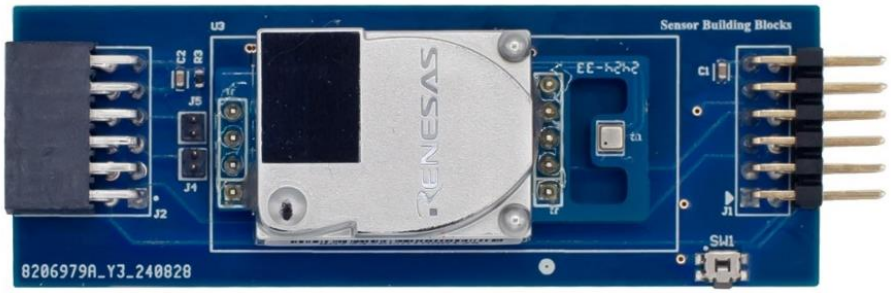


Figure 1. QCIOT-RRH47000POCZ NDIR CO2 Pmod

Contents

Figures

1. Functional Description

The RRH47000 EVB is intended as a quick-connect prototyping solution for a CO_2 monitoring system. The board allows designers to quickly create CO_2 monitoring systems. The EVB can measure CO_2 ranges from 400ppm to 5000ppm.

Figure 2 highlights the main parts of the system.

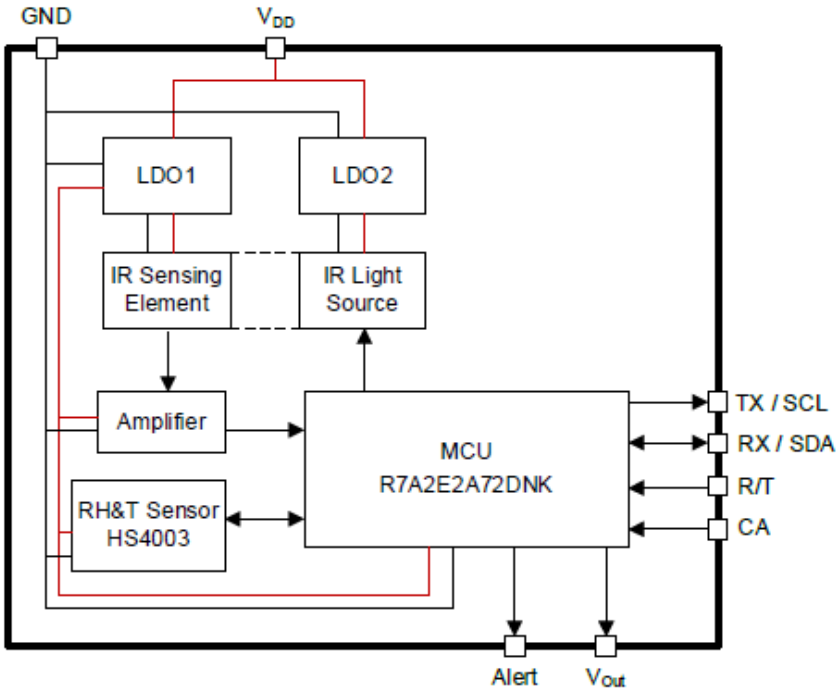


Figure 2. RRH47000 Block Diagram

The following list summarizes the building blocks of the RRH47000 EVB and its functionality:

- HS4003 – Highly accurate, ultra-low power, fully calibrated relative humidity and temperature sensor. Fully calibrated and temperature compensated with an I^2C digital output.
- NDIR CO_2 Sensor – Contains an infrared source, a sample chamber, a filter, and an infrared detector. The infrared light is directed by the infrared source passing through the gas chamber towards the detector.

1.1 Operational Characteristics

The RRH47000 EVB can be used as a starting point for air quality monitoring applications. The board is designed to the following specifications:

- Temperature range = -10 to 50°C
- Relative Humidity range = 0 to 100%
- CO_2 Measurement range = 0 to 5000ppm

1.2 Setup and Configuration

The setup and configuration for the RRH47000 EVB is comprised of the following required or recommended hardware:

- EK-RA6M4 Evaluation Kit
- USB micro-B cable (provided with EK-RA6M4 board)
- PC running windows 10/11 with at least one USB port
- US082-INTERPEVZ (if needed)

The following is required or recommended software:

- Renesas Flexible Software Package v5.7.0 platform installation:
  - e² studio 2023-01 or later
  - FSP 5.7.0 or later
  - GCC Arm Embedded 10.3.1 (10 2021.10)
  - SEGGER J-Link RTT Viewer
- Sample code files (available on the QCIOT-RRH47000POCZ product page)

1.2.1 Software Installation and Usage

Visit the Renesas website for the latest version of the e² studio installer. The minimum FSP version supporting the QCIOT-RRH47000 Pmod is 5.7.0.

Visit J-Link RTT Viewer to install the latest version of RTT Viewer.

1.2.2 Kit Hardware Connections

Complete the following procedure to set up the kit (see Figure 3):

1. Ensure that the MCU development kit has at least one Type 6A Pmod.
   a. For the EK-RA6M4, two Pmods, PMOD1 and PMOD2, are available. The default for these Pmods is type 2A. Use the US082-INTERPEVZ to allow compatibility with type 6A.
   b. If no interposer is available, then PMOD1 can be rerouted from 2A to 6A. For more information, see the EK-RA6M4 Manual.
2. Ensure that pin 12 of the Pmod is 3.3V, which is requested by the RRH47000 Pmod.
   a. For the EK-RA6M4, pin 12 of PMOD1 and PMOD2 are 3.3V by default. No change needed.
   b. For some evaluation boards, pin 12 is defaulted to 5.0V and may require rerouting. Check the user manual to verify that pin 12 is 3.3V.
3. Mount the J2 and J3 jumpers on the RRH47000 Pmod board.
4. Plug the RRH47000 Pmod into PMOD1 of the EK-RA6M4.
5. Connect the EK-RAM64 board with the computer using the USB micro-B cable.
   The kit is now ready for use.

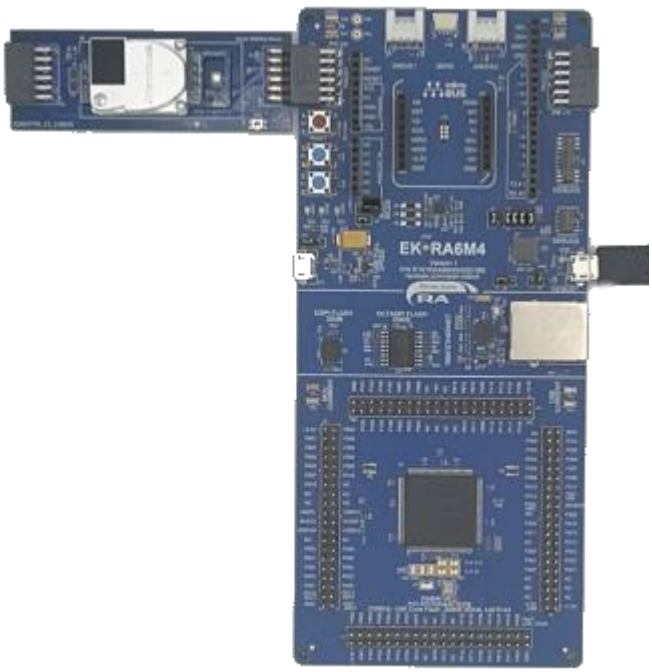


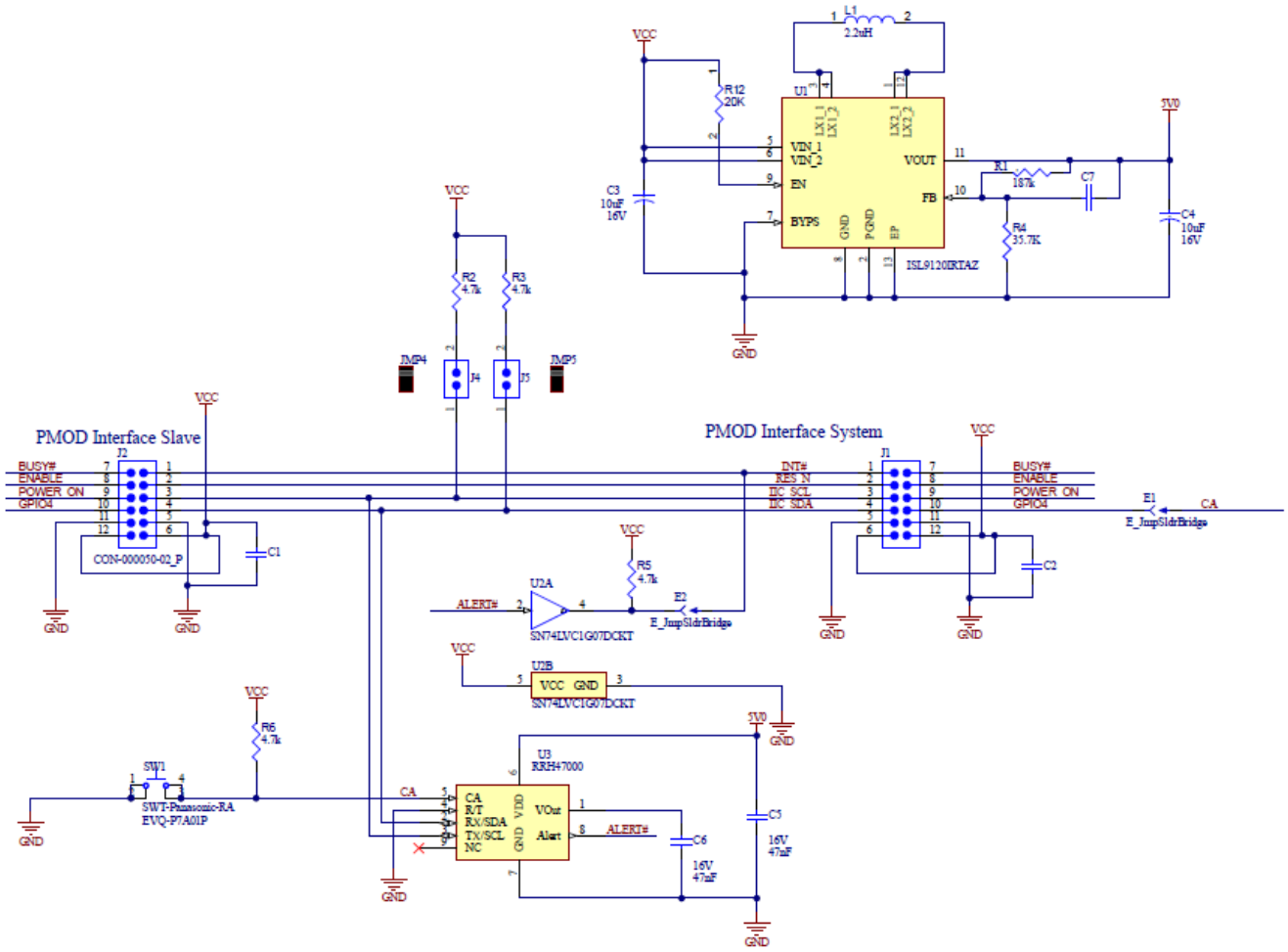
Figure 3. QCIOT-RRH47000 Pmod with EK-RA6M4 MCU Kit

2. Board Design

Figure 4. QCIOT-RRH47000 Pmod (Top)

Figure 5. QCIOT-RRH47000 Pmod (Bottom)

2.1 Schematic Diagrams



2.2 Bill of Materials

Qty	Designator	Description	Manufacturer	Manufacturer Part Number
1	C1, C2	Capacitor, 0.1uF, 50V, SM	KEMET	C0603C104J5RACTU
2	C3, C4	10uF, X5R, MLCC Ceramic capacitor, 0805	Samsung	CL21A106KOQNNNG
3	C5, C6	Ceramic Chip Capacitor 0402 47nF 16V	Samsung	CL05B473KO5NNNC
4	C7	Capacitor, 22pF, 25V, SM 0603	KEMET	C0603C220K3GACTU
5	FOOT1	Foot, Rubber, Self-adhesive, Black, 6.4mm dia, 2.1mm tall	Bumper Specialties	BS25BL07X30RP
6	J1	Male Header 0.1" pitch PMOD 2x6 Right Angle, through hole	Wurth Electronics	61301221021
7	J2	Samtec Female Header 0.1" pitch PMOD 2x6 Right Angle	Samtec	SSW-106-02-F-D-RA
8	J4, J5	CONN HEADER VERT 2POS 1.27mm	Samtec	FTS-102-01-L-S
9	JMP4, JMP5	2 C, Closed Top, .050" CC; No Mounting, 105 C, Nylon 66; Phos Bronze, Gold Flash	Sullins	NPB02SVFN-RC
10	L1	Ind Power Chip Shielded Multi-Layer 2.2uH 20% 1MHz Ferrite 1.15A 0603 Paper T/R	Murata	LQM18PN2R2MGHD

Qty	Designator	Description	Manufacturer	Manufacturer Part Number
11	R1	Resistor 187K, Smt 0603	Yageo	RC0603FR-07187KL
12	R2, R3	Res Thick Film 0603 4.7 Ohm 1% 1/10W ±100ppm/°C Molded SMD Paper T/R	Vishay Dale	CRCW06034R70FKEA
13	R4	Fixed Resistor, Metal Glaze/thick Film, 0.1W, 49.9ohm, 75V, 1% ±Tol, 100ppm/Cel, Surface Mount, 0603	Vishay Dale	CRCW060349R9FKEC
14	R5, R6	Chip Resistor, 4.7 KOhm, ±1%, 0.1 W, -55 to 155°C, 0603 (1608 Metric)	Panasonic	ERJ-3EKF4701V
15	R12	20 kOhms ±1% 0.1W, 1/10W Chip Resistor 0603 (1608 Metric) Moisture Resistant Thick Film	Yageo	RC0603FR-0720KL
16	SW1	Sealed Push Button Switch 3.5 x 2.9mm 1.3mm High	Panasonic	EVQ-P7A01P
17	U1	Integrated Circuit	Renesas Electronics	ISL9120IRTAZ
18	U2	IC, Digital, Buffer, Non-Inverting, Open Drain, SM	Texas Instruments	SN74LVC1G07DCKT
19	U3	NDIR CO2 Sensor	Renesas	RHH47000

2.3 Board Layout

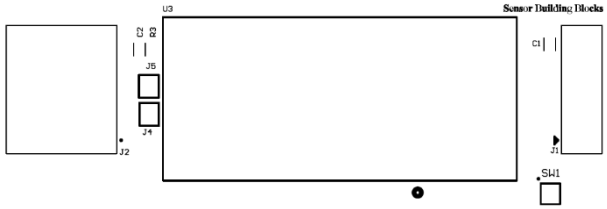


Figure 6. Top Layer

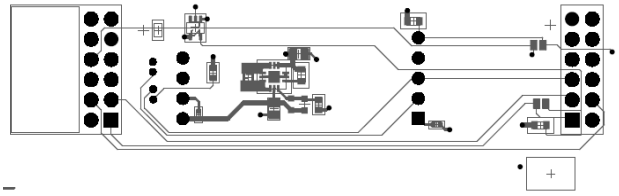


Figure 7. Bottom Layer

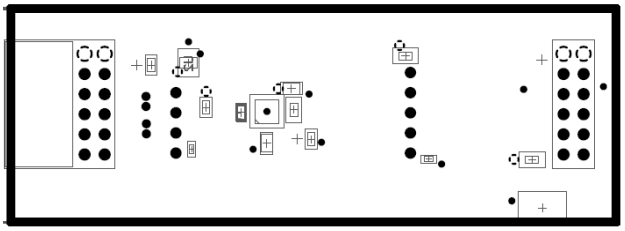


Figure 8. Int 1 (PWR)

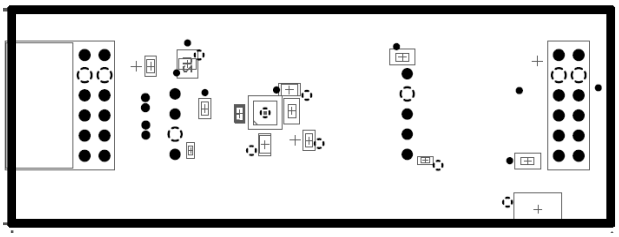


Figure 9. Int 2 (GND)

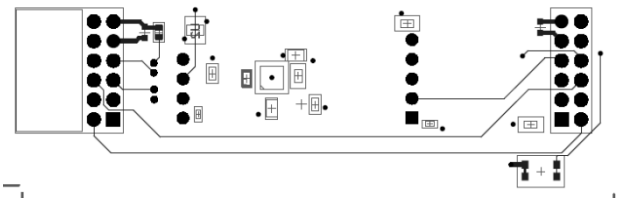


Figure 10. Bottom Layer

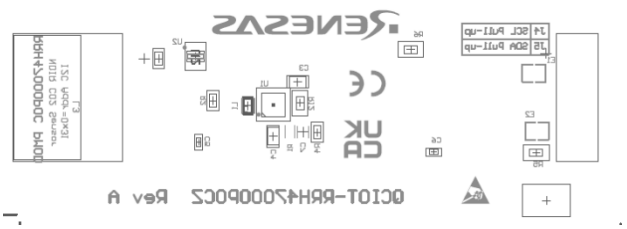


Figure 11. Bottom Overlay

3. Software Design

This section provides an overview of the software implementation for the QCIOT-RRH47000 Pmod, which is based on the Renesas RA Family's Flexible Software Package (FSP). It also explains the project's code structure, the system's software modules, and the main system flow.

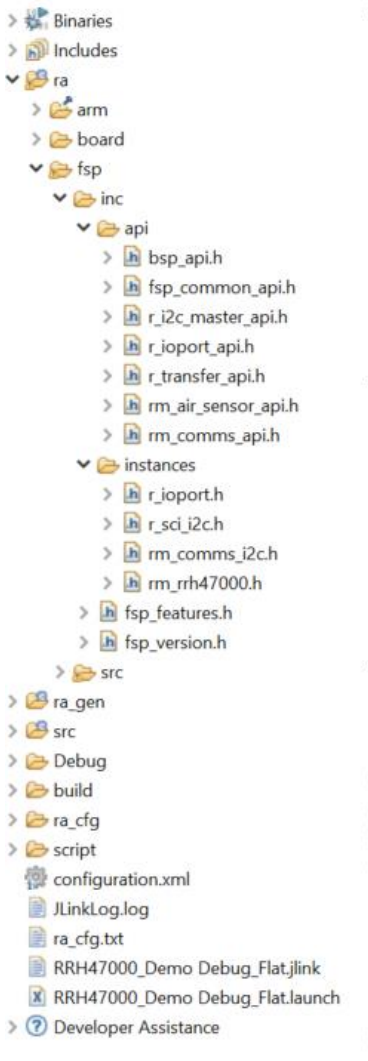
3.1 Project Code Structure

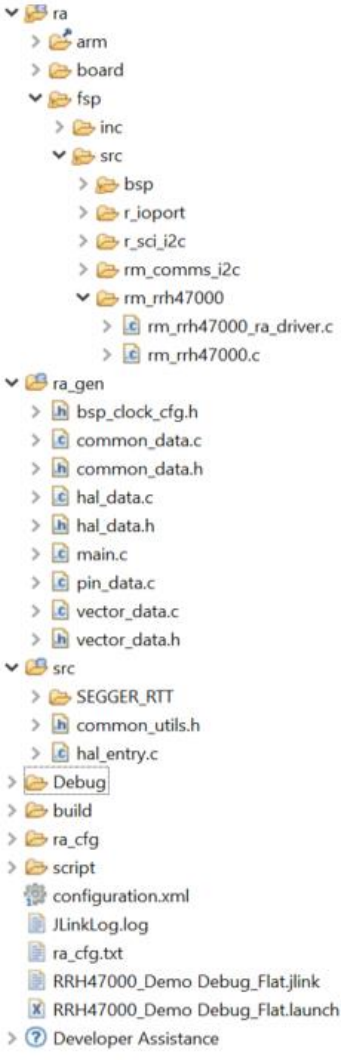
The All-In-One Air Quality Demo Project is designed to be a highly modular solution that can be easily configured independently of other modules (if required), or ported to other end applications.

The project is split into two main parts:

- RRH47000 driver – Device driver code for RRH47000 that includes the I^2C communication driver.
- Application code – Main system code that enables the driver code and implements system flow.

The driver module contains the C source files and header files. The specific user configuration is included in the application code. Refer to the User Settings section for details regarding user configurations.





ra – Automatically generated files for FSP drivers, RRH47000 driver source code, and header files.

- rm_rrh47000.h – RRH47000 driver header file
- rm_rrh47000.c – RRH47000 driver source file
- rm_rrh47000_api.h – RRH47000 API header file
- rm_rrh47000_ra_driver.c – Software delay function

ra_gen – Generated files by FSP configuration

src – Application code

- hal_entry.c – Start of code execution, which calls system main
- common_utils.h – RTT-Viewer driver header file
- SEGGER_RTT – RTT-Viewer driver source files

Figure 12. RRH47000 Project Structure

When you click **configuration.xml** in the project and select the **Stack** tab, a stack configuration appears (see Figure 13).

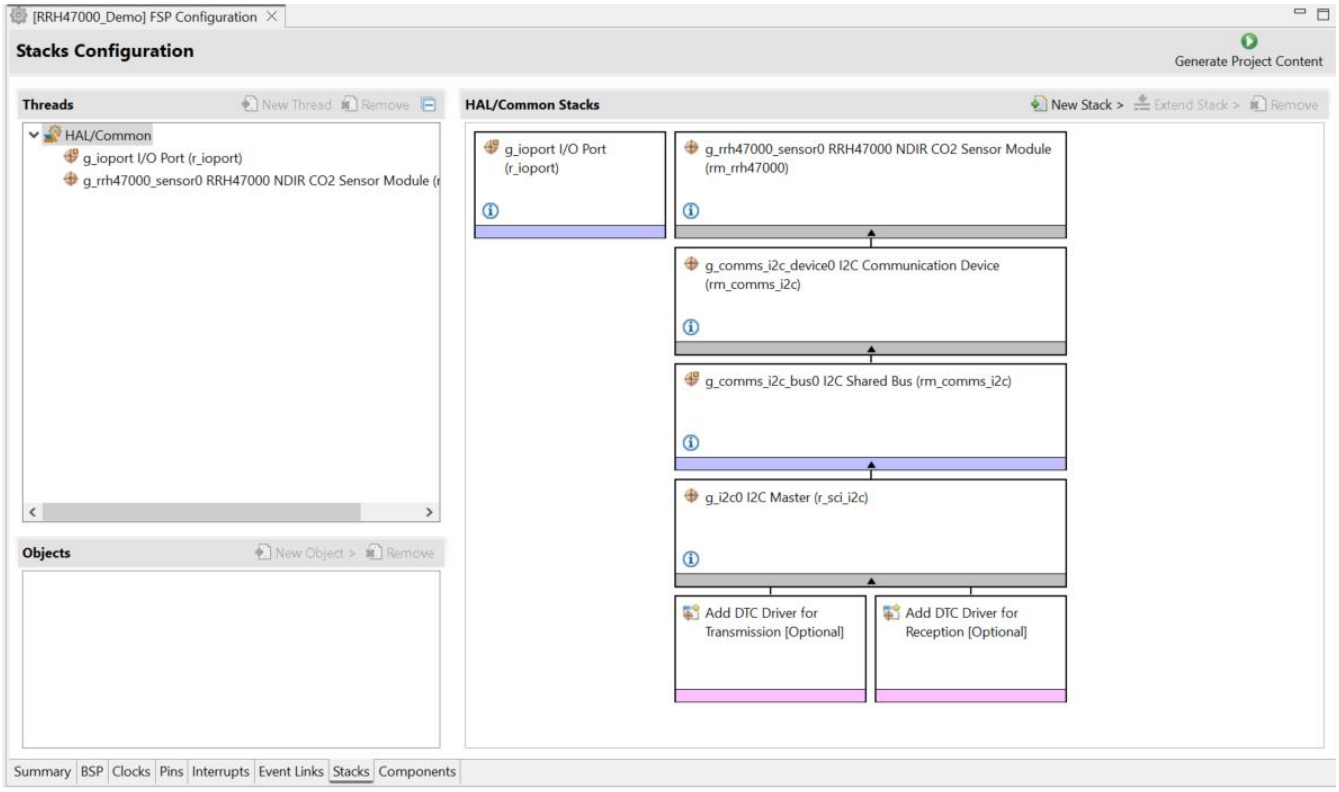


Figure 13. Stack Configuration – Hal/Common

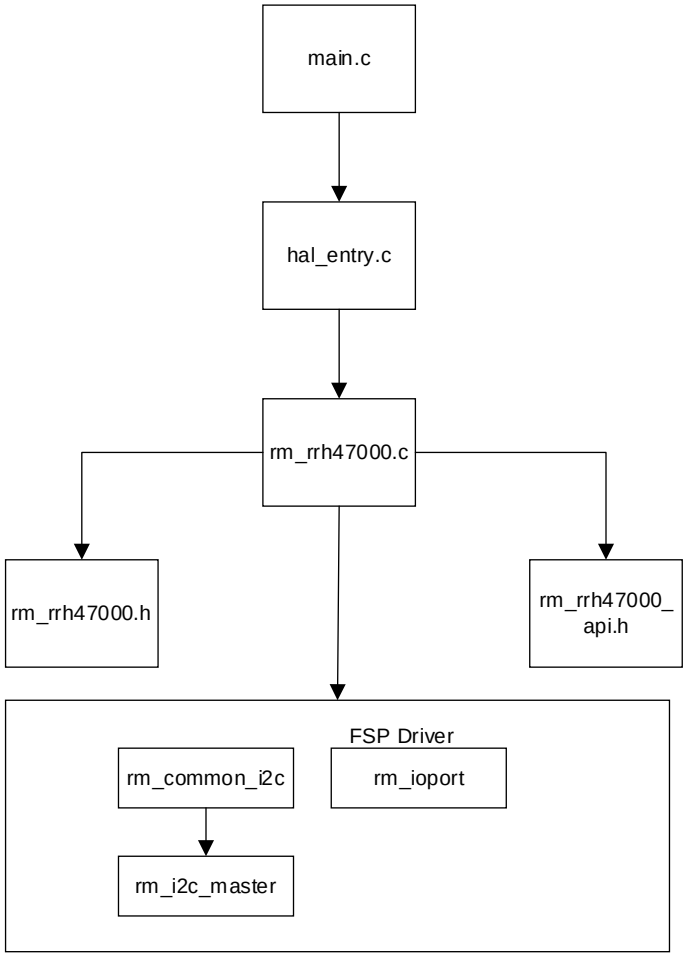


Figure 14. Code Dependency Graph

3.2 Software Module Overview

The RRH47000 demo project shows the basic use of FSP API calls to set up and read sensor data from the RRH47000.

3.2.1 Hal_entry

This module is responsible for initializing the FSP I^2C driver and setting up the RRH47000 device with the user-configured settings. After setup, the module provides the following features:

- Performs device setup commands
- Reads sensor values
- Prints sensor values to RTT Viewer

3.2.2 Algorithm Flowchart

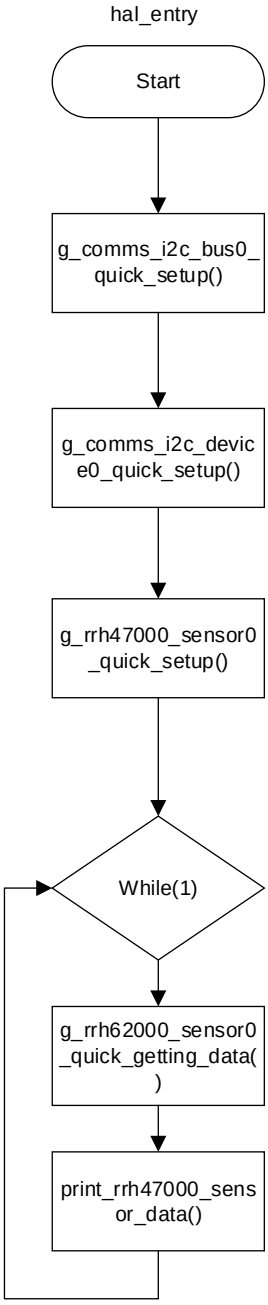


Figure 15. Algorithm Flowchart

The I²C bus is opened by g_comms_i2c_bus0_quick_setup(). Then, the RRH47000 instance is opened by g_rrh47000_sensor0_quick_getting_data().

The main program loops continuously to get the air quality readings by g_rrh47000_sensor0_quick_getting_data() function calls. The sensor readings can be seen in the Virtual Expression window.

The functions outlined in Figure 15 are described as follows:

hal_entry ()

- Call g_comms_i2c_bus0_quick_setup()
  - Open I2C driver, this must be done before calling device setup.

- Call g_comms_i2c_device0_quick_setup()
  - Open I2C Communications device instance, this must be done before calling any COMMS_I2C_API.
- Call g_rrh62000_sensor0_quick_setup()
  - Open RRH62000 instance, this must be done before calling any RRH47000 API.
- Continuously call g_rrh62000_sensor0_quick_getting_data()
  - Sends the read data command to the RRH47000.
  - Waits for Measurement to be finished.
  - Converts raw sensor measurement data to calculated data.
- Continuously call print_rrh47000_sensor_data()
  - Prints sensor data to the RTT-Viewer terminal.

4. Board Test

4.1 Setting Up the Boards and Cable

Verify that you have followed the procedure in “Kit Hardware Connections”.

4.2 Programming the Development Board and Running Example Code in Debug Mode

1. Open the sample project in e2 studio.
2. Click the **Build** icon.

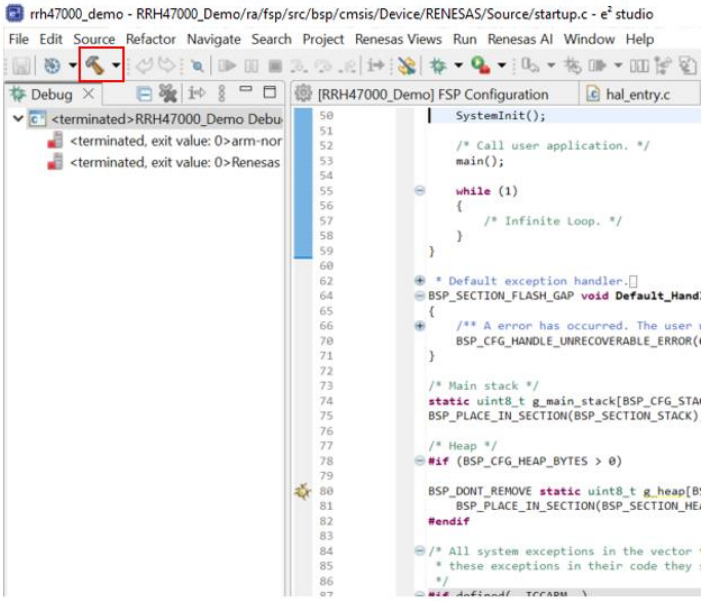


Figure 16. Project Build

3. Go to the menu bar and select **Run > Debug Configuration**.

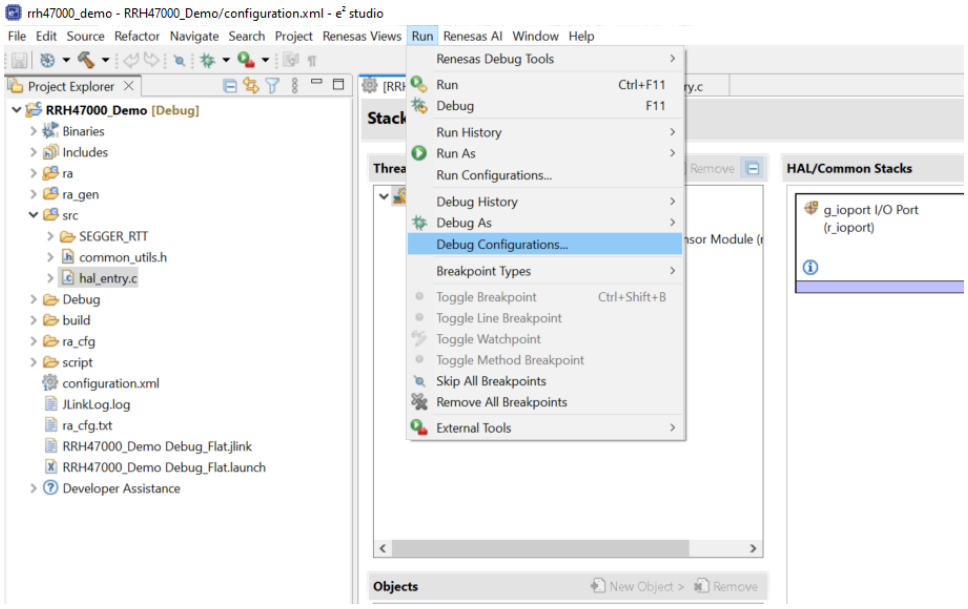


Figure 17. Debug Configuration

4. Select Renesas GDB Hardware Debugging > rrh47000_Demo Debug.
5. Click the **Debug** button.

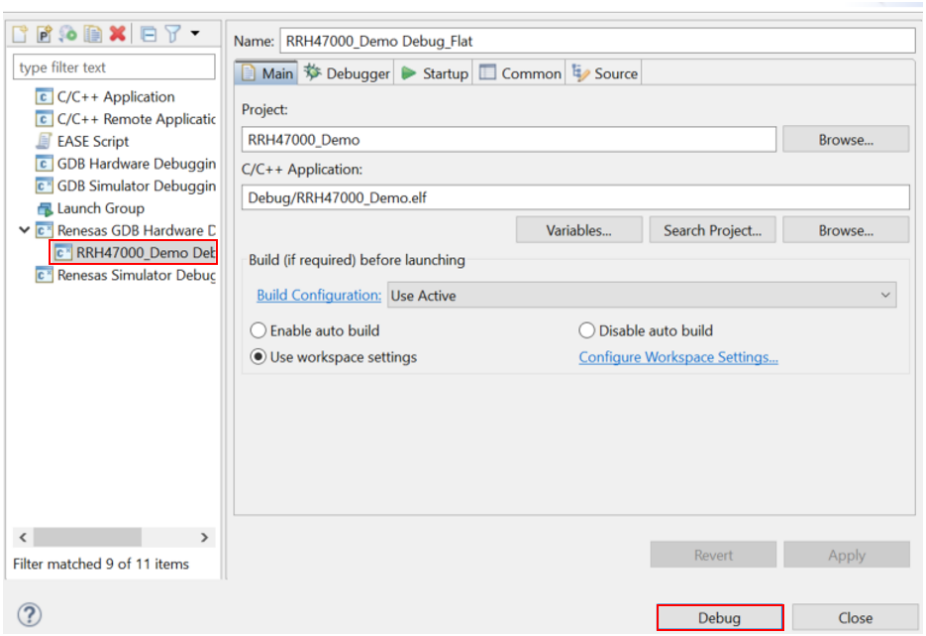


Figure 18. Start Debug Mode

6. Click the **Play** button to run the code.

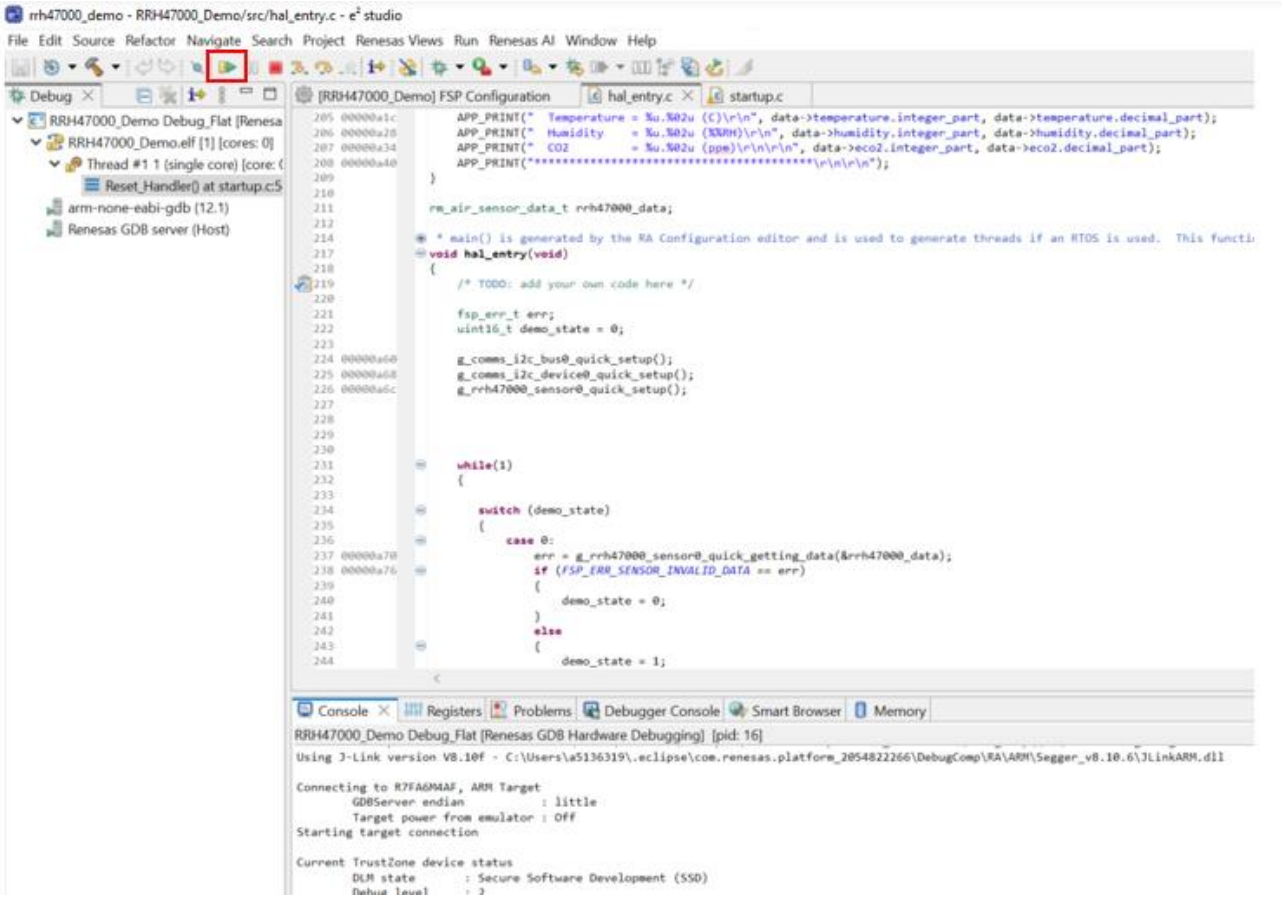


Figure 19. Running the Code

4.3 Using RTT Viewer

1. Open the J-Link RTT Viewer
2. Unplug the EKRA6M4 from your PC and then plug it back in.
3. Press **S3** on the EK-RA6M4.
4. Click **File > Connect**.

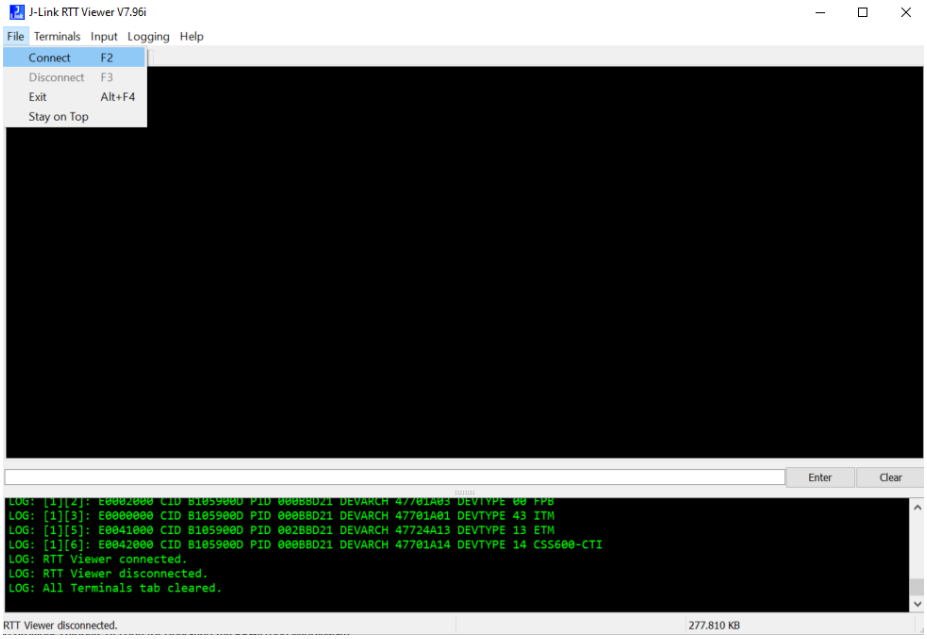


Figure 20. RRT Viewer

5. Ensure your configuration matches the configuration shown in Figure 21.

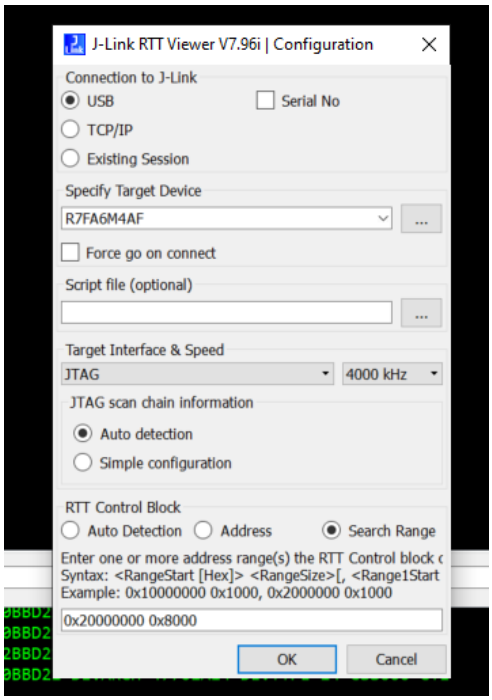


Figure 21. RTT Viewer Options

6. Click **OK**. You should see the following output in the “All Terminals” tab.

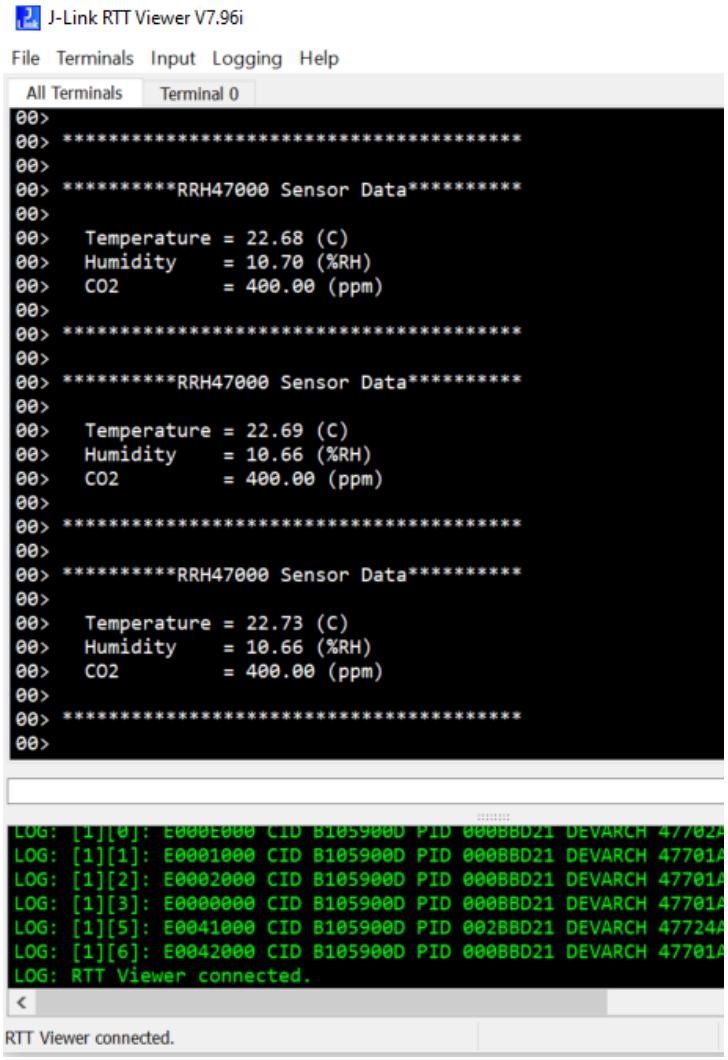


Figure 22. RRH47000 Output

5. Website and Support

Visit the following resources to learn about key elements of the RA family, download components, and related documentation, and get support:

RA Product Information	www.renesas.com/ra
RA Product Support Forum	https://community.renesas.com/mcu-mpu/ra/
RA Flexible Software Package	www.renesas.com/FSP
Renesas Support	www.renesas.com/support

6. Ordering Information

Part Number	Description
QCIOT-RRH47000POCZ	NDIR CO_2 Sensor

7. Revision History

Revision	Date	Description
1.00	Jan 29, 2025	Initial release.

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