QCIOT-RRH62000POCZ

All-In-One Air Quality Pmod™

Description

The RRH62000 evaluation board demonstrates the functionality and performance of the RRH62000 all-in-one air quality sensor. The RRH62000 series is used for measuring critical air quality parameters. The design of the RRH62000 evaluation board is generic so that the customer can embed the sensor into their specific application.

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 RRH62000 evaluation board can be added to the end of a daisy-chained solution with multiple Type 6/6A devices on the same MCU Pmod connector.

The Renesas e2 studio software included with the Renesas IDE (integrated development environment) allows for code generation to connect the device and the MCU, significantly reducing development time. With its standard connector and software support, the RRH62000 evaluation board is ideal for the Renesas Quick-Connect IoT to rapidly create an IoT system.

Features

- Simultaneous multi-sensor measurements of all relevant air quality parameters
- Sensor outputs feature:
  - Detection of particle sizes from 0.3µm to 10.0µm
  - Output mass concentration bins for PM1, PM2.5, and PM10
  - Temperature (T) and Relative Humidity (RH)
  - Measurement of Total Volatile Organic Compounds (TVOC) concentrations and indoor air quality (IAQ) index according to UBA[1]
  - Estimated carbon dioxide level (eCO_2)
- Operating temperature range from -10°C to 60°C
- Operating humidity range up to 90%RH
- 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

- RRH62000 Evaluation Board

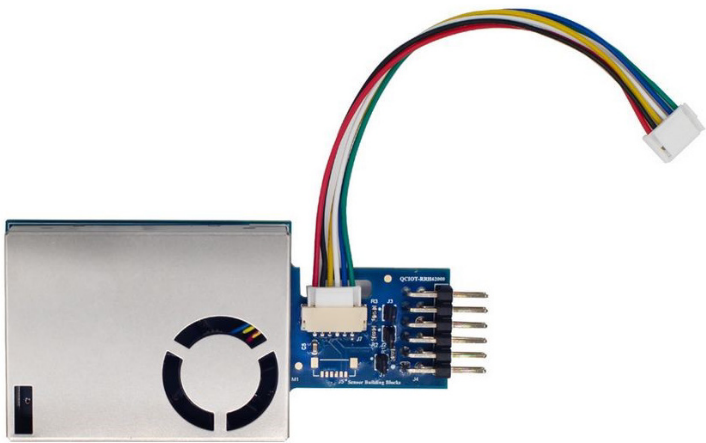

Figure 1. QCIOT-RRH62000POCZ All-In-One Air Quality Pmod

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1. Functional Description

The QCIOT-RRH62000POCZ Pmod is intended as a quick-connect prototyping solution for an air quality monitoring system. This board enables the quick creation air quality monitoring systems. The QCIOT-RRH62000POCZ Pmod can measure particle sizes from 0.3µm to 10.0µm, mass concentration bins from PM1, PM2.5, and PM10, temperature (T), relative humidity (RH), Total Volatile Organic Compounds (TVOC), indoor air quality (IAQ) index according to UBA, and estimated carbon dioxide level (eCO_2).

The building blocks of the QCIOT-RRH62000POCZ Pmod and their functionality are listed below:

- **ZMOD4410** – Gas sensor module providing indoor air quality (IAQ) designed for detecting total volatile organic compounds (TVOCs), estimating CO_2, and monitoring indoor air quality in different smell-based use cases, including very humid and dusty applications.
- **HS4003** – Highly accurate, ultra-low power, fully calibrated relative humidity and temperature sensor. Fully calibrated and temperature compensated with an I^2C digital output.

Figure 2 highlights the main parts of the system.

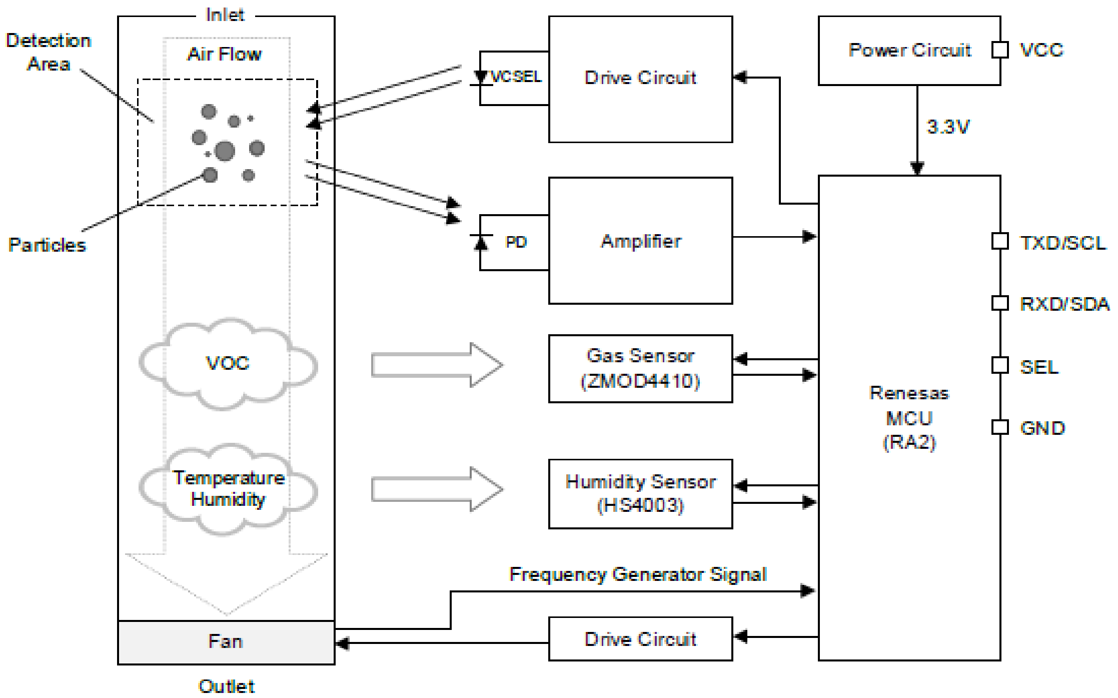


Figure 2. RRH62000 Functional Block Diagram

1.1 Operational Characteristics

Use the QCIOT-RRH62000POCZ Pmod as a starting point for air quality monitoring applications.

The board is designed to the following specifications:

- Temperature range: -40°C – 125°C
- Relative Humidity range: 0% – 100%
- TVOC: 160ppb – 10000ppb
- eCO_2: 400ppm – 5000ppm

1.2 Setup and Configuration

The setup and configuration for the RRH62000 Pmod 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 Interposer board (if needed)

The following is required or recommended software:

- Renesas Flexible Software Package (FSP) v5.4.0 platform installation:
  - e2 Studio 2023-01 or later
  - FSP 5.4.0 or later
  - GCC Arm Embedded 10.3.1 (10 2021.10)
- Sample code files are available on the RRH62000 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-RRH62000 Pmod is FSP 5.4.0.

1.2.2 Kit Hardware Connections

Follow these procedures to set up the kit and refer to 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 interposer board to allow compatibility with Type 6A.
   b. If no interposer is available, then PMOD1 can be rerouted from Type 2A to 6A. For more information, see the EK-RA6M4 User Manual.
2. Ensure that pin 12 of the Pmod is 3.3V, which is requested by the RRH62000 Pmod.
   c. For the EK-RA6M4, pin 12 of PMOD1 and PMOD2 are 3.3V by default. No change needed.
   d. 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 RRH62000 Pmod board.
4. Plug the RRH62000 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.

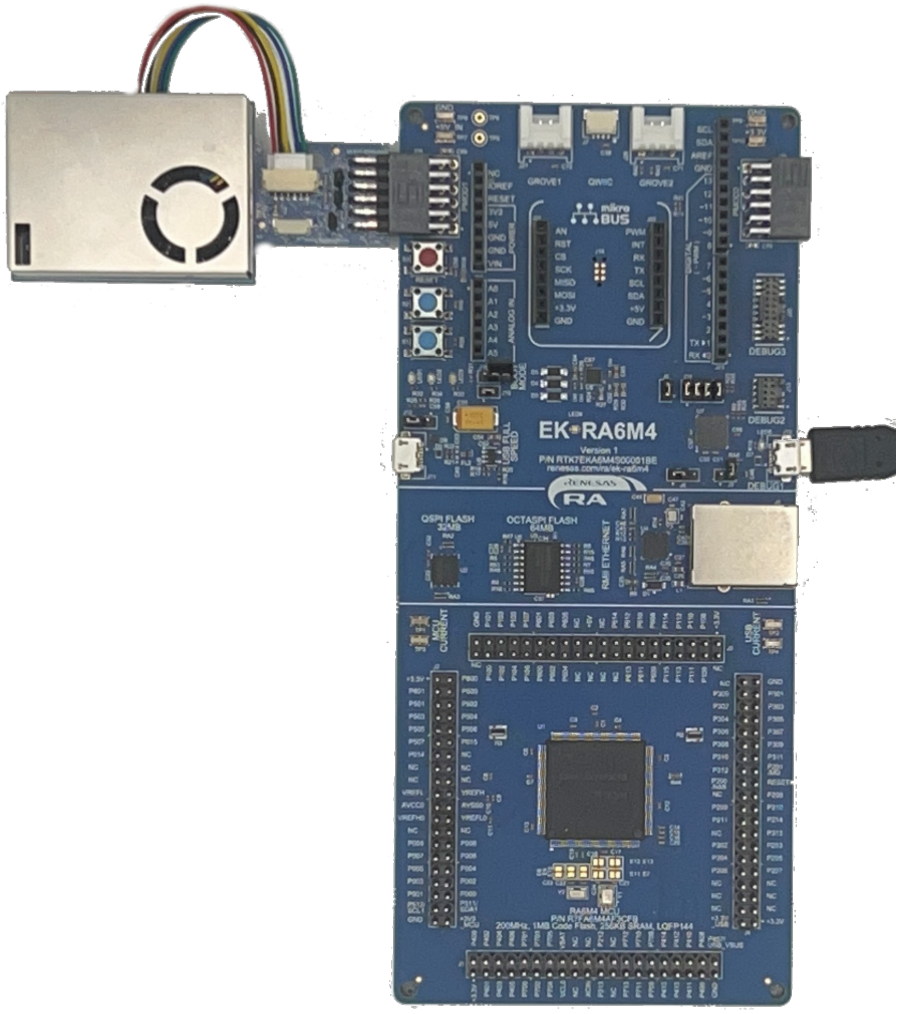


Figure 3. QCIOT-RRH62000 Pmod with EK-RA6M4 MCU Kit

2. Board Design

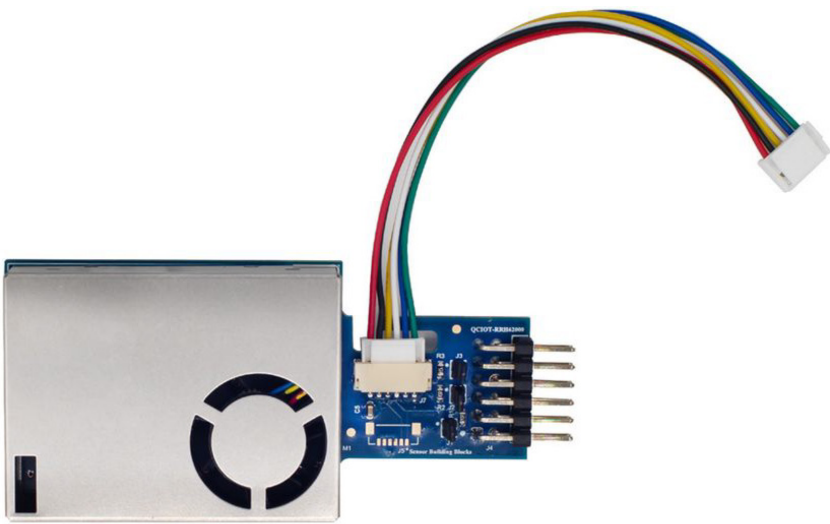


Figure 4. QCIOT-RRH62000 Pmod (Top)

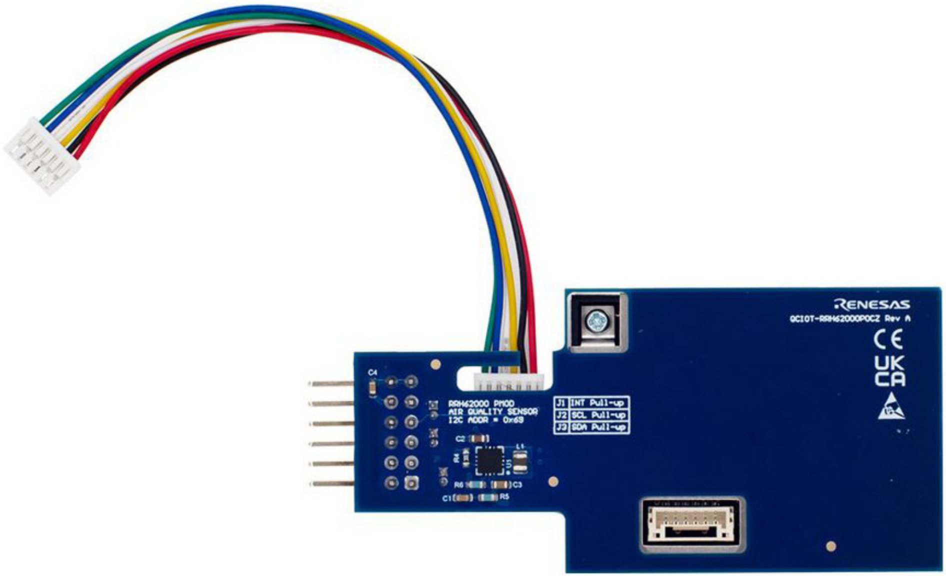
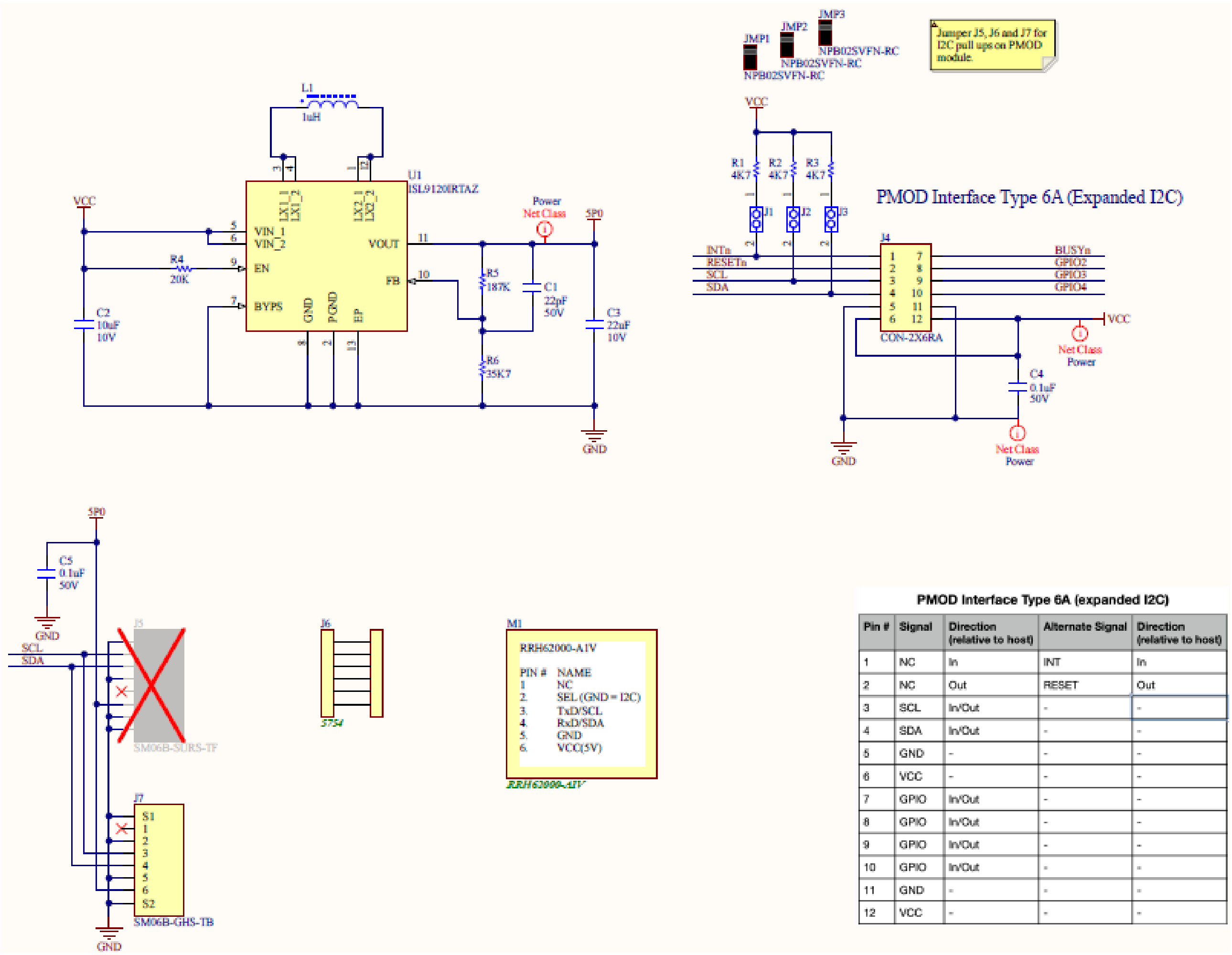


Figure 5. QCIOT-RRH62000 Pmod (Bottom)

2.1 Schematic Diagrams



PMOD Interface Type 6A (expanded I2C)

Pin #	Signal	Direction (relative to host)	Alternate Signal	Direction (relative to host)
1	NC	In	INT	In
2	NC	Out	RESET	Out
3	SCL	In/Out	-	-
4	SDA	In/Out	-	-
5	GND	-	-	-
6	VCC	-	-	-
7	GPIO	In/Out	-	-
8	GPIO	In/Out	-	-
9	GPIO	In/Out	-	-
10	GPIO	In/Out	-	-
11	GND	-	-	-
12	VCC	-	-	-

Figure 6. QCIOT-RRH62000 Pmod Schematic Diagrams

2.2 Bill of Materials (BOM)

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part Number
1	C1	Capacitor, 22pF, 50V, COG/NPO, SM	Yageo	CC0603JRNPO9BN220
1	C2	Capacitor, 10µF, 10V, SM	Murata	GRM188R61A106KE69D
1	C3	Capacitor, 22µF, 10V, SM	Murata	GRM188R61A226ME15D
2	C4, C5	Capacitor, 0.1µF, 50V, SM	Yageo	CC0603KRX7R9BB104
1	FOOT1	Foot, Rubber, Self-adhesive, Black, 6.4mm diameter, 2.1mm tall	Bumper Specialties	BS25BL07X30RP
3	J1, J2, J3	Jumper, 1×2, 0.05" Pitch	Sullins	GRPB021VWVN-RC
1	J4	Connector, 2×6, 0.1", PMOD, Header, Right Angle, Unshrouded	Harwin	M20-9950645
1	J6	Cable, 1×6W, 4", 1.25mm Pitch, 28ΩAWG, 1A, Sockets, GH Series	Adafruit	5754
1	J7	Connector, 1×6 Pin, 1.25mm, GH Series, Right Angle, SM	JST	SM06B-GHS-TB
3	JMP1, JMP2, JMP3	2 C, Closed Top, .050" CC; No Mounting, 105 C, Nylon 66; Phos Bronze, Gold Flash	Sullins	NPB02SVFN-RC
1	L1	Inductor, 1µH, 3.1A, 60mOhm, SM	TDK	TFM201610GHM-1R0MTAA
1	M1	Sensor, Air Quality Sensor, RoHS, SM	Renesas	RRH62000-A1V
3	R1, R2, R3	Resistor, 4.7kΩ, 1/8W, 1%, SM	KOA Speer	RK73H1JTTD4701F
1	R4	Resistor, 20kΩ, 1/8W, 1%, SM	KOA Speer	RK73H1JTTD2002F
1	R5	Resistor, 187kΩ, 1/8W, 1%, SM	KOA Speer	RK73H1JTTD1873F
1	R6	Resistor,35.7kΩ, 1/8W, 1%, SM	KOA Speer	RK73H1JTTD3572F
1	U1	Regulator, Buck-Boost, SM	Renesas	ISL9120IRTAZ

2.3 Board Layout

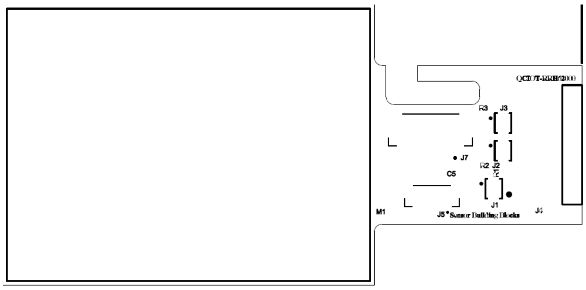


Figure 7. Top Overlay

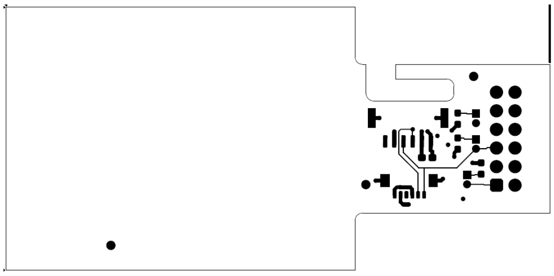


Figure 8. Top Layer

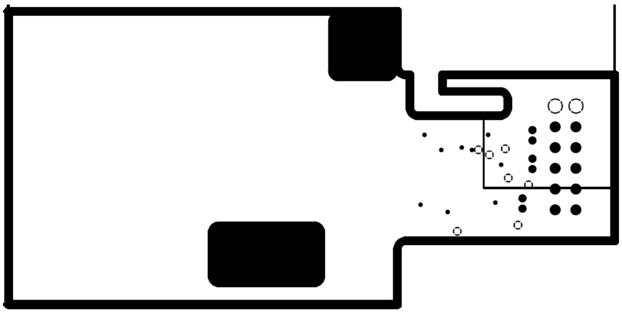


Figure 9. Int 1 (PWR)

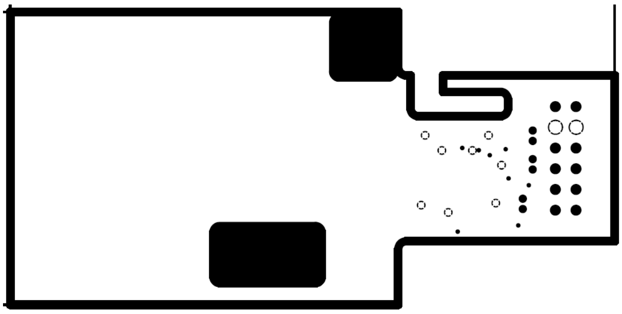


Figure 10. Int 2 (GND)

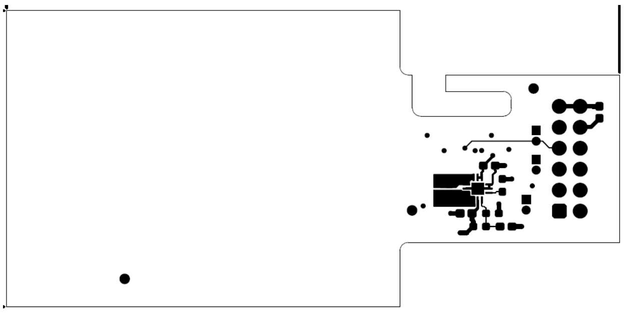


Figure 11. Bottom Layer

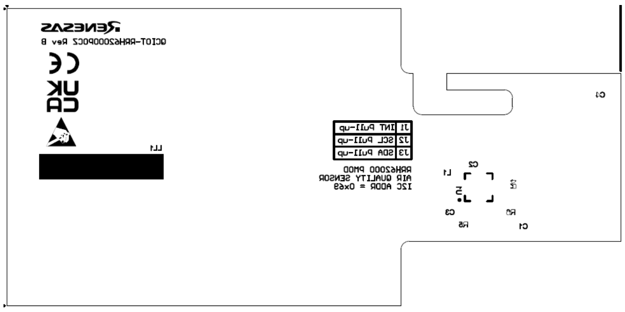


Figure 12. Bottom Overlay

3. Software Design

The following sections give an overview of the software implementation for the QCIOT-RRH62000 Pmod based on the Renesas RA Family's Flexible Software Package (FSP), and detail the project's code structure, the system's software modules, and the main system flow.

3.1 Project Code Structure

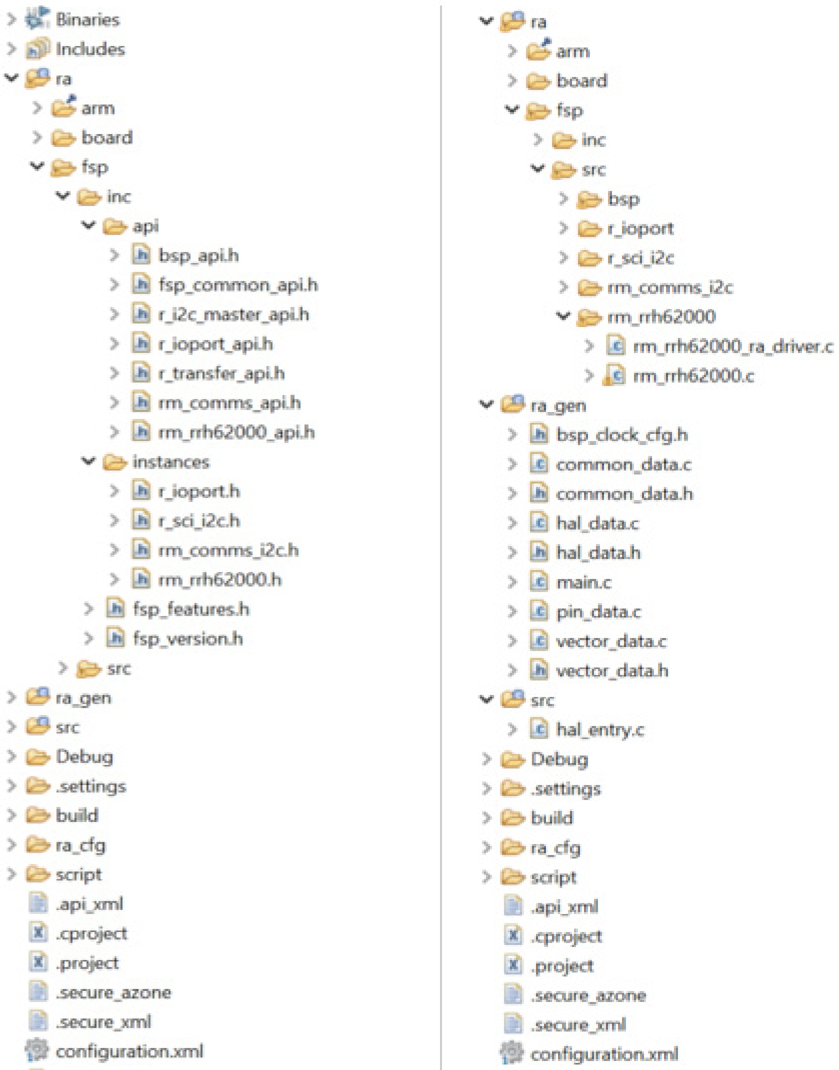
The All-In-One Air Quality Demo Project is designed to be a highly modular solution that can be easily configured independently of other modules (if required) or ported to other end-applications.

The project is split into two main parts:

- **RRH62000 driver** – Device driver code for air quality sensor 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.

Figure 13 shows the structure of the project in e2 studio.



Project Structure Definitions

ra – Automatically generated files for FSP drivers, RRH62000 driver source code, and header file.

- **rm_rrh62000.h** – RRH62000 driver header file
- **rm_rrh62000.c** – RRH62000 driver source file
- **rm_rrh62000_api.h** – RRH62000 API header file
- **rm_rrh62000_ra_driver.c** – Software delay function

ra_gen – Generated files by FSP configuration.

src – Application code that uses rrh62000 driver.

- **hal_entry.c** – Start of code execution which calls system main.

Figure 13. RRH62000 Project Structure

Click **configuration.xml** in the project and select the *Stacks* tab. This opens the Stacks Configuration – Hal/Common interface window as shown in Figure 14.

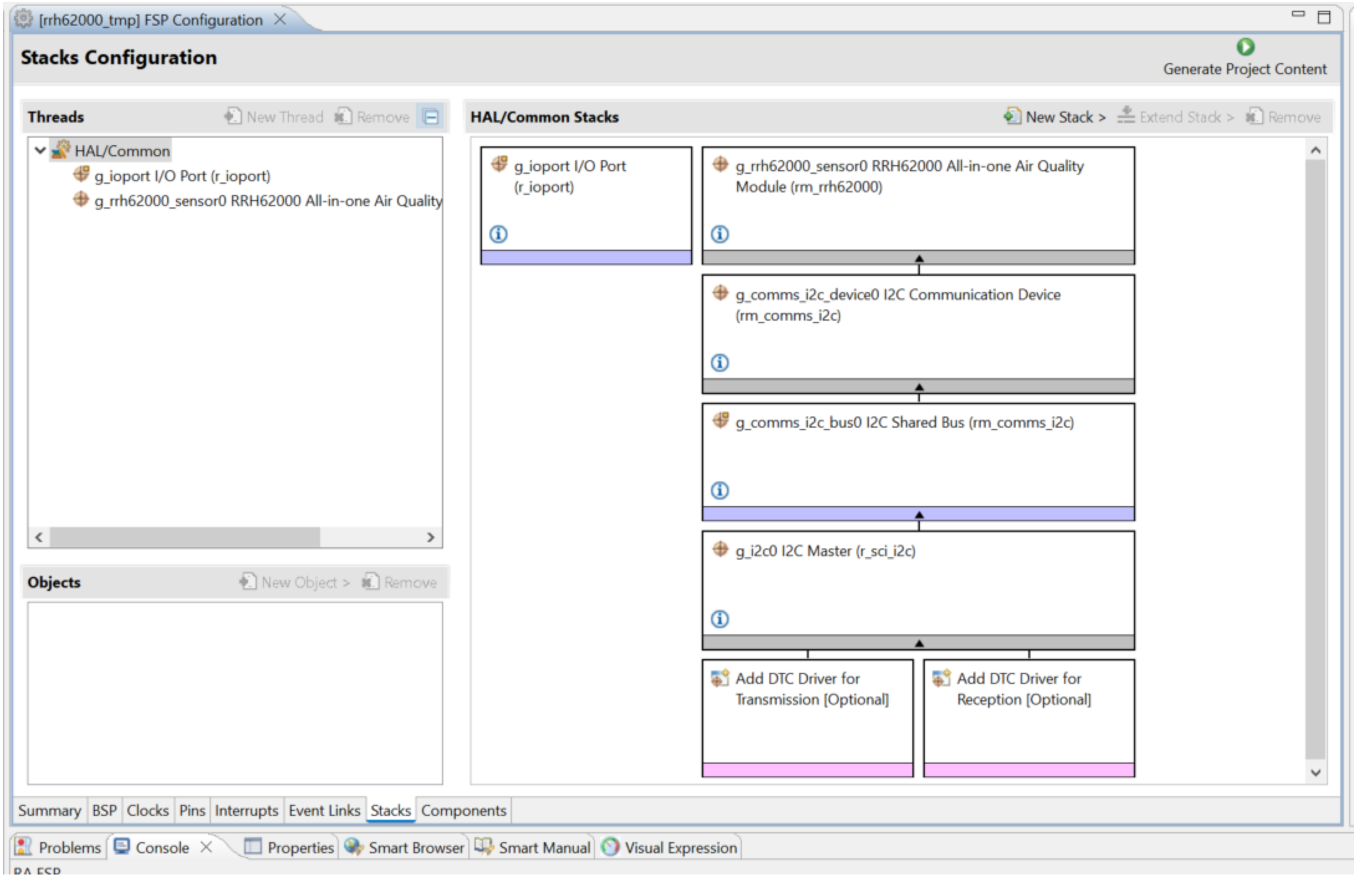


Figure 14. Stack Configuration – Hal/Common Interface Window

Figure 15 shows the general code structure of its dependencies. Execution begins in the main function (**main.c**) initiating the application flow. The RRH62000 driver module is called in **hal_entry**. All associated header files reference the lower-level Flexible Software Package (FSP) drivers.

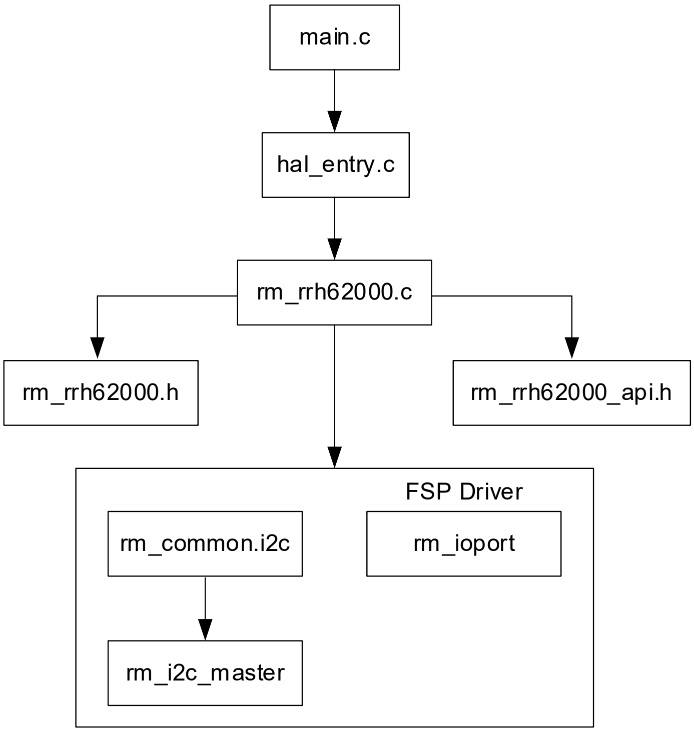


Figure 15. Code Dependency Flowchart

3.2 Software Module Overview

The RRH62000 demo project shows the basic use of FSP API calls to setup and read sensor data from the RRH62000.

3.2.1 Hal_entry

This module is responsible for initializing the FSP I^2C driver and setting up the RRH62000 device with the user-configured settings.

After setup, the module provides the following features:

- Performs device setup commands
- Reads sensor values

3.2.2 Algorithm Flowchart

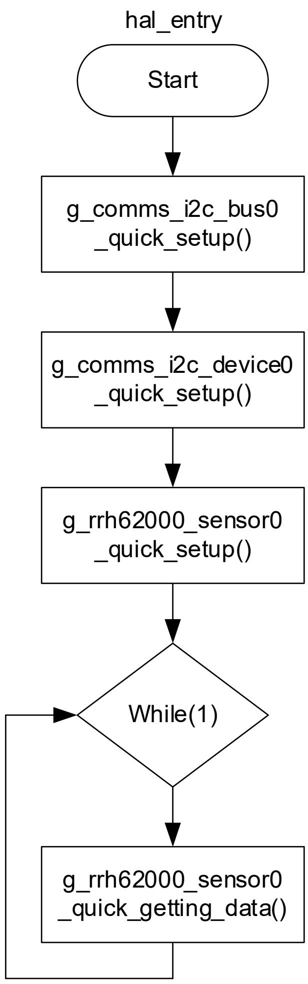


Figure 16. Algorithm Flowchart

The I^2C bus is opened by **g_comms_i2c_bus0_quick_setup()**. Then, the RRH62000 instance is opened by **g_rrh62000_sensor0_quick_getting_data()**.

The main program loops continuously to get the air quality readings by **g_rrh62000_sensor0_quick_getting_data()** function calls. The sensor readings can be seen in the Virtual Expression window.

The functions outlined in Figure 16 are described as follows:

hal_entry ()

- Call **g_comms_i2c_bus0_quick_setup()**
  - Open I^2C driver. This must be performed before calling device setup.
- Call **g_comms_i2c_device0_quick_setup()**
  - Open I^2C Communications device instance. This must be performed before calling any COMMS_I2C_API.
- Call **g_rrh62000_sensor0_quick_setup()**
  - Open RRH62000 instance. This must be performed before calling any RRH62000 API.
- Continuously call **g_rrh62000_sensor0_quick_getting_data()**
  - Sends the read data command to the RRH62000
  - Waits for measurement to be finished
  - Converts raw sensor measurement data to calculated data

3.3 Board Test

3.3.1 Setting Up the Boards and Cable

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

3.3.2 Programming the Development Board and Run Example Code in Debug Mode

1. Open the sample project in e2 studio.
2. Go to the menu bar and select **Run > Debug Configurations** (see Figure 17). This opens the **Debug Configurations** window (see Figure 18).

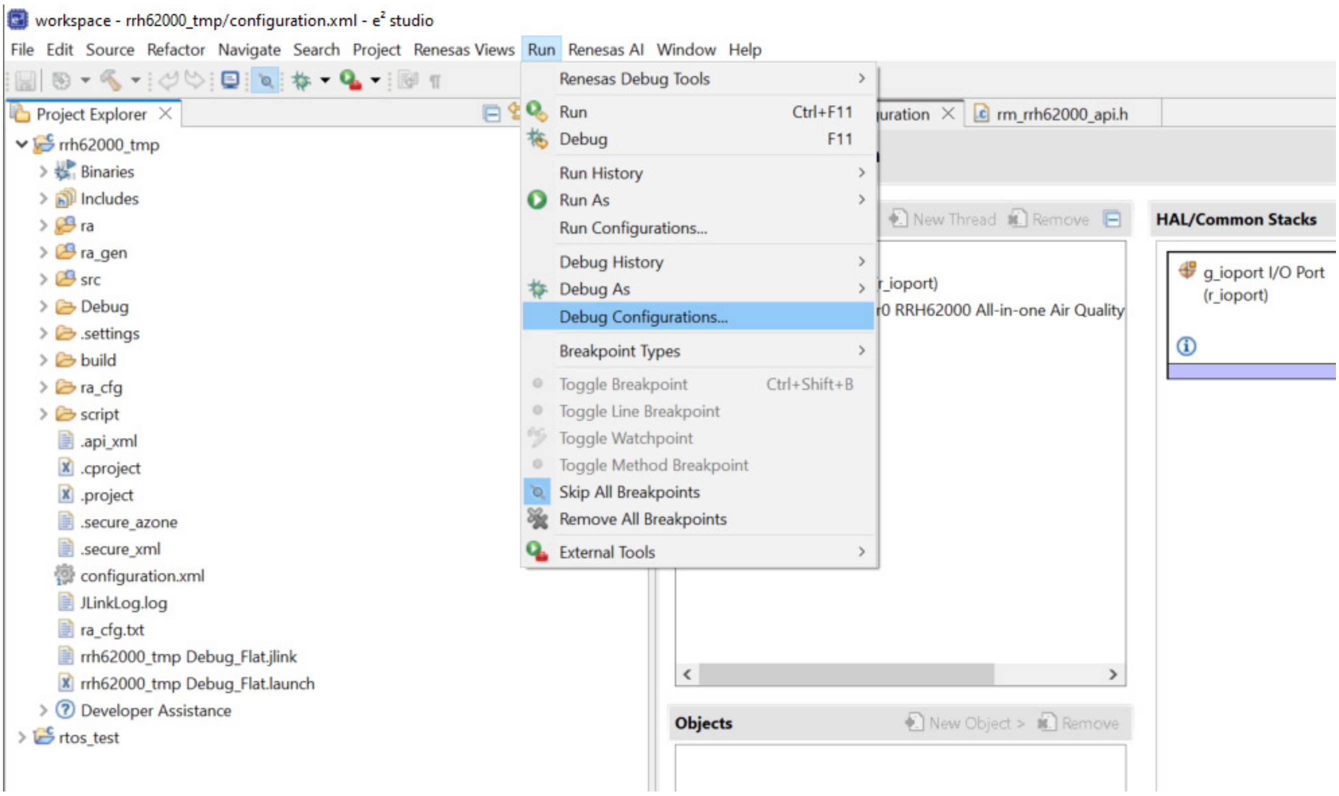


Figure 17. Debug Configuration Selection

3. Select **Renesas GDB Hardware Debugging > rrh62000_tmp_Debug**.
4. Click the *Debug* button. The code enters debug mode.

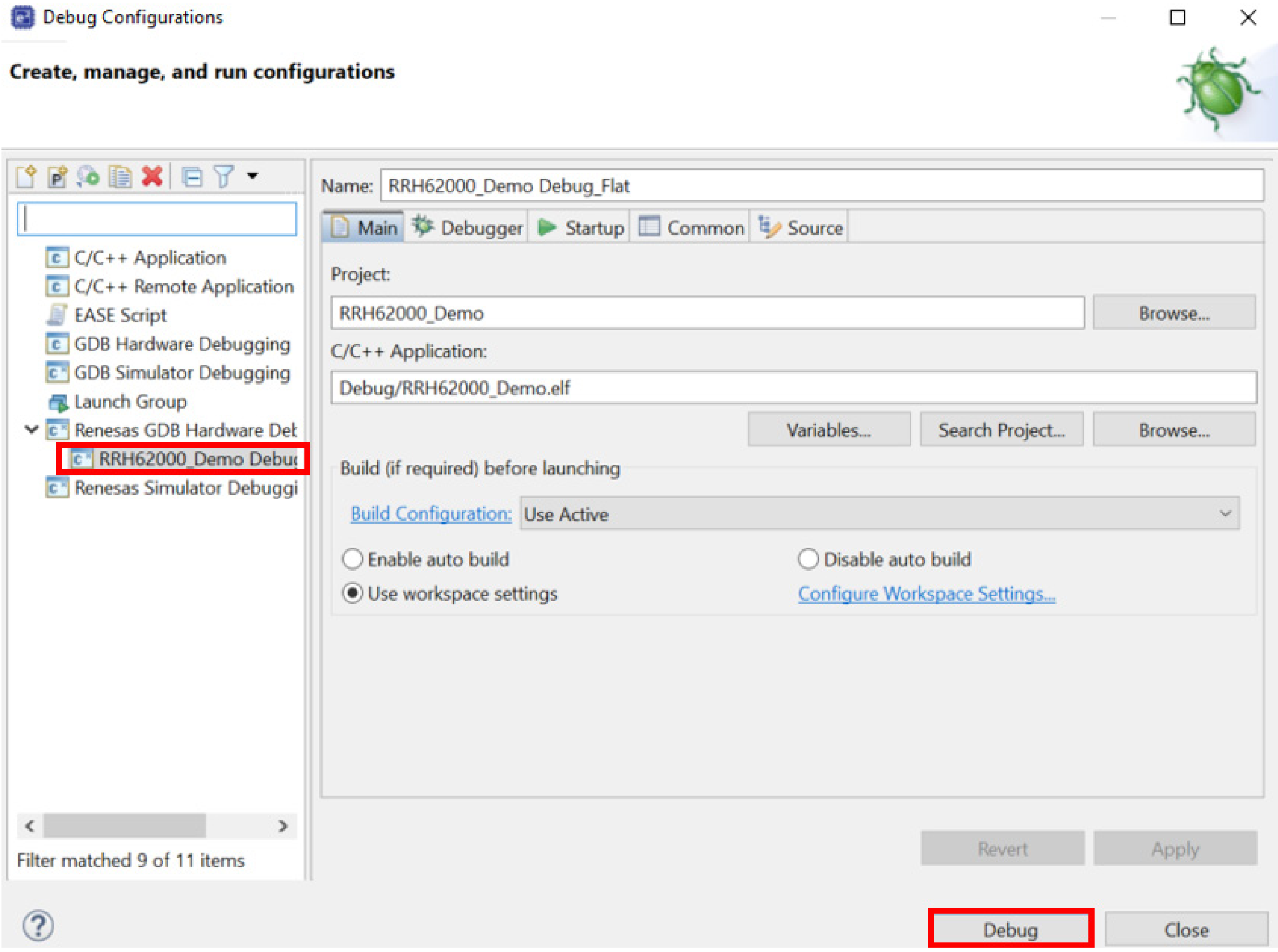


Figure 18. Debug Configurations – Start Debug Mode

5. From the Menu bar, select **Renesas Views > Debug > Visual Expression** (see Figure 19).

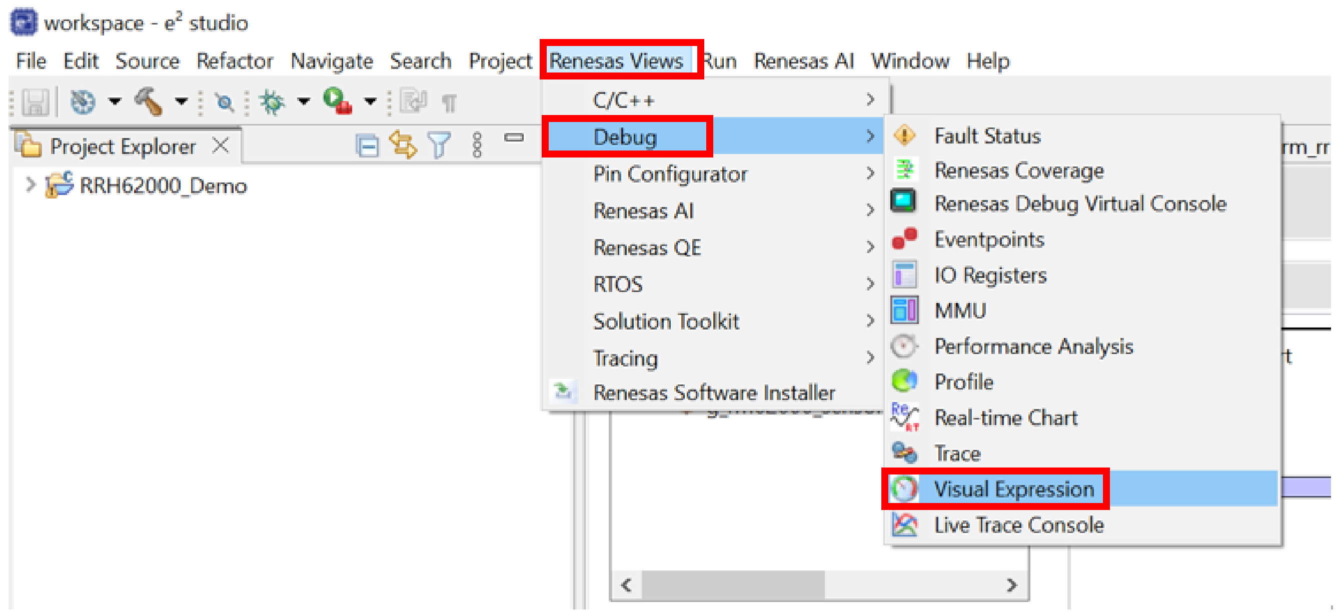


Figure 19. Open Visual Expression

In the bottom panel, the **Visual Expression** window appears (see Figure 20).

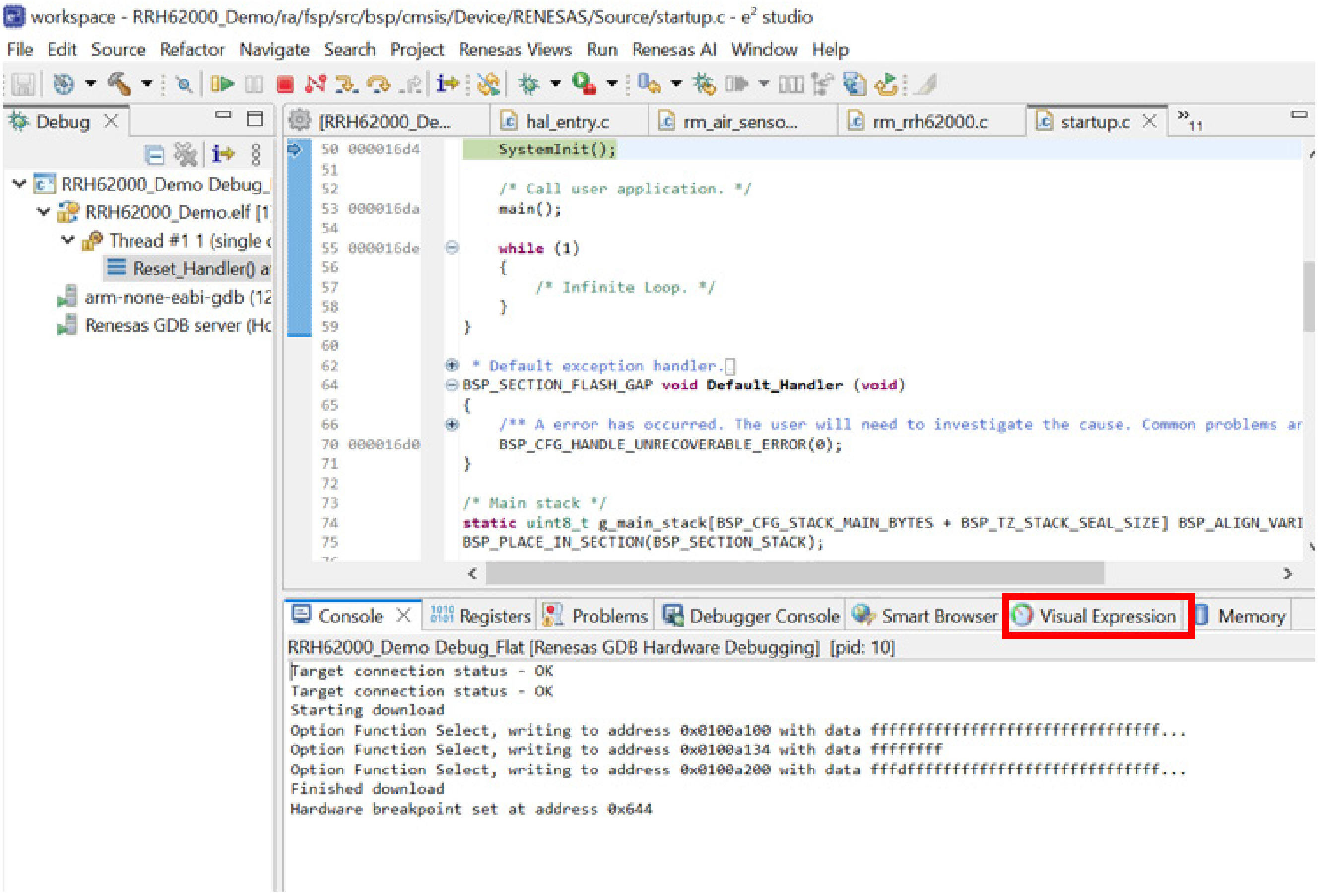


Figure 20. Visual Expression Window

6. Add gauges to see sensor data from the RRH62000 by dragging the **GAUGE** icon into the Visual Expression window (see Figure 21).

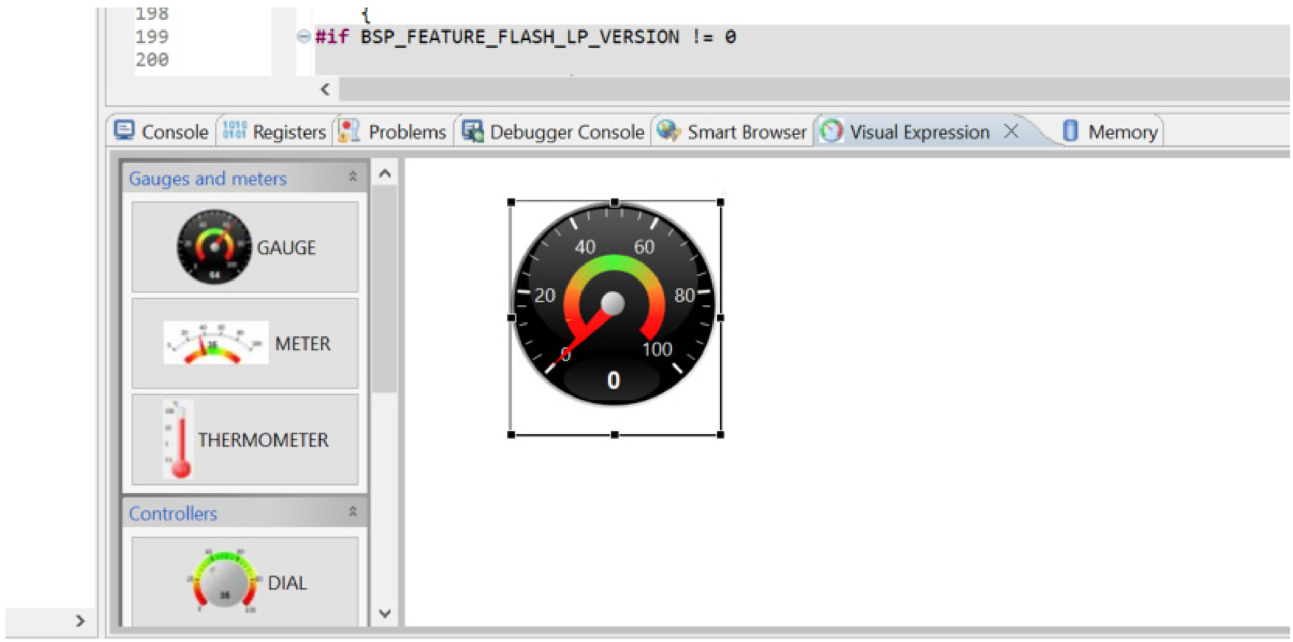


Figure 21. Gauge Setup

7. Right-click on the GAUGE and select **Set expression** (see Figure 22). This opens the **Set expression/Expression name** window (see Figure 23).

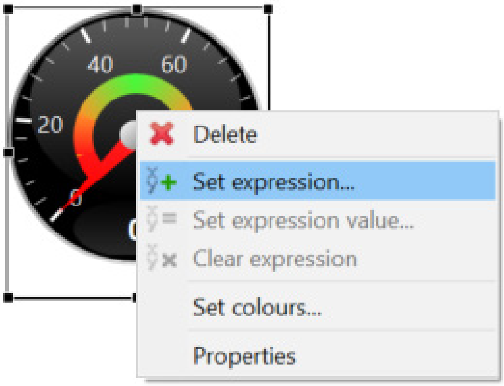


Figure 22. Set Gauge Expression

8. Enter **complete_data->temperature** in the dialog box for the expression name. Click *OK*.

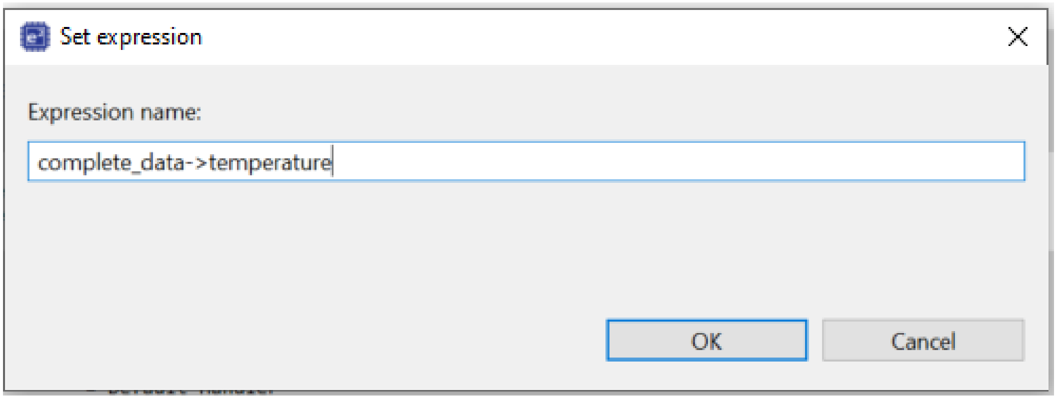


Figure 23. Set Expression Name

9. Right-click on the GAUGE and select **Properties** (see Figure 24).

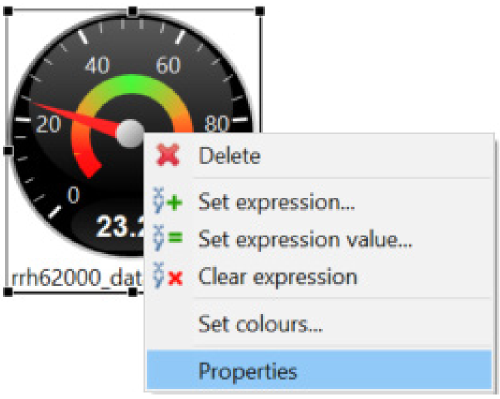


Figure 24. Gauge Properties

10. In the Properties window, enter **-40** for the temperature **Minimum range** and **125** for the temperature **Maximum range** (see Figure 25).

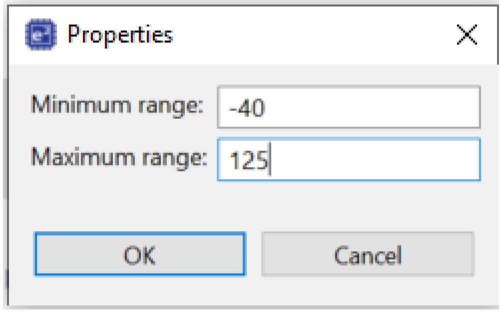


Figure 25. Gauge Minimum and Maximum Temperature

Add a **GAUGE** for each sensor value you wish to see. A list of available sensor values is shown in Figure 26.

```
typedef struct st_rm_air_sensor_conc_data
{
    float_t nc_0p3;        ///< Number concer
    float_t nc_0p5;        ///< Number concer
    float_t nc_1;          ///< Number concer
    float_t nc_2p5;        ///< Number concer
    float_t nc_4;          ///< Number concer
    float_t pm1_1;         ///< Mass concentr
    float_t pm2p5_1;       ///< Mass concentr
    float_t pm10_1;        ///< Mass concentr
    float_t pm1_2;         ///< Mass concentr
    float_t pm2p5_2;       ///< Mass concentr
    float_t pm10_2;        ///< Mass concentr
    float_t temperature;   ///< Temperature [
    float_t humidity;      ///< Humidity [%RH
    float_t tvoc;          ///< Total volatil
    float_t eco2;          ///< Estimated car
    float_t iaq;           ///< Indoor Air Qu
    float_t rel_iaq;       ///< Relative IAQ
} rm_air_sensor_conc_data_t;
```

Figure 26. Available Sensor Values

4. Ordering Information

Part Number	Description
QCIOT-RRH62000POCZ	All-In-One Air Quality Pmod Board

5. Revision History

Revision	Date	Description
1.00	Dec 3, 2024	Initial release.

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