US082-ZSSC3230EVZ

The US082-ZSSC3230EVZ Pmod board demonstrates the functionality and performance of the ZSSC3230. The ZSSC3230 is a CMOS integrated circuit for accurate capacitance-to-digital conversion and sensor-specific correction of capacitive sensor signals.

ZSSC3230 is configurable for capacitive sensors with capacitances up to 30pF and provides an output resolution that is scalable up to 18-bit. It is compatible with single-ended capacitive sensors. Measured and corrected sensor values can be output as I^2C.

Features

- Capacitive input range 0pF to 30pF
- Capacitive offset compensation 0pF to 15pF
- Internal auto-compensated temperature sensor, not stress sensitive
- High sampling rate with 2ms at 14-bit resolution
- Standardized type 6A Pmod connector supports
- I^2C/SMBUS extended interface
- Dual connectors allow pass-through signals for daisy-chained solution
- Software support in e^2 studio minimizes development time with one-click code generation

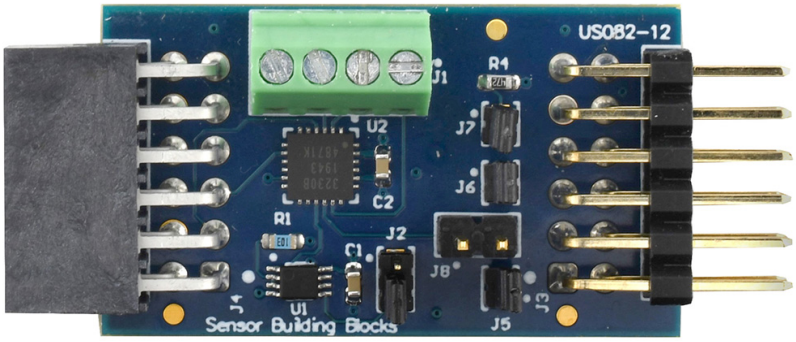


Figure 1. US082-ZSSC3230EVZ Board Image

Contents

1. Functional Description

The US082-ZSSC3230 Pmod Board is intended as a quick-connect prototyping solution for the ZSSC3230.

Figure 2 highlights the main parts of the system:

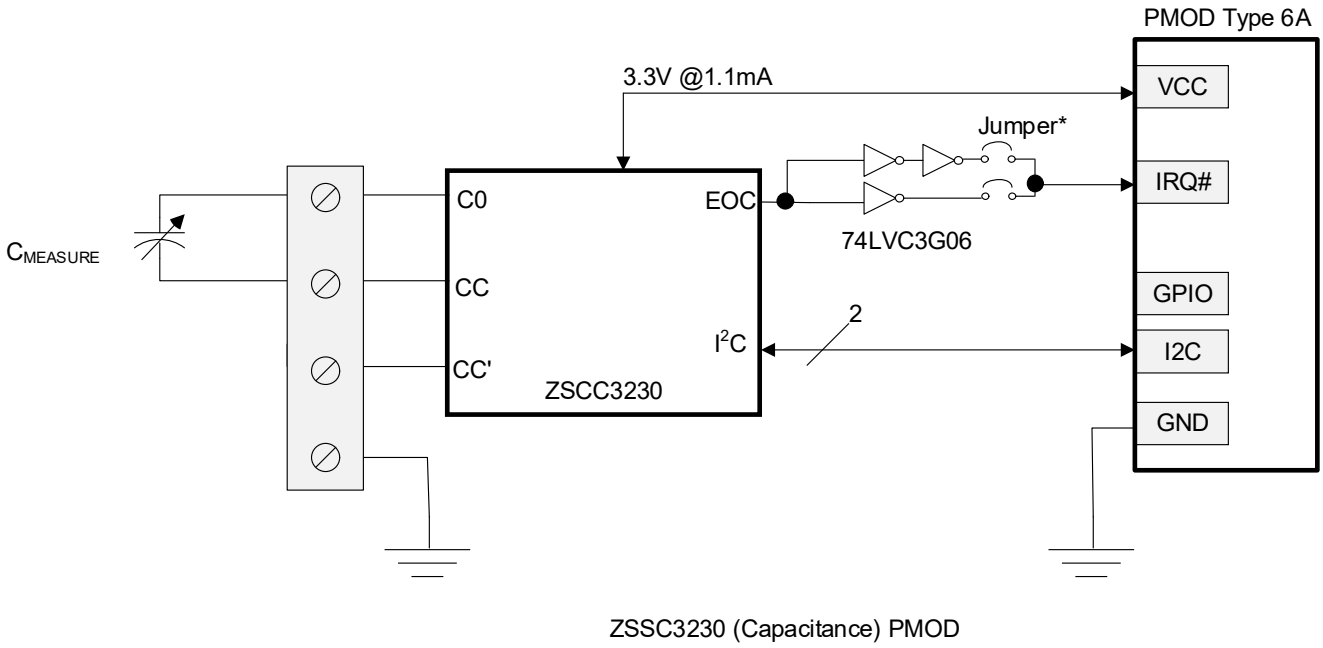


Figure 2. US082-ZSSC3230EVZ Pmod Board Block Diagram

1.1 Setup and Configuration

Required or recommended user equipment:

- Renesas Evaluation Board: EK-RA2E1
- USB micro-B cable (provided with EK board)
- PC running Windows 10/11 with at least two USB ports.
- US082-INTERPEVZ board
- Capacitive sensor or 1pF to 30pF through hole capacitor for quick evaluation

Required or recommended software:

- Renesas Flexible Software Package v4.5.0 platform installation
  - Renesas e^2 studio 2023-01 or later
  - FSP 4.5.0 or later
  - GCC Arm Embedded 10.3.1 (10 2021.10) or later
- Sample code files (available on the ZSSC3230 page)

The US082-ZSSC3230EVZ Pmod Board should be calibrated before running this demonstration. The calibration software and documentation are available on the ZSSC3230 page.

1.1.1 Software Installation

Visit the Renesas website for the latest version of the e^2 studio installer.

1.1.2 Kit Hardware Connections

Follow these procedures to set up the kit (see Figure 3).

1. Ensure that the MCU development kit supports a Type 6A Pmod connector.
   a. For EK-RA2E1, PMOD1 connector is available.
2. On the US082-ZSSC3230 board, populate J5, J6, and J7 with jumpers and leave J8 open. Place jumper on Pin 2-3 of J2.
3. Plug in the US082-INTERPEVZ board to the PMOD1 connector of EK-RA2E1. Be careful to align Pin 1 on the Pmod board and MCU kit.
4. Plug in the US082-ZSSC3230EVZ Board to the US082-INTERPEVZ board.
5. Connect the capacitive sensor or 1pF to 30pf through hole capacitor to connector Pin 1 and Pin 2 of J1 on the US082-ZSSC3230EVZ board.
6. Connect the EK board with the computer using a USB micro-B cable. The device is now ready to be used in the system.

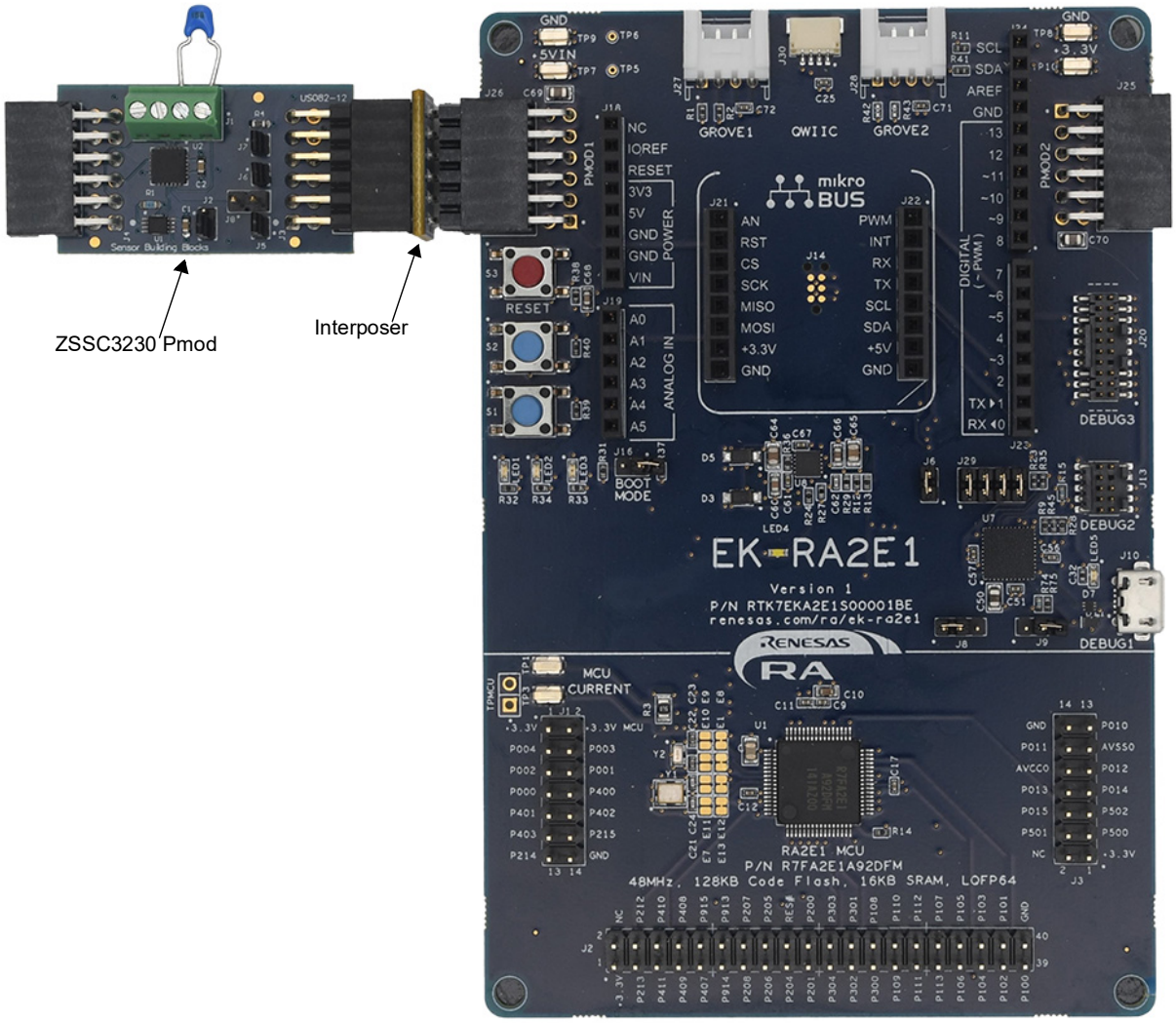


Figure 3. US082-ZSSC3230EVZ Pmod Board with the EK-RA2E1 MCU Kit

2. Board Design

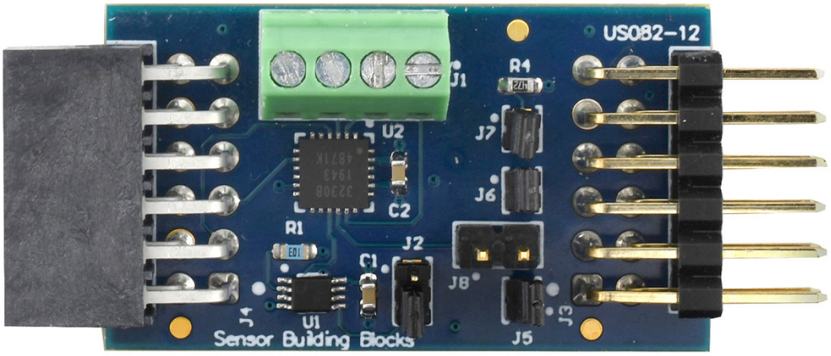
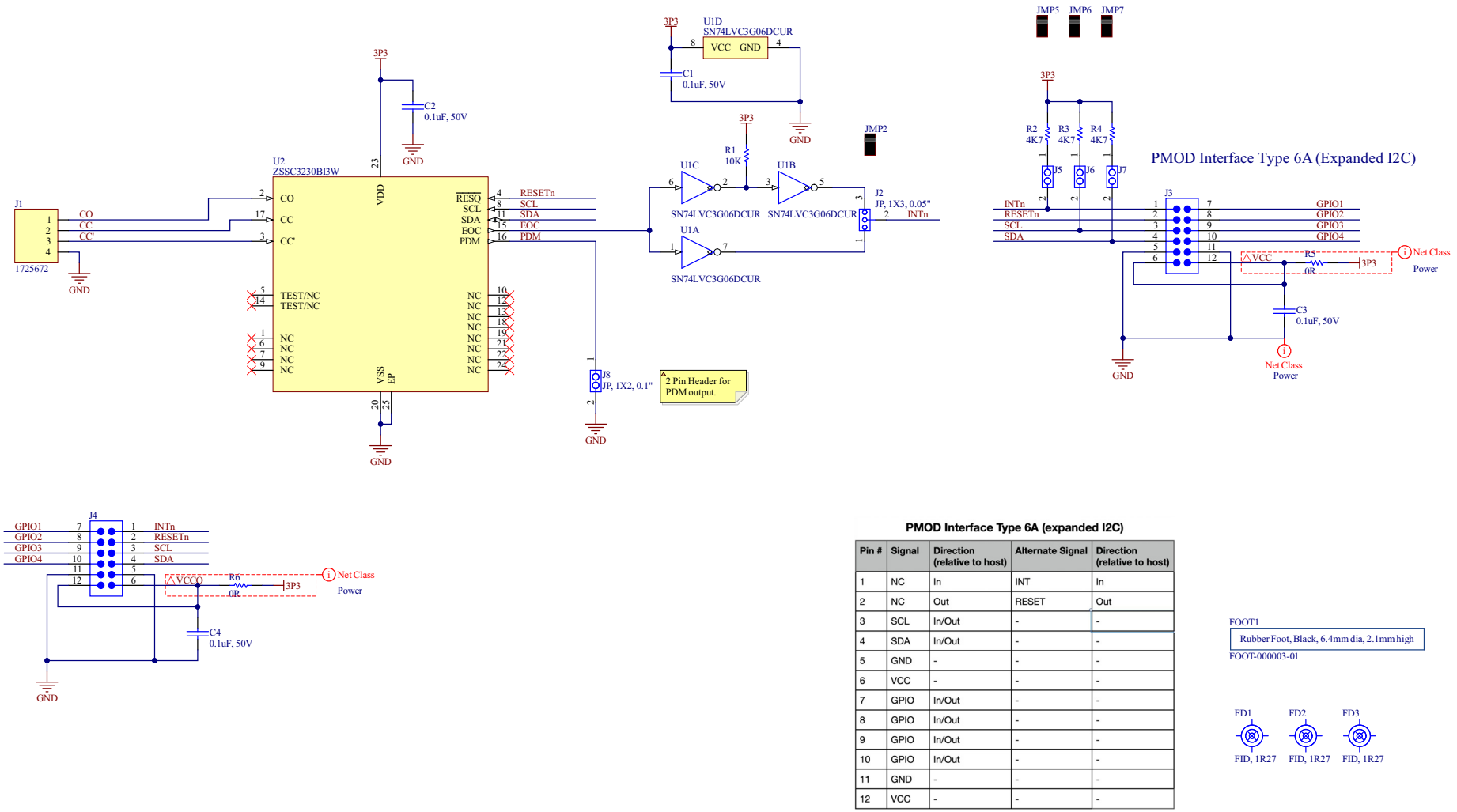


Figure 4. US082-ZSSC3230EVZ Pmod Board (Top)

Figure 5. US082-ZSSC3230EVZ Pmod Board (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. Schematic

2.2 Bill of Materials

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part Number
4	C1, C2, C3, C4	Capacitor, 0.1µF, 50V, SM	Wurth Electronics	885012206095
1	FOOT1	Foot, Rubber, Self-adhesive, Black, 6.4mm dia, 2.1mm tall	Bumper Specialties	BS25BL07X30RP
1	J1	Connector, 1×4, 2.54mm, RA, Terminal Block, TH	Wurth Electronics	691210910004
1	J2	Jumper, 1×3, 0.05" Pitch	Sullins	GRPB031VWVN-RC
1	J3	Male Header 0.1" pitch PMOD 2×6 Right Angle, through hole	Wurth Electronics	61301221021
1	J4	Samtec Female socket 0.1" pitch PMOD 2×6 Right Angle, through hole	Wurth Electronics	613012243121
3	J5, J6, J7	Jumper, 1×2, 0.05" Pitch	Sullins	GRPB021VWVN-RC
1	J8	Jumper, 1×2, 0.1" Pitch	Sullins	PBC02SAAN
4	JMP2, JMP5, JMP6, JMP7	2 C, Closed Top, 050" CC; No Mounting, 105°C, Nylon 66; Phos Bronze, Gold Flash	Sullins	NPB02SVFN-RC
1	R1	Resistor, 10kΩ, 1/8W, 1%, SM	KOA Speer	RK73H1JTTD1002F
3	R2, R3, R4	Resistor, 4.7kΩ, 1/8W, 1%, SM	KOA Speer	RK73H1JTTD4701F
2	R5, R6	Resistor, 0Ω, 1/8W, 1%, SM	KOA Speer	RK73Z1JTTD
1	U1	IC, Digital, Buffer, Triple, Inverting, Open Drain, SM	Texas Instruments	SN74LVC3G06DCUR
1	U2	Sensor Signal Conditioner, Capacitive Sensor, SM	Renesas	ZSSC3230BI3W

2.3 Board Layout

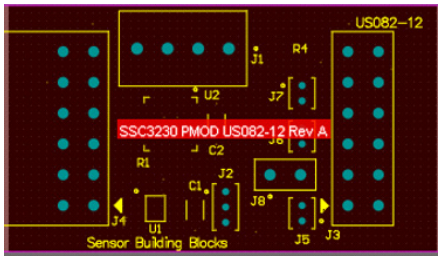


Figure 7. Top Overlay

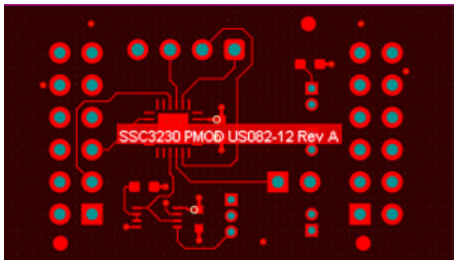


Figure 8. Top Layer

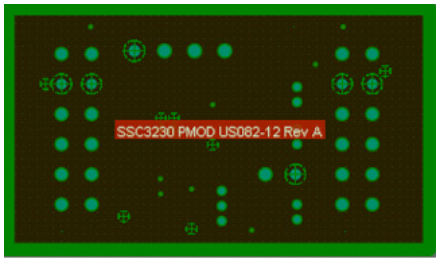


Figure 9. Layer 2 (GND)

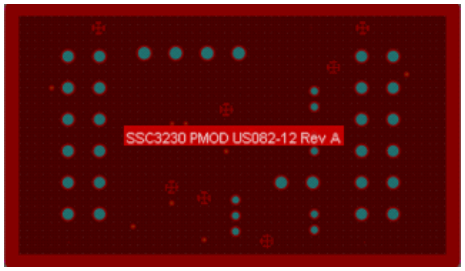


Figure 10. Layer 3 (Signal)

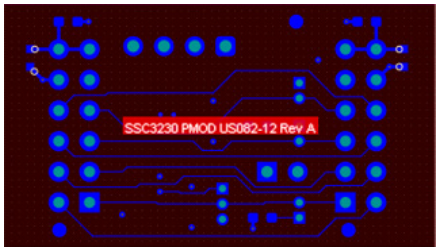


Figure 11. Bottom Layer

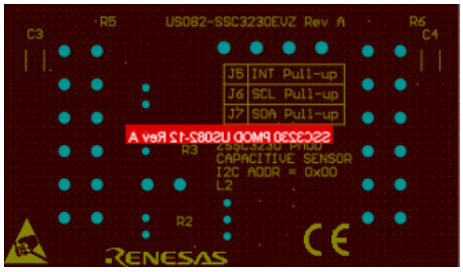


Figure 12. Bottom Overlay

3. Software Design

This section gives an overview of the software implementation for the US082-ZSSC3230EVZ Pmod Board, based on the Renesas RA Family's Flexible Software Package (FSP), and it details the project code structure, the system software modules, and the main system flow.

The demo sets the ZSSC3230 to command mode on start-up and uses the commands, RM_SSC3230_MeasurementStartComplete and RM_SSC3230_Read, to periodically take temperature and capacitance measurements every 250ms. The capacitance is converted to a percentage, and the temperature is converted to degrees Fahrenheit. The results from each measurement are stored in output array cap_temp_vals.

The ZSSC3230 supports single and differential ended mode measurement using the four pins on connector J1. Refer to sections Differential Mode and Single-Ended Mode in the *ZSSC3230 Datasheet* to configure the required connection of the capacitive sensor. ZSSC3230 API details the specification of the ZSSC3230 middleware.

For this demo, the ZSSC3230 is set to operate using pins CC and CC' for capacitance measurements. See the *ZSSC3230 Datasheet* (section Capacitive Sensor Front-End) for more information.

3.1 Project Code Structure

The Quick Connect project is a highly modular solution that can be easily configured independently of other modules (if required) or ported to other end-applications.

Figure 13 shows the structure of the project in e^2 studio.

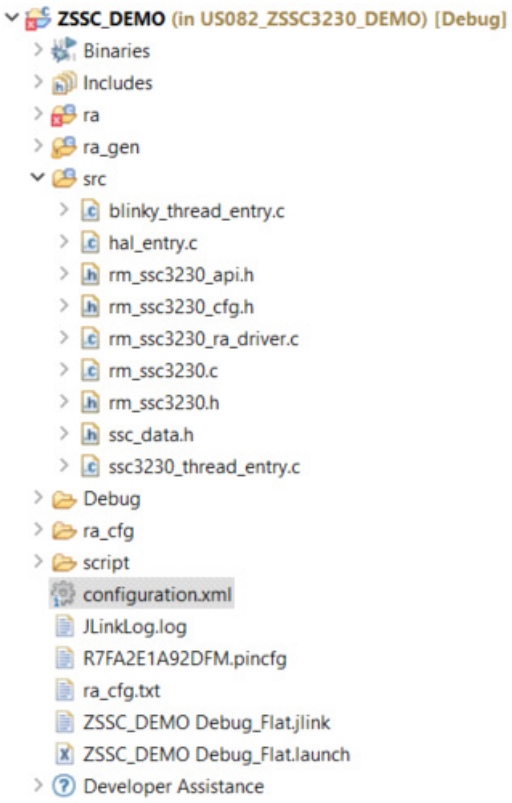


Figure 13. Project Structure

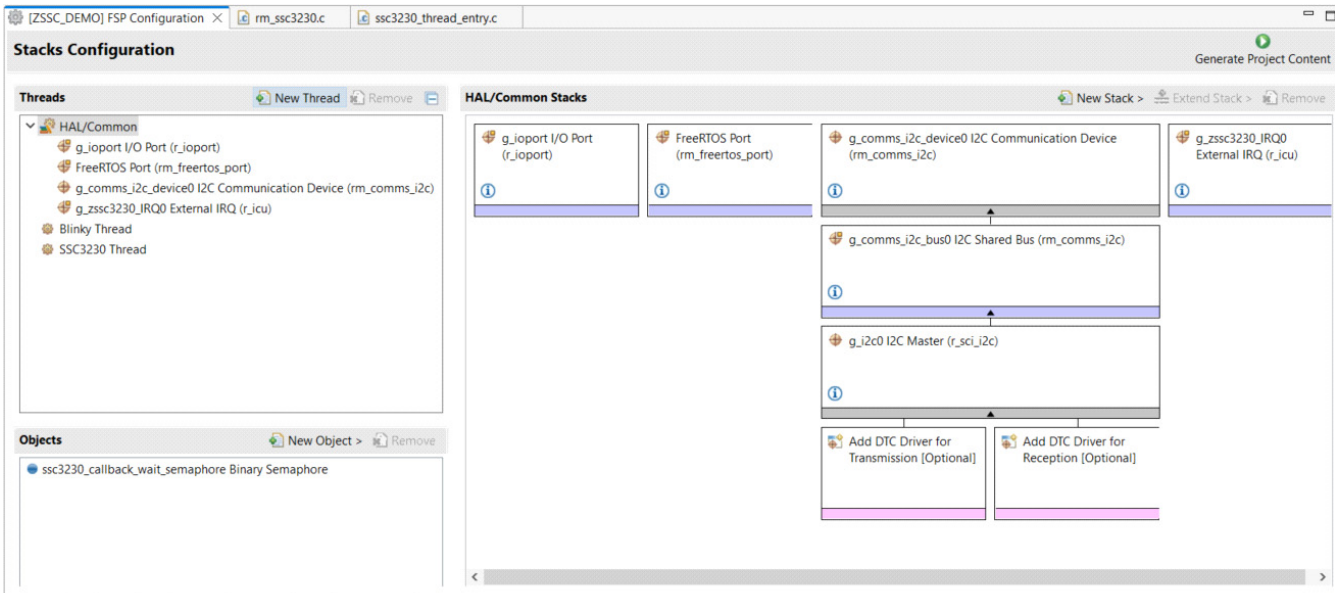


Figure 14. FSP Stacks

3.2 ZSSC3230 API

The ZSSC3230 middleware supports the API calls in Table 1.

Table 1. ZSSC3230 API Calls

API Call	Function
RM_SSC3230_Open	Opens connection between RA2E1 and ZSSC3230.
RM_SSC3230_Close	Closes connection between RA2E1 and ZSSC3230.
RM_SSC3230_MeasurementStartRawTemp	Sends raw temperature measurement command. ZSSC3230 returns 24-bit raw temperature data. See the *ZSSC3230 Datasheet* (Command List table) for more info.
RM_SSC3230_MeasurementStartRawCap	Sends raw capacitance/sensor measurement command. ZSSC3230 returns 24-bit raw capacitance/sensor data. See the *ZSSC3230 Datasheet* (Command List table) for more info.
RM_SSC3230_MeasurementStartComplete	Sends Measure command which calculates temperature and capacitance. ZSSC3230 returns adjusted 24-bit temperature and 24-bit capacitance data. See ZSSC3230 Datasheet (Command List table) for more info.
RM_SSC3230_SetCapRange	Takes the required capacitance range as input and sets the proper register bits in the ZSSC3230 NVM. See *ZSSC3230 Datasheet* (Memory (NVM) Content Assignments table) for more info.
RM_SSC3230_SetCapOffset	Takes desired capacitance offset/shift as input and sets the proper register bits in the ZSSC3230 NVM. See the *ZSSC3230 Datasheet* (Memory (NVM) Content Assignments table) for more info.
RM_SSC3230_ModeSelect	Changes operating mode of ZSSC3230 to Sleep, Command, or Cyclic. See the *ZSSC3230 Datasheet* (Command List table) for more info.
RM_SSC3230_Read[1]	Used after any of the measurement API calls to receive data from the ZSSC3230.

Table 1. ZSSC3230 API Calls

API Call	Function
RM_SSC3230_Write	Writes commands to the ZSSC3230.
RM_SSC3230_SensorIdGet	Returns the ZSSC3230 Sensor Id.

1. The first byte returned by RM_SSC3230_Read is a status byte. See the General Status Byte table in the *ZSSC3230 Datasheet* for more information.

4. Board Test

4.1 Run Code in Debug Mode

1. Open the sample project code in Renesas e^2 studio IDE.
2. In the menu bar, select on **Run** > **Debug Configurations**.

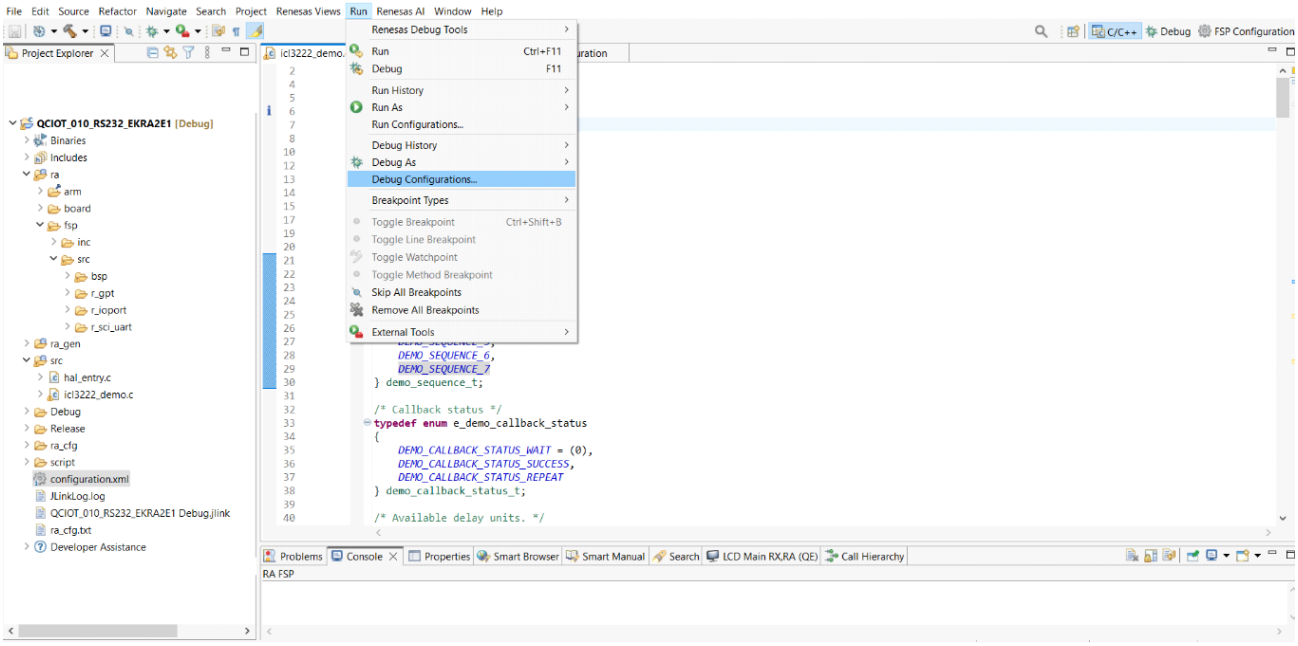


Figure 15. Debug Configuration

3. Select **Renesas GDB Hardware Debugging** > **ZSSC_DEMO Debug Flat**. Click the **Debug** button.

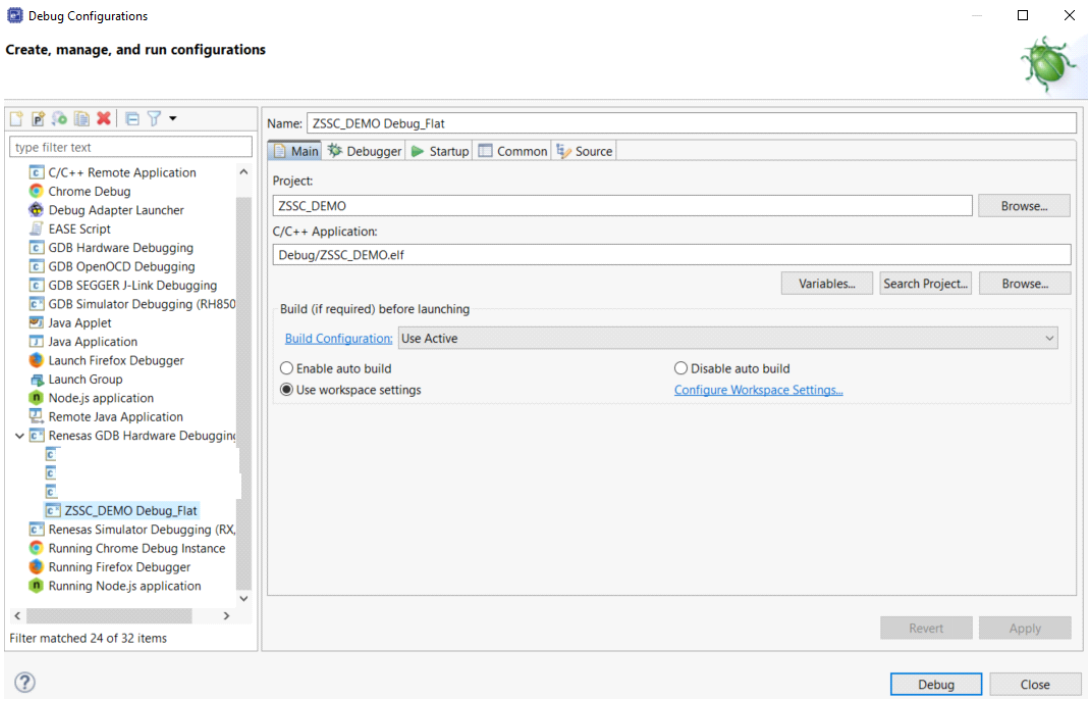


Figure 16. Starting Debug Mode

4. The code enters Debug mode (see Figure 17).

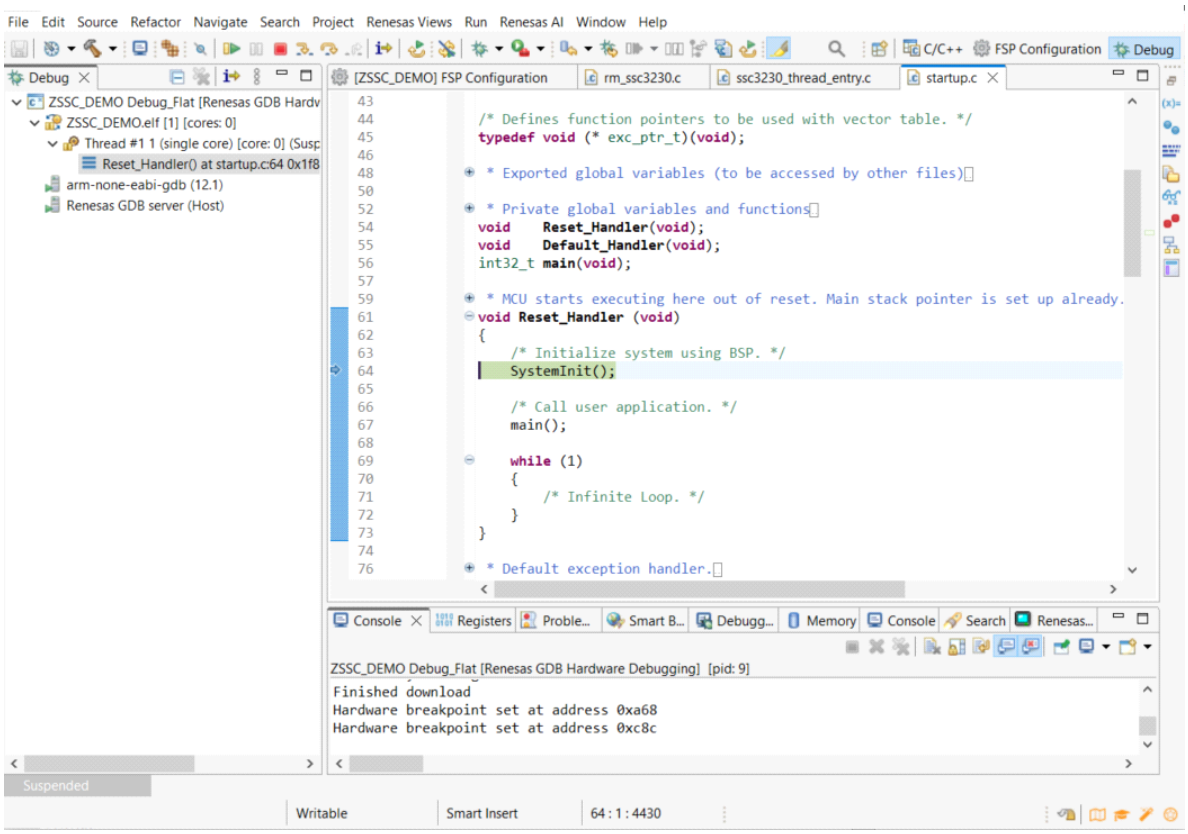


Figure 17. Debug Mode

5. Press F8 or click on the resume  icon to run the demo code.

4.2 Check Sensor Output

1. In the menu bar, select **Renesas Views > Debug > Visual Expression**.
2. Next, click on **Windows > Show Views > Expressions**.

The variables appear in the Expression window, and the gauge icons appear in the Visual Expression window. If the variables do not appear, they can be added manually. *Note*: The capacitor reading and temperature reading are available in real time.

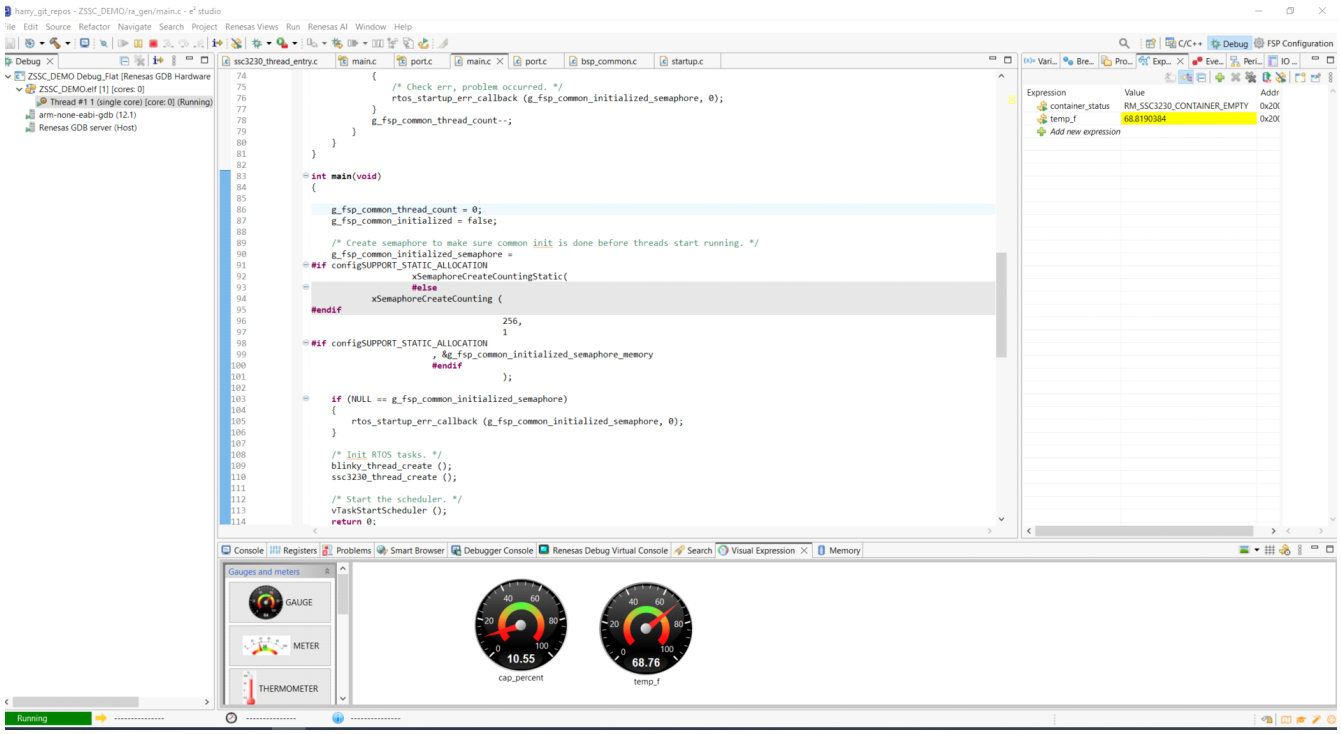


Figure 18. Debug Mode

5. Ordering Information

Part Number	Description
US082-ZSSC3230EVZ	ZSSC3230 Pmod board
US082-INTERPEVZ	Interposer board

6. Revision History

Revision	Date	Description
1.00	Jun 24, 2024	Initial release

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Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
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