ZMID4200MROT36001
Rotary Application Module

Description

The ZMID4200 application modules provide an easy demonstration of Renesas' ZMID4200 inductive sensing solutions for specific application cases. The typical sensor performance for a defined application use case can be evaluated via reference measurements performed with the application module.

Renesas' ZMID4200MROT36001 Rotary Application Module demonstrates inductive rotary position sensing. The Application Module can be programmed for a specific application range using ZMID-COMBOARD, which is separately available.

The Rotary Application Module Sensor PCB can be easily attached to an existing mechanical configuration for prototyping.

Kit Contents

- Rotary Application Module Sensor PCB
- Sensor Target, Target Holder, Rotation Axis, and Knob
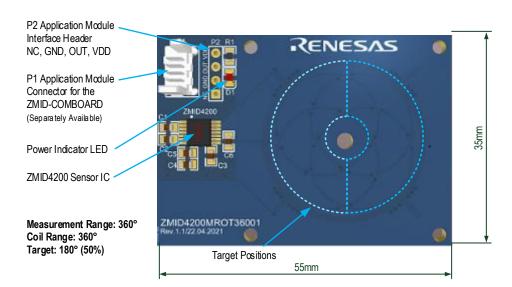- Module Connection Cable
- *Quick Start Guide* and *Kit Disclaimer*

Features

- Easy application prototyping
- Measurement reports available.
- Programmable output slope and linearization
- Tolerance to mechanical misalignment
- No magnets required; reduces cost
- Module design data, *ZMID4200 EVK Application Software*, and user manual available online depending on the module: http://www.renesas.com/ZMID4200stkit

Rotary Module Summary

- Measurement range: 360° (using a 50% target)
- Output resolution:
  - 10-bit Analog Output = 0.35°
  - 10-bit PWM Output = 0.35°
  - 12-bit SENT Output = 0.09°

ZMID4200MROT36001 Rotary Application Module Sensor PCB

P2 Application Module Interface Header NC, GND, OUT, VDD

P1 Application Module Connector for the ZMID-COMBOARD (Separately Available)

Power Indicator LED

ZMID4200 Sensor IC

Measurement Range: 360°
Coil Range: 360°
Target: 180° (50%)

Target Positions

35mm

55mm

Important Notes

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Restrictions in Use

ZMID520xMROT36001 Rotary Application Module, consisting of the Rotary Application Module Sensor PCB, Sensor Target, Target Holder, Knob, and Module Connection Cable, and the *ZMID4200 EVK Application Software* are designed for use only in a laboratory for evaluation purposes. The hardware and software must not be used for characterization measurements in terms of replacing calibrated laboratory environment and measurement devices. It must not be used with any setup where there is a risk of injury or death.

⚠ **!**   **Important Safety Warning:** These procedures can result in high currents, which can cause severe injury or death and/or equipment damage. Only trained professional staff should connect external equipment and operate the software.

⚠ **!**   **Important Equipment Warning:** Ensure the correct connection of all cables. Supplying the board using the wrong polarity could result in damage to the board and/or the equipment.

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Tables

1. Introduction

This user manual describes the ZMID4200MROT36001 Rotary Application Module. This application module is designed to measure the rotary movement of a sensor target using the ZMID4200 Inductive Position Sensor IC, which is connected to an application specific coil design and located on the Rotary Application Module Sensor PCB.

For a first evaluation of the Application Module, the kit contains a target holder to locate and move the sensor target over the sensor coils. Using the separately available ZMID-COMBOARD, the Application Module can be connected to the user's computer. Using the *ZMID4200 EVK Application Software*, the module can be programmed and configured. To download the software and its user manual, visit the web page given on page 1.

After the first evaluation of the Application Module performance, the Rotary Application Module Sensor PCB and the sensor target can be mounted on any application for rapid prototyping. The design data of the Application Module is available (see section 1.1.3). The following sections describe technical details of the Application Module.

1.1   Module Description

The following tables provide the system, electrical, and mechanical parameters for the Application Module.

Note: For detailed information about the expected accuracy, refer to section 2.

Table 1. System Data

Symbol	Parameter	Conditions	Typical	Unit
TA_R	Angle Measurement Range		360	Degrees
TA_A	Target Angle		180	Degrees
COIL_L	RX Coil Range		360	Degrees
AG	Recommended Airgap between Coil and Target		1.5	mm
RES_DIG	Internal Digital Resolution		16	Bits
RES_OUT	Output Resolution	ZMID4200 Analog	10	Bits
		ZMID4200 PWM	10	Bits
		ZMID4200 SENT	12	Bits
F_S	Output Update Rate		10	kHz
T_A	Data Acquisition Time		50	µs

1.1.1.   Electrical Data

For detailed information about the electrical data, refer to the *ZMID4200 Datasheet*.

Table 2. Electrical Data

Symbol	Parameter	Conditions	Typical	Unit
VDD	Supply Voltage		4.5 to 5.5	V
I_CC	Typical Current Consumption, No Load		12 to 21.5 (typical: 13)	mA
ZMID4200 Analog Output				
R_PUA	Output Pull-Up Resistor		3 to 10 (typical: 4.7)	kΩ
R_PDA	Output Pull-Down Resistor		3 to 10 (typical: 4.7)	kΩ
C_ANA	Output Capacitor for Analog		0.47 to 27	nF

Symbol	Parameter	Conditions	Typical	Unit
ZMID4200 PWM Output				
R_PUB		V_PU = 5V	1 to 10	kΩ
		V_PU = 16V	3 to 10	
C_PWM			1 to 20	nF
F_PWM	PWM Output Frequency Depending on Module Configuration		Programming options: 0.125, 0.25, 0.50, 0.75, 1.00, 1.25, 1.50, 2.00 (default)	kHz
	Normal Operating Range	Limits are programmable	5 to 95	% duty cycle
ZMID4200 SENT Output (see the *ZMID4200 Datasheet* regarding circuit options)				
R_01	SENT Output pi (π) Filter Resistor	Circuit option A, B, or C	120	Ω
C_11	SENT Output pi (π) Filter First Capacitor	Circuit option A, B, or C	2.2	nF
T_TICK	Clock Tick Time		3.0 to 3.67	µs
C_12	SENT Output pi (π) Filter, Second Capacitor	Circuit option C	2.2	nF
		Circuit option A or B	3.9	nF

1.1.2. Electrical Connections to interfacing an Application MCU

If the Application Module is connected to an application host MCU, additional components might be required. The connection diagrams and additional components required for the different output interface options are found in the *ZMID4200 Datasheet.*

1.1.3. Design Documentation

The design data are available on the webpage (see page 1), or they can be requested from (see contact information on the last page). The support package contains the design files as well as the fabrication outputs for the ZMID4200MROT36001 Rotary Application Module including the following:

- 3-D data (*.step*)
- Fabrication outputs (Gerber)
- PCB design files (Altium)
- Mechanical dimensions (*.dxf)*

1.2 Getting Started

1.2.1. Module Hardware Connections

Follow these procedures to set up the kit as shown in Figure 1:

1. Connect the Application Module to a ZMID-COMBOARD or to an external application using the sensor cable using the connectors shown in Figure 1. See Table 3 for the details for the connectors.
2. If using the ZMID-COMBOARD, connect it to the user's computer using a USB cable or power up the user's application controller.
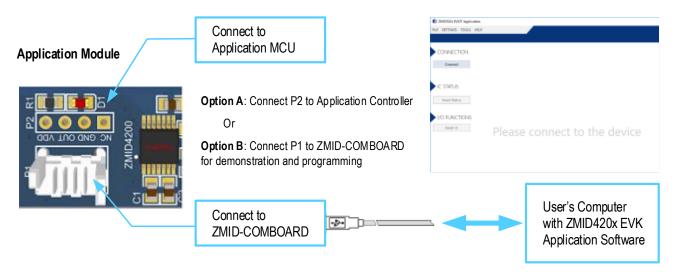
Figure 1. Application Module Connections

Table 3. Evaluation Kit Connection Descriptions

Connector	Type	Description	
P1	4-Pin Molex Picoflex	Header to connect the Application Module to the ZMID-COMBOARD	4 VDD 3 OUT 2 GND 1 Not connected
P2	4-Pin Header	Header to connect the Application Module to an existing application	4 VDD (4.5 to 5.5 V) 3 OUT 2 GND 1 Not connected

1.2.2. Target Holder Assembly Instructions

The target holder is assembled as shown below.

1. Place the rotation axis on the Rotary Application Module Sensor PCB.

2. Mount the target on the rotation axis.

3. Place the target holder within the angular limits on the inductive sensor PCB and rotation axis.

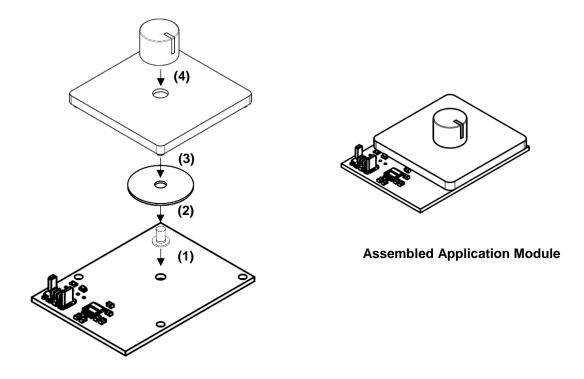4. Mount the knob on the rotation axis.

Figure 2. Target Holder Assembly

1.2.3. Sensor Configuration and Calibration

The application module is preconfigured for the mechanical configuration when using the target holder. If the Rotary Application Module Sensor PCB is mounted on any existing application with a mechanical configuration different from the application module mechanics, the sensor IC must be configured and programmed for the new setup. This can be done using the ZMID-COMBOARD and the *ZMID4200 EVK Application Software*.

2. Application Measurement

The application module was measured to assess the typical sensing performance. For positioning the target at different positions and displacements relative to the center axis, a four axis measurement table was used. At each displacement position, the digital output value was read to obtain the data shown in the graphs in section 2.1. In the graphs that show the effects of displacement, the X direction is right/left displacement parallel to the board surface as oriented in the figure on page 1 and the Y direction is displacement perpendicular to the X axis and parallel to the board surface.

The graphs show the effects of differences in the airgap, which is the distance between the sensor coils and the target surface.

2.1 Output Measurement at 1.5mm Airgap

For this measurement, the sensor was calibrated at an airgap of 1.5mm. The sensor gain, offset, and slope were configured for the measurement range, and the output was linearized.

Table 4. Sensor Configuration for the Measurement

Name	Offset	Slope	Clamping	LinInt0	LinInt1	LinInt2	LinInt3
Register	00_{HEX}	01_{HEX}	02_{HEX}	03_{HEX}	04_{HEX}	05_{HEX}	06_{HEX}

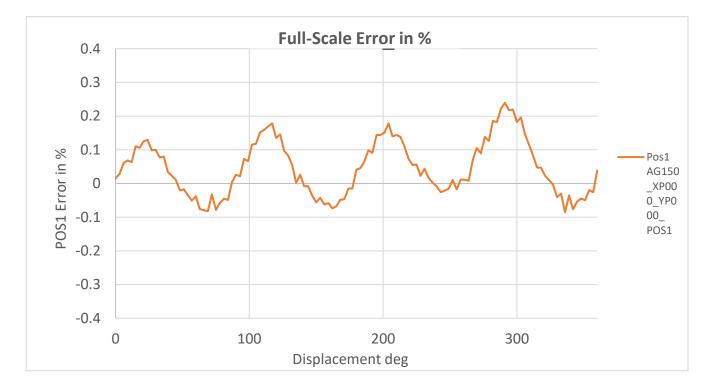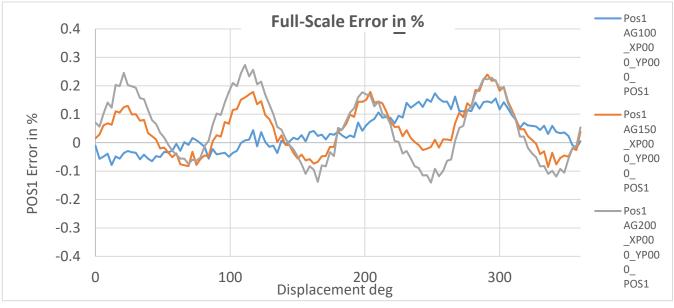| Value	17C0	0400	0000	8200	8481	8500	8683
Name	**LinInt4**	**CoilOffset**	**CalMode**	**Trimming**	**AGC0**	**AGC1**	**Mask**
Register	07$_{HEX}$	08$_{HEX}$	09$_{HEX}$	0B$_{HEX}$	0C$_{HEX}$	0D$_{HEX}$	0E$_{HEX}$
Value	0080	1000	1100	B103	0838	0055	BFFF
Name	**Trace0**	**Trace1**	**Misc**				
Register	0F$_{HEX}$	10$_{HEX}$	11$_{HEX}$				
Value	0000	0000	00C2				

Figure 3. Accuracy with Linearization at 1.5mm Airgap (AG150)

Note: AG100 = 1mm airgap; AG150 = 1.5mm; and AG200 = 2.0mm airgap.

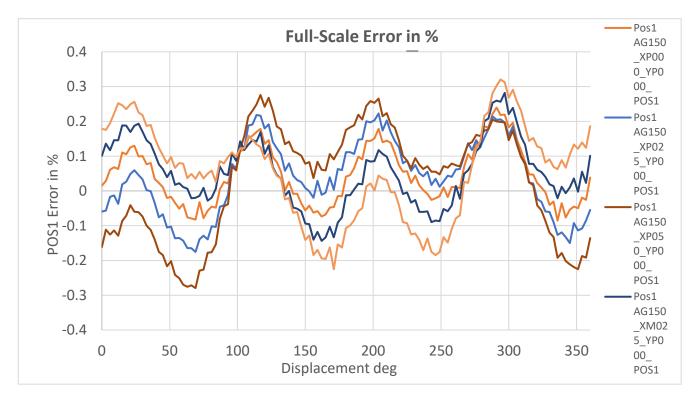**Figure 4. Accuracy with Linearization at 1.5mm Airgap and Effects of Airgap Changes**

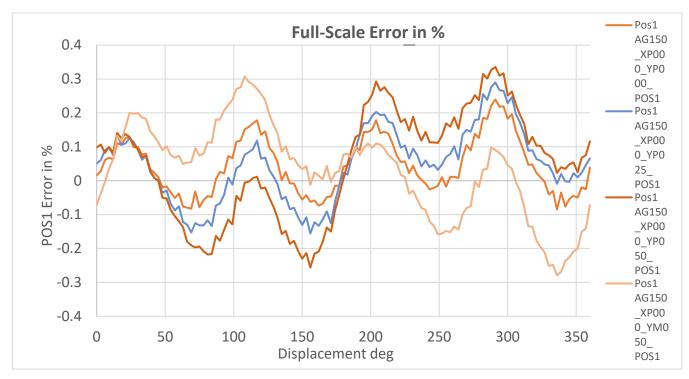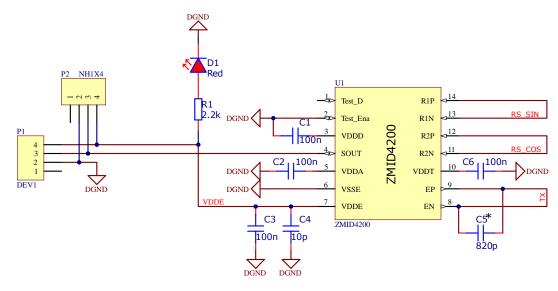**Figure 5. Accuracy with Linearization at 1.5mm Airgap and Effects of Displacement in X**

Figure 6. Accuracy with Linearization at 1.5mm Airgap and Effects of Displacement in Y

3. Rotary Application Module Sensor PCB

3.1 Schematic

The Rotary Application Module Sensor PCB schematic is shown below. The board contains the ZMID4200 contactless inductive position sensor as well as the headers, power LED, and required capacitors for the integrated voltage regulator and the integrated oscillator. Also take into consideration any components required on the receiver side depending on the output type for the ZMID4200.
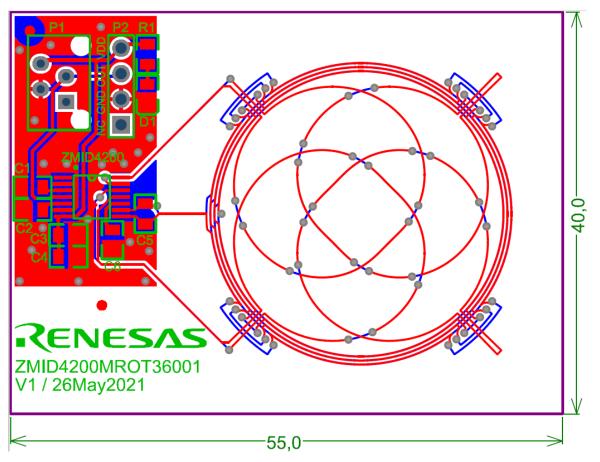

Note: C5* needs to be calculated in base of TX inductance.

Figure 7. Rotary Application Module Sensor PCB Schematic

3.2 Layout

For an appropriate coil design, specific tools to generate the coil pattern were used. These tools are available to Renesas customers if custom coil designs are needed.

Note: Dimensions are in mm.

Figure 8. Rotary Application Module Sensor PCB Layout and Dimensions

3.3 Bill of Materials (BOM)

Table 5. Rotary Application Module Sensor PCB BOM

DNP = Do not populate.

Designator	Value	Package	Manufacturer P/N	Manufacturer	Quantity
U1	ZMID4200	TSSOP-14	(Refer to the ZMID4200 Datasheet)	Renesas	1
C1, C2, C3, C4	100nF	0805	CL21B104KCFSFNG	Comet	4
C5	10pF	0805	CL21C100DBNC	Comet	1
C6, C7 (DNP), C8 (DNP)	820pF	0805	CGA4F2COG2A222J085AA	Comet	3
D1	LED Red	0805	OSR50805C1E	Comet	1
P1	Header	NH1X4	HN1X4	Comet	1
P2	Header	Molex Picoflex 4-pin	90325-0004	Farnell	1
R1	2kΩ	0805	R0805 2.0K 1%	Comet	1

4. Mechanical Components

The Application Module is shipped together with a target holder which is used to move the target over the receiver coil for evaluation purposes. A description of the target holder mechanics is shown below.

4.1 Sensor Target

Note: Dimensions are in mm.

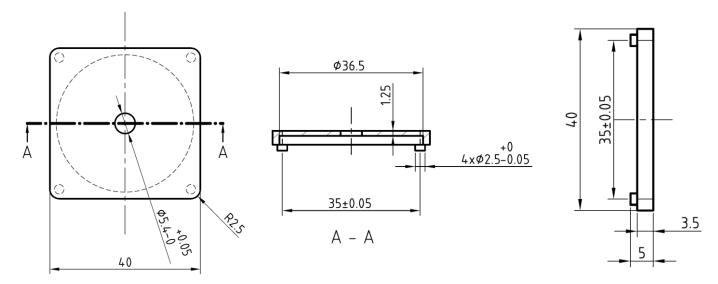**Figure 9. Sensor Target Dimensions**

4.2 Target Holder

The target holder allows rotary movement of the sensor target at an airgap of 1mm. The target knob is used as well to define the start and stop position of the travel.

Note: Dimensions are in mm.

Figure 10. Sensor Target Holder Dimensions

4.3   Target Holder Knob

The target knob is used to slide the target inside the target holder.

Note: Dimensions are in mm.

Figure 11. Sensor Target Knob Dimensions

5.   Ordering Information

Orderable Part Number	Description
ZMID4200MROT36001	Inductive Rotary Application Module with 360° Measurement including Rotary Application Module Sensor PCB, Sensor Target, Target Holder, Rotation Axis, Knob, Module Connection Cable

6.   Revision History

Revision	Date	Description
1.0	Jul 21, 2021	Initial release.

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