Description

The ZMID520x application modules provide an easy demonstration of IDT's ZMID520x inductive sensing solutions for a specific application case. The typical sensor performance for a defined application use case can be evaluated via reference measurements performed with the application module.

IDT's ZMID520xMLIN01201 Linear Application Module demonstrates inductive linear position sensing. The Application Module can be programmed for a specific application range using IDT's ZMID-COMBOARD, which is separately available.

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

Features

- Easy application prototyping
- Measurement report available
- Programmable output slope and linearization
- Tolerance for mechanical misalignment
- No magnets required; reduced cost
- Module design data, *ZMID520x EVK Application Software*, and user manual available online depending on the module:

  www.IDT.com/ZMID5201MLIN

  www.IDT.com/ZMID5202MLIN

  www.IDT.com/ZMID5203MLIN

Kit Contents

- Linear Application Module Sensor PCB
- Sensor Target, Target Holder, and Knob
- Module Connection Cable
- Quick Start Guide and Disclaimer

Linear Module Summary

- Measurement range: 12mm (using a 50% target)
- Output resolution:
  — ZMID5201 10-bit Analog = 12μm
  — ZMID5202 10-bit PWM = 12μm
  — ZMID5203 12-bit SENT = 3μm

ZMID520xMLIN01201 Linear Application Module Sensor PCB
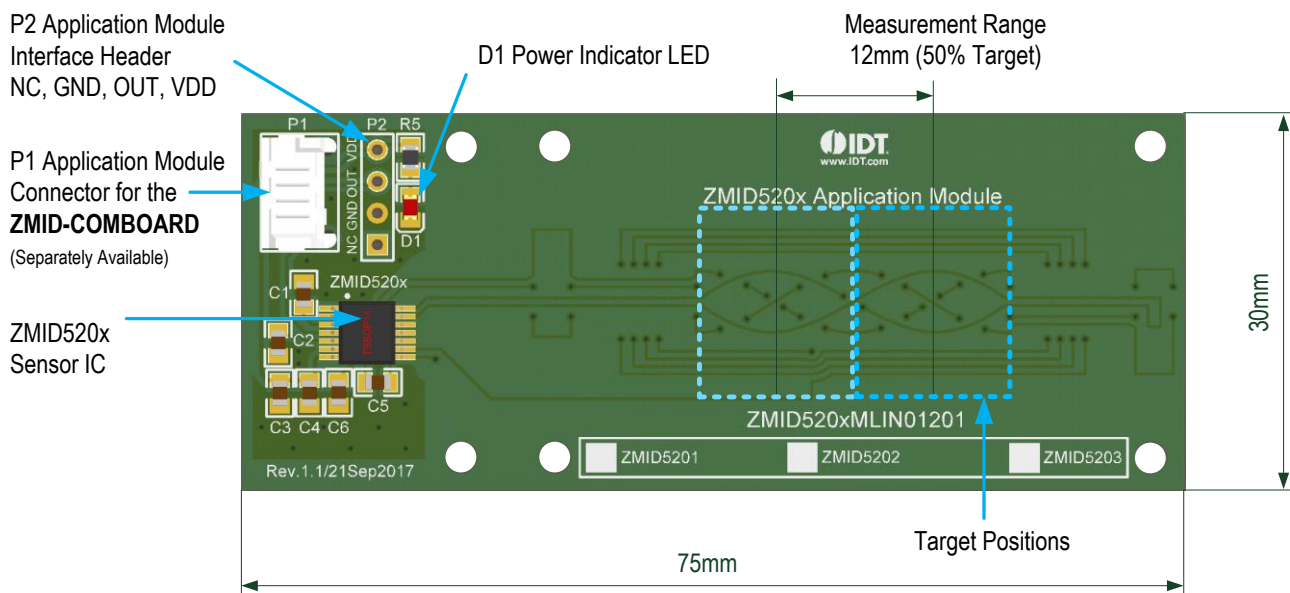
Important Notes

Disclaimer

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(i) delivered hardware or software

(ii) non-observance of instructions contained in this manual and in any other documentation provided to user, or

(iii) misuse, abuse, use under abnormal conditions, or alteration by anyone other than IDT.

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Restrictions in Use

IDT's ZMID520xMLIN01201 Linear Application Module, consisting of the Linear Application Module Sensor PCB, Sensor Target, Target Holder, Knob, and Module Connection Cable, and the *ZMID520x 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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1. Introduction

This user manual describes the ZMID520xMLIN01201 Linear Application Module. This application module is designed to measure a linear movement of a sensor target using the ZMID520x Inductive Position Sensor IC, which is connected to an application-specific coil design and located on the Linear 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 *ZMID520x EVK Application Software*, the module can be programmed and configured. To download the software and its user manual, visit the IDT web page given on page 1.

After the first evaluation of the Application Module performance, the Linear 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
TR	Linear Measurement Range[a]		12	mm
TA_W	Target Width[a]		12.5	mm
COIL_L	RX Coil Length		25	mm
AG	Recommended Airgap Between Coil and Target		1	mm
RES_DIG	Internal Digital Resolution		16	Bit
RES_OUT	Output Resolution	ZMID5201	10	Bits
		ZMID5202	10	Bits
		ZMID5203	12	Bits
T_R	Output Update Rate		10	kHz
T_A	Data Acquisition Time		50	µs

[a]   The Linear Application Module Sensor PCB can also be used with a smaller width. Using a smaller target will increase the measurement range.

December 12, 2017

1.1.1 Electrical Data

For detailed information about the electrical data, refer to the *ZMID520x Datasheet*. See the connection diagrams in section 1.2.

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
ZMID5201 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
ZMID5202 Output				
R_PUB		V_PU = 5V	1 to10	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
ZMID5203 Output (see the *ZMID5203 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 given in the *ZMID520x Datasheet.*

1.1.3 Design Documentation

The design data are available on the IDT webpage (see page 1) or can be requested via IDT's sales team (see contact information on the last page). The support package contains the design files as well as the fabrication outputs for the ZMID520xMLIN01201 Linear 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
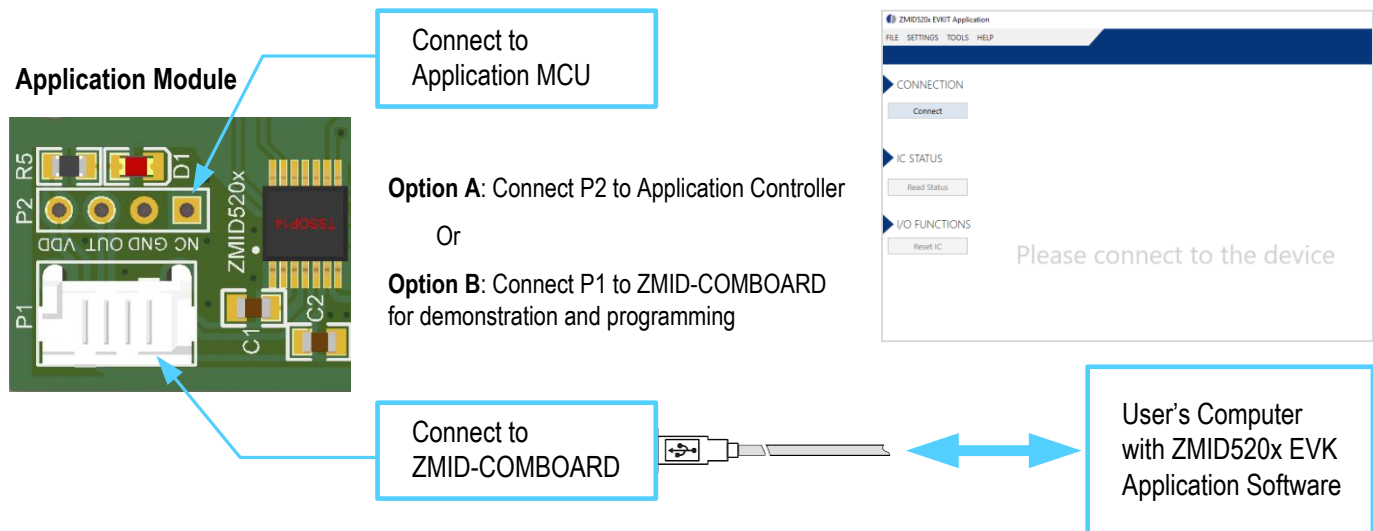
Table 3. Evaluation Kit Connection Descriptions

Connector	Type	Description	
P1	4-Pin Molex Picoflex	Header to connect the Application Module to the ZMID-COMBOARD	P1 4 VDD 3 OUT 2 GND 1 Not connected
P2	4-Pin Header	Header to connect the Application Module to an existing application	P2 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 target holder on the Linear Application Module Sensor PCB.

2. Insert the sensor target into the target holder.

3. Add the knob to define the start and stop position.

Figure 2.   Target Holder Assembly

Assembled Application Module
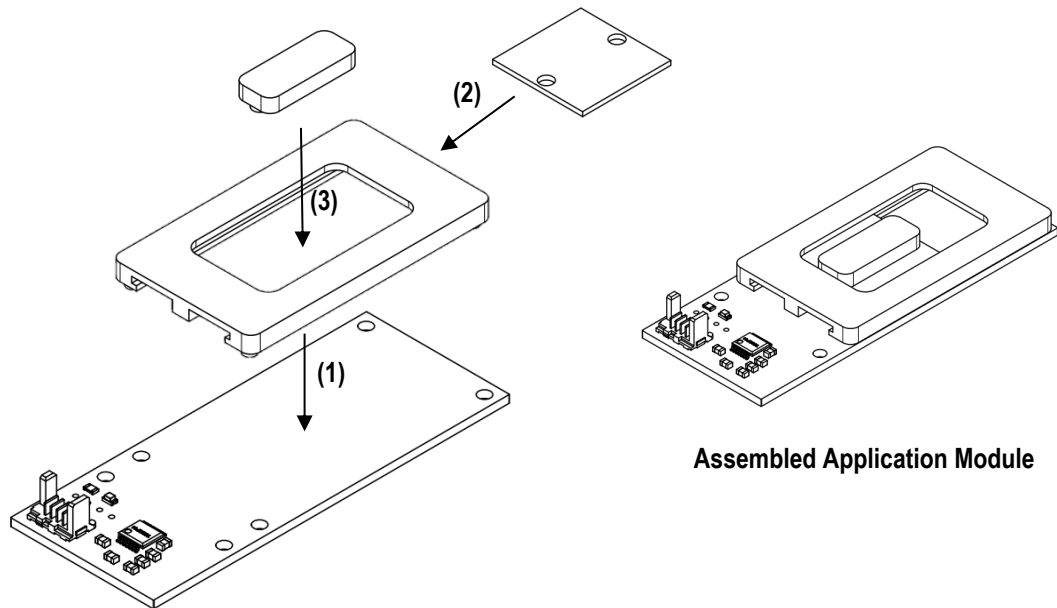
1.2.3 Sensor Configuration and Calibration

The Application Module is preconfigured for the mechanical configuration when using the target holder. If the Linear 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 *ZMID520x 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, a four axis measurement table was used. At each displacement position, the digital output value was read to obtain the data shown in the following graphs.

2.1 Output Measurement at 1.0mm Airgap

For this measurement, the sensor was calibrated at an airgap of 1.0mm. The sensor gain, offset, and slope were configured for the measurement range, and the output was linearized.

Figure 3. 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	**21FE**	**0835**	**0000**	**0500**	**0306**	**8081**	**8584**
Name	LinInt4	CoilOffset	CalMode	Trimming	AGC0	AGC1	Mask
Register	07_{HEX}	08_{HEX}	09_{HEX}	$0B_{HEX}$	$0C_{HEX}$	$0D_{HEX}$	$0E_{HEX}$
Value	**0082**	**0000**	**010E**	**B107**	**083A**	**0055**	**BFFF**
Name	Trace0	Trace1	Misc				
Register	$0F_{HEX}$	10_{HEX}	11_{HEX}				
Value	**0000**	**0000**	**00C2**				

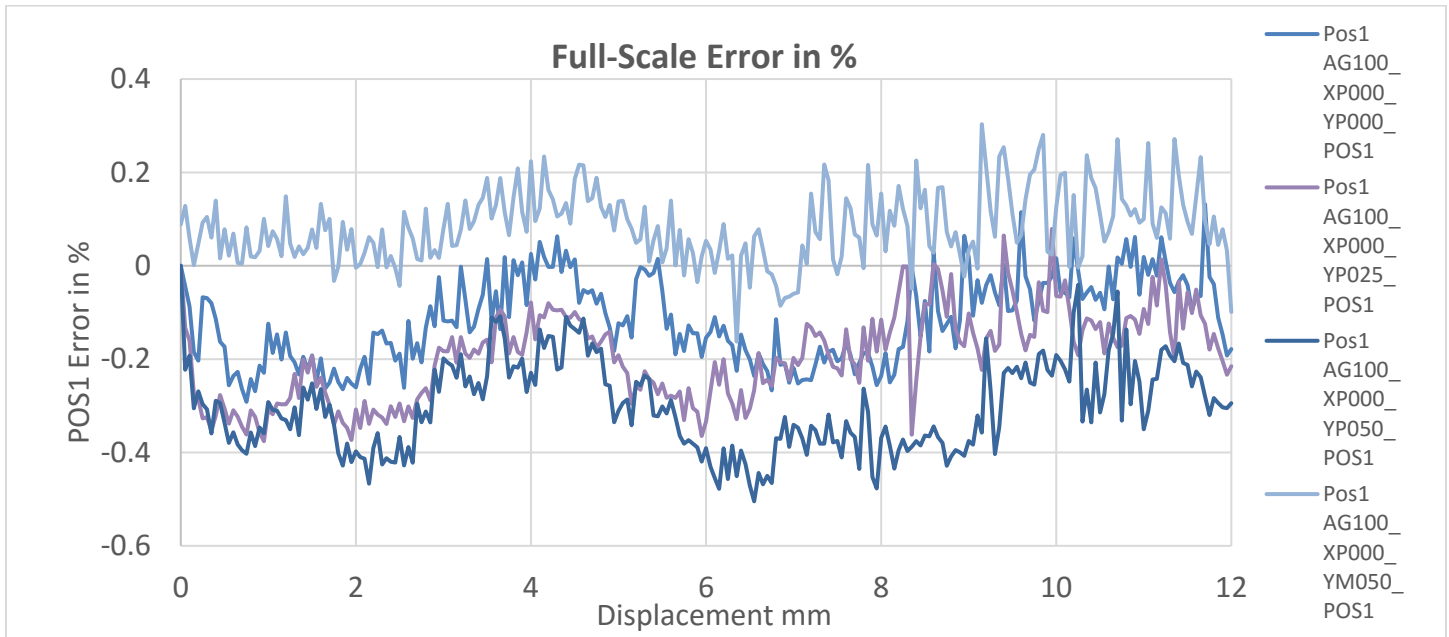**Figure 4. Accuracy with Linearization at 1mm Airgap (AG100)**
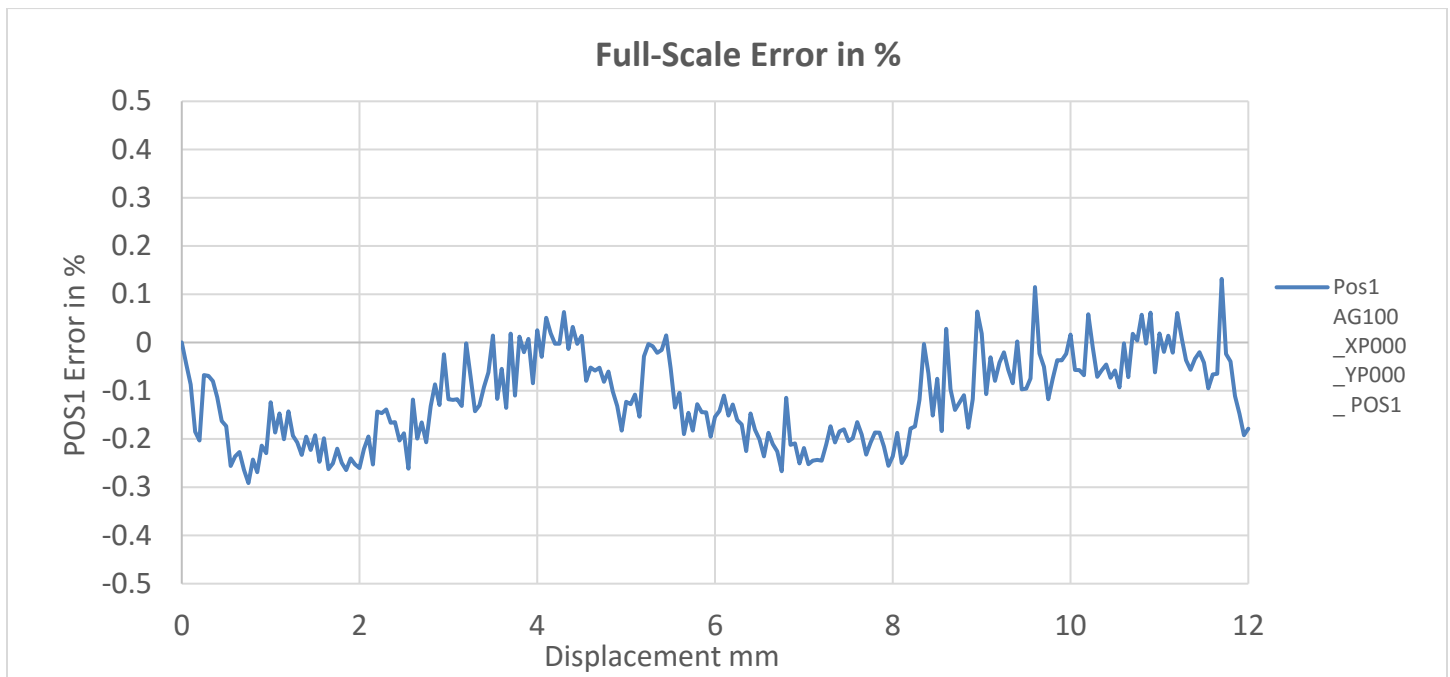
Figure 5.   Accuracy with Linearization at 1mm Airgap and Effects of Airgap Changes

Note: AG050 = 0.5mm airgap; AG100 = 1mm airgap; and AG150 = 1.5mm.
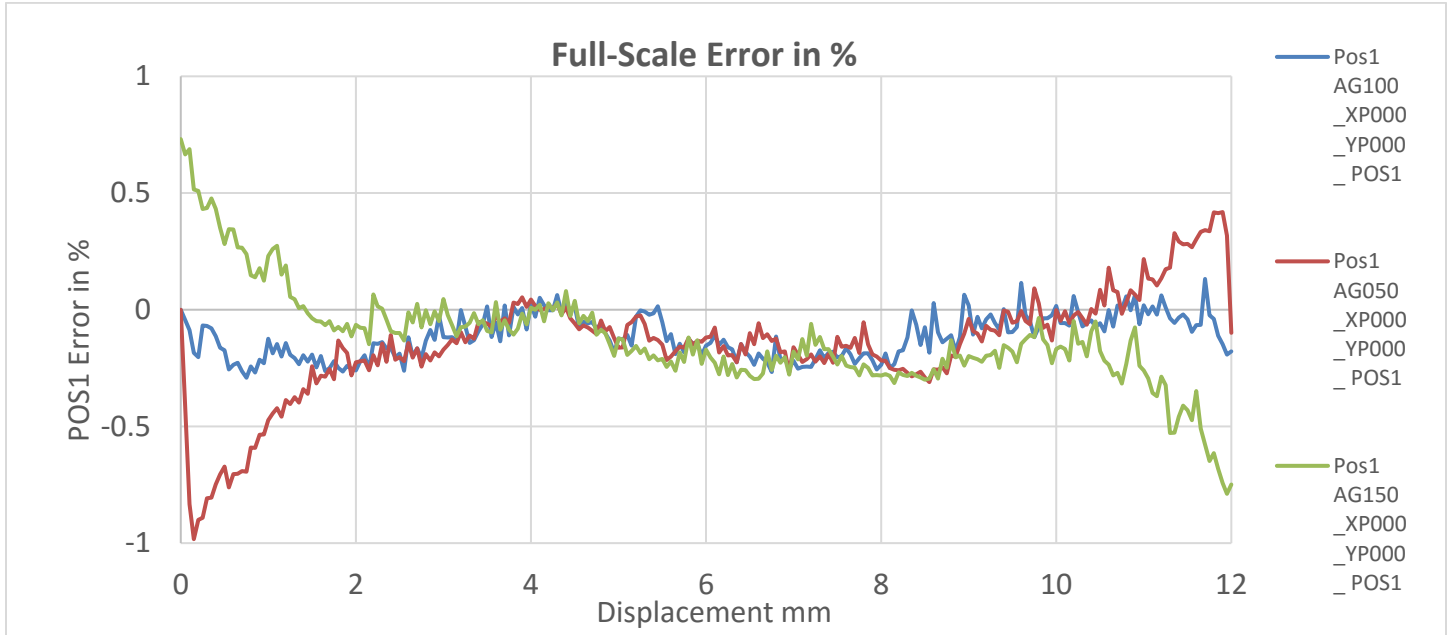
**Figure 6.   Accuracy with Linearization at 1mm Airgap and Effects of Displacement**

3. Linear Application Module Sensor PCB

3.1 Schematic

The Linear Application Module Sensor PCB schematic is shown below. It contains the ZMID520x 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 at the receiver side depending on the selected output variant.

Figure 7. Linear Application Module Sensor PCB Schematic
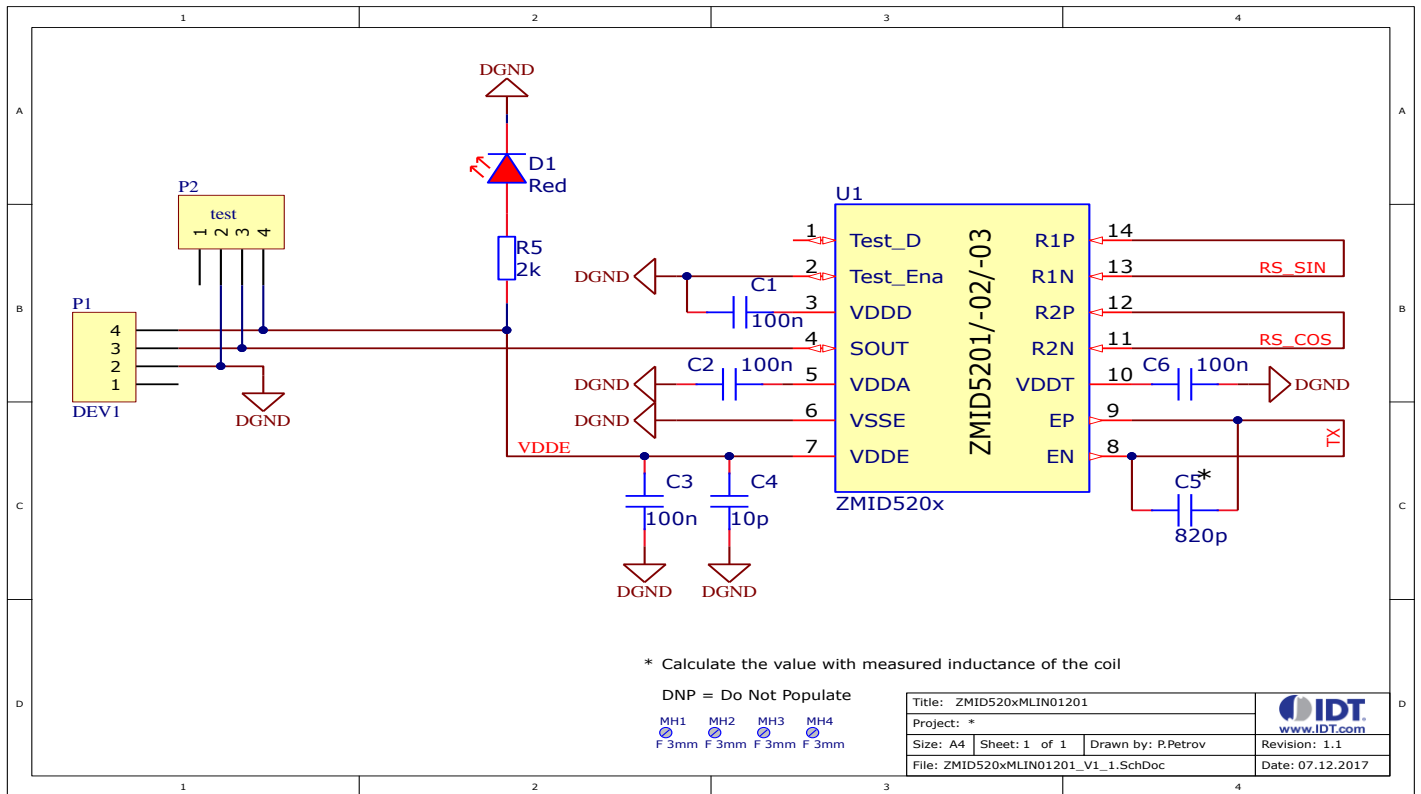
3.2   Layout

The Linear Application Module Sensor PCB layout is shown in Figure 8. For an appropriate coil design, specific tools to generate the coil pattern were used. These tools are available to IDT customers if custom coil designs are needed.

Figure 8.   Linear Application Module Sensor PCB Layout and Dimensions

Note: Dimensions are in mm.
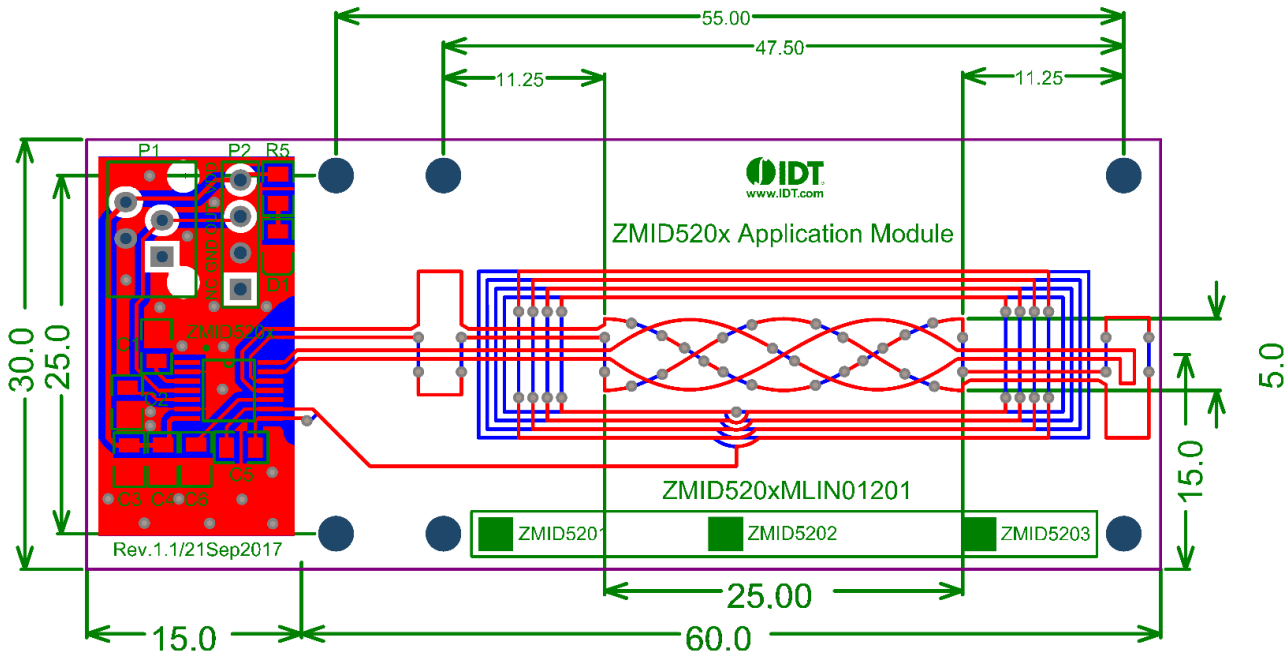
3.3   Bill of Materials (BOM)

Table 4.   Linear Application Module Sensor PCB BOM

Designator	Value	Package	Manufacturer P/N	Manufacturer	Quantity
U1	ZMID520x	14-TSSOP	(Refer to the *ZMID520x Datasheet*)	IDT	1
C1, C2, C3, C6	100nF	0805	CL21B104KCFSFNG	Comet	4
C4	10pF	0805	CL21C100DBNC	Comet	1
C5	820pF	0805	CGA4F2COG2A222J085AA	Comet	1
D1	LED Red	0805	OSR50805C1E	Comet	1
P2	Header	NH1X4	HN1X4	Comet	1
P1	Header	Molex Picoflex 4pin	90325-0004	Farnell	1
R5	2kΩ	0805	R0805 2.0K 1%	Comet	1

4. Mechanical Components

The Application Module is shipped together with a target holder that 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

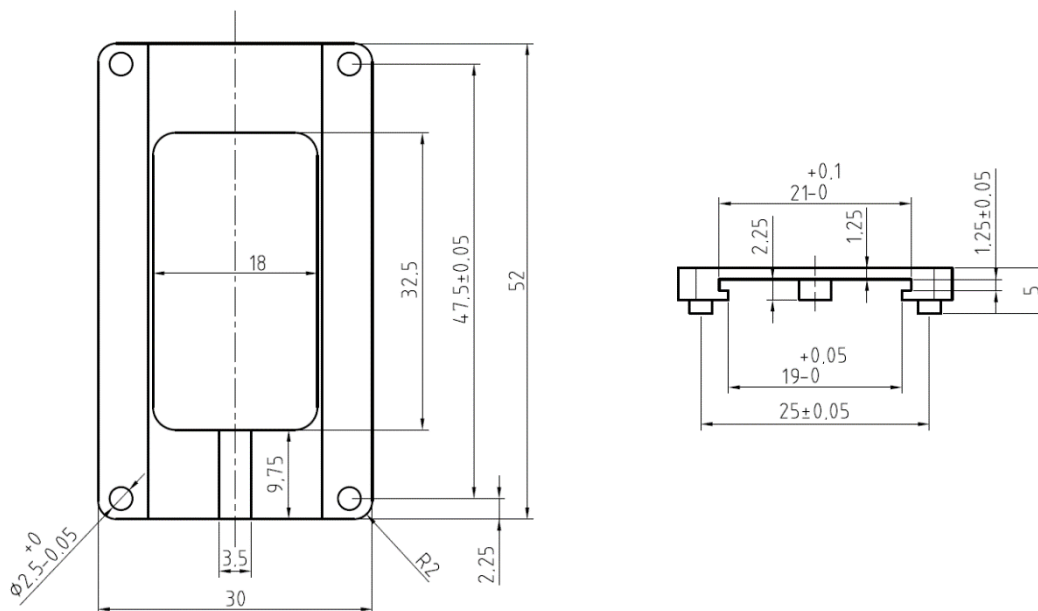**Figure 9. Sensor Target Dimensions**

Note: Dimensions are in mm.
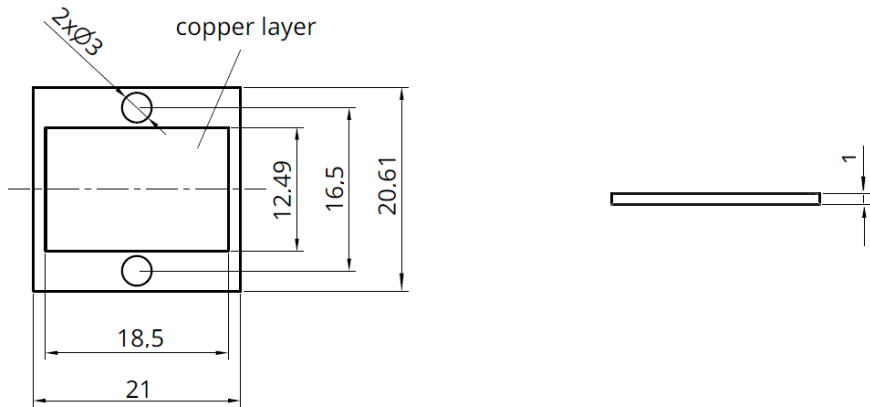
4.2 Target Holder

The target holder allows linear movement of the sensor target at an airgap of 1mm. The opening in the target holder enables the user to move the target with a finger.

Figure 10. Sensor Target Holder Dimensions

Note: Dimensions are in mm.

4.3   Target Holder Knob

The target knob is used to slide the target inside the target holder. The target knob is used as well to define the start and stop position of the linear travel.

Figure 11. Sensor Target Knob Dimensions

Note: Dimensions are in mm.
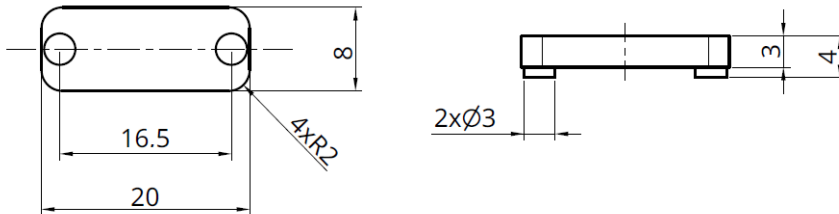
5.   Ordering Information

Orderable Part Number	Description
ZMID5201MLIN01201	Linear Inductive Application Module with 12mm Measurement Range and Analog Output including the Linear Application Module Sensor PCB, Sensor Target, Target Holder, Knob, and Module Connection Cable
ZMID5202MLIN01201	Linear Inductive Application Module with 12mm Measurement Range and PWM Output including the Linear Application Module Sensor PCB, Sensor Target, Target Holder, Knob, and Module Connection Cable
ZMID5203MLIN01201	Linear Inductive Application Module with 12mm Measurement Range and SENT Output including the Linear Application Module Sensor PCB, Sensor Target, Target Holder, Knob, and Module Connection Cable
ZMID-COMBOARD	USB Communication and Programming Interface for ZMID Inductive Application Modules

6. Revision History

Revision Date	Description of Change
December 12, 2017	▪ Revision for kit contents on page 1 and addition of kit contents to order information. ▪ Minor edit for schematic.
December 5, 2017	Initial version.

Corporate Headquarters
6024 Silver Creek Valley Road
San Jose, CA 95138
www.IDT.com

Sales
1-800-345-7015 or 408-284-8200
Fax: 408-284-2775
www.IDT.com/go/sales

Tech Support
www.IDT.com/go/support