NFC wireless power supply/communication reference circuit for the rotating part equipped with a sensor

ML7661-EVK-002/ML7660-EVK-002 User's Guide

first edition Issue Date: February 19, 2025

Preface

ML7660-EVK-002/ML7661-EVK-002 is a reference design that performs NFC (Near Field Communication) wireless power supply/communication to a moving part equipped with a sensor.

It is possible to wirelessly power and acquire data from sensors mounted on moving parts that are difficult to wire, such as electric assist bicycles and bearings.
Since wireless power supply and communication can be performed with a single antenna, it can be realized with a simple circuit configuration.

This user's guide explains the ML7660-EVK-002/ML7661-EVK-002.
When purchasing an evaluation kit, please check the instructions in Chapter 3 Evaluation Kit.

This document describes the overview and evaluation procedure of this evaluation kit, as well as hardware information for the two evaluation boards that make up this evaluation kit (ML7660 evaluation board, ML7661 evaluation board).

In addition to this document, please also read the following documents as necessary.

- ML7660 Data Sheet / ML7661 Data Sheet
  Describes LSI specifications (electrical characteristics, pin arrangement, etc.) and characteristics
- ML7660/ML7661 Application Note
  Describes the information necessary for proceeding with development, such as operation when using the LSI and evaluation flow
- ML7661/ML7660 Battery less SDK Software Manual
  SDK software development manual for customizing the control of SPI peripheral devices connected to the Rx side
- ML7661/ML7660 Battery less SDK Host Microcontroller Sample Software Manual
  Software manual for when TX side host control is performed with the ML63Q2557 reference board
- NFC Reference Software Host Command Manual
  Describes the types and contents of commands to be controlled from the host microcontroller via SPI
- NFC Configuration Tool Manual
  Describes how to use the tools required to rewrite the LSI configuration

Notation

Classification	Notation	Description
● Numeric value	XXh, XXH, 0xXX	Represents a hexadecimal number.
● Unit	word, W	1 word = 16bits
	byte, B	1 byte = 8 bits
	nibble, N	1 nibble = 4 bits
	Mega, M	10^6
	Kilo, K (uppercase)	2^{10}=1024
	Kilo, k (lowercase)	10^3=1000
	Milli, m	10^{-3}
	Micro, μ	10^{-6}
	Nano, n	10^{-9}
	Second, s (lowercase)	Second
● Terminology	"H" level	Indicates high level voltage V_{IH} and V_{OH} as specified by the electrical characteristics in the data sheet.
	"L" level	Indicates low level voltage V_{IL} and V_{OL} as specified by the electrical characteristics in the data sheet.

Table of Contents

1. Overview

1.1 Overview

The ML7660-EVK-002 is equipped with the power receiving LSI ML7660-NN0GD (Sample software is built in) , and the ML7661-EVK-002 is equipped with the power transmitting LSI ML7661-210GD.
The ML7660-EVK-002 is equipped with an SPI controller, so sensors connected via SPI can be controlled without a microcontroller. If you use the SR-300 series made by Glosel Co., Ltd. as a sensor, it will operate without the need for program development. By using the SDK (Software Development Kit) provided by ROHM, you can change the software to suit your sensor specifications. For details on the SDK, please refer to the ML7661/ML7660 Battery less SDK Software Manual
The ML7661-EVK-002 is equipped with an SPI peripheral and is controlled by the host microcontroller.
By facing the antennas, power can be supplied to the ML7660-EVK-002, and data from the sensor connected to the ML7660-EVK-002 can be periodically obtained. For control of the ML7661-EVK-002 from the host microcontroller, please refer to the ML7661/ML7660 Battery less SDK Host Microcontroller Sample Software Manual

1.2 Feature

- Achieve wireless power supply and communication to moving parts with a single antenna
- Circular reference design considering rotating bodies, the inner diameter of the RX board can be cut to fit the customer's housing
- ML7661-EVK-002 is controlled from the host microcontroller, and the control program for the sensor can be changed from ML7660-EVK-002
  (If it is SR-300, it will work without program development)
- Evaluation kits that can be used to check operation are available

1.3 Specification

The specifications of the ML7660-EVK-002 and ML7661-EVK-002 are shown in Table 1.

Table 1 ML7660-EVK-002/ML7661-EVK-002 hardware specifications

ML7660-EVK-002	
LSI	U1: ML7660-NN0GD
Components	C1, C3-C17: Capacitor
	D1-D4: Rectifier diode
	MOSFET1: FET
	Q1: FET
	R2-R12: Resistor
	RX-coil: Receiving antenna
	SR1, SR2: Sensor connector: 0.5mm pitch
	U2: LDO
Component mounting pads	C2, C18: Filter capacitor
	L1: Filter inductor
	FTDI-IF1: 9-pin, 1.27mm pitch for debugger connection
Operating voltage	Supplied from magnetic field
External dimensions	ϕ70mm x 1.0mm
ML7661-EVK-002	
LSI	U1: ML7661-210GD
Components	C1-C9, C11, C12, C14-C21, C23, C26-C31: Capacitor
	FB1: Ferrite bead
	L2-L3: Filter inductor
	Q1: FET
	R2-R6, R8-R10, R12-R15: Resistor
	TX-coil: Power transmission antenna
	U2: LDO
	X1: Oscillator
Component mounting pads	C10, C13, C24, C22, C24, C25: Capacitor
	FTDI-IF1: For connecting to debugger: 9 pins, 1.27mm pitch
	L1: Filter inductor
	R1, R7, R11, R16: Resistor
Power supply pad	CN1 (Pitch=2.54mm,φ=1.0mm)
Screw hole	ϕ3.2mm
Operating voltage	VDD: 5.0 to 5.5V
External dimensions	ϕ74mm x 1.0mm

1.4 Configuration example

This reference design is intended to be used to wirelessly connect a strain sensor mounted on the moving part of the drive unit of an electrically assisted bicycle. By connecting a strain sensor to the two connectors of this reference design (ML7660-EVK-002), a configuration example like that shown in Figure 1 can be realized.

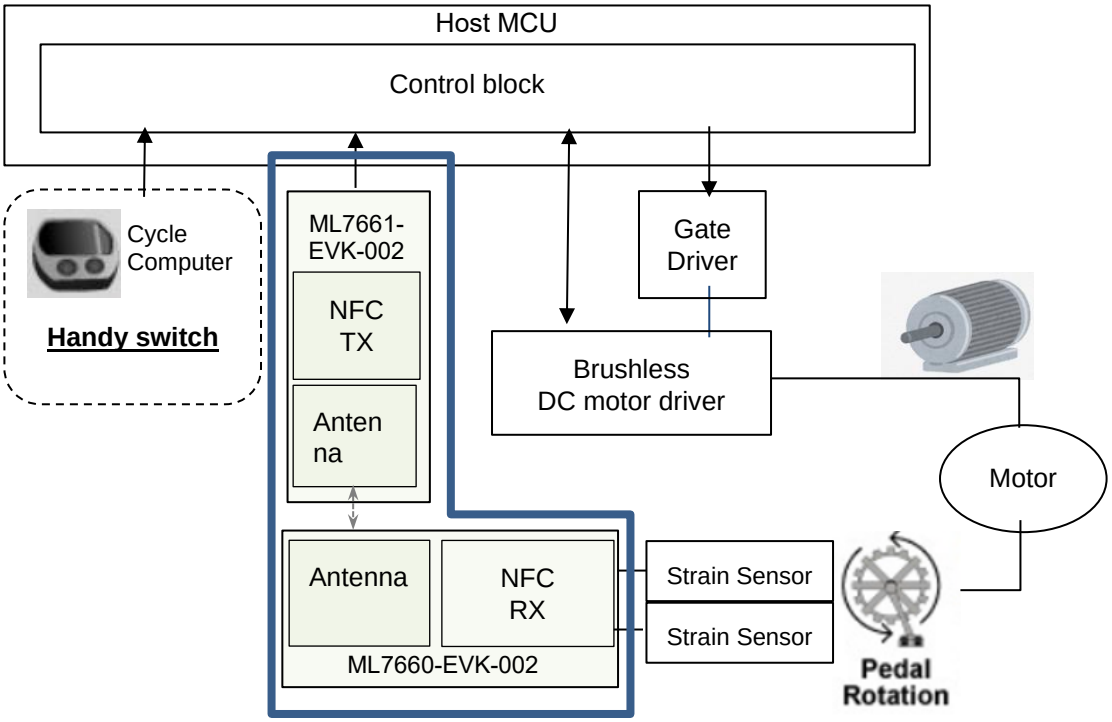


Figure 1. Example of block configuration of the drive unit of an electrically assisted bicycle

1.5 Specification

1.5.1 ML7660-EVK-002 Specification

Figure 2 shows the external view of the ML7660_EVK-002.
ML7660_EVK-002 consists of the power receiving LSI ML7660-NN0GD, a circular antenna, and a connector for sensor control.

- Power is supplied from the high-frequency magnetic field generated by the ML7661_EVK-002
- Equipped with a connector (FTDI-IF) for connecting to a debugger to EASE1000V2 for program development
- Power can be supplied to the device via the rectified output terminal (TP1)
- Sensors can be controlled via the sensor connectors (SR1, SR2)
- The inner diameter of the board can be cut to match the thickness of the rotating shaft.

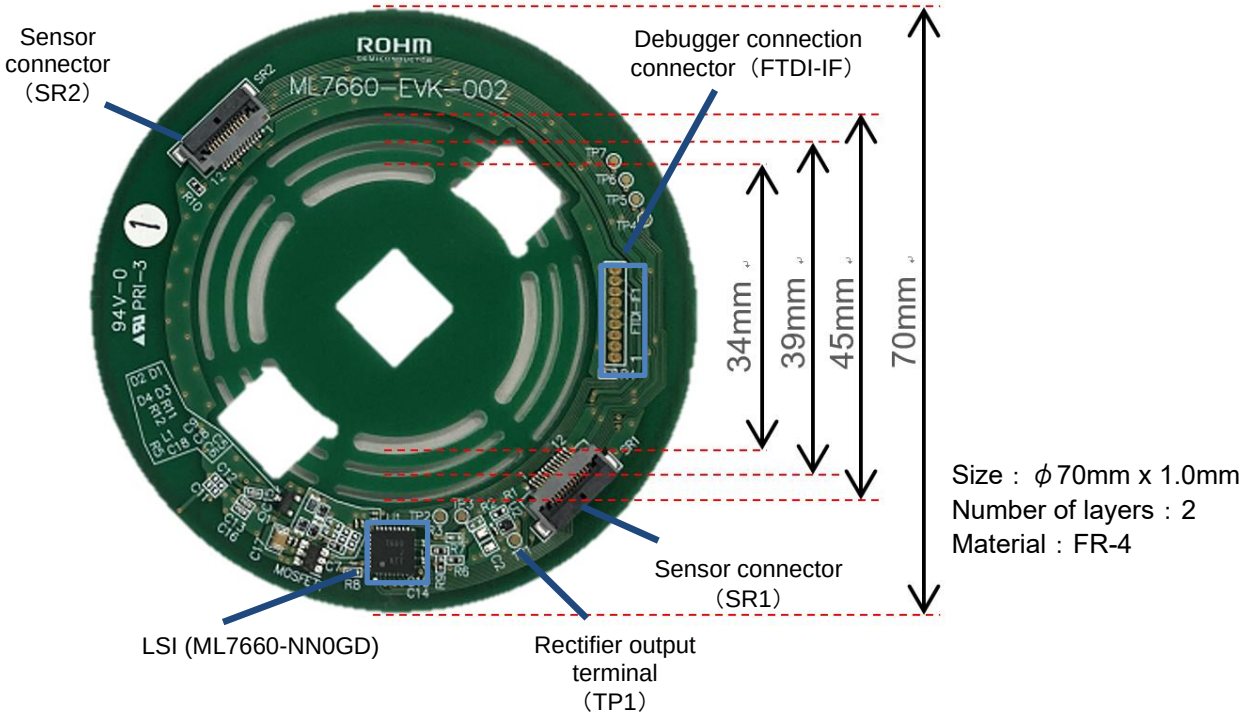


Figure 2. ML7660-EVK-002 board external view

1.5.2 ML7661-EVK-002 Specification

Figure 3 shows the external view of the ML7661-EVK-002.
The ML7661-EVK-002 consists of the ML7661-210GD and a circular antenna.

- When 5V is applied to the power supply connector (CN1), a high-frequency magnetic field is generated to supply power to the RX board.
- Equipped with a HOST interface connector (FTDI-IF) that connects to the host microcontroller and FTDI board.
- Can be connected to the debug terminal monitor connector (TP1) to monitor the operating status.
- Equipped with screw holes for fixing the board.

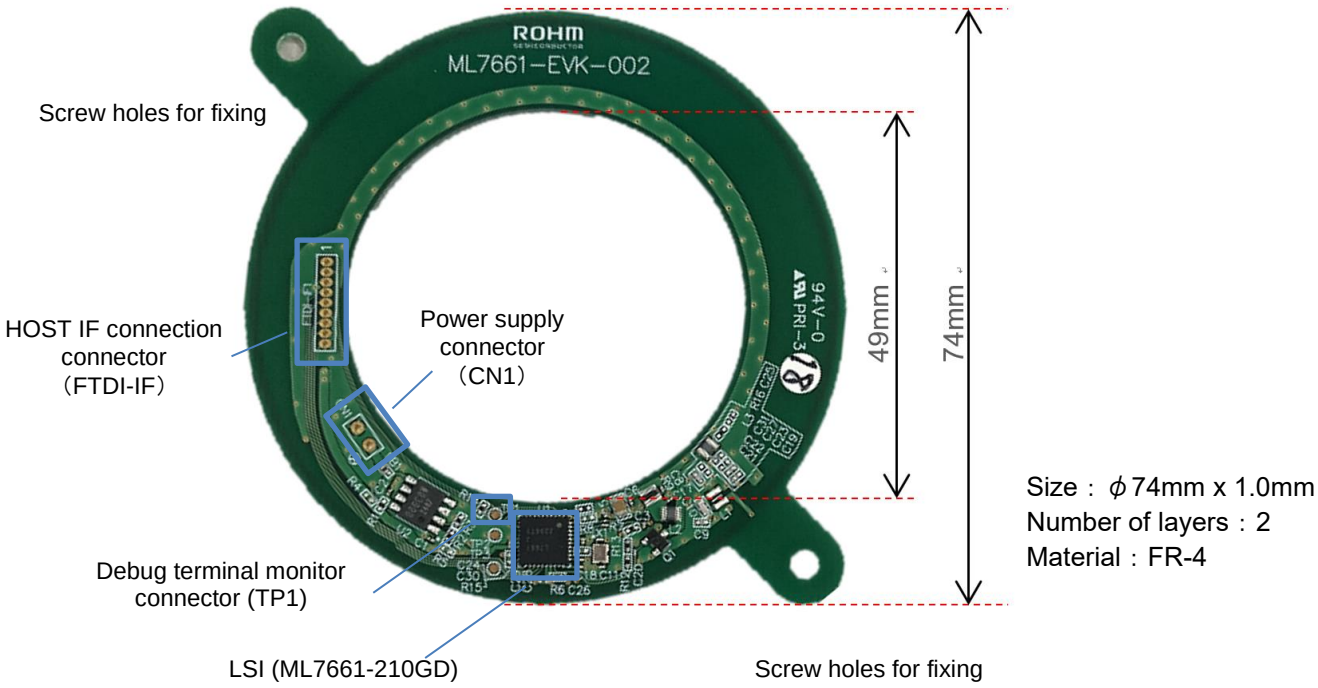


Figure 2. ML7661-EVK-002 board external view

2. Function

2.1 Power supply circuit

Adjust the voltage so that it is +5V at the power supply connector (CN1) of the ML7661-EVK-002.
Set the current limit to 500mA to prevent damage to the LSI or external components due to overcurrent.

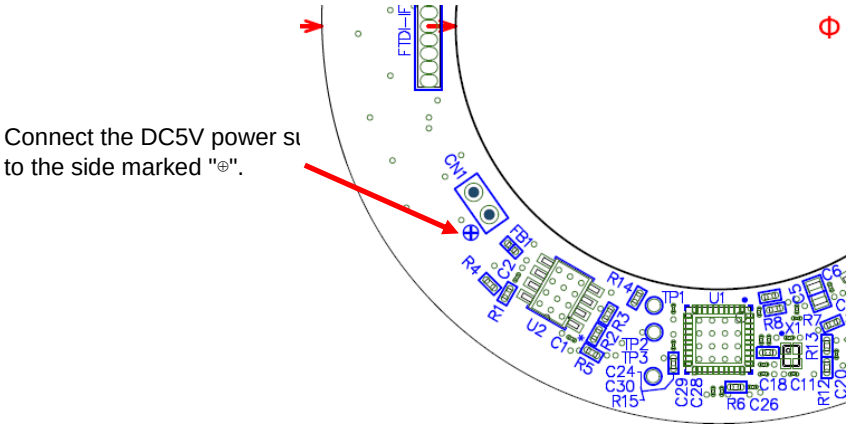


Figure 4. ML7661-EVK-002 power terminal connection

2.2 Antenna

Align the antennas of the ML7661-EVK-002 and ML7660-EVK-002 facing each other as shown in the diagram below.
To keep the distance between the antennas constant, insert a 3mm spacer between the antennas and secure it with tape.
Aligning the antenna holes will ensure that the centres of the antennas match.

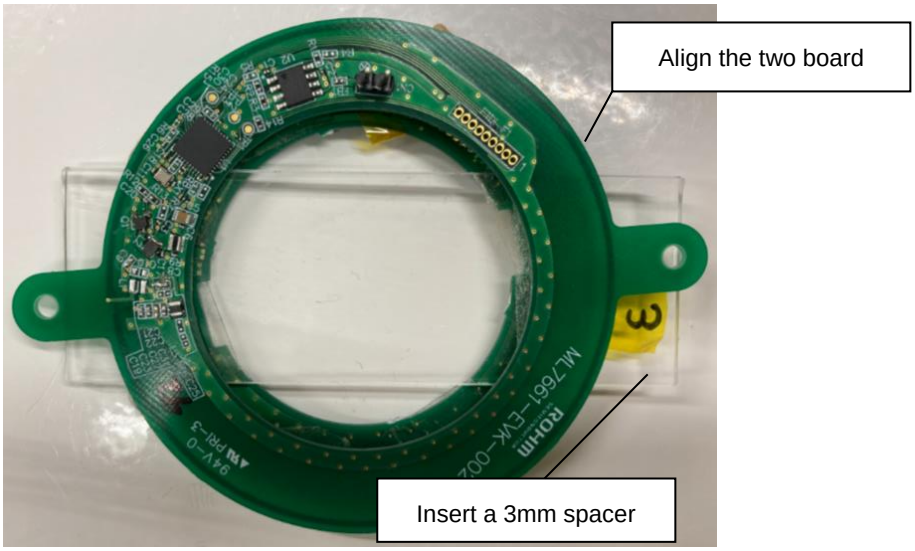


Figure 5. ML7660-EVK-002/ML7661-EVK-002 antenna placement

2.3 Connection to the host microcontroller（ML7661　FTDI-IF）

Connect the SPI terminal of the host microcontroller to pins 4 to 9 of FTDI-IF1 on the ML7661-EVK-002 (Figure 6). For reference on how to control from the host microcontroller, refer to the NFC Reference Software Host Command Manual

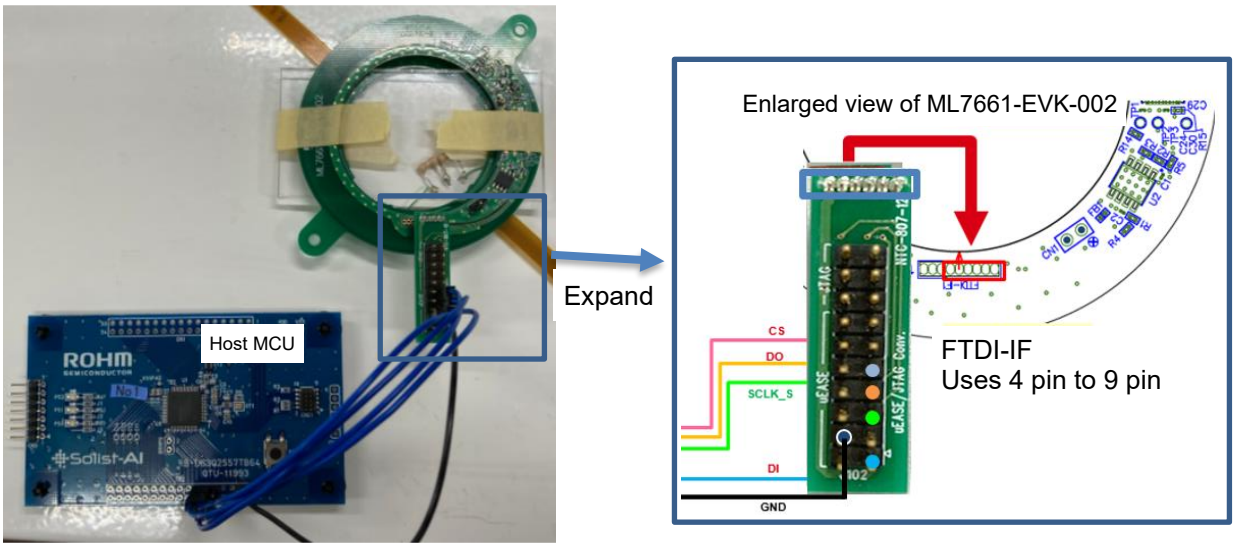


Figure 6. SPI connection to host microcontroller

2.4 Connection to the FTDI board（ML7661　FTDI-IF）

It is possible to rewrite the configuration data of the ML7661 and ML7660 using the FTDI board.
The ML7660 rewrites using the ML7661's NFC communication function.
When using the evaluation kit, connect to the FTDI board and perform evaluation.
Connect the SPI terminals of the FTDI board to pins 4 to 9 of FTDI-IF1 on the ML7661-EVK-002 (Figure 7).
For information on how to use the configuration tool and parameters, refer to the configuration tool manual and the ML7660/ML7661 application note.

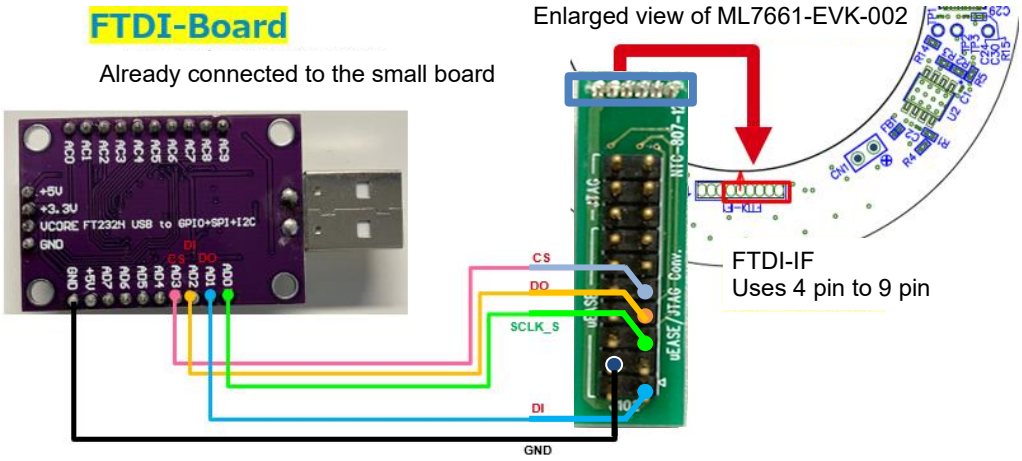


Figure 7. Connection to FTDI board

2.5 Connecting to EASE1000V2 Debugger (ML7660　FTDI-IF)

By using the SDK, it is possible to modify the ML7660 software to suit the sensor specifications.
Use ROHM's EASE1000V2 as a debugger when developing programs.
Connect the EASE1000V2 terminal to the FTDI-IF1 of the ML7660-EVK-002 (Figure 8).
For reference on how to use the SDK, please refer to the ML7661/ML7660 Batteryless SDK Software Manual.

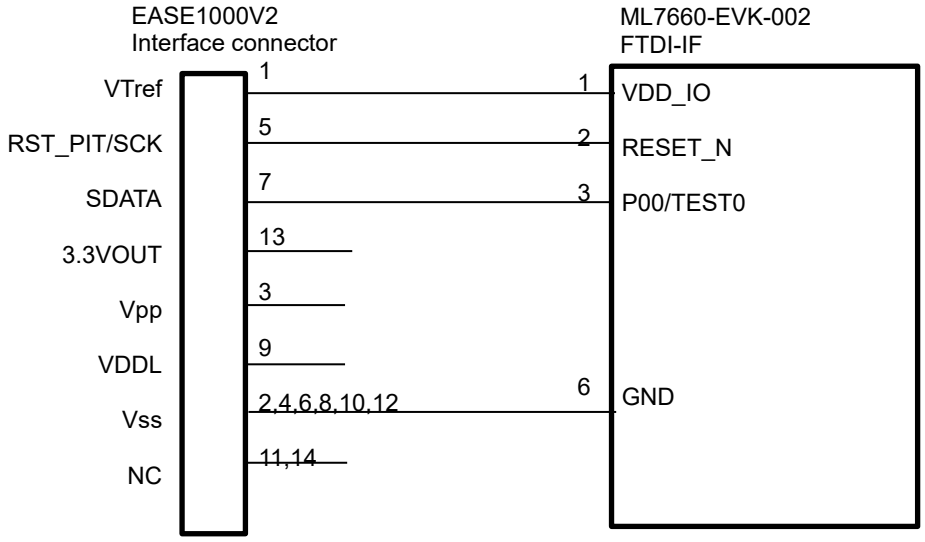


Figure 8. EASE1000V2 and ML7660-EVK-002 connection diagram

2.6 Connecting to the Sensor（ML7660　SR1/SR2）

Please connect the sensor to the SR1 and SR2 connectors of the ML7660-EVK-002. The ML7660-NN0GD mounted on the ML7660-EVK-002 is programmed to match the interface of the SR300 series manufactured by Glosel Co., Ltd.
When connecting two SR300 series units, please set them to different sensor IDs.
If you use a different sensor, please change the ML7660 software to match the sensor specifications.

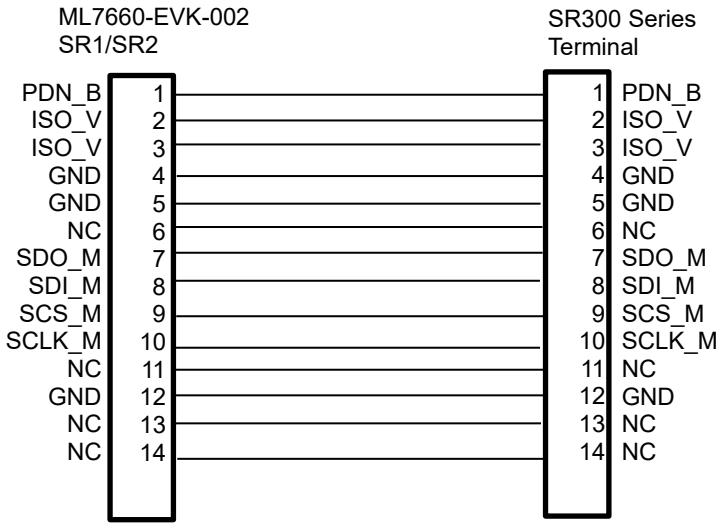
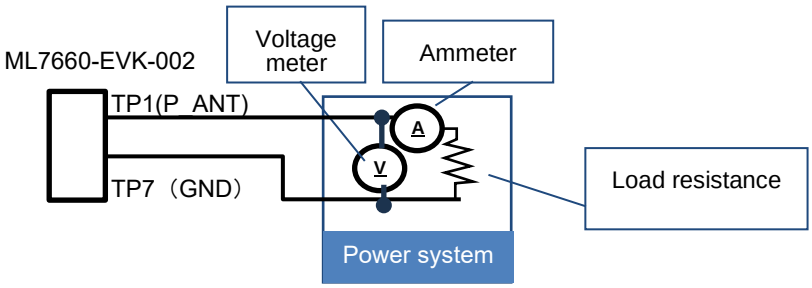


Figure 9. Connection diagram of the SR300 series sensor and the ML7660-EVK-002

2.7 Power supply from ML7660 to the system（ML7660 P_ANT）

The power obtained through wireless power transfer is output to the P_ANT terminal. Connect the power supply for the system connected to the ML7660-EVK-002 to the P_ANT terminal.
To check the amount of power received by the ML7660-EVK-002, check the P_ANT terminal of the rectified output connector (CN1).
To measure this voltage and current, connect a voltmeter, ammeter, and load resistor as shown in the diagram below.



[Caution]
Do not connect an electronic load. The terminals of the electronic load (internal capacitance or current ripple) may affect the product and cause it to malfunction.

2.8 Connecting to the Debug port monitor (ML7660 TP1）

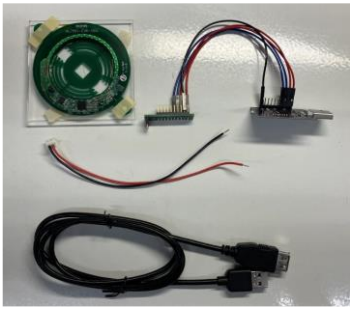
When debugging the operation of the ML7661-EVK-002, connect an oscilloscope to the debug terminal monitor connector (TP1). For information on debugging methods and output waveforms, refer to the ML7660/ML7661 application notes.

3. Evaluation Tool

3.1 Evaluation Kit

We have prepared a rotating object reference evaluation kit (ML766XRT2-EVK-001) that can be used to check the operation of the ML7660-EVK-002 / ML7661-EVK-002. The evaluation kit is programmed assuming sensor control of the SR300 series manufactured by Glosel Co., Ltd.
When using your own sensor, please modify the software to match the sensor specifications.
When using the evaluation kit, in addition to the evaluation kit provided by ROHM, the following [customer preparations] are required.

[Included]
- ML7660-EVK-002/ML7661-EVK-002 board (with 3mm thick acrylic spacer)
- FTDI-Board & conversion board, EASE1000V2 conversion board
- Power cable
- USB extension cable



[Software provided]
- GUI tool: BatteryLessDemo.exe

[Preparation by customer]
- PC (※)
- Stabilized power supply (5V/0.5A)
- Sensor (SR300 manufactured by Glosel Co., Ltd.)
- Resistive load (volume resistor, etc.)
- Voltmeter and ammeter for measuring power

(※) Please install the demo application software provided by ROHM on your PC.

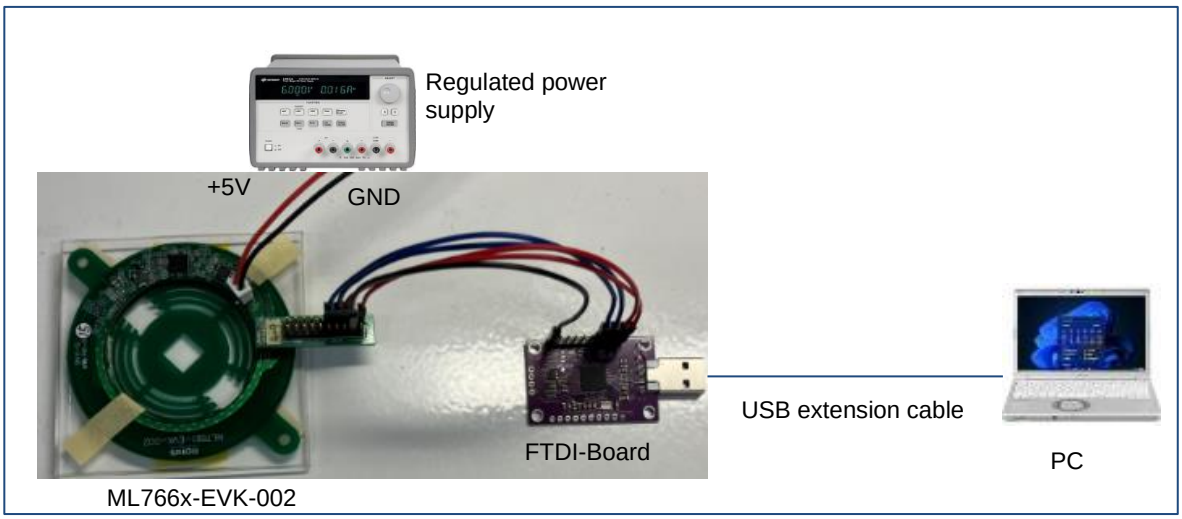


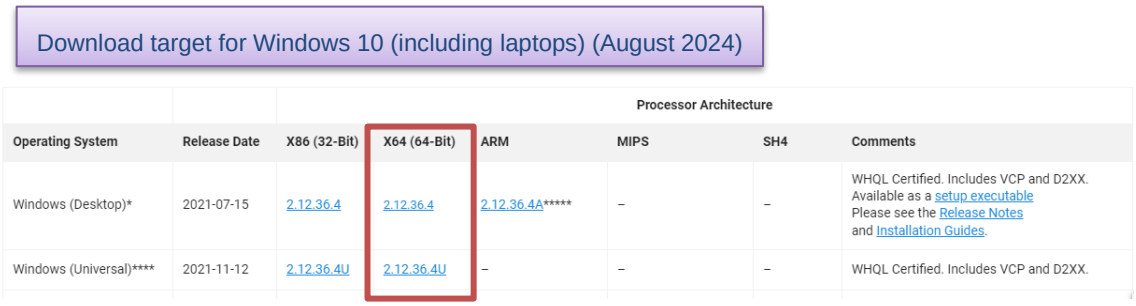
Figure 10. Connection diagram

3.2 Evaluation Process

3.2.1 Computer setting

3.2.1.1 Installing FTDI drivers

If you connect the FTDI Board to your PC and it is not recognized by the PC, you will need to install the FTDI driver.
The device driver can be downloaded for free from the FTDI website.
It is supported on multiple operating systems, including Windows, Linux, Mac, and Windows CE.TDI Board
https://www.ftdichip.com/Drivers/D2XX.htm


Download target for Windows 10 (including laptops) (August 2024)

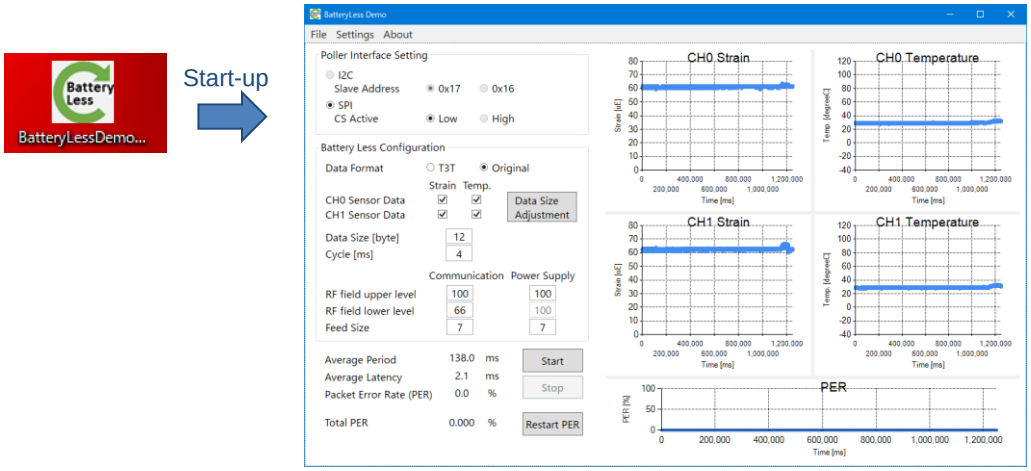
		Processor Architecture					
Operating System	Release Date	X86 (32-Bit)	X64 (64-Bit)	ARM	MIPS	SH4	Comments
Windows (Desktop)*	2021-07-15	2.12.36.4	2.12.36.4	2.12.36.4A*****	–	–	WHQL Certified. Includes VCP and D2XX. Available as a setup executable Please see the Release Notes and Installation Guides.
Windows (Universal)****	2021-11-12	2.12.36.4U	2.12.36.4U	–	–	–	WHQL Certified. Includes VCP and D2XX.

This GUI tool has been confirmed to work on Windows 10 PCs.
Download the latest version (see right) for Windows (Desktop) from the website above.
As of February 2025, it is "CDM-v2.12.36.4-WHQL-Certified.zip".
Unzip this file to a suitable folder.
Please install the driver with administrator privileges on the PC.
* Please note that depending on your company's security environment, you may need to disable security before running the tool.
- If the FTDI Board is not automatically recognized by the PC, you will need to install the FTDI driver manually.
If it is not recognized by the PC, the following will be displayed in Device Manager.

- Right-click and click "Update driver (P)".
- Click "Browse my computer for driver software (R)".
- Specify the location of the extracted folder for the FTDI driver.
- Run the installation. The Start button on the GUI tool will now function with mouse clicks.

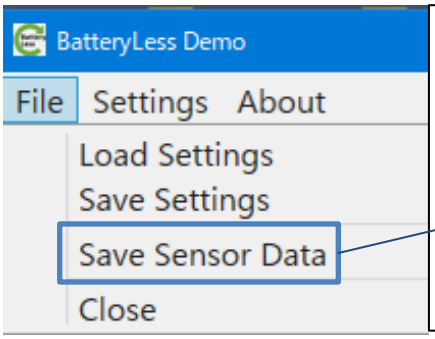
3.2.2 Demo application software program execution

1. When the PC and FTDI-Board are connected with an extension cable, the LED (red) on the FTDI-Board will light up.
2. Apply 5.0V DC from the stabilized power supply.
3. Start the GUI tool. Start by running (double-clicking) the executable file (BatteryLessDemo.exe).
4. After making various settings, press the Start button to display a graph of the data acquired by the sensor.
   Press the Stop button to end the measurement.



The following can be evaluated using this evaluation kit (ML766XRT2-EVK-001).

1. Sensor (strain, temperature) data
   Select Menu > File > Save Sensor Data to output the data in CSV format and check.



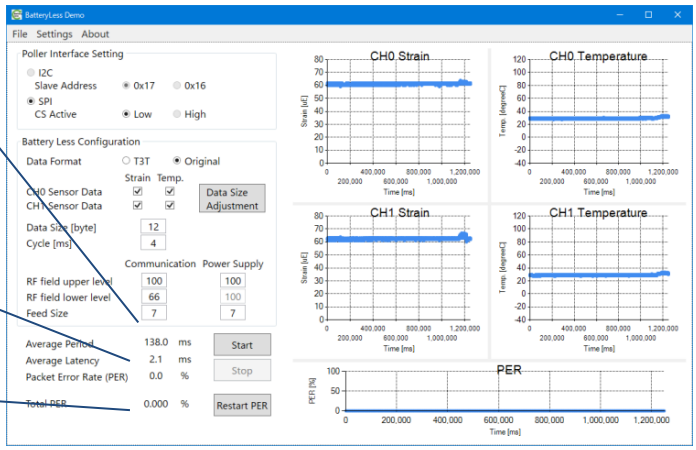
The following data is stored in the CSV.
- Strain data for Ch0: Strain0
- Strain data for Ch1: Strain1
- Temperature data for Ch0: Temp0
- Temperature data for Ch1: Temp1
- Number of successful TX↔RX communications: Success
- Number of successful TX↔RX communications: Failure
- TX↔RX communication PER: PER

2.Delay value, error rate
   This can be confirmed on the GUI.

Latency (Average Latency) :
Displays the delay between when the ML7660 acquires data and when the ML7661 receives the data

Error Rate (Packet Error Rate) :
Displays the most recent NFC communication error rate

Accumulative Error Rate (Total PER):
Displays the cumulative NFC communication error rate.

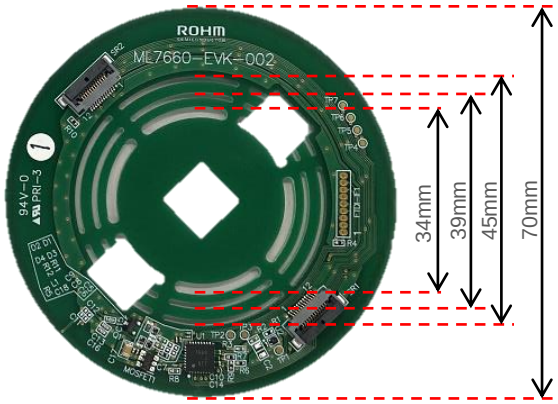


4. Hardware information

4.1 ML7660-EVK-002

4.1.1 PCB

- Size: φ70mm x 0.5mm
- Number of layers: 2
- Material: FR-4



4.1.2 Schematic

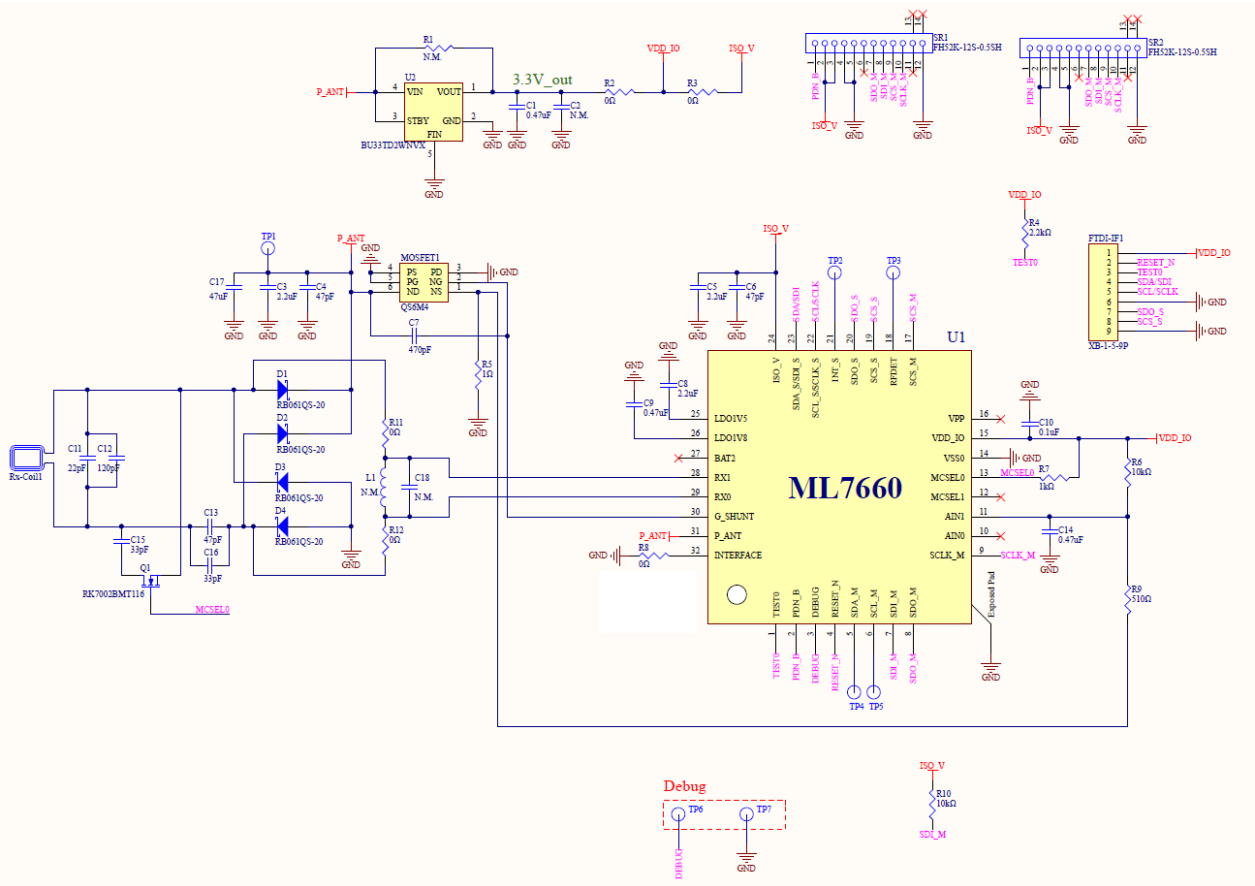


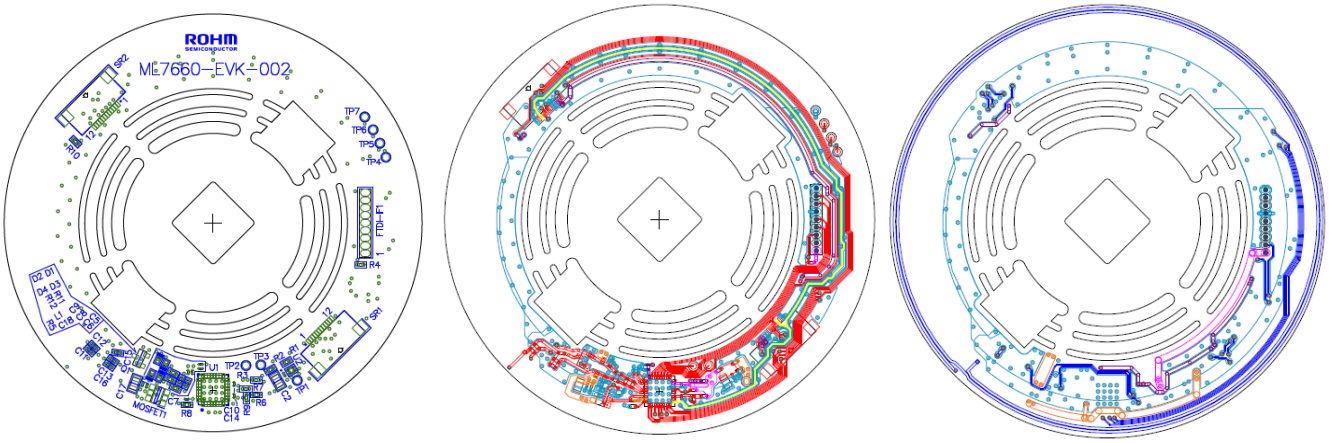
Figure 11. ML7660-EVK-002 circuit diagram

4.1.3 BOM List

Table-2. ML7660-EVK-002 parts list

Designator	Value	Size	Part Number	Maker	Mounted
C1, C9, C14	0.47uF	0603(JIS)	GRM033R60J474KE90#	Murata	○
C2	N.M.	2012(JIS)	-	-	-
C3, C5, C8	2.2uF	0603(JIS)	GRM033R61A225KE47#	Murata	○
C4	47pF	0603(JIS)	GRM0335C1H470FA01#	Murata	○
C6	47pF	0603(JIS)	GRM0335C1H470FA01#	Murata	○
C7	470pF	0603(JIS)	GRM033R11C471KA01#	Murata	○
C10	0.1uF	0603(JIS)	GRM033R61C104KE18#	Murata	○
C11	22pF	1005(JIS)	GRM1555C2A220GA01#	Murata	○
C12	120pF	1005(JIS)	GRM1555C2A121GE01#	Murata	○
C13	47pF	1005(JIS)	GRM1555C2A470GA01#	Murata	○
C15, C16	33pF	1005(JIS)	GRM1555C2A330GA01#	Murata	○
C17	47uF	2012(JIS)	GRM21BR61A476ME15#	Murata	-
C18	N.M.	1005(JIS)	-	-	-
D1, D2, D3, D4	-	SMD1006	RB061QS-20	Rohm	○
FTDI-IF1	9-Pin Header	9-Pin(Pitch=1.27mm)	XB-1-5-9P	-	-
L1	N.M.	1005(JIS)	-	-	-
MOSFET1	-	SOT-457T	QS6M4TR	Rohm	○
Q1	-	SOT-23	RK7002BMT116	Rohm	○
R1	N.M.	1005(JIS)	-	-	-
R2, R3, R8, R11, R12	0Ω	1005(JIS)	RK73Z1ERTTP	KOA	○
R4	2.2kΩ	1005(JIS)	MCR01MZPJ222	Rohm	○
R5	1Ω	1005(JIS)	MCR01MZPJ1R0	Rohm	○
R6, R10	10kΩ	1005(JIS)	MCR01MZPJ103	Rohm	○
R7	1kΩ	1005(JIS)	MCR01MZPJ102	Rohm	○
R9	510Ω	1005(JIS)	MCR01MZPJ511	Rohm	○
Rx-Coil1	Pattern Coil	-	-	-	-
SR1, SR2	12P(0.5mm Pitch)-Receptacle	W=11.1mm, H=2.0mm	FH52K-12S-0.5SH	Hirose	○
TP1	Small Pad	φ=1.0mm	-	-	-
TP2	Small Pad	φ=1.0mm	-	-	-
TP3	Small Pad	φ=1.0mm	-	-	-
TP4	Small Pad	φ=1.0mm	-	-	-
TP5	Small Pad	φ=1.0mm	-	-	-
TP6	Small Pad	φ=1.0mm	-	-	-
TP7	Small Pad	φ=1.0mm	-	-	-
U1	-	WQFN32(5mm x 5mm)	ML7660-NN0GD	Rohm	○
U2	-	SSON004X1010(1.0mm x 1.0mm x 0.6mm)	BU33TD2WNVX	Rohm	○

4.1.4 Layout



SILK L1 L2

4.1.5 External Interface Information

Connector for Rectification output monitor

TP No	Terminal Name	I/O	explanation
1	P_ANT		Rectifier circuit output monitor terminal
7	GND		ground

Connector for Debugging

TP No	Terminal Name	I/O	explanation
2	INT_S		Unused
3	RFDET		Unused
4	SDA_M		Unused
5	SCL_M		Unused
6	DEBUG		Unused

Connector for Debugger

CN No	PIN No	Terminal Name	I/O	explanation
FTDI-IF	1	VDD_IO		Logic IO power supply terminal
	2	RESET_N	I	Reset Input Terminal (for EASE1000V2 debugger)
	3	TEST0	I/O	Debugger input/output terminal (for EASE1000V2 debugger)
	4	SDA/SDI		Unused
	5	SCL/SCLK		Unused
	6	GND		ground
	7	SDO_S		Unused
	8	SCS_S		Unused
	9	GND		ground

Connector for Sensor

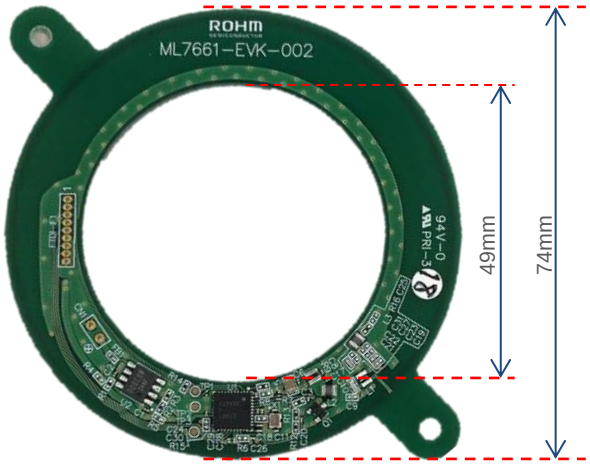
CN No	PIN No	Terminal Name	I/O	explanation
SR1	1	PDN_B		Unused
	2	ISO_V		Logic IO power supply terminal (for Host IF)
	3	ISO_V		Logic IO power supply terminal (for Host IF)
	4	GND		ground
	5	GND		ground
	6	NC		NC pin
	7	SDO_M	O	SPI Controller data output terminal
	8	SDI_M	I	SPI Controller data input terminal
	9	SCS_M	O	SPI Controller chip select input terminal
	10	SCLK_M	O	SPI Controller clock input terminal
	11	NC		NC pin
	12	GND		ground
	13	NC		NC pin
	14	NC		NC pin

CN No	PIN No	Terminal Name	I/O	explanation
SR2	1	PDN_B		Unused
	2	ISO_V		Logic IO power supply terminal (for Host IF)
	3	ISO_V		Logic IO power supply terminal (for Host IF)
	4	GND		ground
	5	GND		ground
	6	NC		NC pin
	7	SDO_M	O	SPI Controller data output terminal
	8	SDI_M	I	SPI Controller data input terminal
	9	SCS_M	O	SPI Controller chip select input terminal
	10	SCLK_M	O	SPI Controller clock input terminal
	11	NC		NC pin
	12	GND		ground
	13	NC		NC pin
	14	NC		NC pin

4.2 ML7661-EVK-002

4.2.1 PCB

- Size: φ74mm x 0.5mm
- Number of layers: 2
- Material: FR-4



4.2.2 Schematic

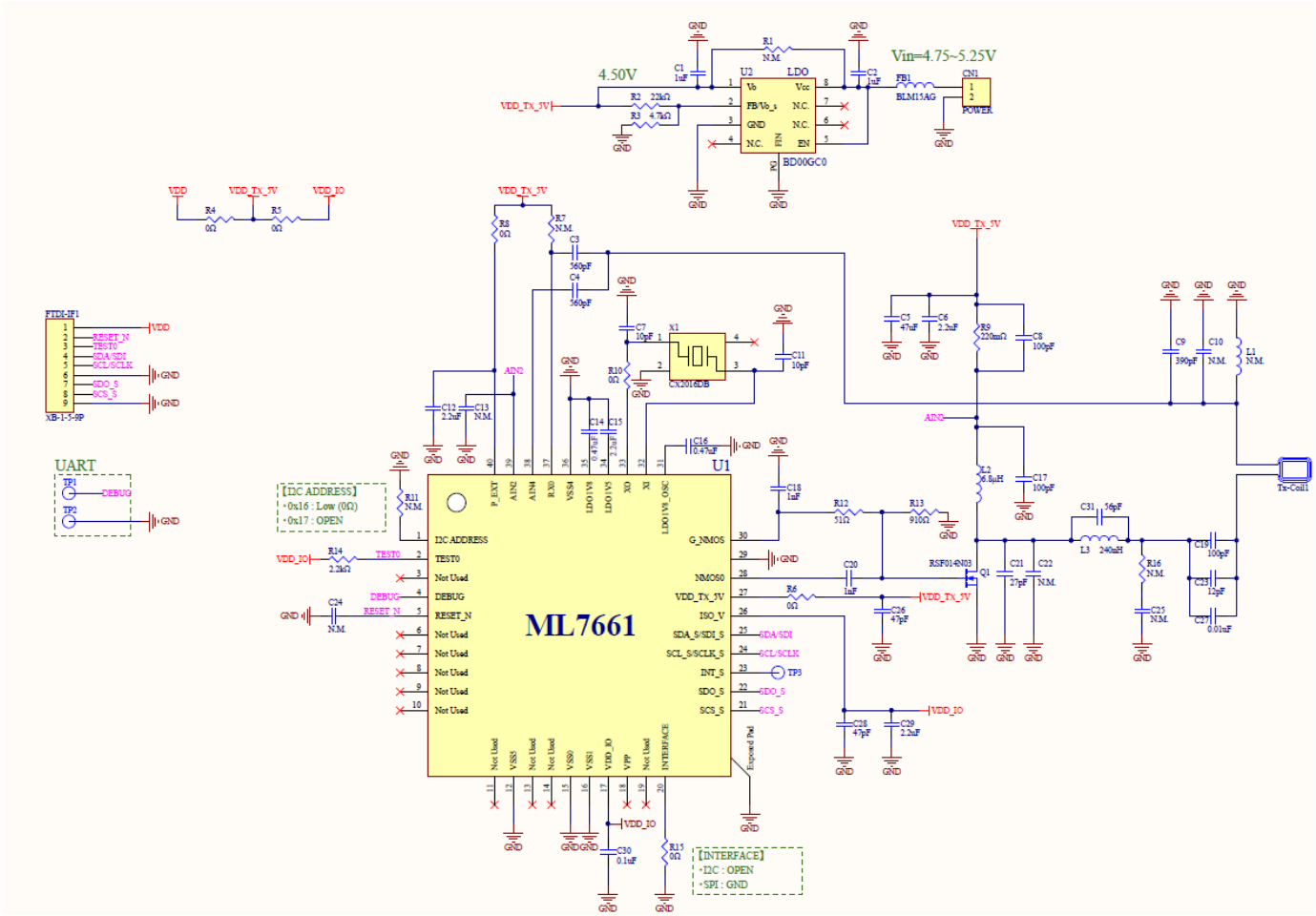


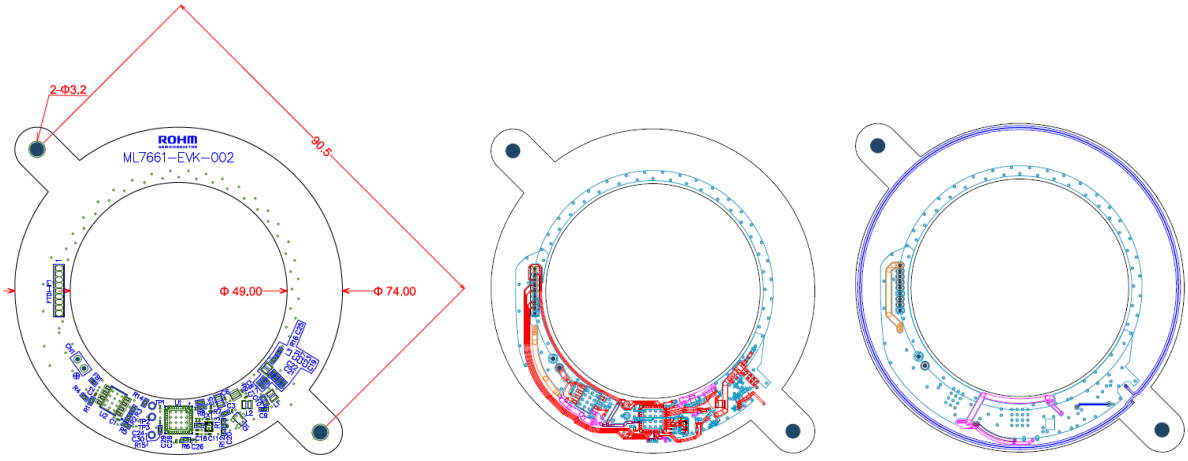
Figure 12. ML7661-EVK-002 circuit diagram

4.2.3 BOM List

Table 3. ML7661-EVK-002 Parts List

Designator	Value	Size	Part Number	Maker	Mounted
C1, C2	1uF	0603(JIS)	GRM033R61A105ME15#	Murata	○
C3, C4	560pF	0603(JIS)	GRM033R71C561KA01#	Murata	○
C5	47uF	2012(JIS)	GRM21BR61A476ME15#	Murata	○
C6, C12, C15, C29	2.2uF	0603(JIS)	GRM035R61C225ME01#	Murata	○
C7, C11	10pF	0603(JIS)	GRM0335C1H100FA01#	Murata	○
C8, C17	100pF	0603(JIS)	GRM0335C1H101FA01#	Murata	○
C9	390pF	1005(JIS)	GRM1555C1H391FA01#	Murata	○
C10	N.M.	1608(JIS)	-	-	-
C13, C24	N.M.	0603(JIS)	-	-	-
C14, C16	0.47uF	0603(JIS)	GRM033R60J474KE90#	Murata	○
C18	1nF	0603(JIS)	GRM033B11E102KA01#	Murata	○
C19	100pF	1005(JIS)	GRM1555C2A101GA01#	Murata	○
C20	1nF	0603(JIS)	GRM0335C1E102FA01#	Murata	○
C21	27pF	1005(JIS)	GCM1555C1H270FA16#	Murata	○
C22	N.M.	1005(JIS)	-	-	-
C23	12pF	1005(JIS)	GRM1555C2A120GA01#	Murata	○
C25	N.M.	1005(JIS)	-	-	-
C26, C28	47pF	0603(JIS)	GRM0335C1E470JA01#	Murata	○
C27	0.01uF	1005(JIS)	GRM1555CYA103GE01#	Murata	○
C30	0.1uF	0603(JIS)	GRM033R61C104KE18#	Murata	○
C31	56pF	1005(JIS)	GRM1555C2A560GA01#	Murata	○
CN1	2-Pin Header	2-Pin(Pitch=2.54mm, φ=1.0mm)	-	-	-
FB1	-	1005(JIS)	BLM15AG100SN1D	Murata	○
FTDI-IF1	9-Pin Header	9-Pin(Pitch=1.27mm)	XB-1-5-9P	-	-
L1	N.M.	2mm×1.6mm	-	-	-
L2	6.8μH	2mm×1.6mm	LQH2MPN6R8MGRL	Murata	○
L3	240nH	2mm×1.6mm	LQM2MPNR24MEHL	Murata	○
Q1	-	SOT-323T	RSF014N03		Difference Size ○
R1, R7, R11	N.M.	1005(JIS)	-	-	-
R2	22kΩ	1005(JIS)	MCR01MZPJ223	Rohm	○
R3	4.7kΩ	1005(JIS)	MCR01MZPJ472	Rohm	○
R4, R5, R6, R8, R10, R15	0Ω	1005(JIS)	RK73Z1ERTTP	KOA	○
R9	220mΩ	1.2mm×2.0mm	LTR10LPZPZFLR220	Rohm	○
R12	51Ω	1005(JIS)	MCR01MZPJ510	Rohm	○
R13	910Ω	1005(JIS)	MCR01MZPJ911	Rohm	○
R14	2.2kΩ	1005(JIS)	MCR01MZPJ222	Rohm	○
R16	N.M.	1005JIS)	-	-	-
TP1	Small Pad	φ=1.0mm	-	-	-
TP2	Small Pad	φ=1.0mm	-	-	-
TP3	Small Pad	φ=1.0mm	-	-	-
Tx-Coil1	Pattern Coil	-	-	-	-
U1	-	WQFN40(6mm x 6mm)	ML7661-210GD	Rohm	○
U2	-	HTSOP-J8	BD00GC0	Rohm	○
X1	-	2.0mm×1.6mm	CX2016DB27120D0	Kyocera	○

4.2.4 Layout



SILK L1 L2

4.2.5 External Interface

Connector for Debug terminal monitor

TP No	Terminal Name	I/O	explanation
1	DEBUG	O	Debug terminal
2	GND		ground

Connector for Power supply

CN No	PIN No	Terminal Name	I/O	explanation
CN1	1	POWER		Power input terminal (+5V)
	2	GND		ground

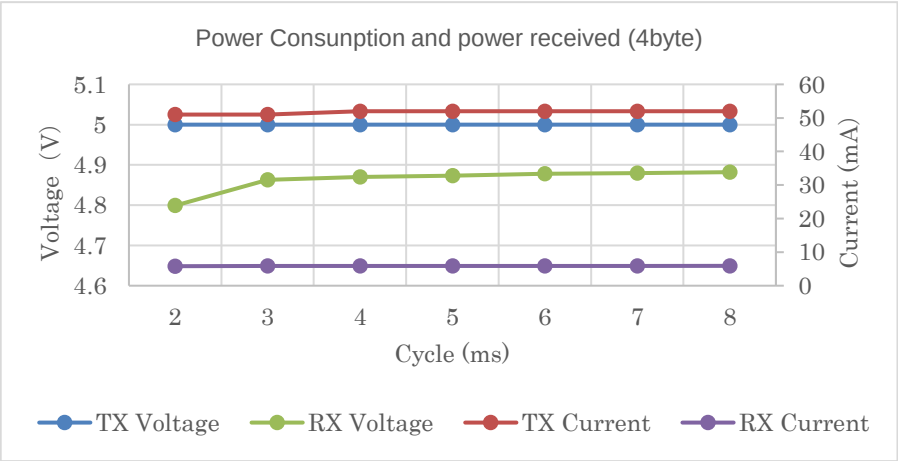
Connector for FTDI, Host Microcontroller

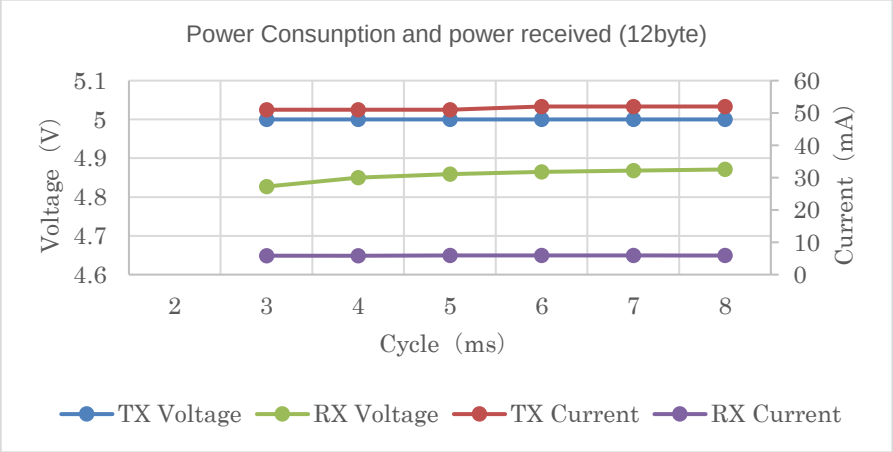
CN No	PIN No	Terminal Name	I/O	explanation
FTDI-IF	1	VDD_IO		Logic IO power supply terminal
	2	RESET_N		Unused
	3	TEST0		Unused
	4	SDA/SDI	I	SPI Peripheral data input terminal
	5	SCL/SCLK	I	SPI Peripheral clock input terminal
	6	GND		Ground
	7	SDO_S	O	SPI Peripheral data output terminal
	8	SCS_S	I	SPI Peripheral chip select input terminal
	9	GND		ground

5. Evaluation data for reference

5.1 Current Consumption

The current consumption changes depending on the data communication cycle and size.
The longer the cycle, the higher the current consumption.
The trends in current consumption of the TX board and the amount of power received by the RX board are shown below.
When the communication size is 4 bytes or less, operation is possible with a cycle of 2 ms or more, but when it is 8 bytes or more, a cycle of 3 ms or more is required for operation.



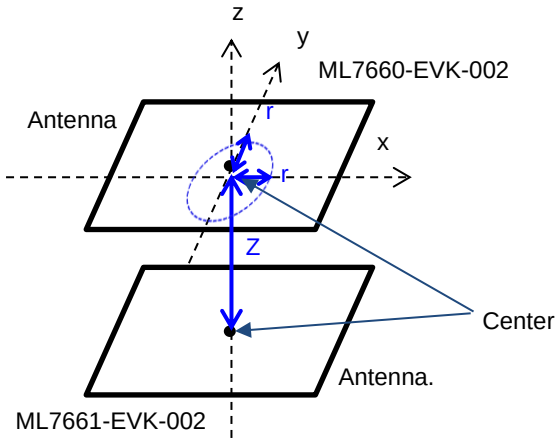


Conditions
Voltage: 5V
Room Temperature: 25 degree
Distance between antennas: 3mm
Data size: 2byte, 4byte, 12byte
Cycle: 2ms/3ms. 8ms
Load Resistance: 825 ohms

Note: The data listed is for reference only and is not a guaranteed value.

5.2 Operating Area

The antenna placement for the ML7660-EVK-002/ML7661-EVK-002 is 3mm in the Z (height) direction, and is intended to be used with the central axis aligned.
This placement has been adjusted to provide optimal communication and power supply.
These are the results of checking the operating area when the position is misaligned from this placement.
Operation is possible even with a misalignment of ±2mm in the height direction, ±7.5mm on the X axis, and ±5mm on the Y axis in the horizontal direction.
The change in current consumption and current received due to this misalignment is shown below.



Definition of operating region evaluation

Conditions
Voltage: 5V
Room Temperature: 25 degree
Data size: 4byte
Cycle: 5ms
Load Resistance: 825 ohms

Planar operating area and current consumption (Z=3mm)

Unit: mA

	-7.5mm	-5mm	-2.5mm	0mm	+2.5mm	+5mm	+7.5mm
+7.5mm	-	-	-	-	-	-	-
+5mm	-	-	59	61	61	-	-
+2.5mm	-	62	59	55	61	62	-
0mm	65	61	57	51	54	61	63
-2.5mm	-	64	58	54	55	59	-
-5mm	-	-	60	59	56	-	-
-7.5mm	-	-	-	-	-	-	-

Planar operating area and power receiving amount (Z=3mm)

Unit; mA

	-7.5mm	-5mm	-2.5mm	0mm	+2.5mm	+5mm	+7.5mm
+7.5mm	-	-	-	-	-	-	-
+5mm	-	-	5.93	5.94	5.94	-	-
+2.5mm	-	5.95	5.94	5.93	5.94	5.94	-
0mm	5.94	5.95	5.94	5.91	5.93	5.94	5.94
-2.5mm	-	5.95	5.94	5.93	5.93	5.94	-
-5mm	-	-	5.94	5.94	5.94	-	-
-7.5mm	-	-	-	-	-	-	-

Height direction operating area, current consumption and power receiving amount (X=0mm、Y=0mm)

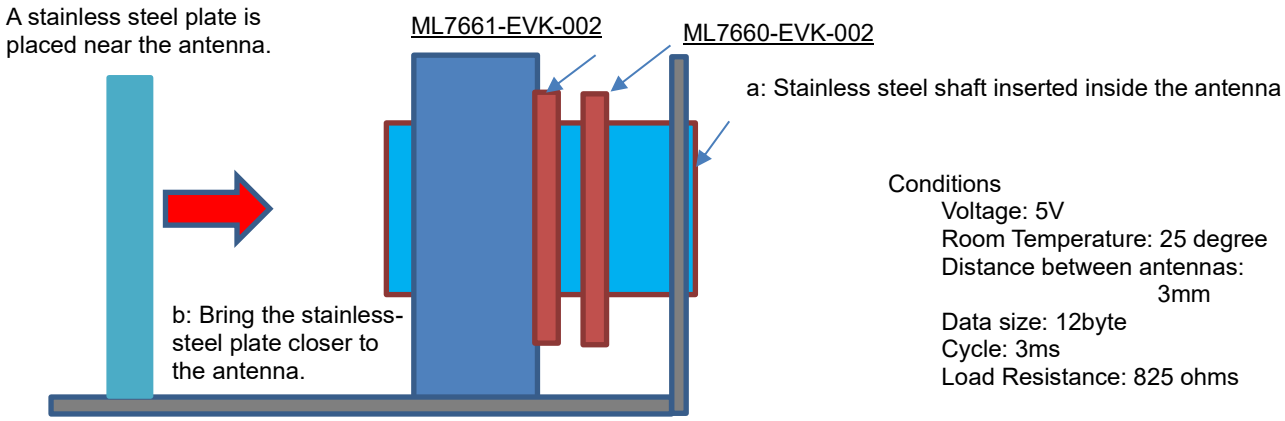
Unit：mA

	Current consumption	Power receiving
1mm	46	5.54
2mm	50	5.84
3mm	52	5.91
4mm	60	5.94
5mm	69	5.94

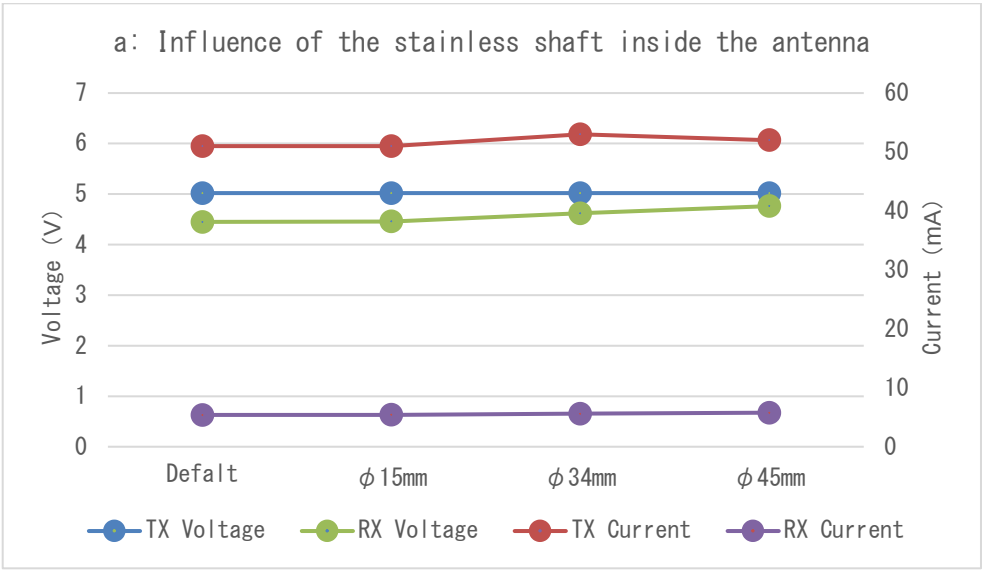
Note: The data listed is for reference only and is not a guaranteed value.

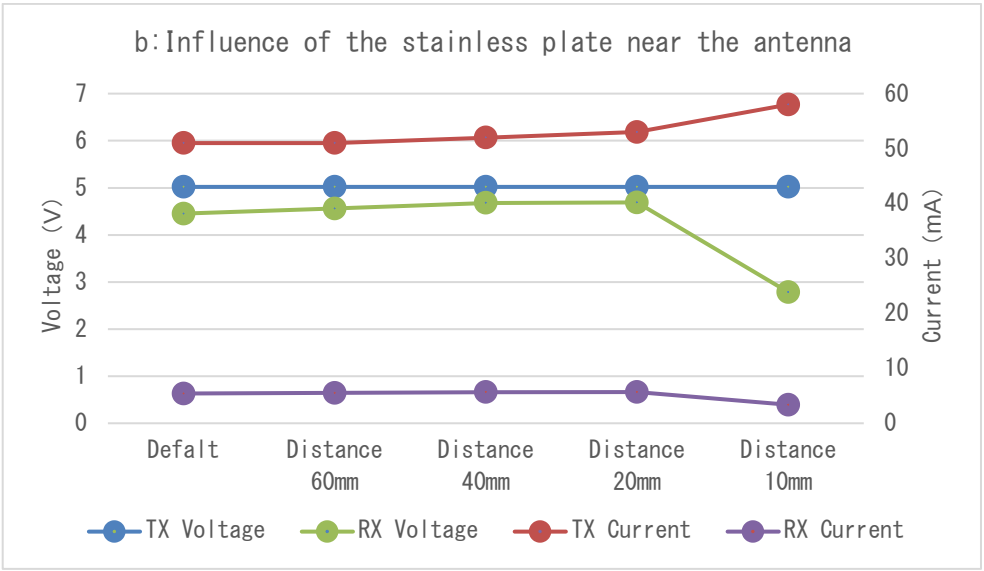
5.3 Effects of Metals

These are the results of an evaluation of the effect of the stainless steel placed on the shaft and housing on the amount of received power.
The effect of the stainless steel shaft is small, but the stainless steel plate near the antenna has an effect at a distance of



Conditions
Voltage: 5V
Room Temperature: 25 degree
Distance between antennas: 3mm
Data size: 12byte
Cycle: 3ms
Load Resistance: 825 ohms

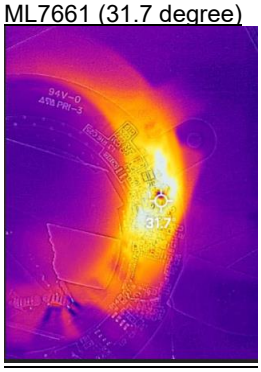
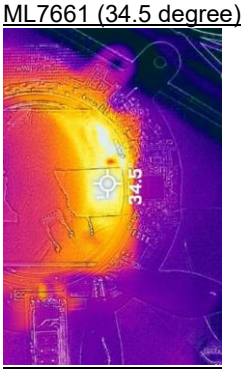
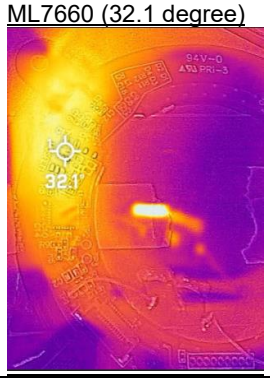




Note: The data listed is for reference only and is not a guaranteed value.

5.4 Temperature Measurement Result

The evaluation results of the board temperature during power supply operation are as follows.
We checked the temperature rise of the board under conditions of long communication times and long power supply times.
We confirmed that under both conditions the temperature rise only reached 35 degree or less.。

	Long communication Data: 4byte Cycle: 2ms	Long power supply Data: 4byte Cycle: 8ms
ML7661 position 	ML7661 (31.7 degree) 	ML7661 (34.5 degree) 
ML7660 position 	ML7660 (32.1 degree) 	ML7660 (32.2 degree) 

Conditions
Voltage: 5V
Room Temperature: 25 degree
Distance between antennas:
XY=0mm, Z=3mm
Data size: 4byte
Cycle: 2ms, 8ms
Load Resistance: 825 ohms

Note: The data listed is for reference only. It is not a guaranteed value.
Temperatures may vary depending on the actual usage environment.

6. Notes

- ROHM shall not be liable for any modification or illegal use of this product.
- This evaluation kit has not been confirmed to comply with the radio laws of each country.
  ROHM recommend using it in a test facility such as an anechoic chamber to avoid interference with other devices.
- To avoid interference from metals, keep the evaluation board as far away as possible from metals.
- Avoid placing metals around the antenna coil.
  If metals are nearby, keep them at least about 4 cm away from the antenna coil.
- If strong force is applied to the antenna coil on the evaluation board, the antenna part may be broken.
- Depending on the conditions of use, the surface temperature of some components and antennas can rise to around 65°C.
- Some circuits may be subject to high voltage, such as 100 V. If the related circuits are accidentally shorted, there is a risk of circuit breakdown, fire, or electric shock.

Revision History

Document No.	Issue Date	Page		Description
		Previous Edition	Previous Edition	
FEXT766x-EVK-002_UG-01	Feb. 19, 2025	–	–	first edition

Notice

Precaution on using ROHM Products

1) When using ROHM Products, refer to the latest product information and ensure that usage conditions (absolute maximum ratings[*1], recommended operating conditions, etc.) are within the ranges specified. ROHM disclaims any and all liability for any malfunctions, failure or accident arising out of or in connection with the use of ROHM Products outside of such usage conditions specified ranges, or without observing precautions. Even if it is used within such usage conditions specified ranges, semiconductors can break down and malfunction due to various factors. Therefore, in order to prevent personal injury, fire or the other damage from break down or malfunction of ROHM Products, please take safety at your own risk measures such as complying with the derating characteristics, implementing redundant and fire prevention designs, and utilizing backups and fail-safe procedures.
   *1: Absolute maximum ratings: a limit value that must not be exceeded even momentarily.

2) The Products specified in this document are not designed to be radiation tolerant.

3) Descriptions of circuits, software and other related information in this document are provided only to illustrate the standard operation of semiconductor products and application examples. You are fully responsible for the incorporation or any other use of the circuits, software, and information in the design of your product or system. And the peripheral conditions must be taken into account when designing circuits for mass production. ROHM disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, and other related information.

4) No license, expressly or implied, is granted hereby under any intellectual property rights or other rights of ROHM or any third party with respect to ROHM Products or the information contained in this document (including but not limited to, the Product data, drawings, charts, programs, algorithms, and application examples, etc.). Therefore, ROHM shall have no responsibility whatsoever for any dispute, concerning such rights owned by third parties, arising out of the use of such technical information.

5) ROHM intends our Products to be used in a way indicated in this document. Please be sure to contact a ROHM sales office if you consider the use of our Products in different way from original use indicated in this document. For use of our Products in medical systems, please be sure to contact a ROHM representative and must obtain written agreement. Do not use our Products in applications which may directly cause injuries to human life, and which require extremely high reliability, such as aerospace equipment, nuclear power control systems, and submarine repeaters, etc. ROHM disclaims any and all liability for any losses and damages incurred by you or third parties arising by using the Product for purposes not intended by us without our prior written consent.

6) Please use the Products in accordance with any applicable environmental laws and regulations, such as the RoHS Directive. ROHM shall have no responsibility for any damages or losses resulting non-compliance with any applicable laws or regulations.

7) When providing our Products and technologies contained in this document to other countries, you must abide by the procedures and provisions stipulated in all applicable export laws and regulations, including without limitation the US Export Administration Regulations and the Foreign Exchange and Foreign Trade Act.

8) Please contact a ROHM sales office if you have any questions regarding the information contained in this document or ROHM's Products.

9) This document, in part or in whole, may not be reprinted or reproduced without prior consent of ROHM.

(Note) "ROHM" as used in this document means ROHM Co., Ltd.

Other Precaution

1) All information contained in this document is subject to change for the purpose of improvement, etc. without any prior notice. Before purchasing or using ROHM Products, please confirm the latest information with a ROHM sales office.

2) ROHM has used reasonable care to ensure the accuracy of the information contained in this document, however, ROHM shall have no responsibility for any damages, expenses or losses arising from inaccuracy or errors of such information.

TSZ72037・01・001