

RL78/G23 Group

RL78/G23 Microcontroller Group
Inductive Proximity Sensor Shield
Quick Start Guide

Renesas RL78 Family
G23 Series
Inductive Proximity Sensing Solution

All information contained in these materials, including products and product specifications, represents information on the product at the time of publication and is subject to change by Renesas Electronics Corp. without notice. Please review the latest information published by Renesas Electronics Corp. through various means, including the Renesas Electronics Corp. website (<http://www.renesas.com>).

Notice

1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the 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. Renesas Electronics disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, or information.
2. Renesas Electronics hereby expressly disclaims any warranties against and liability for infringement or any other claims involving patents, copyrights, or other intellectual property rights of third parties, by or arising from the use of Renesas Electronics products or technical information described in this document, including but not limited to, the product data, drawings, charts, programs, algorithms, and application examples.
3. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
4. You shall be responsible for determining what licenses are required from any third parties, and obtaining such licenses for the lawful import, export, manufacture, sales, utilization, distribution or other disposal of any products incorporating Renesas Electronics products, if required.
5. You shall not alter, modify, copy, or reverse engineer any Renesas Electronics product, whether in whole or in part. Renesas Electronics disclaims any and all liability for any losses or damages incurred by you or third parties arising from such alteration, modification, copying or reverse engineering.
6. Renesas Electronics products are classified according to the following two quality grades: "Standard" and "High Quality". The intended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below.

"Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; industrial robots; etc.

"High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control (traffic lights); large-scale communication equipment; key financial terminal systems; safety control equipment; etc.

Unless expressly designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not intended or authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems; surgical implantations; etc.), or may cause serious property damage (space system; undersea repeaters; nuclear power control systems; aircraft control systems; key plant systems; military equipment; etc.). Renesas Electronics disclaims any and all liability for any damages or losses incurred by you or any third parties arising from the use of any Renesas Electronics product that is inconsistent with any Renesas Electronics data sheet, user's manual or other Renesas Electronics document.
7. No semiconductor product is absolutely secure. Notwithstanding any security measures or features that may be implemented in Renesas Electronics hardware or software products, Renesas Electronics shall have absolutely no liability arising out of any vulnerability or security breach, including but not limited to any unauthorized access to or use of a Renesas Electronics product or a system that uses a Renesas Electronics product. RENESAS ELECTRONICS DOES NOT WARRANT OR GUARANTEE THAT RENESAS ELECTRONICS PRODUCTS, OR ANY SYSTEMS CREATED USING RENESAS ELECTRONICS PRODUCTS WILL BE INVULNERABLE OR FREE FROM CORRUPTION, ATTACK, VIRUSES, INTERFERENCE, HACKING, DATA LOSS OR THEFT, OR OTHER SECURITY INTRUSION ("Vulnerability Issues"). RENESAS ELECTRONICS DISCLAIMS ANY AND ALL RESPONSIBILITY OR LIABILITY ARISING FROM OR RELATED TO ANY VULNERABILITY ISSUES. FURTHERMORE, TO THE EXTENT PERMITTED BY APPLICABLE LAW, RENESAS ELECTRONICS DISCLAIMS ANY AND ALL WARRANTIES, EXPRESS OR IMPLIED, WITH RESPECT TO THIS DOCUMENT AND ANY RELATED OR ACCOMPANYING SOFTWARE OR HARDWARE, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY, OR FITNESS FOR A PARTICULAR PURPOSE.
8. When using Renesas Electronics products, refer to the latest product information (data sheets, user's manuals, application notes, "General Notes for Handling and Using Semiconductor Devices" in the reliability handbook, etc.), and ensure that usage conditions are within the ranges specified by Renesas Electronics with respect to maximum ratings, operating power supply voltage range, heat dissipation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions, failure or accident arising out of the use of Renesas Electronics products outside of such specified ranges.
9. Although Renesas Electronics endeavors to improve the quality and reliability of Renesas Electronics products, semiconductor products have specific characteristics, such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Unless designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not subject to radiation resistance design. You are responsible for implementing safety measures to guard against the possibility of bodily injury, injury or damage caused by fire, and/or danger to the public in the event of a failure or malfunction of Renesas Electronics products, such as safety design for hardware and software, including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult and impractical, you are responsible for evaluating the safety of the final products or systems manufactured by you.
10. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. You are responsible for carefully and sufficiently investigating applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive, and using Renesas Electronics products in compliance with all these applicable laws and regulations. Renesas Electronics disclaims any and all liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
11. Renesas Electronics products and technologies shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You shall comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions.
12. It is the responsibility of the buyer or distributor of Renesas Electronics products, or any other party who distributes, disposes of, or otherwise sells or transfers the product to a third party, to notify such third party in advance of the contents and conditions set forth in this document.
13. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
14. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products.

(Note1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries.

(Note2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

(Rev.5.0-1 October 2020)

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.

Contact information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit:
www.renesas.com/contact/.

General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Precaution against Electrostatic Discharge (ESD)

A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.

2. Processing at power-on

The state of the product is undefined at the time when power is supplied. The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the time when power is supplied. In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the time when power is supplied until the reset process is completed. In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the time when power is supplied until the power reaches the level at which resetting is specified.

3. Input of signal during power-off state

Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.

4. Handling of unused pins

Handle unused pins in accordance with the directions given under handling of unused pins in the manual. The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of the LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible.

5. Clock signals

After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is stabilized. When the clock signal is generated with an external resonator or from an external oscillator during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Additionally, when switching to a clock signal produced with an external resonator or by an external oscillator while program execution is in progress, wait until the target clock signal is stable.

6. Voltage application waveform at input pin

Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (Max.) and V_{IH} (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (Max.) and V_{IH} (Min.).

7. Prohibition of access to reserved addresses

Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.

8. Differences between products

Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

Renesas Inductive Sense Shield Disclaimer

By using this Inductive Sense Shield, the User accepts the following terms, which are in addition to, and control in the event of disagreement, with Renesas' General Terms and Conditions available at <https://www.renesas.com/legal/disclaimer.html>.

The Inductive Sense Shield is not guaranteed to be error free, and the entire risk as to the results and performance of the Inductive Sense Shield is assumed by the User. The Inductive Sense Shield is provided by Renesas on an "as is" basis without warranty of any kind whether express or implied, including but not limited to the implied warranties of good workmanship, fitness for a particular purpose, title, merchantability, and non-infringement of intellectual property rights. Renesas expressly disclaims any implied warranty.

Renesas does not consider the Inductive Sense Shield to be a finished product and therefore the Inductive Sense Shield may not comply with some requirements applicable to finished products, including, but not limited to recycling, restricted substances and electromagnetic compatibility regulations. Refer to Certifications section, for information about certifications and compliance information for the Inductive Sense Shield. It is the kit User's responsibility to make sure the kit meets any local requirements applicable to their region.

Renesas or its affiliates shall in no event be liable for any loss of profit, loss of data, loss of contract, loss of business, damage to reputation or goodwill, any economic loss, any reprogramming or recall costs (whether the foregoing losses are direct or indirect) nor shall Renesas or its affiliates be liable for any other direct or indirect special, incidental or consequential damages arising out of or in relation to the use of this Inductive Sense Shield, even if Renesas or its affiliates have been advised of the possibility of such damages.

Renesas has used reasonable care in preparing the information included in this document, but Renesas does not warrant that such information is error free nor does Renesas guarantee an exact match for every application or parameter to part numbers designated by other vendors listed herein. The information provided in this document is intended solely to enable the use of Renesas products. No express or implied license to any intellectual property right is granted by this document or in connection with the sale of Renesas products. Renesas reserves the right to make changes to specifications and product descriptions at any time without notice. Renesas assumes no liability for any damages incurred by you resulting from errors in or omissions from the information included herein. Renesas cannot verify, and assumes no liability for, the accuracy of information available on another company's website.

Precautions

This Evaluation Kit is only intended for use in a laboratory environment under ambient temperature and humidity conditions. A safe separation distance should be used between this and any sensitive equipment. Its use outside the laboratory, classroom, study area, or similar such area invalidates conformity with the protection requirements of the Electromagnetic Compatibility Directive and could lead to prosecution.

The product generates, uses, and can radiate radio frequency energy and may cause harmful interference to radio communications. There is no guarantee that interference will not occur in a particular installation. If this equipment causes harmful interference to radio or television reception, which can be determined by turning the equipment off or on, you are encouraged to try to correct the interference by one or more of the following measures:

- Ensure attached cables do not lie across the equipment.
- Reorient the receiving antenna.
- Increase the distance between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that which the receiver is connected.
- Power down the equipment when not in use.
- Consult the dealer or an experienced radio/TV technician for help.

Note: It is recommended that wherever possible shielded interface cables are used.

The product is potentially susceptible to certain EMC phenomena. To mitigate against them it is recommended that the following measures be undertaken:

- The user is advised that mobile phones should not be used within 10 m of the product when in use.
- The user is advised to take ESD precautions when handling the equipment.

The Evaluation Kit does not represent an ideal reference design for an end product and does not fulfill the regulatory standards for an end product.

Renesas RL78 Family

Inductive Proximity Sensor Shield

Contents

1. Introduction.....	6
1.1 Assumptions and Advisory Notes.....	6
2. Kit Contents	6
2.1 Modifications Required.....	7
3. Running the Example Project	8
3.1 Requirements	8
3.2 Running the Quick Start Example Project.....	9
3.2.1 Download the example firmware using RFP	9
3.2.2 Connect the boards	12
3.2.3 Power up and evaluate sense.....	12
3.2.4 Open the serial terminal application.....	13
4. Next Steps	14
5. Website and Support	15
Revision History	16

Figures

Figure 1. Inductive Proximity Sensor Shield Kit Contents	6
Figure 2. AVREFP AVREFM tracks	7
Figure 3. Create Project RFP	9
Figure 4. New Project Dialog.....	9
Figure 5. Post connect RFP main window.....	10
Figure 6. File browser for programming binaries.....	11
Figure 7. Firmware programming completed RFP main window	11
Figure 8. Sensor shield connected to RL78/G23 FPB	12
Figure 9. Conductive target detection illuminating LED	12
Figure 10. RealTerm port settings.....	13
Figure 11. Sense counter reading	13

1. Introduction

This Quick Start Guide (QSG) provides:

- An introduction to the Inductive Proximity Sensor Shield and the components shipped with it.
- An outline of the steps to be taken for setting up the Inductive Sensor Shield hardware and the RL78/G23 64pin FPB.
- An outline of the steps to be taken to start evaluating the sample project for the RL78/G23 64pin FPB and the Inductive Sensor Shield.

1.1 Assumptions and Advisory Notes

This document assumes the following:

1. The reader has access to an RL78/G23 64 pin Fast Prototyping Board (FPB).
2. The reader has installed the serial terminal application [RealTerm](#).
3. The reader has access to a USB micro-B cable.

2. Kit Contents

The following components are included in the RL78/G23 Inductive Sensor shield kit:

1. Inductive Sensor Shield
2. Row MCU Pin Headers (16 positions)
3. Row MCU Pin Headers (19 positions)

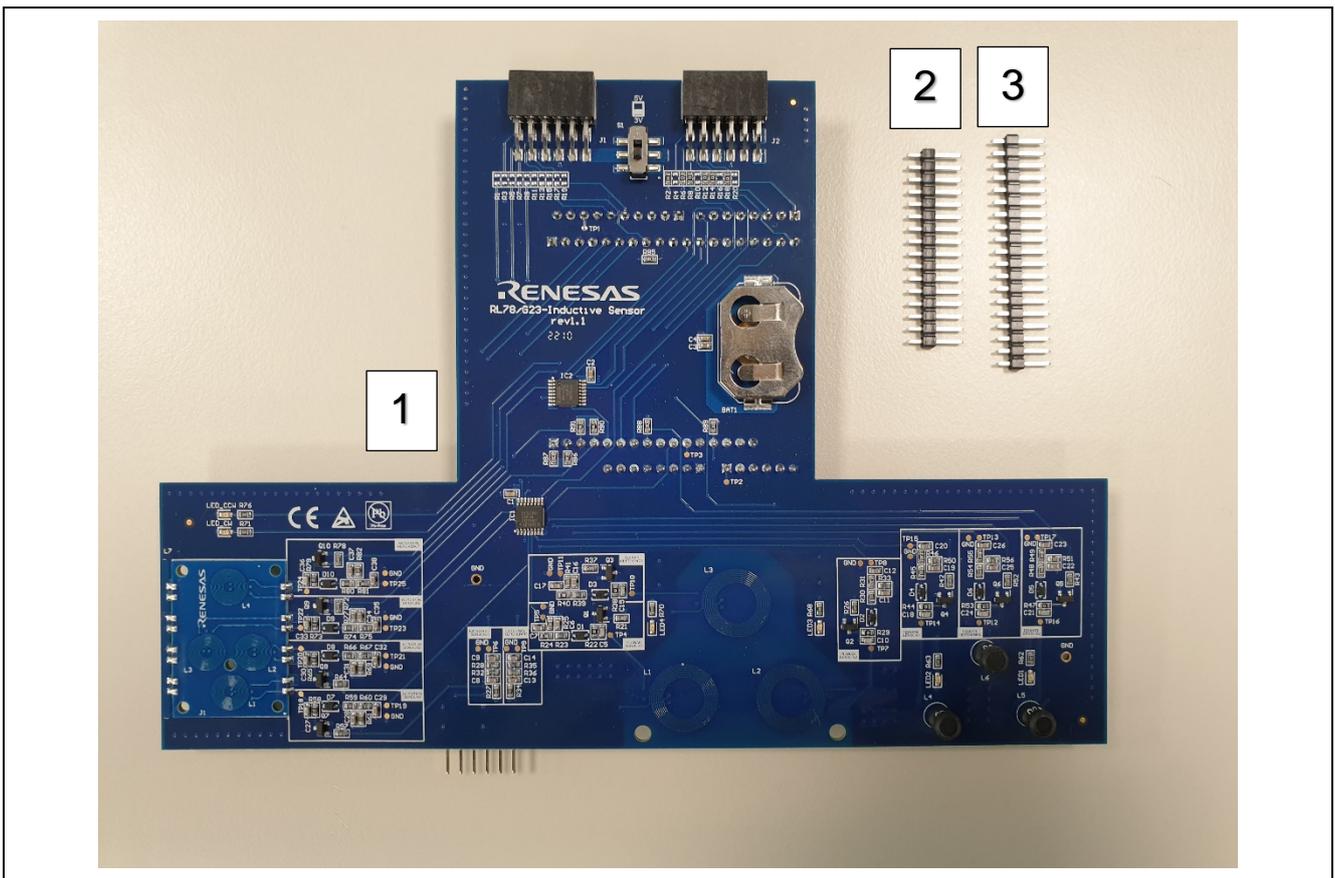


Figure 1. Inductive Proximity Sensor Shield Kit Contents

2.1 Modifications Required

The following four board modifications are required on the RL78/G23 FPB for the application to run:

1. Cut the **AVREFP** track. (Figure 2)
2. Cut the **AVREFM** track. (Figure 2)
3. Fit jumper **J17** to **pos 2-3** (+3V3).
4. Populate **J6** and **J7** with the **pin headers provided**.

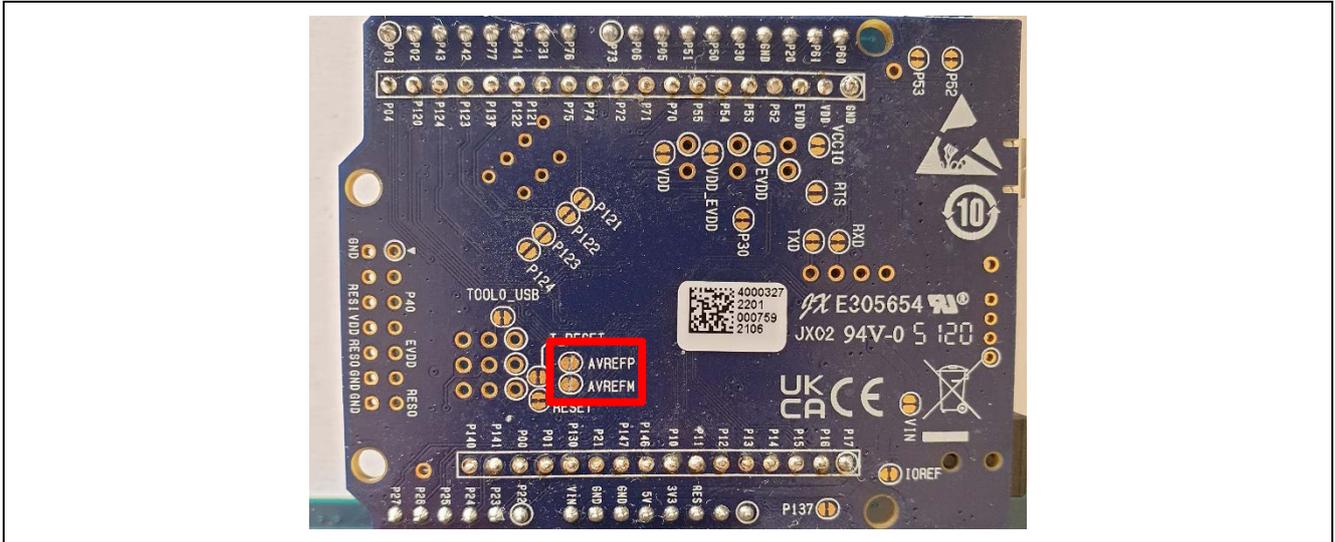


Figure 2. AVREFP AVREFM tracks

3. Running the Example Project

The example project for the RL78/G23 Inductive Sensor Shield periodically and sequentially scans each available coil group:

- Planar
- Ferrite Core
- Rotation

Action is then taken depending on the scan results to turn an LED on or off as well as incrementing internal counters for the serial terminal application.

3.1 Requirements

Hardware Requirements

- [RL78/G23-64p Fast Prototyping Board](#)
- Inductive Sense Shield Kit

Software Requirements

- RL78G23_Inductive_Sensor_v1_0_CodeFlash.srec
- RL78G23_Inductive_Sensor_v1_0_DataFlash.hex
- [RealTerm](#)
- [Renesas Flash Programmer \(Programming GUI\) | Renesas](#) (Minimum V3.09)

Important Notes:

1. Ensure all modifications from section 2.1 are made – this is very important; the application will not work correctly without these modifications and prolonged running without these modifications may cause damage.
2. Do not connect the RL78/G23 FPB and the sensor shield until the firmware is programmed.

3.2 Running the Quick Start Example Project

The following section outlines how to run the Inductive Proximity Sensing example project.

3.2.1 Download the example firmware using RFP

Connect to the RL78/G23 FPB using the USB micro-B cable.

Launch the Renesas flash programmer tool and follow the steps below.

Create a new project: File → New Project...

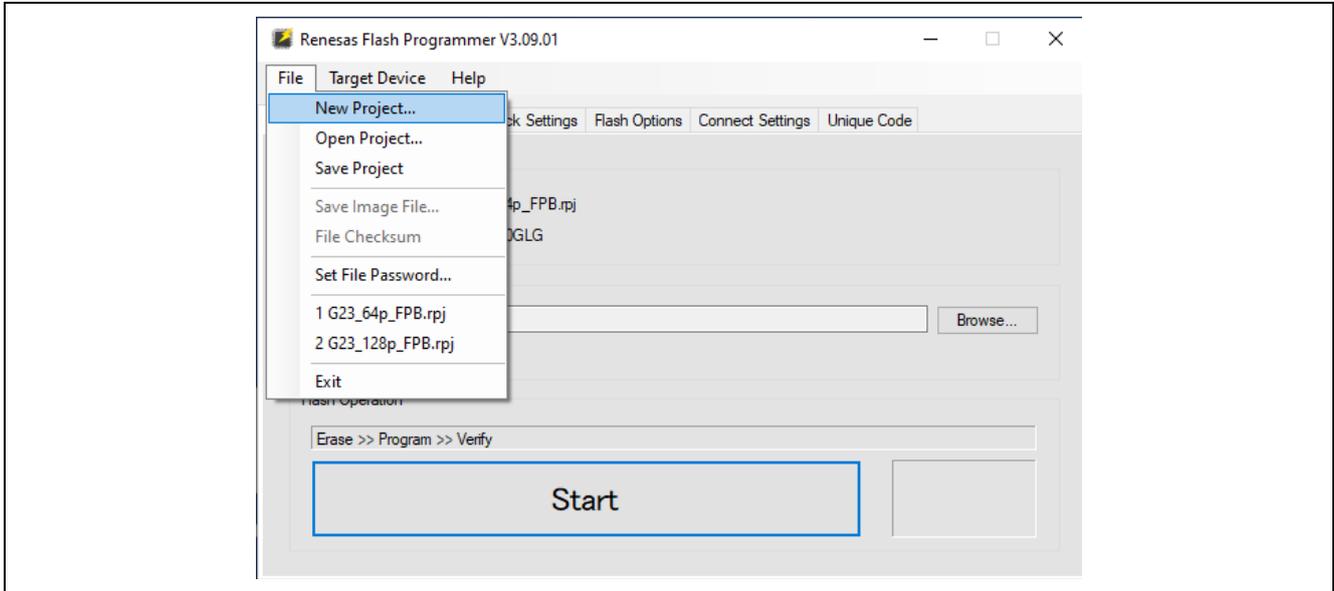


Figure 3. Create Project RFP

Make the following Selections (Figure 4):

Microcontroller: RL78/G2x

Project Name: [ANY_NAME]

Project Folder: [ANY_FOLDER] (Leave as default)

Tool: COM port

Interface: 2 wire UART

Tool Details... → Select appropriate COM Port

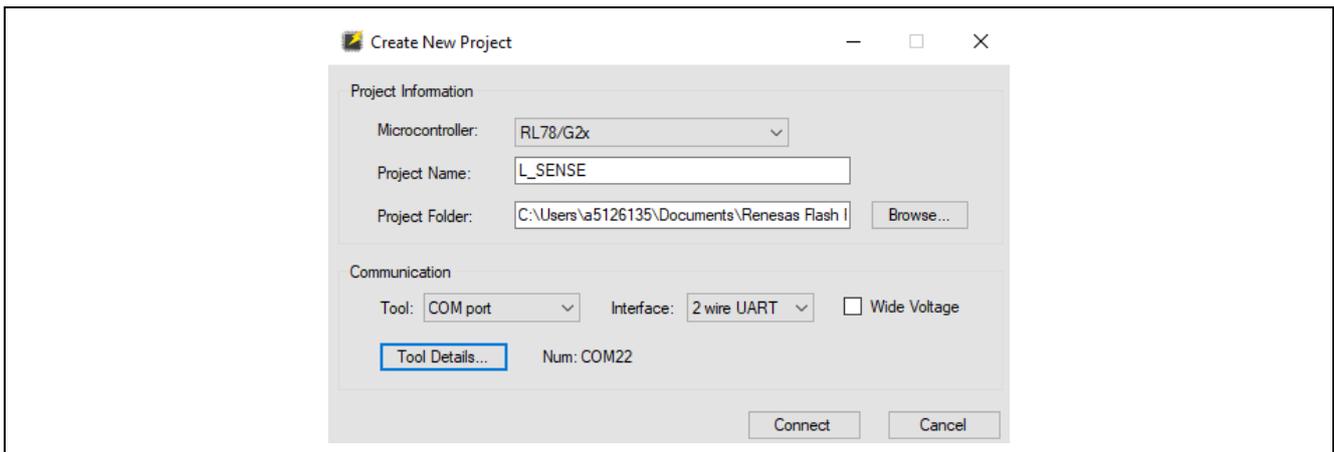


Figure 4. New Project Dialog

Click **Connect** and **Operation completed** should be displayed in the console dialog (Figure 5).

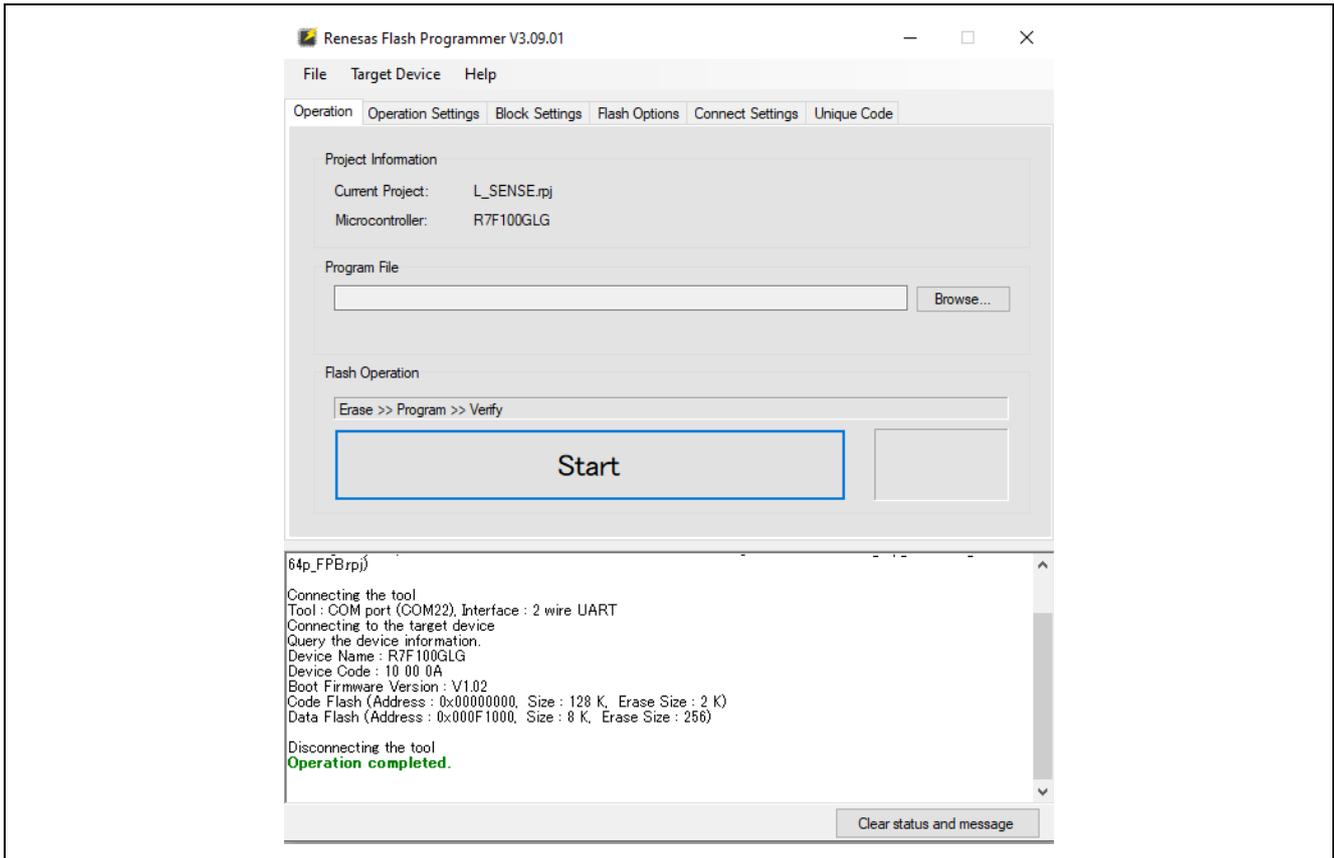


Figure 5. Post connect RFP main window

Select **Browse**.

As shown in Figure 6 Navigate to the location containing both:

- **RL78G23_Inductive_Sensor_v1_0_CodeFlash.srec**
- **RL78G23_Inductive_Sensor_v1_0_DataFlash.hex**

Using **Ctrl + click** select both images and click **Open**.

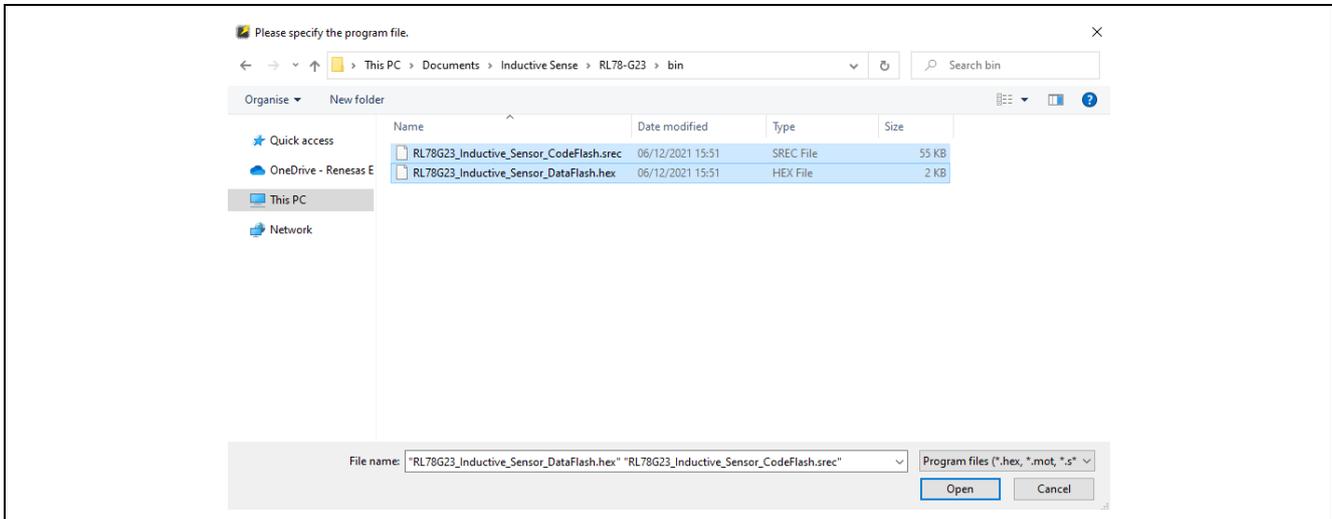


Figure 6. File browser for programming binaries

Click **Start** to program the board.

The console dialog will present the **Operation completed** message indicating the firmware has been written to the device (Figure 7).

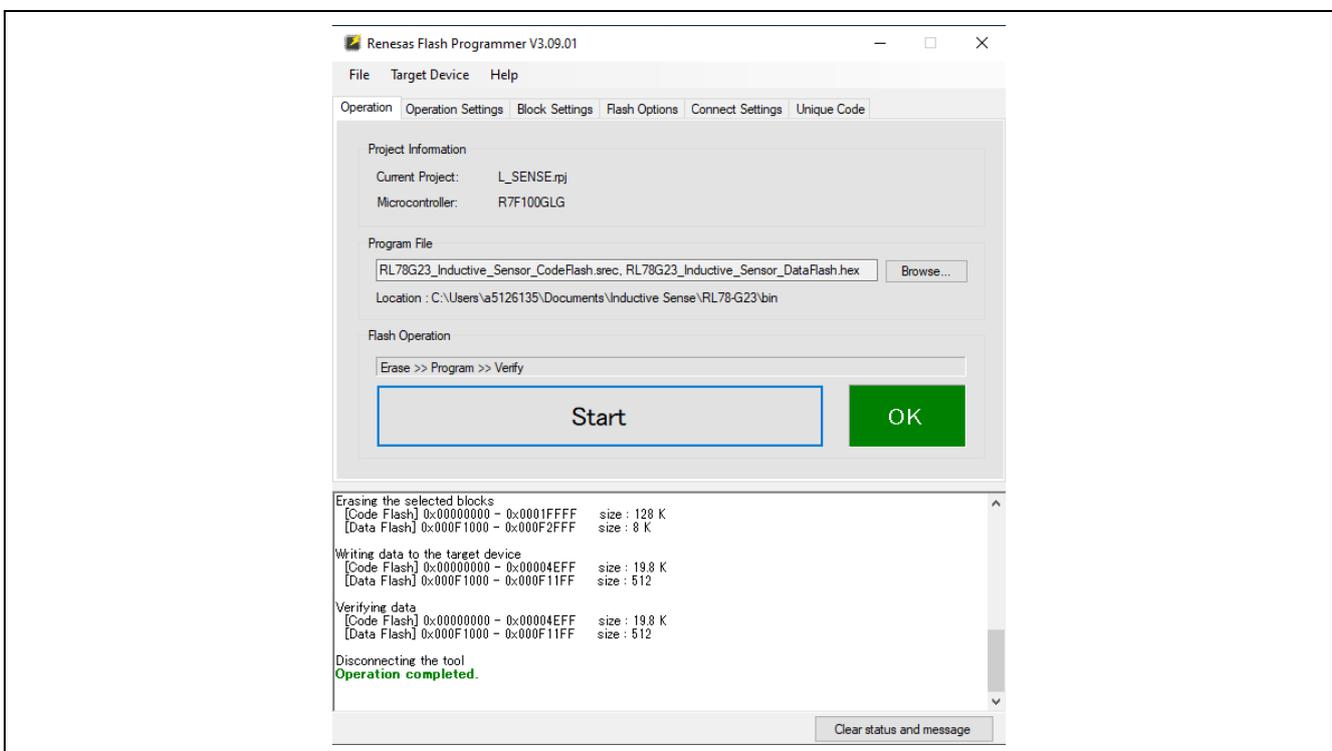


Figure 7. Firmware programming completed RFP main window

3.2.2 Connect the boards

Disconnect the USB cable to ensure the board is not live when connecting to the shield.

Connect the RL78/G23 FPB and the Inductive Sense Shield together, the headers are polarized using the Arduino interface specification so this can only be performed in one orientation. This is shown in Figure 8.

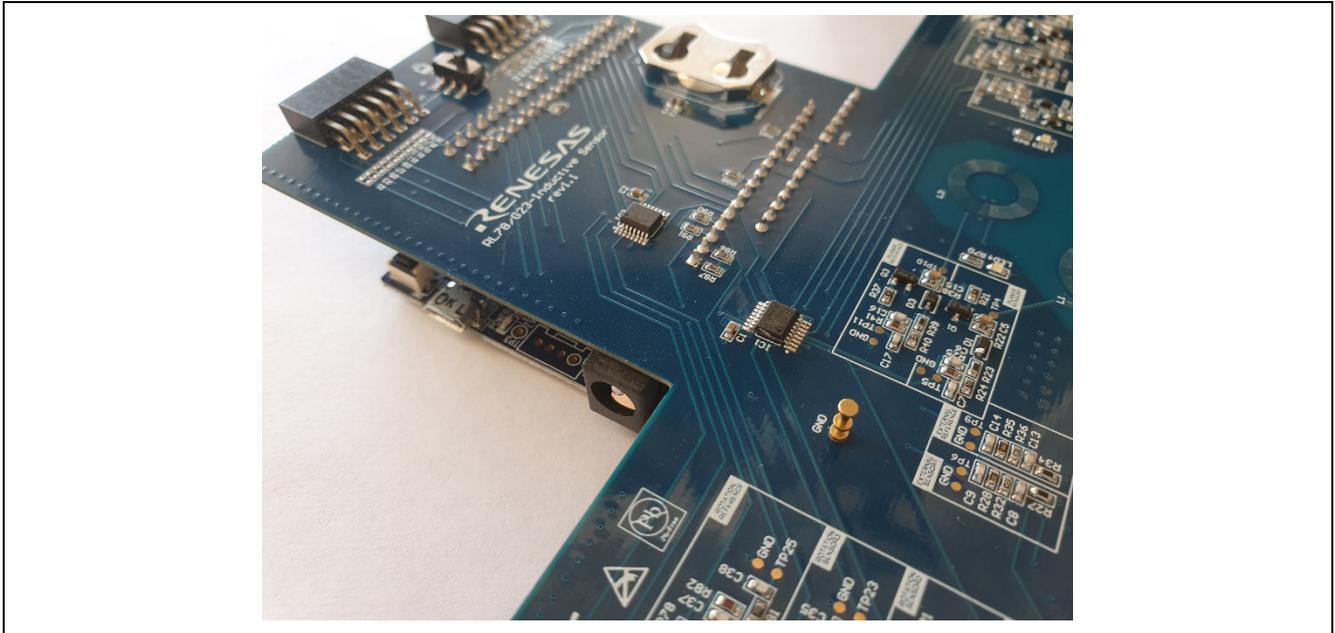


Figure 8. Sensor shield connected to RL78/G23 FPB

3.2.3 Power up and evaluate sense

Connect the USB cable to the RL78/G23 FPB.

You can now wave conductive targets near the coils and the coils corresponding LED's will illuminate (Figure 9).

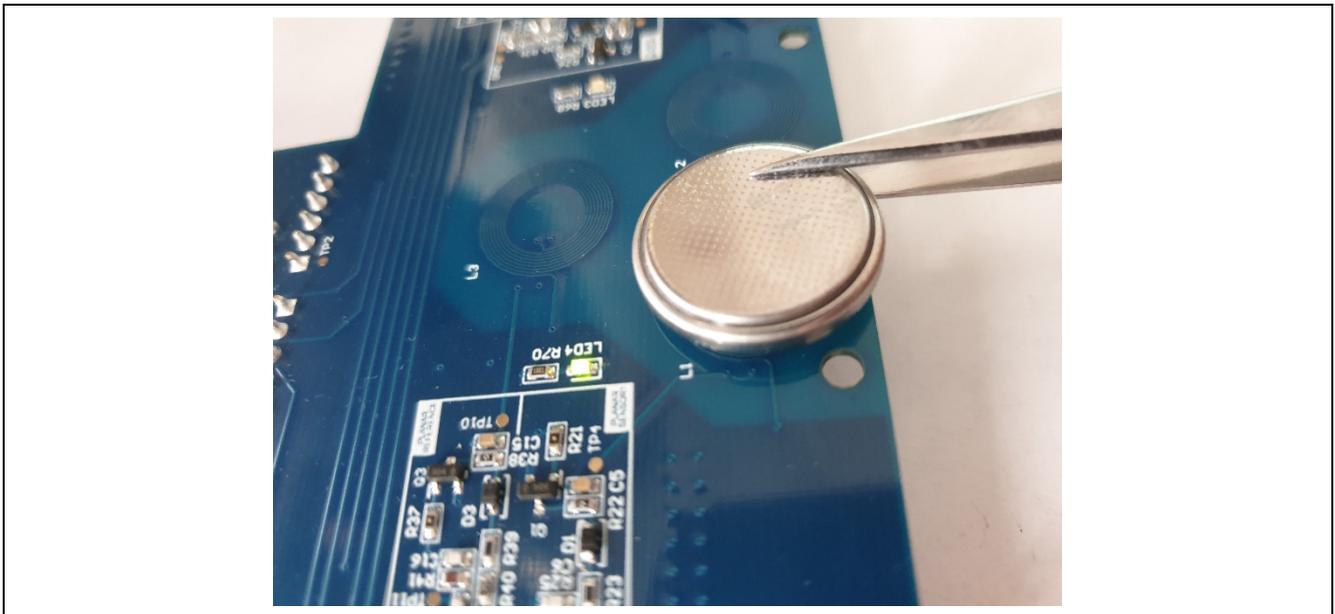


Figure 9. Conductive target detection illuminating LED

3.2.4 Open the serial terminal application

Launch the [RealTerm](#) application.

Select the **Port** tab and make the following settings (Figure 10):

Baud: 15625 (non-conventional proven to work)

Parity: None

Data Bits: 8

Stop Bits: 1

Hardware Flow Control: None

Select the correct COM port on your machine, using the drop-down, and click the **Change** button.

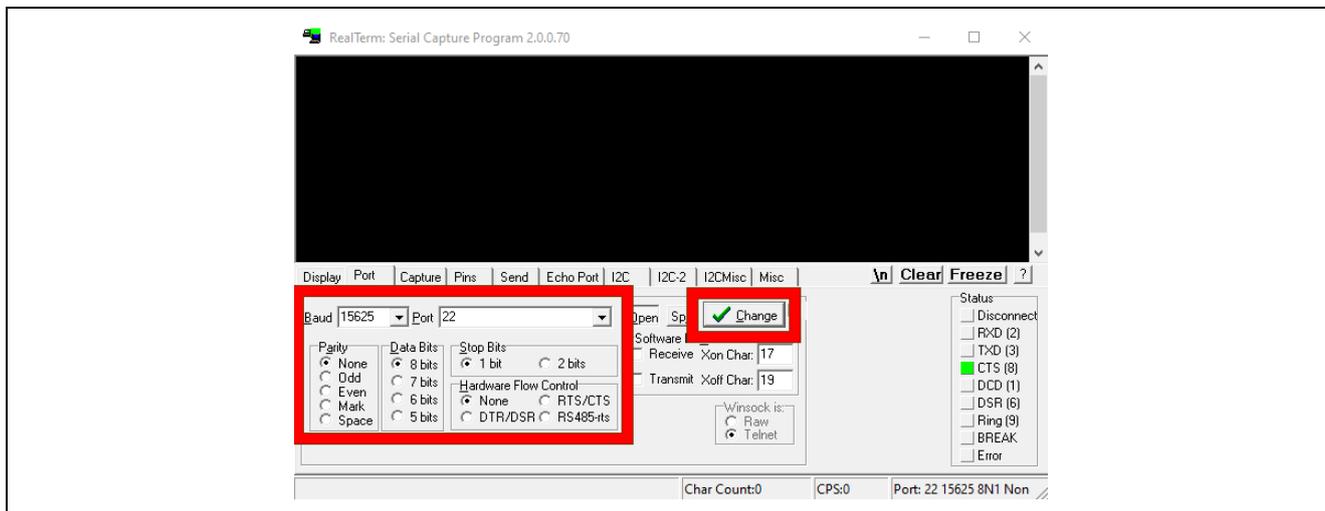


Figure 10. RealTerm port settings

Then Select the **Send** tab.

In the top text field enter: **0x22 0xFF 0x1B**

And press **Send Numbers**.

The console should display the sense counters for each coil on the shield as can be seen in Figure 11.

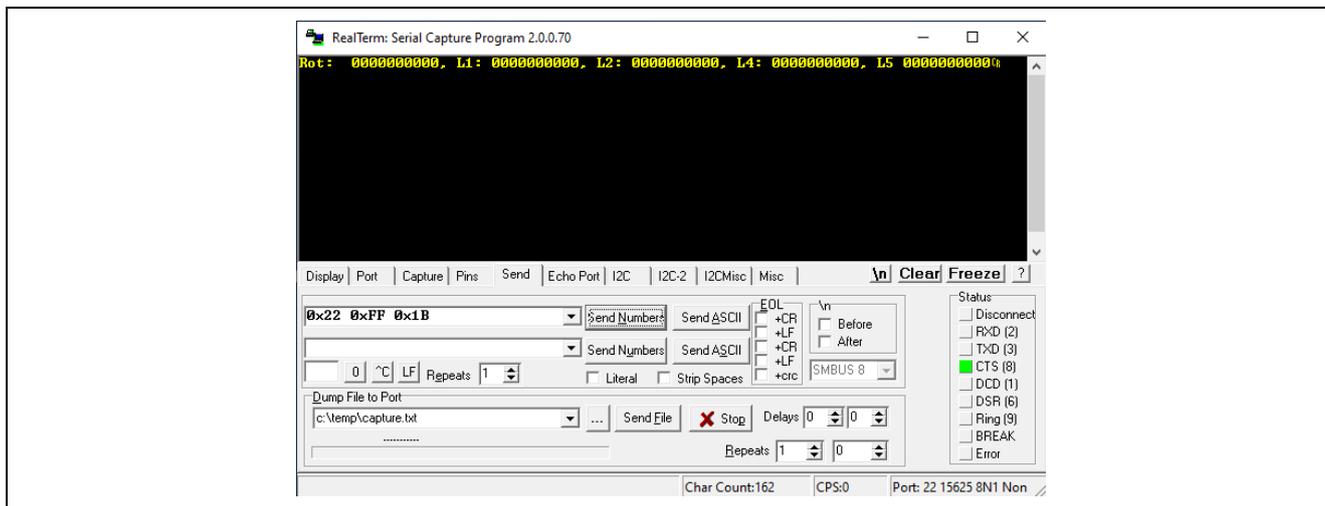


Figure 11. Sense counter reading

For further evaluation please refer to the Inductive Sense Shield user manual and the relevant application note.

4. Next Steps

Acquire the inductive proximity sensor shield user manual (R12UZ0106EG0100) and e²studio software project to evaluate further – both of which can be found on the website: www.renesas.com/rl78g23-sensor-shield

5. Website and Support

Visit the following URLs to learn about the kit and the RL78 family of microcontrollers, download tools and documentation, and get support.

RL78/G23 64p FPB Resources	RL78/G23-64p Fast Prototyping Board Renesas
RL78 Product Information	RL78 Low Power 8 & 16-bit MCUs Renesas
RL78 Product Support Forum	RenesasRulz
RL78 Videos	RL78 Family Software & Tool Course Renesas
Renesas Support	renesas.com/support
Inductive Proximity sensor User Guide	R12UZ0106EG0100
Renesas Inductive Proximity Sensor	www.renesas.com/rl78g23-sensor-shield

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Jun.6.2022	—	Initial release

Inductive Proximity Sensor Shield – Quick Start Guide

Publication Date: Jun.6.2022

Published by: Renesas Electronics Corporation

Inductive Proximity Sensor Shield – Quick Start Guide