Implement Position, Motion, and Proximity Sensing into Your Next Development with A Single MCU

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Overview

In the ever-evolving landscape of technology, the demand for compact, efficient, and versatile microcontroller units (MCUs) continues to soar. As we navigate through a world increasingly reliant on smart devices and IoT applications, the need for advanced sensing capabilities becomes more apparent. Let's dig into the RL78/G23 MCU – a single-chip MCU that goes beyond conventional capabilities.

How MCUs Leverage Inductive-Based Proximity Sensing

In the quest for innovation, MCUs have evolved beyond mere processors, becoming integral components in enabling sophisticated sensing technologies. One such advancement that has gained prominence is inductive-based proximity sensing. This transformative approach relies on electromagnetic fields to detect the presence or absence of objects without physical contact.

At its core, inductive-based proximity sensing operates on the principle of electromagnetic induction. An electromagnetic field is generated by a coil in the sensor, and when an object enters this field, it induces a change in the field. This alteration is then detected and interpreted by the MCU, allowing for precise proximity measurements. Here, the MCUs act as the brains behind the operation, orchestrating the entire process of inductive-based proximity sensing. Their ability to rapidly process data and execute complex algorithms in real time is pivotal in ensuring accurate and responsive proximity detection. Here's how MCUs leverage this innovative sensing method:

Data Processing and Analysis	Real-Time Decision Making	Customization & Flexibility	Precision	Non-Contact Operation	Versatality
• MCUs excel at swiftly processing raw data received from the inductive sensors • Advanced algorithms within the MCU analyse the electromagnetic field changes and translate them into meaningful proximity information	• Crucial in dynamic environments • Optimize system performance through the high-speed processing capabilities of MCUs and enable instantaneous responses to proximity changes.	• MCUs provide a platform for customization, allowing to fine-tune parameters and algorithms to suit specific application requirements • Flexibility of MCUs ensures adaptability to diverse scenarios, from industrial automation to consumer electronics	• MCUs enhance the proximity sensing precision, enabling applications where accuracy is paramount	• Inductive sensing, facilitated by MCUs, enables non-contact operation, minimizing wear and tear and extending the lifespan of sensing components.	• The versatility of MCUs empowers inductive sensors to be deployed across a spectrum of applications, from automotive systems to smart home devices

Figure 1: The Merits that MCU Brings to Sensing Methods

Renesas RL78/G23 is a powerful MCU that enables position, motion, and proximity sensing in various applications within a single-chip MCU. With its key features and capabilities, the RL78/G23 MCU can leverage inductive-based proximity sensing making it ideal for inductive-based proximity sensing applications. Many IoT-based applications can benefit from the trio of position, motion, and proximity sensing where RL78/G23 MCU provides an integrated and highly optimized solution which can be seen through its product specifications indicated in the below table.

Feature	Renesas RL78/G23
Core	16-bit CISC
Clock Speed	Up to 32MHz
Flash Memory	Up to 768 KB
SRAM	Up to 48 KB
Analog Peripherals	ADCs, DACs, comparators
Digital Peripherals	Timers, counters, communication interfaces (SPI, I2C, UART)
Low Power Consumption	Yes. 41µA/MHz CPU operation. 210nA at stop (4KB SRAM retention).
Cost	Highly competitive
Development Tools	Renesas IDE, compilers, libraries
Community Support	Yes
Proximity Sensing Options	On-chip CTU (capacitive touch sensing), external capacitive sensing peripherals
Remark	On-chip CTS is sufficient and cost-effective, especially for low-power applications.

Table 1. Renesas RL78/G23 Key Features

Key Features of RL78/G23 for Inductive-Based Proximity Sensing Applications

The RL78/G23 MCU is packed with features designed for accuracy and efficiency, making it an ideal choice for applications that need smooth coordination of position, motion, and proximity sensing. The figure below provides a glimpse of the features/capabilities of new generation RL78 general-purpose microcontrollers with further refined low-power performance and expanded peripheral functions.
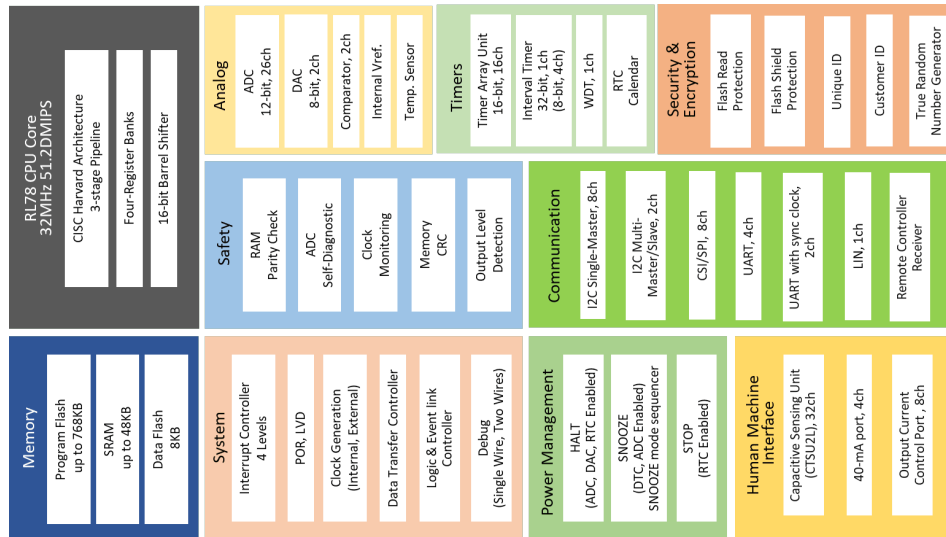
Figure 2: Extended feature-wise block diagram in RL78/G23

Inspired by the above, let's explore what makes the RL78/G23 MCU ideal for these advanced applications.

1. **Optimized Design Architecture:**
   a. Rotational sensor with indicating LEDs.
   b. Independent planar ferrite cored coils for buttons.
   c. Connector for external coils
   d. PMOD connectors (Type 2A- expanded SPI and Type 4A- expanded UART for system configuration) with additional configurable resistor bank to convert any of these into I2C.
   e. Low power mode
   f. Multiple power supplies – coin cell, +5V micro-USB, or +12V DC barrel connector.

The RL78/G23 MCU boasts an optimized architecture designed for low-power operation without compromising on performance. This architecture ensures the efficient execution of inductive-based proximity sensing algorithms, striking a balance between responsiveness and energy conservation.

2. **Integrated Analog Front-End (AFE):**

Inductive-based proximity sensing heavily relies on accurate analog signal processing. The built-in integrated AFE plays a crucial role in ensuring precise and reliable conversion of analog signals. An on-chip comparator uses simple binary detection for "target present" or "absent" instead of complex signal processing. An RL78/G23 built-in AFE monitors EM field decay, which detects target presence by analyzing changes in the sensor's electromagnetic field. A successive approximation method estimates target distance efficiently without demanding high processing power. As a result, the system is simpler to design and uses fewer external components reducing costs and optimizes performance. This allows for accurate and reliable proximity detection even in challenging environments, and there are significant savings in the bill of materials (BOM) thanks to the elimination of these components. The AFE gives designers the tools they need to build inductive proximity sensing solutions that are effective, affordable, and simple to deploy.

3. **Dedicated Timer Units:**

Proximity sensing often demands precise timing for data acquisition and signal processing. The RL78/G23 MCU is equipped with dedicated 32-bit low-power timer units that facilitate accurate timing control. These timers enhance the MCU's ability to synchronize with inductive sensors such as rotation, planar, and Ferrite sensor groups, enabling efficient and synchronized proximity measurements. Once all group scans

are completed, STOP mode is activated until the interval timer interrupt is activated and another set of measurements begins.
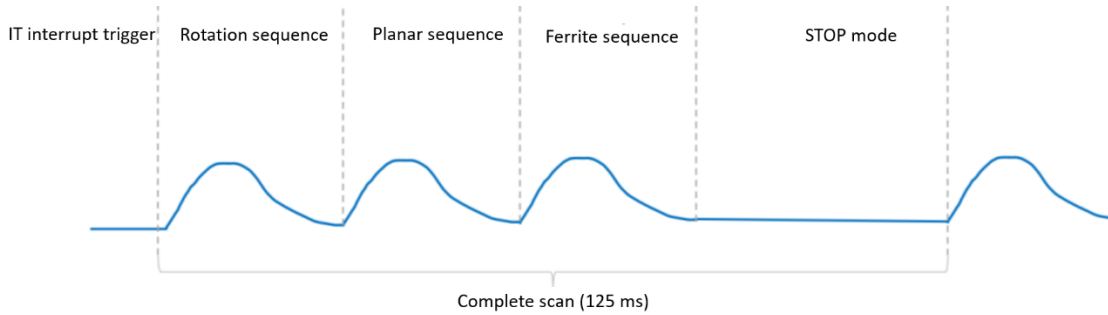

Figure 3: Scan sequence and measurement mechanism

4. **High-Speed Data Processing:**

Time-sensitive applications require MCUs with rapid data processing capabilities. The RL78/G23 MCU can execute instructions at a rapid rate with the built-in high-speed clock of 32MHz, and excels in high-speed data processing, ensuring real-time analysis of inductive sensor outputs. This capability is crucial for applications where instantaneous responses to changes in proximity are paramount.

5. **Low-Power Consumption:**

Energy efficiency is a cornerstone of the RL78/G23 MCU design. Its low power consumption is instrumental in applications where prolonged operation on battery power is essential. The RL78/G23 MCU has a high-speed clock which is configured at 32MHz using the on-chip high-speed oscillator which is the clock source or the CPU and most other peripherals. The low-power timer used to control the scan period uses the external crystal oscillator XT1 with a frequency of 32.768kHz.
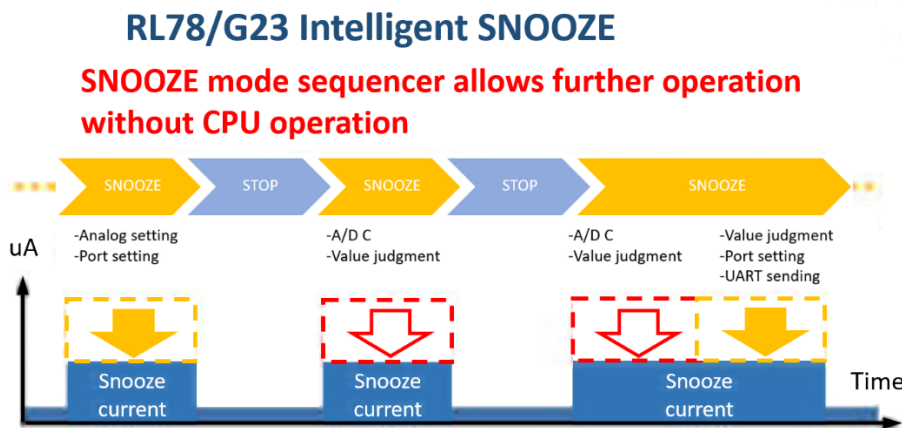
Figure 4: RL78/G23 Intelligent Snooze

The RL78/G23 MCU's ability to operate in low-power modes while maintaining responsiveness enhances its suitability for battery-powered devices.

6. Rich Peripheral Set:

The RL78/G23 MCU has a rich set of peripherals, including communication interfaces and general-purpose I/Os. This versatility allows developers to implement custom features and interface seamlessly with other components, expanding the range of applications for inductive-based proximity sensing.

7. Robust Ecosystem and Development Support:

Renesas, as the manufacturer of the RL78/G23, provides a robust ecosystem of development tools and resources. Comprehensive support, including development kits and documentation, empowers engineers to harness the full potential of the RL78/G23 in their proximity sensing applications.

Summary

The RL78/G23 MCU provides an ideal fit for a wide range of sensing applications, backed by the integration of advanced analog features, low power consumption, as well as a rich peripheral set. Its application in inductive-based proximity sensing spans across various applications, from smart home devices to industrial automation, prioritizing precision and responsiveness. Looking ahead, the synergy between MCUs and inductive-based proximity sensing is poised for exponential growth. The RL78/G23 MCU, backed by a robust ecosystem and development support, lays a solid foundation for continued innovation. Renesas is well-positioned to enable the dynamic evolution of MCUs, steering us toward a future where these devices play a central role in shaping our interconnected, sensor-driven world.
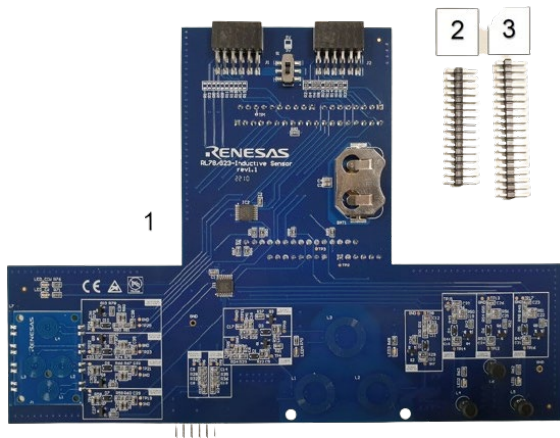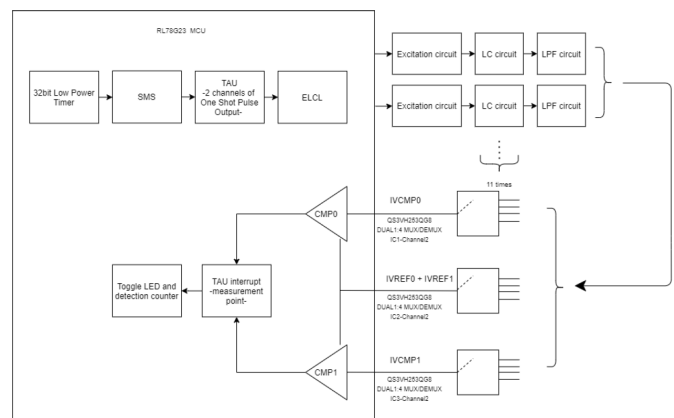

Figure 5: Inductive Proximity Sensor Shield Kit

Figure 6: Hardware block diagram in RL78/G23

References

- RL78/G23 – General-purpose microcontroller with further refined low-power performance and expanded peripheral functions

- RL78/G23 Inductive Proximity Sensor Shield Kit– Specifically designed plug-on expansion board for the RL78/G23 microcontroller 64-pin Fast Prototyping Board (FPB), for inductive proximity sensing application

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