

White Paper

RL78/G1M Applications in Portable Spray Disinfection Equipment

Xu Jing, Application Engineering Department, IoT Platform Department, IoT & Infrastructure Business, Renesas Electronics (China) Co.

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Introduction

The COVID-19 pandemic is still a global challenge and many people are required to take preventative measures in their daily lives. This includes the wearing of masks, goggles, and the use of UV and spray disinfection equipment. The use of portable spray equipment has many advantages, including greater convenience, better disinfection of surfaces, the ability to adjust water volumes through knobs, blue light functionality, LED light status indication, low lithium-ion battery levels, and charging status.

Renesas Solution

This white paper provides a highly effective portable spray disinfection solution example. The solution uses multiple parts from Renesas, including an 8-bit MCU, the RL78/G1M, a battery charger IC, an integrated FET controller, the ISL85415, and a synchronous buck or boost-buck converter, the ISL85403. Combining these devices with other parts including a lithium-ion battery, LED lighting and other components, this solution can be realized cheaply and easily.

RL78/G1M Features

The RL78/G1M series is available in a 20-pin TSSOP package (4.4 x 6.5 mm, 0.65 mm) and is equipped with real-time output terminals for motor drive, along with 120-degree energization control, and BLDC motor support. It is suitable for motor control for small home appliances, toys, office automation (OA) equipment, and other applications.

BLDC offers advantages in high-drive capability, low noise, and low jitter. Extensive application documentation for BLDC firmware is available on the [Renesas website](#). The RL78/G1M Fast Prototyping Board (FPB) can also be used for quick development. The solution can also be easily ported to higher specification RL78 MCUs such as RL78/G14, RL78/G1F, and others.

The outline of the RL78/G1M microcontroller is shown below.

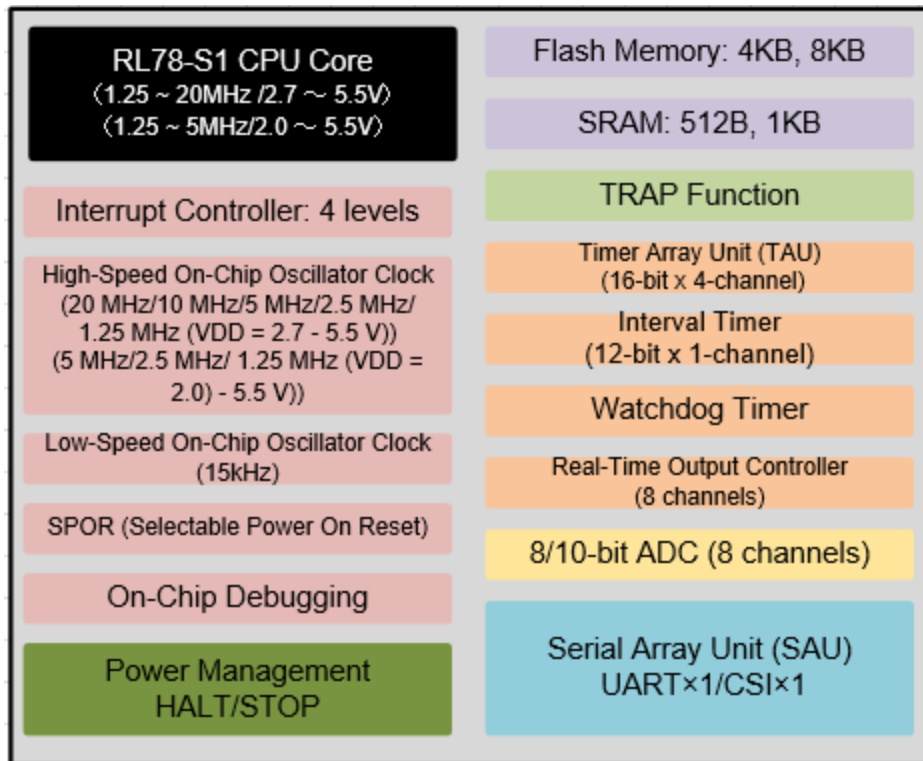


Figure 1: RL78/G1M MCU Block Diagram

This solution uses the RL78/G1M real-time output controller, which can control one DC motor or two stepper motors through the TAU PWM output function. The real-time output controller can cut off the timer output by using the interrupt INTPO as a trigger.

Forced cutoff signals can be outputted using software settings in any of the following states: high impedance, logical low, logical high, or cutoff-invalidated. The block diagram of the real-time output controller is shown below.

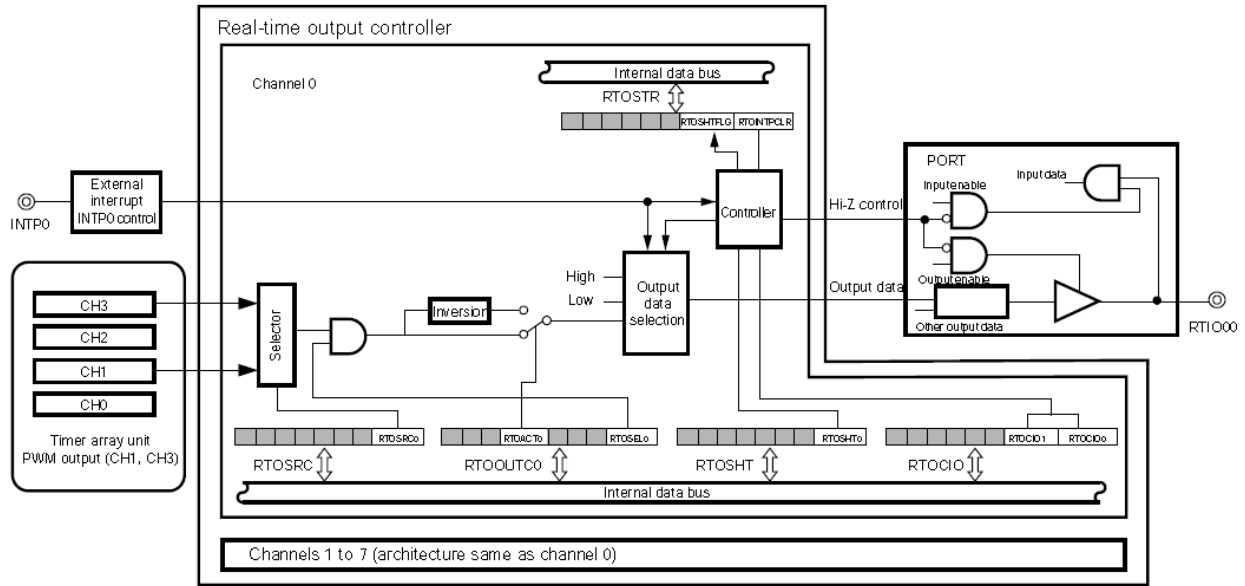


Figure 2: Real-Time Output Controller Block Diagram

System Design

System Requirements:

- Lithium-ion battery: 3.7V
- Battery charger IC: used to charge lithium-ion battery
- Integrated FET regulator: ISL85415 (3.7V to 3.3V battery voltage conversion); ISL85403 (3.7V to 12V battery voltage conversion)
- Knob: Water volume control
- LED light status: Always on during normal operations; flashes quickly when lithium-ion battery is low; flashes slowly when charging; off when fully charged
- Blue light: Turned on/off with corresponding switch

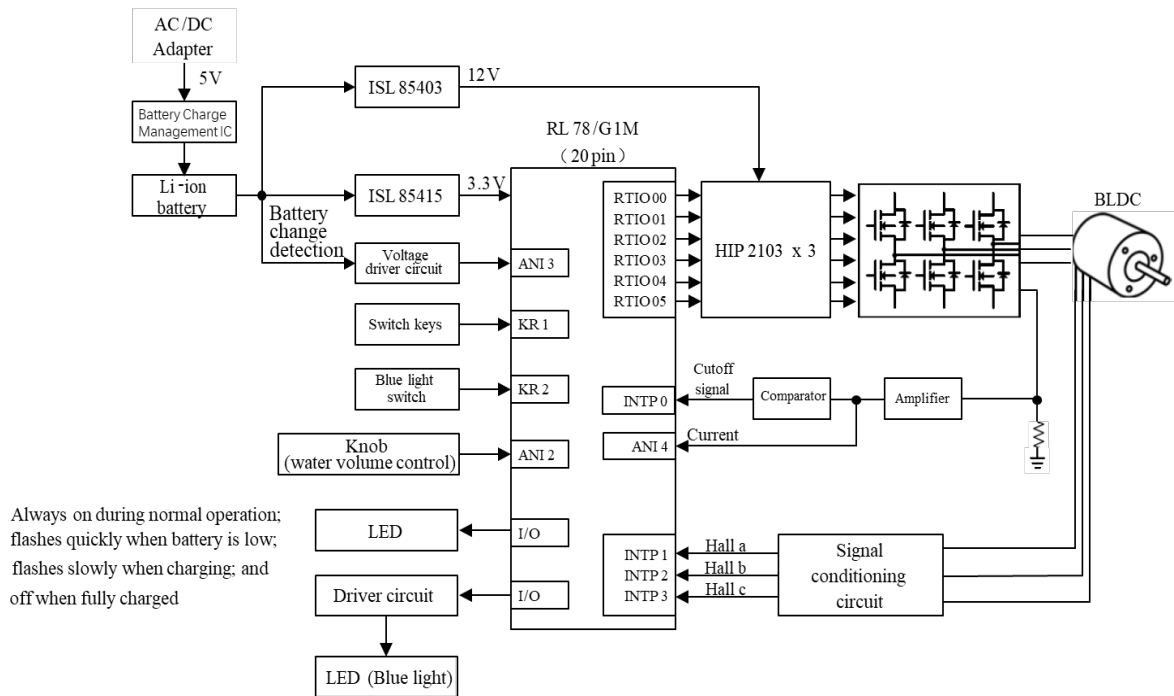


Figure 3: System Block Diagram

Note: Although the hall sensor is used in this figure, the application can be realized without using the hall sensor.

Peripheral Functions Used by RL78/G1M:

Peripheral Function	Purpose
A/D Converter	Detects lithium-ion battery charge Detects knob position for water volume adjustment Detects BLDC drive current
Real-Time Output (RTO) Controller	Controls BLDC with the TAU PWM output function
Key Interrupt	Turn spray equipment on/off Turn blue LED on/off
Interrupt	BLDC Hall feedback signal BLDC cutoff signal
I/O Port	Turn blue LED on/off Control status LED

Table 1: Peripheral Function Diagram

Pins Used by RL78/G1M:

Pin Name	Input/Output	Application
P00/RTIO00, P01/RTIO01, P02/RTIO02, P03/RTIO03, P04/RTIO04, P05/RTIO05	Output	Control BLDC through the HIP2105 driver chip
P137/INTP0	Input	BLDC cutoff signal
P06/INTP1, P15/INTP2, P14/INTP3	Input	BLDC Hall feedback signal
P13/ANI4	Input	BLDC drive current signal
P12/ANI3	Input	Detects lithium-ion battery voltage
P125/KR1	Input	Key interrupt (on/off)
P07/KR2	Input	Blue light switch
P11/ANI2	Input	Detects knob value for water volume adjustment
P16	Output	Control status LED: The LED is always on during normal operation The LED flashes rapidly when lithium-ion battery level is low The LED flashes slowly when charging The LED is off when fully charged
P10	Output	Blue LED drive
P40/TOOL0	Input/Output	On-chip debugging

Table 2: Pin Function Diagram

The ISL85415 is a 500mA synchronous buck regulator with an input range of 3V to 36V, support for high- and low-side NMOS FET integration, and a PFM mode for improved efficiency at light loads. This function can be disabled if forced PWM is required. The device switches at a default frequency of 500kHz but can also be programmed with external resistors from 300kHz to 2MHz. The ISL85415 can use either internal or external compensation. Through integration of two NMOS devices and supported internal configuration options, only a minimal number of external components are required, reducing BOM cost and design complexity.

With a wide VIN range and reduced BOM costs, the device provides an easily implementable and high performance design solution for a variety of applications. It serves as a robust design for high-voltage industrial applications and an effective solution for lithium-ion battery-powered applications.

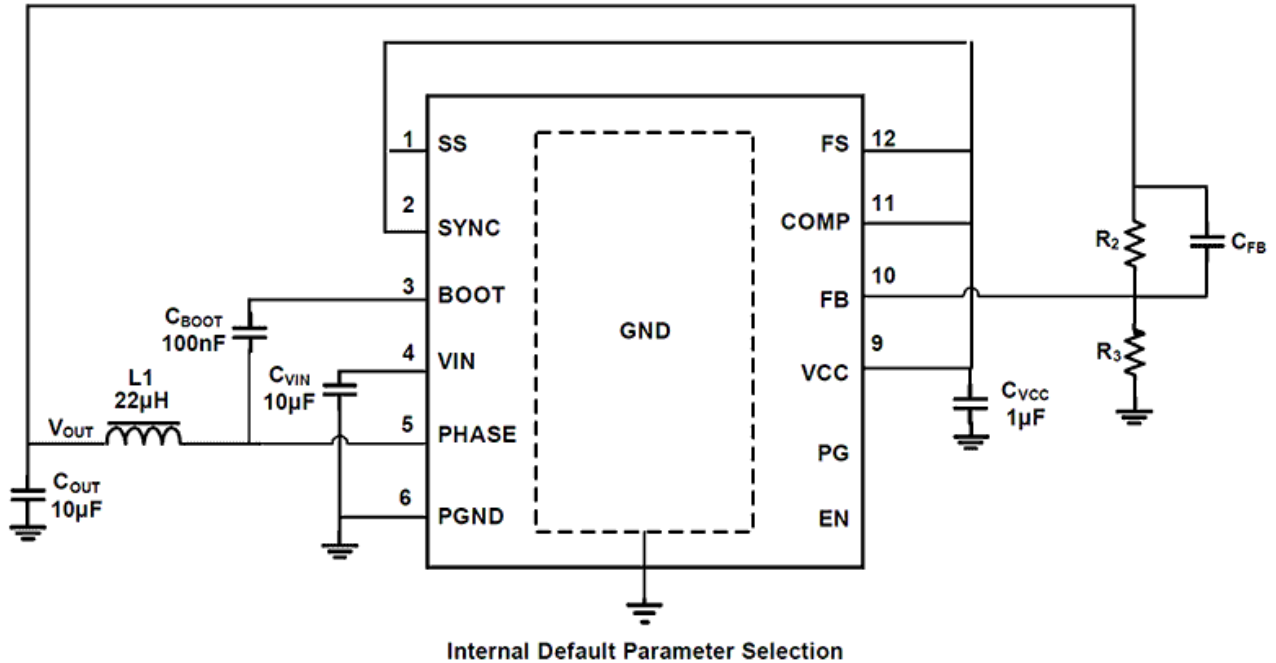


Figure 4: External Reference Connection Diagram

The ISL85403 is a 40V, 2.5A synchronous buck or boost buck converter with an integrated high-side MOSFET and low-side driver. The ISL85403 supports a wide input range of 3V to 40V in buck mode. In boost-buck mode, the input range can be extended down to 2.5V when the VIN drops below VOUT. Output regulation enables sensitive electronics to remain on during low input voltage conditions.

The ISL85403 flexibility supports either forced PWM mode and PFM mode. In PFM mode, the quiescent input current can reach as low as 180µA (AUXVCC connected to VOUT). The load boundary between PFM and PWM can be programmed to cover a wide range of applications.

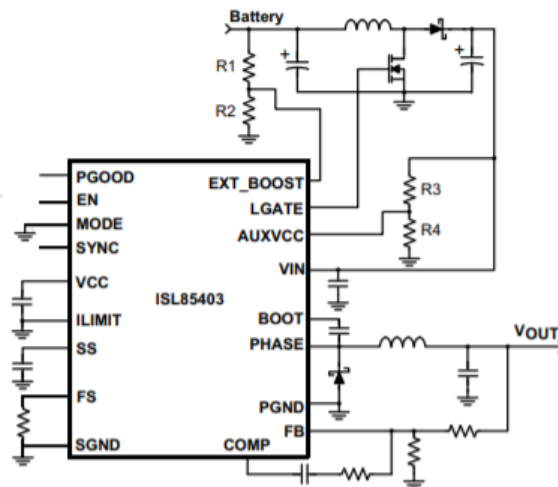


Figure 5: 2-Stage Boost Buck Converter Terminal Layout

System Operation Overview

- The handheld spray disinfection device is powered by a lithium-ion battery. Ensure that the lithium-ion battery is charged before use.
- Select the water volume with the knob and press the switch button to turn on the device.
- The device can disinfect and sterilize the goods packaging. You can also use it to kill any invisible disease-causing bacteria on the goods themselves by moving the spray nozzle close to the goods, then slowly moving it back and forth.
- The status LED will remain on during normal operation.
- The amount of water can also be changed during the disinfection process with the knob.
- The status LED will flash rapidly (once every 2 seconds) when the lithium-ion battery is low. The lithium-ion battery must be charged with an external power source. The status LED will flash slowly (once every 5 seconds) during charging, and turn off when fully charged.
- Pressing the on/off key again turns the device off.

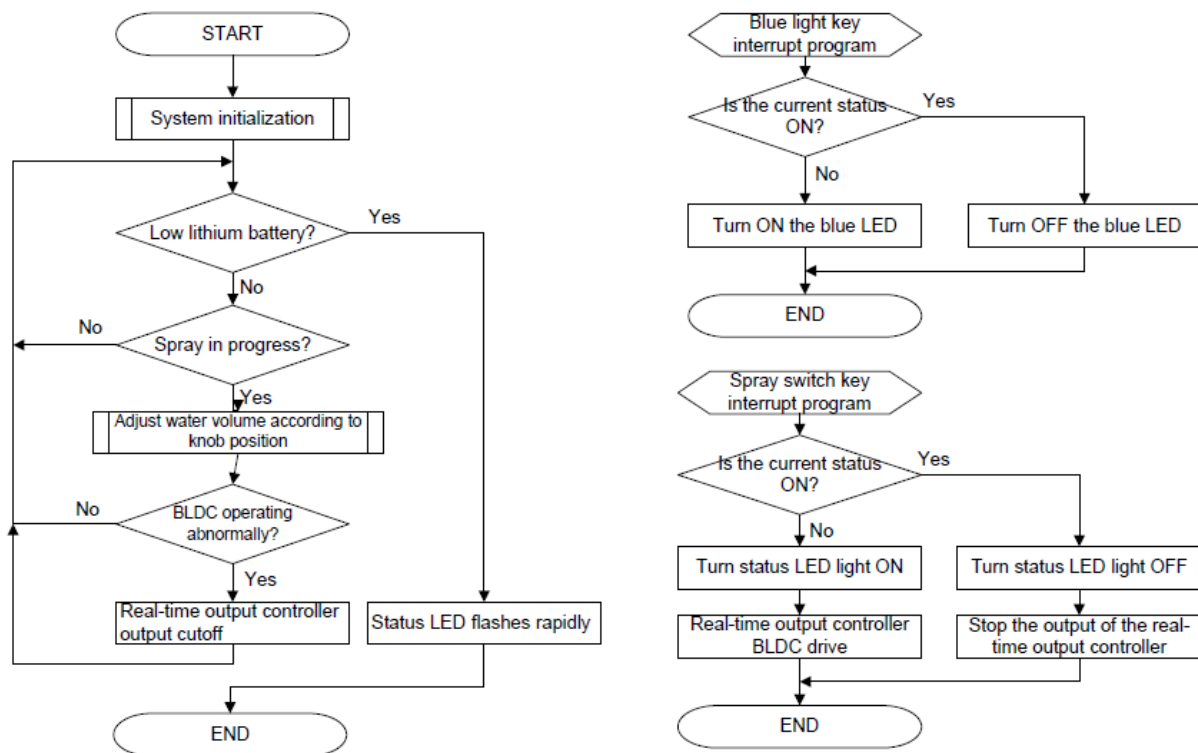


Figure 6: Firmware Flowchart

Conclusion

The RL78/G1M is quite suitable for handheld portable devices due to its low power consumption. Its on-chip and off-chip resources, especially its real-time output terminal for motor drive, are fully utilized in the implementation of the system's functions and provide excellent efficiency for cost. The combination of a high performance, high input voltage charger and an integrated FET regulator solution greatly enhances the intelligence and applicability of the product while reducing development time and costs.

References

- [1] [RL78/G1M](#) Family of 8-bit Microcontrollers
- [2] RL78/G1M, RL78/G1N User Manual ([R01UH0904EJ](#))
- [3] RL78/G1M User Manual RL78/G1M 120-degree conducting control of permanent magnetic synchronous motor (Implementation) ([R01AN5516EJ](#))
- [4] [ISL85415](#) Wide Input Voltage 500mA Synchronous Buck Regulator
- [5] [ISL85403](#) 2.5A regulator with integrated high-side MOSFETs for synchronous buck or boost-buck converters

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