

White Paper

Application of RL78/G12 in Portable Ultraviolet Disinfection Equipment

Ken Wong, Assistant Product Marketing Manager, IoT Infrastructure Business Unit, Renesas Electronics Corp.

Jing Xu, Supervisor, IoT Infrastructure Business Unit, Renesas Electronics Corp.

July 2020

Abstract

At the beginning of 2020, the new coronavirus swept the world suddenly at an unprecedented speed. In order to combat the new COVID-19 pandemic, on top of the regular masks, alcohol, and goggles, ultraviolet disinfection equipment is also an effective anti-pandemic option. The general ultraviolet sterilization lamp does not have a folding function and could not achieve a variety of close-range ultraviolet sterilization and disinfection irradiation, which is inconvenient for traveling on business trips. At the same time, there is no cumulative recorder for the running time of the ultraviolet lamp, which makes it difficult to grasp its use of time. Also, it does not have safety protection devices, which could cause harm to personnel. The portable ultraviolet disinfection equipment can solve the above problems well: it is foldable and travel-friendly. The built-in ultraviolet lamp can illuminate the objects at close range, and the use of lithium batteries make it more convenient to use. At the same time, it is able to record the running time of the ultraviolet lamp and the tilt detection function adds protection for the operator.

RL78/G12 Features

The RL78/G12 microcontroller (MCU) achieves the industry's lowest current consumption level (CPU: 63 μ A/MHz, standby (STOP): 230 nA) and high performance of 32.4 DMIPS (24 MHz). With an internal oscillator, data flash memory, A/D converter, etc. The built-in safety function (function to detect illegal operation of hardware) supports the household appliance safety standard (IEC/UL 60730). The compact package lineup with 20 to 30 pins is ideal for small appliances and consumer and industrial equipment.

*Caution Note: Direct irradiation of 254nm ultraviolet light is harmful to the human body. Handle with care.

The outline of the RL78/G12 microcontroller is as follows:

G12

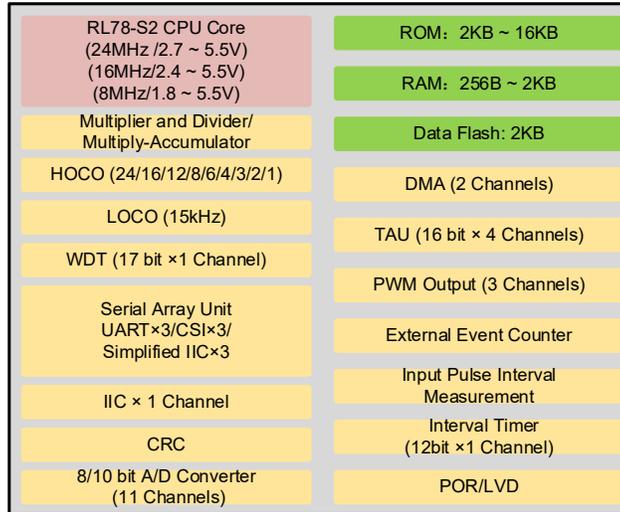


Figure 1: Renesas RL78/G12 Block Diagram

System Design

■ System Requirements

- UV lamp: 254nm band, 4W, continuous use time up to 20,000 hours
- Lithium battery voltage specification: 3.7V
- Charging chip: ISL9205D (charging lithium battery)
- LDO chip: ISL9021A (Realize the conversion of battery voltage 3.7V to 3.3V)
- LED display (2-digit 8-segment digital tube): four mode settings (5 minutes/15 minutes/30 minutes/duration time); remaining sterilization time display
- Buzzer: when the UV lamp is working, the sound continues to remind the operator
- Anti-tilt detection: automatically shut down when tilting to protect the operator

*Caution Note: Direct irradiation of 254nm ultraviolet light is harmful to the human body. Handle with care.

■ System Block Diagram

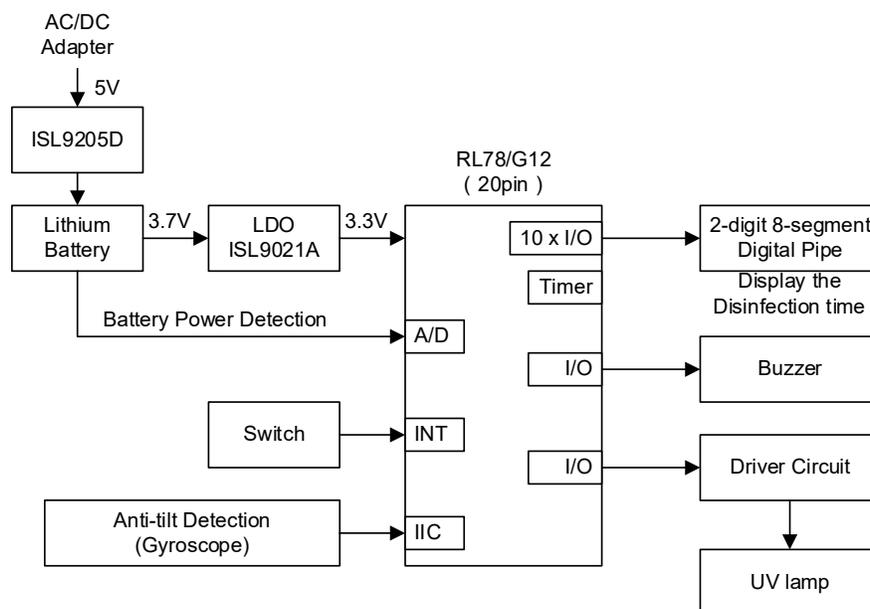


Figure 2: Portable Ultraviolet Disinfection Equipment System Block Diagram

■ Peripheral Functions and Pins Used by RL78/G12

Peripheral Functions	Description
A/D Converter	Detect remaining power of the lithium battery
Key Interrupt	ON/OFF; Set sterilization duration
Serial Interface IICA	IIC0: receive data from the gyroscope
Timer Array Unit	Record sterilization duration
I/O Ports	Control the LED indicator (10 ports) Drive the buzzer (1 port) Drive the UV lamp (1 port)

Figure 3: Usage of Peripheral Functions

*Caution Note: Direct irradiation of 254nm ultraviolet light is harmful to the human body. Handle with care.

Pin Name	Input/ Output	Overview
P14/ANI20	Input	Detect the voltage of the lithium battery
INTP0/P137	Input	Key interrupt (ON/OFF; Set sterilization duration)
P60/SCLA0, P61/SDAA0	Input / Output	Communicate with the gyroscope
P10, P11, P12, P13, P20, P21, P22, P23, P41, P42	Output	Control the LED indicator (10 ports)
P122	Output	Drive the buzzer (1 port)
P123	Output	Drive the UV lamp (1 port)
P40/TOOL0	Input / Output	On-chip debug
RESET	Input	Hardware reset

Figure 4: Usage of Pins

■ **Voltage Charger and LDO Integrated Solution**

The ISL9205D is an integrated single-cell lithium-ion or lithium-polymer charger that can operate at input voltages as low as 2.5V. The low operating voltage allows the charger to work with various AC adapters.

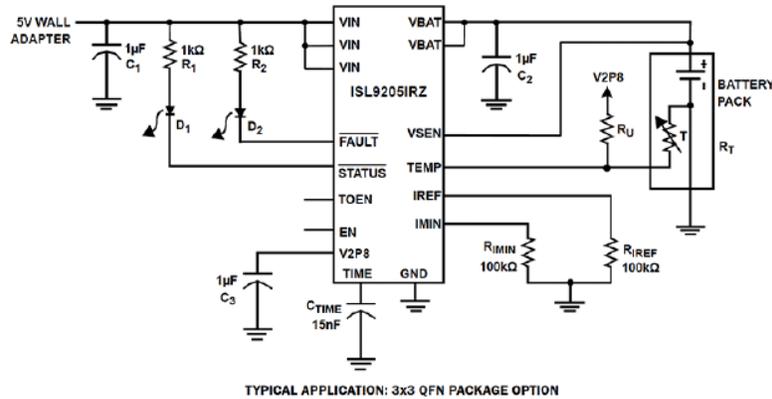


Figure 5: Voltage Charger and LDO System Block Diagram

*Caution Note: Direct irradiation of 254nm ultraviolet light is harmful to the human body. Handle with care.

When the AC adapter is a voltage source, the ISL9205D works as a linear charger. The battery is charged in the standard lithium ion charging mode, that is, the constant current phase is followed by the constant voltage phase (CC/CV). The charging current during the constant current phase is determined by the external resistor connected to the IREF pin. When the adapter output is a current-limited voltage source and the current limit is less than the IC's programmed constant current, the ISL9205D works as a pulse charger, where the charging current is determined by the current limit of the AC adapter during the constant current stage. In the case of two adapters, the ISL9205D operates in linear mode during the constant voltage phase.

The ISL9205D integrates Thermaguard to protect the IC from excessive temperature. If the IC package temperature is higher than the typical value of +100°C, the thermal foldback function reduces the charging current to prevent the temperature from increasing further. The ISL9205D has an external temperature monitoring function (not available in some software package options). Connect a negative temperature coefficient (NTC) thermistor between the temperature contact pin and ground to monitor the battery or ambient temperature. The ISL9205D also includes a timer for setting the time reference for various charging time limits. The timer can be programmed via an external capacitor. Two logic inputs and two open-drain logic outputs can be used to control the charger and indicate the charger status. The en-pin activates the charger. TOEN pin (Available in) to enable the timeout function to terminate charging when the preset time limit is reached. The fault pin is an open drain output, which is turned on when a fault is encountered. The status pin is also an open-drain output, which is turned on when the charger provides current.

The ISL9021A (low-noise LDO chip) converts the battery voltage from 4.5V to 3.3V. The LDO can support a minimum quiescent current of 35µA, which guarantees excellent light load efficiency. The solution is simple and highly integrated.

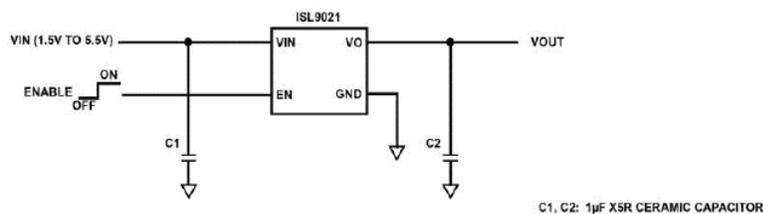


Figure 6: LDO Battery Conversion Circuit Diagram

The ISL9021A provides a guaranteed continuous 250mA load current and has an output capacitance of 1µF to 4.7µF (±30%) and is stable, with an ESR range of 5mΩ to 400mΩ. It also has a reverse current protection function, which can prevent the current from flowing back to the power supply when the output voltage is pulled higher than the input voltage.

*Caution Note: Direct irradiation of 254nm ultraviolet light is harmful to the human body. Handle with care.

■ Use I2C to Read Gyroscope Data

The BMI160 inertial measurement unit is used in this system to detect whether the device is tilted.

When the BMI160 communicates with the outside through I2C, the BMI160 will hang on the I2C bus of the master control chip RL78/G12 as an I2C slave device. RL78/G12 calls the BMI160 library function through the I2C function to read the value of the angular velocity to determine whether the disinfection equipment is tilted. When the tilt occurs, the ultraviolet lamp is immediately turned off.

■ Operation Summary

First of all, the handheld ultraviolet sterilization stick itself relies on the lithium battery to work. Check the lithium battery power is charged before using it. When the lithium battery power is insufficient, the operator will be notified through the LED, and an external battery is needed to charge the lithium battery.

Long press the button to turn on the device, and short press to prevent a child from turning on by mistake.

Select the sterilization time after booting and change the option each time you press on it. The first time is 5 minutes, the second time is 15 minutes, the third time is 30 minutes, and the fourth time is unlimited.

It can sterilize keyboards, phones, mobile phones, steering wheels, toys, and other items. Move the sterilization stick close to the items (about 2mm) and slowly move back and forth to the left or right to kill the invisible pathogenic bacteria on the items.

When the ultraviolet lamp operates, the buzzer sounds to remind the operator that the disinfection equipment is working. If the disinfection equipment is tilted, the ultraviolet lamp will be turned off immediately to prevent exposure to human skin and eyes.

When the set time is over, or when the switch is long-pressed, the sterilization stick will be turned off.

*Caution Note: Direct irradiation of 254nm ultraviolet light is harmful to the human body. Handle with care.

Below is the operation flowchart:

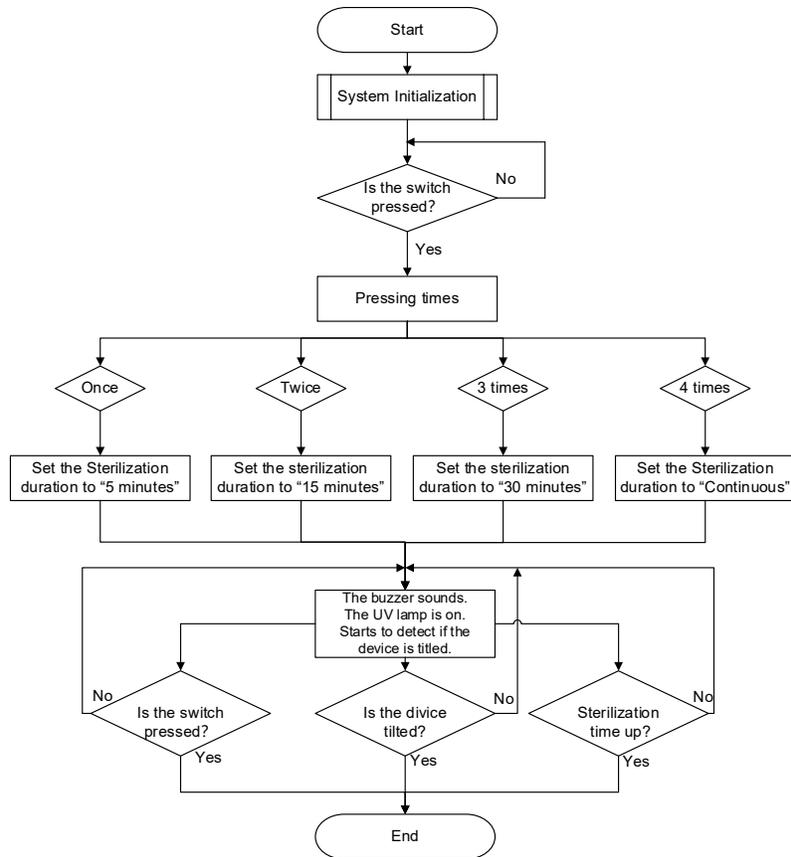


Figure 7: Portable Ultraviolet Disinfection Equipment Operation Flow Chart

Conclusion

The RL78/G12's low power consumption is ideal for handheld portable devices. At the same time, it also has optimal cost performance on the basis of the system's existing functions to achieve full use of RL78/G12 on-chip and off-chip resources. In addition, the combination of high-performance, high-input voltage chargers, and LDO integrated solutions has greatly improved the product's intelligence and application. In so doing, the development time and development costs are shortened.

*Caution Note: Direct irradiation of 254nm ultraviolet light is harmful to the human body. Handle with care.

Learn More

[RL78/G12](#) Family of 16-bit Microcontrollers

[ISL9205D](#) Li-ion Battery Charger

[ISL9021A](#) 250mA Single LDO with Low IQ, Low Noise and High PSRR LDO

© 2020 Renesas Electronics Corporation or its affiliated companies (Renesas). All rights reserved. All trademarks and trade names are those of their respective owners. Renesas believes the information herein was accurate when given but assumes no risk as to its quality or use. All information is provided as-is without warranties of any kind, whether express, implied, statutory, or arising from course of dealing, usage, or trade practice, including without limitation as to merchantability, fitness for a particular purpose, or non-infringement. Renesas shall not be liable for any direct, indirect, special, consequential, incidental, or other damages whatsoever, arising from use of or reliance on the information herein, even if advised of the possibility of such damages. Renesas reserves the right, without notice, to discontinue products or make changes to the design or specifications of its products or other information herein. All contents are protected by U.S. and international copyright laws. Except as specifically permitted herein, no portion of this material may be reproduced in any form, or by any means, without prior written permission from Renesas. Visitors or users are not permitted to modify, distribute, publish, transmit or create derivative works of any of this material for any public or commercial purposes.