RL78/G12

Remotely Controllable Button Pusher

Introduction
This application note describes an example to control the Wi-Fi module ESP-WROOM-02 by using RL78/G12 and control the button pusher via a network.

The application note "RL78 / G10 Wi-Fi module (ESP-WROOM-02) control sample software for TCP/IP Slave Transmission/Reception" is used to control the Wi-Fi module.

Target Device
RL78/G12

When applying the sample program covered in this application note to another microcomputer, modify the program according to the specifications for the target microcomputer and conduct an extensive evaluation of the modified program.
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1. Specifications

Figure 1.1 shows the system configuration. In this application note, the button pusher is controlled via a network using the Wi-Fi module ESP-WROOM-02.

When the button pusher is powered on, the RL78/G12 controls the Wi-Fi module and obtains an IP address from the access point. After that, it notifies the TCP server (PC, smartphone, etc.) that the button pusher is connected to the network, and the button pusher waits for reception from the TCP server.

When receiving data from the TCP server, the RL78/G12 analyzes the received data and executes the operation according to the received data. Port output and the PWM output of the Timer Array Unit are used for DC motor control.

1.1 Control of DC motor

Use a motor driver to control a DC motor. RL78/G12 controls Port output and PWM waveform as input signals for the motor driver.

Table 1.1 shows the relationship between RL78/G12 and DC motor status.

<table>
<thead>
<tr>
<th>RL78/G12 P13 output</th>
<th>TO01 (PWM output)</th>
<th>State of DC motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>Normally rotated</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>Stop</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>Stop</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>Inversely rotated</td>
</tr>
</tbody>
</table>
Figure 1.2 shows how to control the DC motor. As process of pushing the button, normal rotation, stop, and inverse rotation are executed. Press the button during normal rotation and release the button during inverse rotation. The rotation time of the DC motor can be adjusted by software.

![Diagram of DC motor control](image)

**Figure 1.2 How to control DC motor**

### 1.2 Format of the communication packet

Table 1.2 shows the data sent from the TCP server. The data is composed of bytes of ASCII codes.

<table>
<thead>
<tr>
<th>Data</th>
<th>Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>“ON&amp;OFF\n”</td>
<td>Normal and inverse operation of DC motor</td>
</tr>
</tbody>
</table>

**Figure 1.2 Data sent from the TCP server**
2. Conditions of Operation Confirmation Test

The sample code with this application note runs properly under the conditions below.

<table>
<thead>
<tr>
<th>Items</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCU</td>
<td>RL78/G12 (R5F1026A)</td>
</tr>
<tr>
<td>Operating frequencies</td>
<td>High-speed on-chip oscillator clock (fIH): 24MHz</td>
</tr>
<tr>
<td></td>
<td>CPU/peripheral hardware clock: 24 MHz</td>
</tr>
<tr>
<td>Operating voltage</td>
<td>3.3V</td>
</tr>
<tr>
<td></td>
<td>LVD operations (VLVD):</td>
</tr>
<tr>
<td></td>
<td>Rising edge TYP. 2.81V (2.76V~2.87V)</td>
</tr>
<tr>
<td></td>
<td>Falling edge TYP. 2.75V (2.70V~2.81V)</td>
</tr>
<tr>
<td>Integrated development environment (CS+)</td>
<td>CS+ for CC V8.10.00 from Renesas Electronics Corp.</td>
</tr>
<tr>
<td>C compiler (CS+)</td>
<td>CC-RL V1.12.01 from Renesas Electronics Corp.</td>
</tr>
<tr>
<td>Integrated development environment (e2studio)</td>
<td>e2 studio 2023-01 (23.1.0) from Renesas Electronics Corp.</td>
</tr>
<tr>
<td>C compiler (e2studio)</td>
<td>CC-RL V1.12.01 from Renesas Electronics Corp.</td>
</tr>
<tr>
<td>Integrated development environment (IAR)</td>
<td>IAR Embedded Workbench for Renesas RL78 V4.21.3 from IAR Systems</td>
</tr>
<tr>
<td>C compiler (IAR)</td>
<td>IAR C/C++ Compiler for Renesas RL78 V4.21.3.2447 from IAR Systems</td>
</tr>
<tr>
<td>Wi-Fi Module</td>
<td>ESP-WROOM-02 (ESP8266EX) from Espressif Systems</td>
</tr>
<tr>
<td></td>
<td>AT version: 1.7.3.0</td>
</tr>
<tr>
<td></td>
<td>SDK version: 3.0.3</td>
</tr>
</tbody>
</table>
3. Hardware

3.1 Hardware configuration

Figure 3.1 shows an example of the hardware configuration used in this application note.

![Figure 3.1 Hardware Configuration](image)

Note 1: This simplified circuit diagram was created to show an overview of connections only. When actually designing your circuit, make sure the design includes sufficient pin processing and meets electrical characteristic requirements. (Connect each input-only port to VDD or VSS through a resistor.)

3.2 Used Pins

Table 3.1 shows list of used Pins and assigned functions.

<table>
<thead>
<tr>
<th>Pin Name</th>
<th>Input/Output</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>P12/TXD0</td>
<td>Output</td>
<td>Serial data transmission (UART)</td>
</tr>
<tr>
<td>P11/RXD0</td>
<td>Input</td>
<td>Serial data reception (UART)</td>
</tr>
<tr>
<td>P13</td>
<td>Output</td>
<td>Control rotate direction of DC motor</td>
</tr>
<tr>
<td>P14/TO01</td>
<td>Output</td>
<td>Control ON/OFF of DC motor (PWM)</td>
</tr>
</tbody>
</table>
4. Software

4.1 Overview of the Sample Software

In this application note, RL78/G12 analyzing the data sent from the TCP server and execute operations according to the received data. The DC motor is controlled using the INTTM00 interrupt that occurs every 40us.

(1) Initial settings for the RL78/G12.
(2) Initial settings for the Wi-Fi module.
(3) Connect to the access point and get an IP address.
(4) Connect to the TCP server and notify that the button press device is connected to the network.
(5) RL78/G12 waits for data sent from the TCP server.
(6) RL78/G12 stores the received data in RAM and analyzes the data.
(7) RL78/G12 operates the DC motor according to the received data.
(8) RL78/G12 repeats (5) to (7).

4.2 Option Byte Settings

Table 4.1 lists the option byte settings.

<table>
<thead>
<tr>
<th>Address</th>
<th>Setting Value</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>000C0H</td>
<td>11101111B</td>
<td>Operation of Watchdog timer is stopped  (counting is stopped after reset.)</td>
</tr>
</tbody>
</table>
| 000C1H   | 01111111B     | LVD operations (VLVD):  
Rising edge TYP. 2.81V (2.76V~2.87V)  
Falling edge TYP. 2.75V (2.70V~2.81V) |
| 000C2H   | 11100000B     | High-speed on-chip oscillator clock: 24 MHz         |
| 000C3H   | 10000101B     | On-chip debugging enabled                           |

4.3 Global Variables

Table 4.2 lists the global variables used in this application note.

<table>
<thead>
<tr>
<th>Type</th>
<th>Name</th>
<th>Contents</th>
<th>Functions used in</th>
</tr>
</thead>
<tbody>
<tr>
<td>uint16_t</td>
<td>g_duty</td>
<td>Duty of PWM waveform</td>
<td>main()</td>
</tr>
<tr>
<td>uint16_t</td>
<td>g_on_time</td>
<td>Rotating time of the DC motor</td>
<td>main()</td>
</tr>
<tr>
<td>uint16_t</td>
<td>g_wait_time</td>
<td>Wait time of the DC motor</td>
<td>main()</td>
</tr>
</tbody>
</table>
4.4 Constants
Table 4.3 lists the constants used in this application note.

<table>
<thead>
<tr>
<th>Constant Name</th>
<th>Value</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>FCLK_MHZ</td>
<td>24</td>
<td>CPU clock frequency (fCLK) [MHz]</td>
</tr>
</tbody>
</table>

4.5 Functions
Table 4.4 lists functions used in this application note.

Please refer to the application note “RL78/G10 Wi-Fi module (ESP-WROOM-02) control sample software for TCP/IP Slave Transmission/Reception” for specifications of Wi-Fi module controlling functions.

<table>
<thead>
<tr>
<th>Function Name</th>
<th>Outline</th>
</tr>
</thead>
<tbody>
<tr>
<td>main</td>
<td>Main function</td>
</tr>
<tr>
<td>R_MAIN_UserInit</td>
<td>User initialization function</td>
</tr>
<tr>
<td>R_start_motor</td>
<td>Start to drive the DC motor</td>
</tr>
<tr>
<td>R_wait_100ms</td>
<td>Wait for 100ms</td>
</tr>
<tr>
<td>R_wait_1s</td>
<td>Wait for 1s</td>
</tr>
</tbody>
</table>
4.6 Function Specifications
The following describes detailed specifications and flowchart of the functions used in this application note.

<table>
<thead>
<tr>
<th>Function Name</th>
<th>R_MAIN_UserInit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outline</td>
<td>User initial setting</td>
</tr>
<tr>
<td>Header</td>
<td>None</td>
</tr>
<tr>
<td>Declaration</td>
<td>static void R_MAIN_UserInit(void);</td>
</tr>
<tr>
<td>Description</td>
<td>User initialization function</td>
</tr>
<tr>
<td>Arguments</td>
<td>None</td>
</tr>
<tr>
<td>Return value</td>
<td>None</td>
</tr>
<tr>
<td>Remarks</td>
<td>None</td>
</tr>
</tbody>
</table>

![Flowchart](image)

### R_MAIN_UserInit

1. **Set duty of PWM waveform as 0**
   - `TDR01 = 0`

2. **Start the timer for output PWM**
   - `R_TAU0_Channel0_Start()`

3. **Enable maskable interrupts**
   - `IE = 1`

4. **return**
### main function

**After executing the main user initialization function, control the Wi-Fi module and connect to the TCP server as a client. After that, RL78/G12 waits in the communication waiting state. When receiving data from the Wi-Fi module, it analyzes the received data and controls the DC motor by controlling the motor driver according to the received data. If a Wi-Fi module error occurs, exit the program.**

**Arguments**  
None

**Return value**  
None

**Remarks**  
None

#### Outline

- **Function Name**: main
- **Header**: –
- **Declaration**: –
- **Description**: After executing the main user initialization function, control the Wi-Fi module and connect to the TCP server as a client. After that, RL78/G12 waits in the communication waiting state. When receiving data from the Wi-Fi module, it analyzes the received data and controls the DC motor by controlling the motor driver according to the received data. If a Wi-Fi module error occurs, exit the program.

#### Arguments

None

#### Return value

None

#### Remarks

None

#### Diagram

```
main()

User Initialization function
R_MAIN_UserInit()

Initialize the Wi-Fi module
result = R_ESP_Init()

Initialization Succeeded?
result = ESP_OK

yes

Connect to access point
result = R_ESP_ConnectToAP()

Connect succeeded?
result = ESP_OK

yes

Connect to TCP server
result = R_ESP_TCP_Open()

Connect succeeded?
result = ESP_OK

yes

Start receiving data from TCP server
R_ESP_Receive()

Else

Receive result
result

ESP_OK

yes

Get received data
R_ESP_GetDataFromNetwork()

Received data

"ON&OFF"

Else

Start receiving data from TCP server (for next data)
R_ESP_Receive()

Drive the DC motor
R_start_motor()

Loop

return
```
**Function Name** | R_start_motor
--- | ---
**Outline** | Start to drive the DC motor
**Header** | None
**Declaration** | void R_TAU0_Channel0_Start(void);
**Description** | Output signals to control the DC motor
**Arguments** | None
**Return value** | None
**Remarks** | None

```
R_start_motor()

Set PWM duty to 50%
TDR01 = 4650H

Wait for motor normal rotation time
R_wait_100ms()
Set "g_on_time" as argument

Set PWM duty to 0%
TDR01 = 0H

Wait
R_wait_100ms()
Set "g_wait_time" as argument

Set motor rotation direction to inverse
P13 = 1

Set PWM duty to 50%
TDR01 = 4650H

Wait for motor inverse rotation time
R_wait_100ms()
Set "g_on_time" as argument

Set PWM duty to 0%
TDR01 = 0H

Set motor rotation direction to normal
P13 = 0

return
```
**Function Name**  
**R_wait_100ms**

**Outline**  
wait for 100ms

**Header**  
None

**Declaration**  
void R_wait_100ms(uint16_t time);

**Description**  
Executes 100ms wait for the number of times designated by the argument.

**Arguments**  
uint16_t time  
Wait time [100ms]

**Return value**  
None

**Remarks**  
None

---

**Diagram**

- **R_wait_100ms()**
  - Copy argument to the variable "time"
  - Clear INTTM02 interruption flag
  - TMIF02 = 0
  - Mask INTTM02 interruption
  - TMIF02 = 1
  - Start Timer
  - TSO = 0000H
  - Loop for "time" times
  - Loop
  - INTTM02 interruption occurred
  - TMIF02 = 1
  - NOP()
  - Loop
  - Loop
  - Clear INTTM02 interruption flag
  - TMIF02 = 0
  - Loop for "time" times
  - Stop timer
  - TTO = 0000H
  - Clear INTTM02 interruption flag
  - TMIF02 = 0
  - return
### Function Name: R_wait_1s

**Outline:** Wait for 1 second

**Header:** None

**Declaration:**

```c
void R_wait_1s(uint8_t time);
```

**Description:**

Waits for 1 second. Executes 1s wait for the number of times designated by the argument.

**Arguments:**

- `uint8_t time` Wait time [s]

**Return value:** None

**Remarks:** None

---

**Diagram:**

```
R_wait_1s()

Loop “time” times

Wait for 100 milliseconds
R_wait_100ms()

Loop end

return
```

- Copy argument to the variable “time”
- Set 10 for argument
5. Sample Code

Sample code can be downloaded from the Renesas Electronics website.

Referenced Application Note:
“RL78 / G10 Wi-Fi module (ESP-WROOM-02) control sample software for TCP/IP Slave Transmission/Reception”

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## Revision History

<table>
<thead>
<tr>
<th>Rev.</th>
<th>Date</th>
<th>Description</th>
<th>Page</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00</td>
<td>Apr. 9, 2020</td>
<td>—</td>
<td>—</td>
<td>First Edition</td>
</tr>
<tr>
<td>1.10</td>
<td>June. 24, 22</td>
<td>5</td>
<td>5</td>
<td>Operation check condition is updated.</td>
</tr>
<tr>
<td>1.11</td>
<td>Aug. 4, 23</td>
<td>5</td>
<td>5</td>
<td>Operation check condition is updated.</td>
</tr>
</tbody>
</table>
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   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.

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   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.

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   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.).

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