

## RL78 Family

### DMX512 Receive Communication sample software using SIS

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#### Introduction

This application note describes a sample application for DMX512 communication using the DMX512 Receive module SIS (Software Integration System).

The sample application operates as a Receive device. Supported standards are as follows:

- USITT DMX512 / 1990

For details on DMX512 communication standards, refer to the respective standard documents listed above.

#### Target Device

RL78/G24

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## 1. Specifications Overview

This application note describes a sample application that realizes a receive function in DMX512 communication. DMX512 is a wired communication protocol for digital data transmission and is widely used in industrial lighting applications such as stage and exhibition lighting (devices equipped with dimmers, scanners, moving lights, strobes, etc.).

The DMX512 Receive module SIS is used for the DMX512 communication protocol stack in the sample application. For more information on DMX512 Receive module SIS, refer to the following document.

- RL78 Family DMX512 Receive module Software Integration System (R01AN7213)

The following figure shows a schematic diagram of the sample application. The sample application runs on the RL78/G24 DC/DC LED Control Evaluation Board. The three LEDs on the board are used as Illuminator, and the LEDs are dimmed according to data received via DMX512.

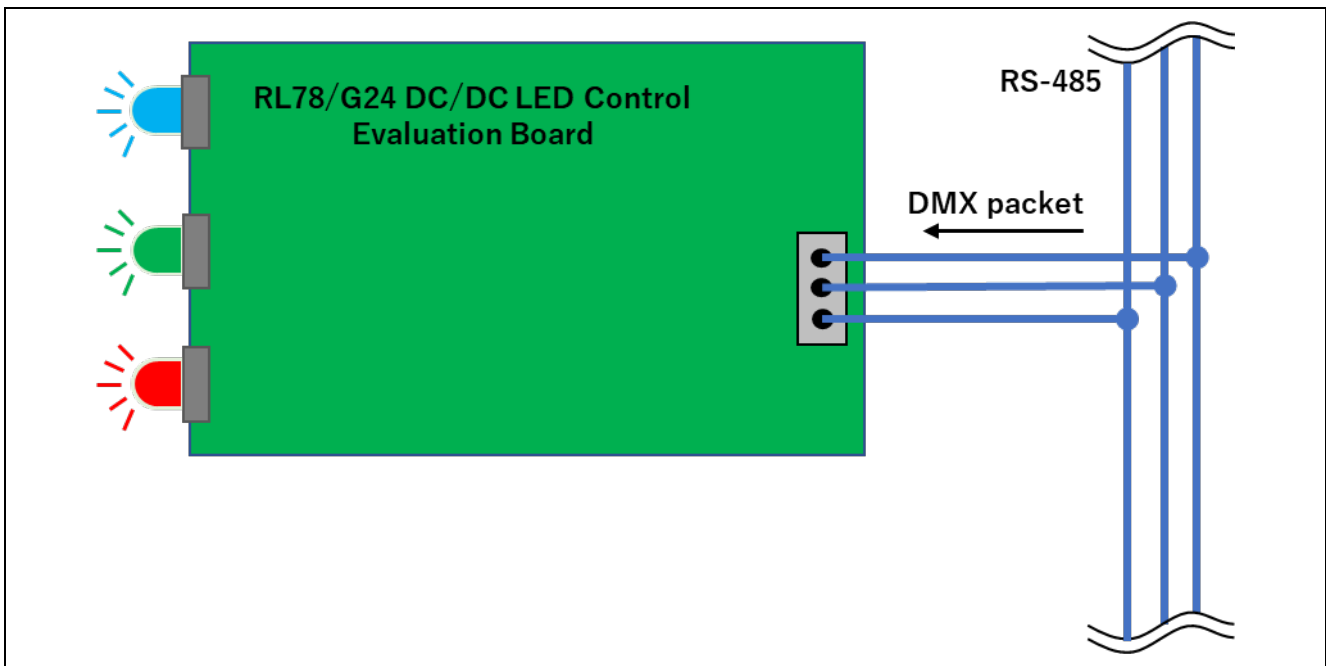


Figure 1-1 DMX512 Receive Sample Application Operation Diagram

## 2. Operation Check Conditions

The sample application has been tested in the following environments.

**Table 2-1 Operation Check Conditions**

Item	Description
Microcontroller used	RL78/G24 (R7F101GLG2DFB)
Board used	RL78/G24 DC/DC LD Control Evaluation Board from Renesas Electronics Corp.
Operating frequency	High-speed on-chip oscillator clock ( $f_{HOCO}$ ): 8MHz PLL clock ( $f_{PLL}$ ): 96MHz CPU / peripheral hardware clock ( $f_{CLK}$ ): 48MHz
Operating voltage	5.0V
Integrated development environment (CS+)	CS+ for CC 8.10.00 from Renesas Electronics Corp.
C compiler (CS+)	CC-RL V1.12.01 from Renesas Electronics Corp.
Integrated development environment (IAR)	IAR Embedded Workbench IDE V5.10.3 from IAR Systems
C compiler (IAR)	IAR C/C++ Compiler for Renesas RL78 V5.10.3 from IAR Systems
Smart Configurator (SC)	V1.8.0
Emulator	E2 Emulator Lite

### 3. Description of the Hardware

#### 3.1 System Configuration

The system configuration is shown below.

The control device is connected as a competing device for this sample application. The control device operates on the RL78/G23 Lighting Communication Master Evaluation Board, and the receiving device operates on the RL78/G24 DC/DC LED Control Evaluation Board.

By connecting the control device to a PC with a USB cable, LED dimming instructions can be given via the DMX512 master controller GUI.

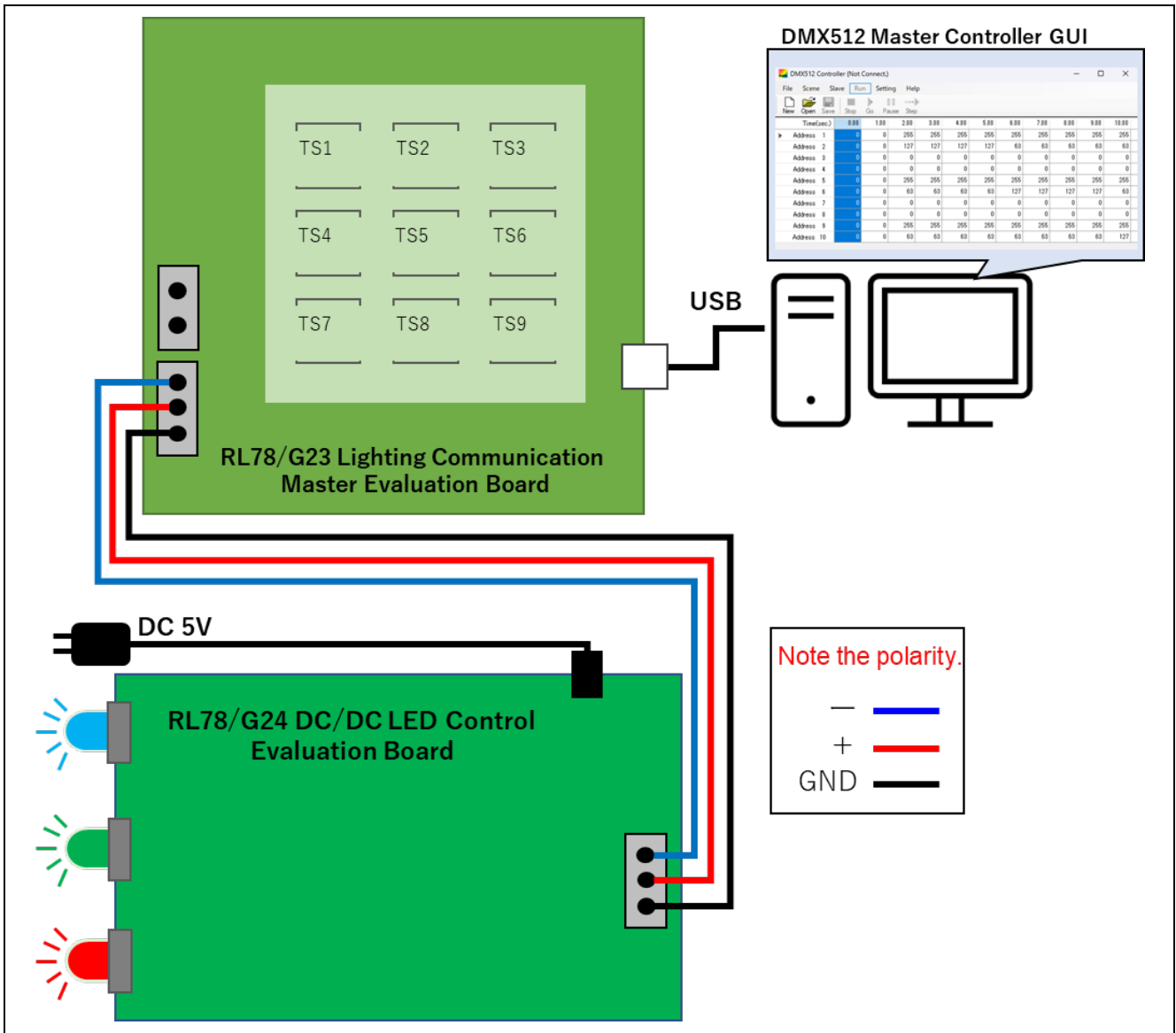


Figure 3-1 System Configuration Diagram

### 3.2 List of pins used

The receiving device pins and features used in the sample application are shown below.

**Table 3-1 Pins and features used**

Pin name	I/O	Description
P77 / TxD2	Input / Output	UART2 Transmission pin
P76 / RxD2	Input / Output	UART2 Receiving pin
P30	Output	Link common pin (Fixed Output Low)
P31	Input	Input Capture Input pin

## 4. Description of the Software

### 4.1 Environment Construction

#### 4.1.1 Software Installation

To operation for this sample application, a communication GUI is required. For details on installing a GUI, refer to the following user’s manual.

- DMX512 Master Controller GUI User’s Manual (R01US0200)

Also, the flash writing software Renesas Flash Programmer (hereinafter referred to as RFP) is required to write the firmware. Download the software form the Renesas Electronics website.

Refer to the following User’s Manual for basic RFP operations.

- Renesas Flash Programmer V3.13 Flash memory programming software User’s Manual (R20UT5312)

#### 4.1.2 Writing firmware

Write the target firmware to the receiving device. The Motorola S-type format file is stored in the project folder, so use RFP to write the flash, Refer to 4.5.1 Folder Structure for information on storage folders.

When writing firmware to the RL78/G24 DC/DC LED Control Evaluation Board, it is necessary to set SW1 on the board according to the connection method.

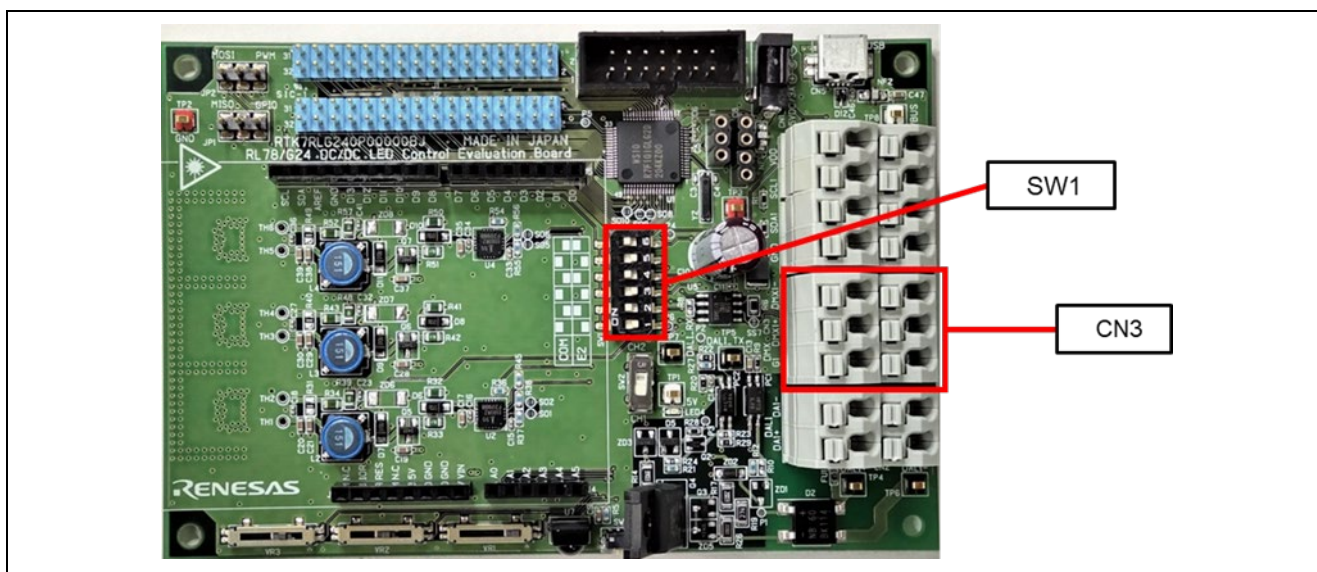


Figure 4-1 RL78/G24 DC/DC LED control Evaluation Board

Table 4-1 RL78/G24 DC/DC LED control Evaluation Board SW1 setting

SW1	COM port	E2
1	ON	OFF
2	OFF	ON
3	ON	OFF
4	OFF	ON
5	ON	OFF
6	OFF	ON
7	ON	OFF
8	OFF	ON

### 4.1.3 How to connect the sample application to hardware

This section describes how to connect the hardware. Connect an AC adapter to the receiving device side to supply power. The control device is powered by connecting the USB port on the board to a PC and can be turned on/off and dimmed from the DMX512 master controller GUI.

The control device should be prepared for operation with reference to the RL78/G23 Lighting Communication Master Board User's Manual, Operation with PC Connected (DMX512 Communication).

- RL78/G23 Lighting Communication Master Board User's Manual (R20UT5072)

The connections between the control device and receiving device are described below.

**Table 4-2 Board connection**

Item	Control device	Receiving device
DMX (-)	CN3 DMX2 (-) or DMX1 (-)	CN3 DMX1 (-) or DMX2 (-)
DMX (+)	CN3 DMX2 (+) or DMX1 (+)	CN3 DMX1 (+) or DMX2 (+)
DMX GND	CN3 G2 or G1	CN3 G1 or G2

Note That the DMX512 communication protocol has polarity. Check the polarity of the connection source and destination before connecting.



### 4.2 Operation Overview

The following is an overview of the sample application.

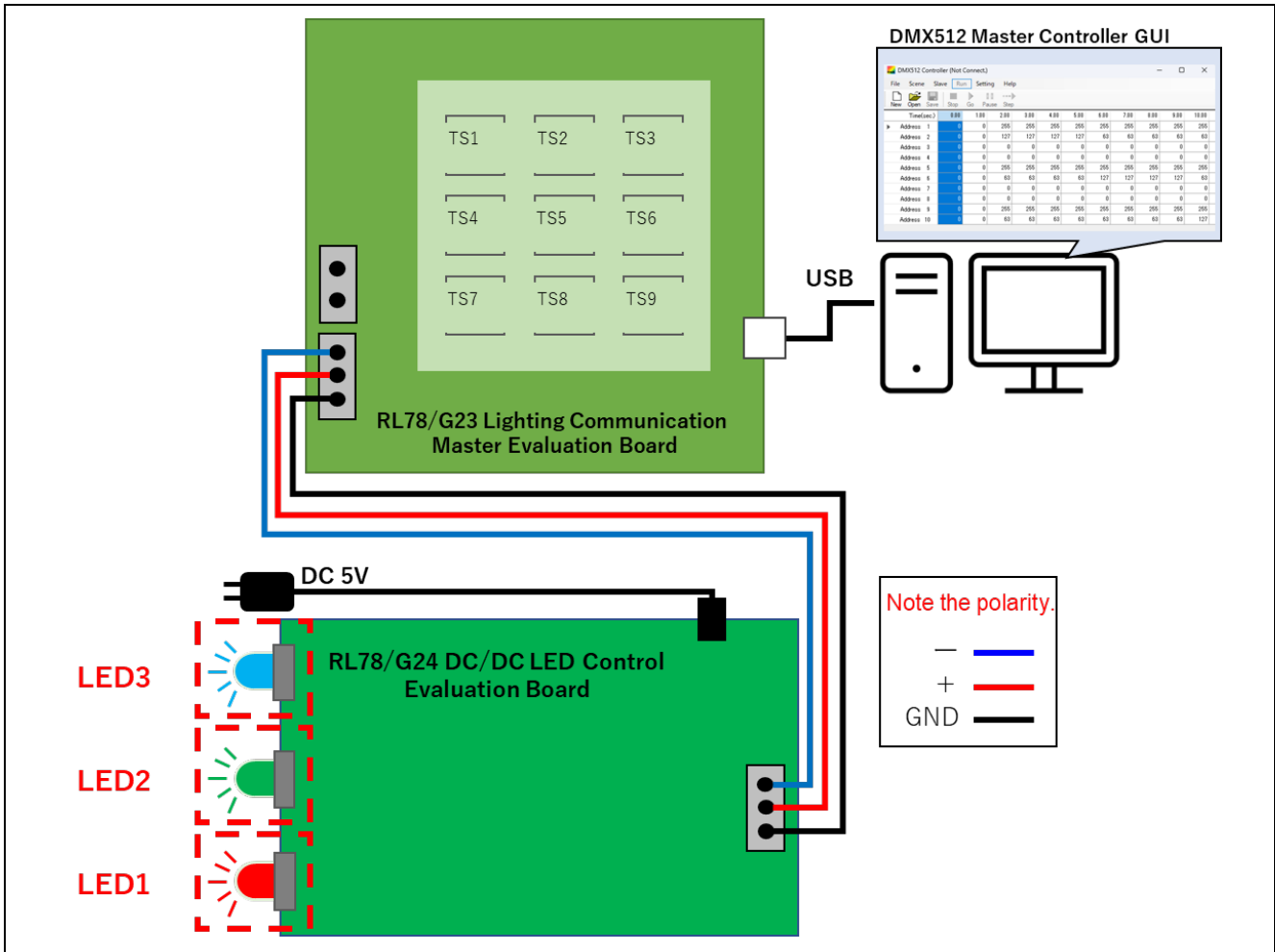


Figure 4-2 System Configuration

The three-color LEDs (red, green, and blue) on the receiver device are used as illuminators, and a start address is assigned to each LED for independent dimming instructions.

The DMX512 master controller GUI sets dimming instructions based on the assigned start address. Dimming instructions are sent from the DMX512 master controller GUI via the control device, and the receiving device switches the dimming level of each LED in response.

### 4.2.1 Connection Specifications

This section describes the data structure of the DMX512 standard used in this sample application.

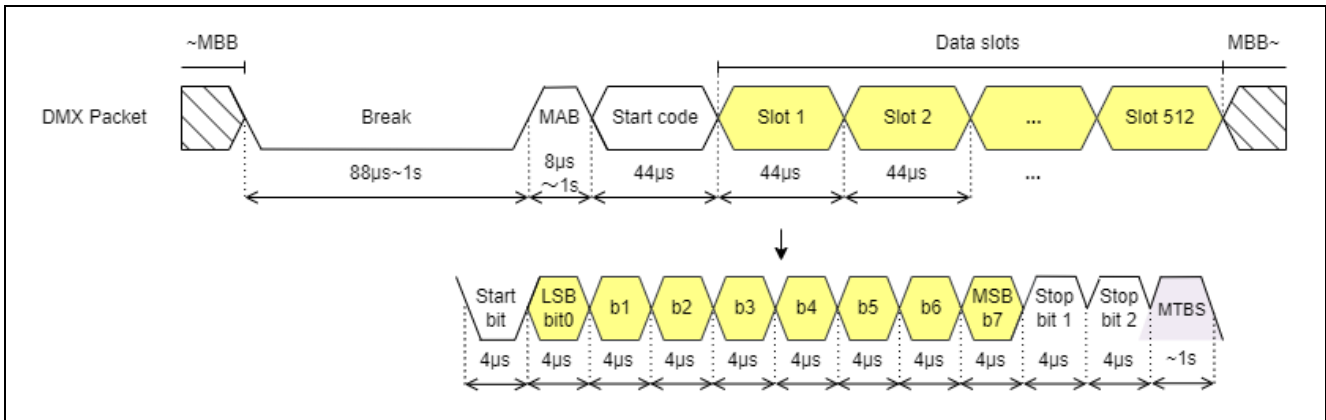


Figure 4-3 data structure diagram

Details of each data:

**MBB (Mark Before Break)**

Indicates the time from the last Data Slot to the next Break.

**MAB (Mark After Break)**

Split Break and Start code.

**MTBS (Mark Time Between Slots)**

Split each Data slots.

**Break**

Indicates the start of a new packet.

**Start code**

In the first Slot after MAB, the Data slots indicate what kind of data is stored.

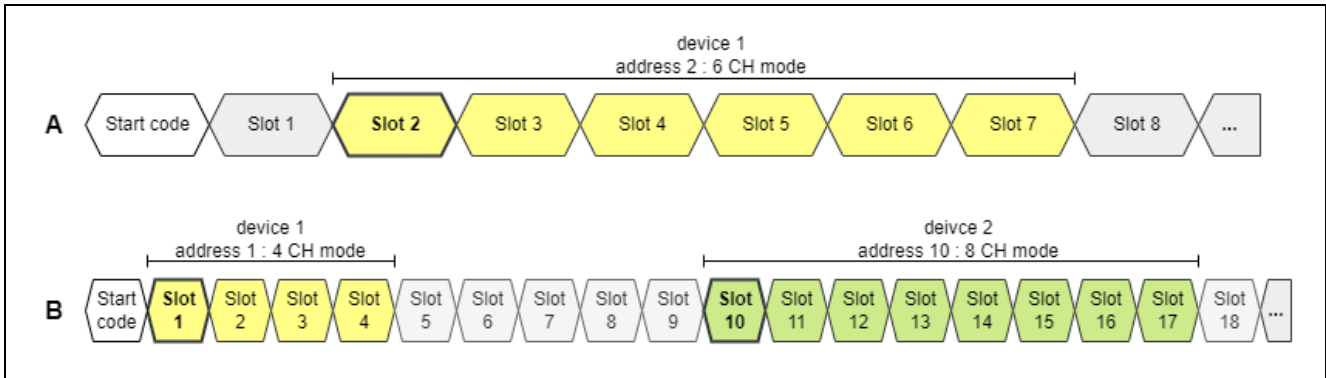
For dimming commands, 0x00 is stored.

**Data slots**

Each data slot consists of 1 start bit, 8-bit data, and 2 stop bits, with a maximum of 512 bytes

The time between each data slots may vary depending on the MTBS.

If you want to execute multiple devices individually, you need to give a unique Start Address to each device. Also, if the content to be executed differs for each device, the number of Data slots (4CH, 8CH, etc.) must be set according to the purpose. An example assignment is shown below.



**Figure 4-4 Example of Start Address and Channel settings**

Details of example assignments:

A: 1 DMX device.

Assigned Start Address in Data slot 2.

Use Data slots 2 ~ 7 as the device operates 6 CHs of information.

B: 2 DMX device.

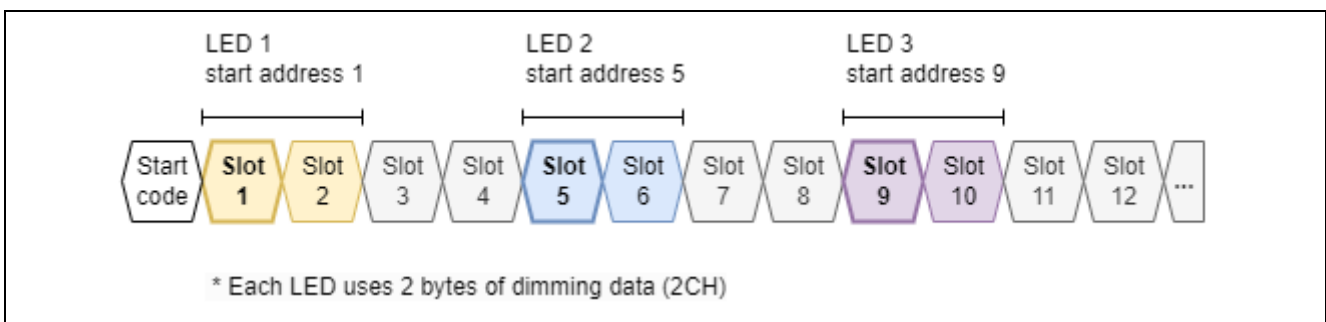
The Start Address of device 1 is assigned to 1 in the Data slot.

Use Data slots 1 ~ 4 as the device 1 operates with 4 CHs of information.

The Start Address of device 2 is assigned to 10 in the Data slot.

Use Data slots 10 ~ 7 as the device 2 operates with 8 CHs of information.

This sample application makes the following assignments to each LED to provide independent dimming instructions.



**Figure 4-5 Start Address and Channel setting for sample application**

## 4.2.2 Application Operation Specifications

This section describes the operation specifications of this sample application.

### 4.2.2.1 LED Dimming Operation

Converts dimming instructions (2 bytes) received from the DMX512 master controller GUI into dimming driver indication value. Switches the LED to be controlled and gives LED output instructions.

## 4.3 Operating Procedure

The following is an example of the operating procedure for this application.

1. Connect each board and supply power according to 4.1 Environment Construction.
2. Start up DMX512 Master Controller GUI on the PC.
3. Register the Start Address assigned in the sample application in the DMX512 master controller GUI. Click "Select..." from the "Slave" tab.

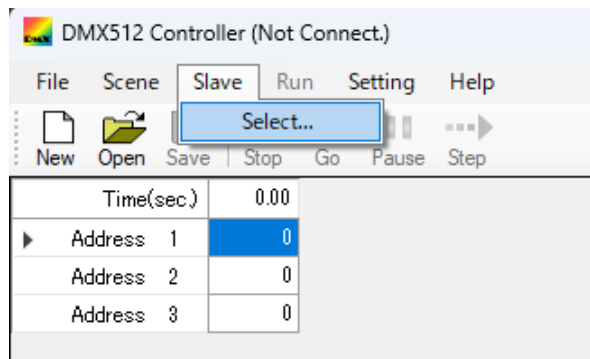


Figure 4-6 Screen of DMX512 Master Controller GUI (1/3)

- Each LED operates with a 2-byte dimming instruction value, so select and add a Start Address and a slave of the Start Address + 1 byte.

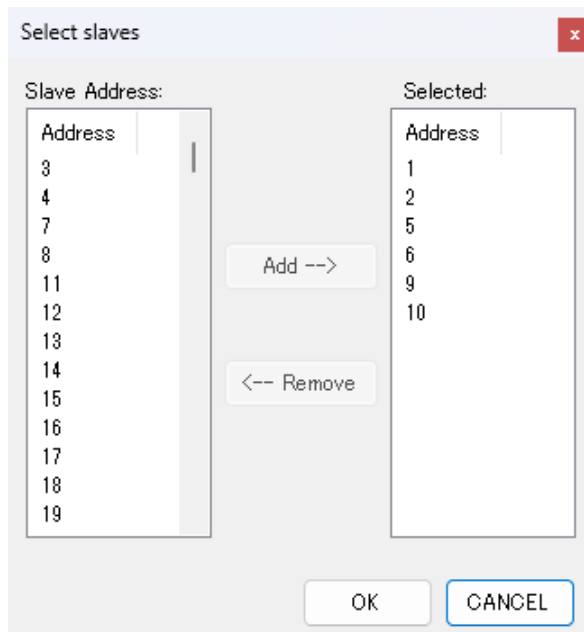


Figure 4-7 Screen of DMX512 Master Controller GUI (2/3)

- Set the dimming indication value. In the case of the instruction value shown in the image example, the LED output is turned on at 50%.

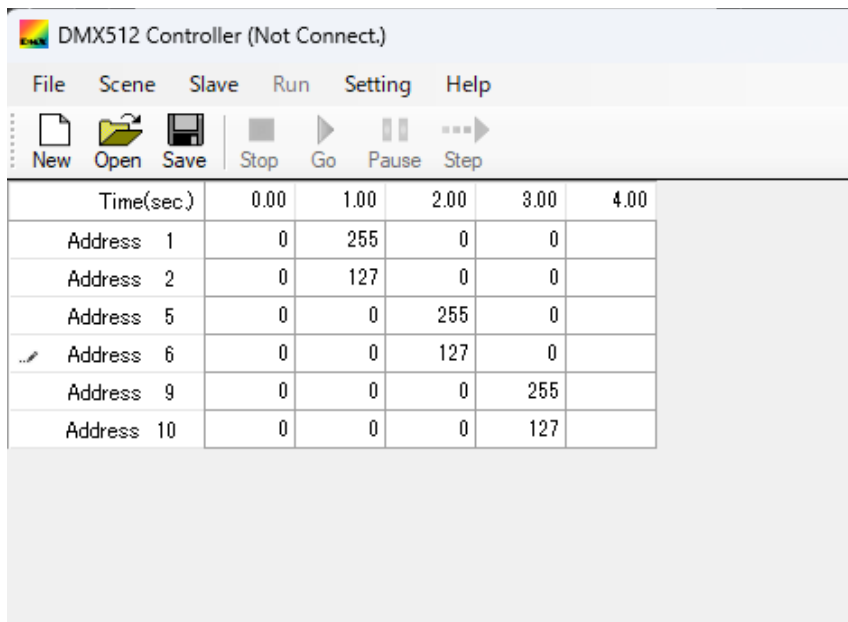


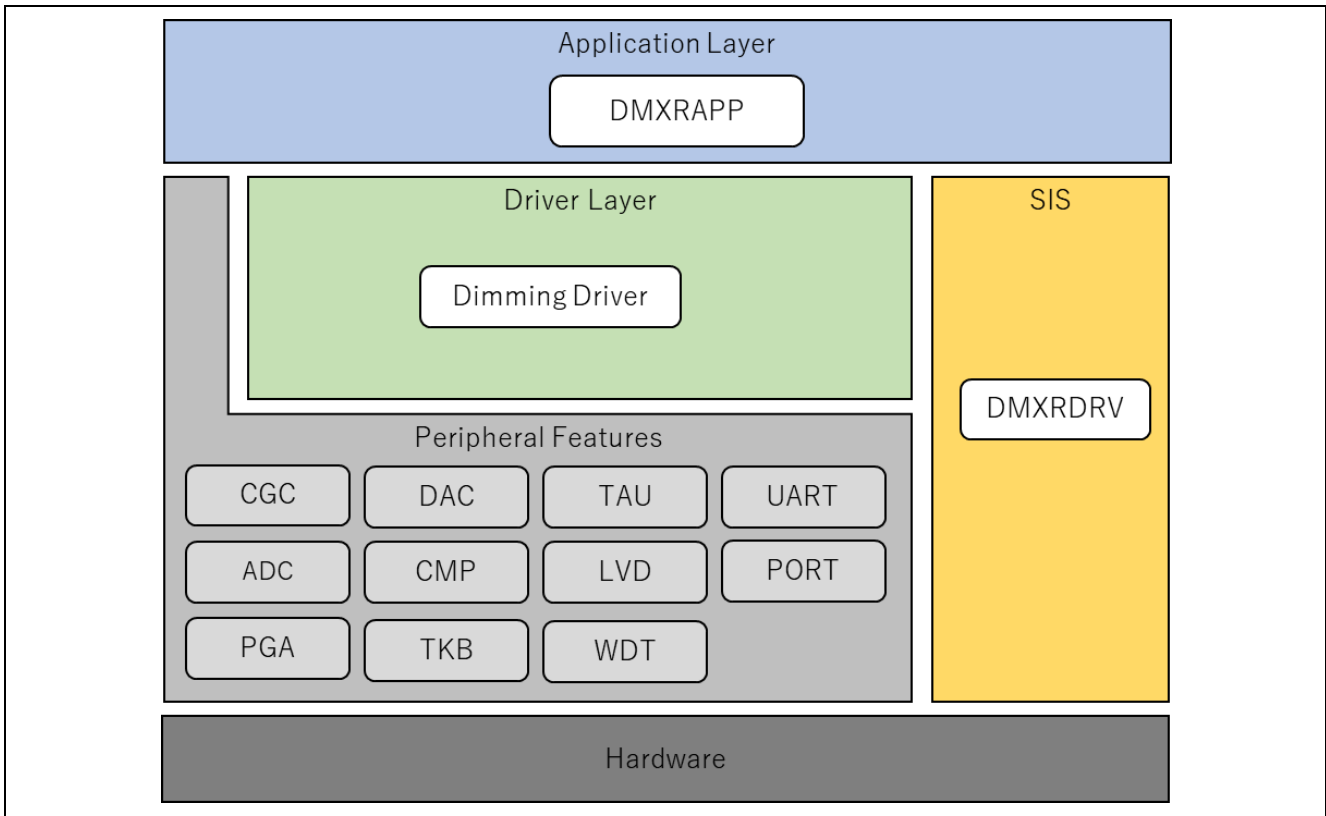
Figure 4-8 Screen of DMX512 Master Controller GUI (3/3)

- click "Go" to start transmitting the indicated value and confirm that the LED light intensity changes every second. For other operations of the DMX512 master controller GUI, please refer to the user's manual.

## 4.4 Feature Overview

### 4.4.1 Feature Block Diagram

The sample application's feature block diagram is shown below.



**Figure 4-9 Feature Block Diagram**

### 4.4.2 Driver Layer

#### 4.4.2.1 Dimming Driver

This driver performs dimming control for three-LED colors (red, green, and blue).

The following peripheral features are used to control the dimming of each LED.

- ADC
- PGA
- DAC
- CMP
- TKB

Refer to the following document for detailed information on the dimming control.

- LED control with RL78/G24 (R01AN6673)

### 4.4.3 SIS (Software Integration System)

#### 4.4.3.1 DMXRDRV (DMX512 Receive Driver)

This is the driver part of DMX512 Receive module SIS. It realizes DMX512 Receive operation using the serial array unit SAU.

Refer to the following document for detailed information on the module.

- RL78 Family DMX512 Receive Module Software Integration System (R01AN7213)

The configuration settings in this sample application are shown below.

**Table 4-3 DMX512 Receive Driver setting items list**

Item	Possible values	Description
Number of receive device	3	Select the number of receiving devices to be controlled.
Start address of receive device 1	1	Set the starting address of device 1.
Start address of receive device 2	5	Set the starting address of device 2.
Start address of receive device 3	9	Set the starting address of device 3.
Number of channel used by receive device 1	2	Sets the number of channels used by device 1.
Number of channel used by receive device 2	2	Sets the number of channels used by device 2.
Number of channel used by receive device 3	2	Sets the number of channels used by device 3.
UART channel	UART2	Select UART resource for DMX512 communication.
Timer resource for input capture	TAU0_3	Select the Timer Source for measuring Break time.
Timer resource for interval timer	TAU0_0	Selects the Timer Source for measuring Receive Timeout.
Interrupt level for INTSR	Level 3(Lowest)	Selects the interrupt priority for INTSR2.
Interrupt level for INTTM by input capture	Level 2	Selects the interrupt priority for INTTM03.
Interrupt level for INTTM by interval timer	Level 3(Lowest)	Selects the interrupt priority for INTTM00.
Pin for setting DMX512 Link common	P30	DMX512 Link Sets the terminal to be connected to the Common.

#### **4.4.4 Application Layer**

##### **4.4.4.1 DMXRAPP (DMX512 Receive Application)**

This is the application part of the DMX512 communication function. Interprets the received data and performs the operation upon reception.

##### **(1) Application Task Processing**

Application task processing performs following processing.

##### **(a) Receive data acquisition**

The API function "R\_DMXRDRV\_GetReceiveData" provided by DMXRDRV is used to acquire receive data for each LED.

##### **(b) LED target value setting**

After converting the received data into dimming values, these values are reflected to the dimming driver as target values for each LED.



## 4.5 Software Configuration

This section describes the software configuration of the sample application.

### 4.5.1 Folder Structure

The folder structure of this sample application is shown below.

**Table 4-4 Folder Structure**

Folder, File Name	Description
DMXReceiver_Sample<DIR>	Sample application folder
\App<DIR>	Application program storage folder
r_main.c	Main source file
r_dmrx_app.c	DMX512 Receive application source file
r_dmrx_app.h	DMX512 Receive application header file
\Driver<DIR>	Driver program storage folder
r_led.c	Dimming driver source file
r_led.h	Dimming driver header file
r_led1.c	Dimming driver source file for LED1(Red)
r_led1.h	Dimming driver header file for LED1(Red)
r_led2.c	Dimming driver source file for LED2(Green)
r_led2.h	Dimming driver header file for LED2(Green)
r_led3.c	Dimming driver source file for LED3(Blue)
r_led3.h	Dimming driver header file for LED3(Blue)
\Utility<DIR>	Common program storage folder
r_timer16.c	Timer module source file
r_timer16.h	Timer module header file
r_usertype.h	Type definition header file
\src<DIR>	Smart configurator generation file storage folder
\smc_gen<DIR>	Smart configurator generation folder (Omitted below) *DMX512 Receive module SIS code is generated under
\DefaultBuild<DIR>(CC-RL)	Project output file storage folder (CC-RL development environment only)
DMXReceiver_Sample.mot	Motorola S-type format file used for writing to firmware
\Release\Exe<DIR>(IAR)	Project output file storage folder (IAR development environment only)
DMXReceiver_Sample.mot	Motorola S-type format file used for writing to firmware

### 4.5.2 List of Option Byte Settings

The following table shows the option byte settings for the sample application.

**Table 4-5 List of Option Byte Settings**

Address	Set value	Contents
000C0H / 010C0H	01110001B	Watchdog timer operation enabled (count starts after reset is released)
000C1H / 010C1H	11111011B	LVD reset mode (falling: 2.97V, rising: 2.91V)
000C2H / 010C2H	11101010B	HS mode, high-speed on-chip oscillator: 8MHz
000C3H / 010C3H	10000100B	On-chip debugging permitted

## 5. Notes

- This sample application is configured and operated in accordance with the RL78/G24 DC/DC LED Control Evaluation Board.
- The operation provided by this sample application is only a sample. The application layer should be redesigned and evaluated according to the intended use.

## 6. Documents for Reference

RL78/G24 User's Manual: Hardware (R01UH0961)

RL78 Family DMX512 Receive module Software Integration System (R01AN7213)

LED control with RL78/G24 (R01AN6673)

Renesas Flash Programmer V3.12 Flash memory programming software User's Manual (R20UT5312)

(The latest version can be downloaded from the Renesas Electronics website.)

Technical Updates/Technical News

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DMX512 Standards

USITT DMX512 / 1990

**Revision History**

Rev.	Date	Description	
		Page	Summary
1.00	Apr.19.24	-	First edition issued

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

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### 1. Precaution against Electrostatic Discharge (ESD)

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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.

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### 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.).

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