

# RL78 Family

RTK7RLG240P00000BJ  
RL78/G24 DC/DC LED Control Evaluation Board  
User's Manual

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

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

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

A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. 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.

### 5. Clock signals

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.

### 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.).

### 7. Prohibition of access to reserved addresses

Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.

### 8. Differences between products

Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

# How to Use This Manual

## 1. Purpose and Target Readers

This manual is intended for users who want to develop Lighting systems or Digital power supply systems with RL78/G24 microcontrollers.

Basic knowledge of electrical circuits, logic circuits, and microcomputers is required to use this manual. This manual is broadly categorized and consists of product overview, specifications, and usage instructions.

Particular attention should be paid to the precautionary notes when using the manual. These notes occur within the body of the text, at the end of each section, and in the Usage Notes section.

The revision history summarizes the locations of revisions and additions. It does not list all revisions. Refer to the text of the manual for details.

## 2. Symbols Used

This document uses the following symbols for items to be observed to ensure the safe use of the unit. The symbols are followed by a brief explanation of the possible extent of problems which may occur if the items are not observed.

|                                                                                     |                |                                                                                                   |
|-------------------------------------------------------------------------------------|----------------|---------------------------------------------------------------------------------------------------|
|   | <b>Danger</b>  | The risk is high if the warning is not observed, and the user may suffer death or serious injury. |
|  | <b>Warning</b> | The user may suffer death or serious injury if the warning is not observed.                       |
|  | <b>Caution</b> | Human injury or property damage may occur if the caution is not observed.                         |

The following symbols express behaviors that are prohibited in order to prevent injury or accident.

|                                                                                     |                                                                                                                                         |                                                                                     |                                                                          |                                                                                       |                                                                                                            |
|-------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------|---------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
|  | <b>General prohibition</b><br>The action mentioned is prohibited.                                                                       |  | <b>Do not touch</b><br>Touching the specified location may cause injury. |  | <b>Do not disassemble.</b><br>Disassembly may cause a problem such as electric shock or product failure.   |
|  | <b>Keep away from water</b><br>Use near water poses the risk of electric shock or product failure if moisture were to contact the unit. |  | <b>Flammable</b><br>Proximity to flame may cause the unit to catch fire. |  | <b>Do not touch with wet hands</b><br>Touching with wet hands may cause electric shock or product failure. |

The following symbols are used for cautions to prevent product failure and accidents.

|                                                                                     |                                                        |                                                                                     |                                                               |
|-------------------------------------------------------------------------------------|--------------------------------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------|
|  | <b>General caution</b><br>Unspecified general cautions |  | <b>Caution: Hot</b><br>Human injury due to a high temperature |
|-------------------------------------------------------------------------------------|--------------------------------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------|

## Warnings

|  <b>Warning</b> |                                                                                                                                                                                                                                                                                                                                                        |
|--------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                 | <b>Be careful to avoid burns.</b><br>The temperature of this part of board increases when AC power is connected.                                                                                                                                                                                                                                       |
|                 | <b>Be careful of LED brightness and the LED On/Off interval.</b><br>Simulations of strong light may cause symptoms linked to an epileptic condition.                                                                                                                                                                                                   |
|                 | <b>Do not use this board for a purpose other than the evaluation of an MCU.</b><br>This board does not include the safety measures or anti-EMI measures required for lighting equipment.                                                                                                                                                               |
|                 | <b>Do not heat the board or expose it to fire and do not short the terminals.</b><br>Doing so may cause the product to fail, heat up, catch fire, or rupture.                                                                                                                                                                                          |
|                 | <b>Do not disassemble or modify the board.</b><br>Doing so may cause the product to fail, emit smoke, or catch fire, or result in electric shock.                                                                                                                                                                                                      |
|                 | <b>Do not touch with wet hands.</b><br>Doing so while connected to power may cause the product to fail or result in electric shock.                                                                                                                                                                                                                    |
|                | <b>Do not look directly at the LEDs on this board.</b><br>Doing so may weaken eyesight.                                                                                                                                                                                                                                                                |
|                                                                                                  | <b>Do not drop the board or subject the board to heavy impact.</b><br>Doing so may break or damage the board, causing fire or electric shock.                                                                                                                                                                                                          |
|                                                                                                  | <b>Do not turn on the power switch when the AC adapter, interface cable, or other cables are not properly connected.</b><br>Doing so may cause the product to fail, heat up, or catch fire, or result in electric shock.                                                                                                                               |
|                                                                                                  | <b>Do not plug in or unplug a connector or cable with power applied to the board.</b><br>Doing so may cause the product to fail, heat up, or catch fire, or result in electric shock.                                                                                                                                                                  |
|                                                                                                  | <b>Do not move this board when the AC adapter or any cables are connected.</b><br>Doing so may damage cables and cause the product to fail, heat up, or catch fire, or result in electric shock.                                                                                                                                                       |
|               | <b>Use this board with a spacer and on an electrically isolated bench.</b><br>If a conductor contacts the board, the product may fail, heat up, or catch fire, or it may result in electric shock.                                                                                                                                                     |
|                                                                                                  | <b>Use an AC adapter adapted to the safety standard of each country.</b><br>Using an inappropriate AC adapter may cause the product to fail, heat up, or catch fire, or result in electric shock.                                                                                                                                                      |
|                                                                                                  | <b>Use the specified AC adapter.</b><br>Using an AC adapter other than that specified may cause the product to fail, heat up, or catch fire, or result in electric shock.                                                                                                                                                                              |
|                                                                                                  | <b>Use an AC adapter of the following size and DC plug polarity.</b><br>EIAJ Type2 Plug (outer diameter: 4.0 mm, inner diameter: 1.7 mm) <br>Using another type of AC adapter may cause the product to fail, heat up, or catch fire, or result in electric shock. |
|                                                                                                  | <b>Using another type of AC adapter may cause the product to fail, heat up, or catch fire, or result in electric shock.</b>                                                                                                                                                                                                                            |
|               | <b>Confirm that the outlet is near this board and can be easily unplugged.</b>                                                                                                                                                                                                                                                                         |
|                                                                                                  | <b>If smoke or an abnormal smell or sound is emitted or if overheating occurs, promptly switch off the board power and unplug the AC power supply.</b><br>Using the board in such a state poses a risk of fire, burning or electric shock.                                                                                                             |



## Warning

**Be careful to avoid burns.**

Parts of the board, especially the area enclosed by a dotted line, become extremely hot.

**Do not look directly at LEDs on this board.**

Doing so may weaken eyesight.  
Use this board with the LED mounting surface back.

**Use a specified AC adapter.**

Using an AC adapter other than that specified causes the product to fail, heat up, or catch fire, or electric shock.



## Caution

**Do not touch directly LEDs on this board.**

Doing so may cause a product failure.

# Table of Contetns

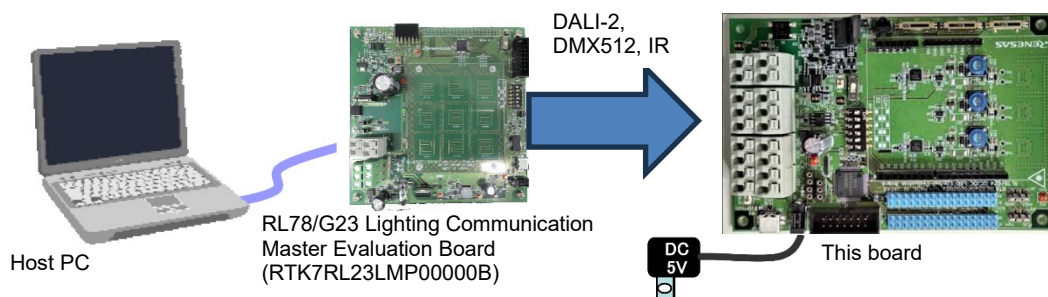
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## 1. Overview

RTK7RLG240P00000BJ is an evaluation board for LED, DC/DC control and communication by the RL78/G24 microcontroller.

This board can operate with the 5 VDC power supply provided by an AC adapter, which should be prepared separately. The customer should also prepare USB cable.

By using the RL78/G23 Lighting Communication Master Evaluation Board (RTK7RL23LMP00000B) and a GUI tool (which can be downloaded from the Renesas Electronics' website), dimming evaluation by DALI-2, DMX512 or infrared data communication protocol is possible.



Prepare an USB cable and an AC adapter that satisfies the following:

USB Cable

- TYPE MINI-B that can data communication

AC adapter

- Output Voltage : DC5V
- Output current : > 2A
- Connector : EIAJ- 2 (outer diameter: 4.0 mm, inner diameter: 1.7 mm)



- Circuit type : Switching regulator type with overcurrent protection circuit
- Do not use an AC adapter whose output voltage is guaranteed only when the rated load current flows.



## 1.1 Configuration of this product

This product configures as below :

- RTK7RLG240P00000BJ (RL78/G24 DC/DC LED Control Evaluation board)

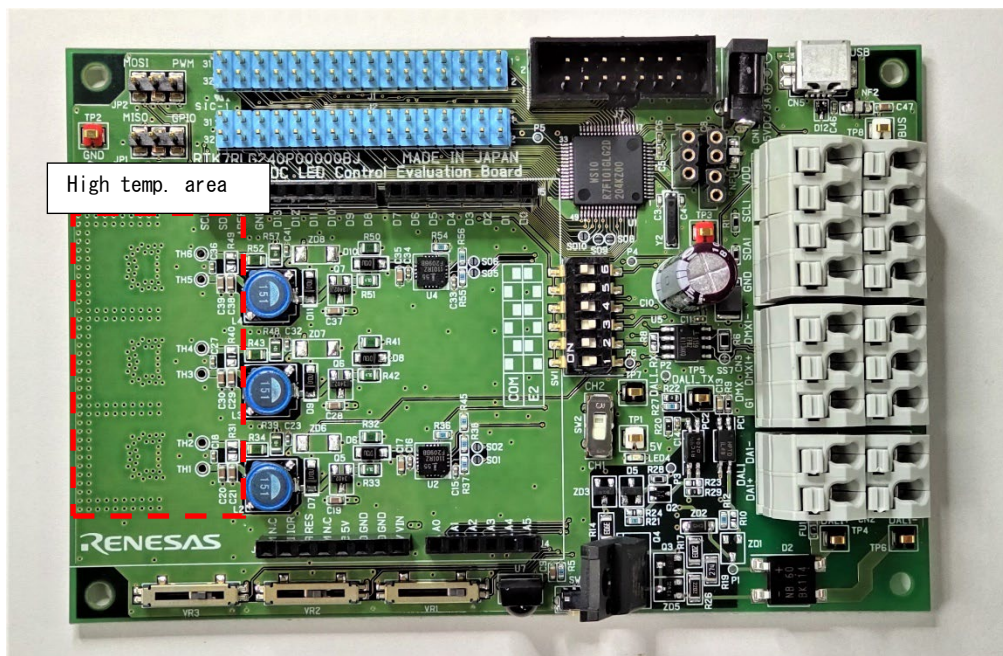


Fig 2-1 Top

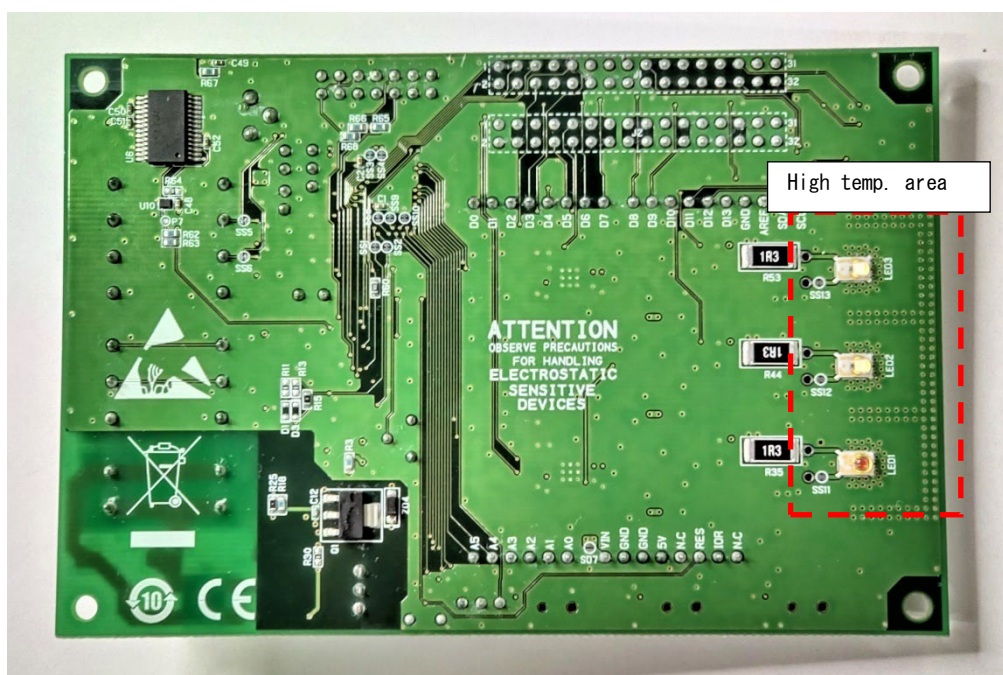


Fig 2-2 Bottom

## 1.2 Main features of RL78/G24 DC/DC LED Control Evaluation Board

- LED lighting system and DC/DC converter control system demonstration capabilities
- This board demonstrates constant current control of LEDs by using 16-bit timers KBn( n = 0, 1, 2 ) dedicated to PWM output
  - Back topology
  - Constant current drive of 350 mA ( max. ) x 3 channels
- 5types of dimming control interface supported
  - DALI-2 protocol communication interface
  - DMX512 protocol communication interface ( also available as RDM-DMX )
  - SMBus/PMbus protocol communication interface
  - IR remote control interface
  - 3 ch. analog volume control interface (for standalone evaluation)
- Easy to use device demonstration capabilities

The RL78/G24 DC/DC LED Control Evaluation Board contains elements to easily demonstrate I/O-functions (i.e. LED output, I/O lines, UART serial interface) together with Real Time Clock (RTC), ADC and Timers. Also, The board has Arduino UNO R3 compatible interface. Various shields can be connected.
- Power supply via 5V DC connector

The RL78/G24 DC/DC LED Control Evaluation Board is powered via a 5V DC jack connector. This power supply is used for power the RL78/I1A as well as the LEDs.
- On-Board debugging function

The RL78/G24 DC/DC LED Control Evaluation Board supports an On-Board debugging function by using the IDE, without the need of additional debugging hardware. It allows flash programming and supports standard debugging functions such as code execution, step execution, software breakpoints, memory manipulation etc. (The E2 emulator lite can also be used for on-chip debugging.)
- Renesas Flash Programmer (RFP)

Windows based Flash programming software allows the user to select and download application programs to the RL78/G24 DC/DC LED Control Evaluation Board for evaluation purposes via USB.

## 2. Specification

This section describes the specification of this products.

### 2.1 Spec. of this board

Describes the specification table as below:

**Table 2-1 Specification Table**

| Item                         | Specification                                                   |                               |                                 |                 |
|------------------------------|-----------------------------------------------------------------|-------------------------------|---------------------------------|-----------------|
| Product Name                 | RTK7RLG240P00000BJ（RL78/G24 DC/DC LED Control Evaluation board） |                               |                                 |                 |
| List of products             | Main product                                                    | RTK7RLG240P00000BJ 1pcs       |                                 |                 |
|                              | Spacer                                                          | 4 pcs                         |                                 |                 |
|                              | Screw                                                           | 4 pcs                         |                                 |                 |
|                              | Attached documents                                              | Precautions for use           |                                 | 1 letter        |
| MCU                          | RL78/G24（P/N：R7F101GLG2DFB）                                     |                               |                                 |                 |
| External sub clock           | 32.768KHz oscillator                                            |                               |                                 |                 |
| Converters and Interface     | DC/DC Converters and power LED                                  | LED1（RED）                     |                                 | 1ch             |
|                              |                                                                 | LED2（GREEN）                   |                                 | 1ch             |
|                              |                                                                 | LED3（BLUE）                    |                                 | 1ch             |
|                              | Communication / Dimming Interrace                               | DALI                          |                                 | 1ch             |
|                              |                                                                 | DMX512                        |                                 | 1ch             |
|                              |                                                                 | SMbus/PMbus                   |                                 | 1ch             |
|                              |                                                                 | IR Remote Control             |                                 | 1ch             |
|                              |                                                                 | Analog volumes                |                                 | 3ch             |
|                              | USB<br>*Exclusive use with COM port debugging                   | UART                          |                                 | 1ch             |
|                              | Debugging I/F                                                   | COM Port debugging            |                                 |                 |
|                              |                                                                 | E2 emulator/ E2 emulator Lite |                                 |                 |
|                              | Expanded connector                                              | Expanded connector            |                                 |                 |
| Arduino UNO R3 I/F connector |                                                                 |                               |                                 |                 |
| Size                         | 140×90[mm]                                                      |                               |                                 |                 |
| Weight                       | Around 80g                                                      |                               |                                 |                 |
| Power input                  | AC adapter                                                      | DC5V/2A                       |                                 |                 |
| Current consumption          | 5V/1.1A [max.]                                                  | Detail                        | Board consumption（/w Power LED） | 5V/0.05A [max.] |
|                              |                                                                 |                               | Power LED consumption           | 5V/1.050A[max.] |
| Operation environment        | Temperature                                                     | 0Cdeg～+40Cdeg                 |                                 |                 |
|                              | Humidity                                                        | 5%～95%RH(no condensation)     |                                 |                 |

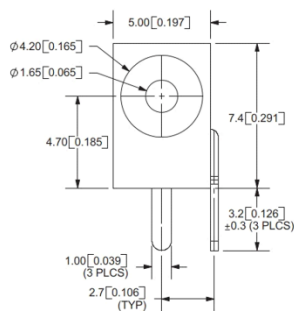
## 2.2 Power input

Describes specification of power input as blow

**Table 2-2 Power input specification**

| Power input | Voltage | Current | Power connector |        |
|-------------|---------|---------|-----------------|--------|
| AC adapter  | 5V      | 2A      | DC Jack(CN1)    | EIAJ-2 |

**Table 2-3 Specification of DC Jack**

| Item        |                         | explanation                                                                                                                                                             |
|-------------|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Manufacture |                         | CUI                                                                                                                                                                     |
| P/N         |                         | PJ-018H                                                                                                                                                                 |
| Spec.       | Input voltage / current | +5V/ >2A                                                                                                                                                                |
|             | Recommended Plug        | JEITA RC-5320A TYPE2                                                                                                                                                    |
|             | Contact num.            | 3 pole                                                                                                                                                                  |
|             | Polarity                | Center plus                                                                          |
|             | Size                    |   |



## Warning



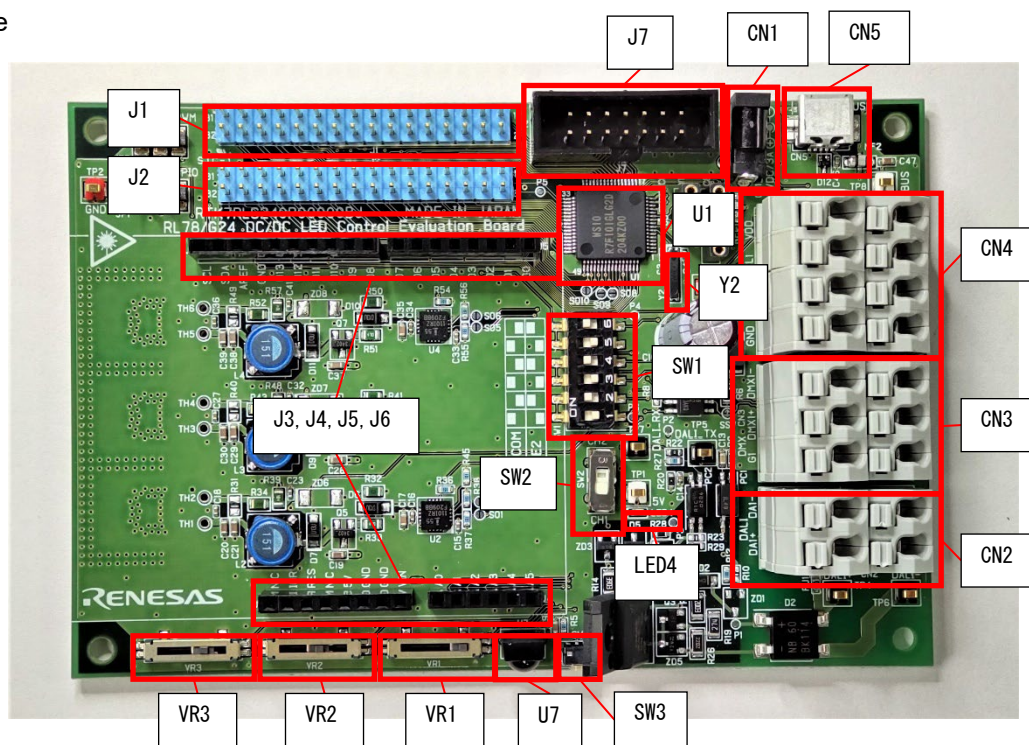
Use an AC adapter that conforms to the safety standard of each country. Using an incorrect AC adapter causes the product to fail, heat up, or catch fire, or result in electric shock.



## 2.3 Main components

The location of main components is shown Fig. 2-1 and Talb 2-4. Also show recommended spec. of cable for DALI communication connector (CN2), DMX512 communication connector(CN3), SMBus/PMBus communication connector(CN4) as Fig.2-2.

### ●Parts side



### ●Soldering side

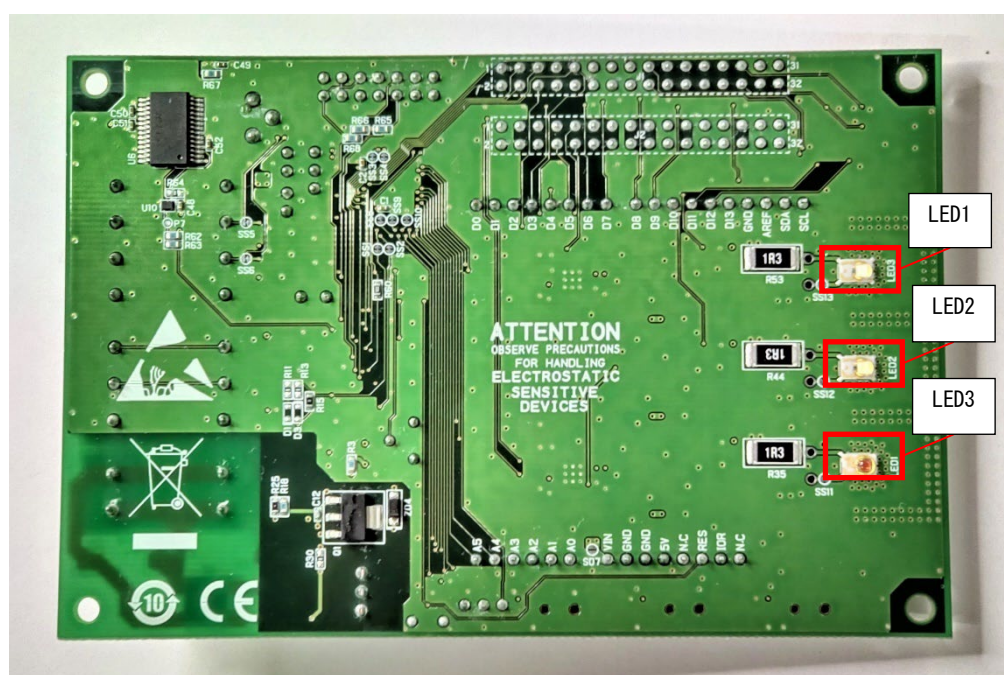


Fig. 2-1 The location of main components

Table 2-4 Main parts

| Reference Num. | Name                                | Note                                       |
|----------------|-------------------------------------|--------------------------------------------|
| U1             | MCU (RL78/G24)                      | -                                          |
| Y2             | 32.768KHz Xtal oscillator           | Connected to XT1 OSC circuit ( subclock )  |
| CN1            | DC jack                             | +5V Center EIAJ2                           |
| CN5            | USB connector                       | Mini-B type                                |
| LED4           | Indicator LED                       | Yellow                                     |
| CN2            | DALI communication connector        | Push in/Cascade                            |
| CN3            | DMX512communication connector       | Push in/Cascade                            |
| CN4            | SMbus/PMbus communication connector | Push in/Cascade                            |
| SW1            | switch                              | Operation mode change switch               |
| SW2            | switch                              | IR ch change switch                        |
| SW3            | Reset Switch                        | Reset for MCU                              |
| U7             | IR receiver                         | -                                          |
| VR1,VR2,VR3    | Analog volume                       | 10k $\Omega$<br>Dimming for LED1,LED2,LED3 |
| J1,J2          | Expanded connector                  | -                                          |
| J3,J4,J5,J6    | Arduino UNO R3 Interface connector  | -                                          |
| J7             | Connector for E2 emulator lite      | -                                          |
| LED1           | Power LED (RED)                     | -                                          |
| LED2           | Power LED (GREEN)                   | -                                          |
| LED3           | Power LED (BLUE)                    | -                                          |

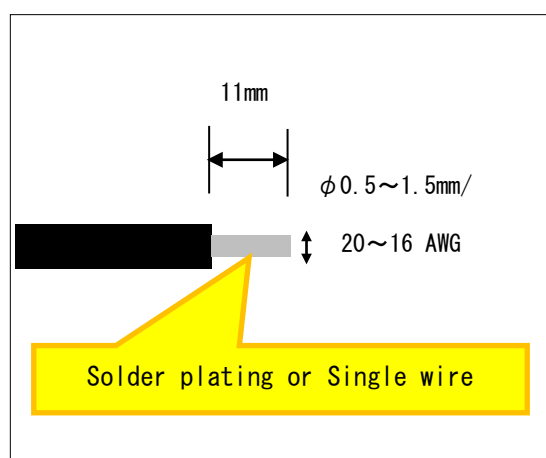


Fig. 2-2 The specification of recommended communication cable

## 2.4 Function

This section describes explanation of each function.

### 2.4.1 Power LED

It is equipped with three colors of Power LED: LED1 (red), LED2 (green), and LED3 (blue). The PWM output of the TKBO pin activates the buck converter and controlling each LED. In addition, by detecting the LED current at each analog input terminal, constant current control by feedback can be performed. Constant current control should be performed so that the current value of each LED does not exceed 350mA.

Note 1: Fixing the TKBO pin to the HIGH output by the general-purpose output port is prohibited. Overcurrent can cause the LED to fail.

**Table 2-5 Power LED control port**

| Channel     | Port                    | Direction from MCU | Description                                      |
|-------------|-------------------------|--------------------|--------------------------------------------------|
| LED1(Red)   | P12/TKBO00              | Out                | For buck converter gate PWM control, active high |
|             | P120/ANI19/IVCMP0/PGAI0 | In                 | Current detection for Feedback PGA analog input  |
| LED2(Green) | P13/TKBO01              | Out                | For buck converter gate PWM control, active high |
|             | P00/ANI29/IVCMP1/PGAI1  | In                 | Current detection for Feedback PGA analog input  |
| LED3(Blue)  | P14/TKBO10              | Out                | For buck converter gate PWM control, active high |
|             | P01/ANI30/IVCMP2/PGAI2  | In                 | Current detection for Feedback PGA analog input  |

**Table 2-6 Power LED Parts name**

| Item        | Parts name     | Manufacture |
|-------------|----------------|-------------|
| LED1(Red)   | LXM2-PD01-0050 | Lumileds    |
| LED2(Green) | LXML-PM01-0090 |             |
| LED3(Blue)  | LXML-PB01-0030 |             |

## 2.4.2 Dimming control interface

This board supported 5 types of dimming control interfaces. This section describes each dimming control interface.

DALI-2 protocol communication interface

DMX512 protocol communication interface ( also available as RDM-DMX )

SMbus/PMbus protocol communication interface

IR remote control interface

3 ch. analog volume control interface (for standalone evaluation)

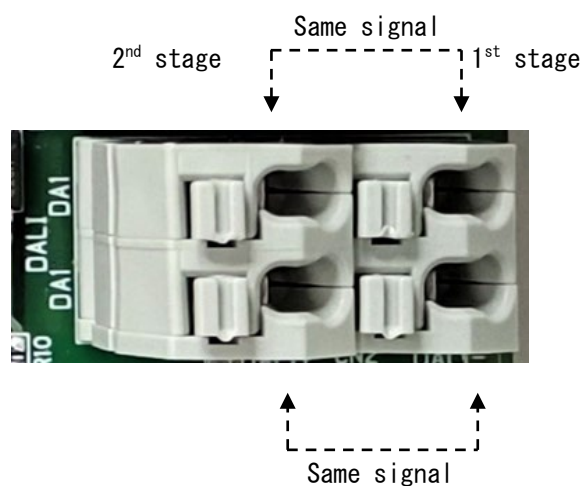
### 2.4.2.1 DALI-2 protocol communication interface

It is equipped with connector CN2 for DALI protocol communication interface and enables communication with the DALI Control device. In order to enable cascading of connectors, the signals printed on silk are connected as the same signal in the front (1st stage) and back (2nd stage) of the connector.

**Table 2-7 DALI-2 protocol communication port**

| Port name                       | Direction from MCU | Description           |
|---------------------------------|--------------------|-----------------------|
| P02/(DALITxD0) <sup>Note1</sup> | Out                | DALI sending signal   |
| P03/(DALIRxD0) <sup>Note1</sup> | In                 | DALI receiving signal |

Note 1 : PIOR registers setting is needed



**Fig. 2-3 DALI communication connector CN2**



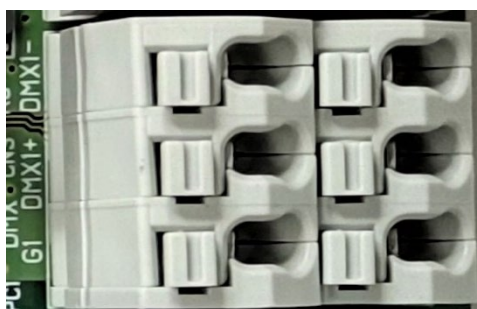
### 2.4.2.2 DMX512 protocol communication interface

It is equipped with connector CN3 for DMX512 protocol communication interface and enables communication with the DMX512 master. In order to enable cascading of connectors, the signals printed on silk are connected as the same signal in the front (first stage) and back (second stage) of the connector.

**Table 2-8 DMX512 protocol communication port**

| Port name                    | Direction from MCU | Description                                                            |
|------------------------------|--------------------|------------------------------------------------------------------------|
| P77/(Tx/D2) <sup>Note1</sup> | Out                | DMX512 sending signal                                                  |
| P76/(Rx/D2) <sup>Note1</sup> | In                 | DMX512 receiving signal                                                |
| P31/TI03                     | In                 | DMX512 receiving signal                                                |
| P30                          | Out                | DMX512 direction signal<br>HIGH=Enable sending<br>LOW=Enable receiving |

Note 1 : PIOR registers setting is needed



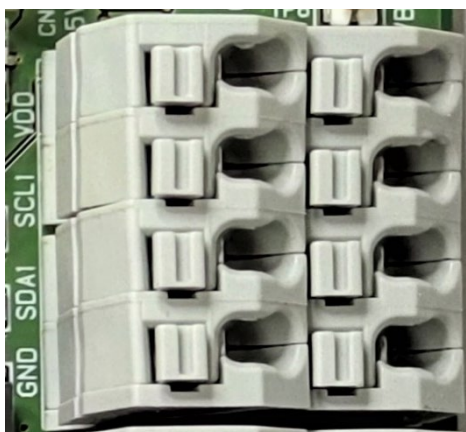
**Fig. 2-4 DMX512 communication connector CN3**

### 2.4.2.3 SMBus/PMbus protocol communication interface

It is equipped with connector CN4 for SMBus/PMbus protocol communication interface and enables communication with the SMBus/PMbus master. In order to enable cascading of connectors, the signals printed on silk are connected as the same signal in the front (first stage) and back (second stage) of the connector.

**Table 2-9 SMBus/PMbus protocol communication port**

| Port name | Direction from MCU | Description                |
|-----------|--------------------|----------------------------|
| P60/SCLA0 | In/Out             | Serial clock in/out signal |
| P61/SDAA0 | In/Out             | Serial data in/out signal  |



**Fig. 2-5 SMBus/PMbus communication connector CN4**

### 2.4.2.4 IR remote control interface

The infrared (IR) detector U7 can be used for performing IR communication between the controller device and the RL78/G24. The controller device can send commands to the RL78/G24 microcontroller using the IR communication protocol.

**Table 2-10 IR remote control interface control port**

| Port name  | Direction from MCU | Description            |
|------------|--------------------|------------------------|
| P17/TI02   | In                 | IR detection port      |
| P140/INTP6 | In                 | IR channel select port |

- **IR detector U7**

Describes basic specification of IR detector U7

**Table 2-11 IR detector U7 basic specification**

| Parts name | Manufacture                     | BPF Center frequency | Angle            |
|------------|---------------------------------|----------------------|------------------|
| BRM-2508   | American Bright Optoelectronics | 38kHz (typ.)         | 45 degree (typ.) |

- **Switch SW2**

IR remote control channel can be selected by switch SW2. Setting is below.

**Table 2-12 Switch SW2 setting**

| Setting                            |                                                                                             | Description  |
|------------------------------------|---------------------------------------------------------------------------------------------|--------------|
| Setting slide bar to CH1 silk side | CH1  CH2 | CH1 selected |
| Setting slide bar to CH2 silk side | CH1  CH2 | CH2 selected |

### 2.4.2.5 Analog volume control interface

Three volumes are included for stand-alone evaluation. It can be used as a brightness indication for LED1 (red), LED2 (green), and LED3 (blue) LEDs. For how to operate volumes, see Fig. 2-6.

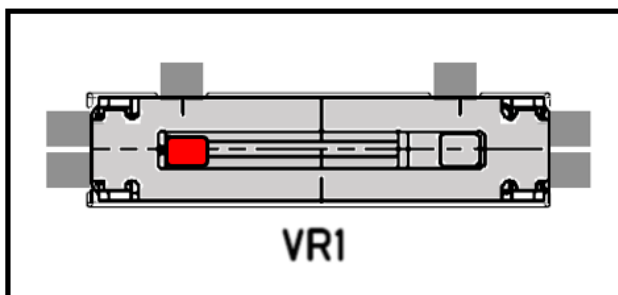
**Table 2-13 Volume connected port**

| Port name  | Direction from MCU | Description                        |
|------------|--------------------|------------------------------------|
| P22/ANI2   | In                 | LED1 (Red) dimming setting (VR1)   |
| P147/ANI18 | In                 | LED2 (Green) dimming setting (VR2) |
| P146/ANI28 | In                 | LED3 (Blue) dimming setting (VR3)  |

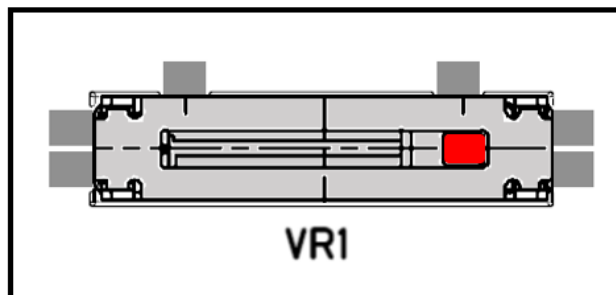


**Fig. 2-6 Volume VR1, VR2, VR3**

**Minimum position**



**Maximum position**



**Fig. 2-6 Volume position**

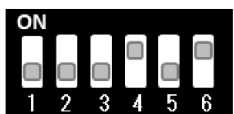
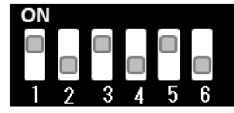
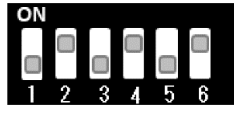
### 2.4.3 On chip debugging function

The product supports two on-chip debugging methods: COM Port debugging (Chapter 2.4.3.2) and debugging using the E2 emulator/E2 emulator Lite (Chapter 2.4.3.3). The on-chip debugging method and normal operating mode are switched by switch SW1.

#### 2.4.3.1 Switch SW1

Controls various operating modes. Each operation mode and setting are as follows.

**Table 2-14 Switch Sw1 setting**

| Mode                                | Description                                                                                                      |
|-------------------------------------|------------------------------------------------------------------------------------------------------------------|
| Normal operation mode               |  <p>Turn on bit 4 and 6</p>     |
| COM port debugging mode             |  <p>Turn on bit 1, 3 and 5</p>  |
| E2 emulator / E2 emulator lite mode |  <p>Turn on bit 2, 4 and 6</p> |

**2.4.3.2 COM Port debugging / Virtual UART communication**

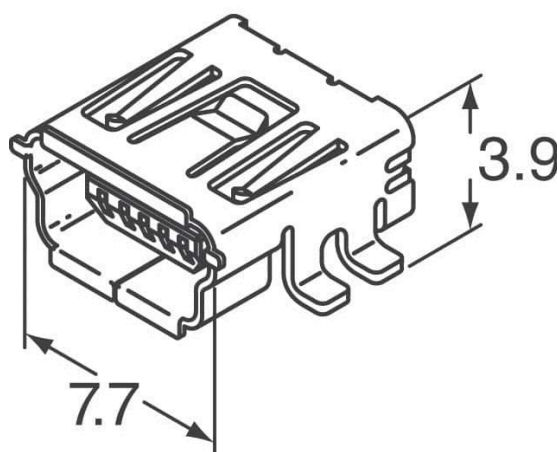
COM Port debugging is a function that allows you to debugging application software or write a flash program to RL78/G24 devices via USB connection. Connects to a host system via the Mini-B USB connector (CN5).

The RL78/G24 device ~ USB connector is connected via a USB serial converter (FT232RL).

Note that COM Port debugging and virtual UART interface share the same control port, so they are used exclusively.

**Table 2-15 USB interface port**

| Port name             | Direction from MCU | Description                                                                                                     |
|-----------------------|--------------------|-----------------------------------------------------------------------------------------------------------------|
| P51/TOOLTxD           | Out                | COM Port debugging sending signal                                                                               |
| P51/TxD0              |                    | Virtual UART sending signal                                                                                     |
| P50/TOOLRxD           | In                 | COM Port debugging receiving signal                                                                             |
| P50/RxD0              |                    | Virtual UART receiving signal                                                                                   |
| RESET<br>(Low Active) | In                 | Reset signal<br>*Reset control is controlled by DTR signal of USB serial converter when use COM Port debugging. |

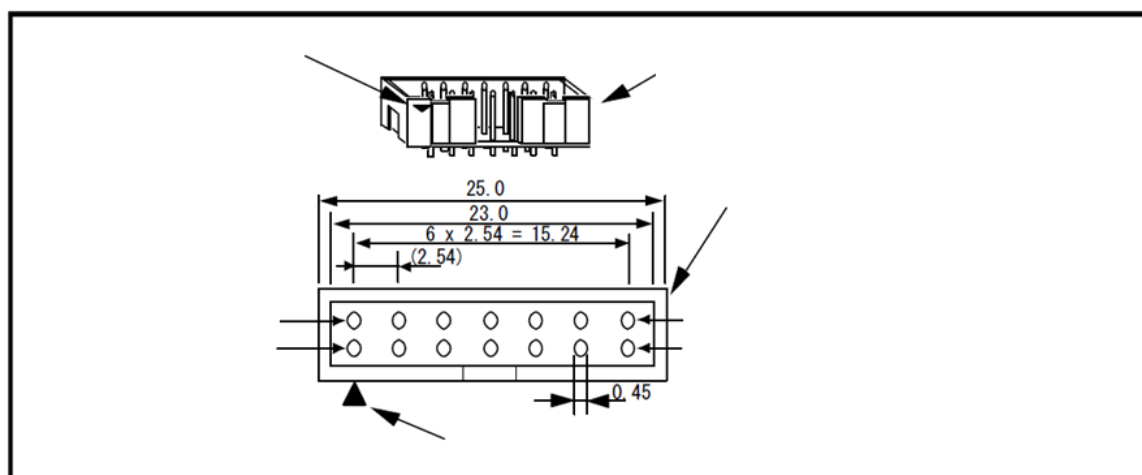
**Fig. 2-7 Out shape of Mini-B USB type connector**

**2.4.3.3 E2 emulator / E2 emulator lite debugging**

This function enables on-chip debugging and flash program writing via E2 Emulator / E2 Emulator Lite (manufactured by Renesas Electronics). Connect the user interface cable (14-pin) of the E2 emulator Lite accessory to the debugging connector (J7) of this product and connect to the host system. Using this method, it is possible to perform virtual serial communication and debugging by COM Port at the same time.

**Table2-16 Debugging connector (J7) specification**

| Number of positions | Number of columns | Pitch  | Connector type | Mounting type | Parts name | Manufacturer |
|---------------------|-------------------|--------|----------------|---------------|------------|--------------|
| 14 pin              | 2                 | 2.54mm | Male           | Through hole  | 7614-6002  | 3M Japan     |

**Fig. 2-8 Out shape of Debugging connector****Table2-17 Debugging connector (J7) pin assignment**

| Pin num. | Pine name | Direction * | Function                                  |
|----------|-----------|-------------|-------------------------------------------|
| 1        | N.C       | —           | —                                         |
| 2        | GND       | —           | —                                         |
| 3        | N.C       | —           | —                                         |
| 4        | N.C       | —           | —                                         |
| 5        | TOOL0     | In/Out      | Command and data sending / receiving      |
| 6        | RESI      | Out         | Reset signal to emulator from the product |
| 7        | N.C       | —           | —                                         |
| 8        | VDD       | —           | —                                         |
| 9        | EVDD      | In          | —                                         |
| 10       | RESO      | In          | Reset signal to the product from emulator |
| 11       | N.C       | —           | —                                         |
| 12       | GND       | —           | —                                         |
| 13       | RESO      | In          | Reset signal to the product from emulator |
| 14       | GND       | —           | —                                         |

\* Direction detail : Input = The product <- emulator, Output = The product -> Emulator



## 2.4.4 Arduino UNO R3 Interface connector J3 to J6

J3~J6 is the Arduino UNO R3 interface connector. A 2.54 pitch, straight socket is implemented. For electrical specifications of the available pins, refer to the user's manual for the RL78/G24 device. Fig. 2-9 shows the pin assignments and precautions when using them.

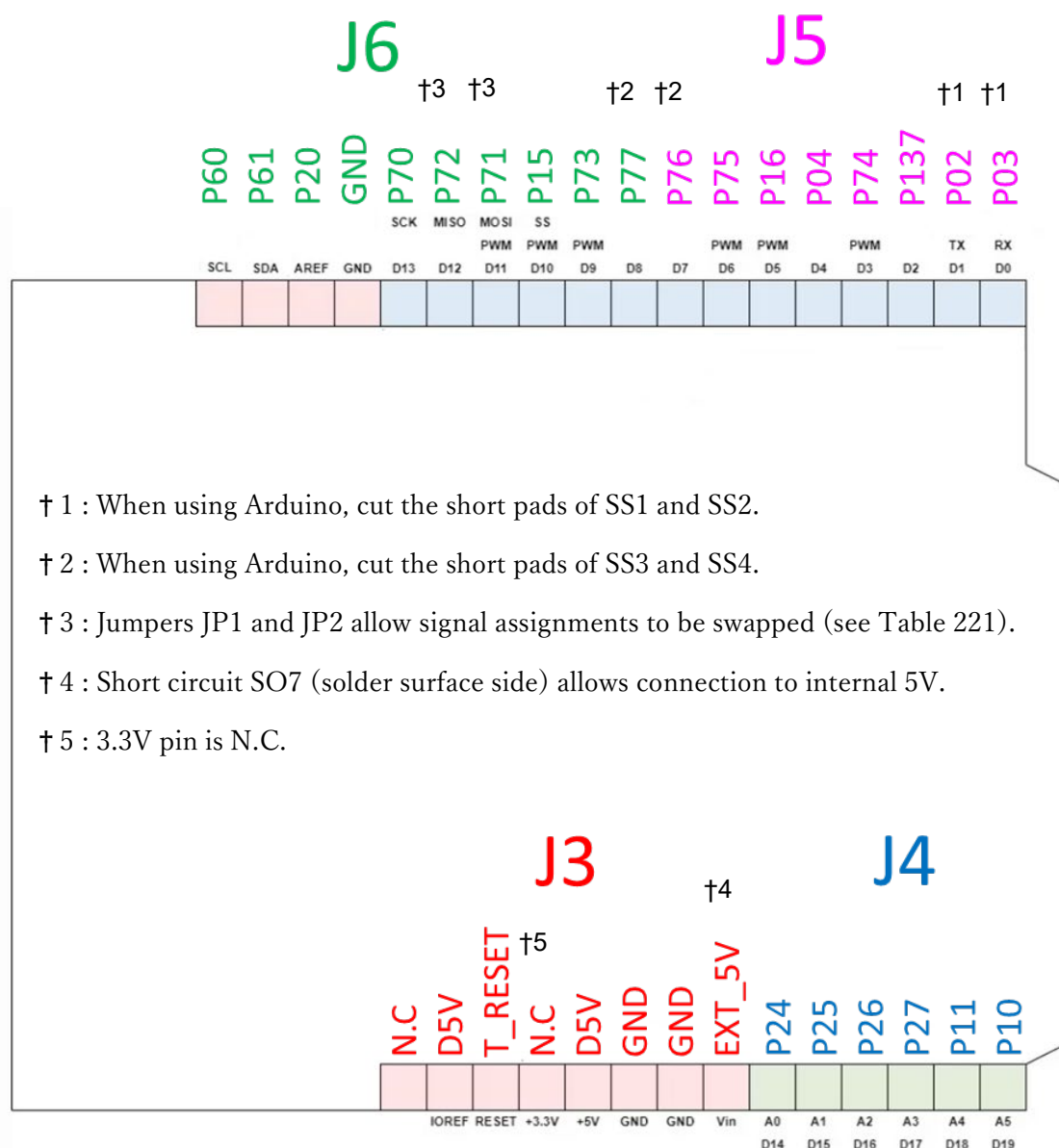


Fig. 2-9 Pin assignment of Arduino UNO R3 Interface connector J3 to J6

Table 2-18 Jumper JP1, JP2 setting

| Jumper | Setting                   | J6 pin   | Signal assignment |
|--------|---------------------------|----------|-------------------|
| JP1    | GPIO side (Short 1 and 2) | J6-5 pin | P72               |
| JP2    | PWM side (Short 1 and 2)  | J6-4 pin | P71               |
| JP1    | MISO side (Short 2 and 3) | J6-5 pin | P71               |
| JP2    | MOSI side (Short 2 and 3) | J6-4 pin | P72               |

## 2.4.5 Extended connector J1 ,J2

J1 and J2 are connectors for external user hardware. A 2.54 pitch, straight header is implemented and connected to the RL78/G24 pin. For electrical specifications of the available pins, refer to the user's manual for the RL78/G24 device. Table 2-19 and 2-20 show the pin assignments.

Table 2-19 Extended J1 pin assignment

| Extended connector (J1) |                         | MCU      |                                                 |
|-------------------------|-------------------------|----------|-------------------------------------------------|
| Pin num                 | Pin name                | Pin num. | Pin name                                        |
| 1                       | P120/ANI19/IVCMP0/PGAI0 | 1        | P120/ANI19/IVCMP0/PGAI0/TRGIDZ/TRGTRG           |
| 2                       | P43                     | 2        | P43/(INTP9)                                     |
| 3                       | P42                     | 3        | P42/(INTP8)                                     |
| 4                       | P41                     | 4        | P41/(TRJIO0)                                    |
| 5                       | P40/TOOL0               | 5        | P40/TOOL0                                       |
| 6                       | T_RESET                 | 6        | RESET                                           |
| 7                       | N.C                     | -        | -                                               |
| 8                       | N.C                     | -        | -                                               |
| 9                       | P137                    | 9        | P137/INTP0                                      |
| 10                      | N.C                     | -        | -                                               |
| 11                      | N.C                     | -        | -                                               |
| 12                      | N.C                     | -        | -                                               |
| 13                      | GND                     | 13,14    | VSS, EVSS                                       |
| 14                      | GND                     | 13,14    | VSS, EVSS                                       |
| 15                      | D5V                     | 15,16    | VDD, EVDD                                       |
| 16                      | D5V                     | 15,16    | VDD, EVDD                                       |
| 17                      | P60/SCLA0               | 17       | P60/CCD04/SCLA0                                 |
| 18                      | P61/SDAA0               | 18       | P61/CCD05/SDAA0                                 |
| 19                      | P62                     | 19       | P62/CCD02/SSI00                                 |
| 20                      | P63                     | 20       | P63/CCD03                                       |
| 21                      | P31                     | 21       | P31/TI03/TO03/INTP4/(TRJIO0)/(VCOUT0)/(PCLBUZ0) |
| 22                      | P77/(TxD2)              | 22       | P77/KR7/INTP11/(TxD2)                           |
| 23                      | P76/(RxD2)              | 23       | P76/KR6/INTP10/(RxD2)                           |
| 24                      | P75                     | 24       | P75/KR5/INTP9/SCK01/SCL01/(TRDIOD1)             |
| 25                      | P74                     | 25       | P74/KR4/INTP8/SI01/SDA01/(TRDIOB1)              |
| 26                      | P73                     | 26       | P73/KR3/(RxD1)/(TRDIOC1)/SO01                   |
| 27                      | P72                     | 27       | P72/KR2/SO21/(TxD1)/(TRDIOA1)                   |
| 28                      | P71                     | 28       | P71/KR1/SI21/SDA21/(TI01)/(TO01)/(TRDIOD0)      |
| 29                      | P70                     | 29       | P70/(TRDIOB0)/KR0/SCK21/SCL21                   |
| 30                      | P06_LED1PD              | 30       | P06/(INTP11)/(TRJIO0)                           |
| 31                      | P05_LED1EN              | 31       | P05/(INTP10)                                    |
| 32                      | P30_DM512_EN            | 32       | P30/INTP3/RTC1HZ/SCK00/SCL00/TRJIO0/(VCOUT1)    |

\* If the pin name of the external connector is the port name alone, it is unused on the board and is directly connected to the MCU. If the pin name is not the port name alone, it is used for the circuit in the board.

\* Terminals used in the Arduino UNO R3 interface connector are shown in blue.

Table 2-20 Extended J2 pin assignment

| Extended connector (J2) |                        | MCU     |                                                                              |
|-------------------------|------------------------|---------|------------------------------------------------------------------------------|
| Pin num                 | Pin name               | Pin num | Pin name                                                                     |
| 1                       | P50/RxD0/TOOLRxD       | 33      | P50/INTP1/SI00/RxD0/TOOLRxD/DALIRxD0/SDA00/TRGIOA/(TRJO0)/(TI03)/(VCOUT3)    |
| 2                       | P51/TxD0/TOOLTxD       | 34      | P51/INTP2/SO00/TxD0/TOOLTxD/DALITxD0/TRGIOB/(VCOUT2)                         |
| 3                       | P52_LED2EN             | 35      | P52/(INTP1)                                                                  |
| 4                       | P53_LED2PD             | 36      | P53/(INTP2)                                                                  |
| 5                       | P54_LED3EN             | 37      | P54/(INTP3)                                                                  |
| 6                       | P55_LED3PD             | 38      | P55/(PCLBUZ1)/(SCK00)/(INTP4)                                                |
| 7                       | P17/TI02               | 39      | P17/CCD01/TI02/TO02/TRDIOA0/TRDCLK/TKBO21/(TxD0)/(TRGIOA)/ANI27/(SO00)       |
| 8                       | P16                    | 40      | P16/ANI26/CCD00/TI01/TO01/INTP5/TRDIOC0/TKBO20/IVREF0/(RxD0)/(TRGIOB)/(SI00) |
| 9                       | P15                    | 41      | P15/SCK20/SCL20/TRDIOB0/TKBO11/VCOUT1/(SDAA0)/ANI25                          |
| 10                      | P14/TKBO10             | 42      | P14/RxD2/SI20/SDA20/TRDIOD0/TKBO10/VCOUT0/(SCLA0)/ANI24                      |
| 11                      | P13/TKBO01             | 43      | P13/ANI23/TxD2/SO20/TRDIOA1/TKBO01/(TRDIOC0)                                 |
| 12                      | P12/TKBO00             | 44      | P12/ANI22/SO11/TRDIOB1/TKBO00/IVREF1/(INTP5)/(TxD0_1)                        |
| 13                      | P11                    | 45      | P11/ANI21/PGAO/CCD07/SI11/SDA11/TRDIOC1/(TO03)/(RxD0_1)/VCOUT3               |
| 14                      | P10                    | 46      | P10/ANI20/CCD06/SCK11/SCL11/TRDIOD1/VCOUT2                                   |
| 15                      | P146/ANI28             | 47      | P146/ANI28                                                                   |
| 16                      | P147/ANI18             | 48      | P147/ANI18/ANO2/IVCMP3/PGAI3                                                 |
| 17                      | P27                    | 49      | P27/ANI7                                                                     |
| 18                      | P26                    | 50      | P26/ANI6                                                                     |
| 19                      | P25                    | 51      | P25/ANI5                                                                     |
| 20                      | P24                    | 52      | P24/ANI4                                                                     |
| 21                      | P23/PGAGND             | 53      | P23/ANI3/ANO1/PGAGND                                                         |
| 22                      | P22/ANI2               | 54      | P22/ANI2/ANO0/PGAI4                                                          |
| 23                      | P21/AVREFM             | 55      | P21/ANI1/AVREFM/(INTP7)                                                      |
| 24                      | P20/AVREFP             | 56      | P20/ANI0/AVREFP/(INTP6)                                                      |
| 25                      | P130                   | 57      | P130                                                                         |
| 26                      | P04                    | 58      | P04/SCK10/SCL10                                                              |
| 27                      | P03/(DALIRxD0)         | 59      | P03/ANI16/RxD1/(DALIRxD0)/(TI00)/SI10/SDA10                                  |
| 28                      | P02/(DALITxD0)         | 60      | P02/ANI17/TxD1/(DALITxD0)/SO10                                               |
| 29                      | P01/ANI30/IVCMP2/PGAI2 | 61      | P01/ANI30/IVCMP2/PGAI2/TO00/TRGCLKB/TRJIO0                                   |
| 30                      | P00/ANI29/IVCMP1/PGAI1 | 62      | P00/ANI29/IVCMP1/PGAI1/TI00/TRGCLKA/(TRJO0)                                  |
| 31                      | P141                   | 63      | P141/PCLBUZ1/INTP7                                                           |
| 32                      | P140/INTP6             | 64      | P140/PCLBUZ0/INTP6                                                           |

### 3. Quick start

This chapter explains programming and operation. This chapter covers how to start the system, execute the EPV command (Erase, Program, Verify), operate RL78/G24 device.

The conditions of the series of operations described in this chapter are as follows:

Hardware Configuration of this board

Board : RTK7RLG240P00000BJ (RL78/G24 DC/DC LED Control Evaluation Board)

CPU : RL78/G24

Target device : R7F101GL

Voltage level : 5 V

Software configuration of RFP

Operation setting : Erase, Write, Verify

Tool : COM port

Interface : 2 wire UART

Speed : 115200 bps

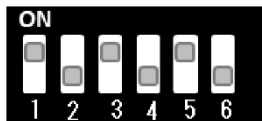
Tool detail : COMx ( depends on environment each PC )

Write HEX file : \*.hex, \*.mot

#### 1. Setting and connecting

Connect power source with this board and set the switch SW1 as following:

**Table 3-1 COM Port Setting for Debugging**

| Mode                       | Description                                                                                                       |
|----------------------------|-------------------------------------------------------------------------------------------------------------------|
| COM Port<br>Debugging mode |  <p>Turn on bit 1, 3 and 5</p> |

Connect this board with host PC.

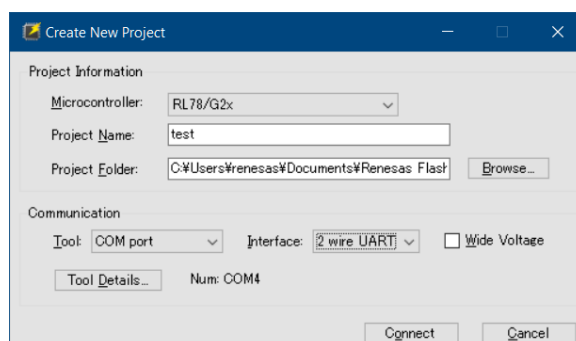
#### 2. Starting

Start the RFP from the start menu:

[Start] - [All Programs] - [Renesas Electronics Utilities] - [Renesas Flash Programmer Vx.xx]

#### 3. Creating project

Select [File] - [New project]



**Fig. 3-1 Create New Project**

Open new project window

Select Target microcontroller and input project name.

Select Tool (COM port), Interface(2 wire UART), COM port num in Tool details.

Click connect button

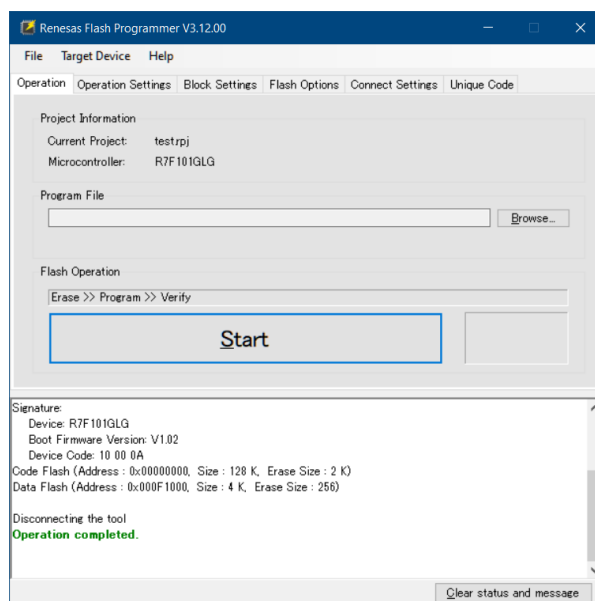


Fig. 3-2 Connected

#### 4. Execution

Select the program file to be written to the target microcontroller in the “User/Data area” box.

Next, click Start to start writing of the selected program file.

When “completed” is displayed, close the window.

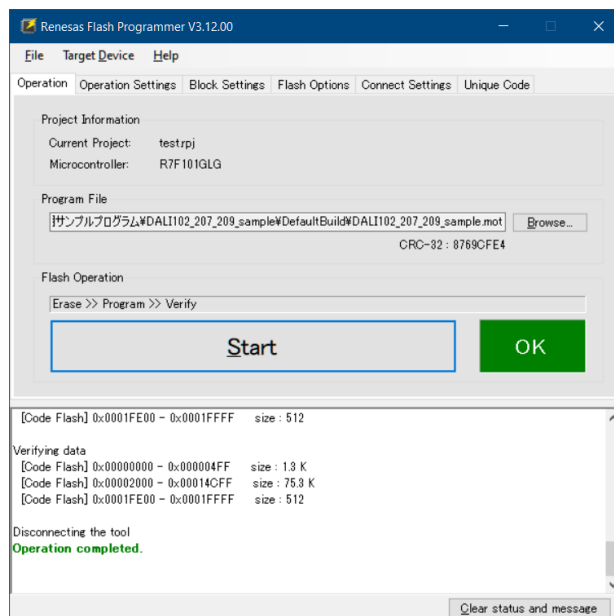


Fig. 3-3 Complete Flash

## 5. Terminating

Select [File] - [Quit] to terminate the RFP.

## 6. Execute application

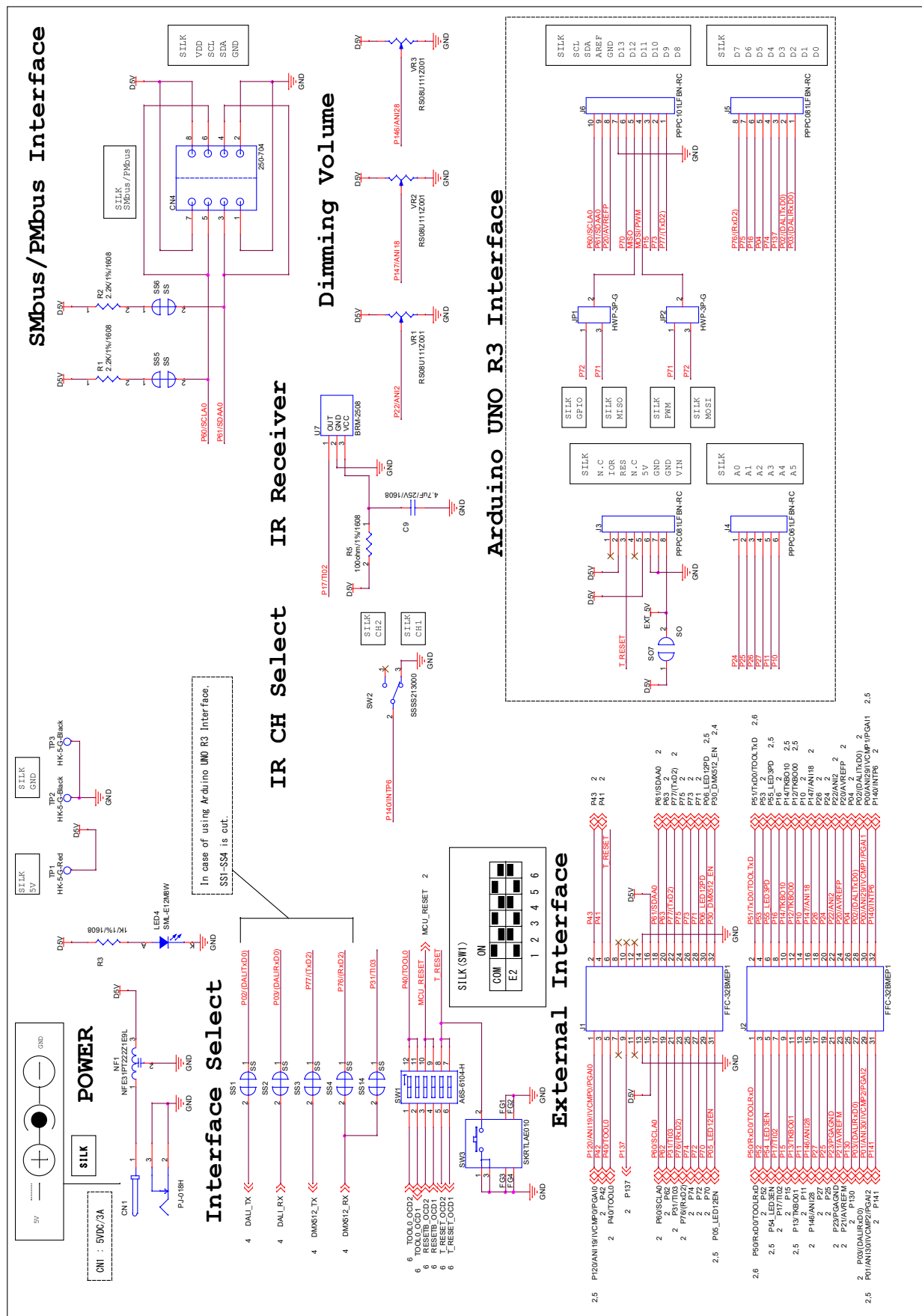
Set this board to the normal operation mode by applying the following settings.

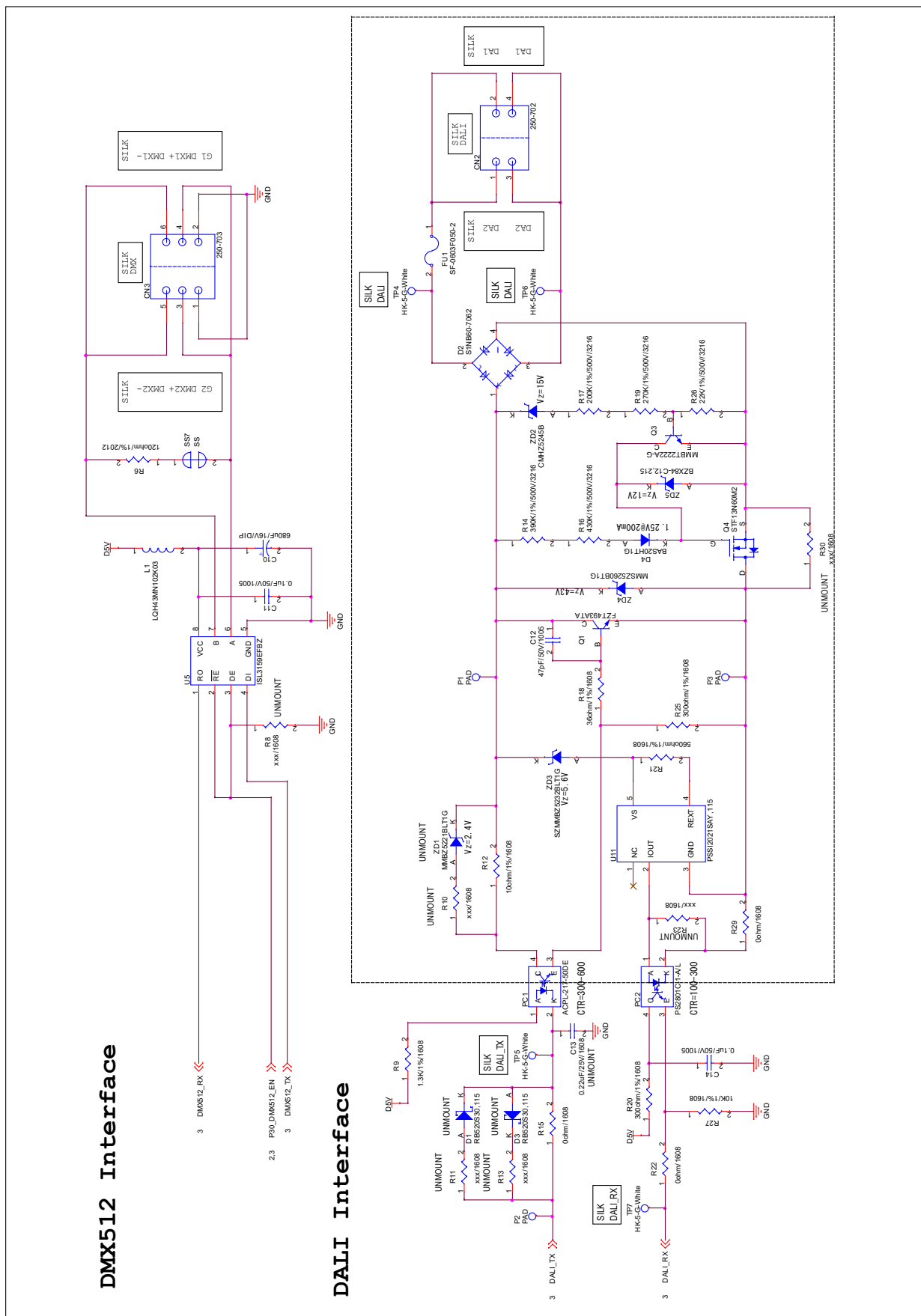
**Table 3-2 COM Port Setting for Normal Operation**

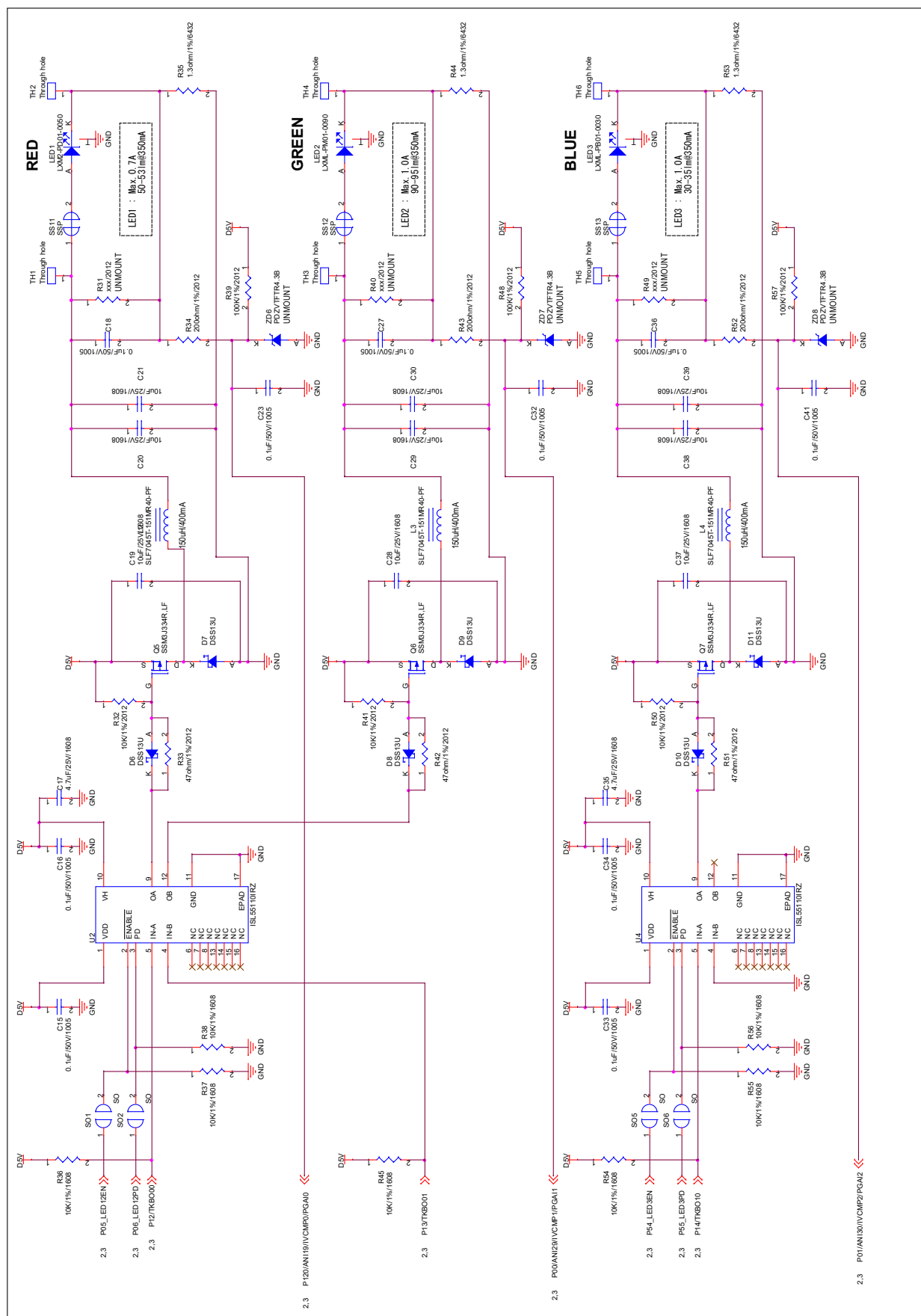
| Mode                  | Description                                                                                           |
|-----------------------|-------------------------------------------------------------------------------------------------------|
| Normal operation mode |  Turn on bit 4 and 6 |

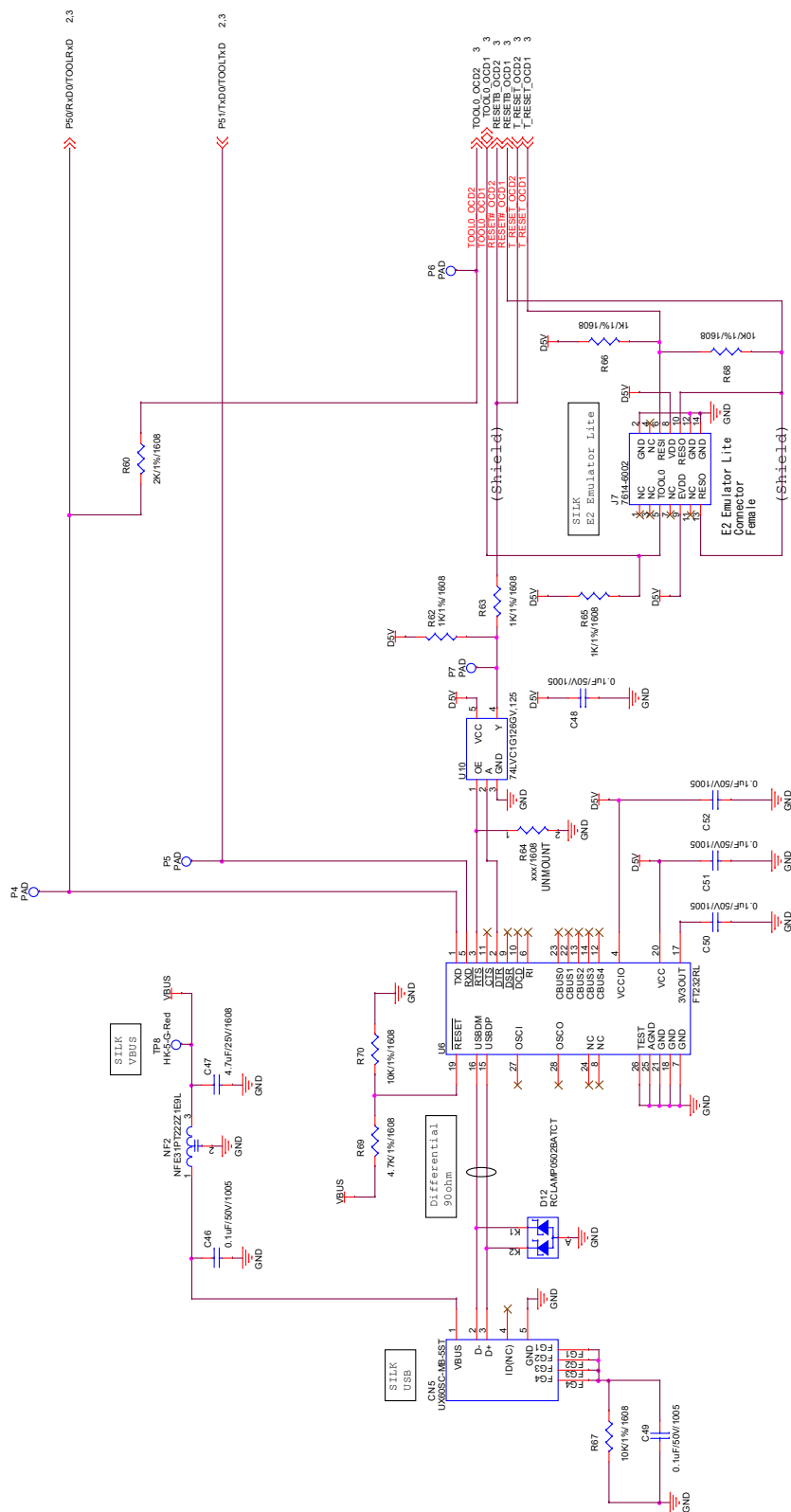












## 5. Parts list

| ItemNo | Quantity | Mount component reference                                                        | Unmount component reference | Schematic part name | Kind               | Part name            | Manufacture                 |
|--------|----------|----------------------------------------------------------------------------------|-----------------------------|---------------------|--------------------|----------------------|-----------------------------|
| 1      | 1        | CN1                                                                              |                             | PJ-018H             | JACK               | PJ-018H              | CUI Devices                 |
| 2      | 1        | CN2                                                                              |                             | 250-702             | Terminal Block     | 250-702              | WAGO                        |
| 3      | 1        | CN3                                                                              |                             | 250-703             | Terminal Block     | 250-703              | WAGO                        |
| 4      | 1        | CN4                                                                              |                             | 250-704             | Terminal Block     | 250-704              | WAGO                        |
| 5      | 1        | CN5                                                                              |                             | UX60SC-MB-5ST       | USB Connector      | UX60SC-MB-5ST        | Hirose Electric             |
| 6      | 21       | C1,C5,C6,C11,C14,C15,C16,C18,C23,C27,C32,C33,C34,C36,C41,C46,C48,C49,C50,C51,C52 |                             | 0.1uF/50V/1005      | CERAMIC CAPACITOR  | GRT155R71H104KE01D   | Murata Electronics          |
| 7      | 1        | C2                                                                               |                             | 0.47uF/50V/1005     | CERAMIC CAPACITOR  | GRM155R61H474KE11D   | Murata Electronics          |
| 8      | 2        | C4,C3                                                                            |                             | 3.7pF/50V/1005      | CERAMIC CAPACITOR  | GCQ1555C1H3R7CB01D   | Murata Electronics          |
| 9      | 2        | C7,C8                                                                            |                             | xxxF/1005           | Pin Socket         | 801-87-002-10-001101 | Preci-Dip                   |
| 10     | 4        | C9,C17,C35,C47                                                                   |                             | 4.7uF/25V/1608      | CERAMIC CAPACITOR  | GRM188R61E475KE11D   | Murata Electronics          |
| 11     | 1        | C10                                                                              |                             | 680uF/16V/DIP       | ALUMINUM CAPACITOR | UPW1C681MPD6         | Nichicon                    |
| 12     | 1        | C12                                                                              |                             | 47pF/50V/1005       | CERAMIC CAPACITOR  | GCM1555C1H470JA16J   | Murata Electronics          |
| 13     | 0        |                                                                                  | C13                         | 0.22uF/25V/1608     | CERAMIC CAPACITOR  | CC0603JRX7R8BB224    | YAGEO                       |
| 14     | 9        | C19,C20,C21,C28,C29,C30,C37,C38,C39                                              |                             | 10uF/25V/1608       | CERAMIC CAPACITOR  | GRM188R61E106KA73D   | Murata Electronics          |
| 15     | 0        |                                                                                  | D3,D1                       | RB520S30,115        | Schottky Diode     | RB520S30,115         | Nexperia USA                |
| 16     | 1        | D2                                                                               |                             | S1NB60-7062         | Bridge Rectifiers  | S1NB60-7062          | Shindengen                  |
| 17     | 1        | D4                                                                               |                             | BAS20HT1G           | Diode              | BAS20HT1G            | onsemi                      |
| 18     | 6        | D6,D7,D8,D9,D10,D11                                                              |                             | DSS13U              | Schottky Diode     | DSS13U               | SMC Diode Solutions         |
| 19     | 1        | D12                                                                              |                             | RCLAMP0502BATCT     | TVS Diode          | RCLAMP0502BATCT      | Semtech                     |
| 20     | 1        | FU1                                                                              |                             | SF-0603F050-2       | FUSE               | SF-0603F050-2        | Bourns                      |
| 21     | 2        | JP2,JP1                                                                          |                             | HWP-3P-G            | Pin Header         | HWP-3P-G             | MAC8                        |
| 22     | 2        | J2,J1                                                                            |                             | FFC-32BMEP1         | Pin Header         | FFC-32BMEP1          | Honda                       |
| 23     | 2        | J5,J3                                                                            |                             | PPPC081LFBN-RC      | Pin Socket         | PPPC081LFBN-RC       | Sullins Connector Solutions |
| 24     | 1        | J4                                                                               |                             | PPPC061LFBN-RC      | Pin Socket         | PPPC061LFBN-RC       | Sullins Connector Solutions |
| 25     | 1        | J6                                                                               |                             | PPPC101LFBN-RC      | Pin Socket         | PPPC101LFBN-RC       | Sullins Connector Solutions |
| 26     | 1        | J7                                                                               |                             | 7614-6002           | Connector          | 7614-6002BL          | 3M                          |
| 27     | 1        | LED1                                                                             |                             | LXM2-PD01-0050      | LED                | LXM2-PD01-0050       | Lumileds                    |
| 28     | 1        | LED2                                                                             |                             | LXML-PM01-0090      | LED                | LXML-PM01-0090       | Lumileds                    |
| 29     | 1        | LED3                                                                             |                             | LXML-PB01-0030      | LED                | LXML-PB01-0030       | Lumileds                    |
| 30     | 1        | LED4                                                                             |                             | SML-E12M8W          | LED                | SML-E12M8W           | Rohm Semiconductor          |
| 31     | 1        | L1                                                                               |                             | LQH43MN102K03       | Inductor           | LQH43MN102K03        | Murata Electronics          |
| 32     | 3        | L2,L3,L4                                                                         |                             | SLF7045T-151MR40-PF | Inductor           | SLF7045T-151MR40-PF  | TDK                         |
| 33     | 2        | NF2,NF1                                                                          |                             | NFE31PT222Z1E9L     | Filter             | NFE31PT222Z1E9L      | Murata Electronics          |
| 34     | 1        | PC1                                                                              |                             | ACPL-217-50DE       | Photo Coupler      | ACPL-217-50DE        | Broadcom Limited            |
| 35     | 1        | PC2                                                                              |                             | PS2801C-1-A/L       | Photo Coupler      | PS2801C-1-A/L        | Renesas Electronics         |
| 36     | 0        |                                                                                  | P1 to P7                    | PAD                 | PAD                |                      |                             |
| 37     | 1        | Q1                                                                               |                             | FZT493ATA           | Transistor         | FZT493ATA            | Diodes Incorporated         |
| 38     | 1        | Q3                                                                               |                             | MMBT2222A-G         | Transistor         | MMBT2222A-G          | Comchip Technology          |
| 39     | 1        | Q4                                                                               |                             | STF13N60M2          | Transistor         | STF13N60M2           | STMicroelectronics          |
| 40     | 3        | Q5,Q6,Q7                                                                         |                             | SSM3J334R,LF        | Transistor         | SSM3J334R,LF         | TOSHIBA                     |
| 41     | 2        | R1,R2                                                                            |                             | 2.2K/1%/1608        | Resistor           | RK73H1JTTD2201F      | KOA Speer Electronics       |

|    |    |                                                 |                               |                     |                   |                      |                                 |
|----|----|-------------------------------------------------|-------------------------------|---------------------|-------------------|----------------------|---------------------------------|
| 42 | 5  | R3,R62,R63,R65,R66                              |                               | 1K/1%/1608          | Resistor          | RK73H1JTDD1001F      | KOA Speer Electronics           |
| 43 | 11 | R27,R36,R37,R38,R45,R54,<br>R55,R56,R67,R68,R70 |                               | 10K/1%/1608         | Resistor          | RK73H1JTDD1002F      | KOA Speer Electronics           |
| 44 | 1  | R5                                              |                               | 100ohm/1%/1608      | Resistor          | RK73H1JTDD1000F      | KOA Speer Electronics           |
| 45 | 1  | R6                                              |                               | 120ohm/1%/2012      | Resistor          | RK73H2ATDD1200F      | KOA Speer Electronics           |
| 46 | 0  |                                                 | R8,R10,R11,R13<br>R23,R30,R64 | xxx/1608            | Resistor          |                      |                                 |
| 47 | 1  | R9                                              |                               | 1.3K/1%/1608        | Resistor          | RK73H1JTDD1301F      | KOA Speer Electronics           |
| 48 | 1  | R12                                             |                               | 10ohm/1%/1608       | Resistor          | RK73H1JTDD10R0F      | KOA Speer Electronics           |
| 49 | 1  | R14                                             |                               | 390K/1%/500V/3216   | Resistor          | KTR18EZPF3903        | Rohm Semiconductor              |
| 50 | 3  | R15,R22,R29                                     |                               | 0ohm/1608           | Resistor          | RK73Z1JTDD           | KOA Speer Electronics           |
| 51 | 1  | R16                                             |                               | 430K/1%/500V/3216   | Resistor          | KTR18EZPF4303        | Rohm Semiconductor              |
| 52 | 1  | R17                                             |                               | 200K/1%/500V/3216   | Resistor          | KTR18EZPF2003        | Rohm Semiconductor              |
| 53 | 1  | R18                                             |                               | 36ohm/1%/1608       | Resistor          | RK73H1JTDD36R0F      | KOA Speer Electronics           |
| 54 | 1  | R19                                             |                               | 270K/1%/500V/3216   | Resistor          | KTR18EZPF2703        | Rohm Semiconductor              |
| 55 | 2  | R20,R25                                         |                               | 300ohm/1%/1608      | Resistor          | RK73H1JTDD3000F      | KOA Speer Electronics           |
| 56 | 1  | R21                                             |                               | 560ohm/1%/1608      | Resistor          | RK73H1JTDD5600F      | KOA Speer Electronics           |
| 57 | 1  | R26                                             |                               | 22K/1%/500V/3216    | Resistor          | KTR18EZPF2202        | Rohm Semiconductor              |
| 58 | 0  |                                                 | R31,R40,R49                   | xxx/2012            | Resistor          |                      |                                 |
| 59 | 3  | R32,R41,R50                                     |                               | 10K/1%/2012         | Resistor          | RK73H2ATDD1002F      | KOA Speer Electronics           |
| 60 | 3  | R33,R42,R51                                     |                               | 47ohm/1%/2012       | Resistor          | RK73H2ATDD47R0F      | KOA Speer Electronics           |
| 61 | 3  | R34,R43,R52                                     |                               | 200ohm/1%/2012      | Resistor          | RK73H2ATDD2000F      | KOA Speer Electronics           |
| 62 | 3  | R35,R44,R53                                     |                               | 1.3ohm/1%/6432      | Resistor          | ERJ-1TRQF1R3U        | Panasonic Electronic            |
| 63 | 3  | R39,R48,R57                                     |                               | 100K/1%/2012        | Resistor          | RK73H2ATDD1003F      | KOA Speer Electronics           |
| 64 | 1  | R60                                             |                               | 2K/1%/1608          | Resistor          | RK73H1JTDD2001F      | KOA Speer Electronics           |
| 65 | 0  |                                                 | SO1 to 10                     | SO                  | ShortPAD          |                      |                                 |
| 66 | 0  |                                                 | SS1 to SS14                   | SS                  | ShortPAD          |                      |                                 |
| 67 | 1  | SW1                                             |                               | A6S-6104-H          | Switch            | A6S-6104-H           | Omron Electronics               |
| 68 | 1  | SW2                                             |                               | SSSS213000          | Switch            | SSSS213000           | Alps Alpine                     |
| 69 | 1  | SW3                                             |                               | SKRTLAE010          | Switch            | SKRTLAE010           | Alps Alpine                     |
| 70 | 0  |                                                 | TH1 to TH6                    | Through hole        | Through hole      |                      |                                 |
| 71 | 2  | TP8,TP1                                         |                               | HK-5-G-Red          | Test Pin          | HK-5-G-Red           | MAC8                            |
| 72 | 2  | TP3,TP2                                         |                               | HK-5-G-Black        | Test Pin          | HK-5-G-Black         | MAC8                            |
| 73 | 4  | TP4,TP5,TP6,TP7                                 |                               | HK-5-G-White        | Test Pin          | HK-5-G-White         | MAC8                            |
| 74 | 1  | U1                                              |                               | R7F101GLG2DFB       | IC                | R7F101GLG2DFB        | Renesas Electronics             |
| 75 | 2  | U2,U4                                           |                               | ISL55110IRZ         | IC                | ISL55110IRZ          | Renesas Electronics             |
| 76 | 1  | U5                                              |                               | ISL3159EFBZ         | IC                | ISL3159EFBZ          | Renesas Electronics             |
| 77 | 1  | U6                                              |                               | FT232RL             | IC                | FT232RL              | FTDI                            |
| 78 | 1  | U7                                              |                               | BRM-2508            | IC                | BRM-2508             | American Bright Optoelectronics |
| 79 | 1  | U10                                             |                               | 74LVC1G126GV,125    | IC                | 74LVC1G126GV,125     | Nexperia                        |
| 80 | 3  | VR1,VR2,VR3                                     |                               | RS08U111Z001        | Variable Resistor | RS08U111Z001         | Alps Alpine                     |
| 81 | 1  | Y1                                              |                               | CSTLS20M0X51x       | Pin Socket        | 801-87-003-10-001101 | Preci-Dip                       |
| 82 | 1  | Y2                                              |                               | SSP-T7-FL 32.768KHz | CRYSTAL           | SSP-T7-FL 32.768KHz  | Seiko Instruments               |
| 83 | 0  |                                                 | ZD1                           | MMBZ5221BLT1G       | Zener Diode       | MMBZ5221BLT1G        | onsemi                          |
| 84 | 1  | ZD2                                             |                               | CMHZ5245B           | Zener Diode       | CMHZ5245B            | Central Semiconductor           |
| 85 | 1  | ZD3                                             |                               | SZMMBZ5232BLT1G     | Zener Diode       | SZMMBZ5232BLT1G      | onsemi                          |
| 86 | 1  | ZD4                                             |                               | MMSZ5260BT1G        | Zener Diode       | MMSZ5260BT1G         | onsemi                          |
| 87 | 1  | ZD5                                             |                               | BZX84-C12,215       | Zener Diode       | BZX84-C12,215        | Nexperia USA                    |
| 88 | 0  |                                                 | ZD6,ZD7,ZD8                   | PDZVTFTR4.3B        | Zener Diode       | PDZVTFTR4.3B         | Rohm Semiconductor              |
| 89 | 1  | R69                                             |                               | 4.7K/1%/1608        | Resistor          | RK73H1JTDD4701F      | KOA Speer Electronics           |

|    |   |     |  |                 |    |                 |          |
|----|---|-----|--|-----------------|----|-----------------|----------|
| 90 | 1 | U11 |  | PSSI2021SAY,115 | IC | PSSI2021SAY,115 | Nexperia |
|----|---|-----|--|-----------------|----|-----------------|----------|

|                  |                                                                                             |
|------------------|---------------------------------------------------------------------------------------------|
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|------------------|---------------------------------------------------------------------------------------------|

| Rev. | Date                        | Description |                      |
|------|-----------------------------|-------------|----------------------|
|      |                             | Page        | Summary              |
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