User's Manual

EZ-0011

LED Evaluation Board for 78K0/IB2 PFC

User's Manual

Target device
78K0/IB2

Renesas Electronics
www.renesas.com

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Safety Precautions

This document explains matters to be noted for safe use of this evaluation board. Be sure to read this document before using this evaluation board.

Symbols Used

This document used the following symbols for matters to be observed for 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 notices are not observed.

Danger	The user may suffer death or serious injury and it's risk is high if the warning is not observed.
Warning	The user may suffer death or serious injury if the warning is not observed.
Caution	Human injury or property damage may occur if the caution is not observed.

The following symbols express matters which are prohibited in order to prevent injury or accident.

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

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

General caution Unspecified general cautions.	**Caution Hot** Human injury by high temperature may occur.

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

Compulsory action based on an instruction for the user.	Instruction to unplug from AC power supply.

Warnings Display on Product

	Danger
	**Do not use this board in the purpose except the evaluation of MCU.** This board is developed for Power electronics engineer and it use is only for MCU evaluation. This board does not take safety measures or anti-EMI measures required for lighting equipment and power supply unit.
	**Do not use this board in other countries outside Japan.** This board is assumed to be used only in Japan and it may not comply with regulation or standards of any other countries except for Japan.
	**Do not touch to the high voltage area of the board.** Touching the board by tools or body while power is being supplied cause product failure or electric shock.
	**Do not touch with wet hands.** Doing so cause product failure or electrical shock.
	**Do not use or store this board in any of the following locations.** - Environments with copious water, humidity, steam, dust, fumes, etc. - Environments where static electricity or electrical noise is readily generated. Such influences can lead to electric shock or product failure.
	**Limit the user of this board.** **Use glove to protect electric shock.**
	Warning
	**Be careful to burns.** The part of board becomes high temperature during AC power is connected.
	**Do not disassemble or modify the board.** Doing so may cause product failure, emission of smoke, fire or electric shock.
	**Do not heat the board or expose it to fire and do not short the terminals.** Doing so may cause product failure, generation of heat, fire or rupture.
	**Do not drop or jolt the board.** Doing so may break or damage the board, causing fire or electric shock.
	Use AC power supply in the range of 100 VAC to 240 VAC. Using AC power supply out of this range may cause product failure, generation of heat, fire or electric shock.
	Do not plug in or unplug a connector or cable with power applied to the board. Doing so may cause product failure, generation of heat, fire or rupture.
	Do not turn on the power switch in insufficient state of each cable connection such as AC power cable, LED connection cable and interface cable. Doing so may cause product failure, generation of heat, fire or electric shock.
	Do not carry this board with connecting any cable. Doing so may cause damage of cable and cause product failure, generation of heat, fire or electric shock.
	Do not use except the AC power cable attached to this board. Using a incompatible cable may cause product failure, generation of heat, fire or electric shock.
	Do not put or leave any electrical conductor, if you open the chassis. A conductor on the circuit of the board may cause product failure, generation of heat, fire or electric shock.
	**Confirm the outlet is near this board and easily unplugged.**
	**If smoke or an abnormal smell or sound is emitted or heating occurs, promptly switch off the board power and unplug from AC power supply.** Using the board in such a state poses a risk of fire, burning or electric shock.

Cautions Display on Product

Caution	
	To prevent damage due to static electricity, be careful of electrostatic charge when touching a metal part such as a connector. Electrostatic charge may cause product failure.

How to Use This Manual

Purpose

This manual is intended to give users an understanding of the basic specifications and correct usage of the EZ-0011.

Organization

This manual is divided into the following sections.

- OVERVIEW
- SPECIFICATIONS
- USING EZ-0011

Related Documents

Please use the following documents in conjunction with this manual.
The related documents listed below may include preliminary versions. However, preliminary versions are not marked as such.

Document Name	Document Number
EZ-0011 User's Manual	This manual
78K0/Ix2 User's Manual: Hardware	R01UH0010E
78K0/Ix2 Microcontrollers LED Lighting System with PFC Control APPLICATION NOTE	R01AN0674E

Caution The related documents listed above are subject to change without notice. Be sure to use the latest version of each document for designing, etc.

Table of Contents

CHAPTER 1 OVERVIEW

The EZ-0011(LED Evaluation Board for 78K0/IB2 PFC) is an evaluation kit for LED control that uses the 78K0/IB2 microcontroller.

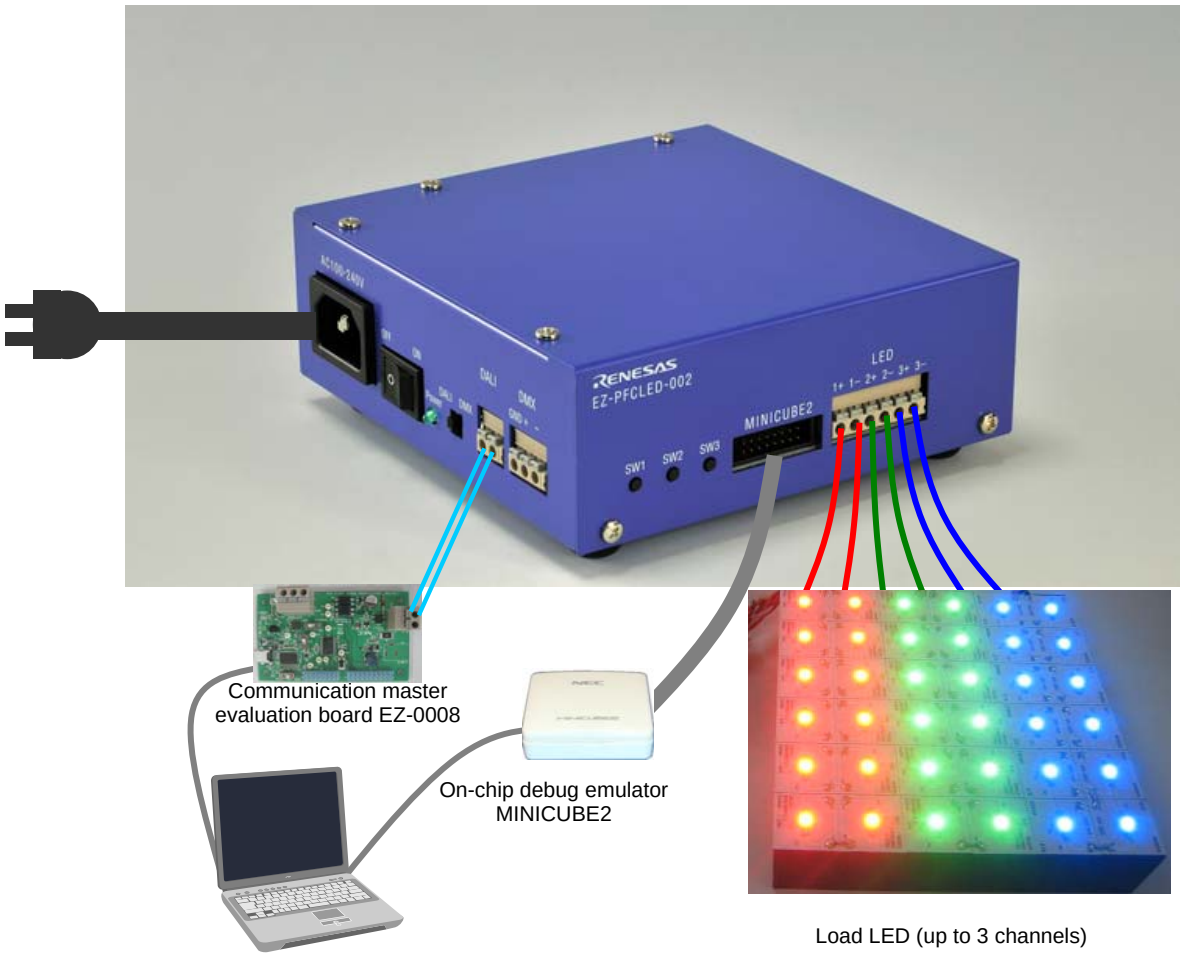
This product operates with power supply of 100 - 240 VAC (50 [Hz]/60 [Hz]).

This product allows you to perform PFC control required to improve the power factor and Buck converter control (3 channels) required for dimming and toning of the LED by using the functions of the 78K0/IB2. It supports the software auto generation tool Applilet EZ for HCD provided by Renesas Electronics, that allows you to evaluate the functions of the microcontroller easily.

For writing programs to the 78K0/IB2 and on-chip debug, a separately sold on-chip debug emulator MINICUBE2 with programming functions is required.

Also, our lighting communication master evaluation board (EZ-0008) can be used to perform dimming control via DALI communication/DMX512 communication by using the GUI software on the PC. You can download the GUI software from our website.

Figure 1-1. System Configuration



1.1 Configuration of This Product

This product consists of the following:

- Main unit (EZ-PFCLED-002)
- Power cable
- Communication cable

Caution The product configuration is subject to change without prior notice. For details, refer to the list attached to the product.

1.2 Features of This Product

The 78K0/IB2 enables PFC control required to improve the power factor and Buck converter control (3 channels) required for dimming and toning of the LED.

- PFC control with the PWM timer that works with the built-in comparator
- Independent LED control of three channels with Buck converter control using the internal timer
- 100 to 240 VAC (50 [Hz]/60 [Hz]) supported

Three types of interfaces are incorporated.

- DALI communication interface
- DMX512 communication interface
- MINICUBE2 interface (for on-chip debug/flash memory write)

1.3 Modes of This Product

Various types of dimming operation can be done with the programming of the 78K0/IB2. The software auto generation tool Applilet EZ for HCD supports 5 types of dimming operation.

- Fix dimming mode
- Variable dimming mode
- Switch dimming mode
- DALI dimming mode
- DMX512 dimming mode

1.4 Information on This Product And Related Products

For information on this product and related products, visit the following URL of Renesas Electronics.

URL: http://www2.renesas.com/micro/ja/solution/lighting/download.html

CHAPTER 2 SPECIFICATIONS

This chapter describes the specifications of this product.

2.1 Appearance

Figure 2-1. Appearance of Main Unit (1/2)

(a) Appearance of the main unit

(b) Main unit front side

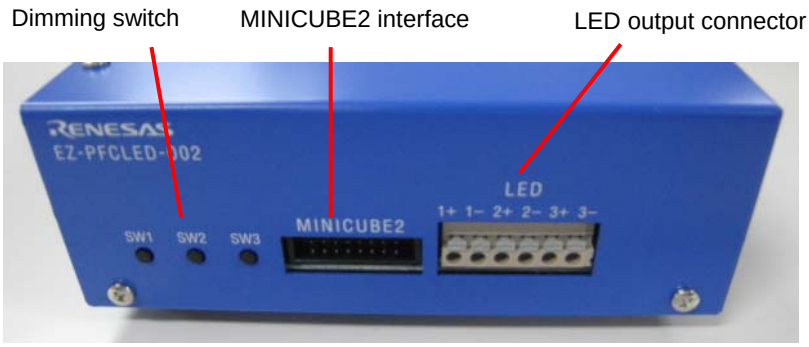
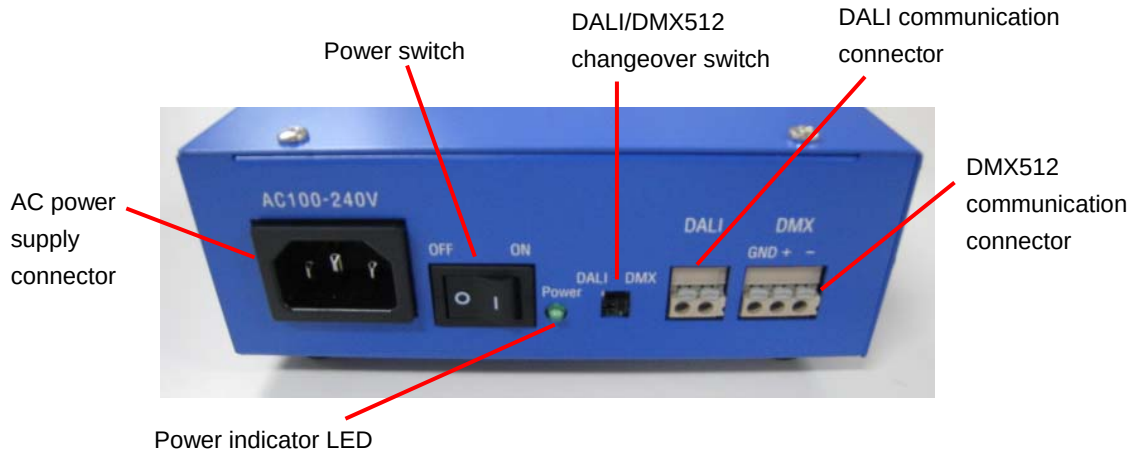
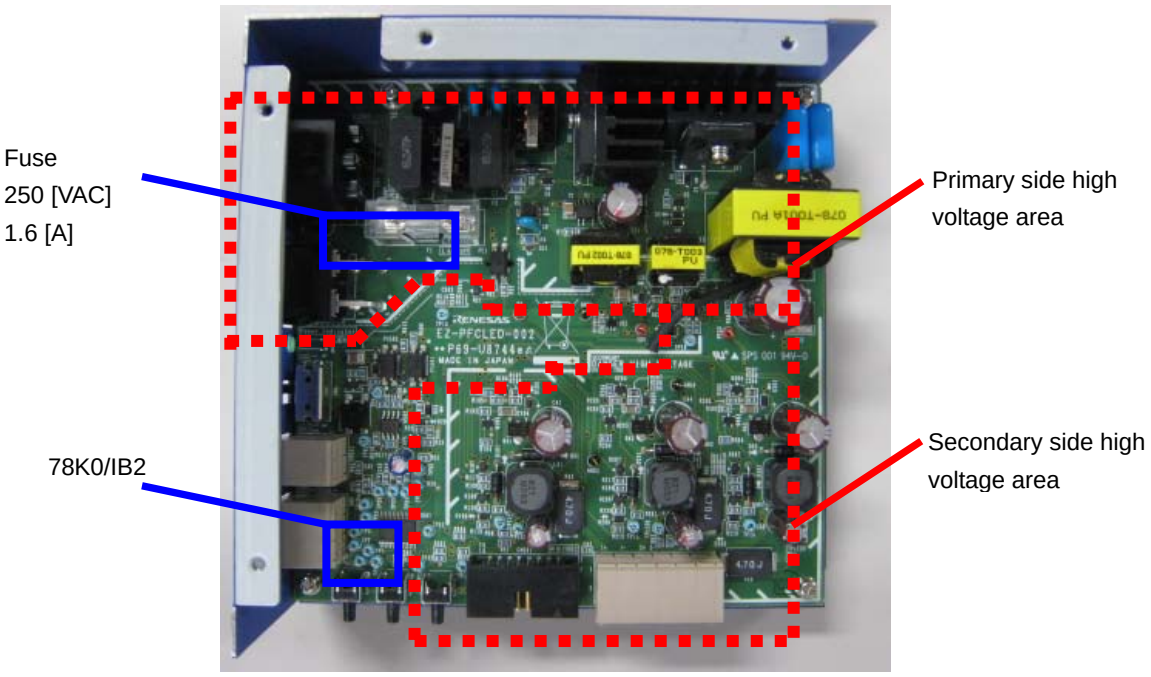


Figure 2-1. Appearance of Main Unit (2/2)

(c) Main unit right side



(d) Board appearance (interior of the main unit)



Danger	
	Do not touch the area enclosed with RED line because of high voltage while power is being supplied. This area is also indicated by white heavy line on the board.
	Do not put or leave any electrical conductor, if you open the chassis. A conductor on the circuit of the board may cause product failure, generation of heat, fire or electric shock.

2.2 Detailed Specifications

Main unit model name indication: EZ-PFCLED-002
Input: 100 to 240 VAC [V] (50 [Hz]/60 [Hz])
Output: 3 channels 50 VDC/ch (max.), 400 [mA]/ch (max.)
Power supply fuse: 250 VAC, Fuse current 1.6 [A], 5×20 [mm]
Microcontroller: 78K0/IB2 (UPD78F0756MC-CAB-AX)
Critical conduction insulating type PFC circuit (controlled by the 78K0/IB2)
3 channels of Buck converter circuit (controlled by the 78K0/IB2)
MINICUBE2 interface (for writing to the 78K0/IB2 and on-chip debug)
DALI communication interface circuit
DMX512 communication interface circuit
3 channels of dimming control switch

2.3 Customer-supplied Items

•On-chip debug emulator with programming function MINICUBE2
•LED load
Supply LED loads with the following specifications.
Voltage: 50 [V] or less per channel
Current: 400 [mA] or less per channel

Caution **Depending on the characteristics of the load, input voltage, and program algorithm, intended output characteristics may not be obtained even within the ratings above. When a program created with the auto generation tool Applilet EZ for HCD is used, dimming operation of the main unit may stop due to overvoltage or overcurrent. If intended output characteristics cannot be obtained or if dimming operation stops in the program created with Applilet EZ for HCD, review the characteristics of the load, input voltage, and program algorithm, etc.**

•LED load connection cable
Use a cable that can withstand the voltage and current applied to the LED load used.
•Lighting communication master evaluation board (EZ-0008)
It is required for evaluation of the DALI communication/DMX512 communication.

Warning	
	**Use AC power supply in the range of 100 VAC to 240 VAC.** Using AC power supply out of this range may cause product failure, generation of heat, fire or electric shock.
	**When connecting the LED load to this product, the user must be responsible for performing work and connection of wiring properly to avoid defective connection.** Improper wiring work or connection may cause failure, heat generation, fire, or electric shock.
	Use wires that have the ratings of the LED load complying with the safety standard or better to connect the LED load. Using nonconforming items or items that do not satisfy the ratings may cause failure, heat generation, fire, or electric shock.

For the circuit diagram of the EZ-0011, refer to **APPENDIX A CIRCUIT DIAGRAM**.

2.4 Settings of Major Switches and Connector Functions

Table 2-1 Power Switch Setting

	ON	OFF
Power switch	Power ON	Power OFF

Table 2-2 DALI/DMX512 Changeover Switch Setting

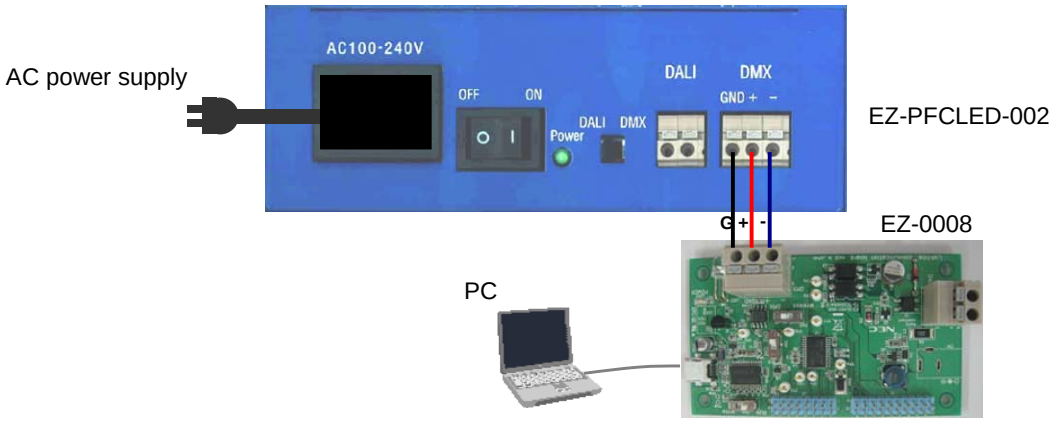
Position	Communication interface selected
DALI	DALI communication interface
DMX	DMX512 communication interface

Table 2-3 DMX512 Communication Connector

Terminal	Function
GND	GND terminal for DMX512 communication
+	DMX512 communication data positive terminal
-	DMX512 communication data negative terminal

Figure 2-2 Connection Examples for DALI Communication/DMX512 Communication (with EZ-0008 Board)

(a) Connection for DMX512 communication



(b) Connection for DALI communication

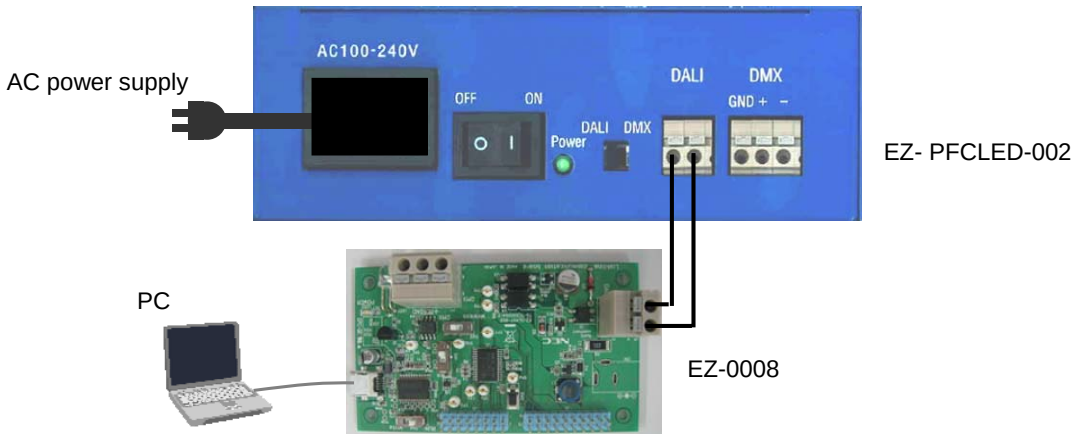


Table 2-4 Dimming Switch Setting and Microcontroller Connection Destination Port

Switch	Function [Note]	Destination port
SW1	Starting of auto-tuning Dimming setting for LED channel 1	P35
SW2	Dimming setting for LED channel 2	P36
SW3	Dimming setting for LED channel 3	P37

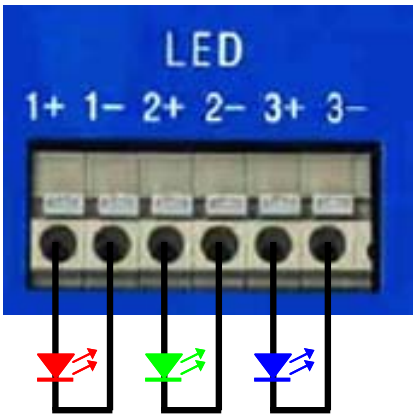
Note The switch functions are the functions in the program created with the software auto generation tool Applilet EZ for HCD.

Table 2-5 Functions of LED Output Connectors

Terminal	Function [Note]
1+	Output terminal of channel 1 (+)
1-	Output terminal of channel 1 (-)
2+	Output terminal of channel 2 (+)
2-	Output terminal of channel 2 (-)
3+	Output terminal of channel 3 (+)
3-	Output terminal of channel 3 (-)

Note When connecting the LED load to the output, connect the anode side of the LED to the output terminal (+) side, and the cathode side to the output terminal (-) side.

Figure 2-3 Example of LED Output Connector Terminal Layout and LED Connection



Warning	
	Do not plug in or unplug a connector or cable with power applied to the board. Doing so may cause product failure, generation of heat, fire or rupture.
	Do not carry this board with connecting any cable. Doing so may cause damage of cable and cause product failure, generation of heat, fire or electric shock.
	When connecting the LED load to this product, the user must be responsible for performing work and connection of wiring properly to avoid defective connection. Improper wiring work or connection may cause failure, heat generation, fire, or electric shock.
	Use wires that have the ratings of the LED load complying with the safety standard or better to connect the LED load. Using nonconforming items or items that do not satisfy the ratings may cause failure, heat generation, fire, or electric shock.

CHAPTER 3 USING EZ-0011

3.1 Preparation

3.1.1 Downloading software

To perform development and evaluation of software using this product, the following software is required.

- •Assembler for 78K0 core (RA78K0)
- •Compiler for 78K0 core (CC78K0)
- •Device file (DF780756)
- •Parameter (PRM78F0756)
- •Integrated debugger (ID78K0-QB)
- •Programming GUI for MINICUBE2 (QB-Programmer)
- •Software auto generation tool (Applilet EZ for HCD)

To perform evaluation of DALI communication/DMX512 communication using the lighting communication master evaluation board (EZ-0008), the following software is required in addition to the above.

- •Windows device driver for the EZ board
- •DALI master controller GUI
- •DMX512 master controller GUI

Please download the software from the respective download pages for the EZ-0011 and EZ-0008 at the following URL.

URL: http://www2.renesas.com/micro/ja/solution/lighting/download.html

3.1.2 Installing programming GUI for MINICUBE2

To write programs to the 78K0/IB2 on this product, the programming GUI for MINICUBE2 (QB-Programmer) is required. Install it to the PC in the following steps.

Caution To use the programming GUI, a separate parameter file is required. For the actual steps for write operation, refer to the QB-Programmer User's Manual (U18527E)

<1> Download the QB-Programmer from the download page for the EZ-0011.
<2> Click the installer file qbp_vxxx_j.exe to execute it. ("xxx" indicates the version.)
<3> Follow the instructions of the installer. Read the license agreement, and continue the installation if it is OK.
When the QB-Programmer is installed by default setting, the driver for MINICUBE2 is also instaled.

3.1.3 Installing assembler, compiler, and integrated debugger

To perform program development and on-chip debugging for the 78K0/IB2 on this product, the assembler, compiler, and integrated debugger are required. Install them to the PC in the following steps.

<1> Download the assembler (RA78K0), compiler (CC78K0), and integrated debugger (ID78K0-QB) from the download page for the EZ-0011.
<2> Click the assembler installer file ra78k0_wxxx_j.exe to execute it. ("xxx" indicates the version.)
<3> Follow the instructions of the installer. Read the license agreement, and continue the installation if it is OK.
<4> When the assembler is installed, the integrated development environment (PM+) is also installed.
<5> Similarly, install the compiler (installer file name: cc78k0_wxxxj.exe) and integrated debugger (installer file name: id78k0-qb_v320_j.exe).
<6> Decompress the device file (compressed file name: df780756_vxxx.zip), and install it with the device file installer.
(For details, refer to the help of the device file installer.)

3.1.4 Installing software auto generation tool Applilet EZ for HCD

The software auto generation tool Applilet EZ for HCD is provided for easy evaluation of the functions of this product. Files generated by his application can also be used as sample programs. Install it to the PC in the following steps.

Caution To use this software, the assembler (RA78K0) and complier (CC78K0) are required.

<1> Download the Applilet EZ for HCD from the download page for the EZ-0011.
<2> Decompress the compressed file AppliletEZforHCD_VxxxJ.zip, and execute the installer file AppliletEZforHCD_VxxxJ.msi. (("xxx" indicates the version.)
<3> Follow the instructions of the installer. Read the license agreement, and continue the installation if it is OK.

3.1.5 Installing DALI/DMX512 master control GUI

To perform dimming control via DALI communication/DMX512 communication, our “lighting communication master evaluation board (EZ-0008)” and GUI can be used for easy evaluation.

For the lighting communication master evaluation board (EZ-0008), refer to Lighting Communication Master Evaluation Board (EZ-0008) Quick Start Guide (Document No.: ZUD-CE-09-0018).

For details and installation method of the DALI master controller GUI, refer to DALI Master Controller GUI User's Manual (Document No.: U19607). For details and installation method of the DMX512 master controller GUI, refer to **DMX512 Master Controller GUI User's Manual (U19596E)**.

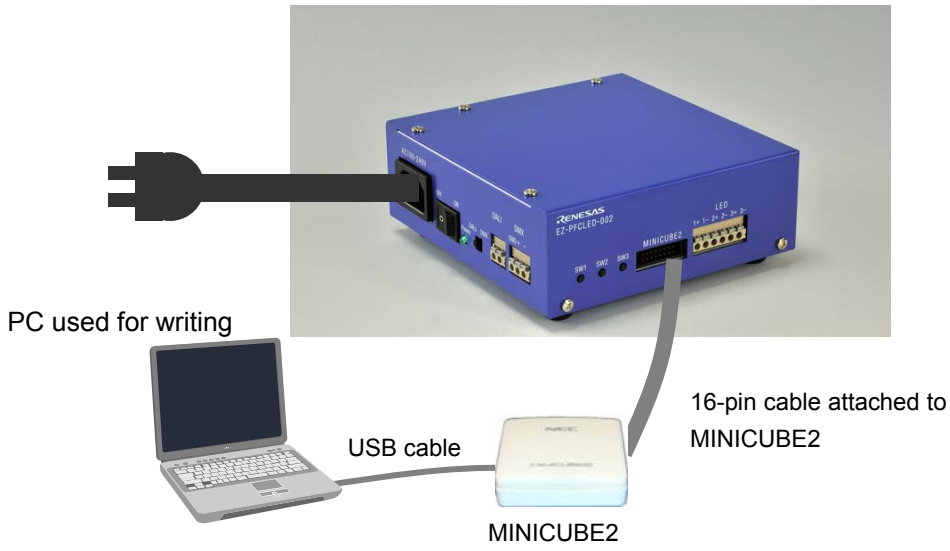
3.2 Writing

This section describes how to write a generated program (hex file) to the 78K0/IB2 installed on this product.

3.2.1 Starting write

<1> Set the mode selection switch of MINICUBE2 to M2 (select the 78K0 microcontroller), and set the power supply selection switch to T (use the power supply of the target system). Connect it to the PC using the USB cable.
<2> Make sure that the power supply of the main unit is off, and connect MINICUBE2 to the main unit.
<3> Connect the power cable to the main unit, and connect it to the receptacle.
<4> Turn the power switch of the main unit to the ON position to supply AC power.
<5> Check that the power indicator LED is on.

Figure 3-1. Connection for Write



<6> Start the programmer GUI (QB-Programmer) on the PC.
<7> Set the parameter file 78F0756.prm on the Setup screen of the QB-Programmer.
<8> Load the hex file to write.
<9> Execute “Blank check”→”Erase”→”Program”→”Verify” separately, or execute ”Autoprocedure” to perform erasure and write.
<10> Exit from the QB-Programmer.
<11> Turn the power switch of the main unit to the OFF position to stop the AC power supply.
<12> Disconnect the USB connection between the PC and MINICUBE2, and remove MINICUBE2 from the main unit.

Danger	
	**Do not touch to the high voltage area of the board.** Touching the board by tools or body while power is being supplied cause product failure or electric shock.
	**Do not touch with wet hands.** Doing so cause product failure or electrical shock.
	**Do not turn on the power switch in insufficient state of each cable connection such as AC power cable, LED connection cable and interface cable.** Doing so may cause product failure, generation of heat, fire or electric shock.
	**Confirm the outlet is near this board and easily unplugged.**
	**If smoke or an abnormal smell or sound is emitted or heating occurs, promptly switch off the board power and unplug from AC power supply.** Using the board in such a state poses a risk of fire, burning or electric shock.

3.3 Operation

This section describes how to operate the program written to this product.
For information on how to write a program, refer to "3.2 Writing."

3.3.1 Steps when communication is not used

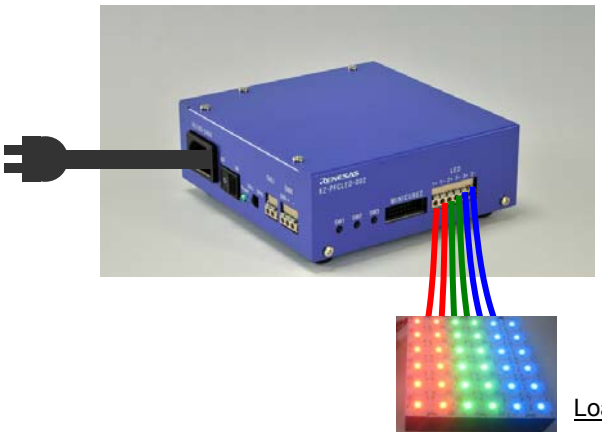
<1> Make sure that the power supply of the main unit is off, and connect the load to the LED output connector.
<2> Connect the power cable to the main unit, and connect it to the receptacle.
<3> Turn the power switch of the main unit to the ON position to supply AC power. The program written to the microcontroller starts to operate.

Caution **For programs created with the Applilet EZ for HCD, auto tuning operation is required before performing the selected dimming operation. Parameters of preview control are obtained in auto tuning, so voltage is applied to the load up to the preset current.**

To start auto tuning, press the dimming switch (SW1). When auto tuning is complete, communication operation starts.

<4> When the evaluation is finished, turn the power switch of the main unit **to** the OFF position to stop the AC power supply.

Figure 3-2. Example of Connection When Communication Is Not Performed



Danger	
	**Do not touch to the high voltage area of the board.** Touching the board by tools or body while power is being supplied cause product failure or electric shock.
	**Do not touch with wet hands.** Doing so cause product failure or electrical shock.
	**Do not turn on the power switch in insufficient state of each cable connection such as AC power cable, LED connection cable and interface cable.** Doing so may cause product failure, generation of heat, fire or electric shock.
	**Confirm the outlet is near this board and easily unplugged.**
	**If smoke or an abnormal smell or sound is emitted or heating occurs, promptly switch off the board power and unplug from AC power supply.** Using the board in such a state poses a risk of fire, burning or electric shock.

3.3.2 Steps when communication is used

This product has the DALI communication and DMX512 communication circuits. By using the serial interface UART6/DALI incorporated on the 78K0/IB2, slave operation of DALI communication and DMX512 communication can be achieved. To use communication, connection is required according to the communication method. This section describes the steps in which the lighting communication master evaluation board (EZ-0008) is used.

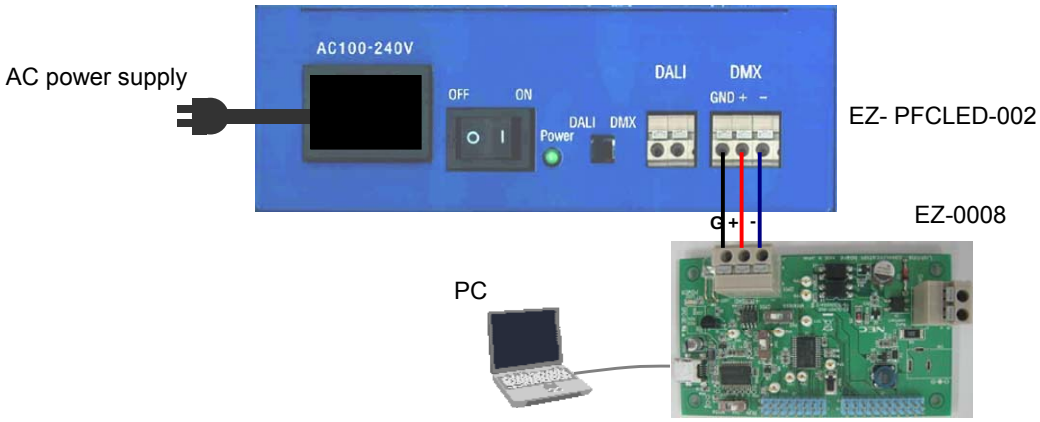
<1> Make sure that the power supply of the main unit is off, and connect the load to the LED output connector.
<2> Connect the main unit and EZ-0008 with a cable. Connection varies depending on the communication method. For details, refer to Figure 3-3.
<3> Adjust the DALI/DMX512 changeover switch to the communication to be used.
<4> Connect the EZ-0008 to the PC.
<5> Connect the power cable to the main unit, and connect it to the receptacle.
<6> Turn the power switch of the main unit to the ON position to supply AC power. The program written to the microcontroller starts to operate.

Caution For programs created with the Applilet EZ for HCD, auto tuning operation is required before performing the selected dimming operation. Parameters of preview control are obtained in auto tuning, so voltage is applied to the load up to the preset current.
To start auto tuning, press the dimming switch (SW1). When auto tuning is complete, communication operation starts.

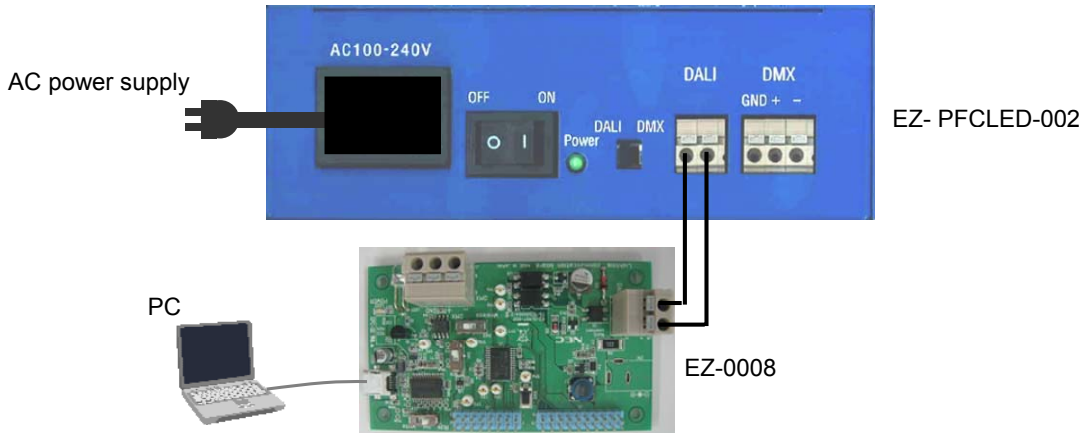
<7> Start the DALI master controller GUI or DMX512 master controller GUI on the PC to start evaluation.
<8> When the evaluation is finished, turn the power switch of the main unit to the OFF position to stop the AC power supply.

Figure 3-3 Connection Examples for DALI Communication/DMX512 Communication (with EZ-0008 Board)

(a) Connection for DMX512 communication



(b) Connection for DALI communication



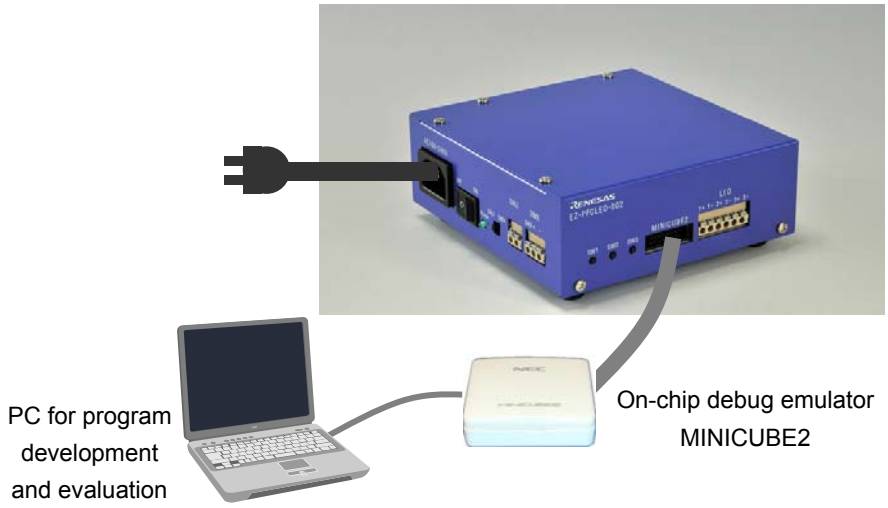
Danger	
	**Do not touch to the high voltage area of the board.** Touching the board by tools or body while power is being supplied cause product failure or electric shock.
	**Do not touch with wet hands.** Doing so cause product failure or electrical shock.
	**Do not turn on the power switch in insufficient state of each cable connection such as AC power cable, LED connection cable and interface cable.** Doing so may cause product failure, generation of heat, fire or electric shock.
	**Confirm the outlet is near this board and easily unplugged.**
	**If smoke or an abnormal smell or sound is emitted or heating occurs, promptly switch off the board power and unplug from AC power supply.** Using the board in such a state poses a risk of fire, burning or electric shock.

3.4 On-chip Debug

The 78K0/IB2 installed on this product supports the on-chip debug function. MINICUBE2 is required for on-chip debugging. This section describes the procedure for on-chip debugging.

<1> Make sure that the power supply of the main unit is off, and connect MINICUBE2 to the main unit.
<2> Set the mode selection switch of MINICUBE2 to M2 (select the 78K0 microcontroller), and set the power supply selection switch to T (use the power supply of the target system). Connect it to the PC using the USB cable.
<3> Connect the power cable to the main unit, and connect it to the receptacle.
<4> Turn the power switch of the main unit to the ON position to supply AC power.
<5> Check that the power indicator LED is on.

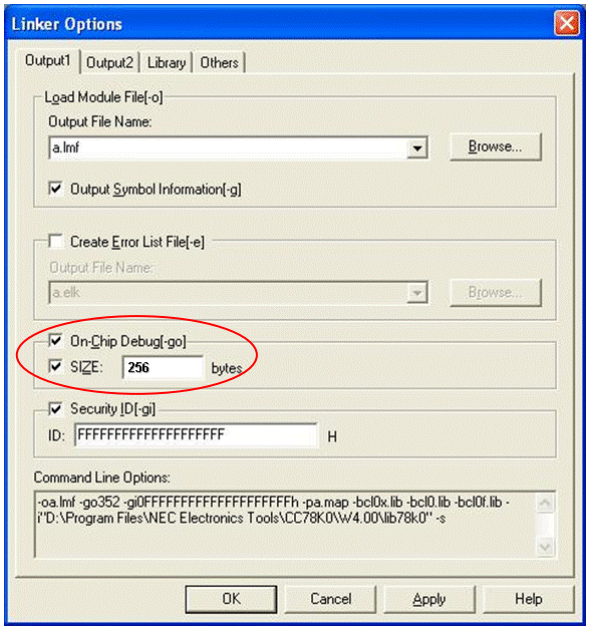
Figure 3-4. Connection for On-chip Debugging



<6> Start the integrated debugger (ID78K0-QB) on the PC.
The on-chip debug function can be used for evaluation by operating the ID78K0-QB.
<7> When the evaluation is finished, exit from the ID78K0-QB.
<8> Turn the power switch of the main unit to the OFF position to stop the AC power supply.

Cautions 1. To use the on-chip debug function, memory space must be reserved in the 78K0/IB2 in advance. When our compiler is used, this setting can be done with the linker option. To use the on-chip debug function, select the "On-chip debug[-go](C)" check box in the linker option to specify the size.
If the pseudo real-time RAM monitor (RRM) function is not used, reserve 256 bytes as a debugging monitor area.

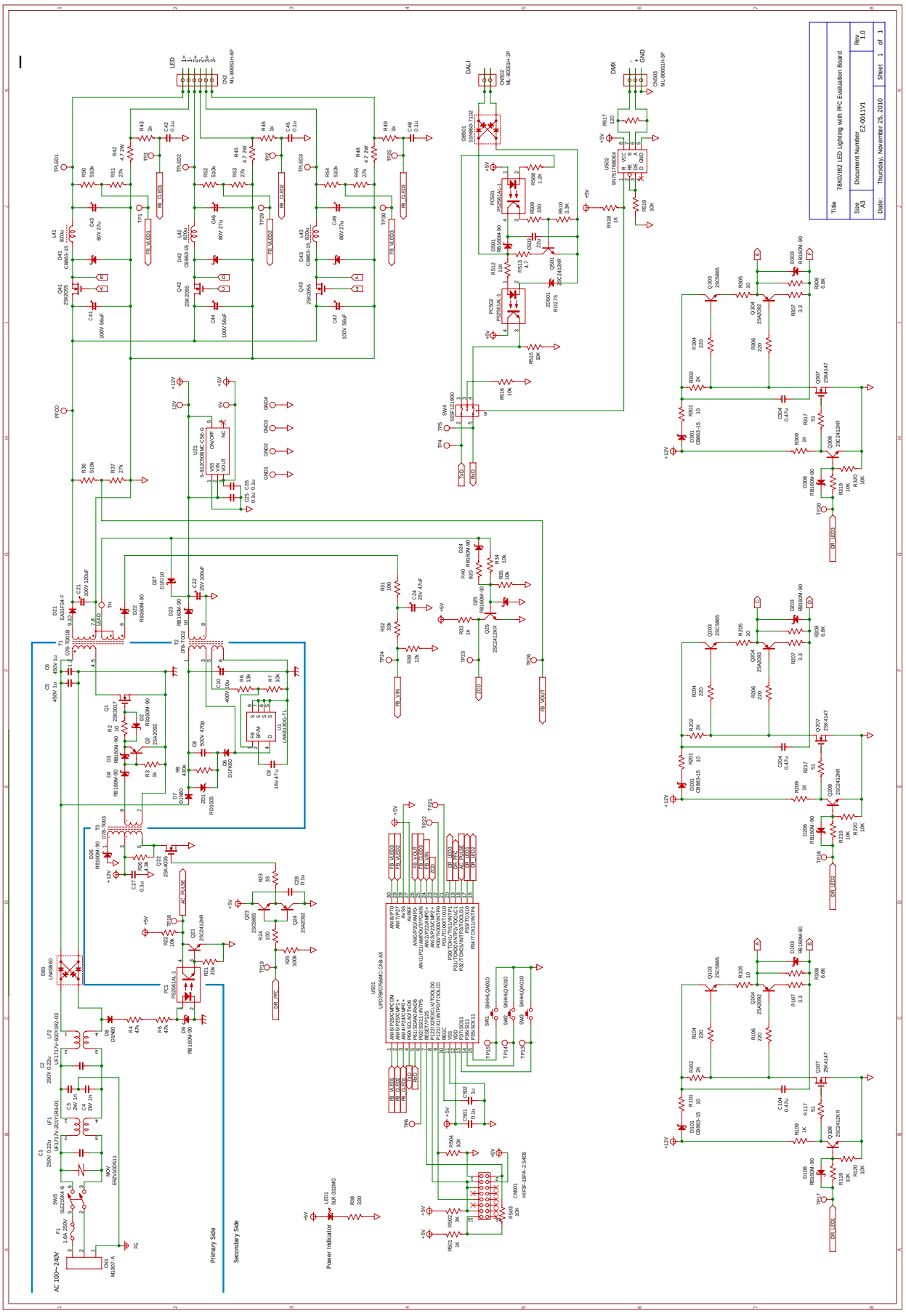
Figure 3-5. Linker Option Setting



Cautions 2. When performing debugging with the on-chip debug function, be careful of the positions and timing for step executions and breaks. Stopping the PFC circuit or Buck converter abruptly may damage the circuit elements on the board due to overvoltage or overcurrent, resulting in smoke or fire in the worst case. Especially, do not set any break for the Peripheral Break function because it stops the timer for PFC and Buck converters upon a break.

Danger	
	**Do not touch to the high voltage area of the board.** Touching the board by tools or body while power is being supplied cause product failure or electric shock.
	**Do not touch with wet hands.** Doing so cause product failure or electrical shock.
	**Do not turn on the power switch in insufficient state of each cable connection such as AC power cable, LED connection cable and interface cable.** Doing so may cause product failure, generation of heat, fire or electric shock.
	**Confirm the outlet is near this board and easily unplugged.**
	**If smoke or an abnormal smell or sound is emitted or heating occurs, promptly switch off the board power and unplug from AC power supply.** Using the board in such a state poses a risk of fire, burning or electric shock.

APPENDIX A CIRCUIT DIAGRAM



APPENDIX B PARTS LIST

Table B-1. Parts List (1/4)

Part	Part No.	Item name	Manufacturer	Model No. or Drawing No.
PC	1	Photocoupler	Renesas Electronics	PS2561AL-1
PC	501	Photocoupler	Renesas Electronics	PS2561AL-1
PC	502	Photocoupler	Renesas Electronics	PS2561AL-1
Q	22	Power MOSFET	Renesas Electronics	2SK4035
Q	41	Power MOSFET	Renesas Electronics	2SK2055
Q	42	Power MOSFET	Renesas Electronics	2SK2055
Q	43	Power MOSFET	Renesas Electronics	2SK2055
Q	107	Power MOSFET	Renesas Electronics	2SK4147
Q	207	Power MOSFET	Renesas Electronics	2SK4147
Q	307	Power MOSFET	Renesas Electronics	2SK4147
U	501	CPU	Renesas Electronics	UPD78F0756MC-CAB-AX
ZD	1	Zener diode	Renesas Electronics	RD150S
ZD	501	Zener diode	Renesas Electronics	RD2.7S
SW	5	Rocker switch	Fujisoku	SLE210K4-6
TP	1	Test tap	Mac8	LC-2-G-Skyblue
TP	2	Test tap	Mac8	LC-2-G-Skyblue
TP	3	Test tap	Mac8	LC-2-G-Skyblue
TP	4	Test tap	Mac8	LC-2-G-Skyblue
TP	5	Test tap	Mac8	LC-2-G-Skyblue
TP	6	Test tap	Mac8	LC-2-G-Skyblue
TP	13	Test tap	Mac8	LC-2-G-Skyblue
TP	14	Test tap	Mac8	LC-2-G-Skyblue
TP	15	Test tap	Mac8	LC-2-G-Skyblue
TP	16	Test tap	Mac8	LC-2-G-Skyblue
TP	17	Test tap	Mac8	LC-2-G-Skyblue
TP	18	Test tap	Mac8	LC-2-G-Skyblue
TP	19	Test tap	Mac8	LC-2-G-Skyblue
TP	20	Test tap	Mac8	LC-2-G-Skyblue
TP	21	Test tap	Mac8	LC-2-G-Skyblue
TP	22	Test tap	Mac8	LC-2-G-Skyblue
TP	23	Test tap	Mac8	LC-2-G-Skyblue
TP	24	Test tap	Mac8	LC-2-G-Skyblue
TP	25	Test tap	Mac8	LC-2-G-Skyblue
TP	26	Test tap	Mac8	LC-2-G-Skyblue
TP	29	Test tap	Mac8	LC-2-G-Skyblue
TP	30	Test tap	Mac8	LC-2-G-Skyblue
TPLED	1	Test tap	Mac8	LC-2-G-Skyblue
TPLED	2	Test tap	Mac8	LC-2-G-Skyblue
TPLED	3	Test tap	Mac8	LC-2-G-Skyblue
GND	1	Test tap	Mac8	LC-2-G-Black
GND	2	Test tap	Mac8	LC-2-G-Black
GND	3	Test tap	Mac8	LC-2-G-Black
GND	4	Test tap	Mac8	LC-2-G-Black
PFCO		Test tap	Mac8	LC-2-G-Red
12V		Test tap	Mac8	LC-2-G-Red
5V		Test tap	Mac8	LC-2-G-Red
C	3	Ceramic capacitor	Murata Manufacturing	DEHR33D102KB3B
C	4	Ceramic capacitor	Murata Manufacturing	DEHR33D102KB3B
C	8	Ceramic capacitor	Murata Manufacturing	DEHC32H471KA2B
C	9	Multilayer ceramic capacitor	Murata Manufacturing	GRM32EB31C476ME15
C	25	Multilayer ceramic capacitor	Murata Manufacturing	GRM188B31H104KA92
C	26	Multilayer ceramic capacitor	Murata Manufacturing	GRM188B31H104KA92
C	27	Multilayer ceramic capacitor	Murata Manufacturing	GRM188B31H104KA92
C	28	Multilayer ceramic capacitor	Murata Manufacturing	GRM188B31H104KA92
C	42	Multilayer ceramic capacitor	Murata Manufacturing	GRM188B31H104KA92
C	45	Multilayer ceramic capacitor	Murata Manufacturing	GRM188B31H104KA92
C	48	Multilayer ceramic capacitor	Murata Manufacturing	GRM188B31H104KA92
C	104	Multilayer ceramic capacitor	Murata Manufacturing	GRM31MR71H474KA01
C	204	Multilayer ceramic capacitor	Murata Manufacturing	GRM31MR71H474KA01
C	304	Multilayer ceramic capacitor	Murata Manufacturing	GRM31MR71H474KA01
C	501	Multilayer ceramic capacitor	Murata Manufacturing	GRM188B31H104KA92
C	502	Multilayer ceramic capacitor	Murata Manufacturing	GRM188B31C105KA92
C	503	Multilayer ceramic capacitor	Murata Manufacturing	GRM32EC81E226ME15
Q	1	Power MOSFET	Toshiba	2SK3017
F	1	Fuse holder	BULGIN	FX0321

Table B-1. Parts List (2/4)

Part	Part No.	Item name	Manufacturer	Model No. or Drawing No.
		Fuse holder cover	BULGIN	12760
		Fuse (AC250[V]1.6[A])	Littlefuse	021701.6HXP
U	1	Power supply IC	Power Integrations	LNK613DG-TL
LF	1	Common mode choke	TDK	UF1717V-201Y1R6-01
LF	2	Common mode choke	TDK	UF1717V-300Y1R2-03
U	502	Interface IC	Texas Instruments	SN75176BDE4
SW	1	Push type switch	Alps Electric	SKHHLQA010
SW	2	Push type switch	Alps Electric	SKHHLQA010
SW	3	Push type switch	Alps Electric	SKHHLQA010
SW	4	Slide switch	Alps Electric	SSSF121900
R	2	Chip type resistor	KOA	RK73H2ATTD10R0F
R	3	Chip type resistor	KOA	RK73H2ATTD1001F
R	4	Chip type resistor	KOA	RK73H2BTTD4702F
R	5	Chip type resistor	KOA	RK73H2BTTD4702F
R	6	Chip type resistor	KOA	RK73H2ATTD1302F
R	7	Chip type resistor	KOA	RK73H2ATTD1002F
R	8	Chip type resistor	KOA	RK73H2BTTD4303F
R	21	Chip type resistor	KOA	RK73H2ATTD2002F
R	22	Chip type resistor	KOA	RK73H2ATTD1002F
R	23	Chip type resistor	KOA	RK73H2ATTD33R0F
R	24	Chip type resistor	KOA	RK73H2ATTD1000F
R	25	Chip type resistor	KOA	RK73H2ATTD1003F
R	26	Chip type resistor	KOA	RK73H2ATTD4301F
R	31	Chip type resistor	KOA	RK73H2ATTD1000F
R	32	Chip type resistor	KOA	RK73H2ATTD3302F
R	33	Chip type resistor	KOA	RK73H2ATTD1001F
R	34	Chip type resistor	KOA	RK73H2ATTD1002F
R	35	Chip type resistor	KOA	RK73H2ATTD1002F
R	36	Chip type resistor	KOA	RK73H2ATTD5103F
R	37	Chip type resistor	KOA	RK73H2ATTD2702F
R	38	Chip type resistor	KOA	RK73H2ATTD3300F
R	39	Chip type resistor	KOA	RK73H2ATTD1202F
R	40	Chip type resistor	KOA	RK73H2ATTD8200F
R	42	Metal oxide film resistor	KOA	SL2TBK4R7J
R	43	Chip type resistor	KOA	RK73H2ATTD1001F
R	45	Metal oxide film resistor	KOA	SL2TBK4R7J
R	46	Chip type resistor	KOA	RK73H2ATTD1001F
R	48	Metal oxide film resistor	KOA	SL2TBK4R7J
R	49	Chip type resistor	KOA	RK73H2ATTD1001F
R	50	Chip type resistor	KOA	RK73H2ATTD5103F
R	51	Chip type resistor	KOA	RK73H2ATTD2702F
R	52	Chip type resistor	KOA	RK73H2ATTD5103F
R	53	Chip type resistor	KOA	RK73H2ATTD2702F
R	54	Chip type resistor	KOA	RK73H2ATTD5103F
R	55	Chip type resistor	KOA	RK73H2ATTD2702F
R	101	Chip type resistor	KOA	RK73H2ATTD10R0F
R	102	Chip type resistor	KOA	RK73H2ATTD2001F
R	104	Chip type resistor	KOA	RK73H2ATTD2200F
R	105	Chip type resistor	KOA	RK73H2ATTD10R0F
R	106	Chip type resistor	KOA	RK73H2ATTD2200F
R	107	Chip type resistor	KOA	RK73B2ATTD3R3J
R	108	Chip type resistor	KOA	RK73H2ATTD6801F
R	109	Chip type resistor	KOA	RK73H2ATTD1001F
R	117	Chip type resistor	KOA	RK73H2ATTD51R0F
R	119	Chip type resistor	KOA	RK73H2ATTD1002F
R	120	Chip type resistor	KOA	RK73H2ATTD1002F
R	201	Chip type resistor	KOA	RK73H2ATTD10R0F
R	202	Chip type resistor	KOA	RK73H2ATTD2001F
R	204	Chip type resistor	KOA	RK73H2ATTD2200F
R	205	Chip type resistor	KOA	RK73H2ATTD10R0F
R	206	Chip type resistor	KOA	RK73H2ATTD2200F
R	207	Chip type resistor	KOA	RK73B2ATTD3R3J
R	208	Chip type resistor	KOA	RK73H2ATTD6801F
R	209	Chip type resistor	KOA	RK73H2ATTD1001F
R	217	Chip type resistor	KOA	RK73H2ATTD51R0F
R	219	Chip type resistor	KOA	RK73H2ATTD1002F
R	220	Chip type resistor	KOA	RK73H2ATTD1002F
R	301	Chip type resistor	KOA	RK73H2ATTD10R0F
R	302	Chip type resistor	KOA	RK73H2ATTD2001F

Table B-1. Parts List (3/4)

Part	Part No.	Item name	Manufacturer	Model No. or Drawing No.
R	304	Chip type resistor	KOA	RK73H2ATTD2200F
R	305	Chip type resistor	KOA	RK73H2ATTD10R0F
R	306	Chip type resistor	KOA	RK73H2ATTD2200F
R	307	Chip type resistor	KOA	RK73B2ATTD3R3J
R	308	Chip type resistor	KOA	RK73H2ATTD6801F
R	309	Chip type resistor	KOA	RK73H2ATTD1001F
R	317	Chip type resistor	KOA	RK73H2ATTD51R0F
R	319	Chip type resistor	KOA	RK73H2ATTD1002F
R	320	Chip type resistor	KOA	RK73H2ATTD1002F
R	501	Chip type resistor	KOA	RK73H2ATTD1001F
R	502	Chip type resistor	KOA	RK73H2ATTD3001F
R	503	Chip type resistor	KOA	RK73H2ATTD1002F
R	504	Chip type resistor	KOA	RK73H2ATTD1002F
R	508	Chip type resistor	KOA	RK73H2ATTD1201F
R	509	Chip type resistor	KOA	RK73H2ATTD3300F
R	510	Chip type resistor	KOA	RK73H2ATTD3301F
R	512	Chip type resistor	KOA	RK73H2ATTD1102F
R	513	Chip type resistor	KOA	RK3B2ATTD4R7G
R	515	Chip type resistor	KOA	RK73H2ATTD1002F
R	516	Chip type resistor	KOA	RK73H2ATTD1002F
R	517	Chip type resistor	KOA	RK73H2ATTD1200F
R	518	Chip type resistor	KOA	RK73H2ATTD1001F
R	519	Chip type resistor	KOA	RK73H2ATTD1002F
CN	2	Connector	Sato Parts	ML-800-S1H-6P
CN	502	Screwless terminal block	Sato Parts	ML-800-S1H-2P
CN	503	Screwless terminal block	Sato Parts	ML-800-S1H-3P
L	41	Coil	Sumida Corporation	CDRH127/LDNP-821M
L	42	Coil	Sumida Corporation	CDRH127/LDNP-821M
L	43	Coil	Sumida Corporation	CDRH127/LDNP-821M
U	21	Power supply IC	Seiko Instruments	S-812C50BMC-C5E-G
CN	1	AC inlet 3-terminal connector	EMUDEN	M1907-A
C	1	Film capacitor	Panasonic	ECQU2A224ML
C	2	Film capacitor	Panasonic	ECQU2A224ML
MOV		Absorber	Panasonic	ERZV10D511
CN	501	Straight type pin header	Hirose Electric	HIF3F-16PA-2.54DS
T	1	Transformer	Pony Electric	078-T001B
T	2	Transformer	Pony Electric	078-T002
T	3	Transformer	Pony Electric	078-T003
D	2	Schottky Barrier diode	Rohm	RB160M-90
D	3	Schottky Barrier diode	Rohm	RB160M-90
D	4	Schottky Barrier diode	Rohm	RB160M-90
D	9	Schottky Barrier diode	Rohm	RB160M-90
D	22	Schottky Barrier diode	Rohm	RB160M-90
D	23	Schottky Barrier diode	Rohm	RB160M-90
D	24	Schottky Barrier diode	Rohm	RB160M-90
D	25	Schottky Barrier diode	Rohm	RB160M-90
D	26	Schottky Barrier diode	Rohm	RB160M-90
D	103	Schottky Barrier diode	Rohm	RB160M-90
D	106	Schottky Barrier diode	Rohm	RB160M-90
D	203	Schottky Barrier diode	Rohm	RB160M-90
D	206	Schottky Barrier diode	Rohm	RB160M-90
D	303	Schottky Barrier diode	Rohm	RB160M-90
D	306	Schottky Barrier diode	Rohm	RB160M-90
D	501	Schottky Barrier diode	Rohm	RB160M-90
LED	1	LED	Rohm	SLR-332MG
Q	2	Transistor	Rohm	2SA2092
Q	21	Transistor	Rohm	2SC2412KR
Q	23	Transistor	Rohm	2SC5865
Q	24	Transistor	Rohm	2SA2092
Q	25	Transistor	Rohm	2SC2412KR
Q	103	Transistor	Rohm	2SC5865
Q	104	Transistor	Rohm	2SA2092
Q	108	Transistor	Rohm	2SC2412KR
Q	203	Transistor	Rohm	2SC5865
Q	204	Transistor	Rohm	2SA2092
Q	208	Transistor	Rohm	2SC2412KR
Q	303	Transistor	Rohm	2SC5865
Q	304	Transistor	Rohm	2SA2092
Q	308	Transistor	Rohm	2SC2412KR
Q	501	Transistor	Rohm	2SC2412KR
D	6	Fast recovery diode	Shindengen Electric Manufacturing	D1FK60

Table B-1. Parts List (4/4)

Part	Part No.	Item name	Manufacturer	Model No. or Drawing No.
D	7	Rectifying diode	Shindengen Electric Manufacturing	D1N60
D	8	Rectifying diode	Shindengen Electric Manufacturing	D1N60
D	27	Schottky Barrier diode	Shindengen Electric Manufacturing	D1FJ10
DB	1	Rectifying stack	Shindengen Electric Manufacturing	LN4SB60
DB	501	Rectifying stack	Shindengen Electric Manufacturing	S1NB60-7102
		Heat sink	Mizutani Electric	PUE26-25
		Heat sink	Mizutani Electric	PUE26-25
C	5	Film capacitor	Nitsuko	MDX22W105K
C	6	Film capacitor	Nitsuko	MDX22W105K
D	21	Fast recovery diode	Nihon Inter Electronics	EA31FS4-F
C	10	Electrolytic capacitor	Nippon Chemi-Con	EKXJ401ELL100MJ16S
C	21	Electrolytic capacitor	Nippon Chemi-Con	ELXV101ELL121MK25S
C	22	Electrolytic capacitor	Nippon Chemi-Con	ELXZ250ELL101MFB5D
C	24	Electrolytic capacitor	Nippon Chemi-Con	ELXZ250ELL470MEB5D
C	41	Electrolytic capacitor	Nippon Chemi-Con	ELXV101ELL560MJ20S
C	43	Electrolytic capacitor	Nippon Chemi-Con	ELXV800ELL270MF15D
C	44	Electrolytic capacitor	Nippon Chemi-Con	ELXV101ELL560MJ20S
C	46	Electrolytic capacitor	Nippon Chemi-Con	ELXV800ELL270MF15D
C	47	Electrolytic capacitor	Nippon Chemi-Con	ELXV101ELL560MJ20S
C	49	Electrolytic capacitor	Nippon Chemi-Con	ELXV800ELL270MF15D
D	41	Schottky Barrier diode	Fuji Electric	CB863-15
D	42	Schottky Barrier diode	Fuji Electric	CB863-15
D	43	Schottky Barrier diode	Fuji Electric	CB863-15
D	101	Schottky Barrier diode	Fuji Electric	CB863-15
D	201	Schottky Barrier diode	Fuji Electric	CB863-15
D	301	Schottky Barrier diode	Fuji Electric	CB863-15

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