User's Manual

Applilet™ EZ for HCD Controller

For Ver. 8.30

User's Manual

Renesas Electronics
www.renesas.com

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How to Use This Manual

Target Readers

This manual is intended for user engineers who wish to understand the functions of the μPD78F8024, 78F8025, 78F0754, or 78F0756 in order to design and develop its application systems and programs.

Purpose

This manual is intended to give users an understanding how to use Applilet EZ for HCD Controller and of the functions described in the **Organization** below.

Organization

This manual is broadly divided into the following parts.

- Overview
- Installation
- Startup and termination
- Applilet EZ for HCD Controller operation
- Windows reference

How to Use This Manual

It is assumed that the readers of this manual have general knowledge of electrical engineering, logic circuits, and microcontrollers.

◊ To understand the overall functions of Applilet EZ for HCD Controller
→ Read this manual in the order of the **CONTENTS**. The mark <R> shows major revised points. The revised points can be easily searched by copying an "<R>" in the PDF file and specifying it in the "Find what:" field.
◊ To learn the details of the hardware functions of the μPD78F8024
→ Refer to **μPD78F8024, 78F8025 User's Manual (U18976E)**.
◊ To learn the details of the hardware functions of the78K0/Ix2
→ Refer to **78K0/Ix2 User's Manual (R01UH0010E)**.
◊ To learn the details of the hardware functions of theRL78/I1A
→ Refer to **RL78/I1A User's Manual (R01UH0169E)**.

Conventions

Data significance:	Higher digits on the left and lower digits on the right
Active low representation:	$\overline{\times\times\times}$ (overscore over pin or signal name)
Note:	Footnote for item marked with **Note** in the text
Caution:	Information requiring particular attention
Remark:	Supplementary information
Numerical representation:	Binary ... ×××× or ××××B
	Decimal ... ××××
	Hexadecimal ... ××××H

Related Documents The related documents indicated in this publication may include preliminary versions. However, preliminary versions are not marked as such.

Documents Related to Devices

Document Name	Document No.
μPD78F8024, 78F8025 User's Manual	U18976E
78K0/Ix2 User's Manual	R01UH0010E
RL78/I1A User's Manual	R01UH0169E

Documents Related to Development Hardware Tools

Document Name	Document No.
PG-FP5 Flash Memory Programmer User's Manual	R20UT0008E
78K0/IA2 PWM Evaluation Board (EZ-0006) User's Manual	ZBB-CE-09-0009-E
78K0/IB2 HBLED Evaluation Board (EZ-0005) User's Manual	ZBB-CE-09-0010-E
RL78/I1A DC/DC LED Control Evaluation Board User's Manual	R01UH0363E

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

Documents Related to Development Software Tools

Document Name		Document No.
RA78K0 Ver.3.80 Assembler Package User's Manual[Note 1]	Operation	U17199E
	Language	U17198E
	Structured Assembly Language	U17197E
78K0 Assembler Package RA78K0 Ver.4.01 Operating Precautions (Notification Document)[Note 1]		ZUD-CD-07-0181-E
CC78K0 Ver.3.70 C Compiler User's Manual[Note 2]	Operation	U17201E
	Language	U17200E
78K0 C Compiler CC78K0 Ver. 4.00 Operating Precautions (Notification Document)[Note 2]		ZUD-CD-07-0103-E
SM+Note 3 System Simulator User's Manual	Operation	U18601E
	User Open Interface	U18212E
ID78K0-QB Ver.2.94 Integrated Debugger User's Manual	Operation	U18330E
ID78K0-QB Ver.3.00 Integrated Debugger User's Manual	Operation	U18492E
PM plus Ver.5.20[Note 4] User's Manual		U16934E
PM+ Ver.6.30[Note 5] User's Manual		U18416E
CubeSuite+ V. 2.02.00 User's Manual	Start	R20UT2865E
	Analysis	R20UT2868E
	Message	R20UT2871E
	RL78 Design	R20UT2684E
	78K0 Design	R20UT2138E
	RL78, 78K0R Coding	R20UT2774E
	78K0 Coding	R20UT2141E
	RL78, 78K0R Build	R20UT2623E
	78K0 Build	R20UT0783E
	RL78 Debug	R20UT2867E
	78K0 Debug	R20UT0731E

Notes 1. This document is installed into the PC together with the tool when installing RA78K0 Ver. 4.01. For descriptions not included in "78K0 Assembler Package RA78K0 Ver. 4.01 Operating Precautions", refer to the user's manual of RA78K0 Ver. 3.80.

2. This document is installed into the PC together with the tool when installing CC78K0 Ver. 4.00. For descriptions not included in "78K0 C Compiler CC78K0 Ver. 4.00 Operating Precautions", refer to the user's manual of CC78K0 Ver. 3.70.

3. The current SM+ version supports only instruction simulation.

4. PM+ Ver. 5.20 is the integrated development environment included with RA78K0 Ver. 3.80.

5. PM+ Ver. 6.30 is the integrated development environment included with RA78K0 Ver. 4.01. Software tool (assembler, C compiler, debugger, and simulator) products of different versions can be managed.

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

CONTENTS

CHAPTER 1 OVERVIEW

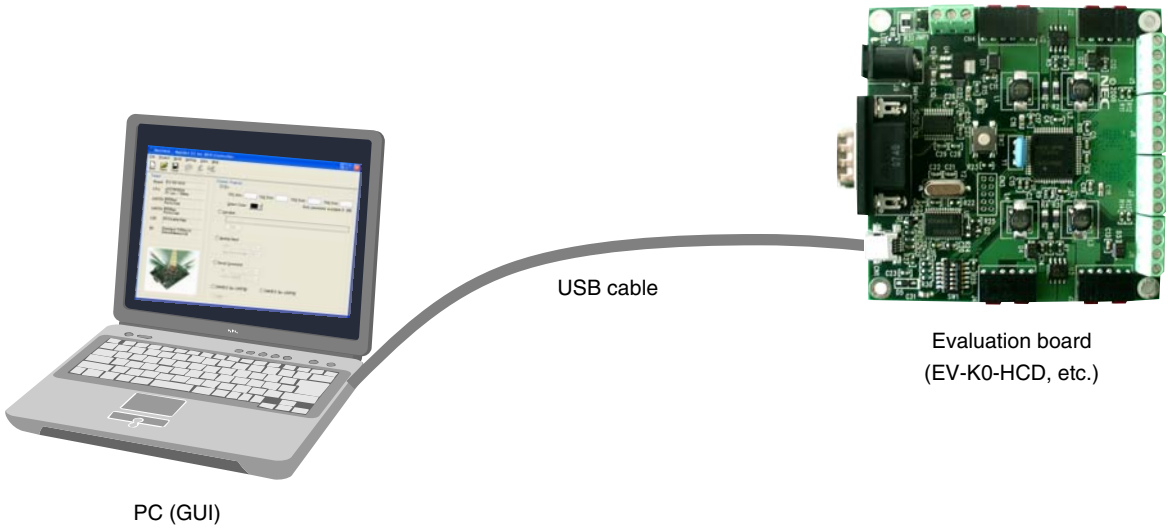
1.1 Overview

Applilet EZ for HCD Controller is a tool used to automatically generate software for microcontrollers for LED lamps and illumination and to write programs.

By specifying dimming and the communication mode on the GUI, Applilet EZ for HCD Controller can be used to easily generate the programs that control the software for microcontrollers that control LEDs at a constant current. It can also be used to automatically write the generated software to the flash memory in microcontrollers via a USB cable and to check operation by using an evaluation board.

By using Applilet EZ for HCD Controller, the labor hours for controlling LEDs, developing communication software, and checking operation can be significantly reduced. In addition, application systems for LED lamps and illumination that use microcontrollers can be evaluated without microcontroller expertise.

<Configuration example>



1.2 Host Machine, Software, and Hardware Configurations

The host machine, software, and hardware configurations for using Applilet EZ for HCD Controller are shown below.

(1) Host machine

- OS: Windows XP™ (32-bit mode), Windows Vista™ (32-bit mode), Windows 7 (32-/64-bit mode)
- CPU: Must satisfy the recommended requirements for each OS
- Memory: Must satisfy the recommended requirements for each OS
- USB: USB 1.1 interface or later

(2) Software

- Applilet EZ for HCD Controller (this software)
- Browser: Internet Explorer™ 6.0 or later
- Software that can edit CSV files, such as Microsoft Excel™
- Assembler/compiler/integrated development environment/device file[Note 1]

  <Renesas Electronics[Note 2]>

  Compiler[Note 6]: CC78K0 (Ver. 3.80 or Ver. 4.00)

  Assembler[Note 6]: RA78K0 (Ver. 3.70 or Ver. 4.01)[Note 3]

  Device file: DF788025 or DF780756 (only when developing a system in PM+)[Note 4]

  Or

  Integrated Development Environment: CubeSuite+ CA78K0, CA78K0R

  <IAR Systems>

  Integrated development environment: IAR Embedded Workbench

  Compiler[Note 6]: IAR C/C++ Compiler for Renesas 78K0
  IAR C/C++ Compiler for Renesas RL78

  Assembler[Note 6]: IAR Assembler for Renesas 78K0
  IAR Assembler for Renesas RL78

  Device file[Note 6]: DF-78K0-788025-EE_xxxxx[Note 5]
  DF-78K0-Ix2-EE_xxxxx[Note 5]
  DF-RL78I1A-EE_xxxxx[Note 5]

  <KPIT (GCC)>

  Tool package: GNURL78[Note 7]
- Parameter file

  PRM78F8025 ····· Parameter file for the μPD78F8024, 78F8025 including information of flash memory programming

  PRM78F0756 ····· Parameter file for the μPD78F0754, 78F0756 including information of flash memory programming
- Renesas Flash Programmer or WriteEZ5 ····· Software for flash memory programming
- Board driver ····· Driver used to make the host PC recognize the evaluation board (EV-K0-HCD, etc.)

(3) Hardware

- Evaluation board

  EV-K0-HCD (Shine it) ····· This is an evaluation board for high-brightness LEDs that uses the μPD78F8024. Red, green, blue, and white LEDs are mounted on the board. The LEDs can be controlled in 8-bit resolution by using the constant-current driver IC mounted on the μPD78F8024.

  EV-K0-HCD2 ····· This evaluation board is the same as the EV-K0-HCD—a board for evaluating high-brightness LEDs—except that it uses the μPD78F8025 as the microcontroller unit.

EZ-0005 (78K0/Ix2LED)····· This is an evaluation board for high-brightness LEDs that uses the μPD78F0756 (78K0/IB2). Red, green, and blue LEDs are mounted on the board. The LEDs can be controlled by using the internal features of the μPD78F0756 and an FET without the constant-current driver IC.

EZ-0006····· This is an evaluation board for high-brightness LEDs that uses the μPD78F0754 (78K0/IA2). Red, green, blue, and white LEDs can be controlled in up to 16-bit resolution, by using this board with the EZ-0007 (a μPD168804 voltage reduction HBLED evaluation board).

EZ-0009····· This is a development kit for the μPD78F8024 and 78F8025. This kit consists of a simple on-chip debug emulator and a target board. Up to four LEDs can be controlled by adding circuits to the μPD78F8025 mounted on the target board.

EZ-0011····· This is an AC/DC evaluation board that uses the μPD78F0756. It can control PFC and up to 3ch of LED. It writes in the microcontroller. MINICUBE2 is used to debug.

EZ-0012····· This is an evaluation board for LEDs that uses the RL78K/I1A. Red, green, and blue LEDs are mounted on the board. The LEDs can be controlled by using the internal features of the L78/I1A and an FET without the constant-current driver IC.

RL78/I1A AC/DC full digital 3-ch LED control unit····· This is an evaluation unit for the LED power source with the RL78/I1A implemented. It can control the power factor correction circuit (PFC) and up to three channels of LED. Writing to the microcomputer and debugging are handled by using the on-board USB interface or E1.

Notes 1. The supported development environment differs depending on the OS used.

2. When using a software tool made by Renesas Electronics, software can be automatically generated using Applilet EZ for HCD Controller without installing a device file.
However, to develop a system in the integrated development environment PM+ by using the generated source file, a device file must be installed.
Device file for μPD78F8024, 78F8025: DF788025
Device file for μPD78F0754, 78F0756: DF780756

3. This includes the integrated development environment PM+.

4. The device file for PM+ is necessary to re-edit or re-compile a source file that was generated by Applilet EZ for HCD Controller in PM+. The device file is not required when using the source file only in Applilet EZ for HCD Controller.

5. "xxxx" indicates the version.

6. Applilet EZ for HCD may not operate depending on the versions of the complier, assembler, and device file.

7. Use e2studio from Renesas as the integrated development environment for GNURL78.

Cautions 1. It is recommended that the latest service pack be installed for any OS.

2. Applilet EZ for HCD Controller requires the compiler, assembler, or integrated development environment and device file of an Renesas Electronics or IAR Systems product.

Remarks 1. For details about how to obtain compilers, assemblers, integrated development environments, and device files, contact your local Renesas Electronics sales representative.

2. For details of the evaluation boards, refer to each user's manual.

CHAPTER 2 INSTALLATION

2.1 Installing Application

The following applications must be installed to use Applilet EZ for HCD Controller.

- Applilit EZ for HCD Controller
- Compiler, assembler, or integrated development environment and device file[Note 1]

Notes 1. Install one of the following as the compiler, assembler, integrated development environment and device file. Install the device file according to the chip mounted on the evaluation board.

<Renesas Electronics>

Compiler: CC78K0 (Ver. 3.80 or Ver. 4.00)

Assembler: RA78K0 (Ver. 3.70 or Ver. 4.01)

Device file: DF788025 or DF780756 (only when developing a system in PM+)[Note 2]

Or

Integrated development environment: CubeSuite CA78K0/Ix2LED

<IAR Systems>

Integrated development environment: IAR Embedded Workbench

Compiler: IAR C/C++ Compiler for Renesas 78K0
IAR C/C++ Compiler for Renesas RL78

Assembler: IAR Assembler for Renesas 78K0
IAR Assembler for Renesas RL78

Device file: DF-78K0-788025-EE_xxxxx
DF-78K0-Ix2-EE_xxxxx
DF-RL78I1A-EE_xxxxx

<KPIT (GCC)>

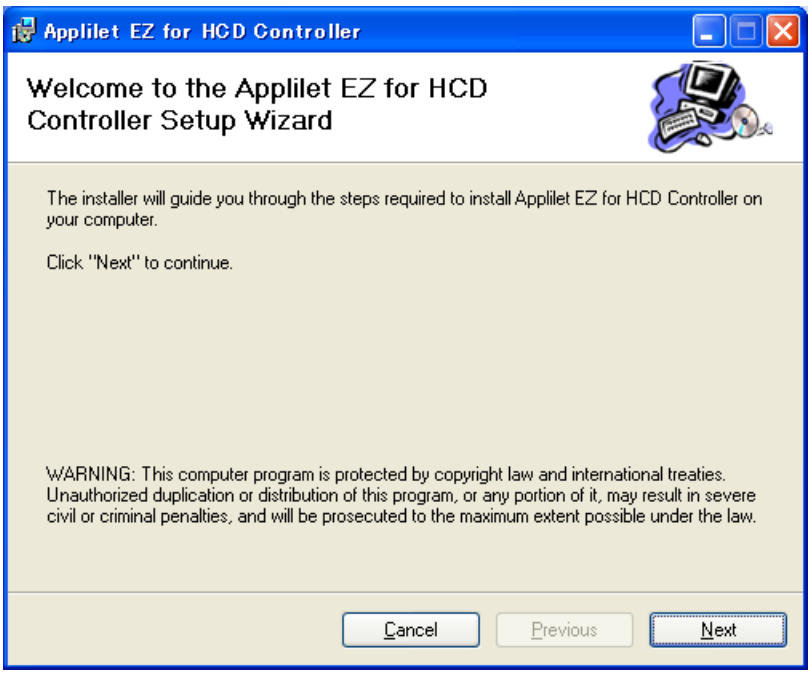
Tool package: GNURL78

2. The device file for PM+ is necessary to re-edit or re-compile a source file that was generated by Applilet EZ for HCD Controller in PM+. The device file is not required when using the source file only in Applilet EZ for HCD Controller.

Remark For details about how to obtain compilers, assemblers, integrated development environments, and device files, contact your local Renesas Electronics sales representative.

2.1.1 Installing Applilit EZ for HCD Controller

Double-click the AppEZHCD.msi file to start the installation wizard of Applilet EZ for HCD Controller.



Click the [Next] button and proceed with the installation by following the instructions that will be displayed in the wizard window.

2.1.2 Installing compiler, assembler, or integrated development environment and device file

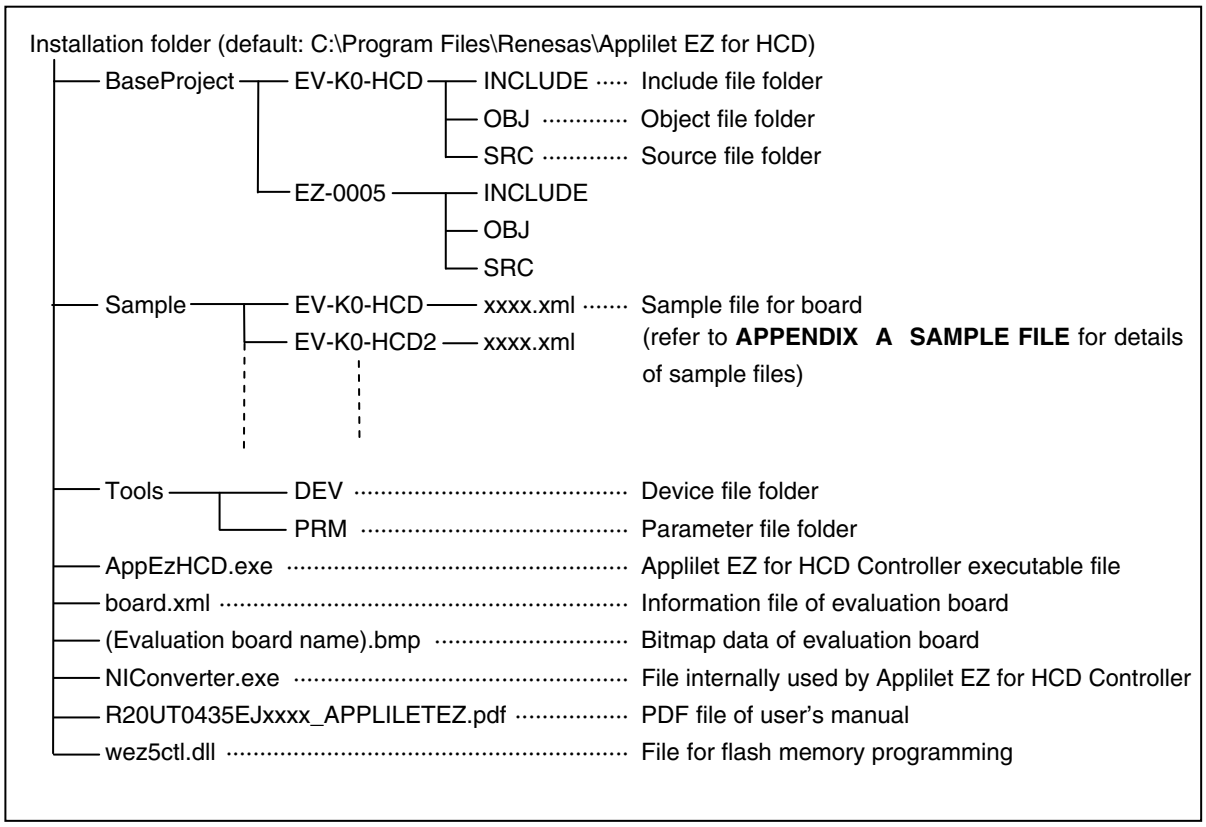
Install the compiler, assembler, or integrated development environment and device file according to each product manual.

Caution After installation, the compiler to be used must be selected. For details, refer to 3.1.1 Setting up at the first startup • Compiler setting.

2.1.3 Folder configuration

Once the application has been successfully installed, the following folders are copied to the specified installation folder.

Figure 2-1. Folder Configuration

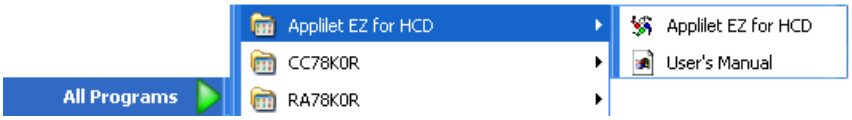


Caution The files under BaseProject are internally used by the system. Do not change the folders and files under BaseProject.

2.1.4 Windows [start] menu and shortcut icon

When installing of the application has been completed normally, the following folder will be copied into the specified installation folder.

Figure 2-2. Windows [start] Menu (Windows XP)



The following shortcut icon is displayed on the Windows desktop.

Figure 2-3. Shortcut Icon

2.2 Installing USB Driver

USB driver is required when using an evaluation board. The USB driver for evaluation board is stated in the disk media provided or in an e-mail message.

The first time that the host machine is connected to the evaluation board via the bundled USB cable, Windows' [Found New Hardware Wizard] appears, prompting for installation of the USB driver.

Proceed with the installation by following the windows that will be displayed.

2.3 Uninstall

To uninstall Applilet EZ for HCD Controller, C compiler, and assembler, go to the Windows Control Panel and select [Add or remove programs] (in Windows XP).

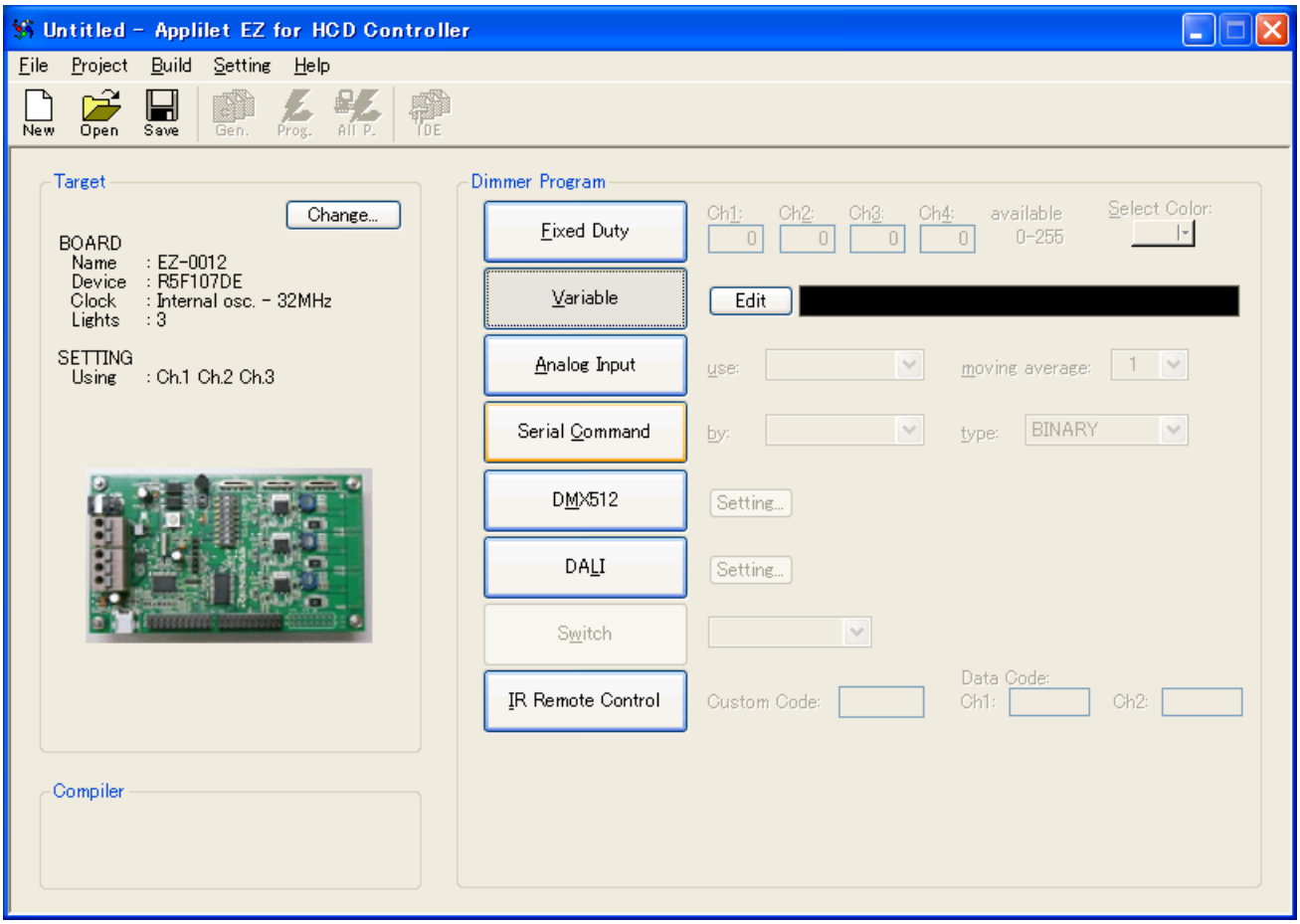
CHAPTER 3 STARTING AND ENDING

3.1 Starting

To start Applilet EZ for HCD Controller, go to the Windows [start] Menu and select [All Programs] →[Programs] → [Applilet EZ for HCD] → [Applilet EZ for HCD] (refer to **Figure 2-2 Windows [start] Menu (Windows XP)**), or double click the shortcut icon on the Windows Desktop (refer to **Figure 2-3 Shortcut Icon**).

Once Applilet EZ for HCD Controller is started, the following Main window opens.

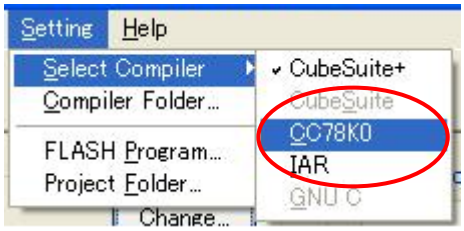
Figure 3-1. Main Window When Starting



3.1.1 Setting up at the first startup

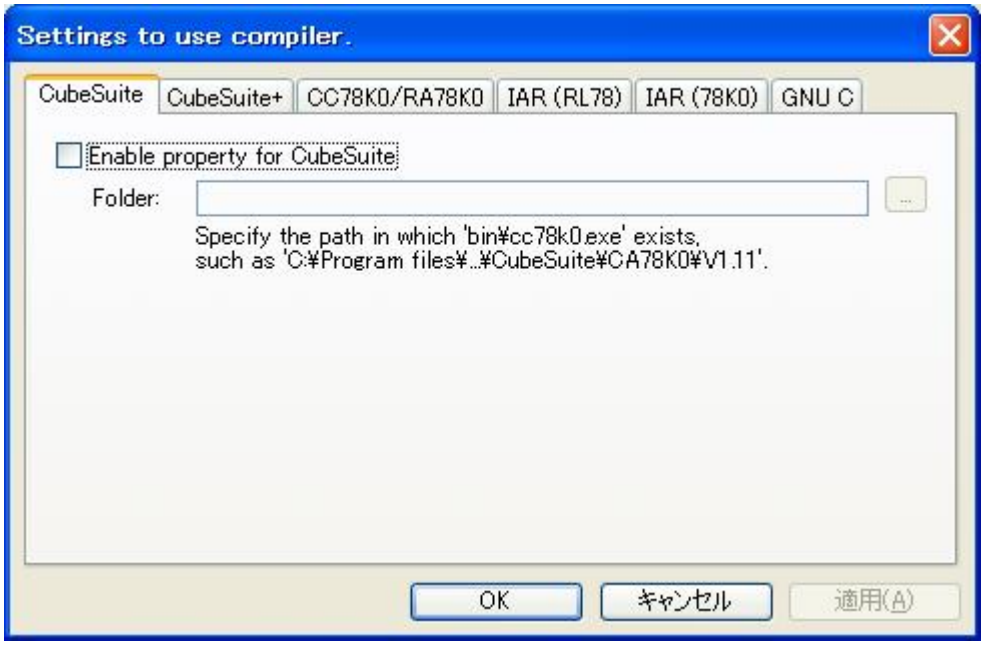
- **Compiler setting**

  On [Setting] menu, select [Select Compiler], and then select the compiler name to be used.

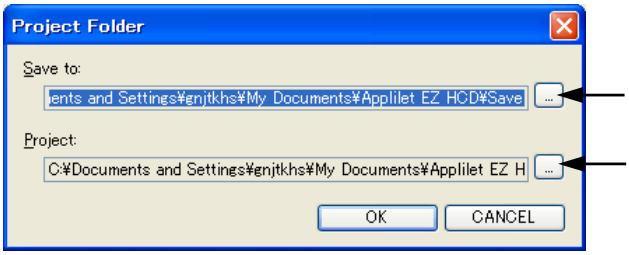


- **Compiler folder setting**

  (a) On the [Setting] menu, select [Compiler Folder] to specify the folder in which the compiler to be used is installed. Inputting the path is not usually required because the path is automatically retrieved. If the path is not automatically entered, enter it manually.



(b) Specifying the folder in which to save the generated configuration file (*.xml) and the source and project files (*.prj).
On the [Setting] menu, select [Project Folder] . The following dialog box will then be displayed.

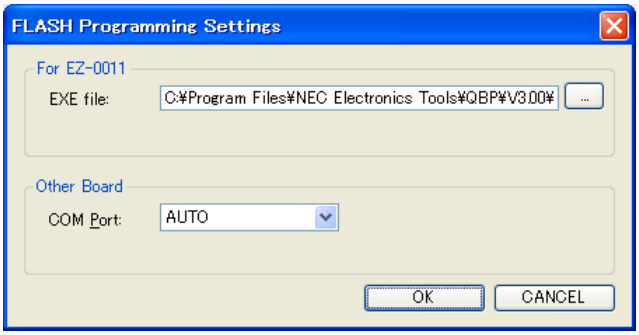


Folder in which to save the generated configuration file (*.xml) .

Folder in which to save the source and project files (*.prj) .

Change the location where the *.xml and *.prj files are saved as required.

(c) Flash programming setting
The COM Port connected to the flash memory programmer or the board is specified here.
The location for setting will vary depending on the board used.
On the [Setting] menu, select [Flash Program…] .The following dialog box will be displayed when menu.



If the evaluation board (EZ-0011, etc.) is using MINICUBE2, specify the place where the programming GUI QB-Programmer is installed in “for EZ-0011”.
If an evaluation board which has a USB interface (EV-K0-HCD, EV-K0-HCD2, or EZ-00xx) is used, select the connected COM Port in “Other Board” and press the [OK] button.

Remark If an evaluation board which has a USB interface is used, leave the setting of step (b) as AUTO, because the COM port will be automatically detected. However, if multiple boards are connected or boards cannot be properly connected, select the COM port to which the boards are connected.

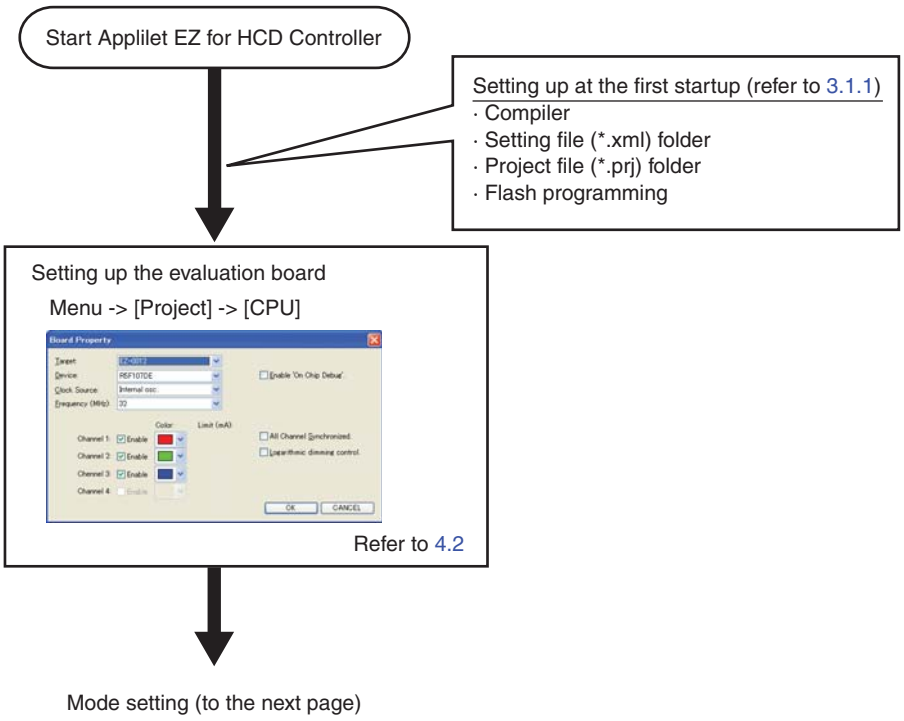
3.2 Ending

To exit from Applilet EZ for HCD Controller, go to the Main window’s [File] menu and select [Exit].

CHAPTER 4 APPLILET EZ FOR HCD CONTROLLER OPERATION

This chapter describes the operation flow, from automatically generating object codes (*.hex) by using Applilet EZ for HCD Controller and writing to the flash memory, up to checking operation by using the evaluation board.

4.1 Operation Flow



Setting up the evaluation board (from the previous page)

Mode setting

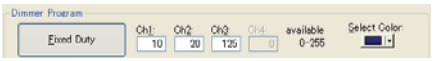
Switch mode

In this mode, the dimming levels are changed by the switch connected to the board.

Refer to 4.3.7

Fix mode

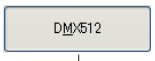
In this mode, the LEDs are dimmed according to the input fixed values.



Refer to 4.3.1

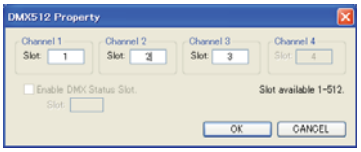
DMX512 mode

In this mode, the LEDs are dimmed using the DMX512 protocol.



Select

Menu -> [Project] -> [DMX512]



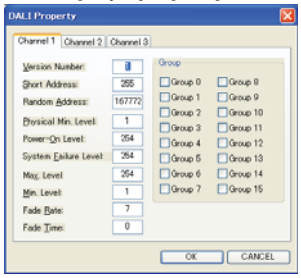
Refer to 4.3.5, Chapter 5

DALI mode

In this mode, the LEDs are dimmed using the DALI protocol.

Select

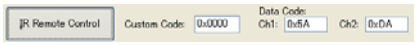
Menu -> [Project] -> [DALI]



Refer to 4.3.6, Chapter 5

IR remote control mode

In this mode, the LEDs are dimmed using the remote control signal reception function on the board.

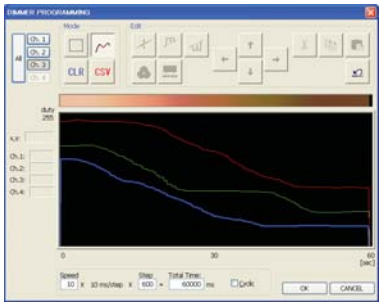


Refer to 4.3.8

Variable mode

In this mode, LED dimming can be continuously changed. The output pattern can be specified as in art software.

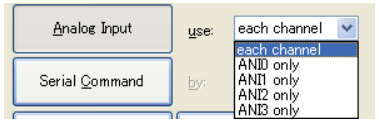
Select Click the [Edit] button



Refer to 4.3.2

Analog Input mode

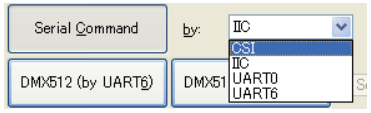
In this mode, the LEDs are dimmed according to the A/D converted values.



Refer to 4.3.3

Serial Command mode

In this mode, the LEDs are dimmed by using commands depending on the type of communication. Specify the communication format, communication command type, and channels to use for serial communication.



Refer to 4.3.4

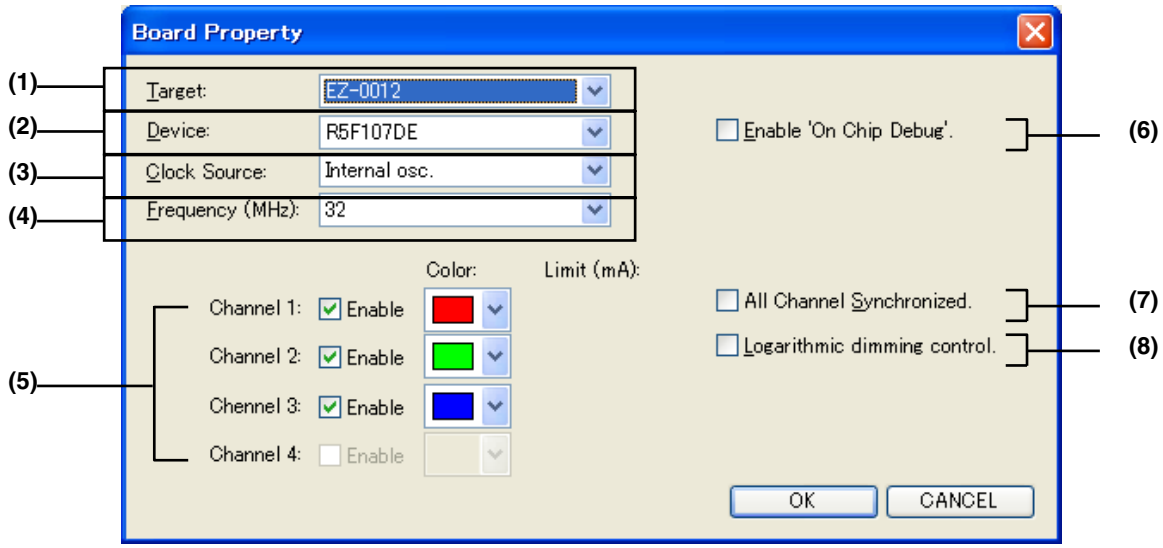
Caution Some modes may be unavailable, depending on the board specifications. For details, see the each board's manual.

Save the project

Generation, writing, and evaluation (refer to 4.4)

4.2 Setting Up the Evaluation Board

In the menu, select [Project] and then [CPU] to set up the evaluation board in the dialog box below.
Performing this setup updates the specified mode displayed in the main window.



(1) Target:

Select the evaluation board to use.

(2) Device:

If an evaluation board is selected, the mounted microcontroller is displayed. (This setting cannot be changed.)

(3) Clock Source:

Select the clock to use. This setting might be fixed depending on the setting of (1).

(4) Frequency (MHz):

Select the frequency. This setting might be fixed depending on the setting of (1) and (3).

(5) Channel X:

Specify the channels to enable by selecting their [Enable] checkboxes.
Specify the color of the lighting of each channel by using the [Color] buttons.
These settings might not be selectable or changeable depending on the setting of (1).
Enter the max current level of each channel in [Limit].
* This setting may be unavailable, depending on the board.

(6) Enable 'On Chip Debug'.:

If this checkbox is selected, a program that enables on-chip debugging is generated.
If this setting is specified for the EV-K0-HCD, EV-K0-HCD2, and EZ-0009, UART6 cannot be selected in serial command mode.

(7) All Channel Synchronized.:

If this checkbox is selected, the brightness of all selected channels will be the same.
If only one channel is selected, this checkbox is disabled.

(8) Logarithmic dimming control.:

Select this checkbox to logarithmically change the dimming of the LEDs.
If this checkbox is not selected, values such as duty factors are handled as direct values. If the checkbox is selected, the specified value is converted to logarithmic value.

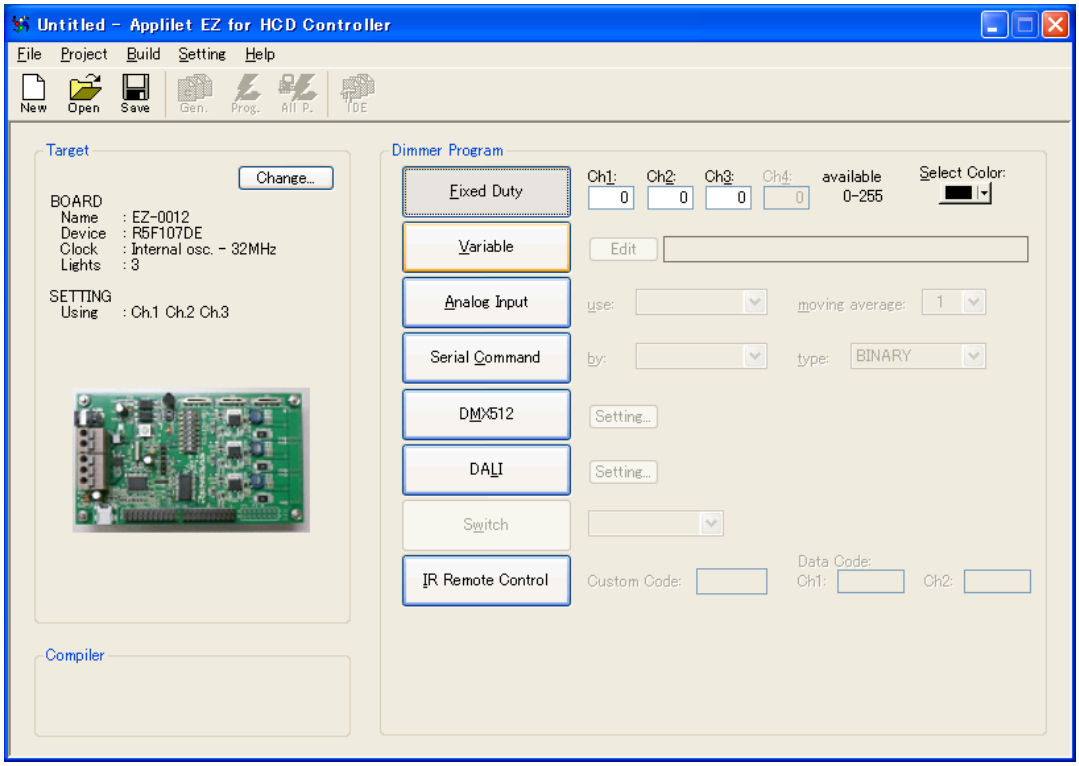
4.3 Mode Setting

Select a mode to use from Dimmer Program on the main window and set the details.

4.3.1 Fix mode

In this mode, the LEDs are dimmed according to the input fixed values.

If multiple channels are set to synchronization mode (refer to **4.2 (7)**), the duty value can be specified only for channels that have lower numbers. (The duty value cannot be entered for the other channels, but the same duty value applies.) The corresponding [Chx duty] (where x is the channel number) turns black for the other channels to synchronize.

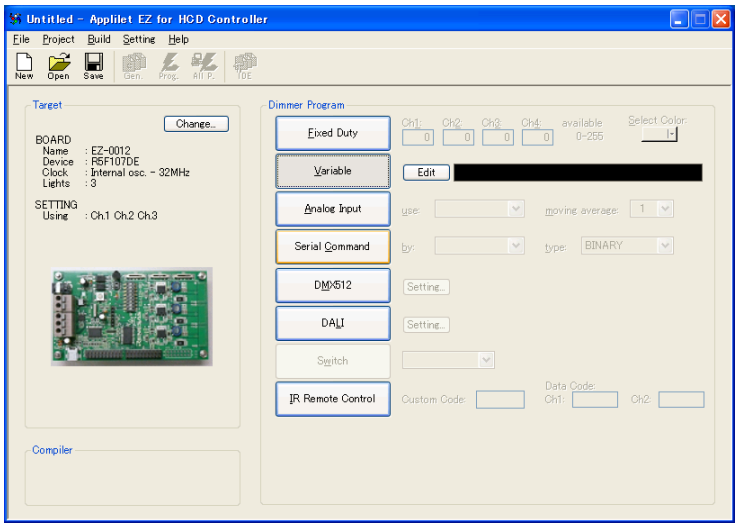


<1> Select the [Fixed Duty] button in Dimmer Program (This button is selected by default.).
<2> Enter a value into the [Ch1] to [Ch4] boxes[Note] or select a color from the [Select Color] drop-down list.
<3> Click  icon or select Menu → [File] → [Save] to save the project.

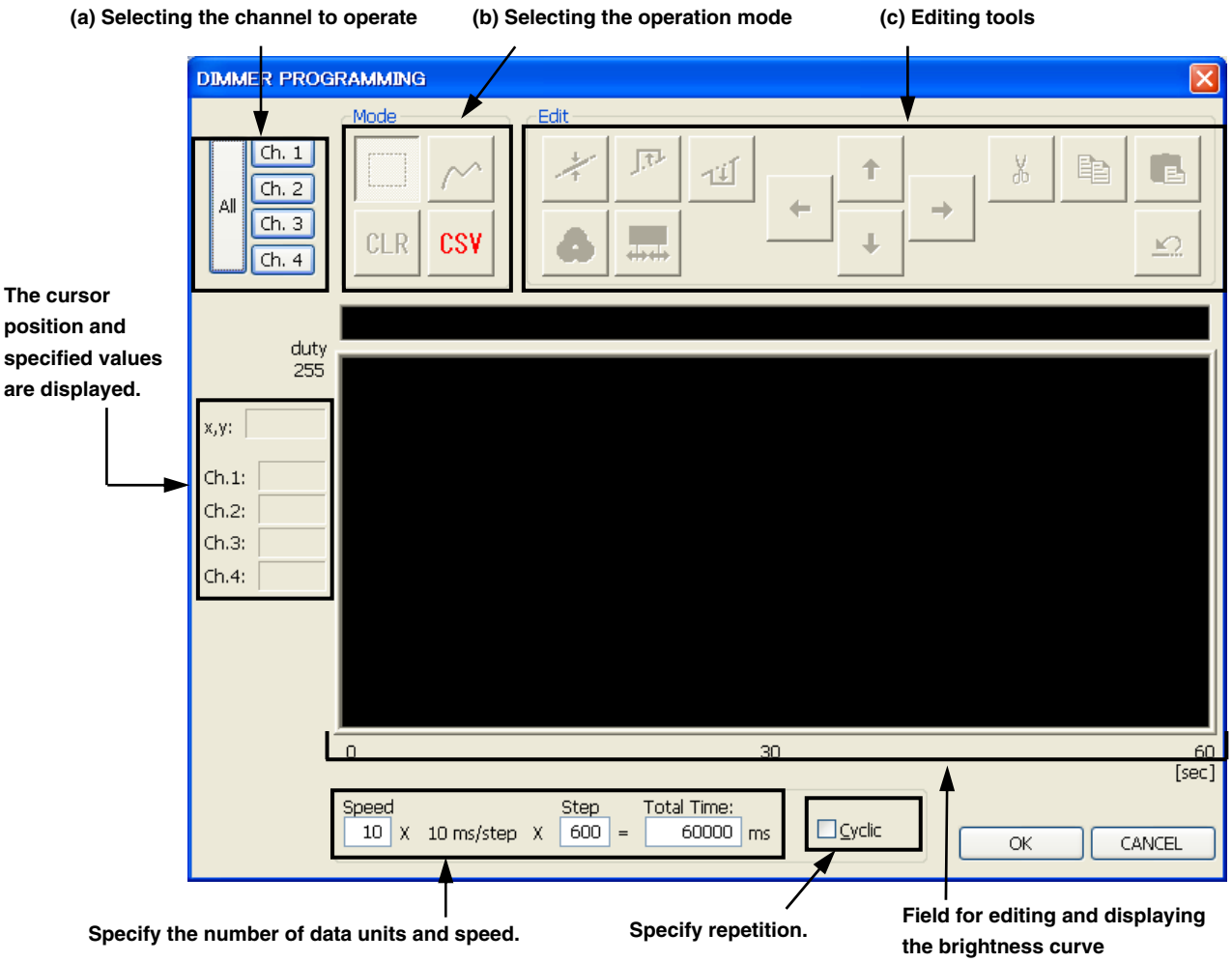
Note The values that can be entered vary depending on the evaluation board.

4.3.2 Variable mode

In this mode, LED dimming can be continuously changed.
The output pattern can be specified as in art software.



<1> Select the [Variable] button in Dimmer Program.
<2> Click the [Edit] button to open a separate window, shown below.
Edit the output pattern in this window.



(a) Selecting the channel to operate

Select the channel to edit. Only channels that can be edited can be selected.

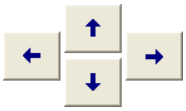
Select all channels or individual channels.

The brightness curve of a selected channel is displayed as a bold line.

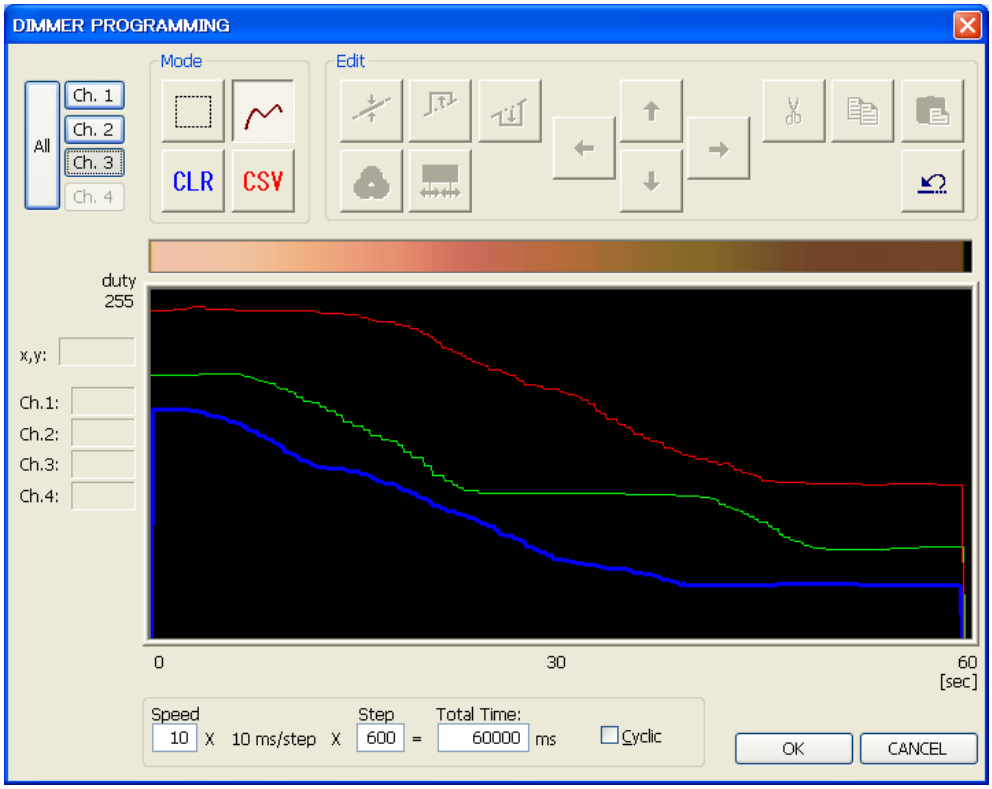
(b) Selecting the operation mode

 Range selection mode	A range can be selected by left-clicking and then dragging the mouse in the brightness curve editing field. Editing tools are used for the selected range.
 Freehand line mode	A freehand line can be drawn by left-clicking and then dragging the mouse in the brightness curve editing field. This mode is enabled only if one operation channel is selected.
 Clear mode	All data of the selected channel is cleared.
 CSV editing mode	The brightness values are output to a CSV file and an editing application (the application associated with the extension .csv) starts. Control does not return to Applilet EZ for HCD Controller until the application is closed.

(c) Editing tools

 Straight line	Turns changes in the values of a selected channel or selected range into a straight line. The straight line connects the values of the start and end positions in the selected range.
 Maximization	Sets the values in the selected range to their maximum specifiable values.
 Minimization	Sets the values in the selected range to their minimum value (0).
 Color specification	Specifies the color of a value in the selected range from the color specification window. This tool is enabled only if all operation channels and a range are selected.
 Shifting	Shifts the values in the selected range to the left, right, up, or down by one point. If these buttons are clicked while holding down the [Ctrl] key, the values shift in 10-point units.
 Cutting	Cuts the values in the selected range and temporarily retains them in a buffer. The cut values can be pasted to any position by using the paste button. This tool is enabled only if one operation channel is selected.
 Copying	Temporarily copies the values in the selected range to a buffer. The copied values can be pasted to any position by using the paste button. This tool is enabled only if one operation channel is selected.
 Pasting	Pastes the data temporarily retained in a buffer. The position to which to paste the data must be selected as a range. Multiple channels can be selected for pasting. Values that were cut or copied when one channel was selected are applied to the values of the selected channels.
 Undo	Undoes the previous operation. This can be used to undo only the most recent operation.

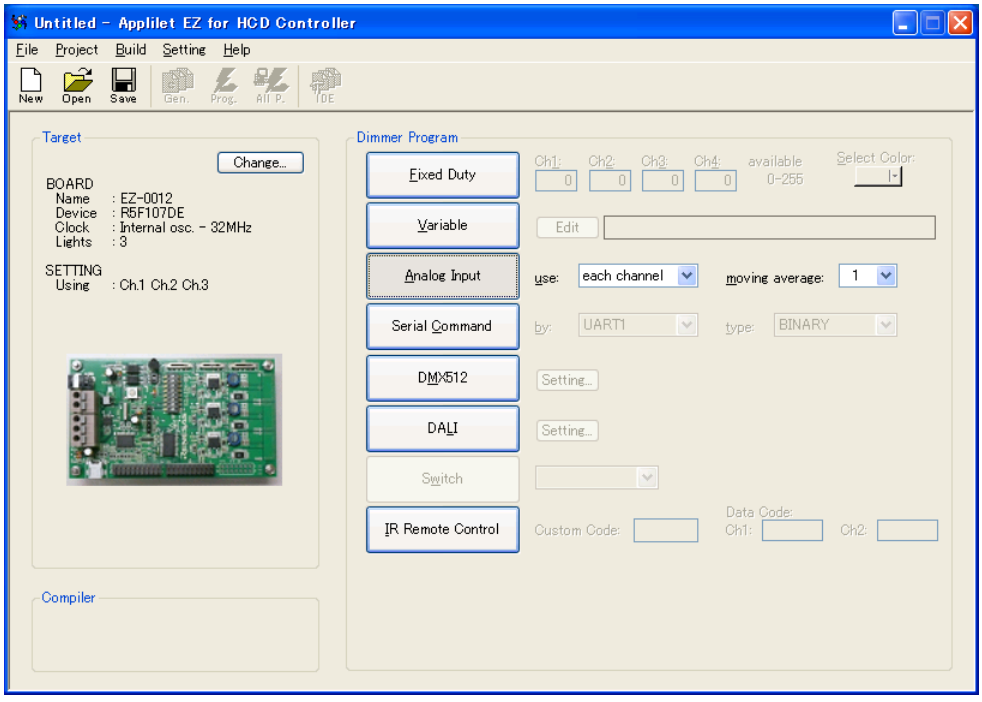
<3> When editing has been completed, click the [OK] button.



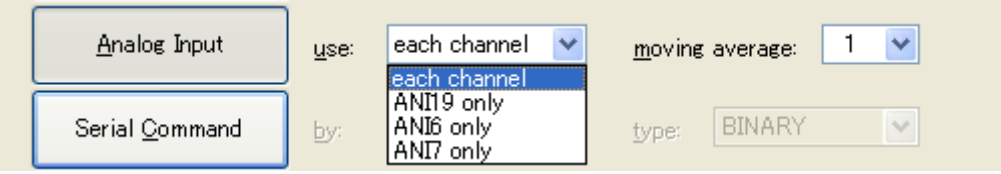
<4> Click  icon or select Menu → [File] → [Save] to save the project.

4.3.3 Analog Input mode

In this mode, the LEDs are dimmed according to the A/D converted values.



<1> Select the [Analog Input] button in Dimmer Program and specify from the [use] drop-down list the A/D conversion value to be used for the duty.



(For the EV-K0-HCD)

- [each channel]
  The conversion value of each A/D conversion port is applied to the duty of the corresponding effective channel.
  <Example> When Channels 1 and 2 are effective
  ANI0 → Channel 1
  ANI1 → Channel 2
- [ANIx only]
  The conversion value of the selected A/D conversion port is applied to the duty of all effective channels.
  <Example> When ANI3 is selected and Channels 1 and 2 are effective
  ANI3 → Channels 1, 2

Caution ANIx varies depending on the evaluation board.

<2> Set the number of samples to be used in moving average processing.

Caution When the number of samples is set to 1, the moving average processing is not performed.

<3> Click  icon or select Menu → [File] → [Save] to save the project.

Remarks 1. To use this mode, an analog signal source must be connected to the analog input port (ANI) of the microcontroller. For details, refer to the user's manuals of the microcontroller and evaluation board.

2. The moving average interval is 5 ms.

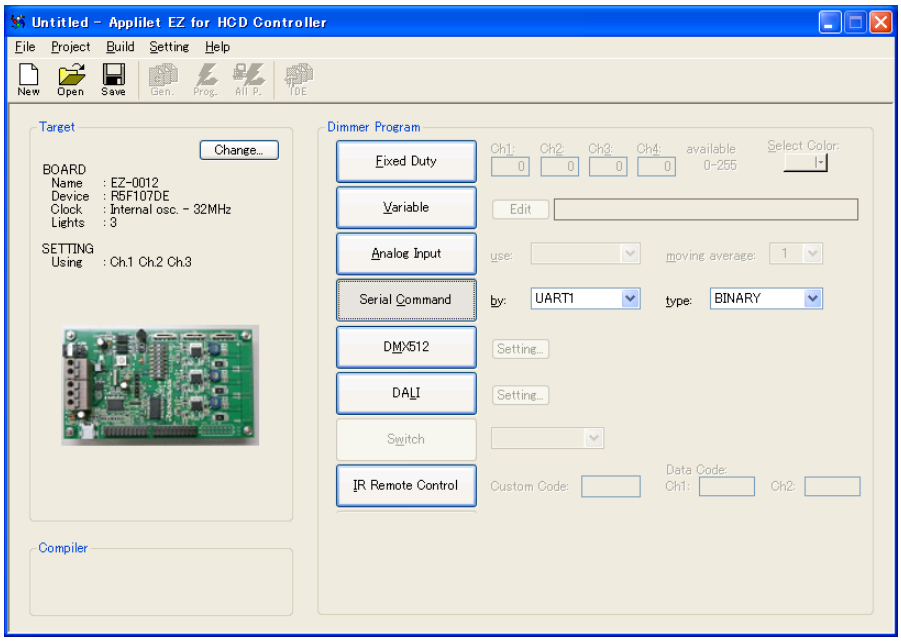
4.3.4 Serial Command mode

In this mode, the LEDs are dimmed by using commands depending on the type of communication.

Specify the communication format, communication command type, and channels to use for serial communication.

To use this mode, a host controller for serial communication must be connected to the serial communication port of the evaluation board. For details, refer to the user's manuals of the microcontroller and evaluation board.

For the command of Serial Command mode, refer to **APPENDIX B SERIAL COMMAND MODE COMMUNICATION COMMANDS**.



<1> Select the [Serial Command] button in Dimmer Program and specify from the [by] and [type] drop-down lists the communication mode and communication command system to be used, respectively.

- [by]

  Select from UART6[Note 1], UART0, SPI, and IIC.

UART6	Serial communication is performed in this mode by using UART (universal asynchronous receiver transmitter) with the TxD6 or RxD6 pin of the device.
UART1	Serial communication is performed in this mode by using UART (universal asynchronous receiver transmitter) with the TxD1 or RxD1 pin of the device.
UART0	Serial communication is performed in this mode by using UART with the TxD0 or RxD0 pin of the device.
SPI	3-wire serial communication is performed in this mode by using the SI1n, SO1n, or $\overline{\text{SCK1n}}$ pin of the device. The following pins can be used as enabling pins when using the device of the evaluation board as the slave. (For details, see the **[CSI Property] dialog box** described in **CHAPTER 5 WINDOW REFERENCE**.) • The $\overline{\text{INTP0}}$, INTP2, or INTP3 pin: EV-K0-HCD, EV-K0-HCD2, and EZ-0009 • The SSI11 pin: EZ-0005 and EZ-0006 **Remark** n = 0: EV-K0-HCD, EV-K0-HCD2, and EZ-0009 n = 1: EZ-0005 and EZ-0006
IIC	Serial communication is performed in this mode via the I^2C (inter-integrated circuit) bus by using the SCLn and SDAn pins of the device. **Remark** n = 0: EV-K0-HCD, EV-K0-HCD2, and EZ-0009 n = A0: EZ-0005 and EZ-0006

- [type]Note 2
  Select from ASCII and BINARY.

ASCII	Communication by using ASCII codes is performed.
BINARY	Communication by using binary data is performed.

<2> Click  icon or select Menu → [File] → [Save] to save the project.

Notes 1. For the EV-K0-HCD, EV-K0-HCD2, and EZ-0009, UART6 cannot be selected when [Enable 'On Chip Debug'] is checked in the [Board Property] dialog box.

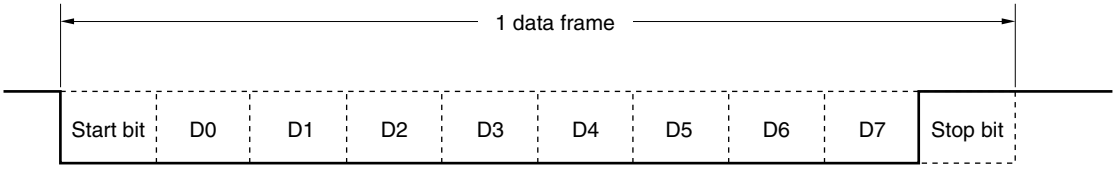
2. [type] can be set only if UART is selected.

Remark A program that corrects errors in the internal high-speed oscillation clock frequency is generated when the EV-K0-HCD, EV-K0-HCD2, and EZ-0009 are selected and the CPU clock and communication mode to be used are set as follows.

- CPU clock: Internal high-speed oscillation clock (Set to "Internal osc." via the [Board Property] dialog box.)
- Communication mode: UART0 or UART1 or UART6 (Select the [Serial Command] option button for the Dimmer Program, select "UART0" or "UART1" or "UART6" via [by], and select "ASCII" or "BINARY" via [type].)

This correction program calibrates one frame of receive data in the following format immediately after a reset (about 100 ms) when the CPU operates with the internal high-speed oscillation clock and serial communication is to be performed with UART0 or UART6. Accordingly, data for calibration must be transmitted first from the host controller.

[Format of data for calibration]



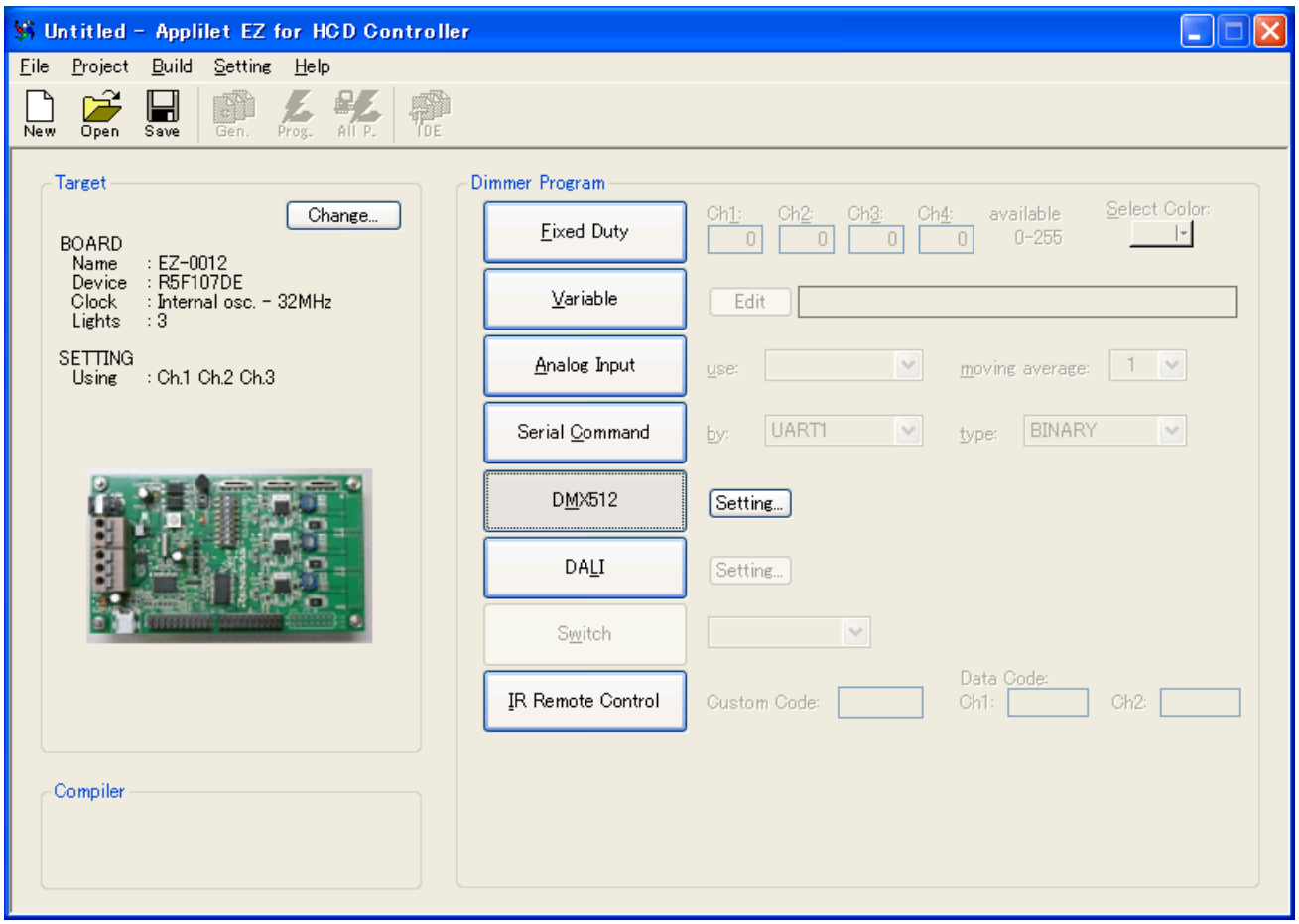
- Baud rate: Selected clock
- Parity bit: None
- Data length: 8 bits (LSB)
- Stop bit: 1 bit

To perform calibration with UART0, connect P00/TI000 and P11/RxD0.
UART reception operation can be started after calibration has ended normally.
When calibration succeeds in ASCII mode, the welcome message is displayed.

4.3.5 DMX512 mode

In this mode, the LEDs are dimmed by using the DMX512 protocol.

For the communication command of DMX512, refer to **APPENDIX C DMX512 MODE COMMUNICATION DATA**.



<1> Select the [DMX512] button in Dimmer Program[Note].

<2> Push the [Setting] button and then [DMX512…] in the menu, and then specify the channel number. For details about this setting, see the **[DMX512 Property] dialog box** described in **CHAPTER 5 WINDOW REFERENCE**.

<3> Click  icon or select Menu → [File] → [Save] to save the project.

Note For the EV-K0-HCD, EV-K0-HCD2, and EZ-0009, DMX512 cannot be selected with the following settings.

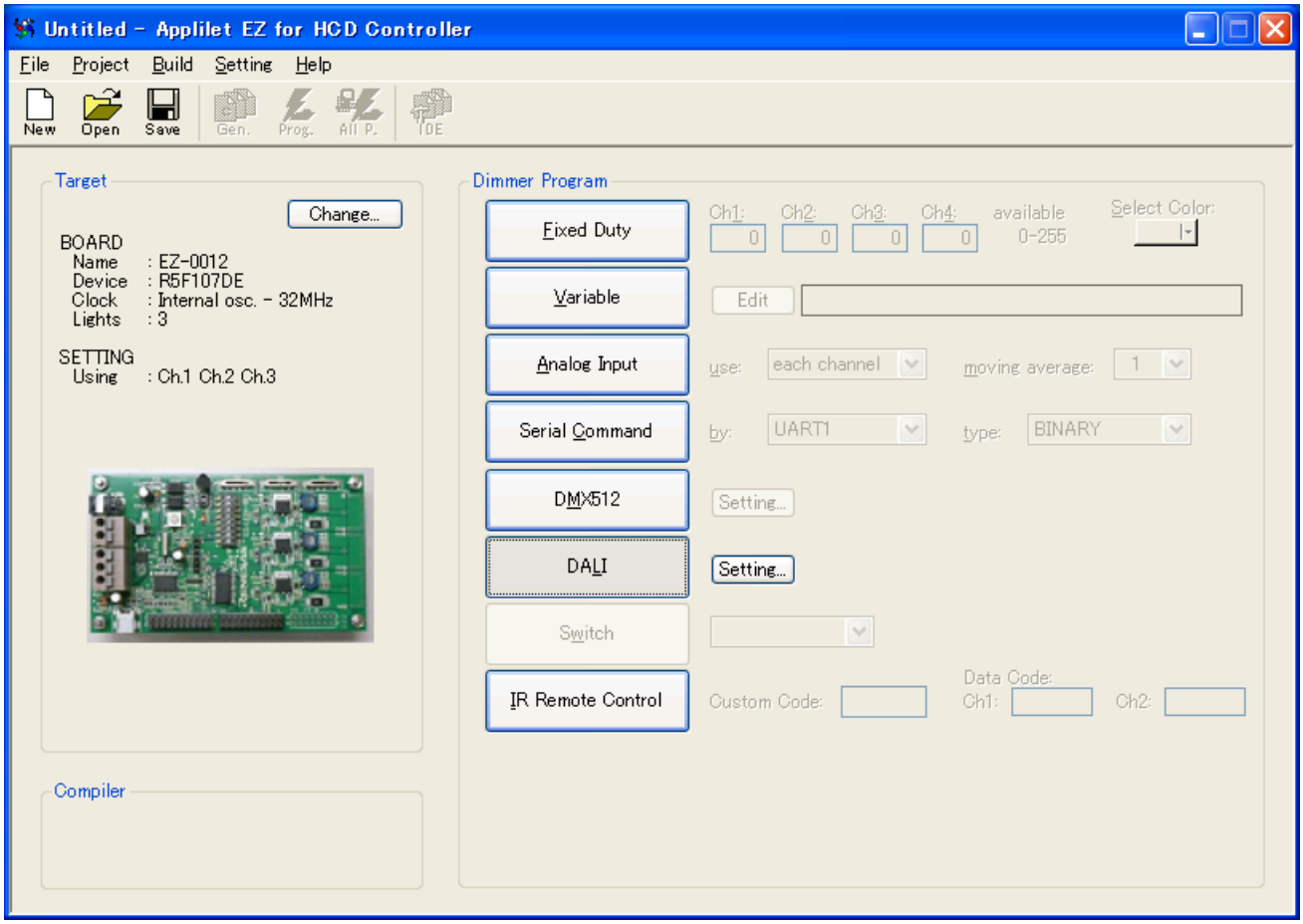
- When the clock source is set to [Internal osc.] in the [Board Property] dialog box
- When the CPU clock is set to 4 MHz by selecting UART0 or UART6 via [by]

4.3.6 DALI mode

In this mode, the LEDs are dimmed by using the DALI protocol.

DALI (Digital Addressable Lighting Interface) is an international open standard lighting control communication protocol, mainly used for light control of multiple fluorescent lamps or LED lights.

For the communication command of DALI, refer to **APPENDIX D DALI MODE COMMUNICATION DATA**.



<1> Select the [DALI] button in Dimmer Program.

<2> Open the [DALI Property] dialog box by selecting [Project] and then [DALI…] in the menu, and then specify the channel number. For details about this setting, see the **[DALI Property] dialog box** described in **CHAPTER 5 WINDOW REFERENCE**.

<3> Click  icon or select Menu → [File] → [Save] to save the project.

Caution: When using the GNU GCC compiler in RL78/I1A AC/DC full digital 3-ch LED control unit, values specified for the Factory Burn in parameter in the Memory Bank section defined by IEC62386-102 and values specified for all parameters in the Declaration of variables section except the ROM parameter are not retained when the power to the microcontroller is turned off or the microcontroller is reset.

4.3.7 Switch mode

In this mode, light is controlled depending on the switches connected to the board. Only EZ-0011 can be selected. Each switch number corresponds to an LED channel in EZ-0011. Switch mode has 2 modes.

Mode1: Fade mode

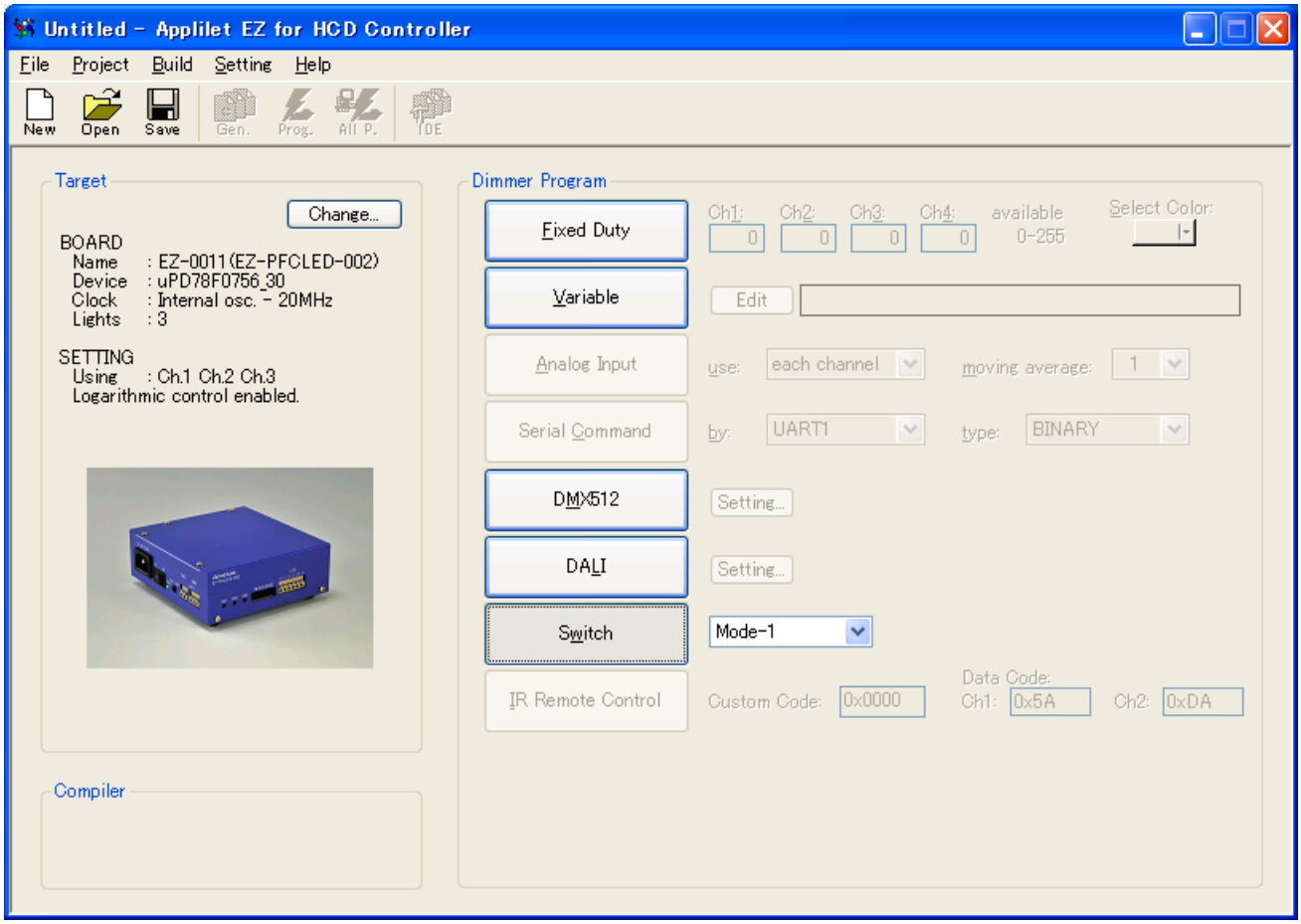
You can press and hold the switch to gradually raise or lower (fade) the dimming level.

Press and release the switch to turn the light ON or OFF.

Press and hold to raise/lower the dimming level to the degree to which it is pressed.

Mode 2 level dimming mode

Go to 15→20→30→50→100→50→30→20→15 [%] by pressing down the switch to change the dimming level in steps.



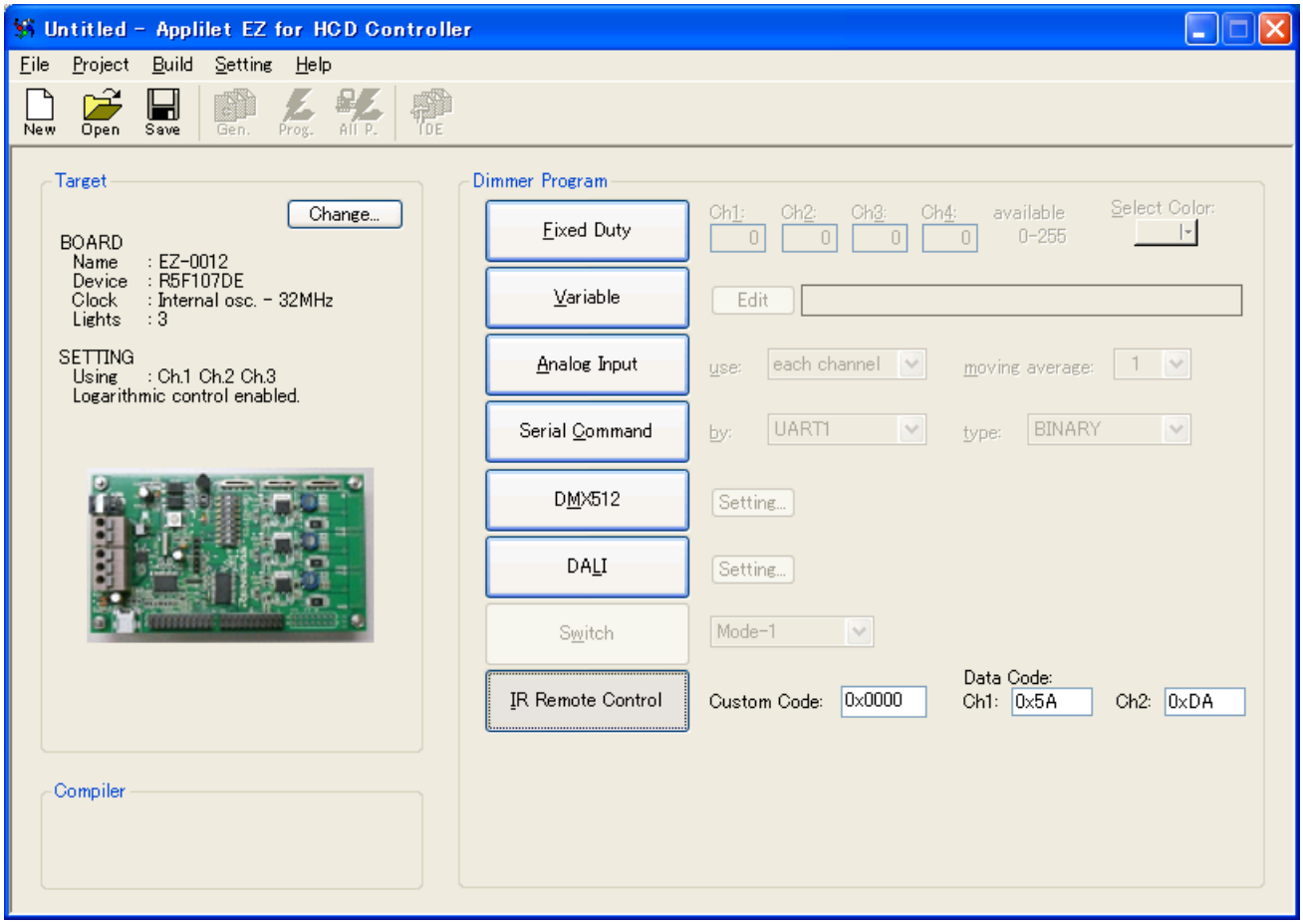
4.3.8 IR Remote controller control mode

In this mode, lights are dimmed by using the on-board function for receiving remote control signals. Remote control signals in the Renesas format can be received. This mode can be selected only for EZ-0012.

In this mode, the custom code and data code can be specified as a four-digit and a two-digit hexadecimal respectively. The dimming level is changed as OFF --> 100% --> 50% --> 10% --> OFF every time the remote control code is received.

When an evaluation is performed using the infrared remote control function of the lighting communication master evaluation board (EZ-0008), which is optionally available, set the following values based on the channel settings on the master evaluation board.

- CH01: Custom code = 0x0000. Data code = 0x5AA5
- CH02: Custom code = 0x0000. Data code = 0xDA25

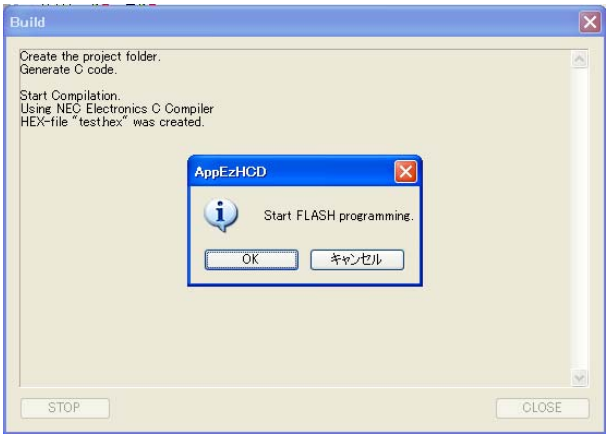


4.4 Generation, Writing, and Evaluation

In the following procedures, object codes (*.hex) are automatically generated and software is written to a microcontroller. After writing has been completed, the operation can be checked by using the evaluation board.
The write procedure differs depending on the board used.
If the board has a USB interface, first confirm that the PC and USB cable are connected properly.

<1> Click the 

icon to open the Build window. Preparation for generating object codes (*.hex) and writing will be performed.

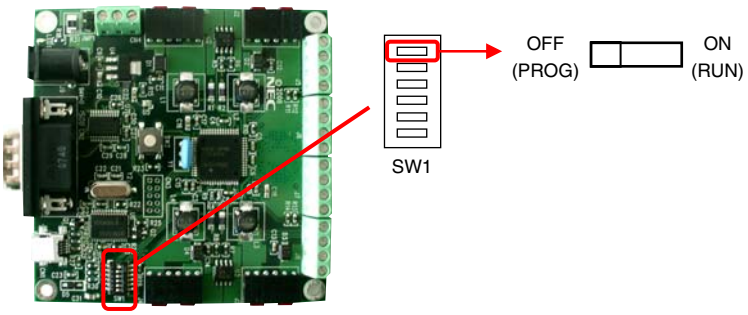


Remark If an abnormality occurs during object code generation (*.hex) or flash writing, an error code may be displayed.
Example: “code = xx”
Take the following countermeasures according to the code number (xx) displayed.

Code No.	Countermeasures
2	Applilet EZ for HCD Controller may not be correctly installed. Reinstall it.
3	Data cannot be written because the folder that should be set via the [Folders...] setting on the [Setting] menu does not exist. Re-set an appropriate folder.
4	The compiler or assembler selected via the [Compiler] setting on the [Setting] menu cannot be found. Check whether the compiler or assembler is correctly selected and installed. If it still cannot be found, reinstall the compiler or assembler.
5	The compiler or assembler selected via the [Compiler] setting on the [Setting] menu is not correctly installed. Reinstall the compiler or assembler.
9	The folder set via the [Folders...] setting on the [Setting] menu or the BASEPROJECT folder in the installation folder of Applilet EZ for HCD Controller is set as a read-only folder. Cancel the read-only setting for the whole folder.
23	This is a system error of the compiler or assembler selected via the [Compiler] setting on the [Setting] menu or the main body of Applilet EZ for HCD Controller. Handle this error by checking the following points. If a read-only folder or file exists under the folder set via the [Folders...] setting on the [Setting] menu, cancel all read-only settings. If the error still cannot be fixed, reinstall the compiler or assembler and the main body of Applilet EZ for HCD Controller.
26	Illegal value of DALI propaty. Details of the error are displayed by text as below. If two or more errors exist, only the first detected error is displayed. "Power-On Level" < "Min. Level“, "Power-On Level" > "Max. Level”, "System Failure Level" < "Min. Level“, "System Failure Level" > "Max. Level" "Min. Level" < "Physical Min. Level“, "Min. Level" > "Max. Level“, "Min. Level" < 1 "Min. Level" > 254, "Max. Level" < "Min. Level“, "Max. Level" > 254, "Max. Level" < 1, "Fade Rate" < 1, "Fade Rate" > 15, "Fade Time" < 1 "Fade Time" >15, "Random Address" < 0x000000, "Random Address" > 0xFFFFFF

<2> Writing preparation

- If the board has a USB interface
  Toggle the Program (PROG)/Run (RUN) switch on the evaluation board to “PROG” and then turn the evaluation board off and on (The picture below shows an example of the EV-K0-HCD.). For details, refer to each user’s manual of the evaluation boards.

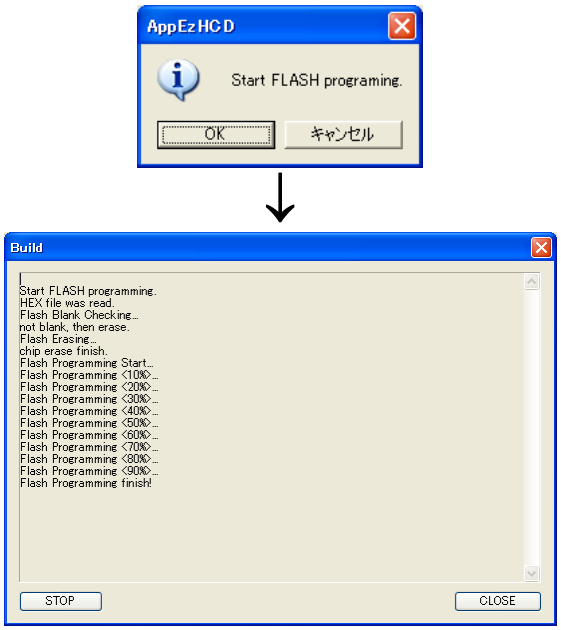


EV-K0-HCD

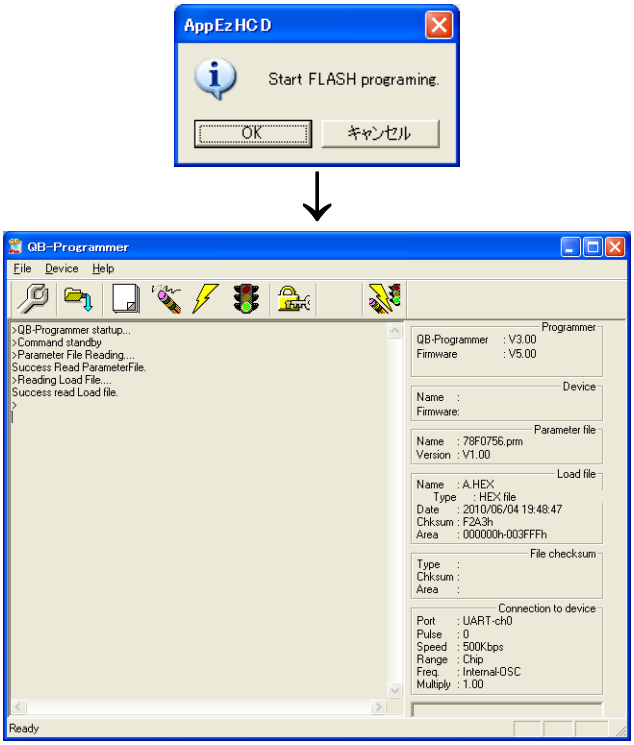
- If the board is using MINICUBE2
  Connect the PC, MINICUBE2 and the board to each other, and turn ON the power of the evaluation board.

<3> Writing

- If the board has a USB interface
  Click OK button and flash programming is started.



- If the board is using MINICUBE2
  Press the OK button. The flash programmer GUI will start.
  Follow the flash programmer GUI operation procedure to write in the board.



<4> Operating preparation

- If the board has a USB interface
  When the program has been written normally, toggle the Program (PROG)/Run (RUN) switch to “RUN” and then turn the evaluation board off and on.
- If the board is using MINICUBE2
  Switch OFF the power of the board, remove the connection of MINICUBE2, and turn ON the power of the evaluation board once again.

<5> Operating

- For EZ-0011 or RL78/I1A AC/DC Full digital 3ch LED control unit
  Perform the auto tuning operation (lights all the LEDs of the connected channels) first to check the characteristics of the connected LEDs. To start the auto tuning, push the switch 1 (SW1) after power ON. The operation of auto selected program starts after the auto tuning.
  If an illegal condition (such as internal overvoltage) occurs, the LEDs are automatically turned off and the operation backs before auto tuning. In that case, push the switch 1 (SW1) again to start again from the auto tuning.[Note]

- For boards other than the above
  The operation will start immediately when the power is turned ON.

Note When protection against the circuit by the comparator is actuated in the RL78/I1A full digital LED control unit, the status lamp will be turned on and off. In such cases, push a reset switch to start an auto tuning again.

Caution Since the Write/Execute procedure differs depending on the board used, see the board’s manual for details.

Remark When only generating object codes (*.hex), click 

icon.

CHAPTER 5 WINDOW REFERENCE

5.1 Overview of Windows and Dialog Boxes

The following windows and dialog boxes are provided with Applilet EZ for HCD Controller.

Table 5-1. List of Windows and Dialog Boxes in Applilet EZ for HCD Controller

Window/Dialog Box Name	Description
Main window	This window is opened automatically when Applilet EZ for HCD Controller is started. This window is used to select and set all functions to be included in the automatically generated object codes.
[UART6 Settings] dialog box	This dialog box is used to set UART6.
[UART1 Settings] dialog box	This dialog box is used to set UART1.
[UART0 Settings] dialog box	This dialog box is used to set UART0.
[IIC Property] dialog box	This dialog box is used to set IIC. This setting operates only in slave mode.
[CSI Property] dialog box	This dialog box is used to set SS pin of CSI10. This setting operates only in slave mode.
[DALI Property] dialog box	This dialog box is used to set DALI.
[DMX512 Property] dialog box	This dialog box is used to set DMX512.
[Board Property] dialog box	This dialog box is used to set the evaluation board. For details, refer to **4.2**.
[Compiler]	Select the compiler to be used. For details, refer to **3.1.1**.
[FLASH Programming Settings] dialog box	This dialog box is used to set flash programming. For details, refer to **3.1.1**.
[Folder Settings] dialog box	This dialog box is used to set a folder into which the generated file is to be saved. For details, refer to **3.1.1**.

5.2 Description of Windows and Dialog Boxes

The following format is mainly used to describe Applilet EZ for HCD Controller's windows and dialog boxes.

Window/dialog box name

The name of the window or dialog box is indicated in this text frame.
Next, the window or dialog box's functions are described briefly and an illustration of the window or dialog box is shown.

Menu bar

The options that appear in pull-down menus under each item in the window's menu bar are enumerated and described briefly.

Tool bar

The functions corresponding to the buttons in the window's tool bar are described.

Description of function-related areas

The areas corresponding to functions set via the dialog box are described below.

Function buttons

The various function buttons in the dialog box are described.

Other

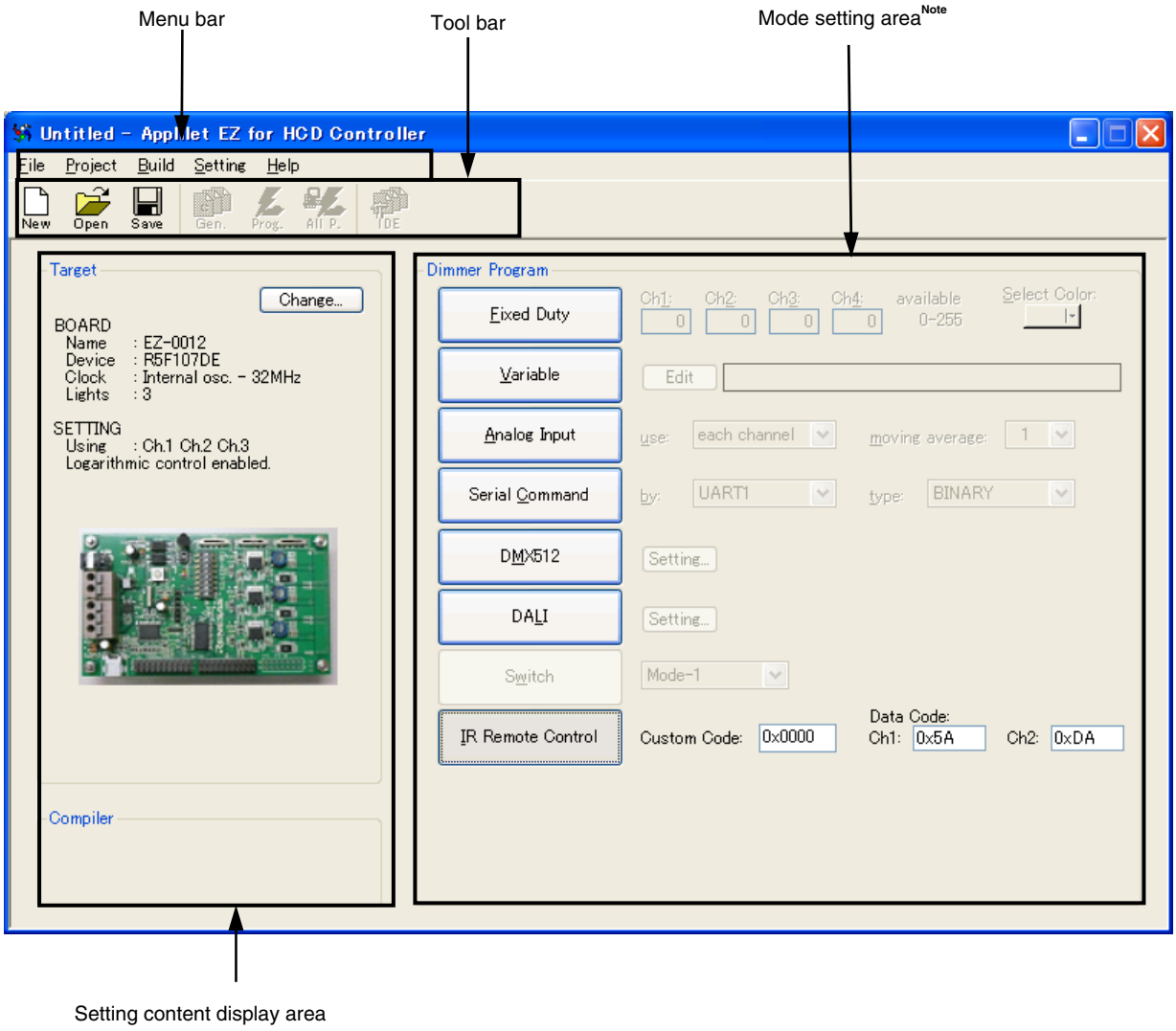
Operation methods, functions, and other noteworthy items or caution points are described.

Main window

This window is opened automatically when Applilet EZ for HCD Controller is started.

Setting items (Setting up the evaluation board, mode setting (refer to **4.2** and **4.3**), etc.) are sequentially selected in this window to automatically generate object codes (*.hex) that can be directly written to the flash memory of a microcontroller.

Figure 5-1. Main Window



The following parts of this window are described below.

- Menu bar
- Tool bar

Note For the mode setting area, refer to **4.3 Mode Setting**.

Menu bar

(1) [File] menu

[Create New]	This option is used to create a new setting. Clicking the  button selects the same function.
[Open...]	This option is used to open an existing setting file. Use the dialog box that opens for this option to select the existing setting file (*.xml). Clicking the  button selects the same function.
[Save]	This option is used to save the current settings. Clicking the  button selects the same function.
[Save as...]	This option is used to save the current settings with a newly named.
[Exit]	This option is used to close Applilet EZ for HCD Controller.

(2) [Project] menu

[Board...]	This option is used to open the [Board Property] dialog box.
[UART6...]	This option is used to open the [UART6 Settings] dialog box.
[UART0...]	This option is used to open the [UART0 Settings] dialog box.
[IIC..]	This option is used to open the [IIC Property] dialog box.
[CSI...]	This option is used to open the [CSI Property] dialog box.
[DALI...]	This option is used to open the [DALI Property] dialog box.
[DMX512...]	This option is used to open the [DMX512 Property] dialog box.
[Motion sensor.]	This option is used to open the [Motion sensor mode] dialog box.
[Light sensor.]	This option is used to open the [LightSensor mode] dialog box.

(3) [Build] menu

[Generate and Build]	Executes automatic generation of object codes (*.hex). Clicking the  button selects the same function.
[FLASH Programming]	Writes an already generated object codes (*.hex). Clicking the  button selects the same function.
[All procedure]	Executes automatic generation and writing of object codes (*.hex). For the procedures from generation to writing, refer to **4.4 Generation, Writing, and Evaluation**. Clicking the  button selects the same function.

(4) [Setting] menu

[Compiler]	Select the compiler to be used.
[FLASH Program...]	This option is used to open the [FLASH Programming Settings] dialog box.
[Folders...]	This option is used to open the [Folder Settings] dialog box.

(5) [View] menu

[Toolbar]	Displays or hides the tool bar and status bar every time this is selected. (default: display)
[Statusbar]	

(6) [Help] menu

[Version...]	This option is used to display version information about Applilet EZ for HCD Controller.

Tool bar

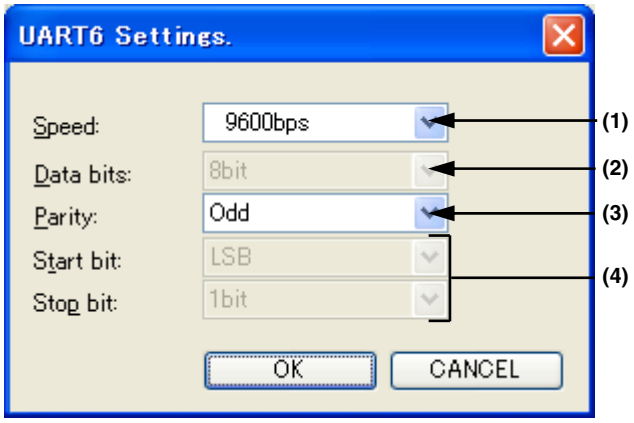
The icons on the Tool bar are provided to enable one-click selection of frequently used menu items.

	This selects the same function as when [Create New] is selected in the [File] menu.
	This selects the same function as when [Open...] is selected in the [File] menu.
	This selects the same function as when [Save] is selected in the [File] menu.
	This selects the same function as when [Generate and Build] is selected in the [Build] menu.
	This selects the same function as when [FLASH Programming] is selected in the [Build] menu.
	This selects the same function as when [All procedure] is selected in the [Build] menu.

[UARTx Settings] dialog box

This dialog box can be opened by clicking [UARTx...] in the [Project] menu.
Set UARTx in this dialog box.
The setting items are identical in both dialog boxes. The [UARTx Settings] dialog box is used below as an example.

Figure 5-2. [UARTx Settings] dialog box



The following parts of this window are described below.

- Description of function-related areas
- Function buttons

Description of function-related areas

(1) Speed:
This can be selected from 9,600, 19,200, and 115,200 bps.

(2) Data bits:
This is fixed to 8 bits and cannot be changed.

(3) Parity:
This can be selected from None, Odd, and Even.

(4) Start bit:, Stop bit:
These are fixed to LSB and 1 bit respectively, and cannot be changed.

Function buttons

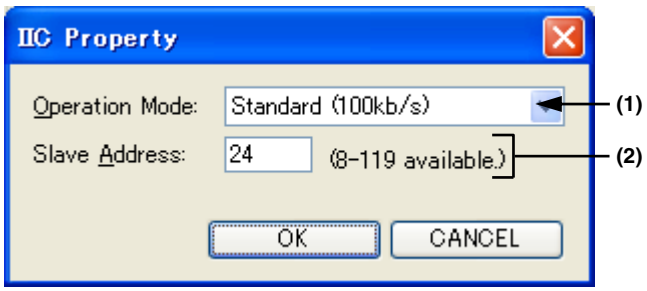
Button	Description
OK	Click this button to save the current settings and close the open dialog box.
CANCEL	Click this button to close the open dialog box without saving the current settings.

Remark When the EV-K0-HCD, EV-K0-HCD2, and EZ-0009 are selected and the CPU clock is set to the internal high-speed oscillation clock (f_{RH}), the data received first is used as data for calibration (refer to **Remark** in **4.3.4 Serial Command mode**). The settings made via the [UART6 Settings] or [UART0 Settings] dialog box result in the communication data format after calibration.

[IIC Property] dialog box

This dialog box can be opened by clicking [IIC...] in the [Project] menu.
Set IIC in this dialog box.
This setting operates only in slave mode.

Figure 5-3. [IIC Property] dialog box



The following parts of this window are described below.

- Description of function-related areas
- Function buttons

Description of function-related areas

(1) Operation Mode:
This is fixed to Standard (100 kb/s) and cannot be changed.

(2) Slave Address:
A numeral of 8 to 119 can be entered. 24 is entered by default.

Function buttons

Button	Description
OK	Click this button to save the current settings and close the open dialog box.
CANCEL	Click this button to close the open dialog box without saving the current settings.

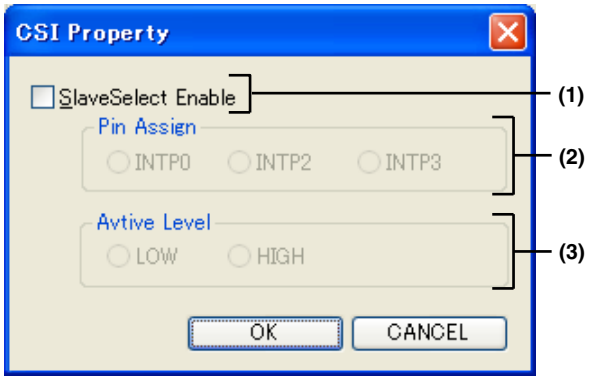
Note A half of the value set in the field becomes IIC bus slave address.
For example, when 9 is set in the field, the address becomes 7-bit slave address as "0001001."

[CSI Property] dialog box

This dialog box can be opened by clicking [CSI...] in the [Project] menu.
Set SS pin of CSI10 in this dialog box.
This setting operates only in slave mode.

Figure 5-4. [CSI Property] dialog box

<For the EV-K0-HCD, EV-K0-HCD2, and EZ-0009>



< For the EZ-0005>

The following parts of this window are described below.

- Description of function-related areas
- Function buttons

Description of function-related areas

(1) SlaveSelect Enable

Select this checkbox when using the SS pin function.
Items (2) and (3) cannot be set when this checkbox is not selected.

(2) Pin Assign

For the EV-K0-HCD, EV-K0-HCD2, and EZ-0009, any of INTP0, INTP2, and INTP3 can be selected.
For the EZ-0005, this setting is fixed to SSI11.

(3) Active Level

For the EV-K0-HCD, EV-K0-HCD2, and EZ-0009, either LOW or HIGH can be selected.
For the EZ-0005, this setting is fixed to LOW.

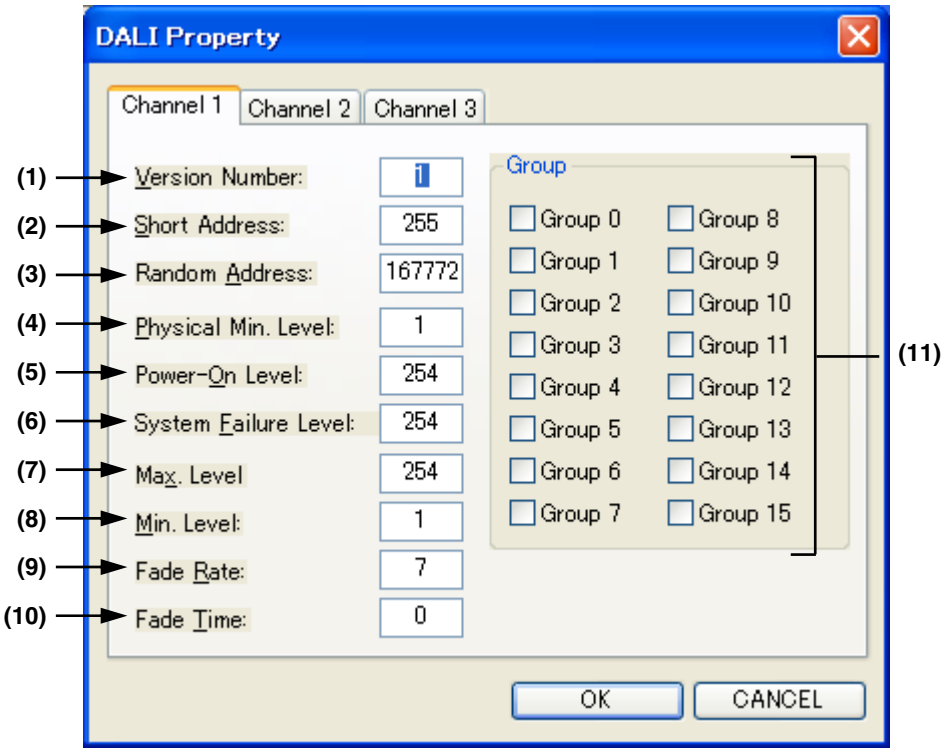
Function buttons

Button	Description
OK	Click this button to save the current settings and close the open dialog box.
CANCEL	Click this button to close the open dialog box without saving the current settings.

[DALI Property] dialog box

This dialog box can be opened by clicking [DALI...] in the [Project] menu.
Set parameter of DALI in this dialog box.

Figure 5-5. [DALI Property] dialog box



The following parts of this window are described below.

- Description of function-related areas
- Function buttons

Description of function-related areas

(1) Version Number:

Specify the version number of the evaluation board (as a value from 0 to 255).

(2) Short Address:

Specify the default address of the evaluation board (as a value from 0 to 63 and 255).

Caution When the short address is assigned to the same address of the mounted LED channels, a right result may not be acquired in command replies such as Query.

(3) Random Address:

Specify a value (from 0 to 0xFFFFFF) when assigning a random address to the evaluation board.

(4) Physical Min. Level:

Specify the minimum dimming level (as a value from 1 to 254) for the evaluation board.

(5) Power-On Level:

Specify the dimming level for when turning on power (as a value from 1 to 255).

(6) System Failure Level:

Specify the dimming level for when a failure occurs (as a value from 0 to 255).

(7) Max. Level:

Specify the maximum dimming level (as a value from the minimum level to 254).

(8) Min. Level:

Specify the minimum dimming level (as a value from the physical minimum level to the maximum level).

(9) Fade Rate:

Specify the amount by which the dimming level is changed by fading (as a value from 1 to 15).

(10) Fade Time:

Specify the time required for the dimming level to be changed by fading (as a value from 0 to 15).

(11) Group

Specify the group the evaluation board belongs to. Multiple groups can be specified.

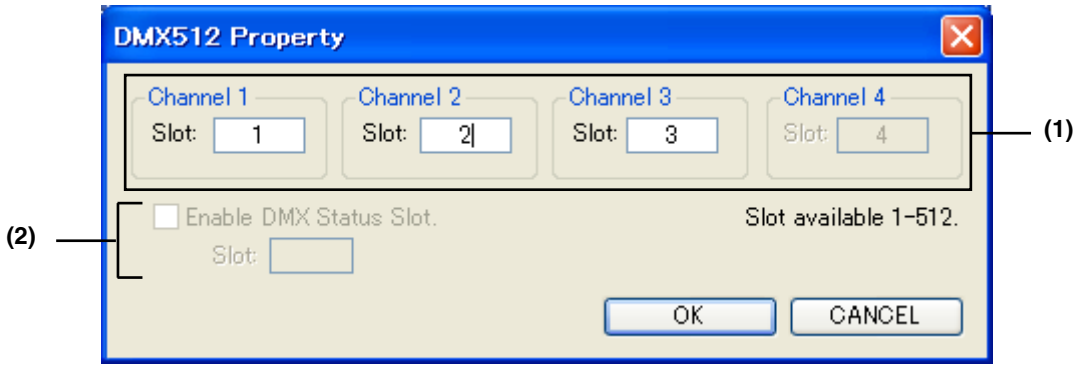
Function buttons

Button	Description
OK	Click this button to save the current settings and close the open dialog box.
CANCEL	Click this button to close the open dialog box without saving the current settings.

[DMX512 Property] dialog box

This dialog box can be opened by clicking [DMX512...] in the [Project] menu.
Set channel numbers of DMX512 in this dialog box.

Figure 5-6. [DMX512 Property] dialog box



The following parts of this window are described below.

- Description of function-related areas
- Function buttons

Description of function-related areas

(1) Channel X

Enter a number from 1 to 512 in order to assign each channel to a slot (channel) of the DMX512 protocol.
If an existing configuration file is open, the value in that file is displayed.

(2) Enable DMX Status Slot.

Input the slot (channel) to which to assign the DMX status as a value from 1 to 512.
Do not select this checkbox if not using the DMX status slot.
The status is valid only for EV-K0-HCD, EV-K0-HCD2, EZ-0009, or EZ-0006.
The following operations are performed according to the data of the slot (channel) to which the status is assigned.
0x80 (128): Sets the constant-current driver IC enable signal to low level (the shutdown status).
0x00 (0): Sets the constant-current driver IC enable signal to high level (the enabled status).
No operation is performed for other values.

Remark The channel 4 and DMX status slot cannot be used for EZ-0005, EZ-0011.

Function buttons

Button	Description
OK	Click this button to save the current settings and close the open dialog box.
CANCEL	Click this button to close the open dialog box without saving the current settings.

APPENDIX A SAMPLE FILE

This chapter introduces sample files for specific colors.
These sample files are stored in the following folder.
C:\Program Files\Renesas\Applilet EZ for HCD\Sample\Board name\

Sample File Name	Description	Operation Mode
Candle_xxxxx.xml	Candle light	Fix mode
color_temperature_3000K_xxxxx.xml	Color temperature 3,000 K	
color_temperature_3500K_xxxxx.xml	Color temperature 3,500 K	
color_temperature_4200K_xxxxx.xml	Color temperature 4,200 K	
color_temperature_5000K_xxxxx.xml	Color temperature 5,000 K	
color_temperature_6500K_xxxxx.xml	Color temperature 6,500 K	
Flame_of_candle_xxxxx.xml	Candle flame	Variable mode
Flash_xxxxx.xml	Flash	
Flame_of_Gas_xxxxx.xml	Flame of gas	
Rainbow_xxxxx.xml	Rainbow	
Random_xxxxx.xml	Random color	

Remarks 1. In the sample file names, “xxxxx” represents the name of an evaluation board.

2. Refer to **A.1 [Reference] Measurement Environment for the Color Temperature** for measurement environment for the color temperature.

3. Depending on the board, these files may not exist.

4. If the LED being beforehand mounted on a board is changed, the color may be changed.

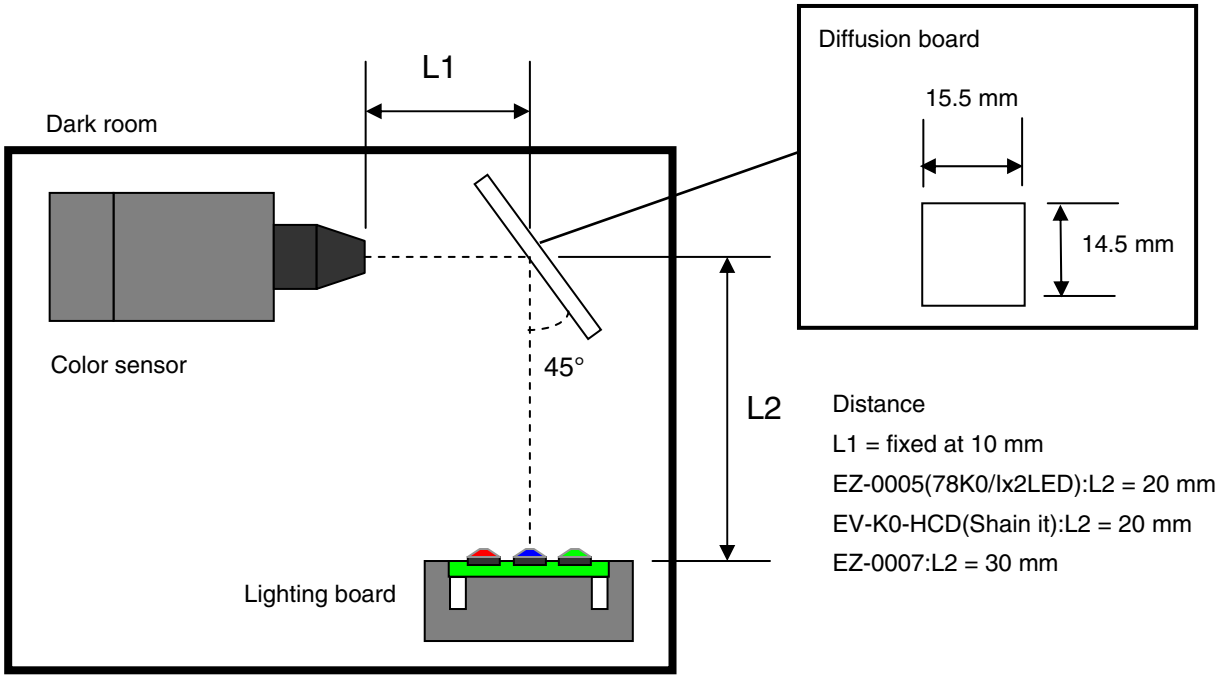
5. In the condition of ch1 = Red, ch2 = Green, and ch3 = Blue for EZ-0011.

A.1 [Reference] Measurement Environment for the Color Temperature

Data that was measured in the following environment is used for the color temperature sample file (color_temperature_xxxxxK_) included with Applilet EZ for HCD Controller.

< Measurement environment >

- The whole measurement equipment is set up in a dark room where all outside light is cut off.
- A color sensor and lighting board are installed perpendicularly. A diffusion board is installed at the intersecting point, tilted at 45°.
- The distance L2 is set up so that the colors of the three LEDs are sufficiently mixed.
- The status of the mixed colors that is projected on the diffusion board is acquired by the color sensor.
- The lighting board is installed at a height so that the center of the LEDs and diffusion board are at the same height.



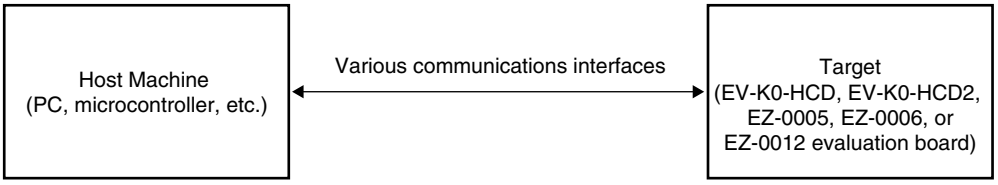
Caution **The above measurement environment is intended for acquiring data to create a sample file and does not guarantee the accuracy or reproducibility of colors.**

Remark In the above measurement environment, the following multimedia display tester, made by Yokogawa Electric Corporation, is used as the measuring equipment:

Multimedia display tester: 3298F (3298 02 (the main unit) + 3298 21 (the color sensor))

APPENDIX B SERIAL COMMAND MODE COMMUNICATION COMMANDS

This chapter describes the communication commands used between a host device (such as a PC or a microcontroller) and a target device (the EV-K0-HCD, EV-K0-HCD2, or EZ-00xx evaluation board). An application software that uses the communication commands can be generated by selecting [Serial Command] in the Applilet EZ for HCD Controller and determining the communication method. Refer to **4.3.4** for operation details.



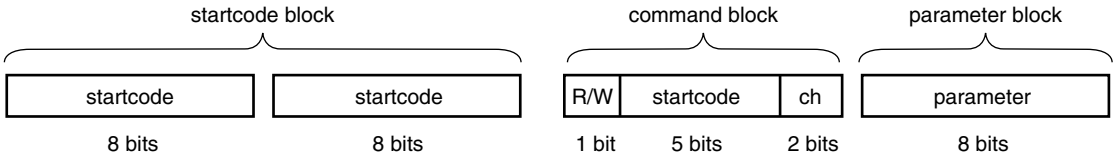
The communication methods that can be selected with the Serial Command mode are UART6, UART0, IIC, and SPI (CSI). With UART, binary types and ASCII types of these communication methods can be selected. With IIC and SPI (CSI), only binary types are supported.

Refer to **B.1 Overview of Binary Type**, **B.2 Overview of ASCII Type** for details of each type.

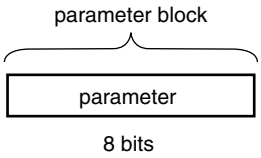
Refer to **B.3** for the timings of each communication method.

B.1 Overview of Binary Type

Basic format 1 (host → target)



Basic format 2 (target → host)



Basic formats 1 and 2 are binary type communication formats. Basic format 1 is used to transmit data from a host device to a target device and consists of a startcode block, a command block, and a parameter block.

Basic format 2 is used to transmit data from a target device to a host device and consists of only a parameter block.

Details of each block are described below.

B.1.1 Details of basic format 1 (host → target)

- startcode block

  2 [byte] data, each byte consisting of 8 bits fixed to 0. It is required when transmitting data from a host device to a target device.

- command block

  1 [byte] data consisting of 8 bits. The meaning of each bit is as follows.

  R/W (1 bit): This bit specifies the flow of information. Whether status acquisition is requested to the target device or an operation status is set to the target device changes, depending on this bit.

  1 (READ): This specifies status acquisition (during reception).

  0 (WRITE): This specifies setting (during transmission).

  Command (5 bit): These bits specify the items whose status is to be acquired (during reception) or that is to be set (during transmission). The following two item types exist and their meanings vary, depending on whether they are set to status acquisition (during reception) or setting (during transmission).

  01000 (Duty): This item represents the duty.

  Status acquisition (during reception) = When this command is selected, the target device returns as 1 [byte] data the duty setting value of the channel instructed with "Ch". Refer to **B.1.2** for details.

  Setting (during transmission) = When this command is selected, the duty of the channel instructed with "Ch" is set by using the value specified by "parameter".

  10000 (Status): This item represents the status[Note].

  Status acquisition (during reception) = Status acquisition (during reception) = When this command is selected, the target device returns as 1 [byte] data the current status. Refer to **B.1.2** for details.

  Setting (during transmission) = When this command is selected, the value specified by "parameter" is used to set the status of the target device.

  1000 0000 (0x80): Shutdown (sets the EN pin to low level)

  0000 0000 (0x00): Enable status (sets the EN pin to high level)

  Ch (2 bit): These bits specify the target channel.

  00 Channel 1

  01 Channel 2

  10 Channel 3

  11 Channel 4

Note Do not use the status command for EZ-0005, which does not use a constant-current driver IC, because no status acquisition or status specification command is provided in EZ-0005.

- parameter block

  1 [byte] data consisting of 8 bits.

  This block has no meaning when set to status acquisition (during reception: R/W = 1)[Note 1]. Specify 0x00 for status acquisition (during reception).

  When it is set to setting (during transmission: R/W = 0), it has the following meaning according to “Command (5 bits)” of the command block.

  01000 (Duty): During duty setting

  This specifies the duty of the channel instructed with “Ch”. A value within the range of 0 to 0xFF (255) can be specified.

  10000 (Status): During status setting[Note 2]

  This specifies the current status of the target device.

  1000 0000 (0x80): Shutdown status (sets the EN pin to low level)

  0000 0000 (0x00): Enable status (sets the EN pin to high level)

Notes 1. This has no meaning but it cannot be omitted.

2. Do not use the status command for EZ-0005, which does not use a constant-current driver IC, because no status acquisition or status specification command is provided in EZ-0005.

B.1.2 Details of basic format 2 (target → host)

- parameter block

  1 [byte] data consisting of 8 bits.

  It is not transmitted when the host device has selected setting (during transmission: R/W = 0).

  When status acquisition (during reception: R/W = 1) has been selected, it has the following meaning according to “Command (5 bits)”.

  01000 (Duty): During duty setting

  This returns as 1 [byte] data the duty setting value of the channel instructed with “Ch”.

  The duty value holds a value within the range of 0 to 0xFF (255).

  10000 (Status): During status setting[Note 1]

  This returns as 1 [byte] data the current status of the target device. The status of the target device is one of the following.

  1000 0000 (0x80): Shutdown status (EN pin: low level)[Note 2]

  0000 0000 (0x00): Enable status (EN pin: high level)

Notes 1. Do not use the status command for EZ-0005, which does not use a constant-current driver IC, because no status acquisition or status specification command is provided in EZ-0005.

2. Shutdown status during status acquisition occurs due to the following causes.

- When overheat protection alarm output (SH) of the constant-current driver IC enters an alert state (high level)
- When Shutdown status has been set by a communication command

In both cases, operation or standby input (EN pin) of the constant-current driver IC becomes low level in Shutdown status.

B.1.3 Binary type execution example (EV-K0-HCD)

1. Target device status acquisition
   - Transmission from the host device

     Hexadecimal: 00 00 C0 00

     Binary: 0000 0000 0000 0000 1100 0000 0000 0000
   - Reception from the target device (Enable status)

     Hexadecimal: 00

     Binary: 0000 0000

2. Setting the duty of channel 1 of the target device to 10
   - Transmission from the host device

     Hexadecimal: 00 00 20 0A

     Binary: 0000 0000 0000 0000 0010 0000 0000 1010
   - Reception from the target device

     None

3. Acquiring the duty value of channel 3 of the target device
   - Transmission from the host device

     Hexadecimal: 00 00 A3 00

     Binary: 0000 0000 0000 0000 1010 0011 0000 0000
   - Reception from the target device (duty value = 255)

     Hexadecimal: FF

     Binary: 1111 1111

4. Setting the status of the target device to Shutdown
   - Transmission from the host device

     Hexadecimal: 00 00 40 80

     Binary: 0000 0000 0000 0000 0100 0000 1000 0000

B.2 Overview of ASCII Type

Basic format 3 (host → target)

ch	Comma (0x2C)	cmd	Comma (0x2C)	data	LineFeed (0x0D)	CarriageReturn (0x0A)
1 byte	1 byte	2 bytes	1 byte	3 bytes	1 byte	1 byte

Basic format 4 (target → host)

data	LineFeed (0x0D)	CarriageReturn (0x0A)
3 bytes	1 byte	1 byte

The ASCII-type communication format uses ASCII characters for transmission and reception, and can be selected only if UART6 or UART0 has been selected as the communication method. Similarly with the binary type, there are two communication formats of the ASCII type. Basic format 3 is used to transmit data from a host device to a target device, consists of a ch block, a cmd block, and a data block, and is delimited by commas. Basic format 4 is used to transmit data from a target device to a host device and consists of only a data block. Furthermore, LineFeed (0x0D) and CarriageReturn (0x0A) are added to each format.

B.2.1 Details of basic format 3 (host → target)

- ch block

  1 [byte] data. It specifies the channel to be controlled[Note 1].

  Specifiable values: “1”, “2”, “3”, “4”

- cmd block

  2 [byte] data. It can be used to specify for the duty and status of each channel of the target device, status acquisition (during reception) or setting (during transmission). The following four items can be specified.

  Specifiable items: “wd” Set Duty[Note 2] ·····This sets the duty of the channel specified with the “ch” block.

  “rd” Read Duty[Note 2] ·····This requests the setting of duty of the channel specified with the “ch” block.

  “ws” Set Status[Notes 2, 3] ·····This sets the status of the target device[Note 1].

  “rs” Read Status[Notes 2, 3] ··This requests the status of the target device[Note 1].

  When requesting to the target device has been specified, the target device returns the current status. Refer to **B.2.2** for details.

Notes 1. When “status” has been selected for an item of the cmd block, specification of the ch block has no meaning, but it cannot be omitted. Specify fixing to “1”.

2. All items of the cmd block must be expressed by using lowercase characters. Uppercase characters cannot be specified.

3. Do not use the status command for EZ-0005, which does not use a constant-current driver IC, because no status acquisition or status specification command is provided in EZ-0005.

- data block

  3 [byte] data. It has the following meanings according to the items specified with the cmd block.

  cmd = “wd”[Note 1]: This specifies as 3 digits in decimal format the value of the duty to be set. (“000” to “255”)

  cmd = “ws”: This specifies as 3 digits in decimal format the value of the status to be set. Two values can be specified.

  “128”: Shutdown status (sets the EN pin to low level)

  “000”: Enable status (sets the EN pin to high level)

  cmd = “rd” and “rs”[Note 1]: This specifies “000” with a duty or status request to the target device[Note 2].

Notes 1. Do not use the status command for EZ-0005, which does not use a constant-current driver IC, because no status acquisition or status specification command is provided in EZ-0005.

2. When cmd is “rd” and “rs”, the data block has no meaning, but it cannot be omitted.

B.2.2 Details of basic format 4 (target → host)

- data block

  3 [byte] data. The data is transmitted from the target device only when cmd is “rd” and “rs”, among the items specified for basic format 3.

  cmd = “rd”: This returns as 3 digits in decimal format the duty value of the specified channel. (“000” to “255”)

  cmd = “rs”[Note 1]: This returns as 3 digits in decimal format the status state.

  “128”: Shutdown status (EN pin: low level)[Note 2]

  “000”: Enable status (EN pin: high level)

Notes 1. Do not use the status command for EZ-0005, which does not use a constant-current driver IC, because no status acquisition or status specification command is provided in EZ-0005.

2. Shutdown status during status acquisition occurs due to the following causes.

- When overheat protection alarm output (SH) of the constant-current driver IC enters an alert state (high level)
- When Shutdown status has been set by a communication command

In both cases, operation or standby input (EN pin) of the constant-current driver IC becomes low level in Shutdown status.

B.2.3 ASCII type execution example

Remark LineFeed (0x0D) and CarriageReturn (0x0A) are expressed as \r and \n, respectively, in this section.

1. Target device status acquisition
   - Transmission from the host device

     “1,rs,000\r\n”
   - Reception from the target device (Enable status)

     “000\r\n”

2. Setting the duty of channel 1 of the target device to 10
   - Transmission from the host device

     “1,wd,010\r\n”
   - Reception from the target device

     None

3. Acquiring the duty value of channel 3 of the target device
   - Transmission from the host device

     “3,rd,000\r\n”
   - Reception from the target device (duty value = 255)

     “255\r\n”

4. Setting the status of the target device to Shutdown
   - Transmission from the host device

     “1,ws,128\r\n”
   - Reception from the target device

     None

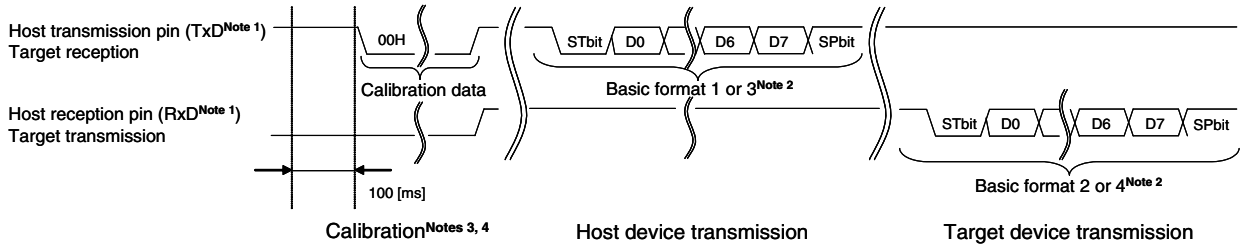
B.3 Transmission/Reception Timing According to Communication Method

The method and timing of transmission and reception differ according to the communication method. The differences of each communication method are as follows.

<UARTx (ASCII/BINARY)>

In communication using a UART, transmission and reception are performed completely asynchronously. A transmission operation of the target device uses basic format 1 or 3, and occurs only when the host device has requested information acquisition (during reception) to the target device.

UART communication example



Notes 1. Name of the signal line on the host side

2. This is a waveform of when parity has been set to “None”.

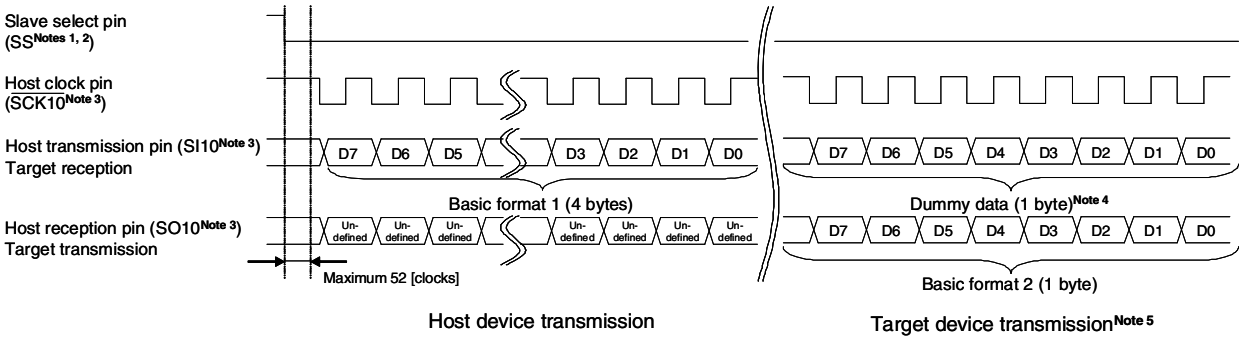
3. Calibration will be required when using the internal high-speed oscillation for the EV-K0-HCD board. Transmit 00H data after 100 [ms] have elapsed since having started the target device.

4. To perform calibration with UART0, short the RxD0 and P00/TI000 pins.

<SPI/CSI>

During transmission and reception with the SPI or CSI, the host device is the master device. For information acquisition (during reception) of the target device, dummy data is transmitted.

SPI communication example



Notes 1. Select whether to use an SS pin and which pin to use for the SS pin in [CSI Property] dialog box. Because, for the EV-K0-HCD board, the SS pin is controlled using software, up to 52 cycles of the target system CPU clock are required for the signal status of the SS pin to be recognized and transfer to be enabled.

2. This waveform is an example of when the SS pin is set to LowActive.

3. Name of the signal line on the host side

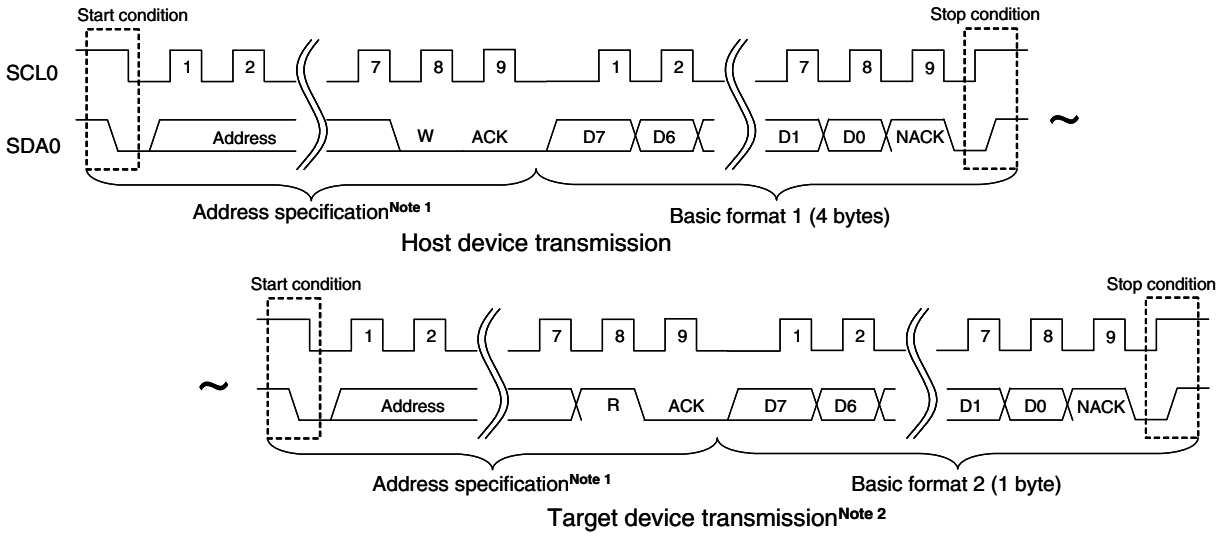
4. To acquire information by using basic format 2, transmit dummy data of one byte from the host device.

5. In target device transmission, only information acquisition (during reception) occurs for transmission from the host device.

<IIC>

In communication using an IIC, the host device is the master device. A communication operation such as that shown below is performed for information acquisition (during reception) of the target device.

IIC communication example

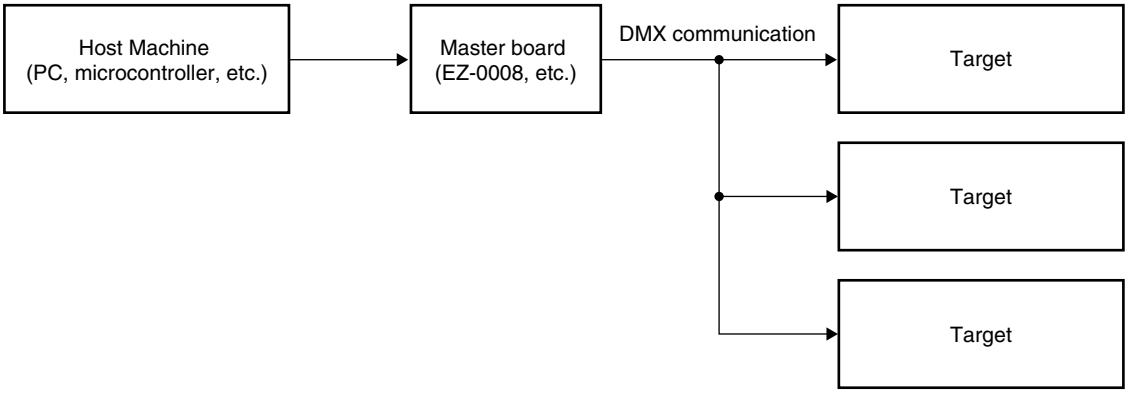


Notes 1. Specify the address of the subject target device.

2. When the host device has transmitted a command whose status must be received with basic format 1, communication must be performed by issuing a start condition from the host side, such as shown above for “Target device transmission”.

APPENDIX C DMX512 MODE COMMUNICATION DATA

The communication data by DMX512 mode is described below.



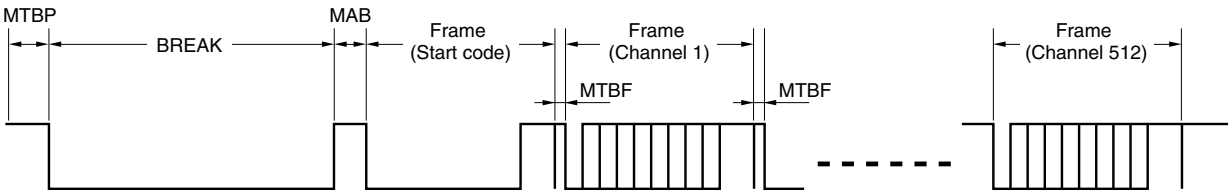
DMX512 performs communication using the following protocol.

C.1 Protocol Specifications

<1> Packet

One packet is configured of one MTBP, one BREAK, one MAB, 513 frames, and 512 MTBFs.

The first frame is a start code and data is fixed to 0.

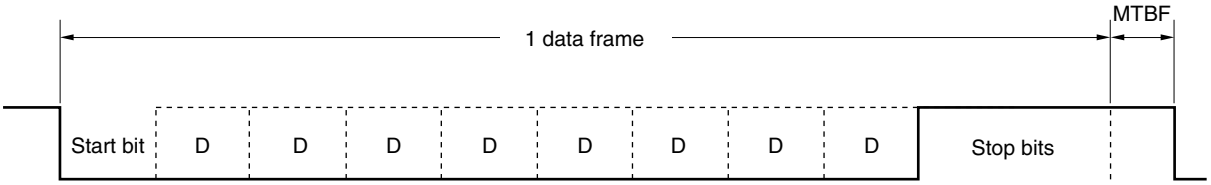


Name	Data width			Level
	MIN.	TYP.	MAX.	
BREAK	88 μs	88 μs	176 s	Low-level
MAB	8 μs	8 μs	1 s	High-level
FRAME	44 μs	44 μs	44 μs	Low-level/High-level
MTBF	0 μs	–	1 s	High-level
MTBP	0 μs	–	1 s	High-level

<2> Frame

One frame is configured of one start bit, eight data bits, and two stop bits.

One frame is equivalent to one UART communication data byte with a baud rate of 250 kbps, no parity, and two stop bits.



Name	Data width	Level
Start bit	4 μs	Low-level
Data bits	4 μs × 8 bits	Low-level/High-level
Stop bits	4 μs × 2 bits	High-level

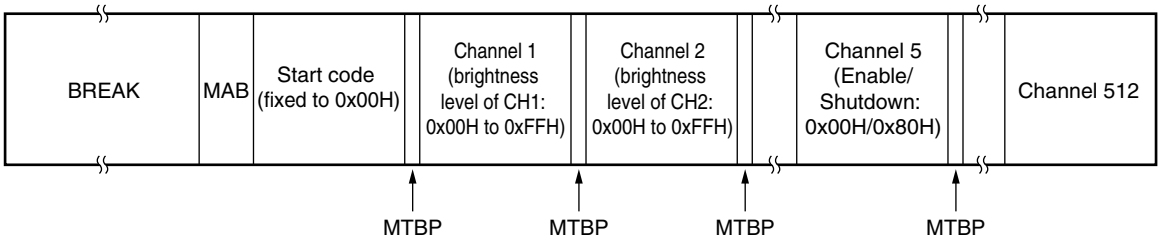
C.2 Communication Data Specification

- The frame data bits are LSB first.
- The start code is fixed to 0x00. Packets with a start code other than 0x00 are invalid.
- Brightness data corresponding to channels 1 to 4 on the board are set to each frame (0 ≤ brightness data ≤ 255).
- If the DMX status is assigned to a channel in the μPD78F8024 that has a constant-current driver IC or an evaluation board that uses a constant-current driver IC (EV-K0-HCD or EZ-0006), the following operations are performed depending on the channel data.

  If 0x80 is received when DMX communication is enabled, DMX communication is shut down.

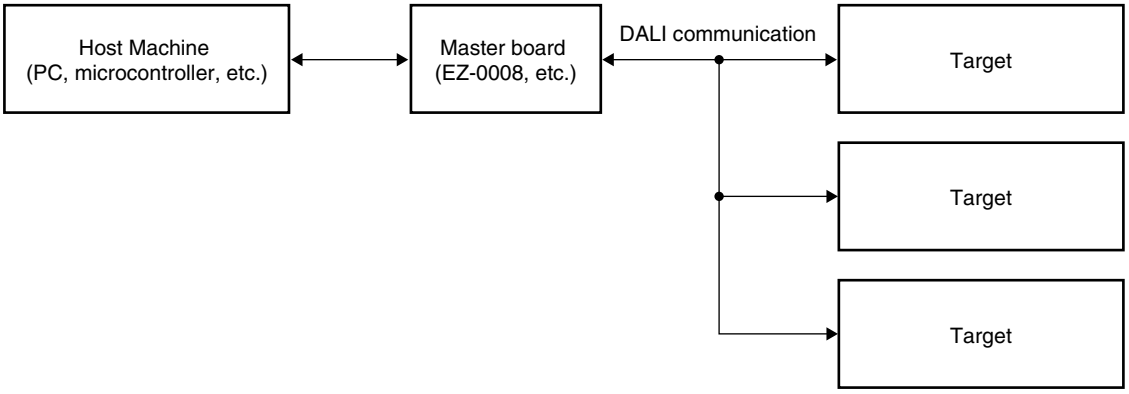
  If 0x00 is received when DMX communication is shut down, DMX communication is enabled.

Example of communication data (when the DMX status is assigned to channel 5)



APPENDIX D DALI MODE COMMUNICATION DATA

The communication data by DALI (Digital Addressable Lighting Interface) mode is described below.



Remark The EV-K0-HCD is not supported DALI communication.

DALI performs communication using the following protocol.

D.1 Protocol Specifications

DALI is a network consisting of up to 64 short addresses and 16 group addresses, and performs half-duplex command communication between one master and one slave or multiple slaves.

DALI commands are used for purposes such as setting the dimming level with 8-bit accuracy and saving or switching among up to 16 arbitrary dimming levels.

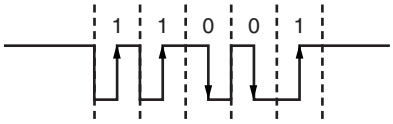
The communication speed is 1,200 Hz ±10%.

<1> Bit definition

A falling edge is bit-defined as “0” and a rising edge as “1”, because DALI communication uses Manchester code.

If no communication is performed, DALI communication is fixed to the high level.

Figure D-1. Bit Definition

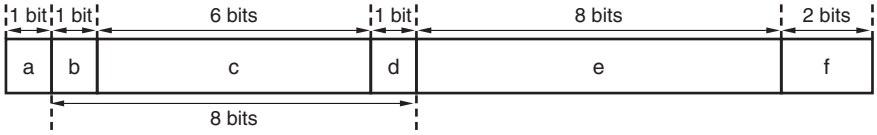


<2> Frame

- Forward frame

This is a frame used when transmitting from the master to a slave. A frame consists of 19 bits.

Figure D-2. Forward-Frame Structure



a: Start bit

This indicates the start of the frame. It is always the same waveform as “1”.

b-d: Address byte

This specifies the transmission destination of the frame.

e: Data byte

This specifies a command.

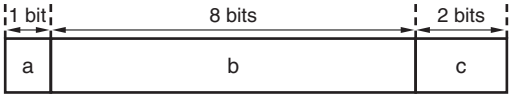
f: Stop bits

These indicate the end of the frame. These are fixed to the high level.

- Backward frame

This is a frame used when transmitting from the slave to a master. A frame consists of 11 bits.

Figure D-3. Backward-Frame Structure



a: Start bit

This indicates the start of the frame. It is always the same waveform as “1”.

b: Data byte

This replies to the master.

c: Stop bits

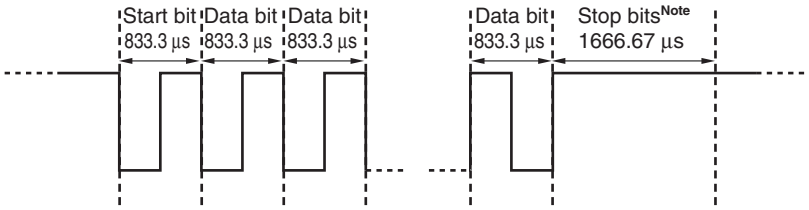
These indicate the end of the frame. These are fixed to the high level.

D.2 Transmission/Reception Timing Rules

<1> Timing in the frame

1 bit width in DALI is 833.3 μs ±10% for both Forward and Backward frames.

Figure D-4. Timing in the Frame



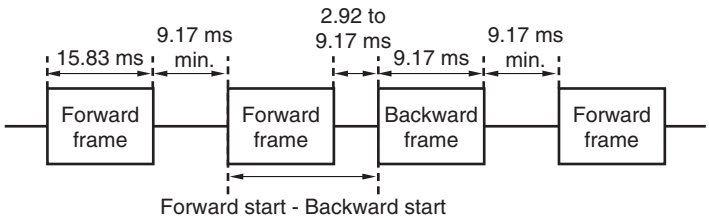
Note Because there are two stop bits, their timing is 1666.67 μs.

<2> Timing among frames

With DALI, the following timing must be controlled in frame units.

- Forward frame width: 15.83 ms ±10%
- Backward frame width: 9.17 ms ±10%
- Communication interval between one Forward frame and the Backward frame: 2.92 to 9.17 ms
- Communication interval between one Forward frame and the next Forward frame: 9.17 ms min.
- Communication interval between one Backward frame and the next Forward frame: 9.17 ms min.

Figure D-5. Timing among frames



APPENDIX E RESERVED AREAS USED IN ON-CHIP DEBUGGING

The reserved areas shaded in gray in Figures F-1 and F-2 are used during on-chip debugging.

Figure F-1. Reserved Areas Used in On-chip Debugging (μPD78F8024)

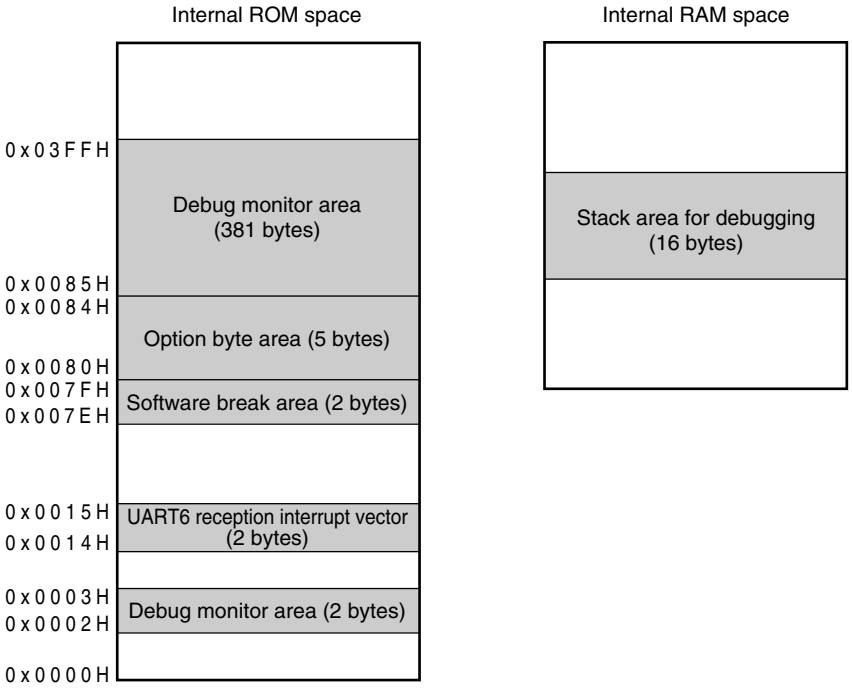


Figure F-2. Reserved Areas Used in On-chip Debugging (78K0/Ix2)

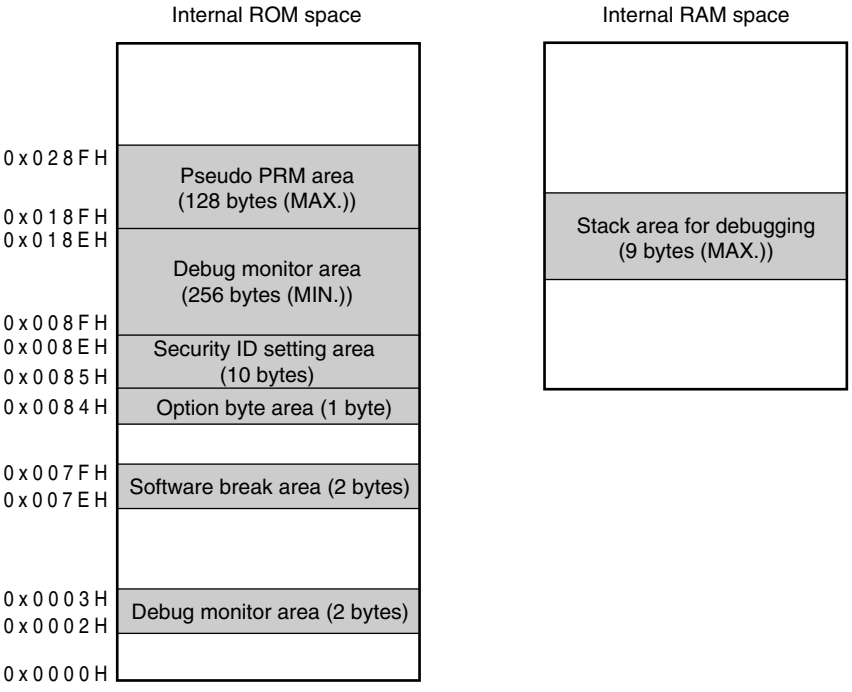
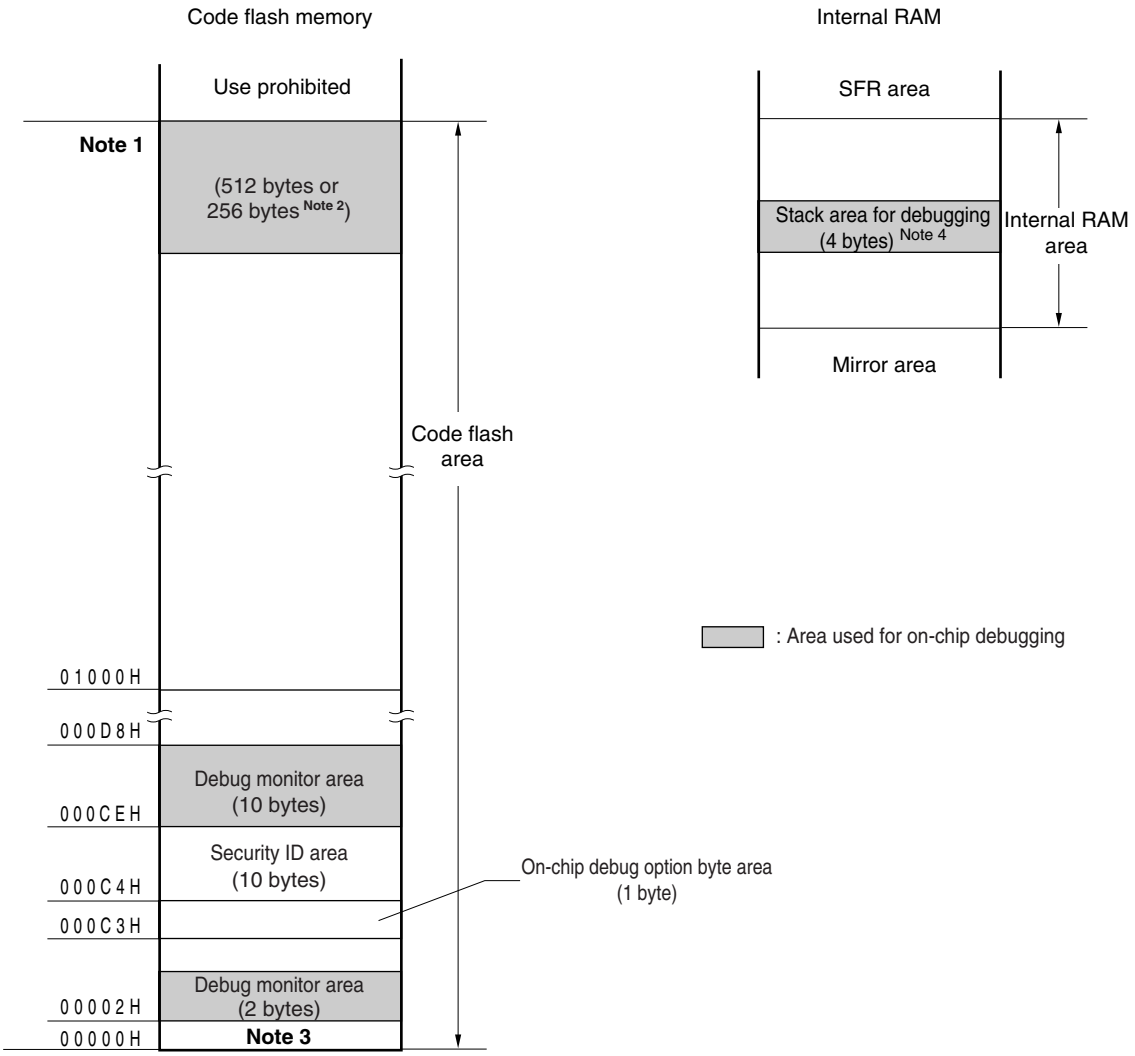


Figure F-3. Reserved Areas Used in On-chip Debugging (RL78K/I1A)



Notes 1. Address differs depending on products as follows.

Products	Address of **Note 1**
R5F1076C, R5F107AC, R5F107BC	07FFFH
R5F107AE, R5F107DE	0FFFFH

2. When real-time RAM monitor (RRM) function and dynamic memory modification (DMM) function are not used, it is 256 bytes.

3. In debugging, reset vector is rewritten to address allocated to a monitor program.

4. Since this area is allocated immediately before the stack area, the address of this area varies depending on the stack increase and decrease. That is, 4 extra bytes are consumed for the stack area used. When using self-programming, 12 extra bytes are consumed for the stack area used.

APPENDIX F 16-BIT TIMER/EVENT COUNTER 00 FUNCTIONS (FOR μPD78F8024/78F8025 AND 78K0/Ix2 ONLY)

Driver functions are provided for using 16-bit timer/event counter 00 as an interval timer or for pulse width measurement.

When using the functions, they must be added to a PM+ (integrated development environment) or SubeSuite+ project.

Add TM00Int.c and TM00Int_user.c to the project when using 16-bit timer/event counter 00 as an interval timer, and add TM00PIs.c and TM00PIs_user.c to the project when using 16-bit timer/event counter 00 for pulse width measurement.

Cautions 1. 16-bit timer/event counter 00 functions is not support with RL78/I1A.
2. TM00 cannot be used in variable mode or when using UART0 or UART6 for internal high-speed oscillation.
3. 16-bit timer/event counter 00 functions cannot be used while DALI or the EZ-0011 board is used.

(1) TM00Int.c

- void IntervalTimer_init(void)

[Processing overview]
This function initializes TM00 as an interval timer.
After TM00 is initialized, it is stopped, and IntervalTimer_Start() must be called to start it.
[Return value]
None
[Parameter]
None
[Prototype definition source]
TM00Int.h

- void IntervalTimer_Start(void)

[Processing overview]
This function starts a count operation of TM00 that has been initialized.
Interval interrupts are set to be unmasked and the interrupt handler is set to be called.
[Return value]
None
[Parameter]
None
[Prototype definition source]
TM00Int.h

- void IntervalTimer_Stop(void)

[Processing overview]
This function stops the count operation of TM00.
Interval interrupts are set to be masked and the interrupt handler is set not to be called.
[Return value]
None
[Parameter]
None
[Prototype definition source]
TM00Int.h

- unsigned char IntervalTimer_SetInterval(unsigned char ucUnit, unsigned long ulValue)

[Processing overview]
This function reflects the interval specified by a parameter to the interval setting-related registers (CR000, PRM00) of TM00.

[Return value]
Processing result Successful ... TRUE (1)
Failed ... FALSE (0)
[Parameter]
unsigned char ucUnit ..... Unit of interval setting value
UNIT_SEC.....1 s
UNIT_MILLISEC.....1 ms
UNIT_MICROSEC.....1 μs
UNIT_NANOSEC.....1 ns
UNIT_FALLING_EDGE...Number of times the falling edge of the TI000 pin is detected
UNIT_RISING_EDGE....Number of times the rising edge of the TI000 pin is detected
UNIT_BOTH_EDGE...Number of times the rising or falling edge of the TI000 pin is detected
unsigned long ulValue .....Interval setting value
[Prototype definition source]
TM00Int.h
[Remark]
A failure will be returned if this function is called while starting TM00.

(2) TM00Int_user.c

- __interrupt void Interval_interrupt(void)

[Processing overview]
This is the interval interrupt handler.
The processing content is to be described by the user.
[Return value]
None
[Parameter]
None
[Prototype definition source]
TM00Int_user.c

(3) TM00Pls.c

- void PulseMeasure_init(void)

[Processing overview]
This function initializes TM00 as the pulse width measurement function.
After TM00 is initialized, it is stopped, and PulseMeasure_Start() must be called to start it.
[Return value]
None
[Parameter]
None
[Prototype definition source]
TM00Pls.h

- void PulseMeasure_Start()

  [Processing overview]

  This function starts a count operation of TM00, which has been initialized, in clear & start mode set by inputting the valid edge of the TI000 pin.

  Interrupts are set to be unmasked by detecting the valid edge of the TI000 pin and the interrupt handler is set to be called.

  [Return value]

  None

  [Parameter]

  None

  [Prototype definition source]

  TM00Pls.h

- void PulseMeasure_Stop()

  [Processing overview]

  This function stops the count operation of TM00.

  Interrupts are set to be masked by detecting the valid edge of the TI000 pin and the interrupt handler is set not to be called.

  [Return value]

  None

  [Parameter]

  None

  [Prototype definition source]

  TM00Pls.h

- void PulseMeasure_GetPulseWidth(unsigned long* ulPulseCycle, unsigned long* ulHighWidth, unsigned long* ulLowWidth)

  [Processing overview]

  This function acquires the measured pulse cycle and positive and negative pulse widths.

  [Return value]

  None

  [Parameter]

  unsigned long* ulPulseCycle ..... Pointer of the area in which the pulse cycle is to be stored

  unsigned long* ulHighWidth ..... Pointer of the area in which the positive pulse width is to be stored

  unsigned long* ulLowWidth ..... Pointer of the area in which the negative pulse width is to be stored

  [Prototype definition source]

  TM00Pls.h

  [Remark]

  The pulse cycle and positive and negative pulse widths are stored in the form of a count value of TM00.

  Their values must be converted to time values, based on the time of one count of each setting.

  ∗Time of one count of each setting

	4 MHz	8 MHz	16 MHz
MEASURE_RANGE_FPRS_1	0.25 μs	0.125 μs	0.0625 μs
MEASURE_RANGE_FPRS_2_2	1 μs	0.5 μs	0.25 μs
MEASURE_RANGE_FPRS_2_8	64 μs	32 μs	16 μs

(4) TM00Pls_user.c

- __interrupt void TI000_Capture_Interrupt(void)

[Processing overview]

This function calculates the pulse cycle and positive and negative pulse widths, based on the TM00 count values stored in CR000 and CR010.

[Return value]

None

[Parameter]

None

[Prototype definition source]

TM00Pls_user.c

Applilet EZ for HCD Controller Ver. 8.30
User's Manual

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