RL78/G24

LED Lighting Control Application Model

Introduction

This application note describes how to use the simulation model for LED lighting control system using the RL78/G24 microcontroller. This model simulates the LED lighting system control sample program [R01AN6673JJ0100] ("LED control program") and the RL78/G24 DC/DC LED control evaluation board [RTK7RLG240P00000BJ] ("LED control evaluation board").

This model enables users to verify the control operation of LED lighting system using RL78/G24 microcontroller on a PC. Users can efficiently develop LED control devices by examining control parameters in the preliminary stage of using actual devices.

This model simulates the operation of the microcontroller and software evaluation board. Please confirm the real operation with the actual device.

Target Evaluation Kit / Sample Programs

- LED control with RL78/G24 [R01AN6673JJ0100]
- RL78/G24 DC/DC LED Control Evaluation Board [RTK7RLG240P00000BJ]

operating environment

OS	Windows 11 (64bit) Windows 10 (version 20H2 or higher) (64bit)
MATLAB Runtime	R2022b

This model was created using MATLAB/Simulink and requires MATLAB Runtime to run. See chapter 4.2 for details.

Contents

1. Overview

This application note describes how to use the simulation model for LED lighting control system using the RL78/G24 microcontroller. This model simulates the LED lighting system control sample program [R01AN6673EJ0100] ("LED control program") and the RL78/G24 DC/DC LED control evaluation board [RTK7RLG240P00000BJ] ("LED control evaluation board").

This model enables users to verify the control operation of LED lighting system using RL78/G24 on a PC. Users can efficiently develop LED control devices by examining control parameters in the preliminary stage of using actual devices.

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2. Related Documents

(1)R01AN6673EJ0100 LED control with RL78/G24

(2)R01UH0961EJ0100 RL78/G24 User's Manual: Hardware

3. Simulation Model Operation

This model simulates LED lighting control system using the RL78/G24. The scope of simulation is the operations related to constant current and dimming control in the LED control program (see related document (1)). It does not simulate control instructions via the communication interface or the operation of functions related to the protection function when overcurrent (overvoltage) is detected.

Block diagram of the LED lighting control system simulation is shown in Figure 3.1.

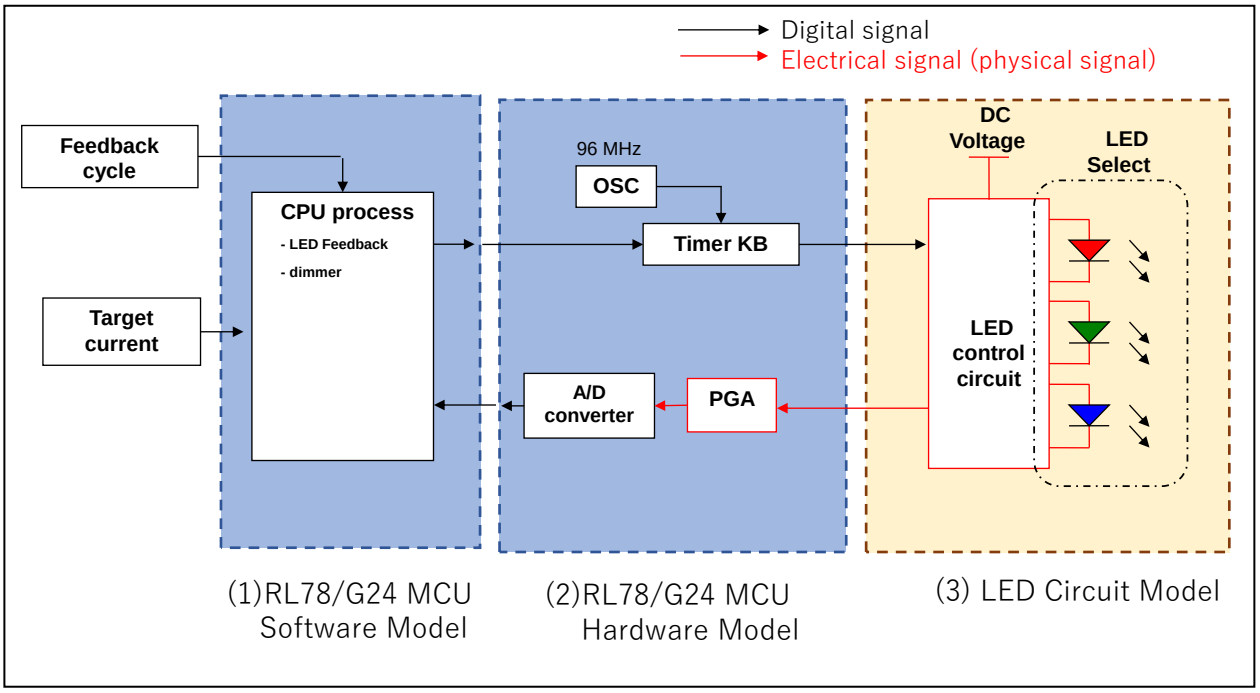

Figure 3.1. Block diagram of LED lighting control system simulation

The functions of (1) through (3) in Figure 3.1 are as follows.

(1) RL78/G24MCU Software Model
Model of software running on CPU
- LED feedback (constant current control)
- Dimming Control

(2) RL78/G24MCU Hardware Model
Models of hardware (I/O functions)
- PWM output by Timer KB0
- AD conversion of LED current (voltage) using PGA and A/D converter

(3) LED Circuit Model
Plant model to be controlled
- LED control circuit (back converter circuit for constant current control)
- LED (select one color as control target)

For details on each operation, refer to the LED control program (see related document (1)).

4. How to use simulation model

This chapter describes the file structure and usage (installation, simulation setup, and run) of the model.

4.1 File Structure

The model consists of the following files.

File and folder structure

./ RL78G24_LED_Simulator_setup.exe r20an0720ej0100-rl78g24-ledlightingcontrol-model.pdf readme.txt	 - Model installer - Application Note (this file) - Read Me file (please read first)

Installation folder structure

./ Renesas_RL78G24_LED_Simulator/ icon_48.png application uninstall	 - Icon file - Model exe file and data folder - Uninstall folder

application folder structure

Model exe file and data files are included.

./ Renesas_RL78G24_LED_Simulator.exe static_parameter_CPU.csv static_parameter_FAA.csv default_DiodeVI.csv default_InputVoltage.csv default_LEDlevel.csv readme.txt splash.png	 - IModel exe file - Static parameter (CPU) setting example File - Static parameter (FAA) setting example File - Static parameter (Custom LED VI characteristics) template file - Dynamic parameter (Input Voltage) template file - Dynamic parameter (LED current level) template file - Read Me file - Image File for exe file

4.2 Installation

To install the model, follow steps (1)-(2) .

(1) Extract the contents of the file (r20an0720jj0100-rl78g24-ledlightingcontrol-model.zip) to any folder.

(2) Run the installer (RL78G24_LED_Simulator_setup.exe) and follow the instructions.

MATLAB Runtime (Version R2022b) is required to run this model. MATLAB Runtime is installed from the installer.

Windows security warnings may appear when running this model. Permission to communicate on the network is not required to run this model.

4.3 simulation

Describes how to use simulations of the model.

4.3.1 Operation steps and Screen structure

To RUN the simulation, follow steps (1) - (4) .

(1) Run the program (Renesas_RL78G24_LED_Simulator.exe)

(2) Set simulation parameters (static and dynamic) :See chapter 4.3.3 for details

(3) Start and Stop simulation : See chapter 4.3.4 for details

(4) Check simulation results : See chapter 4.3.5 for details

Run the program and a window (Figure 4.1) will open.

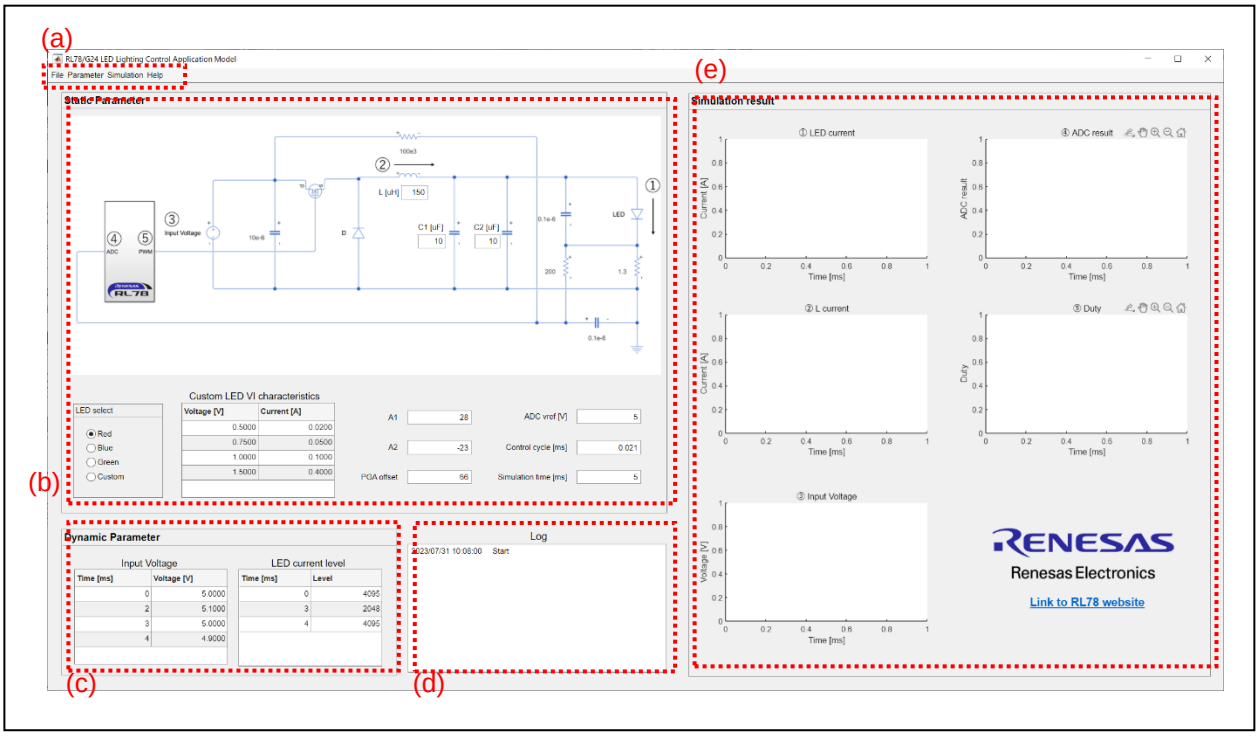

Figure 4.1. execution window

The functions of Figuer(a) - (e) are as follows

(a) Menu
Control menu for this model :See chapter 4.3.2 for details

(b) Simulation parameters (static)
Input section for static simulation parameters :See chapter 4.3.3 for details

(c) Simulation parameters (dynamic)
Input section for dynamic simulation parameters :See chapter 4.3.3 for details

(d) Operation & Status Log
Displays operation history and simulation status

(e) Simulation results
Waveform display of simulation results :See chapter 4.3.5 for details

4.3.2 Menu

Operations that can be controlled from the menu are shown in Table 4.1

Table 4.1. Menu List

Menu name	Operation	reference chapter
File		Chapter 4.3.5
=> Autosave	If Check box is enabled Automatically saves simulation results to a file	
=> Save simulation result	saves simulation results to a file	
Parameter		Chapter 4.3.3
=> Load parameter	Load each parameter from a file	
=> Save static parameter	Save static parameters to a file	
Simulation		Chapter 4.3.4
=> Run	Start Simulation	
=> Stop	Stop Simulation	
Help		–
=> About	View information about the model	

4.3.3 Simulation parameters

Simulation parameters are shown in Table 4.2

Table 4.2. Parameter List

Type	Parameter name	unit	Setting range Min/Max	Description
Static	L	uH	0.0001/5000	L constants of LED circuits
Static	C1	uF	0.0001/1000	C constants of LED circuits
Static	C2	uF	0.0001/1000	C constants of LED circuits
Static	LED select	-	-	LED color select for control (Red, Blue, Green, Custom)
Static	Custom LED VI characteristics	V,A	-	1-D Lookup Table of LED VI characteristics parameters when Custom is selected in LED select
Static	A1	-	-500/500	PI control parameter A1 *
Static	A2	-	-500/500	PI control parameter A2 *
Static	PGA offset	-	0/4095	Offset voltage correction value of PGA *
Static	ADC vref	V	0/10	Converted reference voltage of ADC
Static	Control cycle	ms	0.001/1	Feedback period T *
Static	Simulation time	ms	0.1/1000	Simulation end time
Dynamic	Input Voltage	ms,V	-	Supply voltage of LED circuit
Dynamic	LED current level	ms,-	-	Target current indication of PI control *

* See the LED control program (see related document (1)) for details on the parameters.

(1) Static parameter

Static parameters are parameters that are fixed in value during simulation.
Examples: current value of constant current, LED control circuit constants.

Static parameters are indicated in Figure 4.1(b) on the GUI.

Static parameters can be saved and loaded as a file.

Save : Parameter => Save static parameter
Load : Parameter => Load parameter => Load static parameter

The static parameter file is saved in CSV file format.

Note: Do not modify this file manually.

Static parameters have a defined setting range. If a value outside the range is set, the value is automatically changed. See Table 4.2 for the setting range.

Please use the CSV file attached to this model for setting values of static parameters in the LED control program (see related document (1)).

CSV File name (CPU) : static_parameter_CPU.csv
CSV File name (FAA) : static_parameter_FAA.csv

When Custom is selected for LED select, the LED VI characteristics parameters can be specified in the Custom LED VI characteristics field. The default values are the same as those entered for Red in LED select.

It is also possible to load pre-prepared parameters from the menu.

Load : Parameter => Load parameter => Custom LED VI characteristics

The parameter file is a 1-D Lookup Table of voltage V and current I expressed in CSV format. The values interpolated from this table are used as the VI characteristics of the LEDs. When editing, please use the CSV file attached to this model as a template.

Template file name(Custom LED VI characteristics) : default_DiodeVI.csv

Recommended specified values are 2 to 3 points near the current threshold voltage and at least 1 point near a voltage that is proportional.

(2) Dynamic parameter

Dynamic parameters are parameters that give the control scenario a value that changes at specified times during the simulation.

Example: input voltage, LED target current level

Parameters can indicate values at specified timing (time) are shown in Figure 4.1(c) on the GUI.
It is also possible to load parameters prepared in advance from the menu.

Input Voltage : Parameter => Load parameter => Input Voltage
LED current level : Parameter => Load parameter => LED current level

The dynamic parameter file is a 1-D Lookup Table of time and indication values in CSV format. When editing, please use the CSV file attached to this model as a template.

Template file name (Input Voltage) : default_InputVoltage.csv
Template file name (LED current level) : default_LEDlevel.csv

4.3.4 Start and stop simulation

Simulation can be started and stopped from the menu.

Start : Simulation => Run
Stop : Simulation => Stop

The status of the simulation is shown in Figure 4.1(d) on the GUI. Parameter set values are displayed at the start, and progress is shown during running.

4.3.5 Simulation Results

When the simulation is completed, waveforms corresponding to the simulation results are displayed at the position shown in Figure 4.1(e) on the GUI.

Simulation result list is shown in Table 4.3.

Table 4.3. Simulation Results List

Name	Unit	Waveform Name	Description
LED current	A	LED current(blue)	LED current
LED level	A	LED current(red)	LED current indication value (user specified)
L current	A	L current	L current
Input Voltage	V	Input Voltage	LED circuit power supply voltage (user specified)
Duty	-	Duty	Output PWM Duty
ADC result	-	ADC result	AD conversion value of current sensor voltage

Simulation results can be saved as a CSV file.
Save : File => Save simulation result

Simulation results can be saved automatically upon completion.

Auto save: select File => Autosave (check)

Do not auto save: select File => Autosave (no check)

The file name for the autosave file will be in the following format

File name: result_[YYYYYMMDDhhmmss].csv

Legend in [ ] ([ ] is not assigned to the file name)

YYYY : 4-digits

MM : 2-digit month

DD : 2-digit day

hh : 2-digit hour

mm : 2 digits of minute

ss : 2 digits of second

5. Revision History

Rev.	Date	Description	
		Page	Summary
1.00	2023.9.14	–	1st edition issued

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