

Smart Analog

Smart Analog Development Tutorial for TSA-IC500

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Introduction

This tutorial manual is designed to provide the user with an understanding of the hardware functionality of the Smart Analog IC 500 evaluation board TSA-IC500 and its development tool chains. It is intended for users evaluating this Smart Analog IC platform and using this evaluation board.

Target Devices

Smart Analog IC 500 (RAA730500DFP) and RL78/G1A (R5F10ELEAFB)

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1. Overview

This application note describes an example of developing a program that drives a phototransistor and controls LEDs in the Smart Analog development environment, by using the Smart Analog IC 500 evaluation board TSA-IC500 (TSA-IC500) on which a circuit configurable Smart Analog IC 500 and RL78/G1A are mounted.

1.1 Development environment

Use the latest version of development tools for the Smart Analog development environment.

Sensor Select Web Simulator	Renesas VA Version 2.0.0.0 or later
Analog Front End Design Tool	SA-Designer V1.02.00 or later
IDE	CubeSuite+ V2.00.00 or later



2. Required items

Prepare the items below before starting development by following the steps described in this document.

Required items

- Tessera Technology evaluation board TSA-IC500 incorporating Smart Analog IC
- Renesas on-chip debugging emulator E1
- New Japan Radio phototransistor NJL7502L
- LED \times 2 (any color)
- 470 Ω resistor $\times 2$ (1/8W)
- 1 k Ω resistor (1/8W)
- 50-pin female socket $(2 \times 25 \text{ pins}) \times 2$ and 50-pin male header $(2 \times 25 \text{ pins}) \times 2$
- Board $\times 2$

2.1 Tessera Technology evaluation board TSA-IC500 incorporating Smart Analog IC



Smart Analog IC 500 (RAA730500DFP) and RL78/G1A (R5F10ELEAFB) are mounted on this board.

How to obtain TSA-IC500

Corporate customer - Place an order with a Renesas distributor.

Private customer - Purchase the product from the Tessera Technology website.

 Tessera Technology Inc. <u>http://www.tessera.co.jp/tsa-ic500.html</u> (Japanese website)



2.2 Renesas on-chip debugging emulator E1



In this document, the E1 emulator is connected to the evaluation board TSA-IC500 and used as a debugger/flash memory programmer.

For all product sales, samples, status and availability information, please contact a Renesas Electronics distributor or sales representative in your area.

On-chip debugger E1

Part No.: R0E000010KCE00

• Renesas Buy/Samples: http://www.renesas.com/buy/index.jsp?campaign=gn_buy

2.3 New Japan Radio phototransistor NJL7502L



In this document, this phototransistor functions as a sensor driven by the Smart Analog IC. This product is available from parts suppliers or online.



2.4 LED × 2 (any color)



These LEDs are controlled from the RL78/G1A and blink to indicate the sensor operating status. This product is available from parts suppliers or online. You can choose any color.

2.5 470 Ω resistor \times 2 (1/8W)



These resistors determine the current that flows when driving LEDs via the RL78/G1A ports. This product is available from parts suppliers or online.



2.6 1 kΩ resistor (1/8W)



This resistor determines the current that flows when driving the sensor. This product is available from parts suppliers or online.

2.7 50-pin female socket (2 \times 25 pins) \times 2 and 50-pin male header (2 \times 25 pins) \times 2



50-pin male header (2×25 pins)

50-pin female socket (2 × 25 pins)

These connect the sensor to the LEDs on the evaluation board TSA-IC500. Prepare two of each. This product is available from parts suppliers or online.



2.8 Board × 2



These are the boards on which the female sockets are soldered. One is used to mount LEDs, and the other is used to mount the sensor. Prepare boards that have a space larger than a 25×2 matrix to connect the 50-pin sockets.

The photos below show the boards separated in two, onto which the pin sockets, LEDs, and sensor are mounted. Prepare the board as shown in these photos.





3. Overview of development

In this system, the phototransistor senses the amount of light and lights the LEDs accordingly. By using the Smart Analog IC, you can amplify the signal output from the phototransistor to adjust it to an optimum value, and then digitize the signal by using an A/D converter (ADC).

The ADC measurement range is divided into four ranges, and the LEDs are controlled to indicate "00", "01", "10", or "11", according to the signal output from the Smart Analog IC.





4. Procedures

The development flow described in this document is described below.

4.1 Simulating the sensor operation by using Renesas VA

RENESAS Lab. RENESAS RENESAS Lab. VA Virtual Smart Analog Laboratory () Ibit: 600 ø E D A Result: - Simulation result - Smart Analog circuit parameters (AFE register file) LDO_OUT Voltage (N

Simulate the sensor operation by using a simulator (Renesas VA).

4.2 Creating an evaluation board

Create two boards, one to mount the sensor and one to mount the LEDs, and mount them on the evaluation board.





4.3 Reading a register file by using SA-Designer and loading the file to CubeSuite+ to create a program

Read the Smart Analog AFE register file created by Renesas VA, convert it to a C source file by using SA-Designer, load the parameters to CubeSuite+, and then create the program to drive the sensor and control the LEDs.



4.4 Checking the operation on the evaluation board

Check whether the program created in section 4.3 operates as expected on the evaluation board.



Result:

- Sensor evaluation environment and program



5. Simulating the sensor operation by using Renesas VA

First, simulate the operation of the sensor and the Smart Analog IC by using Renesas VA, a web simulator provided by Renesas.

5.1 What is a web simulator

A web simulator enables analog circuits that incorporate a sensor and Smart Analog IC to be simulated and designed just by using a web browser. You do not need to download and install a special program. You can access the tool and simulate the operation any time you want, as long as you can connect to the Internet.

Renesas VA provides the following features:

- Circuit design You can combine a Smart Analog IC and a sensor to design a Smart Analog internal circuit.
- Transient analysis You can check the waveform generated from the analog signal converted by Smart Analog from the input sensor signal.
- AC analysis You can check the amplitude frequency characteristics of the waveform processed in the Smart Analog IC.
- Filtering effect analysis You can check the Smart Analog filter characteristics.
- Synchronous detector operation analysis You can check the operation of the synchronous detector incorporated in the Smart Analog IC.
- Reading and saving simulation details, and uploading and downloading the AFE register file You can read and save simulation results, and upload and download the Smart Analog AFE register file.



5.2 Using Renesas VA

Next, it is time to use Renesas VA.

Launch your web browser, and then access the Renesas website to obtain Renesas VA.

• Renesas VA

http://www.renesas.com/renesas_va Renesas home page \rightarrow **Products** \rightarrow **Smart Analog** \rightarrow **Renesas VA**



Click Try Now on the top right of the screen.



Click Agree on the bottom of the disclaimer screen.



A screen for inputting your My Renesas ID and password appears.

To use Renesas VA, you need a My Renesas ID and password. If you do not have an ID, click **New user? Click here to register now** to create an ID (free of charge).

Note At registration, if you select "Smart Analog" from **Category** under **Subscribe to content / service**, Smart Analog is added to your service list. You will then be able to receive newsletters related to Smart Analog products such as Renesas VA and SA-Designer.

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Type your My Renesas ID and password. The Renesas VA screen appears. Click **Get Started** on the top right of the screen.



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E Lite On (1)		R5F10FM (Configurable Amps with MCU	-	80-pin LOFP	8-bit res \times 4 CH	Manufacturer:	NJR
■ NJR (1)		RAA730300	Configurable Amps	-	48-pin LOFP	8-bit res x 7 CH	Description:	Amhient Light Sense
NJL7502L		RAA730301	natrumentation Amp		48-pn LOFP	8-bit res x 1 CH	Description.	
Para Light Electronics (1)		RAA730500	Configurable Amps	100	48-pin LQFP	8-bit res x 4 CH	Intensity (vv/m2	2): 1n to 73
Vishay (3)		RAA730501	nstrumentation Amp	-	48-pin LQFP	8-bit res x 1 CH	λ^{P} :	5.6e-007
Temperature Thermistor		RAA730502 I	ligh Speed Instrumentation Amp		48-pin LOFP	8-bit res x 5 CH		

Select the sensor to be connected to the Smart Analog IC.

Here, you are using a phototransistor, so click **Phototransistor** to expand the tree, click **NJR** to expand the tree, and then drag **NJL7502L** into the **Selected Sensors** area to specify the model number.





Select how to connect the sensor to the Smart Analog IC.



The PDF icon next to NJL7502L on the top left of the screen is linked to the NJL7502L data sheet. Click this icon to download the data sheet.

There are four types of bias circuit connections available for NJL7502L and the Smart Analog IC. Here, select the common collector type, which allows you to obtain the widest dynamic range when the circuit is driven at 5 V.



Select the Smart Analog product to use for simulation.

The current version of Renesas VA supports Smart Analog MCU (SiP that packages an AFE and MCU) and Smart Analog IC (AFE only).

Here, you are using an evaluation board on which a Smart Analog IC (AFE only) is mounted, so select a Smart Analog IC (RAA730500).





A screen that shows the connection of the sensor and Smart Analog IC appears.

The sensor is connected on the evaluation board in the later steps according to the connection between the sensor and the Smart Analog IC specified here. Although the sensor is automatically connected to the MPXIN20 pin on the screen, expand the drop-down list for the MPXIN21 pin and select "0.S_1" as the signal input from the sensor so that the sensor is connected to MPXIN21.

Here, when you attempt to change the sensor pin from MPXIN20 to MPXIN21, the message below will be displayed. Click **OK**.

Message output:

Custom sensor to AFE connections may not be supported by the Auto Configure function. To return to default connections select "Auto Connect".

ページ renesas.transim.com の記述:	×	
Custom sensor to AFE connections may not be supported by the Auto Configure function. To return to default connections select "Auto Connect". OK		Click here.





On this screen, configure settings such as the Smart Analog internal circuits, external signals input to the sensor, and the simulation type.

The default values are already set as the Smart Analog IC constants. You can start simulation with these settings. Here, to build the simplest configuration, use Amp CH.1 only. Clear the following check boxes that are selected by default: **DAC Enable** in **Amp CH.2**, **Enable** in **Gain AMP**, **DAC Enable** in **Gain AMP**, **LPF Enable** and **HPF Enable** in **Filters**, and **Enable** in **Temp. Sensor**.

The Volt Reg setting is used as the reference voltage for the A/D converter, so leave the setting as is (Enable selected).

Next, select the signal to input to the sensor.

Input Signal			×		
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Pulse Triangle User Defined				 For Input Sigr Min: Max: Frequency: Delay: 	nal, select "Sine". 1m W/m ² 876m W/m ² 500 Hz (default) 100u s (default)
2			Save Cancel	After specifying the Save butto right of the scr	g the above, click n on the bottom een.



Verify the settings by using the sine wave.

Here, specify 876 mW/m² for the maximum power of the signal input to the sensor, based on *Relationship between* W/m^2 and lux (*Lx*) below.

Relationship between W/m^2 and lux (Lx)

The unit of the signal input to the photodiode (used as the sensor in this procedure) is defined by using W/m^2 .

To make this easier to understand, we will convert the unit.

Lux (Lx) is generally used to indicate the luminance of light. The relationship between the lux (Lx) and W/m^2 is expressed as follows:

 $1 Lx = 1.46 \text{ mW/m}^{2 \text{ Note}}$

Therefore, estimate the luminance in lux first and then convert it to W/m2 by using the above formula.

Note To be exact, the condition "where the middle wave length of the visible light spectrum is 555 nm" applies to this formula.

The luminance in standard homes and offices is approximately 150 to 400 lux. (The value differs depending on the location.) In this tutorial, holding your hand above the sensor to shut down the room light is tested as the signal input condition, so estimate the power of the signal input to the sensor to be 400 lux (Lx) = 584 mW/m². To make allowances for the environmental conditions, specify 600 lux (Lx) = 876 mW/m² as the maximum value.



Finally, specify the Smart Analog amplifier gain and configure the bias circuit.

For **Gain** in **Amp CH.1**, use the value optimized by Renesas VA (24 dB) as is, and set the DAC1 value, which determines the bias voltage, to "0".

For **DAC Ref. Voltage**, set **DACVRB**, the lower limit for determining the D/A converter reference voltage, to "AGND".



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Click the Transient Analysis button. Simulation starts and the estimated time it will take is displayed.

You have now finished setting up and can start simulation.

Click the **Transient Analysis** button on the center top of the screen to start simulation.



When simulation finishes, the **Result** link to the simulation results appears immediately below the **Transient Analysis** button, and the waveforms resulting from simulation are displayed on the bottom of the circuit screen.

Based on the simulation results, you can see that the lower level of the AMP1 output is clipped. This is because the AMP1 bias voltage has been set to 0 V and thus the operating point of AMP1 is 0 V.

Based on the results, AMP1 output at 600 Lx is approximately 1.921 V, which seems to be low, so raise the gain.





Set the gain for AMP1 to 26 dB, and then click the Transient Analysis button to perform simulation again.



Based on the simulation results, you can see that the AMP1 output has been amplified to approximately 2.4 V. You have confirmed that sufficient output is obtained, so use this parameter.



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This screen shows a list of parts used for this simulation.

Click the Continue to Summary link on the top right of the screen to move to the next screen.





The simulation results are displayed.

If you click the pdf icon on the top right of the screen, you can download Renesas_RAA730500.pdf, which contains the simulation results shown on this screen.

Under **Registers**, click the **Download** button. You can download and save Renesas.Register.RAA730500.Sensor-XX_XXX.ini on your local disk.

This file contains the Smart Analog circuit configuration parameters (AFE register file) that were obtained as a result of simulation.

Simulation is now complete. Next, start development on the evaluation board.



6. Creating the sensor board and LED board

The following describes how to create the sensor board and LED board to be mounted on the evaluation board.

6.1 Soldering the 50-pin male headers (2 × 25 pins) on the evaluation board

Solder the 50-pin male headers on the top and bottom of the evaluation board TSA-IC 500.





6.2 Creating the sensor board and LED board

Create the sensor board and LED board to be mounted on the evaluation board TSA-IC 500.

6.2.1 Sensor board



Solder the circuits on the sensor board as shown below.



Sensor board circuit schematic



6.2.2 LED board



Solder the circuits on the LED board as shown below.



LED board circuit schematic



6.3 Mounting the sensor board and LED board on the evaluation board

Mount the sensor board and LED board on the evaluation board.



Note Mount the LED board on the top side of the evaluation board (the side facing up in the photograph) and mount the sensor board on the bottom side.



6.4 Configuring the power supply on the evaluation board

You can select an external power supply or USB bus power as the power supply for the evaluation board TSA-IC 500. Here, we are using USB bus power, so check that the jumper pins on the TSA-IC 500 are set as below.



Creation of the evaluation board is now complete.

Next, create a program by using this evaluation board.



7. Reading the AFE register file by using SA-Designer and creating a program by using CubeSuite+

Create a program that runs on the evaluation board by using the AFE register file for the Smart Analog IC created in section 5 and the sensor board, LED board, and evaluation board created in section 6.

7.1 The IC mounted on the evaluation board, connection to the microcontroller, and the program to create

Before developing a program, note the following concerning the Smart Analog IC mounted on the evaluation board, the microcontroller configuration, and the pins.



The figure above shows the connection of the Smart Analog IC 500 (RAA730500DFP) and RL78/G1A (R5F10ELEAFB) pins and a diagram of the internal circuits. Smart Analog IC 500 is connected to and controlled by RL78/G1A via the SPI.

Copy the register values in the AFE register file to the flash memory in the microcontroller, and create a program that drives the Smart Analog IC by transferring the register values from the SPI module in the microcontroller to the Smart Analog IC.



As part of this program, create a program that lights the LEDs by controlling the LED port signals based on the sensor signals sent to the A/D converter in RL78/G1A by the Smart Analog IC and A/D converted.

7.2 Installing SA-Designer

Install SA-Designer before creating the program.

7.2.1 What is SA-Designer?

SA-Designer is used to design analog front-end circuits for Smart Analog products and output the circuit data as C source code.

In conventional analog front-end circuit development, it took a long time to prepare hardware because parts needed to be procured for each sensor operation or each time the parts were changed. Using Smart Analog and SA-Designer resolves this problem, because circuits can be designed simply by using a mouse on the SA-Designer screen.

Using SA-Designer, you can import AFE register files that are created by the web simulator Renesas VA and that can be used to select the sensor, and use SA-Designer in association with integrated development environment CubeSuite+. As a result, you can complete all processes including sensor selection, circuit design, and program development just by using software, enabling efficient system development.

SA-Designer provides the following features:

- Designing and customizing circuits using a circuit schematic GUI
- Listing, saving and restoring created circuit data (such as register values)
- Reading the circuit design (AFE register file) created by using Renesas VA
- Creating C source files for circuit design
- Registering projects to CubeSuite+ and building, downloading, and debugging using CubeSuite+
- Tutorial



7.2.2 Installing SA-Designer

Launch your web browser, and then access the Renesas website > **Development Tools** > **Smart Analog Tools** > **SA-Designer**.

• SA-Designer

http://www.renesas.com/sa_designer

 $\textbf{Renesas home page} \rightarrow \textbf{Development Tools} \rightarrow \textbf{Smart Analog Tools} \rightarrow \textbf{SA-Designer}$

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On the Downloads tab, click Analog Front-End Design Tool SA-Designer Vx.xx.xx.



Click Agree on the disclaimer screen.



Smart Analog

A screen for inputting your My Renesas ID and password appears. Input your ID and password.

If you do not have an ID, click New user? Click here to register now to create an ID (free of charge).

Note At registration, if you select "Smart Analog" from **Category** under **Subscribe to content / service**, Smart Analog is added to your service list. You will then be able to receive newsletters related to Smart Analog products such as Renesas VA and SA-Designer.

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	Smart Analog IC300: KAA/30300 (回路構成)変型) Smart Analog IC301: RAA730301 (汎用計模アンプ型)								
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	СРИ	1GHz 以上 (マルチコア	CPU に対応)						
	メイン・メモリ	1Gバイト以上							
	注意:ホストマシンには、.NET Fra	mework 3.5 SP1がイン	ストールされている必要があります						
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Click the **Download** button on the bottom right of the screen to download and save the file on your local disk.

After you have downloaded the file SADesigner_Package_VXXXXX.exe, double-click it to launch the installer.





Click Next.



The software license agreement screen appears.

Click Accept, and then click Next.

🔯 Installer - step 3/7 [Select Components]			X
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Product Name		Size	
SA-Designer V1.02.00 (Must Install)		12789KB	
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The location where SA-Designer is to be installed is displayed. Check the location, and the click Next.





Click Next.

Install Status:	
SA-Designer V1.02.00:Installing	
	Ábot Installatione

Installation starts.

Installer - step 6/7 [Installation Execution]	X
Install Status: SA-Designer V1.02.00.Installing Installation completed successfully.	
: The installation was completed. Please click [New] button.	
<u></u>	
Abort Installations	

Click Next.

atter - step 777 [setup completion]		
Setup is complete. Click [Finish] to exit setting.		
- All installations were completed successfully.		~
The latest product update information can be check checked.	ed when the "Launch Update Manager." is	
		~

Click Finish. This completes installation of SA-Designer.



7.3 Installing CubeSuite+

Installing CubeSuite+

If you have already installed CubeSuite+, skip this procedure and go to section 7.4.

Note If you are using a CubeSuite+ version earlier than Ver. 1.02, upgrade it the latest version. To use CubeSuite+ in association with SA-Designer, you need to install CubeSuite+ Ver. 1.02 or later.

7.3.1 How to install CubeSuite+

See the following webpage for the features of CubeSuite+ and the environments in which CubeSuite+ can be used.

 Integrated development environment CubeSuite+ http://www.renesas.com/cubesuite+ Renesas home page → Development Tools → IDEs and Project Managers → CubeSuite+

Click the **Downloads** tab, click **[Evaluation Software]** CubeSuite+ Vx.xx.xx (Single Download) or (Multipart Download) to download and install CubeSuite+.

Note Install the latest version of CubeSuite+ (Ver. 1.02 or later).



7.4 Starting SA-Designer

To start programming, start SA-Designer.

Start SA-Designer from the Start menu.

All Programs \rightarrow Renesas Electronics Utilities \rightarrow Smart Analog Tools \rightarrow SA-Designer

On the SA-Designer Start screen, click GO under Open Existing Configuration File.

GO	We recommend reading the tutorial to find out what you The tutorial contains the information on how to effective	u can do with SA-Designer. ely use SA-Designer.
Curter	where BHO & Amplifier Ch3	
Design Net	w Circuit Diagram	Ling Ampatier
GO	Create a new AFE circuit diagram.	
Angela		
0		- Startal 120 2 844
Open Exist	ing Configuration File	
GO	Load an AFE design file of SA-Designer. You can also use this button to load files output by Ren	nesas Virtual AFE Designer (VA).
	a lace out warms	

7.5 Reading the AFE register file (.ini file) generated by Renesas VA

Open the AFE design file (Renesas.Register.RAA730500.Sensor-XX_XX_XXX.ini) obtained as a result of simulating the phototransistor NJL7502L by using Renesas VA.



Click Yes.



Generate Options 🛛 🗙
Source generation path
Eolder name:
Browse
Select compiler
Compiler for use:
When AFE register data files already exists
Overwrite O Not overwrite O Show message
notes : r_sadesigner.h files always overwrite.
C Library
Generate the <u>S</u> PI function.
<u>When they already exists</u>
Overwrite ONot overwrite OShow message
Generate the graph-analysis library.
When they already exists
O Dverwrite O Not overwrite O Show message

In the dialog box that appears, specify the path for the directory in which the source file will be created. For **Compiler for use**, select "CA78K0R (IDE: CubeSuite+)", and then click **OK**.

The SA-Designer circuit design screen appears.




7.6 Starting CubeSuite+

Associate SA-Designer with CubeSuite+.

Click the button in the red frame in the figure below to start CubeSuite+.

😂 Ren	esas.I	Register.RA	A7305	i00.Sen	sor-O	.11_26_20	13.ini (updated) - SA-De 🔳 🗖 🔀
File	View	Generate	Tool	Help			
🏠 Start			G	C 🖻	8	3 🖃 🛙	RAA730500 (Smart Analog IC500)

Create a project for the program described in this document.

One Point Advice	
CubeSuite+	Do you know? To float a panet: A panel can be floated by double-clicking the title bar of the panel and moving it away from the main window. To return the floating panel back inside the main window, double- click the title bar of that floating panel.
Po not show this dialog box at startup	* Displayed contents, random. 004 / 049 < <u>Back</u> <u>Next</u> > OK <u>H</u> elp

Click OK.

On the Start tab, click GO under Create New Project.

© CubeSuite+ - [Start]	
File Edit View Project Build Debug Tool Window Help	
ାଷ୍ଟି Start 🖵 🔋 🎖 🖻 🖻 I ୨ ୯ । ଲି 🕸 📥 💽 🔽 🎽 📳 💀 🖓 🖬	■ <br< th=""></br<>
K Start	→ X
Learn About CubeSuite+	
GO We recommend reading the tutorial to find out what can be done in CubeSuite+. The tutorial contains the information on how to effectively use CubeSuite+.	
Create New Project	
A new project can be created. A new project can also be created by reusing the file configuration registered to an existing project.	
Create New Multi-core Project	+
Open Existing Project	_
Loads the project of CubeSuite+. Can also be opened directly from the following link.	
Recent Projects Favorite Projects	
Nothing Nothing	
Open Existing e2 studio/CubeSuite/High-performance Embedded Workshop/PM+ Project	
The project created with e2 studio and the old IDE can be converted to the CubeSuite+ project.	
GO I Build options also can be canverted between the projects with the same compiler (Dnly CC-RX is supported in this version (1) Dnly include path and macro options can be converted between the projects with the different compiler.	ı
F1 F2 F3 F4 F5 F6 F1 F8 F9 F8	FTT FRE



Note If the above start screen does not appear when you start CubeSuite+, the cause might be plugins. On the **Tool** menu, click **Plug-in Setting**, and then configure plugins as shown below. If the start screen appears, go to the **Create Project** screen on the next page.

Plug-in Manager	
Checked plug-ins are loaded at the CubeSo These settings are enabled at the next star *You can never uncheck a check box of t it is recommended that the checkboxes of t Basic Function Additional Function	uite+ start-up. -up. he grayout plugin that is required by the CubeSuite+. Also, on the [Basic Function] tab, he plug-in for the target microcontroller of the development are not cleared.
Module Name	Description
Code Generator Plug-in	Plug-in to generate the device driver automatically.
Code Generator Plug-in 2	Plug-in to generate the device driver automatically.
📃 Debug Console Plug-in	DebugConsole plug-in to support using standard I/O.
🛛 🗹 Editor plug-in DLL	SEditor DLL
IronPython Console Plug-in	It is a console where the IronPython commands and the CubeSuite+ enhanced featur
📃 🔲 Pin Configurator Plug-in	Plug-in to define the device pin configuration.
Program Analyzer Plug-in	Plug-in to analyze program.
📃 🔲 Stack Usage Tracer	Utility to display and adjust stack usage of each functions.
🔲 🔲 Tool Interface Protocol (TIP) Plug-in	Plug-in that acts as an interface between tools (TIP).
📃 🔲 Update Manager Plug-in	Plug-in to communicate with CubeSuite+ Update Manager.

Select the plugins to be loaded when starting CubeSuite+. On the **Additional Function** tab, select "Code Generator Plug-in", "Code Generator Plug-in 2", "IronPython Console Plug-in", and "Program Analyzer Plug-in".

Plug-in Manager		
Checked plug-ins are loaded at the CubeSuite+ These settings are enabled at the next start-up. *You can never uncheck a check box of the gr it is recommended that the checkboxes of the pl Basic Function Additional Function	start-up. ayout plugin that is required by the CubeSuite+. Also, on the [B ug-in for the target microcontroller of the development are not o	tasic Function] tab, cleared.
Module Name	Description	
 ✓ RH850 Build tool CC-RH Plug-in ✓ Debugger Collection Plug-in ✓ RX Build tool CC-RX Plug-in ✓ V850 Build tool CA850 Plug-in ✓ V850E 2 Build tool CX Plug-in ✓ V850E 2 Build tool CX Plug-in ✓ V850 Emulator Plug-in ✓ V850E 2 Emulator Plug-in ✓ V850E 2 Simulator Plug-in ✓ V850E 2 Simulator Plug-in ✓ RL78,78KOR Build tool CA78KOR Plug-in ♥ RL78,78KOR Simulator Plug-in ♥ 78K0 Build tool CA78K0 Plug-in ♥ 78K0 Build tool CA78K0 Plug-in ♥ 78K0 Emulator Plug-in ♥ 78K0 Simulator Plug-in ♥ 78K0 Simulator Plug-in ♥ 78K0 Simulator Plug-in 	Build tool plug-in to use CC-RH compiler for RH850. Debug tool plug-in to use RH850,RX Emulator/Simulator. Build tool plug-in to use CC-RX compiler for RX. Build tool plug-in to use CA850 compiler for V850. Build tool plug-in to use CA850 compiler for V8502. Debug tool plug-in to use V850 Emulator. Debug tool plug-in to use V850 Emulator. Debug tool plug-in to use V850E2 Emulator. Debug tool plug-in to use V850E2 Emulator. Debug tool plug-in to use V850E2 Simulator. Build tool plug-in to use V850E2 Simulator. Debug tool plug-in to use CA78K0R compiler for RL78,78K0R. Debug tool plug-in to use RL78,78K0R Emulator. Build tool plug-in to use CA78K0 compiler for 78K0. Debug tool plug-in to use 78K0 Emulator. Build tool plug-in to use 78K0 Emulator.	·
	OK Cancel	

On the **Basic Function** tab, select "RL78,78K0R Build tool CA78K0R Plug-in", "RL78,78K0R Emulator Plug-in", and "RL78,78K0R Simulator Plug-in". Click **OK**.



On the Start tab, click GO under Create New Project, and then specify the settings shown below.

Select RL78/G1A to generate the code.

Create Project	<u> </u>	Microcontroller: RL78
Microcon <u>t</u> roller:	RL78	
Using microcontroller:		
(Search microcontroller)	Update	
RL78/G1A (ROM:64KE R5F10E8E(25pin) R5F10E8E(32pin) R5F10E8E(32pin) R5F10E8E(48pin) R5F10ELE(64pin) R178/G1E (ROM:48KE RL78/G1E (ROM:48KE RL78/G1E (ROM:44KE RL78/G1E (ROM:44KE RL78/G1E (ROM:44KE RL78/G	3) Product Name:R5F10ELE Internal R0M size[KBytes]:64 Internal RAM size[Bytes]:4096	Using microcontroller: RL78/G1A (ROM:64KB) > R5F10ELE(64pin)
Kind of project:	Application(CA78K0R)	
Project <u>n</u> ame:	Tutorial-1	
P <u>l</u> ace:	C:\Documents and SettingsDesktop Browse	Kind of project:
	Make the project folder	Application(CA78K0R)
C:\Documents and Settings\xx	xxx\Desktop\Tutorial-1\Tutorial-1.mtpj	Place: Any
Pass the file composition of	an existing project to the new project	
Project to be passed:	[Input project file to be diverted.] Browse	
Copy composition files in th	e diverted project folder to a new project folder.	
-	<u>Create</u> Cancel <u>H</u> elp	

After you complete the above settings, click the **Create** button.



7.7 Configuring the code generation settings

Create the program to actually run the microcontroller.

Here, you create the program by generating the code that configures the initial microcontroller settings, simply by specifying parameters on GUI screens.

Basically, you can start setting the function you want to configure by double-clicking it in the project tree. Configure each feature by following the procedures below.

7.7.1 Assigning clock generator pins







On-chip debug setting for clock generator

Property 📲 Code Generator*		
🚮 Reflect in Pin 🏻 🖳 Generate Code 🏼 🏂 🗯	💕 🐬 💁 🗭 🔗 🔲 🧔 🐠 🏯 🗖	
Pin assignment Clock setting On-chip debug settin	Confirming reset source Safety functions	
- On-chip debug operation setting		On-chip debug operation
🔘 Unused	⊙ Used	setting: Used
- RRM function setting		C
⊙ Used	O Unused	
- Security ID setting		
Use Security ID		
Security ID	0x0000000000000000000000000000000000000	
- Security ID, authentication failure setting		
Do not erase flash memory data		
Erase flash memoru data		

7.7.2 Assigning port pins





Configure port 0. Port 0 is used to control the LED that blinks according to the behavior of the sensor.

	Port0: Select Out for P00.
Property * Code Generator*	
🚮 Reflect in Pin 🖳 Generate Code	a 💕 🖉 💁 🔞 🔗 🔜 🥘 🐠 🏯 🗖
Port0 Port1 Port2 Port3 Port4 Port5	Port6 Port7 Port12 Port13 Port14 Port15
- P00 O Unused O In Out C P01	II-up 🗌 TTL buffer 📃 1
● Unused ○ In ○ Out □ Pu - P02	ull-up 🔲 TTL buffer 🔄 1

Configure port 7. Port 7 is used to control the CS pin on the Smart Analog IC.

The active level of the output from this port is High, so select the check box "1" on the right end of the output port.

	Port7: Select Out for P73.
Property 📲 Code Generator*	
🔣 Reflect in Pin 🛛 🖺 Generate Code 🏾 🍰	🎫 💕 🎜 🐔 🧭 🖉 🛄 🍈 📣 🏯 🔒
Port0 Port1 Port2 Port3 Port4 Port5	Port <mark>5 Port7 P</mark> ort12 Port13 Port14 Port15
● Unused ○ In ○ Out □ I	Pull-up 🗌 1
● Unused ○ In ○ Out □ I	Pull-up 🗌 N-ch 📃 1
● Unused ○ In ○ Out □ I	Pull-up 🗌 1
O Unused O In Out ←	Pull-up
	Select

Configure port 13. Port 13 is used to control the RESET pin on the Smart Analog IC.

	Port13: Select Out for P130.
Property 📲 Code Generator*	
🔣 Reflect in Pin 📲 Generate Code 🤰	💷 💉 🎜 🐔 🙆 🖉 💷 🍏 📣 🏥 🔒
Port0 Port1 Port2 Port3 Port4 Port5	Port6 Port7 Port12 Port13 Port14 Port15
O Unused	🗖 1
⊙ Unused ◯ In	

Configure port 14. Like port 0, port 14 is also used to control the LED that blinks according to the behavior of the sensor.

	Port14: Select Out for P140.
Property * Code Generator*	
📓 Reflect in Pin 🛛 🖳 Generate Code 🛛 🍒	💷 🖉 🖓 🔞 🔗 <u>– 🍈 </u> 構 🗅
Port0 Port1 Port2 Port3 Port4 Port5	Port6 Port7 Port12 Port13 Port14 Port15
O Unused O In Out ←	ull-up 🔲 1
⊙ Unused ◯ In ◯ Out 🔲 F	Pull-up 1

7.7.3 Configuring the A/D converter





Code Generator			
	<u></u>	43) 🛱 👝	
Reflect in Pin Generate Code	, ≭∎ e* /F ∿L (0 &/ II (9)	40) (首: -	
-A/D converter operation setting		/	VD converter operation
🔘 Unused	⊙ Used	s	etting: Used
- Comparator operation setting			
◯ Stop	 Operation 		
- Resolution setting			
12 bits	🔘 8 bits	(Comparator operation
- VREF(+) setting			etting: Operation
AVDD O AVREFP	 Internal reference voltage 		
-VREF(-) setting			
 AVSS 	AVREFM		
- Trigger mode setting			
 Software trigger mode 			
🔘 Hardware trigger no wait mode			
🔘 Hardware trigger wait mode			
Scroll the so	creen to the bottom		
Occurring and a office			
Continuous select mode	0		Operation mode setting.
	Continuous scan mode		Clear all the check beyon
O One-shot select mode	Continuous scan mode Dre-shot scan mode		Clear all the check boxes.
One-shot select mode ANIO ANI/12 shales input selection	Continuous scan mode One-shot scan mode		Clear all the check boxes.
One-shot select mode ANIO - ANI12 analog input selection	Continuous scan mode One-shot scan mode ANIO - ANI12	v	Clear all the check boxes.
 One-shot select mode ANIO - ANI12 analog input selection ANI16 - ANI30 analog input selection 	 Continuous scan mode One-shot scan mode ANIO - ANI12 	•	Clear all the check boxes.
One-shot select mode ANI0 - ANI12 analog input selection ANI16 - ANI30 analog input selection ANI16 ANI17	Continuous scan mode One-shot scan mode ANI0 - ANI12 ANI18 ANI19	• ANI20	Clear all the check boxes.
One-shot select mode ANI0 - ANI12 analog input selection ANI16 - ANI30 analog input selection ANI16 ANI17 ANI21 ANI22	Continuous scan mode One-shot scan mode ANID - ANI12 ANI18 ANI18 ANI19 ANI23 ANI24	 ANI20 ANI25 	Clear all the check boxes.
 One-shot select mode ANI0 - ANI12 analog input selection ANI16 - ANI30 analog input selection ANI16 ANI17 ANI21 ANI22 ANI26 ANI27 ANI27 	Continuous scan mode One-shot scan mode ANIO - ANI12 ANI18 ANI18 ANI19 ANI23 ANI24 ANI29 ANI2 ANI29 ANI2 ANI29 AN	ANI20	Clear all the check boxes.
 One-shot select mode ANI0 - ANI12 analog input selection ANI16 - ANI30 analog input selection ANI16 ANI17 ANI16 ANI21 ANI21 ANI22 ANI26 ANI27 AVU channel selection 	Continuous scan mode One-shot scan mode ANIO - ANI12 ANI18 ANI18 ANI23 ANI23 ANI24 ANI25	ANI20	A/D channel selection:
 One-shot select mode ANIO - ANI12 analog input selection ANI16 - ANI30 analog input selection ANI16 ANI17 ANI16 ANI27 ANI26 ANI27 AVU channel selection 	Continuous scan mode One-shot scan mode ANIO - ANI12 ANI18 ANI18 ANI19 ANI23 ANI24 ANI29 ANI	ANI20	A/D channel selection: Select ANI7.
 One-shot select mode ANI0 - ANI12 analog input selection ANI16 - ANI30 analog input selection ANI16 ANI17 ANI16 ANI21 ANI21 ANI22 ANI26 ANI27 AVU channel selection 	Continuous scan mode One-shot scan mode ANIO - ANI12 ANI18 ANI18 ANI23 ANI23 ANI24 ANI29 ANI29 Z.7 ≤ AVDD ≤ 3.6	ANI20	A/D channel selection: Select ANI7.
 One-shot select mode ANI0 - ANI12 analog input selection ANI16 - ANI30 analog input selection ANI16 ANI17 ANI16 ANI17 ANI21 ANI22 ANI26 ANI27 AVU channel selection - Conversion time setting Power voltage range Conversion time mode 	 Continuous scan mode One-shot scan mode ANI0 - ANI12 ANI18 ANI18 ANI19 ANI23 ANI24 ANI25 ANI25 ANI25 ANI26 ANI25 ANI25 ANI25 ANI26 ANI26 ANI25 ANI25 ANI25 ANI26 ANI25 ANI25 ANI26 ANI26	ANI20 ANI25 ANI30 A	A/D channel selection: Select ANI7.
 One-shot select mode ANI0 - ANI12 analog input selection ANI16 - ANI30 analog input selection ANI16 ANI17 ANI16 ANI21 ANI21 ANI22 ANI26 ANI27 ANI26 ANI27 Conversion time setting Power voltage range Conversion time mode Conversion time 	Continuous scan mode One-shot scan mode ANI0 - ANI12 ANI18 ANI19 ANI23 ANI24 ANI23 ANI25	 ANI20 ANI25 ANI30 ANI30 ANI30 (V) (µs) 	A/D channel selection: Select ANI7.
 One-shot select mode ANI0 - ANI12 analog input selection ANI16 - ANI30 analog input selection ANI16 ANI17 ANI16 ANI27 ANI21 ANI22 ANI26 ANI27 AVU channel selection - Conversion time setting Power voltage range Conversion time mode Conversion time 	 Continuous scan mode One-shot scan mode ANI0 - ANI12 ANI18 ANI18 ANI19 ANI23 ANI24 ANI23 ANI24 ANI25 ANI26 ANI26 ANI27 	 ANI20 ANI25 ANI30 ANI30 (V) (µs) 	A/D channel selection: Select ANI7.

This program only uses ANI7, so clear the check boxes for all the other A/D converter pins AIN16 to AIN30.



7.7.4 Configuring the serial interface



Serial array unit 1 uses channel CSI21, so select "CSI21" and specify its function.

		ا	Click the SAU	J1 tab.
	Reflect in Pin	Code Generator*	± ≈ <i>≥ 3</i> % 8 &	Channel 1: CSI21
	Channel UART2	CSI20 CSI21 II0	20 [1021]	Transmit/receive function
	Channel O	Unused 🔽		
	Channel 1	CSI21 🔽 🗌	Transmit/receive function 🛛 🗸	
ł				_
	Property	Code Generator*		
	Property	Code Generator*	<u>i</u> se e e <u>e</u> Q e	Click the CSI21 tab.
	Property MI	Code Generator*	🏂 💷 💕 🎜 🚳 🔗	Click the CSI21 tab.
	Property M Reflect in Pin SAU0 SAU1 IIC Channel UART2	Code Generator* Generate Code A0 CSI21 CSI21	A 1000	Click the CSI21 tab.
	Property Pro	Code Generator* Generate Code A0 CSI21 CSI21	<u>, 5</u> 5	Click the CSI21 tab.
	Property 12 Reflect in Pin SAU0 SAU1 IIC Channel UART2 - Function Channel 0	Code Generator* Generate Code A0 CSI21 Unused		Click the CSI21 tab.
	Property Reflect in Pin SAU0 SAU1 IIC Channel UART2 -Function Channel 0 Channel 1	CSI21	Transmit/receive function	Click the CSI21 tab.



Property Subscript Code Generator* Code Generator* Code Generator* Code Generator* Code Generator* Channel UART2 CSI20 CSI21 IIC20 IIC21 - Transfer mode setting Code Generator* Code Generato	Cartinuque transformedo	
Single transfer mode Data length setting 7 bits Transfer direction setting LSB Specification of data timing	Continuous transfer mode 8 bits MSB	 Transfer direction setting: MSB
(The below figures are for MSB data transfer direction • Type 1 SCKp SDp SDp SIp input timing • † † † † † † † † † • Type 3 SCKp SDp SCKp SDp SCKp SDp SCKp SDp SCKp SDp SCKp SDp SCKp SDp SCKp SDp SCKp SDp SCKp SDp SCKp SCKp SCKp SCK SCR SDp SCK SCR SCR SCR SCR SCR SCR SCR SCR	Type 2 SCKp SOp Sop Sop Type 4 SCKp SCKp Type 4	
Scroll the screen to	the bottom	
Transfer rate setting Clock mode Int Baudrate Transfer interrupt priority (INTCSI21)	ernal clock (master) 500 (bps) v	5.49) Transfer rate setting: Baudrate: 312500
Callback function setting Transmission end	Reception end 🔽 Overrun error	



7.7.5 Configuring the watchdog timer



Property 📲 Code Generator*		
🚮 Reflect in Pin 🛛 🖫 Generate Code 🏾 🔬 🗯	💕 🎜 💁 🙆 🔗 🔜 🍈 🐠 🍰 🔒	
- Watchdog timer operation setting		
💿 Unused		- Watabdag timor aparation
- Operation in HAL1/STOP/SNOOZE mode setting		softing: Unused
Enabled	Stopped	Setting. Ondeed
- Overflow time setting		
Overflow time	4369.07 (2^16/flL)	
- Window open period setting		
Window open period	100 🗸	
- Interrupt setting		
Enable interval interrupt when 75% of overflow t	me (INTWDTI)	
Priority	Low	



7.8 Generating code

Click Generate Code to generate code.

In the project tree, under the File folder, C source files and header files are generated.

				Clic	k Genera	te Code.		
	Q 0 I							
Project Tree	₽ ×	Property	Code Gunerator	<u>а</u>				
2 🕜 🙎 🔳	_	Reflect in Pin	Generate Co	ide 🔬 💲	🖬 💕 🖉 🖓	. 🕲 🔏 🗆	I 🚯 🐠 🚆	
RL78 Simulator (Debug To	ol) 🔥 📩	-Watchdog timer o	peration setting	unde setting	O Used			
⊕ The Build tool generated his startup Startup Code Generator	les	Enabled Overflow time sett	ng	loge secting	O Stoppe	d		
		Overflow time	ind setting		4369.07 (2	^16/IIL)	~	
r_cg_port.c		Window open	period		100		~	
r_cg_port_user.c		Enable int	erval interrupt when	75% of overflo	w time (INTWDT			
r_cg_adc.c	- 21	Priority			Low		~	
r_cg_adc_user.c	=	Output						
r_cg_macroariver r_cg_userdefine.h r_cg_cgc.h r_cg_port.h r_cg_serial.h r_cg_adc.h		M0409000:r_cg M0409000:r_cg M0409000:r_cg M0409000:r_cg M0409003:The [EOF]	_serial.h was _adc.c was gen _adc_user.c wa _adc.h was gen operation of g	generated erated.ل s generato erated.ل enerating	با ed.ہا file was su	uccessful.		
<	>	All Messages	*Code Generator	/ *Rapid B	Build /			
F1 F2 F3	F4	FS	FG	F7	FB	F9	FHB	FTI

Files for code that initializes the microcontroller are generated. APIs that control specific features are also generated.



7.8.1 Generating and registering C source files of circuit parameters

Return to the operation using SA-Designer.

Use SA-Designer to generate C source files of the Smart Analog IC parameters and register the generated C source files to Cube Suite+ automatically.

Click the icon enclosed by the red frame in the figure below.

😫 Ren	esas.Register.RAA730500.Sensor-0.11_26_2013.ini (updated) - SA-De 🔳 🔲 👌	×
File	View Generate Tool Help	
🏠 Start	🛃 🔚 🎨 🔳 📴 🔁 🎊 🍞 📼 🛛 RAA730500 (Smart Analog IC500)	
SA-Des	igner Information(100002)	
(į)	Generation of an AFE register data source file and registration of the file to a project were completed.	
	ок	

Click OK.



The C source files of circuit parameters are registered in the CubeSuite+ project tree.



7.9 Supplement for the files generated by SA-Designer

The Smart Analog IC parameters are defined as structure variables (const) in CubeSuite+.



Double-click r_sadesigner_reg.c.

The circuit parameters are generated as const variables defined in the form of {address, data}.

 $\{0xff, 0x00\}$ in the last line is a delimiter value.

7.10 Editing the program

7.10.1 r_main.c

Open r_main.c in the project tree. Add the lines **in blue**.



Smart Analog

Includes #include "r_cg_macrodriver.h" #include "r_cg_cgc.h" #include "r_cg_port.h" #include "r_cg_serial.h" #include "r_cg_adc.h" /* Start user code for include. Do not edit comment generated here */ Include the source files generated by #include "r_sadesigner.h" /* End user code. Do not edit comment generated here */ SA-Designer. #include "r_cg_userdefine.h" Global variables and functions /* Start user code for global. Do not edit comment generated here */ void R_SAIC_Write(smartanalog_t * const p_saic_data); Declare the SPI function and global void R SAIC Create(void); variables. extern const smartanalog_t gp_smartanalog_data[]; __ /* End user code. Do not edit comment generated here */ void R_MAIN_UserInit(void); * Function Name: main * Description : This function implements main function. * Arguments : None * Return Value : None void main(void) { R MAIN UserInit(); /* Start user code. Do not edit comment generated here */ R_CSI21_Start(); Configure initial setting of SPI and Smart R_SAIC_Create(); Analog IC and start A/D converter. R_ADC_Start(); while (1U) { ; } /* End user code. Do not edit comment generated here */ * Function Name: R_MAIN_UserInit * Description : This function adds user code before implementing main function. * Arguments : None * Return Value : None void R_MAIN_UserInit(void) { /* Start user code. Do not edit comment generated here */ EI(); /* End user code. Do not edit comment generated here */





When you complete coding up to here, save the changes.



7.10.2 r_cg_adc_user.c

Open r_cg_adc_user.c in the project tree.

```
Add the lines in blue.
```

```
Global variables and functions
/* Start user code for global. Do not edit comment generated here */
                                      Define the variable for acquiring A/D
uint16_t g_tmp = 0;
/* End user code. Do not edit comment generated here */ conversion results.
* Function Name: r_adc_interrupt
* Description : This function is INTAD interrupt service routine.
* Arguments : None
* Return Value : None
_interrupt static void r_adc_interrupt(void)
{
/* Start user code. Do not edit comment generated here */
uint16_t adcr_2bit = 0;
R_ADC_Get_Result(&g_tmp);
/* Example of updating LED by dividing A/D-converted value by 4 */
/* Use higher 2 bits out of A/D-converted lower 12 bits of g_tmp */
adcr_2bit = g_tmp >> 10;
/* Change the LED control port pin output based on 2-bit value. 1: LED = OFF, 0:
LED = ON */
switch (adcr_2bit)
case 0U: P0.0 = 1;
P14.0 = 1;
                                         Divide the A/D conversion result
break;
                                         by 4 to use each for LED control.
case 1U: P0.0 = 0;
P14.0 = 1;
break;
case 2U: P0.0 = 1;
P14.0 = 0;
break;
case 3U: P0.0 = 0;
P14.0 = 0;
break;
default: /* Through */
break;
/* End user code. Do not edit comment generated here */
}
/* Start user code for adding. Do not edit comment generated here */
/* End user code. Do not edit comment generated here */
```

When you complete coding up to here, save the changes.

7.11 Building the program

When you complete editing the source files, generate a program (load module) by using the **Builds the project** button. Click the button enclosed by the red frame in the figure below.



If no error is output here, the program has been generated successfully.

If an error is output, check the error message and review the settings configured in section 7.7 and 7.10.

7.12 Creating a program execution environment (connecting the emulator)



Connect the evaluation board, E1 emulator, and computer.

Prepare two USB cables.

- Use one USB cable to connect the E1 emulator to the computer.
- Use the other USB cable to connect the evaluation board to the computer.

Connect the E1 emulator and evaluation board TSA-IC 500 by using the cable that comes with the E1 emulator.



7.12.1 Configuring the debug tool

Configure the debug tool.



In the project tree, right-click **RL78 E1(Serial)** (**Debug Tool**), point to **Using Debug Tool**, and then click **RL78 E1(Serial**).

Configure the power settings for the E1 emulator connection and the setting to enable memory space access during program execution.



In the project tree, double-click RL78 E1(Serial) (Debug Tool).



Configure the settings as shown below.

	🔊 Propertu 💷 C	ode Generator ^s 🖓 r. coder	rigner regio 📝 rimpin o 📝 ri og odo uper o	
K			signer_reg.c/ = r_main.c/ = r_cg_auc_user.c	
e la comunicación de la comunica	🕺 RL78 E1(Serial) Prop	perty		
	Internal ROM/RAM			
	Size of internal ROM[K	(Bytes]	64	
	Size of internal RAM[B	lytes]	4096	
	Size of DataFlash mer	mory[KBytes]	4	
	Clock			
	Main clock frequency	[MHz]	Using internal clock	
	Sub clock frequency[k	(Hz]	Using internal clock	
	Monitor clock		System	
	Connection with Ta	rget Board		
	Power target from the	emulator.(MAX 200mA)	No	
	riasn			
Γ	Flash Security ID		MEX 000000000000000000000000000000000000	
	Security ID Permit flash programm	ing	HEX 000000000000000000000000000000000000	
	Flash Security ID Permit flash programm Use wide voltage mod	ing le	HEX 000000000000000000000000000000000000	
	Flash Security ID Permit flash programm Use wide voltage mod Erase flash ROM when	ing le n starting	HEX 000000000000000000000000000000000000	
	Flasm Security ID Permit flash programm Use wide voltage mod Erase flash ROM when	ing le n starting	HEX 000000000000000000000000000000000000	
	Flasm Security ID Permit flash programm Use wide voltage mod Erase flash ROM when	ing le n starting	HEX 000000000000000000000000000000000000	
	Flash Security ID Permit flash programm Use wide voltage mod Erase flash ROM when	ing le n starting	HEX 000000000000000000000000000000000000	
P	Flash Security ID Permit flash programm Use wide voltage mod Erase flash ROM when ower target from the	ing le n starting emulator. (MAX 200mA)	HEX 000000000000000000000000000000000000	
P S	Flash Security ID Permit flash programm Use wide voltage mod Erase flash ROM when ower target from the elect whether or not to	ing le n starting emulator. (MAX 200mA) supply power from the emula	HEX 000000000000000000000000000000000000	
P S	Flash Security ID Permit flash programm Use wide voltage mod Erase flash ROM when ower target from the elect whether or not to	ing le n starting emulator. (MAX 200mA) supply power from the emulat	HEX 000000000000000000000000000000000000	
P S	Flash Security ID Permit flash programm Use wide voltage mod Erase flash ROM when ower target from the elect whether or not to	ing le n starting emulator.(MAX 200mA) supply power from the emulat	HEX 000000000000000000000000000000000000	

Connect Settings tab > **Connection with Target Board** > **Power target from the emulator. (MAX 200mA)**:

No

Property 📲 Code Generator* 🗹 r_sade	esigner_reg.c 🛛 🛐 r_main.c 🔄 r_cg_adc_user.c
RL78 E1(Serial) Property	
🗆 Memory	
Memory mappings	[0]
Verify on writing to memory	Yes
Access Memory While Running	
Access by stopping execution	Yes
Update display during the execution	Yes
Display update interval[ms]	100
🗄 Break	
Hask for input Signal	N
Mask IARGET RESET signal	No
Mask INTERNAL RESET signal	NU
Display update intervalms]	
Specifies the interval for updating the watch panel a	and memory panel display during execution in units of 100 ms. T
specifiable value range is from 100 to 65500. Fractio	ins are rounded up.
Connect Settings Debug Tool Settings	Download File Settings / Hook Transaction Settings /

Debug Tool Settings tab > Access Memory While Running

Access by stopping execution: Yes

Display update interval[ms]: 100



7.13 Downloading the program to the microcontroller

Download the created program (load module) to the microcontroller. Click the button enclosed by the red frame in the figure below.

🙆 Tutorial-1 - CubeSuite+ - [Property]								
File Edit View Project Build Debug Tool Window Help								
ିଷ୍କ୍ର start 😺 🗟 🧊 🎖 🖻 🖻 🔊 ୧୦ ଲି 🐥 🔍 💌 🎽 🖬 🐨 🎁 🏹 🗑 💽 ୩୦ 🔍 🖓 🖘								
i 💎 🖓 🖉 🧐 🖓 💷 🗭 🗣 🔍 15	7				Dowr	in ads the pr	rogram to the debug tool.	
Project Tree 🗛 🗘	×	Property 📲 Code Ge	nerator* 🝸 r_sadesij	gner_reg.c 🗹 🗹 r	_main.c 🧃 r_cg_ad	dc_usicc	→ X	
2 🕜 🙎 🔳		🚑 RL78 E1(Serial) Property					P -+	
😑 💦 Tutorial-1 (Project)*	~	🗆 Memory						
R5F10ELE (Microcontroller)		Memory mappings		[0]				
Gode Generator (Design Tool)		Verify on writing to memory		Yes				
CA79K0D (Build Tool)		Access Memory While Ru	nning					
		Access by stopping execution	1 IIIII	Yes				
RL/8 E1(Serial) (Debug Tool)		Update display during the exe	cution	Yes				
		Display update interval[ms]		100				
🚊 🛄 File		🗄 Break						
🛓 📶 Build tool generated files		🖃 Mask for Input Signal						

7.14 Monitoring the A/D-converted values

Values A/D-converted in the program are stored in the variable g_tmp . To monitor the operation, add g_tmp to a watch list.

🔕 Tutorial-1 - RL78 E1(Serial) - CubeSuite	+ - [r	_cg_adc_user	.c]				
File Edit View Project Build Debug Tool Wind	dow He	lp					
: 🕅 Start 🚚 🔚 🍟 🔏 🗈 🛍 🔊 🕫	品	₩ # <u></u>		- 🚆 🖬 🕅		🖓 🖣 🐂 🔳 💽	0 🕑 🖬
i 🖓 🖓 🖉 🧐 🧟 🗖 i 🗖 🖓 🖓							
Project Tree 🛛 🗛 🗙	1	<pre>f r_sadesigner_</pre>	eg.c	🖞 r_main.c/ 🍸 r_cg_adc_user.c*		Local Variables	
2 🕜 🙎	30	 割 ⇒ へ	n 0	iolumns 🕶		💈 Notation 🕶 腾	Encoding
R5F10ELE (Microcontroller)	Line	Address	a 6			Current	
🗉 📲 Code Generator (Design Tool)	58			* Description : This	function	None	
CA78K0R (Build Tool)	59			* Arguments : None		Name	
RL78 E1(Serial) (Debug Tool)	60			* Return Value : Non	e		
	61			*****	******		
File	62			interrupt static v	oid r_ad		
Build tool generated files	63	00218					
S Startup	64	0000-		/* Start user code.	Do not e		
Gode Coperator	65	00220		B ADC Cot Boguli (57	_		
	67	00220		/* Example of LEU or	Register	to Watch1	
r_main.c	68			/* Use upper 2-bit W	1. abil. Die eisten	ha Analysia Chash	-
	69	00234	1.1	adcr 2bit = g tmp >>	Register	to Analysis Chart	
	70			/* Change the pin ou	😽 😽 Register	Action Event	
r_cg_cgc_user.c	71	00239	1	switch (adcr 2bit)	V Cut	CIELLY	-
	72			/	a cut	Ctri+X	
r_cg_port_user.c	73	0024a		case OU: P0.0 = 1;	Copy	Ctrl+C	
r_cg_serial.c	74	0024d		P14.0 = 1;	Paste	Chrl+V	
r_cg_serial_user.c	75	00250		break;		Carrie	_CPU Regist
r_cg_adexe	76	00252		case 1U: P0.0 = 0;	😤 Find	Ctrl+F	
r_cg_adc_user.c*	77	00255		P14.0 = 1;	🐔 Go To	Ctrl+G	Composito
	78	00258		break;	G G G G G G G G G G		ost Ab
- 🔄 r_cg_userdefine.h	79	0025a		case 20: P0.0 = 1;	- Forward	to Next Cursor Position	
📲 r_cg_cgc.h	80	0025d		P14.0 = 0;	🔄 Back to L	ast Cursor Position	
r ca port.h	82	00260		DICAK;			
	02	00262		Case 50: P0.0 - 0;	👌 Go to He	re	
		m.			🧼 Set PC to	Here	<u>/*</u> /
F1 F2 F3 F4		FS	FG	F7 F8	🦂 Jump to i	Function F12	Fi2
Performs registration to Watc Line 66/93 Column	24 1	Insert Wester	n Europe	an (Windows) 🔳 BREAK	Tag Jump	5 Shift+F12	200.00

In the project tree, double-click " $r_cg_adc_user.c$ ". In the right pane, double-click g_tmp in code, right-click the same g_tmp , and then select **Register to Watch1**.

If **Register to Watch1** does not appear, on the menu bar, click **Debug** and then **Download** to add the watch registration function.



7.15 Running the program to check the sensor operation

Run the program downloaded to the microcontroller to check the sensor operation.

Click the button enclosed by the red frame in the figure below.

Tutorial-1 - RL78 E1(Serial) - CubeSuite: File Edit View Project Build Debug Tool Wind	+ - [Watch1] ow Help		
🏽 🖗 Start 🛃 🔚 🍟 👗 🗈 🖺 🛩 (*	🚜 🎄 🐴 💌	- G	୍ମା 🖓 🗅 🦏 🗐 📵 💽 🗠 🛤 🥛
Project Tree A 2 3 B RSF10ELE (Microcontroller) Code Generator (Design Tool) CA78K0R (Build Tool) RL78 E1(Serial) (Debug Tool) Program Analyzer (Analyze Tool) File File	Image: Section 2 Image: Section 2 Image: Section 2 Image: Section 2 Image: Section 2 Image: Section 2 Image: Section 2 Image: Section 2 Image: Section 2 Image: Section 2 Image: Section 2 Image: Section 2 Image: Section 2 Image: Section 2 Image: Section 2 Image: Section 2 Section 2 Image: Section 2 Image: Section 2 Image: Section 2 60 Image: Section 2 Image: Section 2 Image: Section 2 61 Image: Section 2 Image: Section 2 Image: Section 2 62 Image: Section 2 Image: Section 2 Image: Section 2 63 00218 Image: Section 2 Image: Section 2	anc r_cg_adc_user.c* ₹ 4 1 Description : This function Arguments : None Return Value : None 	Watch1 # X Image: Second state Image: Second state Image: Second state
Startup Code Generator	64 /* 65 0022c uin 66 0022d R.2 67 /*	<pre>Start user code. Do not o nt16_t actr_2bit = 0; NDC_Got_Result(&g_tmg);e Example of LED_display.up</pre>	er
r_systeminit.c	68	Watch1	ч х
		🗷 🛞 🐇 🖑 🗙 🕨	Notation - H
		Watch	Value Type(Byte Size)
		♥ g_tmp	<pre>175 (0x00af) unsigned short(2)</pre>

The value of g_tmp that has been added is displayed.

Take an action such as holding your hand above the sensor or move the sensor to a light source such as a fluorescent light, and confirm that the g_tmp value changes according to the sensor operation.

Also check that the LEDs light.

Here, display the sensor operation in graph form to make it easy to grasp.

Stop the program. Click the button enclosed by the red frame in the figure below.

🙆 Tutorial-1 - RL78 E1(Serial) - CubeSuite	-frcgadc	user.c]						
File Edit View Project Build Debug Tool Windo	w Help							
🚳 Start 🚚 📄 🍟 🔏 🖻 🚳 🔊 🔿	A & A		•	" i 😽 😽 i	DefaultBuild	- 200	Dy 🐂 🦲 🕞	🕞 🐴 Se Çe 🛛 🦉
Project Tree 🛛 📮 🗙	1 I r_sades	igner_reg.c	r_main.c	a a a → x	Watch1			д Х
2 🕜 🙎 🔳	30 80 ->	0 5 0	olumns •		2 🧶 ≵	🖓 🗙 🛛 Not	ation 🕶 📴	
R5F10ELE (Microcontroller)	Line 🙀 Ad	dress 🔟 👉			Watch		Value 1	Type(Byte Size)
🗊 📲 Code Generator (Design Tool)	58		* Descriptio	on : This	😜 g_tmp		175 (0x00af) u	unsigned short(2)
- 🔨 CA78KOR (Build Tool)	59		* Arguments	: None				
	61		*********	*******				
Program Analyzer (Analyze Tool)	62			static v				
Build tool generated files	63 0	0218						
Startup	65 0	022c	uint16_t add	r code r_2bit =				



7.16 Displaying the sensor operation in graph form on the Analysis Chart panel

To display the sensor operation in graph form, perform the following steps 1 to 3.



- 1. Click the Displays Analysis Chart panel icon on the top left of the screen.
- 2. A blank graph appears. Click the **Reflect** button above the graph.
- 3. Confirm that g_tmp has been added below the graph.



Tutorial-1 - RL78 E1(Serial) - CubeSuite+ - [Property] File Edit View Project Build Debug Tool Window Help 🚳 Start 🔒 🔠 🦆 🔉 🖻 🛍 🖌 🖓 🗮 🌉 🦀 🍹 😽 😽 DefaultBuild 🔹 🦉 🖓 🐂 💷 🕑 🕑 🐂 🖙 🖓 • 💎 🖓 🖉 🧖 🐻 💷 🗭 🖳 🗩 Project Tree **μ** Χ 🚰 Property 🌇 Disassemble1 🧃 r_sadesigner_reg.c. 🗃 r_main.c. 🗃 r_cg_adc_u 🔻 🔸 🗙 Watch1 **д X** 2 🕜 🙎 🔳 Malysis Chart Property +- ۹ 😰 | 🎨 | 🐉 🌯 🗙 | Notation - 🖳 🗆 General Watch 🖃 [Tutorial-1 (Project)* ~ Value Type (Analysis method Real-time sampling E R5F10ELE (Microcontrolle 170 (OxOOaa) unsig 🛯 g_tmp 🛓 🔚 Code Generator (Design Auto adjustment None 🔨 CA78KOR (Build Tool) Time per grid[Time/Div] 500m: 🕀 Program Analyzer (Analy: Specify foreground color and background color No Cursor-A color PaleGreen 📶 Build tool generated f Cursor-B color PaleTurquoise Zoom-1 color 64, 255, 10, 79 💕 Startup Zoom-2 color Zoom-3 color 64, 91, 228, 22 🛓 🔲 Code Generator 64, 5, 109, 239 🔄 r_sadesigner_reg.c Zoom-4 color 64, 255, 84, 28 r_sadesigner.h 🗆 Triager 🚽 r_sadesigner_reg.h Use trigger function No 🗆 Channel 1 Variable/Address 1 g_tmp 500 Value per grid[Val/Div] 1 Offset 1 -2000 🗆 Channel 2 Variable/Address 2 🗿 Local Variables 🗱 CPU Register 🏹 Watch1 Type/Size 2 Auto Value per grid[Val/Div] 2 25.5 Output **џ** × Offset 2 n. [EOF] 192, 91, 228, 22 Color 2 🗆 Channel 3 Y Offset 1 Specify the offset for the variable value. The offset is added to the variable value in drawing chart. Variable Value Changing < All... Cod... *Ra... / *Pr... *Bu... 🖌 *De... F7 F2 F3 FG F7 FB FS FHD FTT FH2 F4 III F5 BREAK > 0x00290 === RL78 E1(Serial) 👸 40.792 s

In the project tree, double-click **Program Analyzer (Analyze Tool)**.

Variable Value Changing tab > General >

Auto adjustment: None

Time per grid[Time/Div]: 500ms

Channel 1 > Value per grid[Val/Div] 1: 500

Offset 1: -2000



When you have finished the above settings, click the icon enclosed by the red frame in the figure below to run the program again.



On the **Analysis Chart** tab, take an action such as holding your hand above the sensor or moving the sensor to a light source such as a fluorescent light, and confirm that the sensor operation is displayed in graph form.

The program is now created.

Stop the program.

Click the button enclosed by the red frame in the figure below.

🙆 Tutorial-1 - RL78 E1 (Seria	l) - CubeSuite+ - [Analysis Chart]	-7×
<u>File E</u> dit <u>Vi</u> ew <u>Project B</u> uild <u>D</u> e	bug <u>T</u> ool <u>Wi</u> ndow <u>H</u> elp	
🏽 🔍 <u>S</u> tart 🛃 🔚 🍟 🐰 l	🐚 🕼 🔊 🔍 🚆 🤐 🗸 🔍 🔍 🥊 🦉 🦉 DefaultBuild 📼 🎉 🚳 🗅 🐂 🔘 🔘 ઉ) HJ 23 C3 🕺
- 💎 🖓 🖉 😵 🖓 💷 📮		
Project Tree 7 X	1 🝸 r_sadesigner_reg.c. 🏹 r_main.c. 🏹 r_cg_adc_user.cl. 📈 Analysis Chart 🛛 🗢 🖌 🗙 Watch1	џ х
2 🕜 🙎 🔳	ति दा	n. Heg
Intorial-1 (Project)* Intorial-1 (Project)* R5F10ELE (Microcontrolle Code Generator (Design)	Analysis method: Image: Sampling Sampling Reflect Zoom: Zoom1 Image: Sampling	Value Type(5 (0x01b3) unsig
CA78k0R (Build Tool) RL78 E1(Serial) (Debug Tr Program Analyzer (Analy: E I) File	Cursor: [Setting: [Ctr] ke Axis (Time) Yaxis (Value) Target Cursor:	
Build tool generated f	Time:	



Terminate the debug tool to finish debugging.

Click the icon enclosed by the red frame in the figure below.

🙆 Tutorial-1 - RL78 E1(Seria	il) - Cu	ıbeSuite+ - [r_main.c]						PX
<u>File E</u> dit <u>Vi</u> ew <u>Project B</u> uild <u>D</u> e	bug <u>T</u>	ool <u>W</u> indow <u>H</u> elp							
🏽 🚳 <u>S</u> tart 🛃 🔚 🎒 🖁 👗	b C	90 🏦 🚆	-	100%	- 67	🚮 DefaultBuild	- 🔨		
l 💎 🖓 🖉 💖 🤻 🗀 🖗						i 🚮 🗅 🐂	🔳 🕟 🕞 🔫 🔳	ÇI 🖆 👗	
Project Tree 🛛 📮 🗙	1/12	r_sadesigner_reg.c	r_main.c [🛐 r_cg_ad	dc_user.cl 📈 Anal	ysis Chart	₹ 1 Disconn	Watch1 ects from the debug tool an	nd stops vebugging, (Sh	п⊻ ift+F6)
2 🕜 🙎 🔳	30	📸 🔿 🗠 🖍 Co	lumns 🕶				🔳 🦁 🏖 🐧 🗙	N cation •	
🖃 [Tutorial-1 (Project)* 🔼	Line	🟭 Address <u> </u> 🕞					Watch		Type (
R5F10ELE (Microcontr	58		extern const s	martanalog_t	gp_smart	analog_dat	😜 g_tmp	3.2	unsig
🛓 🖳 Code Generator (Desi	59		/* End user co	de. Do not ed	it comme	nt generat(
CA78KOR (Build Tool)	60		void R_MAIN_Us	erInit(void);					
RL78 E1(Serial) (Debu	61		=/**********	**********	******	********			
	62		* Function Nam	e: main					
Eile	63		* Description	: This function	on imple	ments main			•
The Puild heat generate	64		* Arguments : I	None					
States	65		* Return Value	: None					
SA Startun	66		************	**********	*******	******	1		1

Save the project and terminate CubeSuite+.

🙆 Tutorial-1 - RL7	78 E1(Serial) - CubeSuite+ - [Project Tree]			_ 7 🗙
File Edit View Proje	ct Build Debug Tool Window Help			
🕺 🚳 Start 🛛 🌄 🌃	Create New Project	▼ 100% ▼ 🔐 ன DefaultBuild	- 🔨	
i 💎 💎 📈 🌃	Open Project		🔳 🕑 🗠 🕽 🖅 🖉 🕘	
Project Tree	Favorite Projects	🛛 🗹 r_cg_adc_user.cl 📈 Analysis Chart 🛛 🗢 🗙	Watch1	д X
2 🕜 🙎 🛛	Add		🗃 🥮 🐉 🌂 🗙 Notation 🕶	Hex
🖃 🚺 Tutorial- 🎆	Set Tutorial-1 as Active Project		Watch	Value Type(
R5F1C	Dependent Projects Settings	h const smartanalog_t gp_smartanalog_dat i user code. Do not edit comment generat	👻 g_tmp 171 (0:	<mark>x00ab)</mark> unsig
	Close Project	R_MAIN_UserInit(void);		
	Save Project Ctrl+Shift+S	ion Name: main		
E J File ABOA	SaroTrojočkism	ments : None		
	Remove from Project Shift+Del	urn Value : None		
	Save Project and Development Tools as Package	hain(void)		

Remark: When CubeSuite+ is started the next time and this project is loaded, the above settings are automatically restored.



On the File menu, click Exit to terminate CubeSuite+.



Terminate SA-Designer.



On the File menu, click Exit to terminate SA-Designer.

You are asked whether to save the AFE register file used here. Save the file, as necessary.

Keep the evaluation board, the E1 emulator, and the computer connected because they will be used to write the program to the microcontroller in the next step.



7.17 Writing the program to the microcontroller

Write the program to the RL78/G1A. Start the programming tool from the Start menu.

All Programs > Renesas Electronics Utilities > Programming Tools > Renesas Flash Programmer Vx.xx

Welcome!	
 Create new workspace. <u>B</u>asic mode Open latest workspace. 	◯ <u>F</u> ull mode
C:\Documents and Settings O Open workspace. 	\toolgi\Local Settings\Application Data\Renesas Flash Progra

In the Welcome dialog box, select Create new workspace, Basic mode, and then click Next.

Create new workspace			
<u>M</u> icrocontroller: Eilter:	RL78 G1A	•	
Using Target Microcontroler:			
	Device Name	Information	^ ^
HL/8/G1A	K5F10EBC		
RL78/G1A	R5F10EBD		
RL78/G1A	R5F10EBE		
RL78/G1A	R5F10EGA		
RL78/G1A	R5F10EGC		
RL78/G1A	R5F10EGD		
RL78/G1A	R5F10EGE		=
RL78/G1A	R5F10ELC		
PI 79/G1A	R5E10ELD		
RL78/G1A	R5F10ELE		
			<u></u>
Workspace Name:			
Project Name:			
Folder:	C:\Documents and Settings\	.ocal Settings\Application I	Dat Browse
		Next	<u>C</u> ancel

On the **Create new workspace** screen, select RL78/G1A - R5F10ELE under **Group** and **Device Name**, type any workspace name, and then click **Next**.

(The workspace name is automatically inserted to the **Project Name** box.)





Confirm that **Tool** is set to "E1", and then click **Next**.

Frequency		
Target Device Connecti Interface: Interface <u>S</u> peed:	on UART-ch0 1,000,000bps	
Supply Oscillator		
<u>F</u> requency: <u>M</u> ultiply rate:	Internal-OSC MHz	
	Back Next Car	icel

Use the interface speed selected by default as is. Click Next.

Power Supply
Power supply from the emulator Power target from the emulator.
Supply voltage: 3.3V 5.0V(USB VBUS)
Additional Settings
Input <u>V</u> oltage: [V]
<u>B</u> ack <u>N</u> ext <u>C</u> ancel

Click Next.



- Device lafe metice File	
File name	R5F10ELE pr5
File version	V1.00
∃ Target	
Interface	UART-ch0
Communication transfer rate	1,000,000bps
Supply oscillator	Target
Frequency [MHz]	Internal-OSC
Multiply rate	1.00
Supply power	Target
3 Using Tool	
Tool name.	E1
Device Information File	

Click Complete.

Renesas Flash Progr	ammer (Supported Version)	
File Tool Microcontrol	er Help	
Microcontroller:	R5FIUELE	
User/Data area:		<u>B</u> rowse
User Boot area:		Browse
Command:	Autoprocedure(E.P)	
	Start	
		<u>^</u>
		~
		<u>C</u> lear Output Panel

Click the **Browse** button and specify *filename*. hex from the project files created in the above procedure.



ʎ Renesas Flash Progra	mmer (Supported Version)	
File Tool Microcontrolle	r Help	
Microcontroller: User/Data area:	R5F10ELE Tutorial-1.hex	Browse
User Boot area: Command:	Autoprocedure(E.P)	Browse
	Start	
		~
		ear Output Panel

Click Start. Programming then starts.

Renesas Flash Progra	mmer (Supported Version)	
File Tool Microcontrolle	r Help	
Microcontroller: User/Data area: User Boot area: Command:	R5F10ELE Tutorial-1.hex Autoprocedure(E.P)	Browse
	Start	
	PASS	
20% 30% 40% 50% 60% 70% 80% 90% 100% PASS Autoprocedure(E.P) PASS End(Autoprocedure(E.F ======= (Disconnect) =))	
		<u>C</u> lear Output Panel

When **PASS** is displayed, the program has been written successfully.



🖟 Renesas Flash Programmer (Supported Version)	
File Tool Microcontroller Help	
Create a new workspace	
Open a workspace	
Exit	<u>B</u> rowse
User Boot area:	Browse
Command: Autoprocedure(E.P)	
Start	
PASS	
20% 30% 40% 50% 60% 70% 80% 90% 100% PASS Autoprocedure(E.P) PASS End(Autoprocedure(E.P)) ===============================	
	Clear Output Panel

On the File menu, click Exit to terminate the Renesas Flash Programmer.

The program is now written.

Disconnect the cables between the computer and E1 emulator, and between the E1 emulator and evaluation board TSA-IC 500.

Do not disconnect the cable between the computer and evaluation board TSA-IC 500 because it is used to supply power to the evaluation board.

The program creation by using SA-Designer and CubeSuite+ is now complete.

Finally, check the operation.



8. Checking the operation on a real machine

Check the operation on a real machine.

Press the RESET (SW2) switch on the evaluation board to reset the IC on the evaluation board.



Hold your hand above the sensor (seen on the near side in the above figure) to confirm that indication of the LEDs changes according to the luminance around the sensor.

The Smart Analog system has now been developed.

If you still have time to go further, try the following:

- Tune the sensitivity of the sensor by changing the gain setting in Renesas VA.
- Increase the number of LEDs.
- Light LEDs in different ways.

If your system do not work properly

If your system does not work properly, review the following:

- Read section 7 and confirm that the settings and program code are correct.
- Check that the evaluation board, sensor board, and LED board are connected correctly.



9. Supplement

This application note describes how to simulate the sensor operation, how to develop a program for microcontroller operation, and how to verify the operation on a real machine, for those who use Smart Analog for the first time.

Based on the knowledge presented in this application note, we recommend you to try controlling other types of sensor and using Smart Analog internal features (such as filtering and synchronous detector).

Smart Analog products offer additional useful features. Three representative examples are provided below.

9.1 Multi-sensor control

A Smart Analog IC incorporates multiplexers with six channels, each of which has a differential pair on its input stage.

By using a multiplexer and the configurability (that enables changing the amplifier usage among inverting, non-inverting, differential, and transimpedance dynamically) of the built-in amplifier, you can use multi-sensor control that allows you to control multiple sensors with different control method at the same time.



Example of multi-sensor control using Smart Analog



9.2 Low power operation achieved by intermittent operation

In a Smart Analog IC, the incorporated analog circuit blocks can be turned on and off individually.

By using this feature, you can control an analog circuit block so that it is turned on when it is sensing, and off when it is not sensing, which reduces the power consumption.



Example of low-power operation using Smart Analog



9.3 Auto calibration control

In Smart Analog ICs, you can change the parameters such as the gain and offset voltage for internal analog circuits dynamically.

By using this feature, a sensitivity drop caused by dirt or long-term sensor drift can automatically be corrected.



Example of auto calibration control using Smart Analog

In addition to the above features, you can use many other features.

Try your new idea with Smart Analog.


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Revision Record

		Description	
Rev.	Date	Page	Summary
Rev.1.00	Mar 31, 2014		First edition issued

General Precautions in the Handling of MPU/MCU Products

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

1. Handling of Unused Pins

Handle unused pins in accordance with the directions given under Handling of Unused Pins in the manual.

— The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible. Unused pins should be handled as described under Handling of Unused Pins in the manual.

2. Processing at Power-on

The state of the product is undefined at the moment when power is supplied.

- The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the moment when power is supplied.
 In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the moment when power is supplied until the reset process is completed.
 In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the moment when power is supplied until the power reaches the level at which resetting has been specified.
- 3. Prohibition of Access to Reserved Addresses

Access to reserved addresses is prohibited.

- The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.
- 4. Clock Signals

After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has stabilized.

- When the clock signal is generated with an external resonator (or from an external oscillator) during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Moreover, when switching to a clock signal produced with an external resonator (or by an external oscillator) while program execution is in progress, wait until the target clock signal is stable.
- 5. Differences between Products

Before changing from one product to another, i.e. to a product with a different part number, confirm that the change will not lead to problems.

— The characteristics of an MPU or MCU in the same group but having a different part number may differ in terms of the internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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Renesas Electronics America Inc. 2801 Scott Boulesvard Santa Clara, CA 95050-2549, U.S.A. Tel: +1-408-588-6000, Fax: +1-408-588-6130 Renesas Electronics Canada Limited 1101 Nicholson Road, Newmarket, Ontario L3Y 9C3, Canada Tel: +1-905-989-5441, Fax: +1-905-898-3220 Renesas Electronics Europe Limited Dukes Meadow, Milboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K Tel: +44-1628-585-100, Fax: +44-1628-585-900 Renesas Electronics Europe GmbH Arcadiastrasse 10, 40472 Düsseldorf, Germany Tel: +49-211-6503-0, Fax: +44-1628-585-900 Renesas Electronics (China) Co., Ltd. Renesas Electronics (China) Co., Ltd. Rom 1709, Quantum Plaza, No.27 ZhiChunLu Haidian District, Beijing 100191, P.R.China Tel: +86-10-235-1155, Fax: +86-10-235-7679 Renesas Electronics (Shanghal) Co., Ltd. Niti 301, Tower A, Contral Towers, 555 Langao Road, Putuo District, Shanghai, P. R. China 200333 Tel: +86-10-235-1155, Fax: +88-21-2226-0989 Renesas Electronics Hong Kong Limited Unit 1601-1613, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong Tel: +88-10-255-6588, Fax: +858-2022/9044 Renesas Electronics Inwar Co., Ltd. 13F, No. 383, Fu Shing North Road, Taipei 10543, Taiwan Tel: +88-0-8175-9600, Fax: +886 2-8175-9670 Renesas Electronics Mangore Pte. Ltd. 80 Bendemeer Road, Unit 100-155, 9670 Renesas Electronics Mangyais 20.24 Mylux Innovation Centre, Singapore 339949 Tel: +58-21-2020, Fax: +656-21300 Renesas Electronics Mangyais 30n.Bhd. Unit 906, Bloch B, Menara Amoorp. Amoorp Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia Tel: +60-3-7955-9390, Fax: +60-3-7955-9510