

# RX210 Group

## Renesas Starter Kit Software Manual

RENESAS MCU  
RX Family / RX200 Series

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# How to Use This Manual

## 1. Purpose and Target Readers

This manual is designed to provide the user with an understanding of the RSK hardware functionality, and electrical characteristics. It is intended for users designing sample code on the RSK platform, using the many different incorporated peripheral devices.

The manual comprises of an overview of the capabilities of the RSK product, but does not intend to be a guide to embedded programming or hardware design. Further details regarding setting up the RSK and development environment can found in the tutorial manual.

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

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

The following documents apply to the RX210 Group. Make sure to refer to the latest versions of these documents. The newest versions of the documents listed may be obtained from the Renesas Electronics Web site.

Document Type	Description	Document Title	Document No.
User's Manual	Describes the technical details of the RSK hardware.	RSK RX210 User Manual	R20UT0302EG
Software Manual	Describes the functionality of the sample code, and its interaction with the Renesas Peripheral Driver Library (RPDL)	RSK RX210 Software Manual	R20UT0305EG
Tutorial	Provides a guide to setting up RSK environment, running sample code and debugging programs.	RSK RX210 Tutorial Manual	R20UT0303EG
Quick Start Guide	Provides simple instructions to setup the RSK and run the first sample, on a single A4 sheet.	RSK RX210 Quick Start Guide	R20UT0304EG
Schematics	Full detail circuit schematics of the RSK.	RSK RX210 Schematics	R20UT0301EG
Hardware Manual	Provides technical details of the RX210 microcontroller.	RX210 Hardware Manual	R01UH0037EJ

## 2. List of Abbreviations and Acronyms

<b>Abbreviation</b>	<b>Full Form</b>
CPU	Central Processing Unit
DOC	Data Operation Circuit
ELC	Event Link Controller
MCU	Microcontroller Unit
SCI	Serial Communication Interface
SPI	Serial Peripheral Interface
PWM	Pulse Width Modulation
DMAC	Direct Memory Access Controller
WDT	Watchdog Timer
RTC	Real Time Clock
DTC	Data Transfer Controller
IIC	Phillips™ Inter-Integrated Circuit Connection Bus

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## 1. Overview

### 1.1 Purpose

RSK is an evaluation tool for Renesas microcontrollers. This manual explains the operation of the sample code provided, and its interaction with the Renesas Peripheral Driver Library (RPDL). The Renesas Peripheral Driver Library (hereinafter “this library” or RPDL) is based upon a unified API (Application Programming Interface) for the microcontrollers made by Renesas Electronics Corporation.

This manual is not intended to be a tutorial on using RPDL, or how RPDL works – it simply aims to explain to the reader how the RPDL was used to create the sample code supplied with the RSK. For further information regarding RPDL, refer to the RPDL API User’s Manual supplied with the RSK. Alternatively, visit the PDG (Peripheral Driver Group) section of the Renesas website:

<http://www.renesas.com/pdg>

### 1.2 Note Regarding Document

This document explains by text and diagrams the functionality of the sample code and its interaction with the Renesas Peripheral Driver Library (RPDL). The RPDL is preliminary and functionally tested to operate with the RSKRX210 sample code only.

This manual aims to be as clear as possible, by matching the reference sample code as closely as possible. There may be some cases however where the function names in the code differ slightly this document. This does not change its functionality as described in this manual.

## 2. RSK Sample Code Concept

### 2.1 Sample Code Structure

The basic structure of all RSK sample code is shown in Figure 2-1 below. The first two functions, 'PowerOn\_ResetPC' and 'HardwareSetup', configure the MCU before the main program code executes.

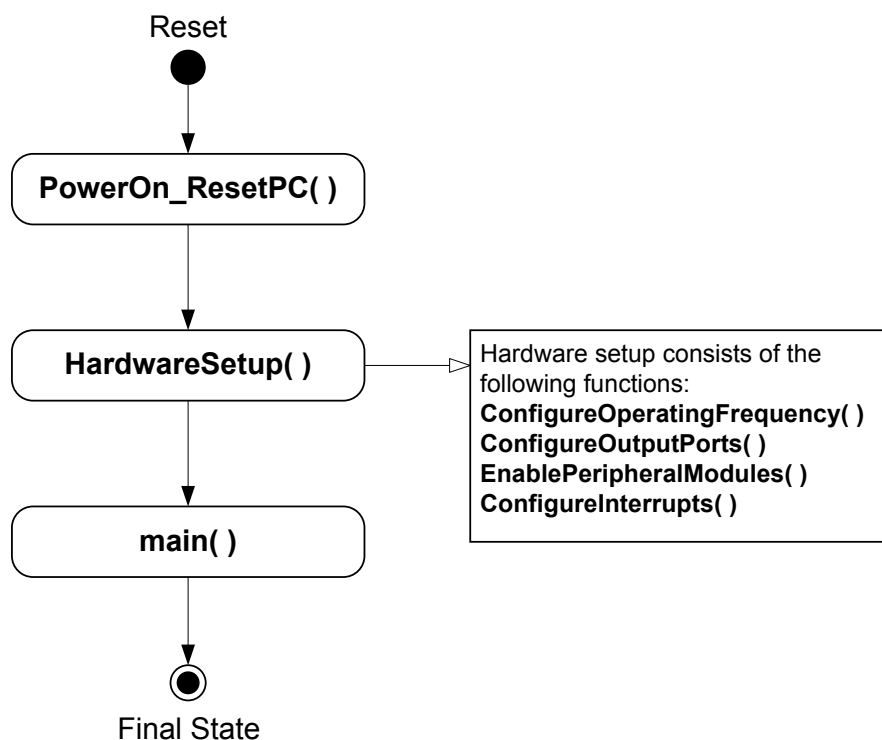


Figure 2-1: Sample Code Structure

The purpose of the functions included in the 'HardwareSetup' function are detailed in Table 2-1 below.

Function Name	Purpose	RPDL Functions Used
ConfigureOperatingFrequency	Initialises the main MCU, bus and peripheral clocks; as well as any real-time clocks and PLL settings.	R_CGC_Set R_CMT_CreateOneShot R_CGC_Control
ConfigureOutputPorts	Configures the MCU port pins as inputs or outputs, depending on the devices on the RSK and the intended function of the sample code. Also sets some pins to suitable initial logic levels.	R_IO_PORT_Set R_IO_PORT_Write
EnablePeripheralModules	Enables or disables peripheral modules on the MCU not controlled by RPDL, as required by the sample code.	Non-RPDL functions only*
ConfigureInterrupts	Configures interrupts external hardware interrupts required by the sample code.	R_INTC_CreateExtInterrupt** R_INTC_CreateFastInterrupt**

Table 2-1: Hardware Setup Functions

\*RPDL functions can not be used to manually enable/disable MCU peripherals, as this is controlled with the Create/Destroy functions for each RPDL group; therefore RPDL functions are not required in this section.

\*\* RPDL functions indirectly called by the function ConfigureInterrupts.

## 3. Tutorial Samples

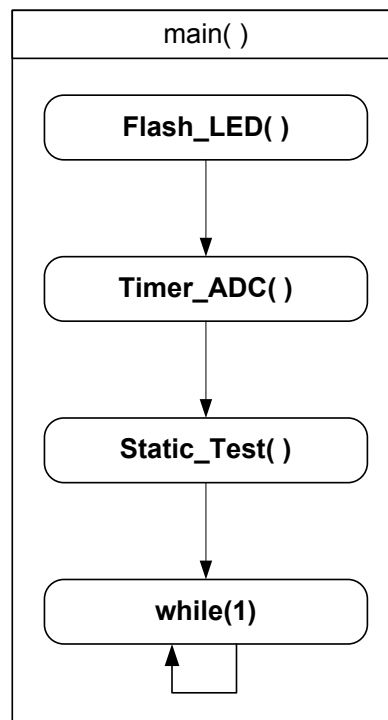
### 3.1 Tutorial

The sample code in this section is basic tutorial code, used to demonstrate basic usage of the RSK and help the user to begin writing his/her own basic sample code.

#### 3.1.1 Description

The tutorial sample code demonstrates basic usage of the debugger and RSK hardware, and is common to all RSKs. This sample is supplied programmed onto the MCU, and executes out of the box when power is applied.

The sample calls three main functions to demonstrate port pin control, interrupt usage and C variable initialisation. These functions are shown in **Figure 3-1** below.



**Figure 3-1: Tutorial Sample Flow**

**3.1.2 Operation**

- ① The tutorial code initialises the LCD module, and displays ‘Renesas’ on the first line of the LCD, and the name of the MCU on the second line.
- ② The tutorial code calls the Flash\_LED function which creates a timer interrupt, with callback function CB\_TimerLED, to toggle the LEDs repeatedly and waits in a loop until either a switch is pressed or the LEDs flash 200 times.
- ③ The tutorial then calls the Timer\_ADC function which configures the ADC unit, and a timer unit to periodically trigger an ADC conversion. The ADC unit is configured to call the function CB\_ADConversion, after each AD conversion completes. The timer is configured to call the function CB\_Timer.
- ④ The callback function CB\_ADConversion is triggered by ADC interrupts. It fetches the ADC result, and uses it to set a new timer period. The callback function also toggles the user LEDs.
- ⑤ After calling Timer\_ADC and setting up the timer & ADC interrupts, the tutorial calls the Static\_Test function which runs in parallel to the callback functions in step 4. This function displays the string ‘STATIC’ which is fetched from a static variable and is replaced, letter by letter, by the string ‘TESTTEST’. The LCD then reverts to the original display on completion.
- ⑥ After the Static\_Test function completes, the MCU waits in an infinite while loop; and is periodically interrupted with the callback function in step 4.

**3.1.3 Sequence Diagram**

Figure 3-2 below shows the program execution flow of the tutorial sample.

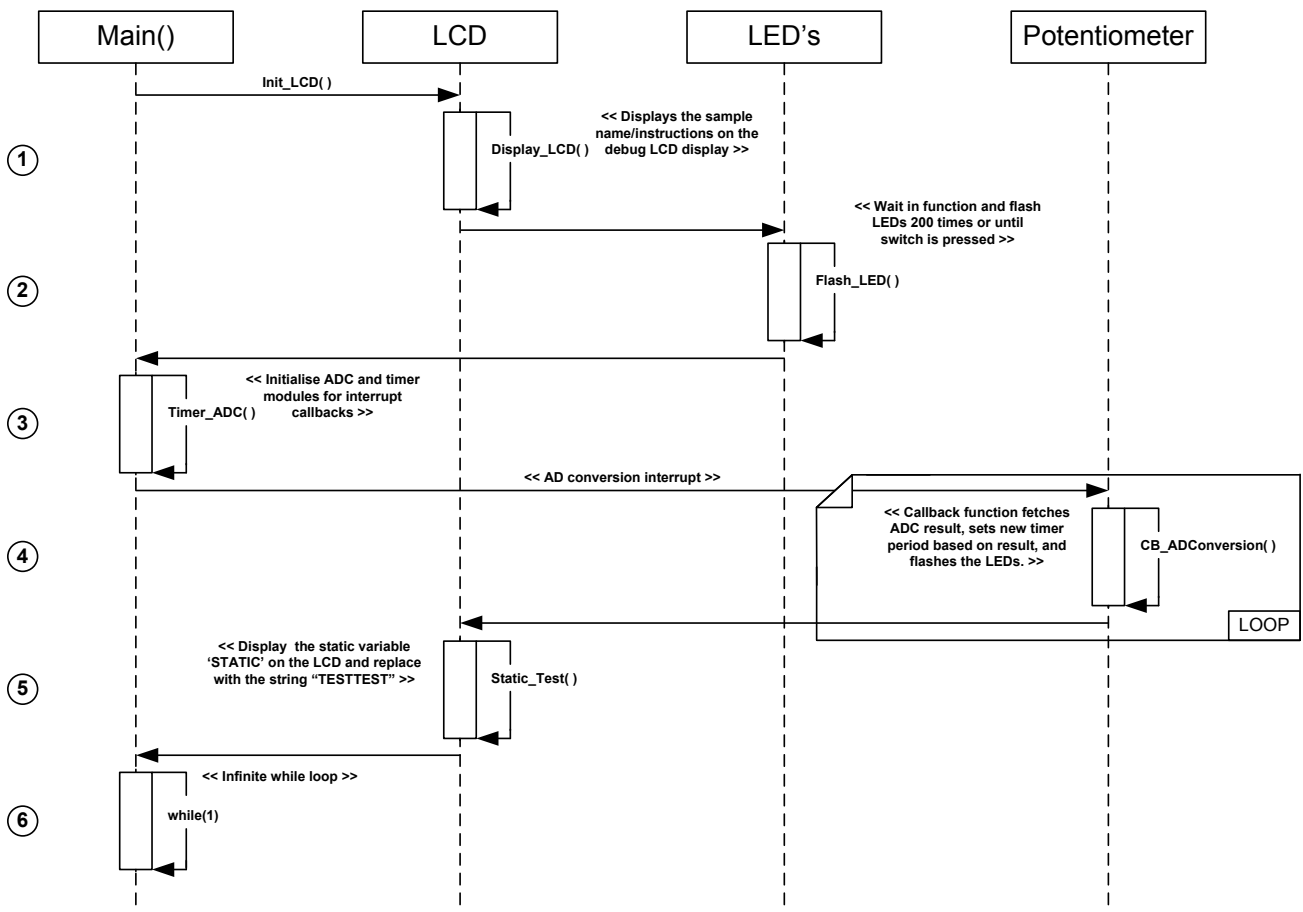


Figure 3-2: Tutorial Sequence Diagram

### 3.1.4 RPD L Integration

**Table 3-1** below details the RPD L functions used in each sample code function shown in the sequence diagram.

Function	RPDL Function
Flash_LED	R_CMT_Create
	R_CMT_Destroy
Start_Timer	R_CMT_Create
Start_ADC	R_ADC_12_Set
	R_ADC_12_CreateUnit
	R_ADC_12_CreateChannel
	R_ADC_12_Control
CB_ADConversion	R_ADC_12_Read
	R_CMT_Control

**Table 3-1: Tutorial Sample RPD L Integration**

## 3.2 Application

### 3.2.1 Description

The application sample is intended as a starting platform for the user to write his/her own code. The sample includes all the necessary initialisation code and configuration settings from previous samples. The `main()` function contains no sample code, and performs no additional functionality.

For more information regarding the hardware initialisation performed before the `main()` function starts, refer back to §2.

## 4. Peripheral Samples

The sample code in this section provides examples of initialisation and usage of some of the MCU’s peripheral modules. The sample code also provides examples of how to debug MCU peripherals.

### 4.1 ADC12\_Repeat

This sample code demonstrates usage of the on-chip analogue to digital converter (ADC), in group scan repeat mode. The sample configures the ADC to repeatedly take readings of the potentiometer voltage (RV1) and other analogue input signals (available through RSK headers). The sample then updates the conversion value displayed on the LCD, by periodic interrupts from the timer module.

#### 4.1.1 Operation

- ① The sample first initialises the debug LCD, and displays the sample name/instructions.
- ② It then calls the function `Init_ADC12Repeat`, to initialise the ADC module to operate in repeat mode – the ADC unit will now continuously take readings. The function also initialises an interval timer interrupt, which calls the `CB_Timer_ADC12Repeat` callback function.
- ③ The sample then enters an infinite while loop. The timer interrupt function `CB_Timer_ADC12Repeat` is called every interval, and fetches the current AD conversion result. The function then displays the result onto the debug LCD. The callback function displays a different analogue input reading each time it is called.

#### 4.1.2 Sequence Diagram

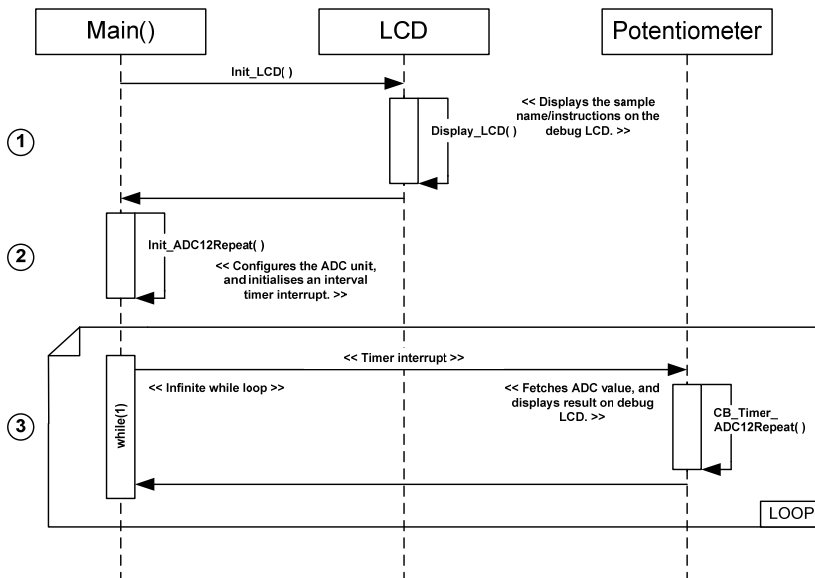


Figure 4-1: ADC\_Repeat Sequence Diagram

### 4.1.3 RPD L Integration

Function	RPDL Function
Init_ADC12Repeat	R_ADC_12_Set
	R_ADC_12_CreateUnit
	R_ADC_12_CreateChannel
	R_CMT_Create
	R_ADC_12_Control
CB_Timer_ADC12Repeat	R_ADC_12_Read

**Table 4-1: ADC\_Repeat Sample RPD L Integration**

## 4.2 Async\_Serial

This sample code demonstrates an asynchronous serial communication using the on-chip serial interface module.

### 4.2.1 Operation

- ➔ Before starting the sample, the user should connect the RSK to a PC via an RS-232 cable and start the terminal program (refer to the instructions in the sample code comments).
- ① The sample first initialises the debug LCD, and displays the sample name/instructions.
- ② The `Init_Async` function is called, which initialises the SCI unit to operate in asynchronous mode with the settings detailed in the sample code comments. The function also configures a SCI receive interrupt, which generates an interrupt every time data is received in the SCI unit. Finally a timer unit is configured, which generates interval interrupts, used to call the `CB_Timer_Async` callback function.
- ③ The sample then enters an infinite while loop. The callback function `CB_Timer_Async` is called with every timer interval interrupt. The function checks the status of the `gSCI_Flag`, and continues to transmit an incrementing number over SCI with the flag is true. The function exits without transmitting if the flag is false. Whilst transmitting, LED0 will remain on and LED1 off.
- ④ The callback function `CB_SCIReceive_Async` is called when data is received on the SCI unit. When a user enters a character in the terminal program, the callback function is called. The function fetches the keypress, and if the character is a 'z' it sets the `gSCI_Flag` variable to false. On all other keypresses, it sets the flag to true. Once 'z' has been pressed, LED1 will turn on and LED0 remain off until another key is pressed to resume transmission.

### 4.2.2 Sequence Diagram

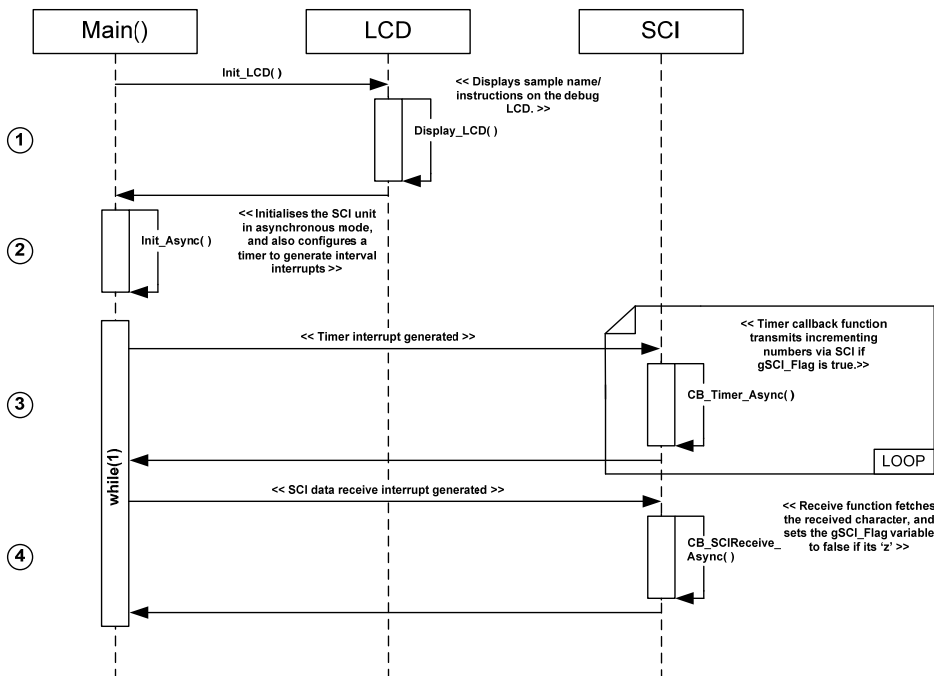


Figure 4-2: Async\_Serial Sequence Diagram

### 4.2.3 RPD L Integration

Function	RPDL Function
Init_Async	R_SCI_Create
	R_SCI_Receive
	R_SCI_Send
	R_CMT_Create
Transmit_Async	R_SCI_Send
	R_IO_PORT_Write
CB_Timer_Async	R_SCI_GetStatus
CB_SCIReceive_Async	R_IO_PORT_Write
	R_SCI_Receive

**Table 4-2: Async\_Serial Sample RPD L Integration**

### 4.3 CRC

#### 4.3.1 Description

This sample demonstrates the CRC unit, by echoing typed characters from the SCI terminal with a corresponding checksum.

#### 4.3.2 Operation

- ➔ Before starting this sample, the user should connect the RSK to the PC via an RS232 serial cable and run a suitable terminal program (see instructions in sample code comments).
- ① The sample first initialises the debug LCD, and displays the sample name/instructions.
- ② The sample then calls the function `Init_CRC`, which configures the CRC unit to produce checksums, and the SCI unit for asynchronous operation to and from the PC terminal.
- ③ The sample then enters an infinite while loop, and the rest of the sample's functionality is performed in interrupts. When the user presses a key in the terminal, the SCI interrupt executes the callback function `CB_SCIReceive_CRC`. This function takes the received character and calls the function `Calculate_CRC` to generate a checksum.
- ④ The function `Calculate_CRC` inserts the received character into the CRC registers, and fetches the calculated checksum, and returns it to the `CB_SCIReceive_CRC` function.
- ⑤ The sample returns from the `Calculate_CRC` function to the callback function and writes a string containing the received character and its checksum to the terminal. The sample then returns to the infinite while loop and waits until a key is entered into the terminal again.

#### 4.3.3 Sequence Diagram

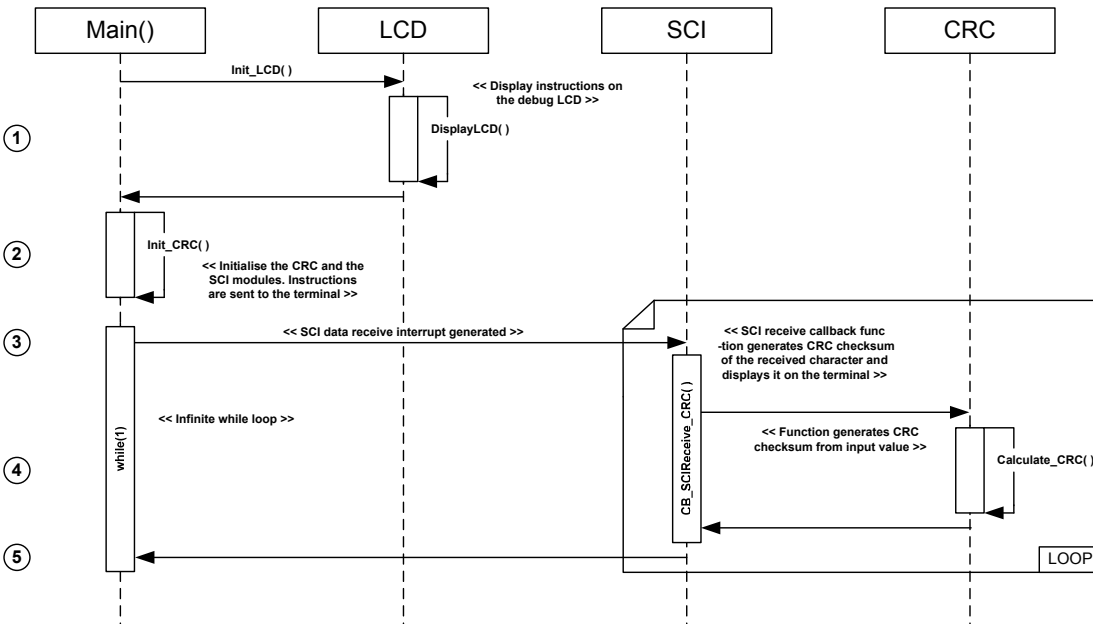


Figure 4-3: CRC Sequence Diagram

**4.3.4 RPD L Integration**

<b>Function</b>	<b>RPDL Function</b>
Init_CRC	R_CRC_Create
	R_SCI_Create
	R_SCI_Receive
	R_SCI_Send
CB_SCIReceive_CRC	R_SCI_GetStatus
	R_SCI_Send
	R_SCI_Receive
Calculate_CRC	R_CRC_Write
	R_CRC_Read

**Table 4-3: CRC Sample RPD L Integration**

### 4.4 DMAC

This sample code configures the DMAC unit to perform a data transfer to the global variable, gDMA\_DataBuff.

#### 4.4.1 Operation

- ① The sample initialises the debug LCD and displays instructions on the screen.
- ② The function Init\_DMAM is called to configure a DMAC channel for consecutive data transfers. The transfer mode is set to automatically increment the data destination address after each transfer. A callback function CB\_DMAMTransferEnd\_DMAM is configured to be called on completion of all transfers. The DMAC is enabled and the transfer operation is started before the sample enters an infinite while loop.
- ③ On completion of all data transfers, the CB\_DMAMTransferEnd\_DMAM callback function is called and turns on LED1 to indicate the operation has ended.

#### 4.4.2 Sequence Diagram

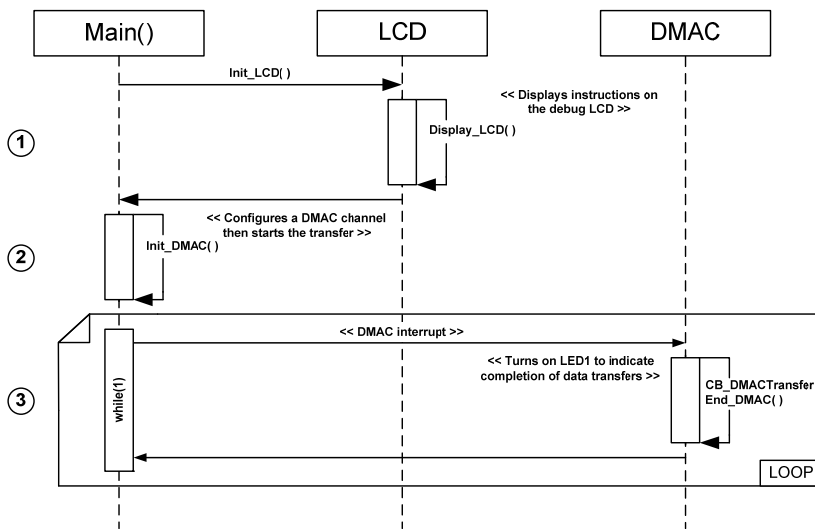


Figure 4-4: DMAC Sequence Diagram

#### 4.4.3 RPD L Integration

Function	RPDL Function
Init_DMAM	R_DMAM_Create
	R_DMAM_Control
	R_INTC_Modify
CB_DMAMTransferEnd_DMAM	R_DMAM_GetStatus
	R_IO_PORT_Write
	R_DMAM_Control

Table 4-4: DMAC Sample RPD L Integration

## 4.5 DTC

This sample demonstrates usage of the DTC unit, by performing a DTC transfer of an ADC result to an incrementing location in an array when a switch is pressed.

### 4.5.1 Operation

- ① The sample initialises the debug LCD, and displays instructions on the screen.
- ② The sample calls the function `Init_DTC`, which configures the DTC unit and also configures an ADC channel which will trigger a DTC transfer after a successful conversion. The DTC transfer is configured to transfer the content of the ADC result register to incrementing locations in the global array, `gDTC_Destination`.
- ③ The sample then enters an infinite while loop, with the rest of the sample's functionality completed in interrupts. When switch SW3 is pressed, the callback function `CB_Switch_DTC` is called. The callback function checks the number of remaining transfers, and triggers an AD conversion. If there are no more remaining transfers, the function clears the contents of the `gDTC_Destination` array and reconfigures the DTC transfer to start from the beginning.

### 4.5.2 Sequence Diagram

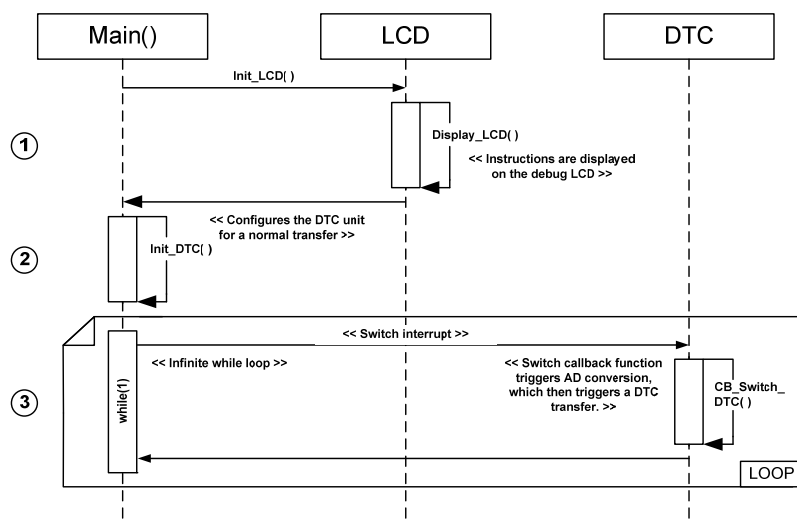


Figure 4-5: DTC Sequence Diagram

## 4.5.3 RPD L Integration

Function	RPDL Function
Init_DTC	R_DTC_Set
	R_DTC_Create
	R_DTC_Control
	R_ADC_12_Set
	R_ADC_12_CreateUnit
	R_ADC_12_CreateChannel
	R_INTC_Write
	R_INTC_Modify
CB_Switch_DTC	R_DTC_GetStatus
	R_DTC_Control
	R_INTC_Write
	R_ADC_12_Control
	R_IO_PORT_Modify

Table 4-5: DTC Sample RPD L Integration

## 4.6 LVD

### 4.6.1 Description

In this sample, the LVD (Low Voltage Detection) circuit's is configured to generate an interrupt when the power supply equals or falls below the detection level.

### 4.6.2 Operation

- ➔ Before starting this sample, follow the instructions in main source file to ensure the RSK is configured correctly. Connect a 5V variable power supply to the power socket, and set the initial voltage to 5V.
- ① The sample initialises the debug LCD, and displays instructions on the screen.
- ② The sample then calls the Init\_VDET function, which initialises the LVD unit to generate interrupts when VCC drops to 4.0V and 1.9V. The function also configures a CMT timer, to periodically toggle the user LEDs.
- ③ The sample then enters an infinite while loop. The while loop periodically interrupt by the callback function CB\_Timer\_VDET. If the global gLEDSync\_flg is set, it toggles LEDs LED0 to LED2 synchronously, and LED3 asynchronously. If gLEDSync\_flg is not set, it toggles all the user LEDs together.
- ④ When the input voltage is lowered to below 4.0V, the CB\_LVD2\_VDET callback function is called by the voltage detect interrupt. This function sets the gLEDSync\_flg, turns off LEDs LED0 to LED2, and waits until the supply voltage returns to over 4.0V.
- ⑤ When the input voltage is lowered to below 1.9V, the CB\_NMI\_VDET callback function is called by the non-maskable voltage detect interrupt. This interrupts any other callback functions that may be running. This function turns off all the user LEDs, and waits until the voltage level rises above 1.9V before exiting.

### 4.6.3 Sequence Diagram

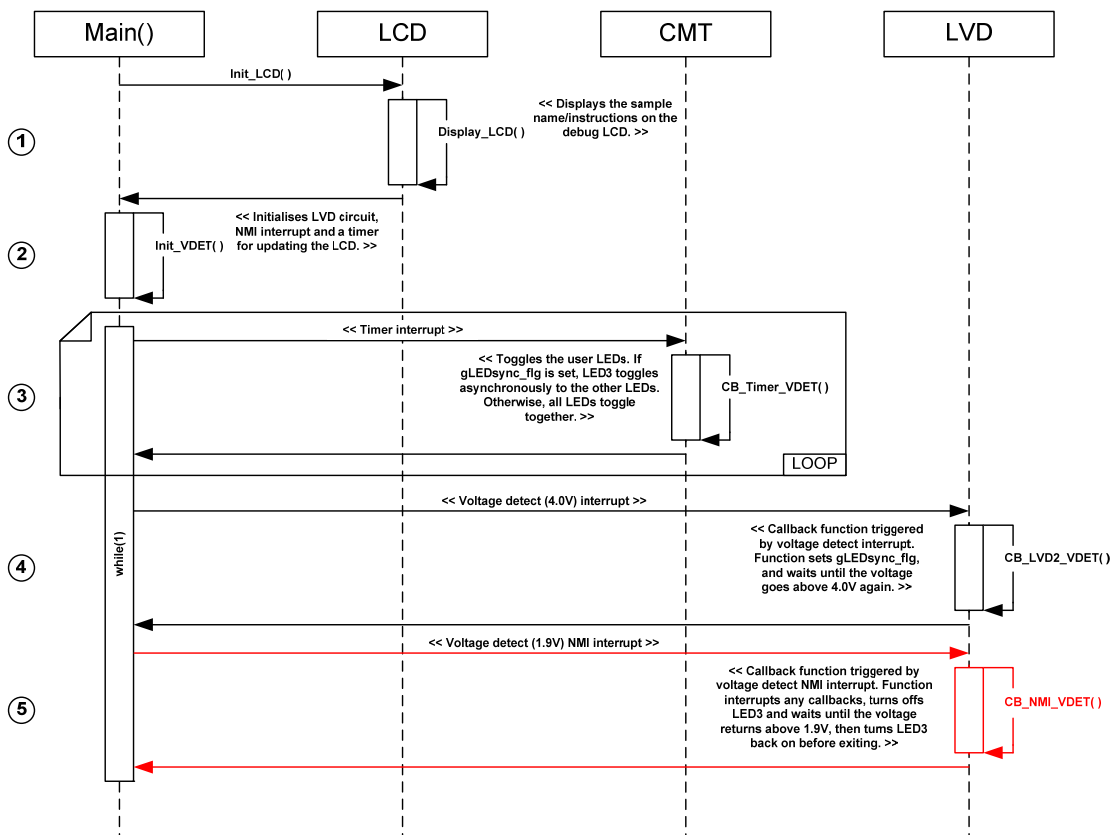


Figure 4-6: LVD Sequence Diagram

## 4.6.4 RPD L Integration

Function	RPDL Function
Init_VDET	R_LVD_Create
	R_INTC_CreateExtInterrupt
	R_CMT_Create
CB_Timer_VDET	R_IO_PORT_Modify
CB_LVD2_VDET	R_CMT_Control
	R_IO_PORT_Write
	R_LVD_GetStatus
	R_INTC_Write
CB_NMI_VDET	R_IO_PORT_Write
	R_LVD_GetStatus
	R_INTC_ControlExtInterrupt

Table 4-6: Low Voltage Detection Sample RPD L Integration



### 4.7.3 RPD L Integration

Function	RPDL Function
Init_PowerDown	R_RTC_Create
	R_RTC_Control
	R_LPC_Create
	R_LPC_Control
CB_RTC_PowerDown	R_RTC_Read
	R_CMT_CreateOneShot

**Table 4-7: Power\_Down Sample RPD L Integration**

### 4.8 Timer\_Mode

This sample code configures the timer to generate 1 KHz waveform. The waveform can be seen on the oscilloscope.

#### 4.8.1 Operation

- ➔ Before starting this sample, the user should refer to the sample code instructions in order to connect the oscilloscope to the correct location.
- ① The sample initialises the debug LCD and displays the sample name/instructions on the screen.
- ② The sample then configures a timer channel to output a 1 KHz periodic square wave with 50% duty.
- ③ The sample then enters an infinite while loop. The timer unit will continue to produce the waveform.

#### 4.8.2 Sequence Diagram

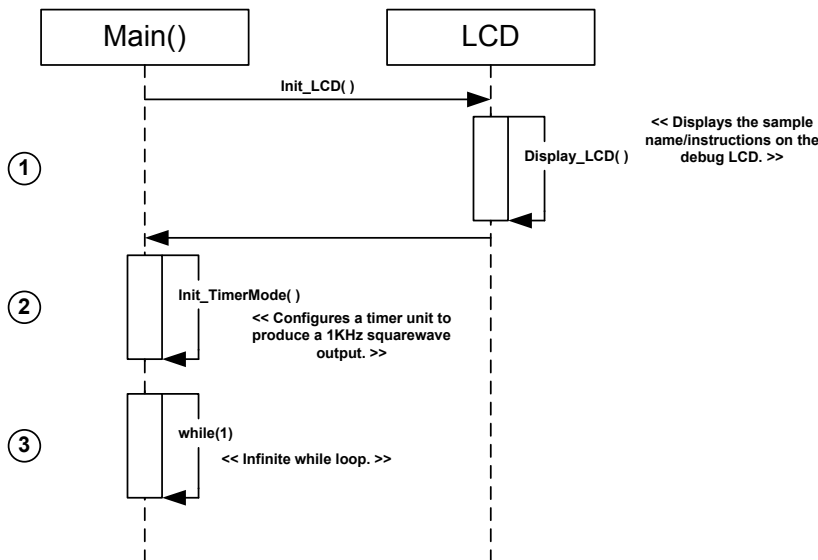


Figure 4-8: Timer Mode Sequence Diagram

#### 4.8.3 RPDL Integration

Function	RPDL Function
Init_TimerMode	R_MTU2_Set
	R_MTU2_Create
	R_MTU2_ControlChannel
CB_Timer_TimerMode	R_IO_PORT_Modiy

Table 4-8: Timer Mode Sample RPDL Integration



### 4.9.3 RPD L Integration

Function	RPDL Function
Init_PWM	R_TMR_Set
	R_TMR_CreatePeriodic
CB_Timer_PWM	R_TMR_ControlPeriodic

**Table 4-9: PWM Sample RPD L Integration**

### 4.10 WDT

This sample code demonstrates the usage of the watchdog timer functionality; by resetting the WDT count regularly, at a rate controlled by the potentiometer to prevent its period from timing out. When the WDT's period is reached, the LEDs stop flashing and the program halts in an infinite while loop.

#### 4.10.1 Operation

- ➔ Before starting this sample, ensure that the potentiometer shaft is turned anti-clockwise fully.
- ① The sample initialises the debug LCD and displays the sample name/instructions on the screen.
- ② The `Init_WDT` function configures the watchdog timer unit, the ADC unit and a timer unit. The ADC unit is configured to operate in continuous mode, and the timer is configured to generate an interval interrupt that executes the callback function `CB_Timer_WDT`.
- ③ The sample then enters an infinite while loop. The while loop is interrupted by the `CB_Timer_WDT` callback function. This function resets the WDT count, toggles the LEDs and fetches the ADC result. This result is used to set the new timer interval period. By adjusting the potentiometer, the length between WDT resets is varied.
- ④ When the WDT reset interval is too long, the watchdog timer will overflow and trigger an interrupt, which calls the callback function `CB_Overflow_WDT`. This function sets the LEDs to static, displays a watchdog overflow message on the debug LCD and waits in an infinite while loop.

#### 4.10.2 Sequence Diagram

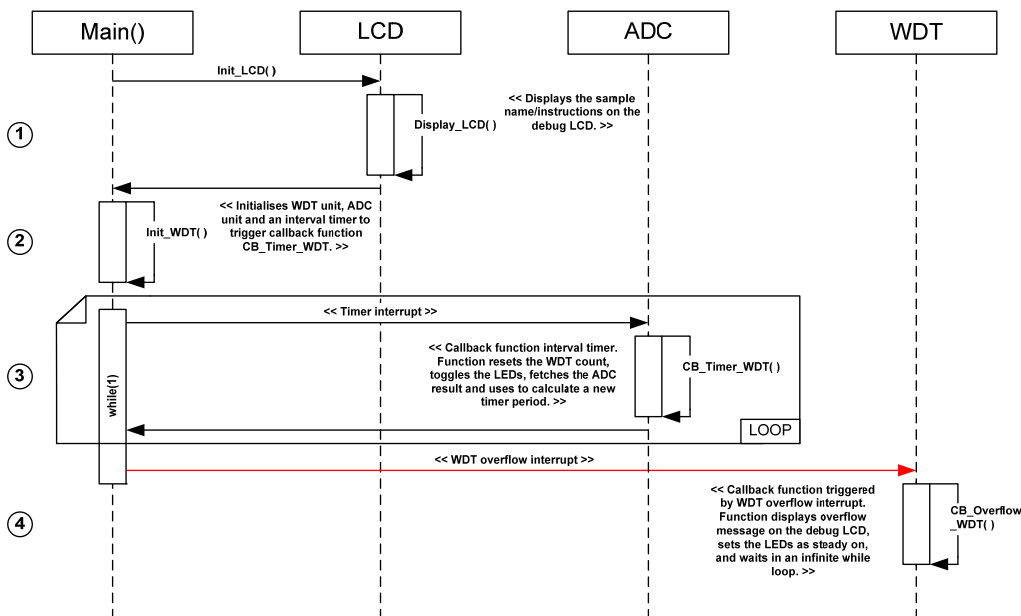


Figure 4-10: WDT Sequence Diagram

## 4.10.3 RPD L Integration

Function	RPDL Function
Init_WDT	R_ADC_12_Set
	R_ADC_12_CreateUnit
	R_ADC_12_CreateChannel
	R_ADC_12_Control
	R_CMT_Create
	R_WDT_Set
	R_INTC_CreateExtInterrupt
	R_WDT_Control
CB_Timer_WDT	R_WDT_Control
	R_ADC_12_Read
	R_IO_PORT_Modify
	R_CMT_Control
CB_WDTOverflow	R_IO_Port_Write

Table 4-10: WDT Sample RPD L Integration

### 4.11 RTC

This sample code demonstrates the usage of the real time clock’s functionality by running a timer from a 32.768 KHz clock source. The time is displayed on the debug LCD using the 24-hour digital format hh:mm:ss, starting from 00:00:00.

#### 4.11.1 Operation

- ① The sample initialises the debug LCD and displays the sample name/instructions on the screen.
- ② The sample then calls the Init\_RTC to initialise the RTC settings and configures two callback functions CB\_Alarm\_RTC and CB\_1HZ\_RTC.
- ③ The sample enters an infinite while loop, which is interrupted every second by the RTC callback function, CB\_1HZ\_RTC. This function fetches the time (time elapsed from sample start) from the RTC unit, and displays it on the debug LCD.
- ④ The while loop is interrupted again when the time matches the alarm time. The interrupt executes the callback function CB\_Alarm\_RTC, which turns on LED1.

#### 4.11.2 Sequence Diagram

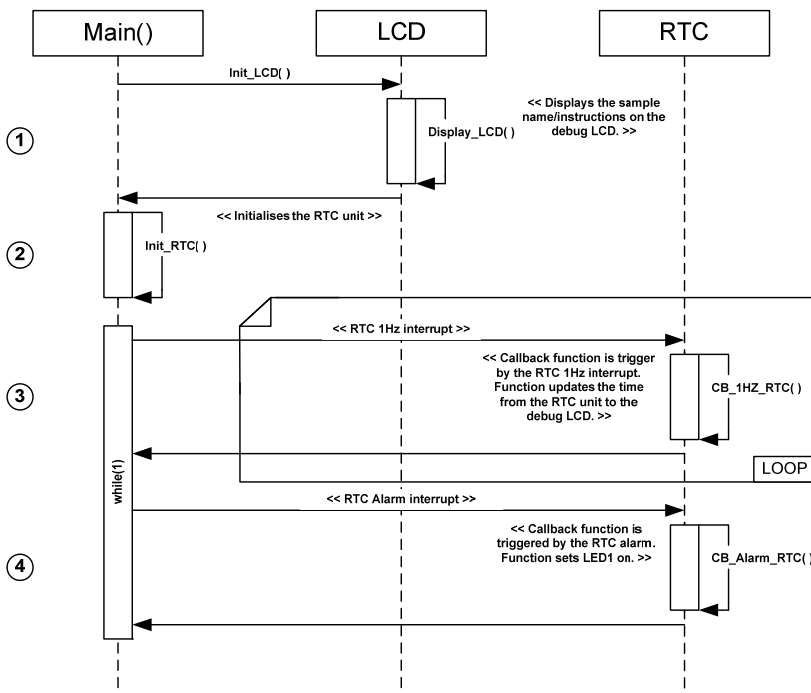


Figure 4-11: RTC Sequence Diagram

**4.11.3 RPD L Integration**

Function	RPDL Function
Init_RTC	R_RTC_Create
	R_RTC_Control
CB_1HZ_RTC	R_RTC_Read
CB_Alarm_RTC	R_IO_PORT_Write

**Table 4-11: RTC Sample RPD L Integration**

### 4.12 IIC\_Master

This sample demonstrates usage of the IIC unit in master mode, by performing read and write operations to an EEPROM memory device. The sample is configured to work with the following Renesas devices:

- HN58X24512I, 1Mbit EEPROM, 1MHz

#### 4.12.1 Operation

- ① The sample initialises the debug LCD and displays the sample name/instructions on the screen.
- ② The sample then enters the main IIC master sequence loop, where it first calls the `Init_EEPROM_Master` function which configures the IIC unit to operate in master mode.
- ③ The master sequence then waits in an infinite while loop, polling the user switch flag. When switch SW2 is pressed, an EEPROM device write operation is executed using the `Write_EEPROM_Master` function. The write operation writes the string “XXRenesas IIC ”, where XX is replaced with an ASCII data identifier, which increments with every write operation. If the write operation fails, the debug LCD displays “Error W.”
- ④ When switch SW3 is pressed, an EEPROM device read operation is executed using the `Read_EEPROM_Master` function. The first 16 bytes of the EEPROM device’s memory are read. If the read data matches the expected data string, “XXRenesas IIC ”, the data identifier (XX) is displayed on the debug LCD to indicate a successful read operation. If the read operation fails, the debug LCD displays “Error R.”

#### 4.12.2 Sequence Diagram

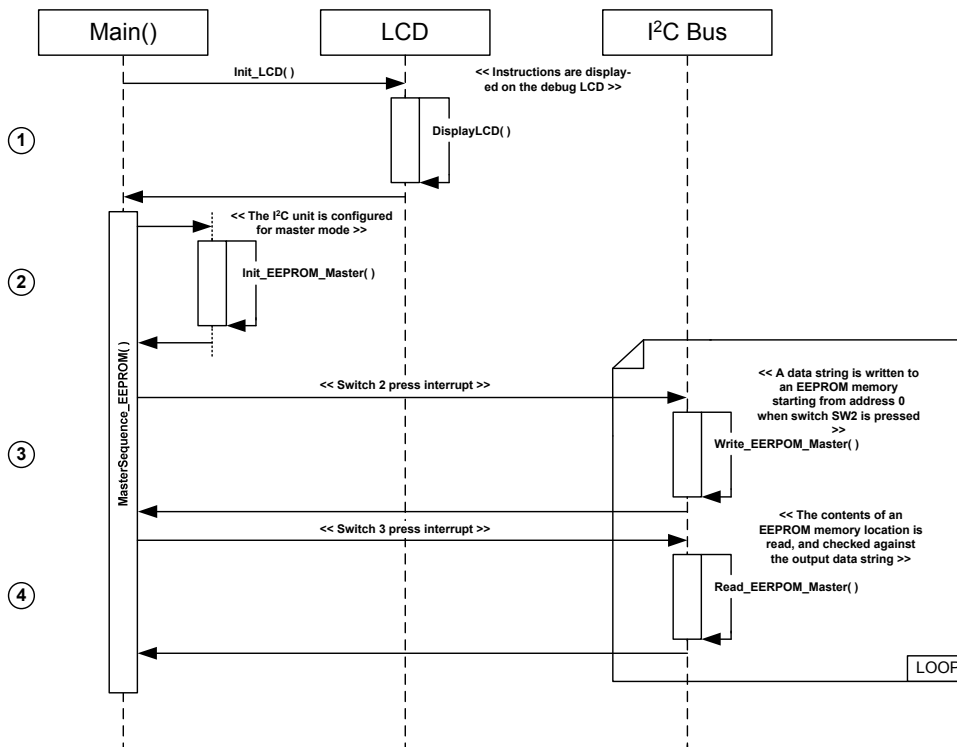


Figure 4-12: IIC\_Master Sequence Diagram

## 4.12.3 RPD L Integration

Function	RPDL Function
Init_EEPROM_Master	R_IIC_Set
	R_IIC_Create
Write_EEPROM_Master	R_IIC_MasterSend
	R_CMT_CreateOneShot
Read_EEPROM_Master	R_IIC_MasterSend
	R_IIC_MasterReceive
	R_CMT_CreateOneShot
CheckStatus_EEPROM_Master	R_IIC_GetStatus
BusActivity_IIC	R_IO_PORT_Write

Table 4-12: IIC\_Master Sample RPD L Integration

### 4.13 SPI\_Loopback

This sample code demonstrates usage of the SPI unit by performing a simple loopback test.

#### 4.13.1 Operation

- ➔ This sample may require hardware modifications in order to operate. Refer to the sample code instructions for further information before proceeding.
- ① The sample first initialises the debug LCD, and displays the sample name/instructions.
- ② The Init\_SPI function is called, which initialises the SPI unit and configures an SPI receive interrupt callback. An ADC unit is configured for single scan operations. The function also configures a switch callback function.
- ③ The sample then enters an infinite while loop. When the user presses the switch specified (see sample code comments), the callback function CB\_Switch is called. This callback function takes an ADC reading, and transmits it via the SPI loopback.
- ④ The data transmitted in the CB\_Switch function is received by the loopback SPI, and generates an interrupt. The SPI receive interrupt calls the CB\_SPIReceive callback function, which fetches the received data and compares it against the original value sent. If they match, it displays the result on the debug LCD. If there is a mismatch between sent and received data, an error is reported on the debug LCD.

#### 4.13.2 Sequence Diagram

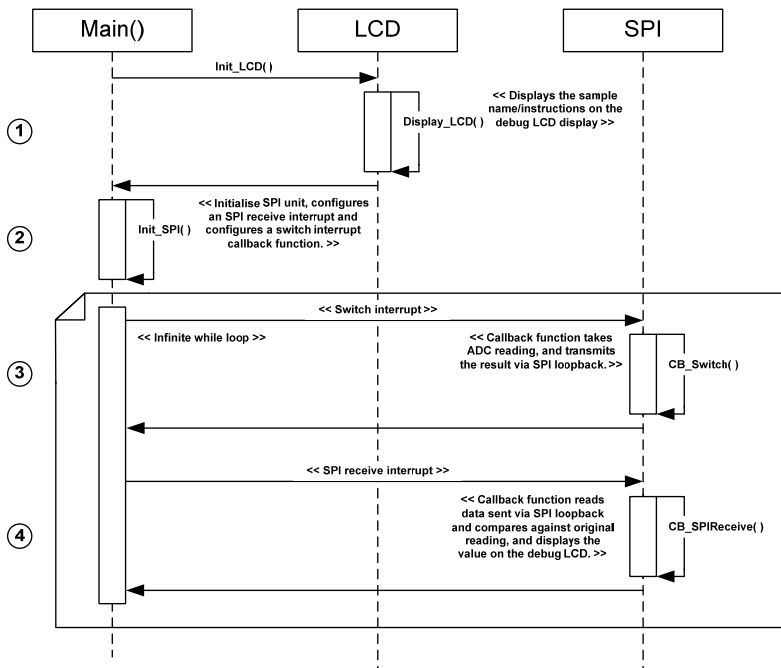


Figure 4-13: SPI Loopback Sequence Diagram

**4.13.3 RPD L Integration**

<b>Function</b>	<b>RPDL Function</b>
Init_SPI	R_SPI_Create
	R_SPI_Control
	R_SPI_Command
	R_ADC_12_Set
	R_ADC12_Create_Unit
	R_ADC_12_CreateChannel
CB_Switch	R_ADC12_Control
	R_ADC12_Read
	R_SPI_Transfer

**Table 4-13: CRC Sample RPD L Integration**

### 4.14 Temperature Sensor

This sample code demonstrates usage of the on-chip temperature sensor. The sample takes repeat readings of the on-chip temperature sensor using an ADC channel, and converts it into degrees Celsius.

#### 4.14.1 Operation

- ① The sample first initialises the debug LCD, and displays the sample name/instructions.
- ② It then calls the function `Init_TempSensor`, to initialise the ADC module to operate in repeat mode – the ADC unit will now continuously take readings of the temperature sensor. The function also initialises an interval timer interrupt, which calls the `CB_Timer_TempSensor` callback function every interval.
- ③ The sample then enters an infinite while loop. The timer interrupt function `CB_Timer_TempSensor` is called every interval, and fetches the current AD conversion result. The result is then converted into degrees Celsius, and displayed on the debug LCD.

#### 4.14.2 Sequence Diagram

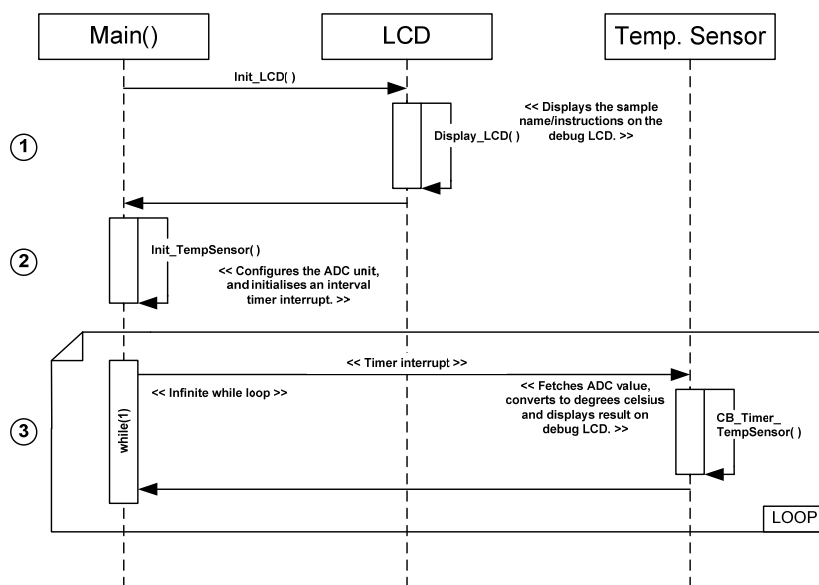


Figure 4-14: Temperature Sensor Sequence Diagram

**4.14.3 RPD L Integration**

Function	RPDL Function
Init_TempSensor	R_RWP_Control
	R_ADC_12_CreateUnit
	R_CMT_Create
CB_Timer_TempSensor	R_ADC_12_Read
	R_ADC_12_Control

**Table 4-14: Temperature Sensor Sample RPD L Integration**

### 4.15 Analog\_Compare

This sample code demonstrates usage of the on-chip analog comparator module. The sample configures a comparator to compare the voltage with a set reference voltage.

#### 4.15.1 Operation

- ➔ This sample may require hardware modifications in order to operate. Refer to the sample code instructions for further information before proceeding.
- ① The sample first initialises the debug LCD, and displays the sample name/instructions.
- ② It then calls the function `Init_AnalogCompare`, which configures the comparator unit. The unit is configured to execute the callback function `CB_Comparator_AnalogCompare` function when the input voltage to comparator is higher than the reference voltage.
- ③ The sample then enters an infinite while loop. When the input voltage exceeds the reference, a comparator interrupt is generated which calls the function `CB_Comparator_AnalogCompare`. This function sets the LCD and user LEDs to indicate that the input voltage is higher than the reference voltage. It also reconfigures the comparator interrupt to trigger when the input goes below the reference voltage.
- ④ When the input voltage goes below the reference voltage, the comparator generates another interrupt and calls the `CB_Comparator_AnalogCompare`. The function sets the LCD and user LEDs to indicate that the input is lower than the reference voltage. The function also reconfigures the comparator interrupt to trigger when the inputs goes above the reference voltage. When the input goes high again, the sample repeats steps 3 & 4.

#### 4.15.2 Sequence Diagram

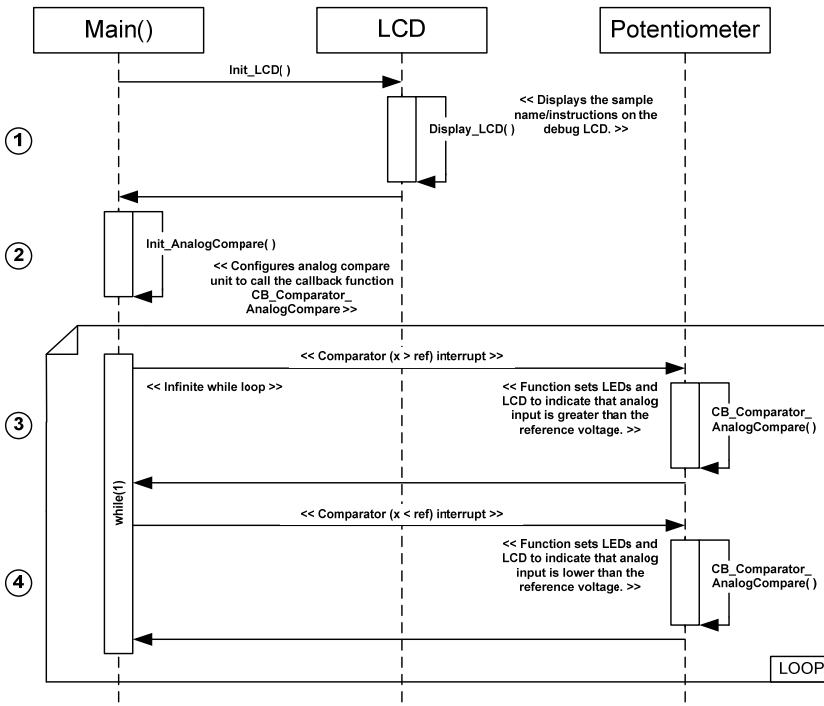


Figure 4-15: Analog\_Compare Sequence Diagram

**4.15.3 RPD L Integration**

<b>Function</b>	<b>RPDL Function</b>
Init_AnalogCompare	R_CPA_Create
CB_Comparator_AnalogCompare	R_CPA_GetStatus
	R_IO_PORT_Write
	R_CMT_CreateOneShot

**Table 4-15: Analog Compare Sample RPD L Integration**

### 4.16 Data Operation Circuit (DOC)

This sample code demonstrates usage of the data operation circuit (DOC), by comparing a user input from a PC terminal, via SCI, to a set reference integer and reporting the comparison result back to the PC terminal.

#### 4.16.1 Operation

- ➔ Before starting the sample, the user should connect the RSK to a PC via an RS-232 cable and start the terminal program (refer to the instructions in the sample code comments).
- ① The sample first initialises the debug LCD, and displays the sample name/instructions.
- ② It then calls the function `Init_DOC`, which configures the SCI unit to communicate with a PC terminal, and configures the SCI unit to execute the callback function `CB_SCIReceive_DOC` when data is received. It also configures the DOC unit to perform comparisons of an input integer to a reference integer (set in the global variable `gCompareReference_DOC`).
- ③ The sample then enters an infinite while loop. When the user enters a key in the PC terminal, the callback function `CB_SCIReceive_DOC` function is called. The function fetches the key entered, and converts it to an ASCII equivalent integer. The function then passes the value to the DOC unit. The DOC unit performs a comparison of the user input and the set reference integer, and updates the PC terminal indicating whether the input was a match or not. The program then returns to the infinite while loop, and repeats step 3 on the next user input.

#### 4.16.2 Sequence Diagram

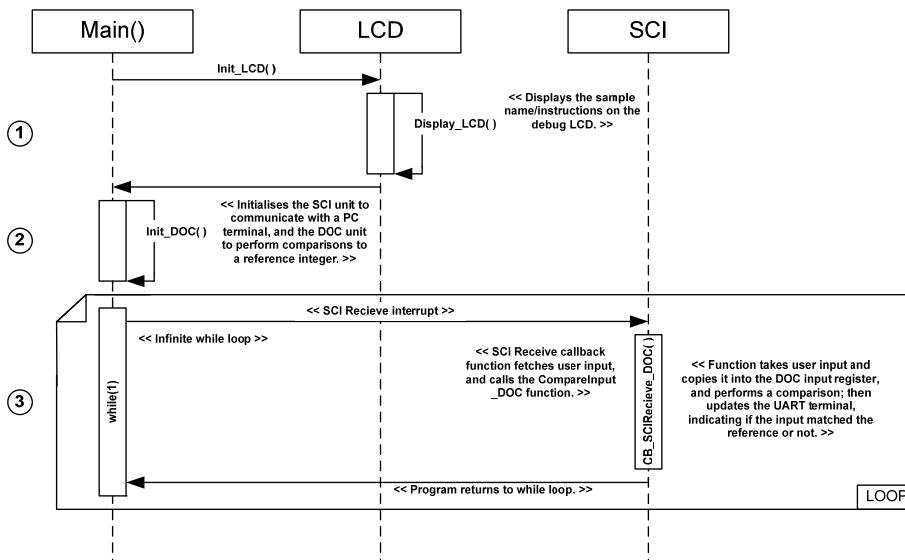


Figure 4-16: Data Operation Circuit (DOC) Sequence Diagram

**4.16.3 RPD L Integration**

Function	RPDL Function
Init_DOC	R_DOC_Create
	R_SCI_Create
	R_SCI_Receive
	R_SCI_Send
CB_SCIReceive_DOC	R_SCI_Send
	R_DOC_Write
	R_DOC_Read
	R_SCI_GetStatus
	R_SCI_Receive

**Table 4-16: Data Operation Circuit (DOC) Sample RPD L Integration**

### 4.17 Event Link Controller (ELC)

This sample code demonstrates usage of the event link controller (ELC). The sample triggers an A/D conversion when a user presses a switch. After the AD conversion completes, the ELC unit automatically triggers a port pin to toggle. The result of the AD operation is displayed on the debug LCD.

#### 4.17.1 Operation

- ➔ This sample may require hardware modifications in order to operate. Refer to the sample code instructions for further information before proceeding.
- ① The sample first initialises the debug LCD, and displays the sample name/instructions.
- ② It then calls the function `Init_ELC`. This function configures the ADC and the ELC units. The ELC unit is set to trigger the event of toggling a port pin after each ADC conversions. A switch interrupt is also set to call the callblack function `CB_Switch_ELC`.
- ③ The program then enters an infinite while loop. When a user switch is pressed, the function `CB_Switch_ELC` executes. If the switch pressed is SW1, the function starts an A/D conversion, reads the result and converts it to a string. The string is then displayed on the LCD. The function then returns to the while loop.
- ④ As soon as an A/D conversion is completed, the ELC toggles the selected port pin without interrupting the CPU.

#### 4.17.2 Sequence Diagram

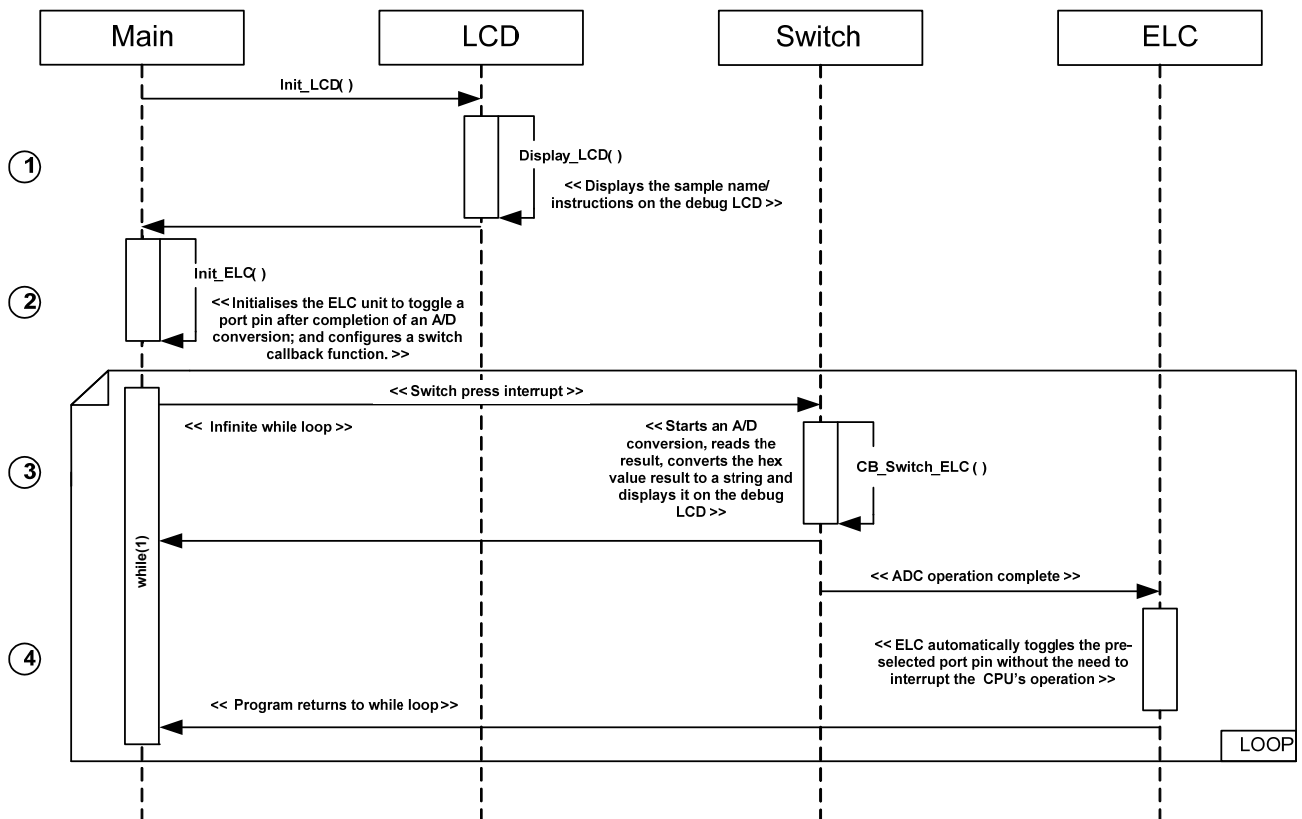


Figure 4-17: Event Link Controller (ELC) Sequence Diagram

## 4.17.3 RPD L Integration

Function	RPDL Function
Init_ELC	R_ADC_12_Set
	R_ELC_Create
	R_ELC_Control
	R_ADC_12_CreateUnit
	R_ADC_12_CreateChannel
	R_IO_PORT_Set
	R_IO_PORT_Write
CB_Switch_ELC	R_ADC_12_Control
	R_ADC_12_Read

Table 4-17: Event Link Controller (ELC) Sample RPD L Integration

### 4.18 Low\_Power

The Low Power sample demonstrates the low power functionality of the MCU. The MCU toggles between low power (CPU active), sleep mode (CPU inactive) and normal full power mode.

#### 4.18.1 Operation

- ➔ This sample should be flashed onto the MCU, and run without the debugger. Before starting the sample, remove the debug LCD from the RSK as it is not used in the sample and can skew any power measurement readings. Refer to the main\_low\_power.c file for instructions on measuring the MCU power consumption.
- ① The sample calls the function Init\_LowPower to configure the low power consumption functions. It also shuts down any unneeded peripherals to reduce power consumption, and configures a switch press interrupt to call the callback function CB\_Switch\_LowPower.
- ② The sample then executes the IdleFunction\_LowPower. This function loops infinitely, and flashes LED0 to indicate CPU activity. This function is interrupted when a user switch is pressed, which calls the CB\_Switch\_LowPower function. This callback function changes the MCU’s power mode depending on which switch is pressed.

**SW1:**  
 Power Mode: Normal  
 Operating Mode: Low Speed 2

**SW2:**  
 Power Mode: Software Standby  
 Operating Mode: X \*

**SW3:**  
 Power Mode: Normal  
 Operating Mode: High Speed

\* Operating mode is preserved from previous setting

#### 4.18.2 Sequence Diagram

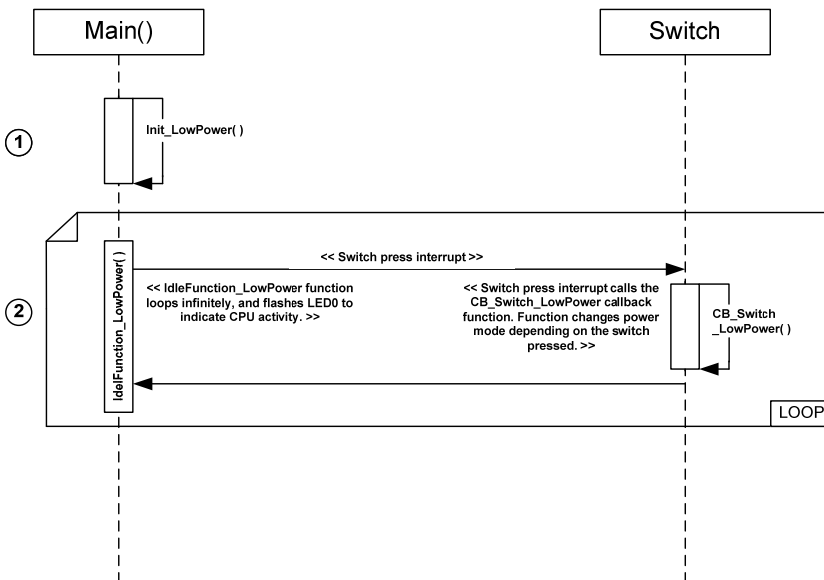


Figure 4-18: Low Power Sequence Diagram

## 4.18.3 RPD L Integration

Function	RPDL Function
Init_LowPower	R_LPC_Create
	R_CGC_Control
	R_DMAC_Destroy
IdleFunction_LowPower	R_IO_PORT_Modify
	R_CMT_CreateOneShot
	R_CGC_Set
	R_CGC_Control
	R_LPC_Create
	R_IO_PORT_Write
	R_LPC_Control

Table 4-18: Low Power Sample RPD L Integration

## 5. Additional Information

### Technical Support

For details on how to use High-performance Embedded Workshop (HEW, refer to the HEW manual available on the CD or from the web site.

For information about the RX210 series microcontrollers refer to the RX210 Group hardware manual.

For information about the RX210 assembly language, refer to the RX Series Software Manual.

Online technical support and information is available at: <http://www.renesas.com/rskrx210>

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