

# RH850/F1KM-S1 Starter Kit V3

User Manual: Hardware

RENESAS MCU  
RH850/F1KM-S1 Series

Y-ASK-RH850F1KM-S1-V3

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## 1. Introduction

The 'RH850/F1KM-S1 Starter Kit' serves as a simple and easy to use platform for evaluating the features and performance of Renesas Electronics' 32-bit RH850/F1KM-S1' microcontroller.

Features:

- Connections for on-chip debugging and flash memory programming
- Access to all microcontroller I/O pins
- User interaction through potentiometer, rotary switch, buttons and LEDs
- Serial interface connections for
  - 1x UART/USB
  - 1x LIN
  - 1x SENT
  - 2x CAN-FD
- Multiple power supply options by
  - RENESAS E2 On-Chip debugger (5V/200mA)
  - Provided 12V DC power supply via DC Jack

This document will describe the functionality provided by the Starter Kit and guide the user through its operation. For details regarding the operation of the microcontroller refer to the RH850/F1KM-S1 Hardware User Manual.

Renesas provides a SENT Extension Board "Y-RH850-SENT-EXT-BRD-V2" that comes with a sample software, which receives the SENT messages from a ZSSC4161D and gives feedback via the peripheral LEDs on the starter kit.

Please find below a short overview of the related Documents:

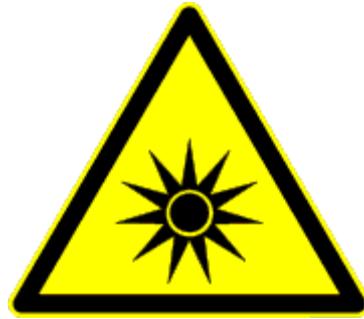
**Table 1 Related documents**

Description	DOC-Number
1. Hardware User Manual of RH850/F1KM-S1	R01UH0684EJxxxx
2. Datasheet of RH850/F1KM-S1	Included in above document
3. QSG for RH850/F1KM-S1 Starter Kit V3	D016351-11
4. RH850 Family SENT Application Board UM	R12UT0014EDxxxx
5. Renesas SENT App Note	R01AN3963ED0201

## 2. Cautions

1. Do not look into the LED beam!

Special care must be taken with the high power LEDs



2. When power supply of E2 On-Chip debugger is used please note that the maximum current provided by the debugger is limited to 200mA. Thus, an external power supply is required in case all functions on the Starter Kit are used to full extend.

### 3. Quick Start Information

#### 3.1 Connector and jumper overview

##### 3.1.1 Microcontroller assembled and Port Pin Interfaces

On the RH850/F1KM-S1 Starter Kit the following device is assembled:

R7F701684

As external clock supply of the microcontroller, a 16MHz crystal is mounted.

Each microcontroller I/O pin is connected to a pin header interface. The pin header interfaces allow easy probing of I/O pins and provide the ability to selectively connect the I/O pins to power, ground or other signals. Table 2 and Table 3 are showing the assignment of the pin header interface.

**Table 2 J3 – J4 – Signal Assignment**

J3			
Pin	Function		Pin
1	P10_3	P10_4	2
3	P10_5	P10_15	4
5	P11_0	P0_0	6
7	P0_1	P0_2	8
9	P0_3	P0_4	10
11	P0_5	P0_6	12
13	P0_11	P0_12	14
15	P0_13	P0_14	16
17	P8_2	P8_10	18
19	P8_11	P8_12	20
21	GND	VDD_5V	22

J4			
Pin	Function		Pin
1	AP0_13	AP0_12	2
3	AP0_11	AP0_10	4
5	AP0_9	AP0_8	6
7	AP0_7	AP0_6	8
9	AP0_5	AP0_4	10
11	AP0_3	AP0_2	12
13	AP0_1	AP0_0	14
15	P9_0	P9_1	16
17	P9_2	P9_3	18
19	P9_4	P9_5	20
21	GND	VDD_5V	22

**Table 3 J7 – J8 – Signal Assignment**

<b>J7</b>			
<i>Pin</i>	<i>Function</i>		<i>Pin</i>
1	P9_6	P10_6	2
3	P10_7	P10_8	4
5	P10_9	P10_10	6
7	P10_11	P10_12	8
9	P10_13	P10_14	10
11	P11_1	P11_2	12
13	P11_3	P11_4	14
15	P11_5	P11_6	16
17	P11_7	P10_0	18
19	P10_1	P10_2	20
21	GND	VDD_5V	22

<b>J8</b>			
<i>Pin</i>	<i>Function</i>		<i>Pin</i>
1	JP0_5	JP0_4	2
3	JP0_3	JP0_2	4
5	JP0_1	JP0_0	6
7	FLMD0	P0_10	8
9	P0_9	P0_8	10
11	P0_7	P8_3	12
13	P8_4	P8_5	14
15	P8_6	P8_7	16
17	P8_8	P8_9	18
19	AP0_15	AP0_14	20
21	GND	VDD_5V	22

**Table 4. Jumper / Connector Settings Overview**

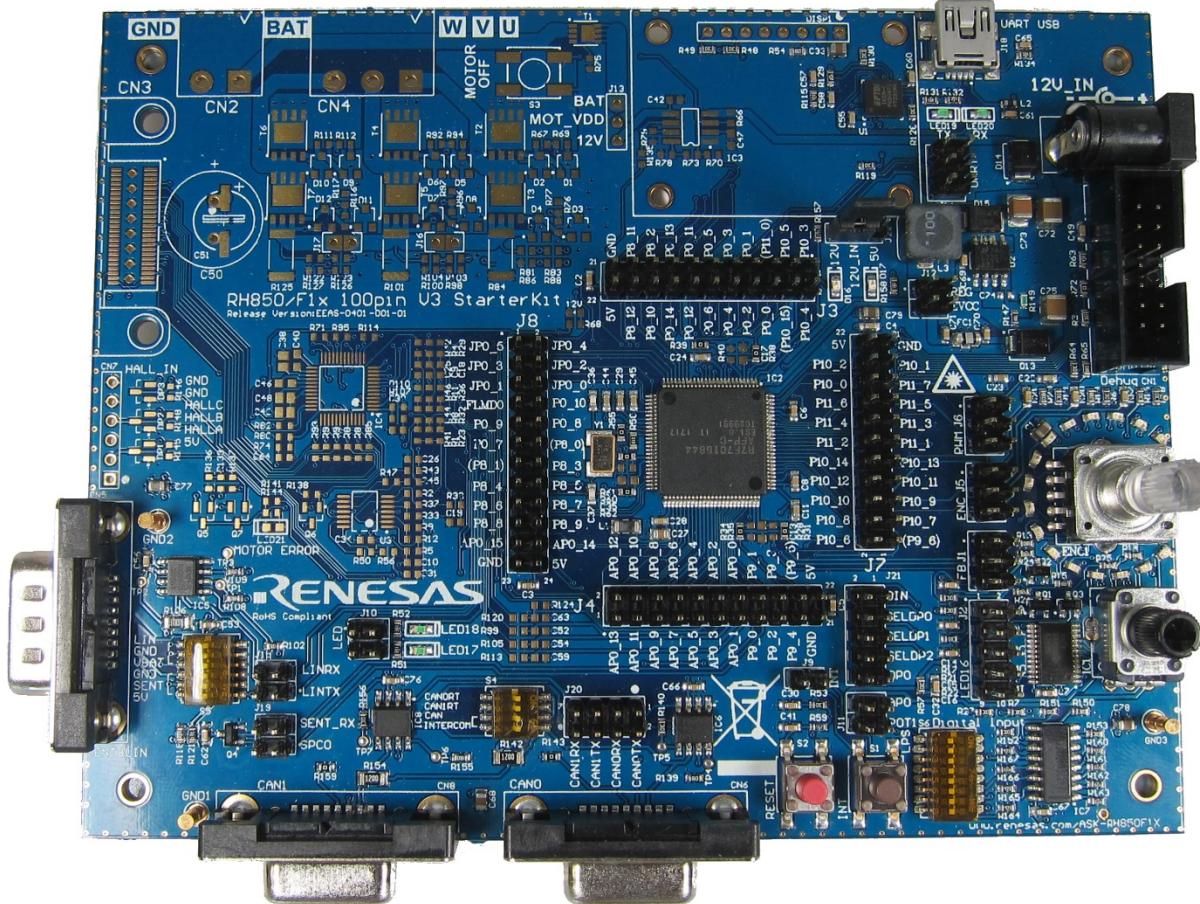
<b>Jumper</b>	<b>Description</b>	<b>Setting</b>	<b>Note</b>
FB J1	RGB LED Connector	<b>1 – 2</b>	R: PWM feedback ↔ AP0_5
		<b>3 – 4</b>	G: PWM feedback ↔ AP0_6
		<b>5 – 6</b>	B: PWM feedback ↔ AP0_7
LED16 J2	Blue LED Circle to MCU connector	<b>1 – 2</b>	LA: SPI driver LE↔P8_10
		<b>3 – 4</b>	BL: SPI driver OE#↔P8_11
		<b>5 – 6</b>	MC: SPI driver CLK↔ P11_3
		<b>7 – 8</b>	MO: SPI driver SDI↔ P11_2
		<b>9 – 10</b>	MI: SPI driver SDO↔ P11_4
ENC J5	Encoder to MCU connector	<b>1 – 2</b>	a: Encoder input 0 ↔ P10_9
		<b>3 – 4</b>	b: Encoder input 1 ↔ P10_10
		<b>5 – 6</b>	B: Encoder button ↔ P0_13
PWM J6	PWM output to RGB LED connector	<b>1 – 2</b>	R: PWM signal ↔ P11_7
		<b>3 – 4</b>	G: PWM signal ↔ P11_6
		<b>5 – 6</b>	B: PWM signal ↔ P11_5
J9	Interrupt Button to MCU connector	<b>1 – 2</b>	INT: Button ↔ P8_2
J10 LED	Indication LED to MCU Connector	<b>1 – 2</b>	LED18 ↔ P0_14
		<b>3 – 4</b>	LED17 ↔ P8_5
J11	Potentiometer to MCU Connector	<b>1 – 2</b>	POT1 ↔ AP0_4
		<b>3 – 4</b>	APO ↔ P0_1
J12	MCU power distribution	<b>1 – 2</b>	REG: REGVCC supply
		<b>3 – 4</b>	EVCC: EVCC/A0VREF supply
J14 UART	UART to USB connector	<b>1 – 2</b>	UART/USB TX ↔ P0_2
		<b>3 – 4</b>	UART/USB RX ↔ P0_3
		<b>5 – 6</b>	UART/USB EN ↔ AP0_9
J15	LIN Transceiver to MCU connector	<b>1 – 2</b>	LIN RX ↔ P0_7
		<b>3 – 4</b>	LIN TX ↔ P0_8
J19	SENT interface connector	<b>1 – 2</b>	SENT RX ↔ P9_0
		<b>3 – 4</b>	SENT SPCO ↔ P9_1
J20	CAN0/1 transceiver TX/RX to MCU connector	<b>1 – 2</b>	CAN0TX ↔ P10_7
		<b>3 – 4</b>	CAN0RX ↔ P10_6
		<b>5 – 6</b>	CAN1TX ↔ P0_10
		<b>7 – 8</b>	CAN1RX ↔ P0_9

J21	Digital LPS input to MCU connector	<b>1 – 2</b>	DIN ↔ P8_3
		<b>3 – 4</b>	SELDP0 ↔ P0_4
		<b>5 – 6</b>	SELDP1 ↔ P0_5
		<b>7 – 8</b>	SELDP2 ↔ P0_6
		<b>9 – 10</b>	DPO ↔ P0_0
J22	VBAT selector	1 – 2	12V ↔ 12V_IN
		<b>2 – 3</b>	5V ↔ 12V_IN

Note: Default jumper setting (Power Supply by E2 Debugger) is indicated by **bold font**.

### 3.3 Board Overview RH850/F1KM-S1 [Y-ASK-RH850F1KM-S1-V3]

The RH850/F1KM-S1 Version of the V3 Starter Kit (without Motor Control Part equipped) is shown in the figure below.



**Figure 1. Starter Kit V3 top view RH850/F1KM-S1 without MC**

## 4. Starter Kit Hardware

### 4.1 Starter Kit functions

#### 4.1.1 RH850/F1KM-S1 Starter Kit

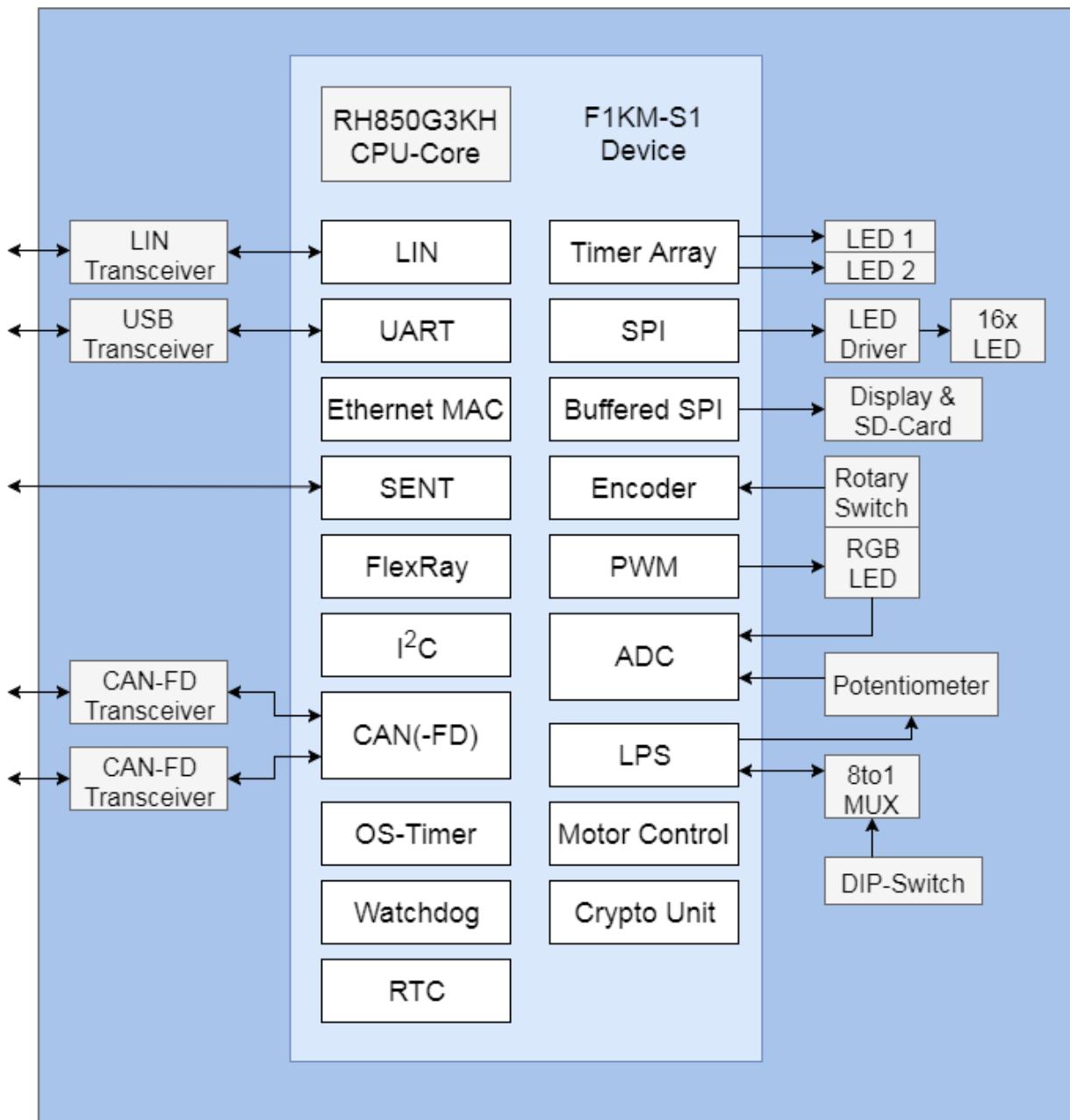


Figure 2. Functional overview

## 4.2 Functional Areas

The functional areas provide various circuits and components useful for interacting with the microcontroller's I/O:

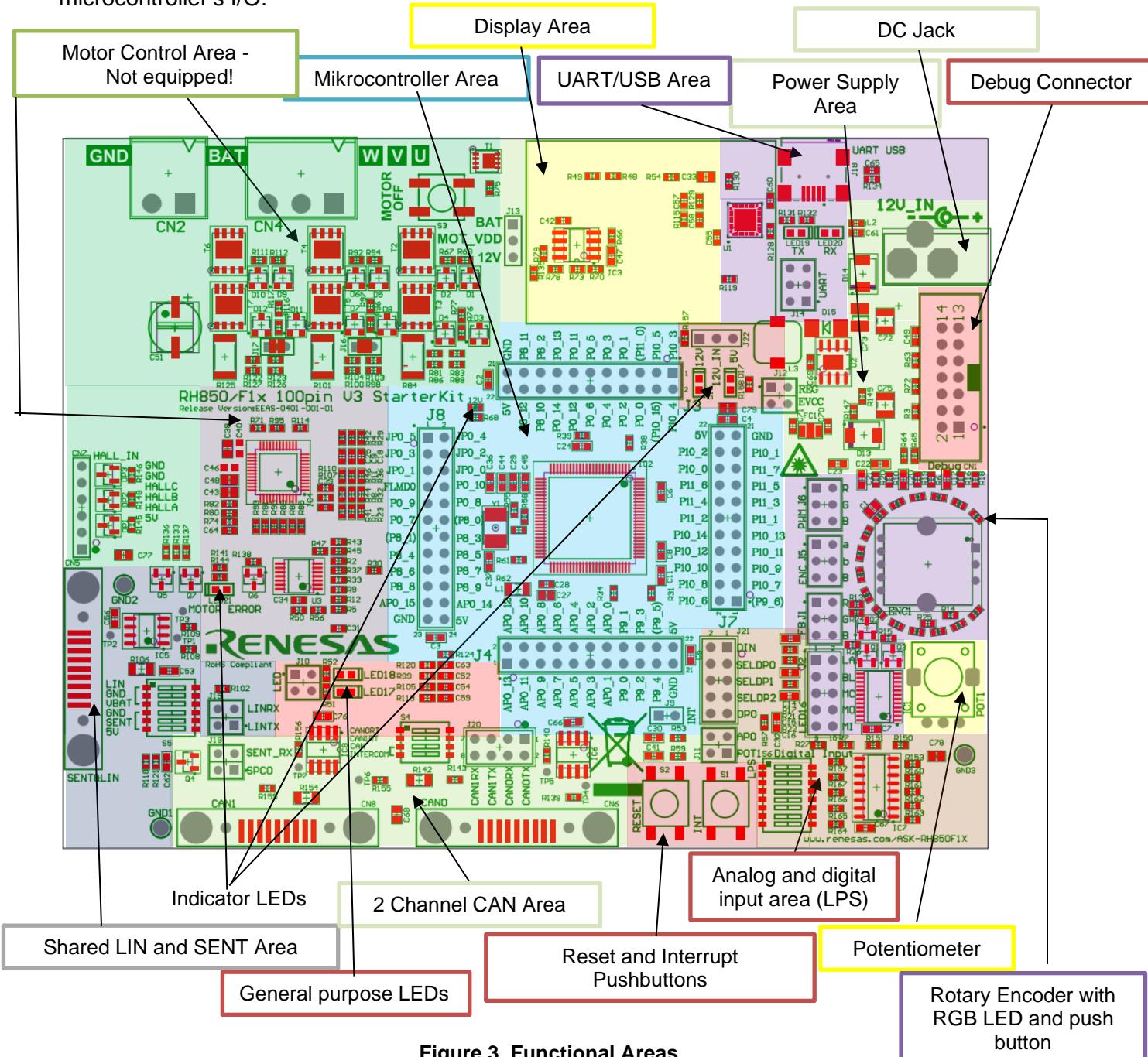


Figure 3. Functional Areas

#### 4.2.1 Power Supply

##### 4.2.1.1 Power supply configuration

The Starter Kit provides two options for powering the board's integrated circuits. It is possible to supply the Starter Kit by using the E2 Debugger or by connecting the provided external 12 Volt power supply to the DC Jack.

With the default jumper setting (see Table 5) the Starter Kit is configured to be power supplied by the E2 Debugger.

The operation of the LIN interface is only possible by using the provided external 12 Volt power supply.

When the board is supplied **by the E2-Debugger**, use the following jumper setting:

**Table 5 Jumper setting for power supply by E2-Debugger**

Jumper	Description	Setting	Note
J22	VBAT selector	1-2, 12V – 12V_IN	open
		2-3, 5V – 12V_IN	closed

When the board is supplied **via the DC Jack**, please choose the following jumper settings:

**Table 6. Jumper setting for power supply over DC Jack**

Jumper	Description	Setting	Note
J22	VBAT selector	1-2, 12V – 12V_IN	closed
		2-3, 5V – 12V_IN	open

The power supply area includes a DC Jack type connector for providing external power supply to the Starter Kit and its components. The external supply is reversibly protected against overvoltage. Nevertheless, please always observe the right polarity and voltage.

**Table 7. Power supply connector specification**

Connector	Description	Input Voltage Range
DC Jack*	DC Power Jack ID=2.0mm, center positive	+10V to +15V

##### 4.2.1.2 Power supply measurement

The current which is consumed by MCU can be measured by using J12. Please find below a description of the jumper.

**RH850/F1KM-S1:****Table 8. RH850/F1KM-S1 MCU power measurement**

<b>Jumper</b>	<b>Description</b>	<b>Pins</b>	<b>Note</b>
J12	MCU power measurement	1-2	REGVCC power supply (5 V)
		3-4	EVCC, AV0REF power supply (5 V)

**4.2.2 LEDs****4.2.2.1 RGB LED**

A RGB LED is provided to allow visual observation of microcontroller output port state and to show the functionality of the PWM Diagnostic Macro. The RGB LED, which is part of the Rotary Encoder, is driven by three N-channel transistors. Feedback for each RGB LED channel is connected to the A/D converter of the microcontroller to evaluate the LED drive state. The LED PWM signals are active high.

Please use the following jumper configuration to activate the full RGB LED functionality:

**Table 9. White RGB Signals Configuration**

<b>Jumper</b>	<b>Description</b>	<b>Setting</b>	<b>Note</b>
J1	RGB LED Connector	1-2	R_PWM feedback ↔ AP0_5
		3-4	G_PWM feedback ↔ AP0_6
		5-6	B_PWM feedback ↔ AP0_7
J6	PWM output to RGB LED connector	1-2	R_PWM signal ↔ P11_7
		3-4	G_PWM signal ↔ P11_6
		5-6	B_PWM signal ↔ P11_5

**4.2.2.2 Green Indicator LEDs**

Two green low power LEDs (LED1 and LED2) are provided to allow visual observation of microcontroller output port states. The LED signals are active high.

**Table 10. Green Indicator LED Signals**

<b>Jumper</b>	<b>Setting</b>	<b>LED</b>	<b>Device Port</b>
J10	1-2	LED18	P0_14
	3-4	LED17	P8_5

#### 4.2.2.3 Blue Power Supply LEDs

The three indicator LEDs are showing which power supply voltages are available:

**Table 11. Power Indicator LEDs**

Name on board	Signal Name	Meaning
D16	VDD_12V	Microcontroller area powered by DC Jack
D17	VDD_5V	Microcontroller area powered by E2

#### 4.2.2.4 Blue LED Circle

Sixteen blue LEDs are driven by the TLC5925, which can be controlled by the SPI command to change the output states.

**Table 12. Blue LED Circle Signals**

Jumper	Setting	Signal	Device Port
J2	1-2	LAT	P8_10
	3-4	BLNK	P8_11
	5-6	MCLK	P11_3
	7-8	MOSI	P11_2
	9-10	MISO	P11_4

#### 4.2.3 Digital Inputs for Low Power Sampler (LPS)

Eight digital input signals, which are generated by a DIP switch array (S3), are provided to trigger the microcontroller's Low Power Sampler. The input signals are connected to the microcontroller via 8 to 1 Multiplexer (IC4). When the DIP switches (S3) are changed during low power mode (DeepSTOP mode), the microcontroller will wake up.

Please use the following jumper configuration to connect the DIP Switch and multiplexer to the microcontroller

**Table 13. LPS Jumper Configuration**

Jumper	Description	Setting	Note
J21	Digital LPS input to MCU connector	1 – 2	DIN ↔ P8_3
		3 – 4	SELDP0 ↔ P0_4
		5 – 6	SELDP1 ↔ P0_5
		7 – 8	SELDP2 ↔ P0_6
		9 – 10	DPO ↔ P0_0

#### 4.2.4 Pushbutton Switches

Two pushbutton switches (S1 and S2) are provided to allow the switching of microcontroller input port states. Those switches are active low and normally open.

**Table 14. Pushbutton Switch Signals**

Switch	Device signal	Active Level	Inactive State
S1	P8_2 (INTP6)	low	open
S2	RESET	low	open

Please use the following jumper configuration to connect the interrupt pushbutton switch (S1) to the microcontroller.

**Table 15. Interrupt Pushbutton Jumper Configuration**

Jumper	Description	Setting	Note
J9	Interrupt pushbutton to MCU connector	1-2	Button ↔ P8_2

Additionally, a pushbutton is provided with the Rotary Encoder. For details, please refer to “Rotary Encoder with Pushbutton”.

#### 4.2.5 Analog Input - Potentiometer

A potentiometer (POT1) is provided to generate an analog voltage, which can be delivered to the microcontroller's analog input pins.

By turning the potentiometer POT1, a voltage derived from the MCU output signal APO (P0\_1) can be adjusted. The APO signal can be controlled by the Low Power Sampler (LPS) macro. If the LPS macro is not used, APO has to be set to high manually (use P0\_1 as general purpose digital output).

**Table 16. Analog Input Signal**

Potentiometer	Analog Input MCU
POT1	AP0_4

Please use the following jumper configuration to connect the potentiometers to the microcontroller:

**Table 17. Potentiometer Jumper Configuration**

Jumper	Description	Setting	Note
J11	Potentiometer to MCU Connector	1-2	POT1 ↔ AP0_4
		3-4	POT1 supply ↔ APO

#### 4.2.6 Rotary Encoder with Pushbutton Switch

An incremental Rotary Encoder (ENC1) is provided on the starter kit. The outputs *ENC1\_a* and *ENC1\_b* of the Rotary Encoder can be connected to the microcontroller internal encoder timer via jumpers. In addition, the Rotary Encoder (ENC1) incorporates a pushbutton switch *ENC1\_Switch*, which can also be connected to a pin of the microcontroller via jumper. The switch is active low and normally open.

**Table 18. Encoder Jumper Configuration**

Jumper	Description	Setting	Note
J5	Encoder to MCU connector	1-2	P10_9 ↔ ENC1_a
		3-4	P10_10 ↔ ENC1_b
		5-6	P0_13 ↔ ENC1_Switch

#### 4.2.7 Serial Communication Interfaces

##### 4.2.7.1 SENT and LIN

*Local Interconnect Network* (LIN) transceiver (IC5) is supplied to provide a LIN interface. The transceiver can be connected to the microcontroller's LIN macro (RLIN21).

The DB9 connector CN5 is shared between the board's LIN and SENT interface. Renesas provides a SENT Extension Board “Y-RH850-SENT-EXT-BRD-V2” that can be connected to the DB9 connector and comes with a sample software, which receives the SENT messages from an Renesas ZSSC4161D.

Please close the following jumpers to connect the LIN transceiver to the microcontroller:

**Table 19. LIN Transceiver Jumper Configuration**

Jumper	Description	Setting	Note
J15	LIN Transceiver to MCU connector	1-2	LIN RX ↔ P0_7
		3-4	LIN TX ↔ P0_8

Please close the following jumpers to connect the SENT interface to the microcontroller:

**Table 20. SENT Jumper Configuration**

Jumper	Description	Setting	Note
J19	SENT interface connector	1-2	SENT SPCO ↔ P9_1
		3-4	SENT RX ↔ P9_0
		5-6	SENT PROG ↔ AP0_14

The serial interfaces are connected to the DB9 connector CN5 via DIP switch S5.

Only one interface can be used at a time. Please see the configuration for LIN in **Table 21** and for SENT in **Table 22**.

**Table 21. Switch S5 configuration for LIN**

Switch		Configuration	Signal	DB9 pin (CN5)
S5	1	on	LIN	7
	2	on	GND	3
	3	on	VBATF (12V DC)	9
	4	off	-	6
	5	off	-	8
	6	off	-	1

**Table 22. Switch S5 configuration for SENT**

Switch		Configuration	Signal	DB9 pin (CN5)
S5	1	off	-	7
	2	off	-	3
	3	off	-	9
	4	on	GND	6
	5	on	SENT_RX (SENT_SPCO)	8
	6	on/off*	VDD_5V	1

\*Caution: If you want to connect your own sensor board, make sure not to exceed the maximum output current of the Port AP0\_14! If you do, please don't use AP0\_14 but turn on the 5th switch of the S5 dip switch.

**Note:** Please ensure that only one interface is configured for operation at the same time (either LIN or SENT) by using DIP switch S5.

#### 4.2.7.2 UART/USB Interface

UART TO USB transceiver (U1) is supplied to provide a serial interface. The transceiver can be connected to the microcontroller's UART macro (RLIN30).

Please close the following jumpers to connect the UART/USB transceiver to the microcontroller:

**Table 23. UART/USB Transceiver Jumper Configuration**

Jumper	Description	Setting	Note
J14	UART to USB connector	1-2	UART/USB TX ↔ P0_2
		3-4	UART/USB RX ↔ P0_3
		5-6	UART/USB EN ↔ AP0_9

#### 4.2.7.3 CAN Interfaces

Controller Area Network (CAN) transceivers (IC6 and IC8) are supplied to provide two CAN bus interfaces. Each transceiver can be connected to one of the microcontroller's CAN interfaces (CAN1, CAN4). The CAN bus interfaces are connected to the DB9 connectors CN6 and CN8. The CAN0/1 transceiver is enabled by default and able to transmit and receive data via the CANH and CANL bus lines. This receive-only mode can be used to test the connection of the bus medium. In silent mode it can still receive data from the bus, but the transmitter is disabled and therefore no data can be sent to the CAN bus. DIP switch S4 provides additional CAN bus interface configuration options including the ability to selectively interconnect CAN bus interfaces on-board.

The CAN transceiver support CAN and CAN-FD communication.

Please close the following jumpers to connect the CAN0 transceiver (IC6) and CAN1 transceiver (IC8) to the microcontroller:

**Table 24. CAN0 and CAN1 Transceiver Jumper Configuration**

Jumper	Description	Setting	Note
J20 (optional)	CAN0 transceiver TX/RX to MCU connector	1 – 2	CANTX0 ↔ P10_7 (CAN1TX)
		3 – 4	CANRX0 ↔ P10_6 (CAN1RX)
	CAN1 transceiver TX/RX to MCU connector	5 – 6	CANTX1 ↔ P0_10 (CAN4TX)
		7 – 8	CANRX1 ↔ P0_9 (CAN4RX)

The on-board CAN bus and the terminal resistors of each CAN channel can be activated by DIP switch S4.

**Table 25. DIP Switch S4 - CAN Interfaces Signals**

Transceiver	CAN channel	Switch	Note
IC6	CAN0	1	Enable termination resistor
IC8	CAN1	2	Enable termination resistor
All	All	3	Connect to on-board CAN bus
		4	Connect to on-board CAN bus

#### 4.2.8 On-chip Debug and Flash Programming Connector

Connector CN1 is provided to allow the connection of microcontroller debug and flash programming tools. Connector CN1 is a 14 pin, 0.1" pin pitch connector. The pinout of this connector supports the Renesas E2 On-chip debug emulator and the Renesas PG-FP6 Flash Programmer. For more information about the E2, please see Chapter 5.1 *E2 On-Chip Debug Emulator* [RTE0T00020KCE00000R]. For more information about the PG-FP6, please see Chapter 5.2 PG-FP6 Programmer [RTE0T00001FWREA000R]

#### 4.2.9 OLED Board (optional)

The Starter Kit offers a pin header to optionally connect an external display to the board. For example, following *OLED* Display is compatible to the connector:

<https://www.adafruit.com/product/326>

**Table 26. OLED header (optional)**

Connector	PCB	Display
1	GND	GND
2	5V	VIN
3	M_DISPLAY_3V3 (AP0_8)	3.3V
4		CS
5	M_DISPLAY_RESET2 (P8_6)	RST
6		DC
7	M_DISPLAY_SCL (P0_12)	SCL
8	M_DISPLAY_SDA (P0_11)	SDA

## 5. Development tools

### 5.1 E2 On-Chip Debug Emulator [RTE0T00020KCE00000R]

The *E2 On-Chip Debug Emulator* is a powerful debugging tool with flash programming functions which supports various Renesas microcontrollers.

Updates and User Manuals for this tool can be found on the Renesas website:

<http://www.renesas.com/e2>

### 5.2 PG-FP6 Programmer [RTE0T00001FWREA000R]

The PG-FP6 Programmer is an easy to use and fast Flash Programmer, which supports various Renesas microcontrollers.

Updates and User Manuals for this tool can be found on the Renesas website:

<http://www.renesas.com/pg-fp6>

### 5.3 Development Software

The following development software tools are included in the Starter Kit package:

- Green Hills MULTI IDE (90 days evaluation version)
- IAR Embedded Workbench for Renesas RH850 (128KB Kickstart version)
- iSYSTEM winIDEA with E2 support
- CS+ integrated development environment (Evaluation Version via download)
- Renesas Flash Programmer (RFP)
- Renesas Smart Configurator (SC)

More information about the usage of these software tools is shown in the Quick Start Guide which is also part of the Starter Kit package.

## 6. RH850/F1KM-S1 Starter Kit Example Software

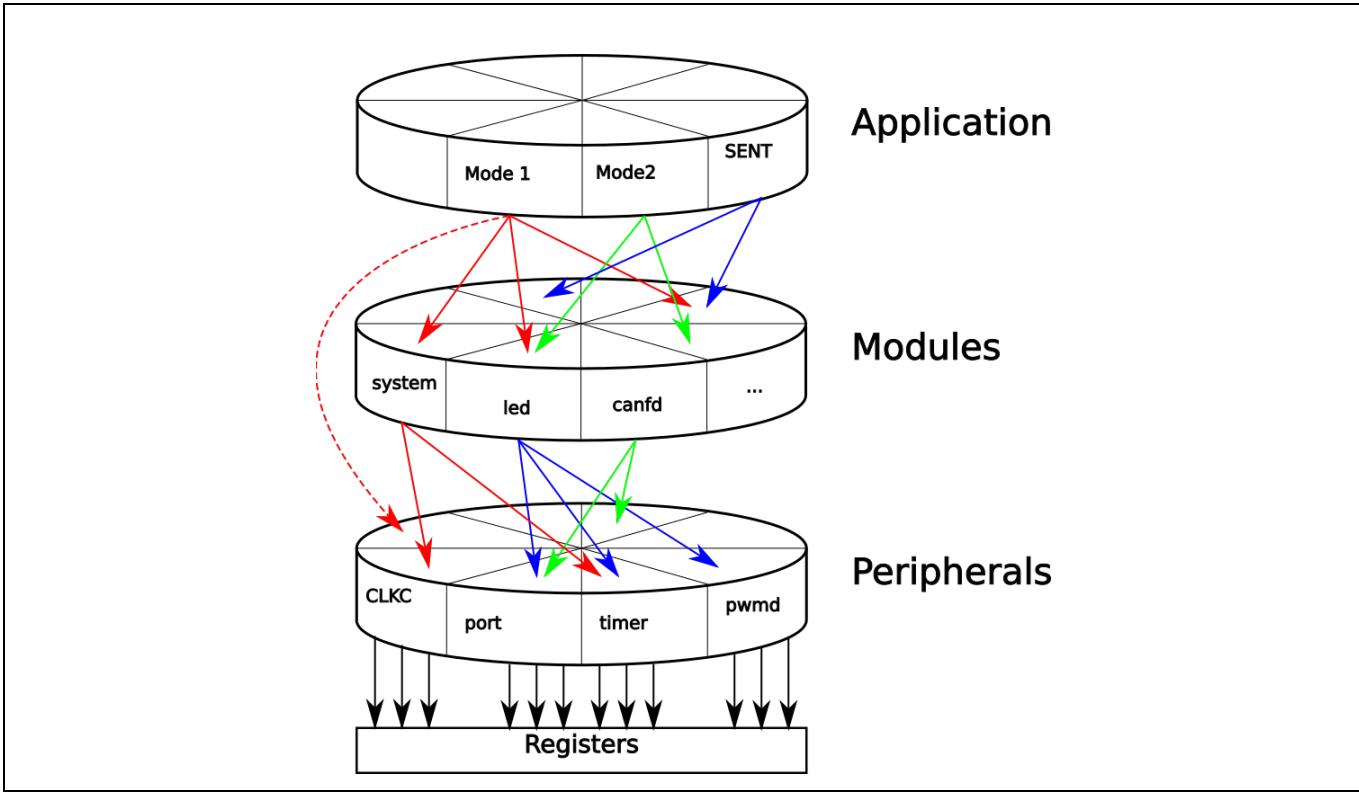
The included demo software provides the following functions:

- Basic MCU Initialization
- PWM Generation for user LEDs and RGB LEDs
- PWM Diagnostic Function for RGB LEDs
- A/D-Converter for PWM-Diagnostics and Potentiometers
- Standby modes including Low Power Sampler (LPS)
- Push-Button Function
- Encoder Function
- CAN Frame Transmission
- LIN Frame Transmission
- UART/USB Transmission
- SENT Transmission
- SPI Transmission
- Operating System Timer
- Timer Array Unit J
- Timer Array Unit B

### 6.1 Framework Description

Renesas provides a software framework with its Starter Kits, so that the customer can easily access and use the modules of the controller. The Starter Kits are equipped with a lot of peripheral devices like encoder, potentiometer, LEDs, optional display, CAN-, LIN- and UART/USB-transceivers, buttons and. To use these modules, the Starter Kit contains software functions which allows an easy and fast use.

The framework is divided in 3 layers:



**Figure 4. Framework Layers**

In the layer peripherals you can find the source code related to the peripherals of the microcontroller. For example, you can find all related functions for the ports in the `r_port.c`. Only the functions defined in this source file should set or read the port registers.

In the modules layer, you can find modules like CAN-FD, which accesses not only the functions for the RS-CANFD peripheral of the MCU, but also for example the functions of the port peripheral. It can also contain a not controller specific module like "led". This module for example uses functions of the port-, timer- and pwmd peripheral to get the behavior of the led you want.

The highest layer is the app layer which contains the actual application. For example, the sample application for the Starter Kit uses the lower layer modules to write to the display, turn on some LEDs and checks the transceivers of the Starter Kit.

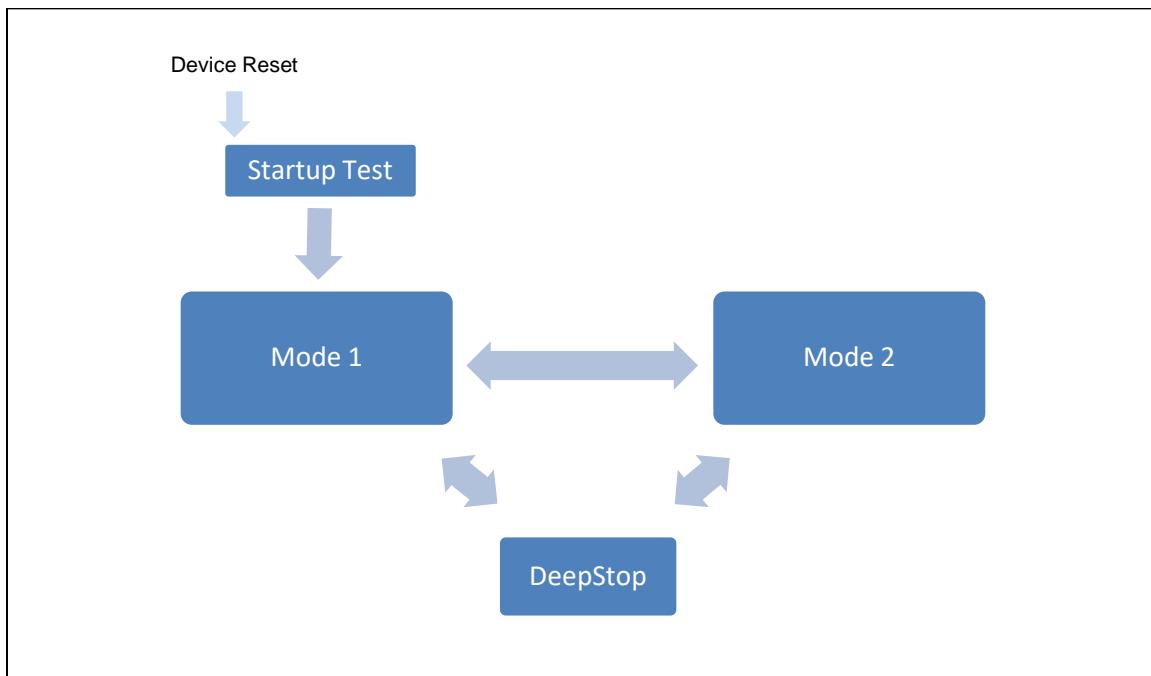
It is intended that a higher layer should only access the lower layers and not the other way around.

## 6.2 Sample Software Classic

The software contains a test function executed at the start and two run modes.

For live documentation of the RH850 actions connect a USB-Port of your computer via a USB Cable to the USB connector "J18" of the board.

**Note:** Use a USB 1.0/2.0 Type A to mini-USB 1.0/2.0 mini-B computer cable and a baud-rate of 9600 Bd.



**Figure 5. Software flow**

### 6.3 Start Up Test

Once started, the clock will be initialized, and a start-up test is performed. During the test, the LEDs of the Blue LED Circle will successively be turned on and then turned off in the same pattern. Simultaneously the RGB LED will sweep through different colors and then turn off. Afterwards the RGB LED will light up in white for 500ms, as well as the whole Blue LED Circle. LED1 and LED2 will light during the whole test. The Serial Interfaces CAN, LIN and the RGB LED PWM feedback signals are checked. The result is printed out in the debugger and via UART/USB. Also, a Test Picture will be output on the Display. After this the SW continues with Mode 1.

### 6.4 Mode 1

LED1 and LED2 glow in different intensities depending on the potentiometer POT1 position. The converted analogue value of POT1 is used to update the duty cycle of the PWM module which drives these LEDs. The LEDs of the Blue LED Circle follow the Rotary Encoder ENC1. By pressing the Rotary Encoder Pushbutton, the color of the RGB LED is changed.

The load current through each of the RGB LEDs is evaluated by converting feedback/sense signal into digital values and applying conversion result upper / lower limit check function of ADC (PWM diagnostic function). In case the measured current is either too high or too low, a fault is assumed and in turn the PWM of the corresponding LED is switched OFF. By switching to Mode 2 the PWM output and diagnostic is started again.

A short push on pushbutton S1 will switch to Mode 2, holding it pressed for 3s or more will switch to DeepSTOP mode.

After 30s without user action, the microcontroller will enter DeepSTOP mode on its own.

Mode 1 is called in a 1ms cycle using the Operating System Timer.

## 6.5 Mode 2

LED1 and LED2 blink alternately and the LEDs of the Blue LED Circle run around the Rotary Encoder in a specific frequency. The frequency is determined by the analogue value of POT1 which is converted to a corresponding Timer Array Unit J interval time. After each interval, the duty cycle of the LEDs LED1 and LED2 is adjusted to generate the alternatively blinking pattern, as well as the positions of the Blue LED Circle. The number of blue LEDs which are circling can be increased/decreased by the Rotary Encoder ENC1.

The load current through each of the RGB LEDs is evaluated by converting feedback/sense signal into digital values and applying conversion result upper / lower limit check function of ADC (PWM diagnostic function). In case the measured current is either too high or too low, a fault is assumed and in turn the PWM of the corresponding LED is switched OFF. By switching to Mode 1 the PWM output and diagnostic is started again.

A short push on pushbutton S1 will switch to mode 1, holding it pressed for 3s or more will switch to DeepSTOP mode.

After 30s without user action, the microcontroller will enter DeepSTOP mode on its own.

Mode 2 is called in a 1ms cycle using the Operating System Timer.

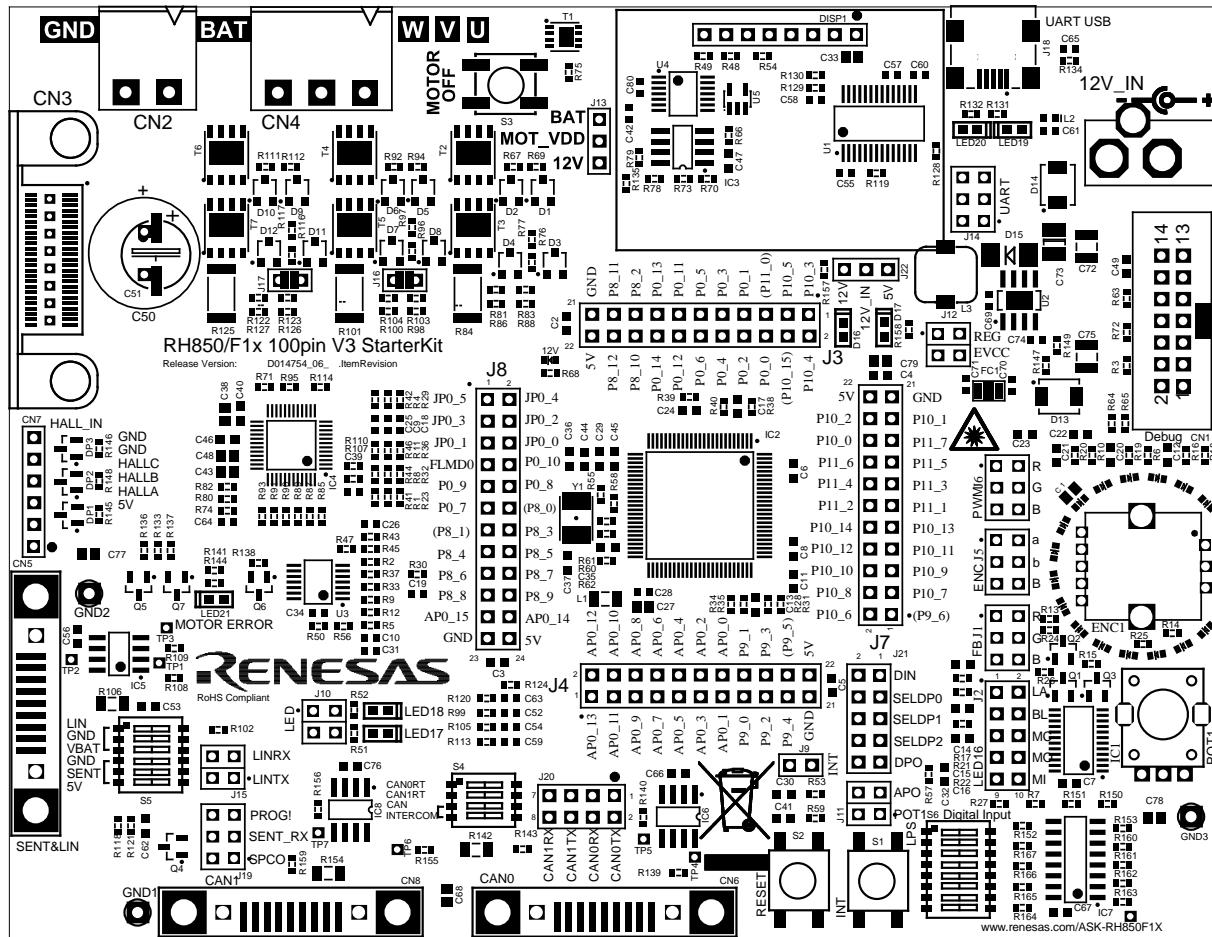
## 6.6 StandBy

Entering standby mode will turn off all unnecessary functions and switch the controller into DeepSTOP for low power consumption. This is indicated by a 2s interval of LED2 generated by the Timer Array Unit J.

A wake-up can be performed by a short push the pushbutton S1, the Rotary Encoder Pushbutton, changing the configuration of the DIP switch S6 or turning potentiometer POT1 more than 25% of the actual state. DIP switch and POT1 related wake-up events are generated by using the Low Power Sampler triggered by Timer Array Unit J in a 500ms interval. Performing a wake-up will resume the last mode the SW was in before standby was entered.

## 7. Component Placement and Schematics

### 7.1 Component placement

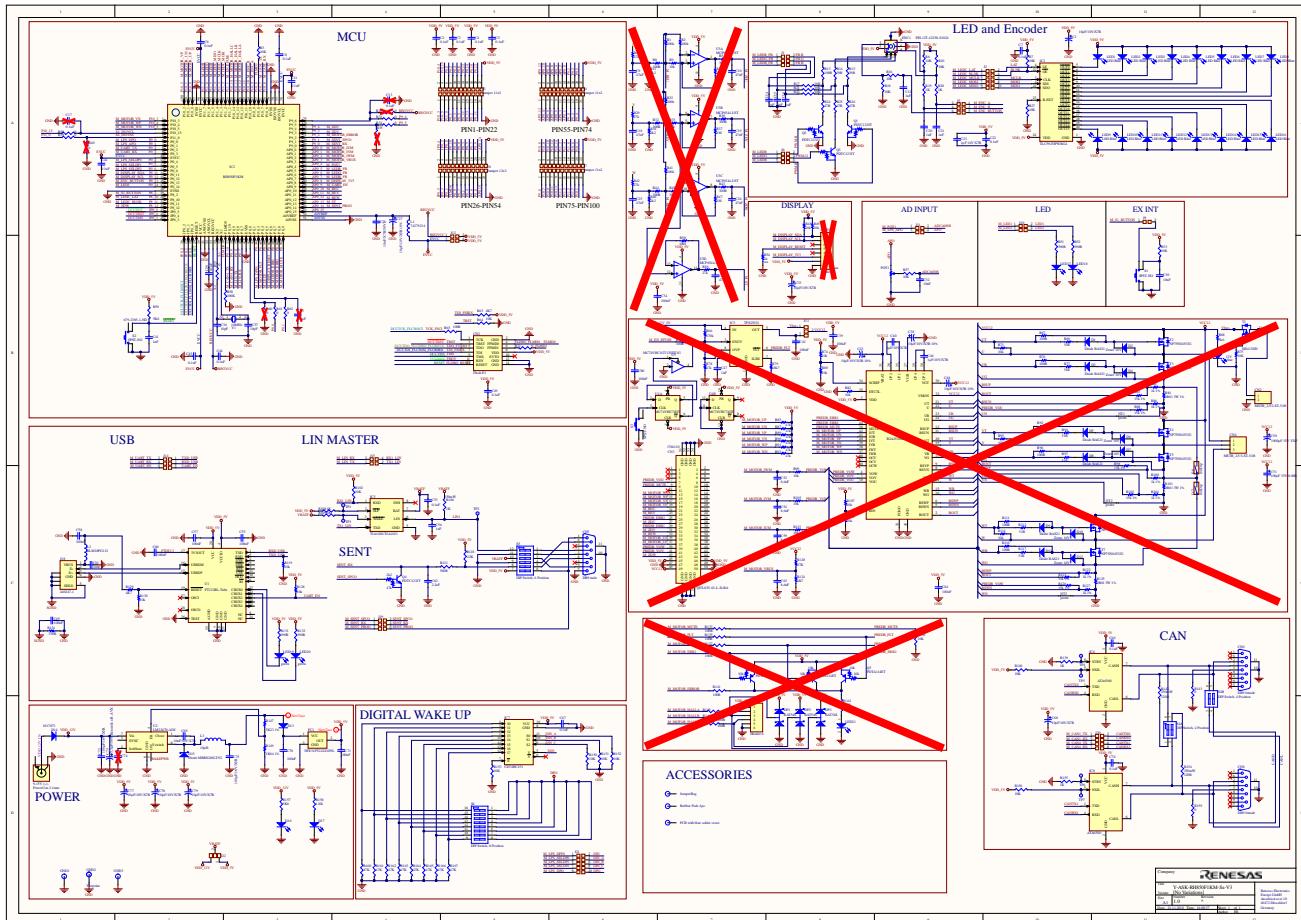


**Figure 6. Component Placement**

Note: This component placement is related to the following release version of the PCB:  
“D01474754\_06\_V02”

## 7.2 Schematics

### 7.2.1 Y-ASK-RH850F1KM-S1-V3 Schematics (without Motor Control)



**Figure 7. Schematics**

Note: This Schematic is related to the following release version of the PCB: "D01474754\_06\_V02"

## Revision History

### RH850/F1KM-S1 Starter Kit V3 User Manual: Hardware

Rev.	Date	Description	
		Page	Summary
1.00	June 2018	—	First edition issued
1.01	November 2018	20, 24, 27, 34, 35	Schematics/component placement updated, Hall Sensor connection added, SENT description extended, Framework Description added
1.02	February 2019	—	Minor corrections
1.03	April 2019	23	Motor connector table corrected.
1.03	October 2019	15, 16	Max power supply current added.
1.10	January 2023	All	Deleted motor control description in this Manual and minor updates. Exchanged SENT Sensor references with new one.

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## Renesas Electronics Corporation

### SALES OFFICES

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#### **Renesas Electronics America Inc.**

2880 Scott Boulevard Santa Clara, CA 95050-2554, 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: +1-905-898-5441, Fax: +1-905-898-3220

#### **Renesas Electronics Europe Limited**

Dukes Meadow, Millboard 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: +49-211-65030, Fax: +49-211-6503-1327

#### **Renesas Electronics (China) Co., Ltd.**

7th Floor, Quantum Plaza, No.27 ZhiChunLu Haidian District, Beijing 100083, P.R.China  
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

#### **Renesas Electronics (Shanghai) Co., Ltd.**

Unit 204, 205, AZIA Center, No.1233 Lujiazui Ring Rd., Pudong District, Shanghai 200120, China  
Tel: +86-21-5877-1818, Fax: +86-21-6887-7858 / -7898

#### **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: +852-2886-9318, Fax: +852 2886-9022/9044

#### **Renesas Electronics Taiwan Co., Ltd.**

7F, No. 363 Fu Shing North Road Taipei, Taiwan  
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

#### **Renesas Electronics Singapore Pte. Ltd.**

1 harbourFront Avenue, #06-10, keppel Bay Tower, Singapore 098632  
Tel: +65-6213-0200, Fax: +65-6278-8001

#### **Renesas Electronics Malaysia Sdn.Bhd.**

Unit 906, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia  
Tel: +60-3-7955-9390, Fax: +60-3-7955-9510

#### **Renesas Electronics Korea Co., Ltd.**

11F., Samik Lavied' or Bldg., 720-2 Yeoksam-Dong, Kangnam-Ku, Seoul 135-080, Korea  
Tel: +82-2-558-3737, Fax: +82-2-558-5141

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