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RENESAS

Renesas Starter Kit for R8C/23
User's Manual

RENESAS 16-BIT SINGLE-CHIP MICROCOMPUTER

M16C FAMILY / R8C/Tiny SERIES

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Chapter 1. Preface

Cautions

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Website: http://www.eu.renesas.com   (Europe)

http://www.renesas.com   (Global)

Glossary

ADC	Analog Digital Converter	IRQ	Interrupt ReQuest
CAN	Controller Area Network	LCD	Liquid Crystal Display
CPU	Central Processing Unit	LED	Light Emitting Diode
DAC	Digital Analog Converter	LIN	Local Interconnect Network
E8a	E8a On-chip debugger module	LSI	Large Scale Integration
HEW	High-performance Embedded Workshop	MCU	Microcontroller

Chapter 2. Purpose

This Renesas Starter Kit is an evaluation tool for Renesas microcontrollers.

Features include:

- Renesas Microcontroller Programming.

- User Code Debugging.

- User Circuitry such as Switches, LEDs and potentiometer(s).

- User or Example Application.

- Sample peripheral device initialisation code.

The Renesas Starter Kit board contains all the circuitry required for microcontroller operation.

NOTE: This manual describes the technical details of the Renesas Starter Kit for R8C/23 hardware. The Quick Start Guide and Tutorial Manual provide details of the software installation and debugging environment.

Chapter 3. Power Supply

3.1. Requirements

This Renesas Starter Kit operates from a 3V to 5V power supply.

A diode provides reverse polarity protection only if a current limiting power supply is used.

All Renesas Starter Kit boards are supplied with an E8a debugger. This product is able to power the Renesas Starter Kit board with up to 300mA. When the Renesas Starter Kit is connected to another system then that system should supply power to the Renesas Starter Kit.

All Renesas Starter Kit boards have an optional centre positive supply connector using a 2.1mm barrel power jack.

Warning

The Renesas Starter Kit is neither under nor over voltage protected. Use a centre positive supply for this board.

3.2. Power – Up Behaviour

When the Renesas Starter Kit is purchased the Renesas Starter Kit board has the 'Release' or stand alone code from the example tutorial code pre-programmed into the Renesas microcontroller. On powering up the board the user LEDs will start to flash. After 200 flashes, or after pressing a switch the LEDs will flash at a rate controlled by the potentiometer.

Chapter 4. Board Layout

4.1. Component Layout

The following diagram shows the top layer component layout of the board.
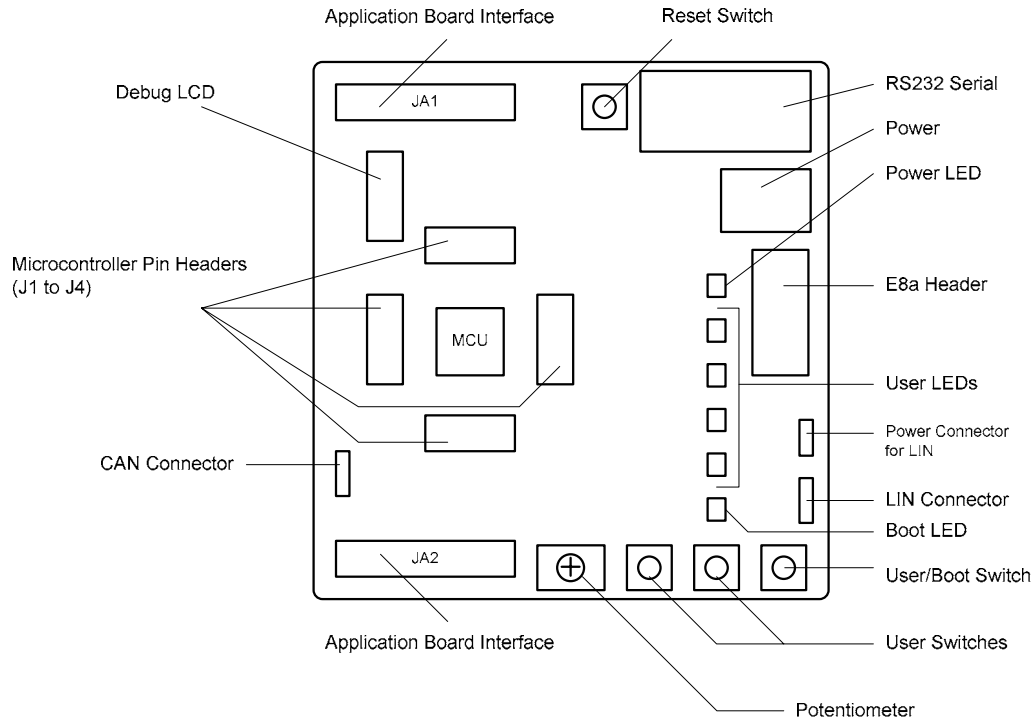
Figure 4-1: Board Layout

4.2. Board Dimensions

The following diagram gives the board dimensions and connector positions. All through hole connectors are on a common 0.1″ grid for easy interfacing.
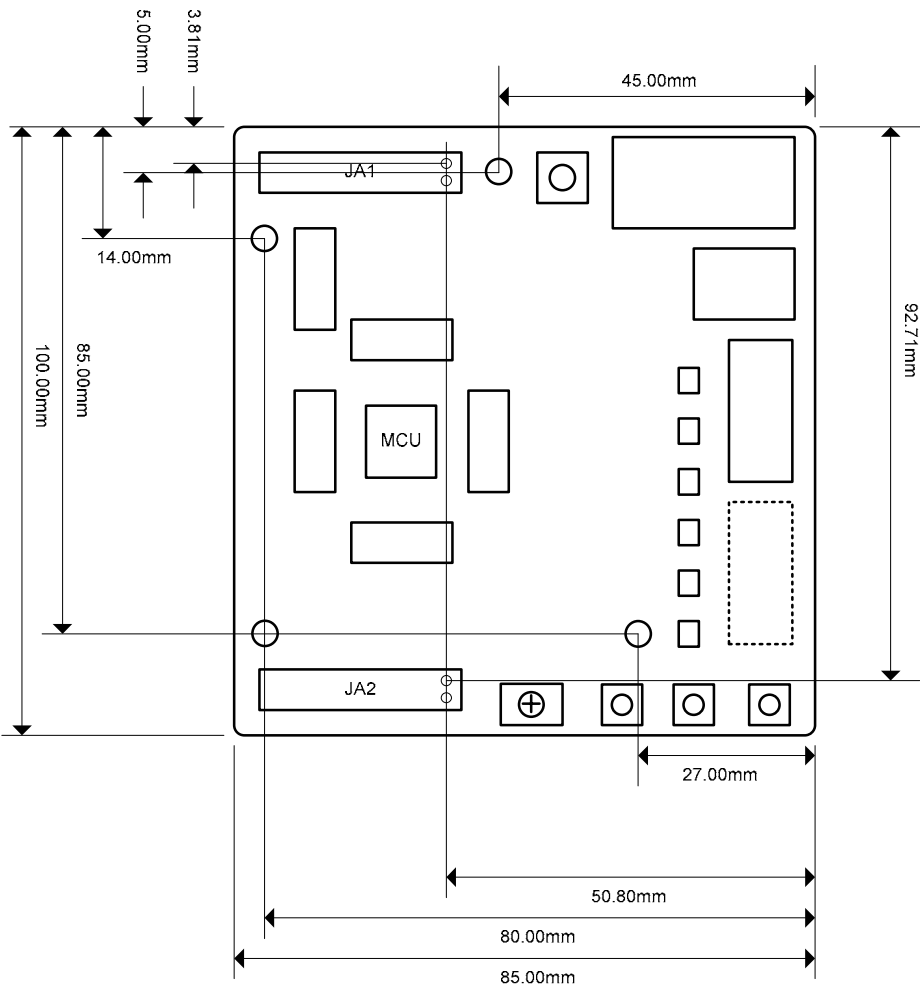
Figure 4-2 : Board Dimensions

Chapter 5. Block Diagram

Figure 5-1 is representative of the CPU board components and their connectivity.

Figure 5-1: Block Diagram

Figure 5-2 is representative of the connections required to the Renesas Starter Kit.

Figure 5-2 : Renesas Starter Kit Connections

Chapter 6. User Circuitry

6.1. Switches

There are four switches located on the board. The function of each switch and its connection are shown in Table 6-1.

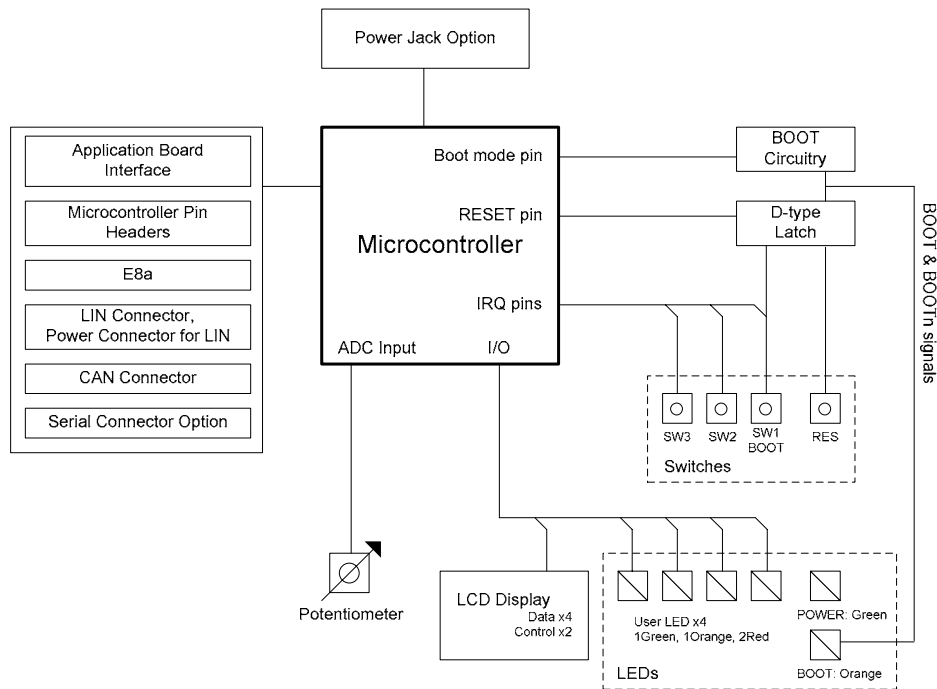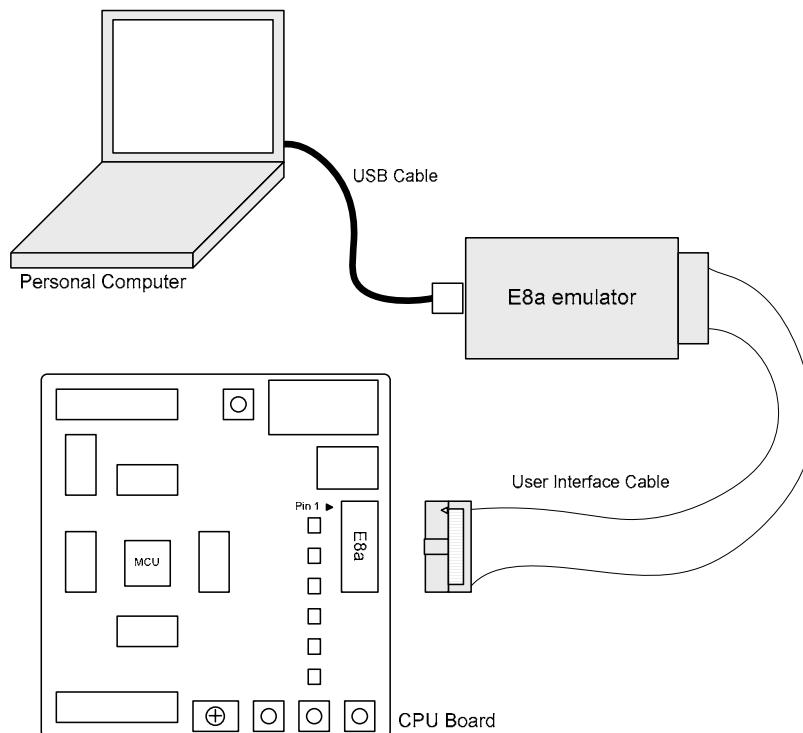| Switch	Function	Microcontroller
RES	When pressed, the board microcontroller is reset.	**RESET** Pin7
SW1/BOOT*	Connects to an IRQ input for user controls. The switch is also used in conjunction with the RES switch to place the device in BOOT mode when not using the E8a debugger.	**INT0** Pin25 (Port 4, pin 5)
SW2*	Connects to an IRQ input for user controls.	**INT1** Pin20 (Port 1, pin 7)
SW3*	Connects to a Key In Interrupt input for user controls	**KI3** Pin24 (Port 1, pin 3)

Table 6-1: Switch Functions

*Refer to schematic for detailed connectivity information.

6.2. LEDs

There are six LEDs on the CPU board. The green 'POWER' LED lights when the board is powered. The orange 'BOOT' LED indicates the device is in BOOT mode when lit. The four user LEDs are connected to an IO port and will light when their corresponding port pin is set low.

Table 6-2, below, shows the LED pin references and their corresponding microcontroller port pin connections.

LED Reference (As shown on silkscreen)	Colour	Microcontroller Port Pin function	Microcontroller Pin Number
LED0	Green	Port 2.4	15
LED1	Orange	Port 2.5	14
LED2	Red	Port 2.6	13
LED3	Red	Port 2.7	12

Table 6-2: LED Port

6.3. Potentiometer

A single turn potentiometer is connected to AN8 (P1.0) of the microcontroller. This may be used to vary the input analog voltage value to this pin between VREF and Ground.

6.4. Serial port

The microcontroller programming serial port 1 is connected to the RS232 transceiver. This serial port can optionally be connected to the RS232 transceiver as well by fitting option resistors. The connections to be fitted are listed in the Table 6-3.

Description	Function	Fit for RS232
TxD1	Programming Serial Port	R45
RxD1	Programming Serial Port	R46

Table 6-3: Serial Port settings

A Secondary serial port is connected to the application headers. This is shared with the LIN module.

6.5. LCD Module

A LCD module is supplied to be connected to the connector J8. This should be fitted so that the LCD module lies over J1. Care should be taken to ensure the pins are inserted correctly into J8.The LCD module uses a 4 bit interface to reduce the pin allocation. No contrast control is provided; this is set by a resistor on the supplied display module. The module supplied with the Renesas Starter Kit only supports 5V operation.

Table 6-4 shows the pin allocation and signal names used on this connector.

J8					
Pin	Circuit Net Name	Device Pin	Pin	Circuit Net Name	Device Pin
1	Ground	-	2	5V Only	-
3	No Connection	-	4	LCD_RS	29
5	R/W (Wired to Write only)	-	6	LCD_E	28
7	No Connection	-	8	No Connection	-
9	No Connection	-	10	No Connection	-
11	LCD_D4	47	12	LCD_5	46
13	LCD_D6	45	14	LCD_7	44

Table 6-4: LCD Module Connections

6.6.Option Links

Table 6-5 below describes the function of the option links associated with Power configuration. The default configuration is indicated by **BOLD** text.

Option Link Settings				
Reference	Function	Fitted	Alternative (Removed)	Related To
R18	Power Supply	**Connects J5 to Board_VCC**	J5 disconnected from Borad_VCC	R20
R20	Power Supply	**Connects Board_VCC to board voltage line**	Board_VCC disconnected from board voltage line	R18, R19, R21, R22, R23
R21	Power Supply (External 5V)	**Connects CON_5V (External 5V) to Board_VCC**	CON_5V disconnected from Board_VCC	R20, R22, R23
R22	Power Supply (External 3.3V)	Connects CON_3V3 (External 3.3V) to Board_VCC	**CON_3V3 disconnected from Board_VCC**	R20, R21, R23
R23	MCU Power Supply	**Supply to MCU**	Fit Low ohm resister to measure current	R20, R21, R22
R30	User I/O Power Supply	**Connects Board_VCC to SW2, 3 and LED0-3**	Board_VCC disconnected from SW2, 3 and LED0-3	

Table 6-5: Power Configuration Links

Table 6-6 below describes the function of the option links associated with Clock configuration. The default configuration is indicated by **BOLD** text.

Option Link Settings				
Reference	Function	Fitted	Alternative (Removed)	Related To
R8	Oscillator (Main clock)	Connects external clock to MCU	**Connects X1 to MCU**	R10, R11, R12
R10	Oscillator (Main clock)	Connects external clock to MCU	**Connects X1 to MCU**	R8, R11, R12
R11	Oscillator (Main clock)	**Connects X1 to MCU**	Connects external clock to MCU	R8, R10, R12
R12	Oscillator (Main clock)	**Connects X1 to MCU**	Connects external clock to MCU	R8, R10, R11
R13	Oscillator (Sub clock)	Do not fit the option resistor	**MCU port P4_3 connects to MCU header**	R14, R15, R16, R17
R14	Oscillator (Sub clock)	Do not fit the option resistor	**MCU port P4_4 connects to MCU header**	R13, R15, R16, R17
R15	Oscillator (Sub clock)	**MCU port P4_3 connects to MCU header**	Do not remove the option resistor	R13, R14, R16
R16	Oscillator (Sub clock)	**MCU port P4_4 connects to MCU header**	Do not remove the option resistor	R13, R14, R15
R17	Oscillator (Sub clock)	Do not fit the option resistor	**Do not fit the option resistor**	R13, R14

Table 6-6: Clock Configuration Links

Table 6-7 below describes the function of the option links associated with Serial configuration. The default configuration is indicated by **BOLD** text.

Option Link Settings				
Reference	Function	Fitted	Alternative (Removed)	Related To
R44	RS232 Serial	Disables RS232 Serial Transceiver	**Enables RS232 Serial Transceiver**	R45, R46
R45	Programming Serial Port	Connects RS232 port to Programming Serial Port	**Disconnected**	
R46	Programming Serial Port	Connects RS232 Port to Programming Serial Port	**Disconnected**	

Table 6-7: Serial Configuration Links

Table 6-8 below describes the function of the option links associated with LIN configuration. The default configuration is indicated by **BOLD** text.

Option Link Settings				
Reference	Function	Fitted	Alternative (Removed)	Related To
R56	LIN	**For Master node setting**	For Slave node setting	R59, R60, R61
R59	LIN	**Connects LIN-NSLP to MCU port P1_6**	Disconnected	R56, R60, R61
R60	LIN	**Connects LIN-RXD0 to MCU port P1_5**	Disconnected	R56, R59, R61
R61	LIN	**Connects LIN-TXD0 to MCU port P1_4**	Disconnected	R56, R59, R60

Table 6-8: LIN Configuration Links

Table 6-9 below describes the function of the option links associated with CAN configuration. The default configuration is indicated by **BOLD** text.

Option Link Settings				
Reference	Function	Fitted	Alternative (Removed)	Related To
R62	CAN	**Connects termination resistor R65 to CAN bus line**	Disconnected	R64, R66, J11
R64	CAN	**Connects CAN0OUT to MCU port P6_1**	Disconnected	R62, R66
R66	CAN	**Connects CAN0IN to MCU port P6_2**	Disconnected	R62, R64

Table 6-9: CAN Configuration Links

Table 6-10 below describes the function of the option links associated with Analog configuration. The default configuration is indicated by **BOLD** text.

Option Link Settings				
Reference	Function	Fitted	Alternative (Removed)	Related To
R7	ADC	**Connects CON_VREF (Reference Voltage) to MCU**	CON_VREF disconnected from MCU	R19
R19	ADC	**Connects CON_VREF to Board_VCC**	CON_VREF disconnected from Board_VCC	R7

Table 6-10: Analog Configuration Links

Table 6-11 below describes the function of the option links associated with microcontroller pin function select configuration. The default configuration is indicated by **BOLD** text.

Option Link Settings				
Reference	Function	Fitted	Alternative (Removed)	Related To
R50	MCU Pin Function Select	**Connects IRQ1 to MCU port P6_6**	Disconnected	R51
R51	MCU Pin Function Select	Connects IO_6 to MCU port P6_6	**Disconnected**	R50
R52	MCU Pin Function Select	**Connects IRQ2 to MCU port P6_7**	Disconnected	R53
R53	MCU Pin Function Select	Connects IO_7 to MCU port P6_7	**Disconnected**	R52
R54	MCU Pin Function Select	**Connects IRQ0 to MCU port P4_5**	Disconnected	R31, R55
R55	MCU Pin Function Select	Connects TRIGa to MCU port P4_5	**Disconnected**	R31, R54

Table 6-11: MCU Pin Function Select Configuration Links

Table 6-12 below describes the function of the option links associated with other options. The default configuration is indicated by **BOLD** text.

Option Link Settings				
Reference	Function	Fitted	Alternative (Removed)	Related To
R31	SW1	**Connects SW1 to MCU port P4_5**	Disconnected	R54, R55
R47	E8a	**Enables E8a Connection**	Do not fit the option resistor	

Table 6-12: Other Option Links

6.7.Oscillator Sources

A crystal oscillator is fitted on the board and used to supply the main clock input to the Renesas microcontroller.

Table 6-13: Oscillator details the oscillators that are fitted and alternative footprints provided on this board:

Component		
Crystal (X1)	Fitted	20 MHz (HC/49U package)

Table 6-13: Oscillator

6.8.Reset Circuit

The CPU Board includes a simple latch circuit that links the mode selection and reset circuit. This provides an easy method for swapping the device between Boot Mode and Single Chip Mode. This circuit is not required on customers' boards as it is intended for providing easy evaluation of the operating modes of the device on the Renesas Starter Kit. Please refer to the hardware manual for more information on the requirements of the reset circuit.

The Reset circuit operates by latching the state of the boot switch on pressing the reset button. This control is subsequently used to modify the MODE pin states as required.

The MODE pin should change state only while the reset signal is active to avoid possible device damage.

The reset is held in the active state for a fixed period by a pair of resistors and a capacitor. Please check the reset requirements carefully to ensure the reset circuit on the customers' board meets all the reset timing requirements.

6.9.LIN Interface

This Renesas Starter Kit has hardware LIN interface. The interface is available on connector 'J10'. The connector 'J9' functions as power connector for LIN. The device can be operated either in Master node or Slave node. The device performs LIN communication in cooperation with Timer RA and UART0.

For mode details on LIN interface please refer to R8C/23 Group Hardware Manual.

6.10.CAN Interface

This Renesas Starter Kit has CAN interface. The interface is available on connector 'J12'.

For mode details on LIN interface please refer to R8C/23 Group Hardware Manual.

Chapter 7. Modes

The Renesas Starter Kit supports Boot mode and Single chip mode.

Details of programming the FLASH memory is described in the R8C/23 Group Hardware Manual.

7.1. Boot mode

The Boot mode settings for this Renesas Starter Kit are shown in Table 7-1: Boot Mode pin settings below:

MODE	LSI State after Reset End
Low	Boot Mode

Table 7-1: Boot Mode pin settings

The software supplied with this Renesas Starter Kit supports Boot mode using an E8a and High-performance Embedded only. However, hardware exists to enter boot mode manually, do not connect the E8a in this case. Press and hold the SW1/BOOT. The MODE pin is held in its boot state while reset is pressed and released. Release the boot button. The BOOT LED will be illuminated to indicate that the microcontroller is in boot mode.

When neither the E8a is connected nor the board is placed in boot mode as above, the MODE pin is pulled high by a 4.7k resistor.

When an E8a is used the MODE pin is controlled by the E8a.

7.2. Single chip mode

Because the MODE pin is pulled high, this Renesas Starter Kit will always boot in Single chip mode when the E8a is not connected and the boot switch is not depressed. Refer to R8C/23 Group Hardware Manual for details of Single chip mode.

MODE	LSI State after Reset End
High	Single chip Mode

Table 7-2: Single chip Mode pin settings

Chapter 8. Programming Methods

The board is intended for use with High-performance Embedded Workshop and the supplied E8a debugger. Refer to R8C/23 Group

Hardware Manual for details of programming the microcontroller without using these tools.

Chapter 9. Headers

9.1. Microcontroller Headers

Table 9-1 to Table 9-4 show the microcontroller pin headers and their corresponding microcontroller connections. The header pins connect directly to the microcontroller pins. * Marked pins are subject to option links.

J1					
Pin	Circuit Net Name	Device Pin	Pin	Circuit Net Name	Device Pin
1	No Connection	-	2	IIC_SCL	1
3	TRISTn	2	4	IIC_SDA	3
5	MODE_E8B	4	6	RING_P4_3	5
7	RING_P4_4	6	8	RESn	7
9	CON_XOUT	8	10	VSS	9
11	CON_XIN	10	12	UC_VCC	11
13	MO_Wn	12	14	No Connection	-

Table 9-1: J1

J2					
Pin	Circuit Net Name	Device Pin	Pin	Circuit Net Name	Device Pin
1	MO_Vn	13	2	MO_Wp	14
3	MO_Vp	15	4	MO_Un	16
5	TMR0	17	6	MO_Up	18
7	P2_0	19	8	TRIGb	20
9	SCIaCK	21	10	SCIaRX	22
11	SCIaTX	23	12	IRQ3	24
13	No Connection	-	14	No Connection	-

Table 9-2: J2

J3					
Pin	Circuit Net Name	Device Pin	Pin	Circuit Net Name	Device Pin
1	IRQ0/TRIGa*	25	2	IRQ1/IO_6*	26
3	IRQ2/IO_7*	27	4	LCD_E	28
5	LCD_RS	29	6	AD_POT	30
7	P3_1	31	8	TMR1	32
9	IO_5	33	10	IO_4	34
11	IO_3	35	12	AD0	36
13	No Connection	-	14	No Connection	-

Table 9-3: J3

J4					
Pin	Circuit Net Name	Device Pin	Pin	Circuit Net Name	Device Pin
1	No Connection	-	2	AD1	37
3	AD2	38	4	AD3	39
5	P4_2/VREF	40	6	IO_0	41
7	IO_2	42	8	IO_1	43
9	LCD_D7	44	10	LCD_D6	45
11	LCD_D5	46	12	LCD_D4	47
13	MO_UD	48	14	No Connection	-

Table 9-4: J4

9.2. Application Headers

Table 9-5 and Table 9-6 below show the standard application header connections. * Marked pins are subject to option links.

Pin	Header Name	Circuit Net Name	Device Pin	Pin	Header Name	Circuit Net Name	Device Pin
			JA1				
1	Regulated Supply 1	CON_5V	-	2	Regulated Supply 1	Ground	-
3	Regulated Supply 2	CON_3V3	-	4	Regulated Supply 2	Ground	-
5	Analogue Supply	NC	-	6	Analogue Supply	NC	-
7	Analogue Reference	CON_VREF	40	8	ADTRG	NC	-
9	ADC0	AD0	36	10	ADC1	AD1	37
11	ADC2	AD2	38	12	ADC3	AD3	39
13	DAC0	NC	-	14	DAC1	NC	-
15	IOPort0	IO_0	41	16	IOPort1	IO_1	43
17	IOPort2	IO_2	42	18	IOPort3	IO_3	35
19	IOPort4	IO_4	34	20	IOPort5	IO_5	33
21	IOPort6	IO_6*	26	22	IOPort7	IO_7*	27
23	IRQ3	IRQ3	24	24	I²C Bus (3rd pin)	NC	-
25	I²C Bus	IIC_SDA	3	26	I²C Bus	IIC_SCL	1

Table 9-5: JA1 Standard Generic Header

Pin	Header Name	Circuit Net Name	Device Pin	Pin	Header Name	Circuit Net Name	Device Pin
			JA2				
1	Reset	RESn	7	2	External Clock Input	CON_XIN	10
3	Interrupt	NC	-	4	Regulated Supply 1	GND	-
5	WDT overflow	NC	-	6	Serial Port	SCIaTX	23
7	Interrupt	IRQ0*	25	8	Serial Port	SCIaRX	22
9	Interrupt	IRQ1*	26	10	Serial Port	SCIaCK	21
11	Motor up/down	MO_UD	48	12	Serial Port Handshake	NC	-
13	Motor control	MO_Up	18	14	Motor control	MO_Un	16
15	Motor control	MO_Vp	15	16	Motor control	MO_Vn	13
17	Motor control	MO_Wp	14	18	Motor control	MO_Wn	12
19	Timer Output	TMR0	17	20	Timer Output	TMR1	32
21	Timer Input	TRIGa*	25	22	Timer Input	TRIGb	20
23	Interrupt	IRQ2*	27	24	Tristate Control	TRISTn	2
25	SPARE	P2_0	19	26	SPARE	P3_1	31

Table 9-6: JA2 Standard Generic Header

Table 9-7 below show the LIN header connections.

J9		
Pin	Function	Signal Name
1	Power Supply (for LIN module)	VBAT
2	Ground	Ground
J10		
Pin	Function	Signal Name
1	Power Supply (for LIN module)	VBAT
2	LIN Bus Line	LIN
3	Ground	Ground

Table 9-7: LIN Headers

Table 9-8 below show the CAN header connections.

J12		
Pin	Functions	Signal Name
1	CAN0 Positive	CANH
2	Ground	Ground
3	CAN0 Negative	CANL

Table 9-8: CAN Header

Chapter 10.Code Development

10.1. Overview

Note: For all code debugging using Renesas software tools, the Renesas Starter Kit board must be connected to a Personal Computer USB port via an E8a. An E8a is supplied with the Renesas Starter Kit product.

10.2. Mode Support

High-performance Embedded Workspace connects to the Microcontroller and programs it via the E8a. Mode support is handled transparently to the user.

10.3. Breakpoint Support

High-performance Embedded Workshop supports breakpoints on the user code, both in RAM and ROM.

Double clicking in the breakpoint column in the code sets the breakpoint. Breakpoints will remain unless they are double clicked to remove them.

10.4. Memory Map
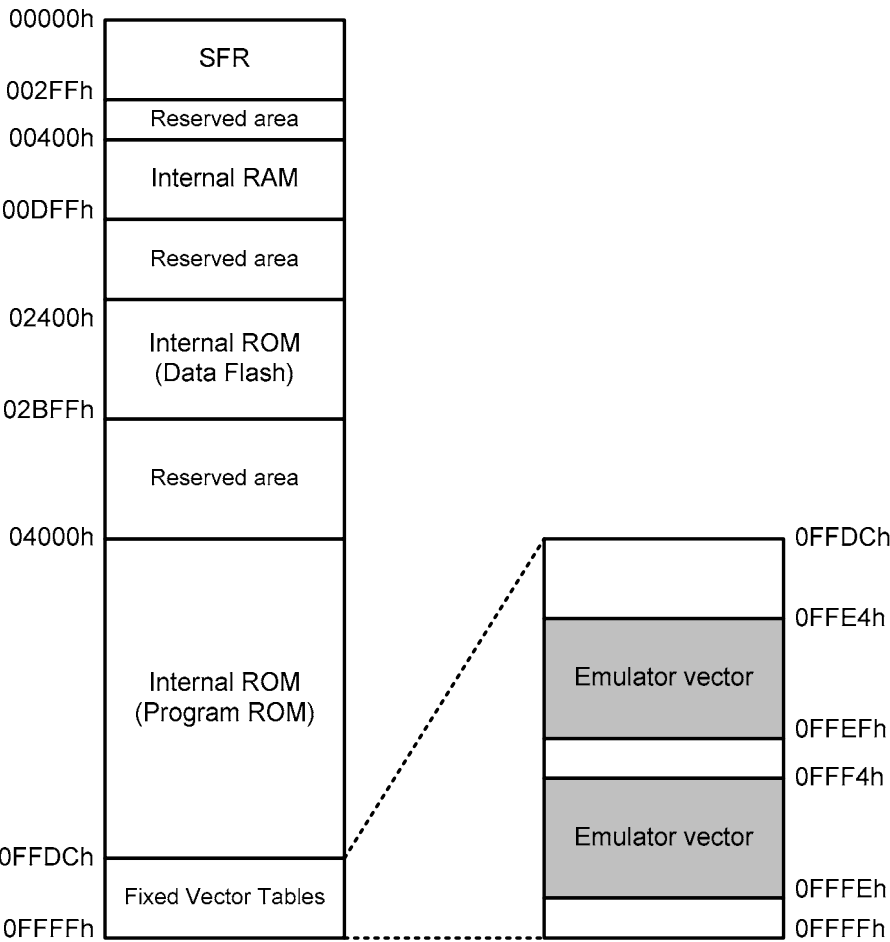
Figure 10-1: Memory Map
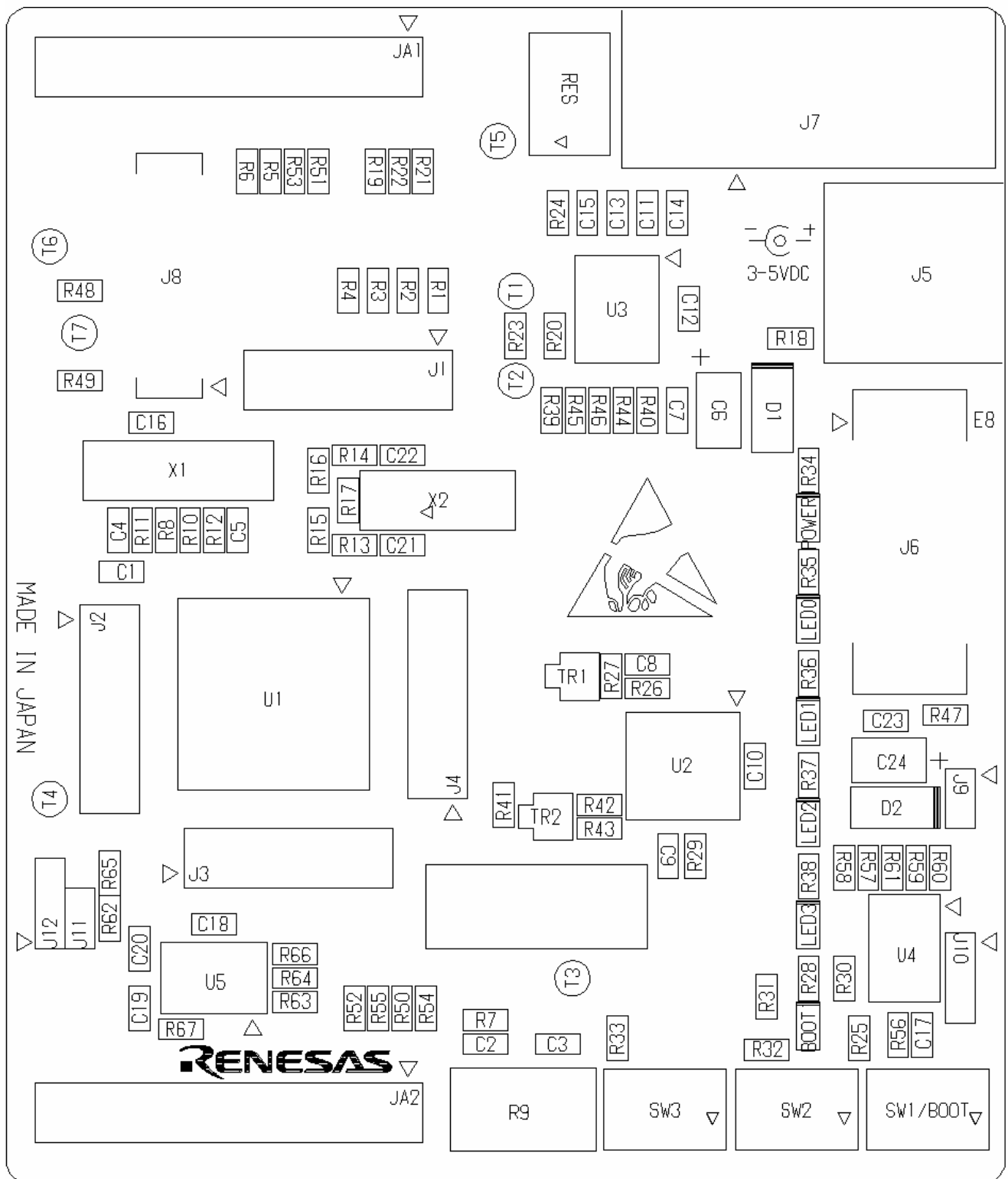
Chapter 11. Component Placement

Figure 11-1: Component Placement

Chapter 12. Additional Information

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

For information about the R8C/23 group microcontrollers, refer to the R8C/22 Group, R8C/23 Group Hardware Manual.

For information about the R8C/23 assembly language, refer to the R8C/Tiny Series Software Programming Manual.
Online technical support and information is available at:

http://www.renesas.com/renesas_starter_kits

Technical Contact Details

America: techsupport.rta@renesas.com

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Japan: csc@renesas.com

General information on Renesas Microcontrollers can be found on the Renesas website at:

http://www.renesas.com/.

Renesas Starter Kit for R8C/23
User's Manual

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