

# RX65N Group

## RX65N Envision Kit User's Manual

RENESAS 32-Bit MCU  
RX Family / RX600 Series

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### 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.

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## Precautions

The following precautions should be observed when operating any development kit product:

This development kit is only intended for use in a laboratory environment under ambient temperature and humidity conditions. A safe separation distance should be used between this and any sensitive equipment. Its use outside the laboratory, classroom, study area or similar such area invalidates conformity with the protection requirements of the Electromagnetic Compatibility Directive and could lead to prosecution.

The product generates, uses, and can radiate radio frequency energy and may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment causes harmful interference to radio or television reception, which can be determined by turning the equipment off or on, you are encouraged to try to correct the interference by one or more of the following measures;

- ensure attached cables do not lie across the equipment
- reorient the receiving antenna
- increase the distance between the equipment and the receiver
- connect the equipment into an outlet on a circuit different from that which the receiver is connected
- power down the equipment when not in use
- consult the dealer or an experienced radio/TV technician for help NOTE: It is recommended that wherever possible shielded interface cables are used.

The product is potentially susceptible to certain EMC phenomena. To mitigate against them it is recommended that the following measures be undertaken;

- The user is advised that mobile phones should not be used within 10m of the product when in use.
- The user is advised to take ESD precautions when handling the equipment.

The development kit does not represent an ideal reference design for an end product and does not fulfil the regulatory standards for an end product.

# How to Use This Manual

## 1. Purpose and Target Readers

This manual is designed to provide the user with an understanding of the hardware design and configuration of the RX65N Envision Kit. It is intended as a reference for users working with the RX65N Envision Kit, using the many different incorporated peripheral devices.

The manual comprises of descriptions of the major circuit blocks of the RX65N Envision Kit and their inter-connectivity. It provides details of the operation, configuration and user-adjustable options available for each of the blocks. Further information concerning the RX65N Envision Kit design can be found in the schematics. Further details of the RX65N microcontroller may be found in the RX65N Group Hardware Manual.

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

The following documents apply to the RX65N 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 Envision Kit hardware.	RX65N Envision Kit User's Manual	R01UH0761
Schematic	Circuit schematic of the Envision Kit.	RX65N Envision Kit Schematic	R12AN0035
Bill of materials	Bill of materials of the Envision Kit.	RX65N Envision Kit BOM list	R12TU0036
Hardware Manual	Provides technical details of the RX65N microcontroller.	RX65NGroup, RX651 Group User's Manual: Hardware	R01UH0590
Software Manual	Details of the RXv2 Instruction Set Architecture.	RX Family RXv2 Instruction Set Architecture User's Manual: Software	R01US0071
Debugger Manual	E2 Emulator Lite Debugger Performance Property.	On-chip Debuggers Performance Property	R20UT0616
User's manual	Getting Started Guide for e <sup>2</sup> studio.	e <sup>2</sup> studio Integrated Development Environment User's Manual: Getting Started Guide	R20UT2771

## 2. List of Abbreviations and Acronyms

Abbreviation	Full Form
DNF	Do Not Fit
DRW2D	RX microcontroller 2D Graphics drawing Engine peripheral.
E1	Renesas Programmer / Debugger Emulator
E2 Lite	Renesas Programmer / Debugger Emulator
E2OB	Renesas On-chip Programming/Debugging Emulators
ESD	Electro Static Discharge
GLCDC	Graphic LCD Controller
I2C	Inter-Integrated Circuit
IC	Integrated Circuit
IDE	Integrated Development Environment
IRQ	Interrupt Request
JTAG	Joint Test Action Group
LCD	Liquid Crystal Display
LED	Light Emitting Diode
MCU	Micro-controller Unit
PC	Personal Computer
PCB	Printed Circuit Board
Pmod™	This is a Digilent Pmod™ Compatible connector. Pmod™ is registered to Digilent Inc. <a href="#">Digilent-Pmod Interface Specification</a>
QSPI	Quad Serial Peripheral Interface
QVGA	Quarter Video Graphics Array
RAM	Random Access Memory
RMI	Reduced Media Independent Interface
ROM	Read Only Memory
RPB	Renesas Promotional Board
SD Card	Secure Digital Card
SDHI	Secure Digital Host Interface
SPI	Serial Peripheral Interface
TFT	Thin Film Transistor
USB	Universal Serial Bus
WQVGA	Wide Quarter Video Graphics Array

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# 1. Overview

## 1.1 Purpose

This development kit is an evaluation tool for Renesas microcontrollers. This manual describes the technical details of the RX65N Envision Kit hardware.

## 1.2 Features

The RX65N Envision Kit provides an evaluation of the following features:

- In-circuit programming and debugging with E2 Lite On Board (E2OB).
- WQVGA (480 x 272) TFT LCD panel driven directly from the RX65N Graphic LCD Controller (GLCDC) peripheral.
- 23V LED driver circuit for LCD backlight.
- Graphics manipulation using the 2D Graphics Drawing Engine (DRW2D).
- Capacitive touch screen sampling via I2C controller.
- On-board QSPI serial Flash.
- USB 2.0 Host.
- Connection for external Pmod™ based peripherals.

The RX65N Envision Kit board contains all the circuitry required for microcontroller operation. A variety of other peripherals are tracked into the RX65N Envision Kit PCB design, but not fitted as standard.

- Ethernet – Requires Ethernet RMII Phy IC and surface mount connector.
- SD Host Interface – Requires SDHI connector and power management IC.
- Joystick – Providing switch inputs for left, right, up, down and centre mapping to RX65N IRQ ports.
- Provision to expand functionality with Arduino™ style shields.

This manual is designed to describe the hardware features of the RX65N Envision Kit and is not intended as a comprehensive introduction to the RX65N microcontroller group, the e<sup>2</sup> studio development IDE or the E2 Emulator Lite. Please refer to the relevant user manuals for more in-depth information.



### 1.3 Board specification

The board specification is shown in Table 1-1 below.

**Table 1-1: Board specification**

Item	Specification
Microcontroller	Part No : R5F565NEDDFB
	Package : 144-pin LQFP (PLQP0144KA-B)
	On-Chip Memory : ROM 2MB+32KB, RAM 640KB
On-Board Memory	QSPI Serial Flash : 32Mbit
Input Clock	RX65N Main : 12MHz
	Ethernet transceiver (for RMI) : 25MHz
Power Supply	Mini-B USB : 5V Input
	Power Supply IC : 5V Input, 3.3V Output
	Backlight Power Supply : 5V Input, 23.5V Output at 15mA
Debug Interface	E2 on board debugger. Provision for external E1 / E2 Lite 14-pin header.
DIP Switch	Debugger Mode Configuration : 2-pole x 2
Push Switch	User Switch x 1
	Joystick (5 switches; Up, Down, Left, Right, Centre) *1
LED	3.3V power indicator : Green x 1
	E2 on board debugger activity Indicator : Green x 1
	User : Blue x 1
	Ethernet Status: Green x 1, Yellow x 1
Ethernet *1	Connector : RJ45 x 1*1
	Transceiver : Single Channel RMI transceiver*1
SDHI *1 *2	SD Card Slot (4-bit) x 1*1
USB	USB0-Host : USB-TypeA
USB to Serial Converter Interface	Connector : USB-MiniB (selectable between debugger or serial operation by DIP switch).
Pmod™	Pmod™ : Angle type, 12-pin Connector
LCD Direct Drive Interface	0.5mm pitch, 40-pin x 1 (TFT)
LCD Touchscreen Interface	0.5mm pitch, 6-pin x 1 (I <sup>2</sup> C)
Arduino™ Headers*1	2.54mm pitch headers for connection to Arduino™ shields*1

\*1. This component is not fitted to the product as standard.

\*2. The RX65N Group incorporates an SD host interface (SDHI) which is compliant with the SD Specifications. When developing host devices that are compliant with the SD Specifications, the user must enter into the SD Host/Ancillary Product License Agreement (SD HALA).

## 2. Power Supply

### 2.1 Requirements

With the display backlight enabled, and operational, the RX65N Envision Kit can typically draw 170mA from the 5V supply provided from the mini-B USB connection CN9. This is a typical figure and not worst case, so it is recommended that the RX65N Envision Kit be supplied from a USB supply capable of supplying at least 500mA. Note that the current drawn from USB Host, Pmod™ or SDHI interfaces when used must also be considered when determining the current requirements of the supply to the Envision Kit.

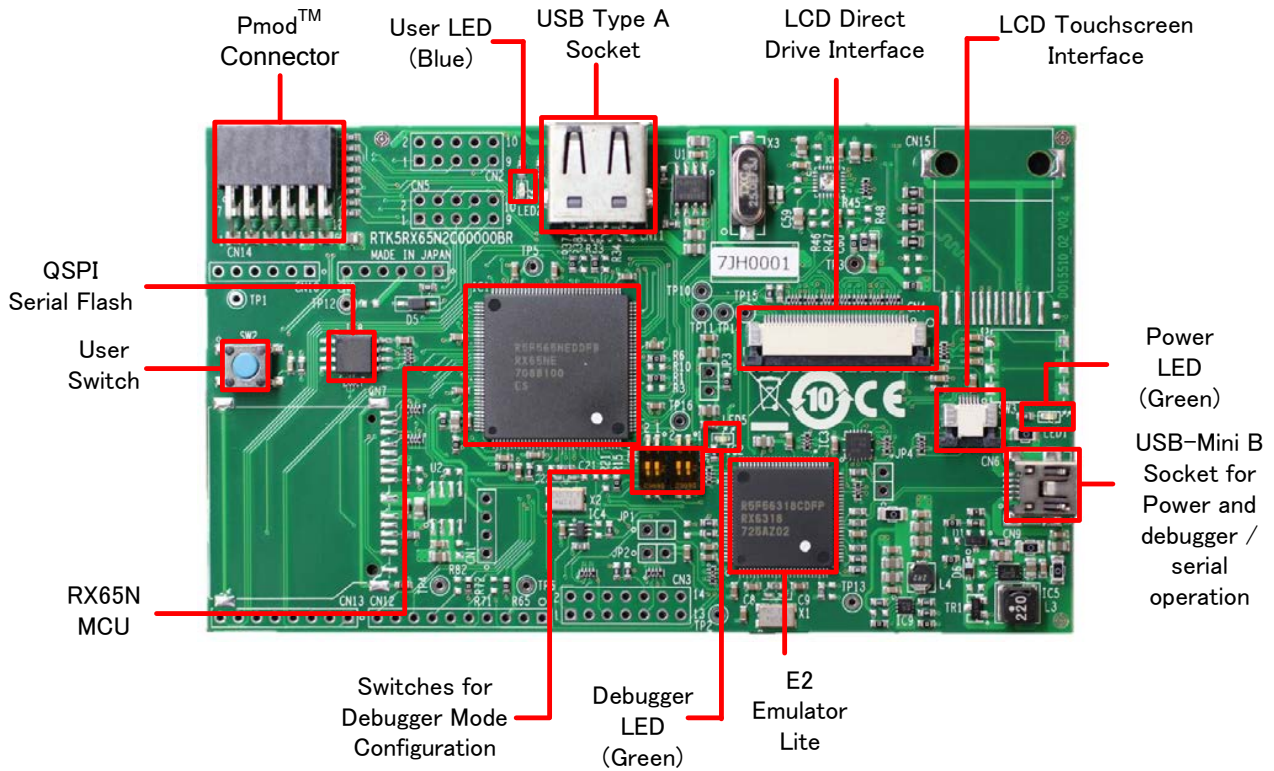
### 2.2 Characteristics

The power supply for the RX65N Envision Kit does not have any user-configurable options. The 5V input from the mini-B USB CN9 is used to source the 5V output from the USB-A Host output on CN11. It is also used to derive the 23.5V supply for the LCD backlight and also the main 3.3V supply for the RX65N MCU and other components. These supplies are described further in section 4 Envision Kit Circuitry.

### 3. Board Layout

#### 3.1 Component Layout

Figure 3-1 below shows the bottom component layout of the board.



**Figure 3-1 : Board Layout (Underside, with display removed)**

Figure 3-2 below shows the User-Fit header locations on the bottom component layout of the board.

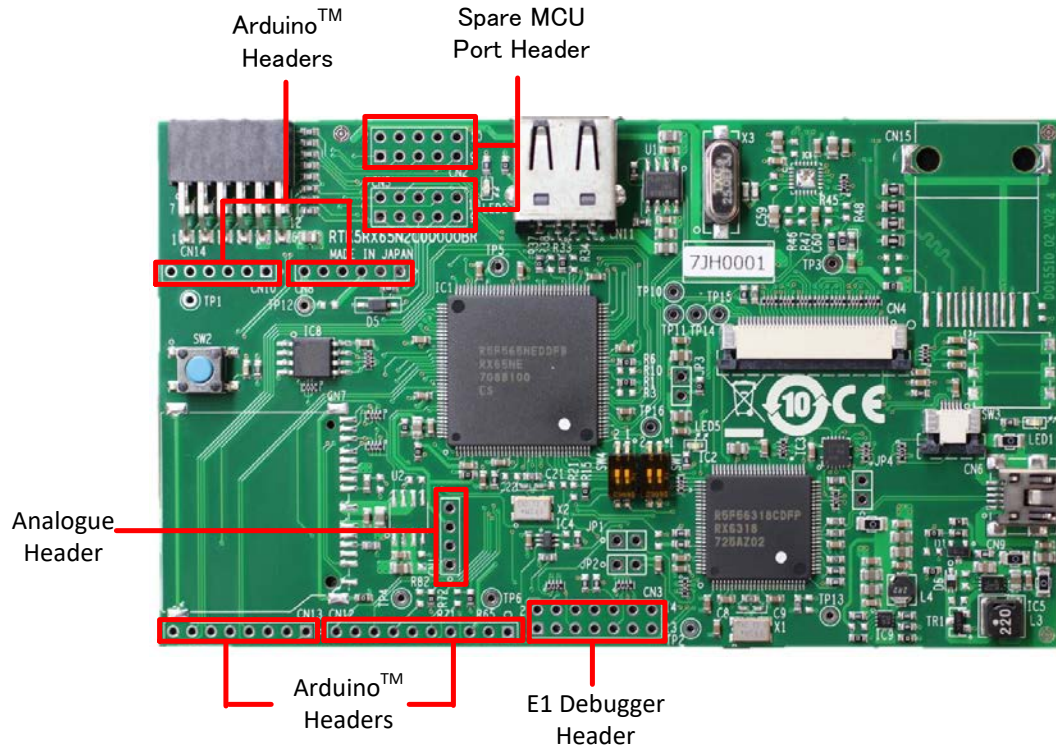


Figure 3-2 : Board Layout Showing User-Fit Header Locations

Figure 3-3 below shows the User-Fit options on the bottom component layout of the board.

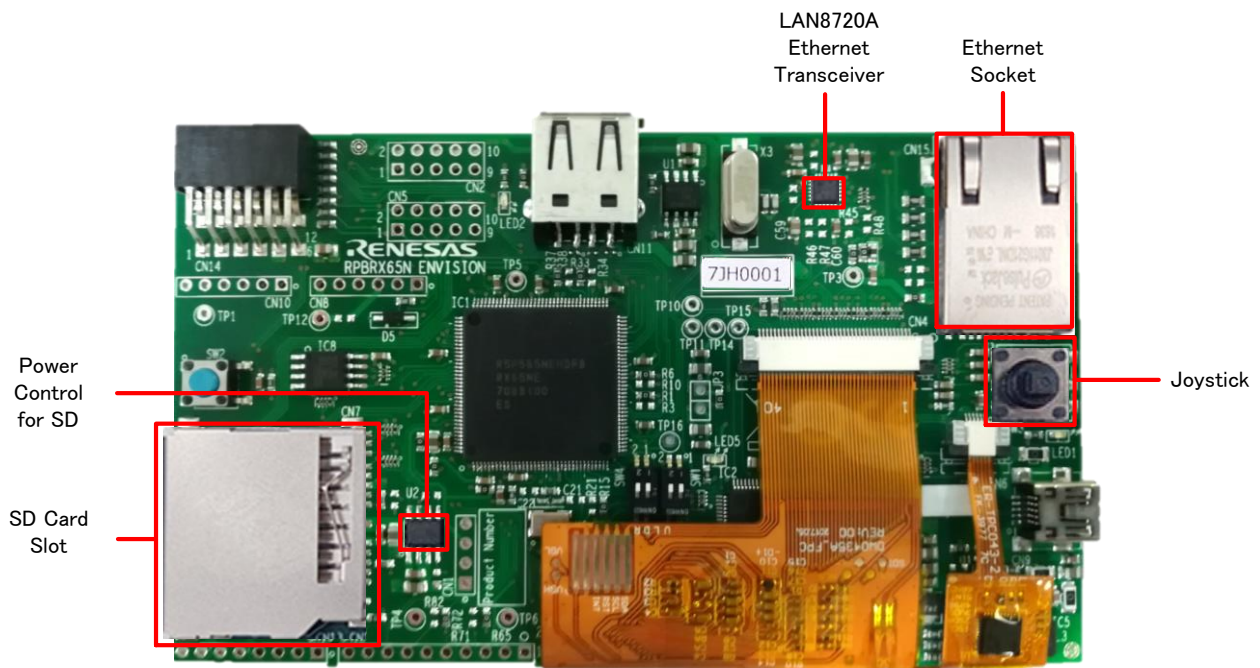


Figure 3-3 : Board Layout Showing User-Fit Options

### 3.2 Component Placement

Figure 3-4 below shows the placement of individual components on the bottom side of the PCB. There are no components located on the top side. Component types and values can be looked up using the board schematics.

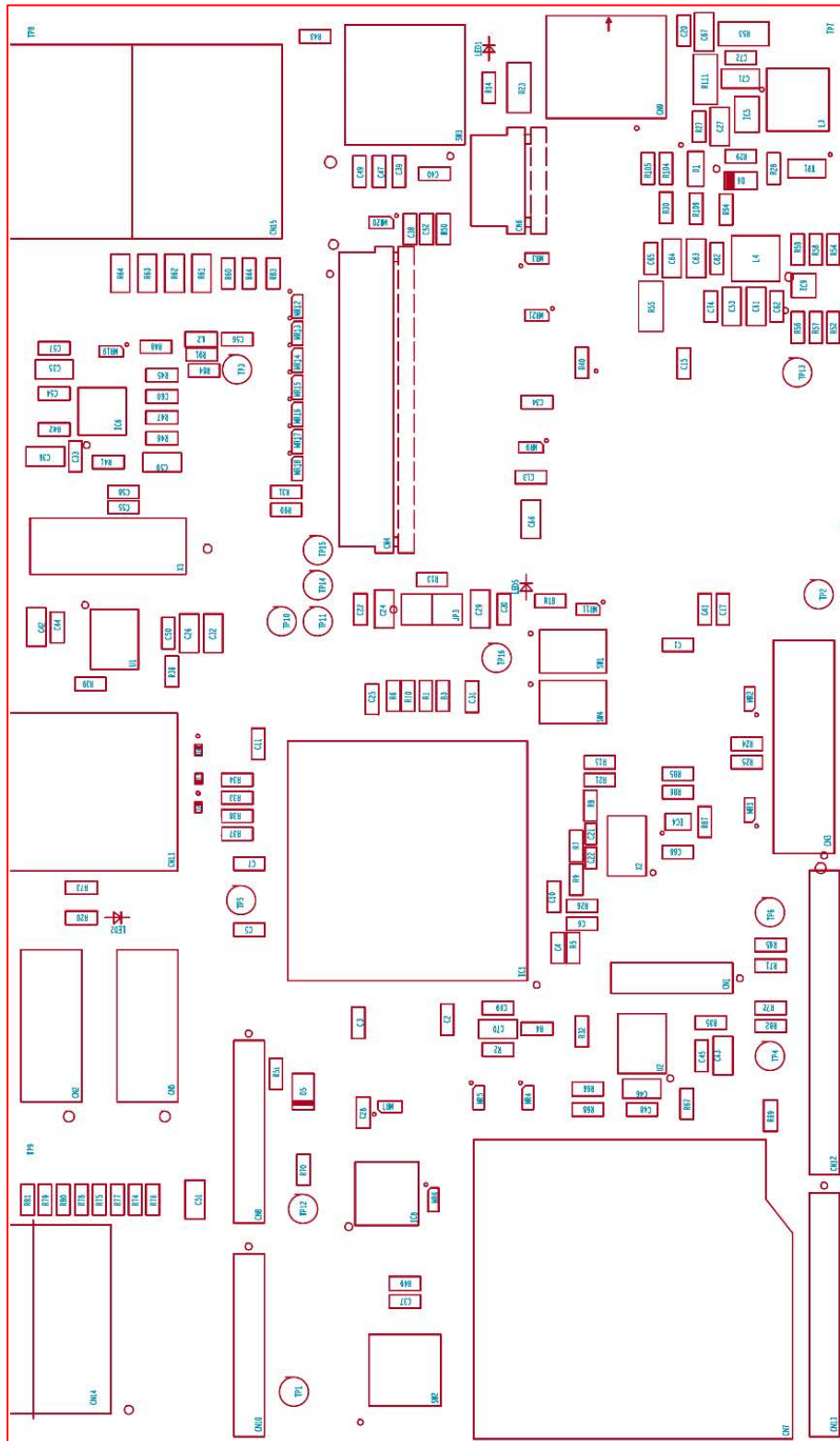


Figure 3-4 : Bottom-Side Component Placement



### 3.3 Internal Functional Connectivity

Figure 3-5 below shows the RX65N Envision Kit functional components and their connectivity to the MCU.

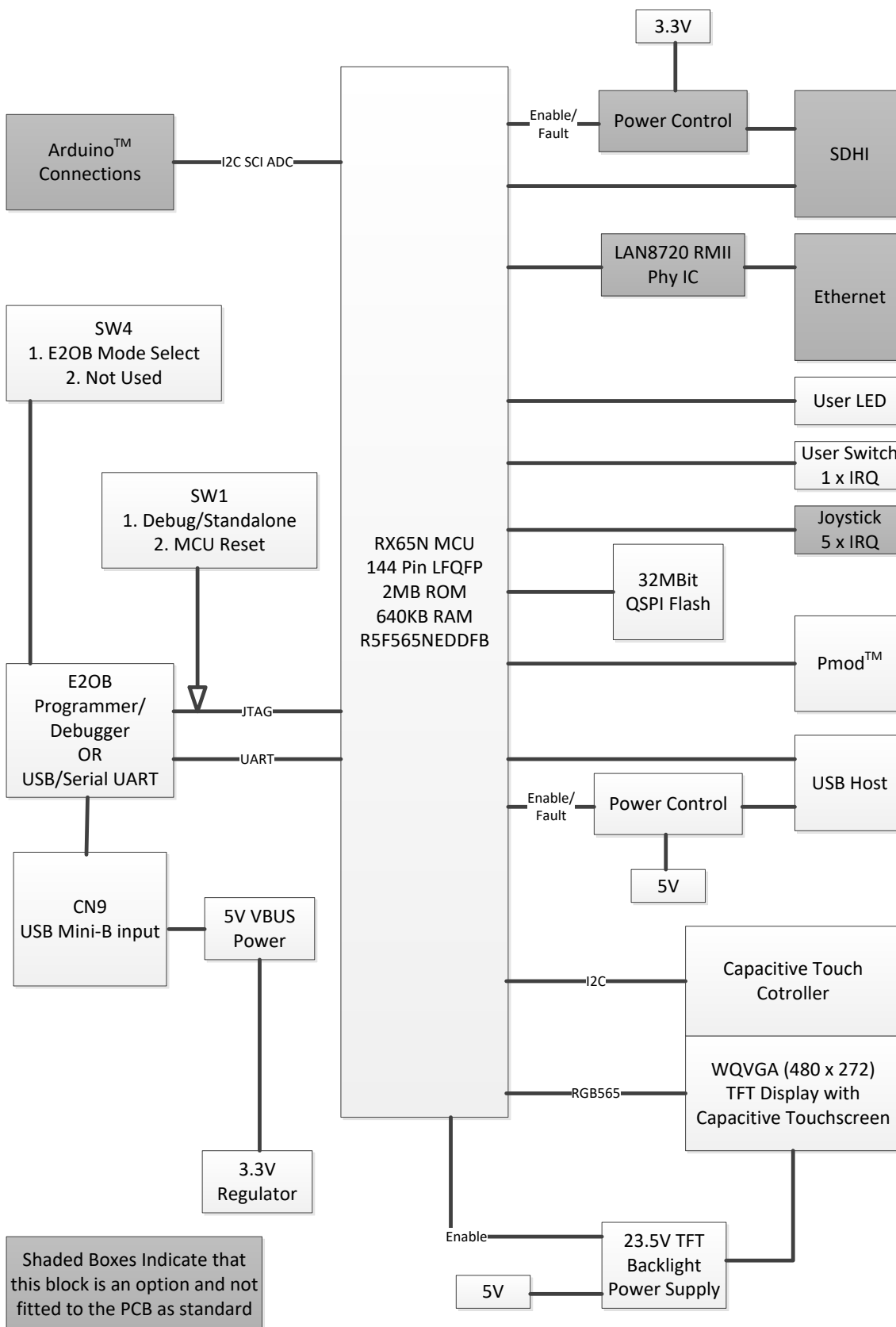


Figure 3-5 : Internal Block Diagram

## 4. Envision Kit Circuitry

### 4.1 Power Scheme

#### 4.1.1 Debug USB – CN9

The mini-B USB socket CN9 provides an interface between the programmer/debugger and the development PC.

Power for the RX65N Envision Kit is sourced from this USB connection; it is important that sufficient current is available. If a USB hub is used it must be externally powered. It is recommended that the USB source be capable of supplying at least 500mA.

#### 4.1.2 5V Supply

The 5V input from the Debug USB, CN9, is used to supply power to the USB Host circuit, see section 4.8. It also provides the input to the LCD backlight power supply, see section 4.1.3, and the 3.3V regulator circuit, see section 4.1.4. This 5V supply does not have any regulation of itself; it is simply the voltage passed through from the USB input from CN9. A zero Ohm link R53 is connected in series to allow the debugger circuit to be operated from the USB supply when the rest of the board is supplied from another source, for example the Arduino™ interface.

#### 4.1.3 LCD Backlight Power Circuit

The LCD backlight power supply is required to drive the backlight of the TFT LCD display fitted to the Envision Kit. The backlight consists of a number of white LEDs connected in series (to ensure that they are driven with the same current and are therefore as closely matched in brightness as possible). For the Envision display, the backlight requires a specified 25V at 15mA. At room temperature, the actual operating voltage at 15mA is about 23.5V.

The backlight power supply is based around the Intersil ISL97634 controller IC. This is a highly integrated, small footprint controller IC. Figure 4-1 shows the schematic for this circuit as implemented on the Envision Kit. Further details on the ISL97634 device can be obtained from the Intersil website [www.intersil.com](http://www.intersil.com).

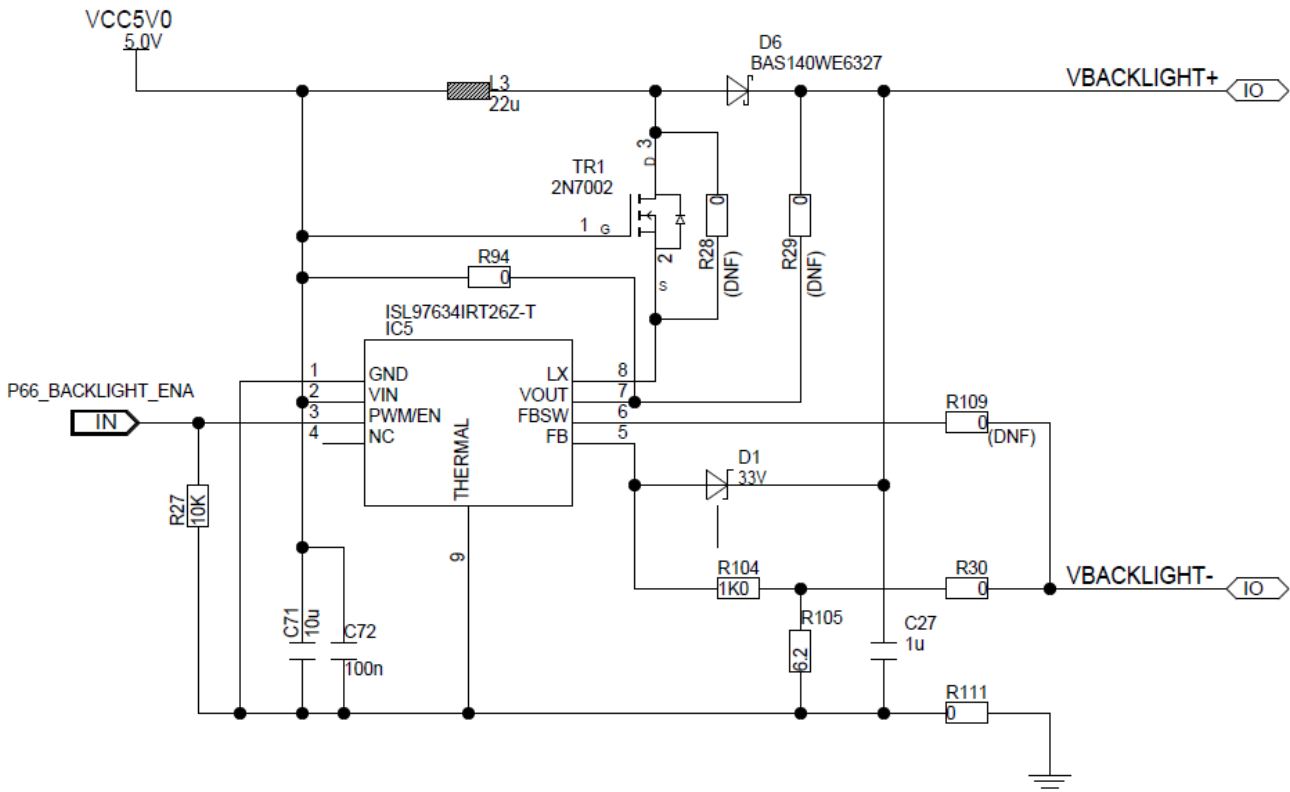


Figure 4-1 : LCD Backlight Power Supply

### 4.1.4 3.3V Power Supply

The 3.3V supply for the RX65N MCU and other circuitry on the Envision Kit is provided from the 5V supply by a switched-mode synchronous buck regulator based around the ISL80019 device from Intersil. This is a highly integrated, small footprint regulator IC, incorporating the power switching devices. Figure 4-2 shows the schematic circuit as implemented on the Envision kit. For further details concerning the ISL80019 device, refer to the Intersil website [www.intersil.com](http://www.intersil.com).

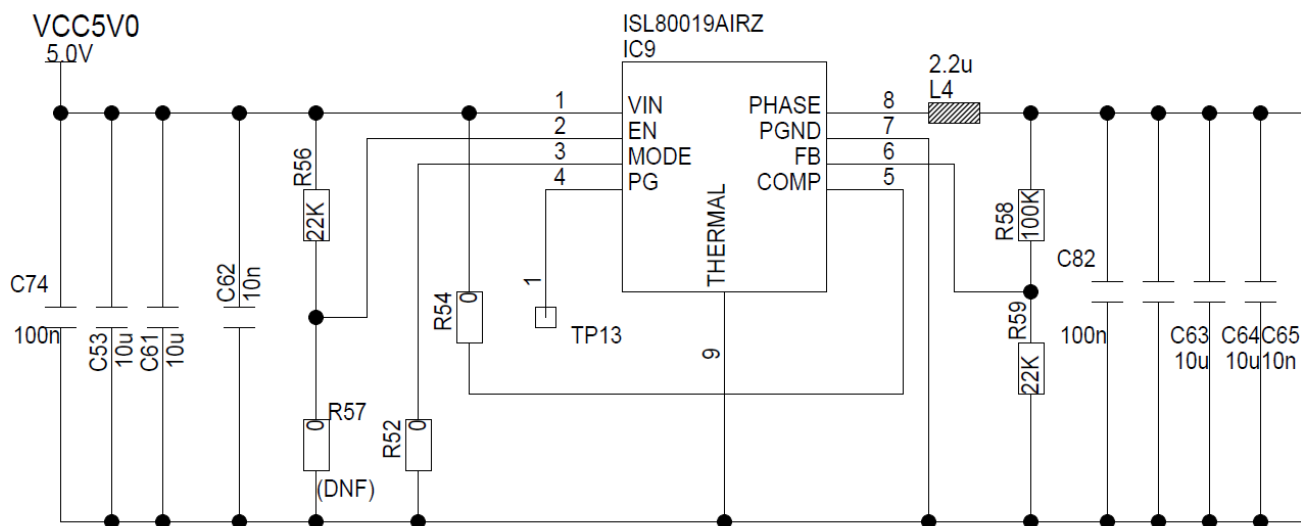


Figure 4-2 : 3.3V Power Supply

## 4.2 Embedded Programmer/Debugger or USB/Serial Communications

The Envision kit board includes an embedded programmer / debugger circuit; E2 On-Board (abbreviated name: E2OB) to work with the RX65N MCU device. Further functionality is provided by the incorporation of USB / Serial communications within the E2OB and the ability to switch between the two operating modes by user switch.

### 4.2.1 E2 On Board Programmer / Debugger

The E2OB implements the functionality of the Renesas E2 Lite Programmer / Debugger on the Envision PCB, requiring just a USB connection to a development PC.

For more details of the E2OB capabilities please see the ‘On-chip Debuggers Performance Property’ reference document.

Host PC Drivers for the E2OB are supplied as part of the e<sup>2</sup> studio development tool installation.

LED5 indicates the status of the E2OB. Refer to Table 4-1 for further details:

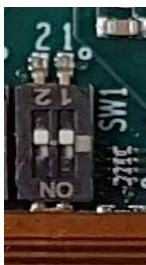
Table 4-1 : E2OB Activity Status Indicator LED5

Illuminated	Communication established with Host PC Driver.
Flashing	Power available but no communication established with host PC.
Not Illuminated	Board not receiving power or E2OB critical error.



### 4.2.2 Operation of E2OB Programmer / Debugger

Switch SW1 is used to enable or disable the E2OB programmer debugger or run the RX65N MCU in standalone mode. A second switch provides user access to the reset pin of the RX65N MCU. Table 4-2 describes the switch configurations.

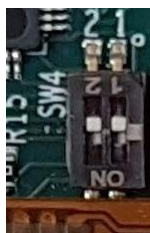


**Table 4-2 : SW1 Debugger / Reset Switch Operation**

SW1	Setting	Description
Position 1	ON	Programmer/Debugger mode
	OFF	Standalone operation
Position 2	ON	Reset RX65N_RES# pulled low. RX65N held in reset state.
	OFF	Reset NOT pulled low by user.

### 4.2.3 USB/Serial UART Operation

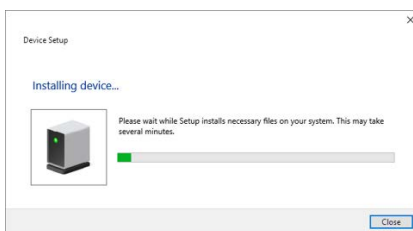
The E2 On Board can be reconfigured to provide a serial port connection from the RX65N Device on the Envision board to a host PC connected to CN9. Note that the serial port connection cannot be used at the same time as operating the debugger. Switch SW4 Position 1 is used to select Programmer / Debugger mode or Serial mode for the E2OB device. Note that in order for any change to take effect, the Envision Kit should be reset by re-cycling the power to the board.



**Table 4-3 : SW4 Configurations for E2OB Mode Setting**

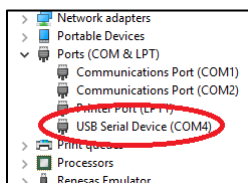
SW4	Setting	Description
Position 1	ON	USB / Serial Mode
	OFF	Programmer / Debugger Mode
Position 2	ON	Not Used
	OFF	

When the Envision Kit is first connected to a PC running Windows™ (Windows 10) with the USB / Serial connection, the PC will look for a driver. The PC will report that it is installing a driver and then report that a driver has been installed successfully, as shown in Figure 4-3. The exact messages may vary depending upon operating system. If Windows 7 use, USB driver for Windows 7 is required. USB driver can be obtained from the website [www.renesas.com/envision](http://www.renesas.com/envision).



**Figure 4-3: USB-Serial Windows™ (Windows 10) Installation message**

In serial port mode, when connected to a host PC, the Envision board will map to a COM port, which can be accessed by any standard serial terminal application, such as PuTTY. Some computers may require a driver to be installed before the USB / Serial port can be used. When connected, the COM port can be determined by looking in device manager on the host PC, see Figure 4-4.



**Figure 4-4 : COM Port on PC**

#### 4.2.4 USB/Serial UART Connections to MCU

**Table 4-4 : USB/Serial UART Connections**

Circuit Net Name	MCU		Function
	Port	Pin	
PC2_USBRXD	PC2	70*	UART5 receive line from USB
PC3_USBTXD	PC3	67*	UART5 transmit line from USB

\*Note that the configuration of this port-pin is subject to on-PCB option links. Refer to Table 4-5 for further details.

#### 4.2.5 USB/Serial UART Configuration

Table 4-5 below details the function of the zero-Ohm option links associated with the USB / Serial UART Interface configuration. **Bold, blue text** indicates the default configuration that the Envision Kit is supplied with.

**Table 4-5 : Option links affecting configuration of USB / Serial UART Interface**

MCU		MCU Signal name	MCU Peripheral Selection	Link		Destination Selection	
Pin	Port			Fit	DNF	Function Signal Name	Peripheral Function
70	PC2	PC2_USBRXD_ARD_D12	<b>RXD5</b>	<b>R65</b>	<b>R71</b>	<b>PC2_USBRXD</b>	<b>USB/Serial UART RXD5</b>
			MISO5	R71	R65	PC2_MISO5_ARD_D12	Arduino D12 MISO5
67	PC3	PC3_USBTXD_ARD_D11	<b>TXD5</b>	<b>R72</b>	<b>R82</b>	<b>PC3_USBTXD</b>	<b>USB/Serial UART TXD5</b>
			MOSI5	R82	R72	PC3_MOSI5_ARD_D11	Arduino D11 MOSI5

#### 4.2.6 External E1 / E2 Lite Emulator Connection

The connector CN3 (not fitted as standard) allows the use of an external E1 or E2 Lite (not supplied) to be used instead of the existing E2OB. When in use, the on-board E2OB should be switched off by setting SW1 position 1 to OFF. See section 4.2.2.

For details of obtaining and using an external E1 Emulator please contact your local Renesas representative.

### 4.3 Clock Circuit

Clock circuits are fitted to the Envision Kit to generate the required clock signal to drive the MCU, and other peripherals. Refer to the RX65N User's Manual : Hardware for details regarding the clock signal requirements, and the Envision Kit schematics for information regarding the clock circuitry in use. Details of the oscillators fitted to the board are listed in Table 4-6 below.

**Table 4-6: Oscillators used on the Envision Kit design**

Crystal Oscillator	Function	Default Placement	Frequency	Device Package
X2	Main MCU crystal for RX65N MCU	Fitted	12MHz	Encapsulated, SMT
X3	Oscillator for Ethernet (RMII)	Fitted*	25MHz	Encapsulated, SMT

\*Note that although the Ethernet oscillator X3 is fitted, Ethernet transceiver IC6 is not fitted to the board by default.

## 4.4 Switch and Joystick

There is one user-switch located on the Envision Kit board and provision has also been made for a 5-way micro-switch operated joystick, which is not fitted as standard. The switch and joystick connections to the RX65N MCU are shown in **Table 4-7** and **Table 4-8**. For further information regarding switch connectivity, refer to the Envision Kit schematics.

**Table 4-7 : Switch SW2 Connection to MCU**

Switch	MCU		
	Signal (Port)	Pin	IRQ
SW2	P05	2	IRQ13

**Table 4-8 : Joystick SW3 Connection to MCU**

Switch	MCU		
	Signal (Port)	Pin	IRQ
UP	P67	98	IRQ15
DOWN	PF5	9	IRQ4
LEFT	P13	44	IRQ3
RIGHT	P03	4	IRQ11
CENTRE	P12	45	IRQ2

The joystick, SW3 is not fitted as standard to the Envision board. The part number details are shown in Table 4-9 below. For its location on the Envision Kit PCB, refer to Figure 3-3.

**Table 4-9 : Not Fitted Joystick SW3 Component Details**

RefDes	Description	Manufacturer	Manufacturer's Part Number
SW3	5-switch joystick, surface-mount	ALPS	SKQUDBE010

## 4.5 LEDs

There are 5 LEDs on the Envision Kit. The LED function, colour and connections are shown in Table 4-10.

**Table 4-10 : LED Connections**

LED	Colour	Function	MCU	
			Port	Pin
LED1	Green	Indicates the status of the Board_3V3 power rail.	NC	NC
LED5	Green	E2OB status. See Table 4-1.	NC	NC
LED2	Blue	User operated LED.	P70	104
ETHERNET Connector CN15*	Green	Ethernet LED (On: Link, flashing: Activity)	NC	NC
ETHERNET Connector CN15*	Yellow	Ethernet LED (Speed)	NC	NC

\* Ethernet connector CN15 is not fitted as standard.

## 4.6 Pmod™

There is a single Pmod™ Interface Type 2A Compatible expansion header on the Envision kit.

Care should be taken when installing Pmod™ modules to ensure pins are not bent or damaged. Pmod™ modules are vulnerable to electrostatic discharge (ESD); therefore appropriate ESD protection should be used.

The Digilent Pmod™ Compatible header uses an SPI interface. Connection information for the Pmod™ Compatible header CN14 is provided in Table 4-11 and Table 4-12.

Please note that the connector numbering adheres to the Digilent Pmod™ standard and is different from other connectors on the development kit design. Details can be found in the Digilent Pmod™ Interface Specification Revision: November 20, 2011.

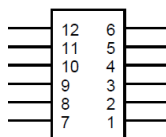


Figure 4-5: Digilent Pmod™ Compatible Header Pin Numbering

Table 4-11 : Pmod™ Interface CN14 Connections

Pin	Circuit Net Name	MCU		Pin	Circuit Net Name	MCU	
		Port	Pin			Port	Pin
1	PJ5_SSL#2_PMOD_1 <sup>*1</sup>	PJ5	11	7	PC6_IRQ13_PMOD_7 <sup>*1</sup>	PC6	61
2	P50_MOSI2_PMOD_2	P50	56 <sup>*2</sup>	8	P55_TXD7_PMOD_8	P55	51
3	P52_MISO2_PMOD_3	P52	54 <sup>*2</sup>	9	PB7_TXD9_PMOD_9	PB7	78 <sup>*2</sup>
4	P51_SCK2_PMOD_4	P51	55	10	PB6_RXD9_PMOD_10	PB6	79 <sup>*2</sup>
5	GROUND	-	-	11	GROUND	-	-
6	Board_3V3	-	-	12	Board_3V3	-	-

<sup>\*1</sup> Note that there is no internal pullup connected to this pin on the Envision Kit PCB.

<sup>\*2</sup> The configuration of this port-pin is subject to on-PCB option links. Refer to Table 4-12 for further details.

### 4.6.1 Pmod™ Configuration

Table 4-12 below details the function of the zero-Ohm option links associated with the Pmod™ Interface configuration. **Bold, blue text** indicates the default configuration that the Envision Kit is supplied with.

Table 4-12 : Option links affecting configuration of the Pmod™ Interface

MCU		MCU Signal name	MCU Peripheral Selection	Link		Destination Selection	
Pin	Port			Fit	DNF	Function Signal Name	Peripheral Function
56	P50	P50_PMOD_2_MOSI2_ARD_D14_SDA2	MOSI2	R6	R10	P50_MOSI2_PMOD_2	PMOD Pin 2 MOSI2
			SDA2	R10	R6	P50_ARD_D14_SDA2	Arduino D14 SDA2
54	P52	P52_PMOD_3_MISO2_ARD_D15_SCL2	MISO2	R1	R3	P52_MISO2_PMOD_3	PMOD Pin 3 MISO2
			SCL2	R3	R1	P52_ARD_D15_SCL2	Arduino D15 SCL2
78	PB7	PB7_TXD9_PMOD_9_ARD_D1	Port / TXD9	R33	R34	PB7_TXD9_PMOD_9	PMOD Pin 9
			SCI TXD9	R34	R33	PB7_TXD9_ARD_D1	Arduino D1
79	PB6	PB6_RXD9_PMOD_10_ARD_D0	Port / RXD9	R37	R38	PB6_RXD9_PMOD_10	PMOD Pin 10
			SCI RXD9	R38	R37	PB6_RXD9_ARD_D0	Arduino D0

## 4.7 Ethernet

When running any Ethernet software, a unique MAC address should be used. As the Envision Kit is not fitted with an Ethernet transceiver IC or Connector by default, it is not supplied with a unique Renesas allocated MAC address. It is recommended that a unique MAC address should be always be used with this device ensured to ensure full compatibility when using other hardware on a common Ethernet connection.

An Ethernet transceiver IC (IC6, Microchip LAN8720A) has been designed into the Envision board (but not fitted as standard), and is connected to the Ethernet MCU peripheral. The RX65N MCU supports full duplex 10Mb/s and 100Mb/s transmission and reception. The connections for the Ethernet controller are listed in Table 4-13 below.

**Table 4-13 : Ethernet Connections**

Ethernet signal	Function	Signal on Envision Kit Schematic	MCU	
			Port	Pin
ET0MDIO	Management data serial I/O	P71_ET0_MDIO	P71	86
ET0MDC	Management serial clock	P72_ET0_MDC	P72	85
RMII0_TXD_EN	Transmit enable.	P80_ET0_TX_EN	P80	65
RMII0TXD0	Transmit data bit 0.	P81_ET0_TXD0	P81	64
RMII0TXD1	Transmit data bit 1.	P82_ET0_TXD1	P82	63
REF50CK0	Receive clock.	P76_ET0_RX_CLK	P76	69
RMII0RXER	Receive data error.	P77_ET0_RX_ER	P77	68
RMII0RXD0	Receive data bit 0.	P75_ET0_RXD0	P75	71
RMII0RXD1	Receive data bit 1.	P74_ET0_RXD1	P74	72
RMII0CRSDV	Carrier sense	P83_ET0_CRS	P83	58

### 4.7.1 Ethernet Transceiver

The Microchip LAN8720A Ethernet transceiver, IC6, is a 25-pin Reduced Media Independent Interface (RMII) device designed to reduce the number of pins used by the Ethernet connection. The circuit configuration on the Envision Kit uses a 25MHz crystal oscillator which is doubled by the LAN8720A to provide a 50MHz clock-out to drive the RMII interface, via the signal P76\_ET0\_RX\_CLK on the Envision Kit schematic.

Various strap resistors are used to enforce a default configuration for the transceiver IC. These are detailed in Table 4-14 below. For further information, refer to the LAN8720A datasheet.

**Table 4-14 : Ethernet Transceiver Configuration Strap Resistors**

Resistor Reference	Resistor Value	Signal on Envision Kit Schematic	Transceiver IC6 Reference		Description
			Reference	Pin	
R45	100K	P77_ET0_RX_ER	RXER/PHYAD0	10	Sets PHY Address to 0
R47	100K	P75_ET0_RXD0	RXD0/MODE0	8	Mode Setting: Mode configured to value of 111 : "All capable. Auto-negotiation enabled."
R46	100K	P74_ET0_RXD1	RXD1/MODE1	7	
R48	100K	P83_ET0_CRS	CRS_DV/MODE2	11	
R60	10K	LED2_INTSEL#	LED2/INTSEL#	2	Selects operation of Transceiver pin 14 INT#/REFCLKO to be the 50MHz reference clock for the RMII interface on the RX65N MCU

Note that with the LAN8720A configured to provide the 50MHz clock-out signal from the 25MHz crystal oscillator, the worst-case output delay time for the RX65N Ethernet controller (15ns) combined with the worst case setup time for the LAN8720A (7ns) exceeds the 20ns clock period for the RMII interface. In practice the combined controller delay time and transceiver setup time does not exceed the clock period. However it is recommended if this design is being considered as a reference for other applications that the LAN8720A is reconfigured to operate in 50MHz clock-in mode from an external 50MHz oscillator in order to avoid this worst-case scenario. In clock-in mode, the combined worst case delay time and setup time is less than the clock period.

A second note concerning the configuration of the LAN8720A in 50MHz clock-out mode is that the nINT/REFCLKO pin on the LAN8720A device is used to provide the 50MHz clock signal. When configured to operate in clock-in mode, this pin is freed and can be used to indicate link status to the Ethernet controller on the RX65N MCU, via the ETO\_LINKSTA pin. This can provide link status to the Ethernet controller as an interrupt driven hardware signal (with the appropriate configuration of the LAN8720A internal registers), rather than requiring the link status to be polled via the management data interface as is currently the case.

#### 4.7.2 Ethernet Connector and RMII Transceiver IC

The Ethernet connector CN15 and RMII transceiver, IC6 are not fitted as standard to the Envision board. The part number details are shown in Table 4-15 below. For their location on the Envision Kit PCB, refer to Figure 3-3.

**Table 4-15 : Ethernet Not Fitted Component Details**

RefDes	Description	Manufacturer	Manufacturer's Part Number
CN15	Ethernet Connector, surface-mount	Pulse	J3011G21DNL
IC6	RMII Ethernet Transceiver IC, QFN24	Microchip	LAN8720A

### 4.8 USB Host

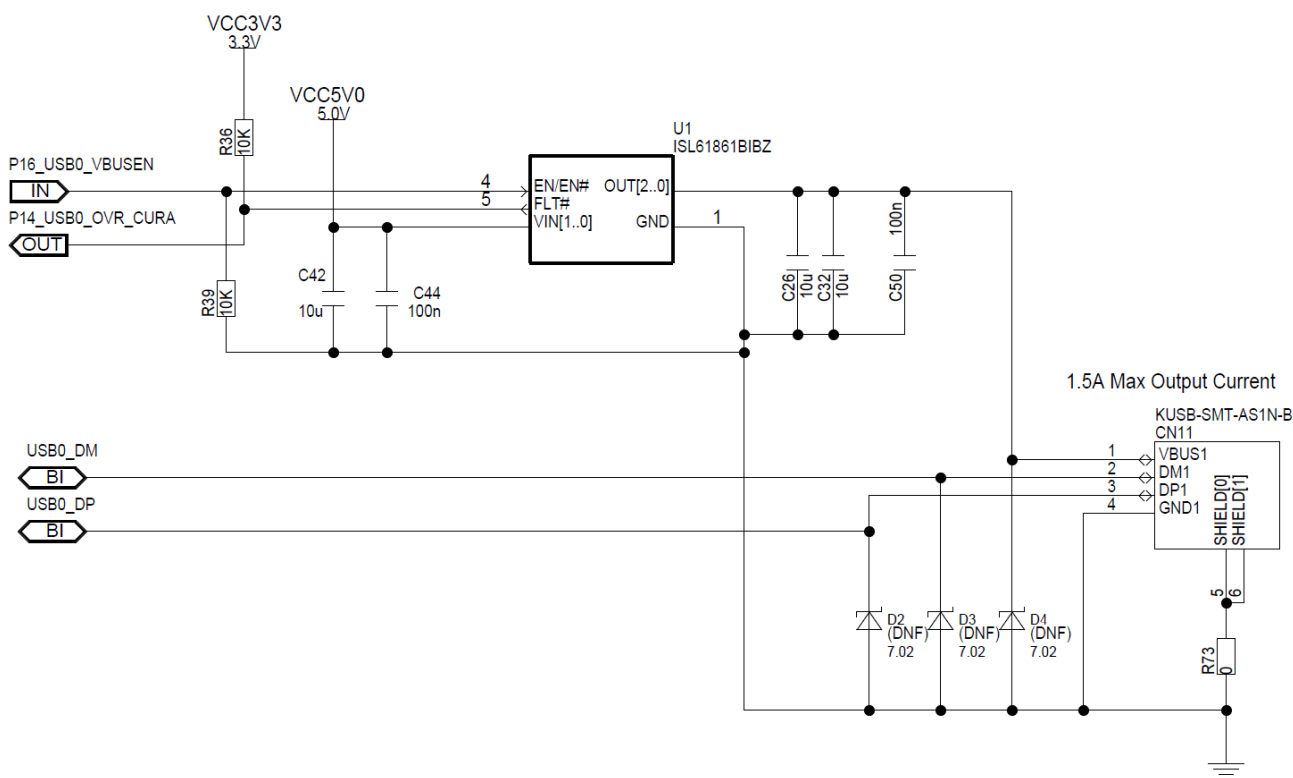
The Envision Kit is fitted with a USB host socket (type A), CN11, which uses the USB module USB0 on the RX65N MCU. The connections for the USB0 module and USBA module are shown in Table 4-16 below.

**Table 4-16 : USB0 Module Connections**

USB Signal	Function	Signal on Envision Kit Schematic	MCU	
			Port	Pin
USB0DP	Positive differential data signal.	USB0_DP	USB0_DP	48
USB0DM	Negative differential data signal.	USB0_DM	USB0_DM	47
USB0VBUSEN	VBUS power supply enable.	P16_USB0_VBUSEN	P16	40
USB0OVRCURA	Over-current detection signal A.	P14_USB0_OVR_CURA	P14	43

#### 4.8.1 USB Host Power Management

The 5V supply to the USB Host output uses a power management circuit to control the power output and provide protection from overloads and short-circuits. The schematic for this is shown in Figure 4-6 below. The circuit is based around the ISL61861 power management IC from Intersil, which has an active-high enable input, an (asserted low) fault output and can supply up to 1.5A from the 5V source supply. For more details concerning the ISL61861 device, visit the Intersil website [www.intersil.com](http://www.intersil.com). Please note that the source supply (the USB connection on CN9) needs to be able to provide at least 1.5A or the source supply will provide the effective current limit instead.



**Figure 4-6 : USB Host Power Management Circuit**

## 4.9 WQVGA LCD Display

### 4.9.1 Display Configuration

The Envision Kit shows the capabilities of the RX65N MCU to directly drive a TFT LCD Display using its internal graphic LCD controller (GLCDC) and 2D drawing engine (DRW2D) peripherals. The display on the Envision Kit is a 4.3 inch 480 x 272 (WQVGA) colour display. On the Envision kit, the display is connected in RGB565 16-bit colour format. In order to map the 16-bit RGB565 format to the 24-bit RGB888 format of the display, the connection of the least significant lines of each colour have been mapped to the most significant bits, to enable a more even colour variation with the increase in brightness for each colour. Refer to the schematics for further information.

The display connects to the Envision kit board via connector CN4. This is a 40 way 0.5mm pitch connector. On the Envision board test points TP10, TP11, TP14, TP15 allow connections to a resistive touchscreen integrated in the display to be made (although circuitry to read this is not in the Envision Kit design).

Table 4-18 below describes the connections from the Envision Kit to the display.

### 4.9.2 Capacitive Touchscreen

The Envision Kit display incorporates a capacitive touchscreen, which is accessed via a multi-touch controller, FocalTech FT5206. This controller is integrated into the cable connection from the touchscreen on the display to the 6-way 0.5mm pitch connector CN6. It communicates with the RX65N MCU via I2C to the SCI peripheral, channel 6. The touchscreen controller uses slave address 0x38. Table 4-17 below describes the connections from the RX65N MCU to the display touchscreen controller.

**Table 4-17 : LCD Display Touchscreen CN6 Pin Connections**

Display Connector CN6 Pin Number	Function	Signal on Envision Kit Schematic	MCU	
			Port	Pin
1	I2C Serial Clock	P01_TSCN_SCL6	P01	7
2	I2C Serial Data	P00_TSCN_SDA6	P00	8
3	VCC	VCC3V3	---	---
4	I2C Reset	P07_IRQ15_TSCN_RES	P07	144
5	I2C Interrupt Line	P02_TSCN_INT	P02	6
6	GND	GND	---	---



Table 4-18 : LCD Display CN4 Pin Connections

Display Connector CN4 Pin Number	Function	Signal on Envision Kit Schematic	MCU	
			Port	Pin
1	Backlight supply negative	VBACKLIGHT-	---	---
2	Backlight supply positive	VBACKLIGHT+	---	---
3	GND	GND	---	---
4	VDD	VCC3V3	---	---
5	Red 0	PE3_LCD_DATA13	PE3	108
6	Red 1	PE2_LCD_DATA14	PE2	109
7	Red 2	PE1_LCD_DATA15	PE1	110
8	Red 3	PE5_LCD_DATA11	PE5	106
9	Red 4	PE4_LCD_DATA12	PE4	107
10	Red 5	PE3_LCD_DATA13	PE3	108
11	Red 6	PE2_LCD_DATA14	PE2	109
12	Red 7	PE1_LCD_DATA15	PE1	110
13	Green 0	PE7_LCD_DATA9	PE7	101
14	Green 1	PE6_LCD_DATA10	PE6	102
15	Green 2	PA3_LCD_DATA5	PA3	94
16	Green 3	PA2_LCD_DATA6	PA2	95
17	Green 4	PA1_LCD_DATA7	PA1	96
18	Green 5	PA0_LCD_DATA8	PA0	97
19	Green 6	PE7_LCD_DATA9	PE7	101
20	Green 7	PE6_LCD_DATA10	PE6	102
21	Blue 0	PA6_LCD_DATA2	PA6	89
22	Blue 1	PA5_LCD_DATA3	PA5	90
23	Blue 2	PA4_LCD_DATA4	PA4	92
24	Blue 3	PB0_LCD_DATA0	PB0	87
25	Blue 4	PA7_LCD_DATA1	PA7	88
26	Blue 5	PA6_LCD_DATA2	PA6	89
27	Blue 6	PA5_LCD_DATA3	PA5	90
28	Blue 7	PA4_LCD_DATA4	PA4	92
29	GND	GND	---	---
30	DCLK – Dot Clock	PB5_LCD_CLK	PB5	80
31	DISP – Display Enable	P63_LCD_RESET	P63	113
32	HSYNC	PB2_LCD_TCON2	PB2	83
33	VSYNC	PB4_LCD_TCON0	PB4	81
34	DE – Data Enable	PB1_LCD_TCON3	PB1	84
35	NC	---	---	---
36	GND	GND	---	---
37	XR – Resistive Touch X - Right	TP10	---	---
38	YD– Resistive Touch Y - Down	TP11	---	---
39	XL– Resistive Touch X - Left	TP14	---	---
40	YU– Resistive Touch Y- Up	TP15	---	---

## 4.10 QSPI Flash

The Envision Kit has a 32Mbit Quad Serial Peripheral Interface Flash memory. Table 4-19 below details the connections to the RX65N MCU, utilising the on-board QSPI-B peripheral. The Flash memory device used is a Macronix MX25L3233F.

**Table 4-19 : QSPI Connections**

QSPI Signal	Function	Signal on Envision Kit Schematic	MCU	
			Port	Pin
CS#	QSPI Chip Select	PD4_QSSL_B_QSPI	PD4	122
SO/SIO1	QSPI Data I/O line 1	PD7_QIO1_B_QSPI	PD7	119
WP#/SIO2	QSPI Data I/O line 2	PD2_QIO2_B_QSPI	PD2	124
HOLD#/SIO3	QSPI Data I/O line 3	PD3_QIO3_B_QSPI	PD3	123
SCLK	QSPI Clock	PD5_QSPCLK_B_QSPI	PD5	121
SI/SIO0	QSPI Data I/O line 0	PD6_QIO0_B_QSPI	PD6	120

## 4.11 SD Host Interface (SDHI)

Provision has been made for an SD Card Slot to be fitted to the Envision Kit, connecting to the SD Host Interface (SDHI) MCU peripheral. For further details regarding the SDHI operation, please refer to the RX65N Group User's Manual: Hardware.

It is not recommended to insert or remove the SD card during MCU reset, because the SD card power supply is enabled during MCU reset.

The connections for the SDHI signals are listed in Table 4-20 below.

**Table 4-20 : SDHI Connections**

SD Card Connector CN7 Pin Number	Function	Signal on Envision Kit Schematic	MCU	
			Port	Pin
1	SDHI Write Protect	P24_SDHI_WP_C	P24	33
2	SDHI Chip Detect	P25_SDHI_CD_C	P25	32
12	SDHI Command Line	P20_SDHI_CMD_C	P20	37
8	SDHI Clock Line	P21_SDHI_CLK_C	P21	36
4	SDHI Data line 0	P22_SDHI_D0_C	P22	35
3	SDHI Data line 1	P23_SDHI_D1_C	P23	34
15	SDHI Data line 2	P87_SDHI_D2_C	P87	39
14	SDHI Data line 3	P17_SDHI_D3_C	P17	38
(U2 ISL61861BIBZ) pin 4	SDHI Power Enable (active-high)	P64_SD_ENABLE	P64	112
(U2 ISL61861BIBZ) pin 5	Supply Fault Signal (asserts low)	P44_AN004_SD_PSU_OK	P44	136



### 4.11.2 SDHI Connector and Power Management IC

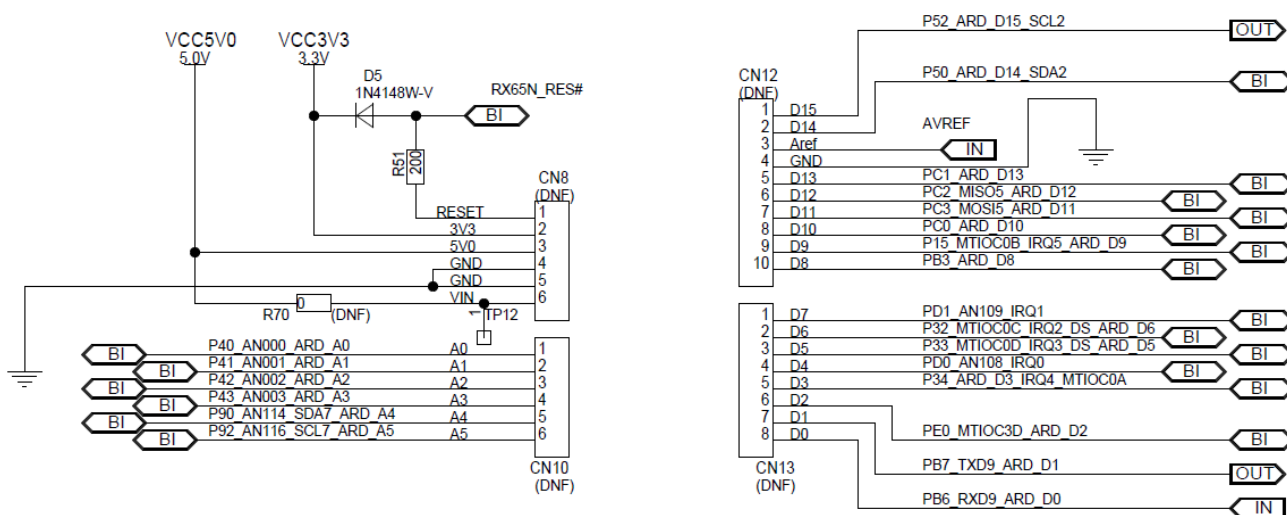
The SD connector CN7 and power management IC, U2 are not fitted as standard to the Envision board. The part number details are shown in Table 4-21. For their location on the Envision Kit PCB, refer to Figure 3-3.

**Table 4-21 : SDHI Not Fitted Component Details**

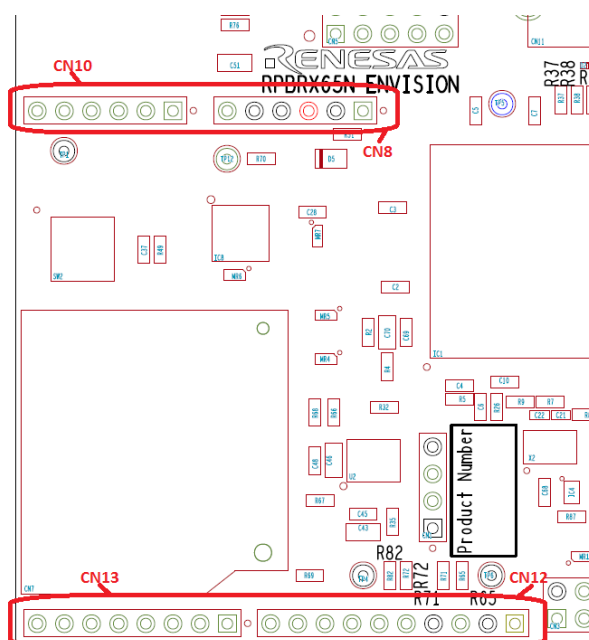
RefDes	Description	Manufacturer	Manufacturer's Part Number
CN7	SD/MMC Connector, surface-mount	Amphenol	101-00565-64
U2	Power Management IC, SOIC8	Intersil	ISL61861BIBZ

### 4.12 Arduino™

The Envision Kit provides the ability to fit Arduino™ shields to be fitted to the board, to add functionality. Note that the headers themselves are not fitted to the Envision PCB and that the display would have to be removed in order to fit them. The Arduino™ connection information and header locations are shown in Figure 4-8 and Figure 4-9 below:



**Figure 4-8 : Arduino™ Connection on Envision Kit Design**



**Figure 4-9 : Arduino™ Header Locations On Envision PCB Underside**

### 4.12.1 Arduino™ Configuration

Table 4-22 below details the function of the zero-Ohm option links associated with the Arduino™ configuration. **Bold, blue text** indicates the default configuration that the Envision Kit is supplied with.

**Table 4-22 : Option links affecting configuration of the Arduino™ Interface**

MCU		MCU Signal name	MCU Peripheral Selection	Link		Destination Selection	
Pin	Port			Fit	DNF	Function Signal Name	Peripheral Function
56	P50	P50_PMOD_2_MOSI2_ARD_D14_SDA2	MOSI2	R6	R10	P50_MOSI2_PMOD_2	PMOD Pin 2 MOSI2
			SDA2	R10	R6	P50_ARD_D14_SDA2	Arduino D14 SDA2
54	P52	P52_PMOD_3_MISO2_ARD_D15_SCL2	MISO2	R1	R3	P52_MISO2_PMOD_3	PMOD Pin 3 MISO2
			SCL2	R3	R1	P52_ARD_D15_SCL2	Arduino D15 SCL2
78	PB7	PB7_TXD9_PMOD_9_ARD_D1	Port / TXD9	R33	R34	PB7_TXD9_PMOD_9	PMOD Pin 9
			SCI TXD9	R34	R33	PB7_TXD9_ARD_D1	Arduino D1
79	PB6	PB6_RXD9_PMOD_10_ARD_D0	Port / RXD9	R37	R38	PB6_RXD9_PMOD_10	PMOD Pin 10
			SCI RXD9	R38	R37	PB6_RXD9_ARD_D0	Arduino D0
25	P34	P34_TGT_TRST#_ARD_D3	JTAG TRST	R15	R21	P34_TGT_TRST#	JTAG Target RST#
			IRQ4/MTIOC0A	R21	R15	P34_ARD_D3_IRQ4_MTI0C0A	Arduino D3 – IRQ4 / MTIOC0A
70	PC2	PC2_USBRXD_ARD_D12	SCI RXD5	R65	R71	PC2_USBRXD	USB/Serial RXD5
			SCI MISO5	R71	R65	PC2_MISO5_ARD_D12	Arduino D12 – MISO5
67	PC3	PC3_USBTXD_ARD_D11	SCI TXD5	R72	R82	PC3_USBTXD	USB/Serial TXD5
			SCI MOSI5	R82	R72	PC3_MOSI5_ARD_D11	Arduino D11 – MOSI5

#### Note concerning the revision of Arduino™ Shields connecting to the Envision Kit

The hardware interface for Arduino™ shields connecting to the Envision Kit does not include the IOREF and (UNUSED) pins added to the Arduino™ Uno at revision 3. These missing pins would have been located at the top of connector CN8, see Figure 4-9 for the location of the Arduino™ headers on the Envision Kit and Figure 4-10 below for the position of the missing pins on the Arduino™ connector system.

The IOREF pin is used to inform the connected shield of the system logic voltage. In the case of the Envision kit, any shield that is connected and uses the IOREF pin should have this pin connected to the 3.3V supply on the Envision Kit board, for example, at test point TP6. Refer to the Envision Kit schematics and layout for further information.



**Figure 4-10 : Missing IOREF and Unused Pin on Envision Kit for Arduino™ Rev 3**

### 4.13 Available MCU Hardware Interrupt Pins (IRQ)

Table 4-23 below shows a list of available hardware interrupt IRQ lines on the Envision PCB.

**Table 4-23 : List of Available IRQ pins on the Envision Board**

IRQ	MCU Port	MCU Pin	Availability on Envision Board
IRQ13	P05	2	user switch SW2
IRQ11	P03	4	joystick SW3 right
IRQ4	PF5	9	joystick SW3 down
NMI	P35	24	Not used CN2 pin 1
IRQ4	P34	25	Debugger target reset or Arduino D3 (CN13 pin 5). Selectable via configuration resistors R15 and R21.
IRQ3-DS	P33	26	Arduino D5 (CN13 pin 3).
IRQ2-DS	P32	27	Arduino D6 (CN13 pin 2).
IRQ9	P21	36	SDHI clock CN7 pin 8
IRQ8	P20	37	SDHI CMD CN7 pin 12 (22K pullup)
IRQ7	P17	38	SDHI D3 CN7 pin 14 (22K pullup)
IRQ5	P15	42	Arduino D9 (CN12 pin 9)
IRQ3	P13	44	joystick SW3 left
IRQ2	P12	45	joystick SW3 centre
IRQ10	P55	51	CN14 Pmod pin 8
IRQ13	PC6	61	CN14 Pmod pin 7
IRQ12	PC1	73	Arduino D13 CN12 pin 5
IRQ14	PC0	75	Arduino D10 CN12 pin 8
IRQ15	P67	98	joystick SW3 up
IRQ1	PD1	125	Arduino D7 CN13 pin 1
IRQ0	PD0	126	Arduino D4 CN13 pin 4
IRQ15-DS	P47	133	Not used CN5 pin 5
IRQ14-DS	P46	134	Not used CN5 pin 3
IRQ13-DS	P45	135	Not used CN5 pin 1
IRQ11-DS	P43	137	Arduino A3 CN10 pin 4
IRQ10-DS	P42	138	Arduino A2 CN10 pin 3
IRQ9-DS	P41	139	Arduino A1 CN10 pin 2
IRQ8-DS	P40	141	Arduino A0 CN10 pin 1

## 5. Additional Information

Further information concerning the Envision Kit product can be found at the following website:

[www.renesas.com/envision](http://www.renesas.com/envision)

### Technical Support

For information about the RX65N Group microcontrollers refer to the RX65N Group Hardware Manual.

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

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