

# ZKit-51-RD2, 8051 Development Kit

*User Manual*

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2.0, Oct 2013



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# Chapter 1. Introduction

ZKit-51-RD2 is a 8051 micro-controller development kit from Zilogic Systems. ZKit is designed for easy usage, immediate prototyping and extensive product design.

## 1. Features

The ZKit-51-RD2 comes with

- Display and On-board keys
- Well defined IO connector interface for I<sup>2</sup>C, SPI, PWM, GPIO, SIO
- USB and External power supply
- Programmable through USB
- Free and open source compiler and programmer
- Zilogic's opensource software library
- Ready to go with Zilogic's Relay, Motor, Display, etc., add-on boards.

## 2. Applications

- Motherboard for embedded product
- Embedded application prototyping
- Teaching and learning embedded systems

## 3. Board Details

The ZKit-51-RD2 offers the following features

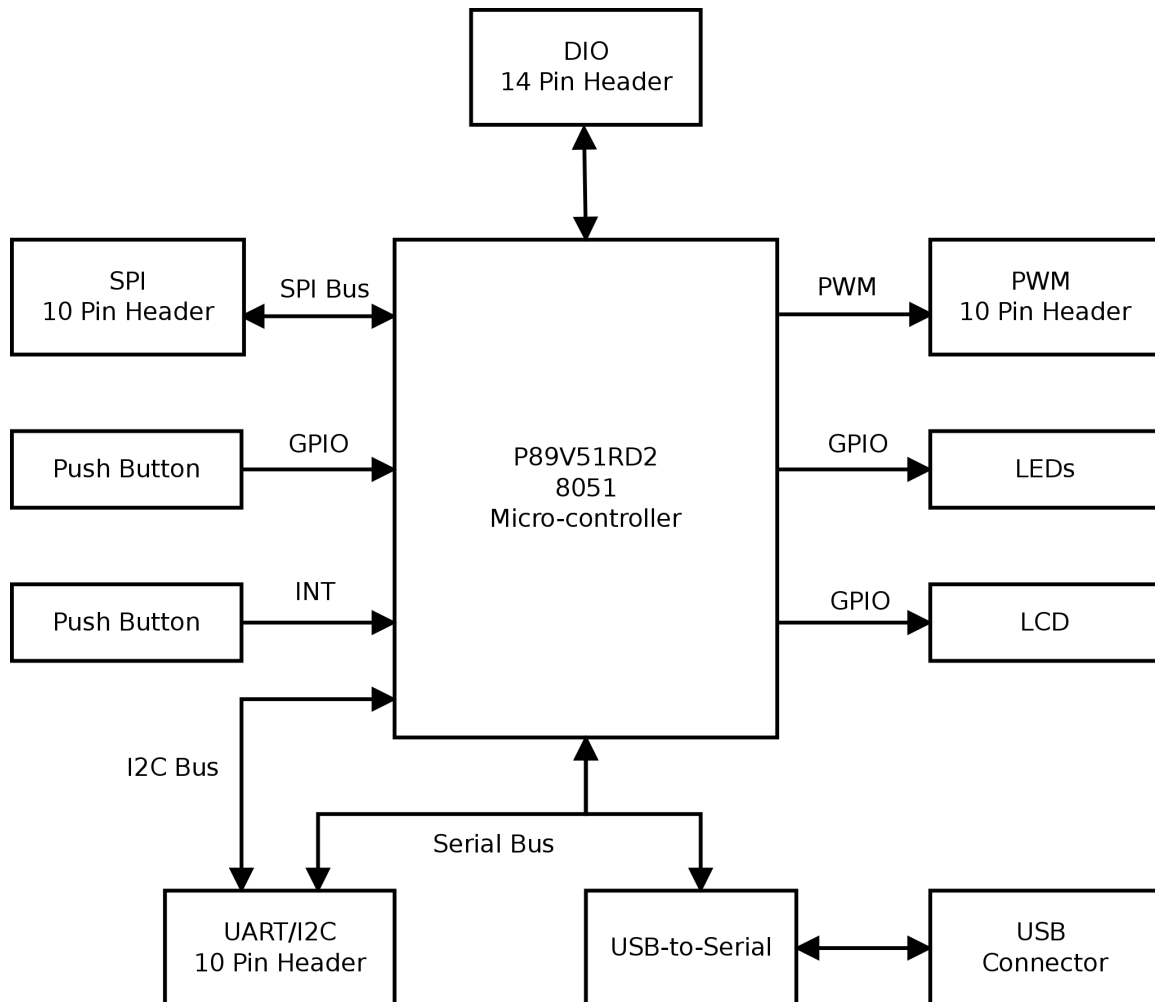
- NXP P89V51RD2 micro-controller with 64KB Flash and 1KB RAM
- 18.432MHz crystal
- Power supply
  - USB
  - External 7.5V supply
- On-board Peripherals
  - 16x2 character LCD, with backlight
  - USB serial interface, for communication and program download
  - Four button keypad
  - Push button with hardware de-bounce (interrupt input)
  - 2 debug LEDs
- Connectors
  - USB, type B connector
  - 2.1mm power supply connector
  - 14 pin header for Digital IO
  - 10 pin header for serial communication / I<sup>2</sup>C
  - 10 pin header for SPI
  - 10 pin header for PWM

# Chapter 2. Board Design

## 1. Overview

A bird's eye view of the devices available on the board, is shown in the following block diagram. Each device connectivity is described in detail in the following sections.

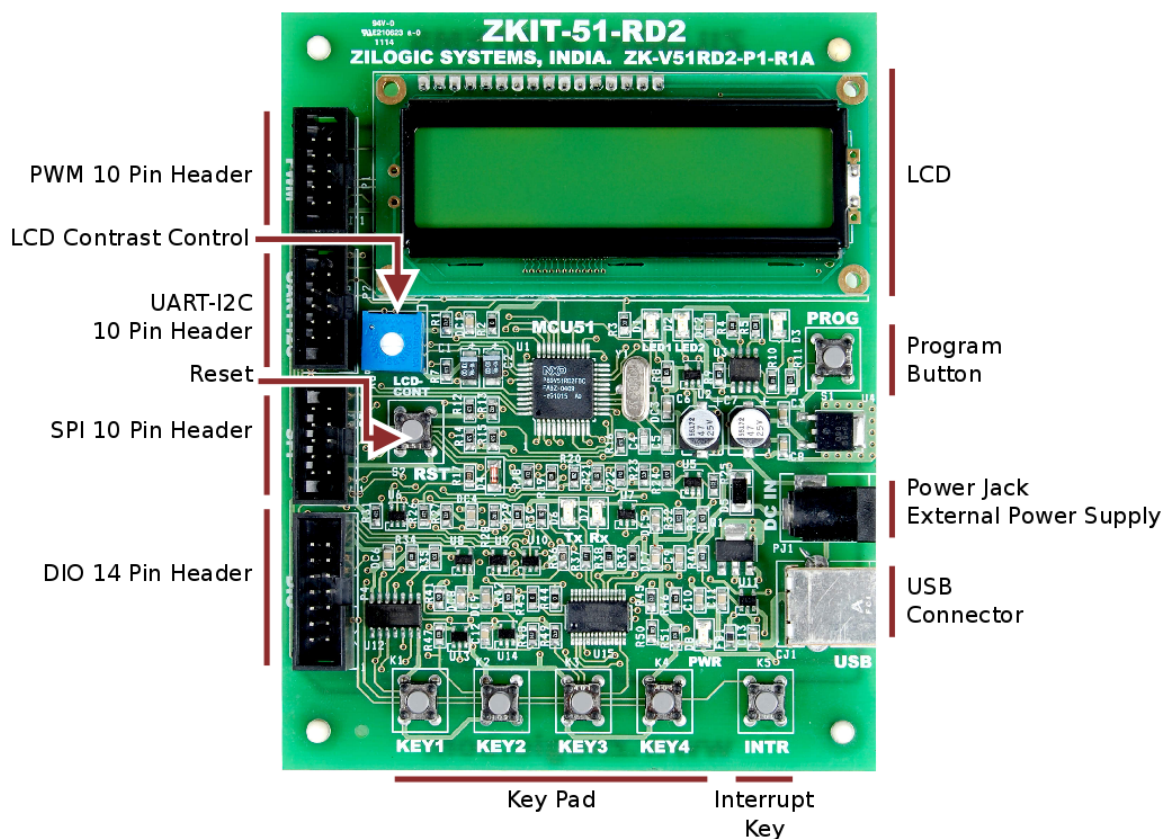
**Figure 2.1. Block Diagram**



## 2. Locating Components

The location of the components on the board are indicated in the following diagrams.

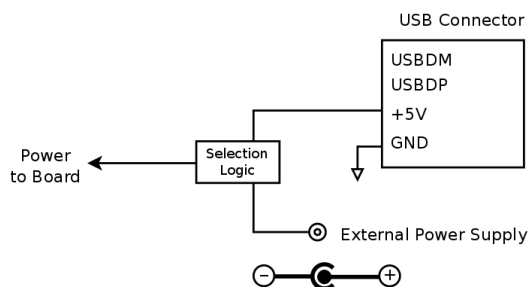
**Figure 2.2. Front View**



### 3. Power Supply

The ZKit-51-RD2 can be powered through USB or an external 7.5V regulated power supply.

**Figure 2.3. Power Supply Connection Diagram**



The external power supply, if used, should be a regulated power supply. The regulated power supply should have the following charactersitics.

Output Voltage	7.5V - 12V
Output Current	> 500mA

Polarity

Shown in diagram

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## 4. CPU

The heart of the ZKit-51-RD2 is an NXP P89V51RD2 micro-controller. The P89V51RD2 is an 8-bit 80C51 5V low power micro-controller with 64 kB Flash, 1KB of data RAM and supports In-System Programming (ISP).

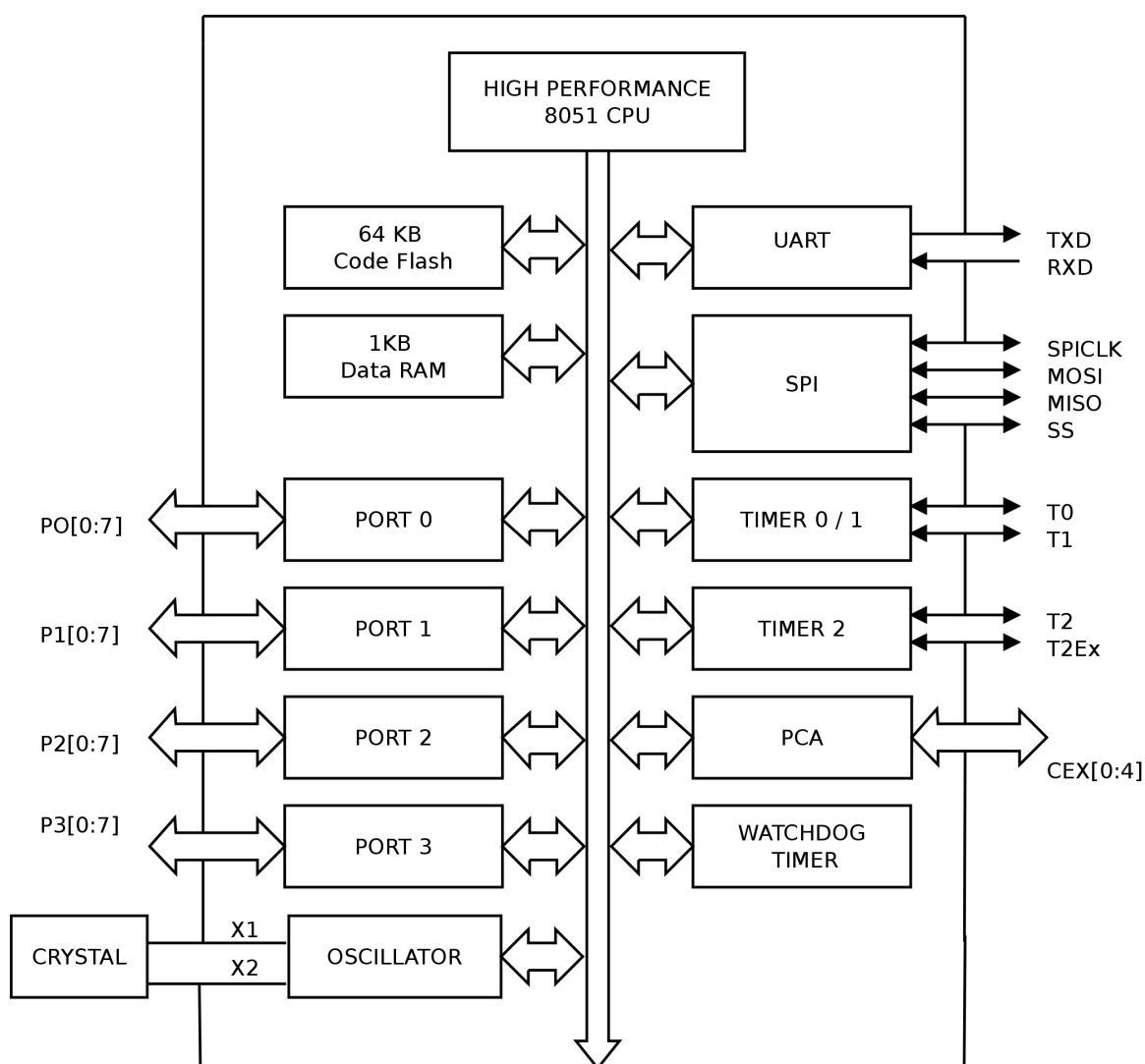
The main features of the micro-controller are listed below.

- 0 MHz to 40 MHz operating frequency in 12x mode, 20 MHz in 6x mode
- 64 kB of on-chip flash user code memory with ISP and IAP
- 1 kB RAM
- SPI (Serial Peripheral Interface) and enhanced UART
- PCA (Programmable Counter Array) with PWM and Capture/Compare functions
- Three 16-bit timers/counters
- Four 8-bit I/O ports
- WatchDog Timer (WDT)
- Support for 12-clock (default) or 6-clock mode selection via ISP
- Low EMI mode (ALE inhibit)
- Power-down mode with external interrupt wake-up

The micro-controller crystal frequency is 18.432 MHz. 8051-based processors generate their serial port timing using a combination of external crystal and internal programmable divider chains. This crystal frequency has been selected in order to ensure the following

1. the timing requirements of the controller's serial interface are met.
2. the CPU runs at high speed in 6-clock mode.

Power to the board is sourced either from the 7.5V external regulated power supply or from USB power.

**Figure 2.4. Micro-controller Block Diagram**

## 5. USB Serial

The ZKit-51-RD2 has a FT232R USB to serial UART converter. The FT232R has the following advanced features:

- The FT232R is fully compliant with the USB 2.0 specification.
- Single chip USB to asynchronous serial data transfer interface.
- Entire USB protocol handled on the chip.
- Supports transmit and receive LED drive signals.

The ZKit-51-RD2 uses USB Serial UART for serial communication between PC and the P89V51RD2 MCU. This is also used to download firmware by activating the bootloader of P89V51RD2 MCU. This is called In-System Programming (ISP).

### 5.1. In-System Programming

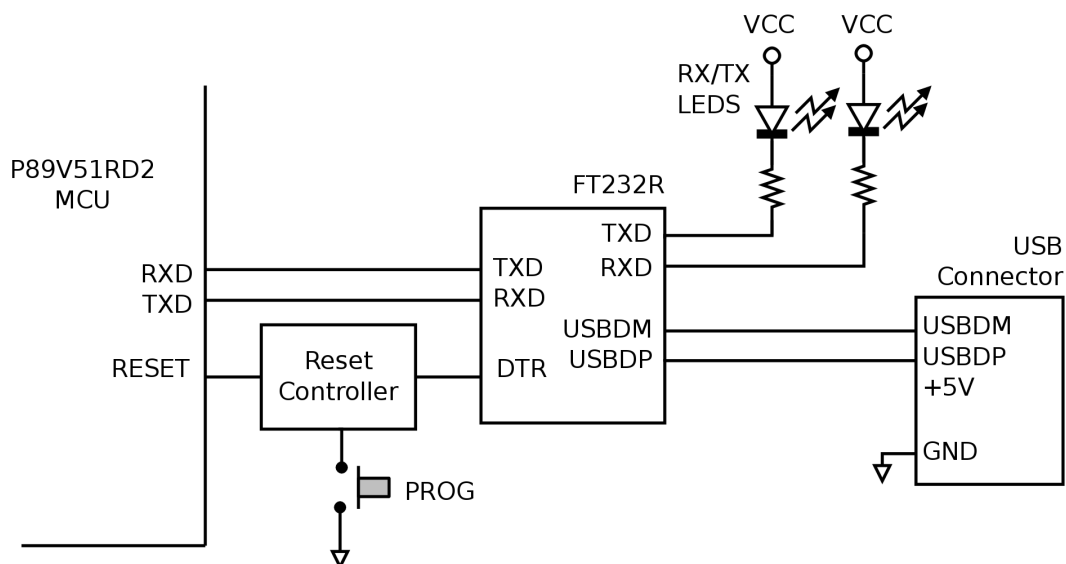
The ZKit-51-RD2 has a **PROG** push button, which can be used to select between Programming mode and Serial Communication mode. When the board is powered on, it is in Serial Communication mode. Press the **PROG** button to switch into Programming mode. The current mode is indicated by the **PROG** LED. The LED glows in Programming mode.



In Programming mode, the RTS is connected to the RESET of the MCU. Flash programming applications like Smash and Flash Magic can utilize this feature to switch the device into ISP mode automatically, without user intervention.

The following diagram shows the FT232R connection details.

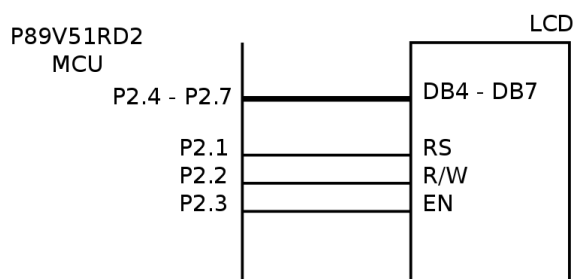
**Figure 2.5. FT232R Connection Diagram**



## 6. LCD Display

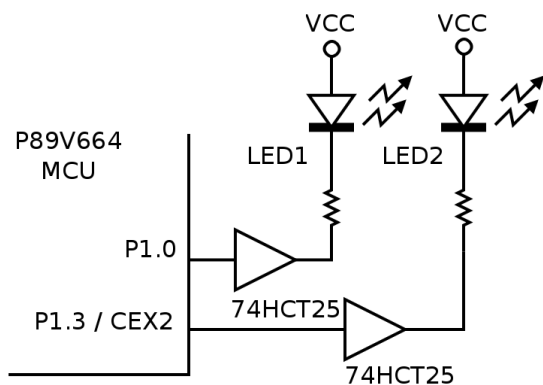
The ZKit-51-RD2 has a HD44780 Hitachi chipset compatible, 16x2 character, LCD. The LCD data lines are connected to P2.4 to P2.7 and the control lines (RS, R/W, EN) are connected to P2.1, P2.2, P2.3 respectively. The following diagram shows the LCD pin connection details.

**Figure 2.6. LCD Connection Diagram**



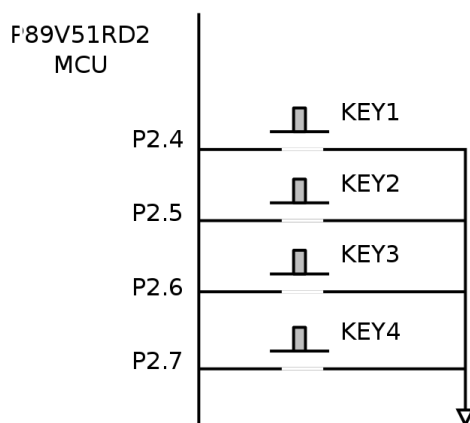
## 7. Debug LEDs

The ZKit-51-RD2 has two debug LEDs, LED1 and LED2, connected to P1.0 and P1.3, through a non-inverting buffer, respectively. By driving P1.0 and P1.3 low, the LEDs can be switched On. The on-chip PCA (Programmable Counter Array) can be used to generate a PWM signal to control the LED brightness of LED2.

**Figure 2.7. LEDs Connection Diagram**

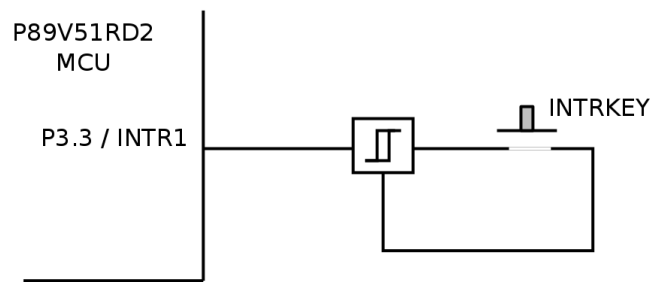
## 8. Keypad

The ZKit-51-RD2 has 4 tactile push button switches connected to P2.4 to P2.7. The keypad connection details are shown in the following diagram.

**Figure 2.8. Keypad Connection Diagram**

## 9. Interrupt Key

The ZKit-51-RD2 has 1 tactile push button switch for testing interrupts. The push button is hardware debounced and connected to INTR1, through a On/Off dip switch. When the switch is Off, INTR1 is available for external usage, through PIO-BUS header. The following diagram shows the interrupt key connection details.

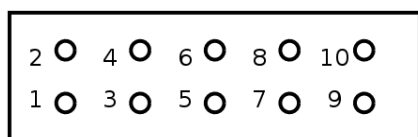
**Figure 2.9. Interrupt Key Connection Diagram**

# Chapter 3. Connecting to ZKit-51-RD2

In this chapter we will describe the connectors in the ZKit-51-RD2.

## 1. PWM Pinmap

The PWM header is terminated with 5 pulse width modulation signals and power supply. Add-on boards like LED control, motor control can be connected through this header.



**Table 3.1. PWM Header**

Pin #	Signal Name	MCU Signal
1	VCC	VCC
2	PWM 0	P1.4/CEX1
3	PWM 1	P1.5/CEX2
4	PWM 2	P1.6/CEX3
5	PWM 3	P1.7/CEX4
6	PWM 4	P1.3/CEX0
7	FWM 5	ECI/P1.2
8	Freq-In 1	T2EX/P1.1
9	Freq-In 2	T2/P1.0
10	GND	GND

### VCC (Pin 1)

This is the power supply for the external sensors. The supply has a total current limit of 200mA when powered through USB.

### PWM Output (Pin 2 - 6)

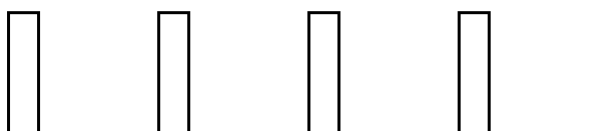
These are PWM output signals. The PWM signal when active produces a stream of pulses whose width can be controlled through software. An important parameter of a PWM signal is the **duty cycle**. The duty cycle is defined as the ratio between the pulse duration and pulse period of a rectangular waveform.

The PWM signal can be used to control the power delivered to a load, by controlling the duty cycle of the PWM signal. PWM signals are generally used for Motor speed control, LED brightness control, power supplies and wave form generation.

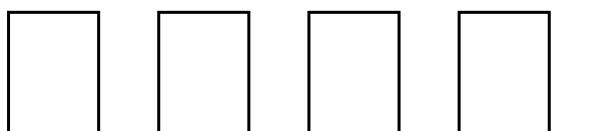
The PWM signal is a 5V CMOS/TTL output.

**Figure 3.1. PWM signals with various pulse widths**

Duty Cycle: 20%



Duty Cycle: 60%

**Freq-In** (Pin 7 - 9)

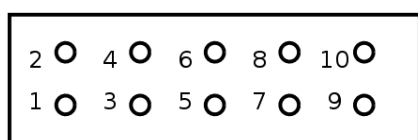
These are input signals and can be used for event counting, frequency measurement, etc. The Freq-In signal is a CMOS/TTL input.

**GND** (Pin 10)

This is the ground signal. All other signals are referenced to this signal.

## 2. **SPI** Pinmap

The **SPI** header is terminated with serial peripheral interface (SPI) bus, 4 general purpose IO and power supply. Add-on boards with SPI interface like MMC/SD card, EEPROM etc., can be connected through this header.

**Table 3.2. **SPI** Header**

Pin #	Header Signal	MCU Signal
1	VCC	VCC
2	SCK	P1.7/SCK
3	MISO	P1.6/MISO
4	MOSI	P1.5/MOSI
5	SS	P1.4/SS
6	DI00	P3.6/WRn
7	DI01	P3.7/RDn
8	DI02	P1.3/CEX0
9	DI03	P3.3/INT1
10	GND	GND

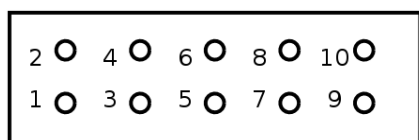
**VCC** (Pin 1)

This is the power supply for the external devices. The supply has a total current limit of 200mA when powered through USB.

<b>SCK</b> (Pin 2)	This is Serial Clock signal. The signal is a 5V logic signal, but the output can drive a 5V device or 3.3V device with 5V tolerance.
<b>MISO</b> (Pin 3)	This is the Master Input, Slave Output signal. The signal is a 5V logic signal.
<b>MOSI</b> (Pin 4)	This is the Master Output, Slave Input signal. The signal is a 5V logic signal, but the output can drive a 5V device or 3.3V device with 5V tolerance.
<b>SS</b> (Pin 5)	This is the SPI chip select signal.
<b>DI0</b> (Pin 6, 7, 8, 9)	These are digital input/output signals. The signal is a 5V logic signal, but the output can drive a 5V device or 3.3V device with 5V tolerance. These lines can be used to interface any extra signals required for a SPI devices like SD Card, etc., or can be used as chip selects for four other devices.
<b>GND</b> (Pin 10)	This is the ground signal. All other signals are referenced to the this signal.

### 3. UART-I2C Pinmap

The **UART-I2C** header is terminated with serial communication signals, I<sup>2</sup>C signals and power supply. I<sup>2</sup>C and UART based add-on boards, can be connected through this header.



**Table 3.3. UART-I2C Header**

Pin #	Header Signal	MCU Signal
1	VCC	VCC
2	RXD	P3.0/RXD
3	TXD	P3.1/TXD
4	SCL	P3.4/SCL
5	SDA	P3.5/SDA
6	DI00	P3.6/WR
7	DI01	P3.7/RD
8	DI02	P1.3/CEX0
9	DI03	P3.2/INT0
10	GND	GND

<b>VCC</b> (Pin 1)	This is the power supply for the external devices. The supply has a total current limit of 200mA when powered through USB.
<b>RXD</b> (Pin 2)	This is transmit line of serial IO. This signal is a 5V CMOS/TTL input
<b>TXD</b> (Pin 3)	This is transmit line of serial IO. This signal is a 5V CMOS/TTL output.
<b>SCL, SDA</b> (Pin 4, 5)	These are I <sup>2</sup> C bus signals(clock, data), and can be used to connect I <sup>2</sup> C devices. Any 5V tolerant I <sup>2</sup> C device, can be

connected to the bus. The signals are pulled up to 5V, through a 4.7K resistor.

**DIO** (Pin 6, 7, 8, 9)

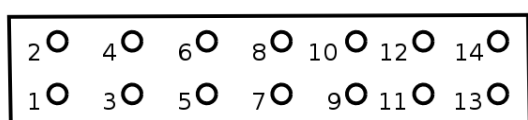
These are digital input/output signals. The signal is a 5V logic signal, but the output can drive a 5V device or 3.3V device with 5V tolerance. These lines can be used to interface any extra signals required for a I<sup>2</sup>C devices.

**GND** (Pin 10)

This is the ground signal. All other signals are referenced to this signal.

## 4. DIO Pinmap

The **DIO** header is terminated with port **P0**, and **P1** signals, along with power supply. Add-on boards, with different functionalities, can be connected through this header, to the ZKit-51-RD2.



**Table 3.4. DIO Header**

Pin #	Header Signal	MCU Signal
1	VCC	VCC
2	D00	P0.0/AD0
3	D01	P0.1/AD1
4	D02	P0.2/AD2
5	D03	P0.3/AD3
6	D04	P0.4/AD3
7	D05	P0.5/AD4
8	D06	P0.6/AD5
9	D07	P0.7/AD6
10	DI00	P1.0/CS
11	DI01	P1.1/ALE
12	DI02	P1.2/R/W#
13	DI03	P3.3/INT1
14	GND	GND

**VCC** (Pin 1)

This is the power supply for the external devices. The supply has a total current limit of 200mA when powered through USB.

**DO** (Pin 2-9)

These are digital output signals. The signal is a 5V logic signal, but the output can drive a 5V device or 3.3V device with 5V tolerance.

**DIO** (Pin 6, 7, 8, 9)

These are digital input/output signals. The signal is a 5V logic signal, but the output can drive a 5V device or 3.3V device with 5V tolerance.

**GND** (Pin 14)

This is the ground signal. All other signals are referenced to this signal.

# Appendix A. Legal Information

## 1. Copying

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## 2. Limited Hardware Warranty

The warranties provided by Zilogic Systems in this Limited Hardware Warranty apply only to Hardware Products you purchase for your use, and not for resale. The term "Hardware Product" means a computing device with a specific function and limited configuration ability.

### 2.1. LIMITED HARDWARE WARRANTY

Zilogic Systems warrants that the hardware components of its Hardware Product shall be free from material defects in design, materials, and workmanship and will function, under normal use and circumstances, in accordance with the documentation provided, for a period of one (1) year from the date of purchase of the Hardware Product.

Your sole and exclusive remedy, and Zilogic Systems' sole and exclusive liability for defective hardware components, shall be that Zilogic Systems, subject to the terms and conditions of this Section, and solely upon confirmation of a defect or failure of a hardware component to perform as warranted, shall at its sole option, either repair or replace the nonconforming hardware component. All replacement parts furnished to you under this warranty shall be refurbished and equivalent to new, and shall be warranted as new for the remainder of the original warranty period. All defective parts, which have been replaced, shall become the property of Zilogic Systems. All defective parts that have been repaired shall remain your property.

### 2.2. EXCLUSIONS

The foregoing warranties and remedies shall be void as to any Hardware Products damaged or rendered unserviceable by one or more of the following: (1) improper or inadequate maintenance by anyone other than Zilogic Systems or Zilogic Systems' authorized engineers, (2) interfacing supplied by anyone other than Zilogic Systems, (3) modifications, alterations or additions to the Hardware Products by personnel not certified by Zilogic Systems or Zilogic Systems' authorized engineers to perform such acts, or other unauthorized repair, installation or other causes beyond Zilogic Systems' control, (4) unreasonable refusal to agree with engineering change notice programs, (5) negligence by any person other than Zilogic Systems or Zilogic Systems' authorized engineers, (6) misuse, abuse, accident, electrical irregularity, theft, vandalism, fire, water or other peril, (7) damage caused by containment and/or operation outside the environmental specifications for the Hardware Products, (8) alteration or connection of the Hardware Products to other systems, equipment or devices (other than those specifically approved by Zilogic Systems) not in accordance to the board and on-board device specifications (9) any use that is inconsistent with the user manual supplied with the Hardware Product. The warranty period is not extended if Zilogic Systems repairs or replaces a warranted product or any parts. Zilogic Systems may change the availability of limited hardware warranties, at its discretion, but any changes will not be retroactive.

### 2.3. HARDWARE RETURN PROCEDURES

If a Hardware Product or one of its component parts does not function as warranted during the warranty period, and such nonconformance can be verified by Zilogic Systems, Zilogic Systems, at



its election, will provide either return and replacement service or replacement with a refurbished part/unit for the Hardware Product under the type of warranty service Zilogic Systems designates for that Hardware Product. A defective Hardware Product or one of its component parts may only be returned to Zilogic Systems upon Zilogic Systems' prior written approval. Any such approval shall reference an RMA number issued by an authorized Zilogic Systems service representative. If you do not register the Hardware Product with Zilogic Systems, you may be required to present proof of purchase as evidence of your entitlement to warranty service. The Hardware Product's serial number will be required for all RMA cases.

Transportation costs, if any, incurred in connection with the return of a defective item to Zilogic Systems shall be borne by You. Any transportation costs incurred in connection with the redelivery of a repaired or replacement item to You by Zilogic Systems shall be borne by Zilogic Systems; provided, however, that if Zilogic Systems determines, in its sole discretion, that the allegedly defective item is not covered by the terms and conditions of the warranty or that a warranty claim is made after the warranty period, the cost of the repair by Zilogic Systems, including all shipping expenses, shall be reimbursed by You.

## **2.4. HARDWARE REPLACEMENT PROCEDURES**

Zilogic Systems will attempt to diagnose and resolve your problem over the phone or e-mail. Upon determination of the hardware issue is related to a malfunction of one of the Hardware Product components, an RMA process will be initiated by Zilogic Systems.

For Warranty Replacement service, it is required that you deliver the faulty unit to a location Zilogic Systems designates, and provide courier name and tracking number to Zilogic Systems. After the Faulty unit is returned to Zilogic Systems, Zilogic Systems will use commercially reasonable efforts to ship the replacement hardware within fourteen (14) business days. Actual delivery times may vary depending on availability of the spares and customer's location.

## **2.5. ADDITIONAL RESPONSIBILITIES**

You agree:

- To provide Zilogic Systems or its partner with sufficient and safe access to your facilities to permit Zilogic Systems to fulfill its obligations.
- To ship back the faulty Hardware Product (or replaceable unit) suitably packaged, quoting the RMA number, to the Zilogic Systems designated location.
- You shall ship the faulty Hardware Product once Zilogic Systems approves the RMA and provide the courier name and tracking number.
- To securely erase from any Hardware Product you return to Zilogic Systems for any reason all programs and data not provided by Zilogic Systems with the Hardware Product. You acknowledge that in order to perform its responsibilities under this Limited Hardware Warranty, Zilogic Systems may ship all or part of the Hardware Product or its software to third party locations around the world, and you authorize Zilogic Systems to do so.

## **2.6. LIMITATION OF LIABILITY**

Zilogic Systems' development kits are not designed, authorized or warranted to be suitable for use in medical, military, aircraft, space or life support equipment, not in applications where failure or malfunction of a Zilogic Systems product can reasonably be expected to result in personal injury, death or severe property or environmental damage.

NOTWITHSTANDING ANYTHING ELSE IN THIS AGREEMENT OR OTHERWISE, NEITHER ZILOGIC SYSTEMS NOR ITS SUPPLIERS WILL BE LIABLE WITH RESPECT TO ANY SUBJECT MATTER OF THIS AGREEMENT UNDER ANY CONTRACT, NEGLIGENCE, STRICT LIABILITY, OR OTHER LEGAL

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