User Manual for

Micro-A748

V3.0

www.microembedded.in

Table of Contents.

1.0 Introduction.

1.1 Overview

Today we see a lot of new and amazing gadgets in the market. We see high end mobile phones, tablet PC, Netbook PC and state of the art electronic devices. It will amaze us that all these devices are using processors which are having ARM Microprocessor inside it. ARM microprocessor technology is the most efficient technology available today.

Micro-A748 Microcontroller Kit is specifically designed keeping in mind the needs of students, to understand and learn the architecture of the ARM 7 microprocessor.

The Micro-A748 kit has interfaced the ARM7 core based SOC (system on chip), to various peripherals on the board. Devices like LED's and LCD, I2C interface based memory devices, RTC, SD/MMC Card interface, Matrix Keypad, ADC, DAC, graphical LCD, Stepper motor, etc are also interfaced on the board.

ARM Controller.

The ARM Processor is a RISC (Reduced Instruction Set Computer) machine. The RISC instruction set is primarily known for smaller number of instructions and higher throughput at a lower power.

The ARM Architecture is characterized by the following;

1. A load-store architecture.
2. Fixed length 32 bit instructions in ARM Mode and 16 bit instructions in THUMB Mode.
3. 3 address instruction format.

There are several modes of operation. In each mode there are 16 registers that are accessible to the user programs. A Current Program Status Register (CPSR) is also available which contains all the mode bits and the interrupt bit and the condition bits. The modes allow the user program restricted access to certain resources of the processor.

Following are the modes in the ARM Processor.

- User Mode : This is the main operating mode for the processor. Program running in this mode can achieve isolation and protection for the resources.
- Fast Interrupt Processing Mode (FIQ): This mode is entered when the Fast interrupt is received. This is called a fast interrupt as it has a dedicated vector address from where the program can immediately execute without any latency.
- Normal Interrupt Processing mode (IRQ): Interrupt from other sources will make the processor enter this mode.
- Software Interrupt Mode: when the processor encounters a Software Interrupt Instruction this mode is entered. Software Interrupts are a standard way to enter the privileged mode from User Mode.
- Undefined Instruction mode: when a processor attempts to execute a instruction which neither its main core or the co-processor can execute then this mode is entered.
- System mode: Privileged operating system task can be run from this mode.
- Abort Mode: this mode is entered when a data fault is occurred.

The 3 Stage Pipeline.

There is a 3 stage pipeline in the ARM 7 processor.

1. Fetch : Fetch the instruction from memory.
2. Decode : Decode the instruction .
3. Execute.: Execute the instruction.

Due to the 3 stage pipeline the ARM processor is able to effectively execute 1 instruction for every clock cycle. Thus it has a very high throughput and performance.

The ARM Processor supports the following Data Types.

8 Bit signed and unsigned byte.

16 Bit signed and unsigned Half word aligned on 2 byte boundary.

32 bit signed and unsigned Word aligned on 4 byte boundary.

The ARM Processor supports both the BIG Endian and Little Endian Memory alignment.

2.7 Features

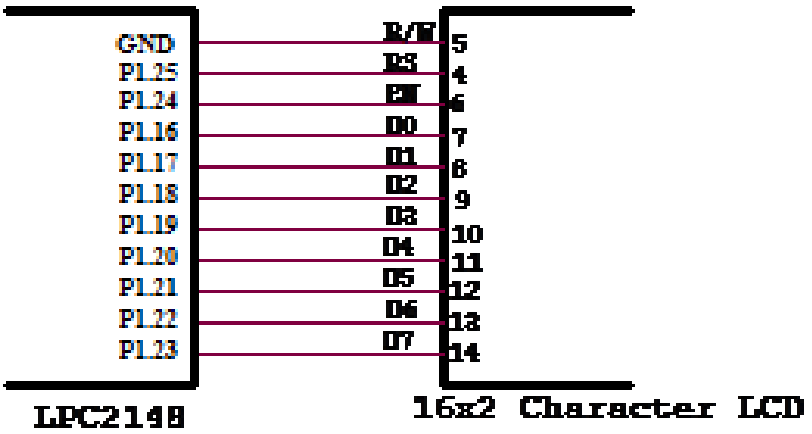
The Micro-A748 microcontroller board has been specifically designed keeping in mind the needs of students for learning the ARM architecture. The board gives a complete overview for interfacing various peripheral devices which are used in the industry and consumer devices alike. A hands-on with the board will develop in the student the experience to design and implement various devices and products based on the ARM Microcontroller.

Following are the features of the Micro-A748 Microcontroller board.

- LPC21xx microcontroller from NXP running at maximum 60 MHz.
- 12 Power Supply.
- Two UART's one with USB to serial and one with RS232 drivers.
- Connector for LCD Modules.
- 16 Key (4x4) Matrix Keypad.
- 8 general purpose LED's.
- RTC with I2C interface with power backup.
- EEPROM with I2C interface.
- SD/MMC card interface on SPI interface.
- 10 bit on Chip ADC interfaced to External voltage source.
- 10 Bit DAC.
- Stepper Motor and DC Motor Driver (L293D).
- Relay and Buzzer.
- Optional 128X64 graphical LCD Display module.

2.0 Hardware: Functional Description and Interfacing.

2.1 LCD.



2.1.1 Character LCD.

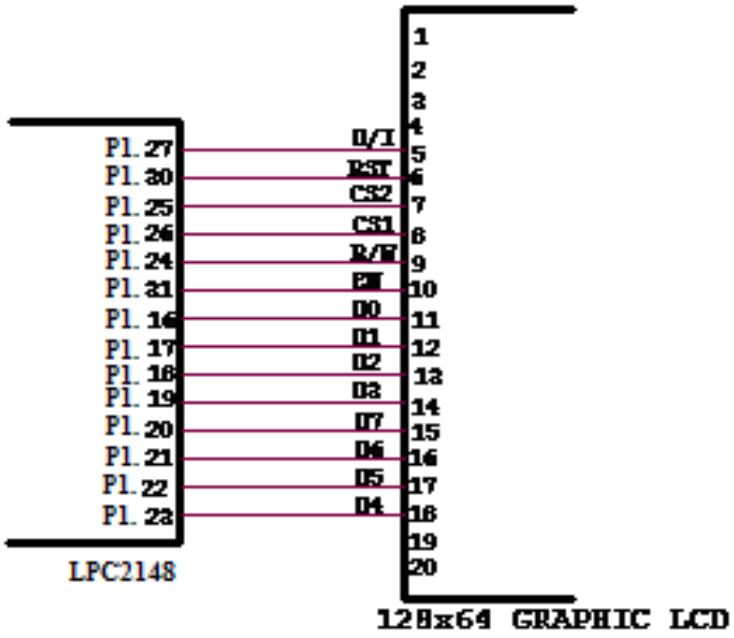
A 16x2 Character LCD module can be connected to over connector CN8 on the Micro-A748 board. The LCD is write only ie we cannot read from the LCD.

Note:Since pins are multiplexed on the board make sure to connect Jumper J1 in position 1-2 to use all LED's.

LCD interfacing details.

16x2 Character LCD	Pin Details		
	LPC2148	Processor Module	Description
D0	P1.16	74	LCD Data Bit 0
D1	P1.17	73	LCD Data Bit 1
D2	P1.18	72	LCD Data Bit 2
D3	P1.19	71	LCD Data Bit 3
D4	P1.20	70	LCD Data Bit 4
D5	P1.21	69	LCD Data Bit 5
D6	P1.22	46	LCD Data Bit 6
D7	P1.23	45	LCD Data Bit 7
EN	P1.24	42	LCD Enable Signal
RS	P1.25	41	LCD Register Select

2.1.2 Graphic LCD.

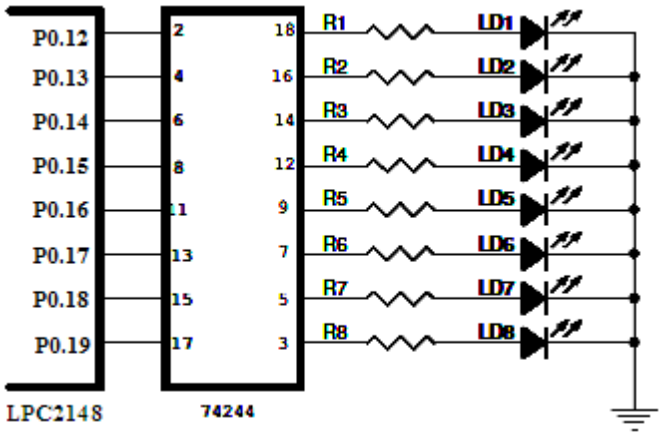


A 128x64 Graphic LCD module is interfaced on the Micro-A748 board on connector CN8. We can read and write data to the LCD module.

Graphic LCD interfacing details.

CN8	Graphical LCD	Pin Details		
		LPC2148	Processor Module	Description
11	D0	P1.16	74	GLCD Data Bit 0
12	D1	P1.17	73	GLCD Data Bit 1
13	D2	P1.18	72	GLCD Data Bit 2
14	D3	P1.19	71	GLCD Data Bit 3
18	D4	P1.20	70	GLCD Data Bit 4
17	D5	P1.21	69	GLCD Data Bit 5
16	D6	P1.22	46	GLCD Data Bit 6
15	D7	P1.23	45	GLCD Data Bit 7
6	RESET	P1.30	35	GLCD Reset
5	D/I	P1.27	38	Data / Instruction Signal
8	CS1	P1.26	40	GLCD Chip Select 1
7	CS2	P1.25	41	GLCD Chip Select 2
10	EN	P1.31	39	GLCD Enable Signal
9	R/W	P1.24	42	GLCD Read / Write
1, 3, 19	VCC	-	-	+5V
2, 4, 20	VSS	-	-	GND

2.2 Light Emitting Diodes (LED).



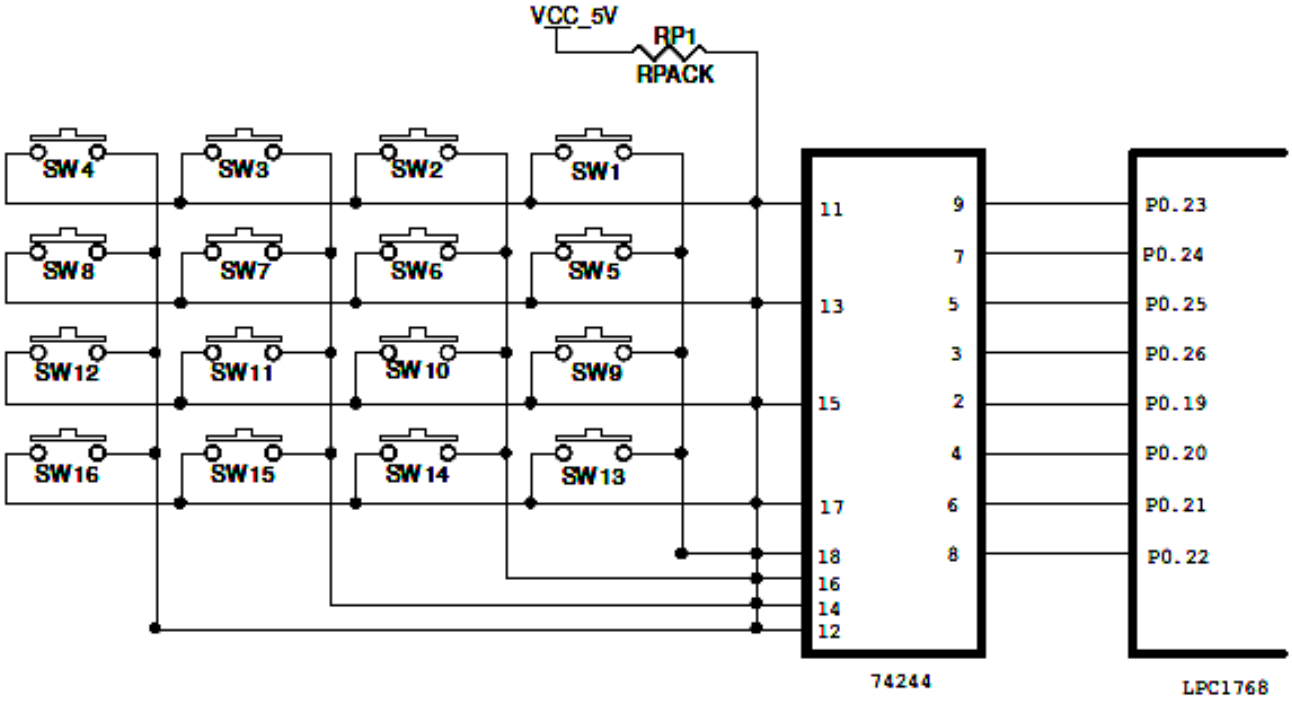
8 general purpose LED's are provided on the Micro-A748 Board in common anode configuration.LD1 thru LD8 are interface to Port Pins P0.12 thru P0.19.

In order to make the LED ON we have to give Logic "1" (HIGH).

LED interfacing details.

Pin Details		
LPC2148	**Processor Module**	**Description**
P0.12	67	LED 0
P0.13	66	LED 1
P0.14	65	LED 2
P0.15	64	LED 3
P0.16	63	LED 4
P0.17	62	LED 5
P0.18	61	LED 6
P0.19	60	LED 7

2.3 Keypad.



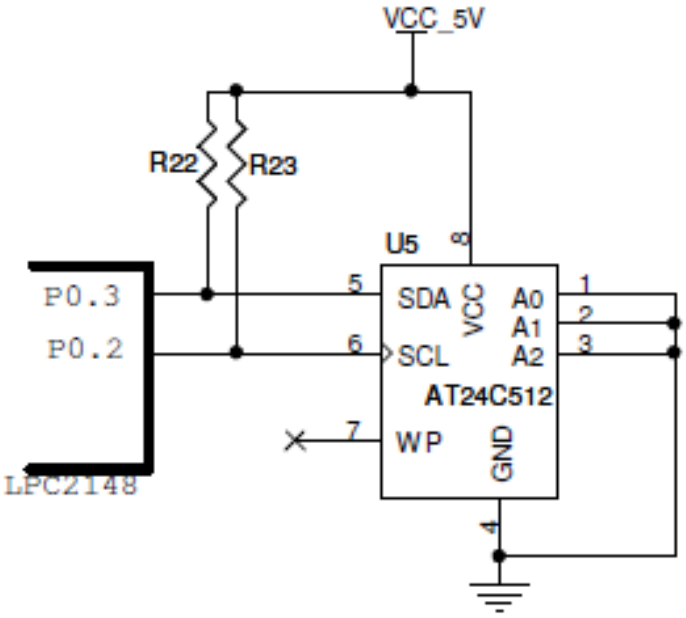
A 16 key Keypad in a 4x4 matrix circuit is provided on the Micro-A748 board. The Keypad is interfaced to the GPIO pins of the processor.

Note: Since pins are multiplexed on the board to use the keypad connect jumper J2 and Jumper J3 in position 1-2. Also close jumper J6 to enable the keypad functionality.

Keypad interfacing details.

Keypad	Pin Details		
	LPC2148	Processor Module	Description
COL 1	P0.4	55	Keypad COL 1 Signal
COL 2	P0.5	54	Keypad COL 2 Signal
COL 3	P0.6	53	Keypad COL 3 Signal
COL 4	P0.7	52	Keypad COL 4 Signal
ROW 1	P0.8	16	Keypad ROW 1 Signal
ROW 2	P0.9	15	Keypad ROW 2 Signal
ROW 3	P0.10	14	Keypad ROW 3 Signal
ROW 4	P0.11	13	Keypad ROW 4 Signal

2.4 I2C Interface (EEPROM).



The I2C interface from the processor has been brought out on the Micro-A748 board. The EEPROM (AT24Cxx) with I2C interface has been integrated on the board.

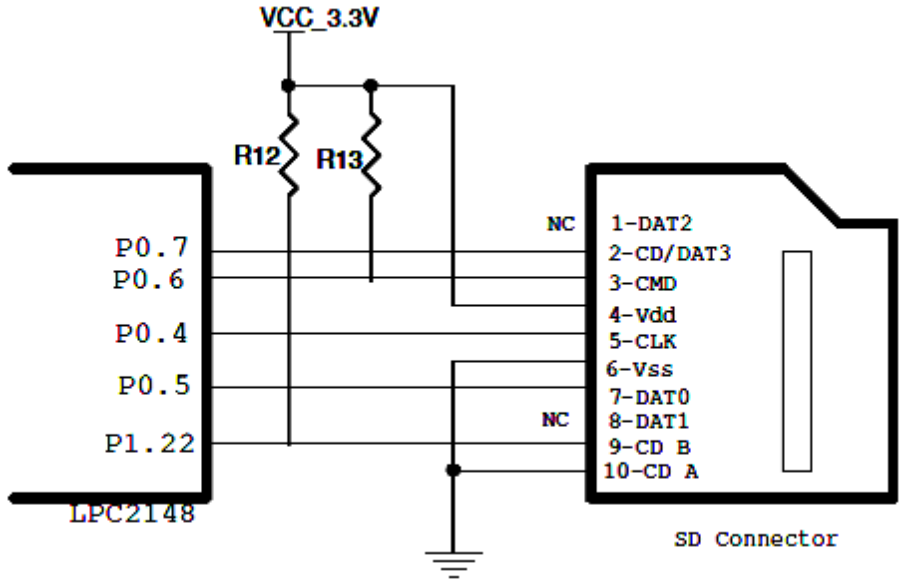
The Port pins have to be configured to work as I2C clock and Data lines.

I2C interfacing details.

I2C	Pin Details		
	LPC2148	**Processor Module**	**Description**
I2C0_SCL	P0.2	19	I2C Clock
I2C0_SDA	P0.3	20	I2C Data

2.5 SPI Interface.

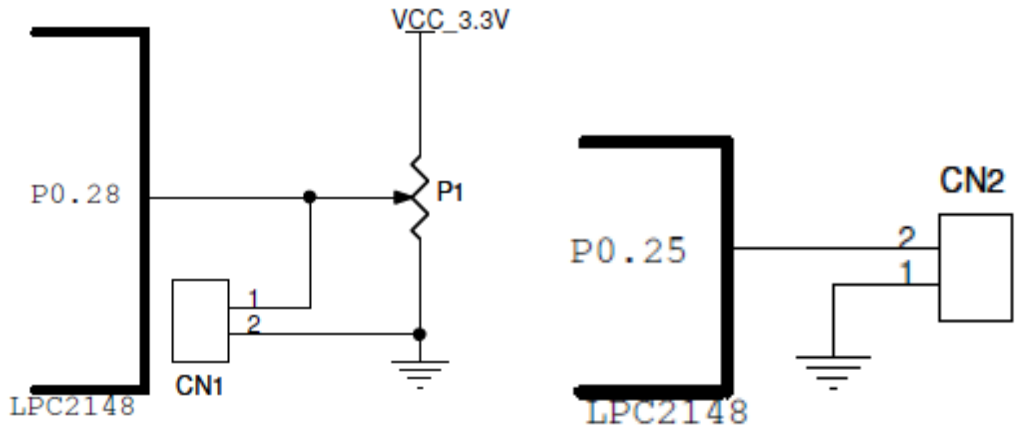
The SPI interface from the processor is available on the Micro-A748 board. Devices such as SPI based SD/MMC Card can be interfaced on the board using the SPI.



SPI interfacing details.

SD Card	Pin Details		
	LPC2148	Processor Module	Description
CLK (5)	P0.4	58	SD Card SPI Clock
CD/DAT3 (2)	P0.7	59	SD Card Chip Select
DAT 0 (7)	P0.5	57	SD Card SPI Data OUT (MISO)
CMD (3)	P0.6	56	SD Card SPI Data IN (MOSI)
CD (9)	P0.22	51	SD Card Card Detect

2.6 Analog to Digital Converter (ADC) and Digital to Analog Convertor (DAC).



The processor on the Micro-A748 contains a 10 bit ADC with 7 channels. The board has provided the user with one analog channel. Analog voltage is provided using potentiometers P1 . ADC0 peripheral is connected to this input. The Analog voltage can be measured at connector CN1.

The Processor on Micro-A748 contains a 10 bit Digital to Analog Convertor. The Output of this DAC is brought out on pin P0.25 on the board at connector CN2

ADC and DAC interfacing details.

Data Acquisition	Pin Details		
	LPC2148	Processor Module	Description
ADC	P0.28	50	ADC Input
DAC	P0.25	82	DAC output

2.7 RTC

The Micro-A748 board uses the internal RTC on the processor LPC2148. A crystal of 32.768 KHz is populated on the board. Backup power is provided by the lithium ion battery cell.

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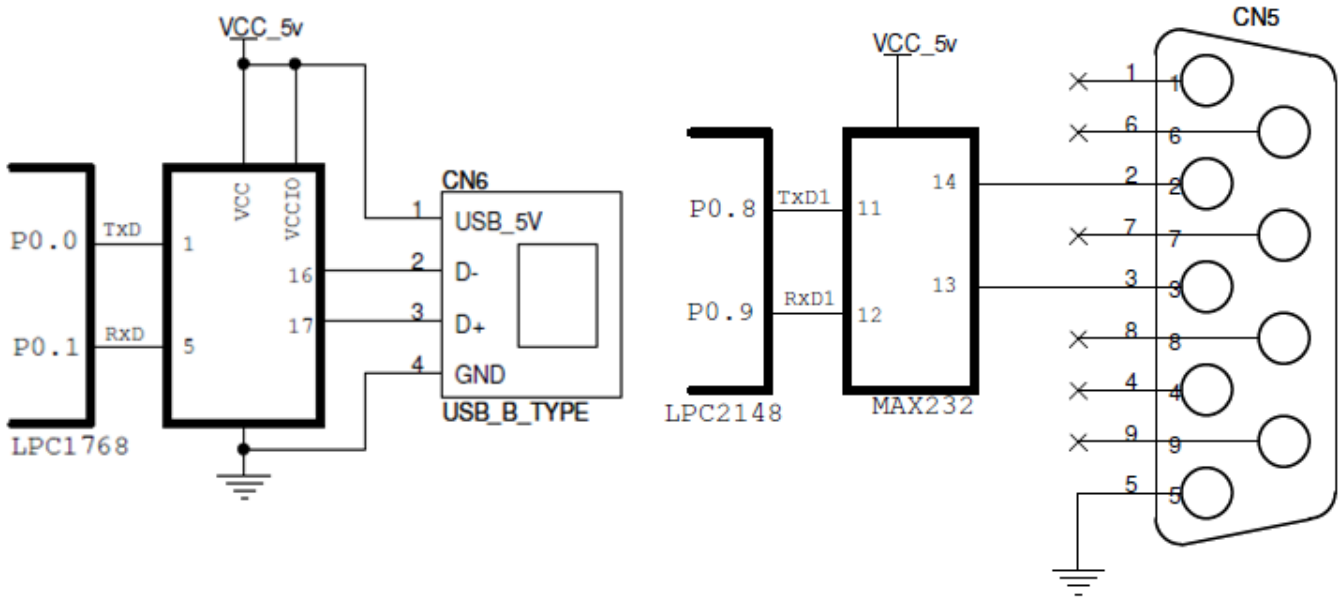
2.8 Serial Communication using UART.



Two UART interfaces from the processor are available for the user on the Micro-A748 board. UART0 is connected to USB to Serial and UART1 is connected to COM1 which is for RS232 interfacing.

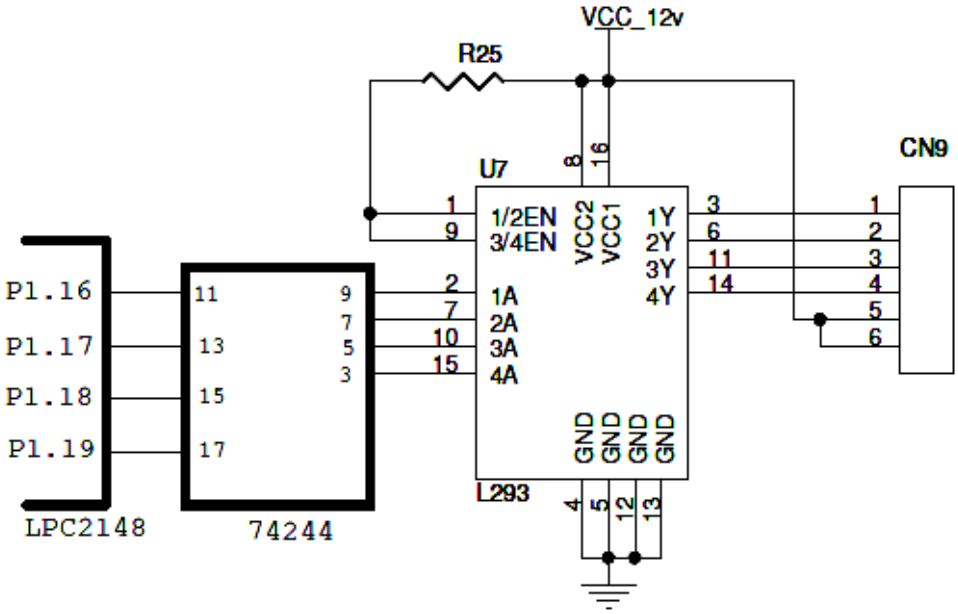
Note: Since pins are multiplexed on the board in order to use theUART1 functionality connect jumper J2 and jumper J3 in position 2-3.

UART interfacing details.

UART1 (COM1)	Pin Details		
	LPC2148	Processor Module	Description
RxD1	P0.9	15	UART1 Receive
TxD1	P0.8	16	UART1 Transmit

UART0 (USB-Serial)-DBGU	Pin Details		
	LPC2148	Processor Module	Description
RxD0	P0.1	86	UART0 Receive
TxD0	P0.0	85	UART0 Transmit

2.9 Stepper Motor and DC Motor.



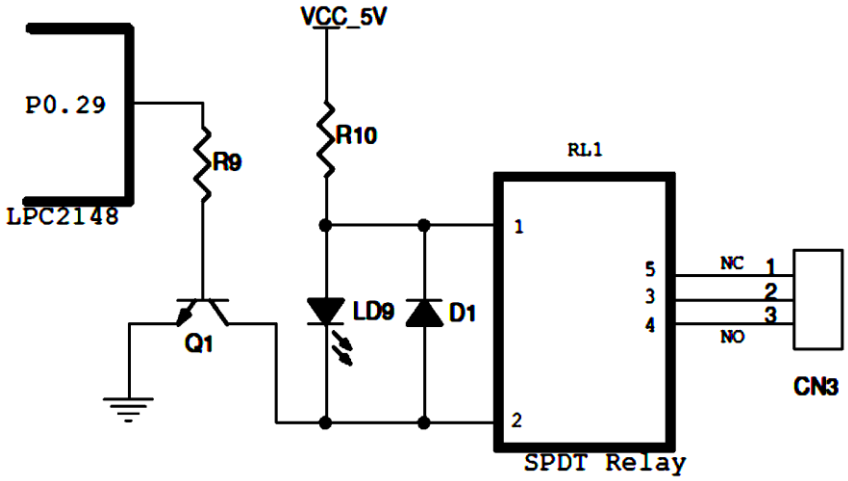
A stepper motor driver (L293D) is provided on the Micro-A748 board for the user. The user can connect the stepper motor to connector **CN9**.

Motor interfacing details.

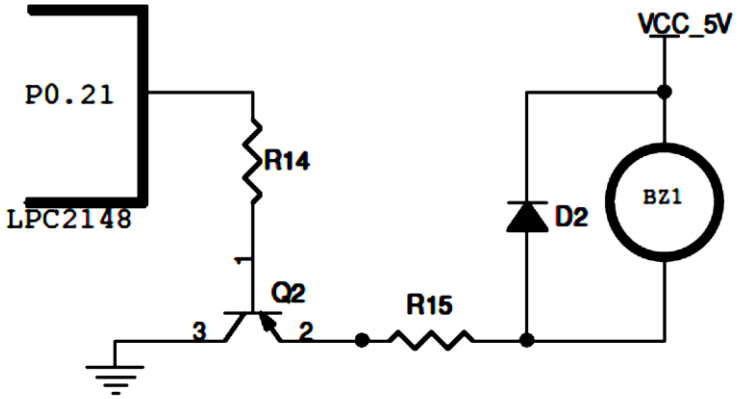
Stepper Motor	Pin Details		
	LPC2148	**Processor Module**	**Description**
STEP_MTR1	P1.16	32	Stepper/DC Motor
STEP_MTR2	P1.17	31	Stepper/DC Motor
STEP_MTR3	P1.18	30	Stepper/DC Motor
STEP_MTR4	P1.19	29	Stepper/DC Motor

2.11 Relay and Buzzer.

A general purpose relay is connected on the Micro-A748 board for the user to interface external high voltage devices to main or AC supply. The external devices /AC supply can be connected on connector CN3.



Buzzer:

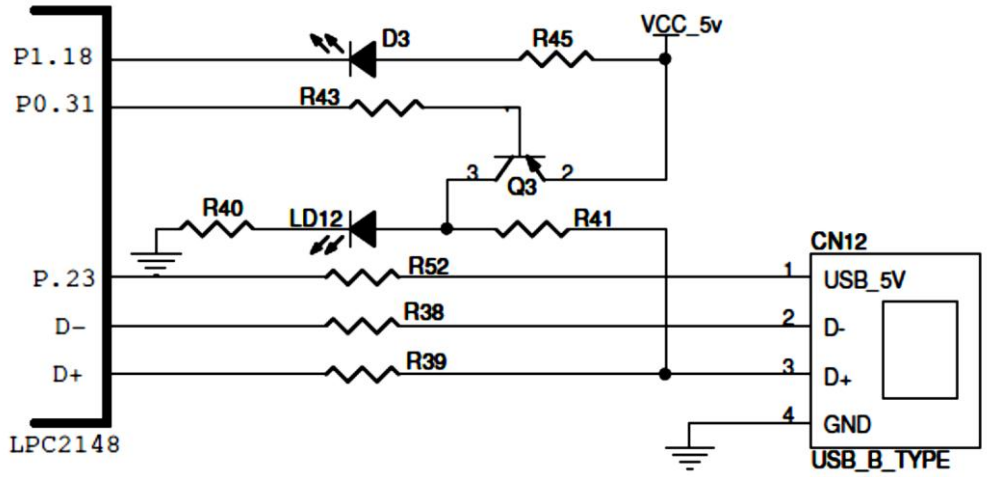


A general purpose buzzer is connected on the Micro-A748 board for indication purpose.

Relay and Buzzer interfacing details.

General	Pin Details		
	LPC2148	**Processor Module**	**Description**
Relay	P0.29	22	Relay Control Output
Buzzer	P0.21	21	Buzzer Control Output

2.12 USB Device Port.



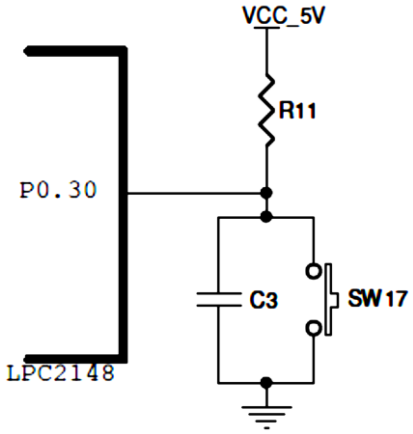
The processor on the Micro-A748 (LPC2148) has a on chip USB device controller and driver interface. The Micro-A748 has connected this interface to a USB device connector (USB-B type connector).

USB Device interfacing details.

USB	Pin Details		
	LPC2148	Processor Module	Description
VBUS	P0.23	18	USB Power Line
D+	D+ (10)	26	Data Bus +
D-	D- (11)	27	Data Bus -
USB_CONN	P0.31	23	USB Connected signal
UP_LED	P1.18	28	Link LED

2.13 External Interrupt Switch

The External Interrupt is generated using a switch SW17 connected to Pin P0.30 (INT3).



2.13 Port Extensions.

CN17 interfacing details.

CN17 Connector	Pin Details
	LPC2148
CN17.1	NC
CN17.2	NC
CN17.3	P0.0
CN17.4	P0.1
CN17.5	P1.16
CN17.6	P1.17
CN17.7	P1.18
CN17.8	P1.19
CN17.9	P1.20
CN17.10	P1.21
CN17.11	P1.22
CN17.12	P1.23
CN17.13	5 v
CN17.14	GND

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CN18 interfacing details.

CN18 Connector	Pin Details
	LPC2148
CN18.1	P0.7
CN18.2	P0.5
CN18.3	P0.6
CN18.4	P0.4
CN18.5	P0.5
CN18.6	P0.6
CN18.7	P0.7
CN18.8	P0.8
CN18.9	P0.9
CN18.10	P0.10
CN18.11	P0.11
CN18.12	P0.3
CN18.13	5 v
CN18.14	GND

CN19 interfacing details.

CN19 Connector	Pin Details
	LPC2148
CN19.1	NC
CN19.2	NC
CN19.3	P1.30
CN19.4	NC
CN19.5	NC
CN19.6	P1.27
CN19.7	P1.31
CN19.8	P1.26
CN19.9	P1.25
CN19.10	P1.24
CN19.11	VBUS
CN19.12	P0.28
CN19.13	5 v
CN19.14	GND

CN20 Connector Details.

CN20 Connector	Pin Details
	LPC2148
CN20.1	P0.30
CN20.2	NC
CN20.3	P0.14
CN20.4	P0.31
CN20.5	NC
CN20.6	P0.19
CN20.7	P0.18
CN20.8	P0.17
CN20.9	P0.16
CN20.10	P0.15
CN20.11	P0.14
CN20.12	P0.13
CN20.13	P0.12
CN20.14	3.3 V
CN20.15	P0.29
CN20.16	P0.21
CN20.17	NC
CN20.18	NC
CN20.19	5 V
CN20.20	GND

3.0 Software : Functional Description and Interfacing.

3.1 PC Connection Setup.

The Micro-A748 Board connects to the PC via the USB to Serial port. The Hex files generated by the IDE can be downloaded into the flash memory using the ISP feature on the microcontroller via the serial port. The Micro-A748 Board development kit has a serial port cable included in the package. Connect the female side of the connector to the PC and the male side to the Micro-A748 Board.

3.2 Creating a new Project In Keil IDE.

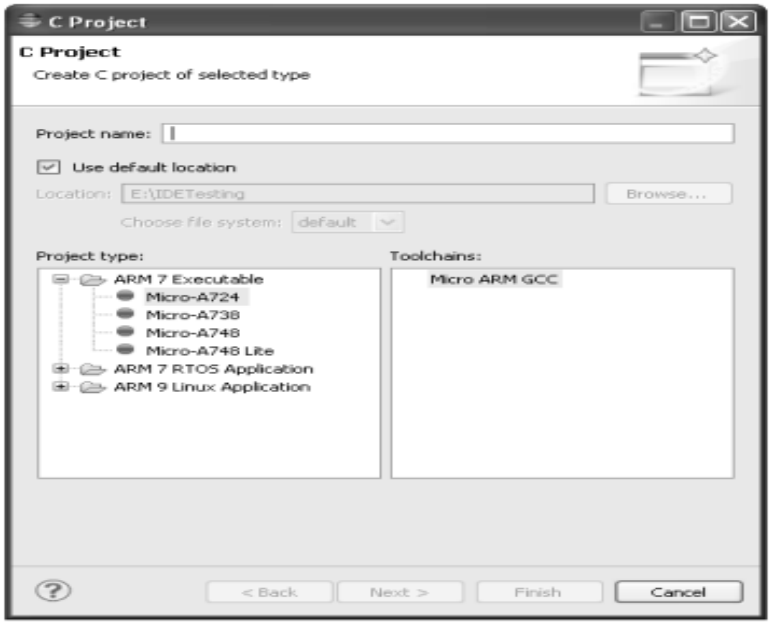
1. Start the Keil µVision 4.2 IDE.
2. Go to **Project Tab** and select **New µVision Project.**
    a. Create a New Folder and Store the Project and give a name.
    b. Select the Device as LPC2148 (under NXP).
    c. It will ask you to **"Copy NXP LPC2148 Startup Code to Project Folder and Add file to Folder"**, Click **Yes**.
3. Go to **File** tab and select **New**.
4. Go to **File** tab and click **Save As ->** save the file as **main.c.**
5. Start writing your code.
6. On the left corner, right click on **Source Group 1** -> **Add Files to Group "Source Group 1".**
7. Select the .c file and click **ADD.**
8. Go to **Project** -> **Options for Target 1** -> **Output** Tab -> Tick on **Create Hex File.**
9. Go to **Linker** Tab -> Tick on **Use Memory Layout From Target Dialogue.**
10. Go to **Project** -> **Build Target** to compile the code.

3.3 µC-Igniter Programming IDE.

Creating a new project.

- Go to the Project Tab.

- Click on New --->C Project.



- Enter the project name.
- Choose the appropriate board name.

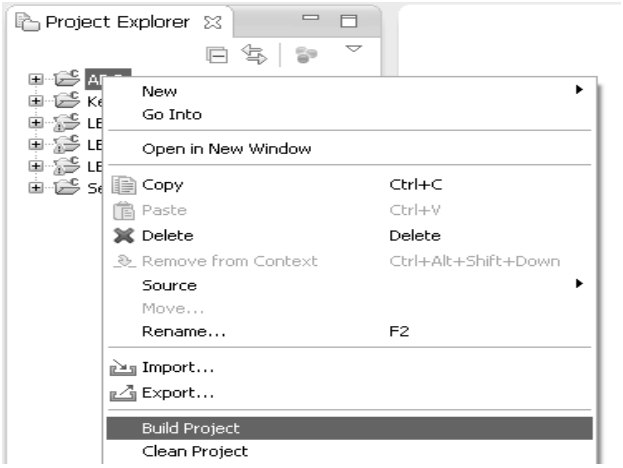
ARM 7 Executable for Standalone application for ARM7.

ARM 7 RTOS Application for RTOS applications on ARM7.

ARM9 Linux Application for Linux Programs on ARM9.

- Click Finish to complete.

Compiling the project

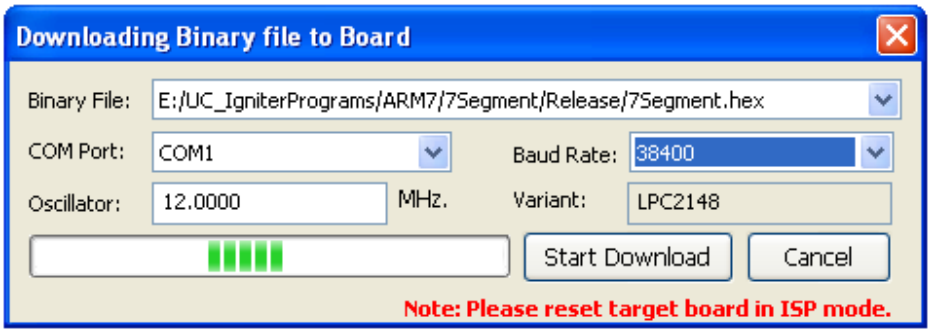


- Right Click on the Project and select **Build Project.** After successful Build a **.hex** file will be generated in the Release folder.

Downloading the hex file on the board.

ARM7 based processors.

- Right Click on the Project and Click on **Download on Target.**

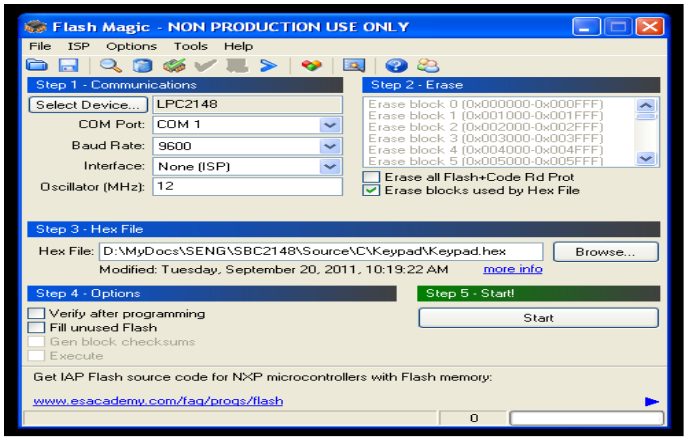


Put the RUN/ISP switch on ISP Mode and press reset Switch.

- Click on Start Download.
- The hex file will get downloaded successfully.

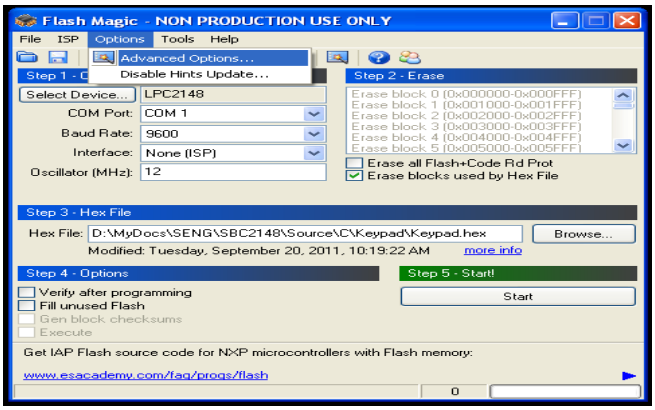
3.4 Executable Flashing Tool (FlashMagic).

Flash Magic Software is used to program the microcontroller on the Micro-A748 Board.



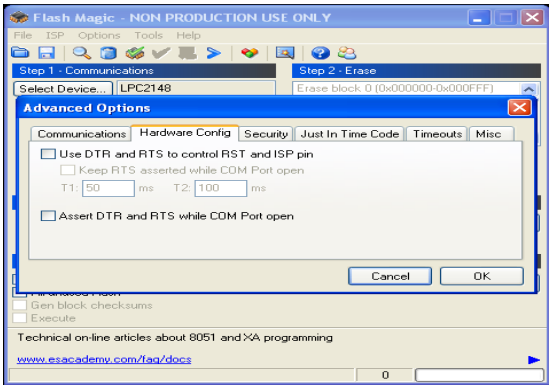
The following setting are to be done to correctly use Flash Magic with Micro-A748 board.

- Select Device as LPC2148.
- Select the correct COM Port. (Port on PC over which serial cable is connected).
- Set baud Rate to 9600.
- Interface: None.
- Oscillator: 12 MHz.
- **Check the box: Erase Blocks Used By hex File.**
  Note: Do not select: Erase all Flash + Code Rd Prot.



Hardware Settings for Flash Magic.

- Select Options tab.



- Select Hardware Config and uncheck USE DTR and RTS to control RST and ISP Pin.

1. **Flashing the Micro-A748 Board**.

Following are the steps to be done while programming the HEX file to the microcontroller Flash Memory.

Power “ON” the board using the ON/OFF Switch.

- Set the RUN/ISP switch to ISP Mode.
- Start Flash Magic and select the Hex file to be downloaded.
- Press the Reset button of the board.
- Press Start button on Flash Magic.
- Check if the program is downloaded.
- Set the RUN/ISP Switch to RUN Mode.
- Press the Reset Button on the board to start the program in the microcontroller.