

LABORATORY MANUAL

18CSL48 - MICROCONTROLLER AND EMBEDDED SYSTEMS LABORATORY

2019-20



DEPARTMENT OF INFORMATION SCIENCE & ENGINEERING
ATRIA INSTITUTE OF TECHNOLOGY
Adjacent to Bangalore Baptist Hospital
Hebbal, Bengaluru-560024

SYLLABUS**MICROCONTROLLER AND EMBEDDED SYSTEMS LABORATORY****SEMESTER – IV****Subject Code 18CSL48****IA Marks 40****Exam Marks 60****Exam Hours 03****Course Learning Objectives: This course (18CSL48) will enable students to:**

- Develop and test Program using ARM7TDMI/LPC2148
- Conduct the experiments on an ARM7TDMI/LPC2148 evaluation board using evaluation version of Embedded 'C' & Keil Uvision-4 tool/compiler.

Programs List:**PART A**

Conduct the following experiments by writing program using ARM7TDMI/LPC2148 using an evaluation board/simulator and the required software tool.

1. Write a program to multiply two 16 bit binary numbers.
2. Write a program to find the sum of first 10 integer numbers.
3. Write a program to find factorial of a number.
4. Write a program to add an array of 16 bit numbers and store the 32 bit result in internal RAM
5. Write a program to find the square of a number (1 to 10) using look-up table.
6. Write a program to find the largest/smallest number in an array of 32 numbers .
7. Write a program to arrange a series of 32 bit numbers in ascending/descending order.
8. Write a program to count the number of ones and zeros in two consecutive memory locations.

PART –B

Conduct the following experiments on an ARM7TDMI/LPC2148 evaluation board using evaluation version of Embedded 'C' & Keil Uvision-4 tool/compiler.

9. Display “Hello World” message using Internal UART.
10. Interface and Control a DC Motor.
11. Interface a Stepper motor and rotate it in clockwise and anti-clockwise direction.
12. Determine Digital output for a given Analog input using Internal ADC of ARM controller.
13. Interface a DAC and generate Triangular and Square waveforms.
14. Interface a 4x4 keyboard and display the key code on an LCD.
15. Demonstrate the use of an external interrupt to toggle an LED On/Off.
16. Display the Hex digits 0 to F on a 7-segment LED interface, with an appropriate delay in between

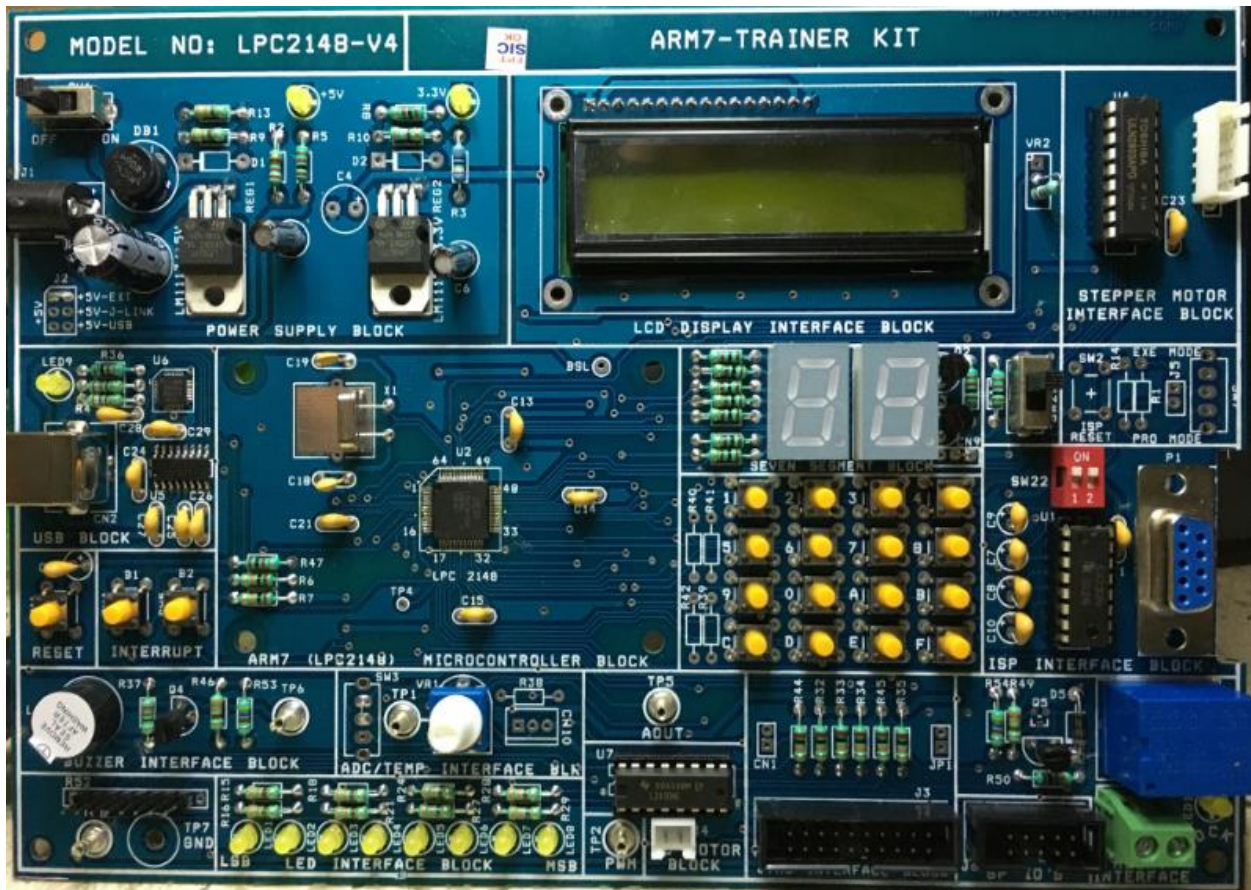
Laboratory Outcomes: The student should be able to:

- Develop and test program using ARM7TDMI/LPC2148
- Conduct the following experiments on an ARM7TDMI/LPC2148 evaluation board using evaluation version of Embedded 'C' & Keil Uvision-4 tool/compiler.

Conduct of Practical Examination:

- Experiment distribution o For laboratories having only one part: Students are allowed to pick one experiment from the lot with equal opportunity. o For laboratories having PART A and PART B: Students are allowed to pick one experiment from PART A and one experiment from PART B, with equal opportunity.
- Change of experiment is allowed only once and marks allotted for procedure to be made zero of the changed part only.
- Marks Distribution (Courseed to change in accordance with university regulations) g) For laboratories having only one part – Procedure + Execution + Viva-Voce: $15+70+15 = 100$ Marks h) For laboratories having PART A and PART B i. Part A – Procedure + Execution + Viva = $6 + 28 + 6 = 40$ Marks ii. Part B – Procedure + Execution + Viva = $9 + 42 + 9 = 60$ Marks

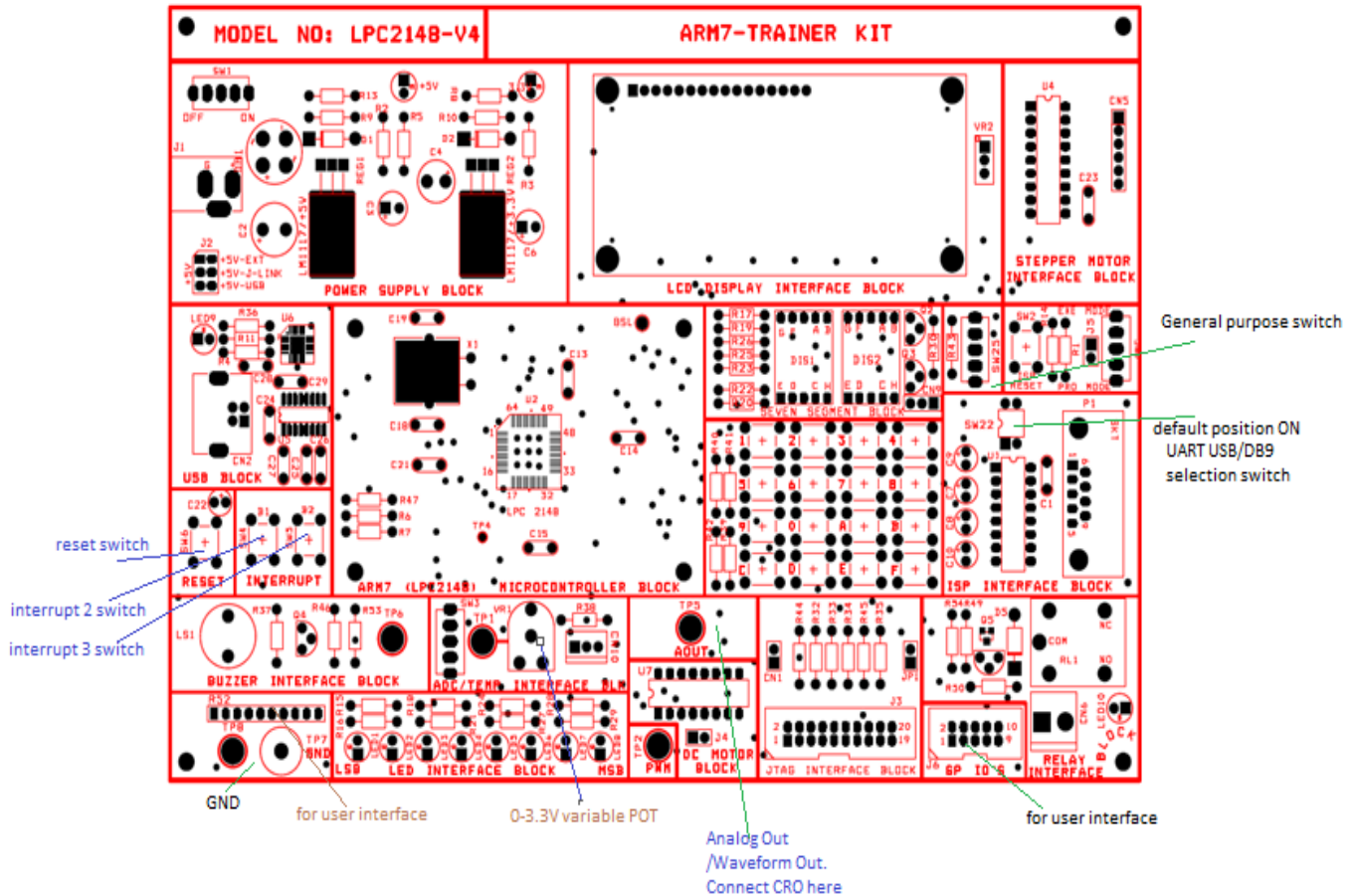
LPC2148 ARM 7 Development Board



Introduction

Thank you for buying **ARM 7 development KIT** based on Philips ARM7TDMI LPC2148 microcontroller. This document is a User's Guide that describes the **ARM 7 (LPC2148) development KIT** hardware design and some basic software interface principles with the Hardware

LPC2148 ARM 7 Laboratory system is a methodology to impart the micro processor concepts through a practical approach. It aims at bridging the gap between the theoretical knowledge and the practical scenario. In the process, the entire structure has been broken down to simpler concepts and takes a guided approach to the complex concepts and development process.



ARM 7 Development Kit Features

ARM7 (LPC2148) STARTER-KIT with Philips ARM7TDMI LPC2148 microcontroller lets you get up-and-running quickly. The small form factor board offers many unique features that ease your learning curve and program development.

ARM LPC2148

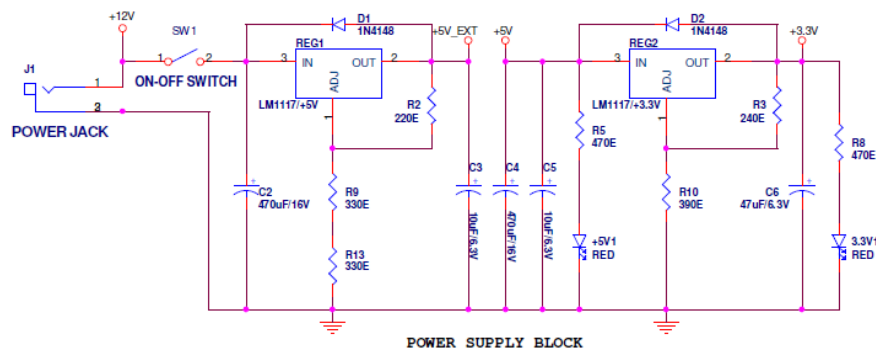
- 16/32-bit ARM7TDMI-S microcontroller in a tiny LQFP64 package.
- 40 kB of on-chip static RAM and 512 kB of on-chip flash program memory.
- USB 2.0 Full Speed compliant Device Controller with 2 kB of endpoint RAM.

- In addition, 8 kB of on-chip RAM accessible to USB by DMA.
- Two 10-bit A/D, with conversion times as low as 2.44 μ s per channel.
- Single 10-bit D/A converter provide variable analog output.
- Two 32-bit timers/external event counters and watchdog.
- Low power real-time clock with independent power and dedicated 32 kHz clock input.
- Multiple serial interfaces including two UARTs (16C550), two Fast I2C-bus (400 kbit/s), SPI and SSP with buffering and variable data length capabilities.
- Vectored interrupt controller with configurable priorities and vector addresses.
- 60 MHz maximum CPU clock available from programmable on-chip PLL with settling time of 100 μ s.
- Up to 45 of 5 V tolerant fast general purpose I/O pins in a tiny LQFP64 package.
- 2 x 16 Character LCD Display.
- Standard JTAG connector with ARM 2x10 pin layout for programming/debugging with H-JTAG
- USB connector, USB link LED
- RS232 Connector.
- LM35 temperature sensor connected to ADC
- On board voltage regulator 3.3V with up to 800mA current.
- Single power supply: 12V DC.
- Power supply LED.
- Power supply filtering capacitor.
- RESET button
- 12 MHz crystal.

ARM 7 Development board components and features

1 POWER SUPPLY

The way of applying power to the ARM7 STARTER- KIT:



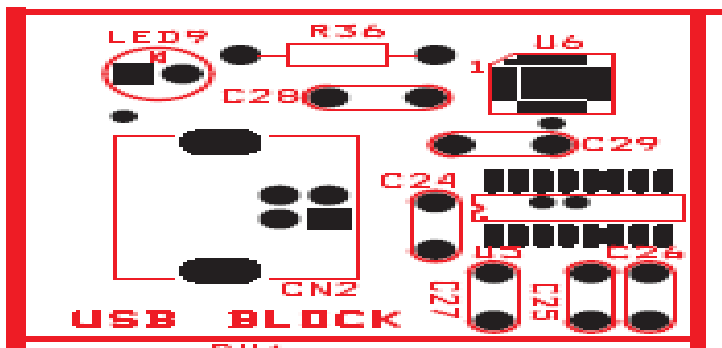
- First method applies DC power supply (+12V) from the lab power supply to **J1** jack

2 CPU

The NXP LPC2148 provided with the Starter- KIT is a high-end device with advanced ADC and DAC features, USB 2.0 Full Speed interface, PWM features, have SPI, SSP and two I2C interfaces. A 12 MHz crystal provides the clock signal to the microcontroller. This crystal is used for develop USB applications. The maximum execution speed is $12.000 * 5 = 60$ MHz.

The crystal frequency may be changed to any desired value. The board also contains a 32.768 kHz crystal that is used by the on-chip real-time clock, and +3V backup battery for save time register values in power down mode.

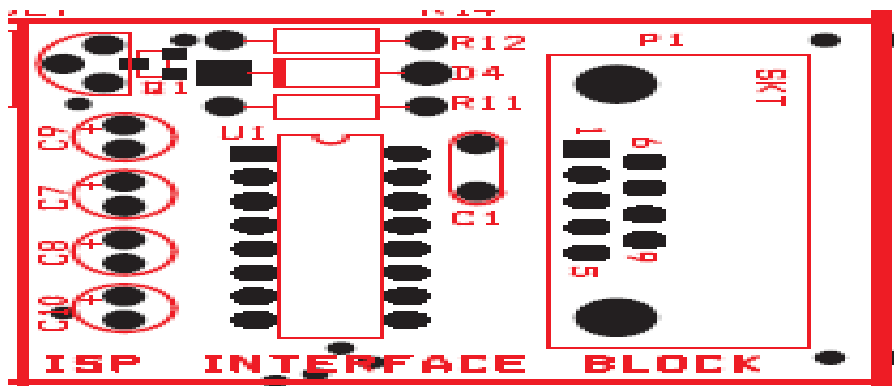
3 USB COMMUNICATION



LPC2148 Starter- KIT support USB 2.0 12 Mbit Full Speed function. USB D+ and D- are connected to CP2102 USB Bridge driver which allows Downloading hex file directly from USB interface. The **LED 9** yellow led will fire, when device configured and connected to the USB Bus. Standard USB B connector used for connect board to the PC Host.

4 SERIAL COMMUNICATION

On board RS232 serial port is connected to the UART1 of the microcontroller, which may be used to interface the target ARM board with host PC/any serial terminal for serial data acquisition? Level transition buffer MAX3232 has been used to make RS232 TTL compatible.

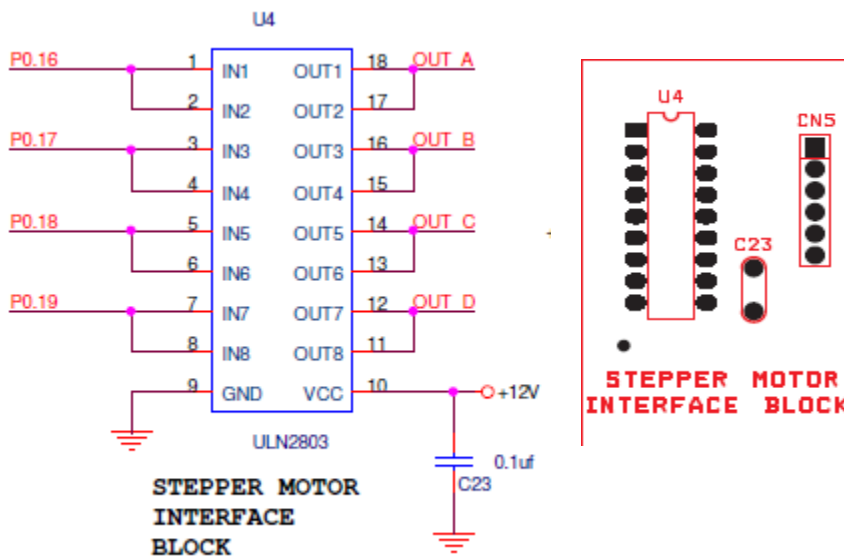


5. LCD Display

DB7	P0.13
DB6	P0.12
DB5	P0.11
DB4	P0.10
DB3	P0.09
DB2	P0.08
DB1	P0.07
DB0	P0.06
E	P0.28
R/W	P0.29
RS	P0.22

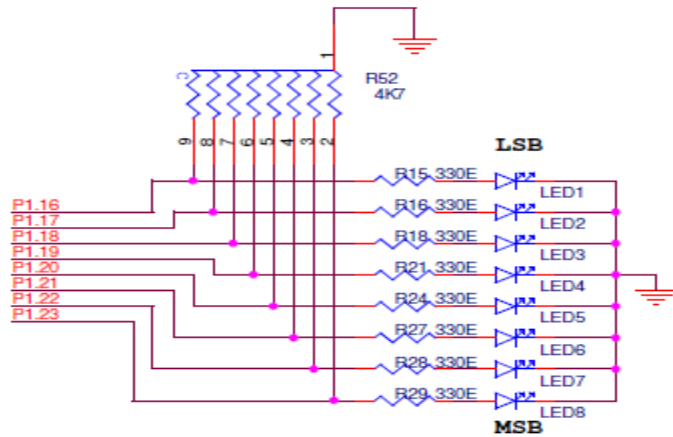
6 STEPPER MOTOR INTERFACE

Connect the Stepper motor which is supplied with the kit to CN5

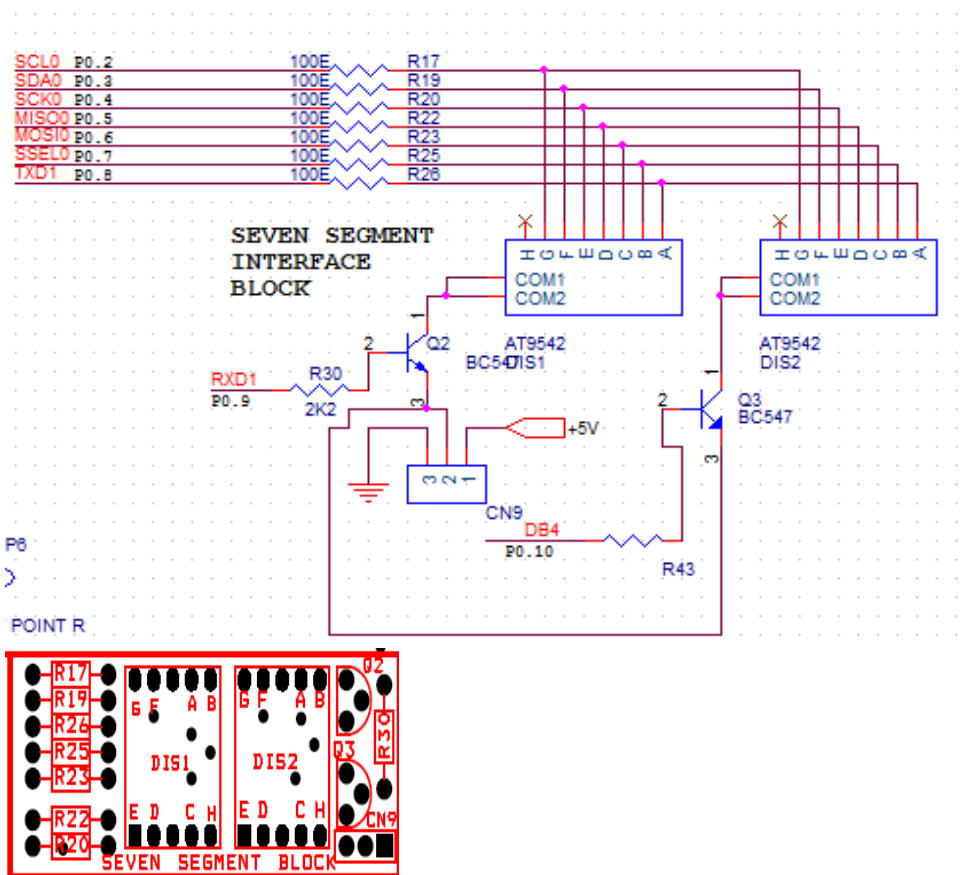


7. LED INTERFACE

8 LED s are connected to P1.16 to P1.23

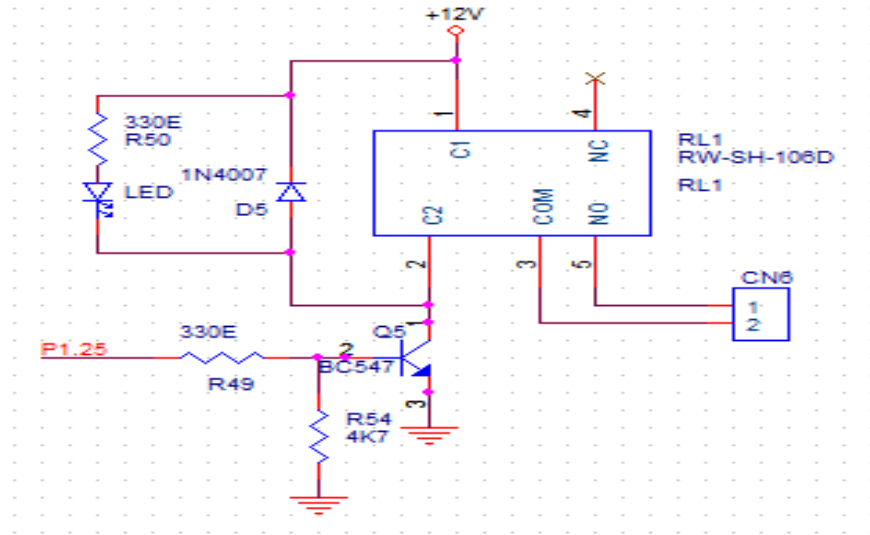


8. 7 SEGMENT DISPLAY



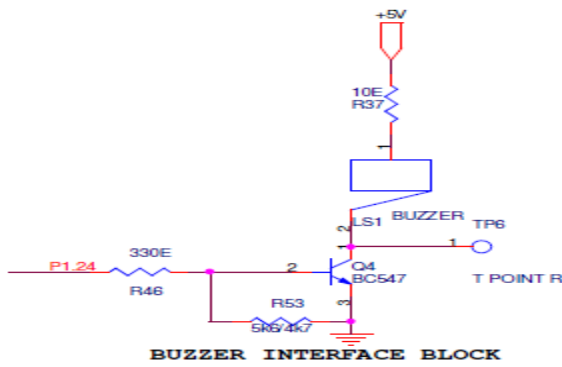
9. RELAY INTERFACE

Relay control pin connected to P1.25



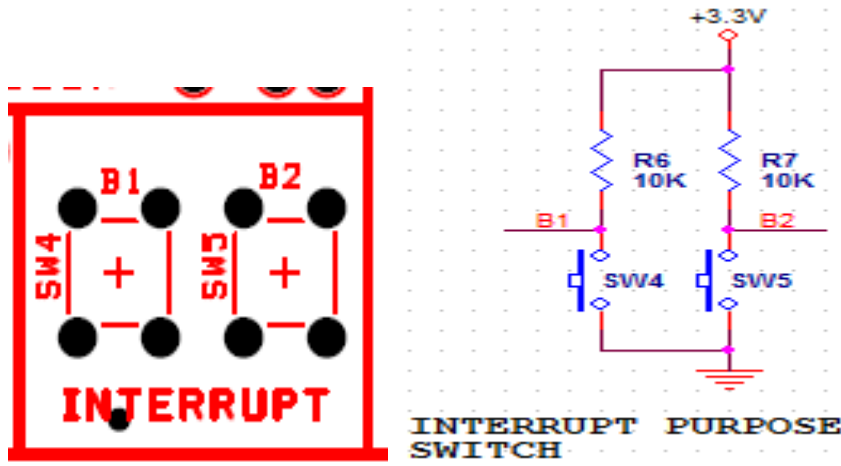
10. BUZZER INTERFACE

Buzzer control pin is connected to P1.24



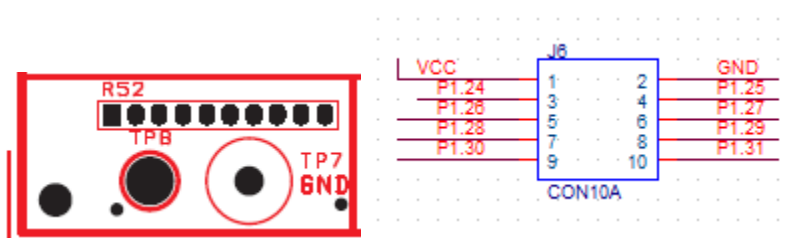
11. EXTERNAL INTERRUPT SWITCHES

There are two external interrupt switches connected to P0.15 and P0.20



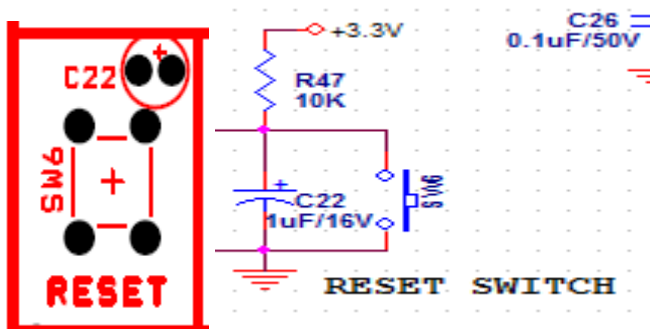
12. GENERAL PURPOSE PINOUT AND GND PINOUT

There are 8 general purpose pin outs connected to P1.16 to P1.23 and GND for ground reference. And 10 pin FRC connector connected to pin no P1.24 to P1.31



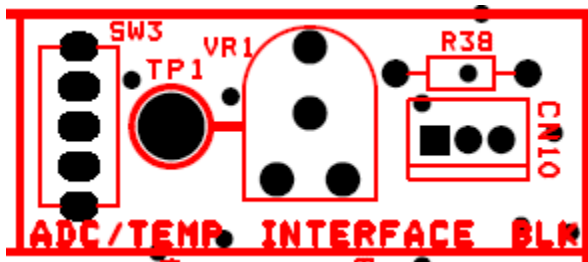
13. RESET SWITCH

This is used to reset the executable program.



14. ADC block

LM35 temperature sensor is directly connected to AD0.3 port P0.30.



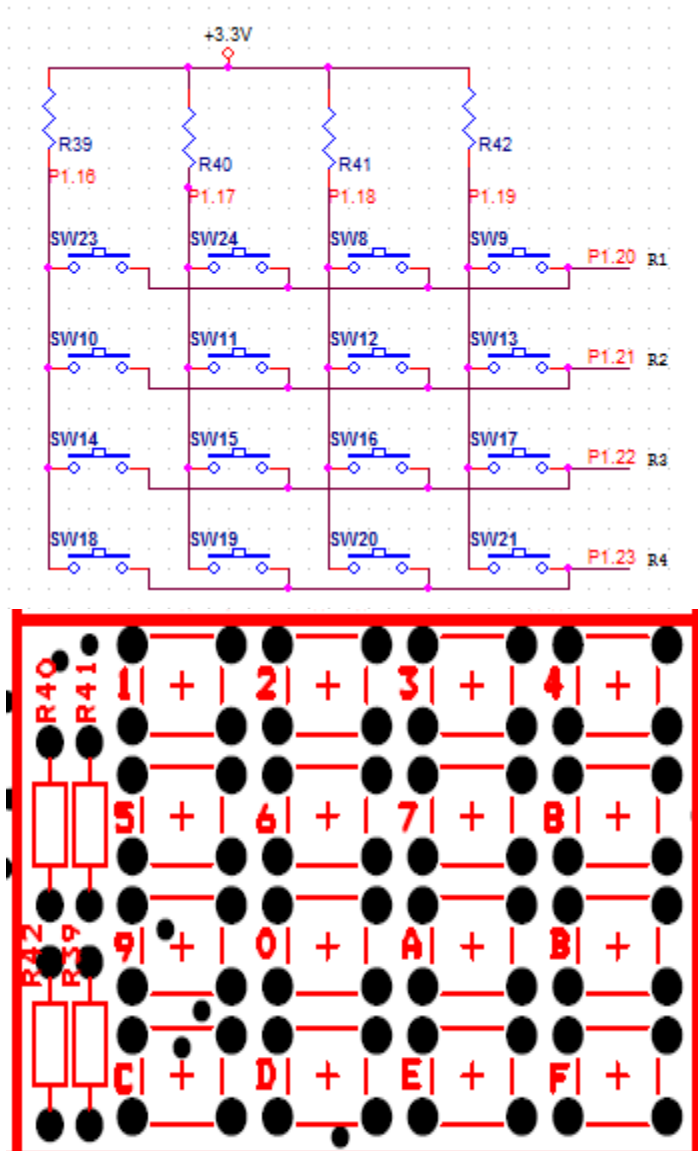
15. DAC block

Analog Out pin is connected to P0.25. Here you can see the generated waveform using CRO probe connected to TP5 test point and Gnd pin.



16. 4x4 matrix keypad

16 keys are connected as follows



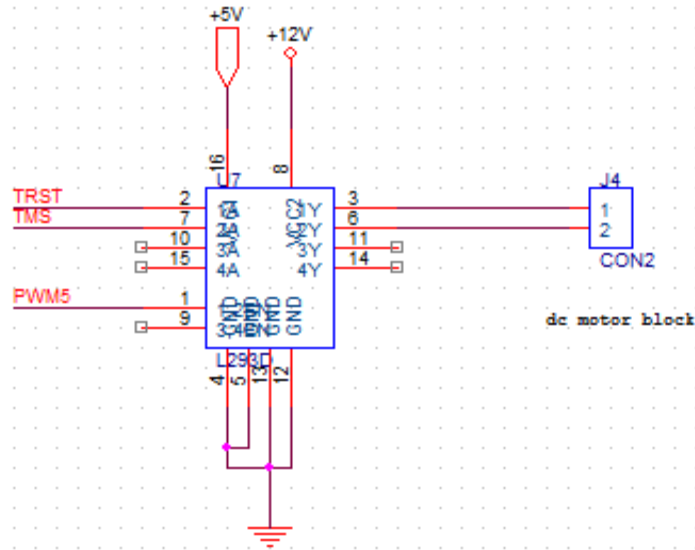
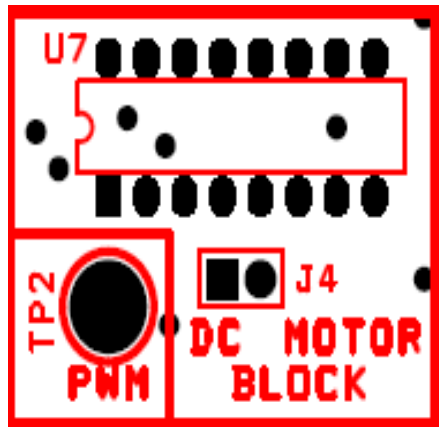
17. DC motor interface block

Connect supplied DC motor to J4 connector

This DC motor controller block is equipped with L293D H bridge driver for Both speed and direction control

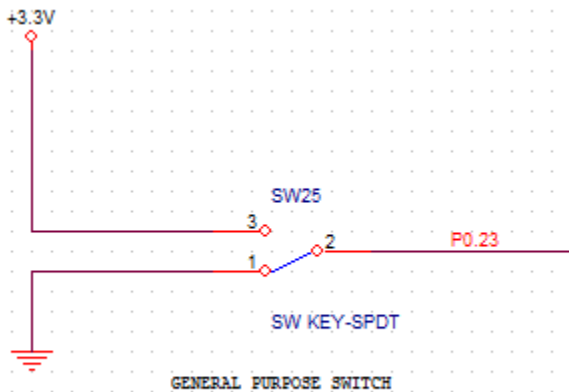
PWM5 is connected to enable pin P0.21. Different PWM signal will control the speed.

TMS=P1.30, TRST=P1.31. For motor rotation any one pin should be High and at the same time another should be Low. Make it Vice versa for reverse rotation



18. General purpose switch

This is connected to P0.23



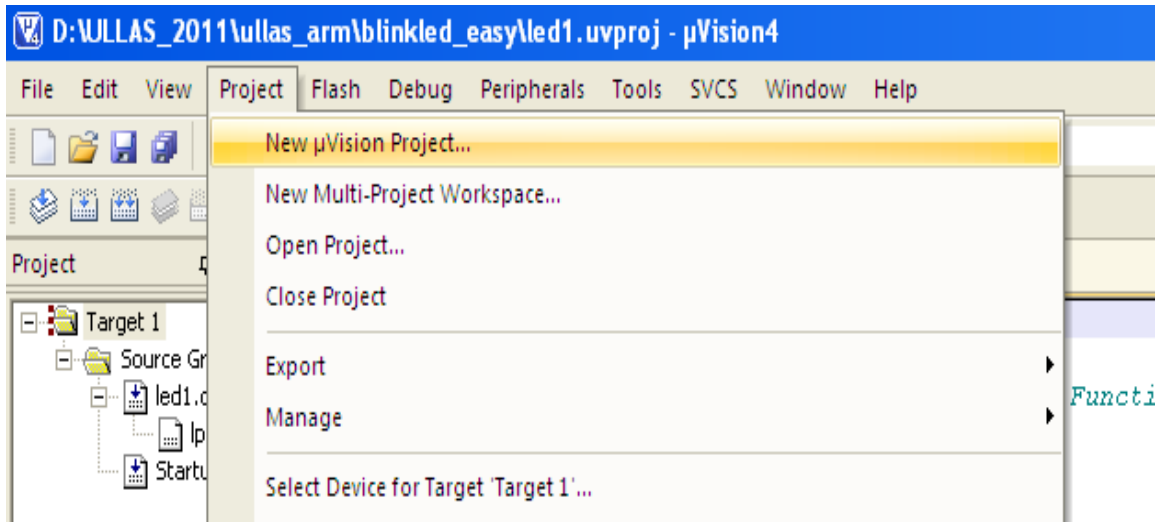
You can use this switch for any general purpose like Stepper /DC motor direction change, Toggling LED etc.

Creating Project in KEIL and Generating HEX file

The UE-ARM7-SK kit is compatible with many commercial and open

source tools. The kit comes along with a evaluation version of KEIL IDE with 32K Code limit. This limit is sufficient enough for the experiments to be conducted. The installer for the same is provided in the CD that comes along with the kit. Follow the simple steps as requested by the installer. The following section explains how to create a KEIL project for the experiments. We will create a example project which will blink the LEDs on the kit. The section assumes that you already have the necessary ‘.c’ and ‘.h’ files required for the project in a specified folder

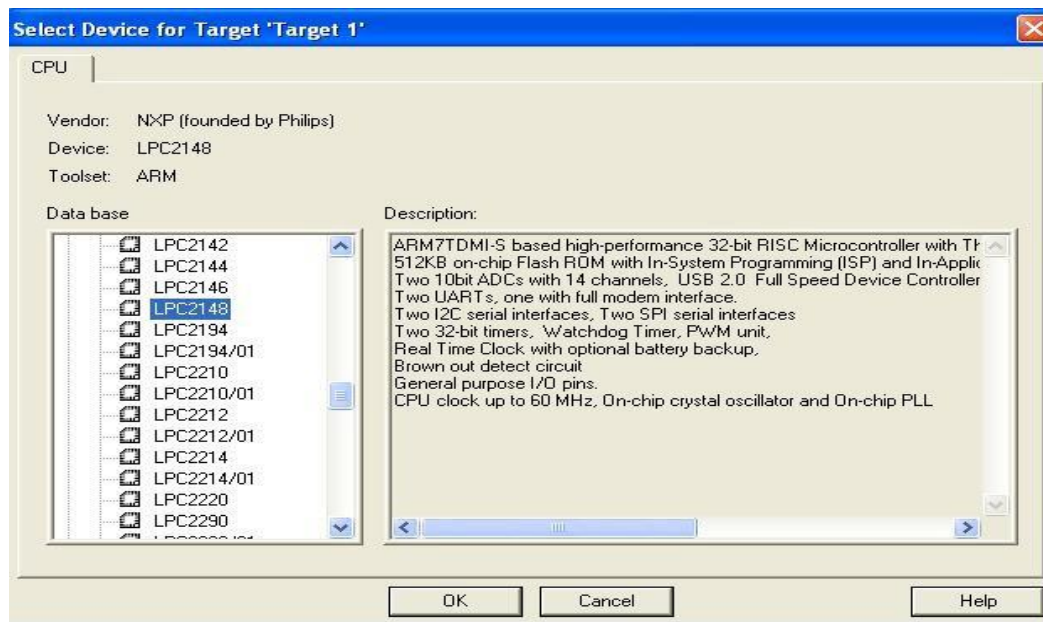
Run the KEIL IDE and go the



2. Lets give the project a name and save it as shown below



3. Select the CPU target as LPC2148 under the option of NXP in the list



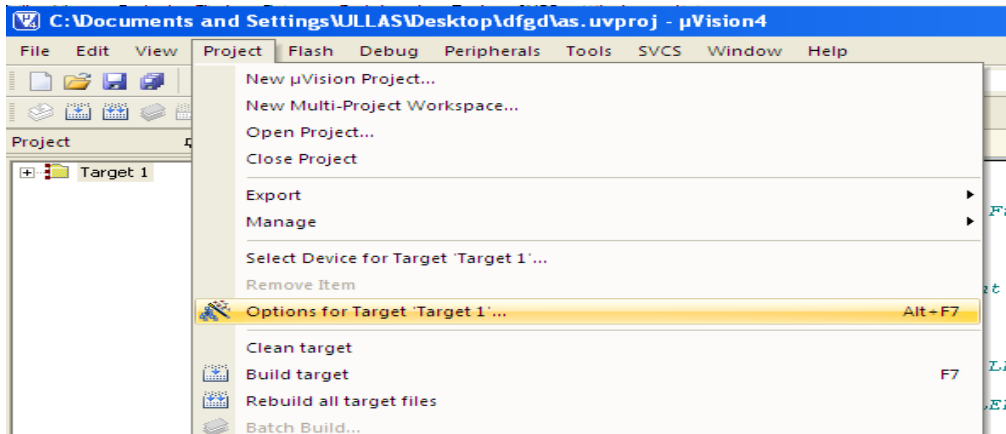
4. Next click YES option in the pop-up window



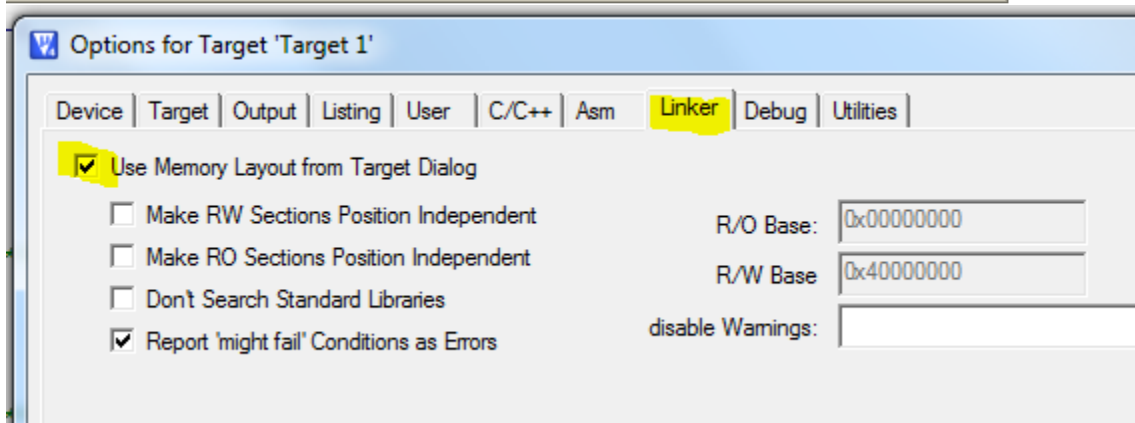
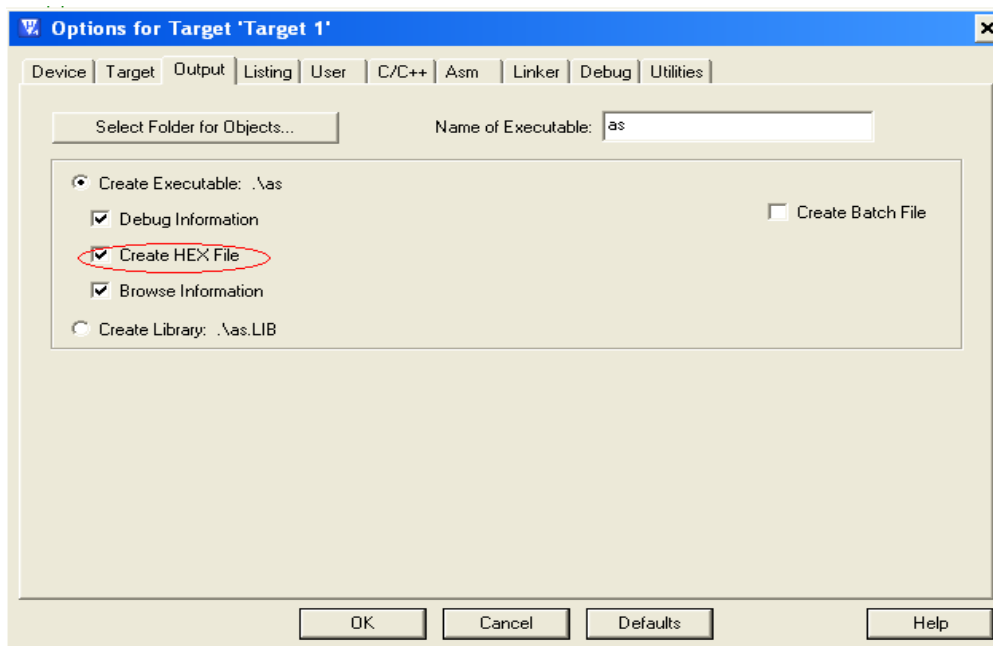
5. Go to file and select new. In that edit the code and click on save.

6. Give the file name as blink_led.c

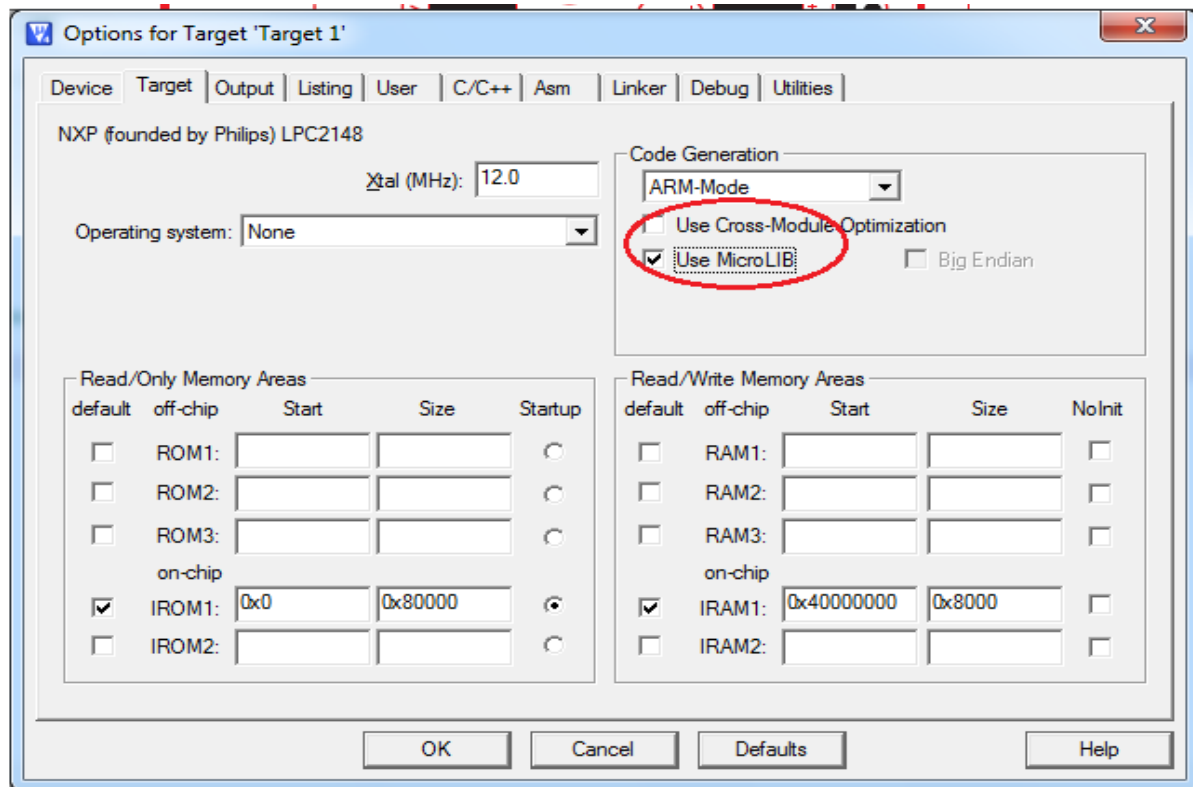
7. Goto project in that click on option as shown below.



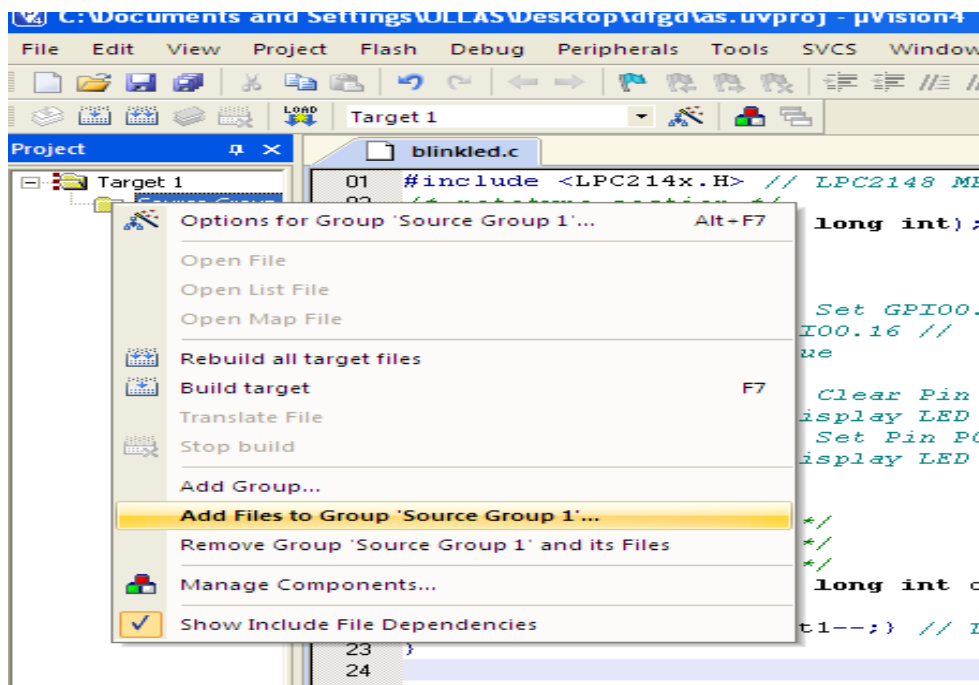
8. In option click on output and mark create hex file as shown below. And go to linker make below changes



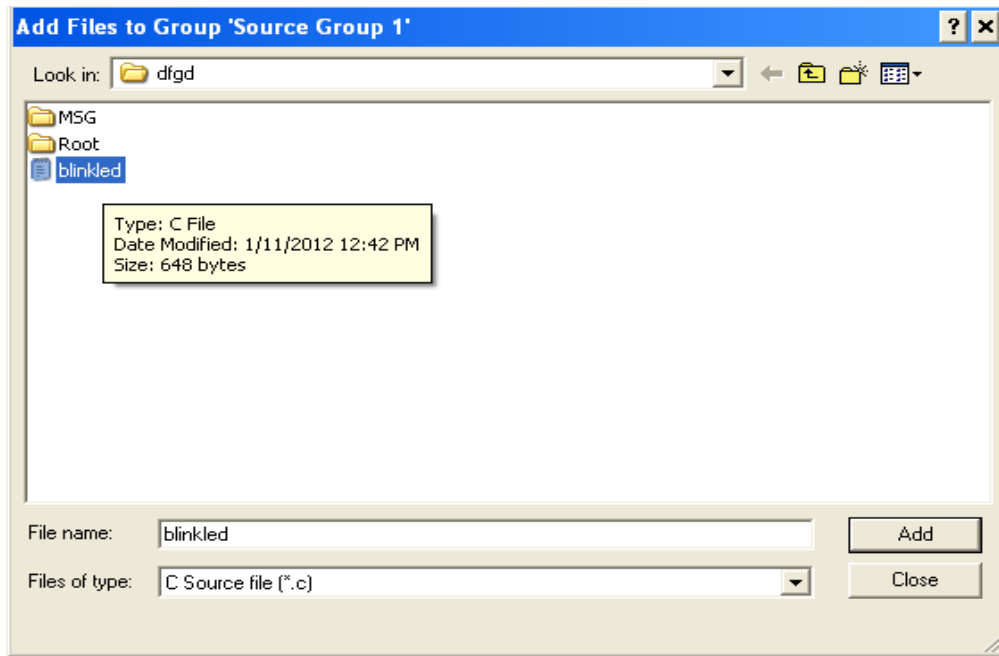
And also check Use MICRO LIB as follows



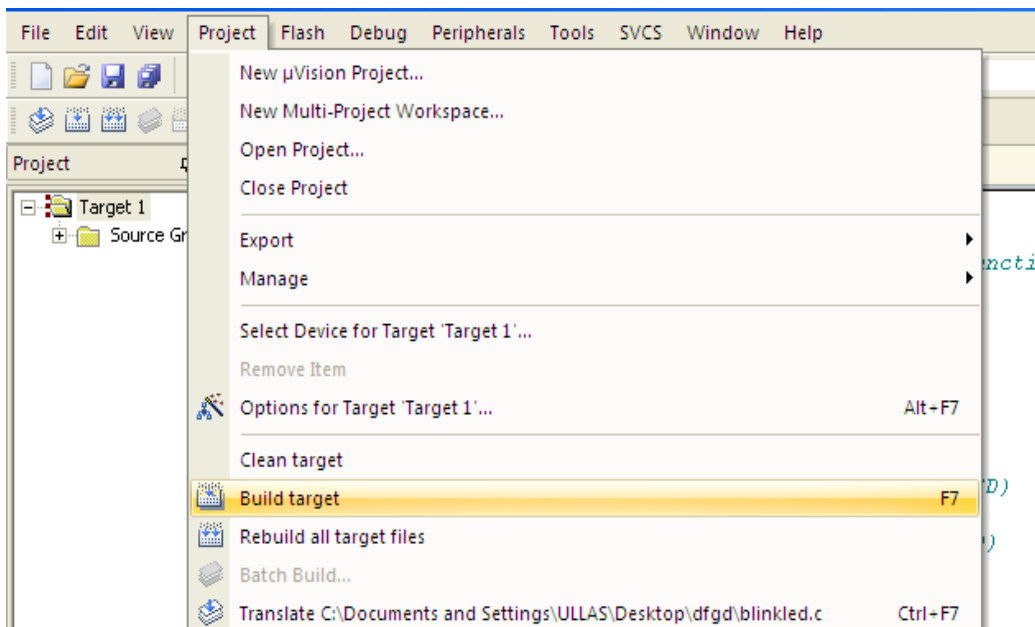
9. Add the file to source group as shown below.



10. Select .C file as shown below



11. Go to project and click on build target.



If code is correct then it shows like

```

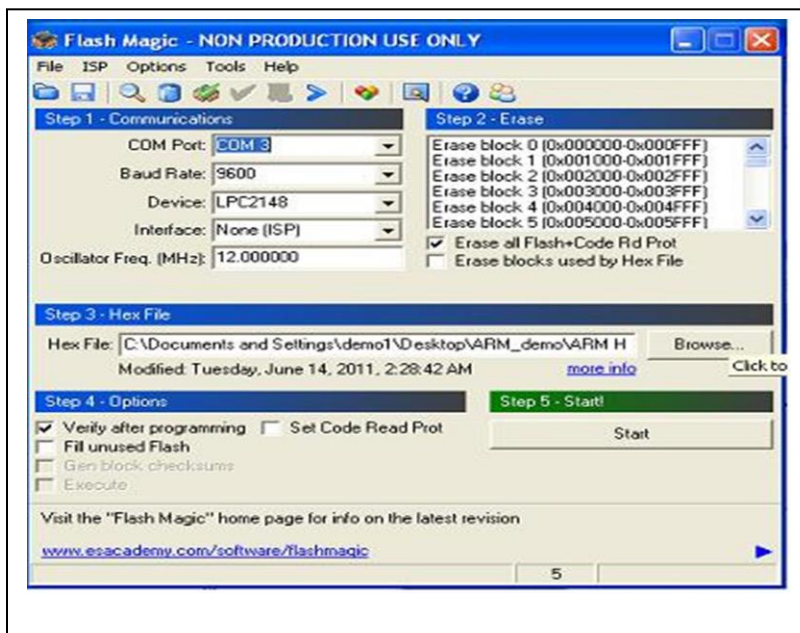
Build Output
Program Size: Code=584 RO-data=16 RW-data=0 ZI-data=96
FromELF: creating hex file...
"as.axf" - 0 Error(s), 0 Warning(s).
    
```

Build target files

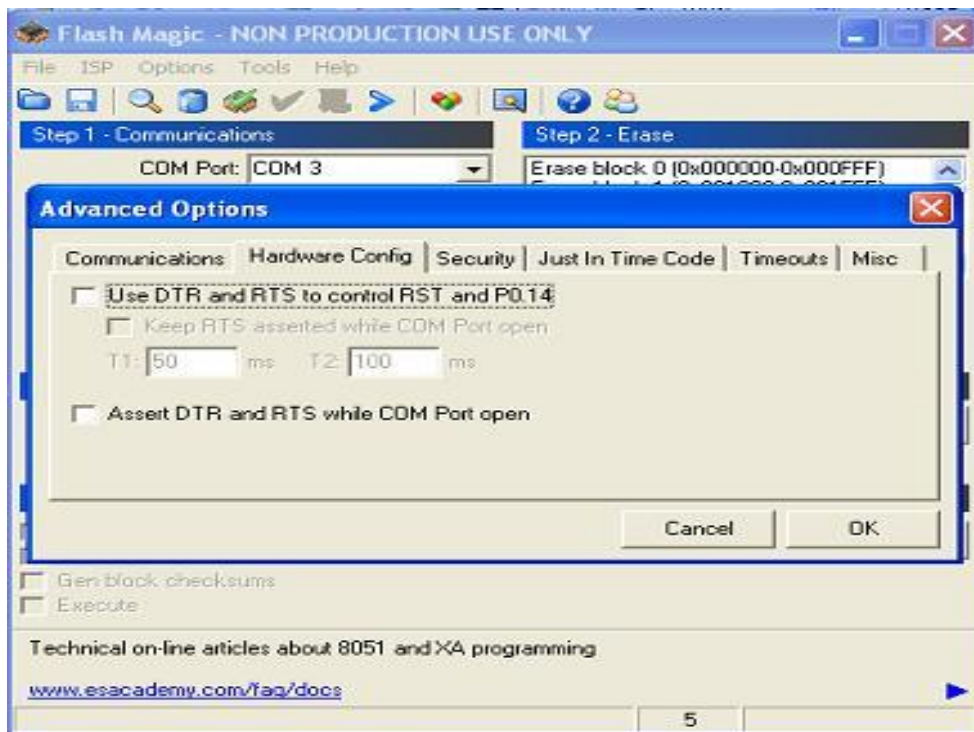
The hex file of the code will be generated now.

Working with Flash Magic Software

Click the start button, select the programs options and select the flash magic software. The main screen appears



Go to options in the main menu and select advanced options the following screen displays.



Select **hardware config** tab and uncheck the use DTR and RTS option and press the OK button

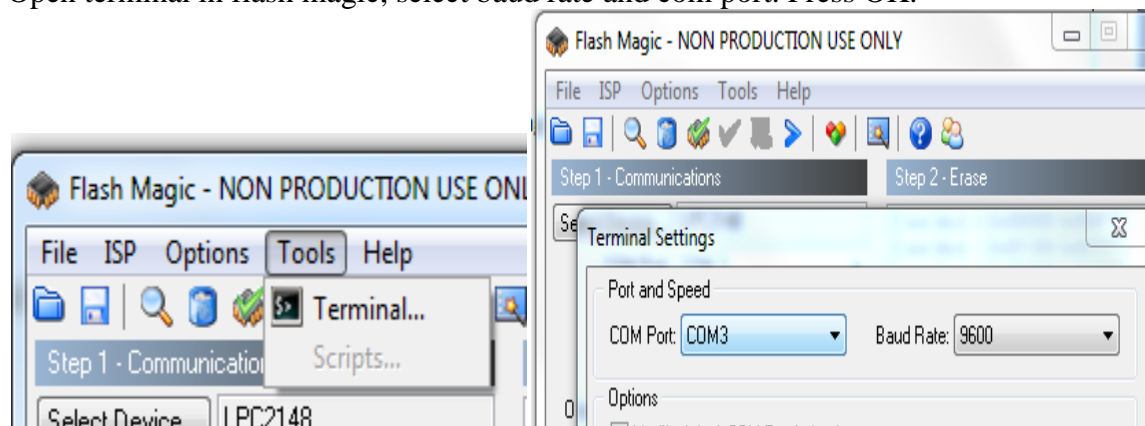
Select the comm. Port (Check in device manager about UART bridge COM port). Select the baud rate as 9600, select device as LPC2148, interface is NoneISP, Oscillator is 12.000

Browse the appropriate hex file provided on the CD and click on the Start Button. The program will be downloaded in the Kit.

UART Program

Hello word will be displayed in terminal

Open terminal in flash magic, select baud rate and com port. Press OK.



DEPARTMENT OF INFORMATION SCIENCE & ENGINEERING

Vision:

To be centre of excellence in Information Science and Engineering equipping students with top notch competencies in the domain of information technology.

Mission:

- Promote best teaching - learning , research, innovation and also instill professional ethics, cultural values and environmental awareness among the students
- Establishing learning ambience with best infrastructure facilities