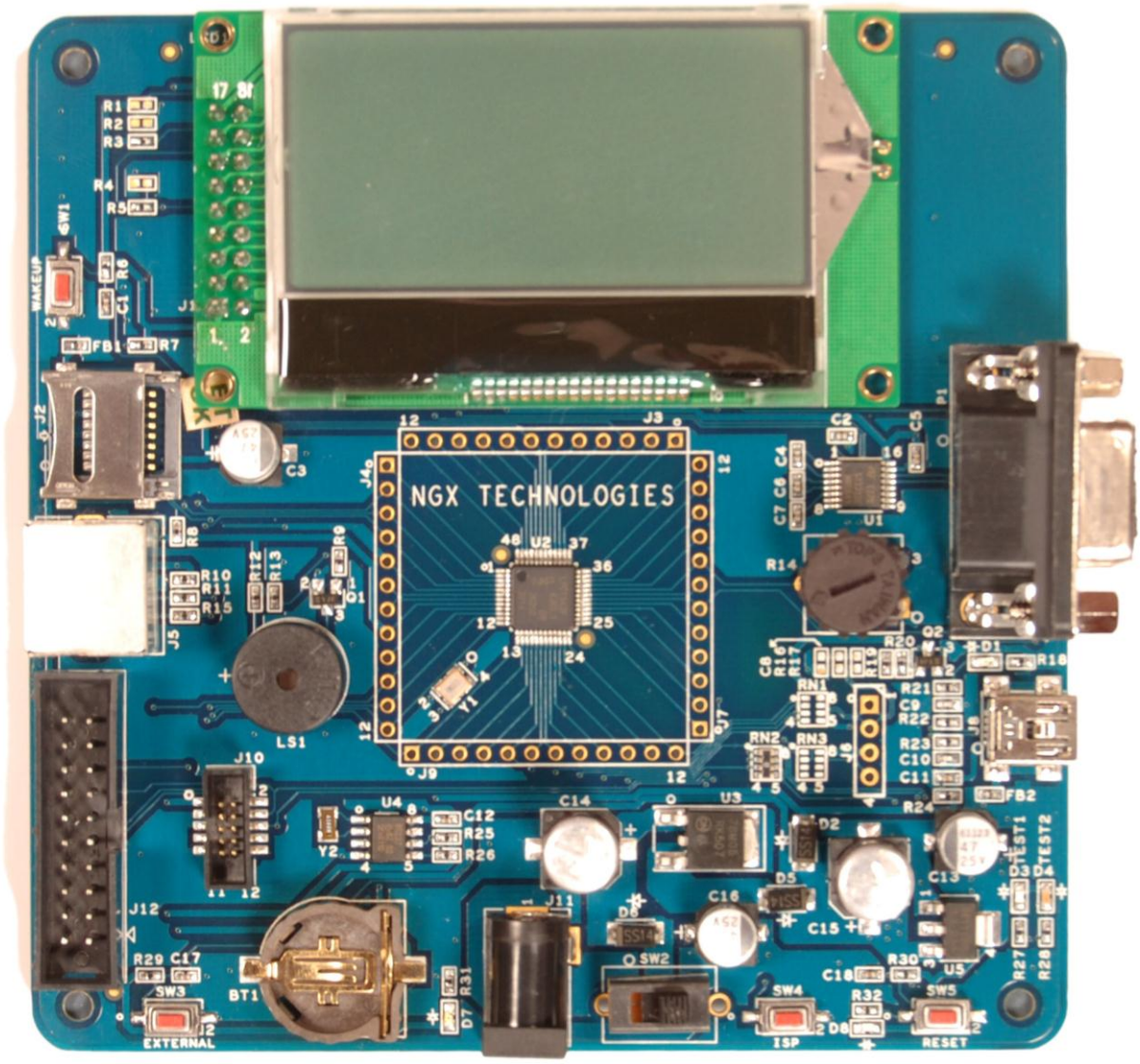

Fig. 1

About NGX Technologies

NGX Technologies is a premier supplier of development tools for the ARM7, ARM Cortex M0, M3 and M4 series of microcontrollers. NGX provides innovative and cost effective design solutions for embedded systems. We specialize in ARM MCU portfolio, which includes ARM7, Cortex-M0, M3 & M4 microcontrollers. Our experience with developing evaluation platforms for NXP controller enables us to provide solutions with shortened development time thereby ensuring reduced time to market and lower development costs for our customers. Our cost effective and feature rich development tool offering, serves as a testimony for our expertise, cost effectiveness and quality.

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CE certification

NGX Technologies BLUEBOARD-LPC1114 board have been tested for radiated emission as per EN55022 class A standard. The device is under the limits of the standard EN55022 class A and hence CE marked. No other test have been conducted other than the radiated emission (EN55022 class A standard). The device was tested with the ports like USB, Serial, and Power excluding the GPIO ports. Any external connection made to the GPIO ports may alter the EMC behaviour. Usage of this device under domestic environment may cause unwanted interference with other electronic equipment's. User is expected to take adequate measures. The device is not intended to be used in and end product or any subsystem unless the user re-evaluates applicable directive/conformance.

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1.0 INTRODUCTION

This document is the System Reference Manual for the BLUEBOARD-LPC1114, a low cost ARM Cortex-M0 based board by NGX Technologies. This document reflects its contents which include system setup, debugging, and software components. This document provides detailed information on the overall design and usage of the board from a systems perspective.

2.0 BLUEBOARD-LPC1114 OVERVIEW

2.1 INTRODUCTION

The NGX BLUEBOARD-LPC1114 is a compact and versatile evaluation platform for the NXP's Cortex-M0-based MCU. NGX's evaluation platforms are generally not tied up to any particular debugger or compiler/IDE. However it is not practical to test and ensure that the solution would work out of box with all the available debuggers and compilers/IDE. As long as the compiler supports the particular MCU and the debugger supports the standard debug interfaces like the SWD you can use this platform with any tool. For our development we use ULINK and KEIL as the debugger and compiler/IDE respectively. The board is supported by extensive sample examples allowing you to focus on the application development.

2.2 Board Features

Following are the salient features of the board

- Dimensions: 110mm X 110mm
- Two layer PCB (FR-4 material)
- Power: DC 6.5V with power LED On-board linear regulators generate +3.3V/500mA and +5V/500mA from power supply USB connector (as alternate power source)
- 10 pin, 20 pin CORTEX debug connector for SWD (Serial Wire Debug)
- ISP, Wakeup, External Interrupt and reset switch
- 12.0000 MHz crystal for MCU, 32Khz crystal for RTC
- Extension headers for all MCU pins
- RS232 connector, PS2 connector, Micro SD/MMC card connector, USB type-B mini connector with link-LED
- 64x128 parallel graphical LCD with Backlight control
- High accuracy external RTC connected on I2C bus
- RTC battery holder
- 10K pot for ADC

Note: The BlueBoard-LPC1114 has support for both 20 pin and 10 pin debug header. You don't need to buy a 20pin to 10pin converter (board which costs 10-15 USD).

2.3 Block Diagram

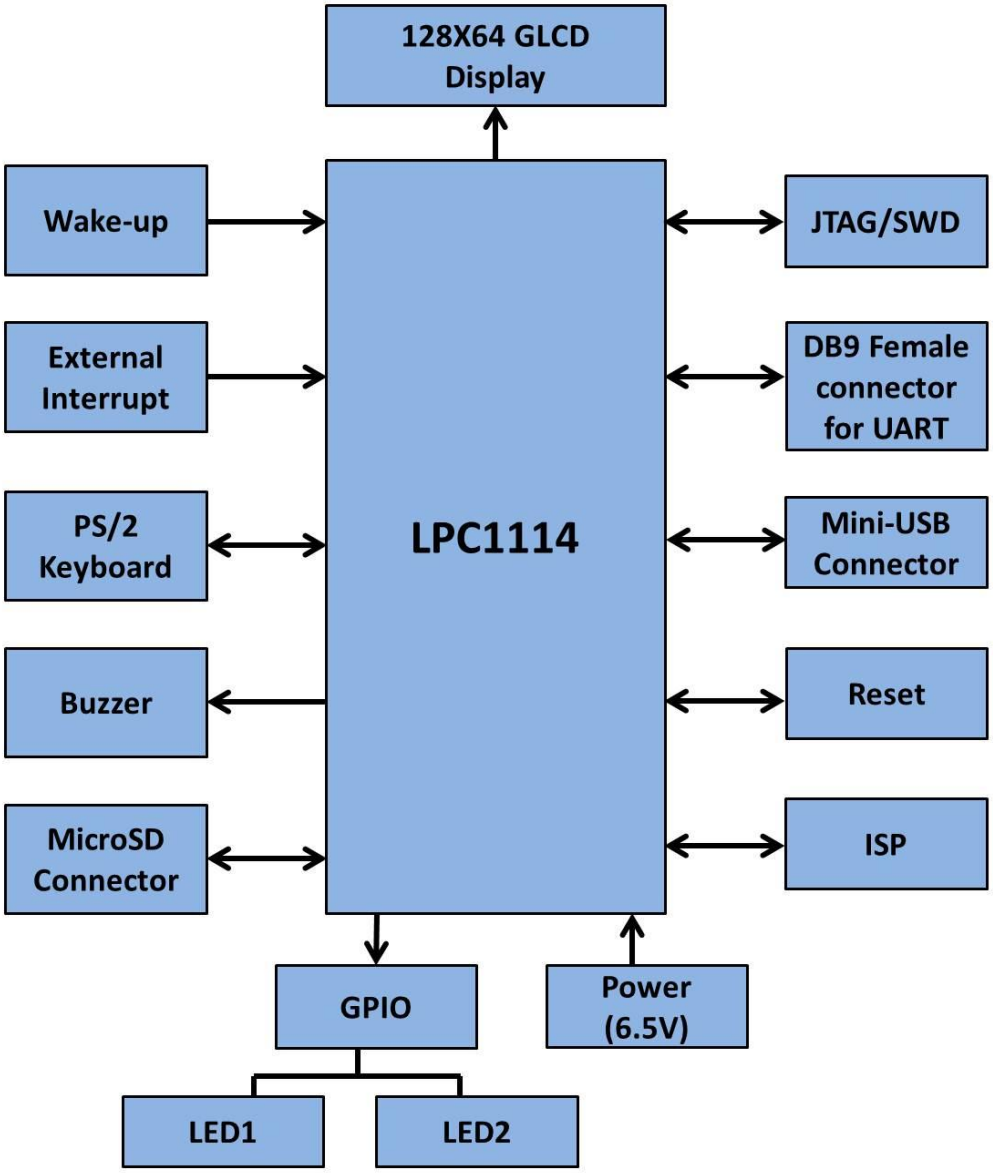

Fig. 2

2.4 MCU Features

- ARM Cortex-M0 processor, running at frequencies of up to 50 MHz
- ARM Cortex-M0 built-in Nested Vectored Interrupt Controller (NVIC)
- Non-Maskable Interrupt (NMI) input selectable from several input sources
- System tick timer
- Up to 32 kB on-chip flash program memory
- Up to 8 kB SRAM data memory
- 16 kB boot ROM
- In-System Programming (ISP) and In-Application Programming (IAP)

- Serial Wire Debug
- Up to 42 General-Purpose I/O (GPIO) pins
- GPIO pins can be used as edge and level sensitive interrupt sources.
- Two GPIO grouped interrupt modules
- High-current source output driver (20 mA) on one pin
- High-current sink driver (20 mA) on true open-drain pins
- Four general-purpose counter/timers
- Programmable Windowed WatchDog Timer (WWDT)
- 10-bit ADC with input multiplexing among eight pins
- USART (Universal Synchronous Asynchronous Receiver/Transmitter)
- Two SPI controllers with SSP features and with FIFO and multi-protocol capabilities
- I2C-bus interface supporting the full I2C-bus specification and Fast-mode Plus
- Crystal Oscillator with an operating range of 1 MHz to 25 MHz
- 12 MHz high-frequency Internal RC oscillator (IRC)
- Internal low-power, low-frequency WatchDog Oscillator (WDO)
- PLL allows CPU operation up to the maximum CPU rate
- A second, dedicated PLL is provided for USB
- Clock output function with divider
- Integrated PMU (Power Management Unit)
- Power profiles residing in boot ROM
- Four reduced power modes
- Processor wake-up
- Power-On Reset (POR)
- Brownout detect with four separate thresholds for interrupt and forced reset
- Unique device serial number for identification
- Single 3.3 V power supply (1.8 V to 3.6 V)
- Temperature range -40 °C to +85 °C

For the most updated information on the MCU please refer to NXP's website.

3.0 BLUEBOARD-LPC1114 Hardware Description

3.1 Introduction

The NGX BLUEBOARD-LPC1114 is based on ARM Cortex-M0 microcontroller from NXP. LPC1114 offers 32-KB Flash memory, 50-MHz operation, I2C controller with data rate of up to 1 Mbit/s and wide range of peripherals. Refer to the LPC1114 data sheet for complete device details.

BLUEBOARD-LPC1114 microcontroller is factory-programmed with a quick start demo program. The quick start program resides in the BB-LPC1114 on-chip Flash memory and runs each time power is applied, unless the quick start has been replaced with a user program.

3.2 Board Image with pointer to each peripheral & connectors

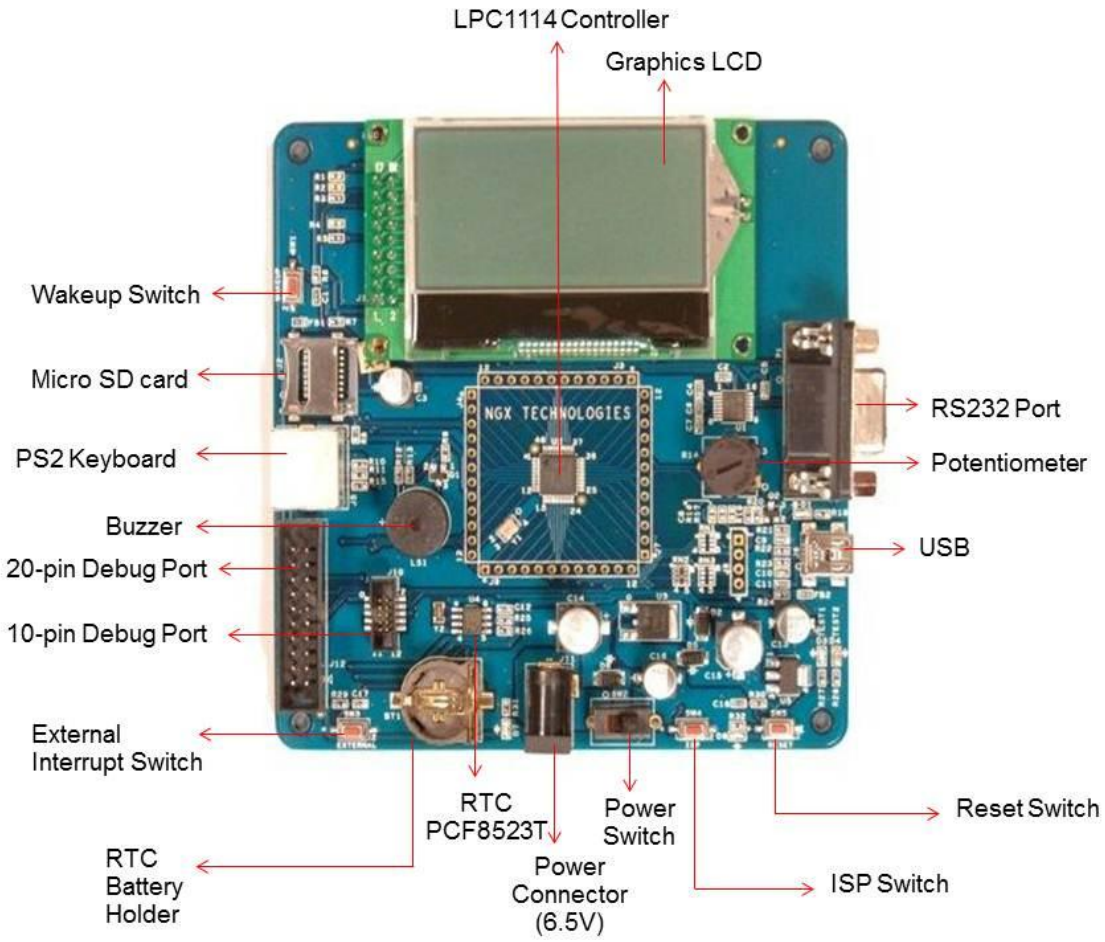

Fig 3

4.0 BLUEBOARD-LPC1114 hardware verification

NGX's Blueboard evaluation platforms ship with a factory-programmed test firmware that verifies the Blueboard peripherals. It is highly recommended that you verify the board, before you start programming. Also this exercise helps you get acclimatized with the board quickly.

To run the tests you will need the following:

- NGX BLUEBOARD-LPC1114
- Power: DC 6.5V Supply & +5V/500mA from power supply USB cable
- PC
- Mini USB type-B cable
- Serial RS232 cable
- PS/2 Keyboard
- Micro SD card

4.1 Board connections

BlueBoard Peripheral	Schematic labels	MCU pins
Test LEDs	T_LED1 T_LED2	42 30
Buzzer	BUZZER	45
128X64 Graphical LCD	LCD_D0 LCD_D1 LCD_D2 LCD_D3 LCD_D4 LCD_D5 LCD_D6 LCD_D7 LCD_EN LCD_R/W LCD_RS LCD_CS NRST LCD_BL	2 13 26 38 11 12 24 25 33 34 35 36 3 37
MicroSD card	SCK MOSI SSEL MISO	31 28 10 27
ADC POT	ADC3	32
External RTC	SDA SCL	16 15
Keyboard (PS/2)	PS2_DATA PS2_CLK	43 48
USB	USB_DM USB_DP VBUS	19 20 14

UART	RXD TXD	46 47
External Interrupt Switch	EXT_SW	23
Wakeup Switch	WAKEUP	40
SWD (Serial Wire Debug)	NRST SWDIO SWO SWDCLK	3 39 28 29
In system Programming switch	ISP	4
Power supply	Connecting this will provide 3.3V supply to board	44

Table. 2

4.2 Powering the Board

The Blueboard requires DC supply of 6.5V or 7.5 V, 1A rating to power it up. Alternatively the board could be powered through USB connector.

Note: The USB power can source only up to 500 mA of current. For applications having higher current requirements we recommend to use an external power supply. Please note that the external adaptor is not a part of standard delivery.

4.3 Verifying all the peripherals on Blueboard

The following section focusses on the verification of all the peripherals supported on the Blueboard. The order of the tests is mentioned in the same manners as the flow of the test firmware. We highly recommend that you follow the order of the test. The test firmware is designed in a manner that the user needs to spend as minimum time as possible to verify all the peripherals.

Note: It is highly recommended that the user tests all the peripherals as soon as the board is received.

Power up the board and we are all set to verify the Blueboard peripherals. The order of the peripherals that are verified by the firmware are as follows:

4.3.1 LEDs

Test setup and verification:
As soon as the BlueBoard is turned ON or reset; the test LEDs go ON & OFF for a couple of times, this simple test validates the LEDs.

4.3.2 Buzzer

Test setup and verification:
When the board is turned ON or reset you will hear a beep after few seconds. This confirms the status of the Buzzer.

4.3.3 Graphics LCD (GLCD)

Test setup and verification:
After the LEDs blink and buzzer test the next interface that the firmware validates is the GLCD. A message "NGX TECHNOLOGIES" should be displayed on the GLCD.

4.3.4 RTC

Test setup and verification:
Next, the firmware validates the external RTC connected over I2C bus. The RTC value is read and displayed on the LCD.

Note: You may place the battery (not part of standard deliverables) for the RTC to retain the time even after power off.

4.3.5 Micro SD Card

Test setup and verification:
Insert the Micro SD card in the SD card holder (J2), the status of the SD card will be displayed on GLCD. If the SD card is inserted properly "SD card detected" is displayed on GLCD else it displays "SD card missing".

NOTE: Please note that we have verified with the Transcend micro SD card. This test basically reads/writes few bytes to the SD-card.

4.3.6 ADC

Test setup and verification:
The ADC pin is connected to a potentiometer. To test the ADC rotate the wheel of the potentiometer, as the position varies the ADC value sensed is displayed on the GLCD.

Note: Since the LPC1114 has a 10-bit ADC, the values of the ADC reading will range from 0x0000 to 0x1023.

4.3.7 PS/2 Keyboard

Test setup and verification:
Connect a PS/2 keyboard to PS2 connector. Press any key on the keyboard. The corresponding key gets displayed on the GLCD

4.3.8 USB

Test setup and verification:
Connect the USB cable to USB connector. The power LED (D7) turns ON. The USB interface can be used only as source for power supply.

4.3.9 UART

Test setup and verification:
Open the hyper terminal as shown in the below image. To test the UART open the hyper terminal with settings 115200 bps 8N1, i.e.

Baud Rate: 115200 bps
Bits: 8
Parity: None
Stop bits: 1
Flow Control: None

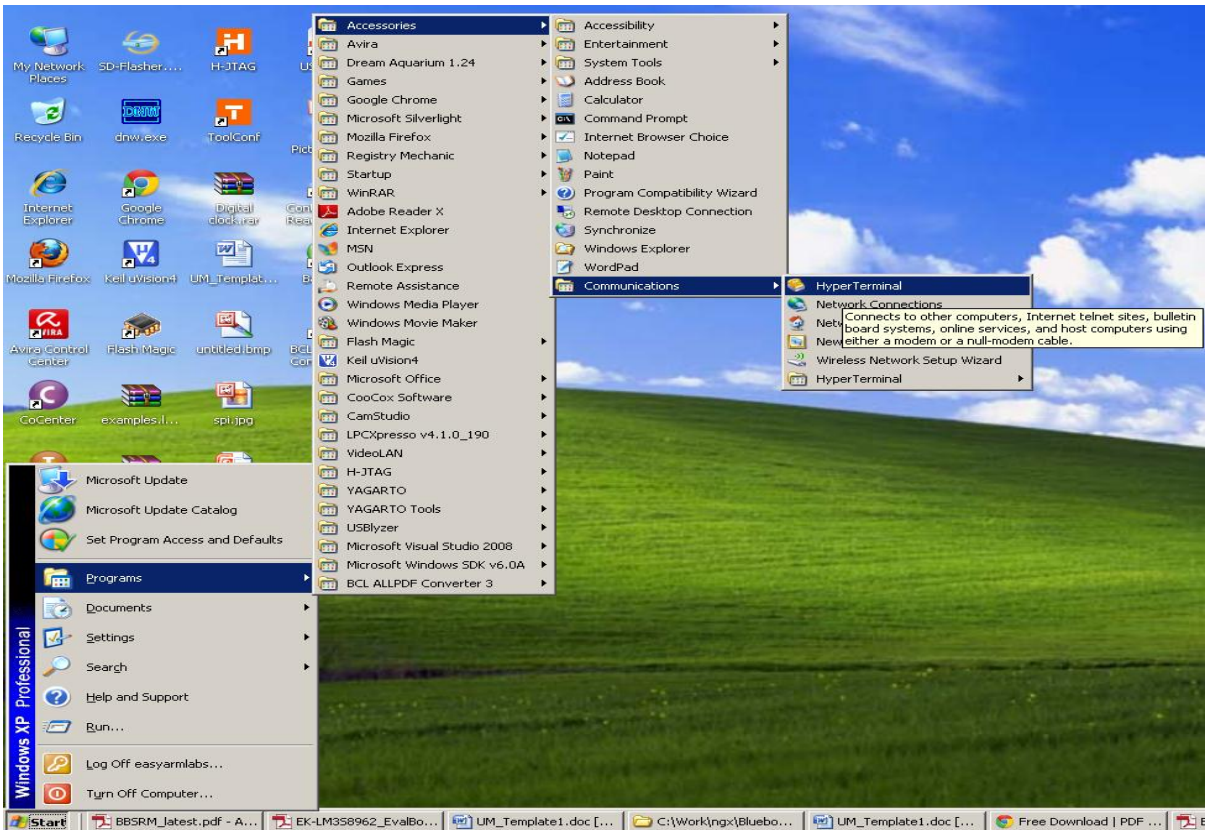

Fig. 4

A ‘Connect To’ window opens where you have to select the COM port. In this example it is COM13. Click OK. A ‘COM13 Properties’ window appears. Set the values as shown below. Click OK.

Note: Please check for your machines COM port number. The COM port number can be different.

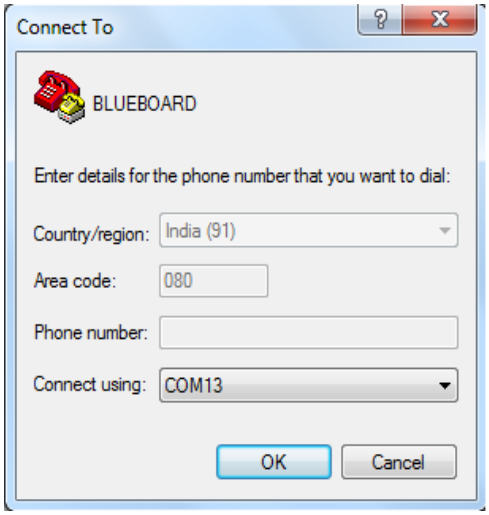

Fig. 5

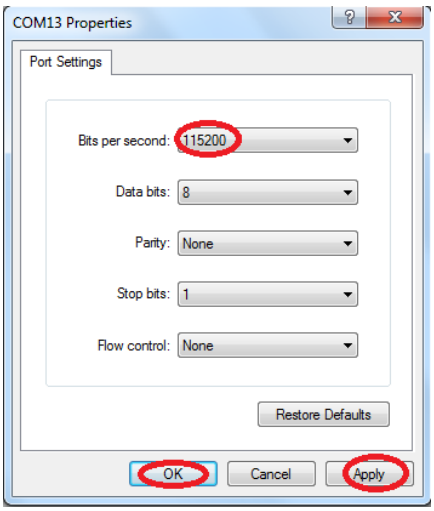

Fig. 6

Next a ‘Hyper Terminal’ window opens as shown.

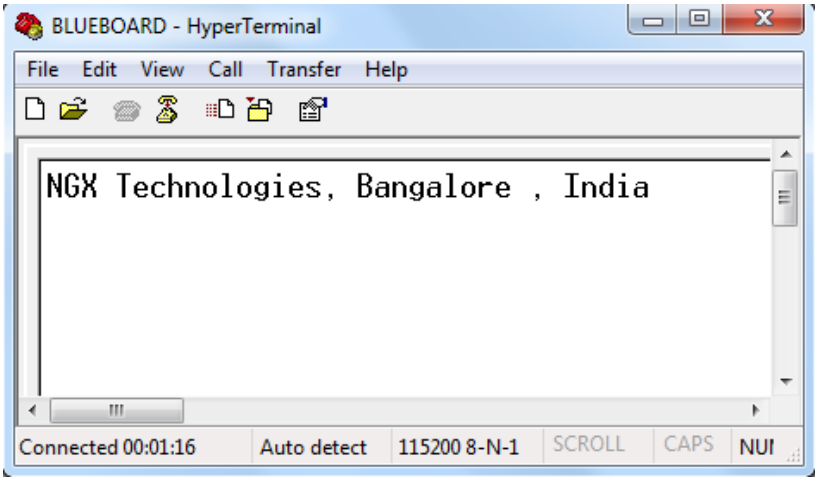

Fig. 7

Make sure the board is powered and the serial port is connected to the board. The key that are typed on the keyboard are echoed back to the hyper terminal.

4.3.9 External Interrupt Switch & Wakeup Switch

Test setup and verification:
When you press the External Interrupt Switch (External SW3) the controller enters into the deep power down mode, once you press the wake up switch (SW1) the controller wakes up from the deep power down mode.

4.3.10 Serial Wire Debug

Test setup and verification:
Connect the Ulink2 debugger to the debug port (10 pin or 20 pin), Open the keil project, build the project and click on load/debug option to program or debug the BlueBoard as shown in the below images.

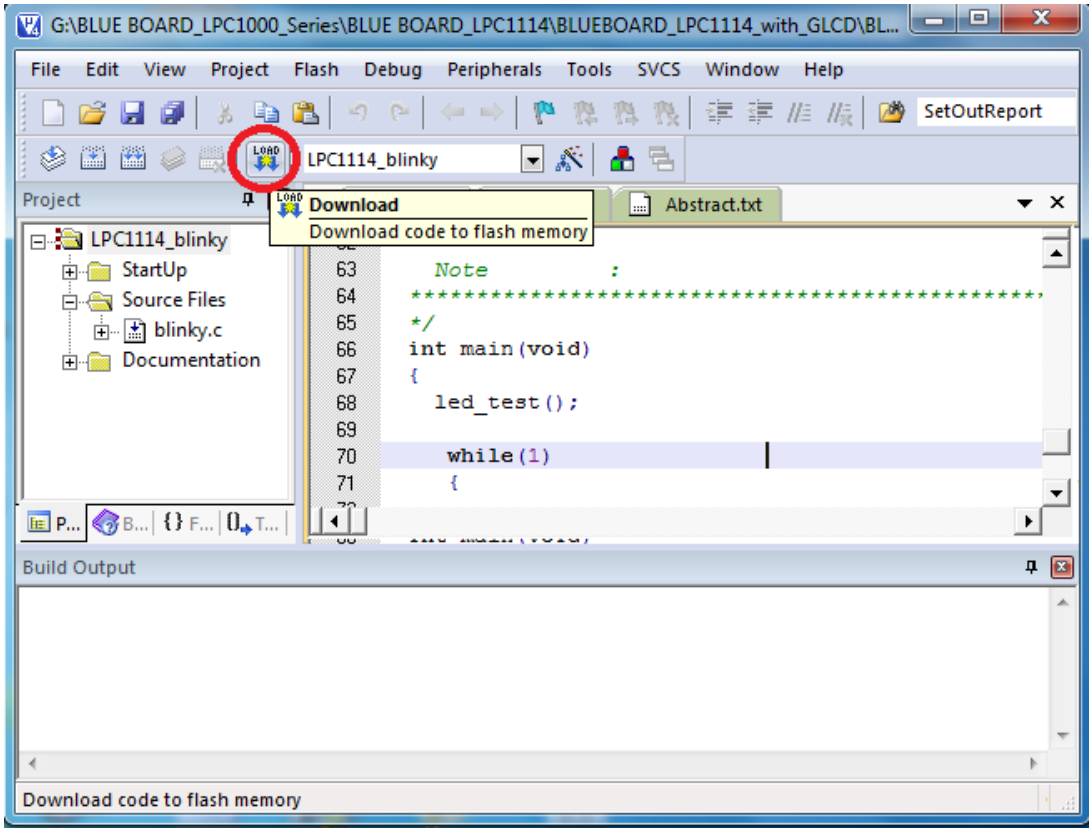
G:\BLUE BOARD_LPC1000_Series\BLUE BOARD_LPC1114\BLUEBOARD_LPC1114_with_GLCD\BL...
File Edit View Project Flash Debug Peripherals Tools SVCS Window Help
SetOutReport
LPC1114_blinky
Download
Download code to flash memory
Project
LPC1114_blinky
StartUp
Source Files
blinky.c
Documentation
Abstract.txt
Note :
*/
int main(void)
{
led_test();
while(1)
{
Build Output
Download code to flash memory

Fig 8

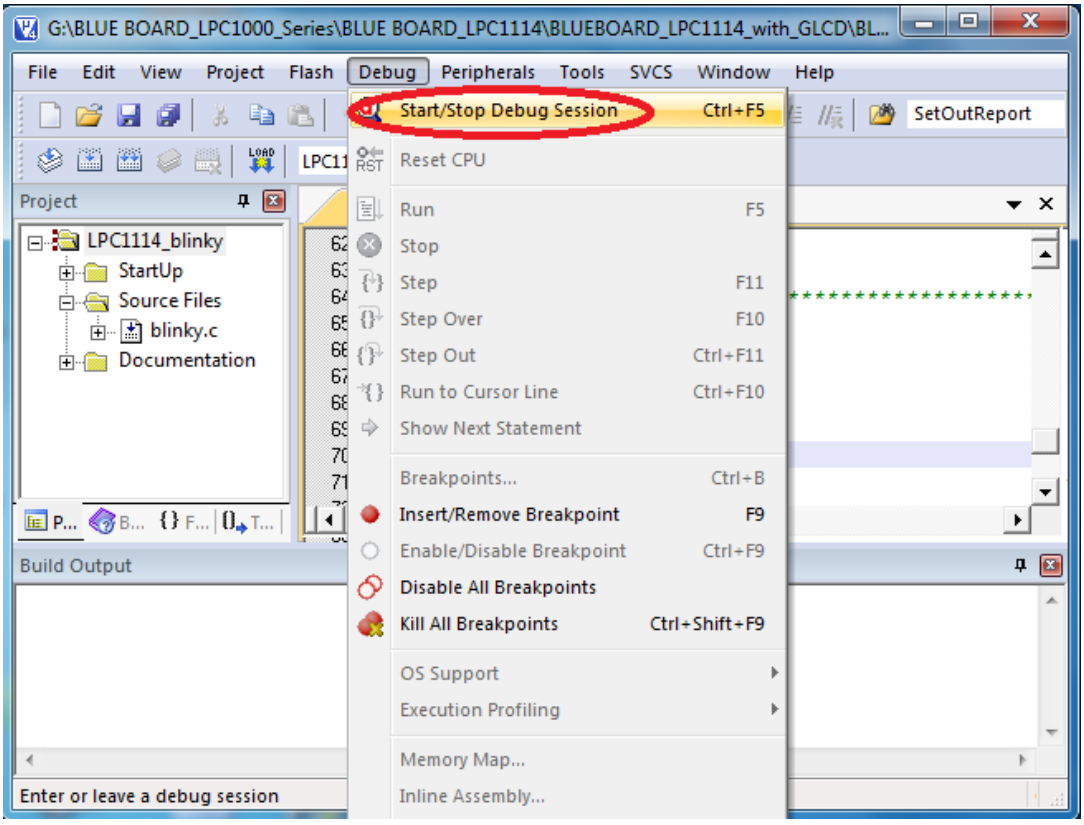
G:\BLUE BOARD_LPC1000_Series\BLUE BOARD_LPC1114\BLUEBOARD_LPC1114_with_GLCD\BL...
File Edit View Project Flash Debug Peripherals Tools SVCS Window Help
Start/Stop Debug Session Ctrl+F5
Reset CPU
Run F5
Stop
Step F11
Step Over F10
Step Out Ctrl+F11
Run to Cursor Line Ctrl+F10
Show Next Statement
Breakpoints... Ctrl+B
Insert/Remove Breakpoint F9
Enable/Disable Breakpoint Ctrl+F9
Disable All Breakpoints
Kill All Breakpoints Ctrl+Shift+F9
OS Support
Execution Profiling
Memory Map...
Inline Assembly...
SetOutReport
Project
LPC1114_blinky
StartUp
Source Files
blinky.c
Documentation
Build Output
Enter or leave a debug session

Fig 9

5.0 BLUEBOARD-LPC1114 Development Tool Setup

5.1 IDE and debugger

As mentioned in the earlier section, NGX's MCU evaluation platforms are not coupled tightly with any one particular combination of IDE and debugger. The following sections will explain the setup for KEIL and ULINK as the IDE and debugger respectively.

Other tool options that could be considered are:

- J-link and IAR
- Co-link and CooCox

5.2 Installation & Configuration of KEIL software

The Installation of KEIL software is explained below:

*Note: We have used **Keil uvision version 4.23** while creating the User manual for this evaluation kit. Please ensure that you are using uvision version 4.23 and above.*

Step 1: Open the keil setup

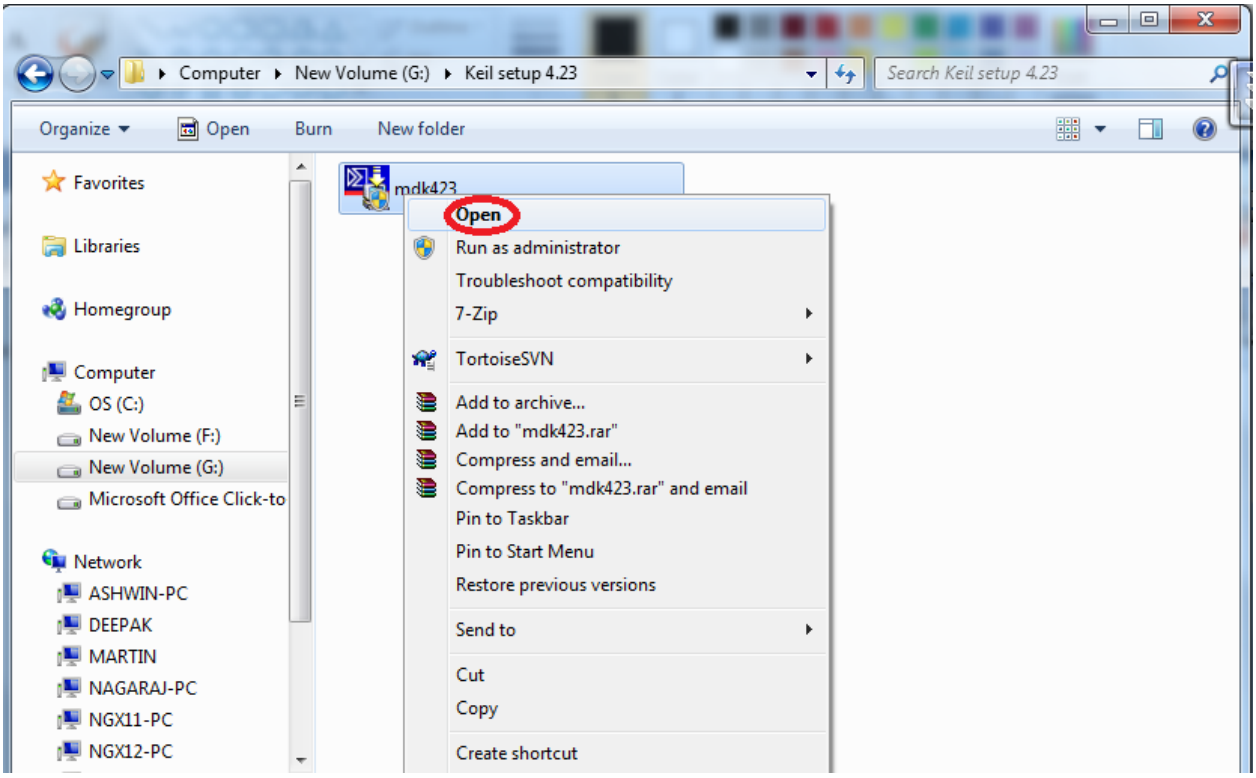

Fig. 10

Step 2: Keil µvision4.23 information Click on Next

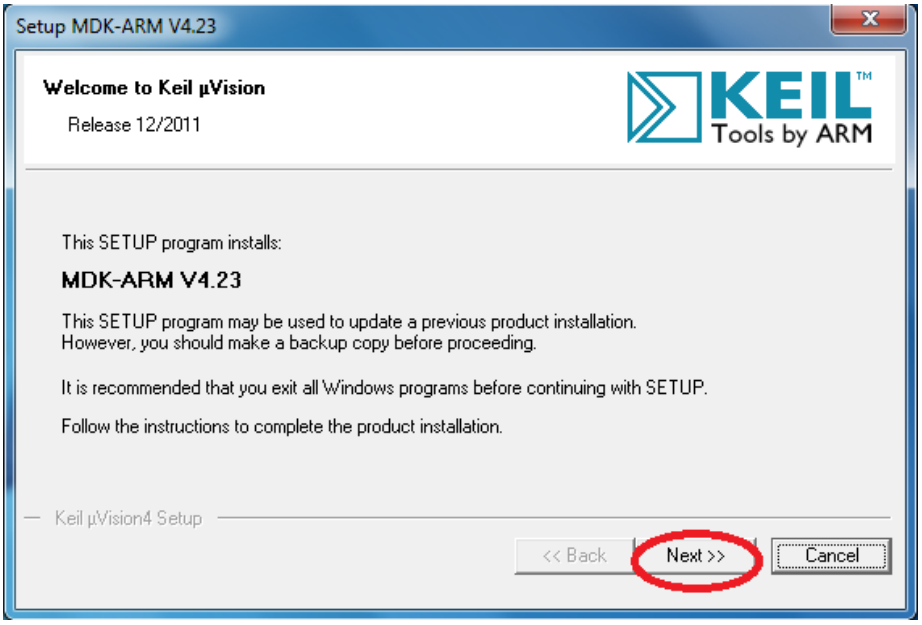

Fig. 11

Step 3: Terms & conditions

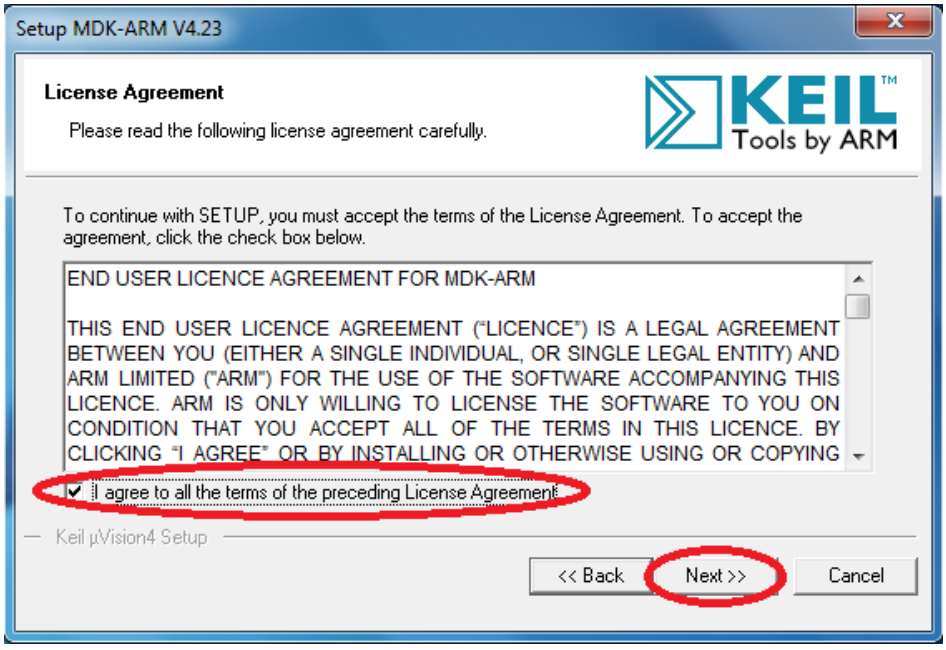

Fig. 12

Step 4: Provide the destination path and Click on Next

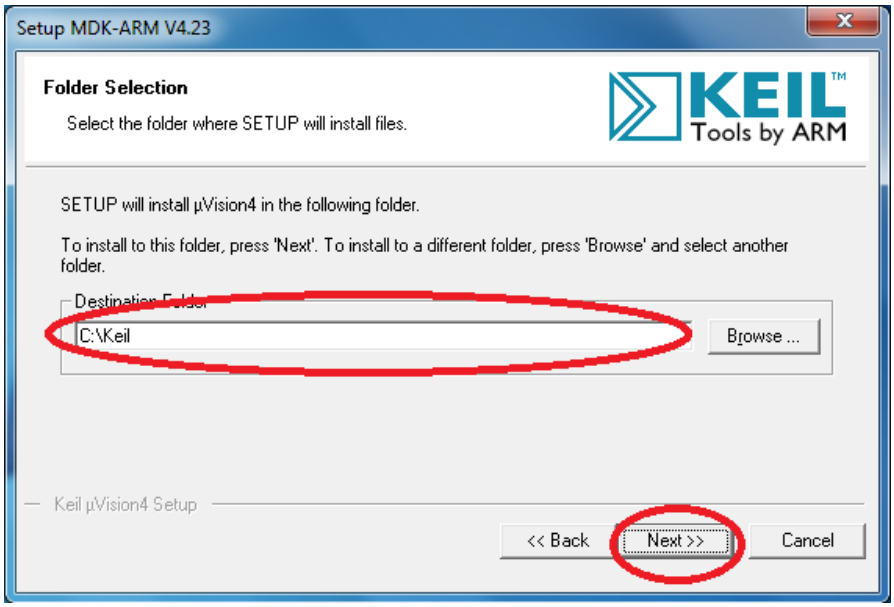

Fig. 13

Step 5: Fill your Personal information and Click on Next

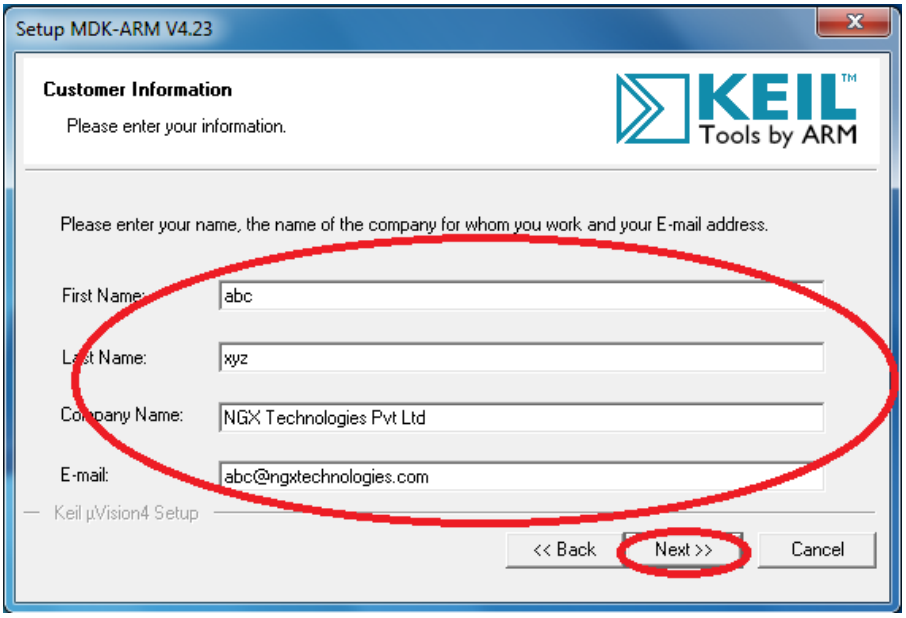

Fig. 14

Step 5: Click on Next

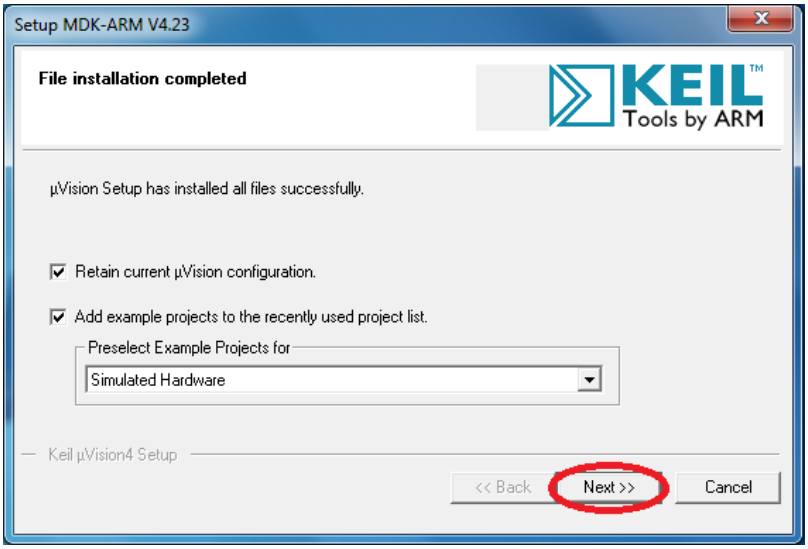

Fig. 15

Step 6: Keil µVision4.23 setup is completed. Click on Finish

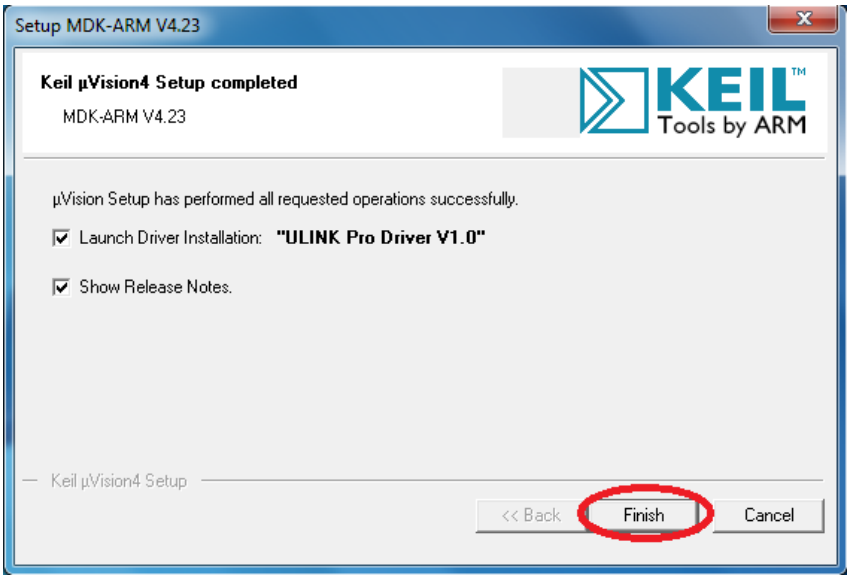

Fig. 16

5.3 Configuration of ULINK Debugger

The configuration flow of ULINK Debugger is explained below:

Step 1: Open the Keil Workspace then by clicking on the **target** option, the window opens as shown below. Next click on Debug option and select the ULINK2 debugger as shown in the image.

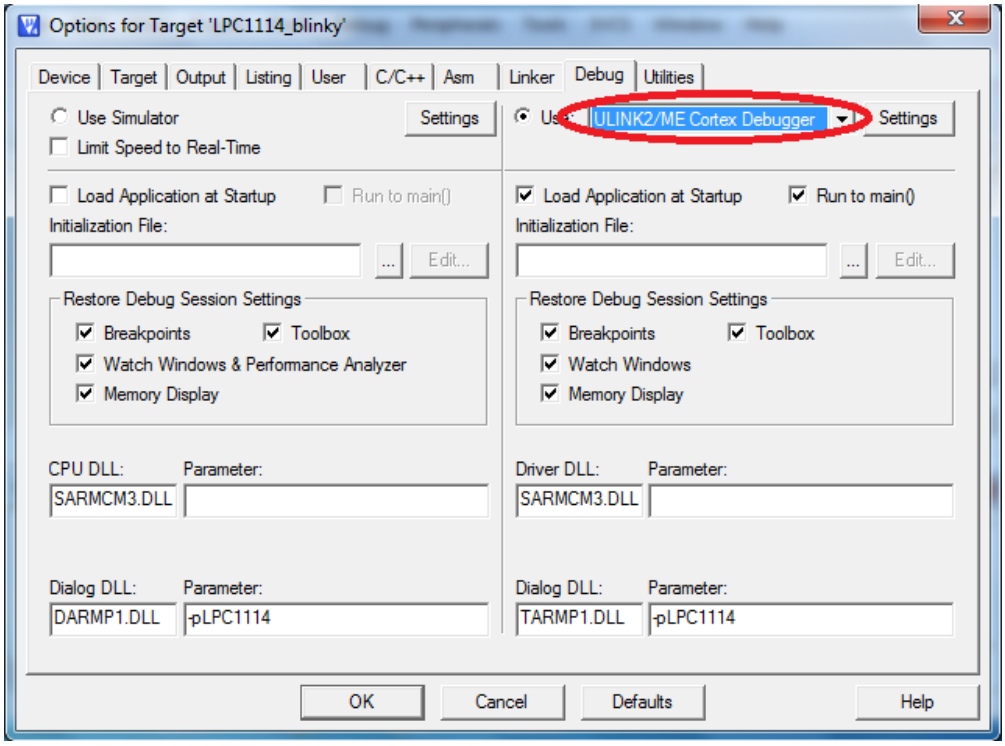

Fig.17

Step 2: Click on the settings option, the Cortex-M Target Driver Setup window opens then select SW port. After selection of the SW port the ULINK2 detected is as shown in the image below

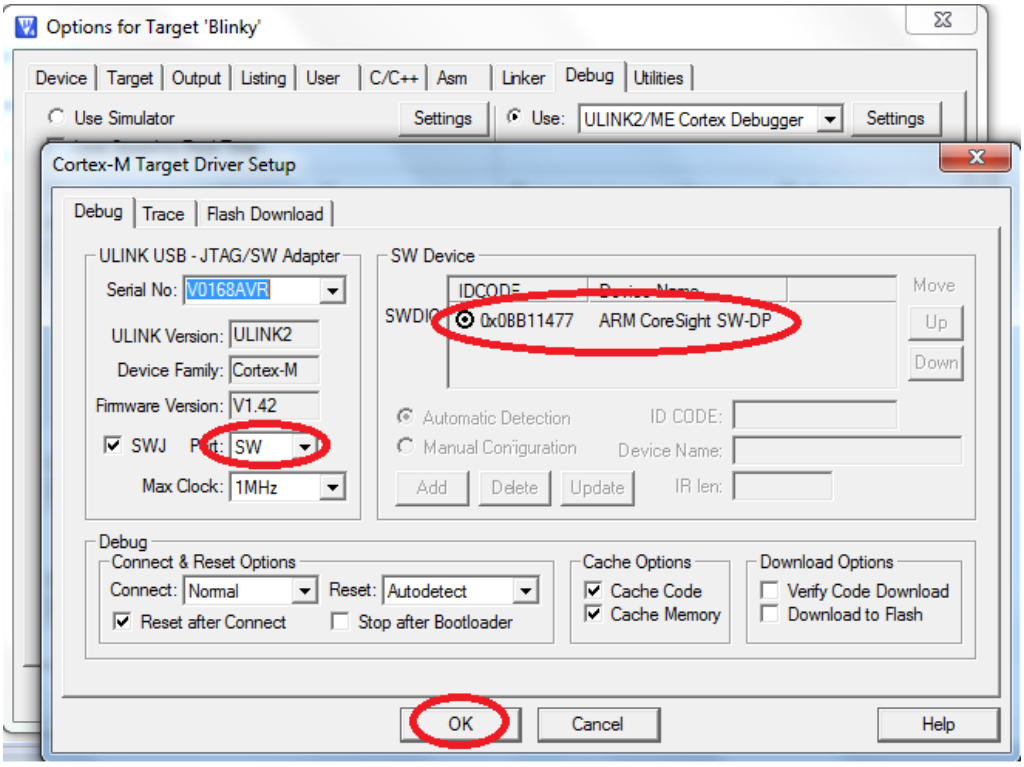

Fig.18

Step 3: Click on Utilities and select ULINK2 Cortex Debugger as shown below

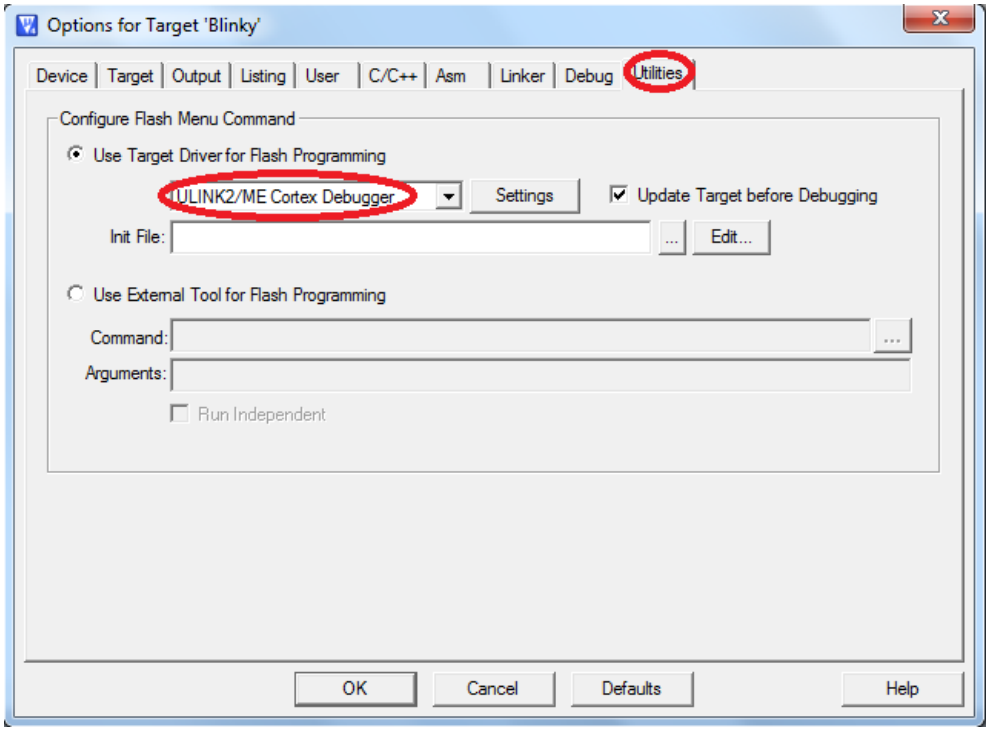

Fig.19

Step 4: By Clicking on Settings the Cortex-M Target Driver Setup window opens, Click on Add to select the flash as shown below

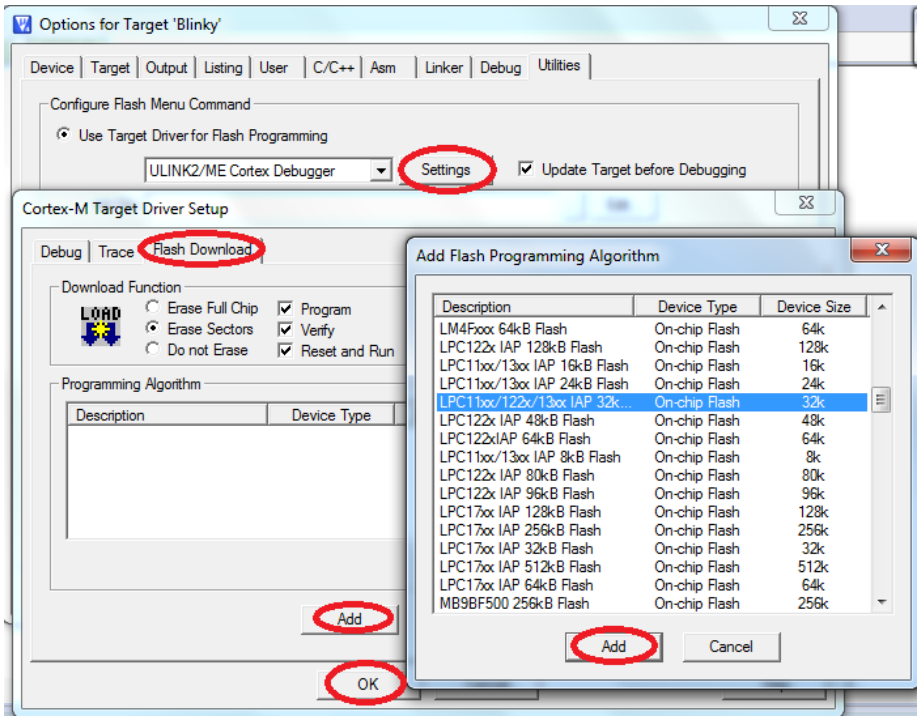

Fig.20

Click OK to complete the ULINK2 Debugger configuration

6.0 BLUEBOARD-LPC1114 Programming

6.1 Programming options

BlueBoard-LPC1114 can be programmed using the

- On-chip bootloader UART)
- Debugger (ULINK)

6.1.1 On-Chip bootloader (UART)

In order to program the board either through UART we need to get the board under programming mode.

Getting the board in programming mode:

Theory: The On-chip bootloader looks for a logic LOW to be present on a pre-defined PIN (ISP pin) during reset. If the ISP pin is held LOW and reset signal is provided to the MCU, the MCU enters into programming mode.

Practical:
On the BlueBoard-LPC1114 the RESET and ISP signals are connected to buttons provided on the board. Look for the RESET and ISP marking on the board. Therefore to enter into programming mode:

- **Press and hold** the ISP button
- Press the RESET button and release it
- Now release the ISP button
- The board is in the programming mode

6.2 Flashing the Hex file through UART

Step 1: Connect the serial cable to the PC as well as to the board UART0 and open the flash magic tool.

Step 2: Input all the parameters as shown in below Fig.

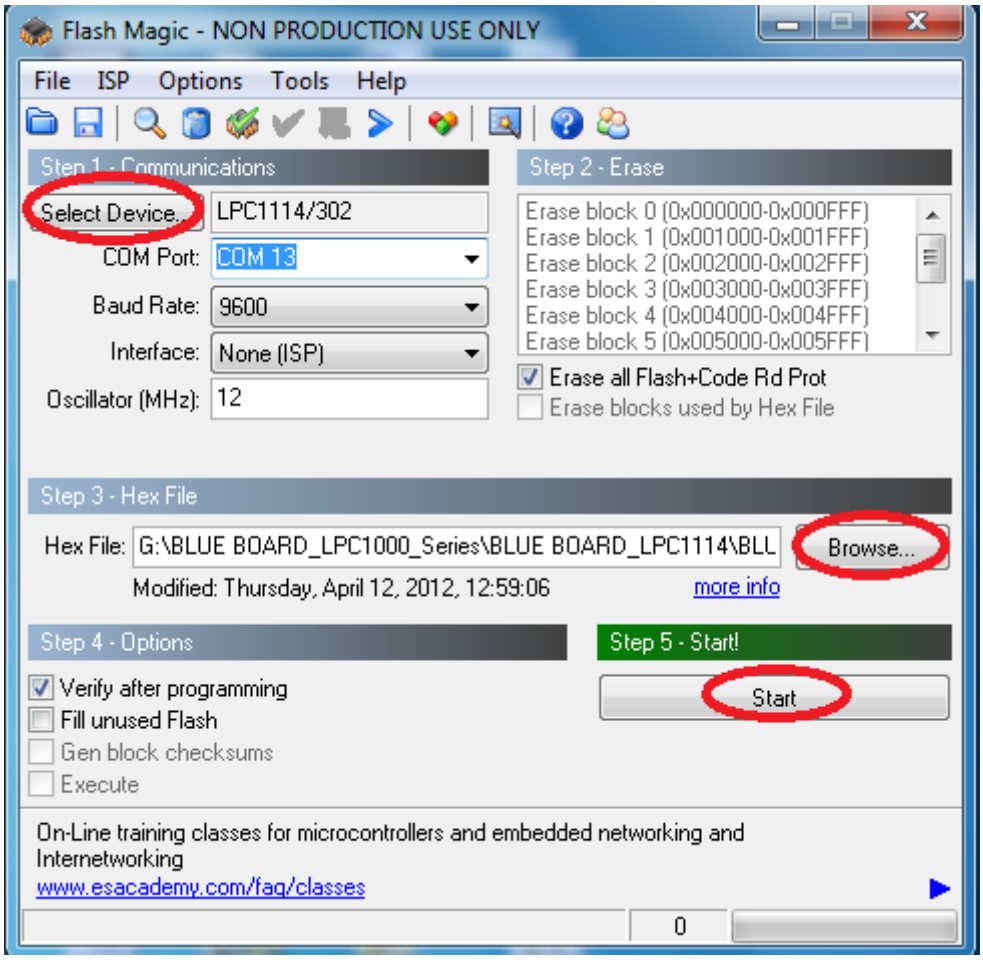

Fig. 21

Step 3: Get the board in programming mode by following the step 6.1.1 then click **star**t to flash the hex file.

NOTE: Make sure that the Board is not powered through USB.

7.0 BLUEBOARD-LPC1114 Software Development

7.1 Executing the sample projects

The sample projects are provided with the available kit.

Steps to execute the sample projects:

1. Open the project folder.
2. Then open the file project_name.uvproj eg blinky.uvproj.

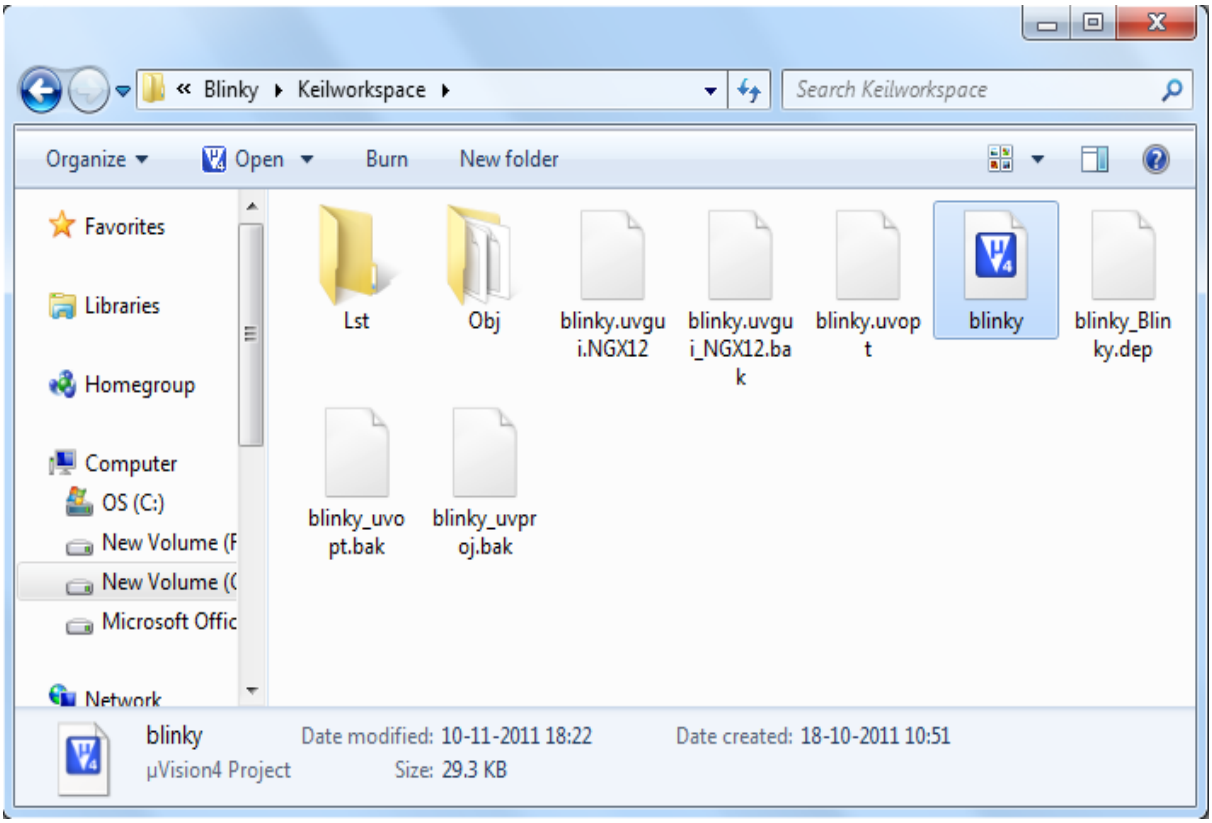

Fig. 22

3. This launches the IDE

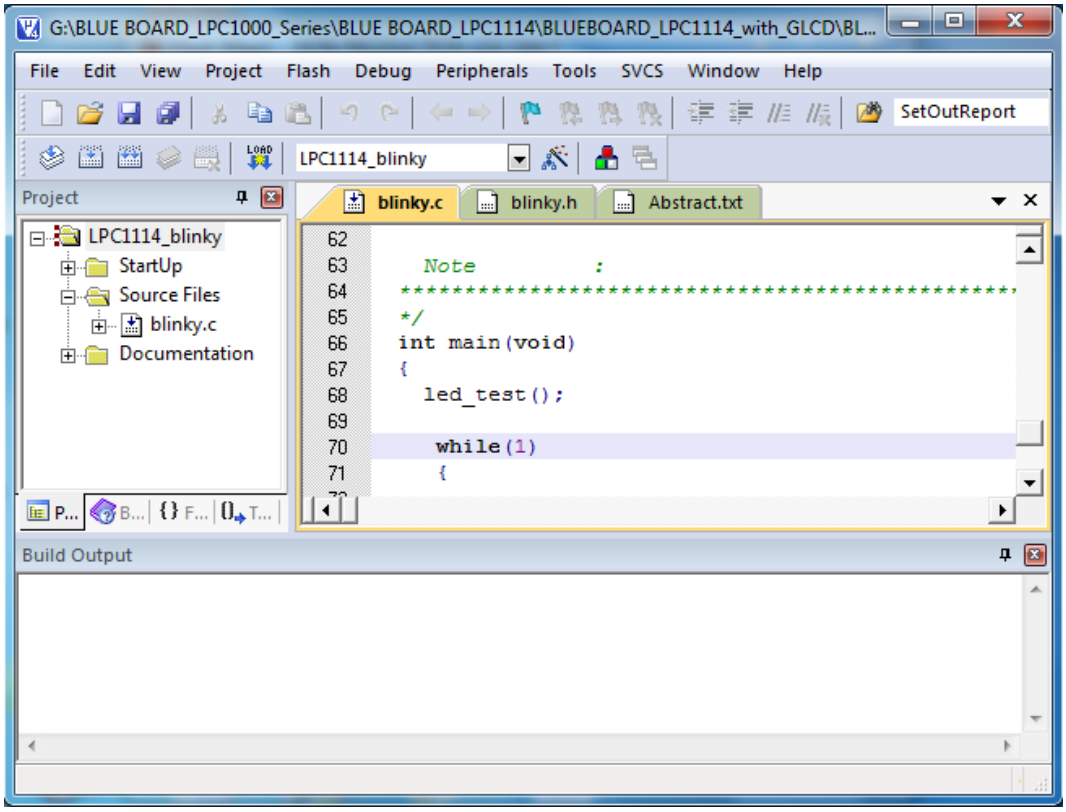

Fig. 23

4. If you have the ulink programmer just click the Debug button on the IDE and the project is loaded onto the controller and ready for debugging. If you wish to just flash/program the generated binaries onto the board, follow the steps in ***6.2 Flashing the Hex file through UART***

7.2 Creating New project

Follow the below steps, for creating new project:

Step 1: Open the keil IDE.

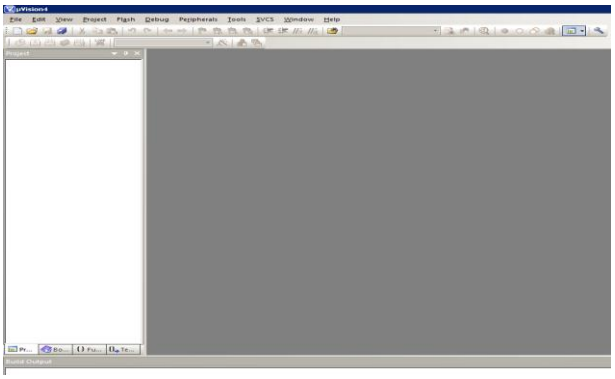

Fig. 24

Step 2: Click on to the Project tab – new uvision project & then click save.

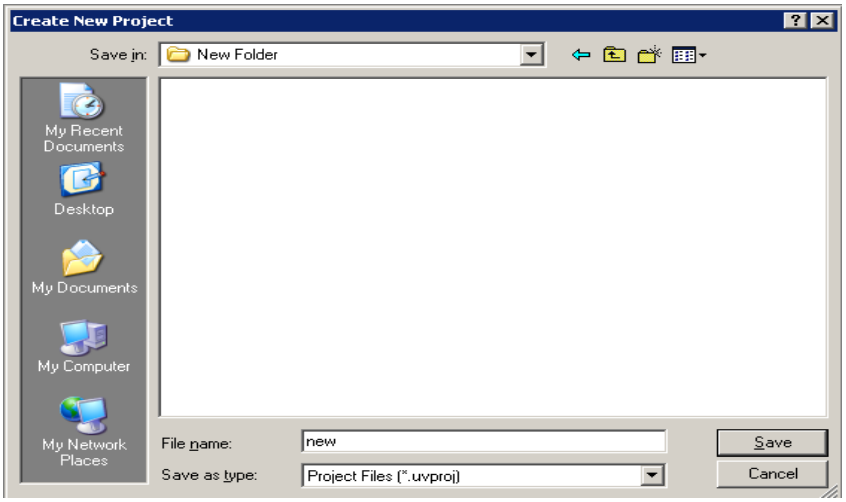

Fig. 25

Step 3: Select the controller.

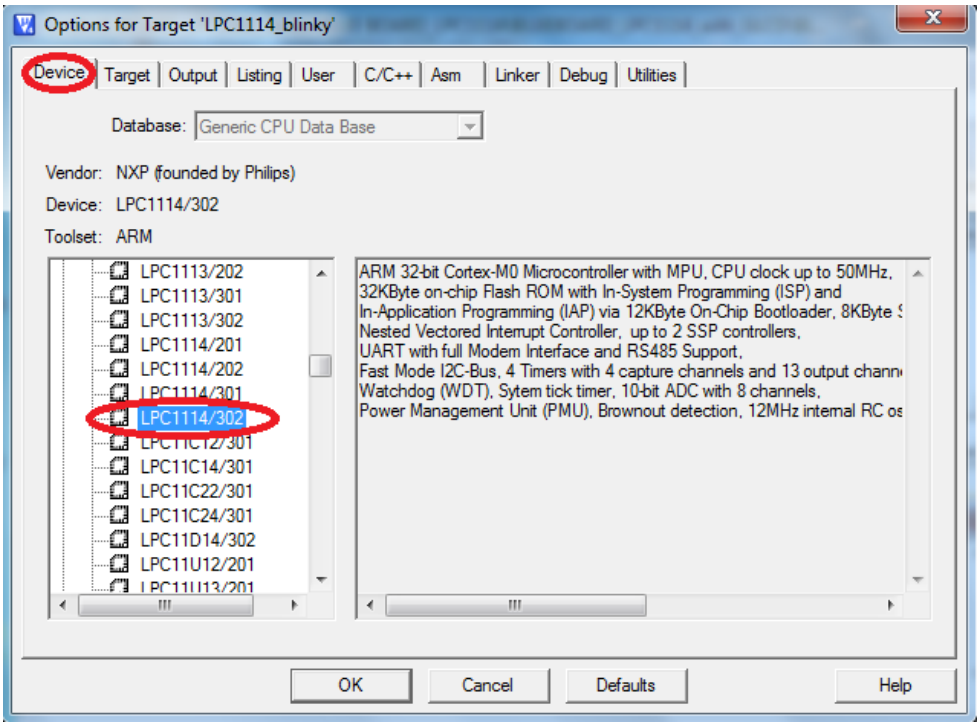

Fig. 26

Step 4: Go to file – new, & start writing the code

Step 5: Save the file with some name & add the files to the source group.

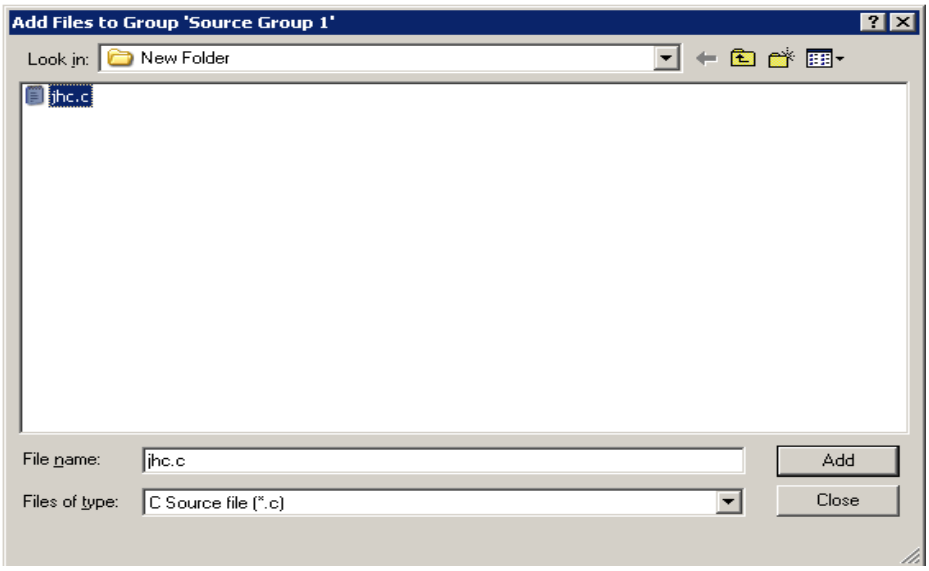

Fig. 27

For creating hex file follow the below steps:

Step 1: Open the project & click **'Target Options'** and a window will appear.

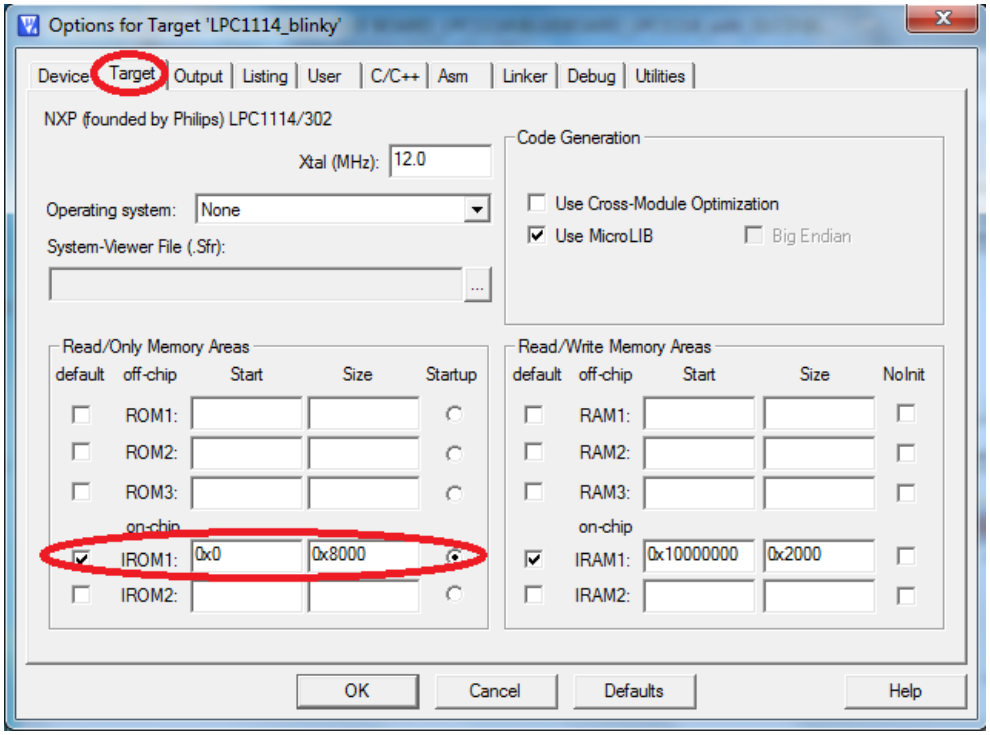

Fig. 28

Step 2: Check the device & the start address of IROM1 should be 0x0.

Step 3: Then go to the Output tab and select options as shown in below image:

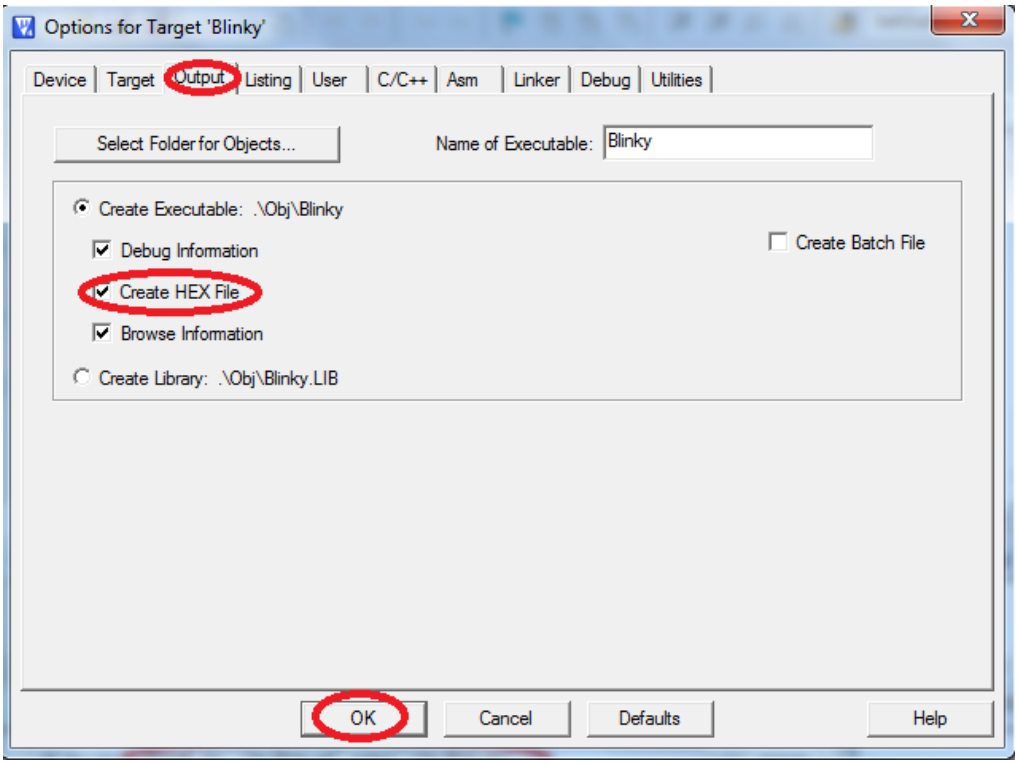

Fig. 29

Step 4: Click on the Linker tab & select the 'Use Memory Layout from Target Dialog', then click ok and build the project, finally .hex file will be created.

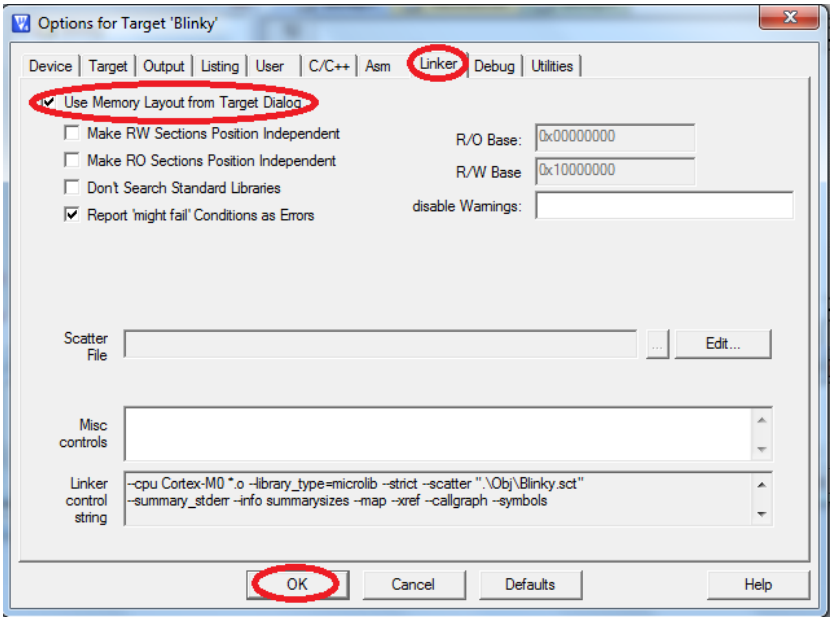

Fig. 30

8.0 Schematic & Board Layout

8.1 Schematic

This manual will be periodically updated, but for the latest documentations please check our website for the latest documents. The Board schematic and sample code are available after the product has been registered on our website.

8.2 Board layout

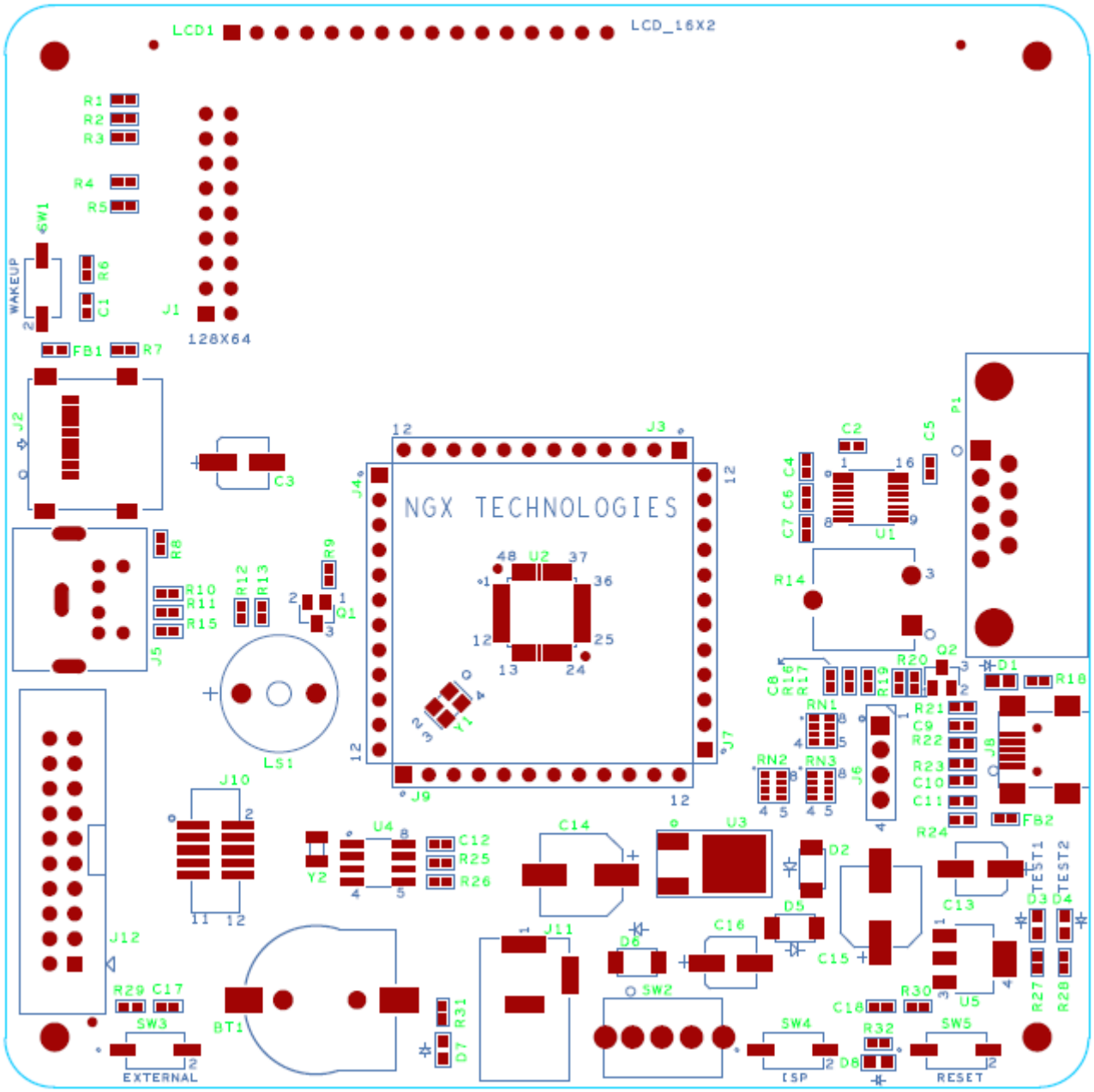

Fig. 31

9.0 CHANGE HISTORY

9.1 Change History

Rev	Changes	Date (dd/mm/yy)	By
1.0	Initial release of the manual	08/03/2012	Veeresh Tumbaragi

10.0 REFERENCES

In addition to this document, the following references are included on the NGX BLUEBOARD-LPC1114 product and can also be downloaded from www.ngxtechnologies.com:

- NGX BLUEBOARD-LPC1114 schematic for the Development board.

Additional references include:

- NGX BLUEBOARD-LPC1114 DATASHEET.
- Information on development tool being used:
  - Keil uvision 4.23, http://www.keil.com/download/product/
  - Flash magic, http://www.flashmagictool.com/

About this document:

Revision History

Version: V1.0 author: Veeresh Tumbaragi

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