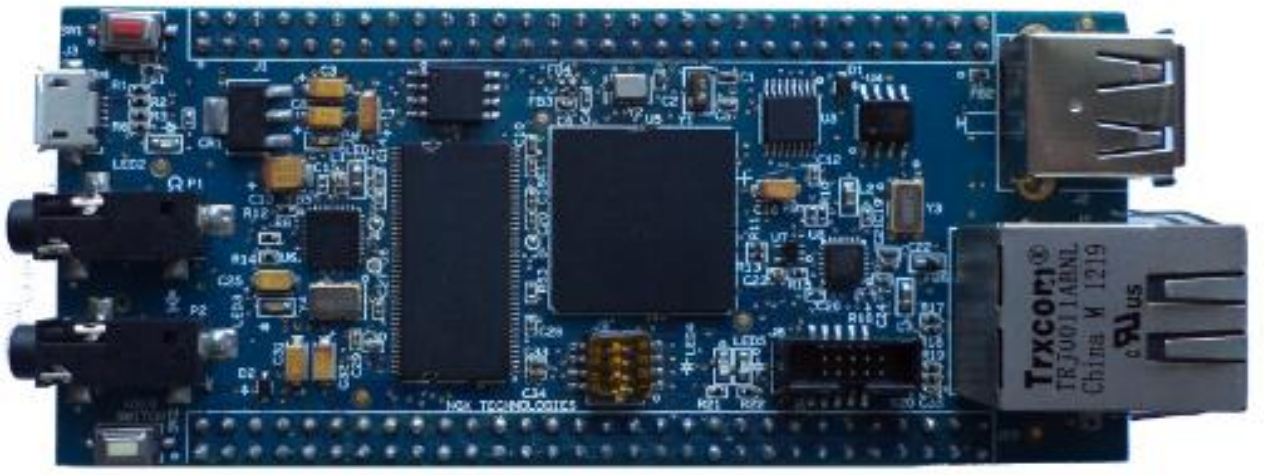
# LPC435x-Xplorer++



**User Manuals for LPC435x-Xplorer++:**
For KEIL MDK-ARM with ULINK2/ME: Click here

**Sample projects for LPC435x-Xplorer++:**
For KEIL MDK-ARM: Click here

**USB Virtual Com INF file:**
Click here to download USB Virtual Com INF file.

## 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.

## Contact Information:

NGX Technologies Pvt. Ltd.
No.216, 5th main Road, R.P.C. Layout,
Vijayanagar 2nd Stage,
Bangalore – 560 104
Phone : +91-80-40925507
email:sales@ngxtechnologies.com

## CE certification:

NGX Technologies LPC435X-Xplorer++ board has 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 behavior. 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.

# Table of Contents

# 1.0 INTRODUCTION

This document is a 'Quick Start Guide' for LPC435x-Xplorer++; a cost effective evaluation platform for NXP's LPC435x MCU. This document focuses on the kit contents, board verification, possible debuggers and IDEs that can be used.

## 1.1 Possible Debuggers and IDEs that can be used

- **ULINK2 with KEIL uVision**
- **NXP LPCLink with LPCXpresso**
- **Red Probe+ with Red Suite from Code Red**
- **I-jet with IAR Embedded Workbench**
- **Segger JLink with IAR Embedded Workbench or KEIL uVision**

The LPC435x-Xplorer++ is packaged as shown in the following image.

**TBD**

**Fig. 1**

After unboxing the package you should find LPC435x-Xplorer++ Board, 'USB AM to Micro B' cable as shown in the following image.

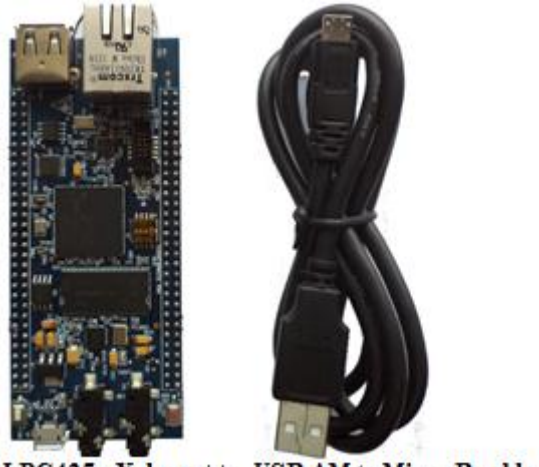



**Fig. 2**

## 1.2 ARM JTAG (20-pin) to Cortex JTAG (10-pin) Adapter

Please note that your existing debugger might be supporting only the '20-pin ARM JTAG connector'. In such scenarios one would require a '20-pin to 10-pin adaptor' and the necessary cables. The LPC435x-Xplorer++ has on board 'Cortex SWD/JTAG 10-pin male connector', the '20-pin to 10-pin adaptor' is not a part of the LPC435x-Xplorer++ package and user needs to buy them separately.

If the debugger supports the '10-pin Cortex header' one needs to have the 10-pin ribbon cable and can directly connect to the LPC435x-Xplorer++. Please note even the 10-pin ribbon cable is not a part of standard delivery and needs to be procured separately.

The picture below shows 20-pin ribbon cable, 10-pin ribbon cable and '20-pin to 10-pin adaptor'.

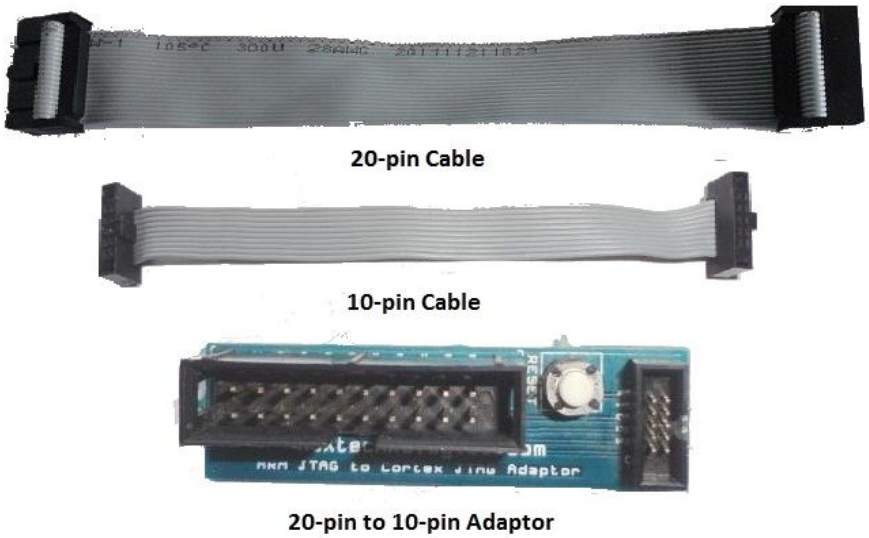



**Fig. 3**

## 1.3 ULINK-ME and KEIL

Connect one end of 10-pin ribbon cable ‘ULINK-ME 10-pin box header’ and other end to LPC435x-Xplorer++ as shown in the below image. The hardware setup is now ready for programing an LPC435x-Xplorer++ board with ULINK-ME and KEIL IDE. Please refer keil knowledgebase article for connecting ‘ULINK-ME 10-pin ribbon cable’ to NGX Xplorer++.

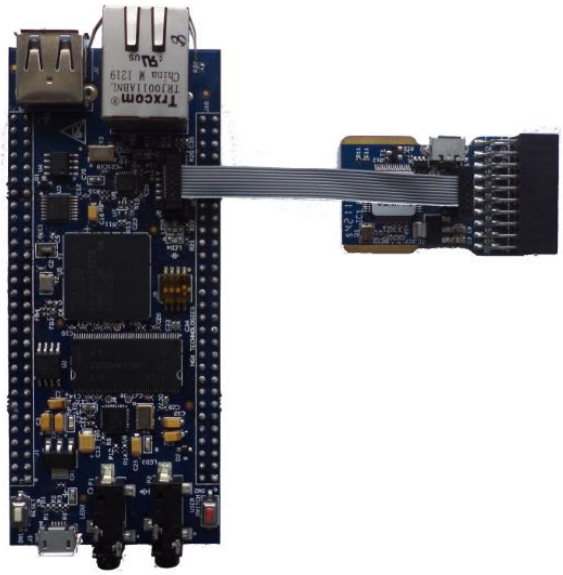


**Fig. 4**

## 1.4 ULINK2 and KEIL

Connect ‘ULINK2 20-pin cable’ to ‘20-pin to 10-pin adaptor’ and connect one end of 10-pin ribbon cable to ‘20-pin to 10-pin adaptor’ and other end to LPC435x-Xplorer++ as shown in the below image. The hardware setup is now ready for programing an LPC435x-Xplorer++ board with ULINK2 and KEIL IDE. Please refer keil knowledgebase article for connecting ULINK2 to NGX Xplorer++.


**Fig. 5**

# 2.0 LPC435x-Xplorer++ Overview

## 2.1 Introduction

The NGX LPC435x-Xplorer++ is a compact and versatile evaluation platform for the NXP's Cortex-M4 based MCUs. 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/JTAG you can use this platform with any tool. 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: 102mm x 43mm
- Controller: LPC435x, 256 pin BGA
- PCB: 4-layer (RoHS complaint)
- Two LEDs
- One user switch and one reset switch
- Boot select switch
- 32Mb Quad flash
- 32MB SDRAM
- On board crystals for controller, RTC and audio codec
- On board Ethernet PHY, 25 MHz Crystal and RJ45 connector with magnetics
- On board audio codec and audio jacks
- On board USB host port
- On board RS232 level
- On board USB port
- 10-pin cortex debug header
- Unused I/Os brought to a header.

## 2.3 BLOCK DIAGRAM

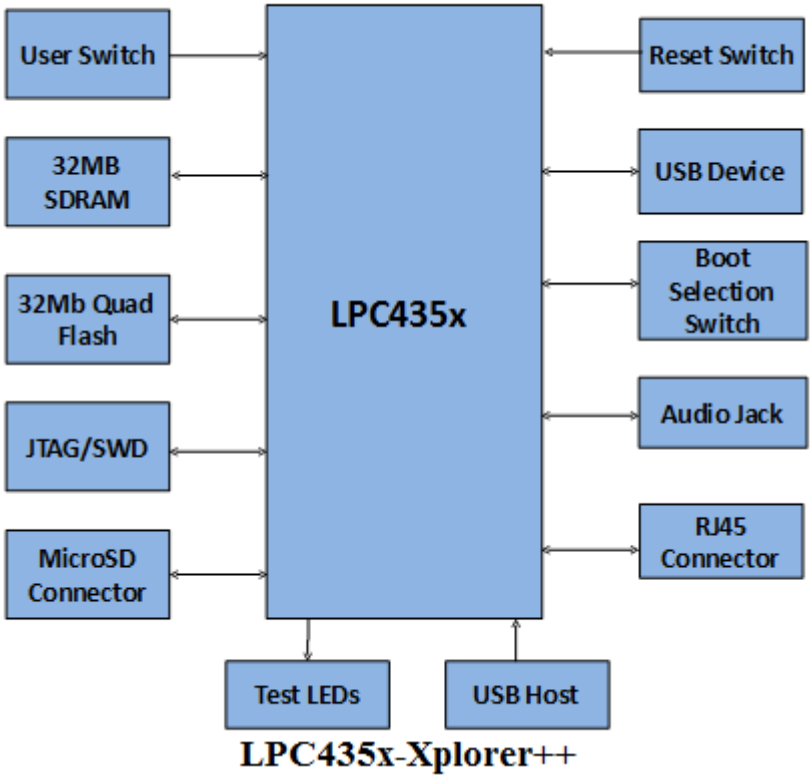



**Fig. 6**

## 2.4 LPC435x-Xplorer++ pinout

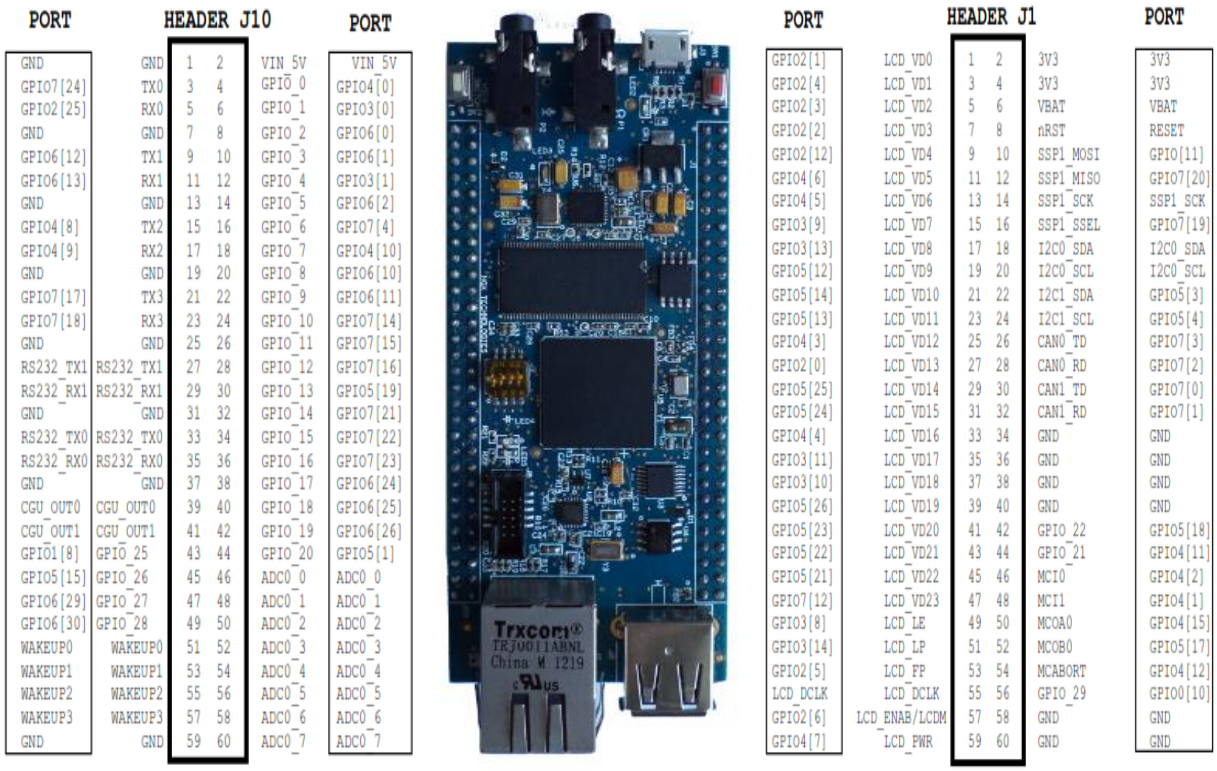



**Fig.7**

## 2.5 LPC435x description

The LPC435x is ARM Cortex-M4 based microcontroller for embedded applications which include an ARM Cortex-M0 coprocessor, up to 1 MB of flash and 136 kB of on-chip SRAM, 16 kB of EEPROM memory, a quad SPI Flash Interface (SPIFI), advanced configurable peripherals such as the State Configurable Timer (SCT) and the Serial General Purpose I/O (SGPIO) interface, two High-speed USB controllers, Ethernet, LCD, an external memory controller, and multiple digital and analog peripherals. The LPC435x operate at CPU frequencies of up to 204 MHz.

Cortex-M4 Processor core

- ARM Cortex-M4 processor, running at frequencies of up to 204 MHz.
- ARM Cortex-M4 built-in Memory Protection Unit (MPU) supporting eight regions.
- ARM Cortex-M4 built-in Nested Vectored Interrupt Controller (NVIC).
- Hardware floating-point unit.
- Non-maskable Interrupt (NMI) input.
- JTAG and Serial Wire Debug (SWD), serial trace, eight breakpoints, and four watch points.
- Enhanced Trace Module (ETM) and Enhanced Trace Buffer (ETB) support.
- System tick timer.

Cortex-M0 Processor core

- ARM Cortex-M0 co-processor capable of off-loading the main ARM Cortex-M4 application processor.
- Running at frequencies of up to 204 MHz.
- JTAG
- Built-in NVIC.

On-chip memory

- Up to 1 MB on-chip dual bank flash memory with flash accelerator.
- 16 kB on-chip EEPROM data memory.
- 136 kB SRAM for code and data use.
- Multiple SRAM blocks with separate bus access. Two SRAM blocks can be powered down individually.
- 64 kB ROM containing boot code and on-chip software drivers.
- 64 bit of general-purpose One-Time Programmable (OTP) memory.

Configurable digital peripherals

- Serial GPIO (SGPIO) interface.
- State Configurable Timer (SCT) subsystem on AHB.
- Global Input Multiplexer Array (GIMA) allows to cross-connect multiple inputs and outputs to event driven peripherals like the timers, SCT, and ADC0/1.

Serial interfaces

- Quad SPI Flash Interface (SPIFI) with four lanes and up to 52 MB per second.
- 10/100T Ethernet MAC with RMII and MII interfaces and DMA support for high throughput at low CPU load. Support for IEEE 1588 time stamping/advanced time stamping (IEEE 1588-2008 v2).
- One High-speed USB 2.0 Host/Device/OTG interface with DMA support and on-chip high-speed PHY. One High-speed USB 2.0 Host/Device interface with DMA support, on-chip full-speed PHY and ULPI interface to external high-speed PHY.
- USB interface electrical test software included in ROM USB stack.
- One 550 UART with DMA support and full modem interface.
- Three 550 USARTs with DMA and synchronous mode support and a smart card interface conforming to ISO7816 specification. One USART with IrDA interface.

- Up to two C_CAN 2.0B controllers with one channel each. Use of C_CAN controller excludes operation of all other peripherals connected to the same bus bridge
- Two SSP controllers with FIFO and multi-protocol support. Both SSPs with DMA support.
- One SPI controller.
- One Fast-mode Plus I2C-bus interface with monitor mode and with open-drain I/Opins conforming to the full I2C-bus specification. Supports data rates of up to 1Mbit/s.
- One standard I2C-bus interface with monitor mode and with standard I/O pins.
- Two I2S interfaces, each with DMA support and with one input and one output.

Digital peripherals

- External Memory Controller (EMC) supporting external SRAM, ROM, NOR flash, and SDRAM devices.
- LCD controller with DMA support and a programmable display resolution of up to1024 H x768V. Supports monochrome and color STN panels and TFT color panels; supports 1/2/4/8 bpp Color Look-Up Table (CLUT) and 16/24-bit direct pixel mapping. Available on parts LPC4357/53 only.
- Secure Digital Input Output (SD/MMC) card interface.
- Eight-channel General-Purpose DMA controller can access all memories on the AHB and all DMA-capable AHB slaves.
- Up to 164 General-Purpose Input/Output (GPIO) pins with configurable pull-up/pull-down resistors.
- GPIO registers are located on the AHB for fast access. GPIO ports have DMA support.
- Up to eight GPIO pins can be selected from all GPIO pins as edge and level sensitive interrupt sources.
- Two GPIO group interrupt modules enable an interrupt based on a programmable pattern of input states of a group of GPIO pins.
- Four general-purpose timer/counters with capture and match capabilities.
- One motor control Pulse Width Modulator (PWM) for three-phase motor control.
- One Quadrature Encoder Interface (QEI).
- Repetitive Interrupt timer (RI timer).
- Windowed watchdog timer (WWDT).
- Ultra-low power Real-Time Clock (RTC) on separate power domain with 256 bytes of battery powered backup registers.
- Alarm timer; can be battery powered.

Analog peripherals

- One 10-bit DAC with DMA support and a data conversion rate of 400 kSamples/s.
- Two 10-bit ADCs with DMA support and a data conversion rate of 400 kSamples/s. Up to eight input channels per ADC.

Unique ID for each device.

Clock generation unit

- Crystal oscillator with an operating range of 1 MHz to 25 MHz.
- 12 MHz internal RC oscillator trimmed to 2 % accuracy over temperature and = voltage (1 % accuracy for $T_{amb}$ = 0 °C to 85 °C).
- Ultra-low power Real-Time Clock (RTC) crystal oscillator.
- Three PLLs allow CPU operation up to the maximum CPU rate without the need for a high-frequency crystal. The second PLL can be used with the High-speed USB, the third PLL can be used as audio PLL.
- Clock output.

Power

- Single 3.3 V (2.2 V to 3.6 V) power supply with on-chip DC-to-DC converter for the core supply and the RTC power domain.
- RTC power domain can be powered separately by a 3 V battery supply.
- Four reduced power modes: Sleep, Deep-sleep, Power-down, and Deep power-down.
- Processor wake-up from Sleep mode via wake-up interrupts from various peripherals.
- Wake-up from Deep-sleep, Power-down, and Deep power-down modes via external interrupts and interrupts generated by battery powered blocks in the RTC power domain.
- Brownout detect with four separate thresholds for interrupt and forced reset.
- Power-On Reset (POR).

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

# 3.0 LPC435x-Xplorer++ verification

NGX's evaluation platforms ship with a factory-programmed test firmware that verifies all the on-board 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:

- LPC435x-Xplorer++
- Power: USB cable or external power supply (Alternatively the LPC435x-Xplorer++ has a 5V in pin available for powering through external power source)
- PC: With Windows7 or XP (32-bit or 64-bit)
- One USB AM to Micro B cable
- Micro SD card
- 2-GB USB pen drive
- Audio-out (Auxiliary) cable (3.5mm diameter connector)

## 3.1 Board Image with pointers to the peripherals

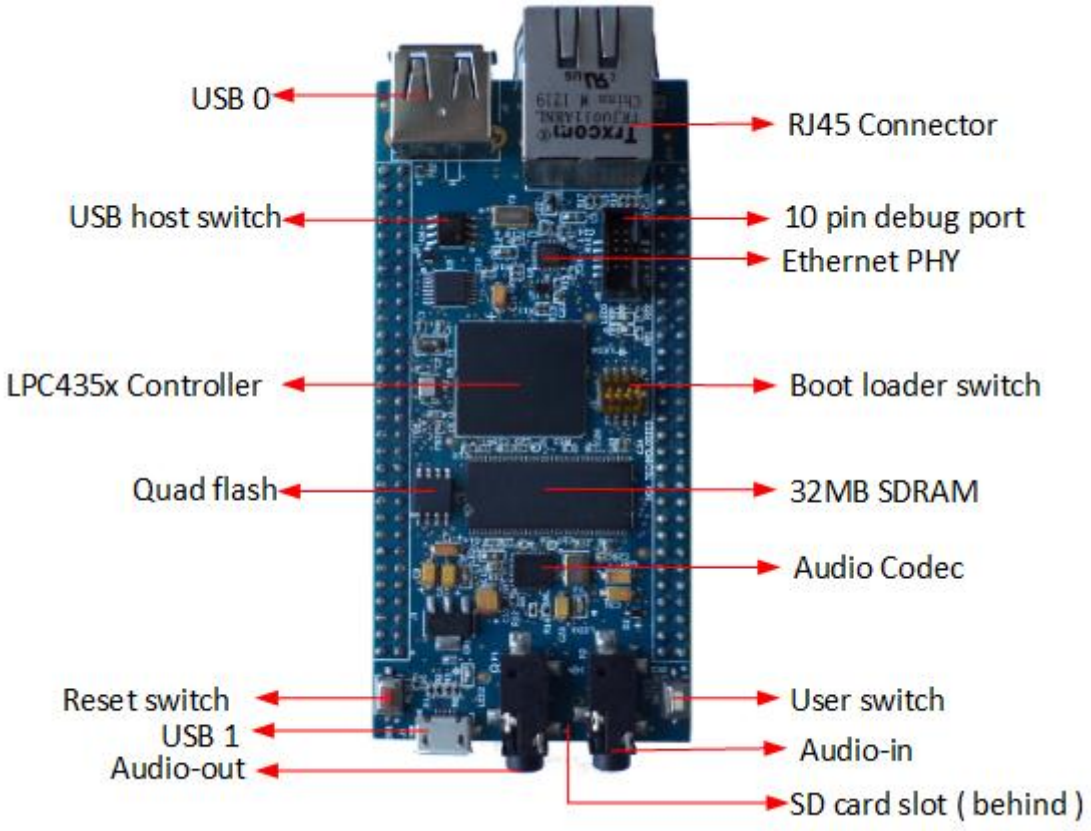



**Fig.8**

## 3.2 Powering the Board

The LPC435x-Xplorer++ can be powered through USB1, It is highly recommended that the user tests all the peripherals as soon as the board is received. A regulated supply can be supplied to the 5V pin on the LPC435x-Xplorer++ header.

*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 power supply is not a part of standard delivery.*

## 3.3 Verifying all the peripherals on LPC435x-Xplorer++

The following section focuses on the verification of all the peripherals supported on theLPC435x-Xplorer++. The order of the tests is mentioned in the same manner 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 on-board peripherals. The test firmware executable resides on the Quad Flash. The BOOT select switch is configured to execute from the Quad Flash interface.

*Note: The test firmware "Debug Messages" or flow might be changed in due course. Generally these are only cosmetic changes so that the usage is easier. If you observe a different message than the one mentioned in the Manual, do not worry and please proceed with the test.*

***Important Note:* The user needs to press the RESET switch to be able to reset the controller. However for the power up reset (USB power cycle) the controller boots up fine.**

Power up the board over USB1 port and we are all set to verify the LPC435x-Xplorer++ peripherals. Before we get to the verification we need to install the Virtual COM port drivers needed for the LPC435x-Xplorer++ (USB1 port) to appear as a Virtual COM port (Used for viewing the debug messages on serial emulation tool). Fortunately, this is a one-time setup and fairly simple. On a Windows machine the user needs to point to the location of the INF file. Download INF file Click Here

Steps to install the VCOM drivers on windows 7 machine:

Step 1: Connect USB1 to the computer, Open device manager, you can find “NXP LPC43xx VCOM” new device listed under ‘Other devices’.

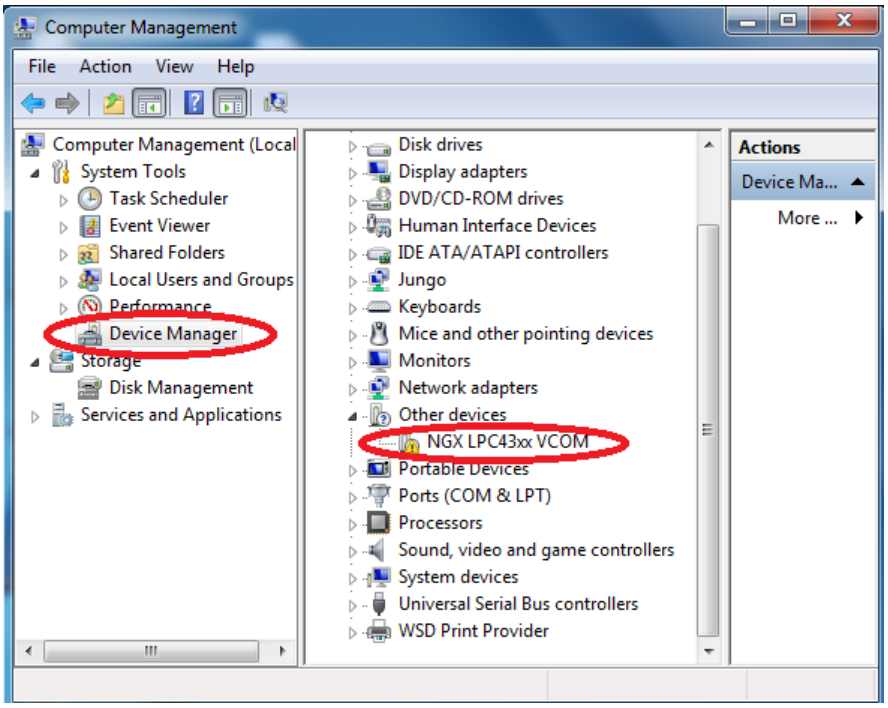



**Fig.9**

Step 2: Right click on the “NXP LPC43xx VCOM” and then left click on ‘Update Driver Software’.

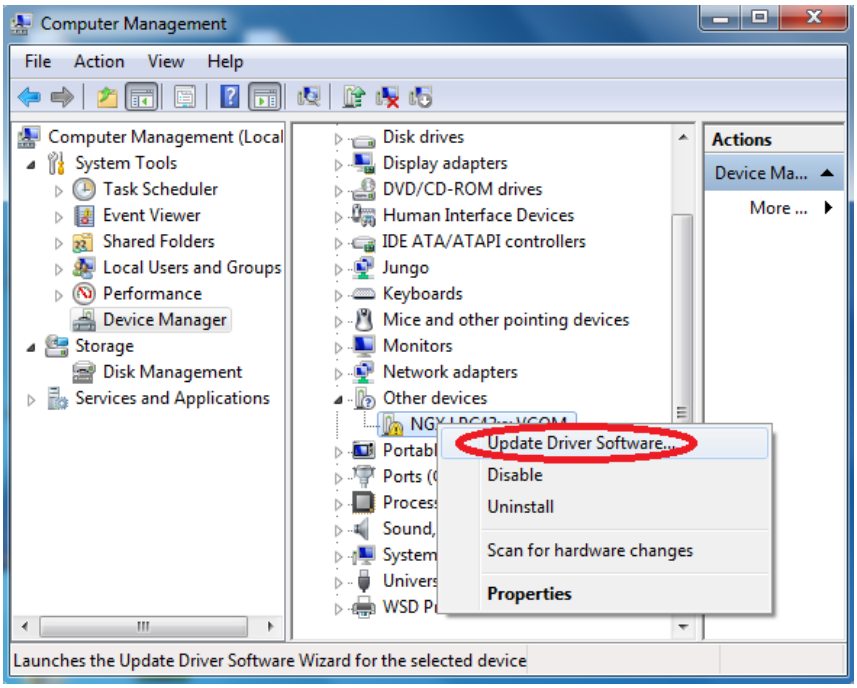



**Fig.10**

Step 3: Click on Browse my computer for driver software.

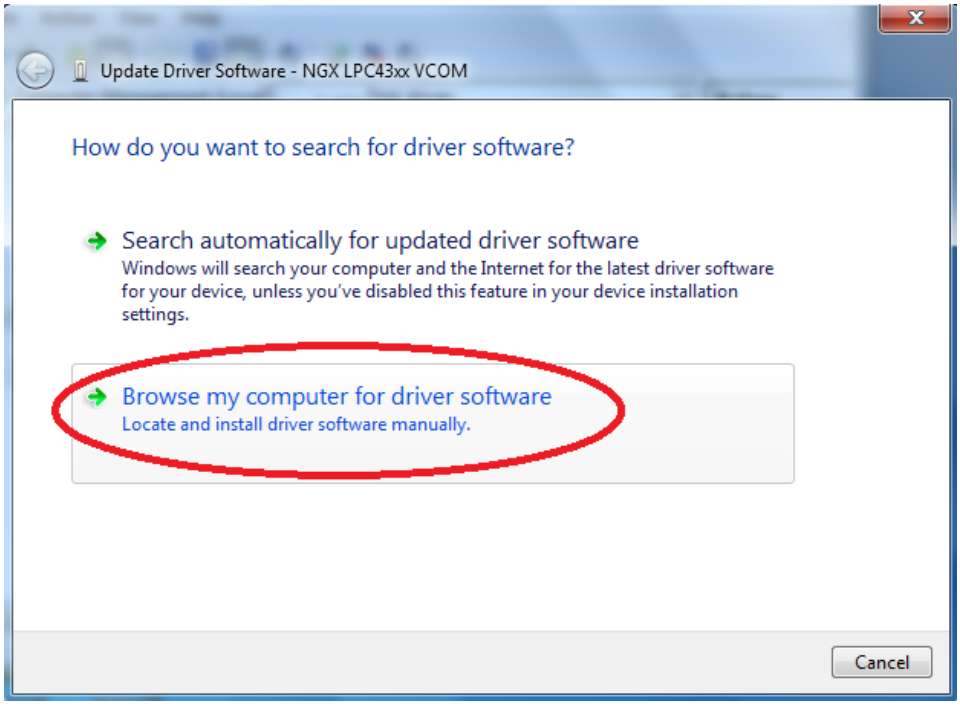



**Fig.11**

Step 4: Click Browse, select downloaded LPC4350-Xplorer++_Rev AR2_Keil\Usb1VcomLib folder and then click on OK.

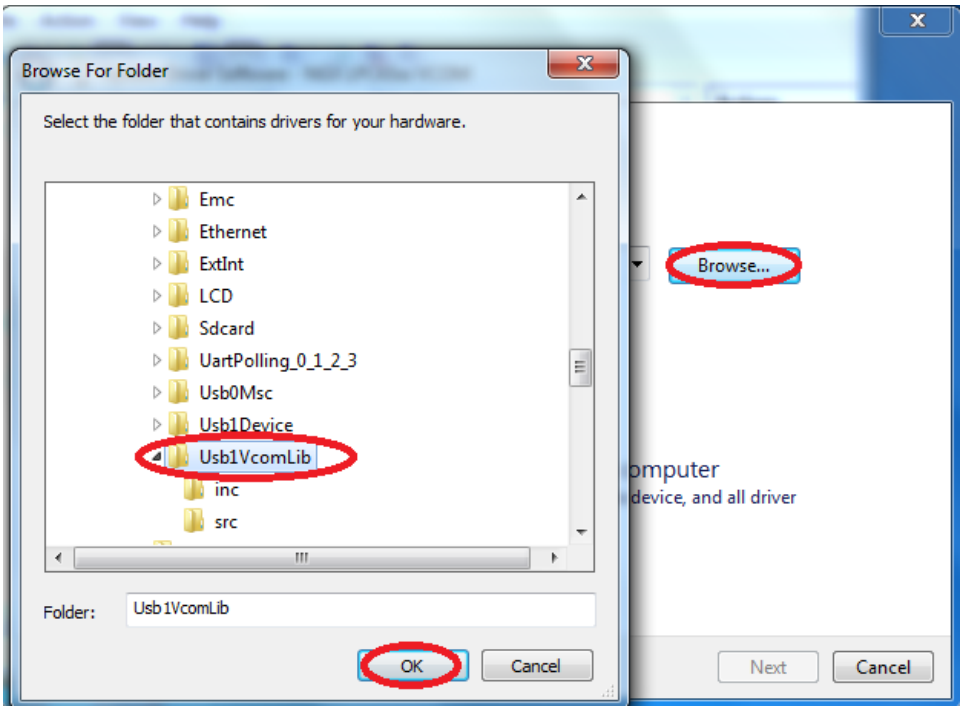



**Fig.12**

Step 5: Click on Next to continue driver installation.

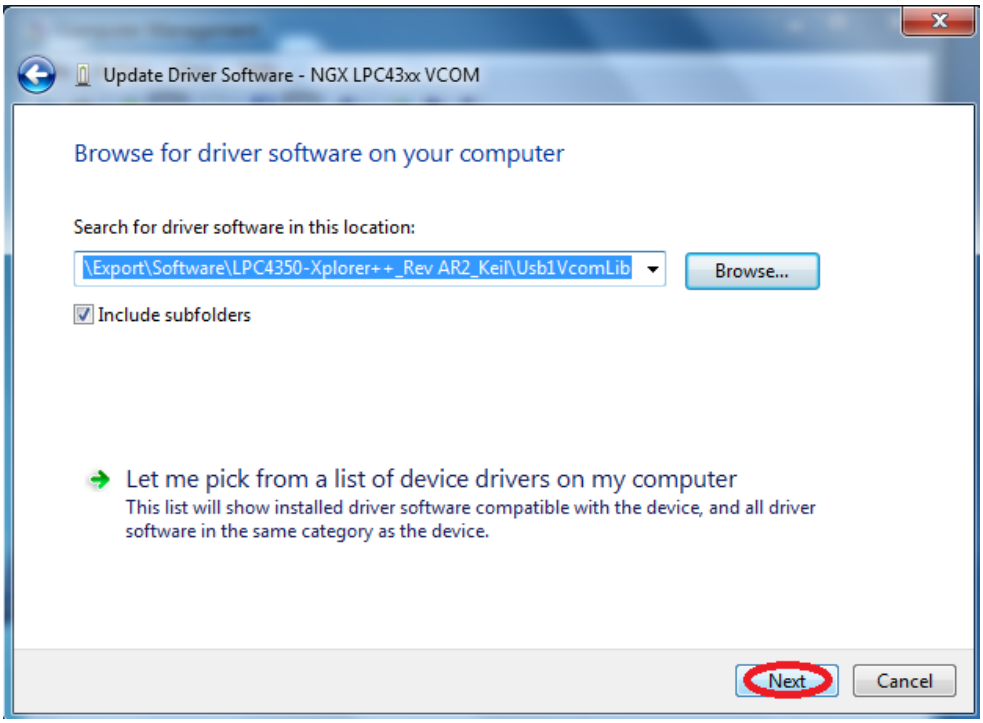



**Fig.13**

Step 6: Click on 'Install this driver software anyway'.

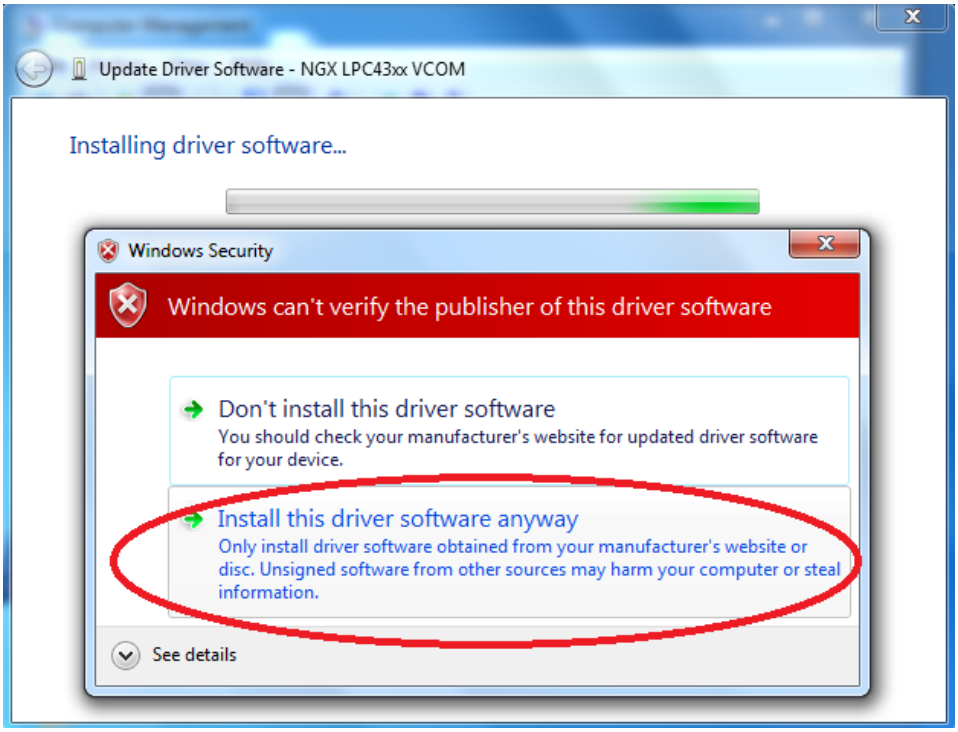



**Fig.14**

Step 7: The ‘LPC43xx USB VCom driver’ is successfully installed, click on close.

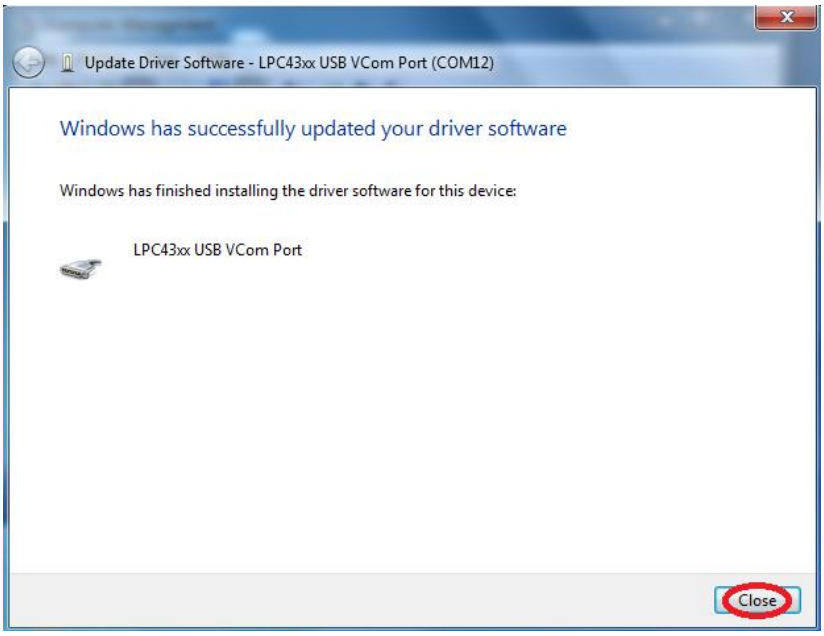



**Fig.15**

Step 8: Now ‘LPC43xx USB VCom Port’ (COM12) is ready to use.

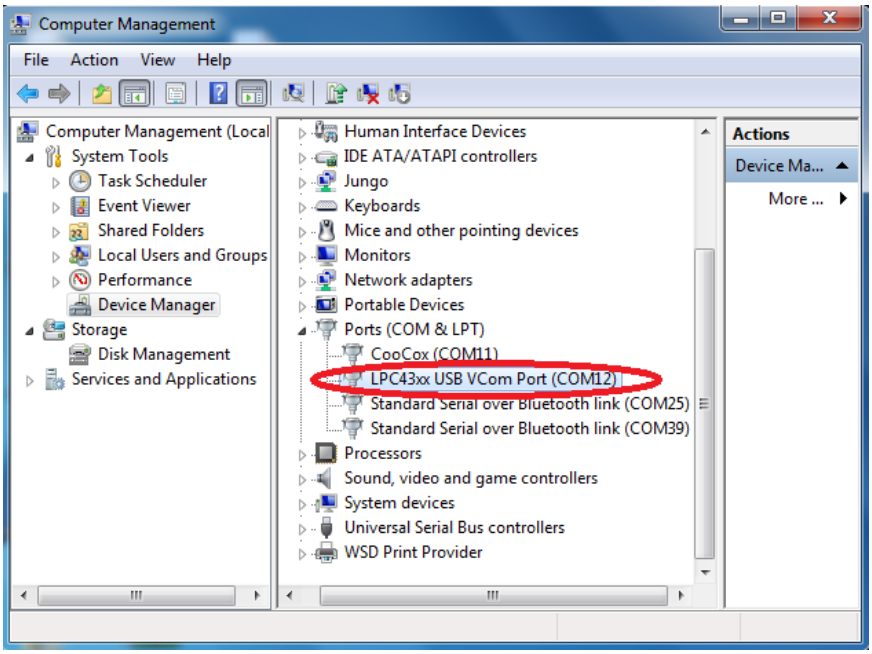
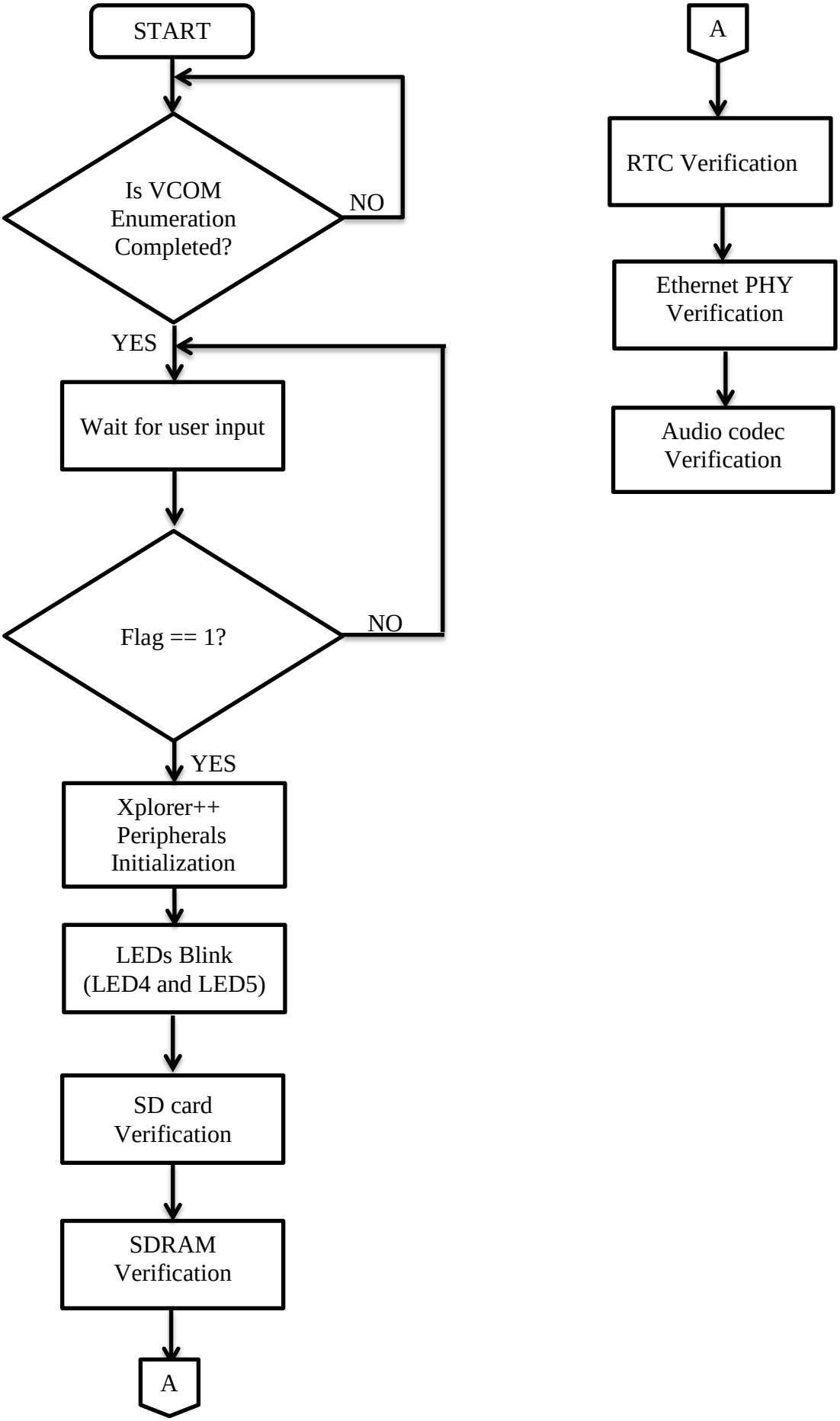



**Fig.16**

*Note: The Virtual COM is listed under the device manager. Please note that the COM port list under the Device Manager is automatically updated with the COM port number for the Virtual COM. On our test machine COM12 is the virtual COM port. The COM12 will appear only if the Xplorer++ board is connected (USB1) to the PC.* ***Every time the Xplorer++ is reset the user needs to close the Hyper Terminal application and restart it again.***

The orders in which the on-board peripherals are verified by the firmware are as follows:
Test Firmware Flowchart:



### 3.3.1 USB1 (Virtual COM port)

**Test setup and verification**:
For the very first time the windows machine will ask for the appropriate virtual COM drivers to be installed.

Steps to select 'USB1 VCOM port' on HyperTerminal in windows 7 machine:

Step 1: Open a HyperTerminal, type name and click on OK.

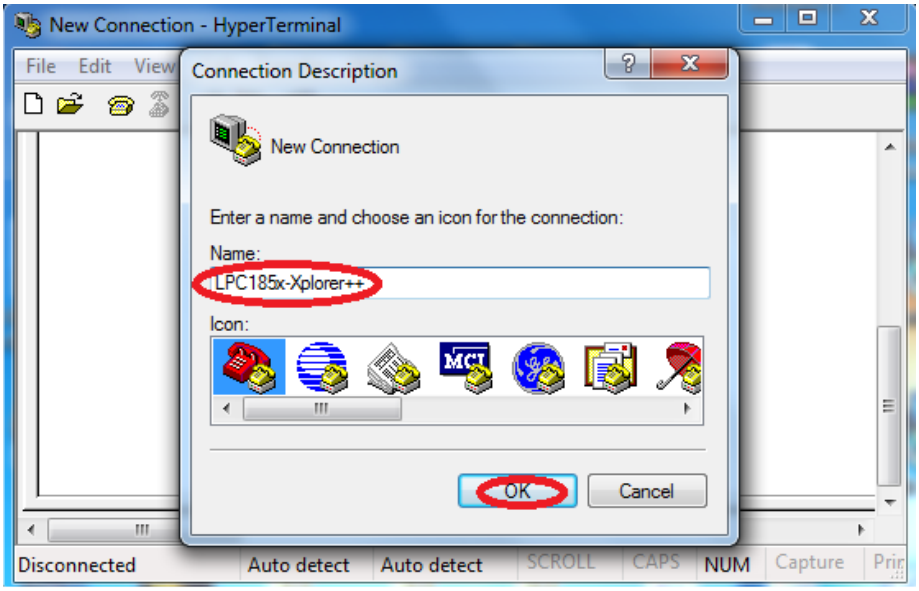



**Fig.17**

Step 2: Select 'USB1 Vcom Port' (COM12) and click on OK.

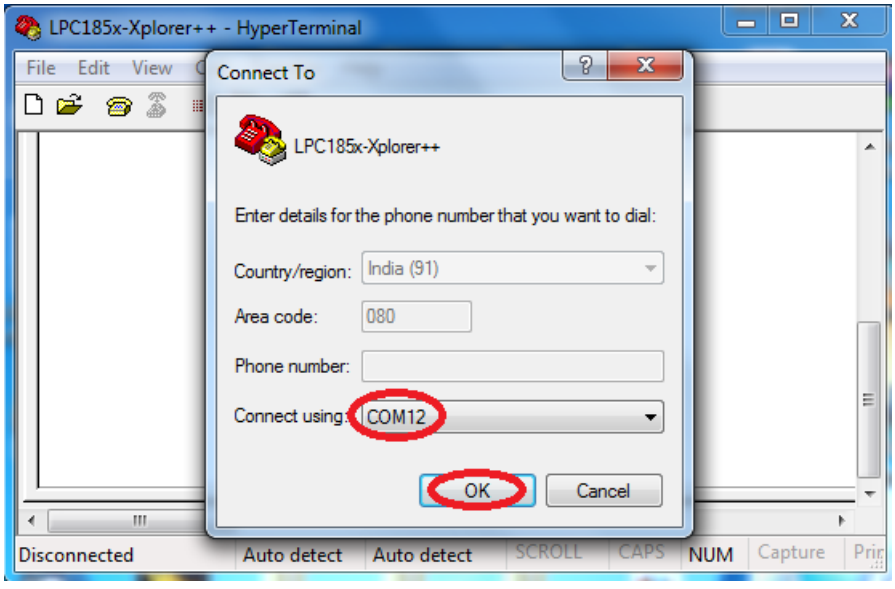



**Fig.18**

Step 3: Click on ‘Restore Defaults’ and click on OK.

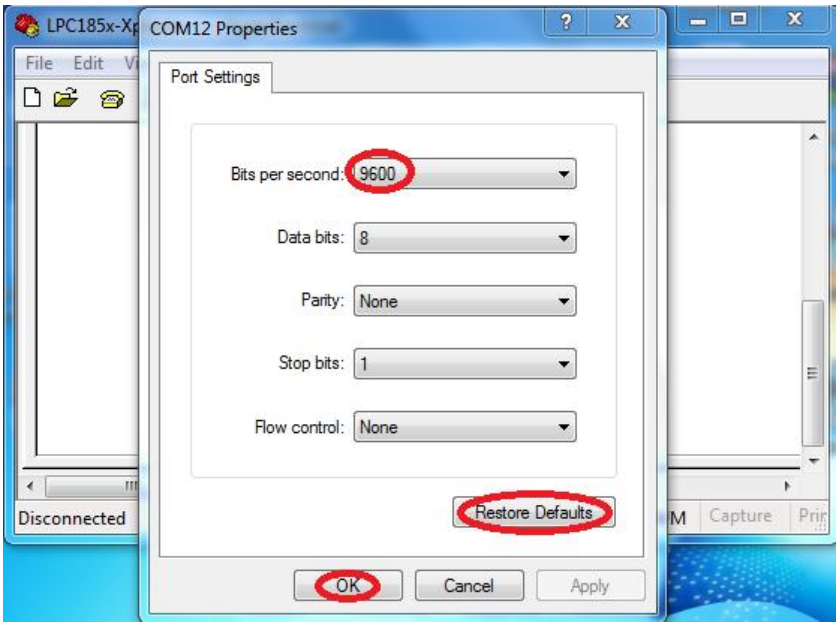



**Fig.19**

Step 4: Now the ‘USB1 VCom’ is ready to use.

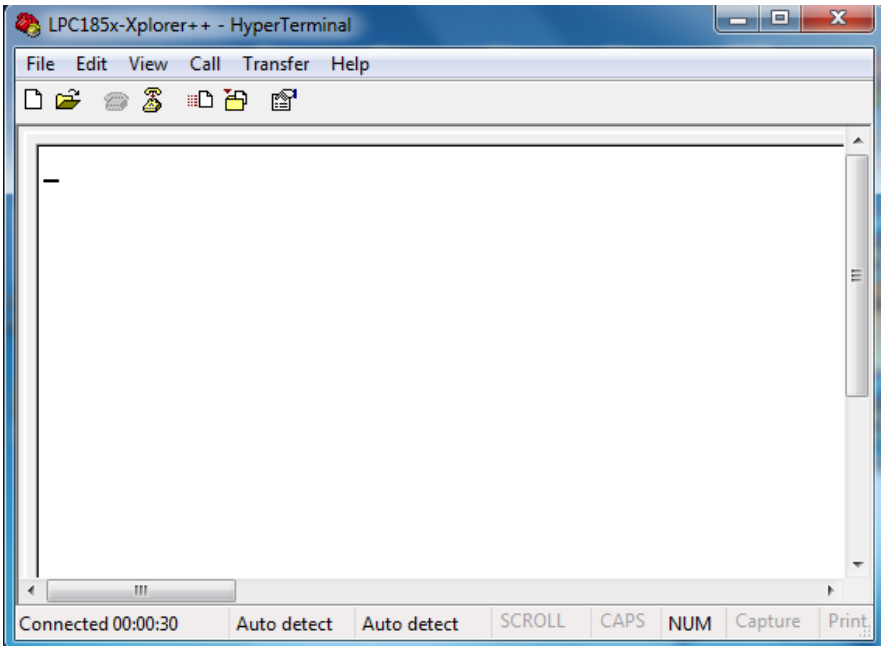



**Fig.20**

*Note: You would not be able to proceed with the verification unless the Virtual COM drivers are installed. The firmware waits for the USB1 to enumerate as VCOM port.*

## 3.3.2 User Input Switch

**Test setup and verification**:

Once the VCOM drivers are installed the Xplorer++ waits for the User Input Switch to be pressed. Only after detecting a user button (SW2) press the test firmware proceeds with validating other peripherals. This synchronization is necessary to ensure that the debug messages on the VCOM port can be viewed from the start of the test. Without this synchronization the test firmware would proceed with the debug messages being displayed, while the user is still configuring the Hyper-Terminal or other serial emulation tool.

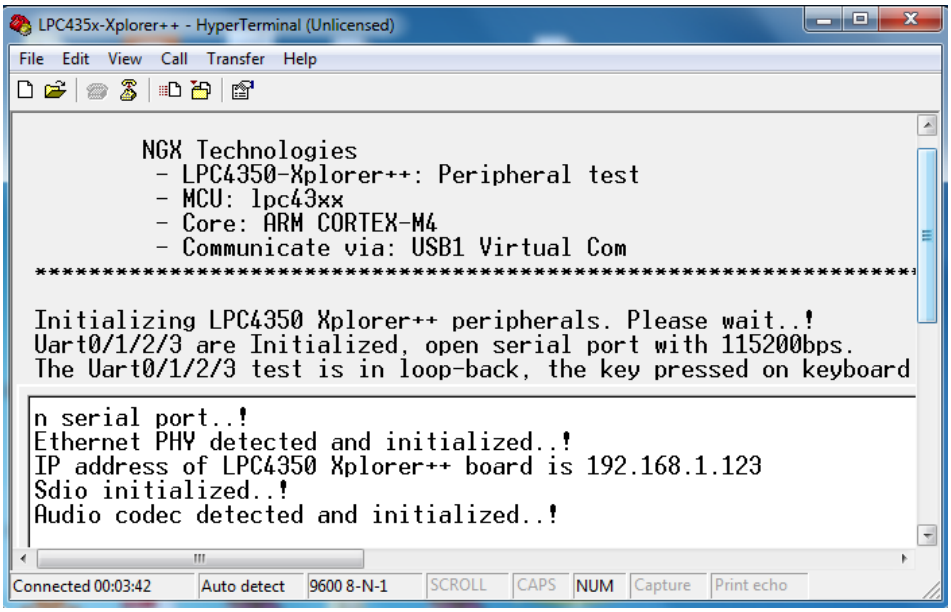



**Fig.21**

Once the hardware initialization is completed menu will be displayed as shown in the following image

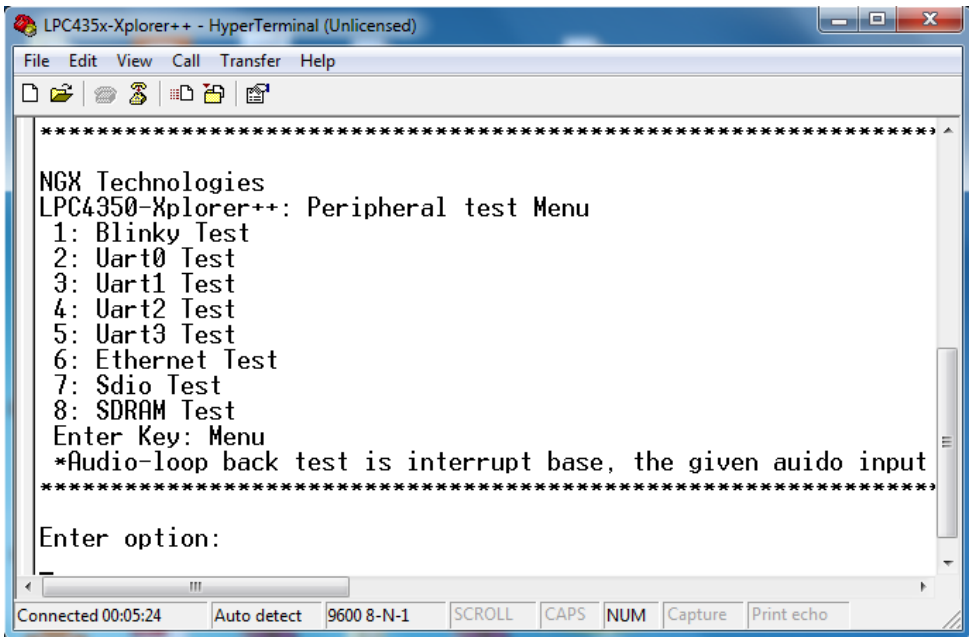



**Fig.22**

### 3.3.3 Test LEDs

**Test setup and verification**:
To test LEDs, enter option 1, the LED4 and LED5 on board starts blinking.

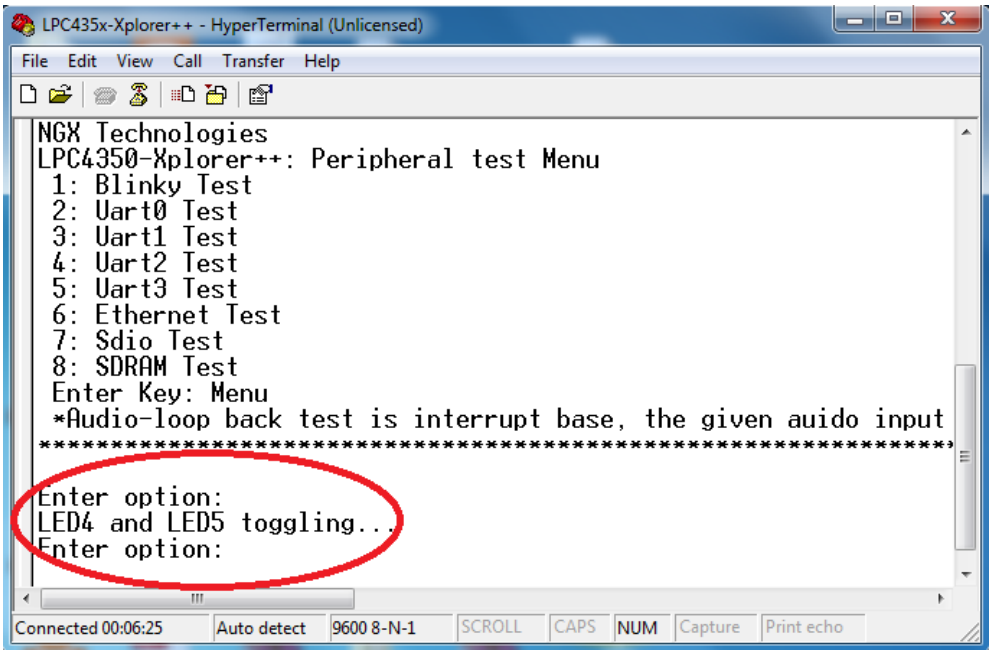



**Fig.23**

### 3.3.4 Micro SD connector

**Test setup and verification**:
To test SDIO enter option 7, the firmware validates the micro SD card interface by writing and reading a sector of the SD card connected. Please note that we need to use a micro SD card with FAT file system. The result of this test is displayed over the VCOM port.

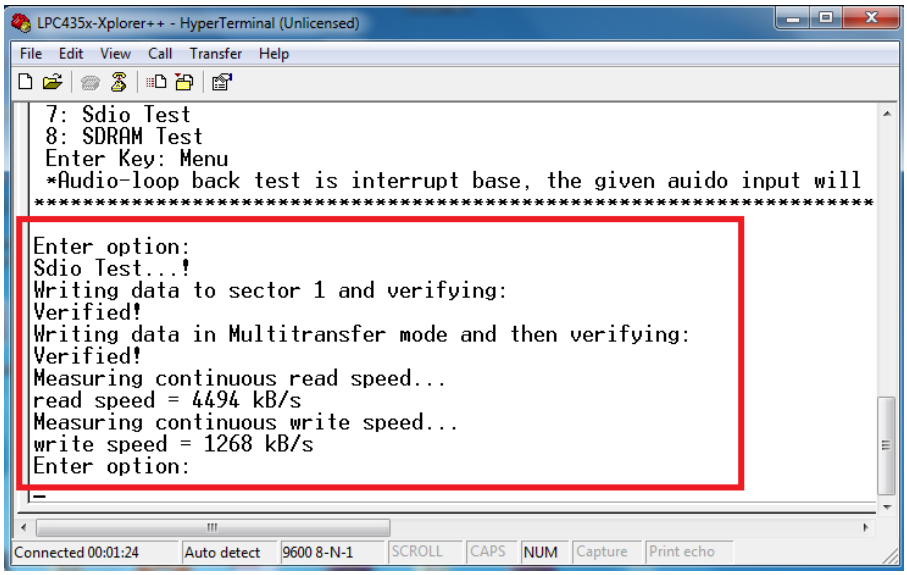



**Fig.24**

### 3.3.5 SDRAM

**Test setup and verification**:
To test SDRAM enter option 8, the result of this test is displayed over the VCOM port as shown in the following image.
*Note: LPC185x and LPC435x are pin to pin and binary compatible; we can use the LPC185x bin files and sample programs.*

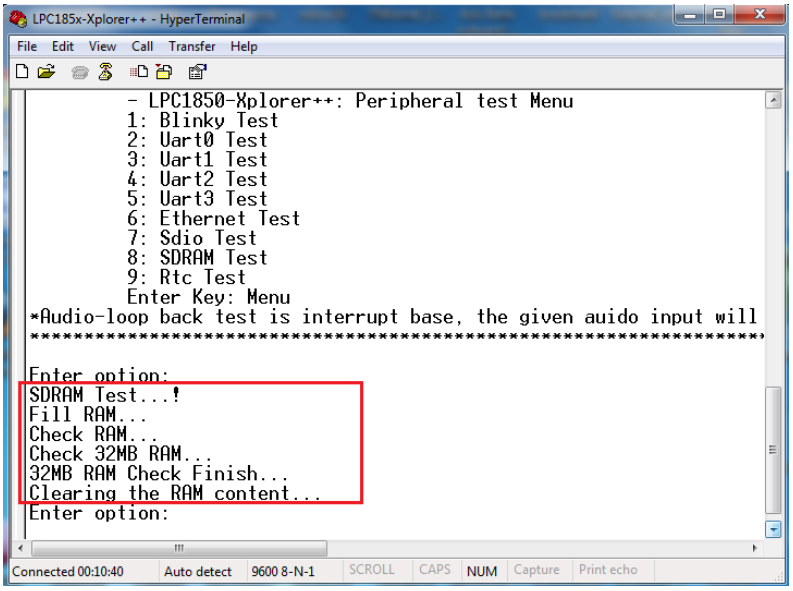



**Fig.25**

### 3.3.6 RTC

**Test setup and verification**:
To test RTC enter option 9, the time and date will be displayed over the VCOM port as shown in the following image.

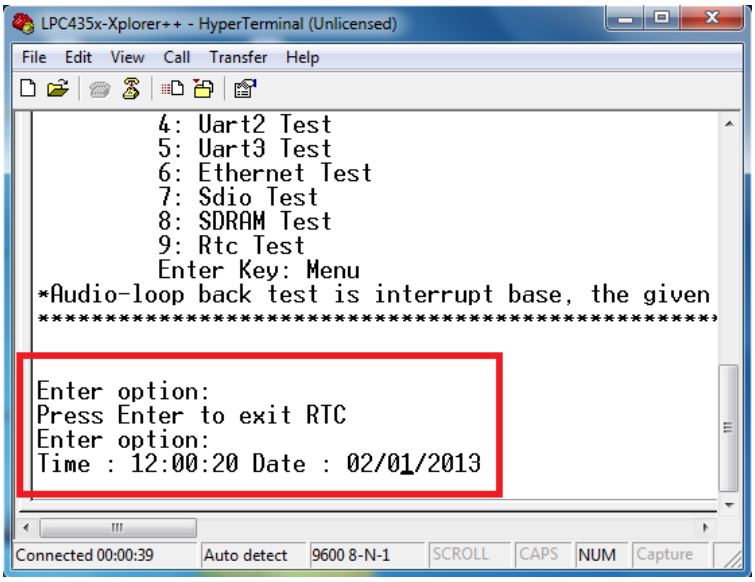



**Fig.26**

## 3.3.7 Ethernet

**Test setup and verification**:
To test Ethernet, enter option 6, the test firmware configures the LPC435x-xplorer++ board as a webserver.

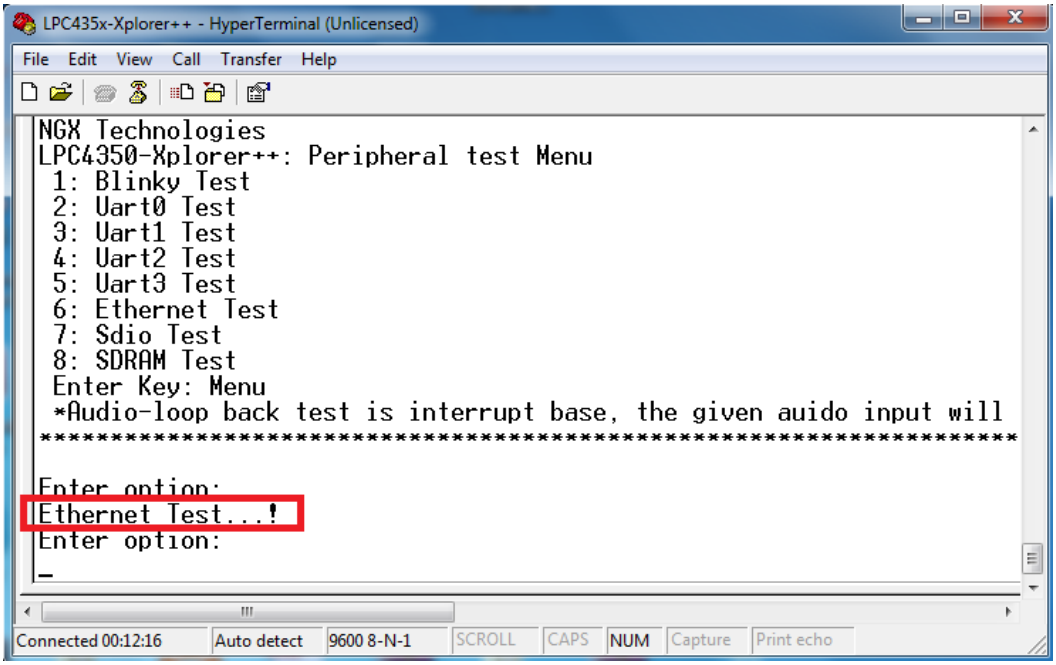



**Fig.27**

The Ethernet interface can be verified by either using a PING command in the windows command prompt.

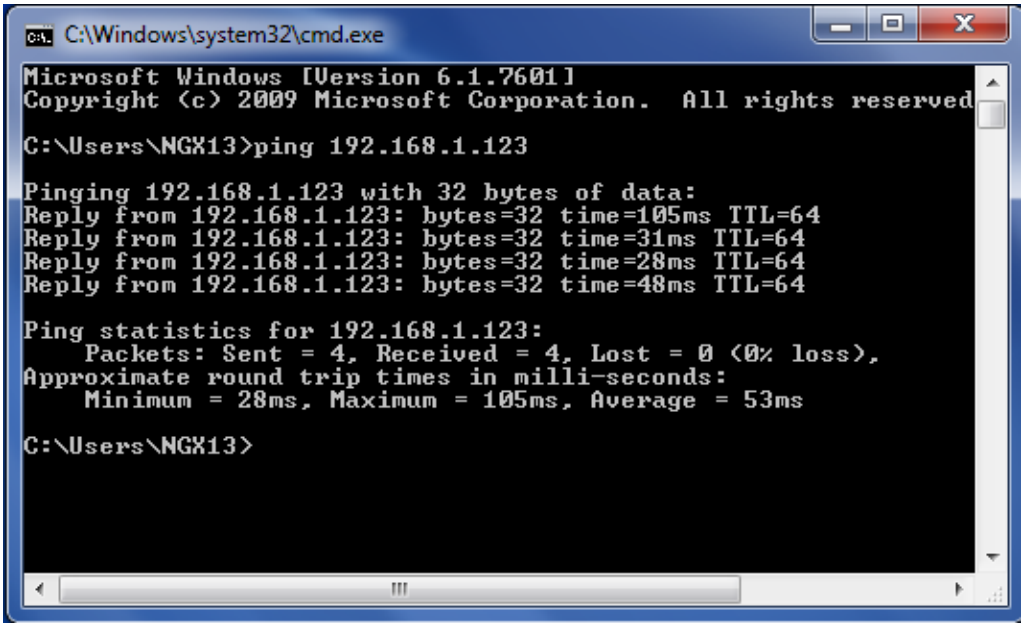



**Fig.28**

The IP address of the LPC435x-Xplorer++ board is configured as 192.168.1.123. Type the same IP address in the browser. Clicking the ON button will TURN-ON LED4 and clicking OFF button will TURN-OFF LED4.


**Fig.29**

## 3.3.8 Audio Interface

**Test setup and verification**:

For the audio interface the LPC435x-Xplorer++ incorporates external audio codec from NXP. The codec is interfaced to the MCU over I2S0 for data and over I2C0 for command interface. The test firmware verifies both the audio-in and audio-out path. To verify the audio interface the user needs to feed some audio data through the audio-in (LINE-IN) interface and then connect a headphone at the audio-out jack. If one is able to hear the same audio data that is being fed over audio-in interface, we have verified.

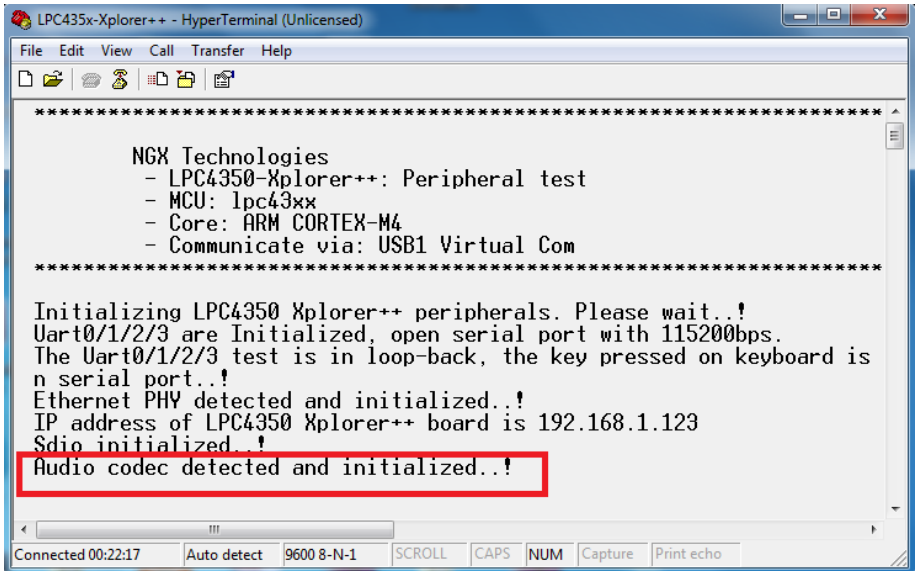



**Fig.30**

### 3.3.9 USB0_HOST

**Test setup and verification**:
Connect the USB AM to Micro cable to USB1 on board connector and PC and Flash the Usb0Msc binary and RESET the board. Open Hyper-Terminal and select Vcom port with 9600Mbps, insert the 2 GB pen drive to on board host connector, the content of first sector is displayed on Hyper-Terminal as shown in the following image.

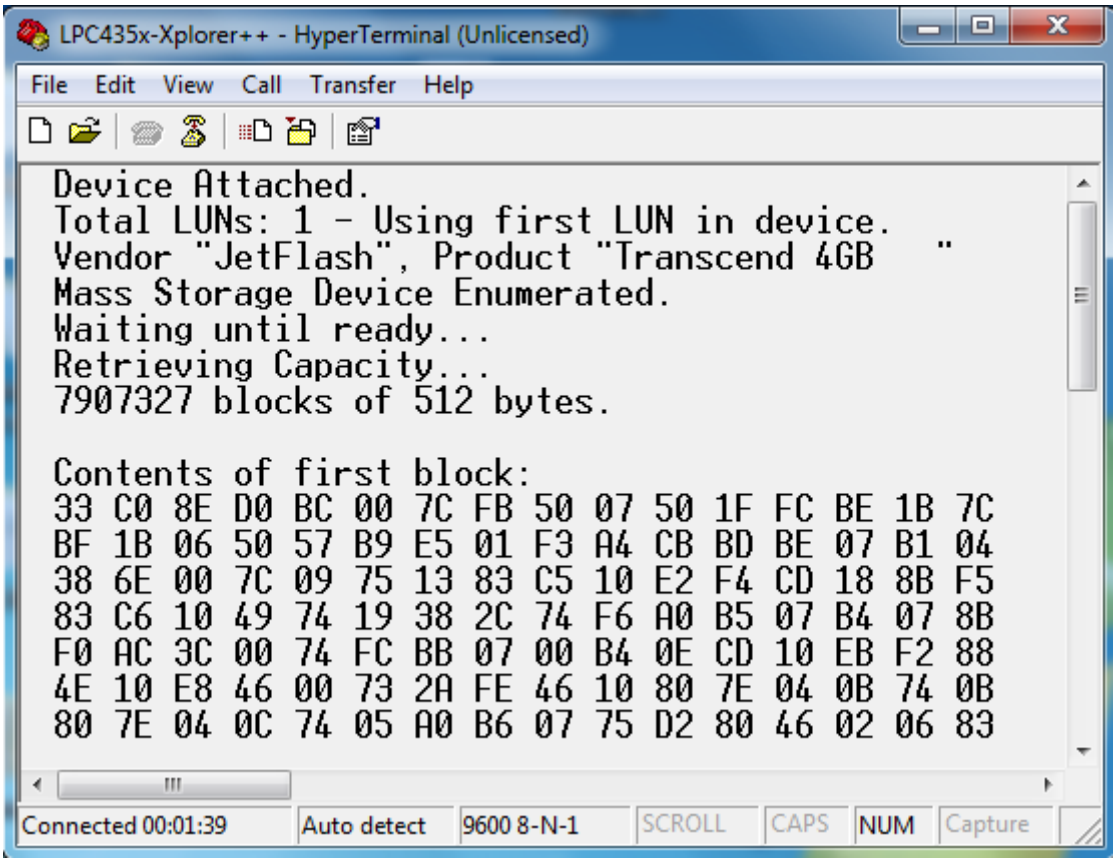



**Fig.31**

**About this document:**

**Revision History**

Version: V1 author: Veeresh Tumbaragi

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