



FLE Fusion uCLinux: Xilinx Spartan3-700AN MP3 Demo Setup Guide  
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**1. Change Log**

Revision	Description	Editor
1.0	Initial Release	SMS

## **2. Introduction**

This document is intended to provide the reader with a step-by-step setup guide for configuring the Finger Lakes Engineering Fusion uCLinux onto the Xilinx Spartan3-700AN Evaluation Board.

The reference design works in conjunction with the FLE Lancer Daughter Card and will demonstrate MP3 Audio Playback as well as NAND Flash Filesystem access using the FLE FUSION uCLinux system.

The FLE Fusion uCLinux is based on the 2.4.31 uCLinux kernel, originally ported to the Microblaze architecture during R&D work at the University of Queensland.

The FLE Fusion uCLinux represents the combination of custom Microblaze IP, Xilinx Microblaze IP, Bootloader technology, uCLinux kernel technology, FLE auto-configuration technology, and the innovative development environment →FLE Fusion←.

Combining these technologies allows expert to inexperienced Linux developers the ability to harness the uCLinux O/S for developing robust and high performance embedded applications in a “straight forward” approach.

Bookmark [www.FL-ENG.com](http://www.FL-ENG.com) for more information on the FLE Fusion system.

### 3. What are we about to do?

Through this guide, we are going to begin a configuration process that will allow the uCLinux 2.4 kernel to be installed on the Xilinx Spartan3-700AN Eval Board. Once installed, it will be possible to demonstrate the following functions

- Intelligent bootload functions available through U-BOOT
- Boot of uCLinux Operating System
- Demonstration of 10/100 Ethernet connectivity (telnet, ftp)
- Variable sample rate MP3 Playback and access to high density NAND Flash



**Before beginning, it is important the reader obtain the following hardware/software items and install them on a Windows XP/2000 host PC before continuing.**

#### Standard Required Items

- Xilinx ISE 10.1 and EDK 10.1
- Xilinx Spartan3-700AN Evaluation Platform
- FLE Lancer Demo Board Rev 1.0 (required for NAND and MP3 Playback)
- RS232 Male to Female Cable
- 10/100 Ethernet cable connected to a 'live' network
- Appropriate power supplies/etc

#### SP3E/Fusion Specific Required Items

- Install a local copy of the SolarWinds TFTP server (available on [www.fl-eng.com](http://www.fl-eng.com))
- Copy and unzip the FLE-XILINX-SP3700AN-MP3.zip project to the host PC
- Copy the bootme4linux.bin, uboot.hex, download.bit files to the host PC (ex: c:/temp)

Once these items have been acquired/installed, proceed to the next section.

#### 4. Installing a TFTP Server

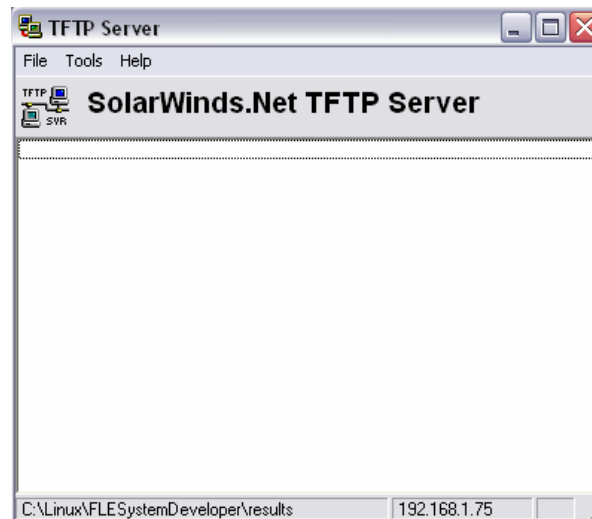
Before beginning, we need to ensure that the SolarWinds TFTP server is installed and configured properly. The TFTP protocol will be used to transfer the Linux O/S to the eval board and to allow demonstration of remote update functions.

Finger Lakes Engineering recommends the use of the FREE SolarWinds-TFTP. This is available on [www.fl-eng.com](http://www.fl-eng.com) on the Fusion Technology page.



**Depending on your local PC, you may need to disable/change the firewall settings to allow the eval board to access the TFTP server.**

Install the TFTP server and launch it from the Window's start menu. It should appear as follows.



The server must be configured for the path and permissions to allow the target hardware to retrieve the uCLinux O/S.

In order to do this, first select File→Configure.

Select the RootDirectory tab. Set the root directory to the location where the uboot.bin, bootme4linux.bin, and uboot.hex files exist.

Select the Security tab and ensure that Send AND Receive files is selected. This will allow the target hardware to access the RootDirectory.

Once this is complete, proceed to the next step.

## **5. Downloading the FPGA Image**

For simplicity, exact details on how to use the Xilinx tool-chain are not covered in this document. It is assumed that the reader is familiar with the Xilinx ISE, EDK, and IMPACT tool.

Within the unzipped project fileset ,a file called download.bit should exist.

This file must be downloaded into the Platform Flash located on the Xilinx Spartan3-700AN eval board. Full details on programming the download.bit into the internal flash of the Sparnat3-700AN can be found with User Guide provided by Xilinx.

A quick-step guide to programming the FPGA internal flash is shown below.

- 1) Remove power from the Eval Board
- 2) Connect the USB Port of the Eval Board to the Host PC.
- 3) Connect a serial cable between the Host PC and J36 (Female DB9) on the Eval Board.
- 4) Connect the FLE Lancer Daughter Card to the expansion port of the Eval Board
- 5) Connect the two RCA Output Ports of the FLE Lancer Daughter Card to amplified speakers.
- 6) Place a shunt on Modem Pin M2 and remove shunts on M1,M0 (J26)
- 7) Apply power and launch Xilinx Impact
- 8) Discover the JTAG chain and cancel out any file-browser boxes that may appear.
- 9) Impact should display a picture of the Xilinx FPGA and an XCF04 Platform Flash
- 10) Double click on the FPGA and select the download.bit file that was provided in the zip.
- 11) Impact should now display the FPGA with the selected download.bit File
- 12) Right click on the FPGA and select Program Flash and Load FPGA
- 13) Programming may take 2-5 minutes
- 14) Start HyperTerminal and set the serial port to 115200,8,N,1 with NO Handshaking
- 15) After completing these steps, power cycle the eval board and the new FPGA image should boot.

Upon booting the FPGA image, the following text should appear in the Hyperterminal window.

```
*****
***      Finger Lakes Engineering      ***
***      www.FL-ENG.COM                ***
*****

Starting External RAM MemoryTest
  Running 32-bit test...PASSED!
  Running 16-bit test...PASSED!
  Running 8-bit test...PASSED!
Clearing main memory...
Press 'F' to enter the first-stage bootloader...
Booting in 5
Booting in 4
Booting in 3
Booting in 2
Booting in 1
Attempting to Direct Boot the User Application [0x00200000].....
Application Appears Invalid!...HALTING!
```

**Note that a 5-second boot countdown is shown. During the boot countdown, press the “F” key to enter the first-stage bootloader. This will allow downloading of the U-BOOT second stage bootloader. Power cycle the board if you did not press the “F” key in time.**

The boot menu will appear with only one option: Erase and download a U-BOOT image.

Select this option (option #1). This will erase the external parallel flash memory to prepare it for uploading the U-BOOT image. After the erase cycle is complete, a prompt will appear to begin the ASCII hex file download. Goto the Transfer→SendTextFile option in hyperterminal and locate the uboot.hex file that was included in the zip package.

The download should take approximately 4 minutes. After ensuring that no transfer errors occurred, power cycle the Eval board and allow the boot countdown to occur without interruption. This will allow U-BOOT to launch.



**It has been observed that some USB<>SERIAL cables will drop data during the serial download process, causing file corruption of UBOOT. It is recommended to use a high quality USB<>SERIAL cable (such as those made by FTDI inc) or ideally a desktop PC with a true DB9 serial port).**

## 6. Configuring the Boot Environment

The first time U-BOOT starts, it is required to configure the Environment settings. The environment settings specify the network mode(s) that will be used to allow the Ethernet port to function.

At the U-BOOT prompt, type the command ‘printenv’ and press return.

A series of environment settings should appear similar to the list below.

```
FUSION> printenv
bootcmd=boot          (autoboot command function to call from the main menu)
bootdelay=10          (approximate number of seconds before uCLinux boot)
ethaddr=12:22:33:44:55:66 (mac address)
ipaddr=192.168.1.222  (target's static IP address)
serverip=192.168.1.190 (IP address of the HOST PC with the TFTP server)
gatewayip=192.168.1.1 (address of the network gateway)
netmask=255.255.255.0 (network submask)
ethact=eth0           (Ethernet adapter)
serialnum =FLE-15WESTMAIN-UNIT1 (unit serial number)
```

The settings ethaddr, ipaddr,serverip,gatewayip, and netmask must be setup for your local network. Make sure that the ipaddr is set for a UNUSED address on your network.

Use the following commands to configure these values.

```
setenv ipaddr A.B.C.D
setenv gatewayip E.F.G.H
setenv netmask I.J.K.L
setenv serverip M.N.O.P
```



**Open a DOS shell and type “ipconfig /all” to see the host PC’s ip, gateway, and netmask. Use the same GATEWAY and NETMASK for the eval board as your local PC uses.**



**Note that the serverip must be the IP address of the PC running the SolarWinds TFTP server. The IP address is visible in the lower right hand side of the SolarWindows TFTP GUI.**

After issuing the above commands, enter the command saveenv

The ‘saveenv’ configuration will preserve the settings in the flash memory associated with U-BOOT. The U-BOOT should respond by saying the environment has been updated.

The final step for configuring the eval board is to transfer the uCLinux kernel into flash memory.



## **8. uCLinux Kernel Startup**

After power cycling the board, the FS-BOOT loader should boot into U-BOOT which will in turn boot the uCLinux O/S and mount the appropriate filesystem(s).

Note that two user read/write filesystems will be mounted.

- 1) A JFFS2 Flash Filesystem of 512KB available in the /flash directory in the O/S
- 2) A YAFFS2 Nand Filesystem of 512MB available in the /nand directory in the O/S

Note that #2 requires the FLE Lancer Demo card. The FLE Lancer Demo card provides the I2S Audio hardware and a NAND Flash memory.

Once the system boots, login to the operating system using the username root and password root.

## 9. Exploring the uCLinux O/S

Congratulations on successfully configuring and loading the Linux O/S.

At this stage, all settings are now resident in Flash Memory.

In this section, we will explore some basic functions of the FLE Fusion uCLinux environment.

Type 'ls' and press return to see the directory contents of the filesystem.

```
bin  etc  fle  lib  proc  tmp  var
dev  flash  nand  home  mnt  sbin  usr
```

type 'ifconfig' and press return to verify the IP Address of the system.

Type 'ping A.B.C.D' where A.B.C.D is an external network host, and press return. This will verify network connectivity through a standard "ping" process. Press Control+C to abort the ping process and return to the shell.

On your host PC, goto the Start→Run option in windows. In the "run" box enter the text "cmd" and press return. This will open a dos shell box. In the dos shell box, type "telnet A.B.C.D" where "A.B.C.D" is the IP address of the Spartan3-700AN eval board. This should establish a remote telnet session with the operating system. It should be possible to login using the root/root username/password and access the board via the Ethernet. Once logged into the board, type "exit" and press return to quit the session.

From the shell prompt (on the serial or ethernet port) type "cd /fle" to change to the fle folder.

Type 'ls' to see the contents of the fle folder. Note that there is a file called demo.mp3

Type the command "mp3 demo.mp3"

This command will invoke the MP3 player and audio should be heard if powered/amplified speakers are connected to the RCA Outputs on the Lancer demo board.

Using your favorite FTP client, it is possible to make an FTP connection to the Spartan3-700AN Board (ensure that the username=root and password=root for authentication). A series of alternate MP3 files can be transferred directly into the /NAND folder available on the physical nand flash. This will provide a bulk storage location for MP3 files which can then be played using the mp3 player as shown in the example above.

A Free GUI FTP Client is called Filezilla and is available at <http://filezilla-project.org/download.php> Alternatively, the dos ftp transfer can also be used. Please ensure to manually select the nand folder (i.e. cd nand) to place the MP3 files into the NAND memory.

## **10. MP3 Technology**

The MP3 Player on this demo is based on the open source library called libMAD (<http://www.underbit.com/products/mad/>).

A basic player has been created by FLE using the libmad software MP3 decode routines. The player is designed to support upto 48KHz sample rate at bitrates of upto 64Kb/s.

Higher bitrates may cause the audio to skip unless additional hardware acceleration is applied. FLE's IP Core technology supports a high performance IDCT transform that can be used to achieve MP3 decode at 48KHz sample rate at bitrates beyond 256Kb/s with a CPU frequency of 50MHz.

The player interfaces directly to the FLE Lancer I2S Core. The Lancer is an I2S BusMastering core that is capable of performing background DMA Transfers of 16-bit audio samples to an external I2S DAC.

Variable sample rates are achieved using the Linear Technology LTC6904 Silicon Oscillator. The Silicon Oscillator is controlled via I2C and provides a master clock to both the I2S DAC and the FLE Lancer. This method is used to precisely tune the sample rate of the audio playback.

## **11. NAND Technology**

The NAND Interface is provided by a FreeFromFLE IP Core (FLE-NAND) and the uCLinux YAFFS2 flash filesystem.

The YAFFS2 filesystem detects all modern NAND flash and provides easy access to a bulk storage device from 16MB to beyond 4GB. The YAFFS2 filesystem provides bad block detection, mirroring, ECC security, and is specifically designed for next generation NAND flash devices. Additional information on the YAFFS2 filesystem can be found at (<http://www.yaffs.net>)

The FLE-NAND core is a simple Microblaze PLB Slave device providing a glueless interface to an 8-bit NAND memory. This core is available as a FreeFromFLE IP Core on [www.fl-eng.com](http://www.fl-eng.com).

## **12. Conclusion**

This tutorial has hopefully guided the user through the process of configuring the Xilinx Spartan3-700AN Eval Board with the FLE Fusion Linux Reference package and demonstration of basic MP3 Audio Playback using the Lancer IP Core and Daughter Card.

Thank you for following this tutorial.

## **13. Appendix**

Finger Lakes Engineering - FLE's Main Website for all FLE, Free-From-FLE, and FUSION materials  
<http://www.fl-eng.com>

NuHorizons – Worldwide distributor of Xilinx Components, Training, and Materials  
<http://www.nuhorizons.com>

Xilinx – Website for Xilinx Corporate  
<http://www.xilinx.com>

University of Queensland – uCLinux Microblaze Original Port  
<http://www.cs.uq.edu.au/~jwilliams/mblaze-uclinux/index.html>

uCLinux main website  
<http://www.uclinux.org>

U-Boot main website  
<http://www.denx.de/wiki/Uboot>