



# Harmony Developers' Kit Hardware Introduction and Setup

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## Introduction

This manual describes the basic, initial setup of a Harmony Tegra 250 developers' kit (devkit), and is designed to assist a new user in understanding the hardware, selecting an operating system to install to the devkit, and connect and configure the hardware to boot that operating system. Very little operating system-specific information will be found in this manual, as each operating system supported by the Harmony devkit includes its own support pack with software and documentation. This manual covers the details that tend to cross over all supported operating systems.

## What is “Harmony”?

The NVIDIA Tegra 250-based “Harmony” devkit is a compact, Smartbook-motherboard form factor computer-on-a-board with the following specifications:

- Dual ARM Cortex A9 CPU @1GHz
- 1GB of RAM
- High-performance, shader-based 3D acceleration
- HD video encode and decode
- 512MB of Flash memory
- Onboard wired Ethernet
- WiFi
- Bluetooth
- Analog stereo audio in/out
- USB keyboard/mouse/storage support
- HDMI/DVI-D and VGA/CRT display support
- Onboard SD(HC) slot

## Getting Started: Overview

There are a few basic steps required to begin developing for the Harmony devkit:

### Unboxing:

- 1) Unpack the Harmony devkit components
- 2) Familiarize yourself with the components

### Host PC Configuration:

- 1) Select your desired Harmony operating system
- 2) Download the support pack for that operating system from the NVIDIA Tegra developers website
- 3) Read the documentation provided with that support pack and install it to the appropriate host PC
- 4) Download and install any host PC support SW as required by the platform support pack's documentation

### Connecting the Harmony HW:

- 1) Locate/procure the required hardware accessories for the Harmony (somewhat dependent upon the selected Harmony operating system image)
- 2) Select the desired video output based on your available display devices and the operating system image

### Installing the Operating System to the Harmony:

- 1) Follow the operating system image installation instructions provided with the support pack
- 2) Boot the Harmony

## Unboxing

### Devkit Contents and Hardware Requirements

As shipped, your Harmony devkit should contain the following items:

- Harmony main board (rectangular circuit board containing the Tegra chip and connectors for networking, USB peripherals, storage and display devices)
- 15V power adapter (USA 120V mains power connection)
- Adjustable, folding, threaded WiFi antenna
- Expansion board (smaller, square circuit board containing a serial port, LEDs and a few buttons)

Also required to use the Harmony devkit, but not supplied (developer must provide these):

- Host PC with USB ports. The exact OS that this host PC must be running may differ depending upon the devkit OS to be used, but is most frequently Microsoft Windows.
- USB mini (NOT micro, as with previous Tegra devkits) to USB cable (for device setup and connectivity)
- External display supporting VGA (15-pin D-Sub), HDMI or DVI (via HDMI-to-DVI adapter)
- SD card or USB-based “thumb drive” for additional storage
- USB mouse
- USB keyboard

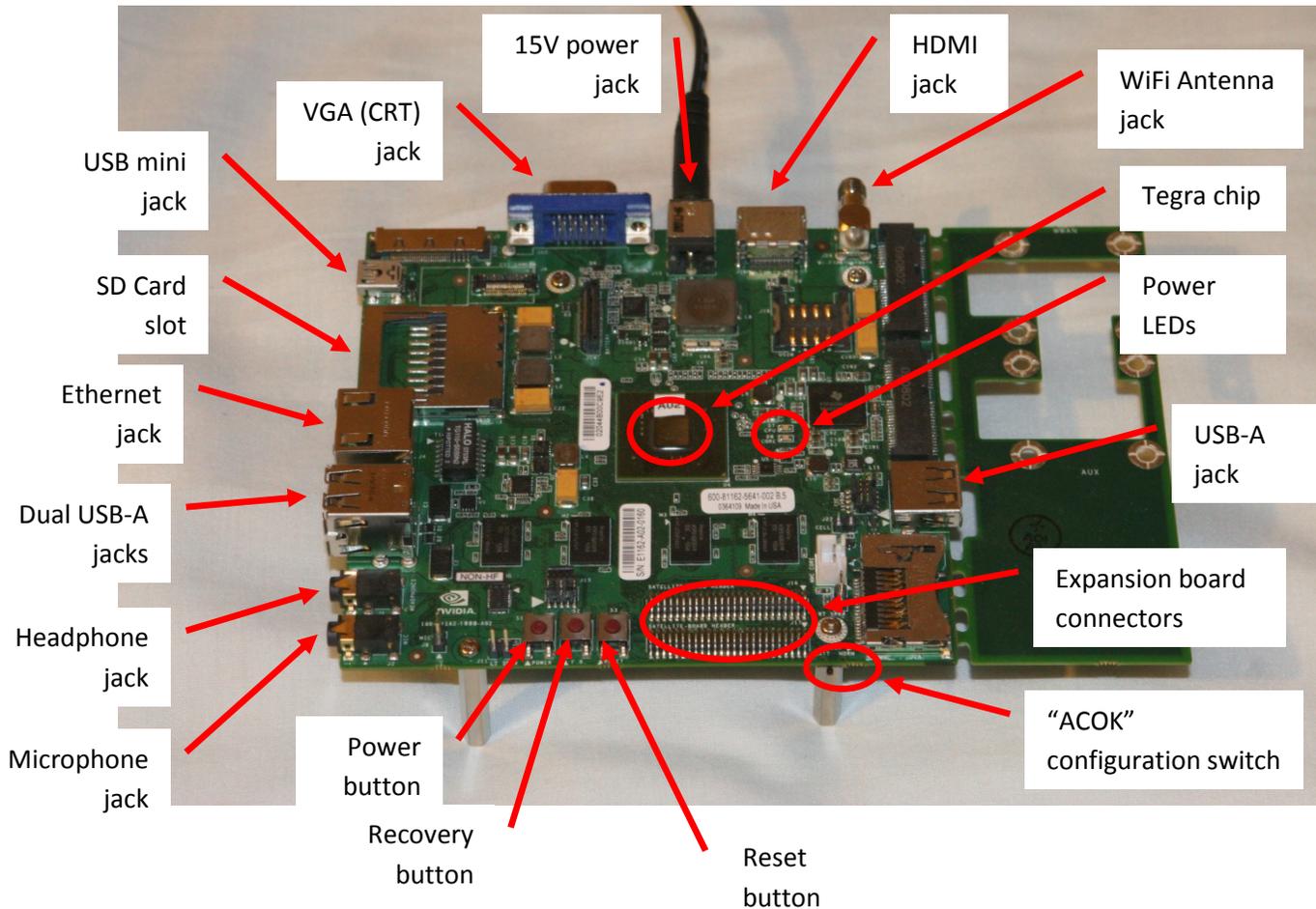
Strongly recommended to use the Harmony devkit, but not supplied (developer should provide these):

- Powered USB hub

## Getting Familiar with the Devkit

### Main Board

The following diagram shows a Harmony main board with power connected. Important connectors are annotated:



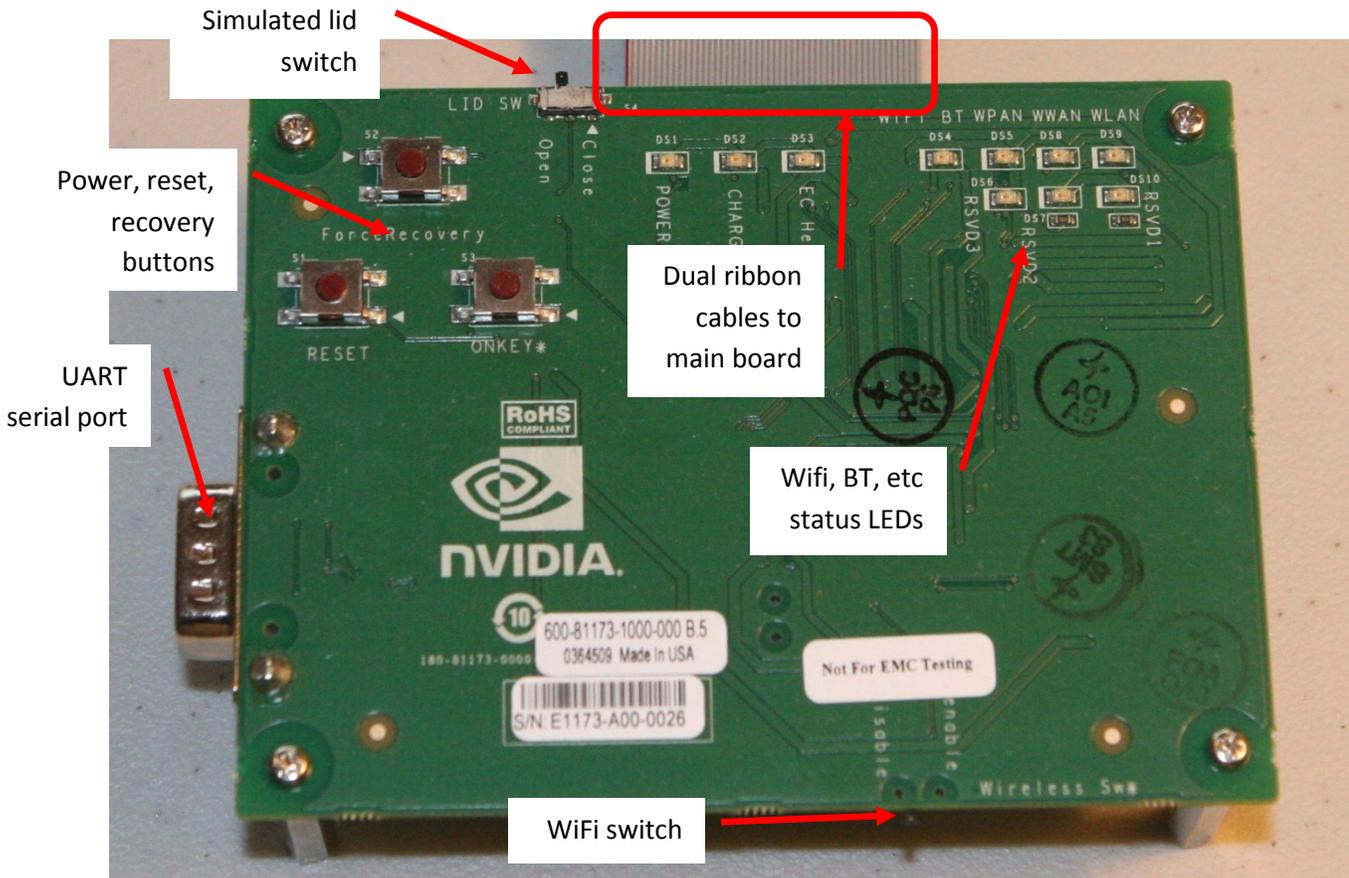
The annotated items include:

- **15V Power jack.** Supplies the main power to the devkit (the Harmony devkit as shipped to developers does not directly support battery power)
- **VGA (CRT) jack.** Support for 15-pin D-Sub analog display output
- **HDMI jack.** Support for digital display output
- **WiFi antenna jack.** Connection point for supplied (or 3<sup>rd</sup>-party) WiFi antenna
- **Tegra 250 chip.** The heart and soul of the Harmony devkit
- **USB-A jacks (3).** Support for common peripherals (use of a powered USB hub is strongly recommended)

- **Expansion board connectors.** “Header” connections for an expansion board (supplied) that adds status LEDs, copies of the power, reset and recovery buttons, and a serial port.
- **“ACOK” configuration switch.** A configuration micro-switch that is used to adjust the power behavior of the devkit. In the left (BATT) position, the AC adapter simulates a battery, and the soft power button functions normally. In the right (NORM) position, applying power causes the device to turn on, without pressing the power button. The left (BATT) position is preferred for developers.
- **Power button.** Pressing this switch will toggle the power to the device on and off
- **Recovery (flashing) button.** Used to place the devkit in a special mode that leaves it ready to receive a new operating system image via USB (“recovery” mode)
- **Reset button.** Soft reset
- **Microphone jack.** Stereo microphone input as a 1/8” phone jack
- **Headphone jack.** Stereo headphone output as a 1/8” phone jack
- **Ethernet jack.** Wired networking if supported by the OS
- **SD card slot.** Supports normal and high-capacity SD card storage
- **USB-mini jack.** USB jack for flashing the device (updating OS images) and connecting the device to a host PC.

## Mini Satellite Board

In addition, most Harmony devkits include the “mini satellite board”, which replicates the main power, reset and recovery buttons, adds a UART serial port for low-level debugging on some OSes, and switches and LEDs for common “smartbook” features like lid close, wifi on/off, etc. An appendix at the end of this document provides connection instructions. The board is pictured below:



- **UART serial port.** Standard serial port for use with some OS images for low-level logging and debugging
- **Power, reset, recovery buttons.** Replicated from the main board so that all controls may be found on the satellite board. Useful if the main board is somehow packaged
- **Simulated lid switch.** On some OS images, setting this switch causes the device to sleep
- **Dual ribbon cables.** Connection to the main board
- **Wifi, BT, etc status LEDs.** Provides activity status of major peripherals
- **WiFi switch.** Enables/disables WiFi radio

## Host PC Configuration

### Selecting and Downloading a Platform Support Pack

Currently, there are several packs available for use with the Harmony devkit, including OS support packs and sample application SDKs. A Harmony OS support pack must be installed (or “flashed”) to the Harmony devkit in order to boot it and use it. The set of supported packs include:

- An Android Éclair OS support pack. This includes scripts to install the Android OS image and associated “getting started” documentation.
- A Windows CE 6.0 OS support pack. This includes a script to install the CE 6.0 operating system image onto a recovery-mode Harmony as well as Khronos headers and libraries to allow developers to use Microsoft Visual Studio 2005 and 2008 to develop and debug applications on Tegra using OpenGL ES, OpenMAX, OpenKODE, etc.
- An Ubuntu-based Linux OS support pack.

These and other packs may be found on the Tegra developers’ website. Developers should select the target operating system that best matches their intended market, feature set and development environment requirements, as each of these operating systems differ significantly on all of these fronts. The developer website information for each OS support pack can assist in the decision. However, OS images may be re-flashed to the Harmony devkit at will, so a single Harmony devkit can change between operating systems in minutes.

Download the desired platform support pack for the Harmony OS you wish to use. At this point, you should transition away from this documentation temporarily and into the documentation supplied with the selected OS image. That documentation will, as needed, provide pointers back to this manual when it is time to connect and “flash” the device. Ensure that all of the selected OS image’s host PC prerequisites are satisfied by your selected host PC before continuing.

### Connecting the Harmony HW

While use-cases will differ, there are a few basic items that must be connected to the Harmony devkit to install an operating system and boot the device. Items common to all operating systems are included in this documentation. Additional items such as serial connections, network connections, and storage devices may be required to install and boot some operating systems. These will be documented along with the particular operating system. The common requirements include:

- 1) **Display connection.** One of the following display devices should be connected. For best results, do not connect more than one of these options at a time unless directed to do so by a particular operating system pack. Be sure to check the documentation for your selected OS support pack, as some OSes may not support all of these display connections:

- a. Analog “VGA” display (LCD or CRT monitor) connected via the devkit’s VGA 15-pin D-sub connector.
  - b. HDMI display (LCD screen or compatible television) via the devkit’s HDMI port and an HDMI cable. Note that on many OS images, using HDMI as the display connection will route audio to the HDMI port as well, disabling the headphone jack.
  - c. Digital DVI-D display connected via the devkit’s HDMI port and an HDMI-to-DVI cable or cable-adapter pair.
- 2) **“Recovery” (or flashing) USB connection.** A USB cable must connect the USB-mini jack on the left-rear corner of the devkit to a USB jack on the host PC. The OS that the host PC must be running will depend on the OS being installed on the devkit, and will be documented in the platform pack for that particular OS.
  - 3) **Power.** The supplied 15V power supply should be connected to the power jack on the rear edge of the Harmony main board. Depending on the setting of the “ACOK” switch described previously, applying power to the board may cause it to switch on automatically. Earlier Tegra devkits used a 12V power supply with a similar connector: ***this 12V power supply is not compatible with the Harmony devkit and must not be used.***

Additional items that should be connected to the Harmony for general post-install interaction with the devkit include

- 1) **Powered USB hub.** As a mobile development kit, the Harmony is not designed to provide large amounts of power to external devices. Thus, external devices other than the most basic mice and keyboards should be connected to a powered USB hub. This powered hub should be connected to one of the two stacked USB jacks on the left-front edge of the Harmony main board.
- 2) **USB keyboard and mouse:** both of these should be connected to the powered USB hub. If required, a basic USB keyboard and mouse pair can be connected to the two stacked USB jacks, but if possible, a powered hub is recommended.
- 3) **WiFi Antenna.** The threaded end of the WiFi antenna should be firmly screwed onto the WiFi antenna connector on the rear edge of the Harmony board.

Some Harmony operating system images may also require additional items to be connected, including:

- 1) **Expansion board.** If required, the two ribbon cables connected to the small expansion board should be connected to the matching pair of headers on the Harmony main board’s front edge. Take care to ensure that all of the pins align.
- 2) **Ethernet.** An Ethernet cable can be connected to the Ethernet jack on the left edge of the Harmony main board.
- 3) **External storage.** Operating systems requiring large file systems may require external storage, either a USB “thumb drive” or a USB hard drive. In either case, these storage devices should be connected to a powered hub that is in turn connected to the Harmony main board.

## “Flashing” (Installing) Operating System Images onto the Harmony

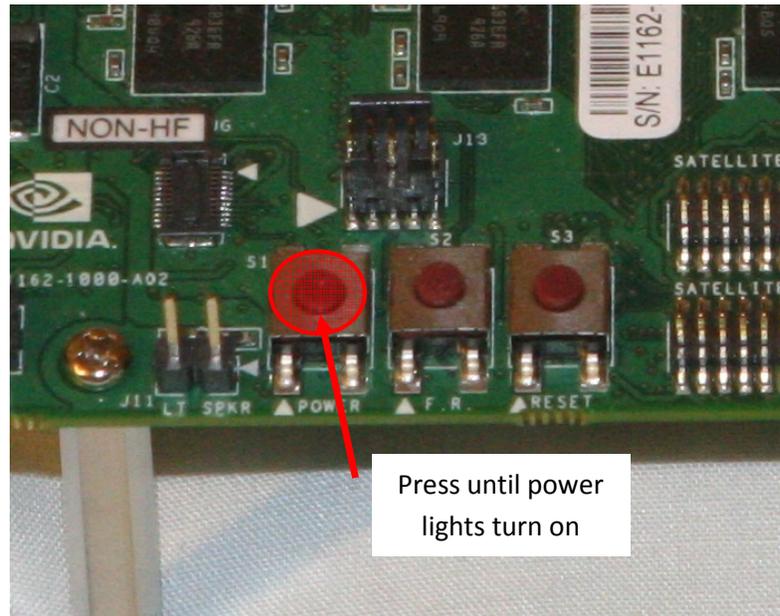
This documentation does not include OS-specific install instructions. Each operating system image ships in its own distribution pack, and developers should consult the documentation for that operating system image for details on how to install it. However, all of the OS support packs require the Harmony device to be in recovery mode as a first step. The operating system image packs will in turn reference *this* documentation with regards to placing the device into “recovery mode”. Recovery mode is a special, low-level booting mode that leaves the device ready to receive a new operating system image over USB.

### Placing the Harmony into Recovery Mode

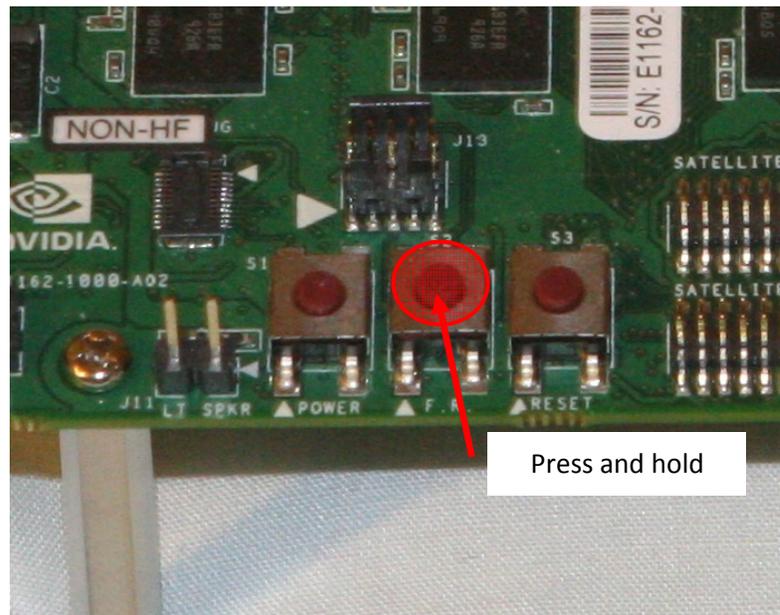
To place the devkit into recovery mode:

- 1) Connect the 15V power supply to the Harmony and to mains power.
- 2) Power on the device
  - a. If the device turns on immediately (i.e. the red and green power LEDs near the center of the main board turn on), you may wish to ensure that the “ACOK” switch on the front edge of the main board is in the leftmost (BATT) position for future use.

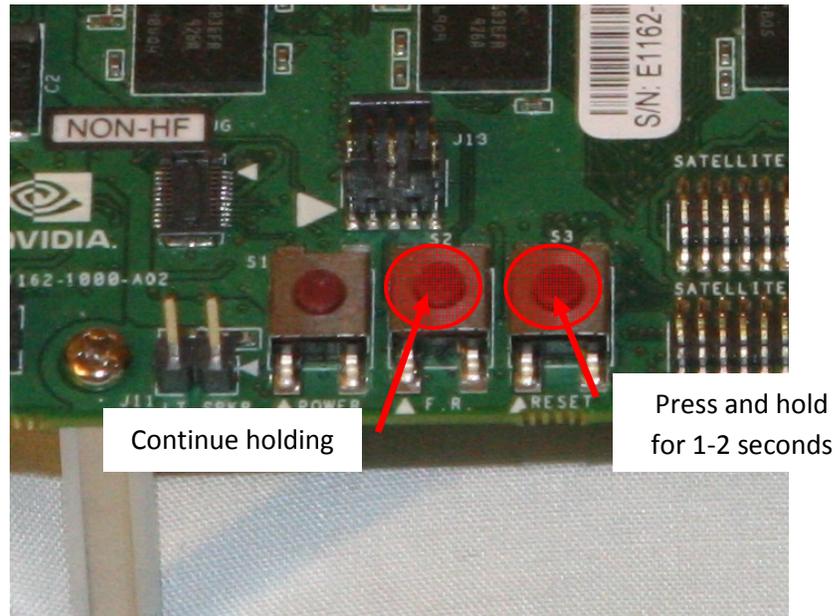
- b. If the board does not spontaneously turn on, then press and hold the power button until the power LEDs light to turn on the device.



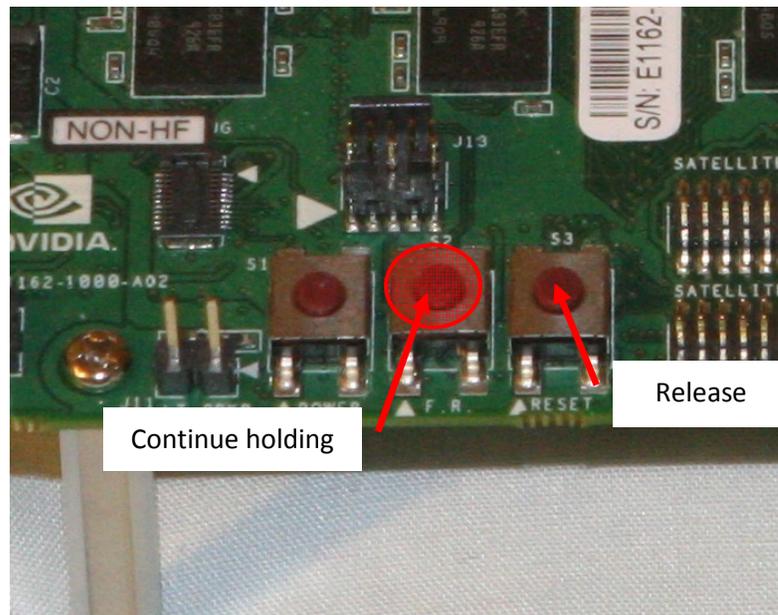
- 3) Press and hold the recovery mode button (marked "F.R." on the main board) along the front edge of the Harmony main board



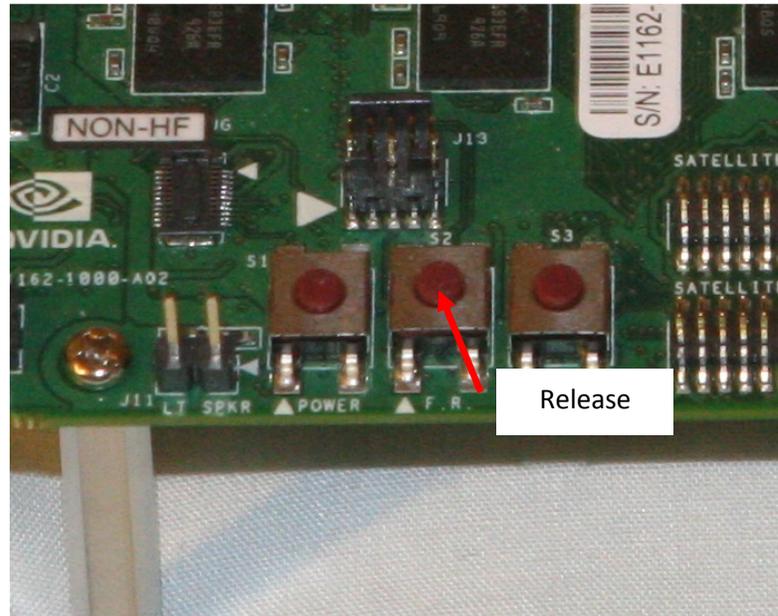
- 4) While continuing to hold the recovery mode button with one finger, use another finger (or another hand) to press the adjacent reset button. Hold the reset button down for 1-2 seconds.



- 5) Release the reset button while still holding the recovery button.



- 6) After a further 1-2 seconds, release the recovery button



- 7) Connect a mini-USB to USB-A cable between the host PC and the mini-USB jack on the rear-left corner of the Harmony main board.
- 8) If this is the first time that the host PC has been used to flash a Harmony device, then you may be prompted to install the USB driver for the newly-found device. This driver should have been supplied with the operating system image, as it is dependent upon the host PC OS used to flash the device. See the following section for a discussion of this process on Windows XP.
- 9) Once the driver is confirmed to be running, the device is in recovery mode. Continue following the platform pack's OS install instructions to complete the OS installation.

## Recovery Mode Host PC USB Driver

While each OS support pack may require its own host PC OS, the most common host OS for Harmony is Windows. This section describes how to install the recovery mode driver onto a Windows host PC. If an OS support pack requires a different host PC OS (such as Linux), that pack's documentation will describe how to install the recovery mode driver.

The documentation for the support pack will indicate the location of the PC recovery mode driver to be used.

In the case of an OS that is flashed using Windows as the host PC OS (e.g. Windows CE 6.0), the method is to install the driver using the "install from a specific location" option in the "New Device Wizard" dialog box. This dialog box will pop up automatically (if required) when the Harmony devkit is connected to the host PC while the devkit is in recovery mode. **Note that the driver can take a long time to install (in some cases, as long as 5 minutes).** During the install process, you may see the following dialog box (under XP):



Click "Continue Anyway" to install the driver. If the host PC OS being used to flash the device is Windows, then to verify that the Harmony is connected to the host PC, open the Device Manager via:

Start Menu : Control Panel : System : Hardware : Device Manager

Verify that you see a device called

"Nvidia USB Boot-recovery driver for Mobile devices"

under the heading

Device Manager -> Universal Serial Bus Controllers

in the device manager as follows:



If you don't see this device, disconnect the Harmony devkit from the host PC, place it into recovery mode again, and restart this procedure from the beginning, as the lack of an active device in the panel indicates that the connection has not been made or that the device was not actually in recovery mode. Do not continue with the following steps until the NVIDIA device appears in the device list. Check the NVIDIA Tegra developers' website for troubleshooting tips.

## Using Your Booted Harmony Devkit

Once you have installed a host OS onto your Harmony devkit, the platform support pack's documentation will describe how you can develop for that Harmony OS using the already-configured host PC. The platform support pack documentation for your selected OS image should also include useful information on developing for that Tegra platform. Consult it for additional details on the development process.

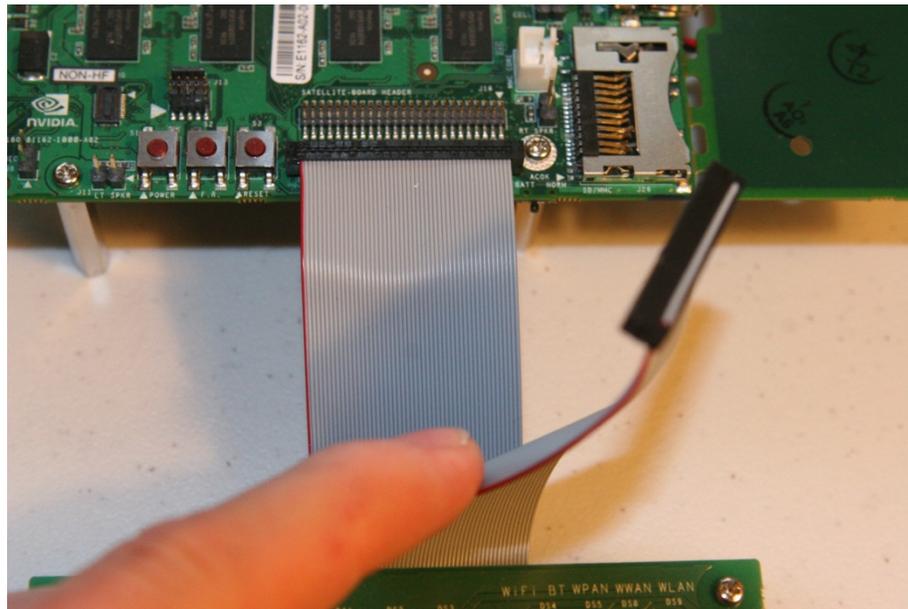
In addition to the platform support packs, other optional packs are available to assist in development for the Harmony devkit, depending on OS:

- A Windows XP/Vista/7 OpenKODE and OpenGL ES2.0 emulation wrapper, which allows cross-platform application development. Code written to compile and run on this PC-based, HW accelerated emulation “wrapper” can also be compiled and run on the Harmony devkit using the aforementioned Windows CE 6.0 Harmony platform pack.
- A cross-platform application-level samples SDK including documentation, support libraries and demos as source code, shader code, and art assets. These libraries and demos can compile for the Harmony under most Tegra operating systems, including Windows CE 6.0, Linux and for the Windows desktop PC ES2 emulator as well, and show how the Tegra's multimedia capabilities can be unlocked via the Khronos media APIs.

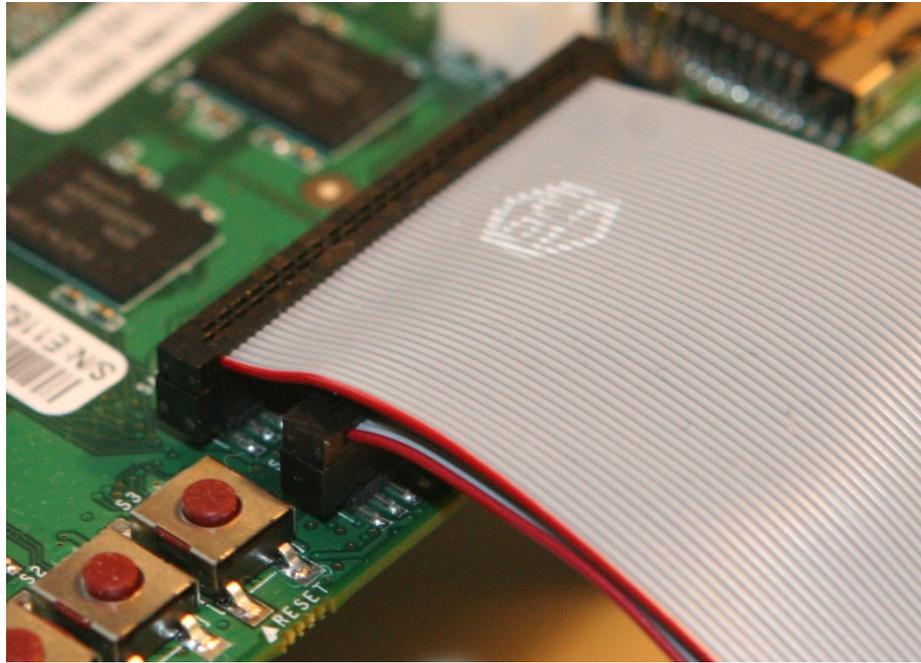
## Connecting the Mini Satellite Board

If the OS image requires it, the mini satellite board can be connected to the main board to add serial port and accessory switch functionalities. The mini satellite board can be connected as follows:

- 1) Disconnect power to the main board!
- 2) Place the satellite board so that the pair of ribbon cables on the back edge of the satellite board roughly match the pair of multi-pin headers on the front edge of the main board
- 3) Connect the lower (shorter) ribbon cable to the frontmost header on the main board as shown in the following figure. Be very careful to align the pins. Minimal force should be required to insert the plug, and it should insert symmetrically:



- 4) Connect the remaining (upper, longer) ribbon cable to the rearmost of the two headers on the main board. Insertion should be similar to the previous ribbon cable and should look like the following figure:



- 5) Reconnect power to the main board. Assembly is complete.

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