Guide to Successful EZ-USB® FX2LP™ and EZ-USB FX1™ Hardware Design and Debug

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Application Note Abstract

This application note outlines a process that catches many of the most likely causes of EZ-USB® FX2LP™ and EZ-USB FX1™ hardware problems. It also facilitates the process of catching potential problems before building a board and assists in the debugging when getting a board up and running.

Introduction

The EZ-USB FX2LP and EZ-USB FX1 devices are an excellent solution for adding a high-performance, high-speed or full-speed USB connection to a design. While these devices are fairly easy to use, sometimes getting a new board up and running is tricky due to the various details that need to be carefully followed to get the hardware functional. This application note not only helps catch potential problems before building a board, but also helps debug the hardware once the board is created. The goal is to get the board ready to download firmware and begin the firmware development process.

Note In this application note, FX2LP is used to refer to both the FX2LP and the FX1 devices except where noted.

Hardware Checklist

The following is a list of items that are critical for successful operation of the FX2LP. Go through this checklist before creating a printed circuit board using the FX2LP. If a board built already and is not behaving properly, go through this list to verify that all the items are being implemented correctly on the target.

1. All power pins (AVCC or VCC) are powered to a proper voltage level (3.0 V to 3.6 V).
2. VCC ramp up time is at least 200 µs, with a maximum ramp rate of 18 V per millisecond.

   Most boards have enough capacitance on VCC to meet this requirement. Many regulators also ramp up VCC fairly slowly. However, occasionally a board has an especially fast ramp up time. In such a case, extra capacitance on VCC slows it down to meet the requirements.
3. When using a crystal, reset remains asserted for at least 5 ms past the point that VCC reaches 3.0 V. When using an external clock source, this hold time is at least 200 µs. If reset is asserted when the FX2LP is already powered, the reset is held asserted for at least 200 µs.
4. The oscillator on the FX2LP requires a crystal or resonator with a load capacitance of 12 pF and a frequency of 24 MHz (±100 ppm). The crystal is required to handle a drive level of at least 500 µW. Drive level is the maximum power dissipation that the crystal is expected to withstand. Using a lower drive level crystal might work but the effect of exceeding the crystal's maximum drive level can vary from faster aging of crystal or loss of accuracy to burnout of the crystal. Hence it is not recommended. Two crystals used successfully with the FX2LP are the eCera™ FX2400026 and the Ecliptek™ EC-12-24.000M. 12-pF load capacitors are required between each crystal pin and ground.
5. The RESERVED pin is grounded.

   The RESERVED pin is a test mode pin. If it is not grounded, the FX2LP is placed into a test mode and does not operate correctly.
6. Make sure that the SCL and SDA pull-up resistors are installed.

   If there are no pull-ups on SCL and SDA, the serial interface engine (SIE) hangs up immediately on booting. The FX2LP looks for a serial electrically erasable programmable read-only memory (EEPROM) on SCL and SDA when booting to determine the mode of operation. If the lines are pulled-up with no EEPROM present, the SIE enumerates as the default USB device that enables connection to the CyConsole application. However, with no pull-up resistors, the FX2LP believes the bus is controlled by another master and waits indefinitely for the other master to release the bus. The recommended value of the pull-up resistors is 2.2 KΩ. A method of temporarily breaking the connection between SDA of the FX2LP and SDA of the EEPROM should be included on the board, especially during development. This enables the reprogramming of a corrupt EEPROM without having to remove it from the board. This disconnect can be a jumper, switch, or a removable 0Ω resistor.

7. EA is tied to ground unless external Flash or ROM is connected to the external memory bus.

   If EA is tied high, the FX2LP immediately attempts to boot from code stored in external memory. If there is no code in external memory, the device cannot boot.

8. The WAKEUP# pin is tied high or low and is not left floating.

   A floating WAKEUP# pin causes erratic suspend behavior. Holding the WAKEUP# pin low inhibits the FX2LP from entering suspend mode when no USB traffic is detected. WAKEUP# is typically tied high with a 10 K or 100 KΩ resistor.

Note High-speed USB PCB Layout Recommendations - AN1168 provides the PCB layout recommendations. DVK related hardware collaterals can be found at $Dvk/Hardware (where $dvk is the installation directory of the CY3684 EZ-USB FX2LP Development Kit/ CY3674 EZ-USB FX1 Development Kit).

Bringing Up the Board

When bringing up the board of a new FX2LP design, start with a board that has only a minimum set of components installed. Populate the board with a minimum number of components as follows:

1. FX2LP or FX1 chip
2. 3.3 V regulation circuit connected to all AVDD and AVCC pins
3. Two pull-up resistors (2.2 KΩ, or other value compliant to the I^2C™ specification), one each on the SCL and SDA lines
4. EEPROM is blank or is not installed
5. Connect the WAKEUP# line to ensure it is not floating. Pulling it high with a 10 K or 100 KΩ resistor is preferred for easier debugging.
6. EA pin is connected to logic low
7. RESERVED pin connected to ground or low
8. Reset circuit that provides the required minimum reset timing
9. Crystal oscillator circuit (including crystal and load capacitors) or external clock source.

The purpose of hardware debugging is to get the default SIE of the FX2LP chip communicating with the EZ-USB interface within the CyConsole application running on a PC. The default SIE is how the device boots up when there is no EEPROM connected, or the connected EEPROM is blank. Connectivity to CyConsole (when bound to CyUSB.sys) is an indication that the FX2LP is running and the USB path is functional. The CyConsole is also used to download firmware on the chip for testing and development.

When the board is ready for testing, connect it to a PC on which the CY3684 or CY3674 development kit is installed. If everything is working properly, CyConsole shows a connection to the device. If enumeration is not successful, determine the cause of the problem using the following procedure.

To help solve an FX2LP enumeration problem, use an oscilloscope to look for a 12 MHz signal on the CLKOUT pin while the board is powering up. The following four scenarios of CLKOUT behavior helps direct the debugging efforts in the right direction:

1. CLKOUT never outputs 12 MHz.

   In this situation, the FX2LP is either not powering up correctly, or it is not receiving a reference clock. Check the VCC/AVCC pins, VCC ramp rate, crystal oscillator circuit, and power-on reset timing. Also make sure that the RESERVED pin is grounded.

2. CLKOUT outputs 12 MHz when powering up, but the 12 MHz disappears after a short period of time.

   The cause of this behavior is that the part is entering suspend mode. Make sure that the WAKEUP# pin is not floating. Suspend mode happens if the FX2LP is not seeing the regular SOF signals from the host and WAKEUP# is tied high. Make sure that the unit is plugged into the host and that D+ and D– connect from the host to the device with the correct polarity and with no external series resistors in between. Suspend mode can also occur if the reference clock (either driven externally or from the crystal oscillator) is outside the tolerated accuracy range. Check the frequency of CLKOUT to make sure it is 12 MHz ±100 ppm.

3. CLKOUT continues to output 12 MHz, but enumeration fails.

   If the WAKEUP# pin is tied low (inhibiting suspend), the device may not be seeing the signals from the host. Check all the items in the previous case where CLKOUT is active but quickly turns off.

   If the WAKEUP# pin is tied high (or if it is tied low and you have double checked all the previous items), make sure that there are pull-ups on SCL and SDA and no EEPROM is connected. Also make sure that EA is tied low.

   If these things are verified and all the other checklist items from the first section are proper, then there is a chance that there is some sort of problem with the operating system drivers. The next section describes some techniques to debug these kinds of driver problems using the Windows® Device Manager.

4. CLKOUT outputs 48 MHz, the device enumerates, but does not connect to CyConsole.

   This is a symptom of the DVB-T driver issue discussed in the following section. Windows Update may have automatically bound the default SIE to a different driver and loaded third party firmware into the device. Read for instructions on how to clear this driver and reattach to the proper Cypress driver.

Drivers and the Device Manager

Even if the hardware is working properly, it is possible for the device to not get linked properly to *CYUSB.SYS*. If this link is not made, CyConsole is unable to connect to the device. The Windows Device Manager is used to examine these kinds of problems, and is sometimes used to fix them.

The Device Manager is found under the System icon in the Windows control panel. On Windows 2000, 2003, XP, and Vista, a shortcut is to type *Devmgmt.msc* in the **Run…** box in the Start menu. As a USB hardware developer, there are times when this utility is used frequently and so create a shortcut for this useful utility for fast and convenient access in the future.

In the Device Manager, all the USB devices are seen connected to the PC in a list under 'Universal Serial Bus controllers'. On operating systems later than Windows 2000, you see the VID and PID for a connected device under 'Device Instance ID' in the **Details** tab of the properties for the device. Windows 2000 does not have this feature, so to observe the VID and PID in Windows 2000, you have to find a copy of the USBCheck utility (previously available on usb.org) or the USBView utility from the Windows 2000 DDK. A black exclamation point within a yellow circle (commonly called a 'bang') indicates that a device is having some sort of difficulty. A bang on a USB device usually has something to do either with a problem during enumeration or a driver issue.

If enumeration to the default SIE is successful, the Device Manager shows a USB device connected called 'Cypress EZ-USB FX2LP - EEPROM missing', with VID=0x04B4 and PID=0x8613. The FX1 is similar, except with a PID of 0x6473. This indicates that the default SIE of the device is enumerated properly. If it appears this way in the Device Manager but is still not showing up in the CyConsole, then for some reason it could not be linked to the *CYUSB.SYS* driver. To fix this, click on 'Update Driver…' on the **Driver** tab and browse to `\$windows\inf\cyusbpre.inf` obtained by installing CY3684 EZ-USB FX2LP Development Kit (where $windows is the directory where Windows is installed, usually either 'windows' or 'winnt'). Once the device becomes associated with the *CYUSB.SYS* driver, it is recognized by CyConsole.

If you get a 'USB Device Not Recognized' error (Figure 1), when the device is first plugged in and the Device Manager shows an Unknown device has connected with a zero for both the VID and PID (Figure 2), the host has detected the connection of a device via the device's internal pull-up assertion on D+ but the first step of enumeration (reading the Device descriptor) was not successful. This problem can be caused by the hardware problems mentioned in the previous section or by a corrupt EEPROM or by a firmware error–if code is loaded from a connected EEPROM or flash.

Figure 1. Error Message Due to Enumeration Failure

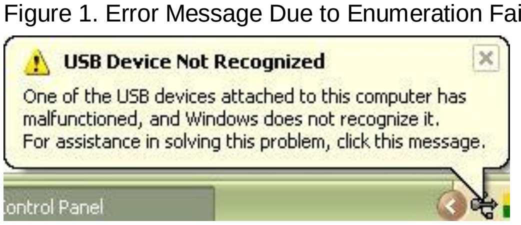
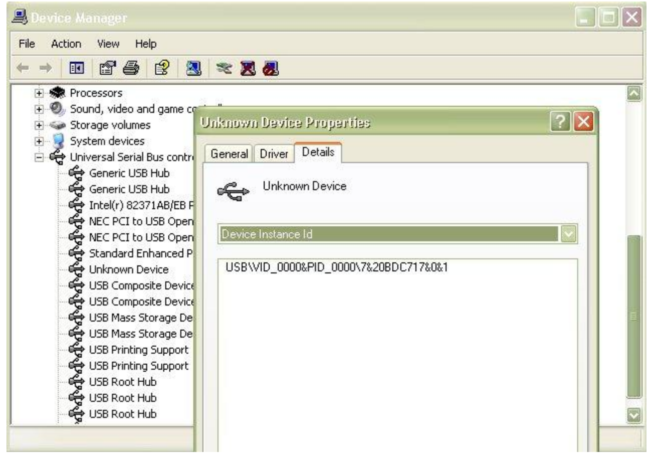


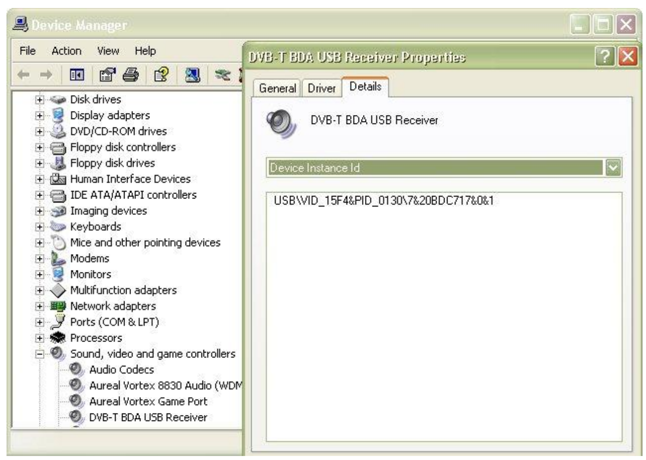
Figure 2. Unknown Device with a Zero VID and PID



There is also a potential problem because the VID and PID for the FX2LP EEPROM missing configuration were inadvertently put into the Windows Driver Update as associated with a third party device (DVB-T). If the device is linked to this other driver (Figure 3), you must clean out the registry and then manually bind the device to the *CYUSB.SYS* driver.

Note This affects only the FX2LP. The FX1 is not susceptible to this issue since its VID or PID combination is not bound to this driver through the Windows update.

Figure 3. FX2LP Bound to the DVB-T Driver



The process required to fix the DVB-T driver issue follows:

1. Disconnect your board from the PC's USB port.
2. If you are inexperienced with registry editing, back up the registry before this step. Go to the registry (by typing '`regedit`**'** in **Start…Run**) and find the `HKEY_LOCAL_MACHINE/SYSTEM/CurrentControlSet/Enum/USB` folder. Locate the key or folder labeled 'Vid_04b4&Pid_8613'. Right click on this key and set the security permissions to enable full control. Delete the key and any subkeys. Repeat these steps for: `HKEY_LOCAL_MACHINE/SYSTEM/ControlSetxxx/Enum/USB` (where xxx is a three digit number from 001 to 004). These alternate control sets may or may not be present.

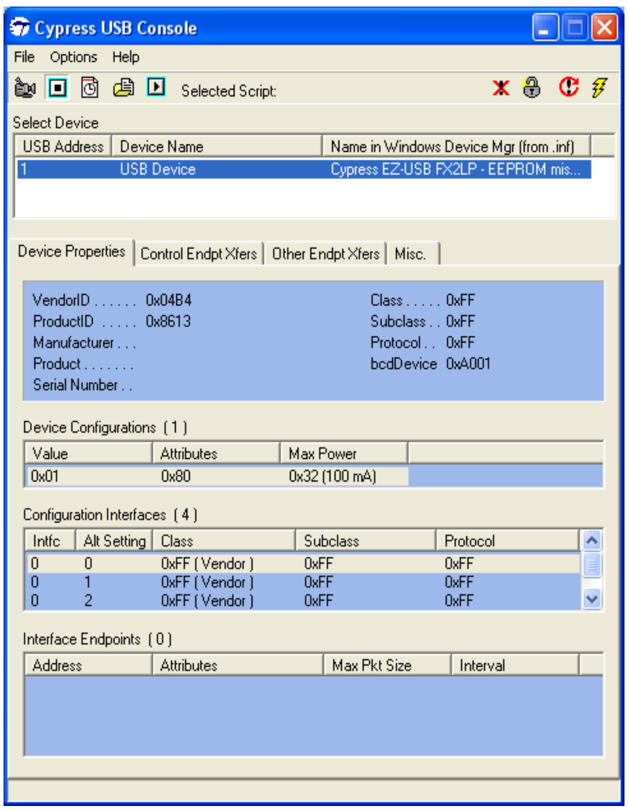
3. Find the *oemxx.inf* file in the `\$windows\inf` directory (where xx is a two digit number) that contains the following line:

   %VID_04B4&PID_8613.DeviceDesc%=CyUsb, USB\VID_04B4&PID_8613

   Delete this INF file, and the *oemxx.PNF* file, where xx is the same two digit number as the INF filename.

4. Reconnect your board to the PC's USB port. When prompted, choose 'Install from a list or specific location', then in the next window choose 'Don't search. I will choose the driver to install'. If you are asked for hardware types, choose 'show all devices'. On the next prompt, click 'Have Disk...' and choose \$windows\inf\CYUSBPRE.INF. If you see an unsigned driver warning, click 'Continue Anyway'.

Figure 4. CyConsole Displaying Devices Bound to *CyUSB.sys*



5. After the process completes, the device manager should show the 'Cypress EZ-USB FX2LP - EEPROM missing', and should indicate that it is bound to *cyusb.sys*. You are ready to run CyConsole. The device should show in Cyconsole (Figure 4).

CyConsole and the EZ-USB Interface

The FX2LP with a blank or no EEPROM installed is bound to the *CYUSB.SYS* driver, The CyConsole is used to get descriptors, program the EEPROM, or download a program to the FX2LP RAM. To do this, go to the **Options** menu of the CyConsole application and choose the EZ-USB interface. For more information on using CyConsole, refer to `$dvk\doc\general\CyConsole.PDF` (where $dvk is the installation directory of the CY3684 EZ-USB FX2LP Development Kit/ CY3674 EZ-USB FX1 Development Kit).

To perform a thorough test of the hardware, load the bulkloop example firmware onto the FX2LP on the board and run it. This is done with the download button in CyConsole (select *bulkloop.hex* from the `$dvk\Examples` directory). The bulkloop example configures the FX2LP to perform USB bulk transfer loopback. *CyBulk.exe*, is an application installed in the `$dvk\bin` directory that is associated with the bulkloop example. *CyBulk.exe* sends bulk data to the FX2LP and tests the data returned to make sure it is the same as was sent. Running the bulkloop example verifies that the FX2LP is operating properly and the communication path to the USB host is clear.

Conclusion

The FX2LP high-speed USB peripheral controller and FX1 full-speed USB peripheral controllers are powerful devices that offer a significant amount of functionality. When doing a design with the EZ-USB FX2LP or FX1, refer to the guidelines of this application note before sending the board for manufacture. If there are problems getting the board up and running the process outlined in this application note enables you to solve most problems quickly and move on to the important task of firmware development.

Document History

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Revision	ECN	Orig. of Change	Submission Date	Description of Change
**	1429925	KLY	08/30/2007	New application note
*A	3023712	AASI	09/06/2010	Added information on crystal drive level Emphasized assumptions on the driver side Textual changes to emphasize other collaterals available

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