Application Note

AN_558

Migrating from FT2232D to FT2232H

Version 1.0

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This Application Note shows design considerations when migrating from FT2232D to FT2232H.

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1 Introduction

This Application Note shows design considerations when migrating from FT2232D to FT2232H.

FT2232D is a USB **Full** Speed device which was first available in 2006. It offers a USB bridge to UART, MPSSE (I2C/SPI/JTAG) and FIFO.

FT2232H is a USB **High** Speed device which was first available in 2009. It also offers a USB bridge to UART, MPSSE (I2C/SPI/JTAG) and FIFO.

FT2232H is recommended over FT2232D as the USB High Speed interface offers better performance. However do note there are differences in power and I/O voltages which are covered in this document. For example, FT2232D operates with a 5V supply and FT2232H operates with a 3.3V supply. FT2232D I/O can operate between 3.0V and 5.25V and FT2232H I/O can operate between 2.97V and 3.63V.

Both devices are supported by FTDI's VCP and D2XX drivers.

2 Block Diagrams

Figure 2.1 and Figure 2.2 show block diagrams of FT2232D and FT2232H.

Similarities between the two devices are:

- USB Protocol Engine
- Same number of ADBUS pins, used for UART, MPSSE and FIFO modes.
- External EEPROM interface
- RESET Generator

Key aspects of the comparison between the two devices show the following differences:

- USB signals are Full Speed on FT2232D and High Speed on FT2232H
- FT2232D requires 5V to be connected to VCC pins. FT2232H requires 3.3V to be connected to VREGIN pin.
- FT2232D I/O can operate between 3.0V and 5.25V. FT2232H I/O can operate between 2.97V and 3.63V.
- FT2232H has more ACBUS and DCBUS I/O signals
- FT2232H has larger TX and RX buffers
- FT2232H uses a 12MHz external crystal and FT2232D uses a 6MHz external crystal
- 3V3OUT (3.3V) is supplied by FT2232D and VREGOUT (1.8V) is supplied by FT2232H, which are used internally by the ICs.
- MPSSE is only available on Channel A on FT2232D. MPSSE is available on Channel A and Channel B on FT2232H.

These differences are detailed in the following sections.

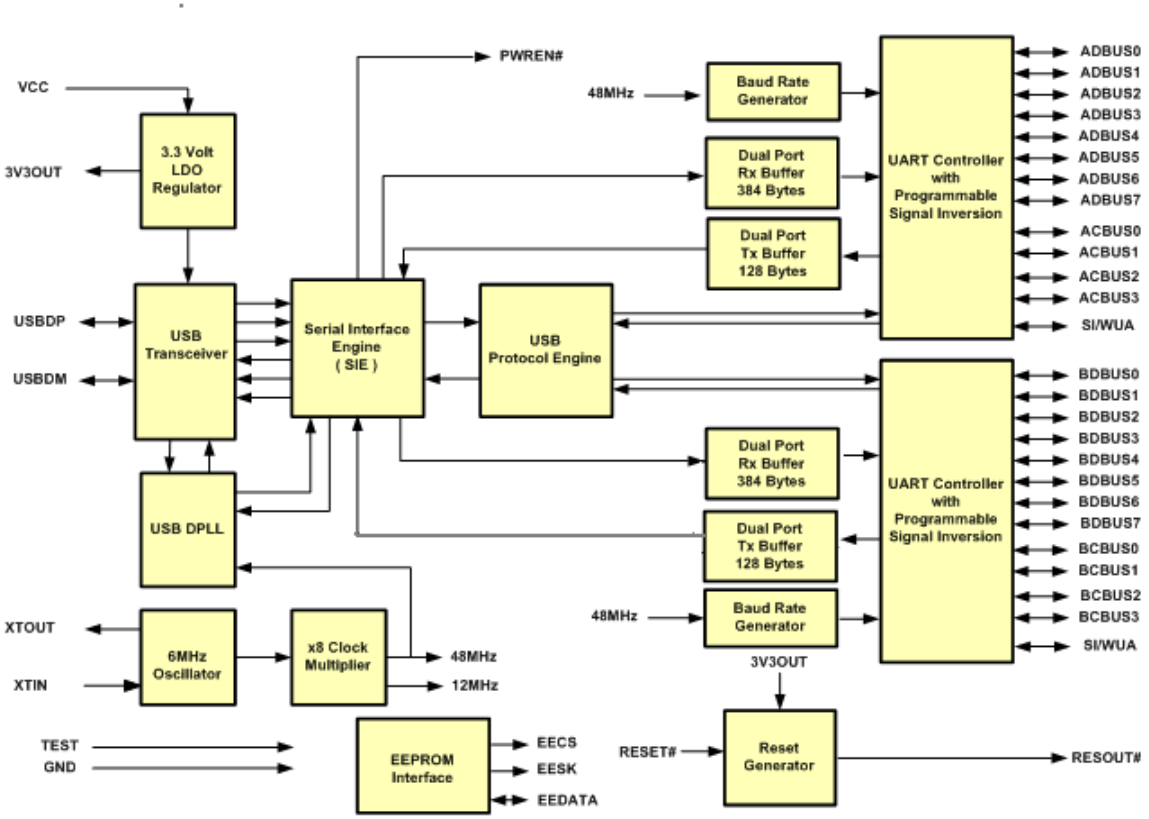

Figure 2.1 FT2232D Block Diagram

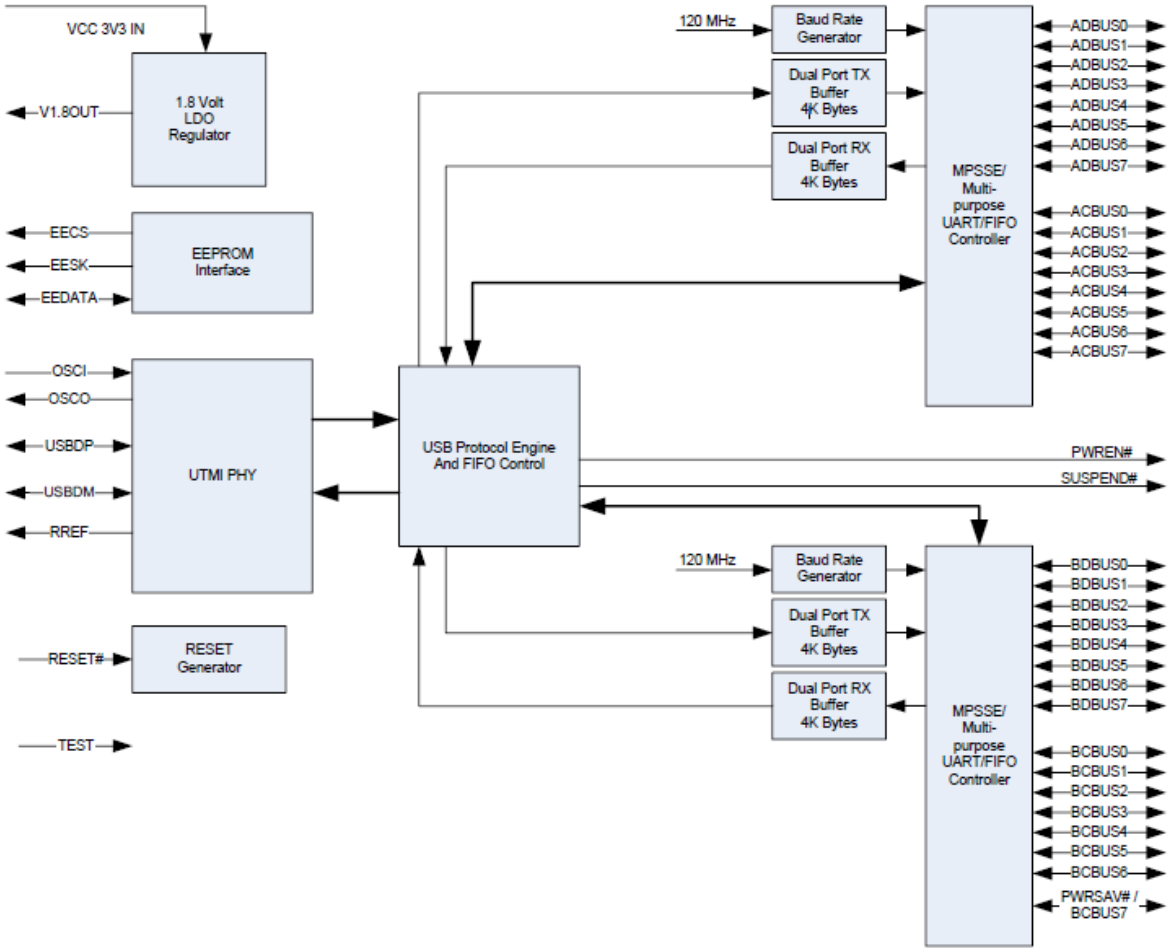

Figure 2.2 FT2232H Block Diagram

3 Packages

FT2232D is only supplied in a 48 pin LQFP package as shown in Figure 3.1.

Figure 3.1 FT2232D IC Photo

FT2232H is available in the following packages as shown in Figure 3.2.

- 64 pin QFN
- 64 pin LQFP
- 56 pin VQFN

The 56-pin variant has less VCCIO and GND pins reducing the IC pin count.

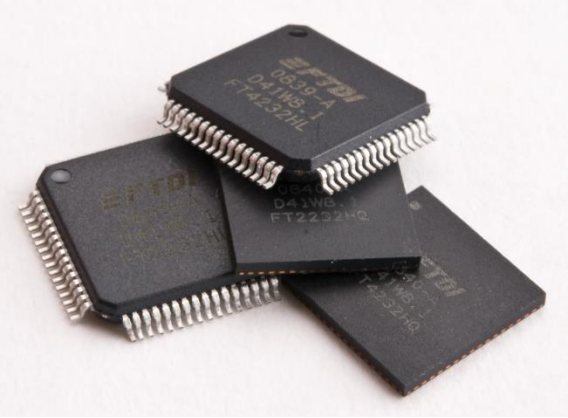

Figure 3.2 FT2232H IC Photos

QFN packages are smaller and easy to handle but require solder reflow to place on a PCB as the pins are less accessible.

LQFP are larger and easier to damage as the pins are exposed more but they can be easily hand-soldered for prototypes as an example.

4 Power

The section details the power differences between FT2232D and FT2232H.

4.1 Main Power

FT2232D requires 5V to be connected to VCC pins as shown in Figure 4.1. This can be sourced from the USB Host 5V supply in a USB Bus Powered configuration.

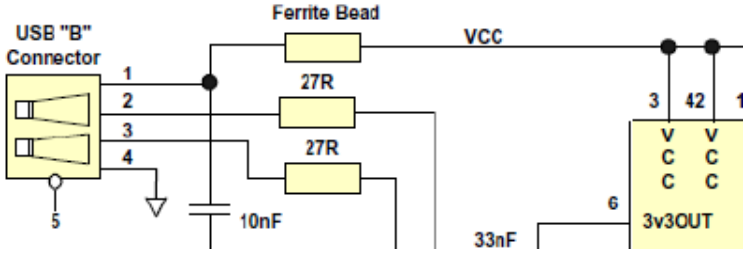

Figure 4.1 FT2232D VCC Connection (Bus Powered)

FT2232H requires 3.3V to be connected to VREGIN pin as shown in Figure 4.2. An LDO can be used to convert USB Host 5V supply to 3.3V in a USB Bus Powered configuration.

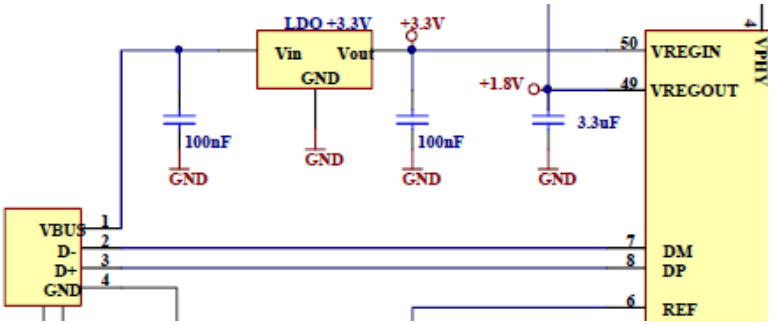

Figure 4.2 FT2232H VREGIN Connection (Bus Powered)

In a USB Self-Powered configuration, the VCC and VREGOUT supplies are sourced elsewhere (not from the USB Host 5V supply).

4.2 I/O Power

FT2232D I/O can operate between 3.0V and 5.25V. This has to be connected to all VCCIOA pins.
FT2232H I/O can operate between 2.97V and 3.63V. This has to be connected to all VCCIO pins.
If your design requires 5V I/O then FT2232D is more suitable.

However, FT2232H I/O pins are 5V tolerant.

4.3 Internal Regulators

FT2232D requires an external 33nF capacitor to GND on the 3V3OUT pin as shown in Figure 4.3.

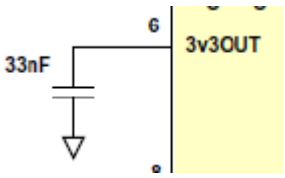

Figure 4.3 FT2232D 3V3OUT Connection

FT2232H requires an external 3.3uF capacitor to GND on the VREGOUT pin and connection to the VCORE pins as shown in Figure 4.4.

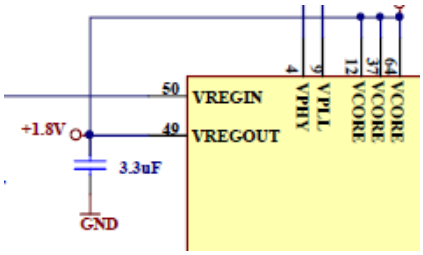

Figure 4.4 FT2232H VREGOUT Connection

4.4 Miscellaneous

FT2232D requires AVCC to be connected to 5V. A low pass filter consisting of a 470ohm series resistor and 0.1uF capacitor to GND should be used on the supply to this pin as shown in Figure 4.5.

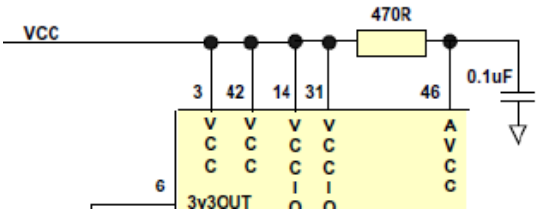

Figure 4.5 FT2232D AVCC Connection

FT2232H requires VPLL and VPHY to be connected to 3.3V. It is recommended that these supplies are filtered using an LC filter as shown in Figure 4.6.

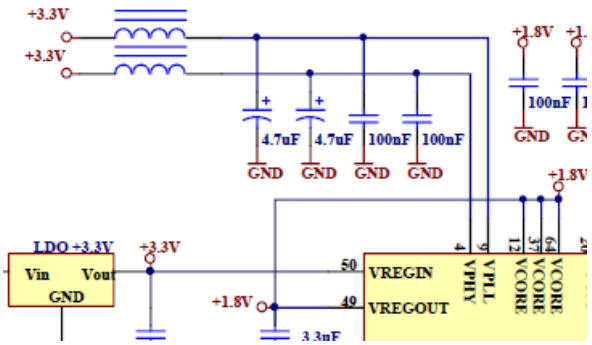

Figure 4.6 FT2232H VPLL/VPHY Connection

FT2232H requires an external 12K ± 1% accuracy resistor connected to the REF pin for current control as shown in Figure 4.7. This is not required on FT2232D.

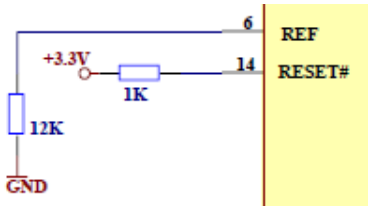

Figure 4.7 FT2232H REF Connection

5 External Clock

5.1 FT2232D

An external 6MHz Crystal is required. In this case, these devices do not have in-built loading capacitors so these have to be added between XTIN, XTOUT and GND as shown in Figure 5.1.

A value of 27pF is shown as the capacitor in the figure. This will be good for many crystals and some resonators but do select the value based on the manufacturer's recommendations.

It is also possible to use a 6MHz Oscillator. In this case the output of the oscillator would be connected to XTIN, and XTOUT should be left unconnected. The oscillator must have a CMOS output drive capability.

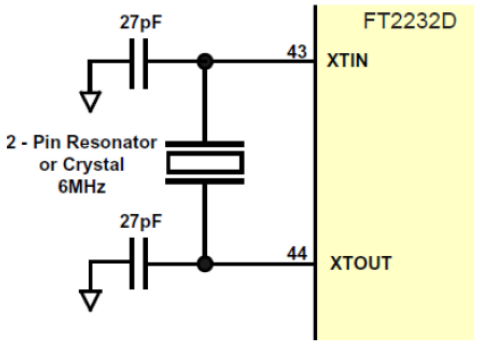

Figure 5.1 FT2232D External Clock

5.2 FT2232H

An external 12MHz Crystal is required with ± 0.003% accuracy. In this case loading capacitors should be added between OSCI, OSCO and GND as shown.

A value of 27pF is shown as the capacitor in the example. This will be good for many crystals but it is recommended to select the loading capacitor value based on the manufacturer's recommendations.

It is also possible to use a 12 MHz Oscillator with the FT2232H. In this case the output of the oscillator would drive OSCI, and OSCO should be left unconnected. The oscillator must have a CMOS output drive capability.

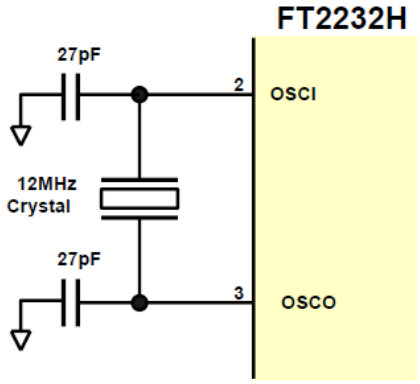

Figure 5.2 FT2232H External Clock

6 USB Data Lines

The USB Data lines require external components for edge rate control as these are high speed data lines.

See AN_146 USB Hardware Design Guidelines for FTDI ICs for more information.

FT2232D requires 27ohm resistors on the USB Data lines as shown in Figure 6.1.

There is also a requirement for 1.5K between RSTOUT# and USB DP for USB Full Speed identification during the enumeration process with the USB Host. Note that this 1.5K external resistor is not required on FT2232H as this is built into the IC.

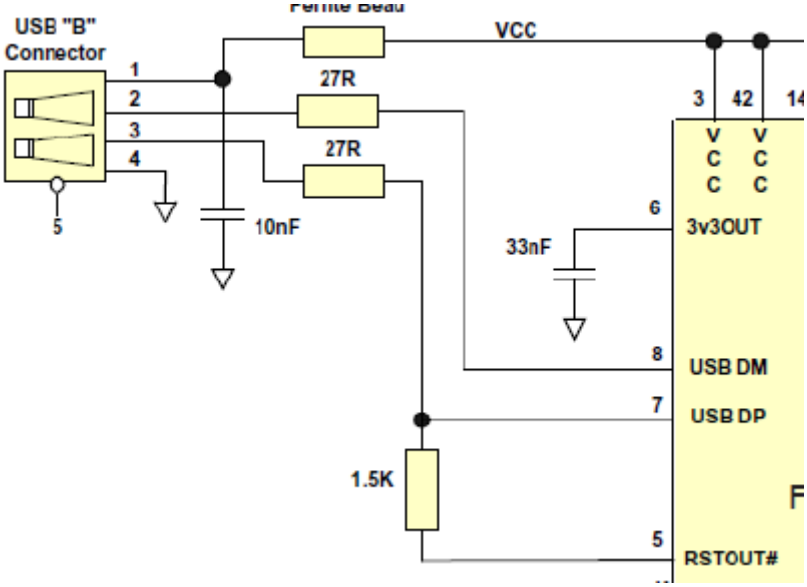

Figure 6.1 FT2232D USB Data Lines

FT2232H requires 0 to 10ohm resistors on the USB Data lines as shown in Figure 6.2.

It's recommended to place 10ohm as this is what is used in our Development Modules.

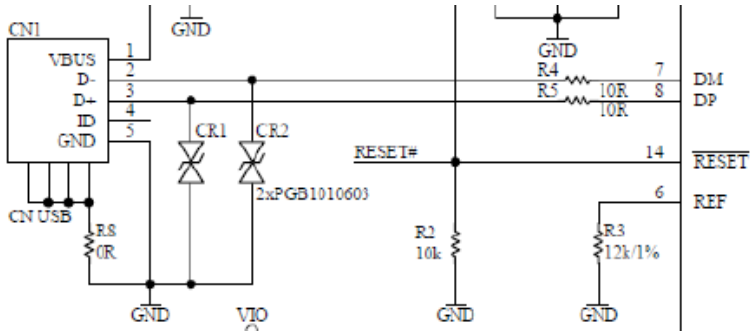

Figure 6.2 FT2232H USB Data Lines

7 EEPROM

Both the FT2232H and FT2232D devices do not have internal EEPROM, however the external EEPROM interface between the FT2232D and FT2232H are the same.

The EEPROM must be 16 bits wide and capable or working at a VCC supply of +3.0 to +3.6 volts for FT2232H and 4.35V to 5.25V for FT2232D.

Recommend EEPROMs are 93LC46/56/66.

The external EEPROM can be used to customise the USB VID, PID, Serial Number, Product Description Strings and Power Descriptor value for OEM applications.

If the devices are used without an external EEPROM (or if the EEPROM is blank), default values are used as detailed in the datasheets.

FT_PROG can be used to program the EEPROM.

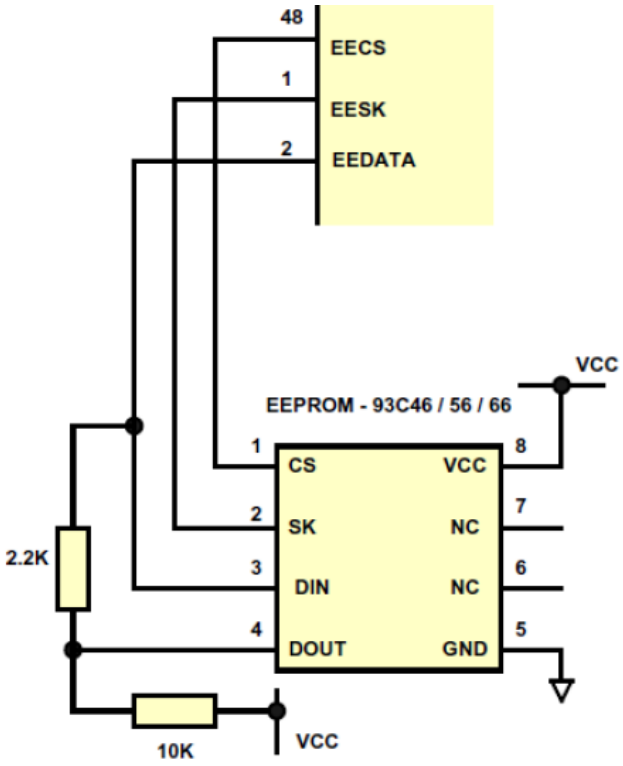

Figure 7.1 EEPROM Interface

8 IC PCB Layout

Please refer to TN_166 FTDI Example IC Footprints for example IC PCB footprints for FT2232D and FT2232H.

9 Software

This section discusses the software aspects of both devices.

Figure 9.1 shows how the devices appear in Windows Device Manager. There are two COM Ports (VCP) and two Universal Serial Bus Controller interfaces (D2XX).

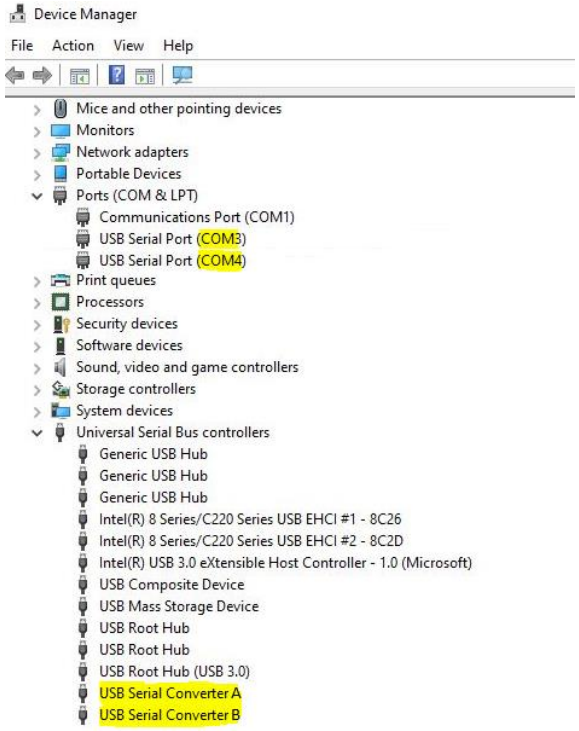

Figure 9.1 Device Manager

9.1 VCP Drivers

When using the VCP Drivers, both devices will appear the same as two unique COM Ports (USB Serial Ports).

The lower COM Port will always be Channel A and the higher COM Port will be Channel B.

Terminal applications like PuTTY and Tera Term can access the device using these COM Port numbers.

9.2 D2XX Drivers

When using the D2XX Drivers, again both devices will appear the same as two unique Universal Serial Bus controllers (USB Serial Converter).

Both devices share the same Product ID (PID) which is 0x6010. The same Vendor ID (VID) is used (0x0403).

The D2XX Programmer's Guide is used to develop D2XX applications.

9.3 MPSSE

MPSSE is only available on Channel A on FT2232D.

MPSSE is available on Channel A and Channel B on FT2232H which are independent of each other. So FT2232H has an advantage over FT2232D if you require more than one MPSSE interfaces (for JTAG, SPI, I2C).

MPSSE software examples can be found here:
https://ftdichip.com/software-examples/mpsse-projects/

10 USB Power Delivery

The FT223xHP products offer the same functionality as the FT2232H products. They can be used for UART, bit bang, I2C/SPI via MPSSE, etc.

The 'HP' variants offer additional power delivery functionality. This allows for control of power direction which can be either supplied from the USB Host or the USB device.

The original FT2232H product only has the ability to get power from the USB Host (5V at 500mA max).

If your device requires more than 5V at 500mA to be supplied over USB, or if your device currently has its own power supply of up to 20V at 3A which you want to eliminate, you could consider the 'HP' product. The ICs support 5V at 3A, 9V at 3A, 12V at 3A, 15V at 3A and 20V at 3A as sink or source. These profiles are configurable through the external EEPROM.

These products fully support the latest USB Type-C and Power Delivery standards enabling support for power negotiation with the ability to sink or source current to a USB host device. These controllers support 2 Type-C ports, with PD1 configurable as a power sink or dual role, and PD2 functioning as power sink, suitable in charging through applications. For Single port versions, the controller supports 1 Type-C port with Power Delivery sink function.

Table 10.1 shows a summary of the FT223xHP products.

Device	Description
FT2232HP	USB to Dual Channel Serial UART/FIFO/JTAG/SPI/I2C with one Power Delivery (PD) Port
FT2233HP	USB to Dual Channel Serial UART/FIFO/JTAG/SPI/I2C with two Power Delivery (PD) Ports

Table 10.1 FT223xHP Product Summary

PD port 1 (which also carries the USB data communication) can switch between the roles of sinking power from the host to power the peripheral and sourcing power to charge the host computer.

PD port 2 is a power sink and can be used to connect an external power source or charger. This can provide power to the peripheral board as well as charging the host via PD port 1.

11 Evaluation Modules

FTDI have no evaluation modules available for FT2232D but there may be some available from third party providers.

There are evaluation modules available for FT2232H:

- FT2232H Mini-Module
- FT2232H-56 Mini-Module

Please note that the -56 is easier to configure power with a couple of jumpers on the board. The other mini module requires multiple external connections.

There are also some application modules available which include FT2232H:

- USB-COM232-PLUS2
- USB-COM422-PLUS2
- USB-COM485-PLUS2

There is also an evaluation module available for FT223xHP. Note that the module includes FT4233HP silicon but this can be used to evaluate FT223xHP as the FT4233HP includes four ports (compared to two ports on the FT223xHP):

- UMFT4233HPEV

FTDI always recommends test, evaluation and reference using our hardware before developing custom hardware.

12 Conclusion

This Application Note details the differences between the FT2232D and FT2232H to help customers design with FT2232H as this newer, high speed USB device has better performance.

13 Contact Information

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Distributor and Sales Representatives

Please visit the Sales Network page of the FTDI Web site for the contact details of our distributor(s) and sales representative(s) in your country.

Appendix A – References

Document References

All FTDI ICs

FT2232H ICs

FT223xHP ICs

FT2232H Modules

UMFT4233HPEV Module

VCP Drivers

D2XX Drivers

D2XX Programmer's Guide

TN_166 FTDI Example IC Footprints

AN_146 USB Hardware Design Guidelines for FTDI ICs

FT_PROG

MPSSE Software Examples

Acronyms and Abbreviations

Terms	Description
CMOS	Complementary Metal Oxide Semiconductor
EEPROM	Electrically Erasable Programmable Read Only Memory
FIFO	First In First Out
I2C	Inter-Integrated Circuit
ICs	Integrated Circuits
JTAG	Joint Test Action Group
LDO	Low Dropout Regulator
LQFP	Low Profile Quad Flat Package
MPSSE	Multi-Protocol Synchronous Serial Engine
PCB	Printed Circuit Board
PID	Product ID
PD	Power Delivery
QFN	Quad Flat No-leads
RX	Receive
SPI	Serial Peripheral Interface

TX	Transmit
UART	Universal Asynchronous Receiver Transmitter
USB	Universal Serial Bus
VID	Vendor ID

Appendix B – List of Tables & Figures

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Appendix C – Revision History

Document Title: AN_558 Migrating from FT2232D to FT2232H

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Clearance No.: FTDI#568

Product Page: https://ftdichip.com/product-category/products/ic/

Document Feedback: Send Feedback

Revision	Changes	Date
1.0	Initial Release	23-12-2021