Future Technology Devices International Ltd.

Application Note AN_131

FT2232D/H Fast Opto-Isolated Serial Interface Mode

Document Reference No.: FT_000187

Version 1.0

Issue Date: 2009-10-21

This application note describes how to use the FTDI FT2232D and FT2232H devices in Fast Opto-Isolated Serial Interface mode

Future Technology Devices International Limited (FTDI)

Unit 1,2 Seaward Place, Glasgow G41 1HH, United Kingdom
Tel.: +44 (0) 141 429 2777 Fax: + 44 (0) 141 429 2758
E-Mail (Support): **support1@ftdichip.com** Web: http://www.ftdichip.com

Table of Contents

1 Introduction

This application note illustrates how to use the FTDI FT2232D or FT2232H in a Fast Opto-Isolated Serial Interface mode. This mode provides a method of communicating with an external device over USB using 4 wires that can have opto-isolators in their path, thus providing galvanic isolation between systems.

2 Hardware Configuration

EEPROM Configuration:

Both of FT2232D and FT2232H device require an external 93C46 EEPROM organized in 16-bit words. They also support the 93C56 and 93C66 EEPROMs organized in 16-bit words.

Opto-Isolation Device connection setting:

Use a USB cable to connect an FT2232D or FT2232H device to a PC - the pin assignment in given in **Table 2-1** which gives details of the required connection between the external system and FT2232D or FT2232H device.

Figure 2-1 is an example opto-isolated circuit; it shows two Agilent HCPL-2430 (see the semiconductor section at www.agilent.com) high speed opto-couplers used to optically isolate an external device which interfaces to USB using the FT2232D. In this example VCC5V is the USB VBUS supply and VCCE is the power supply to the external device.

Care must be taken with the voltage used to power the photo-LEDs. This must be the same voltage as the FT2232D I/Os are driving to, or the LEDs may be permanently on. Limiting resistors should be fitted in the lines that drive the diodes. The outputs of the opto-couplers are open-collector and require a pull-up resistor.

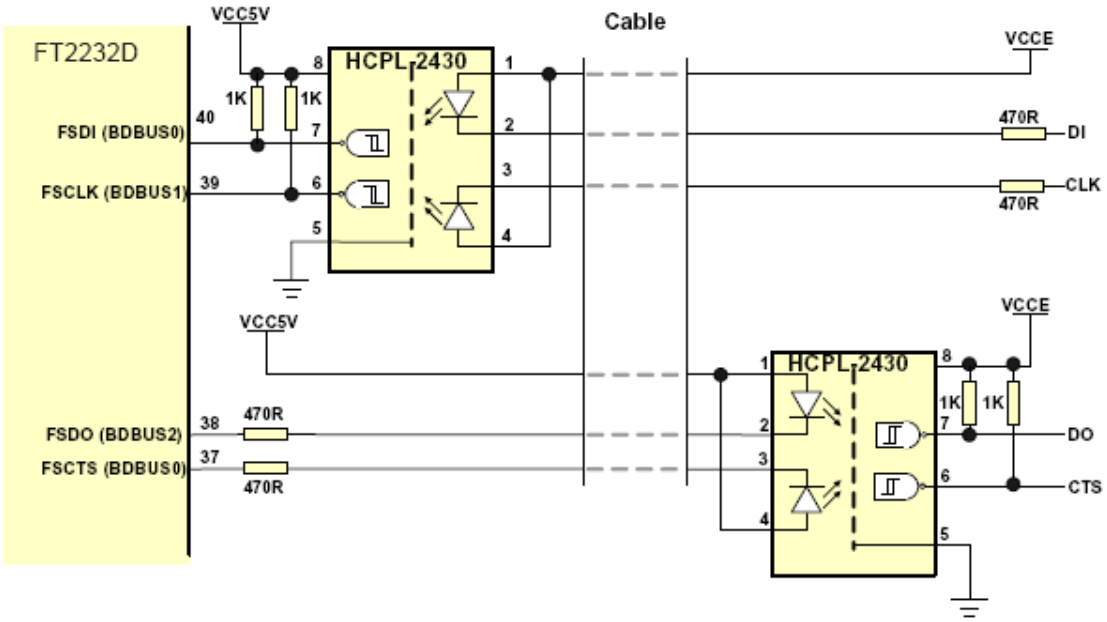

Figure 2-1 Fast Opto-Isolated Serial Interface Example

2.1 Pin Assignment Of Fast Opto-Isolated Serial Interface

If either channel A or channel B of the FT2232D/H is enabled in Fast Opto-Isolated Serial mode then the pins on channel B are switched to the fast serial interface configuration. The I/O interface for fast serial mode is always on channel B, even if both channels are being used in this mode. An address bit is used to determine the source or destination channel of the data. It therefore makes sense to always use at least channel B or both for fast serial mode, but not A own its own.

Table 2-1 is the pin assignment of channel B when it is in Fast Opto-Isolated Serial Mode.

Pin# (FT2232D)	Pin# (FT2232H)	Pin Name	Pin Definitions	Type	Description
40	38	BDBUS0	FSDI	INPUT	Fast serial data input
39	39	BDBUS1	FSCLK	INPUT	Clock input to FT2232D or FT2232H chip to clock data in or out. The external device has to provide a clock signal or nothing will change on the interface pins. This gives the external device full control over the interface. It is designed to be half duplex so that data is only transferred in one direction at a time.
38	40	BDBUS2	FSDO	OUTPUT	Fast serial data output.
37	41	BDBUS3	FSCTS	OUTPUT	Clear To Send control signal output. Driven low to indicate that the chip is ready to send data

Table 2-1 Channel B Fast Serial Interface Configured Pin Descriptions

Note: FSDI & FSCLK are Pulled up to VCCIO via internal 200K resistors. These pins can be programmed to gently pull low during USB suspend (PWREN# = "1") by setting this option in the EEPROM.

2.2 IO Timing

When either Channel B or both Channel A and B are configured in Fast Opto-Isolated Serial Interface mode, it's necessary to follow the IO timing as shown in Figure 2-1 to access the data.

Table 2-2 shows the detail information for the timing.

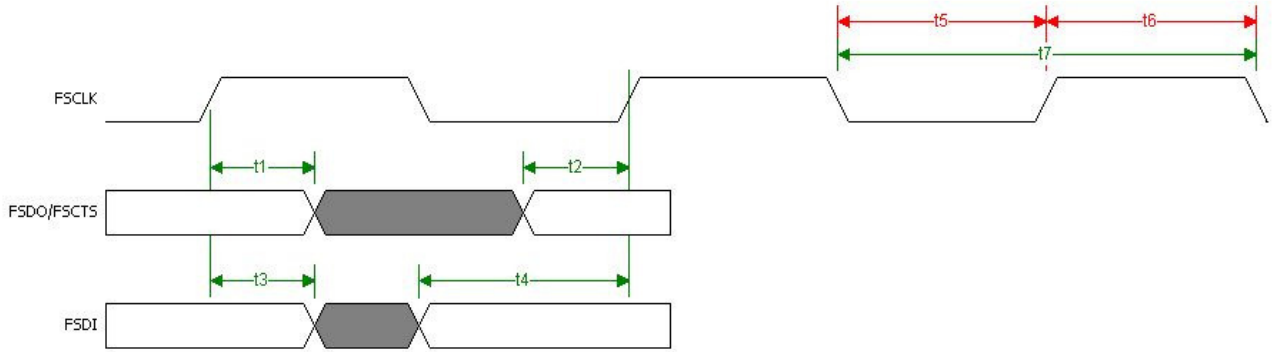

Figure 2-1 Fast Opto-Isolated Serial Interface Signal Waveforms

Time	Description	Min	Max	Unit
t1	FSDO / FSCTS hold time	5	-	ns
t2	FSDO / FSCTS setup time	5	-	ns
t3	FSDI hold time	5	-	ns
t4	FSDI setup time	10	-	ns
t5	FSCLK low	10	-	ns
t6	FSCLK high	10	-	ns
t7	FSCLK Period	20	-	ns

Table 2-2 Fast Opto-Isolated Serial Interface Signal Timings

3 Software Configuration

With FTDI devices, it is necessary to install the FTDI D2XX driver on the PC to which they are connected. Please visit http://www.ftdichip.com/Drivers/D2XX.htm and download and install the necessary driver which matches the PC.

The table below is taken from the FT2232H datasheet. It indicates that it is necessary to set the Fast Opto-Isolated Serial Interface mode by configuring the EEPROM to Fast Serial Interface mode before developing a software application to access data under Fast Opto-Isolated Serial Interface mode. Configuring the EEPROM is illustrated in chapter3.1. Developing software application is illustrated in chapter4

	ASYNC Serial UART	ASYNC 245 FIFO	SYNC 245 FIFO	ASYNC Bit-bang	SYNC Bit-bang	MPSSE	Fast Serial Interface	CPU-Style FIFO	Host Bus Emulation
EEPROM configured	YES	YES	YES				YES	YES	
Application Software configured			YES	YES	YES	YES			YES

Table 3-1 Configuration Using EEPROM And Application Software

3.1 EEPROM Setting

Connect the FT2232D or FT2232H to a PC via USB cable, if the driver is installed already, the EEPROM settings can be programmed using either FTDIs MPROG or FT_PROG utilities (downloadable from FTDI website. Any one of these utilities can be used to set port A and port B to "OPTO Isolate" mode in EEPROM.

Figure 3-1 illustrates using MPROG for an example of FT2232D setting. It is possible to configure channel B or both channel B and A to fast Opto-Isolated Serial interface mode by clicking the right side 'OPTO Isolate' item (please check the red square).

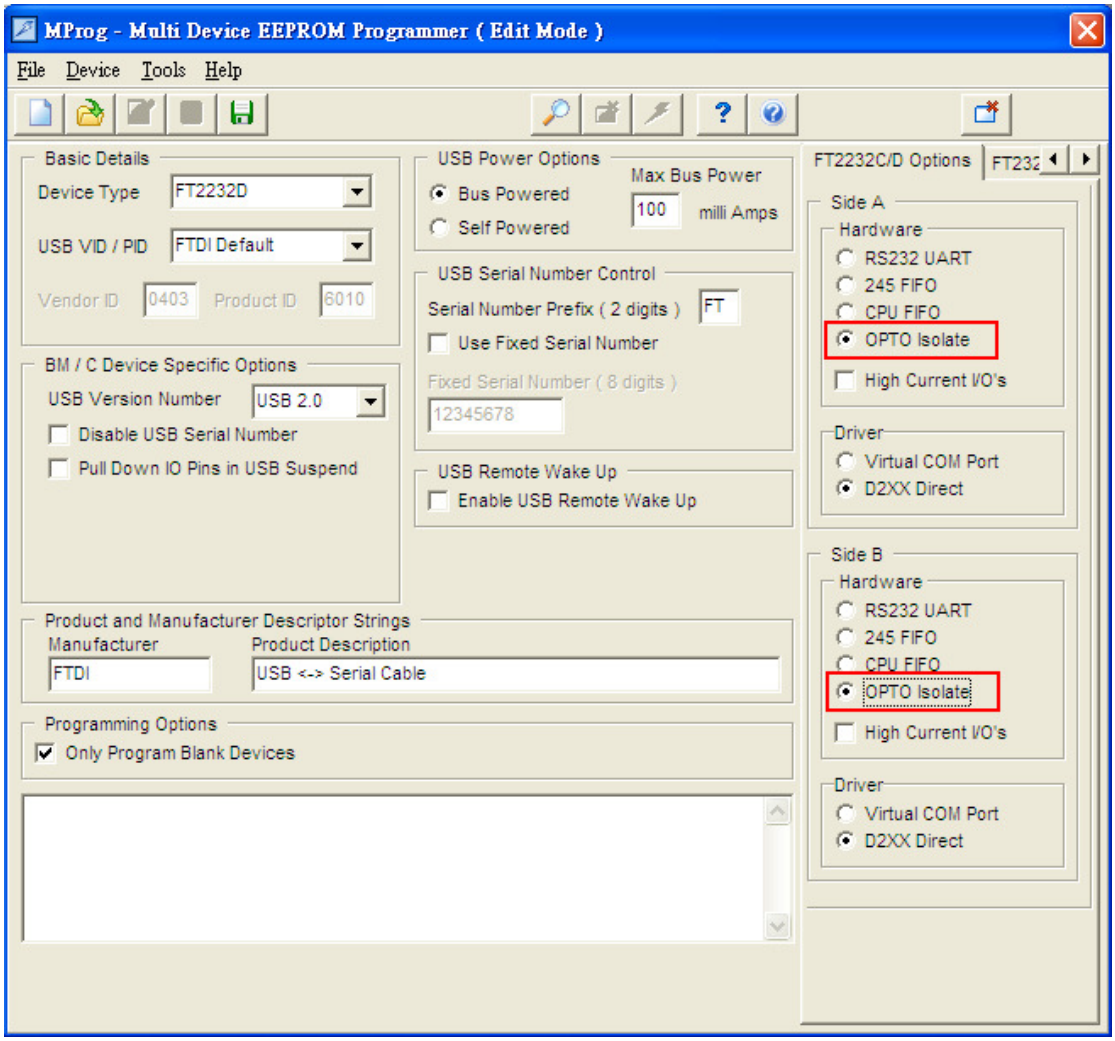

Figure 3-1 EEPROM setting by MProg tool

Note. When channel B is not in Fast Opto-Isolated Serial Mode, it is not possible to configure channel A as Fast Opto-Isolated Serial Mode. If only one Fast Opto-Isolated Serial port is needed, then use channel B.

Channel A can be configured in another IO mode if channel B is in Fast Opto-Isolated Serial Mode. If both Channel A and Channel B are in Fast Opto-Isolated Serial Mode all of the IO will be on Channel B.

4 Application Development

It is necessary to develop an application to access data under Fast Opto-Isolated Serial Interface mode. The following section describes how this can be achieved. The code examples are for illustration only and are not supported by FTDI.

Before developing the application, check Table 4-1 to determine which value is "Mode" is assigned to for Fast Opto-Isolated Serial Interface mode. When Fast Opto-Isolated Serial Interface mode is selected, set mode=0x10 will hold the device mode in reset and set mode=0x0 will release device from reset. This is different from other modes. So When an application is developed , it is recommended to call FT_SetBitMode(0x10) will hold the system in freeze then call FT_SetBitMode(0x0) to free it.

Mode	*Value (hex)*	Result
Asynchronous Bit Bang Mode	0x0	Reset mode to EEPROM setting
	0x1	switch to Asynchronous Bit Bang Mode
MPSSE	0x0	Reset mode to EEPROM setting
	0x2	switch to MPSSE mode
Synchronous Bit bang Mode	0x0	Reset mode to EEPROM setting
	0x4	switch to Synchronous Bit bang Mode
MCU Host bus Emulation	0x0	Reset mode to EEPROM setting
	0x8	switch to MCU Host bus Emulation
Fast Opto-Isolated Serial Mode	0x0	switch to Fast Opto-Isolated Serial Mode (it's setting in EEPROM)
	0x10	hold the mode in reset (freeze)
Synchronous 245 FIFO Mode (FT2232H devices only)	0x0	Reset mode to EEPROM setting
	0x40	switch to Synchronous 245 FIFO Mode

Table 4-1 Mode Value With FT_SetBitMode Command

To use the software commands, it is necessary to download the ftd2xx.dll, ftd2xx.lib, ftd2xx.h from the FTDI CDM driver. Details are available in the following programmers guide on how to use the software commands D2XX_Programmer's_Guide(FT_000071).pdf.

In the example application code, it is firstly necessary to open the Fast Opto-Isolated Serial Port of the FT2232D or FT2232H.

4.1 Code example

The following section gives an application example. This code is not guaranteed and is provided for illustration only. It is not supported by FTDI.

Example code

```
FT_HANDLE ftHandle;
FT_STATUS ftStatus;
UCHAR Mask = 0x00;
UCHAR Mode;

ftStatus = FT_Open(1, &ftHandle); //open port B
if(ftStatus != FT_OK)
{
// FT_Open failed return;
}
Mode = 0x00; //reset mode
ftStatus = FT_SetBitMode(ftHandle, Mask, Mode);

if (ftStatus == FT_OK)
{
//access data from here
}
else
{
// FT_SetBitMode FAILED!
}
FT_Close(ftHandle);
```


4.2 Write Data Mode

When a PC sends data to an external system via FT2232D or FT2232H device, it is referred to as write data mode.

To send fast serial data out of the FT2232D or FT2232H, the external device must drive the FSCLK clock. If the FT2232D or FT2232H has data ready to send, it will drive FSDO output low to indicate the start bit. It will not do this if it is currently receiving data from the external device. This is illustrated in Figure 4-1.

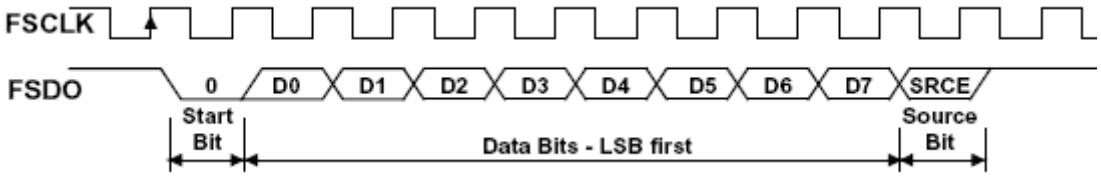

Figure 4-1 Fast Opto-Isolated Serial Interface Output Data Format

Notes :

1. The first bit output (Start bit) is always 0.

2. FSDO is always sent LSB first.

3. The last serial bit output is the source bit (SRCE). It indicates which channel the data has come from. A '0' means that it has come from Channel A, a '1' means that it has come from Channel B.

4. if the target device is unable to accept the data when it detects the START bit, it should stop the FSCLK until it can accept the data.

4.3 Read Data Mode

When a PC reads data from an external system via FT2232D or FT2232H device, it is referred to as read data mode.

An external device is allowed to send data into the FT2232D or FT2232H if FSCTS is high. On receipt of a zero START bit on FSDI, the FT2232D or FT2232H will drop FSCTS on the next positive clock edge. The data from bits 0 to 7 are then clocked in (LSB first). The last bit (DEST) determines where the data will be written to. The data can be sent to either channel A or channel B. If DEST= '0', the data is sent to channel A, (assuming channel A is enabled for fast serial mode, otherwise the data is sent to channel B). If DEST= '1' the data is sent to channel B, (assuming channel B is enabled for fast serial mode, otherwise the data will go to channel A. (Either channel A, channel B or both channels must be enabled as fast serial mode or the function is disabled). This is illustrated in Figure 4-2.

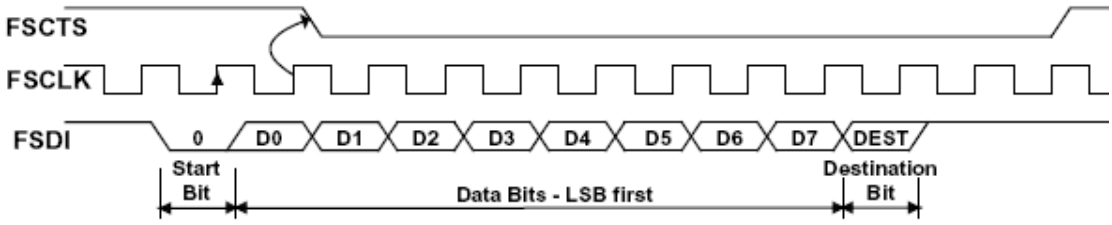

Figure 4-2 Fast Opto-Isolated Serial Interface Input Data Foramt

Notes :

1. The first bit input (Start bit) is always 0.

2. FSDI is always received LSB first.

3. The last received serial bit is the destination bit (DEST).It indicates which channel the data should go to. A '0' means that it should go to channel A, a '1' means that it should go to channel B.

4. The target device should ensure that FSCTS is high before it sends data. FSCTS goes low after data bit 0(D0) and stays low until the chip can accept more data.

Contention

There is a possibility that contention may occur, where the interface goes from being completely idle to both sending and receiving at the same clock instance. In this case the FT2232D/H will back off, and allows the data from the external device to be received.

Data Format

The data format for either direction is :-

1) Zero Start Bit
2) Data bit 0
3) Data bit 1
4) Data bit 2
5) Data bit 3
6) Data bit 4
7) Data bit 5
8) Data bit 6
9) Data bit 7
10) Source/Destination (‘0’ indicates channel A; ‘1’ indicates channel B)

5 Contact Information

Head Office – Glasgow, UK

Future Technology Devices International Limited
Unit 1,2 Seaward Place, Centurion Business Park
Glasgow G41 1HH
United Kingdom
Tel: +44 (0) 141 429 2777
Fax: +44 (0) 141 429 2758

E-mail (Sales) sales1@ftdichip.com
E-mail (Support) support1@ftdichip.com
E-mail (General Enquiries) admin1@ftdichip.com
Web Site URL http://www.ftdichip.com
Web Shop URL http://www.ftdichip.com

Branch Office – Taipei, Taiwan

Future Technology Devices International Limited (Taiwan)
2F, No. 516, Sec. 1, NeiHu Road
Taipei 114
Taiwan , R.O.C.
Tel: +886 (0) 2 8791 3570
Fax: +886 (0) 2 8791 3576

E-mail (Sales) tw.sales1@ftdichip.com
E-mail (Support) tw.support1@ftdichip.com
E-mail (General Enquiries) tw.admin1@ftdichip.com
Web Site URL http://www.ftdichip.com

Branch Office – Hillsboro, Oregon, USA

Future Technology Devices International Limited (USA)
7235 NW Evergreen Parkway, Suite 600
Hillsboro, OR 97123-5803
USA
Tel: +1 (503) 547 0988
Fax: +1 (503) 547 0987

E-Mail (Sales) us.sales@ftdichip.com
E-Mail (Support) us.admin@ftdichip.com
Web Site URL http://www.ftdichip.com

Branch Office – Shanghai, China

Future Technology Devices International Limited (China)
Room 408, 317 Xianxia Road,
Shanghai, 200051
China
Tel: +86 21 62351596
Fax: +86 21 62351595

E-mail (Sales) cn.sales@ftdichip.com
E-mail (Support) cn.support@ftdichip.com
E-mail (General Enquiries) cn.admin@ftdichip.com
Web Site URL http://www.ftdichip.com

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 - Revision History

Revision History

Version 1.0	Initial Release	21/10/2009

