

Manual

USB Driver Installation



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W&T

The serial W&T USB interfaces are operatable under the various operating systems only by means of special drivers (except for Linux). These drivers are subject to continuous development and improvement with respect to their technical features as well as the number and kind of supported operating systems.

Therefore W&T makes the latest drivers and software installation guides available for downloading on the data sheet pages for USB Interfaces at <http://www.wut.de>.

Whereas Linux kernel version 2.4 and higher supports the interfaces directly with no additional drivers, under Windows 98/ME, Windows 2000 and XP the driver installs virtual COM Ports through which the serial ports of the interfaces can be accessed.

Detailed information on installing and configuring the drivers under the various operating systems is found on the following pages.

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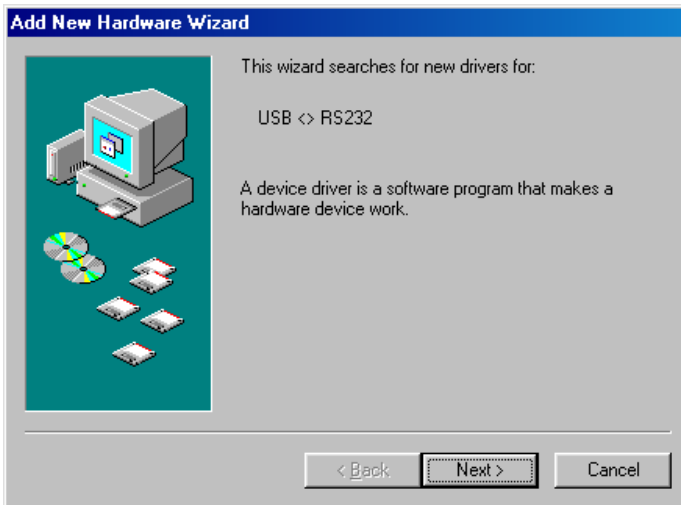
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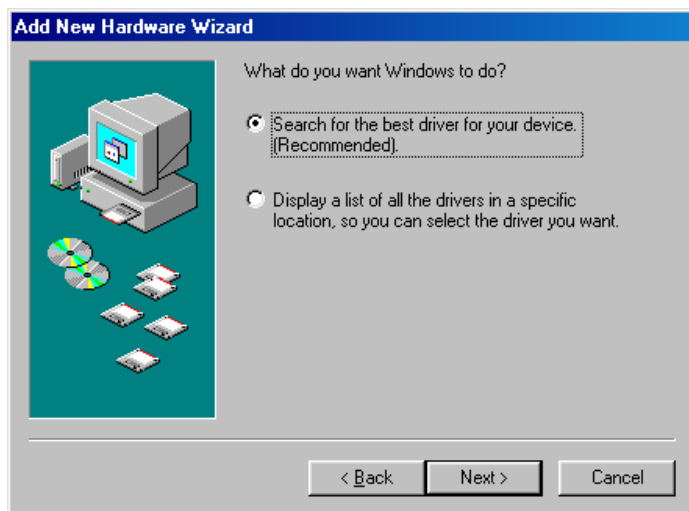
Windows 98/ME**1. Installation**

The driver installation process is for the most part automatic. During the installation you must only specify the path for locating the driver files. This is generally the CD-ROM drive if you are installing the driver contained on the CD-ROM.

The first time you connect the USB Interface to the PC, Windows uses the following window to let you know that a new hardware component was found and that a driver is being installed for these components:



Click on *Next* to confirm the driver installation and allow Windows to search for an appropriate driver for the connected device:



Next enter the path under which Windows should find the drivers:



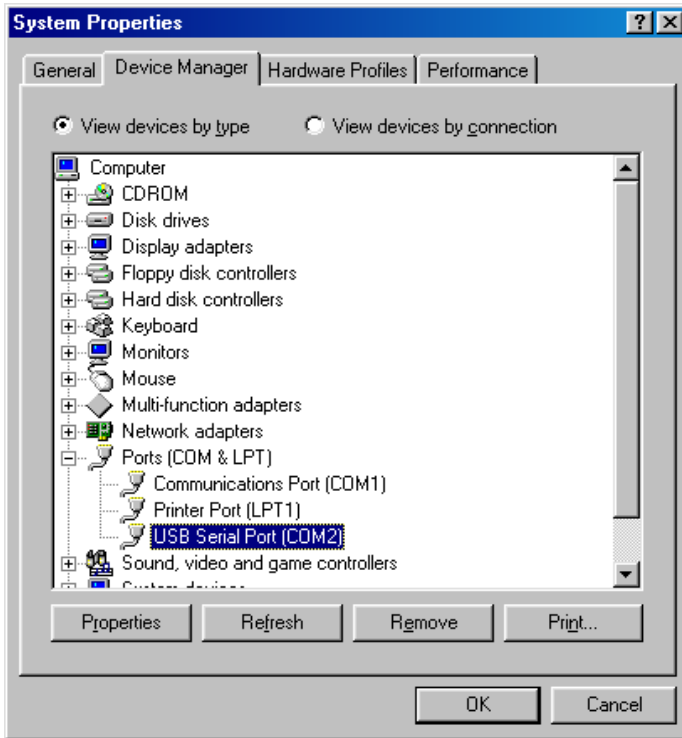
Windows then confirms that the file *ftdibus.inf* associated with the device has been found. Start installation of the driver by clicking on *Next*:



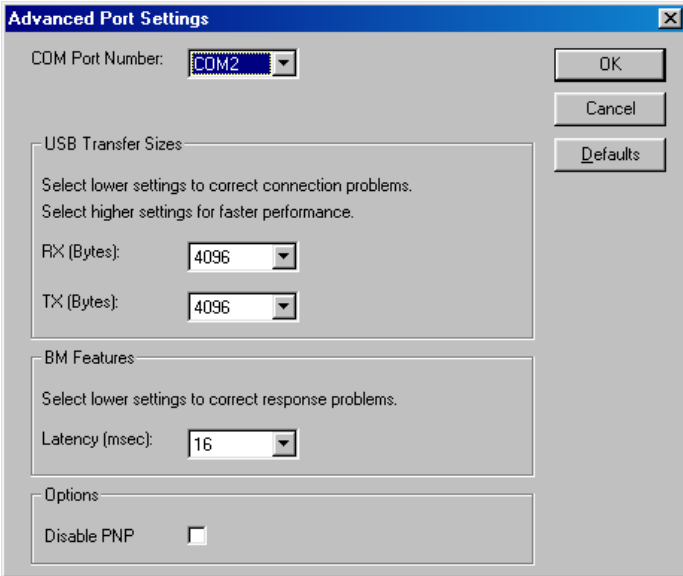
Windows copies the required files and then prompts you to end the driver installation by clicking on *Finish*:



After the installation is complete, you will find an entry for the configured USB Interface under *Start -> Settings -> Control Panel -> System -> Device Manager -> Ports (COM und LPT)* - COM2 in the example below:



Double clicking on the entry allows the interface to be configured, whereby the values set under *Port Settings* are generally overwritten by the configuration selected in the corresponding application. Of interest in this connection are the possibilities provided under *Advanced...* for changing the COM port assigned to the interface and adjusting the Latency Timer (see technical background information).



Be absolutely sure that a COM port number is never assigned more than once. This can happen in cases where not all installed serial devices in or on the PC are permanently in operation.

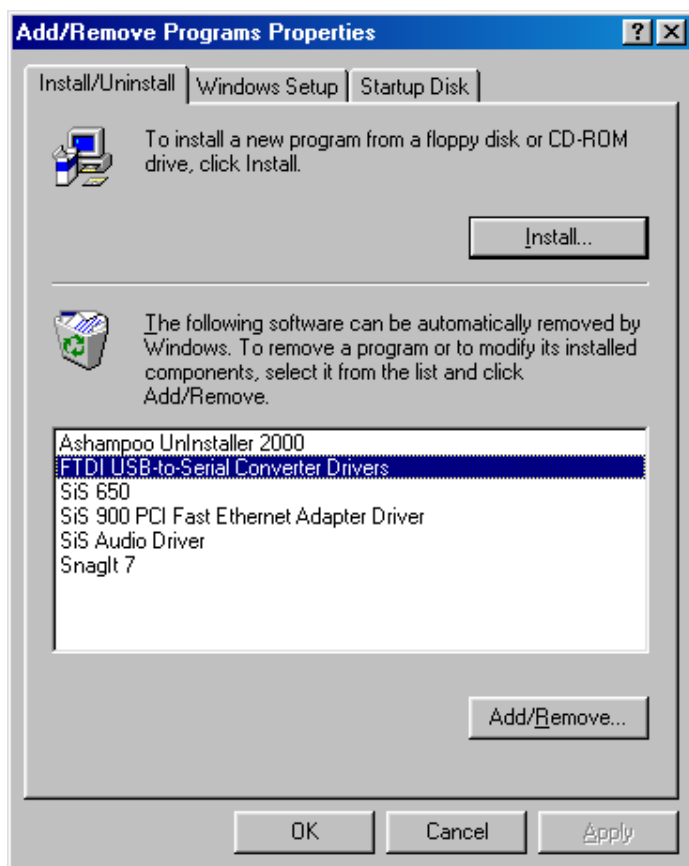
This is the case for example when additional virtual COM ports are set up through a network and are not currently connected to the PC. If the associated driver enables the resources again when the component is not connected, it is possible to select a COM port number which is actually already allocated and will be reactivated as soon as the device is reconnected.



In such cases a COM port thus exists more than once, and if you are fortunate, Windows acknowledges the attempt to open the port simply with an error message.

2. Uninstalling

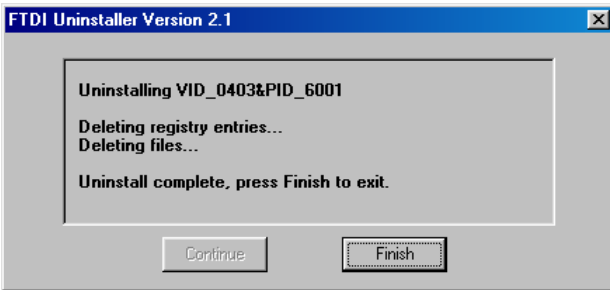
The driver software is uninstalled through the path *Start -> Settings -> Control Panel -> Software*. Choose *FTDI USB-to-Serial Converter Drivers* and confirm your selection by clicking on *Add/Remove...*



If the interface has not yet been removed from the PC, you should do this before uninstalling the driver and acknowledge the following window:



In the following window, confirm deletion of the driver files:



This concludes uninstalling of the drivers.

Windows 2000

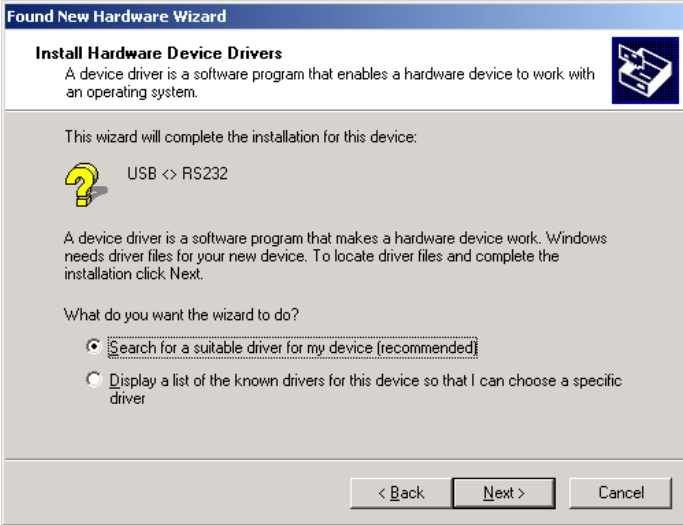
1. Installation

The driver installation process is for the most part automatic. During the installation you must only specify the path for locating the driver files. This is generally the CD-ROM drive if you are installing the driver contained on the CD-ROM.

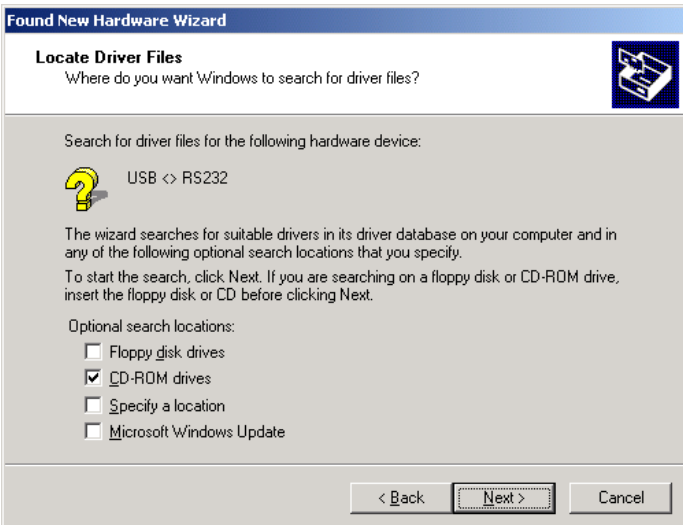
The first time you connect the USB Interface to the PC, Windows uses the following window to let you know that a new hardware component was found and that a driver is being installed for these components:



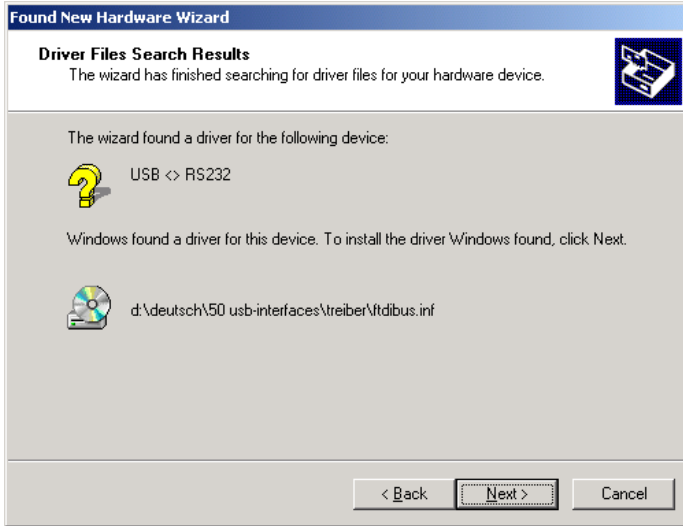
Click on *Next* to confirm the driver installation and allow Windows to search for an appropriate driver for the connected device:



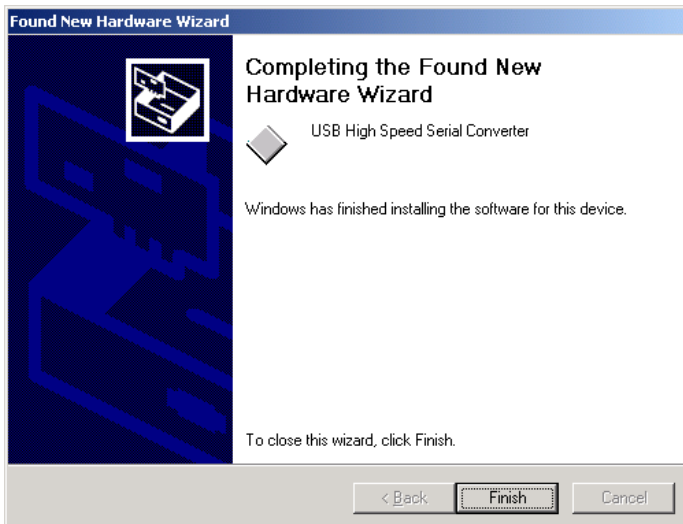
Next enter the path under which Windows should find the drivers:



Windows then confirms that the file *ftdibus.inf* associated with the device has been found. Start installation of the driver by clicking on *Next*:



Windows copies the required files and then prompts you to end the driver installation by clicking on *Finish*:



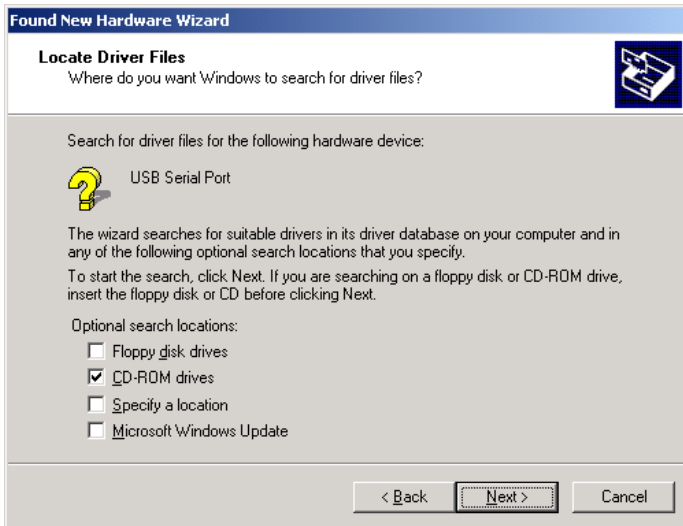
After installing the driver, you must also install the COM Port Redirector, which sets up a virtual COM port for the serial interface. This procedure is automatically started after installing the driver and requires the same entires as for the driver installation.



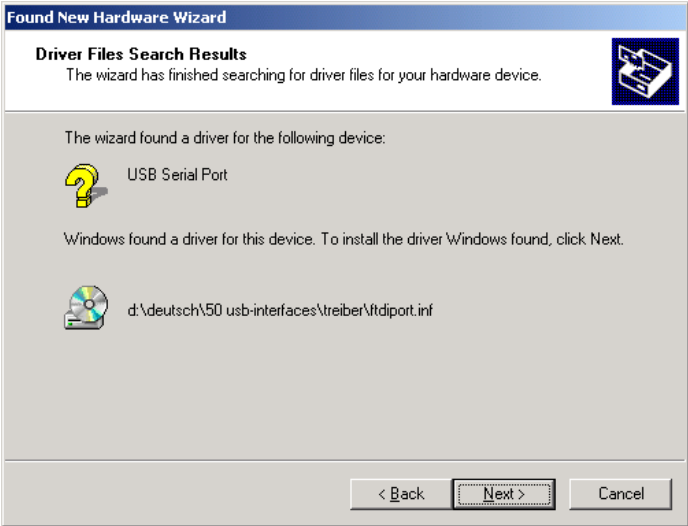
Have Windows search for an appropriate driver for the connected device:



Enter the path under which Windows will find the driver:



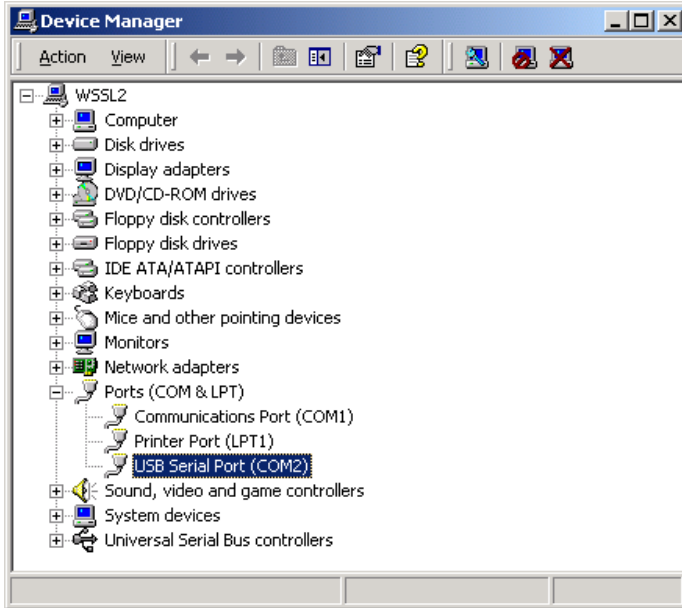
Windows then confirms that the file *ftdiport.inf* associated with the device was found. Start installation of the driver by clicking on *Next*:



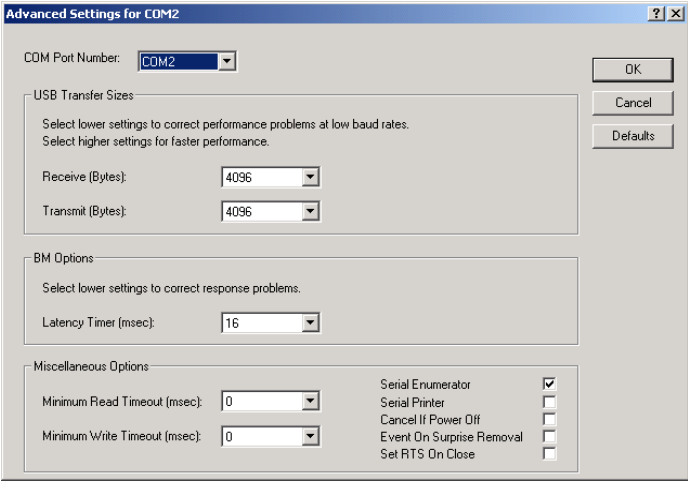
Windows then again prompts you to end the driver installation by clicking on *Finish*:



After installation is complete, you will find an entry for the configured USB Interface under *Start -> Settings -> Control Panel -> System -> Hardware -> Device Manager -> Ports (COM and LPT)*. In our example this is COM2:



Double clicking on the entry allows the interface to be configured, whereby the values set under *Port Settings* are generally overwritten by the configuration selected in the corresponding application. Of interest in this connection are the possibilities provided under *Advanced...* for changing the COM port assigned to the interface and adjusting the Latency Timer (see technical background information).



Be absolutely sure that a COM port number is never assigned more than once. This can happen in cases where not all installed serial devices in or on the PC are permanently in operation.

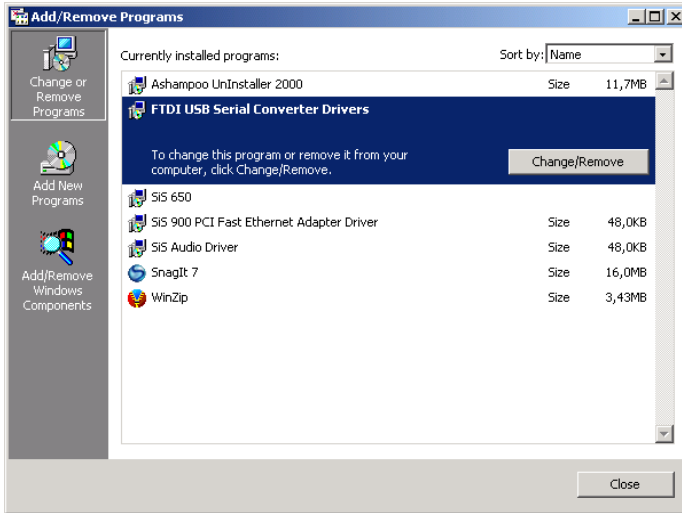
This is the case for example when additional virtual COM ports are set up through a network and are not currently connected to the PC. If the associated driver enables the resources again when the component is not connected, it is possible to select a COM port number which is actually already allocated and will be reactivated as soon as the device is reconnected.



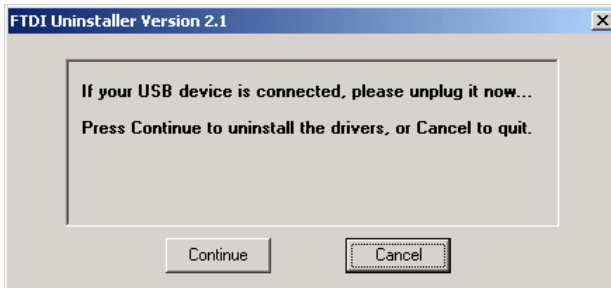
In such cases a COM port thus exists more than once, and if you are fortunate, Windows acknowledges the attempt to open the port simply with an error message.

2. Uninstalling

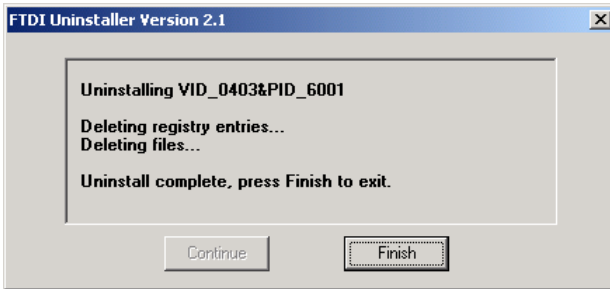
The driver software is uninstalled through the path *Start -> Settings -> Control Panel -> Software*. Choose *FTDI USB-to-Serial Converter Drivers* and confirm your selection by clicking on *Change/Remove*.



If the interface has not yet been removed from the PC, you should do this before uninstalling the driver.



In the following window, confirm deletion of the driver files:



This concludes uninstalling of the drivers.

Windows XP

1. Installation

The driver installation process is for the most part automatic. During the installation you must only specify the path for locating the driver files. This is generally the CD-ROM drive if you are installing the driver contained on the CD-ROM.

The first time you connect the USB Interface to the PC, Windows uses the following window to let you know that a new hardware component was found and that a driver is being installed for these components:



Windows now asks for confirmation that you want to install the driver. Confirm this with *Continue Anyway*.



Windows confirms the completed installation. Confirm this with *Finish*.



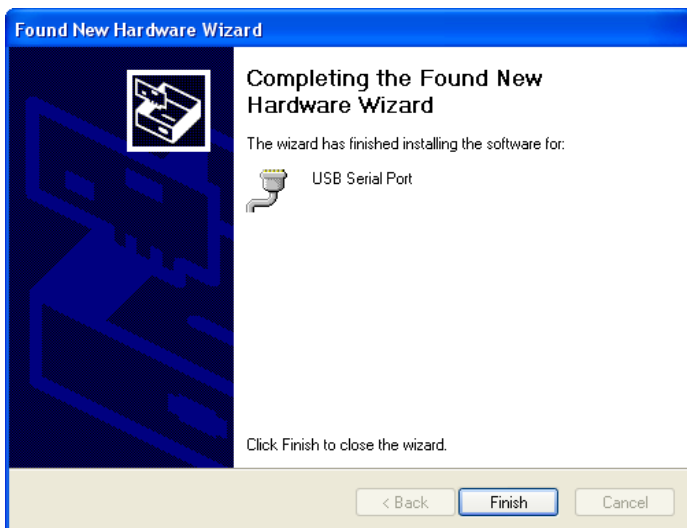
After installing the driver, you must also install the COM Port Redirector, which sets up a virtual COM port for the serial interface. This procedure is automatically started after installing the driver and requires the same entire as for the driver installation.



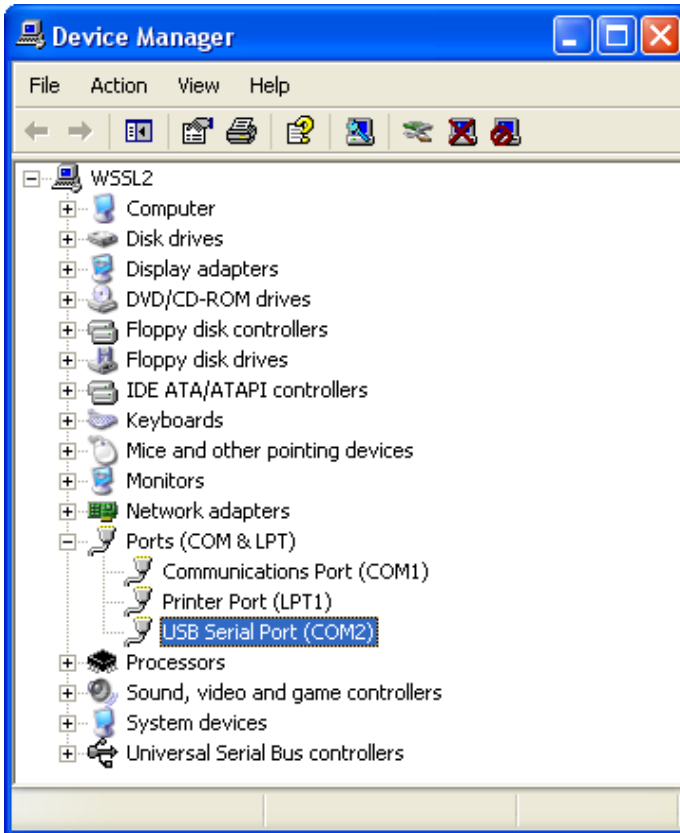
Windows now asks for confirmation that you want to install the driver. Confirm this with *Continue Anyway*.



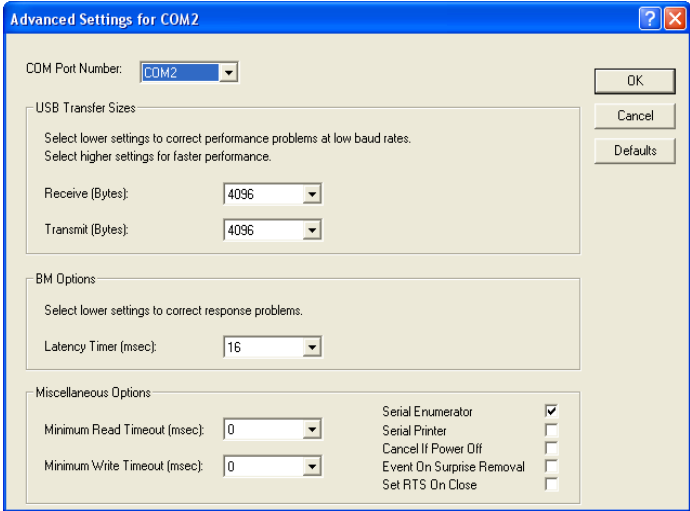
Windows confirms the completed installation. Confirm this with *Finish*.



After installation is complete, you will find an entry for the configured USB Interface under *Start -> Settings -> Control Panel -> System -> Hardware -> Device Manager -> Ports (COM & LPT)*. In our example this is COM2:



Double clicking on the entry allows the interface to be configured, whereby the values set under *Port Settings* are generally overwritten by the configuration selected in the corresponding application. Of interest in this connection are the possibilities provided under *Advanced...* for changing the COM port assigned to the interface and adjusting the Latency Timer (see technical background information).



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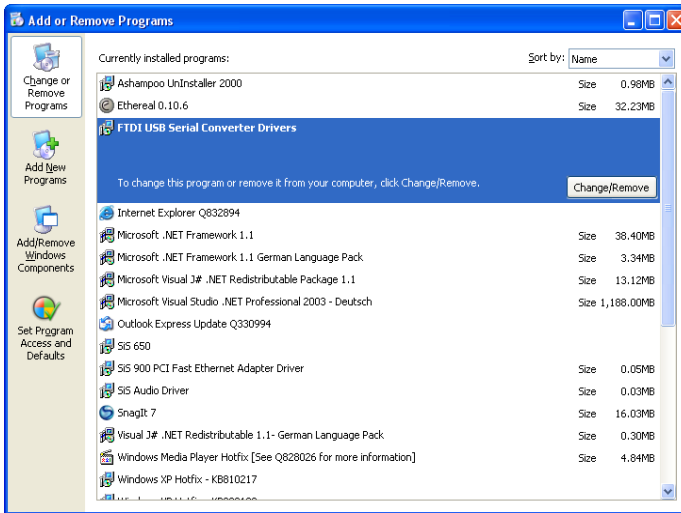
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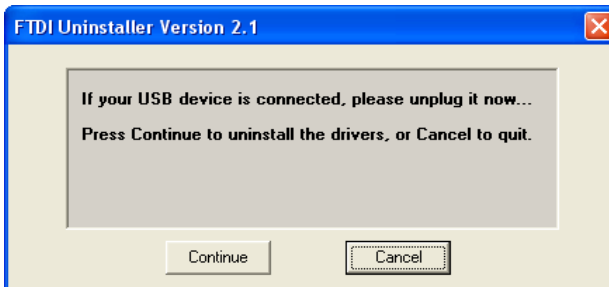
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2. Uninstalling

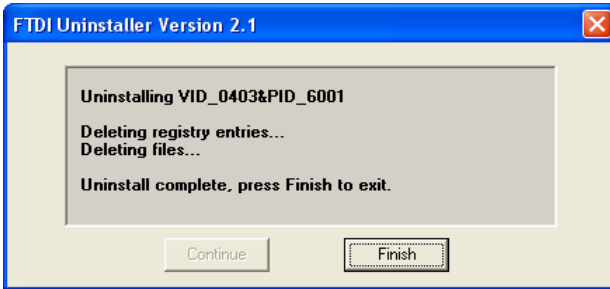
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If the interface has not yet been removed from the PC, you should do this before uninstalling the driver.



In the following window, confirm deletion of the driver files:



This concludes uninstalling of the drivers.

Technical background information

Data Throughput and Latency

Background

The Universal Serial Bus may be new to some users and developers. This application note tries to describe the major architecture differences that need to be considered by both software and hardware designers when changing from a traditional RS232 based solution, to one that uses the FT232BM USB to serial interface device. The information in this application note also applies to the FT245BM USB to parallel FIFO interface devices.

The Need for Handshaking

USB data transfer is prone to delays that do not normally appear in systems that have been used to transferring data using interrupts. The original COM ports of a PC were connected to the motherboard and were interrupt driven. When a character was transmitted or received (depending if FIFO's are used) the CPU would be interrupted and go to a routine to handle the data. This meant that a user could be reasonably certain that, given a particular Baud rate and Data rate, the transfer of data could be achieved without any real need for flow control. The hardware interrupt ensured that the request would get serviced. Therefore data could be transferred without using handshaking and still arrive into the PC without data loss.

Data Transfer Comparison

USB does not transfer data using interrupts. It uses a scheduled system and as a result, there can be periods when the USB request does not get scheduled and, if handshaking is not used, data loss will occur. An example of scheduling delays can be seen if an open application is dragged around using the mouse.

For a USB device, data transfer is done in packets. If data is to be sent from the PC, then a packet of data is built up by the

device driver and sent to the USB scheduler. This scheduler puts the request onto the list of tasks for the USB host controller to perform. This will typically take at least 1 millisecond to execute because it will not pick up the new request until the next 'USB Frame' (The frame period is 1 millisecond). Therefore there is a sizable overhead (depending on your required throughput) associated with moving the data from the application to the USB device. If data were sent 'byte at a time' by an application, this would severely limit the overall throughput of the system as a whole.

Continuous Data – Smoothing the Lumps

Data is received from USB to the PC by a polling method. The driver will request a certain amount of data from the USB scheduler. This is done in multiples of 64 bytes. The 'bulk packet size' on USB is a maximum of 64 bytes. The host controller will read data from the device until either (a) a packet shorter than 64 bytes is received or (b) the requested data length is reached. The device driver will request packet sizes between 64 Bytes and 4 Kbytes. The size of the packet will affect the performance and is dependent on the data rate. For very high speed, the largest packet size is needed. For 'real-time' applications that are transferring audio data at 115200 Baud, for example, the smallest packet possible is desirable, otherwise the device will be holding up 4k of data at a time. This can give the effect of 'jerky' data transfer if the USB request size is too large and the data rate too low (relatively). The latest driver release will automatically vary the requested packet size depending on the baud rate selected.

Small Amounts of Data and End of Buffer Conditions

When transferring data from the FT232BM or FT245BM to the PC, the device will send the data given one of the following conditions: -

1. The buffer is full (64 bytes made up of 2 status bytes and 62 user bytes).

2. One of the RS232 status lines has changed (FT232BM chip only). A change of level (high or low) on CTS# / DSR# / DCD# or RI# will cause it to pass back the current buffer even though it may be empty or have less than 64 bytes in it.
3. An event character had been enabled and was detected in the incoming data stream.
4. A timer integral to the chip has timed out. There is a timer in both the FT232BM and FT245BM chips that measures the time since data was last sent to the PC. The default value of the timer is set to 16 milliseconds. Every time data is sent back to the PC the timer is reset. If it times-out then the chip will send back the 2 status bytes and any data that is held in the buffer.

From this it can be seen that small amounts of data (or the end of large amounts of data), will be subject to a 16 millisecond delay when transferring into the PC. This delay should be taken along with the delays associated with the USB request size as mentioned in the previous section. The timer value was chosen so that we could make advantage of 64 byte packets to fill large buffers when in high speed mode, as well as letting single characters through. The value chosen is 16 milliseconds. This means that it will take 16 milliseconds to receive an individual character, over and above the transfer time on serial or parallel link.

For large amounts of data, at high data rates, the timer will not be used. It may be used to send the last packet of a block, if the final packet size works out to be less than 64 bytes. The first 2 bytes of every packet are used as status bytes for the driver. This status is sent every 16 milliseconds, even when no data is present in the device.

A worst case condition could occur when 62 bytes of data are received in 16 milliseconds. This would not cause a timeout, but would send the 64 bytes (2 status + 62 user data bytes) back to USB every 16 milliseconds. When the USB system driver receives the 64 bytes it would hold on to them, and request another 'IN' transaction. This would be completed another 16 milliseconds later, and so on until USB gets all of the 4K of

data required. The overall time would be $(4096 / 64) * 16$ milliseconds = 1.024 seconds between data packets being received by the application. In order to stop the data arriving in 4K packets, it should be requested in smaller amounts. A short packet (< 64 bytes) will of course cause the data to pass from USB back to our driver for use by the application.

*** For application programmers it must be stressed that data should be sent or received using buffers and not individual characters.

Adjusting the Receive Buffer Latency Timer

FTDI's second generation, BM series chips allow the latency timer to be changed from 16 milliseconds to any value from 1 to 255 milliseconds, in 1 millisecond increments. When using the FTDI Virtual Com Port driver the latency timer can be set in the port properties page. In Windows the port properties page is accessed via the device manager. The initial value of the latency timer can also be pre-configured in `ftdiport.inf` by changing the value of the last number in the following line -

```
HKR,,“LatencyTimer“,0x00010001,16
```

Where again, 16 milliseconds is the default value.

When using FTDI's D2XX direct driver the function `FT_SetLatencyTimer` can be used to adjust the value of the latency timer.

Effect of USB buffer size and Latency on Data Throughput

An effect that is not immediately obvious is the way the size of the USB total packet request has on the smoothness of data flow. When a read request is sent to USB, the USB host controller will continue to read 64 byte packets until one of the following conditions is met: -

- a) It has read the requested size (default is 4 Kbytes).
- b) It has received a packet shorter than 64 bytes from the chip.

c) It has been cancelled.

While the host controller is waiting for one of the above conditions to occur, NO data is received by our driver, and hence the users application. The data, if there is any, is only finally transferred after one of the above conditions has occurred.

Normally condition (c) will not occur so we will look at cases (a) and (b). If 64 byte packets are continually sent back to the host, then it will continue to read the data to match the block size requested, before it sends the block back to the driver. If a small amount of data is sent, or the data is sent data slowly, then the latency timer will take over and send a short packet back to the host, which will terminate the read request. The data that has been read so far is then passed on to the users application via the FTDI driver. This shows a relationship between the latency timer, the data rate, and when the data will become available to the user. A condition can occur where if data is passed into the FTDI chip at such a rate as to avoid the latency timer timing out, it can take a long time between receiving data blocks. This occurs because the host controller will see 64 byte packets at the point just before the end of the latency period, and will therefore continue to read the data until it reaches the block size, before it is passed back to the users application.

The rate that causes this will be:

$62 / \text{Latency Timer} \quad \text{bytes/Second}$

(We use 2 bytes per 64 byte packet)

For the default values:

$62 / 0.016 \sim = 3875 \text{ bytes /second} \sim = 38.75 \text{ KBaud}$

Therefore if data is received at a rate of 3875 bytes per second (38.75 KBaud), or faster, then the data will be subject to delays based on the requested USB block length. If data is received at a slower rate, then there will be less than 62 bytes (64 including our 2 status bytes) available after 16 milliseconds. Therefore a short packet will occur, thus terminating the USB request,

and passing the data back. At the limit condition of 38.75 KBaud it will take approximately 1.06 seconds between data buffers into the users application (assuming a 4Kbyte USB block request buffer size).

To get around this you can either increase the latency timer or reduce the USB block request. Reducing the USB block request is the preferred method though a balance between the 2 may be sought for optimum system response.

Adjusting the USB Transfer Size

Again, when using the FTDI Virtual Com Port drivers the USB Transfer (buffer) size can be set in the port properties page. The initial buffer size is calculated from entries in the ftdiport.inf file - with the size of buffer allocated being equal to the .inf entry plus 1 multiplied by 64 (bytes). So 0 is 64 bytes, and 3F is $(63+1)*64 = 4096$. There are two entries in the INF file - the first one is the transmit buffer and the second is the receive buffer.

```
HKR,,ConfigData,1,01,00,3F,3F,10,27,88,13,C4,09,E2,04,71,02,38,41,9c,80,4E,C0,34,00,1A,00,0D,00,06,40,03,80,00,00,00,00
```

In the example above the two 3F's are the entries in question, with this line being set for 4k byte buffer size operation and

```
HKR,,ConfigData,1,01,00,00,00,10,27,88,13,C4,09,E2,04,71,02,38,41,9c,80,4E,C0,34,00,1A,00,0D,00,06,40,03,80,00,00,00,00
```

being set for 64 byte buffer size operation.

When using FTDI's D2XX direct driver the function FT_SetUSBParameters can be used to adjust the size of the USB block requested. See the separate FTDI application note for advice on using FT_SetUSBParameters to optimize data throughput.

Event Characters

Event characters can be used with either FT232BM or FT245BM devices. If the Event character is enabled, and it is detected in the data stream, then the contents of the devices buffer is sent immediately. The event character is not stripped out of the data stream by the device or by the drivers. It is up to the application to remove it. Event characters may be turned on and off depending on whether large amounts of random data or small command sequences are to be sent. The Event character will not work if it is the first character in the buffer. It needs to be the second or higher. The reason for this being, applications that use the Internet, for example, will program the event character as '\$7E'. All the data is then sent and received in packets that have '\$7E' at the start and at the end of the packet. In order to maximise throughput, and to avoid a packet with only the starting '\$7E' in it, the event character does not trigger on the first position.

Flushing the Receive Buffer Using the Modem Status Lines

Flow control can be used by the FT232BM to flush the buffer in the chip. Changing one of the modem status lines will do this. The modem status lines can controlled by an external device or from the host PC itself. If an unused output line (DTR) is connected to one of the unused inputs (DSR), then it If the DTR line is changed by the application program from low to high or high to low, this will cause a change on DSR and make it flush the buffer.

Flow Control

The FT245BM chip uses its own handshaking as an integral part of its design, by proper use of the TXE# line. The FT232BM chip can use RTS / CTS, DTR / DSR hardware or XON / XOFF software handshaking. It is highly recommended that some form of handshaking be used.

There are 4 methods of flow control that can be programmed for the FT232BM device.

1. **None** - this may result in data loss at high speeds
2. **RTS/CTS** - 2 wire handshake. The device will transmit if CTS is active and will drop RTS if it cannot receive any more.
3. **DTR/DSR** - 2 wire handshake. The device will transmit if DSR is active and will drop DTR if it cannot receive any more.
4. **XON/XOFF** - flow control is done by sending or receiving special characters. One is XON (transmit on) the other is XOFF (transmit off). They are individually programmable to any value.

It is strongly encouraged that flow control is used because we are unable to ensure that we will always be scheduled. The chip can buffer up to 384 bytes of data. Windows can 'starve' the driver program of time if it is doing other things. The most obvious example of this is moving an application around the screen with the mouse by grabbing its task bar. This will result in a lot of graphics activity and data loss will occur if receiving data at 115200 baud (as an example) with no handshaking. If the data rate is low or data loss is acceptable then flow control may be omitted.

Technical background information:

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<http://www.ftdichip.com>