



Future Technology Devices International Ltd.

Application Note AN_120

Aliasing VCP Baud Rates

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The purpose of this document is to provide instruction on how the VCP driver calculates the baud rate used by FTDI devices in UART mode and how non-standard baud rates may be implemented.

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1 Introduction

One of the most basic operations with the FT2232H (UART mode), FT4232H (UART mode), FT232R, FT2232D (UART mode) and FT232B devices is setting a Baud rate. This application note describes the various ways that this can be done. It also describes how to use non-standard baud rates with FTDI's USB-Serial IC devices, including a technique called 'aliasing' - where one Baud rate is substituted by the driver in place of another baud rate.

The second generation FT232B USB UART IC added additional granularity to the divisor used to generate the device Baud rate. This allows a much larger number of baud rates to be used with the FT232B and subsequent devices when compared to its predecessor, the FT8U232AM.

2 Setting the Baud Rate

When using FTDI Virtual COM Port (VCP) drivers, the Baud rate can be set in the Device Manager or from an application. When the Baud rate is set from an application program it is done in exactly the same way as with a standard legacy Windows COM Port - by simply passing the required Baud rate to the port using the Windows VCOMM API calls or a COM Port library. Both standard and non-standard baud rates can be set in this manner.

When using FTDI's D2XX direct driver the function `FT_SetBaudRate` can be used to set both standard and non-standard baud rates.

If a non-standard Baud rate is required, the formulae in this application note can be used to determine if it is possible.

If the required non-standard Baud rate is possible simply pass it to the driver as normal and the required divisor will be calculated by the driver. For D2XX there is no longer any need to use the function `FT_SetDivisor`, but it has been left in for backward compatibility.

3 Baud Rate Calculation

A Baud rate for the FT232R, FT2232 (UART mode) or FT232B is generated using the chips internal 48MHz clock. This is input to Baud rate generator circuitry where it is then divided by 16 and fed into a prescaler as a 3MHz reference clock. This 3MHz reference clock is then divided down to provide the required Baud rate for the device's on chip UART. The value of the Baud rate divisor is an integer plus a sub-integer prescaler.

This is also true for the FT2232H and FT4232H up to 3MBaud. For higher baud rates the reference clock is an internal 12MHz clock and will be discussed later in the document.

The original FT8U232AM only allowed 3 sub-integer prescalers - 0.125, 0.25 or 0.5.

The FT2232H (UART mode), FT4232H (UART mode), FT232R, FT2232 (UART mode) and FT232B support a further 4 additional sub-integer prescalers - 0.375, 0.625, 0.75, and 0.875.

Thus, allowed values for the Baud rate divisor are:

Divisor = $n + 0, 0.125, 0.25, 0.375, 0.5, 0.625, 0.75, 0.875$;
where n is an integer between 2 and 16384 (214).

Note: Divisor = 1 and Divisor = 0 are special cases. A divisor of 0 will give 3 MBaud, and a divisor of 1 will give 2 MBaud. Sub-integer divisors between 0 and 2 are not allowed.

Therefore the value of the divisor needed for a given Baud rate is found by dividing 3000000 by the required Baud rate.

The exact Baud rate may not be achievable - however as long as the actual Baud rate used is within +/- 3% of the required Baud rate then the link should function without errors. When a Baud rate is passed to the driver where the exact divisor required is not achievable the closest possible Baud rate divisor will be used as long as that divisor gives a Baud rate which is within +/- 3% of the Baud rate originally set.

For example:

A non-standard Baud rate of 490000 Baud is required.

Required divisor = $3000000 / 490000 = 6.122$

The closest achievable divisor is 6.125, which gives a baud rate of 489795.9, which is well within the allowed +/- 3% margin of error. Therefore 490000 can be passed to the driver and the device will communicate without errors.

4 Aliasing Baud Rates

4.1 Aliasing

The file FTDIPORT.INF contains entries that are used as the divisors for standard Baud rates. By changing these it is possible to alias standard Baud rates with non-standard values - for instance replacing 115kBaund with 512kBaund. Users would then set up the devices to operate at 512kBaund by selecting 115kBaund for the appropriate serial port.

4.2 Aliasing Using the Original Sub-Integer Divisors

The FtdiPort232.NT.HW.AddReg section of FTDIPIPORT.INF contains the ConfigData string and it is this string that controls the baud rate calculation.

The FTDIPIPORT.inf file may be viewed and edited with any text editor e.g. WordPad.

```
[FtdiPort232.NT.HW.AddReg]
```

```
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,d0,80
```

Each field consists of a pair of bytes, ordered as follows: Byte0, Byte1. Bits 13 through 0 denote the integer divisor while bits 16, 15 and 14 denote the sub-integer divisor, as follows

```
15,14 = 00 - sub-integer divisor = 0  
15,14 = 01 - sub-integer divisor = 0.5  
15,14 = 10 - sub-integer divisor = 0.25  
15,14 = 11 - sub-integer divisor = 0.125
```

The divisor can be extracted for each entry in a few simple steps, as shown here for the entry 9c,80

Step 1 - re-order the bytes: 9c,80 => 809c Hex

Step 2 - extract the sub-integer divisor; 15 = 1, 14 = 0 => sub-integer = 0.25

Step 3 - extract the integer divisor: 13:0 = 009c Hex = 156 Dec

Step 4 - combine the integer and sub-integer divisors: 156.25 Dec

Step 5 - divide 3000000 by the divisor=> 3000000/156.25 = 19,200 baud

The following lists the standard values and their respective baud rates

```
10,27 => divisor = 10000, rate = 300  
88,13 => divisor = 5000, rate = 600  
C4,09 => divisor = 2500, rate = 1200  
E2,04 => divisor = 1250, rate = 2,400  
71,02 => divisor = 625, rate = 4,800  
38,41 => divisor = 312.5, rate = 9,600  
9C,80 => divisor = 156, rate = 19,230  
4E,C0 => divisor = 78, rate = 38,461  
34,00 => divisor = 52, rate = 57,692  
1A,00 => divisor = 26, rate = 115,384  
0D,00 => divisor = 13, rate = 230,769  
06,40 => divisor = 6.5, rate = 461,538  
03,80 => divisor = 3.25, rate = 923,076  
00,00 => RESERVED  
D0,80 => divisor = 208.25, rate = 14406
```

To alias a baud rate of 920k baud to the standard 56k baud menu option under windows:

- change the 34,00 entry to 03,80 (simple as both of the values are available from the previous list)

To alias a rate of 197k baud to the standard 4,800 baud menu option under windows:

- find the best divisor, check that it is sufficiently accurate and then modify the appropriate INF file entry.

$3,000,000/197,000 = 15.228$. The best divisor is 15.25.

$3,000,000/15.25 = 196,721$.

$196,721/197,000 = 99.8\%$.

This is well within the required 3% tolerance.

Set bit 15:14 to 10 for a sub-integer divisor of 0.25, and the lower bits to 0F.

- replace the 71,02 entry with 0F,80.

Incorporating these two changes the FTDIPORT.INF entry becomes

```
[FtdiPort232.NT.HW.AddReg]
HKR,,ConfigData,1,01,00,3F,3F,10,27,88,13,C4,09,E2,04,0F,80,38,41,9C,80,4E,C0,03,80,1A,00,0
D,00,06,40,03,80,00,00,00,00
```

4.3 Aliasing Using the Additional Sub-Integer Divisors

The standard FTDI.PORT.INF ConfigData Baud rate table only supports the original FT8U232AM sub-integer prescalers and not the new ones added for the FT232B and subsequent devices. To allow the addition sub-integer prescalers to be used when aliasing a Baud rate the following ConfigData entry is needed:

```
[FtdiPort232.NT.HW.AddReg]
HKR,,ConfigData,1,11,00,3F,3F,10,27,00,00,88,13,00,00,C4,09,00,00,E2,04,00,00,71,02,00,00,38,
41,00,00,9C,80,00,00,4E,C0,00,00,34,00,00,00,1A,00,00,00,0D,00,00,00,06,40,00,00,03,80,00,00,
00,00,00,00,D0,80,00,00
```

(Note - The current ftdiport.inf file contains both formats for the config data string. You select/disable the correct string by using a ; at the start of the line to comment out the one you do not want. Only one entry for Config Data should be used.)

In this case each field consists of 4 bytes, ordered as follows: Byte0, Byte1, Byte2, Byte3. Bits 13 through 0 denote the integer divisor while bits 16, 15 and 14 denote the sub-integer divisor, as follows:

```
16,15,14 = 000 - sub-integer divisor = 0
16,15,14 = 001 - sub-integer divisor = 0.5
16,15,14 = 010 - sub-integer divisor = 0.25
16,15,14 = 011 - sub-integer divisor = 0.125
16,15,14 = 100 - sub-integer divisor = 0.375
16,15,14 = 101 - sub-integer divisor = 0.625
16,15,14 = 110 - sub-integer divisor = 0.75
16,15,14 = 111 - sub-integer divisor = 0.875
```

Note that this ConfigData entry is the same as before except that each field consists of 4 bytes instead of 2 bytes. The first highlighted byte in ConfigData is the Flags byte and format of the fields is determined by Bit4 of the Flags byte. In the example above, setting Flags byte to 11 means that Bit4 is set and 4 byte fields are being used.

The divisor can be extracted for each entry in a few simple steps, as shown here for the entry 35,40,01,00

```
Step 1 - re-order the bytes: 35,40,01,00 => 00014035 Hex
Step 2 - extract the sub-integer divisor; 16 = 1, 15 = 0, 14 = 1 => sub-integer = 0.625
Step 3 - extract the integer divisor: 13:0 = 0035 Hex = 53 Dec
Step 4 - combine the integer and sub-integer divisors: 53.625 Dec
Step 5 - divide 3000000 by the divisor => 3000000/53.625 = 55944 baud
```

The following lists the standard values and their respective baud rates.

```
10,27,00,00 => divisor = 10000, rate = 300
88,13,00,00 => divisor = 5000, rate = 600
C4,09,00,00 => divisor = 2500, rate = 1200
E2,04,00,00 => divisor = 1250, rate = 2,400
71,02,00,00 => divisor = 625, rate = 4,800
38,41,00,00 => divisor = 312.5, rate = 9,600
9C,80,00,00 => divisor = 156, rate = 19,230
4E,C0,00,00 => divisor = 78, rate = 38,461
34,00,00,00 => divisor = 52, rate = 57,692
1A,00,00,00 => divisor = 26, rate = 115,384
0D,00,00,00 => divisor = 13, rate = 230,769
06,40,00,00 => divisor = 6.5, rate = 461,538
03,80,00,00 => divisor = 3.25, rate = 923,076
00,00,00,00 => RESERVED
D0,80,00,00 => divisor = 208.25, rate = 14406
```

To alias a rate of 920k baud to the standard 56k baud menu option under windows:

- change the 34,00,00,00 entry to 03,80,00,00 (simple as both of the values are available from the previous list)

To alias a rate of 197k baud to the standard 4,800 baud menu option under windows :

- find the best divisor, check that it is sufficiently accurate and then modify the appropriate INF file entry.

$3000000/197,000 = 15.228$. The best divisor is 15.25.

$3000000/15.25 = 196,721$.

$196,721/197,000 = 99.8\%$.

This is well within the required 3% tolerance.

Set bits 16:15:14 to 010 for a sub-integer divisor of 0.25, and the lower bits to 0F.

- replace the 71,02,00,00 entry with 0F,80,00,00.

Incorporating these two changes the FTDIPORT.INF entry becomes

```
FtdiPort232.NT.HW.AddReg]
HKR,,ConfigData,1,11,00,3F,3F,10,27,00,00,88,13,00,00,C4,09,00,00,E2,04,00,00,0F,80,00,00,38
,41,00,00,9C,80,00,00,4E,C0,00,00,03,80,00,00,1A,00,00,00,0D,00,00,00,06,40,00,00,03,80,00,00
,00,00,00,00,D0,80,00,00
```

4.4 Aliasing the FT2232H and FT4232H for Baud Rates up to 12MBaud

The instructions in section 4.3 are still applicable for the FT2232H and the FT4232H up to 3MBaud. The calculations for sub integers still apply.

To alias baud rates between 3MBaud and 12MBaud it is necessary to use driver version 2.4.20 or later and the most significant bit (MSB) of the divisor must be a 1. This will ensure the divisor is dividing a 12MHz clock and not a 3MHz clock.

Example:

Each field consists of 4 bytes, ordered as follows: Byte0, Byte1, Byte2, Byte3. Bits 13 through 0 denote the integer divisor while bits 16, 15 and 14 denote the sub-integer divisor, as follows

16,15,14 = 000 - sub-integer divisor = 0
16,15,14 = 001 - sub-integer divisor = 0.5
16,15,14 = 010 - sub-integer divisor = 0.25
16,15,14 = 011 - sub-integer divisor = 0.125
16,15,14 = 100 - sub-integer divisor = 0.375
16,15,14 = 101 - sub-integer divisor = 0.625
16,15,14 = 110 - sub-integer divisor = 0.75
16,15,14 = 111 - sub-integer divisor = 0.875

The following lists the standard values and their respective baud rates.

10,27,00,80 => divisor = 10000, rate = 1,200
88,13,00,80 => divisor = 5000, rate = 2,400
C4,09,00,80 => divisor = 2500, rate = 4,800
E2,04,00,80 => divisor = 1250, rate = 9,600
71,02,00,80 => divisor = 625, rate = 19200
38,41,00,80 => divisor = 312.5, rate = 38,400
9C,80,00,80 => divisor = 156, rate = 76,923
4E,C0,00,80 => divisor = 78, rate = 153,846
34,00,00,80 => divisor = 52, rate = 230,769
1A,00,00,80 => divisor = 26, rate = 461,538
0D,00,00,80 => divisor = 13, rate = 923,077
06,40,00,80 => divisor = 6.5, rate = 153,846
03,80,00,80 => divisor = 3.25, rate = 3,692,308
00,00,00,80 => RESERVED
D0,80,00,80 => divisor = 208.25, rate = 57,623

To alias a rate of 38400 baud to the standard 300 baud menu option under windows:

- change the 10,27,00,00 entry to 38,41,00,80 (simple as both of the values are available from the previous list)

To alias a rate of 8.5M baud to the standard 4,800 baud menu option under windows:

- find the best divisor, check that it is sufficiently accurate and then modify the appropriate INF file entry.

$12000000/8,500,000 = 1.41$. The best divisor is 1.375.

$12000000/1.375 = 8,727,273$.

$8,727,273/8,500,000 = 102.6\%$.

This is just within the required 3% tolerance.

Set bits 16:15:14 to 100 for a sub-integer divisor of 0.375, and the lower bits to 01.

- replace the 71,02,00,00 entry with 01,00,01,80.

Incorporating these two changes the FTDIPORT.INF entry becomes

FtdiPort232.NT.HW.AddReg]

HKR,,ConfigData,1,11,00,3F,3F,10,27,00,00,88,13,00,00,C4,09,00,00,E2,04,00,00,01,00,01,80,38
,41,00,00,9C,80,00,00,4E,C0,00,00,03,80,00,00,1A,00,00,00,0D,00,00,00,06,40,00,00,03,80,00,00
,00,00,00,00,D0,80,00,00

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Appendix A – FTDIPORT.INF Example

```
; FTDIPORT.INF
; Copyright (c) 2000-2009 FTDI Ltd.
;
; USB serial port driver installation for Windows 2000, XP, Server 2003, Vista, Server 2008 (x86 and
x64).
;

[Version]
Signature="$Windows NT$"
DriverPackageType=PlugAndPlay
DriverPackageDisplayName=%DESC%
Class=Ports
ClassGUID={4d36e978-e325-11ce-bfc1-08002be10318}
Provider=%FTDI%
CatalogFile=ftdiport.cat
DriverVer=02/17/2009,2.04.16

[SourceDisksNames]
1=%DriversDisk%,,,

[SourceDisksFiles]
ftser2k.sys=1,i386
ftserui2.dll=1,i386
ftcserco.dll = 1,i386

[SourceDisksFiles.amd64]
ftser2k.sys=1,amd64
ftserui2.dll=1,amd64
ftcserco.dll = 1,amd64

[DestinationDirs]
FtdiPort.NT.Copy=10,system32\drivers
FtdiPort.NT.CopyUI=10,system32
FtdiPort2232.NT.CopyCoInst=10,system32

[ControlFlags]
ExcludeFromSelect=*

[Manufacturer]
%FTDI%=FtdiHw,NTamd64

[FtdiHw]
%VID_0403&PID_6001.DeviceDesc%=FtdiPort232.NT,FTDIBUS\COMPORT&VID_0403&PID_6001
%VID_0403&PID_6010.DeviceDesc%=FtdiPort2232.NT,FTDIBUS\COMPORT&VID_0403&PID_6010
%VID_0403&PID_6011.DeviceDesc%=FtdiPort2232.NT,FTDIBUS\COMPORT&VID_0403&PID_6011

[FtdiHw.NTamd64]
%VID_0403&PID_6001.DeviceDesc%=FtdiPort232.NTamd64,FTDIBUS\COMPORT&VID_0403&PID_6001
%VID_0403&PID_6010.DeviceDesc%=FtdiPort2232.NTamd64,FTDIBUS\COMPORT&VID_0403&PID_6010
%VID_0403&PID_6011.DeviceDesc%=FtdiPort2232.NTamd64,FTDIBUS\COMPORT&VID_0403&PID_6011

[FtdiPort.NT.AddService]
DisplayName = %SvcDesc%
ServiceType = 1 ; SERVICE_KERNEL_DRIVER
StartType = 3 ; SERVICE_DEMAND_START
ErrorControl = 1 ; SERVICE_ERROR_NORMAL
ServiceBinary = %10%\system32\drivers\ftser2k.sys
LoadOrderGroup = Base

; ----- Serenum Driver install section
[SerEnum_AddService]
```



```
DisplayName = %SerEnum.SvcDesc%
ServiceType = 1 ; SERVICE_KERNEL_DRIVER
StartType = 3 ; SERVICE_DEMAND_START
ErrorControl = 1 ; SERVICE_ERROR_NORMAL
ServiceBinary = %12%\serenum.sys
LoadOrderGroup = PNP Filter
```

```
[FtdiPort.NT.AddReg]
HKR,,EnumPropPages32,, "ftserui2.dll,SerialPortPropPageProvider"
```

```
[FtdiPort.NT.Copy]
ftser2k.sys
```

```
[FtdiPort.NT.CopyUI]
ftserui2.dll
```

```
[FtdiPort232.NT]
CopyFiles=FtdiPort.NT.Copy,FtdiPort.NT.CopyUI
AddReg=FtdiPort.NT.AddReg
```

```
[FtdiPort232.NTamd64]
CopyFiles=FtdiPort.NT.Copy,FtdiPort.NT.CopyUI
AddReg=FtdiPort.NT.AddReg
```

```
[FtdiPort232.NT.HW]
AddReg=FtdiPort232.NT.HW.AddReg
```

```
[FtdiPort232.NTamd64.HW]
AddReg=FtdiPort232.NT.HW.AddReg
```

```
[FtdiPort232.NT.Services]
AddService = FTSER2K, 0x00000002, FtdiPort.NT.AddService
AddService = Serenum,,SerEnum_AddService
DelService = FTSERIAL
```

```
[FtdiPort232.NTamd64.Services]
AddService = FTSER2K, 0x00000002, FtdiPort.NT.AddService
AddService = Serenum,,SerEnum_AddService
DelService = FTSERIAL
```

```
[FtdiPort232.NT.HW.AddReg]
HKR,,"UpperFilters",0x00010000,"serenum"
;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,d0,80
HKR,,"ConfigData",1,11,00,3F,3F,10,27,00,00,88,13,00,00,C4,09,00,00,E2,04,00,00,71,02,00,00,38,41,
00,00,9C,80,00,00,4E,C0,00,00,34,00,00,00,1A,00,00,00,0D,00,00,00,06,40,00,00,03,80,00,00,00,00,0
0,00,D0,80,00,00
HKR,,"MinReadTimeout",0x00010001,0
HKR,,"MinWriteTimeout",0x00010001,0
HKR,,"LatencyTimer",0x00010001,16
```

```
; -----
; FT232C
; -----
```

```
[FtdiPort2232.NT]
CopyFiles=FtdiPort.NT.Copy,FtdiPort.NT.CopyUI
AddReg=FtdiPort.NT.AddReg
```

```
[FtdiPort2232.NTamd64]
CopyFiles=FtdiPort.NT.Copy,FtdiPort.NT.CopyUI
AddReg=FtdiPort.NT.AddReg
```

```
[FtdiPort2232.NT.HW]
```



AddReg=FtdiPort232.NT.HW.AddReg

[FtdiPort2232.NTamd64.HW]
AddReg=FtdiPort232.NT.HW.AddReg

[FtdiPort2232.NT.CoInstallers]
AddReg=FtdiPort2232.NT.CoInstallers.AddReg
CopyFiles=FtdiPort2232.NT.CopyCoInst

[FtdiPort2232.NTamd64.CoInstallers]
AddReg=FtdiPort2232.NT.CoInstallers.AddReg
CopyFiles=FtdiPort2232.NT.CopyCoInst

[FtdiPort2232.NT.Services]
AddService = FTSER2K, 0x00000002, FtdiPort.NT.AddService
AddService = Serenum,,Serenum_AddService
DelService = FTSERIAL

[FtdiPort2232.NTamd64.Services]
AddService = FTSER2K, 0x00000002, FtdiPort.NT.AddService
AddService = Serenum,,Serenum_AddService
DelService = FTSERIAL

[FtdiPort2232.NT.CoInstallers.AddReg]
HKR,,CoInstallers32,0x00010000,"ftcserco.Dll,FTCSERCoInstaller"

[FtdiPort2232.NT.CopyCoInst]
ftcserco.dll

;-----;

[Strings]
FTDI="FTDI"
DESC="CDM Driver Package"
DriversDisk="FTDI USB Drivers Disk"
PortsClassName = "Ports (COM & LPT)"
VID_0403&PID_6001.DeviceDesc="USB Serial Port"
VID_0403&PID_6010.DeviceDesc="USB Serial Port"
VID_0403&PID_6011.DeviceDesc="USB Serial Port"
SvcDesc="USB Serial Port Driver"
Serenum.SvcDesc="Serenum Filter Driver"

Appendix B – Revision History

Version 1.0 First Release

06/11/2009