Future Technology Devices Intl Ltd.

Application Note

Configuring FT232BM Baud Rates

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1 Setting Baud Rates for the FT232BM

1.1 Introduction

One of the most basic operations with the FT232BM 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 the FT232BM, including a technique called 'aliasing' - where one baud rate is substituted by the driver in place of another baud rate.

The second generation FTDI's FT232BM 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 FT232BM when compared to its predecessor, the FT8U232AM.

1.2 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 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 backwards compatibility.

1.3   Baud Rate Calculation

A baud rate for the FT232BM 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 FT232BM's on chip UART. The value of the baud rate divisor is an integer plus a sub-integer prescaler. The original FT8U232AM only allowed 3 sub-integer prescalers - 0.125, 0.25 or 0.5. The FT232BM adds 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 (2^{14}).

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.

2   Aliasing Baud Rates

2.1   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 115k baud with 512k baud. Users would then set up the FT232BM to operate at 512k baud by selecting 115k baud for the FT232BM serial port.

2.2   Aliasing Using the Original Sub-Integer Divisors

There are two sections of the file FTDIPORT.INF which can be changed - one for Windows 98 & Windows Millennium Edition and the other for Windows 2000 and XP. The entry for Windows 98 is shown below with the relevant fields highlighted in bold and italics. Note the entry for Windows 2000 / XP is very similar and can be changed by following the same steps. It is found under the header FtdiPort232.NT.HW.AddReg.

[FtdiPort232.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.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,00,0D,00,06,40,03,80,00,00,00,00

This is for Windows 98 & Windows Millennium Edition, the changes should be repeated in the Windows 2000 / XP entry also.

2.3   Aliasing Using the Additinal FT232BM Sub-Integer Divisors

The standard FTDIPORT.INF ConfigData baud rate table only supports the original FT8U232AM sub-integer prescalers, and not the new ones added for the FT232BM. To allow the addition sub-integer prescalers to be used when aliasing a baud rate the following ConfigData entry is needed...

[FtdiPort232.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 developer should cut and paste the above entry into FTDIPORT.INF, replacing the original one)

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.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

This is for Windows 98 & Windows Millennium, the changes should be repeated in the Windows 2000 / XP entry also.

3   Revision History, Disclaimer, Contact Information

3.1   Document Revision History

AN232B-05 Version 1.0 – Initial document created March 2004.

3.2   Disclaimer

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