Black Pill STM32F411 Stm32duino Virtual COM Port Signals Timing

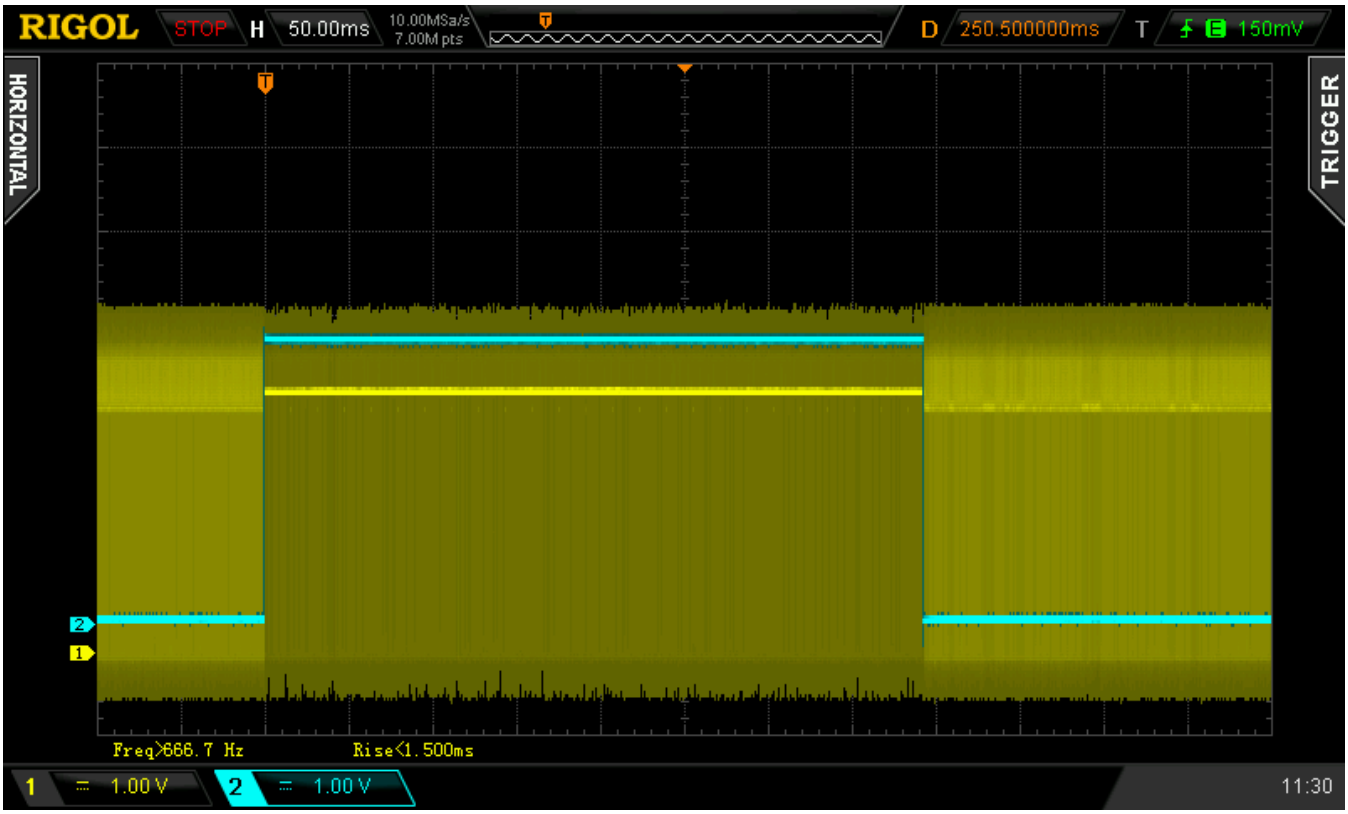
Andrei Talapov

I used simple Arduino command Serial.write(byteArray,arraySize) to observe timing of signals on USB wires using both oscilloscope and Ellisys USN Explorer.

To check the maximum sustained Virtual COM port speed I set arraySize=100000.

I triggered scope by signal from pin PC13, which was set to 1 before Serial.write and to 0 after Serial.write.

On the next screenshot yellow trace is USB_DP (PA12), and blue trace is PC13:

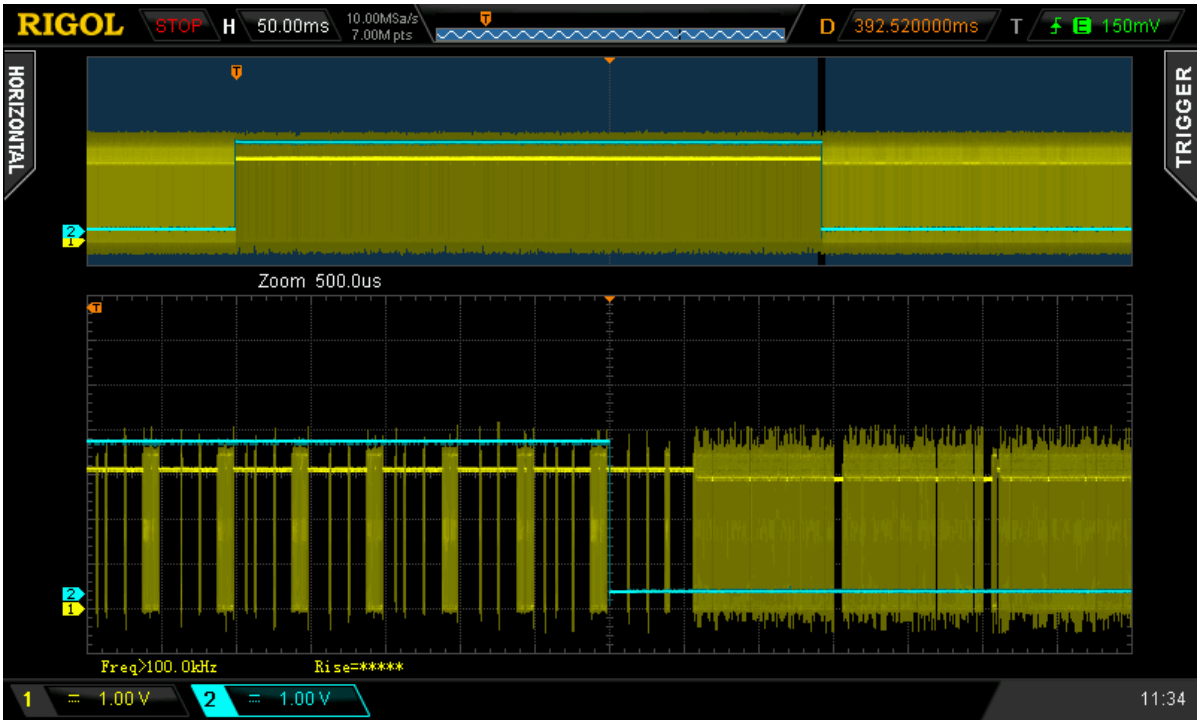


We can see that 100000-byte data transfer took slightly less than 0.4 sec, which means Baud rate about 2.5 Mbaud.

In no way it is related to any COM port Baude settings.

Zoom window provides more detailed views of the start and end of the data transfer:


RIGOL
STOP
H 50.00ms
10.00MSa/s
7.00M pts
D 18.0000000us
T 150mV
HORIZONTAL
TRIGGER
Zoom 500.0us
Freq>66.67kHz
Rise<15.00us
1 1.00 V
2 1.00 V
11:33


RIGOL
STOP
H 50.00ms
10.00MSa/s
7.00M pts
D 392.520000ms
T 150mV
HORIZONTAL
TRIGGER
Zoom 500.0us
Freq>100.0kHz
Rise=*****
1 1.00 V
2 1.00 V
11:34

Before the start of data transfer PC COM port continuously sends IN packets to Black Pill End Point 2, and gets NAK in reply. This happens not very regularly, but approximately with 8 uS period.

When Black Pill starts the data transfer, it acknowledges IN packet, and starts sending data.

USB data packets from Black Pill may have very different sizes, not necessarily equal to the maximum data packet size of the End Point 2, which is equal to 64 bytes.

Scope screenshot for the start of 64 bytes array transfer is shown here:

The scope was triggered by signal from PC13 connected to external trigger input.

Unlike on previous screenshots, blue trace here is USB_DN (PA11).

We can see that few tens of uS after Serial.write start the Black Pill responds to PC IN packet by Data packet.

Unfortunately, it was not possible to synchronize Scope and Hardware USB Sniffer, but timing similar to the scope timing can be observed on Ellisys USB Explorer output:

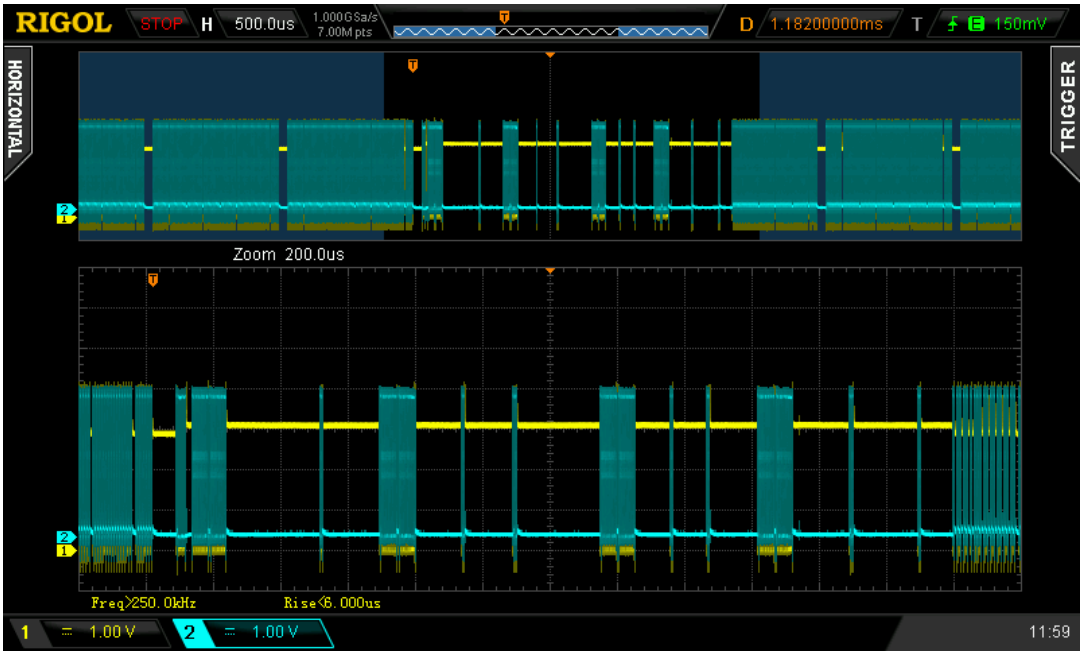
Item	Device	Endp...	Status	Speed	Payload	Time
Enter text here	E...	E...	E...	E...	Enter tex...	Enter text here
IN transaction	1	3	NAK	FS	No data	0.000 000 000
IN transaction (1,505)	1	2	NAK	FS	No data	0.015 926 350
IN transaction	1	3	NAK	FS	No data	0.016 002 300
IN transaction (421)	1	2	NAK	FS	No data	0.019 922 284
IN transaction	1	2	ACK	FS	64 bytes (00...	0.020 043 817
IN packet	1	2		FS		0.020 043 817
DATA0 packet				FS	64 bytes (00...	0.020 047 084
ACK packet			ACK	FS		0.020 092 984
IN transaction	1	2	ACK	FS	No data	0.020 097 567
IN packet	1	2		FS		0.020 097 567
DATA1 packet				FS	No data	0.020 100 834
ACK packet			ACK	FS		0.020 103 984
IN transaction (1,172)	1	2	NAK	FS	No data	0.031 924 034
IN transaction	1	3	NAK	FS	No data	0.032 004 600
IN transaction (1,594)	1	2	NAK	FS	No data	0.047 925 850

We see that the Black Pill sent 2 data packets, one of size 64 bytes, and the other of size 0 bytes.

The complete data transfer took about 60 uS, but it took PC virtual COM much larger time, after the data transfer was completed, to resume sending IN packets to Black Pill EndPoint 2.

Complete IN/DATA/ACK transfer at the end of the data exchange can be seen in the zoom window here:

It is interesting to see timing of larger data transfer, of arraySize=512:



and the Hardware sniffer output for similar case is:

Item	Device	Endp...	Status	Speed	Payload	Time
Enter text here	E...	E...	E...	E...	Enter tex...	Enter text here
IN transaction (270)	1	2	NAK	FS	No data	0.000 000 000
IN transaction	1	2	ACK	FS	64 bytes (00...	0.000 009 717
IN transaction	1	2	ACK	FS	63 bytes (40...	0.000 066 100
IN transaction	1	2	ACK	FS	1 byte (7F)	0.000 357 733
IN transaction	1	2	ACK	FS	64 bytes (80...	0.000 555 100
IN transaction	1	2	ACK	FS	62 bytes (C...	0.000 610 150
IN transaction	1	2	ACK	FS	1 byte (FE)	0.000 807 967
IN transaction	1	2	ACK	FS	1 byte (FF)	0.000 931 067
IN transaction	1	2	ACK	FS	64 bytes (00...	0.001 060 117
IN transaction	1	2	ACK	FS	62 bytes (40...	0.001 121 500
IN transaction	1	2	ACK	FS	1 byte (7E)	0.001 399 067
IN transaction	1	2	ACK	FS	1 byte (7F)	0.001 563 850
IN transaction	1	2	ACK	FS	64 bytes (80...	0.001 683 933
IN transaction	1	2	ACK	FS	62 bytes (C...	0.001 743 150
IN transaction	1	2	ACK	FS	1 byte (FE)	0.001 938 133
IN transaction	1	2	ACK	FS	1 byte (FF)	0.002 060 900
IN transaction (1,125)	1	2	NAK	FS	No data	0.013 279 100
IN transaction	1	3	NAK	FS	No data	0.013 359 617

In general packet sizes may be very different from 64 bytes.