CP316
Serial Communication-UART

Terry Sturtevant

Wilfrid Laurier University

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Serial Communication -UART

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- Universal Asynchronous Receiver Transmitter

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- Universal Asynchronous Receiver Transmitter
- Simplest form of serial communication
- Between 2 devices
- Uses 2 signals (and Ground), Rx and Tx
- Asynchronous, so both must agree on baud rate

Communication parameters

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- 1 Start bit at “0” level

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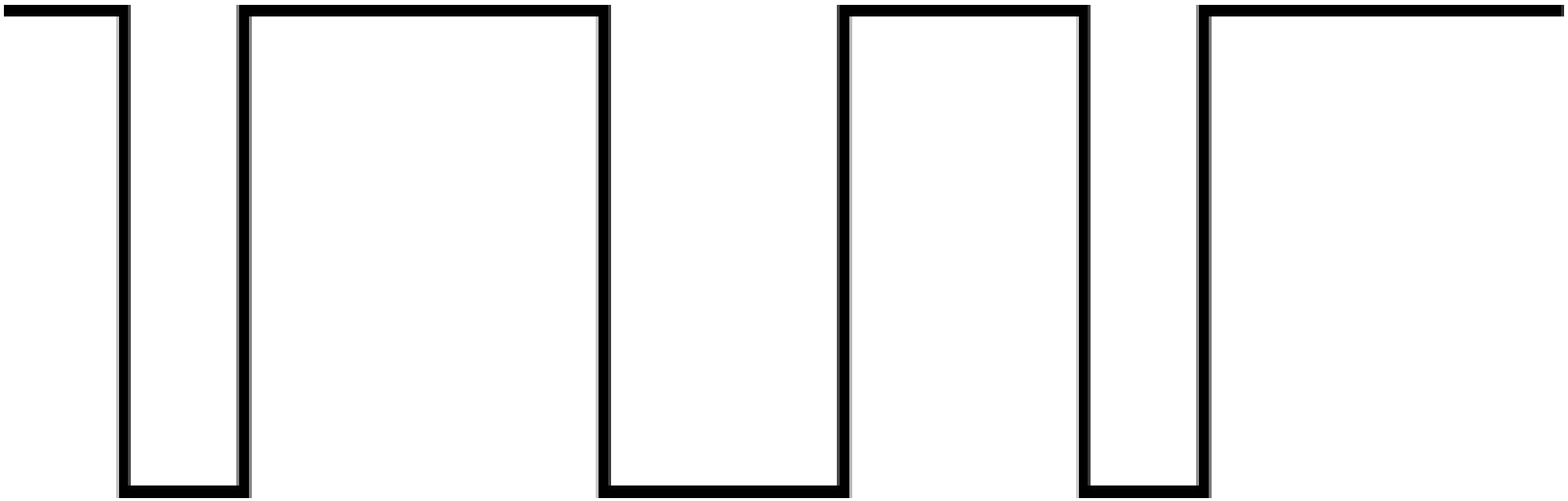
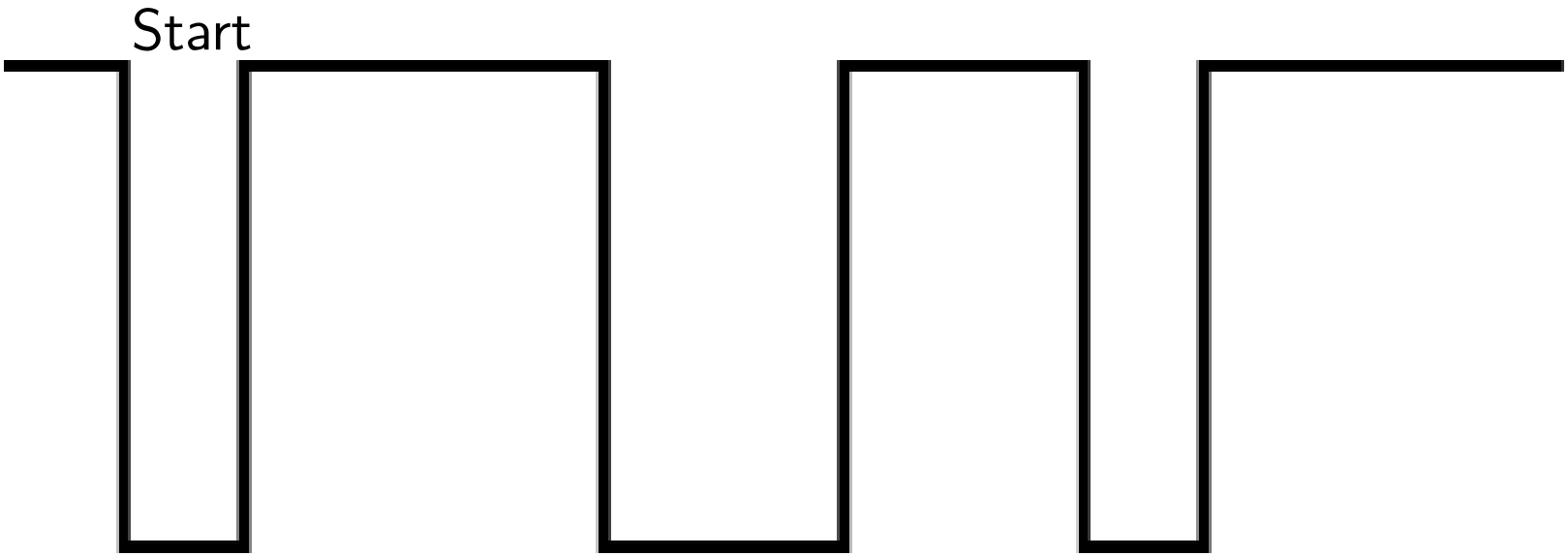
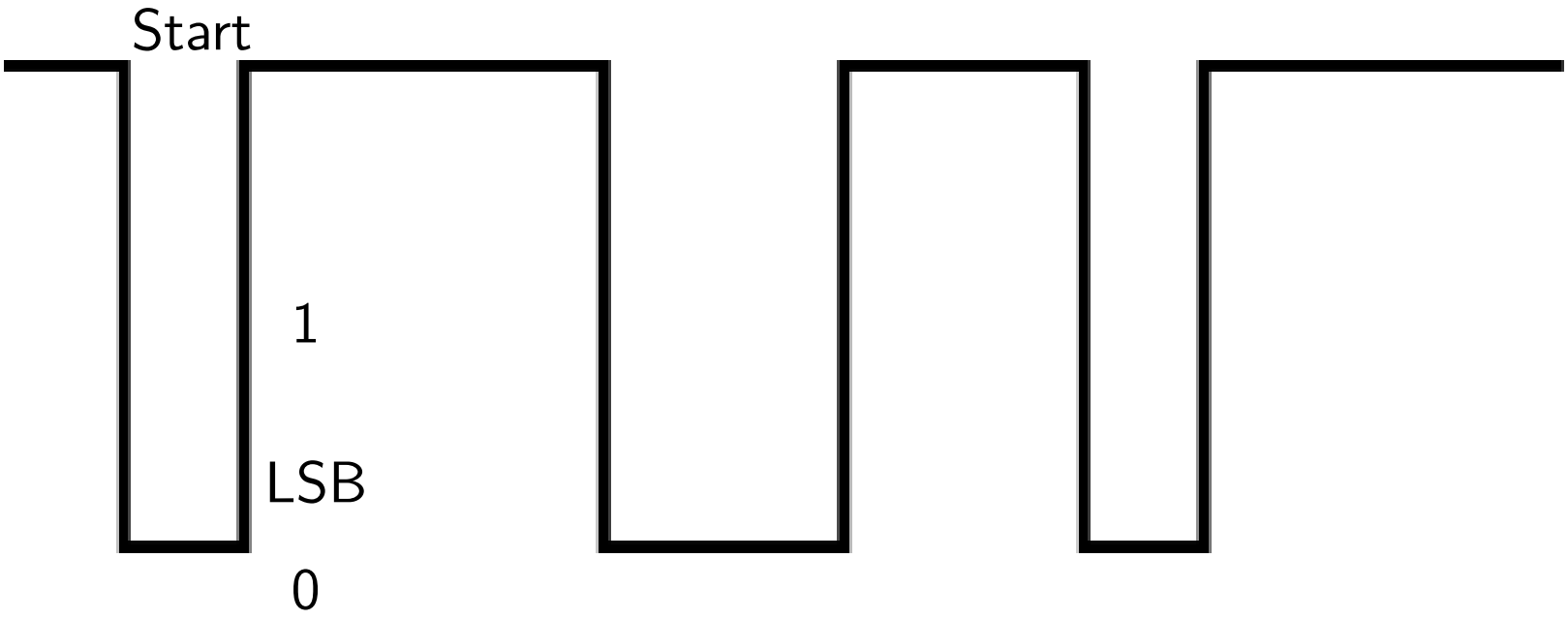
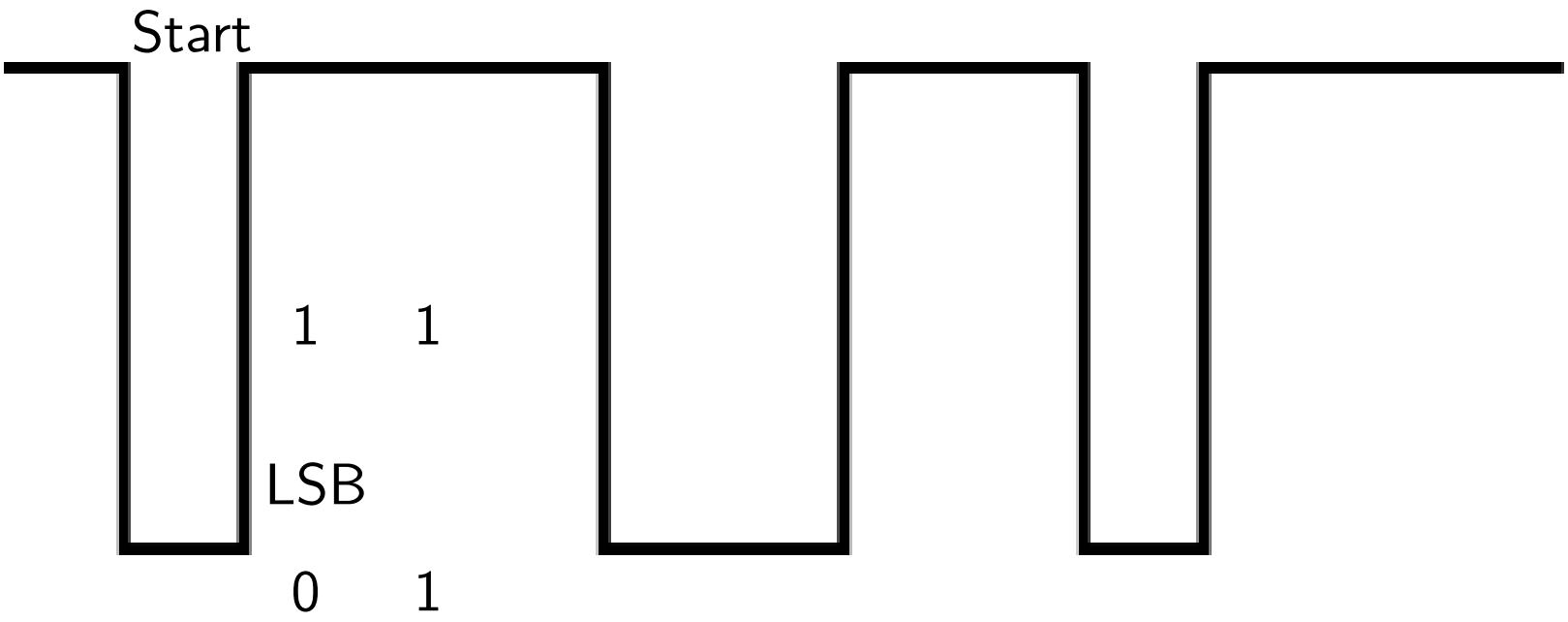
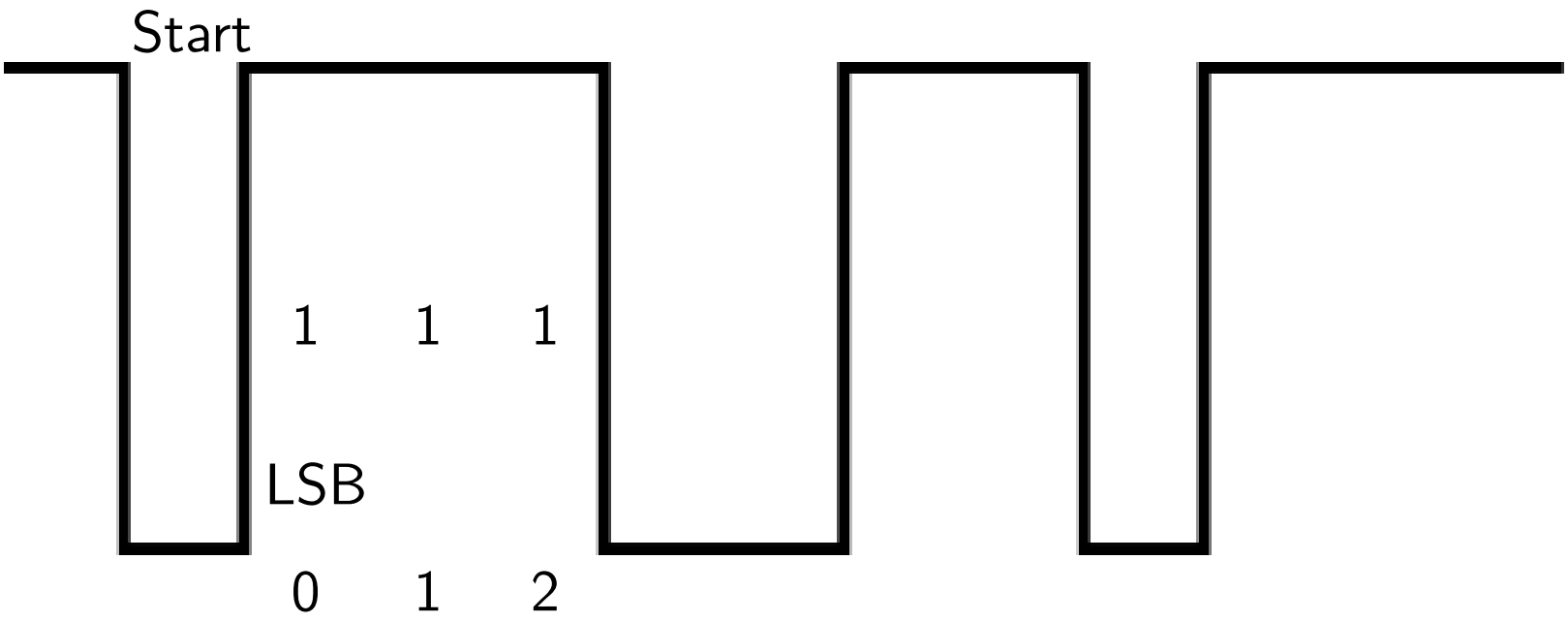
Since start and stop bits are opposite, new characters can always be detected.

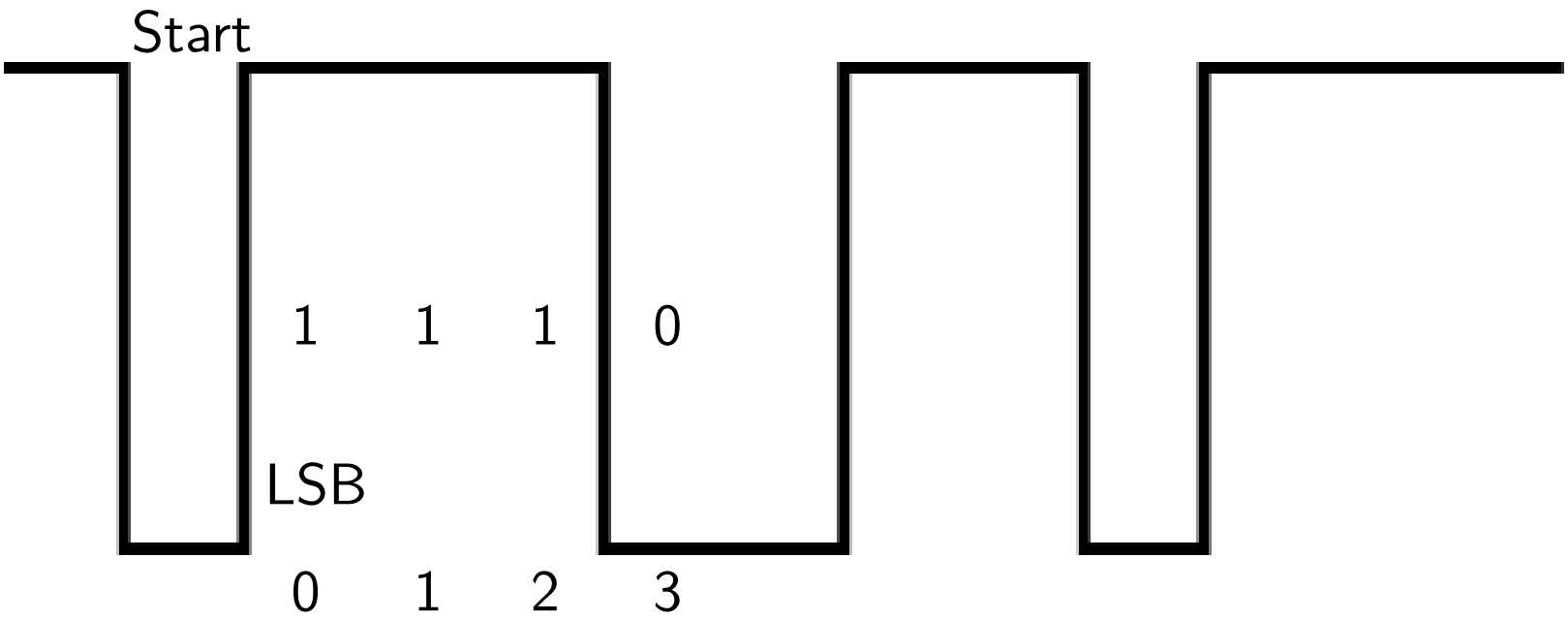


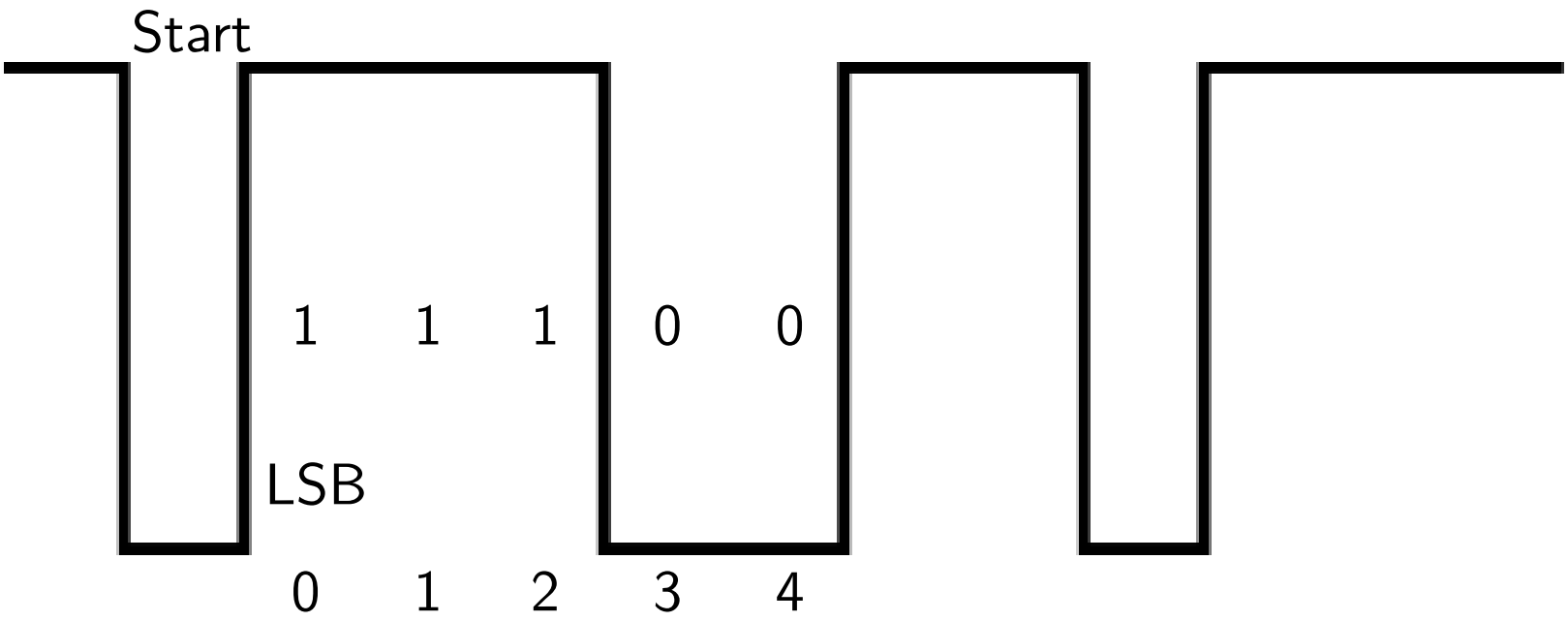

Start

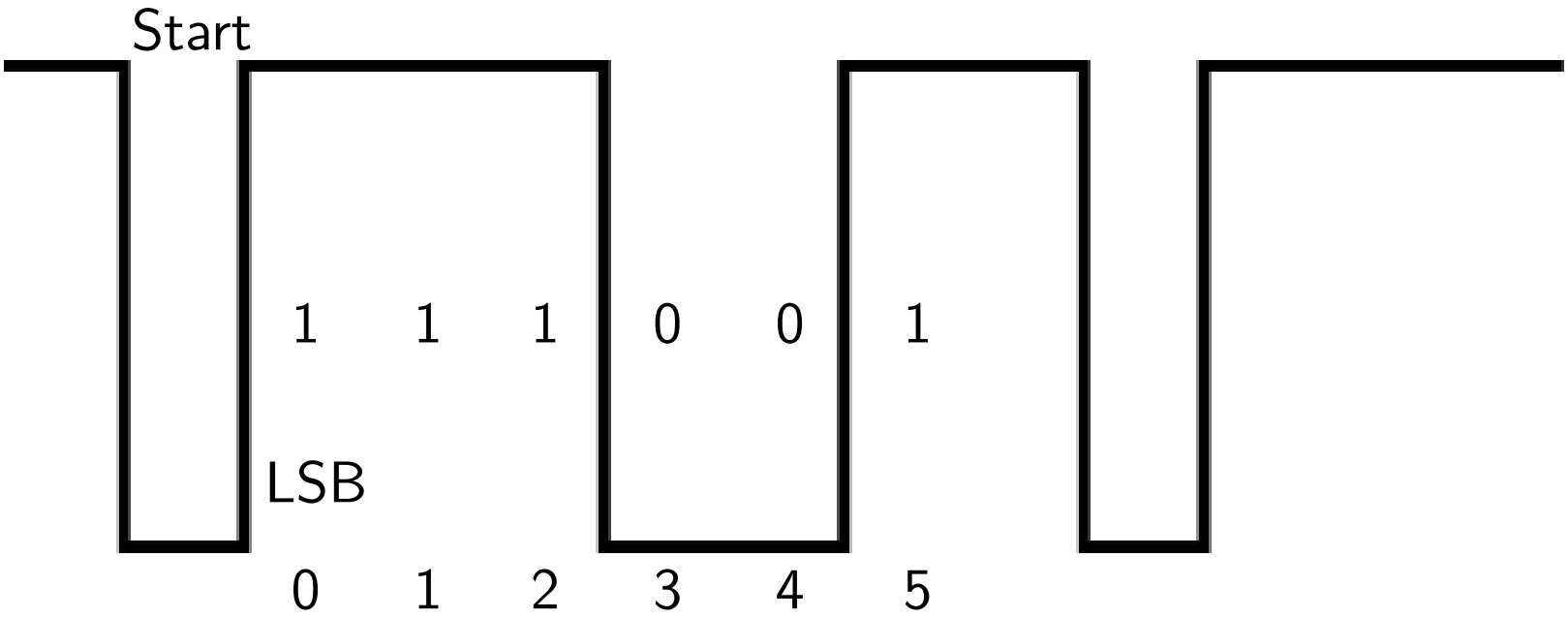

Start
1
LSB
0

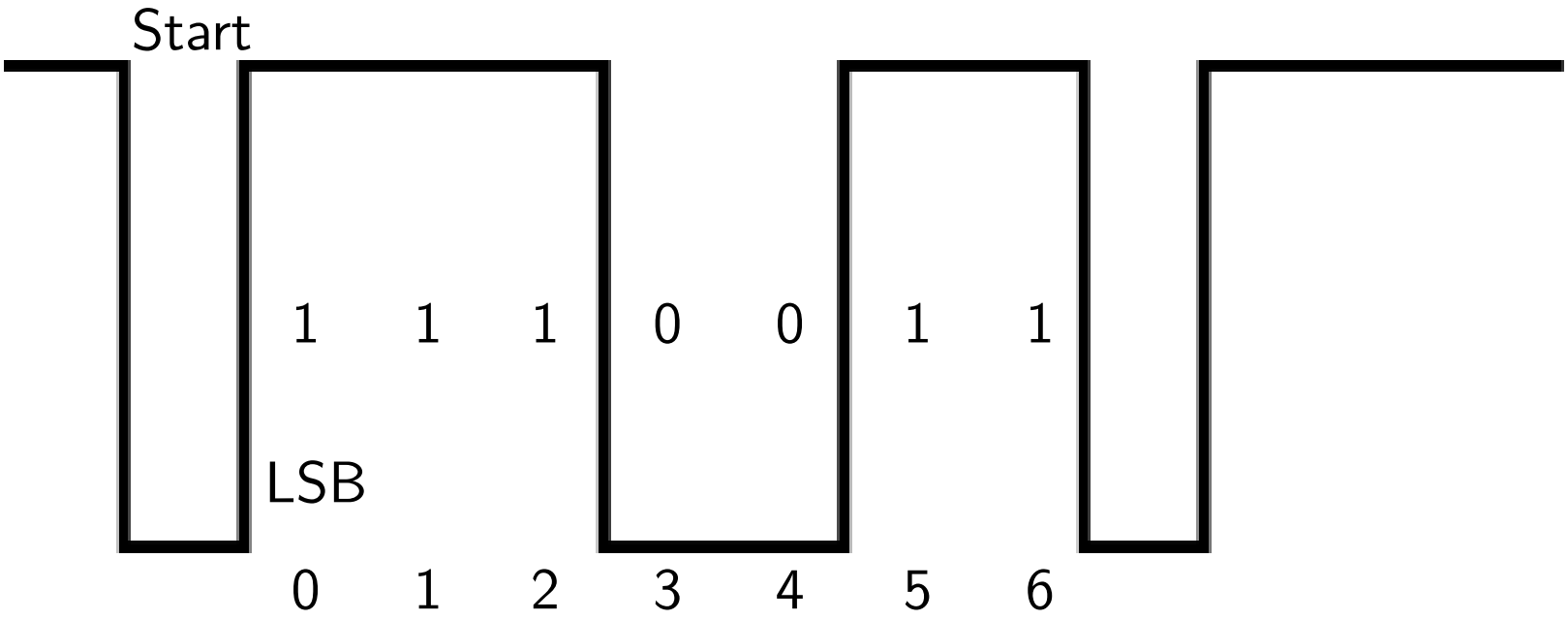

Start
1
1
LSB
0
1

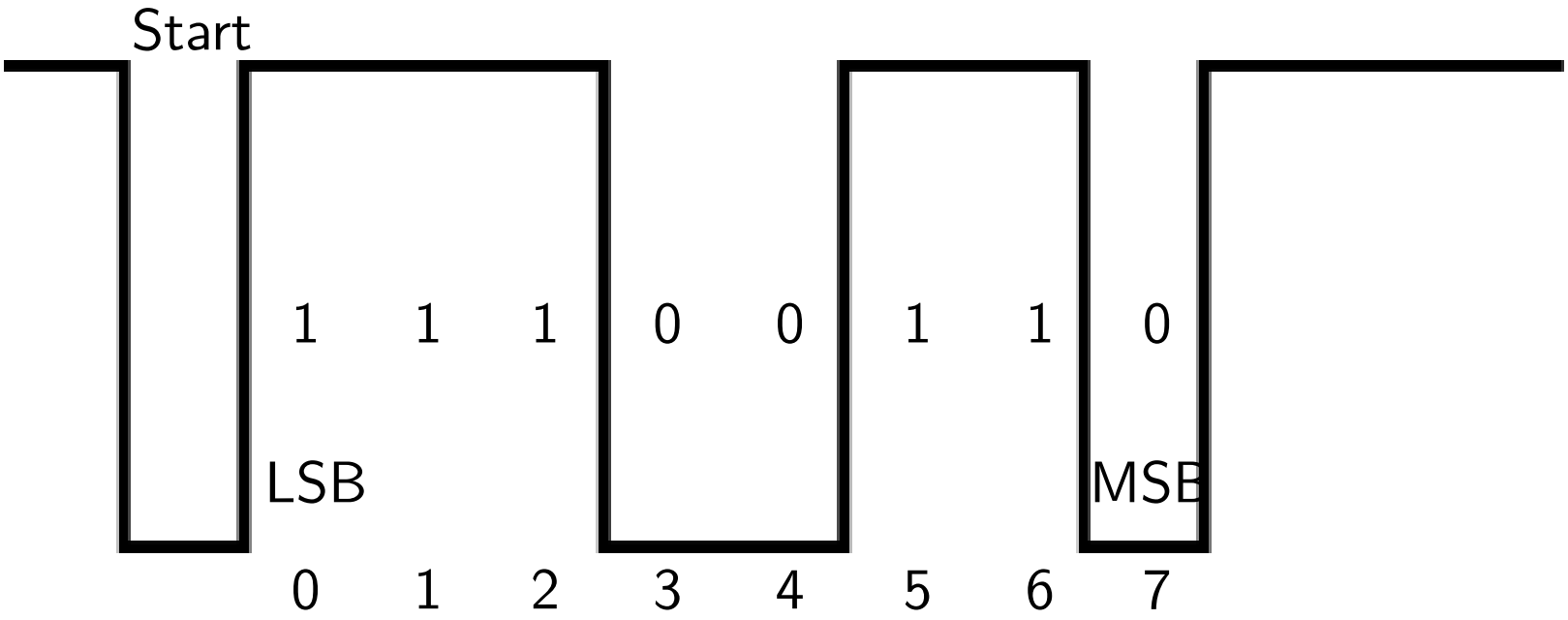

Start
1
1
1
LSB
0
1
2

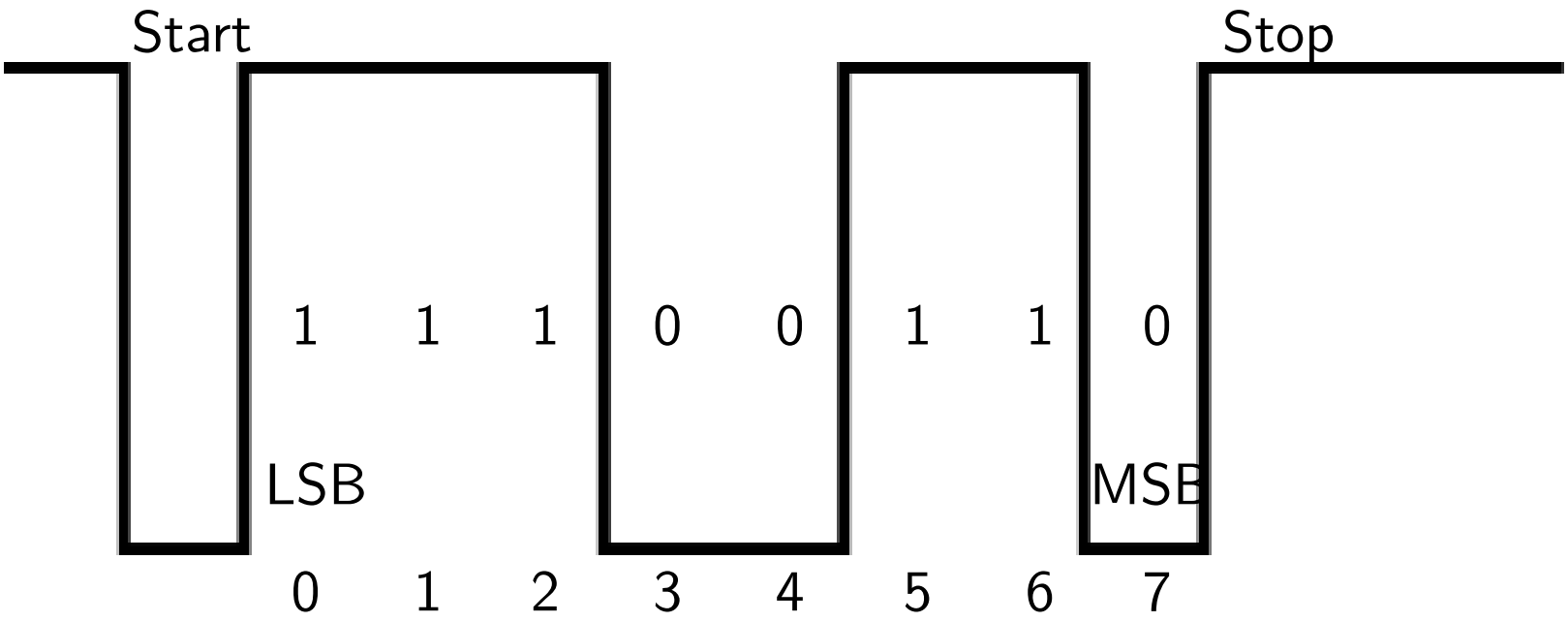

Start
1
1
1
0
LSB
0
1
2
3

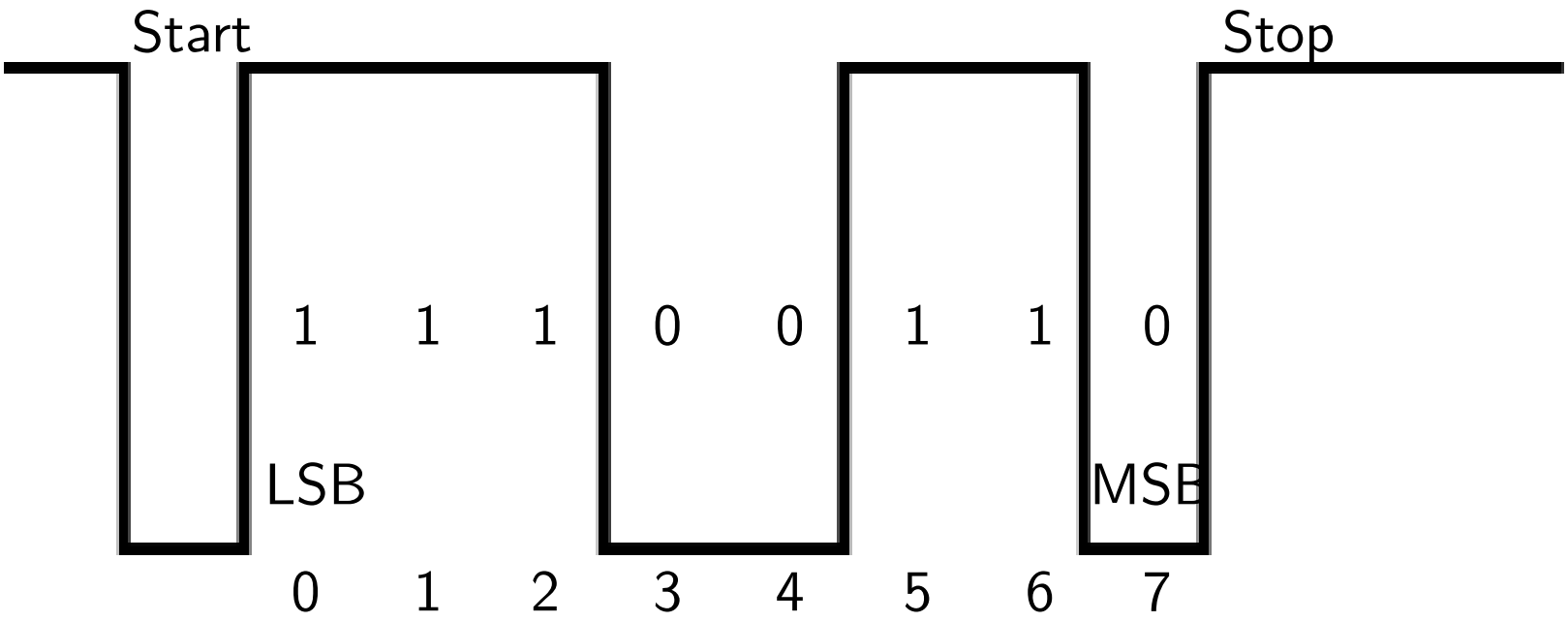

Start
1
1
1
0
0
LSB
0
1
2
3
4


Start
1
1
1
0
0
1
LSB
0
1
2
3
4
5

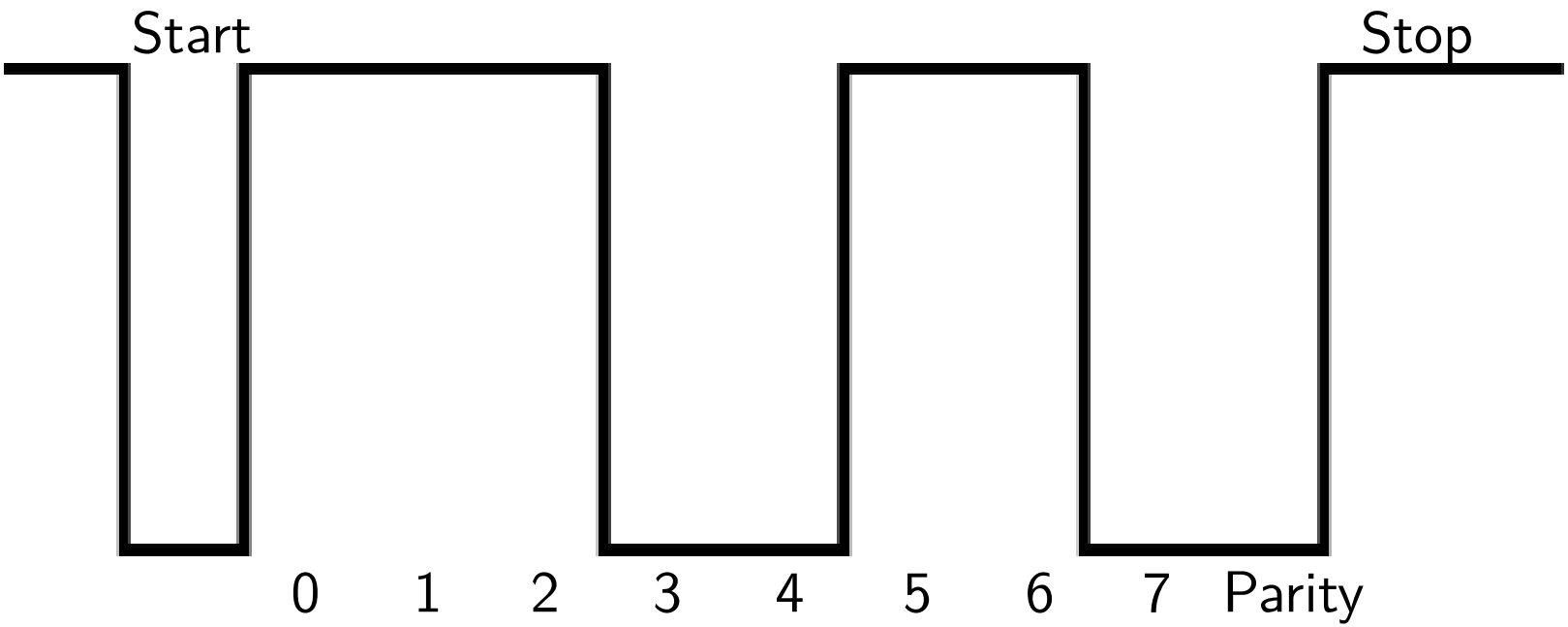

Start
1
1
1
0
0
1
1
LSB
0
1
2
3
4
5
6

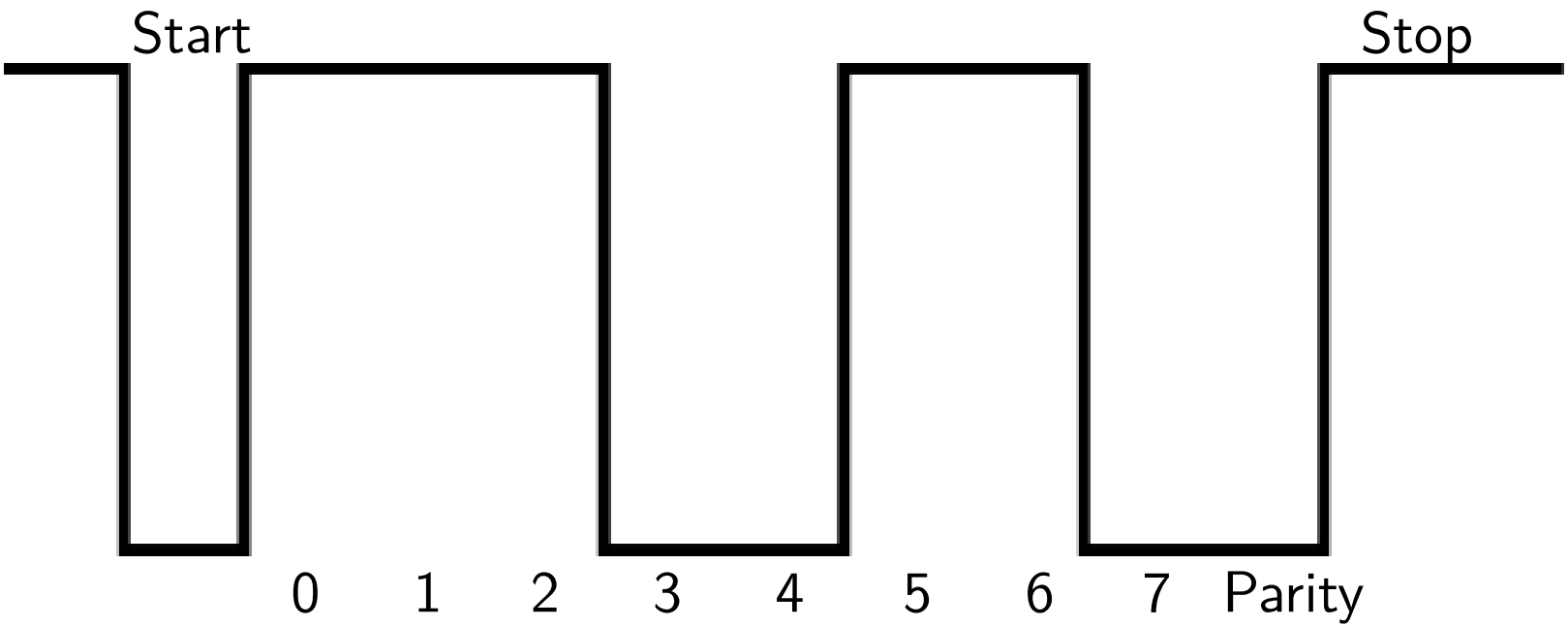

Start
1 1 1 0 0 1 1 0
LSB
MSB
0 1 2 3 4 5 6 7


Start
Stop
1 1 1 0 0 1 1 0
LSB
MSB
0 1 2 3 4 5 6 7

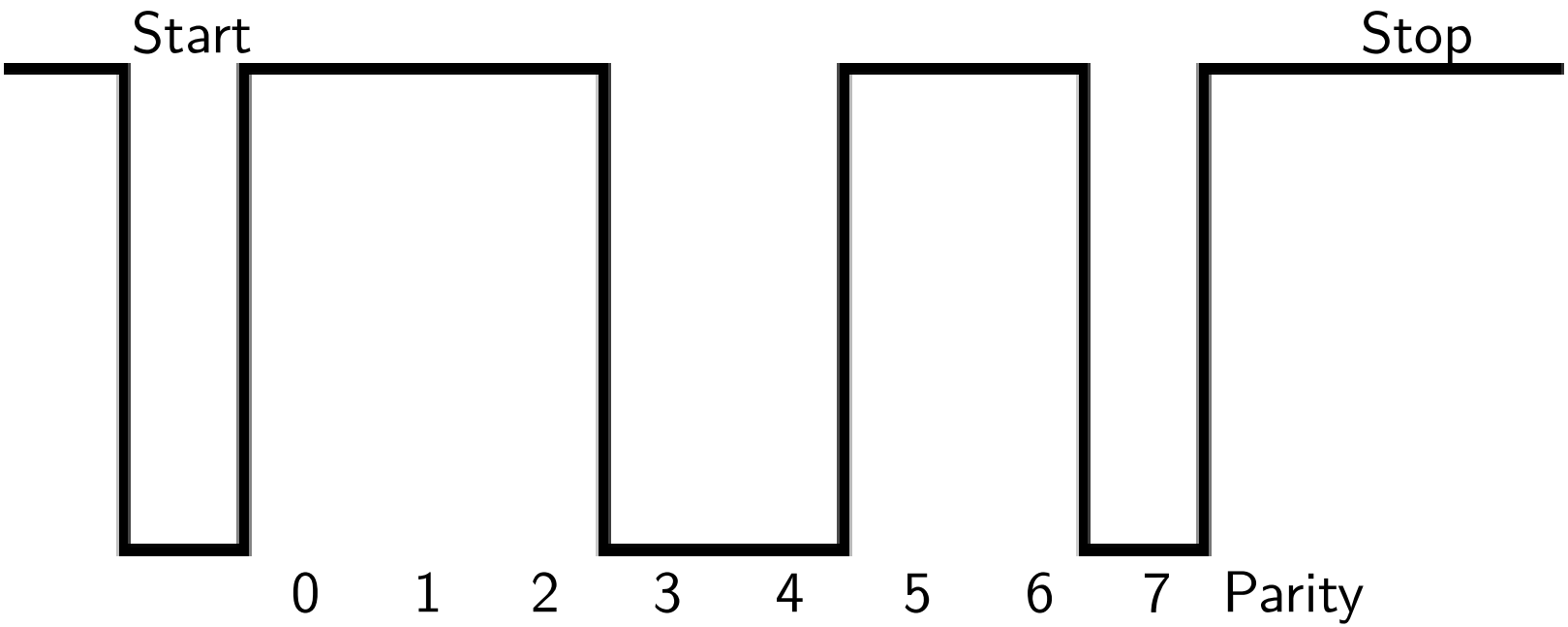


UART no parity - 01100111


Start
Stop
0
1
2
3
4
5
6
7
Parity



UART even parity



UART odd parity

Baud rate calculation

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- Baud rate is the number of bits possible in a second

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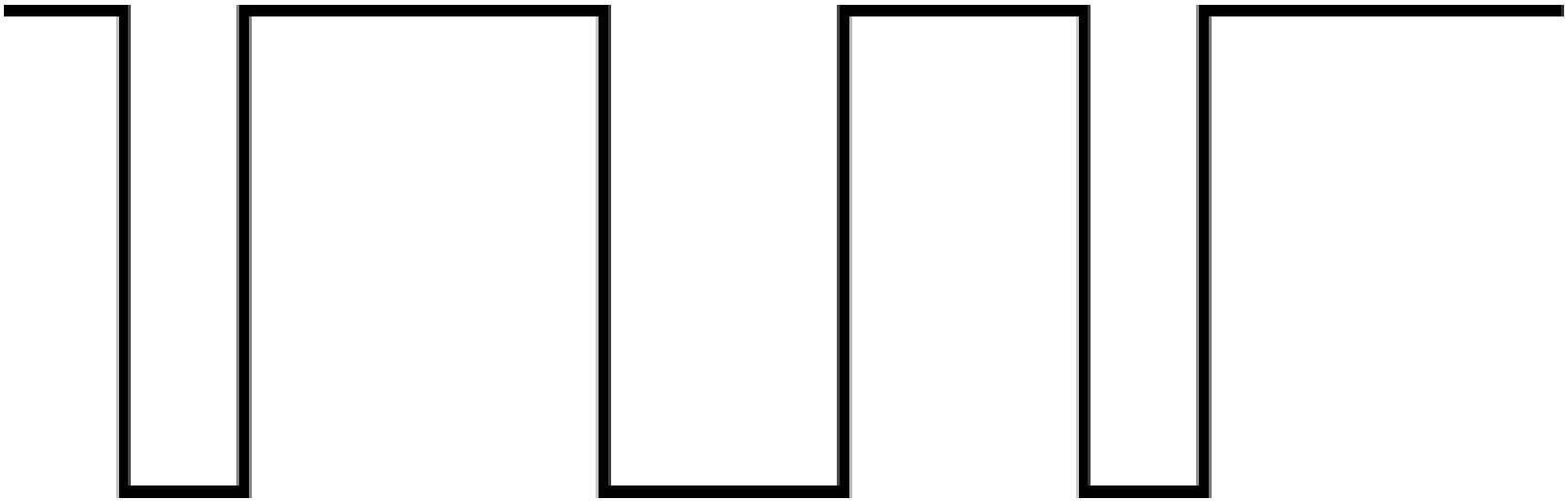
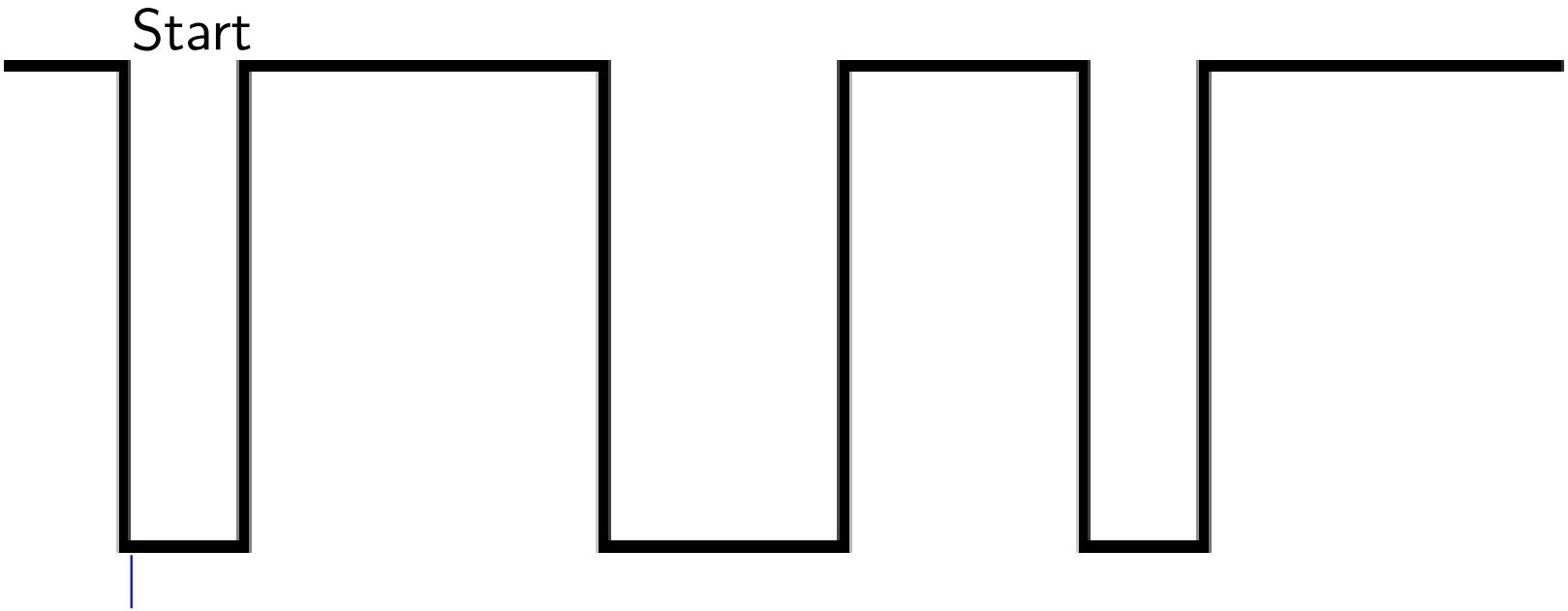
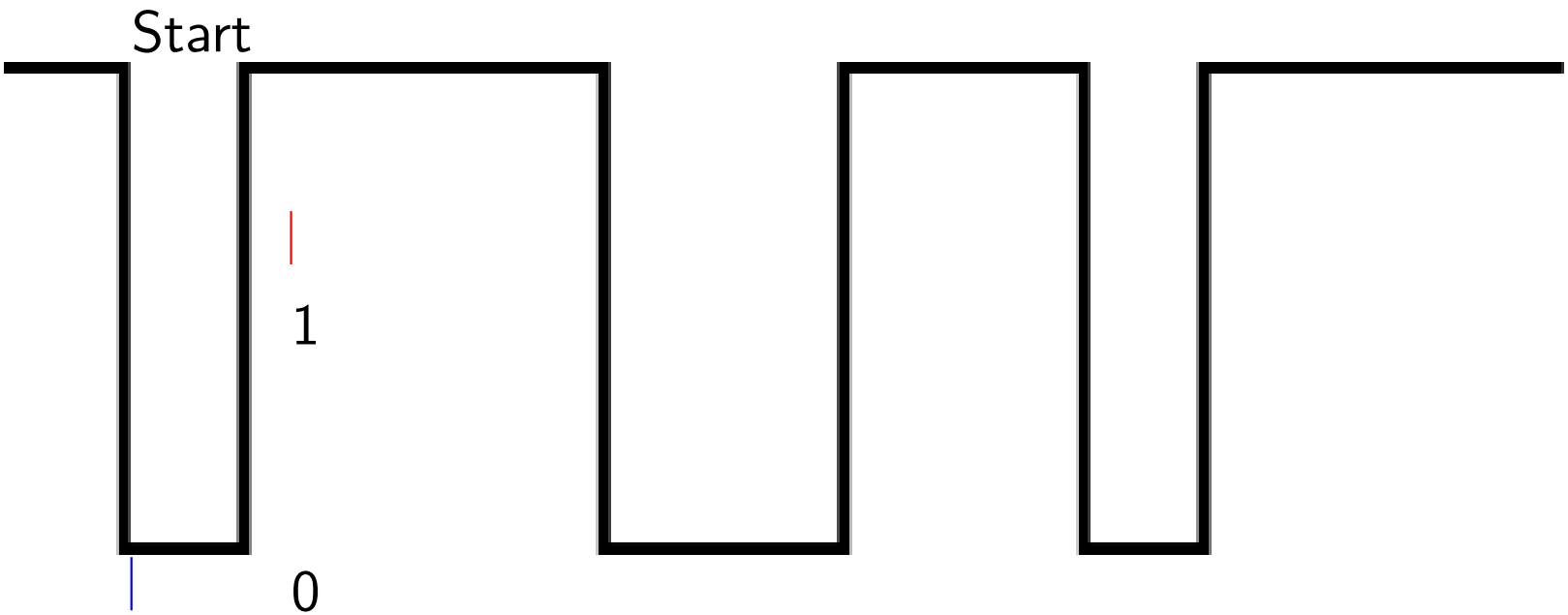
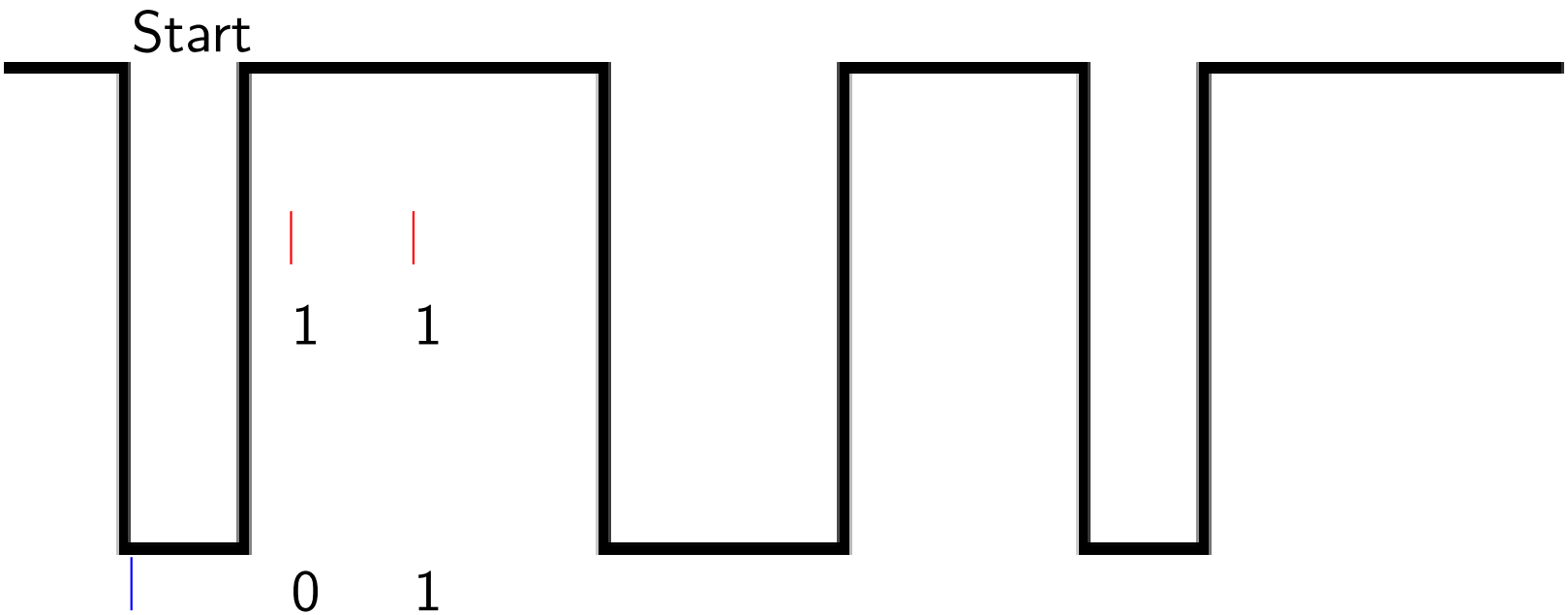
Baud rate calculation

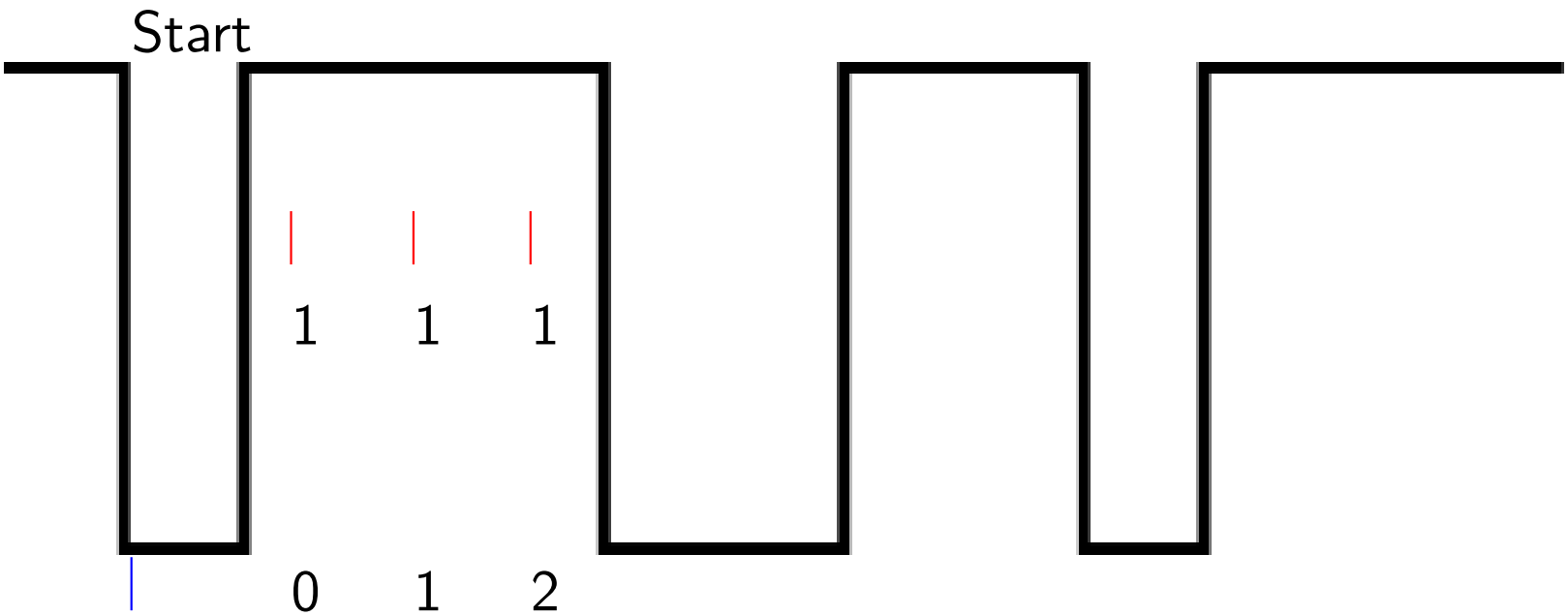
- Baud rate is the number of bits possible in a second
- e.g. 9600 baud $\rightarrow$ 1 bit takes $\frac{1}{9600}$ second
- After start bit is detected, wait time for $1\frac{1}{2}$ bit to test for first data bit and then after every 1 bit interval
- Resetting at the start bit allows some clock variation

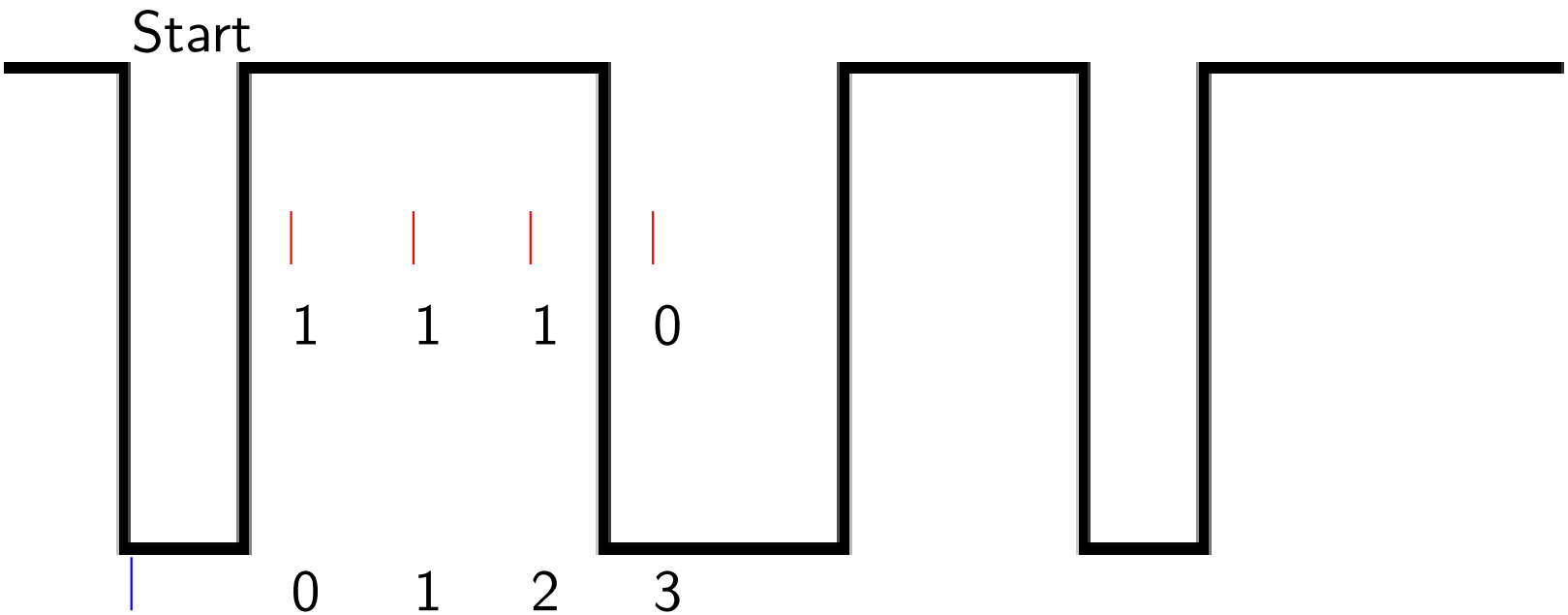


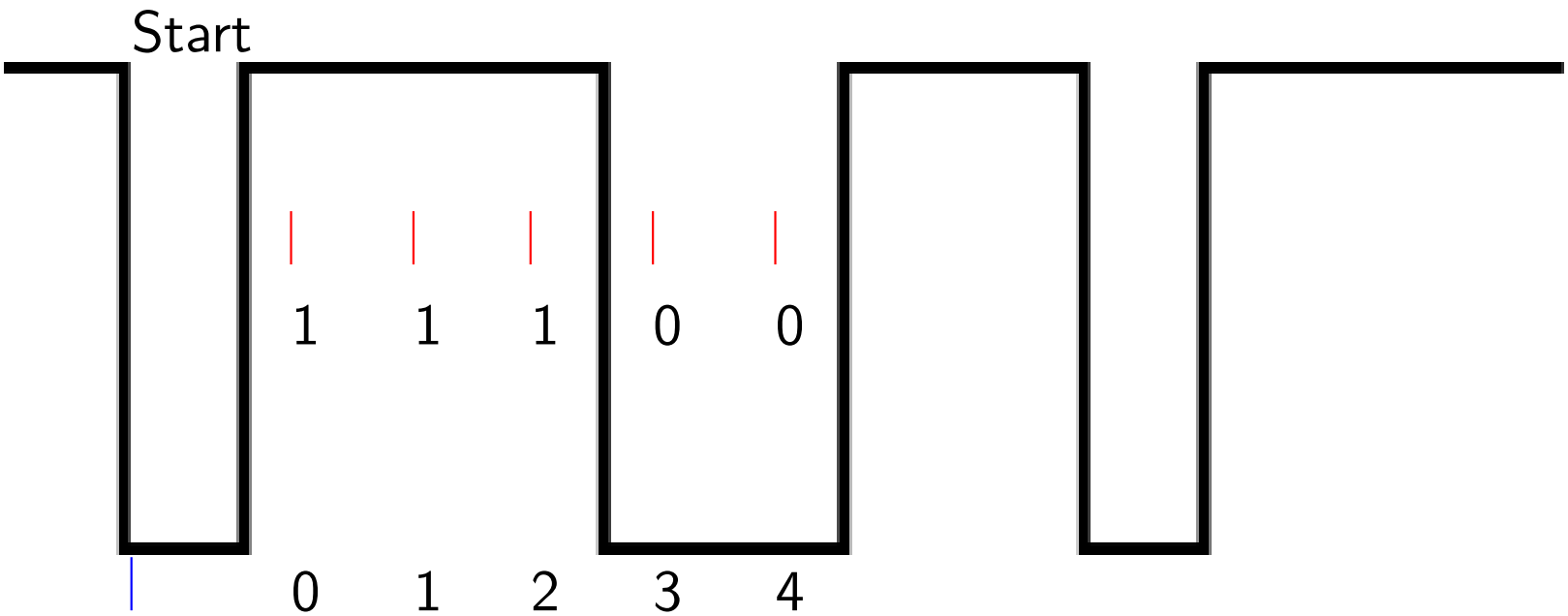

Start

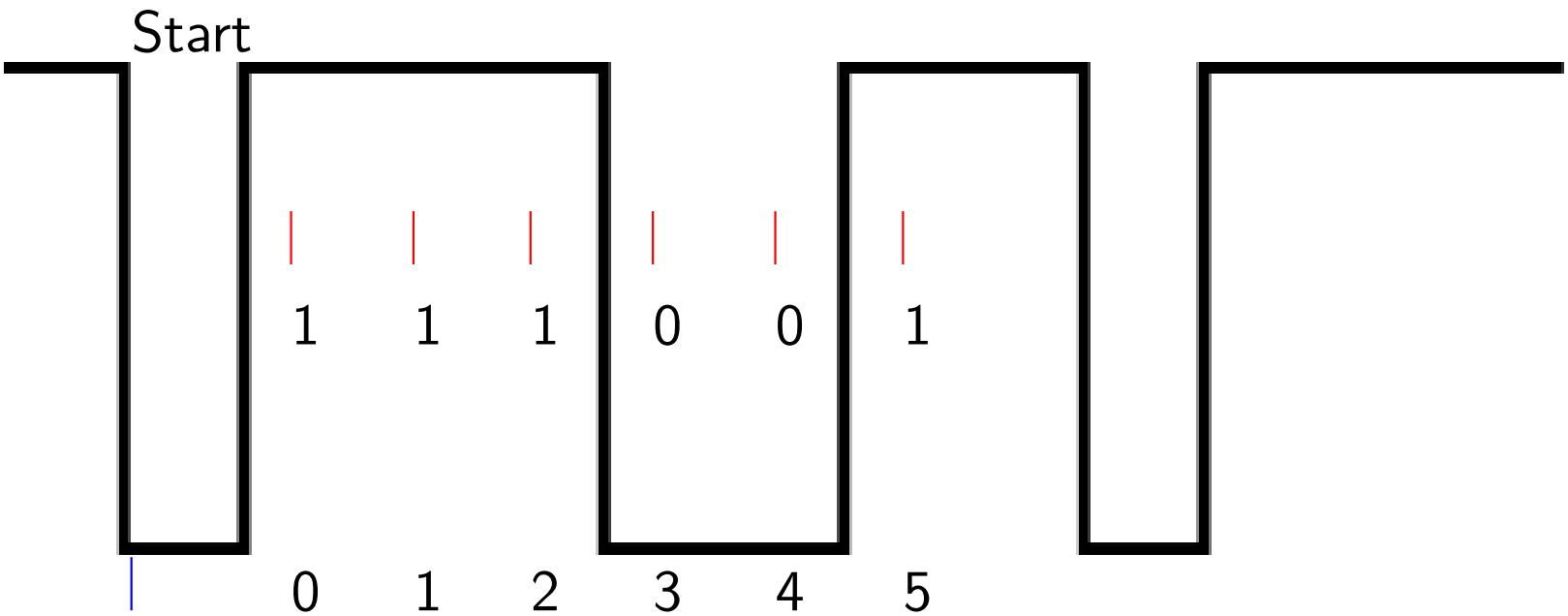

Start
1
0

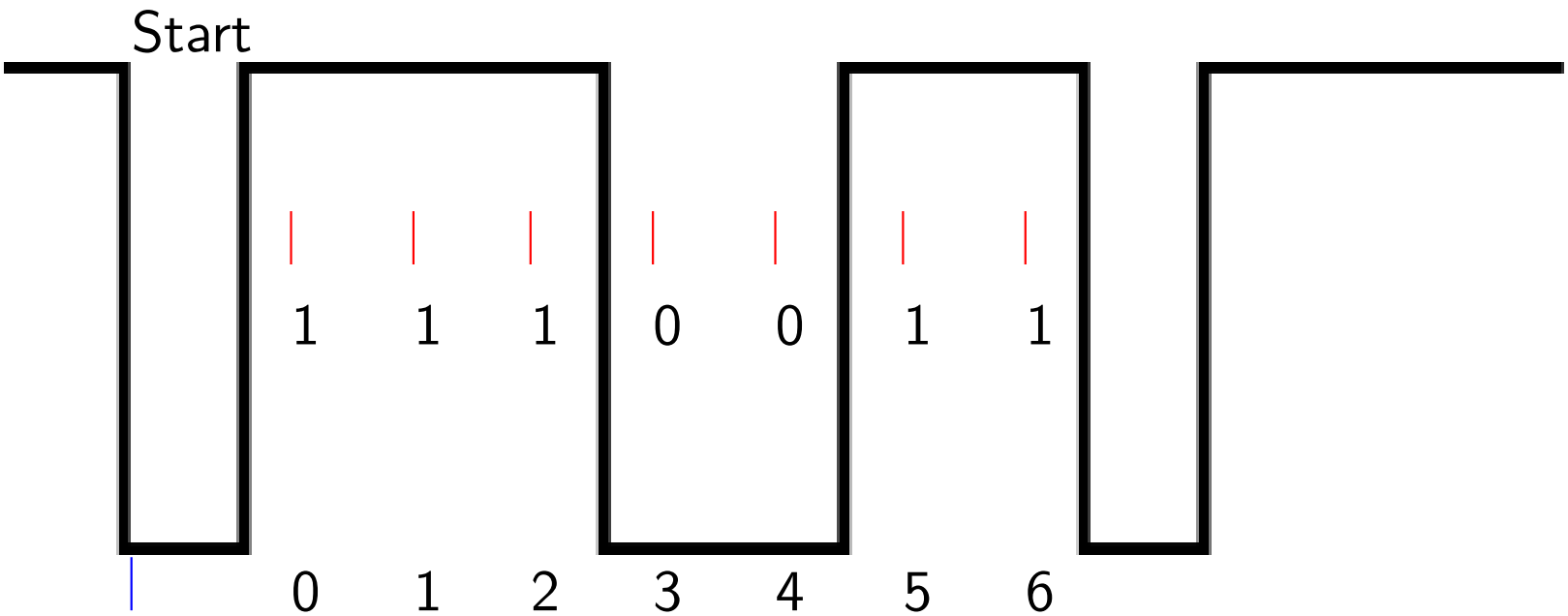

Start
1
1
0
1

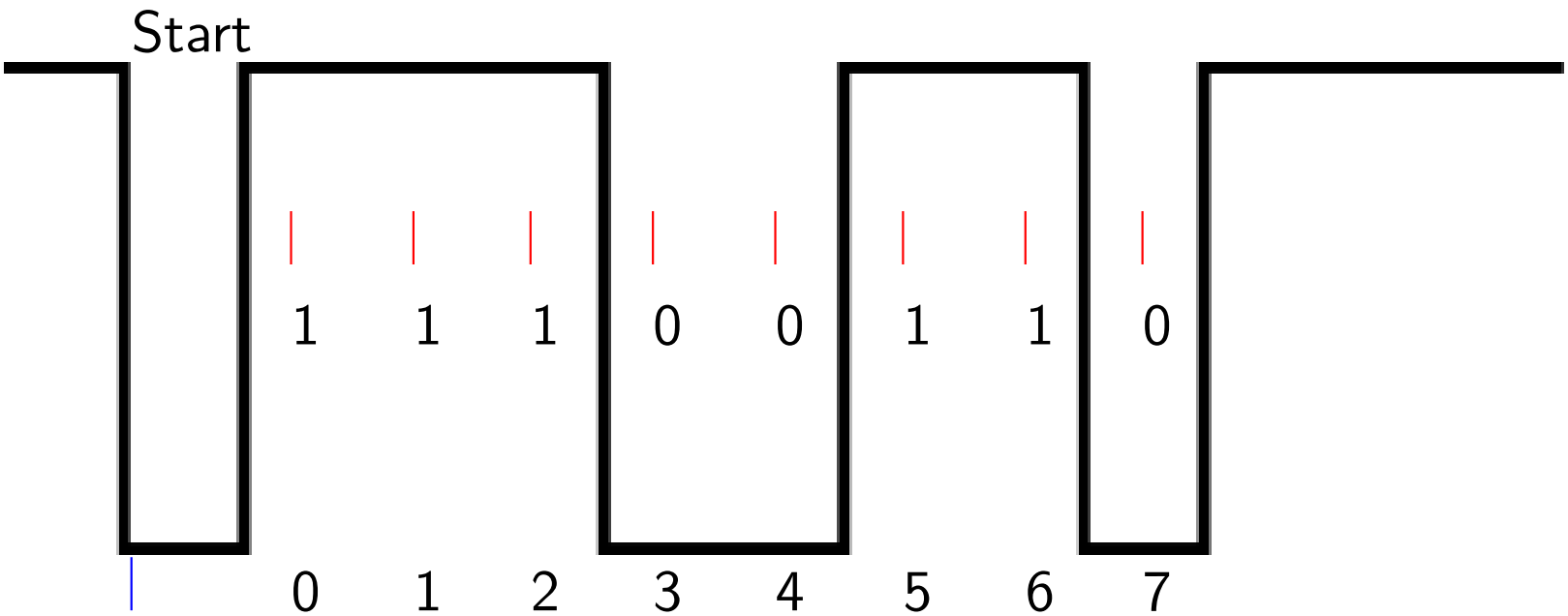

Start
1
1
1
0
1
2

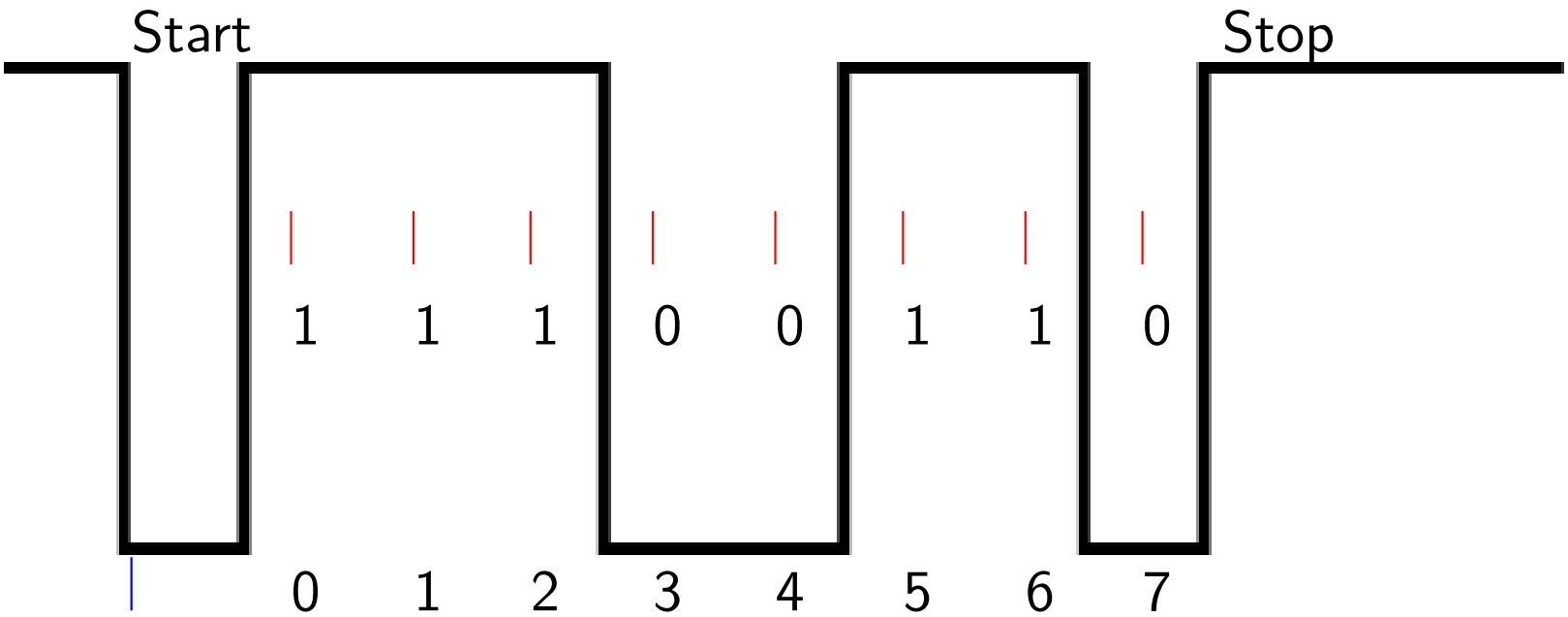

Start
1
1
1
0
0
1
2
3

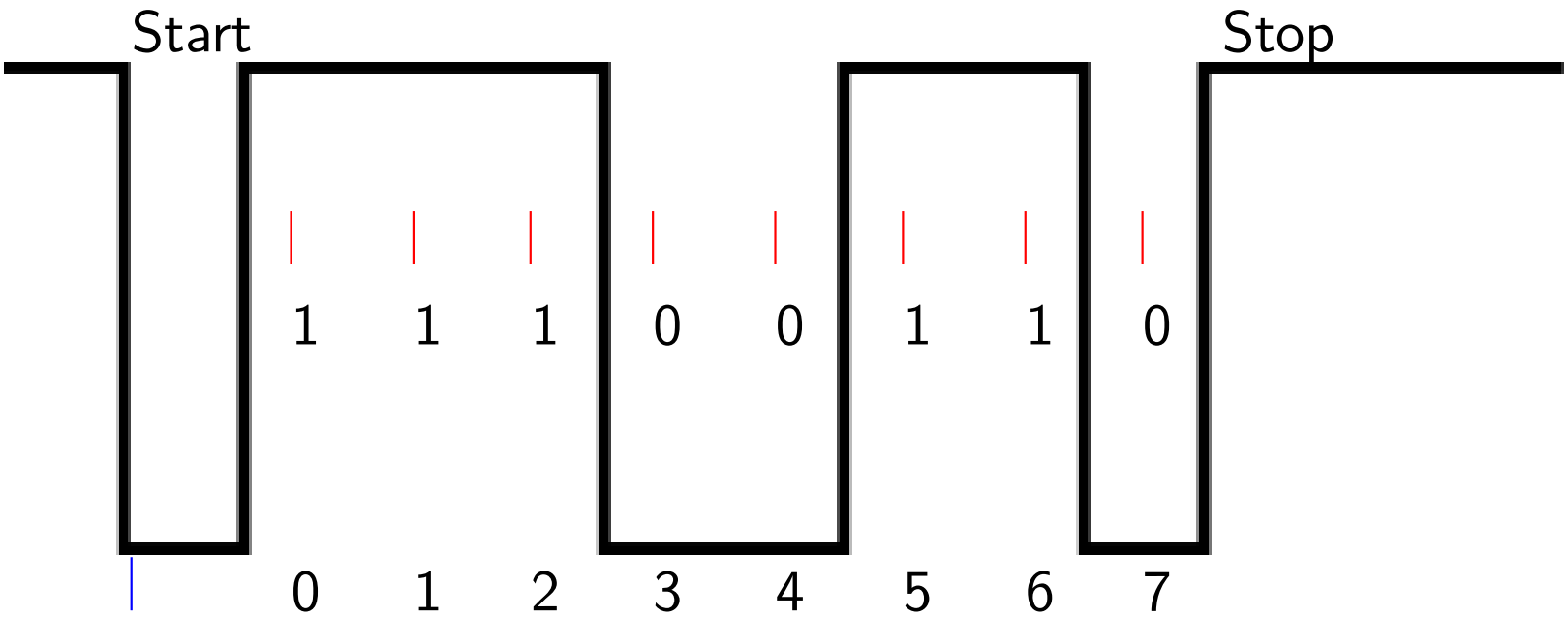

Start
1
1
1
0
0
0
1
2
3
4


Start
1
1
1
0
0
1
0
1
2
3
4
5


Start
1
1
1
0
0
1
1
0
1
2
3
4
5
6


Start
1
1
1
0
0
1
1
0
0
1
2
3
4
5
6
7


Start
Stop
1 1 1 0 0 1 1 0
0 1 2 3 4 5 6 7



Bit timing

RS232 communication

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- Voltages are inverted

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- $\pm 3 \rightarrow \pm 12$

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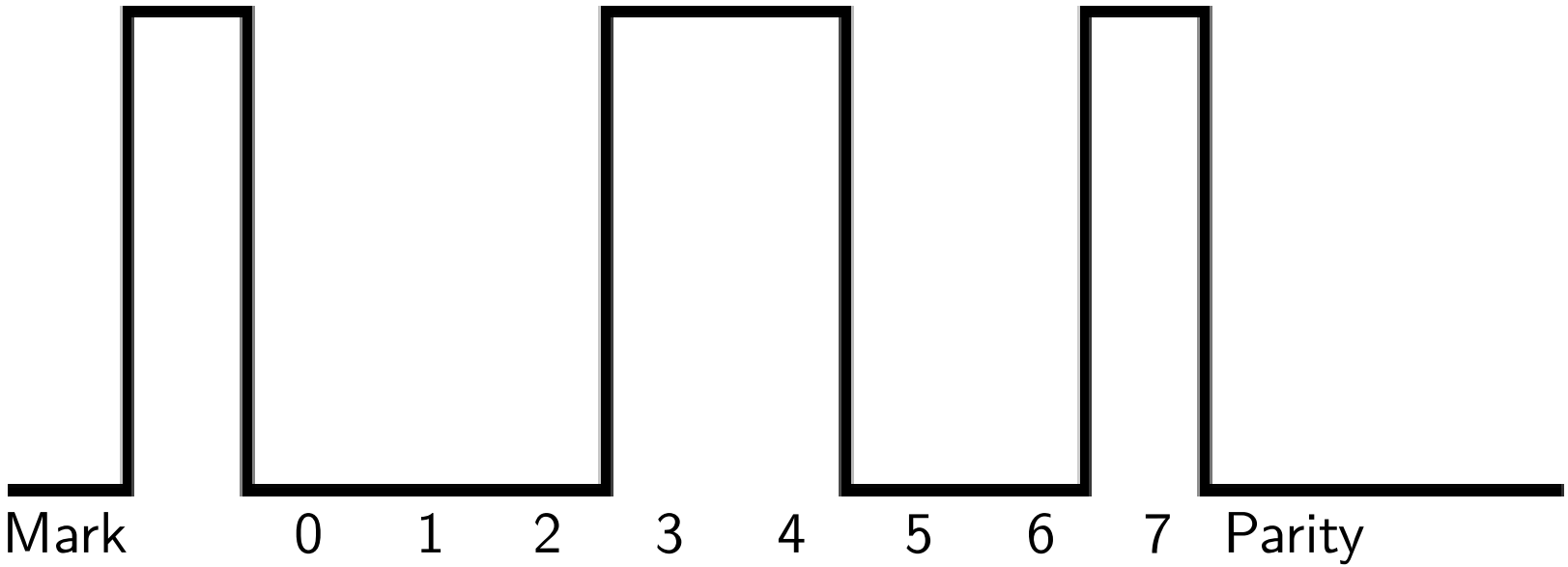
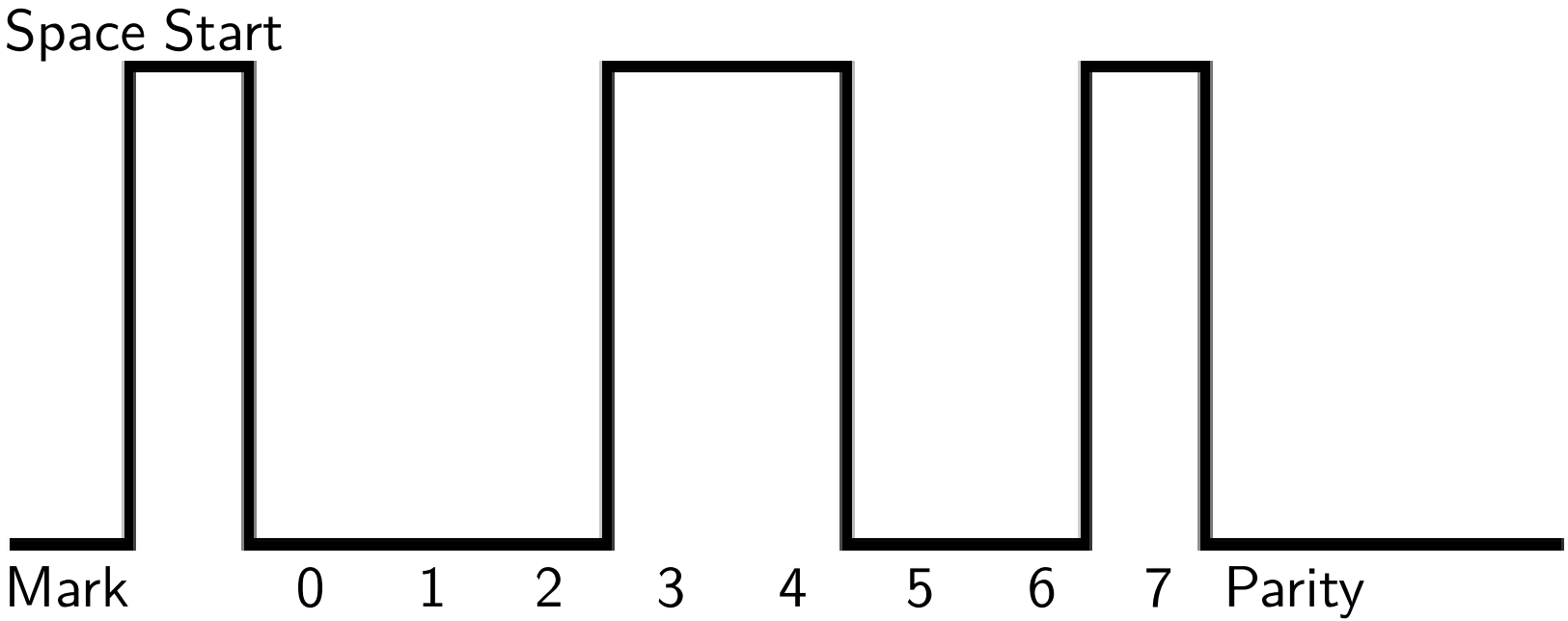
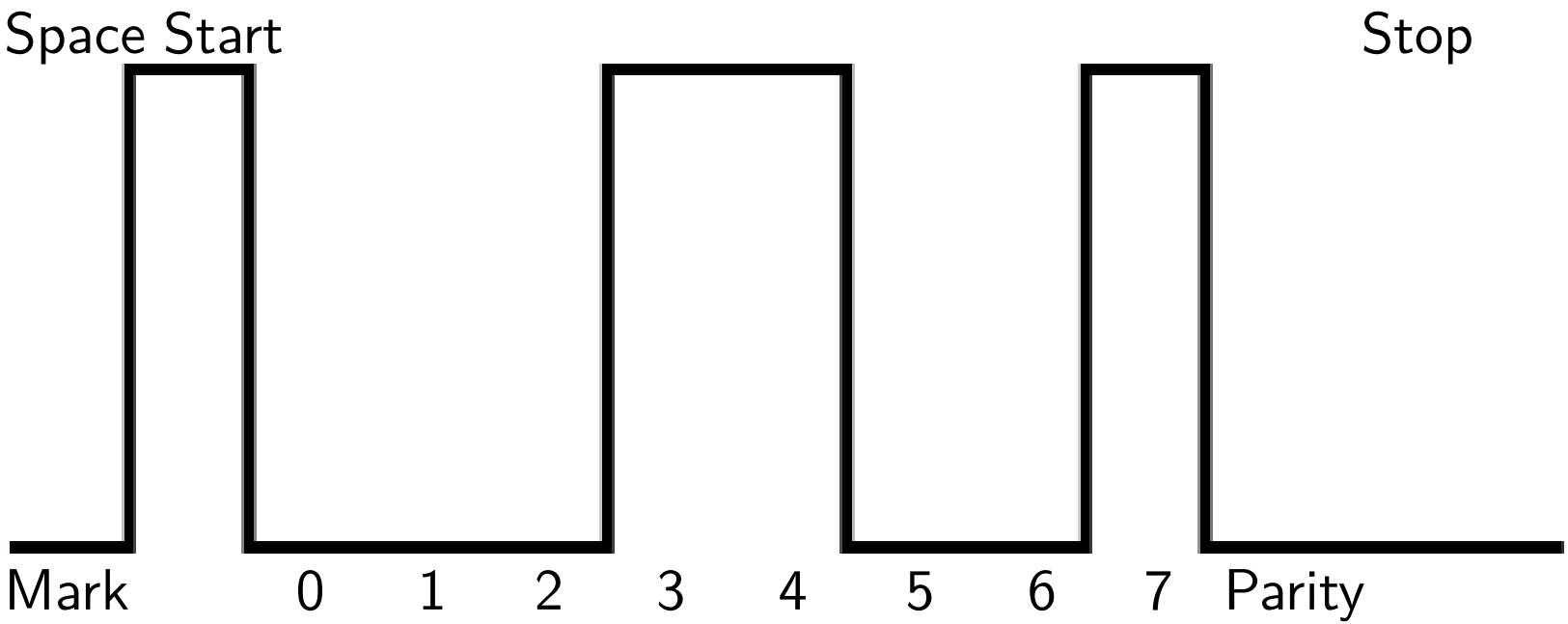
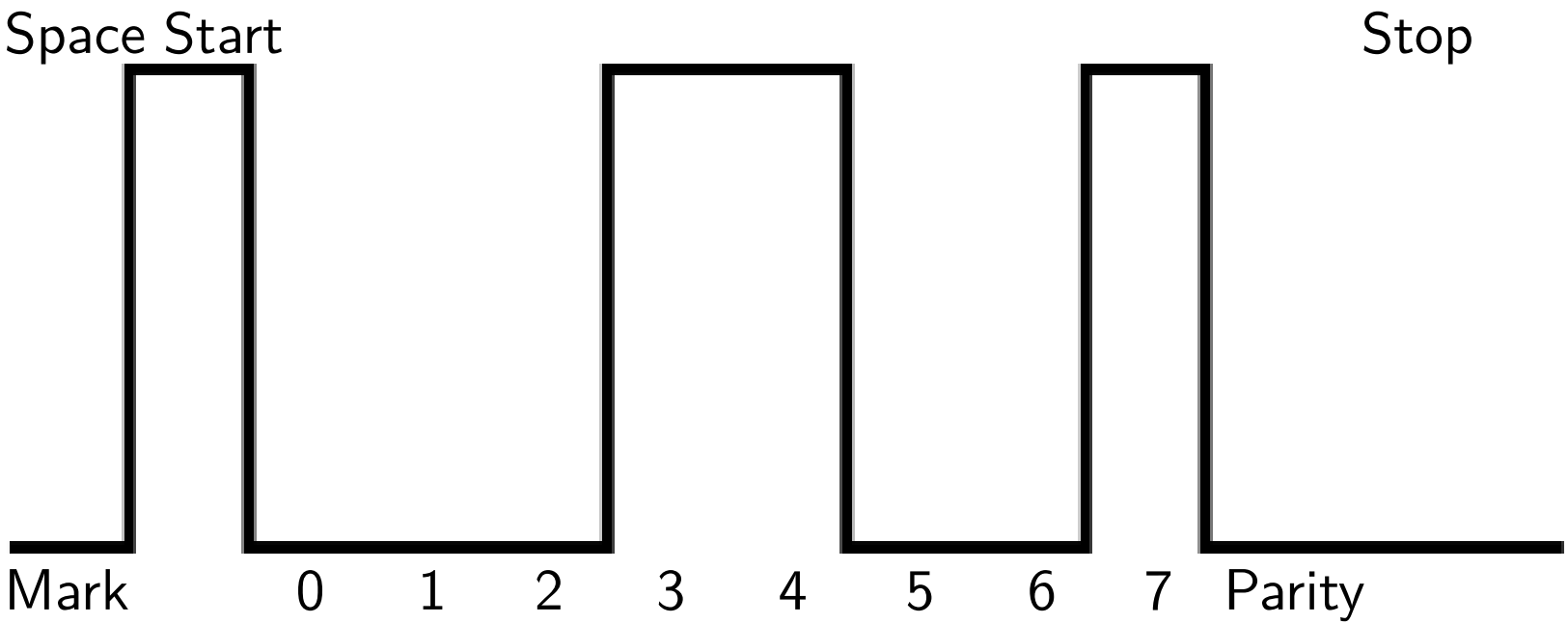
RS232 communication

- Voltages are inverted
- $\pm 3 \rightarrow \pm 12$
- Zero is not a valid voltage
- Mark level (inactive/1) is a negative voltage
- Space level (active/0) is a positive voltage


Mark
0
1
2
3
4
5
6
7
Parity


Space Start
Mark
0
1
2
3
4
5
6
7
Parity


Space Start
Stop
Mark
0
1
2
3
4
5
6
7
Parity



RS232 levels

Introduction

Introduction

QwikFlash modules

Introduction

QwikFlash modules

ramifications???

Introduction

QwikFlash modules

ramifications???

interrupts; transmit and receive

Introduction

QwikFlash modules

ramifications???

interrupts; transmit and receive

$\rightarrow$ Sections 6.4.5 to 6.4.7

Introduction

QwikFlash modules

ramifications???

interrupts; transmit and receive

→ Sections 6.4.5 to 6.4.7

→ Section 8.2

USART

USART

2 wires, one-to-one

USART

2 wires, one-to-one

EIA232 (RS232)

USART

2 wires, one-to-one

EIA232 (RS232)

$\rightarrow$ Section 9.3

USART

2 wires, one-to-one

EIA232 (RS232)

→ Section 9.3

USART registers

USART

2 wires, one-to-one

EIA232 (RS232)

→ Section 9.3

USART registers

→ Section 9.4.1

USART

2 wires, one-to-one

EIA232 (RS232)

→ Section 9.3

USART registers

→ Section 9.4.1

USART asynchronous mode

USART

2 wires, one-to-one

EIA232 (RS232)

→ Section 9.3

USART registers

→ Section 9.4.1

USART asynchronous mode

→ Section 9.4.2

USART

2 wires, one-to-one

EIA232 (RS232)

→ Section 9.3

USART registers

→ Section 9.4.1

USART asynchronous mode

→ Section 9.4.2

USART asynchronous mode to EIA232

USART

2 wires, one-to-one

EIA232 (RS232)

→ Section 9.3

USART registers

→ Section 9.4.1

USART asynchronous mode

→ Section 9.4.2

USART asynchronous mode to EIA232

→ Section 9.4.5

USART

2 wires, one-to-one

EIA232 (RS232)

→ Section 9.3

USART registers

→ Section 9.4.1

USART asynchronous mode

→ Section 9.4.2

USART asynchronous mode to EIA232

→ Section 9.4.5

→ Section 16.0

EIA232 summary

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2 wires (+ ground), one-to-one

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2 wires (+ ground), one-to-one

TX

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2 wires (+ ground), one-to-one

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RX

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Fixed baud rate, common to both devices

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RX

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voltage levels not TTL; inverted (normally)

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(except "TTL serial" devices)

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RX

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At least one *stop* bit

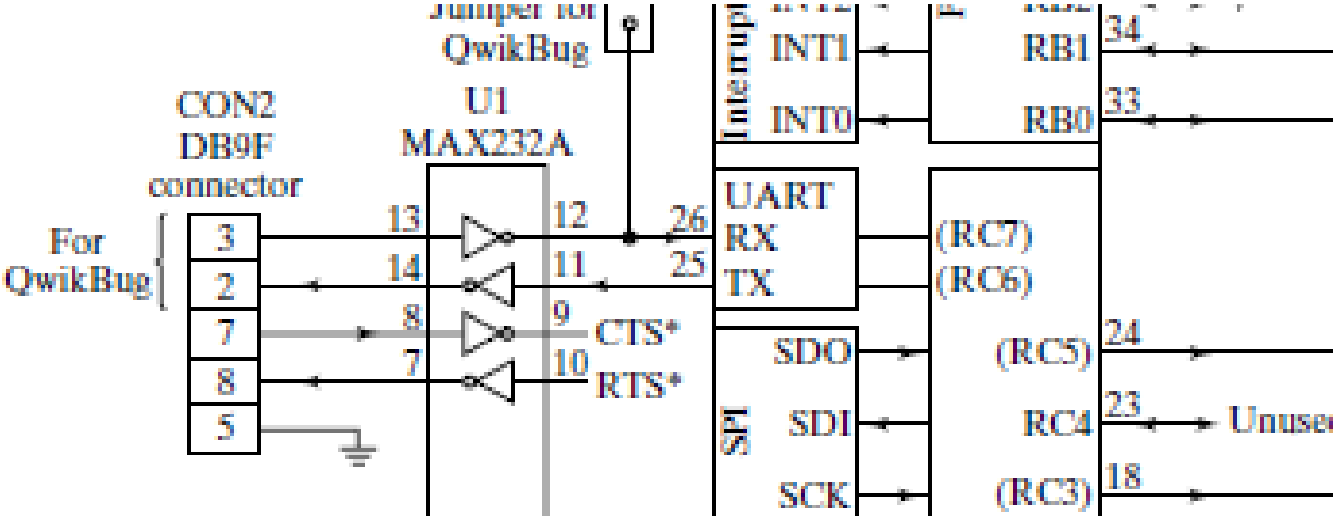
voltage levels not TTL; inverted (normally)

(except "TTL serial" devices)

packets are single characters

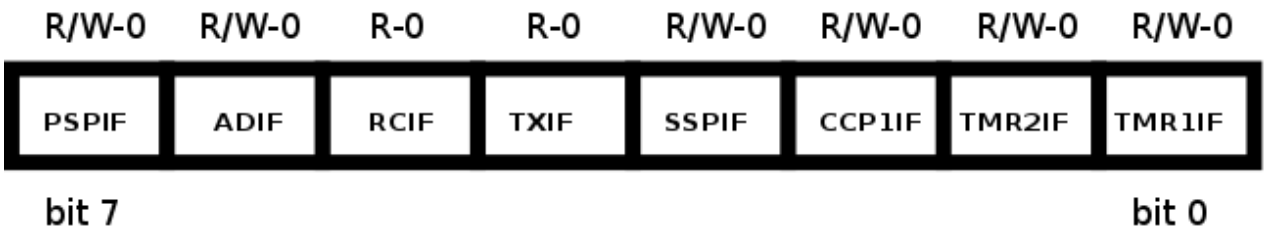
Qwikflash UART connections

Qwikflash UART connections

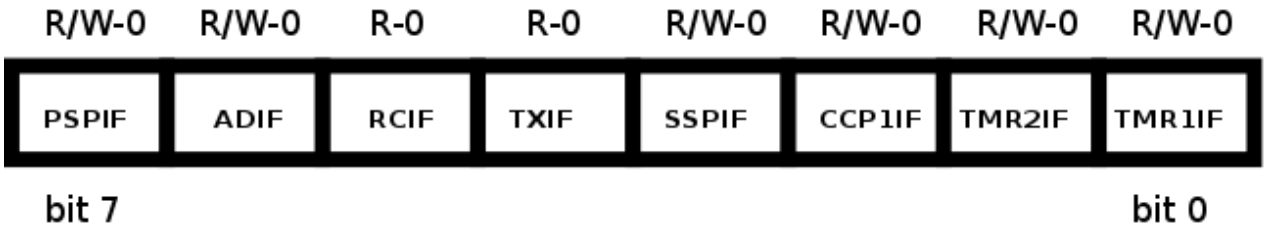


PIR1

PIR1

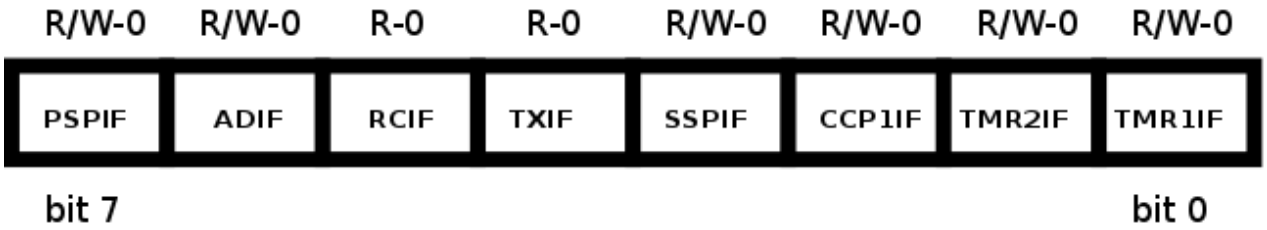

R/W-0
R/W-0
R-0
R-0
R/W-0
R/W-0
R/W-0
R/W-0
PSPIF
ADIF
RCIF
TXIF
SSPIF
CCP1IF
TMR2IF
TMR1IF
bit 7
bit 0

PIR1



Bits in PIR1 register

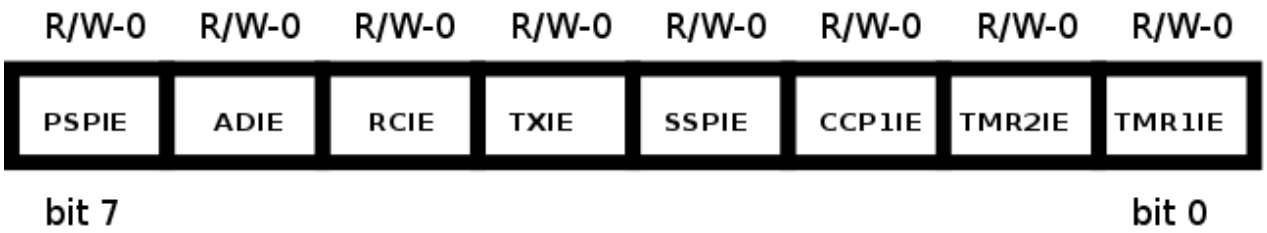
PIR1



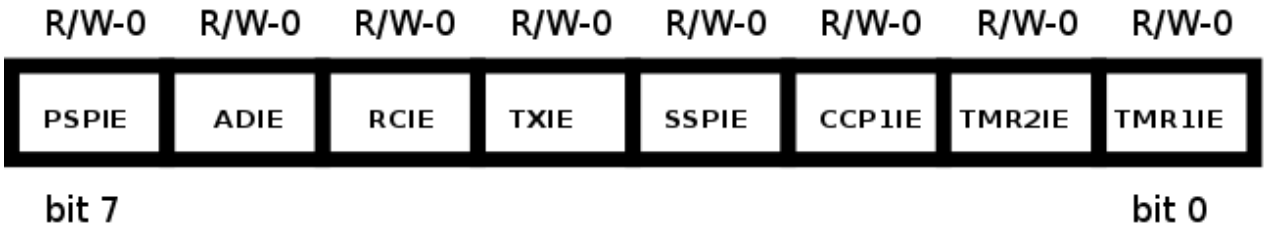
Bits in PIR1 register - Note RCIF, TXIF

PIE1

PIE1

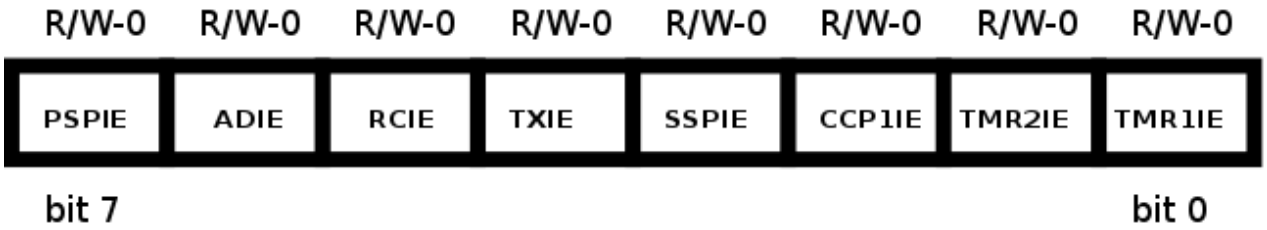

R/W-0
R/W-0
R/W-0
R/W-0
R/W-0
R/W-0
R/W-0
R/W-0
PSPIE
ADIE
RCIE
TXIE
SSPIE
CCP1IE
TMR2IE
TMR1IE
bit 7
bit 0

PIE1



Bits in PIE1 register

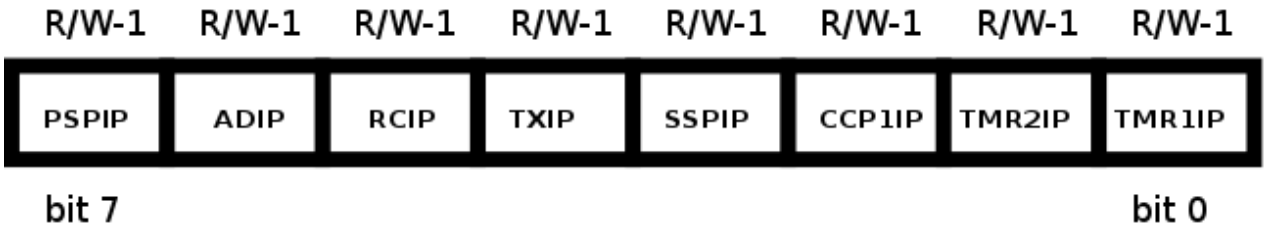
PIE1



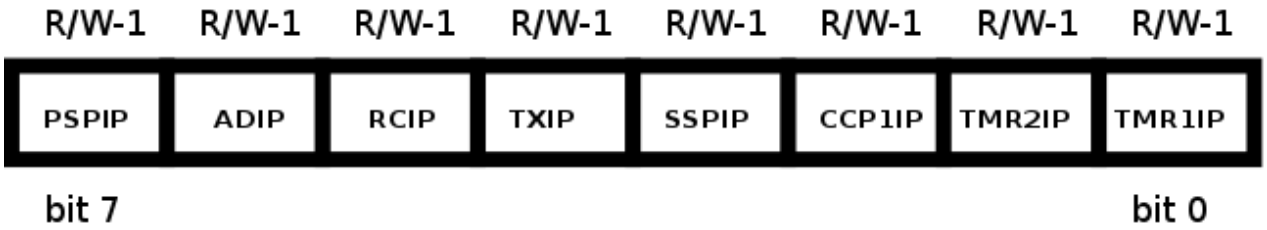
Bits in PIE1 register - Note RCIE, TXIE

IPR1

IPR1

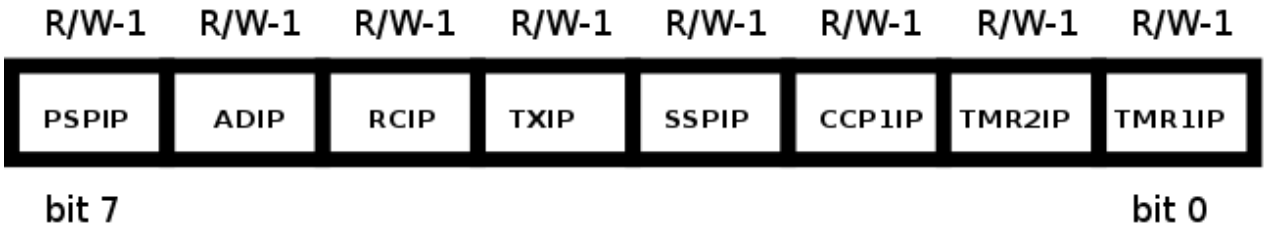

R/W-1
R/W-1
R/W-1
R/W-1
R/W-1
R/W-1
R/W-1
R/W-1
PSPIP
ADIP
RCIP
TXIP
SSPIP
CCP1IP
TMR2IP
TMR1IP
bit 7
bit 0

IPR1



Bits in IPR1 register

IPR1



Bits in IPR1 register - Note RCIP, TXIP

Bit-bashing

Bit-bashing

overview

Bit-bashing

overview

reasons

Bit-bashing

overview

reasons

NIB

Code

Code

PORT configuration

Code

PORT configuration

$\rightarrow$ macro or subroutine?

Code

PORT configuration

$\rightarrow$ macro or subroutine?

Initiallization

Code

PORT configuration

$\rightarrow$ macro or subroutine?

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Code

PORT configuration

$\rightarrow$ macro or subroutine?

Initiallization

$\rightarrow$ macro or subroutine?

Write to device

Code

PORT configuration

→ macro or subroutine?

Initiallization

→ macro or subroutine?

Write to device

→ macro or subroutine?

Code

PORT configuration

$\rightarrow$ macro or subroutine?

Initiallization

$\rightarrow$ macro or subroutine?

Write to device

$\rightarrow$ macro or subroutine?

Read from device

Code

PORT configuration

→ macro or subroutine?

Initiallization

→ macro or subroutine?

Write to device

→ macro or subroutine?

Read from device

→ macro or subroutine?