Communication using MCU

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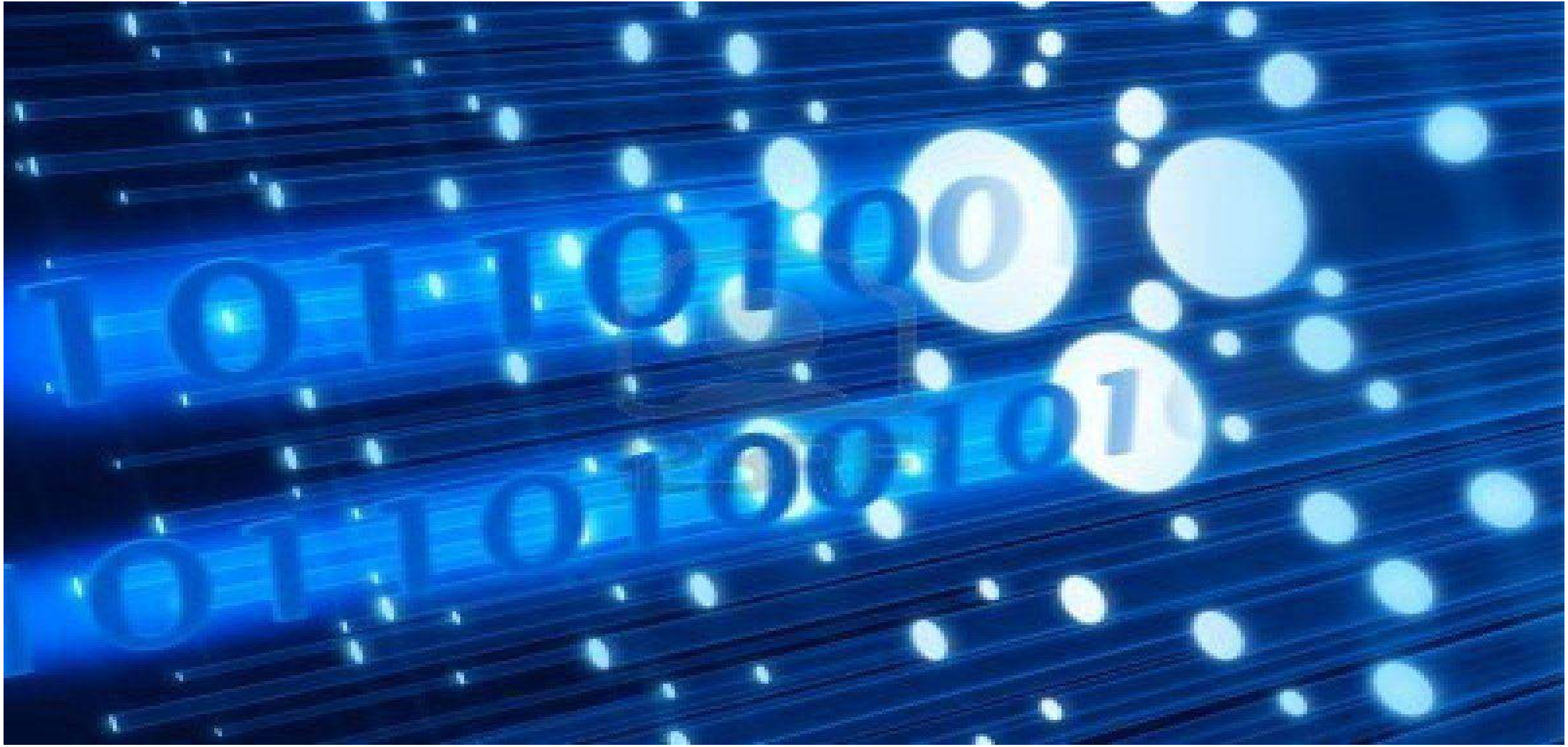
Mechanical Engineering

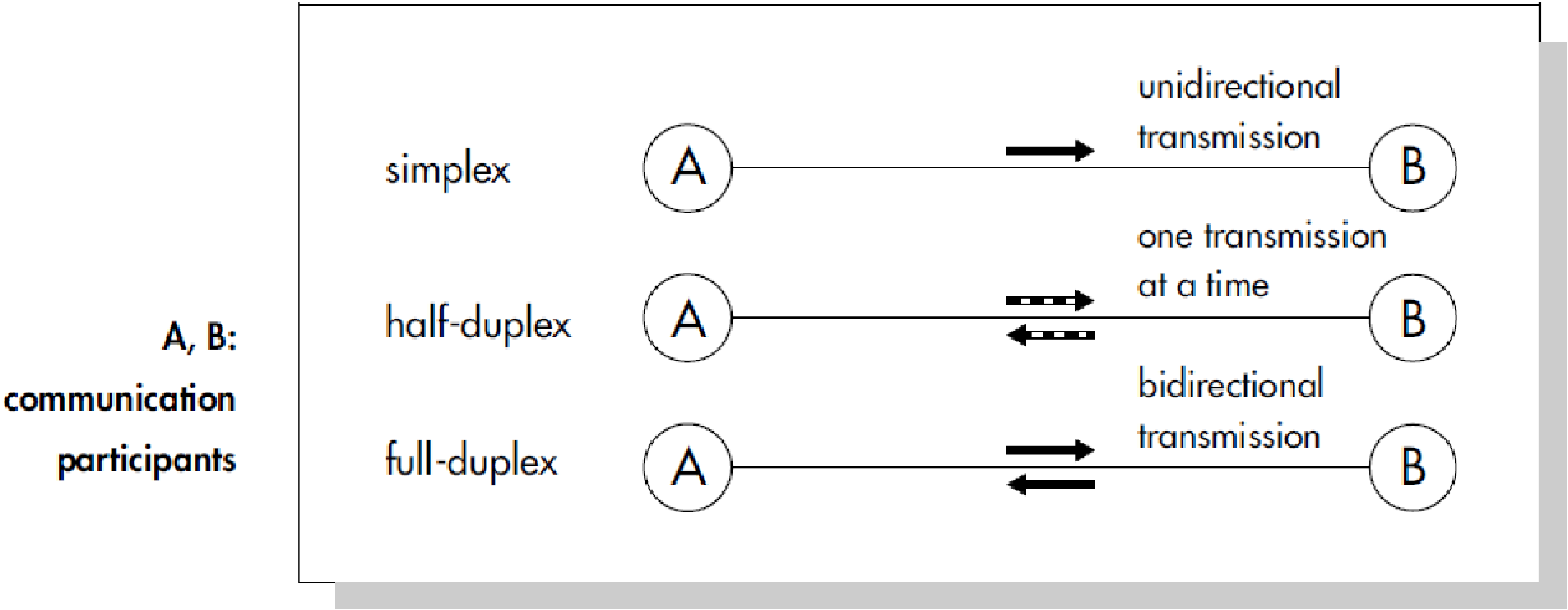
Communication with MCU



Types

- Simple Parallel Transfer
- SPI
- UART
- USB

Communication Technique



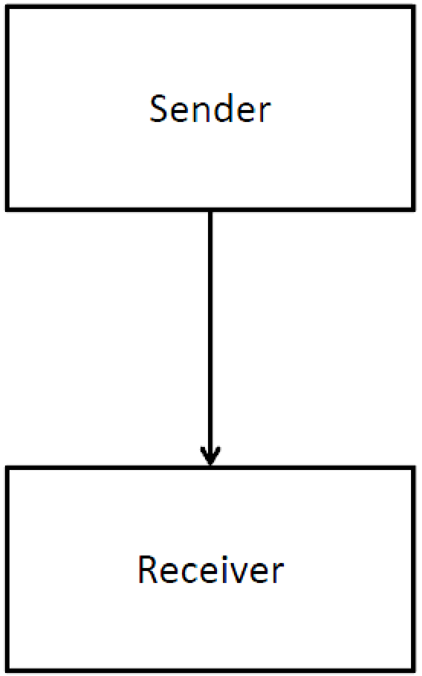
Classification

- Parallel Transfer
- Serial Transfer

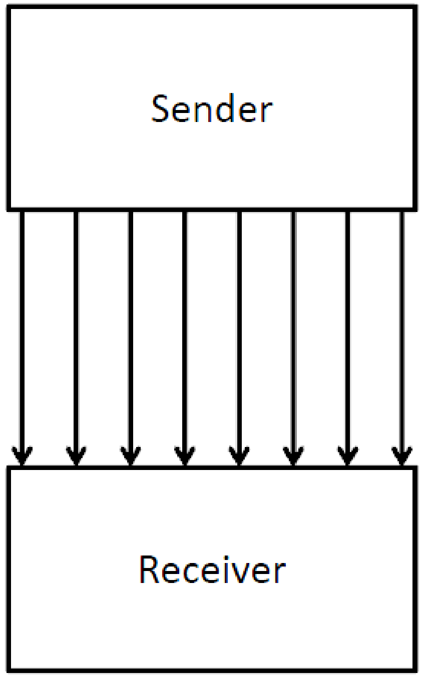
or

- Synchronous
- Asynchronous

Serial and Parallel Mode

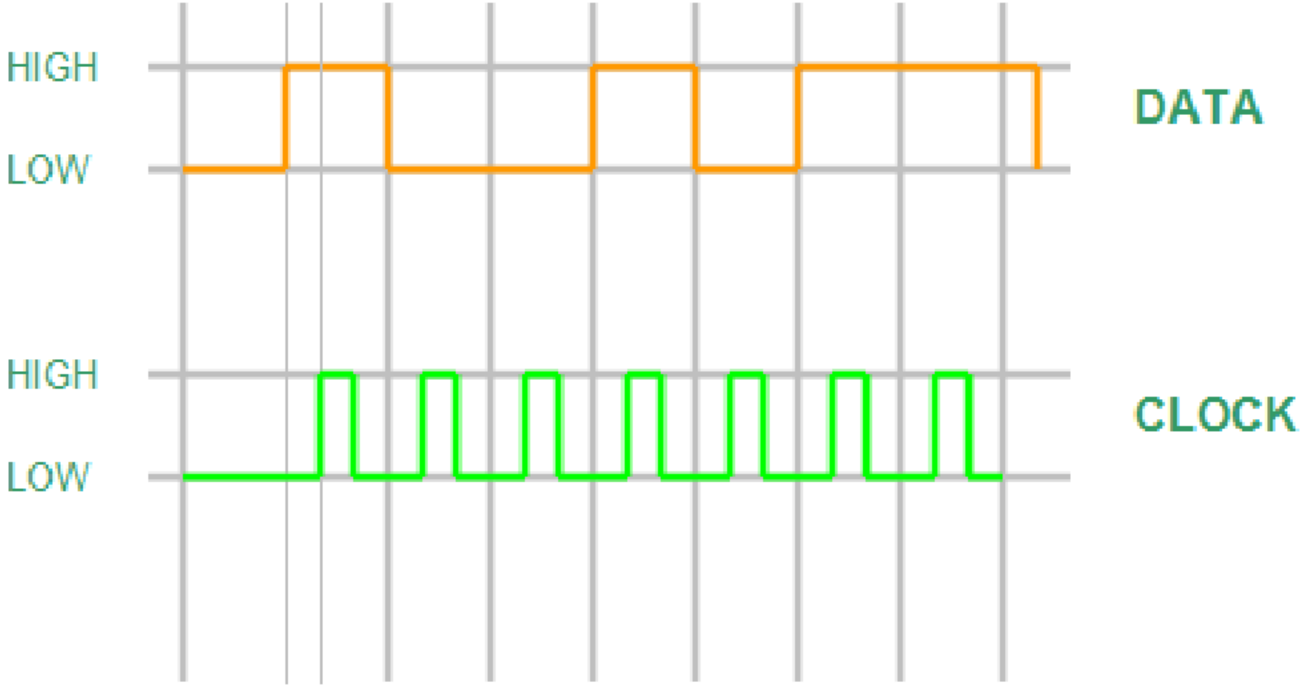


Serial Mode



Parallel Mode

Synchronous Transmission



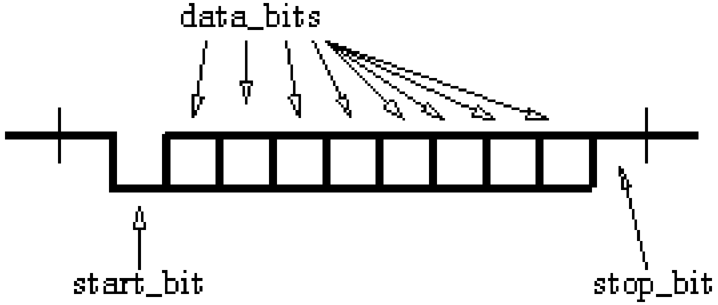
The diagram corresponds to the transfer of the data 10010111. It corresponds to the value of the data at every rising edge of the clock.

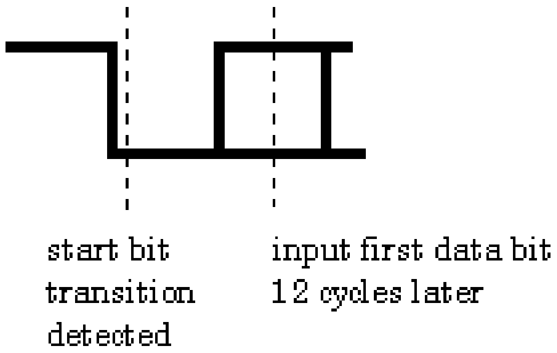
Asynchronous Transmission

- Asynchronous transmission allows data to be transmitted without the sender having to send a clock signal to the receiver.
- Special bits are added to each word which are used to synchronize the sending and receiving units.
- A bit called the "Start Bit" is added to the beginning of each word that is to be transmitted. The Start Bit is used to alert the receiver that a word of data is about to be sent.
- A bit called the “Stop Bit” is also sent.

Baud Rate

No. of bits transmitted/received per second = ______bits/sec.





UART

- UART is a simple half-duplex, asynchronous, serial protocol.
- Simple communication between two equivalent nodes.
- Any node can initiate communication.
- Since connection is half-duplex, the two lanes of communication are completely independent.

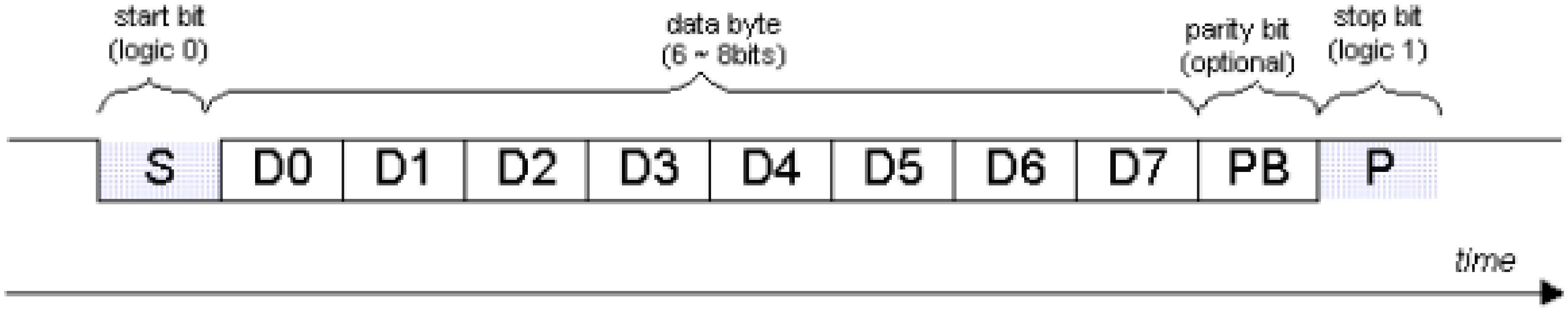
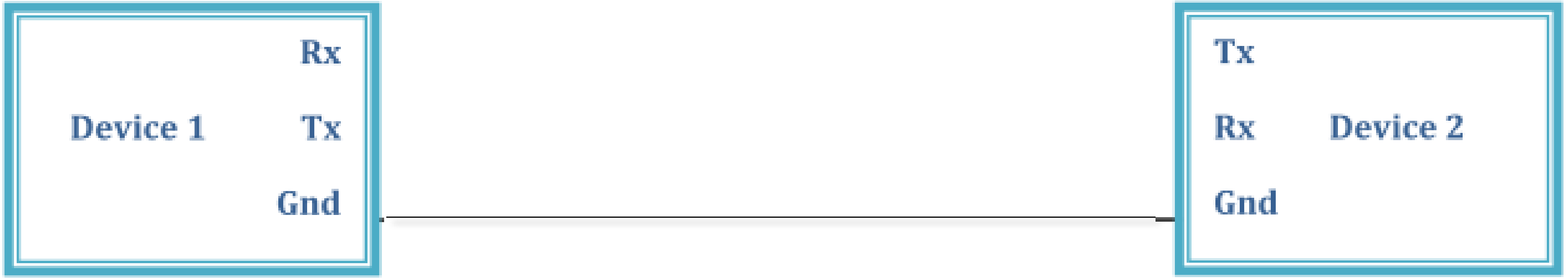


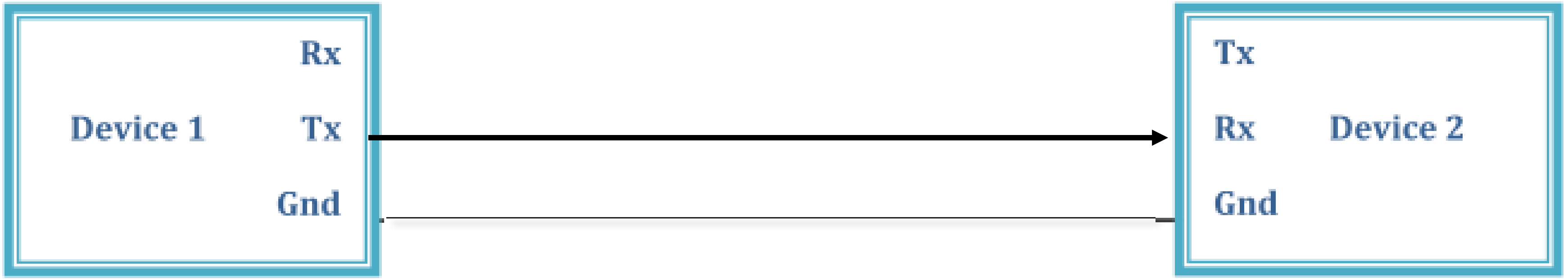
Figure 17: Basic UART packet format: 1 start bit, 8 data bits, 1 parity bit, 1 stop bit.

Connections for UART

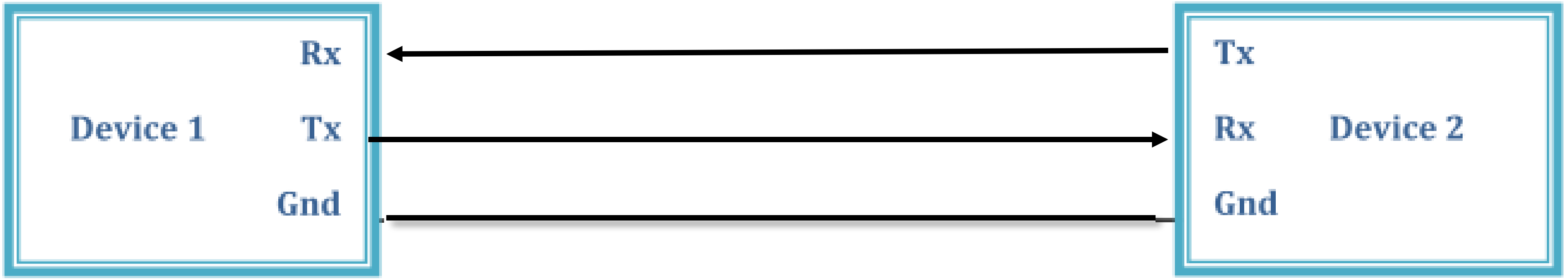
Connections for UART

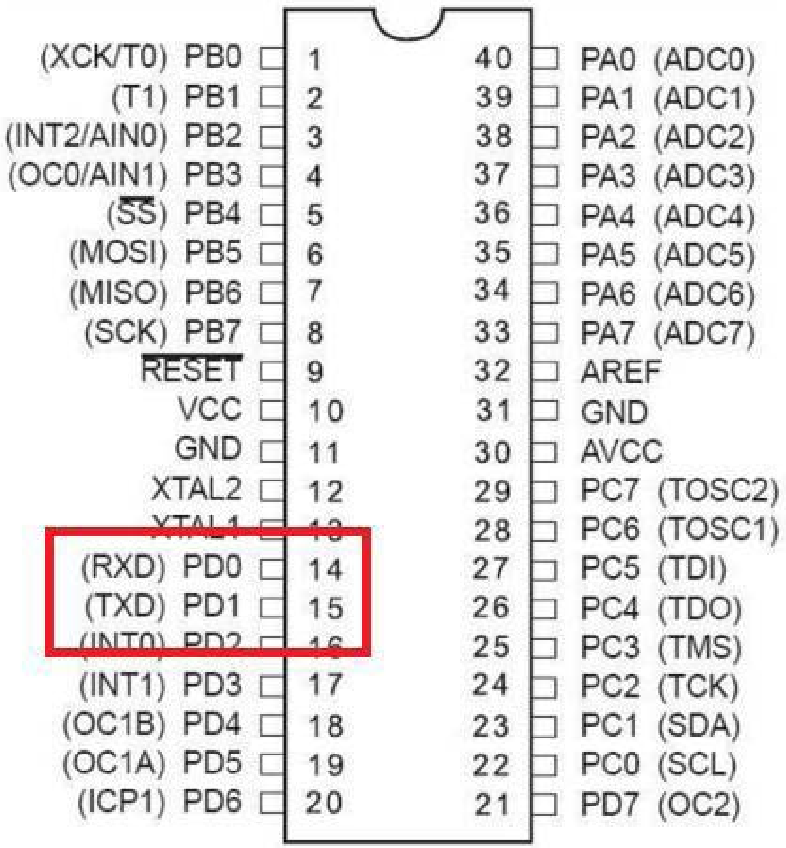


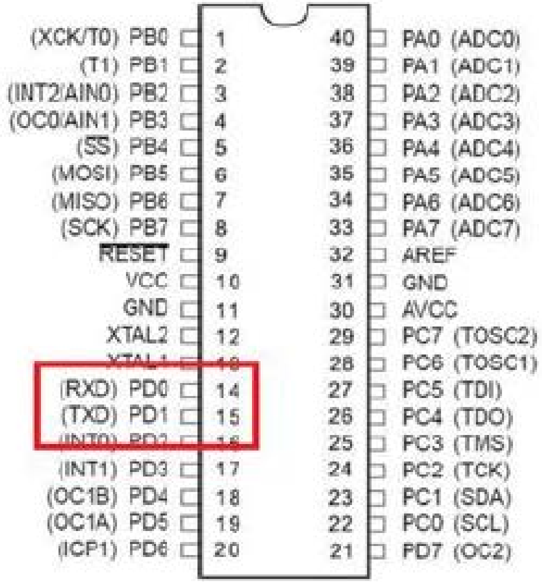
Connections for UART



Connections for UART

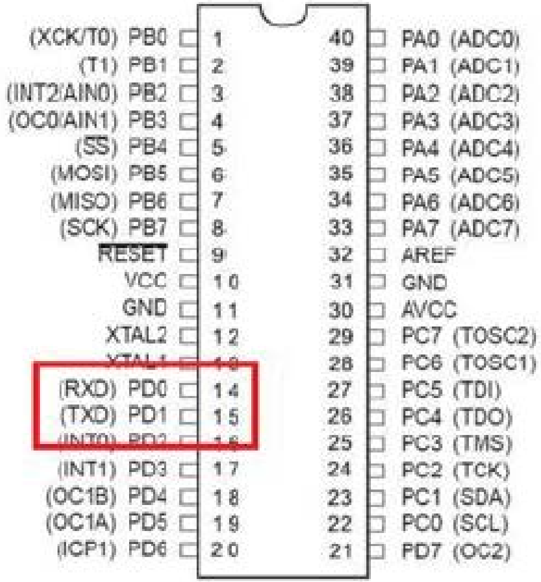



(XCK/T0) PB0 1
(T1) PB1 2
(INT2/AIN0) PB2 3
(OC0/AIN1) PB3 4
($\overline{SS}$) PB4 5
(MOSI) PB5 6
(MISO) PB6 7
(SCK) PB7 8
$\overline{RESET}$ 9
VCC 10
GND 11
XTAL2 12
XTAL1 13
(RXD) PD0 14
(TXD) PD1 15
(INT0) PD2 16
(INT1) PD3 17
(OC1B) PD4 18
(OC1A) PD5 19
(ICP1) PD6 20
40 PA0 (ADC0)
39 PA1 (ADC1)
38 PA2 (ADC2)
37 PA3 (ADC3)
36 PA4 (ADC4)
35 PA5 (ADC5)
34 PA6 (ADC6)
33 PA7 (ADC7)
32 AREF
31 GND
30 AVCC
29 PC7 (TOSC2)
28 PC6 (TOSC1)
27 PC5 (TDI)
26 PC4 (TDO)
25 PC3 (TMS)
24 PC2 (TCK)
23 PC1 (SDA)
22 PC0 (SCL)
21 PD7 (OC2)

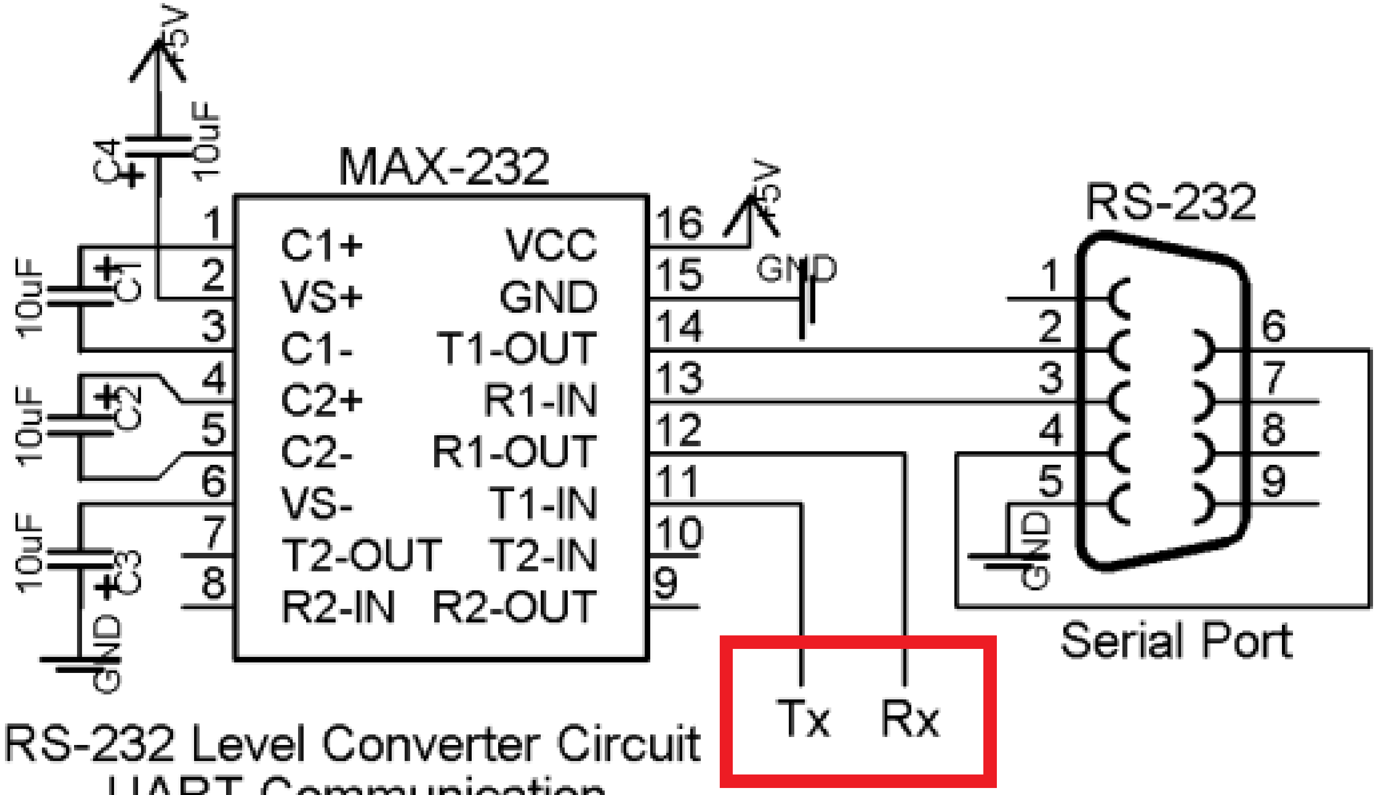


Device 1

Rx	?	Tx
Tx	?	Rx
GND	?	GND



Device 2



RS-232 Level Converter Circuit
UART Communication

- Three simple commands :

✓putchar(char);

  - sends 8-bit characters through UART

✓getchar();

  - receives 8-bit characters via UART

✓puts(string);

  - sends a constant string

- On MCU side use CVAVR
- On computer side :- use C, Java , Matlab , Python

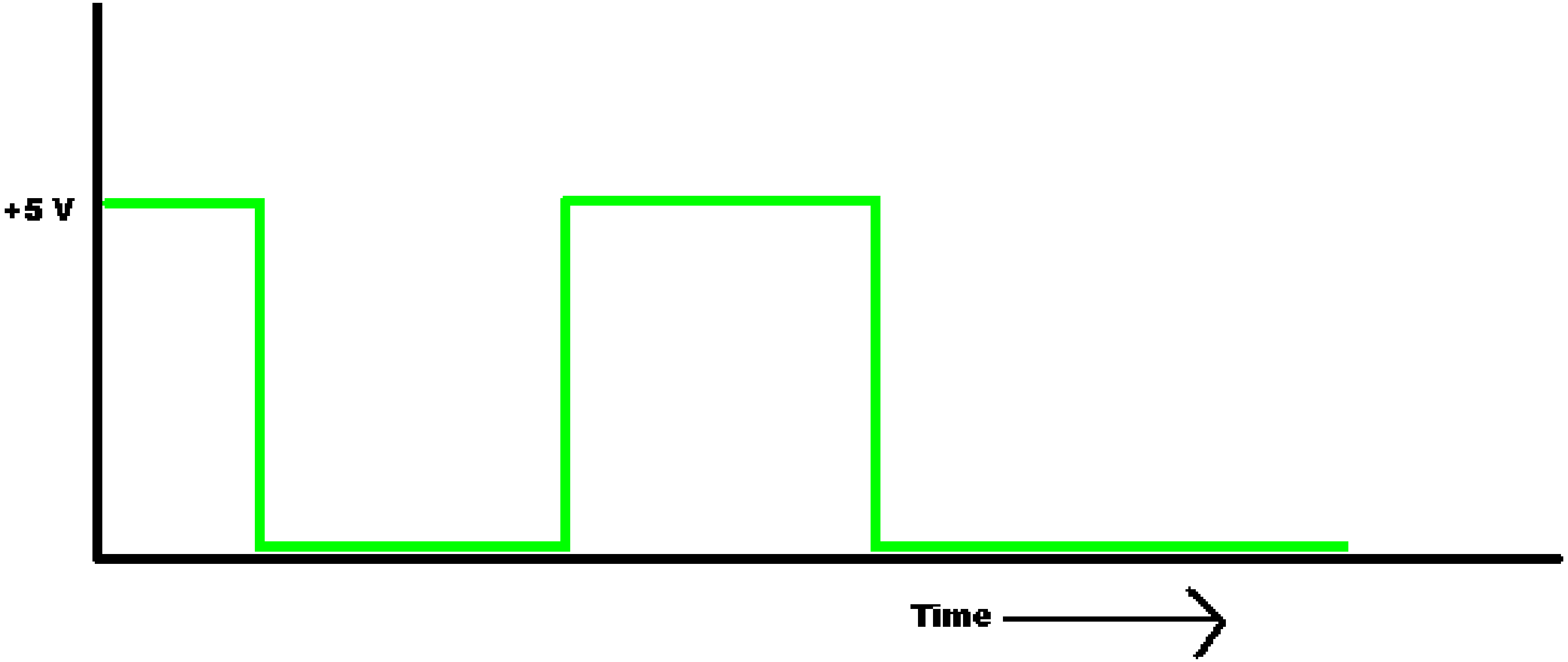
SPI

- In SPI, data is transmitted serially, i.e. bit by bit as opposed to parallel communication where all the data is sent multiple bits at a time.
- We will study synchronous SPI, where there is a clock generated and the data is transferred at the rate of the clock pulse

Pins in SPI

- CLK is generated by Master.
- MOSI is Master Out Slave In: Data sent by Master to Slave.
- MISO is Master In Slave Out: Data sent by Slave to Master.
- $\overline{SS}$ is slave select: Slave communicates with Master only if this pin’s value is set as LOW.

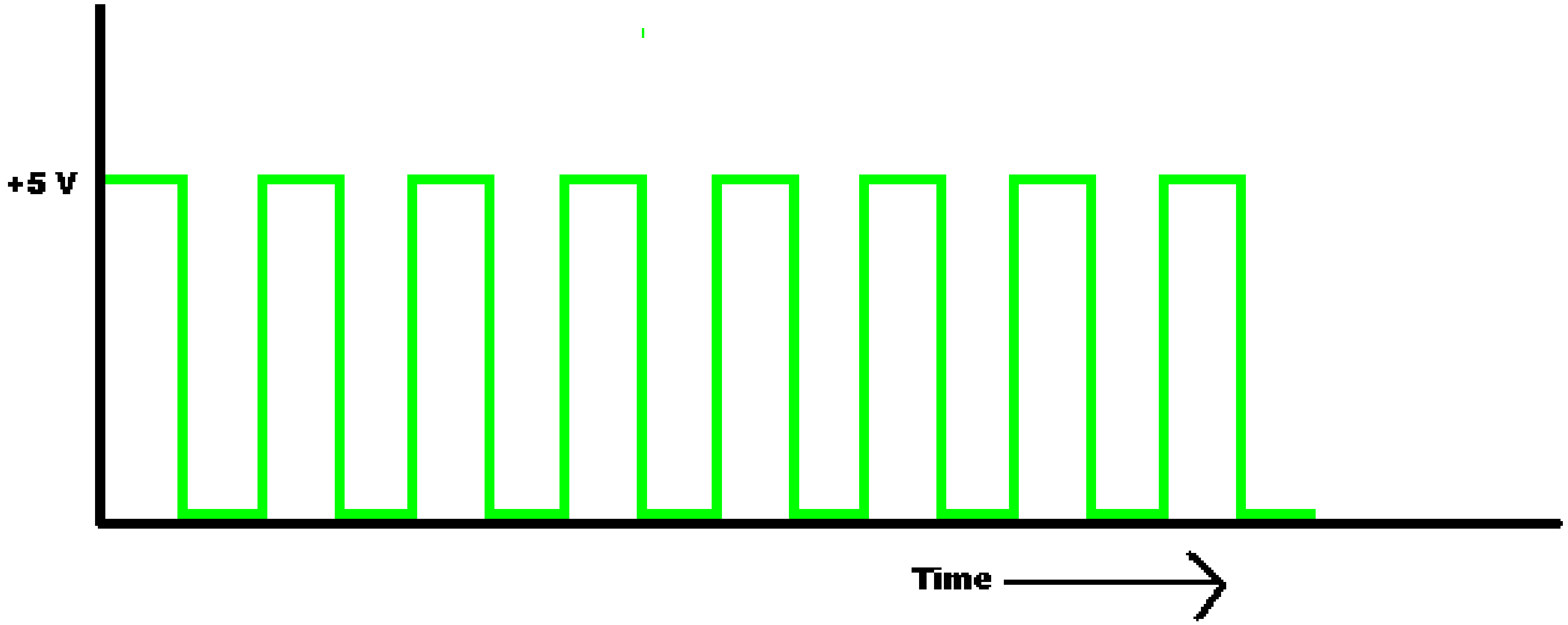
Clock Pulse

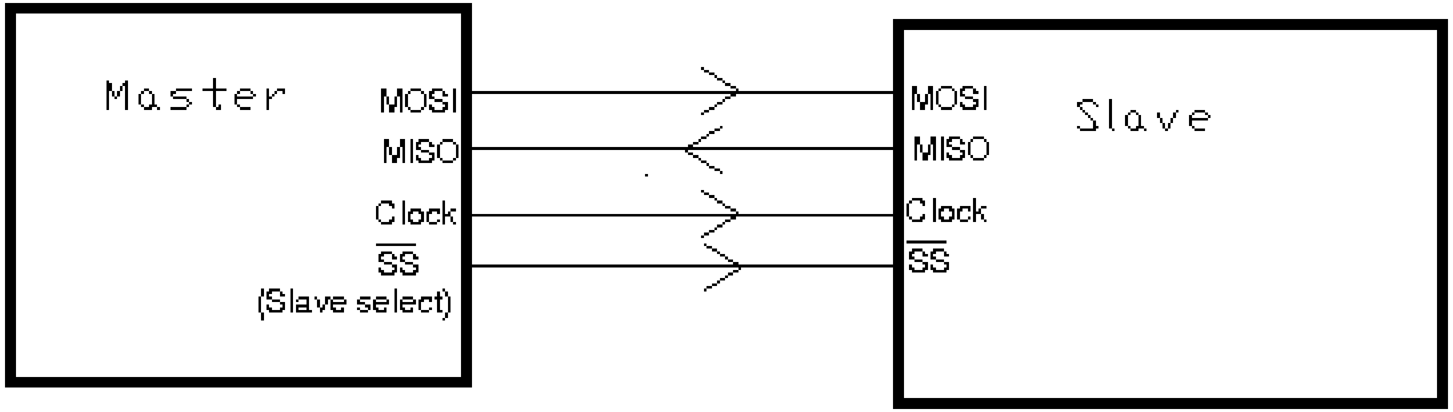


- Set time rates

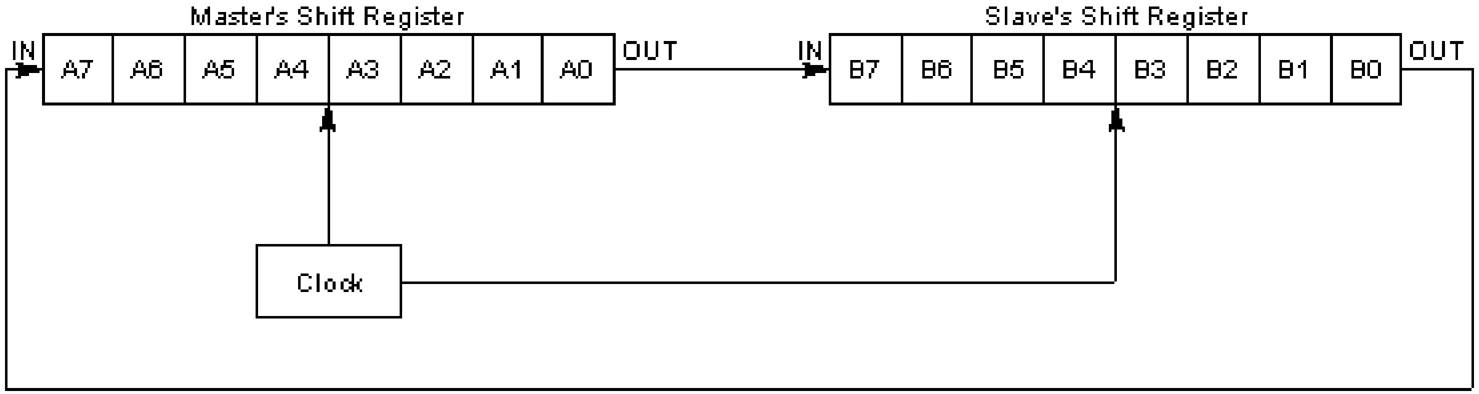
or

- Set clock

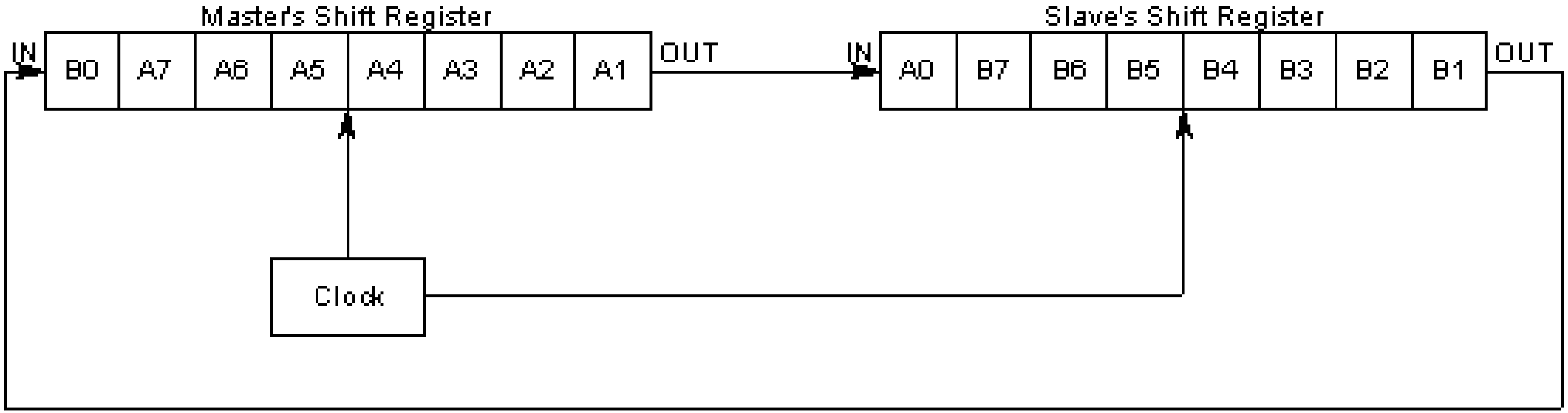



Master
MOSI
MISO
Clock
$\overline{SS}$
(Slave select)
MOSI
MISO
Clock
$\overline{SS}$
Slave

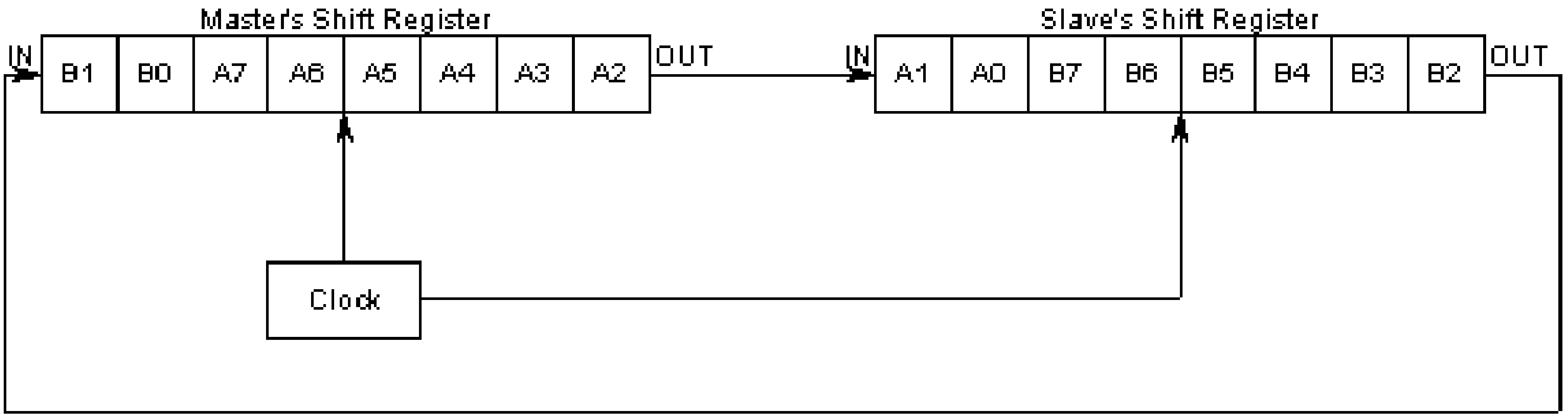
Time t = 0


Master's Shift Register
IN
A7
A6
A5
A4
A3
A2
A1
A0
OUT
Slave's Shift Register
IN
B7
B6
B5
B4
B3
B2
B1
B0
OUT
Clock

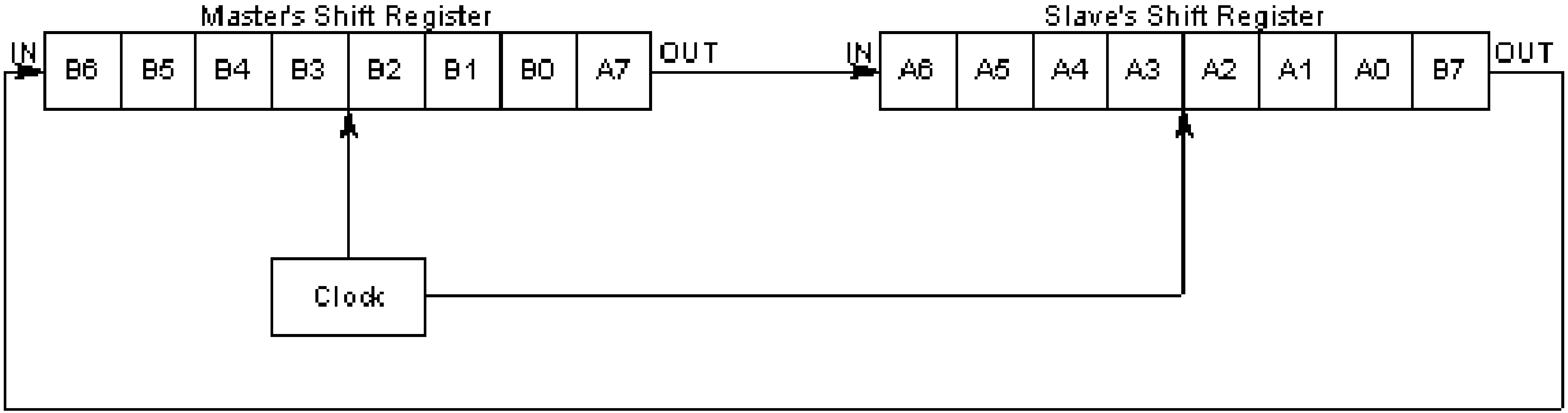
Master generates the first clock pulse:



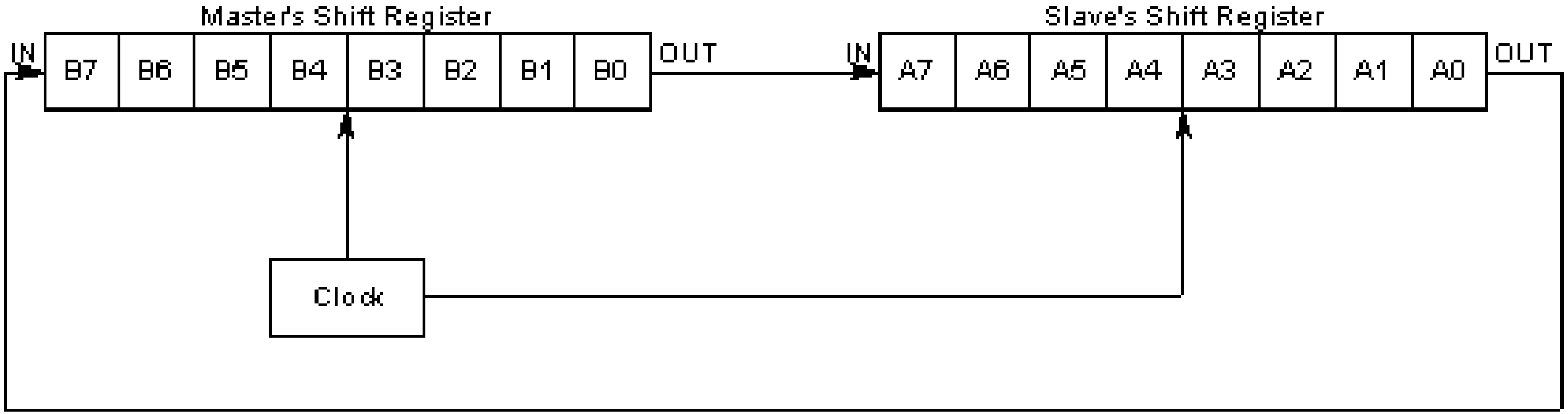
Master generates the second clock pulse:

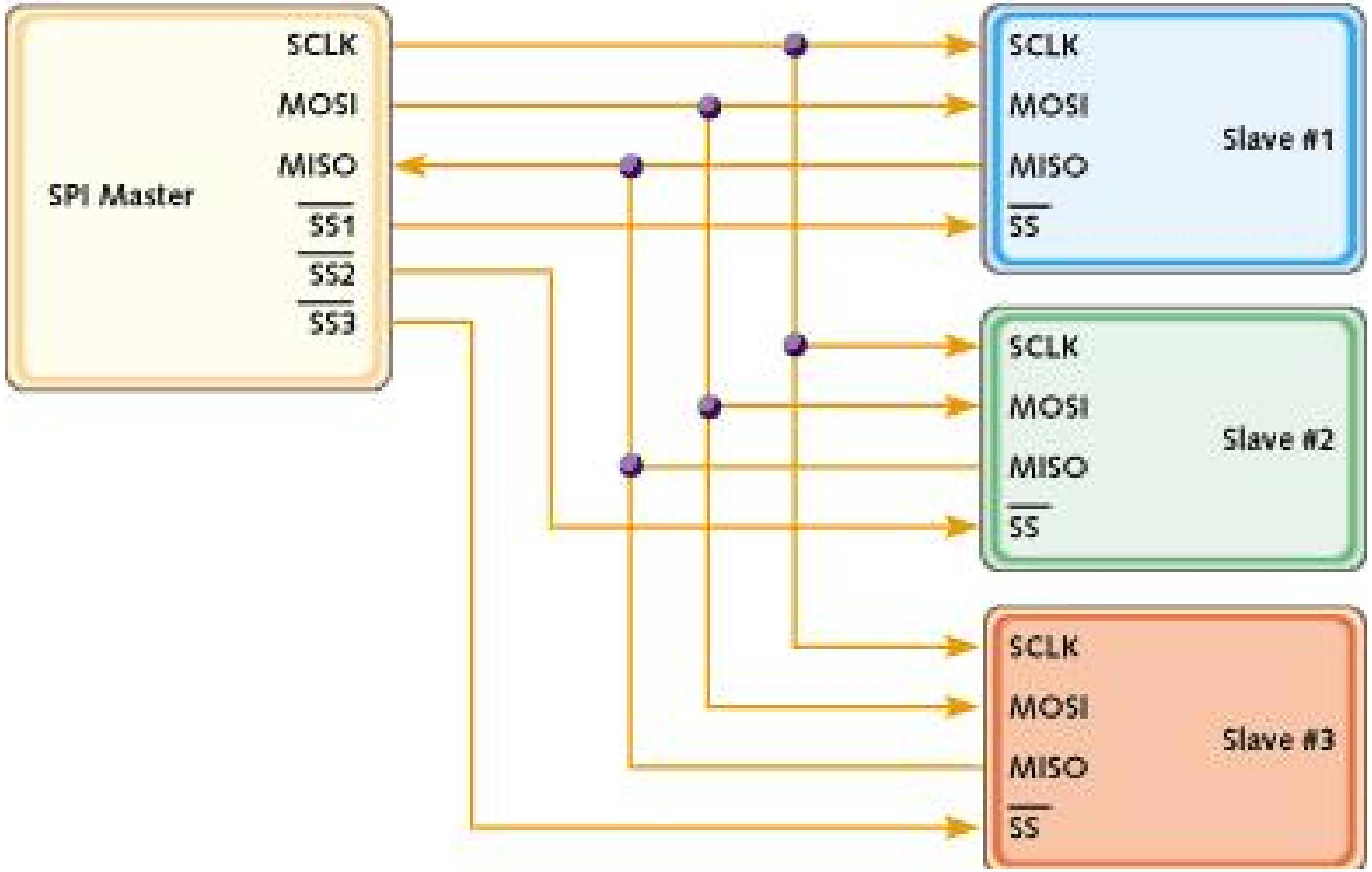


Master generates the seventh clock pulse:



Master generates the last clock pulse:



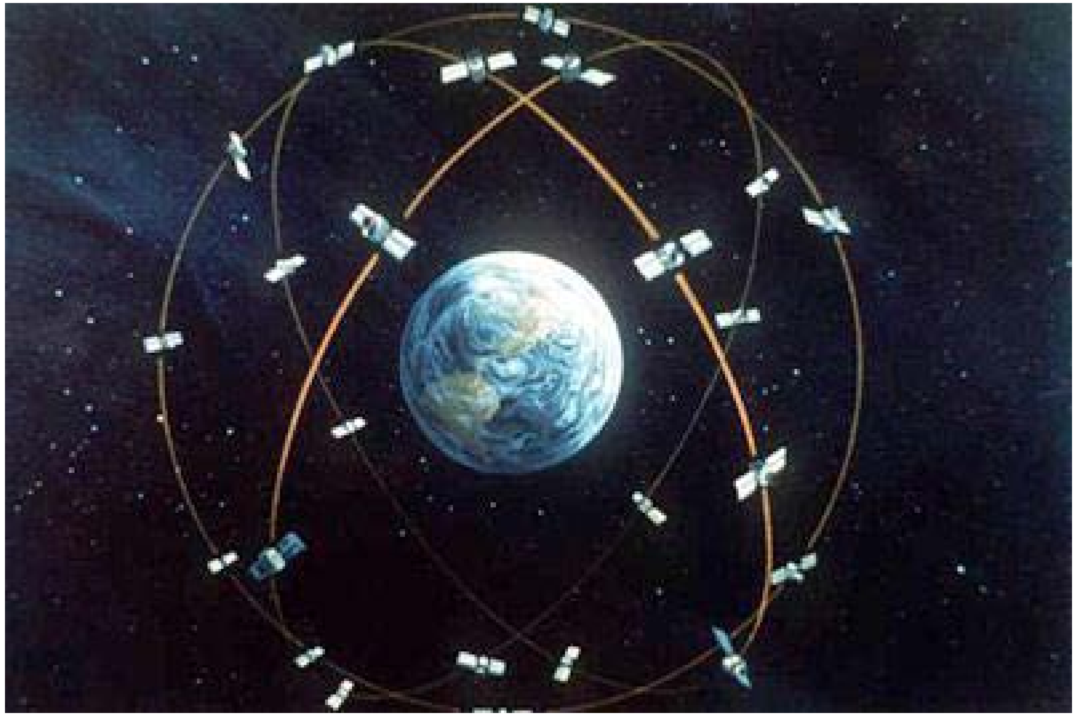

SPI Master
SCLK
MOSI
MISO
$\overline{SS1}$
$\overline{SS2}$
$\overline{SS3}$
SCLK
MOSI
MISO
$\overline{SS}$
Slave #1
SCLK
MOSI
MISO
$\overline{SS}$
Slave #2
SCLK
MOSI
MISO
$\overline{SS}$
Slave #3

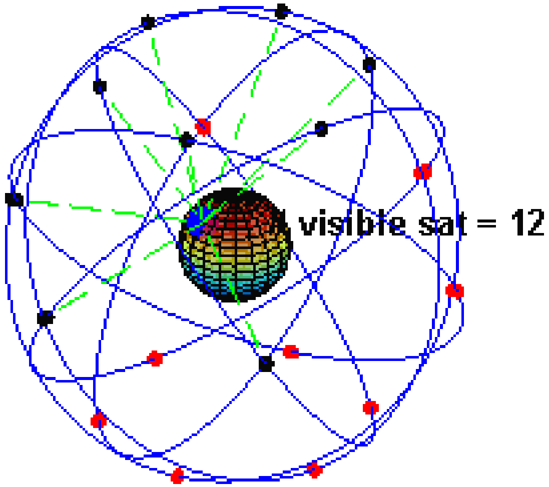
Cool Applications

GPS

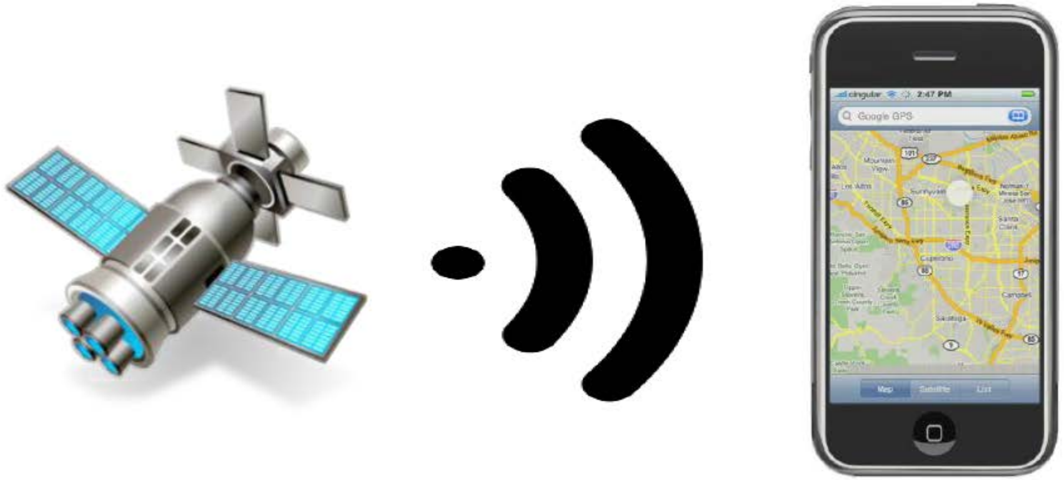
GPS

38th St
Sixth Ave
New Core Labs
Environmental Engineering Bldg
SIDBI
Third Ave
35th St
34th St
33rd St
IIT M
Gate 4
Nankari
NW Labs
IIT Kanpur
32nd St
31st St
34
Overhead Water Tank
62nd St
A
IIT Kanpur
Hall of Residence II
Main Dr
Main Dr
Main Dr
Hall 5
Hall of Residence 1
21st St
22nd St
23rd St
11th St
First Ave
Hall of Residence IX
Hall of Residence III
41st St
Fifth Ave
Fourth Ave
12th St
ACES Grounds
24th St
Hall 7
Hall-10
25th St
Hall 8
Student Activity Center (new)
64th St




visible sat = 12

Distance Calculation



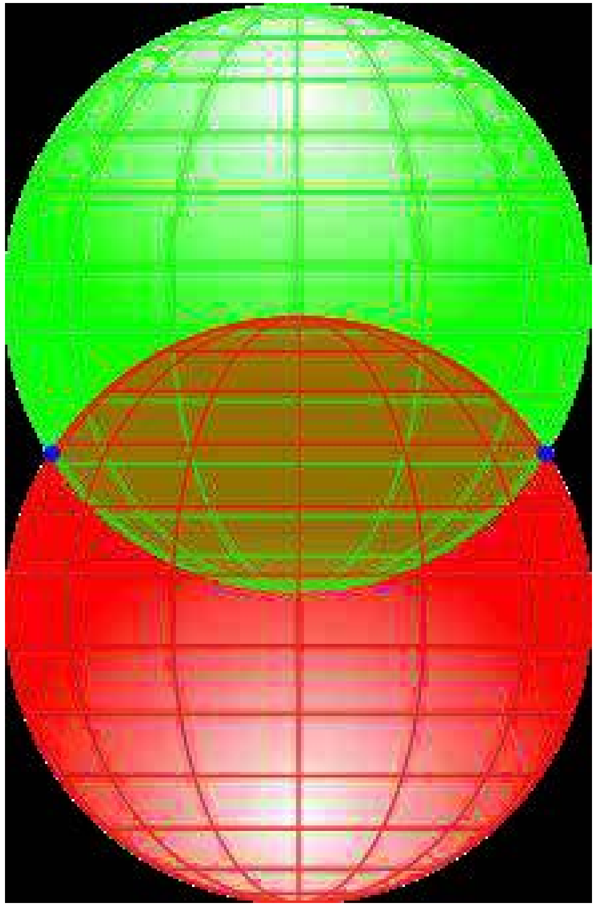
Value Sent: t1
Time Sent : t1

Value Received: t2
Time Received : t2

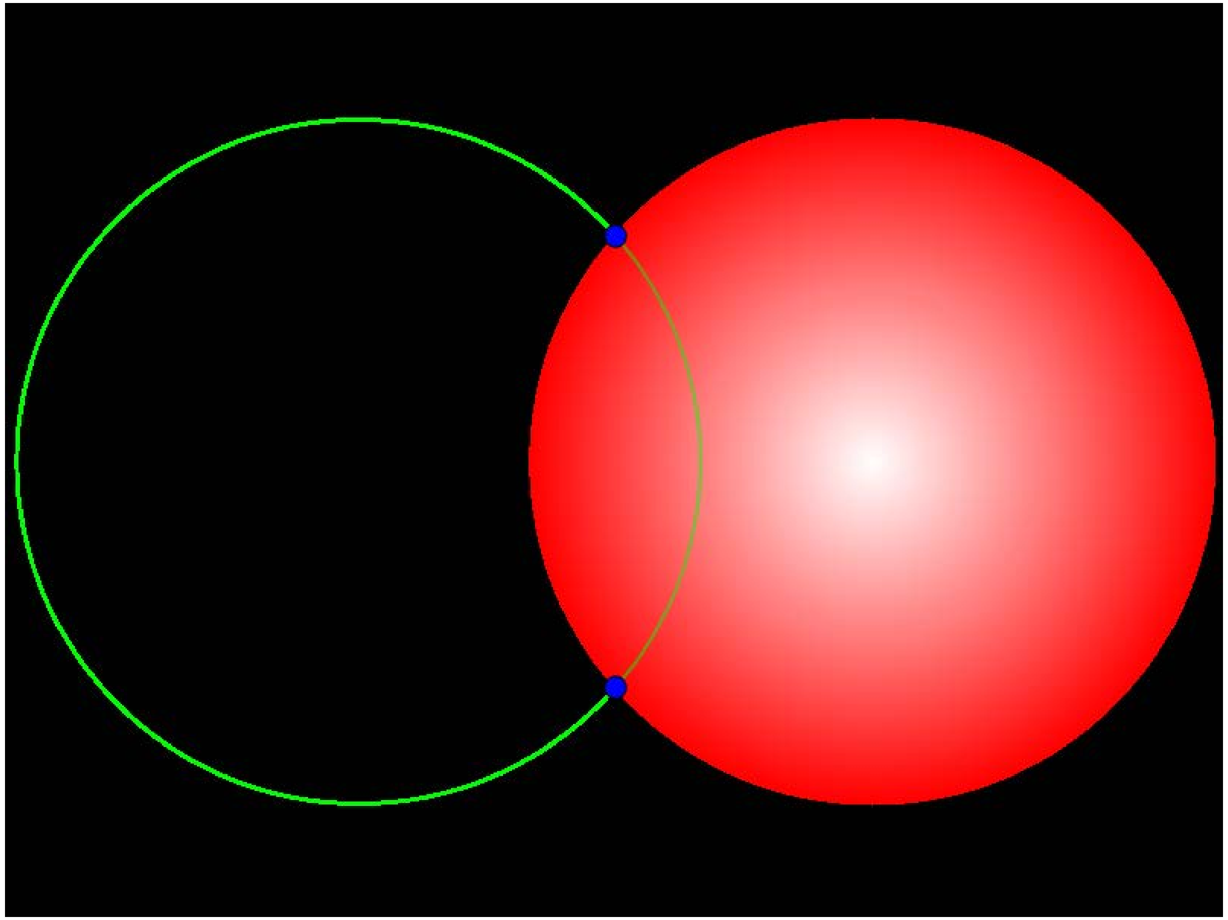
- Distance = speed x time taken

  = c x (t2 – t1)

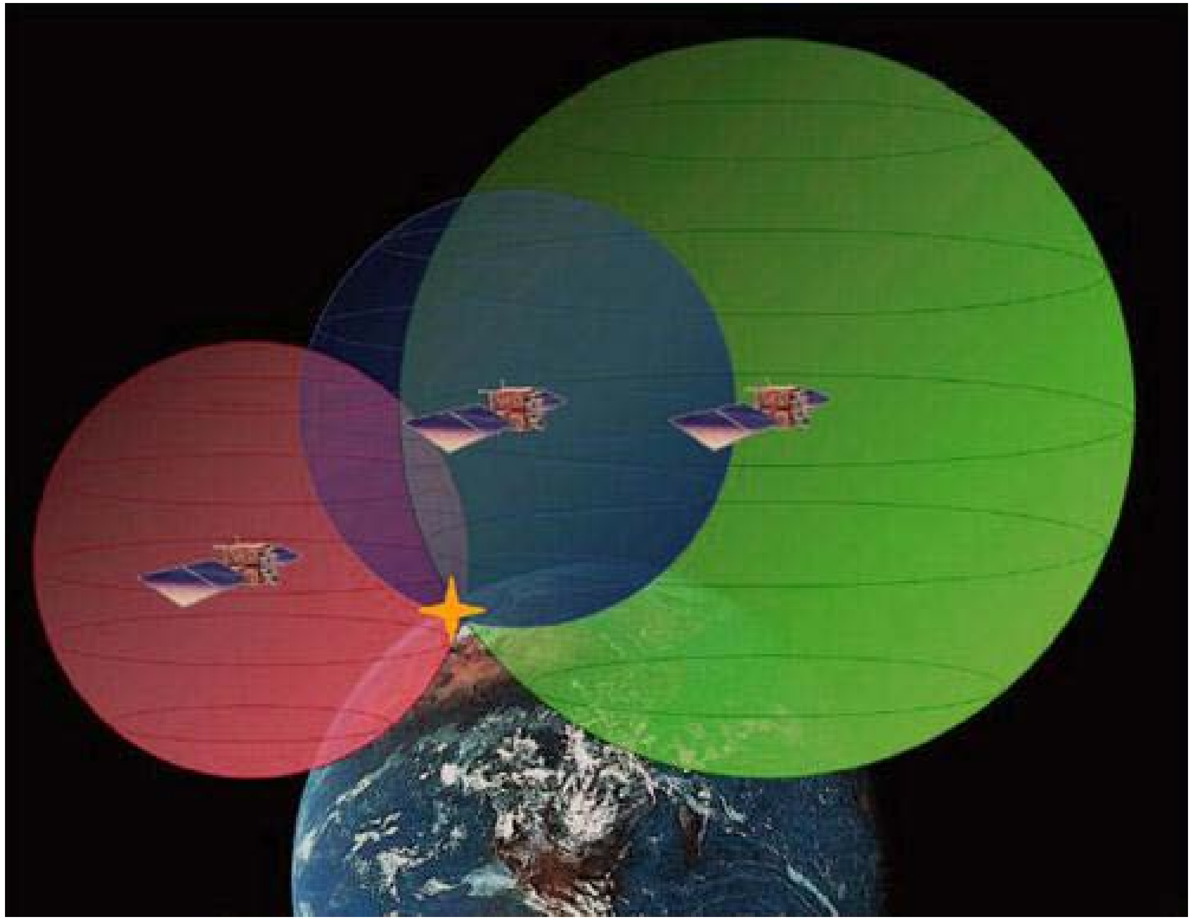
Triangulaltion



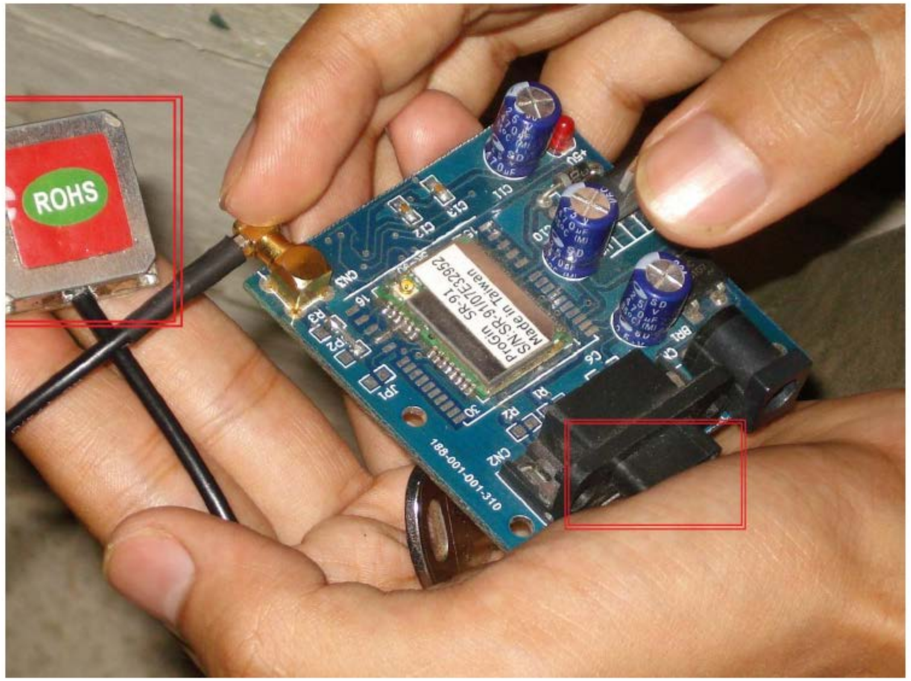
Circle and a sphere

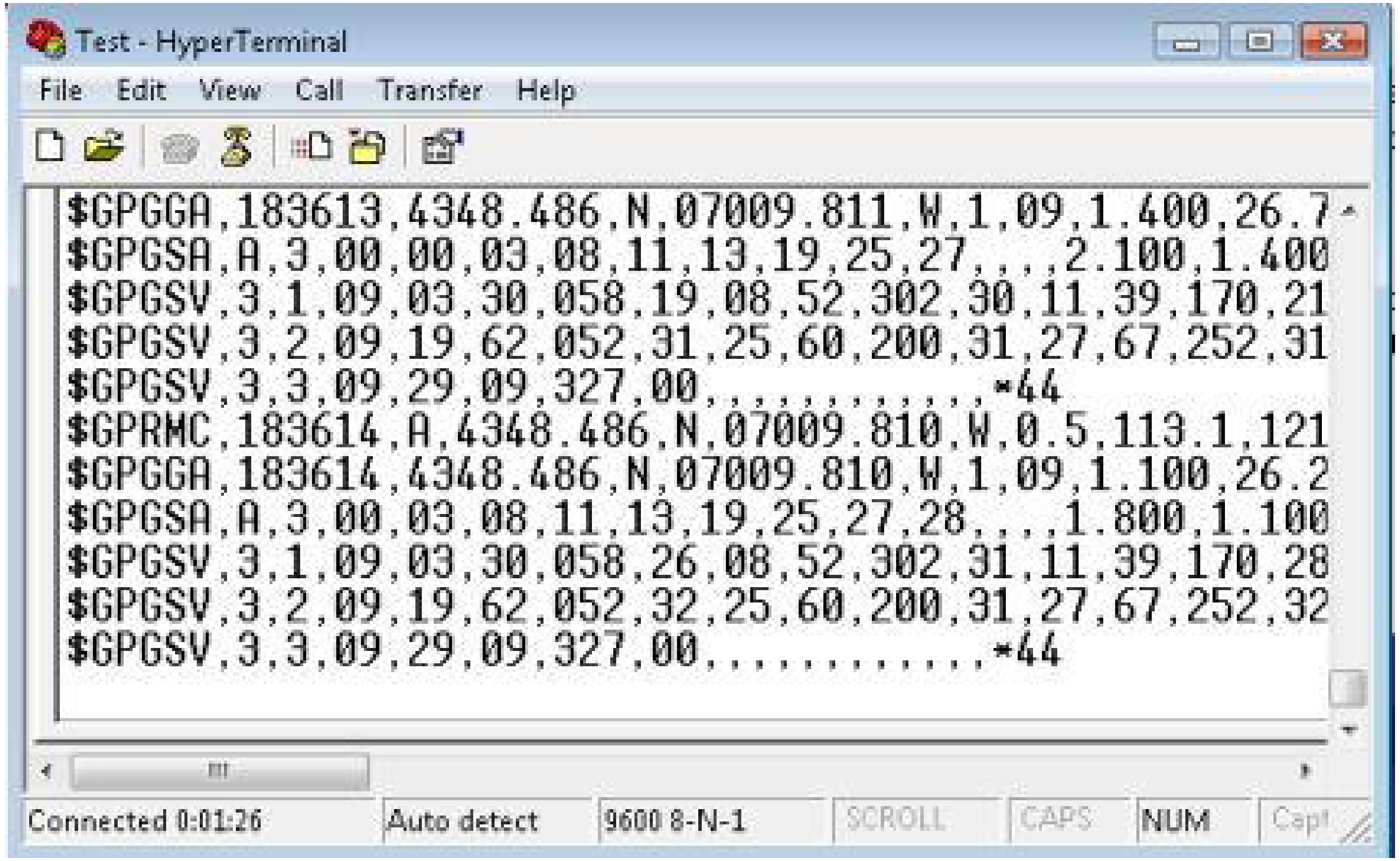


Target locked



GPS Module


ROHS
ProGin SR-91
S/N:SR-91/07E32952
Made in Taiwan
CN3
CN2
188-001-001-310



```
$GPGGA,183613,4348.486,N,07009.811,W,1,09,1.400,26.7
$GPGSA,A,3,00,00,03,08,11,13,19,25,27,,,,2.100,1.400
$GPGSV,3,1,09,03,30,058,19,08,52,302,30,11,39,170,21
$GPGSV,3,2,09,19,62,052,31,25,60,200,31,27,67,252,31
$GPGSV,3,3,09,29,09,327,00,,,,,,,,,,,,*44
$GPRMC,183614,A,4348.486,N,07009.810,W,0.5,113.1,121
$GPGGA,183614,4348.486,N,07009.810,W,1,09,1.100,26.2
$GPGSA,A,3,00,03,08,11,13,19,25,27,28,,,,1.800,1.100
$GPGSV,3,1,09,03,30,058,26,08,52,302,31,11,39,170,28
$GPGSV,3,2,09,19,62,052,32,25,60,200,31,27,67,252,32
$GPGSV,3,3,09,29,09,327,00,,,,,,,,,,,,*44
```

NMEA Format

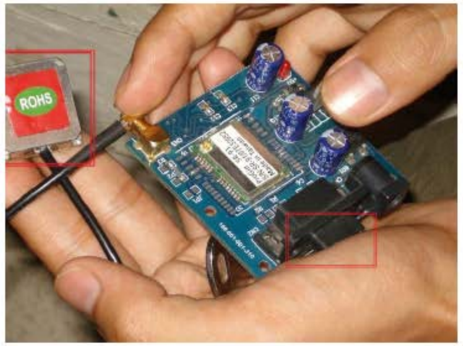
- $GPGGA,123519,4807.038,N,01131.000,E,1,08,0.9,545.4,M,46.9,M,,*47

✓2nd data is Latitude (i.e. 4807.038)

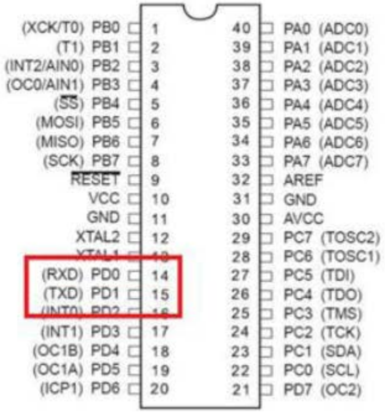
✓4th data is Longitude (i.e. 01131.000)

✓7th data is No. of satellites in view(i.e. 08)

GPS: MCU Interface



Rx	?	Tx
Tx	?	Rx
GND	?	GND



Device 1

Device 2

GSM

GSM Module

1. Modem

2. SIM card

AT Commands Basics

- AT+X? //Queries value of X
- AT+X= //Sets value of X
- ATD 9559753551; //Calls number

  OK

- Entire AT command set can be accessed from:

http://www.developer.nokia.com/Community/Wiki/AT_Commands

SMS: Using AT Commands

-
  ```
  AT+CMGF=1 //Text Mode
  OK
  ```

-
  ```
  AT+CMGS=“7607458472"
  > Hello World<
  +CMGS: 44
  OK
  ```