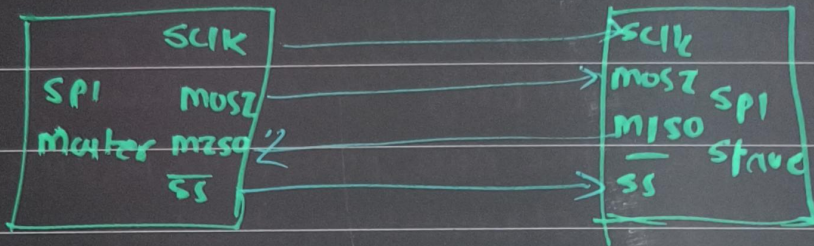# SPI (Serial Peripheral Interface)

MOSI = SDI serial data in
MISO = SDO serial data out

master always initiates transaction.
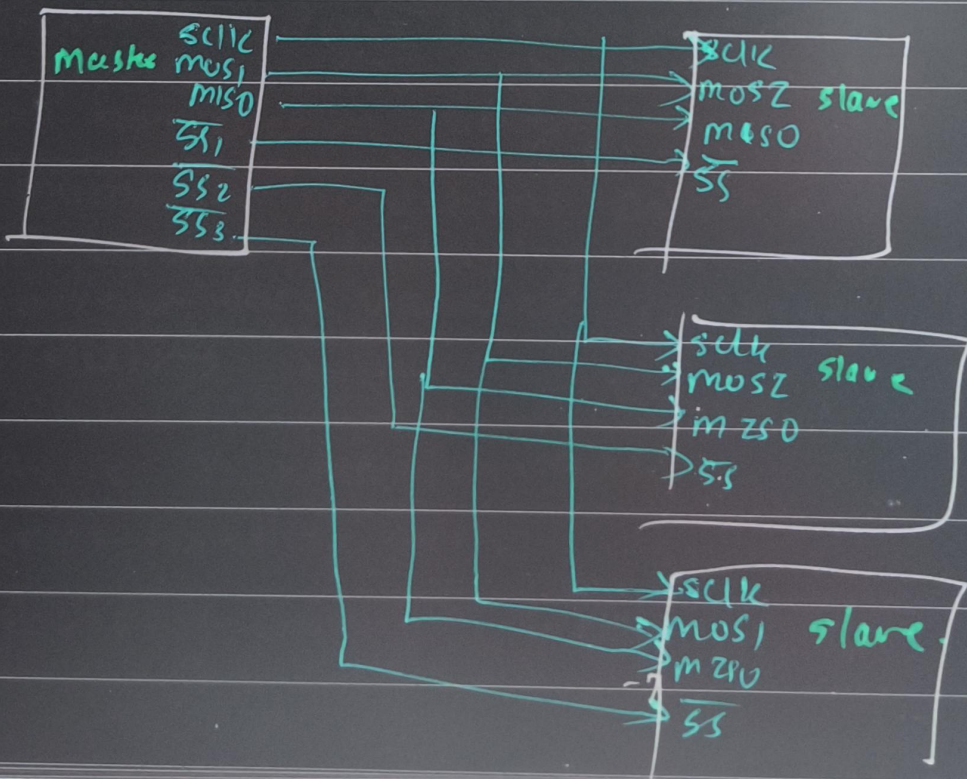

SCLK → serial clock

MOSI → master out slave in

MISO → master in slave out

SS → slave select (chip select, active low)

Advantages/Disadvantages.

→ Full duplex	more pins than UART+I²C
→ Higher speed than UART + I²C	short distance vs. RS485/RS232
→ ubiquitous	Lots of variants

CPOL → clock polarity
CPHA → clock phase.

CPOL = 0

CPOL = 1

SS

CPHA = 1

cycle	1	2	3	4	5
MISO	2	1	2	3	4
MOSI	2	1	2	3	4

CPHA = 0

cycle	1	2	3	4
MISO	.1	2	3	4	5
MOSI	1	2	3	4	5
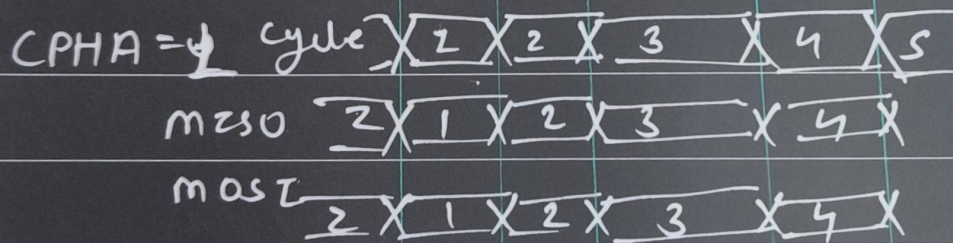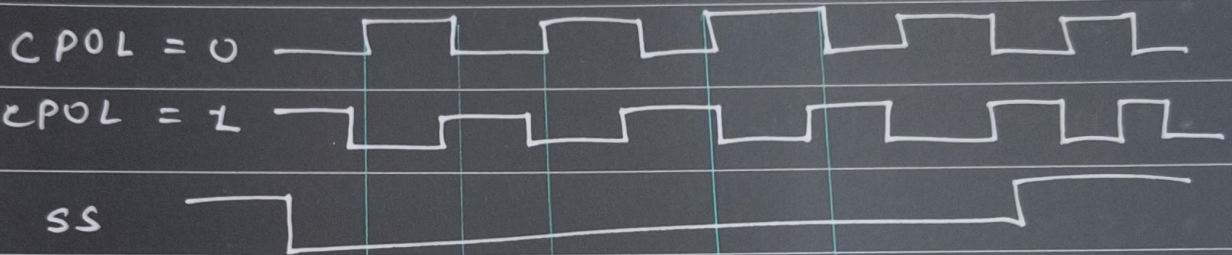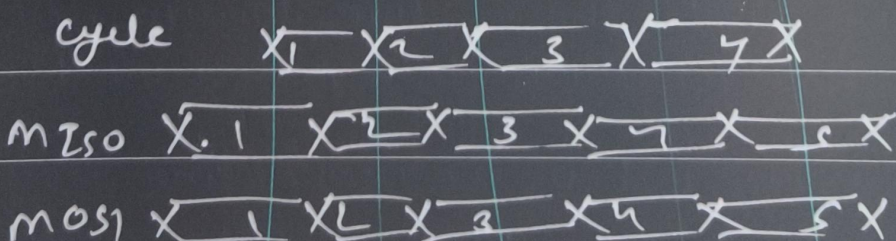
key features of SPI :-

1] Full-Duplex communication
SPI supports simultaneous data transmission and reception.

2] Master slave architecture :-
~~SPI supp~~ There is typically one master device and one or more slave

3] Four-wire interface
- MOSI (master out slave in)
  Carries data from the master to the slave

- MISO (Master in slave out)
  carries data from the slave to the master

- SCLK (serial clk)
  Generated by the master to synchronize data transfer

- SS (slave select)
  Used by master to select which slave device to communicate with.
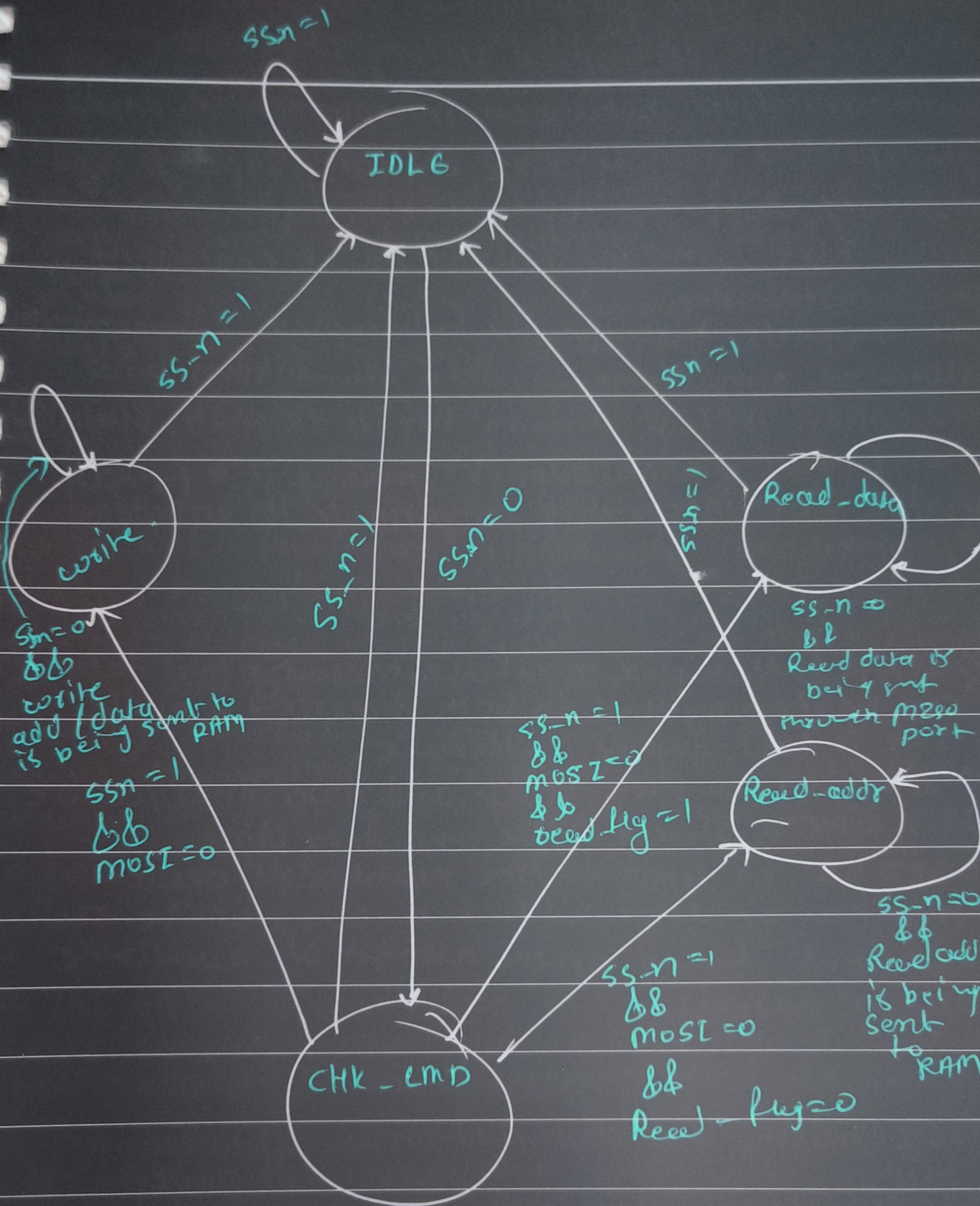
How SPI works :

1] Initialization
master configures the clock polarity (CPOL) and clock phase (CPHA) settings. It also determines the clock frequency.

2] Data Transfer.
- The master pulls the SS line low to select slave.
- The master generates clock pulse on the sclk line.
- Data is shifted out of the MOSI line from master and into the slave, while data from the slave is shifted out of the MISO line and into master.

Slave state Transition Diagram FSM

IDLE (with self-loop: $ssn = 1$)

write (self-loop)
$ssn = 0$
&&
write
add /data sent to RAM
is being

$ssn = 1$
&&
$MOSI = 0$

$ss\_n = 1$ (IDLE → write)
$ss\_n = 1$ (IDLE)
$SSn = 0$
$ssn = 1$ (Read_data)

Read_data (self-loop)
$ss\_n = 0$
&&
Read data is being sent through Miso port

$ss\_n = 1$
&&
$MOSI = 0$
&&
Read flg = 1

Read_addr (self-loop)
$ss\_n = 0$
&&
Read add is being sent to RAM

$ss\_n = 1$
&&
$MOSI = 0$
&&
Read flg = 0

CHK _ CMD

Daisy chain in SPI