Serial Peripheral Interface (SPI)

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SPI

- Synchronous Serial Communications
  - Been around since 1980's
  - Created by Motorola
  - Used for Secure Digital Cards (SD Cards)
  - LCD Displays
- Short Distance (Embedded Systems)
- Full Duplex
  - Allows Communications in Both Directions (Send and Receive)

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SPI Continued

- Uses a master-slave architecture with a single master.
- Master device originates the frame for reading and writing.
- Multiple slave-devices are supported through selection with individual slave select (SS) a.k.a. Chip Select (CS), lines.

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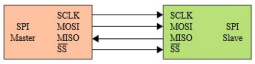
Typical Single Master / Single Slave Configuration



- SCLK: Serial Clock (output from master)
- MOSI: Master Output Slave Input, or Master Out Slave In (data output from master)
- MISO: Master Input Slave Output, or Master In Slave Out (data output from slave)
- SS: Slave Select (often active low, output from master, can be held low if a single slave is used)

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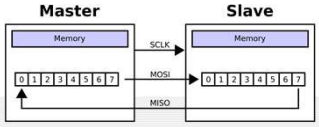
Data Transmission

- Master configures and generates the clock
  - Must ensure the slave can handle the speed selected (usually up to a few MHz)
- Sets SS Low
- During each SPI Clock Cycle, full-duplex data transmission occurs



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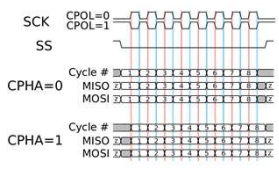
Flexibility

- Can be configured for:
  - Rising Edge Clock or Falling Edge Clock (CPOL)
  - CPHA determines the timing (i.e. phase) of the data bits relative to the clock pulses
- It should be noted that different companies call the modes and lines by different names (as you will see in future slides)



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Mode Numbers

- The combinations of polarity and phases are often referred to as modes which are commonly numbered according to the following convention, with CPOL as the high order bit and CPHA as the low order bit.

For Pic /ARM based Microcontrollers
(NCPHA is the inversion of CPHA)

SPI mode	Clock polarity (CPOL/CKP)	Clock phase (CPHA)	Clock edge (CKE/NCPHA)
0	0	0	1
1	0	1	0
2	1	0	1
3	1	1	0

Other Microcontrollers

Mode	CPOL	CPHA
0	0	0
1	0	1
2	1	0
3	1	1

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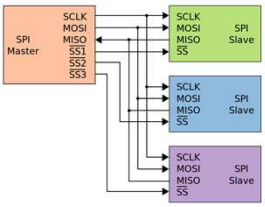
Independent Slave Configuration

- Use when you need to connect more than one SPI device to a Master



- Note you need an additional SS pin for each device to be independently selected (MOSI and MISO pins are tri stated when device is not selected)

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Same Info – Different uCont Family

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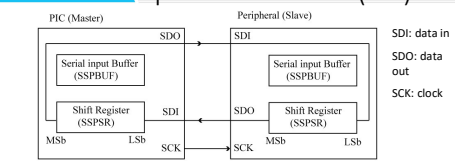
Serial Peripheral Interface (SPI)

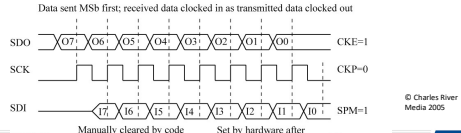


SDI: data in

SDO: data out

SCK: clock

Data sent MSb first; received data clocked in as transmitted data clocked out



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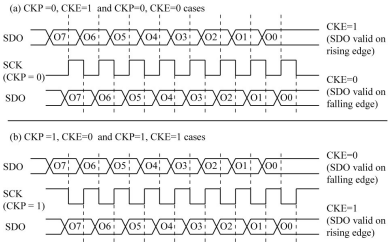
CKE configuration bit allows either falling or rising edge of clock to be used, while CKP selects clock polarity.



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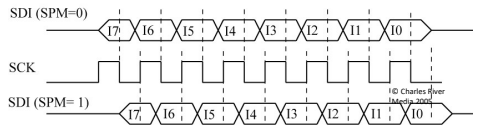
SPM bit selects whether data is sampled in middle of clock period or at end of clock period.

SPM = 0, sample SDI in SCK middle; SPM = 1, sample SDI at SCK end



Between the CKP, CKE, SPM bits there is a lot of flexibility in how data is clocked in. Can make the SPI protocol work with just about any serial device.

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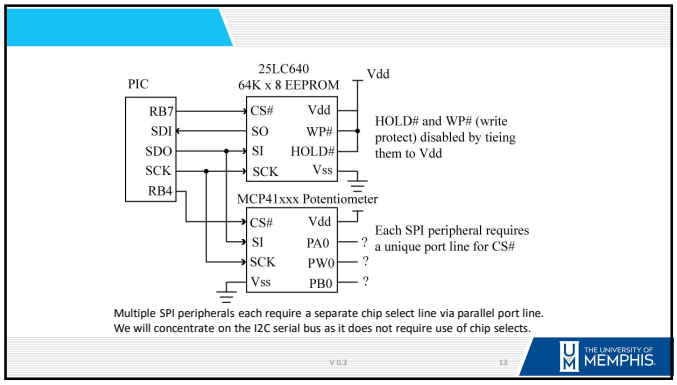

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SPI

Advantages

- Very Flexible
  - Pick your clock
  - Pick your Edge
  - Pick your data timing
  - Pick your own frame size (within limits)
- Been around for years
  - Lots of devices have the ability to communicate via SPI

Disadvantages

- Hard to configure (sometimes it is difficult to determine mode from data sheets)
- Need a separate pin as SS for each slave device (using up IO pins)

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Example 25LC640

- http://users.ece.utexas.edu/~valvano/Datasheets/25LC640.pdf

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New Terminology

- The terms “Master” and “Slave” have been used for decades in communication systems but, for obvious reasons, these terms are being replaced, albeit very slowly.
- Professional organizations, like IEEE discussing updating standards to change these names. One effort is IEEE P1588g
- Some suggested terms are: Controller / Responder, Primary / Secondary, Leader / Follower
- A good article on this can be found at https://www.allaboutcircuits.com/news/how-master-slave-terminology-reexamined-in-electrical-engineering/

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References

- https://en.wikipedia.org/wiki/Serial_Peripheral_Interface
- https://rophoenixmakerevolution.files.wordpress.com/2015/09/i2c1.ppt
- https://www.allaboutcircuits.com/news/how-master-slave-terminology-reexamined-in-electrical-engineering/

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