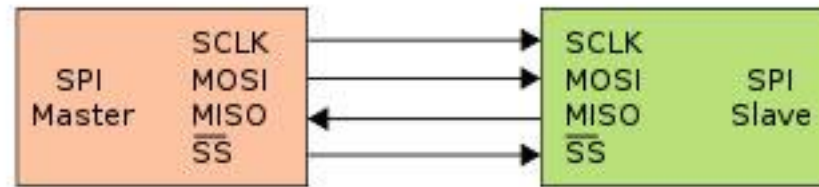


Serial Peripheral Interface

- What is it?
- Basic SPI
- Capabilities
- Protocol
- Pros and Cons
- Uses

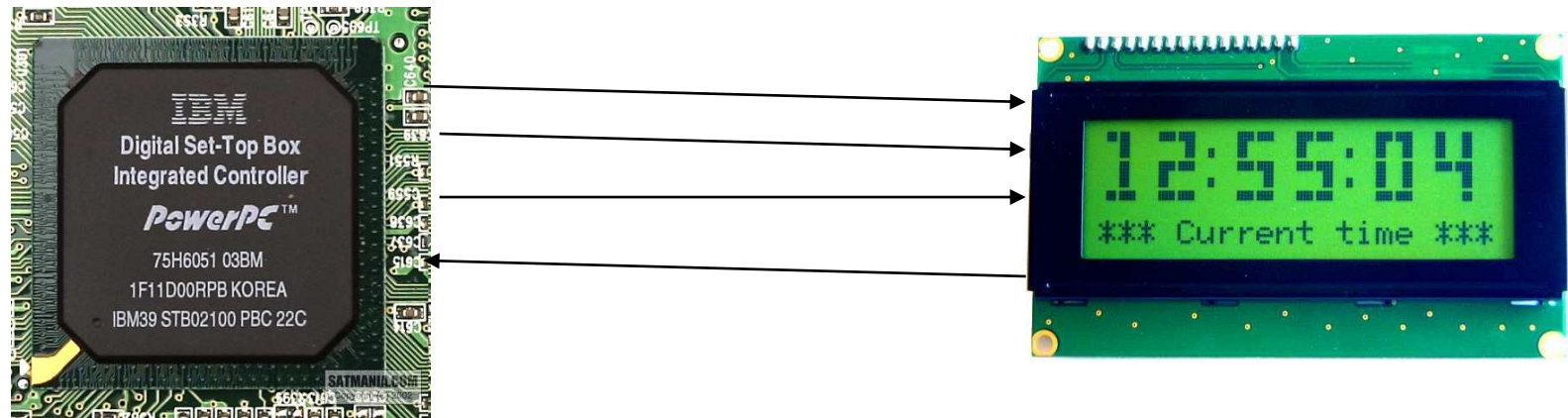


Serial Peripheral Interface

http://upload.wikimedia.org/wikipedia/commons/thumb/e/ed/SPI_single_slave.svg/350px-SPI_single_slave.svg.png

What is SPI?

- Serial bus protocol
- Fast, easy to use, and simple
- Very widely used
- Not “standardized”



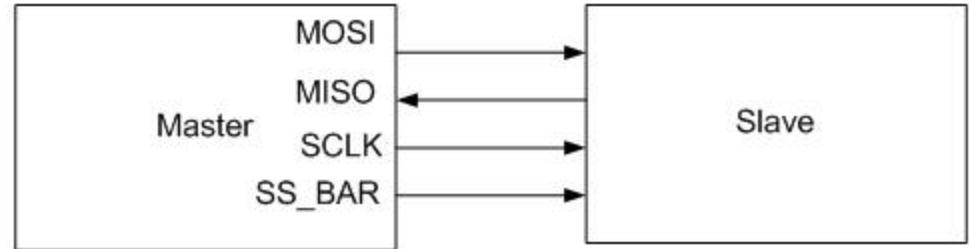
SPI Basics

- A 4-wire communications bus
- Typically communicate across short distances
- Supports
 - Single master
 - Multiple slaves
- Synchronized
 - Communications are “clocked”

SPI Capabilities

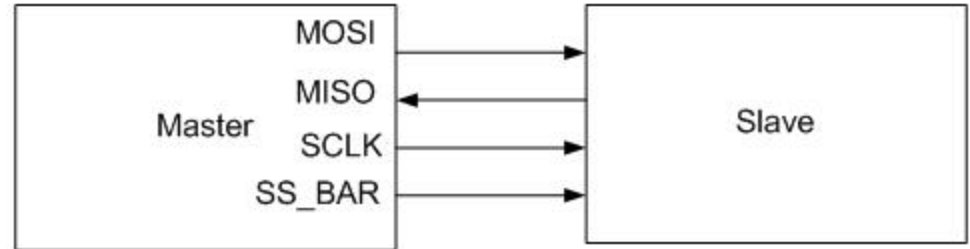
- Always full-duplex
 - Communicates in both directions simultaneously
 - Transmitted (or received) data may not be meaningful
- Multiple Mbps transmission speeds
 - 0-50 MHz clock speeds not uncommon
- Transfer data in 4 to 16 bit characters
- Supports multiple slaves

SPI bus wiring



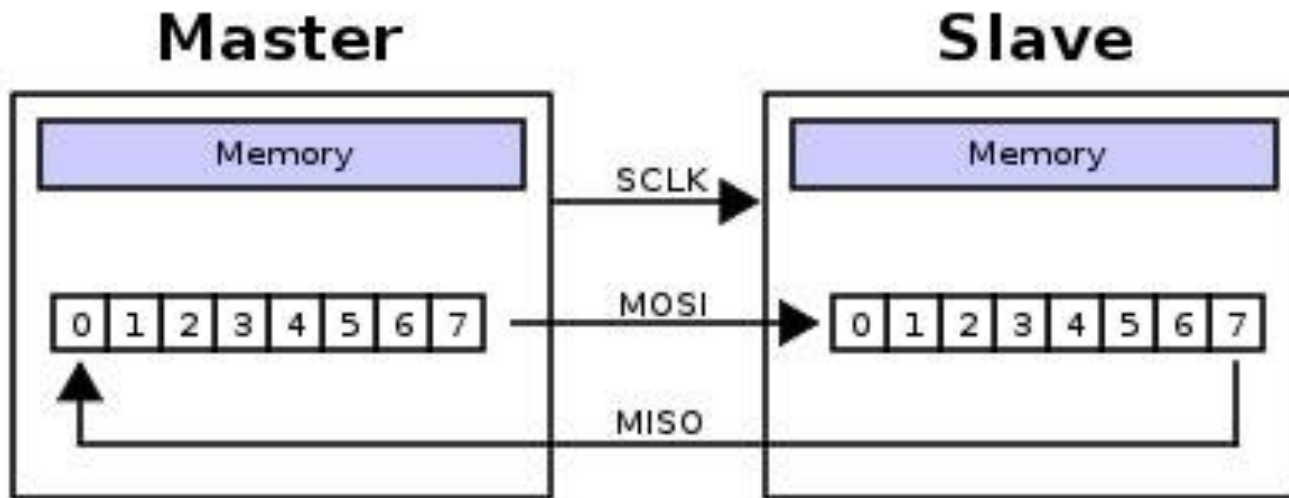
- Bus wires
 - Master-Out, Slave-In (MOSI)
 - Master-In, Slave-Out (MISO)
 - System Clock (SCLK)
 - Slave Select/Chip Select (SS1#, ..., SS#n or CS1, ..., CSn)
- Master asserts slave/chip select line
- Master generates clock signal
- Shift registers shift data in and out

SPI signal functions



- MOSI - carries data out of master to slave
- MISO - carries data out of slave to master
 - Both MOSI and MISO are active during every transmission
- SS# (or CS) - unique line to select each slave chip
- SCLK - produced by master to synchronize transfers

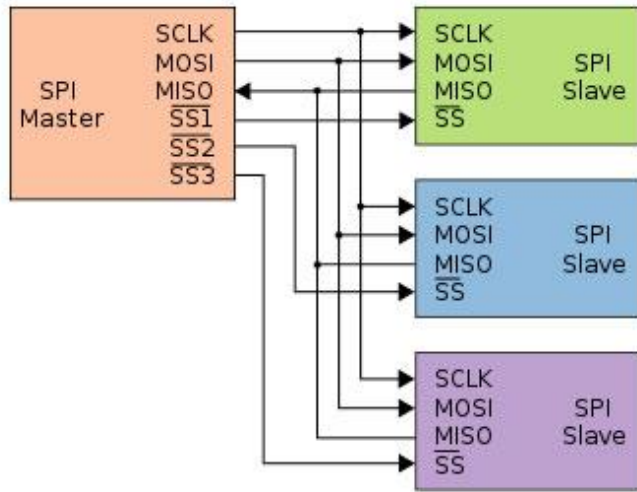
SPI uses a “shift register” model of communications



Master shifts out data to Slave, and shifts in data from Slave

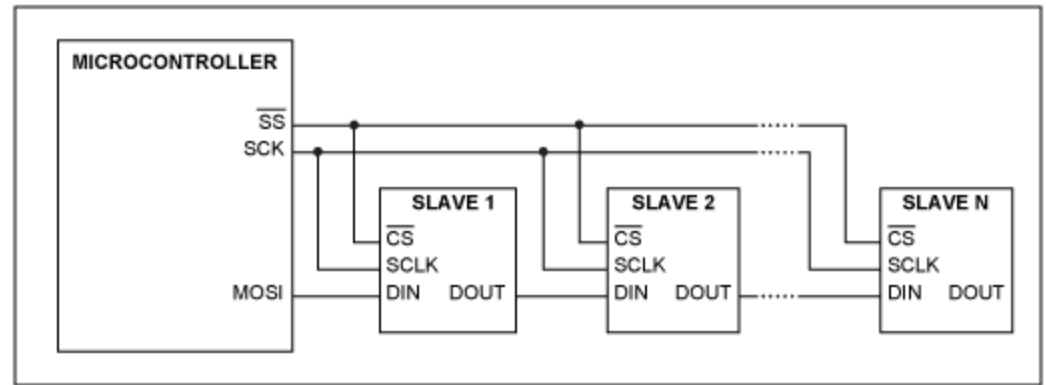
http://upload.wikimedia.org/wikipedia/commons/thumb/b/bb/SPI_8-bit_circular_transfer.svg/400px-SPI_8-bit_circular_transfer.svg.png

Two bus configuration models



Master and multiple independent slaves

http://upload.wikimedia.org/wikipedia/commons/thumb/f/fc/SPI_three_slaves.svg/350px-SPI_three_slaves.svg.png



Some wires have been renamed

Master and multiple daisy-chained slaves

http://www.maxim-ic.com/appnotes.cfm/an_pk/3947

SPI tradeoffs: the pros and cons

- Pros

- Fast for point-to-point connections
- Easily allows streaming/constant data inflow
- No addressing in protocol, so it's simple to implement
- Broadly supported

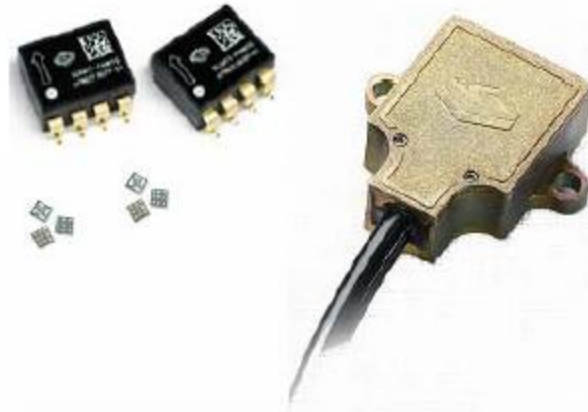
- Cons

- Slave select/chip select makes multiple slaves more complex
- No acknowledgement (can't tell if clocking in garbage)
- No inherent arbitration
- No flow control (must know slave speed)

SPI is used everywhere!

- Peripherals

- LCDs
- Sensors
- Radios
- Lots of other chips



- Microcontrollers

- Almost all MCUs have SPI masters
- Some have SPI slaves

SPI summary

- SPI – a 4-wire serial bus (but not official “standard”)
 - MOSI, MISO, SS/CS, and SCLK signals
- Full-duplex operation
- One master
- Multiple slaves
- Best for point-to-point data transfers
- Easily supported
- Broadly used