



مرکز آموزش نیرا سیستم

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SPI (Serial Peripheral Interface)

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Introduction

- The Serial Peripheral Interface (SPI) is a synchronous serial communication protocol commonly used in embedded systems for communication between microcontrollers and peripheral devices.
- It is a full-duplex, master-slave communication protocol that utilizes multiple wires for data transfer, including a clock signal (SCK), a master-out-slave-in (MOSI) line, a master-in-slave-out (MISO) line, and a chip select (CS) line.
- The SPI interface is widely adopted due to its simplicity, high data transfer rates, and support for multiple devices on the same bus.



Applications

- **Flash Memory and SD Cards**

- SPI is often used to interface with external memory devices, such as Flash memory and SD cards, for data storage and retrieval.

- **Display Modules**

- Some graphical LCDs and display modules use SPI for efficient communication with microcontrollers.

- **Wireless Modules**

- SPI is employed in communication with wireless modules, such as Wi-Fi and Bluetooth modules, to enable wireless connectivity in embedded systems.

- **Sensor Interfacing**

- Many sensors, including accelerometers, gyroscopes, and pressure sensors, use SPI for data transfer to microcontrollers.

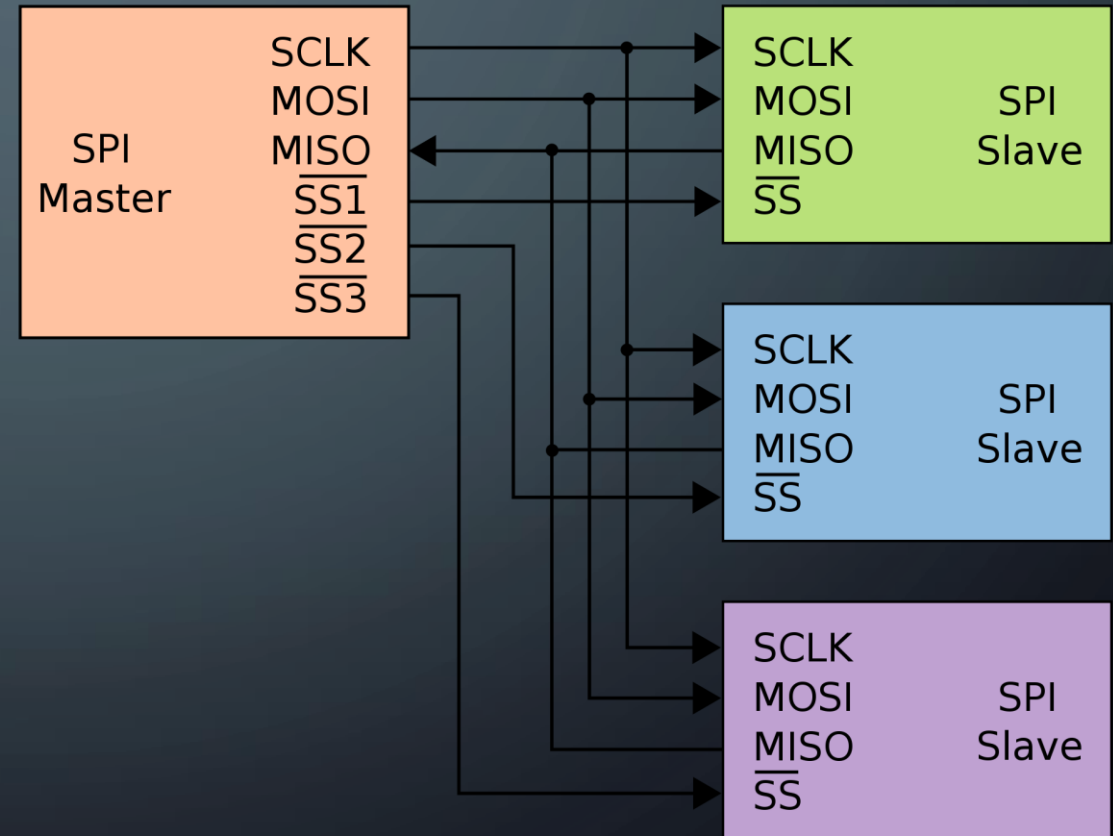
- **Digital-to-Analog Converters (DACs) and Analog-to-Digital Converters (ADCs)**

- SPI is often utilized for interfacing with DACs and ADCs to convert analog and digital signals.



Properties

- Connection Type: Serial
- Communication Type: Full-Duplex
- Data Type: Byte
- Synchronize: Sync
- Channel Type: Copper Wire
- Voltage State: TTL
- Bit Order: MSB First
- Hardware Addressing



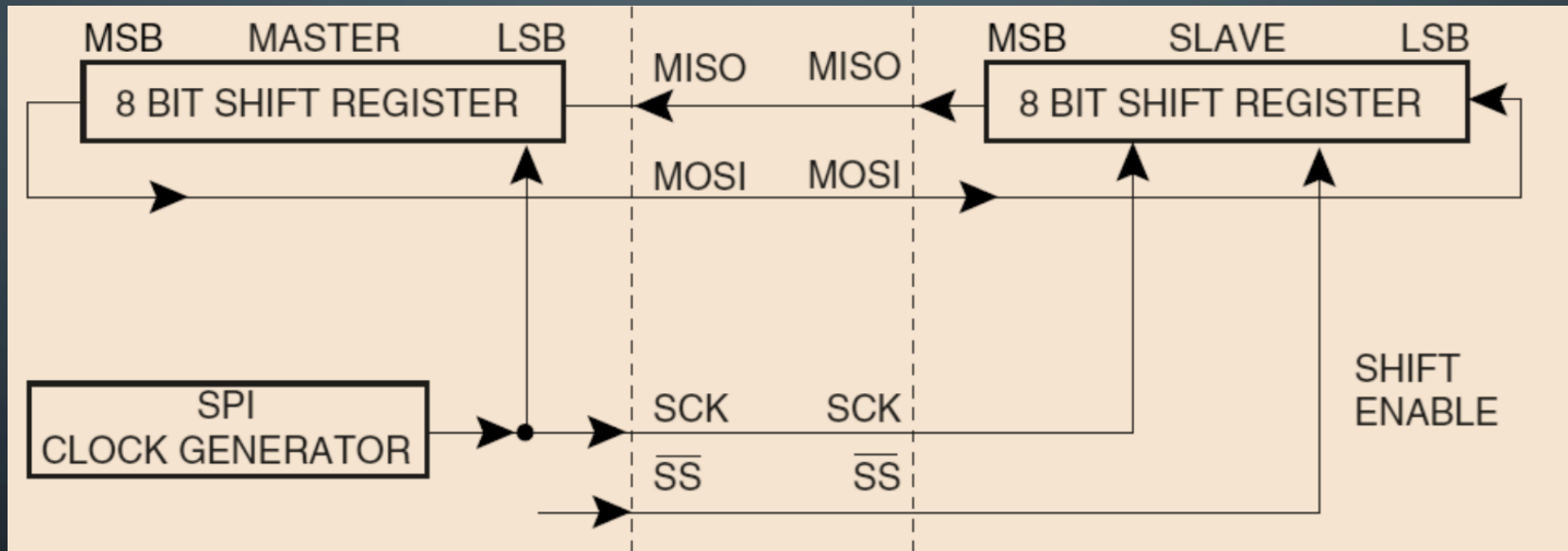


Registers

- **SPI_CR1 (Control Register 1)**
 - Configures the SPI mode, clock polarity, phase, and other parameters.
- **SPI_CR2 (Control Register 2)**
 - Configures the data frame format, frame size, and other parameters.
- **SPI_DR (Data Register)**
 - Contains the data to be transmitted or received.
- **SPI_SR (Status Register)**
 - Indicates the status of the SPI communication, including flags for transmission and reception.
- **SPI_CPSR (Clock Prescaler Register)**
 - Sets the clock speed of the SPI communication.



Data Flow



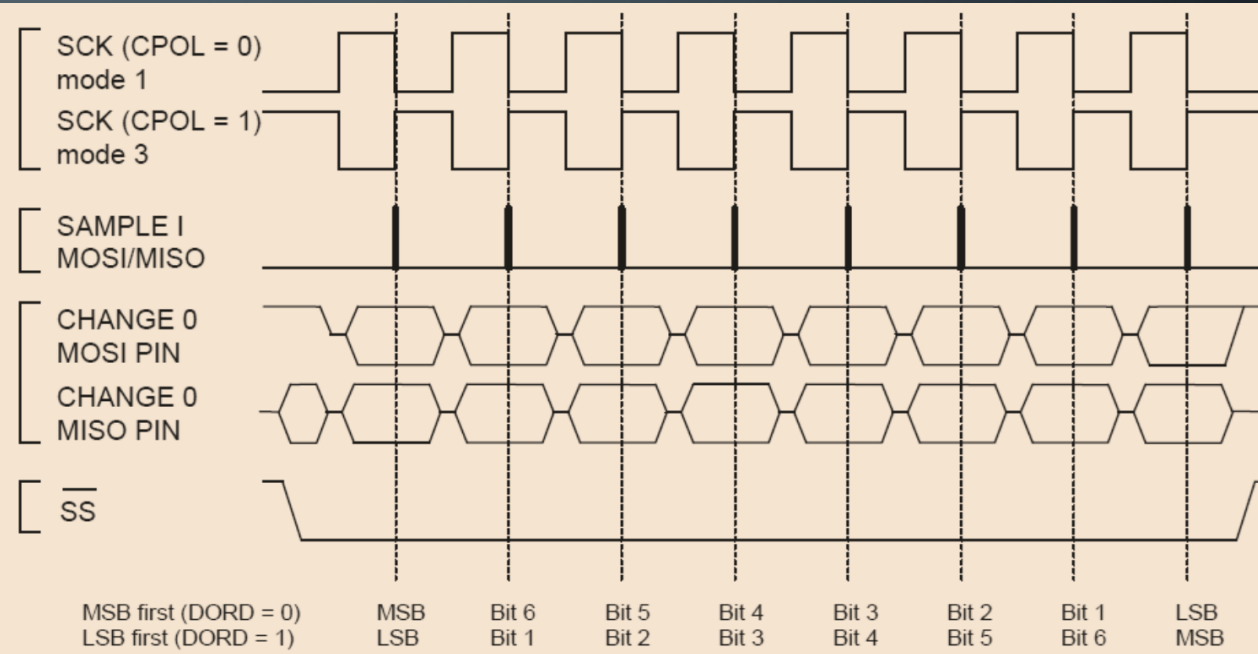


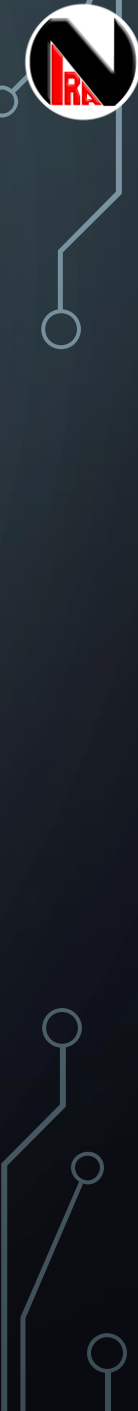
Modes

-	Leading Edge	Trailing Edge	Mode
CPOL = 0, CPHA = 0	Sample (Rising)	Setup (Falling)	0
CPOL = 0, CPHA = 1	Setup (Rising)	Sample (Falling)	1
CPOL = 1, CPHA = 0	Sample (Falling)	Setup (Rising)	2
CPOL = 1, CPHA = 1	Setup (Falling)	Sample (Rising)	3



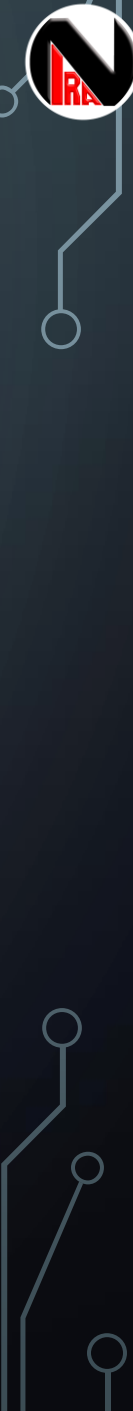
CPHA = 0





Read/Write

Write Only	MOSI	Data	Data	Data	Data	Data
	MISO	X	X	X	X	X
Read Only	MOSI	X	X	X	X	X
	MISO	Data	Data	Data	Data	Data
Write/Read	MOSI	Cmd	Cmd	X	X	X
	MISO	X	X	Data	Data	Data



Process States

1. Set CS to LOW
2. Transmit/Receive Byte(s)
3. Set CS to HIGH