مرکز آموزش نیـــرا سیستم

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Universal Synchronous & Asynchronous Receiver & Transmitter (USART)

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Introduction

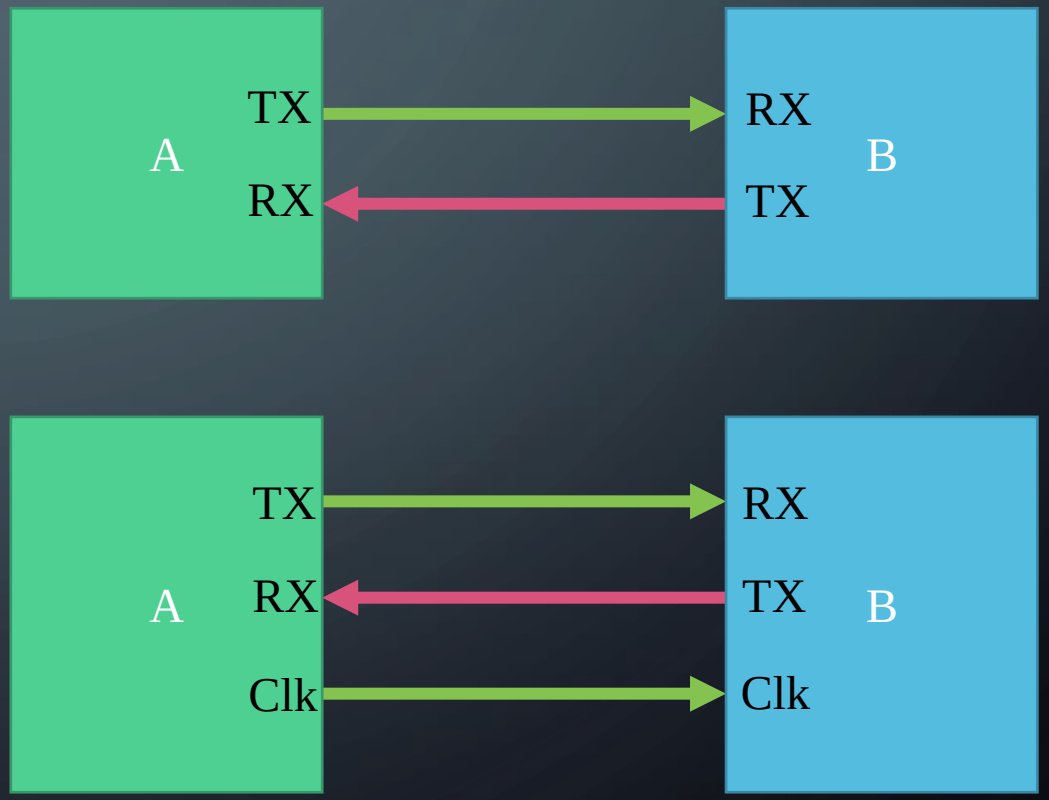
- UART is a serial communication protocol that allows for the asynchronous transmission and reception of data between a microcontroller and other external devices, such as sensors, displays, or other microcontrollers.
- It is commonly used for debugging, data exchange, and interfacing with various peripherals.

Applications

- **Serial Communication**
  - UART is used for point-to-point communication between a microcontroller and other devices, such as GPS modules, Bluetooth modules, or GSM modules. It is also utilized for communication between two microcontrollers in a master-slave configuration.
- **Debugging**
  - UART is an essential tool for debugging embedded systems. Developers can send debug information and error messages from the microcontroller to a computer or terminal, making it easier to diagnose and troubleshoot issues.
- **Data Logging**
  - UART allows microcontrollers to transmit data to external storage devices, such as SD cards or EEPROMs. This is useful for data logging applications where sensor data needs to be saved for later analysis.
- **Human-Machine Interface (HMI)**
  - UART can be used to interface with displays or touchscreens. Microcontrollers can send data to display screens or receive input from user interfaces through UART communication.
- **Wireless Communication**
  - UART is often used to interface with wireless modules like Wi-Fi, Bluetooth, or Zigbee transceivers, enabling wireless communication with other devices or the internet.

Properties

- Connection Type: Serial
- Communication Type: Full-Duplex
- Data Type: Byte
- Synchronize: Async & Sync
- Channel Type: Copper Wire
- Voltage State: TTL
- Bit Order: LSB First



Registers

- USART_CR1 (Control Register 1)
- USART_CR2 (Control Register 2)
- USART_CR3 (Control Register 3)
- USART_SR (Status Register)
- USART_DR (Data Register)
- USART_BRR (Baud Rate Register)

Frame

- Start: 1 Bit, Always 0
- Data: 5~9 Bit, Default 8-bit
- Parity (Optional): Even, Odd
- Stop: 1, 1.5, 2 bit, Always 1

Default: 8N1

Baud Rates (bps)

- 50
- 75
- 110
- 134
- 150
- 200
- 300
- **600**
- **1200**
- **2400**
- **4800**
- **9600**
- 14400
- **19200**
- 28800
- **38400**
- 56000
- **57600**
- 76800
- **115200**
- **230400**
- 460800
- 576000
- **921600**
- 1843200
- 3686400

Error Rate

$$Err = \left(\frac{BaudRate}{BaudRate_{Ideal}} - 1 \right) \times 100$$

Example:

- Baud Rate Ideal: 9600
- Baud Rate: 9615
- Err: 0.15%