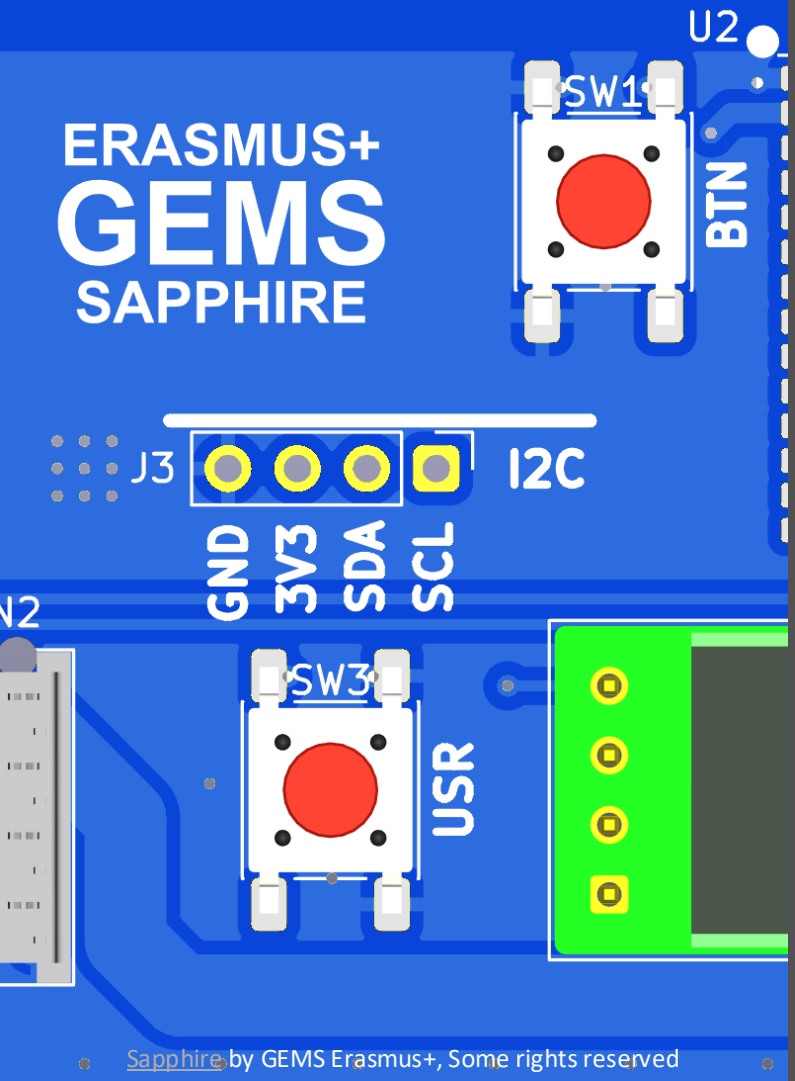


# Fundamentals of Serial Communication

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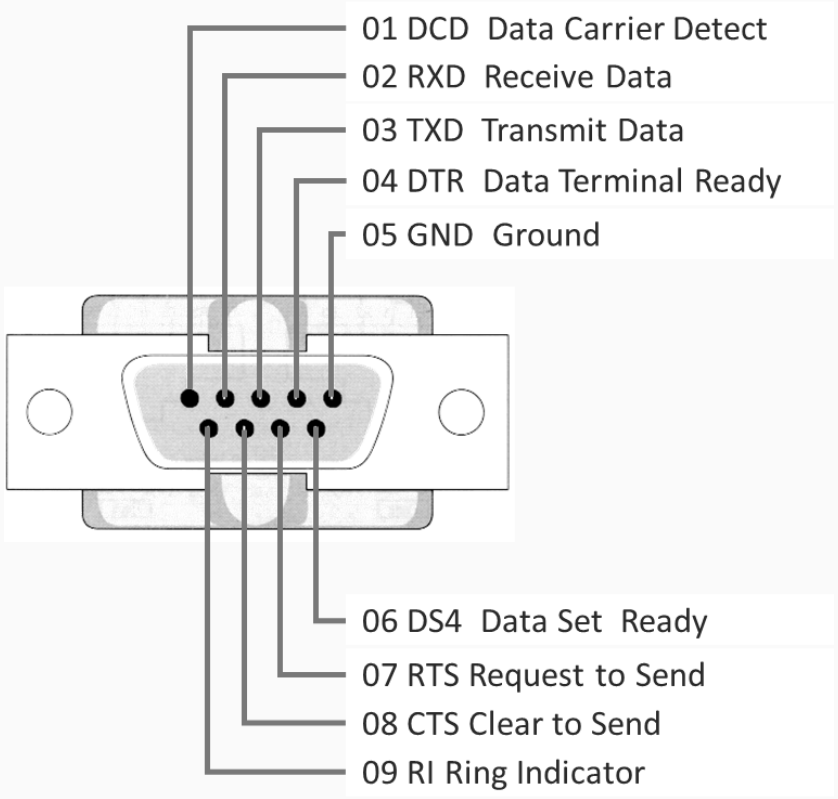
# Learning Objectives

1. Understanding Serial Communication
2. Overview of RS-232, UART/USART, and other serial communication standards
3. Configuration and settings for serial communication

# Serial Communication in Electronics- RS232

- **Extensive Use in Electronics Industry**
  - Relative simplicity
  - Low hardware overhead compared to parallel interfacing
- **Popular Standard: EIA/TIA-232-E**
  - Developed by Electronic Industry Association (EIA) and Telecommunications Industry Association (TIA)
  - Commonly known as "RS232"
- **Purpose and Development**
  - Developed for interfacing Data Terminal Equipment (DTE) and Data Circuit Terminating Equipment (DCE)
- **Application**
  - Designed for serial binary data interchange
  - Primarily for connecting data terminals to modems
- **Historical Context**
  - Issued by the engineering department of the EIA
  - Released in the United States in 1969

# Serial Communication in Electronics- RS232

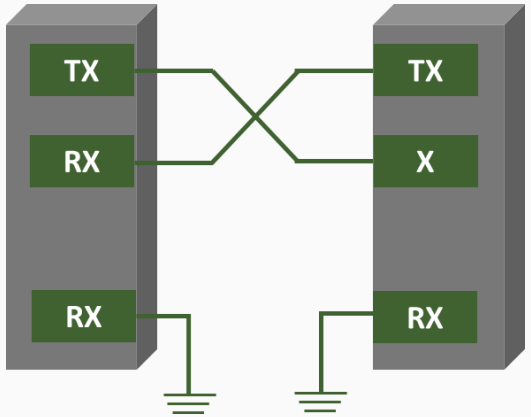


# Advantages of RS-232 in Robotics

- **Ease of Implementation:** RS-232 requires minimal setup, with just a TX (transmit), RX (receive), and ground connection for communication.
- **Universal Standard**: RS-232 is supported by nearly all microcontrollers, PLCs, and PCs, making integration across platforms seamless.
- **Low-Cost Hardware**: RS-232 cables, connectors (e.g., DB9, DB25), and interfacing components are inexpensive and widely available.
- **Supports Long Cables:** RS-232 can transmit data up to 15 meters (50 feet) without significant signal degradation, making it suitable for distributed robotic setups.

# Serial Communication in Electronics
# UART & USART

- **UART (Universal Asynchronous Receiver/Transmitter)**
  - Defines a protocol for serial data exchange
  - Uses two wires for transmission (TX) and reception (RX)
  - Ground connection required at both ends
- **Communication Modes in UART**
  - Simplex Data: sent in one direction only
  - Half-Duplex: Each side can transmit, but only one at a time
  - Full-Duplex:  Both sides can transmit simultaneously
- **Data Transmission in UART**
  - Data transmitted in the form of frames
  - Format and content of frames explained
- **Modern Trends**
  - Decline in popularity with rise of protocols like SPI and I2C
  - Ethernet and USB replacing UART in many applications

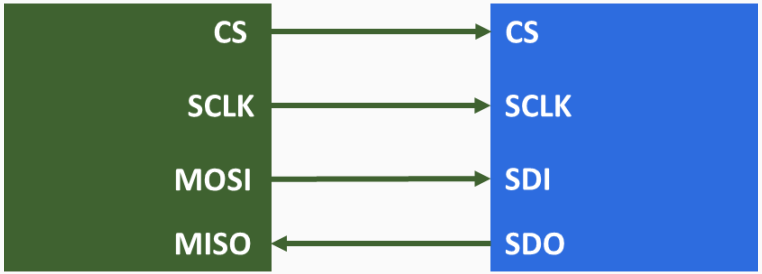


# Advantages of UART in Robotics

- **Simplicity:**
  - Requires only two data lines (TX and RX), making it easy to implement.
  - Supported by virtually all microcontrollers.
- **Flexibility:**
  - UART/USART is versatile, allowing direct communication with a variety of sensors, actuators, and wireless modules.
- **Real-Time Communication:**
  - Facilitates real-time data exchange with peripherals, crucial for robot navigation and decision-making.
- **Low Power Consumption:**
  - UART/USART is ideal for battery-powered systems due to its low power requirements compared to other communication protocols.

# Serial Communication in Electronics
# Serial Peripheral Interface

- **Overview**
  - Synchronous serial communication protocol
  - Used for short-distance communication (embedded systems)
- **Key Features**
  - Full-duplex communication
  - Master-slave architecture
  - Typically uses four wires: MOSI, MISO, SCLK, & SS




**Advantages**

High-speed data transfer
Simple hardware connections
No start and stop bits required

**Disadvantages**

No built-in protocol for device addressing
More wires needed compared to I2C

# Serial Communication in Electronics
# Serial Peripheral Interface

**Advantages**

- High-speed data transfer
- Simple hardware connections
- No start and stop bits required

**Disadvantages**

- No built-in protocol for device addressing
- More wires needed compared to I2C

# Serial Communication in Electronics -I2C

- **Overview**
  - Multi-master, multi-slave, packet-switched, single-ended, serial communication bus
  - Key Features
    - Uses two wires: SDA,SCL
    - Supports multiple devices on the same bus with unique addresses

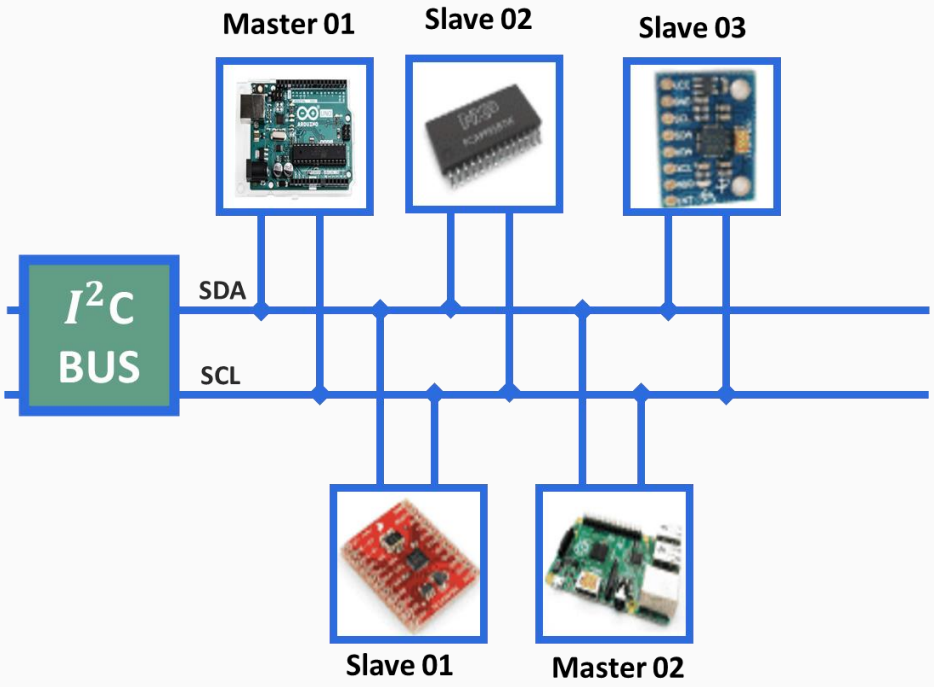
**Advantages**

- Requires only two wires for communication
- Supports multiple masters and slaves
- Built-in addressing scheme

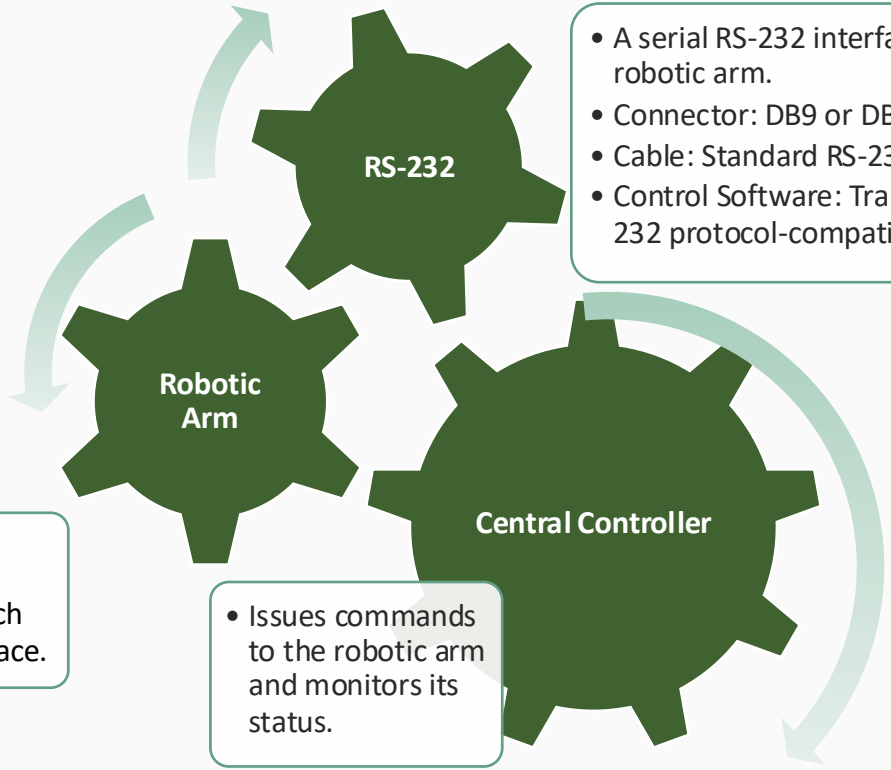
**Disadvantages**

- Slower data transfer rate compared to SPI
- More complex protocol

# Serial Communication in Electronics -I2C



# RS-232 Architecture Example in Robotics: Robotic Arm Control System

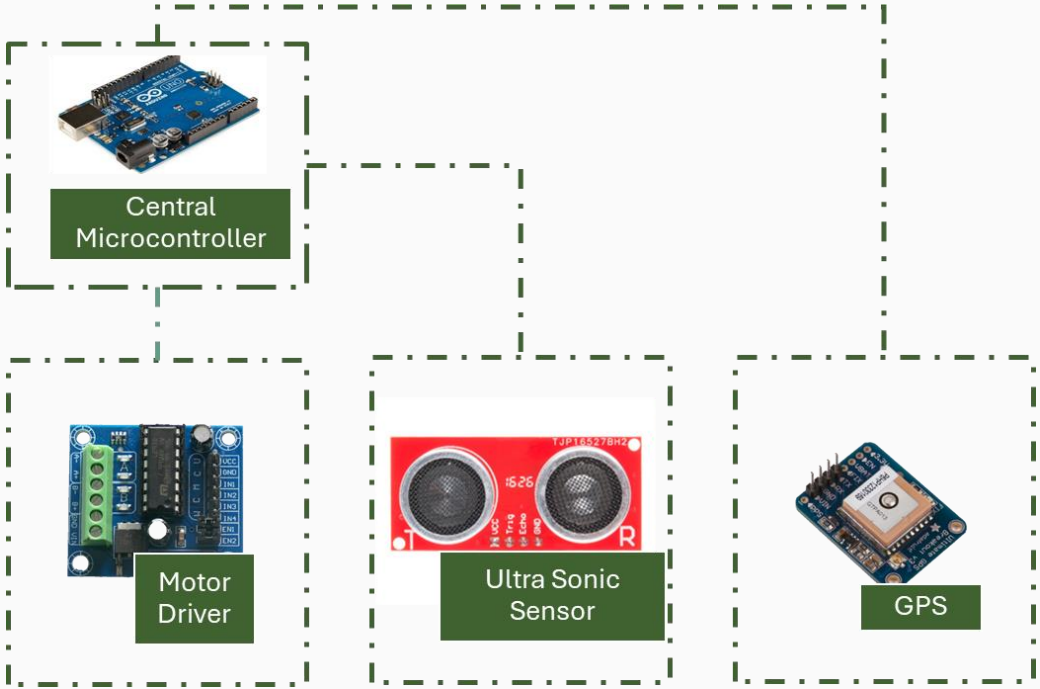



- A serial RS-232 interface links the central controller to the robotic arm.
- Connector: DB9 or DB25 serial port.
- Cable: Standard RS-232 cable for distances up to 15 meters.
- Control Software: Translates high-level commands into RS-232 protocol-compatible instructions

- Executes **movement** commands such as pick-and-place.

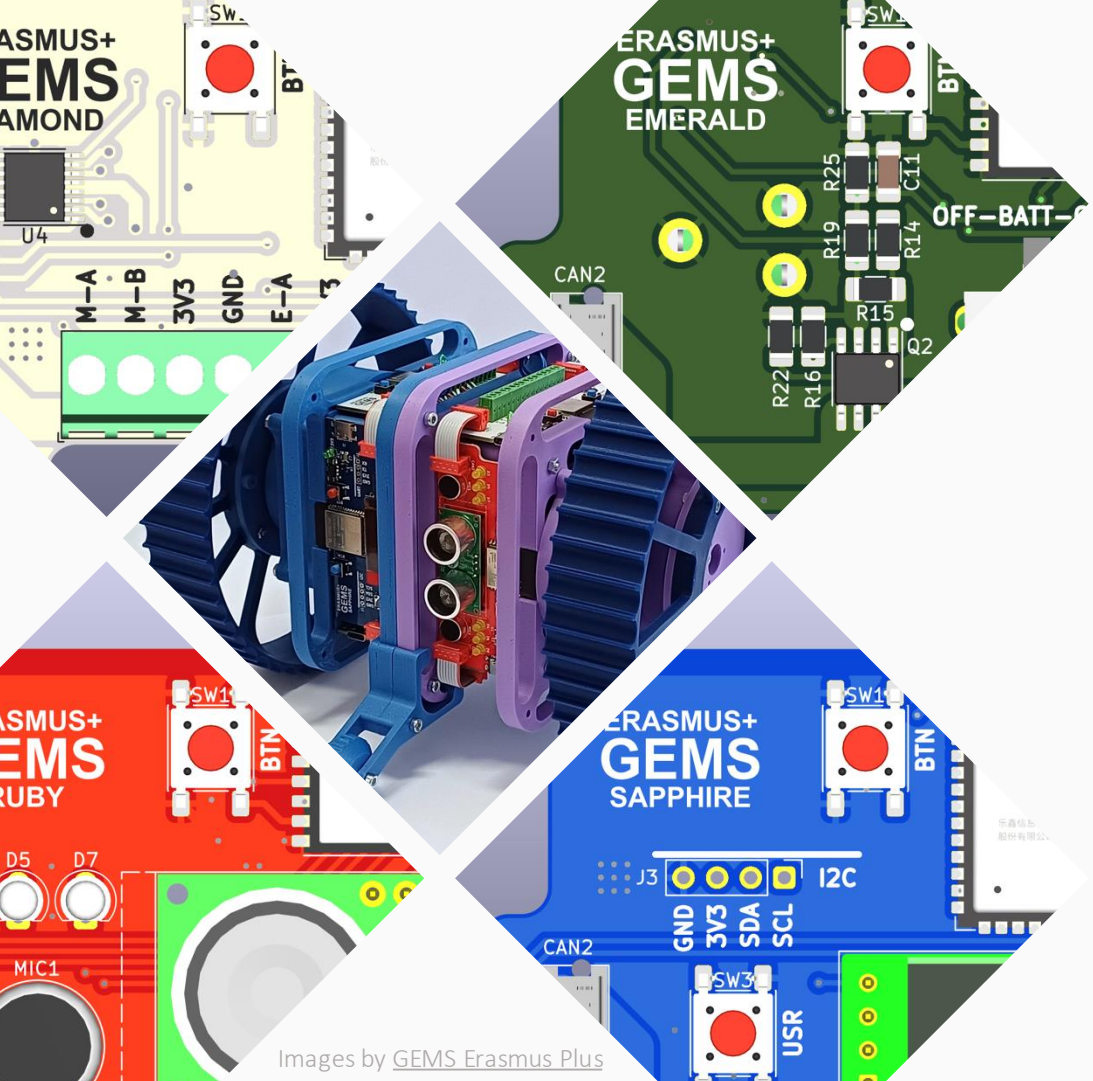
- Issues commands to the robotic arm and monitors its status.

# UART Application in Automated Guided Vehicles



# UART Application in Automated Guided Vehicles

- **System Startup**:
  - The central microcontroller initializes UART configurations for all peripherals.
  - Sends a "READY" signal to all connected devices to check their status.
- **Sensor Data Collection**:
  - The ultrasonic sensor periodically sends distance data to detect obstacles)
  - The IMU sends orientation data
  - The GPS provides location data
- **Decision-Making and Motor Control**:
  - Based on sensor data, the microcontroller calculates the desired speed and direction.
- **Remote Communication (Optional)**:
  - The wireless module transmits telemetry data to a remote-control station
- **Error Handling**:
  - If the ultrasonic sensor detects an obstacle

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