Serial Communication with Arduino

Serial Communication with the Arduino
Serial, UART, TTL, FTDI, USB
Bluetooth
Ethernet
Wi-Fi
Interfacing with One-Wire (Dallas Semiconductor Bus) Devices
Interfacing with I2C (Two-Wire) Devices

Discussion of Serial Communication
Serial Ports and Comm Ports
DB9, DB25, RS-232, UART, TTL, FTID, USB

Serial Ports
Older Technology Serial Connections DB-9 and DB-25

<table>
<thead>
<tr>
<th>Pin #</th>
<th>Signal</th>
<th>Direction</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CD</td>
<td>in → computer</td>
<td>Carrier Detect</td>
</tr>
<tr>
<td>2</td>
<td>RXD</td>
<td>in → computer</td>
<td>Receive Data</td>
</tr>
<tr>
<td>3</td>
<td>TXD</td>
<td>out ↔ computer</td>
<td>Transmit Data</td>
</tr>
<tr>
<td>4</td>
<td>DTR</td>
<td>out ↔ computer</td>
<td>Data Terminal Ready</td>
</tr>
<tr>
<td>5</td>
<td>GND</td>
<td>—</td>
<td>Ground</td>
</tr>
<tr>
<td>6</td>
<td>DSR</td>
<td>in → computer</td>
<td>Data Set Ready</td>
</tr>
<tr>
<td>7</td>
<td>RTS</td>
<td>out ↔ computer</td>
<td>Request To Send</td>
</tr>
<tr>
<td>8</td>
<td>CTS</td>
<td>in → computer</td>
<td>Clear To Send</td>
</tr>
<tr>
<td>9</td>
<td>RI</td>
<td>in → computer</td>
<td>Request Indicator</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pin #</th>
<th>Signal Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CD</td>
<td>Shield to Frame Ground</td>
</tr>
<tr>
<td>2</td>
<td>RXD</td>
<td>Transmitted Data (Tr)</td>
</tr>
<tr>
<td>3</td>
<td>TXD</td>
<td>Received Data (Rx)</td>
</tr>
<tr>
<td>4</td>
<td>DTR</td>
<td>Data Terminal Ready</td>
</tr>
<tr>
<td>5</td>
<td>GND</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>DSR</td>
<td>Data Set Ready</td>
</tr>
<tr>
<td>7</td>
<td>RTS</td>
<td>Request to Send</td>
</tr>
<tr>
<td>8</td>
<td>CTS</td>
<td>Clear To Send</td>
</tr>
<tr>
<td>9</td>
<td>RI</td>
<td>Request Indicator</td>
</tr>
</tbody>
</table>

Modern to Modern Cable - Crossover Cable DB9 to DB25

<table>
<thead>
<tr>
<th>Pin #</th>
<th>RS-232 Signal Names</th>
<th>Signal Direction</th>
<th>Pin #</th>
<th>RS-232 Signal Names</th>
<th>Signal Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>Carrier Detector (DCD)</td>
<td>CD</td>
<td>#1</td>
<td>Shield to Frame Ground</td>
<td>FGND</td>
</tr>
<tr>
<td>#2</td>
<td>Receive Data (Rx)</td>
<td>RD</td>
<td>#2</td>
<td>Transmit Data (Tx)</td>
<td>TD</td>
</tr>
<tr>
<td>#3</td>
<td>Transmit Data (Tx)</td>
<td>TD</td>
<td>#3</td>
<td>Receive Data (Rx)</td>
<td>RD</td>
</tr>
<tr>
<td>#4</td>
<td>Data Terminal Ready</td>
<td>DTR</td>
<td>#4</td>
<td>Request to Send</td>
<td>RTS</td>
</tr>
<tr>
<td>#5</td>
<td>Signal Ground/Common (SG)</td>
<td>GND</td>
<td>#5</td>
<td>Clear to Send</td>
<td>CTS</td>
</tr>
<tr>
<td>#6</td>
<td>Data Set Ready</td>
<td>DSR</td>
<td>#6</td>
<td>Data Set Ready</td>
<td>DSR</td>
</tr>
<tr>
<td>#7</td>
<td>Request to Send</td>
<td>RTS</td>
<td>#7</td>
<td>Signal Ground/Common (SG)</td>
<td>GND</td>
</tr>
<tr>
<td>#8</td>
<td>Clear to Send</td>
<td>CTS</td>
<td>#8</td>
<td>Carrier Detector</td>
<td>CD</td>
</tr>
<tr>
<td>#9</td>
<td>Ring Indicator</td>
<td>RI</td>
<td>#9</td>
<td>Data Terminal Ready</td>
<td>DTR</td>
</tr>
<tr>
<td></td>
<td>Soldered to DB9 Metal - Shield</td>
<td>FGND</td>
<td></td>
<td>#20</td>
<td></td>
</tr>
</tbody>
</table>

Note: Signal Directions Reversed if both devices are DTE but pin connections are the same.
"Null Modem" cable connects pins #1 & #6 on DB9 side and #6 & #8 on DB25 side for Carrier (CD) used by Terminal programs requiring CD to be high for operation.
RS-232 Communication Protocol

In telecommunications, RS-232 is a standard for serial communication transmission of data. It formally defines the signals connecting between a DTE (data terminal equipment) such as a computer terminal, and a DCE (data circuit-terminating equipment, originally defined as data communication equipment), such as a modem. The RS-232 standard is commonly used in computer serial ports. The standard defines the electrical characteristics and timing of signals, the meaning of signals, and the physical size and pinout of connectors. The current version of the standard is TIA-232-F Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange, issued in 1997.

UART

A universal asynchronous receiver/transmitter is a computer hardware device that translates data between parallel and serial forms. UARTs are commonly used in conjunction with communication standards such as RS-232. The universal designation indicates that the data format and transmission speeds are configurable. The electric signaling levels and methods (such as differential signaling etc.) are handled by a driver circuit external to the UART. A UART is usually an individual (or part of an) integrated circuit (IC) used for serial communications over a computer or peripheral device serial port. Many modern ICs now come with a UART that can also communicate synchronously; these devices are called USARTs (universal synchronous/asynchronous receiver/transmitter).

TTL
https://en.wikipedia.org/wiki/Transistor%E2%80%93transistor_logic

Transistor-Transistor-Logic (TTL) is a class of digital circuits built from bipolar junction transistors (BJT) and resistors. After their introduction in integrated circuit form in 1963, TTL integrated circuits were manufactured by several semiconductor companies, with the 7400 series (also called 74xx) by Texas Instruments becoming particularly popular. TTL manufacturers offered a wide range of logic gate, flip-flops, counters, and other circuits (Generally, +5 VDC, however, there are also CMOS devices with voltages up to + 18 VDC.) TTL devices were originally made in ceramic and plastic dual-in-line (DIP) packages, and flat-pack form.

FTDI - Future Technology Devices International
Converts RS-232 or TTL serial transmissions to USB signals.
Note: Arduino UNO incorporates an FTDI that allows seamless communication between the board and USB.

USB

Universal Serial Bus is an industry standard developed in the mid-1990s that defines the cables, connectors and communications protocols used in a bus for connection, communication, and power supply between computers and electronic devices.
**Bluetooth**

Short range wireless interconnection for cell phones, computers, electronics devices originally conceived as a wireless replacement for RS-232 cables. Developed by Eriksson, a Swedish company and named after a Danish King, Harold Bluetooth. Classic Bluetooth - Always on, continuously streams data.

<table>
<thead>
<tr>
<th>Class</th>
<th>Maximum Permitted Power (mW)</th>
<th>Typical Range (dBm)</th>
<th>Typical Range (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>2.5</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>


Bluetooth Low Energy (BLE)

Extremely low energy (range 100 meters), intermittently streams data (2MB bps).
Coin Size Battery CR-2032 estimates of 5-10 years from remote sensors (100 Kbps).
Current version Bluetooth 4.2

**Pairing Process**

Not all Bluetooth devices are designed to pair

One or more profiles

iPhone has seven different profiles but lacks Serial Port Profile (SPP)

SPP defines how to setup virtual serial ports and connect two Bluetooth enabled devices

Passkey required to complete the pairing.

Uses simple numbering system; examples: 0000, 1234, etc.

Arduino compatible Bluetooth HC-05/06 Master / Client

4 wire - Power, GND, RX, TX

**Ethernet**


With the Arduino Ethernet Shield, this library allows an Arduino board to connect to the internet. It can serve as either a server accepting incoming connections or a client making outgoing ones. The library supports up to four concurrent connection (incoming or outgoing or a combination). Arduino communicates with the shield using the SPI bus. This is on digital pins 11, 12, and 13 on the Uno and pins 50, 51, and 52 on the Mega. On both boards, pin 10 is used as SS. On the Mega, the hardware SS pin, 53, is not used to select the W5100, but it must be kept as an output or the SPI interface won't work.

**Wi-Fi**

[https://www.arduino.cc/en/Main/ArduinoWiFiShield101](https://www.arduino.cc/en/Main/ArduinoWiFiShield101)

Arduino Wi-Fi Shield 101 is a powerful IoT shield with crypto-authentication, developed with ATMEL, that wirelessly connects Arduino to the Internet using the IEEE 802.11 wireless specifications. It is based on the Atmel SmartConnect-WINC1500 module, compliant with the IEEE 802.11 b/g/n standard. The WINC1500 module provides a network controller capable of both TCP and UDP protocols. The Wi-Fi Shield 101 also features an hardware encryption/decryption security protocol provided by the ATECC508A CryptoAuthentication chip that is an ultra secure method to provide key agreement for encryption/decryption.
**Arduino Serial Communication Shields**

Interfacing with One-Wire (Dallas Semiconductor Bus) Devices
Interfacing with I2C (Two-Wire) Devices
Interfacing with SPI Devices

**1-Wire Bus**

https://en.wikipedia.org/wiki/1-Wire

Device communications bus system designed by Dallas Semiconductor that provides low-speed data, signaling, and power over a single signal. A 1-Wire is similar in concept to FC, but with lower data rates and longer range. It is typically used to communicate with small inexpensive devices such as digital thermometers and weather instruments.

![1-Wire Bus Diagram](image)

**I2C - Two Wire**

Pronounced "Eye-Two-Sea" or "I Squared C"


![I2C Connection Diagram](image)

**SPI - Serial Peripheral Buss**


![SPI Bus Diagram](image)

**Additional Resources**


http://playground.arduino.cc/Code/LCD

https://learn.adafruit.com/adafruit-arduino-lesson-11-lcd-displays-1/overview


https://arduino-info.wikispaces.com/LCD-Blue-I2C

http://www.geeetech.com/wiki/index.php/Serial_I2C_1602_16%C3%972_Character_LCD_Module
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SPI Devices

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DB 25

Serial to Serial Cables - Connector Pinouts

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Note: Signal directions reversed on terminal connections on 25 pin cables.
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Bluetooth Classic

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</tr>
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<tbody>
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<td>100</td>
<td>20</td>
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</tr>
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**One-Wire**

**I2C - Two Wire**

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**SPI - Serial Peripheral Buss**

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**Additional Resources**

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