Serial Communication with Arduino

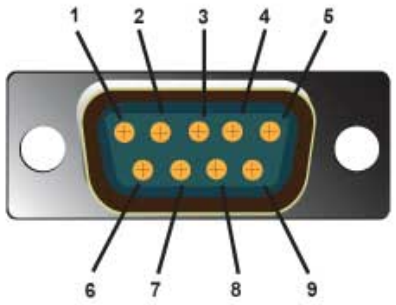
Serial Communication with the Arduino
- Serial, UART, TTL, FTDI, USB
- Bluetooth
- Ethernet
- Wi-Fi
- Interfacing with One-Wire (Dallas Semiconductor Bus) Devices
- Interfacing with I2C (Two-Wire) Devices

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

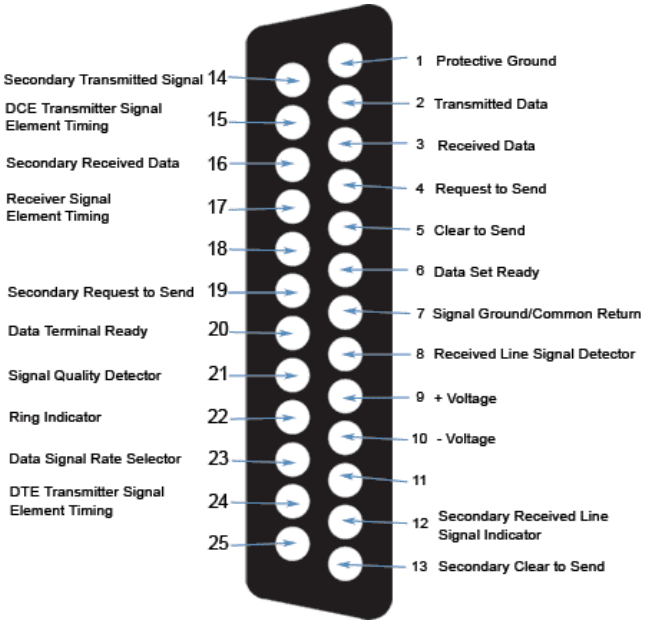
Serial Ports

Older Technology Serial Connections DB-9 and DB-25

DB-9 Connector Pin Outs



Pin #	Signal	Direction	Description
1	CD	in → computer	Carrier Detect
2	RXD	in → computer	Receive Data
3	TXD	out ← computer	Transmit Data
4	DTR	out ← computer	Data Terminal Ready
5	GND	-	Ground
6	DSR	in → computer	Data Set Ready
7	RTS	out ← computer	Request To Send
8	CTS	in → computer	Clear To Send
9	RI	in → computer	Ring Indicator (Cordless Serial Adapter: optional power input 3.3V-5.0V)



Modem to Modem Cable - Crossover Cable DB9 to DB25

DCE Device (Modem) **DB9** — **DCE to DCE Connections** — DCE Device (Modem) **DB25**

Pin# DB9	RS-232 Signal Names	Signal Direction	Pin# DB25	RS-232 Signal Names
#1	Carrier Detector (DCD) CD		#1	Shield to Frame Ground FGND
#2	Receive Data (Rx) RD		#2	Transmit Data (Tx) TD
#3	Transmit Data (Tx) TD		#3	Receive Data (Rx) RD
#4	Data Terminal Ready DTR		#4	Request to Send RTS
#5	Signal Ground/Common (SG) GND		#5	Clear to Send CTS
#6	Data Set Ready DSR		#6	Data Set Ready DSR
#7	Request to Send RTS		#7	Signal Ground/Common (SG) GND
#8	Clear to Send CTS		#8	Carrier Detector CD
#9	Ring Indicator RI		#20	Data Terminal Ready DTR
Soldered to DB9 Metal - Shield	FGND		#22	Ring Indicator RI

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
https://en.wikipedia.org/wiki/RS-232

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
https://en.wikipedia.org/wiki/Universal_asynchronous_receiver/transmitter
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. Classis Bluetooth - Always on, continuously streams data.

Class	Maximum Permitted Power (mW)	(dBm)	Typical Range (m)
1	100	20	100
2	2.5	4	10
3	1	0	1

https://en.wikipedia.org/wiki/Bluetooth

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
https://www.arduino.cc/en/Reference/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

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.

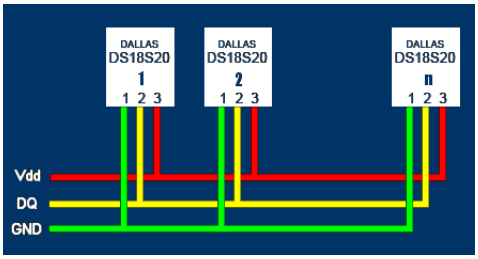
Arduino Serial Communication Shields

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

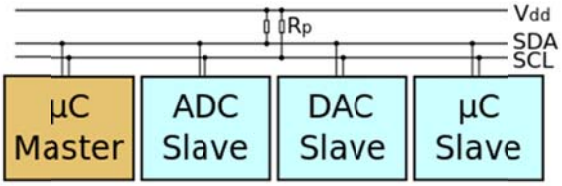
Device communications bus system designed by Dallas Semiconductor that provides low-speed data, signaling, and power over a single signal. A 1-Wire is similar in concept to I²C, but with lower data rates and longer range. It is typically used to communicate with small inexpensive devices such as digital thermometers and weather instruments.



I2C - Two Wire

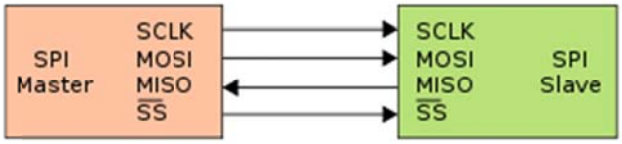
Pronounced "Eye-Two-Sea" or "I Squared C"

https://en.wikipedia.org/wiki/I%C2%B2C



SPI - Serial Peripheral Buss

https://en.wikipedia.org/wiki/Serial_Peripheral_Interface_Bus



Additional Resources

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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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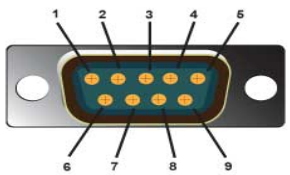

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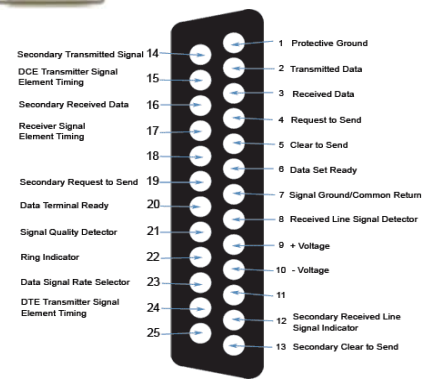
(Cordless Serial Adapter: optional power input 3.3V-5.0V)

DB 25



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#3 Transmit Data (Tx)	TD	←	#3 Receive Data (Rx)	RD
#4 Data Terminal Ready	DTR	→	#4 Request to Send	RTS
#5 Signal Ground/Common (SG)	GND	↔	#5 Clear to Send	CTS
#6 Data Set Ready	DSR	←	#6 Data Set Ready	DSR
#7 Request to Send	RTS	↔	#7 Signal Ground/Common (SG)	GND
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Bluetooth Classic

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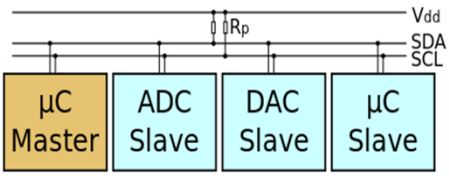
One-Wire

I2C - Two Wire



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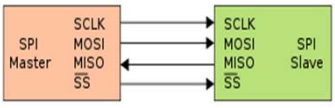

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