Komunikacija sa racunarom

- Serijska
  - Strujna petlja
  - EIA RS-232
  - EIA RS-422
  - EIA RS-485
  - I^2C
  - CAN
  - USB
- Paralelna
  - IEEE 488
  - SCSI
  - IEEE 1248

Serijska komunikacija

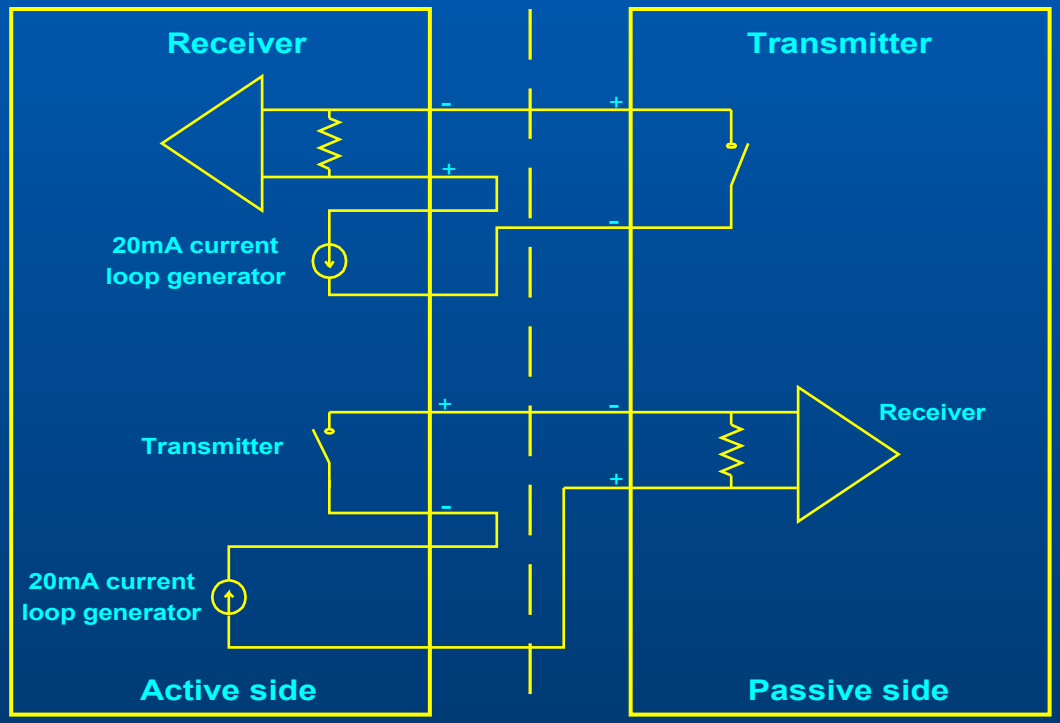
- Najjednostavniji moguci nacin povezivanja racunara sa periferijom, prensosi se serijski bit po bit.
- Postoje mnoge fizicke I elektricne varijacije, kao na primer:
  - Protokoli prenosa (na primer sinhroni, asinhroni)
  - Kodiranje (ACSII)
  - Tip konektora
  - Elektricne karakteristike (napon ili struja)

Strujna petlja

- Strujan petlja omogucava prenos signala na vecim distancama, imuna na smetnje na prenostnom putu.
- 20mA strujna petlja je pogodna za daljine do 600 m sa brzinom prenosa do 19.2K baud (koristi se u telekomunikacijama, broj prenesenih simbola u sekundi).
- Duplex i simplex konfiguracija

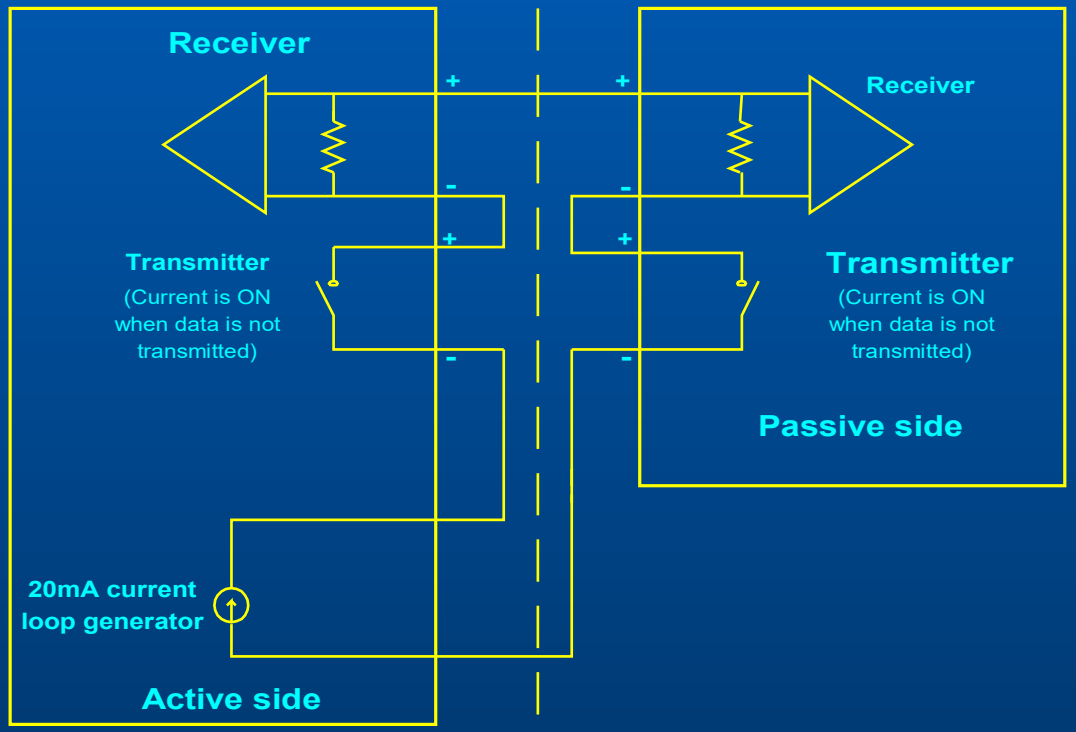
Strujna petlja - Full Duplex

- Na slici je prikazana full duplex 20mA strujan petlja
- Omogucava simultanu komunikaciju u ona smera
- Neophodna su dva 20mA strujna generatora



Strujan petlja - Simplex

- Osnovni elementi:
  - Izvor struje
  - Strujni prekidac
  - Detektor struje
- Interfejs na kome se nalazi izvor struje je aktivni
- Samo jedan uredja moze da salje u vremenu.



EIA RS-232-C Interface Standard

- Nekada(i sada) najzastupljeniji nacin serijske komunikacije
- Bi-directional, full-duplex, single-ended communications
- 1 transmitter, 1 receiver
- Maximum cable length about 15m
- Maximum data rate is 19.2Kb/s

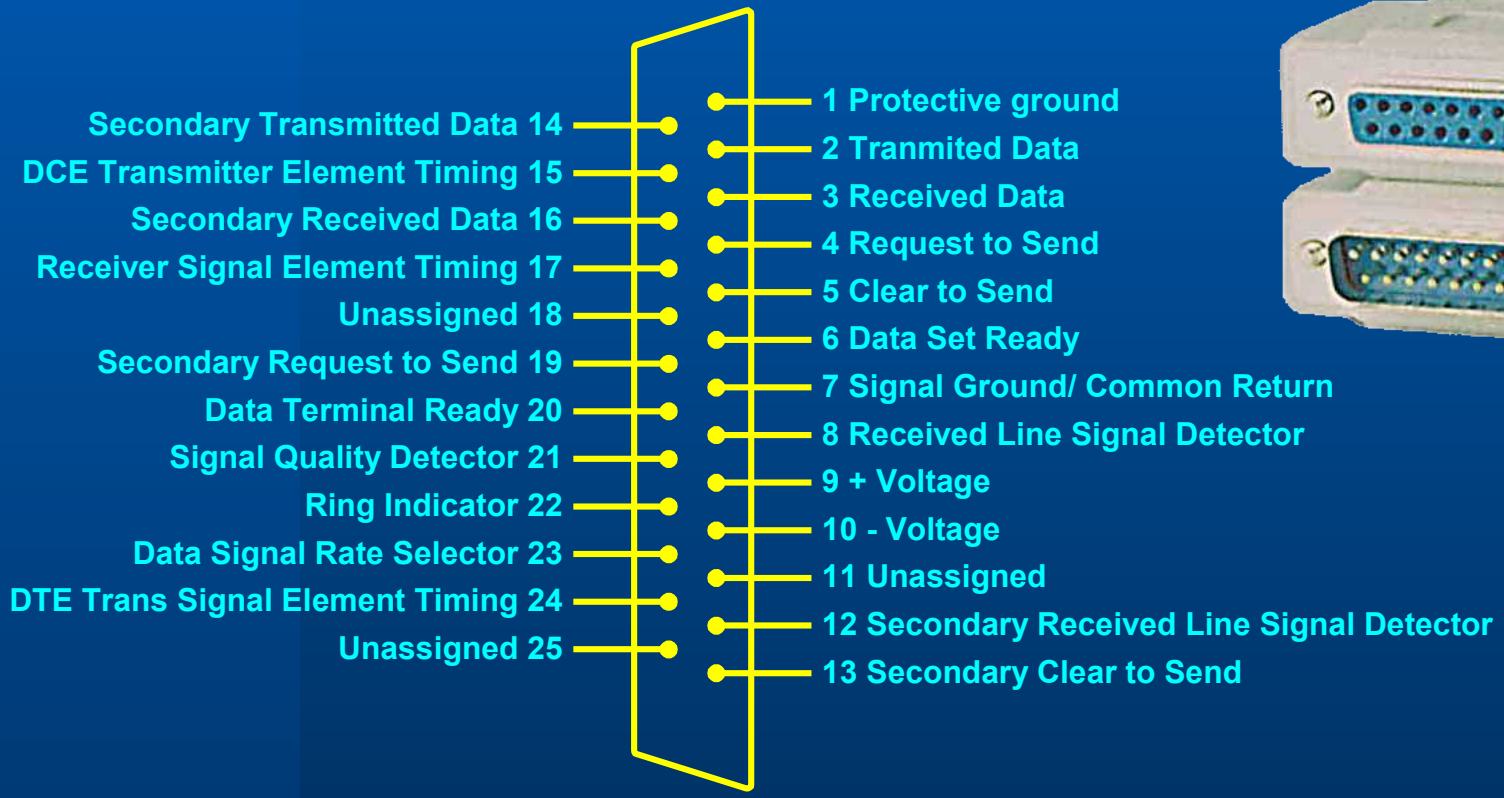
EIA RS-232-C Interface Standard

Electrical Signal Characteristics

- Maximum Driver Output Voltage: +/-25V
- Driver Output Signal Level (Loaded Min.): +/-5V to +/-15V
- Driver Output Signal Level (Unloaded Max): +/-25V
- Driver Load Impedance (Ohms): 3k to 7k
- Receiver Input Voltage Range: +/-15V
- Receiver Input Sensitivity: +/-3V
- Receiver Input Resistance (Ohms): 4k min.
- Output Current: 500mA

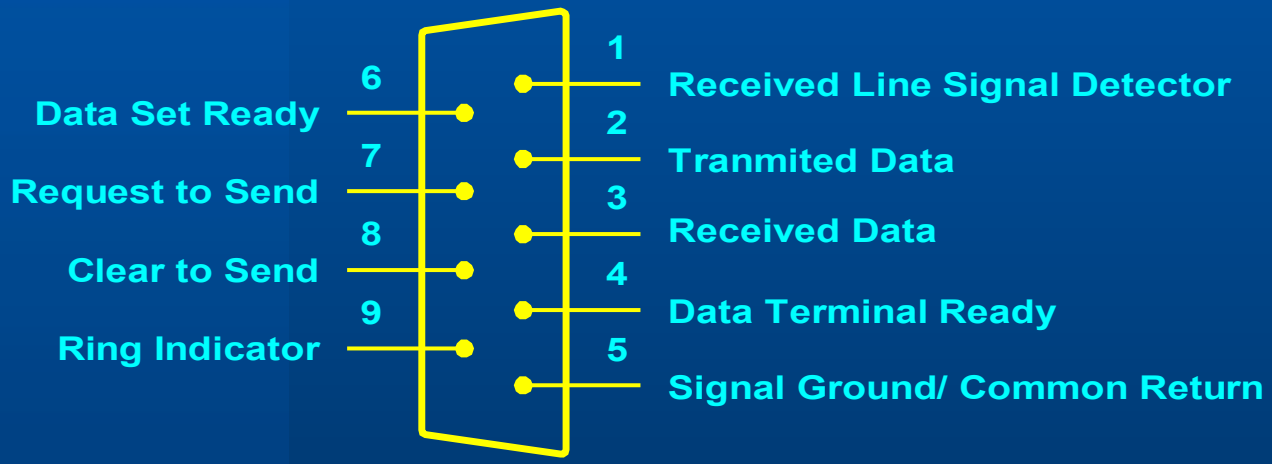
EIA RS-232-C Interface Standard

25-pin Connector



EIA RS-232-C Interface Standard

9-pin Connector



EIA RS-422

- EIA 422 i EIA 485 standards:
  balansirani diferncijalni prenos podataka
- Bi-directional, half/full-duplex, “quasi” multi-drop communications
- 1 driver i 10 receivers on one line
- Maximum cable length about 1200m (at 100Kb/s)
- Maximum data rate is 10Mb/s (for 15m)

EIA RS-422

Electrical Signal Characteristics

- Maximum Driver Output Voltage: -0.25V to 6V
- Driver Output Signal Level (Loaded Min.): +/-2.0V
- Driver Output Signal Level (Unloaded Max): +/-6V
- Driver Load Impedance (Ohms): 100
- Receiver Input Voltage Range: -10V to +10V
- Receiver Input Sensitivity: +/-200mV
- Receiver Input Resistance (Ohms): 4k min.
- Output Current: 150mA

EIA RS-422

RS422 Single Ended Wiring Diagram

EIA RS-485

- EIA RS-485 is an upgraded version of the RS-422 protocol
- Bi-directional, half-duplex, multi-drop communications
- Single or dual twisted pair cable
- Up to 32 drivers and 32 receivers on one line
- Maximum cable length about 1200m (at 100Kb/s)
- Maximum data rate is 10Mb/s (for 15m)

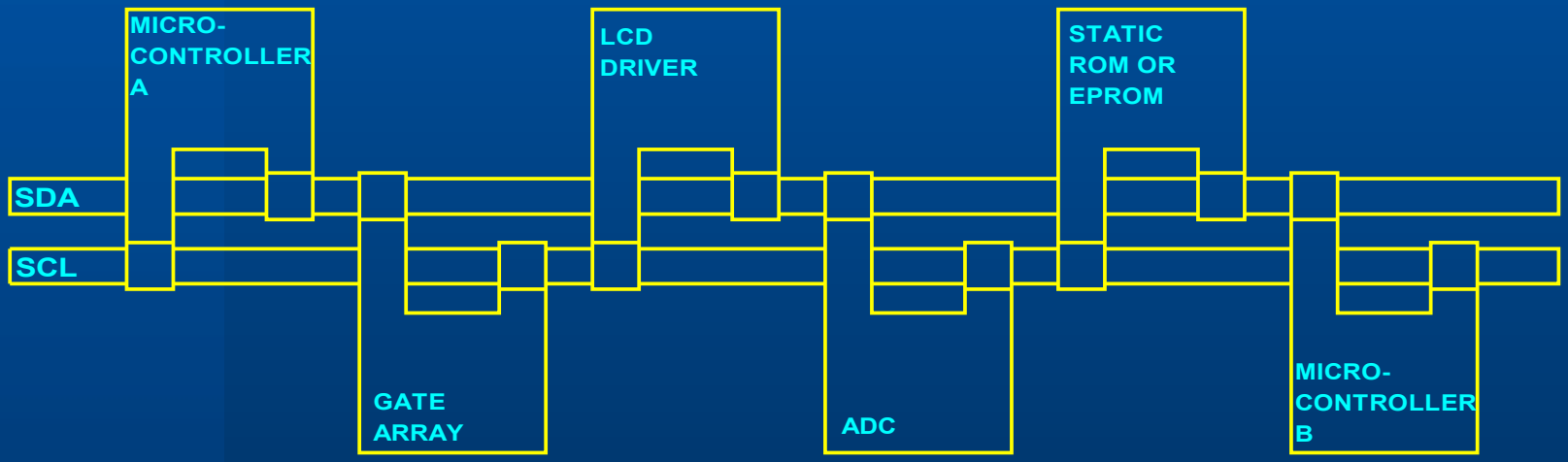
EIA RS-485

Electrical Signal Characteristics

- Maximum Driver Output Voltage: -7V to +12V
- Driver Output Signal Level (Loaded Min.): +/-1.5V
- Driver Output Signal Level (Unloaded Max): +/-6V
- Driver Load Impedance (Ohms): 54
- Receiver Input Voltage Range: -7V to +12V
- Receiver Input Sensitivity: +/-200mV
- Receiver Input Resistance (Ohms): >=12k
- Output Current: 250mA

I²C

- Developed by Philips
- Simple bi-directional 2-wire bus for 8 bit applications
- Multi-master, multi-slave network interface with collision detection



I²C

- Only two bus lines are required
  - serial data line (SDA)
  - serial clock line (SCL)
- Number of devices limited only by a maximum bus capacitance of 400 pF (typical device capacitance is 10pF)
- Devices can be spread over 10 meters
- Data transfer rates:
  - up to 100Kb/s in standard mode
  - up to 400Kb/s in fast mode

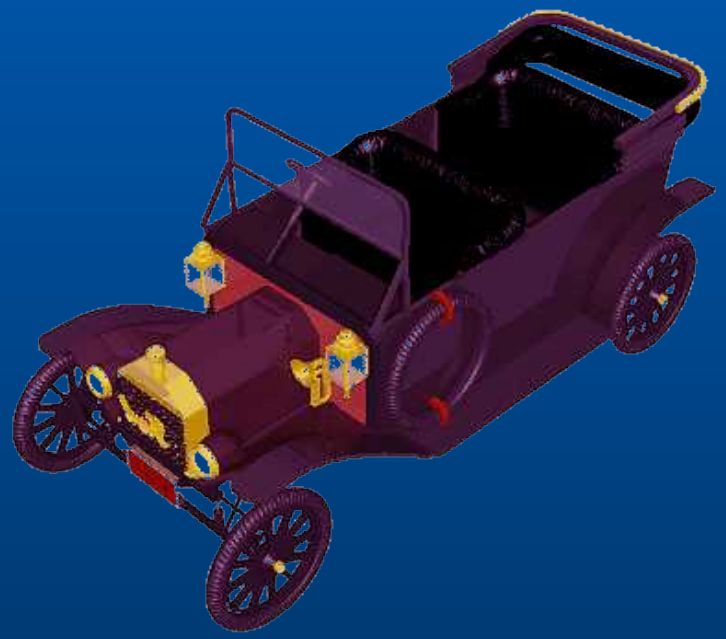
I²C

Electrical Signal Characteristics

- **LOW level input voltage**
  - **standard-mode devices: min. -0.5V, max. 1.5V**
  - **fast-mode devices: min. -0.5V, max. 1.5V**
- **HIGH level input voltage**
  - **standard-mode devices: min. 3V, max. V_{DD}+0.5V**
  - **fast-mode devices: min. -0.5V, max. 1.5V**
- **LOW level output voltage**
  - **standard-mode devices: min. 0V, max. 0.4V**
  - **fast-mode devices: min. 0V, max. 0.4V**
- **Input current** (for both modes): min. -10μA, max. 10 μA
- **Capacitance for each I/O pin** (for both modes): max. 10pF

CAN (Controller Area Network)

- Originally developed for use in automobiles
- Serial bus system
- Multi-master capabilities
- Transmitter broadcast, other nodes listen
- Maximum transmission rate:
  - 1Mbit/s up to 40m
  - 125 kbit/s up to 500m
  - 50 kbit/s up to 1km



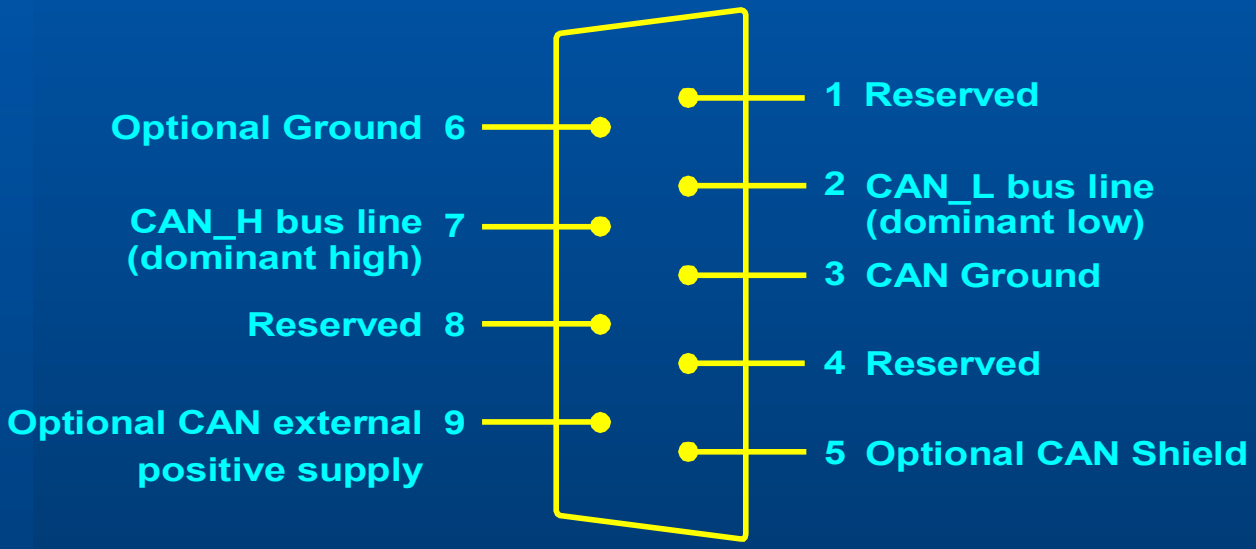
CAN

Electrical Signal Characteristics

- **Output Voltage:**
  - **V_{OH}: min. +4V, max. +5.5V**
  - **V_{OL}: min. 0V, max. +1.5V**
- **Requested differential input voltage is 1V**
- **Minimum differential input resistance is 20KΩ**
- **Minimum termination resistance is 118 Ω**
- **Recommended cable impedance is 120 Ω**
- **Minimum supply voltage is 4.9V (when driving 45 Ω load)**

CAN

9-pin Connector



CAN

- **Features**
  - **high transmission reliability**
  - **relatively simple protocol**
  - **simple programming of applications**
  - **function libraries, starter kits, host interfaces, I/O modules and tools are available from a variety of vendors**

CAN

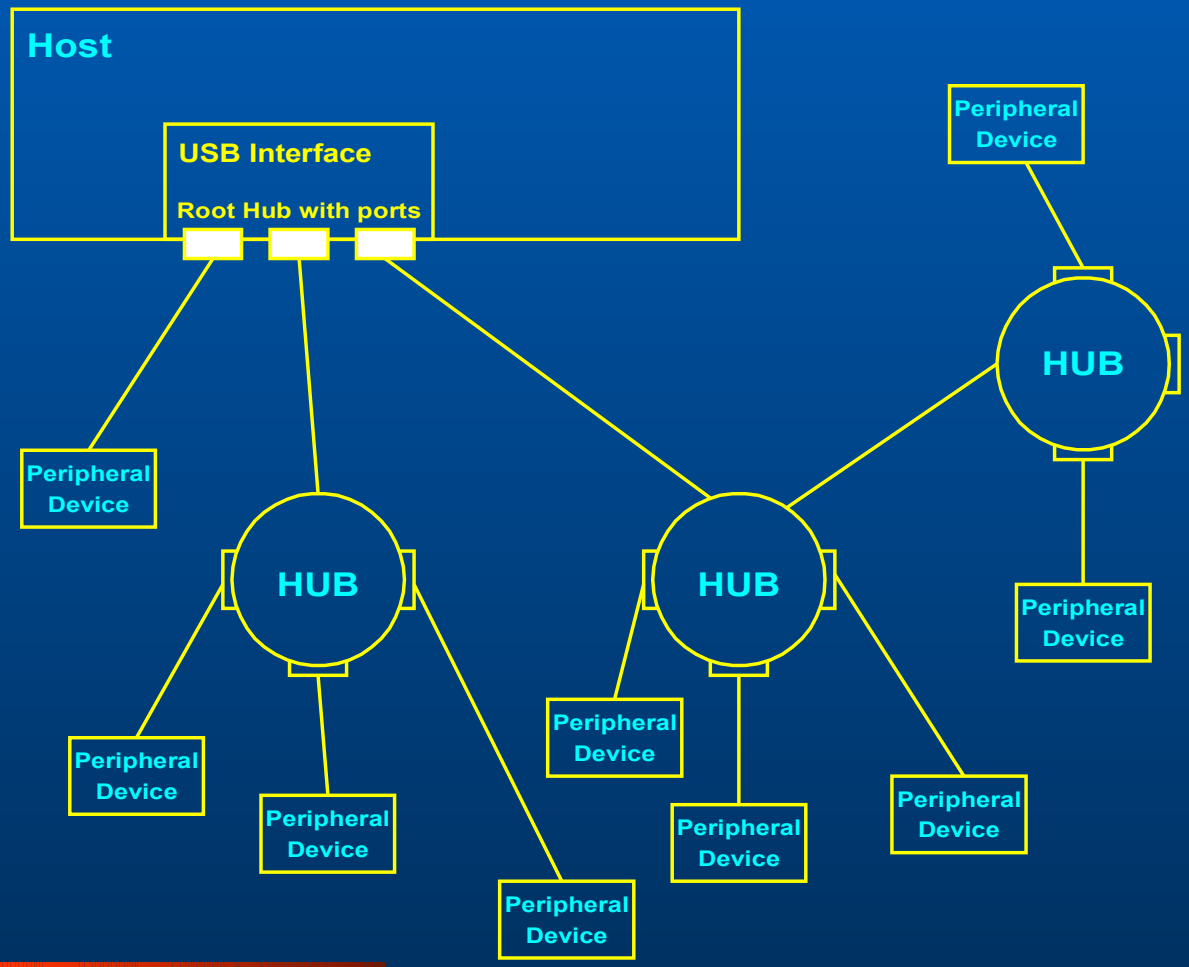
- **Usage:**
  - **automotive industry**
  - **domestic appliances**
  - **industry control**

USB (Universal Serial Bus)

- Developed in 1995
- External serial bus standard
- Plug and Play installation
- Hot plugging
- Up to 127 peripheral devices to one USB interface (using USB hubs)
- Maximum cable length is 5m
- Data transfer rates:
  - low-speed 1.5Mb/s
  - full-speed 12Mb/s
  - high-speed 480Mb/s (USB 2.0)

USB

A Typical USB System



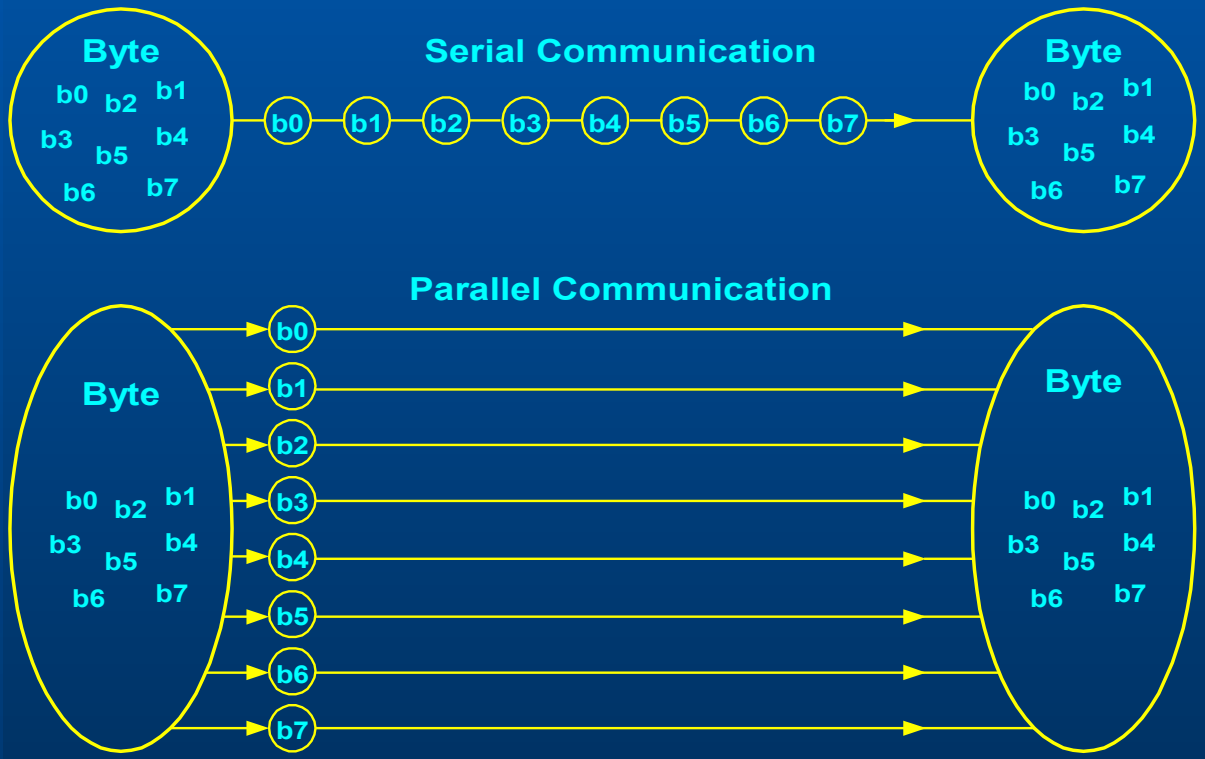
USB

Electrical Signal Characteristics

Class of device		from upstream (PC side)		to downstream (Device side)	
		Imax	Vmin	Imax	Vmin
Hub	Bus-powered	500mA	4.75V	100mA	4.40V
	Self-powered	(100mA)	-	500mA	4.75V
Function	Low power, bus-powered	100mA	4.40V		
	High power, bus-powered	500mA	4.40V		
	Self-powered	(100mA)	-		

Parallel Communication

- Data transfer over separate lines
- Higher information rates



IEEE 488

- **History:**
  - **Developed in late 1960, early 1970's**
  - **Hewlett-Packard patented the 3-wire handshake used by HP-IB/GPIB**
  - **IEEE 488 standard approved by the IEEE in 1975**

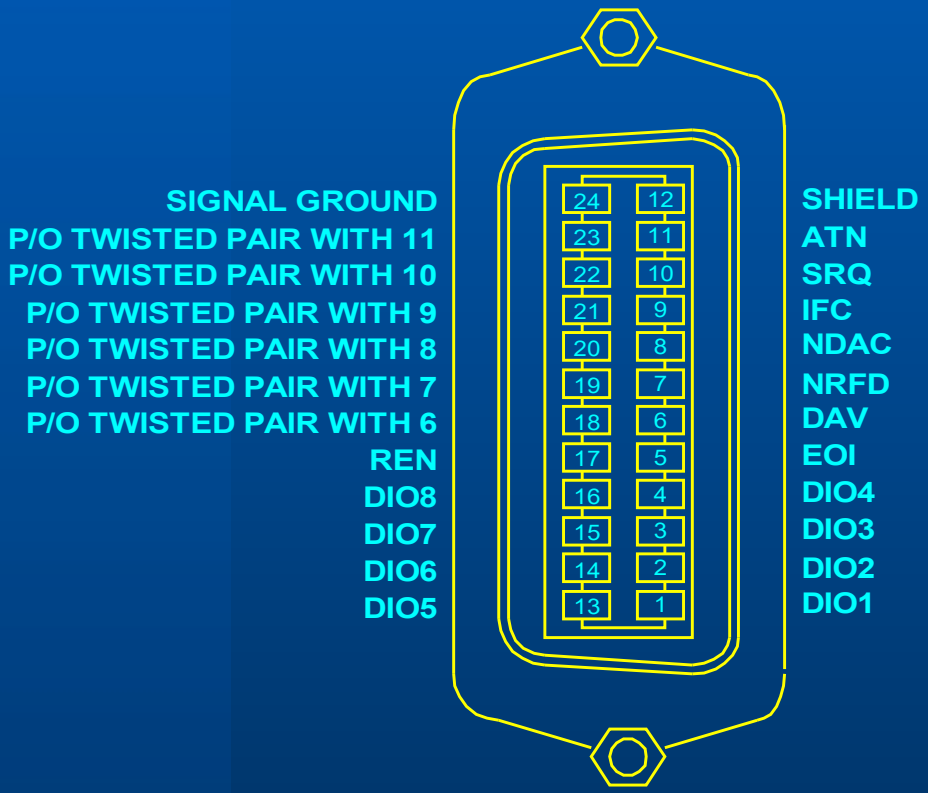
IEEE 488

- Parallel data bus - 8 bits wide
- Daisy chain cable arrangement
- Up to 15 devices
- Up to 20 meters
- 1Mb/s transfer rate

IEEE 488

- **Three type of devices can be connected to the IEEE-488 bus**
  - **Listeners**
  - **Talkers**
  - **Controllers**
- **Minimum system consists one Controller and one Listener or Talker**

IEEE 488


SIGNAL GROUND
P/O TWISTED PAIR WITH 11
P/O TWISTED PAIR WITH 10
P/O TWISTED PAIR WITH 9
P/O TWISTED PAIR WITH 8
P/O TWISTED PAIR WITH 7
P/O TWISTED PAIR WITH 6
REN
DIO8
DIO7
DIO6
DIO5
24 12
23 11
22 10
21 9
20 8
19 7
18 6
17 5
16 4
15 3
14 2
13 1
SHIELD
ATN
SRQ
IFC
NDAC
NRFD
DAV
EOI
DIO4
DIO3
DIO2
DIO1

SCSI (Small Computer System Interface)

- **Parallel interface standard for attaching peripheral devices to computers**
- **I/O bus rather than simply an interface**
- **Data transmission rates up to 80 MB/s**

SCSI

- **Currently implemented:**
  - **SCSI-1: 8-bit bus, support data rates of 4 MBps, 25-pin connector**
  - **SCSI-2: same as SCSI-1, 50-pin connector instead of a 25-pin connector, and supports multiple devices.**
  - **Wide SCSI: wider cable, 16-bit transfers.**
  - **Fast SCSI: 8-bit bus, double clock rate, support data rates of 10 MB/s.**
  - **Fast Wide SCSI: 16-bit bus, supports data rates of 20 MB/s.**
  - **Ultra SCSI: 8-bit bus, supports data rates of 20 MBps.**
  - **SCSI-3: 16-bit bus, supports data rates of 40 MBps.**
  - **Ultra2 SCSI: 8-bit bus, supports data rates of 40 MBps.**
  - **Wide Ultra2 SCSI: 16-bit bus, supports data rates of 80 MBps.**

SCSI

SCSI Maximum Bus Length and Device Addressing

	Single ended (meters)	Differential (meters)	LVD (meters)	Number of Nodes
SCSI-1	6	25	12	8
Fast SCSI	3	25	12	8
Fast Wide SCSI	3	25	12	16
Ultra SCSI	1.5	25	12	8
Wide Ultra SCSI	-	25	12	16
Wide Ultra SCSI	1.5 or 3	-	-	8 or 4
Ultra2 SCSI	not defined	not defined	12	8
Wide Ultra2 SCSI	not defined	not defined	12	16

SCSI

- Supports several types of connectors
  - Centronics-type 50-pin connector (5MB/s)
  - Old Sun and DG Computers
  - 50-pin High-Density connector
  - 25-pin connector
  - 68-pin High Density connector
  - SCA 80-pin

SCSI

- Multitude of hardware types can use a SCSI bus
  - hard drives
  - tape drives
  - CD-ROM
  - scanners
  - etc.