TASK 6

COMMUNICATION PROTOCOLS

- **INTRO :**A communications protocol is a set of formal rules describing how to transmit or exchange data, especially across a network.

- **TYPES :**

A. INTER SYSTEM

1] UART Protocols *:*

UART stands for Universal Asynchronous Receiver Transmitter (UART) and is perhaps the most simplified, oldest and most commonly used form of device-to-device communication. As the name implies, UART uses asynchronous serial communication, which means that no clock signal is used to synchronize data between the transmitter and receiving devices. So, unlike the majority of protocols, UART data transmission follows TX-RX/Transmitter/receiver pin communication connected through two wires. UART adds stop and start bits to detect incoming data. Here, device communication speed must follow around the same baud rate configuration in beats per second (bps) to send and receive data transmission packets.

UART can be configured in three distinct ways:

- Simplex: One-way data Communication.
- Half-Duplex: Data transmission in both directions but not at the same time.
- Full-Duplex: Simultaneous data transmission in both directions at the same time.

UART ADVANTAGES :

1. Only uses two wires to connect
2. Popular and commonly used protocol
3. Asynchronous meaning no clock signal is needed
4. Simple structure means data packets can be easily changed
5. Multiple ways for configuration

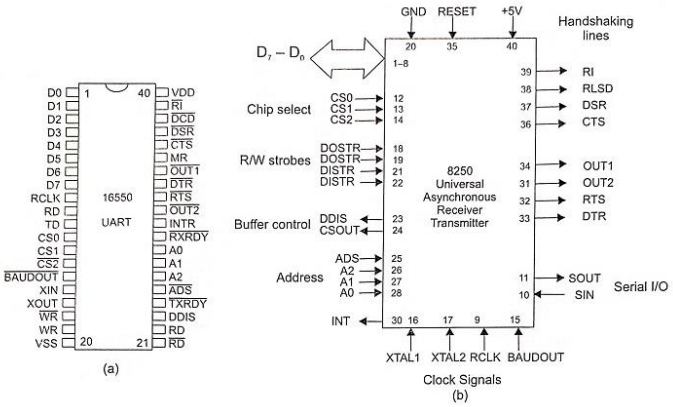
UART Disadvantages:

1. With one master and slave, UART doesn't support multiple systems
2. Baud rate configuration needs to be similar

APPLICATIONS OF UART:

- Achieving communication amongst distant computers around 900 meters.
- Transferring data through PC serial port.
- Baud rate generation for numerous applications that helps to determine the speed of data transmission.
- Microcontroller to implement wireless data communication.
- Bluetooth and GPS modules

PINOUT :



2] USB Protocols

USB refers to Universal Serial Bus and follows an Inter-System Protocol, which communicates between two devices. Prominent in the Computer electronic device world, USB has become popular over UART Protocols. USB follows an Asynchronous Serial Protocol where no clock signal is needed, making it a low-cost device. When the host device is sent communication, data transmission is relayed to a receiving endpoint device via data packets. USB can entail a range of speeds depending on the use case, from 1.5MBS to 10GBS.

USB ADVANTAGES

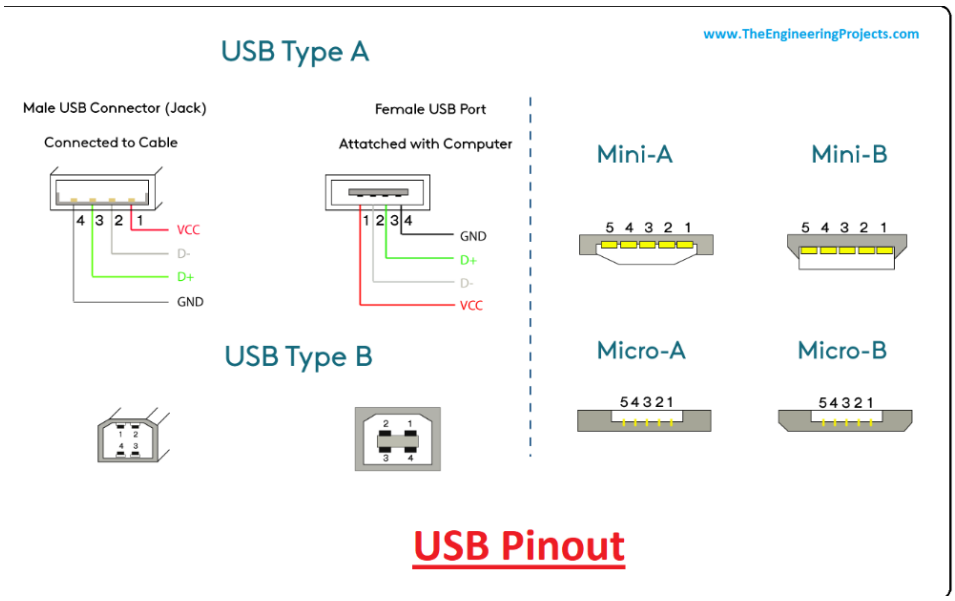
- Low cost, low power and smaller in size
- Can support high-capacity of data
- Plug and play means easy implementation
- Easy to use.
- For multiple devices, a single interface is used.
- Its size is compact.
- Its connector system is robust.
- These are not expensive.
- These are available in different sizes with different connectors.
- Auto configuration.
- Its expanding is easy.
- High speed.
- Reliable and low cost.
- Power consumption is low.
- Compatible and durable.

USB DISADVANTAGES :

- Limited capability
- Limited messages can be communicated between the host and peripheral
- Some manufacturers design low-quality USBs with less cost.
- Its capacity is limited.
- As compared to other systems, its data transfer is not fast.
- USB does not give the broadcasting feature, so individual messages are only communicated between the host & periphera

USB APPLICATIONS

- At present, most of the peripheral devices are connected through a USB to the system like Mouse, Printers, Scanners, Joysticks, Modems, Webcams, Keyboards, Digital cameras, Storage devices, Storage devices, Flight yokes, Network adapters, and data acquisition devices in the scientific field.
- USB is mainly used in computers on hubs & host controllers
- UBB Type-B is mostly used to connect compact devices such as mobile phones and USB peripheral devices like printers.
- It is used most frequently on PCs, video game consoles & smartphones.



B] INTRA SYSTEM

1] I2C Protocols

- I2C means Intern-Integrated Circuit and was first created by Phillips to power electrical lighting.
- I2C communication is popular due to its Multi-Master-Multi-Slave structure, otherwise known as an I2C Bus.
- Such structure is valuable when registering multiple Microcontrollers data to power a device system.
- The I2C communication protocol follows a Half-Duplex configuration, which means data can be transferred bit by bit via two-way communication at a single time.
- This should be taken into consideration when contemplating integration, as data communication happens at a lower rate. I2C follows a Serial Communication Protocol enabling two-wire interface communication between masters and slaves.
- Having a less complex pin structure, I2C is attractive to integrate.Multiple Master and Salve device communication works via Synchronous Communication, where a clock signal controlled by the master is distributed amongst the salve nodes across two-wire interfaces, the Serial Clock Line (SCL) and Serial Data Line (SDA).
- When integrating I2C use cases need to be evaluated as it is more complex than most other Protocols.

I2C ADVANTAGES

- Cheaper cost to integrate than other communication protocols,
- Flexible- the multi-master-slave design makes I2C much more functional
- Adaptable to integrated circuit types

I2C DISADVANTAGES

- Lower transmission speeds,
- It is considered complex, especially as the number of devices used increases.

APPLICATIONS :

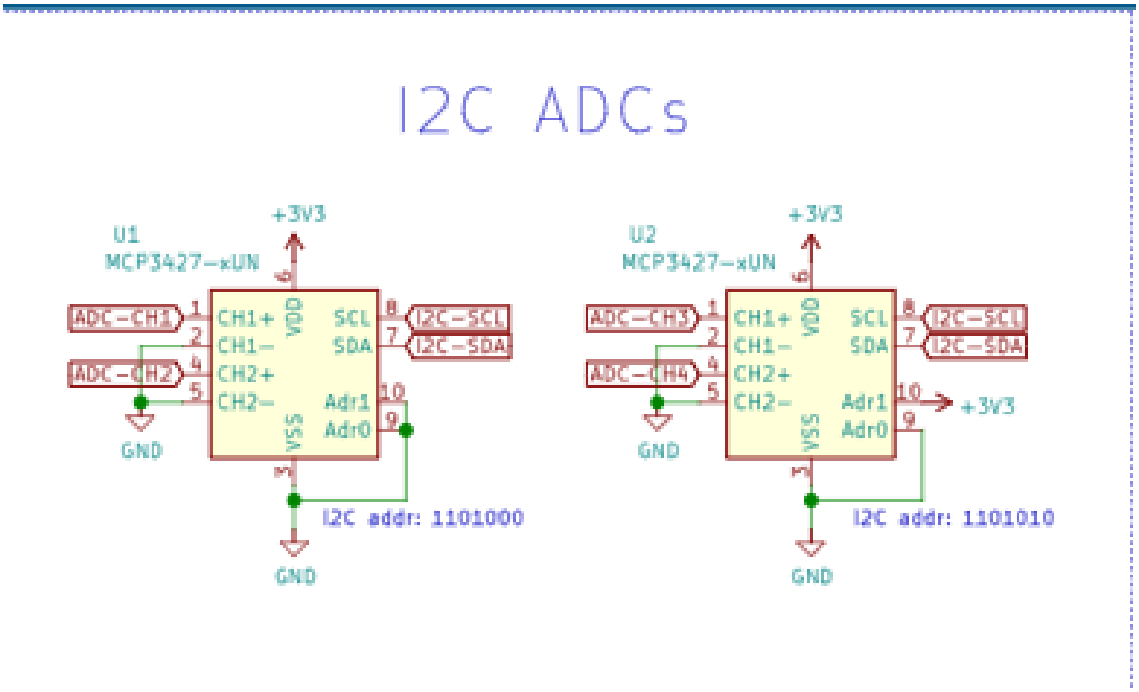
- ***Embedded systems***: I2C is commonly used in embedded systems to communicate with sensors, displays, and other peripherals. Its simplicity and low power consumption make it an ideal choice for these types of applications.

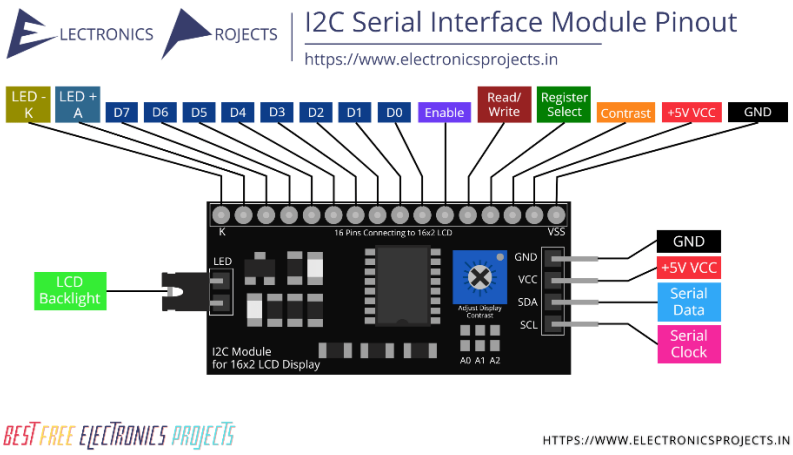
- ***Industrial automation***: I2C is used in industrial automation systems to connect sensors, actuators, and other devices to control and monitor processes.

- ***Consumer electronics***: I2C is used in a range of consumer electronics devices, such as smartphones, tablets, and laptops, to communicate with sensors, displays, and other peripherals.

- ***Medical devices***: I2C is used in medical devices such as monitoring systems, glucose meters, and portable oxygen concentrators to communicate with sensors and other peripherals.

- ***Automotive:*** I2C is used in automotive systems to communicate with sensors, displays, and other peripherals, such as in engine control systems, infotainment systems, and safety systems.





2] SPI Protocols :

- SPI refers to Serial Peripheral Interface and is a famous communication protocol within the embedded world. The SPI protocol is used across a range of chipsets, including SD card and RFID card reader modules. Its essential function as an interface Bus is to send/receive data across Microcontrollers (Master) and Peripherals such as sensors and SD cards (Slaves) to assist device communication.
- SPI follows a Serial Communication Protocol with a Full-Duplex configuration, meaning data bits can be transmitted continuously in both directions at the same time through Master-Slave-IN/ Master-Slave-Out (MOSI/MISO) exchange.
- This holds an advantage over stop/start bit communication, as devices can function without interruption. The overall operation of SPI involves four signals.
- The Serial Clock (SCLK) assists a synchronous interface, allowing faster data transfer.
- The Master node commands Master In Slave Out (MISO) or Maser Out Slave In (MOSI) communication.
- The Slave Select lines (SS) indicate activity; when a line goes low, communication is present between the Master and a Slave Node.
- This enables higher speeds-16Mhz-32Mhz- of data transmission than other Protocols.
- Though SPI holds a higher transfer rate than other multi-slave systems, the one Master to multiple-slave nature of SPI means it is not scalable as multiple wire interfaces are needed to establish Master/Slave transmission amongst the Bus. This should be held as a consideration when contemplating the complexity of a system.

SPI ADVANTAGES

- Flexibility for bits transferred
- Can support multi-master-slave systems
- High speed – faster than asynchronous methods
- Continuous transmission of data bits means less interruption

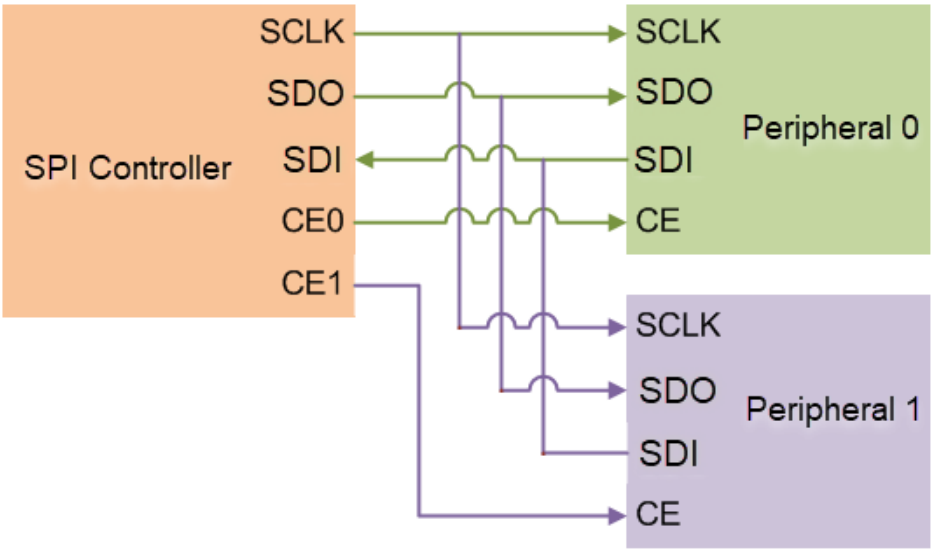
SPI DISADVANTTAGES :

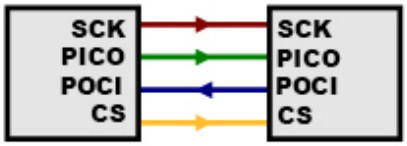
- Not as scalable as other multi-slave systems
- More wires are required for communication
- One master controls all slave communication

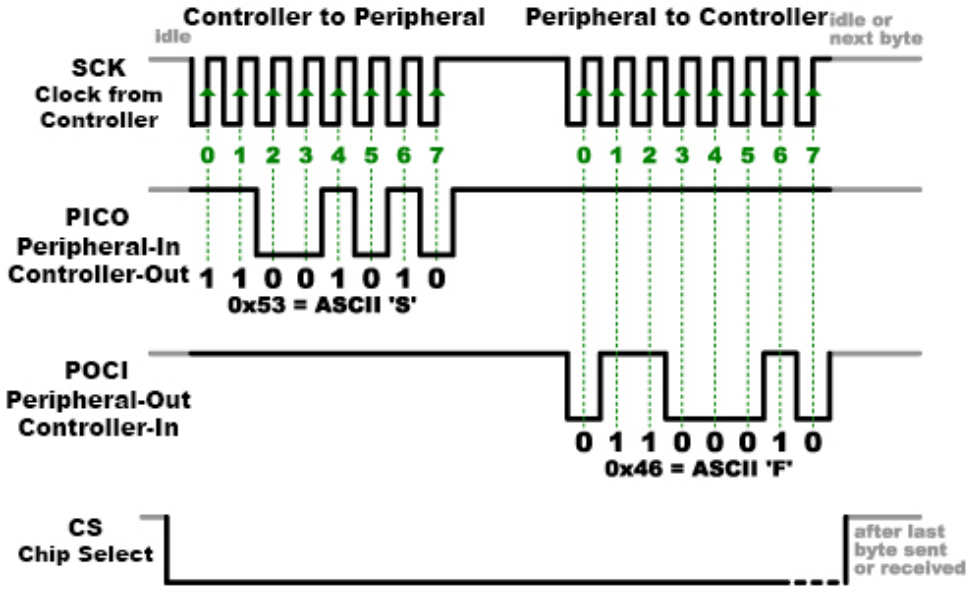
APPLICATIONS :

- Sensors

- Displays
- Memory modules.
- SD Card, MMC, EEPROM, and Flash.
- Temperature and Pressure sensors.
- ADC, DAC, digital POTS, and Audio Codec control devices.
- Camera Lens Mount, Touchscreen, LCD, RTC, and video game controllers.







3] CAN :

- The Controller Area Network protocol (CAN or CAN Bus) is a two-wire (twisted-pair), bidirectional serial bus communication method that allows electronic subsystems to be linked together and interact in a network.
- The physical layer uses differential transmission on a twisted pair wire
- A non-destructive bit-wise arbitration is used to control access to the bus
- The messages are small (at most eight data bytes) and are protected by a checksum
- There is no explicit address in the messages; instead, each message carries a numeric value which controls its priority on the bus and may also serve as an identification of the contents of the message
- An elaborate error handling scheme that results in retransmitted messages when they are not properly received
- There are effective means for isolating faults and removing faulty nodes from the bus

CAN ADVANTAGES :

- Short, high message frequency, more than 10,000/s.
- High bandwidth utilization.
- Reasonable transmission speeds.
- Support for higher-layer protocols like CANopen (standardized protocol for devices and applications from different manufacturers) and J1939 (standard for heavy-duty vehicles).

CAN DISDVANTAGES :

- Because of electrical loading, the number of connected devices is limited to a maximum of 64 nodes.
- Cable length is limited to 40 meters (a touch over 131 feet) in length, which is not a problem for most use cases, but could limit some applications.
- According to the standard, the maximum speed is 1 Mbit/second, although this limitation has been solved in CAN FD, which offers 5 Mbit/s.
- CAN can produce excessive electric noise.
- While CAN reduces some costs, software development and maintenance expenses can be high.

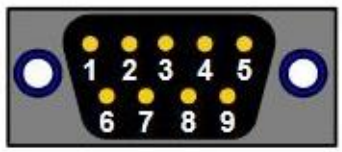
APPLICATIONS :

Automotive Industry

  - Majority of applications as CAN was developed for automobiles
  - In use by most domestic and international car manufacturers
- **Automotive Aftermarket**
  - Fleet and vehicle tracking
  - Vehicle security and remote start applications

Building Automation

  - Elevators and escalators
  - Access control, secure doors
  - Light control
- **Industrial Automation**
  - Robotics
  - Predictive maintenance
- **Medical Equipment**
  - X-ray generators and patient tables
  - Dose measurement systems
  - CT scanners
- **Entertainment**
  - Gaming machines
  - Motion picture camera and lighting systems



Male Female

Pin	Signal	Description
1	Reserved	No connection, only pass-through
2	CAN_L	CAN Low bus line (dominant low)
3	CAN_GND	CAN Ground (see grounding section)
4	Reserved	No connection, only pass-through
5	(CAN_SHLD)	No connection, only pass-through
6	(GND)	CAN Ground (see grounding section)
7	CAN_H	CAN High bus line (dominant high)
8	Reserved	No connection, only pass-through
9	(CAN_V+)	No connection, only pass-through

REFERENCE

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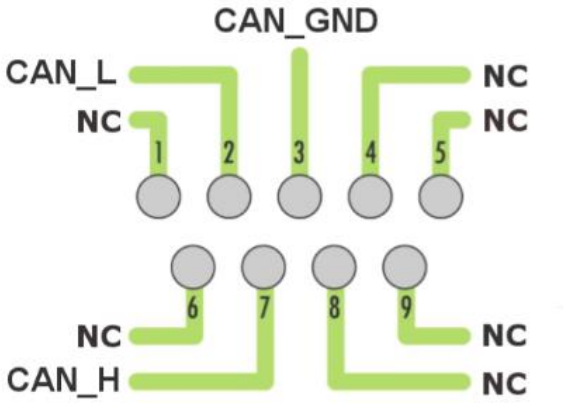
CAN_GND
CAN_L
NC
NC
NC
1
2
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4
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NC
CAN_H
NC
NC