

Microcontroller & Embedded Systems- **Module-3-2**



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An Institute with a Difference

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3.2.1 Core of an Embedded System

3.2.2 Memory

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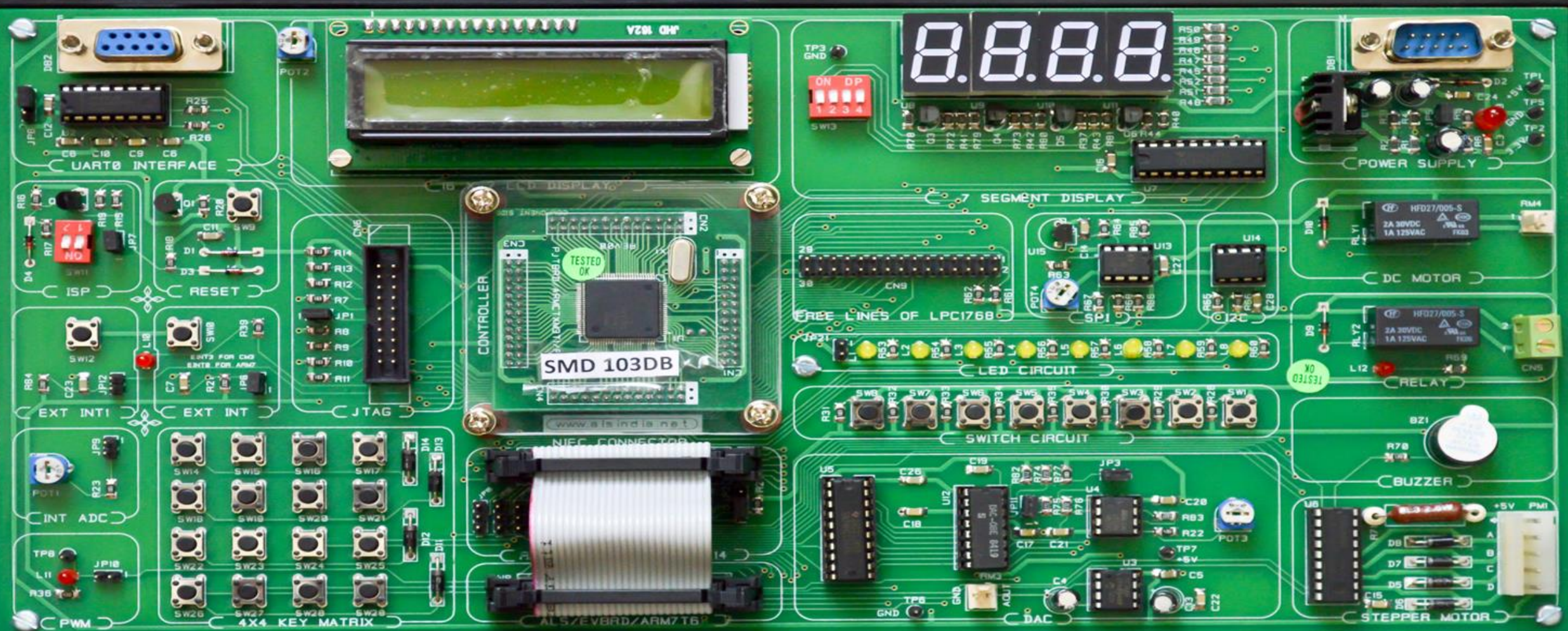
3.2.4 Communication Interface

3.2.5 Embedded firmware

3.2.6 Other system components.

Text book 2: Shibu K V, “Introduction to Embedded Systems”, Tata McGraw Hill Education, Private Limited, 2nd Edition.

Chapter 1(Sections 1.2 to 1.6) ,Chapter 2(Sections 2.1 to 2.6)



ARM7 LPC2148 EVALUATION BOARD

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Communication Interface

- Communication interface is essential for communicating with various subsystems of the embedded system and with the external world.
- For an embedded product, the communication interface can be viewed in two different perspectives; namely;
 1. **Device/board level communication interface (Onboard Communication Interface)**
 2. **Product level communication interface (External Communication Interface)**

External Communication Interfaces:

» The *External Communication Interface* refers to the different communication channels/ buses used by the embedded system to communicate with the external world.

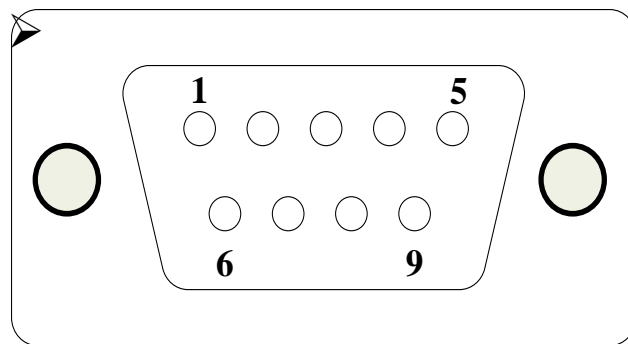
- » RS-232 C & RS-485
- » Universal Serial Bus (USB)
- » IEEE 1394 (Firewire)
- » Infrared (IrDA)
- » Bluetooth (BT)
- » Wi-Fi
- » ZigBee
- » General Packet Radio Service (GPRS), 3G, 4G, LTE

External Communication Interfaces-RS-232 C

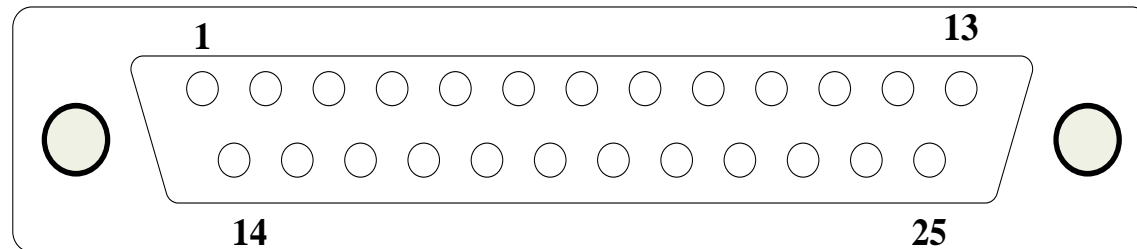
- RS-232 C (Recommended Standard number 232, revision C from the Electronic Industry Association) is a legacy, full duplex, wired, asynchronous serial communication interface.
- The RS-232 interface is developed by the Electronics Industries Association (EIA) during the early 1960s.
- RS-232 extends the UART communication signals for external data communication.
- UART uses the standard TTL/CMOS logic (Logic „High“ corresponds to bit value 1 and Logic “Low” corresponds to bit value 0) for bit transmission whereas RS-232 follows the EIA standard for bit transmission.
- As per the EIA standard, a logic „0“ is represented with voltage between +3 and +25V and a logic “1” is represented with voltage between -3 and -25V.

External Communication Interfaces-RS-232 C

- In EIA standard, logic “0” is known as “Space” and logic “1” as “Mark”. The RS-232 interface defines various handshaking and control signals for communication apart from the “Transmit” and “Receive” signal lines for data communication.
- RS-232 supports two different types of connectors, namely; DB-9: 9-Pin connector and DB-25: 25-Pin connector. Figure illustrates the connector details for DB-9 and DB-25.



DB-9



DB-25

External Communication Interfaces-RS-232 C

- The pin details for the DB-9 connectors are explained in the following table:

Pin Name	Pin No: (For DB-9 Connector)	Description
TXD	3	Transmit Pin. Used for Transmitting Serial Data
RXD	2	Receive Pin. Used for Receiving serial Data
RTS	7	Request to send.
CTS	8	Clear To Send
DSR	6	Data Set ready
GND	5	Signal Ground
DCD	1	Data Carrier Detect
DTR	4	Data Terminal Ready
RI	9	Ring Indicator

External Communication Interfaces-RS-232 C

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External Communication Interfaces-RS-422, RS-485

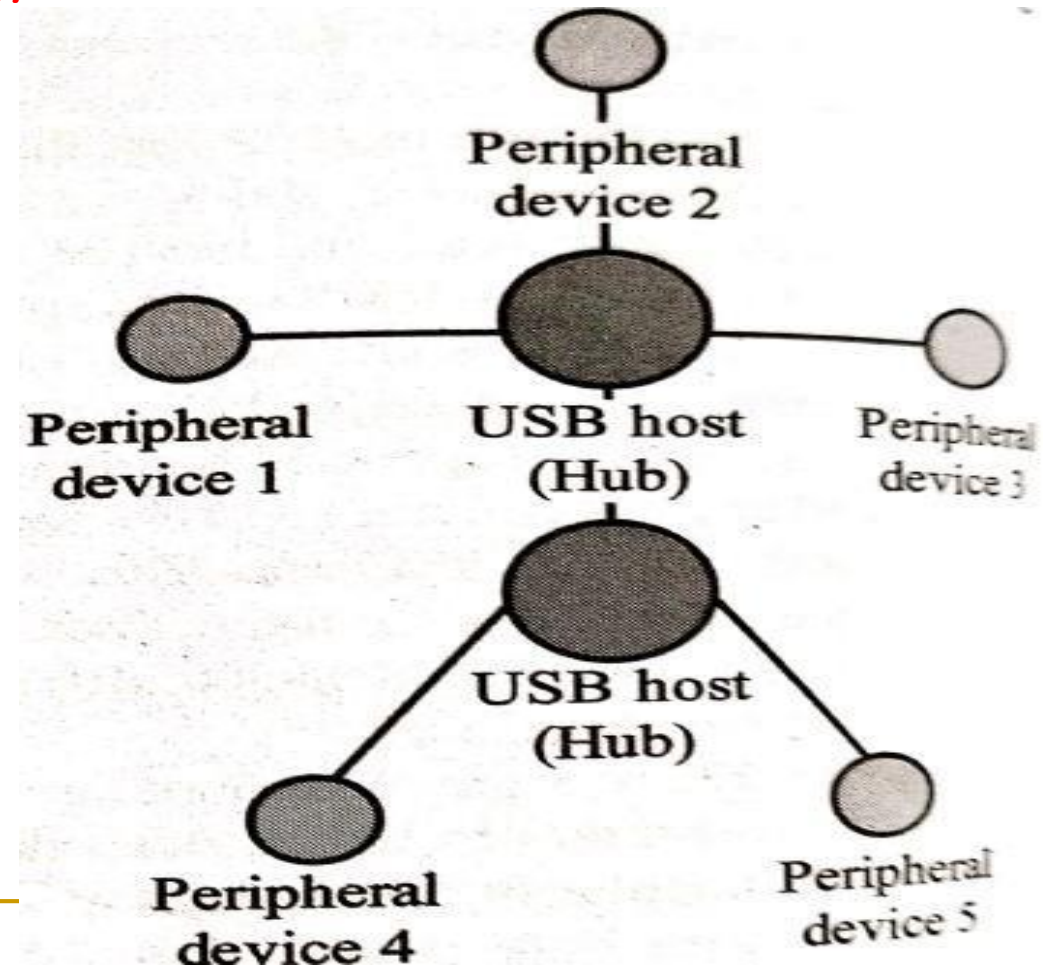
- » RS-232 supports only point-to-point communication and not suitable for multi-drop communication. It uses single ended data transfer technique for signal transmission and thereby more susceptible to noise and it greatly reduces the operating distance.
- » RS-422 is another serial interface standard from EIA for differential data communication. It supports data rates up to 100Kbps and distance up to 400 ft.
- » RS-422 supports multi-drop communication with one transmitter device and receiver devices up to 10.
- » RS-485 is the enhanced version of RS-422 and it supports multi-drop communication with up to 32 transmitting devices (drivers) and 32 receiving devices on the bus. The communication between devices in the bus uses the 'addressing' mechanism to identify slave devices.

External Communication Interfaces-USB

- » *Universal Serial Bus (USB): Universal Serial Bus* is a wired high speed serial bus for data communication.
- » The first version of USB (*USB 1.0*) was released in 1995 and was created by the USB core group members consisting of Intel, Microsoft, IBM, Compaq, Digital and Northern Telecom.
- » The USB communication system follows a star topology with a USB host at the centre and one or more USB peripheral devices/ USB hosts connected to it.
- » A USB 2.0 host can support connections up to 127, including slave peripheral devices and other USB hosts.

» The following Figure illustrates the star topology for USB device connection.

- » USB transmits data in packet format.
- » Each data packet has a standard format.
- » The USB communication is a host initiated one.
- » The USB host contains a host controller which is responsible for controlling the data communication, including establishing connectivity with USB slave devices, packetizing and formatting the data.



USB-Cont

- » There are different standards for implementing the USB Host Control interface; namely Open Host Control Interface (OHCI) and Universal Host Control Interface (UHCI).
- » The physical connection between a USB peripheral device and master device is established with a USB cable. The USB cable in USB 2.0 supports communication distance of up to 5 meters.
- » The USB 2.0 standard uses two different types of connector at the ends of the USB cable for connecting the USB peripheral device and host device.
 - ❑ 'Type A' connector is used for upstream connection (connection with host) and Type B connector is used for downstream connection (connection with slave device).
 - ❑ The USB connector present in desktop PCs or laptops are examples for 'Type A' USB connector.
 - ❑ Both Type A and Type B connectors contain 4 pins for communication.

USB-Cont

Pin No.	Pin Name	Description
1	V _{BUS}	Carries power (5V)
2	D ⁻	Differential data carrier line
3	D ⁺	Differential data carrier line
4	GND	Ground signal line

- » The **Pin details for the connectors** are listed in the table given above.
- » USB uses differential signals for data transmission. It improves the noise immunity.
- » USB interface has the ability to supply power to the connecting devices. Two connection lines (Ground and Power) of the USB interface are dedicated for carrying power. It can supply power up to 500 mA at 5 V.

USB-Cont

- » USB supports four different types of data transfers, namely; Control, Bulk, Isochronous and Interrupt.
- » *Control transfer* is used by USB system software to query, configure and issue commands to the USB device.
- » *Bulk transfer* is used for sending a block of data to a device. Bulk transfer supports error checking and correction.
 - ❑ Transferring data to a printer is an example for bulk transfer.
- » *Isochronous data transfer* is used for real-time data communication. In Isochronous transfer, data is transmitted as streams in real-time. Isochronous transfer doesn't support error checking and retransmission of data in case of any transmission loss.
 - ❑ All streaming devices like audio devices and medical equipment for data collection make use of the isochronous transfer.

USB-Cont

- » *Interrupt transfer* is used for transferring small amount of data.
- » Interrupt transfer mechanism makes use of polling technique to see whether the USB device has any data to send.
- » The frequency of polling is determined by the USB device and it varies from 1 to 255 milliseconds.
 - ❑ Devices like Mouse and Keyboard, which transmits fewer amounts of data, uses Interrupt transfer.

IEEE 1394 (Firewire)

- » *IEEE 1394 (Firewire): IEEE 1394* is a wired isochronous high speed serial communication bus. It is also known as *High Performance Serial Bus (HPSB)*.
- » The research on 1394 was started by Apple Inc. in 1985 and the standard for this was coined by IEEE.
- » The implementation of it is available from various players with different names.
 - ❑ Apple Inc's implementation of 1394 protocol is popularly known as *Firewire*.
 - ❑ *i.LINK* is the 1394 implementation from Sony Corporation
 - ❑ *Lynx* is the implementation from Texas Instruments.

IEEE 1394 (Firewire)

- » 1394 supports peer-to-peer connection and point-to-multipoint communication allowing 63 devices to be connected on the bus in a tree topology. 1394 is a wired serial interface and it can support a cable length of up to 15 feet for interconnection.
- » There are two differential data transfer lines *A* and *B* per connector.
- » In a 1394 cable, normally the differential lines of A are connected to B (TPA+ to TPB+ and TPA- to TPB-) and vice versa.
- » 1394 is a popular communication interface for connecting embedded devices like Digital Camera, Camcorder, Scanners to desktop computers for data transfer and storage.

Thank You