Microcontroller & Embedded Systems- Module-3-2

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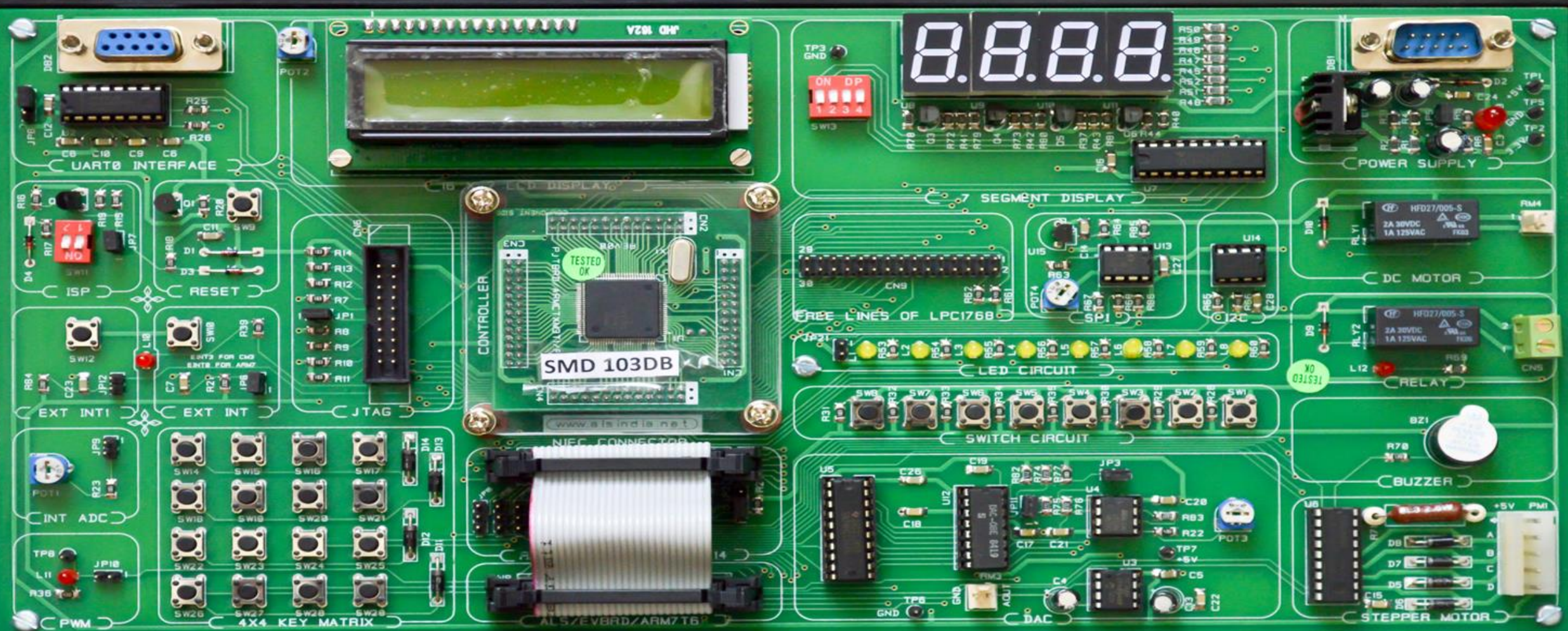3.2.3 Sensors and Actuators

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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
ALS-SDA-ARM7-06

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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:Infrared

» ***Infrared (IrDA):*** *Infrared* is a serial, half duplex, line of sight based wireless technology for data communication between devices.

» IrDA is in use from the olden days of communication and you may be very familiar with it.

  ❑ The remote control of your TV, VCD player, etc., works on Infrared data communication principle.

» Infrared communication technique uses infrared waves of the electromagnetic spectrum for transmitting the data.

» IrDA supports point-point and point-to-multipoint communication, provided all devices involved in the communication are within the line of sight.

» The typical communication range for IrDA lies in the range l0 cm to 1 m. The range can be increased by increasing the transmitting power of the IR device.

*External **Communication** Interfaces:Infrared*

» IR supports data rates ranging from 9600bits/second to 16Mbps.

» Depending on the speed of data transmission IR is classified into Serial IR (SIR), Medium IR (MIR), Fast IR (FIR), Very Fast IR (VFIR) and Ultra Fast IR (UFIR).

- ❑ SIR supports transmission rates ranging from 9600bps to 115.2kbps.

- ❑ MIR supports data rates of 0.576Mbps and 1.152Mbps.

- ❑ FIR supports data rates up to 4Mbps.

- ❑ VFIR is designed to support high data rates up to 16Mbps.

- ❑ The UFIR supports up to 96Mbps.

External *Communication* Interfaces:Infrared

» IrDA communication involves a transmitter unit for transmitting the data over IR and a receiver for receiving the data.

» Infrared Light Emitting Diode (LED) is the IR source for transmitter and at the receiving end a photodiode acts as the receiver.

» Both transmitter and receiver unit will be present in each device supporting IrDA communication for bidirectional data transfer. Such IR units are known as '*Transceiver*'.

» Certain devices like a TV require control always require unidirectional communication and so they contain either the transmitter or receiver unit (The remote control unit contains the transmitter unit and TV contains the receiver unit).

External Communication Interfaces:Bluetooth

» ***Bluetooth (BT):*** *Bluetooth* is a low cost, low power, short range wireless technology for data and voice communication.

» Bluetooth was first proposed by 'Ericsson' in 1994.

» Bluetooth operates at 2.4GHz of the Radio Frequency spectrum and uses the Frequency Hopping Spread Spectrum (FHSS) technique for communication.

» Literally it supports a data rate of up to 1Mbps and a range of approximately 30 to 100 feet (version dependent) for data communication.

External Communication Interfaces:Bluetooth

» Like IrDA, Bluetooth communication also has two essential parts; a physical link part and a protocol part.

- ❑ The *physical link* is responsible for the physical transmission of data between devices supporting Bluetooth communication. The physical link works on the wireless principle making use of RF waves for communication. Bluetooth enabled devices essentially contain a Bluetooth wireless radio for the transmission and reception of data.

- ❑ The *protocol part* is responsible for defining the rules of communication. The rules governing the Bluetooth communication is implemented in the '*Bluetooth protocol stack*'.

External Communication Interfaces:Bluetooth

» Each Bluetooth device will have a 48-bit unique identification number. Bluetooth communication follows packet based data transfer.

» Bluetooth supports point-to-point (device to device) and point-to-multipoint (device to multiple device broadcasting) wireless communication.

» The point-to-point communication follows the master slave relationship. A Bluetooth device can function as either master or slave.

» When a network is formed with one Bluetooth device as master and more than one device as slaves, it is called a *Piconet*.

» A Piconet supports a maximum of seven slave devices.

External Interfaces-Wi-Fi

» **Wi-Fi:** *Wi-Fi* or *Wireless Fidelity* is the popular wireless communication technique for networked communication of devices.

» Wi-Fi follows the IEEE 802.11 standard. Wi-Fi is intended for network communication and supports Internet Protocol (IP) based communication. It is essential to have device identities in a multi-point communication to address specific devices for data communication.

» In an IP based communication each device is identified by an IP address, which is unique to each device on the network.

» Wi-Fi based communications require an intermediate agent called Wi-Fi router/ Wireless Access point to manage the communications.

❑ The Wi-Fi router is responsible for restricting the access to a network, assigning IP address to devices on the network, routing data packets to the intended devices on the network.

External Interfaces-Wi-Fi

» Wi-Fi enabled devices contain a wireless adaptor for transmitting and receiving data in the form of radio signals through an antenna. The hardware part of it is known as Wi-Fi Radio.

» Wi-Fi operates at 2.4GHz or 5GHz of radio spectrum and they co-exist with other ISM band devices like Bluetooth.

» The following Figure illustrates the typical interfacing of devices in a Wi-Fi network.
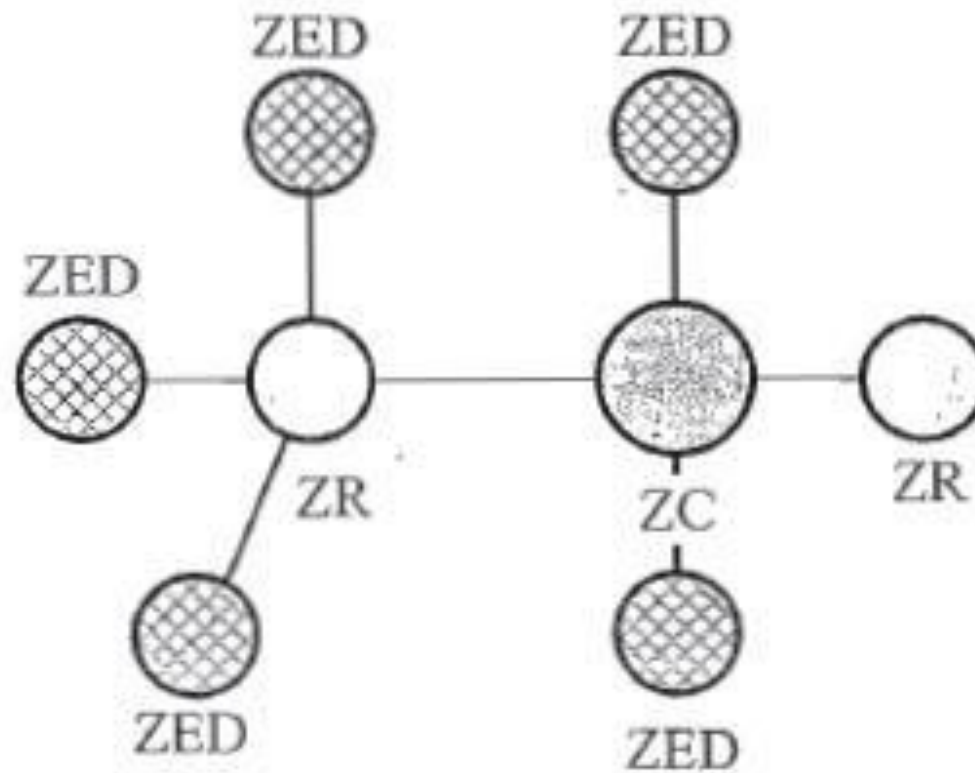
External Interfaces-ZigBee

» ***ZigBee:*** *ZigBee* is a low power, low cost, wireless network communication protocol based on the IEEE 802.15.4-2006 standard.

» ZigBee is targeted for low power, low data rate and secure applications for Wireless Personal Area Networking (WPAN).

» The ZigBee specifications support a robust mesh network containing multiple nodes. This networking strategy makes the network reliable by permitting messages to travel through a number of different paths to get from one node to another.

» ZigBee operates worldwide at the unlicensed bands of Radio spectrum, mainly at *2.400 to 2.484 GHz, 902 to 928 MHz* and *868.0 to 868.6 MHz*.

» ZigBee Supports an operating distance of up to 100 meters and a data rate of 20 to 250Kbps.

External Interfaces-ZigBee

» In the ZigBee terminology, each ZigBee device falls under any one of the following ZigBee device category:

  » *ZigBee Coordinator (ZC)/ Network Coordinator:* The ZigBee coordinator acts as the root of the ZigBee network. The ZC is responsible for initiating the ZigBee network and it has the capability to store information about the network.

  » *ZigBee Router (ZR)/ Full Function Device (FFD):* Responsible for passing information from device to another device or to another ZR.

  » *ZigBee End Device (ZED)/ Reduced Function Device (RFD):* End device containing ZigBee functionality for data communication. It can talk only with a ZR or ZC and doesn't have the capability to act as a mediator for transferring data from one device to another.

External Interfaces-ZigBee

The following Figure gives an overview of ZC, ZED and ZR in a ZigBee network:

External Interfaces-GPRS

» *General Packet Radio Service (GPRS), 3G, 4G, LTE:* *General Packet Radio Service* is a communication technique for transferring data over a mobile communication network like GSM.

» Data is sent as packets in GPRS communication. The transmitting device splits the Data into several related packets.

» At the receiving end the data is re-constructed by combining the received data packets.

» GPRS supports a theoretical maximum transfer rate of 171.2kbps.

» In GPRS communication, the radio channel is concurrently shared between several users instead of dedicating a radio channel to a cell phone user. The GPRS communication divides the channel into 8 timeslots and transmits data over the available channel.

External Interfaces-GPRS

» GPRS supports Internet Protocol (IP), Point to Point Protocol (PPP) and X.25 protocols for communication.

» GPRS is mainly used by mobile enabled embedded devices for data communication. The device should support the necessary GPRS hardware like GPRS modem and GPRS radio.

» To accomplish GPRS based communication, the carrier network also should have support for GPRS communication. GPRS is an old technology and it is being replaced by new generation data communication techniques like EDGE, High Speed Downlink Packet Access (HSDPA), etc. which offers higher bandwidths for communication.

Thank You