I2C Communication Protocol

I2C Stands for Inter - Integrated Circuit. It is a bus interface connection Protocol incorporated into devices for Serial communication. It was originally designed by Philips Semiconductor.

It is a widely used Protocol for short distance communication. It is also known as Two wire interface (TWI).

Working of I2C Communication Protocol :

It uses only 2 bi-directional open-drain lines for data communication called SDA and SCL. Both these lines are Pulled High.

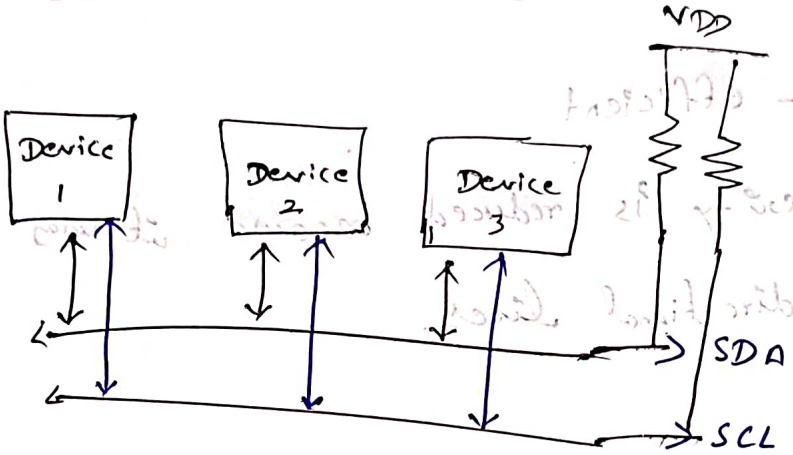
Serial Data (SDA) - Transfer of data takes place through this Pin

Serial Clock (SCL) - It carries the clk signal.

I2C operates in 2 modes -

* Master Mode
* Slave Mode

Each data bit transferred on SDA line is synchronized by a high to the low Pulse of each Clock on the SCL line.



The data line can not change when the Clock line is high, it can change only when the clock line is Low. The 2 lines are open drain, hence a pull-up resistor is required so that the lines are high since, the devices on the I2C bus are active low.

The data is transmitted in the form of Packets which Comprises 9 bits. The sequence of these bits are,

1. Start Condition - 1 bit
2. Slave Address - 8 bit
3. Acknowledge - 1 bit

Advantages:

* Can be Configured in multi-master mode
* Cost - efficient
* Complexity is reduced because it uses only 2 bi-directional lines.

Limitations:

* Slower speed.
* Half-duplex communication is used in the I2C communication Protocol.

Pull-up Resistors

Pull-up and Pull-down resistors are used to correctly bias the inputs of digital gates to stop them from floating about randomly when there is no input condition

Digital logic gates can be used for connection to external circuits or devices but care must be taken to ensure that their inputs or outputs function correctly and provide the expected switching condition.

Pull-down Resistors

A *Pull-down resistor* works in the same way as the previous pull-up resistor, except this time the logic gates input is tied to ground, logic level “0” (LOW) or it may go HIGH by the operation of a mechanical switch. This pull-down resistor configuration is particularly useful for digital circuits like latches, counters and flip-flops that require a positive one-shot trigger when a switch is momentarily closed to cause a state change.

While they may seem to operate in the same way as the pull-up resistor, the resistive value of a passive pull-down resistor is more critical with TTL logic gates than with similar CMOS gates. This is because a TTL input sources much more current out of its input in its LOW state.

Open-drain

An open-drain or open-collector output pin is driven by a single transistor, which pulls the pin to only one voltage (generally, to ground). When the output device is off, the pin is left floating

Active-Low and Active-High

When working with ICs and microcontrollers, you'll likely encounter pins that are active-low and pins that are active-high. Simply put, this just describes how the pin is activated. If it's an active-low pin, you must "pull" that pin LOW by connecting it to ground. For an active high pin, you connect it to your HIGH voltage.

Linux booting process and the role of Kernel.

1.BIOS

BIOS stands for Basic Input/Output System. In simple terms, the BIOS loads and executes the Master Boot Record (MBR) boot loader.

When you first turn on your computer, the BIOS first performs some integrity checks of the HDD or SSD.

Then, the BIOS searches for, loads, and executes the boot loader program, which can be found in the Master Boot Record (MBR). The MBR is sometimes on a USB stick or CD-ROM such as with a live installation of Linux.

Once the boot loader program is detected, it's then loaded into memory and the BIOS gives control of the system to it.

2. MBR

MBR stands for Master Boot Record, and is responsible for loading and executing the GRUB boot loader.

The MBR is located in the 1st sector of the bootable disk, which is typically `/dev/hda`, or `/dev/sda`, depending on your hardware. The MBR also contains information about GRUB, or LILO in very old systems.

3. GRUB

Sometimes called GNU GRUB, which is short for GNU GRand Unified Bootloader, is the typical boot loader for most modern Linux systems.

The GRUB splash screen is often the first thing you see when you boot your computer. It has a simple menu where you can select some options. If you have multiple kernel images installed, you can use your keyboard to select the one you want your system to boot with. By default, the latest kernel image is selected.

The splash screen will wait a few seconds for you to select and option. If you don't, it will load the default kernel image.

4. Kernel

The kernel is often referred to as the core of any operating system, Linux included. It has complete control over everything in your system.

In this stage of the boot process, the kernel that was selected by GRUB first mounts the root file system that's specified in the grub.conf file. Then it executes the /sbin/init program, which is always the first program to be executed. You can confirm this with its process id (PID), which should always be 1.

The kernel then establishes a temporary root file system using Initial RAM Disk (initrd) until the real file system is mounted.

5. Init

At this point, your system executes runlevel programs. At one point it would look for an init file, usually found at /etc/inittab to decide the Linux run level.Modern Linux systems use systemd to choose a run level instead

If you look in the different run level directories, you'll find programs that start with either an "S" or "K" for startup and kill, respectively. Startup programs are executed during system startup, and kill programs during shutdown

Zephyr RTOS

Zephyr is a **small real-time operating system for connected, resource-constrained and embedded devices** (with an emphasis on microcontrollers) supporting multiple architectures and released under the Apache License 2.0.

Zephyr intends to provide all components needed to develop resource-constrained and embedded or microcontroller-based applications. This includes, but is not limited to.

A small kernel

A flexible configuration and build system for compile-time definition of required resources and modules

A set of protocol stacks (IPv4 and IPv6, Constrained Application Protocol (CoAP), LwM2M, MQTT, 802.15.4, Thread, Bluetooth Low Energy, CAN)

A virtual file system interface with several flash file systems for non-volatile storage (FATFS, LittleFS, NVS)

Management and device firmware update mechanisms