

# Assignment #1

## Aim:

In this report, we aim to showcase the various microcontroller families currently existing and to showcase some of the characteristics of each family. After that, we will make a specific comparison between the ARM Cortex-M4F microcontroller and the PIC16F877A.

## Different Types and their Main Characteristics:

- **PIC Microcontroller:** used in electronics design, computer robotics, and similar devices, a PIC (Peripheral Interface Controller) includes an integrated memory, and data bus together with a dedicated microprocessor for all I/O purposes and methods. The flexibility and efficiency of PIC microcontrollers make them a staple in hobbyist projects and professional applications.
- **ARM (Advanced RISC Machine) Microcontroller:** is highly popular in the industrial sector due to its balance of quality, performance, and cost. Its advantages include not only a small size with high performance but also energy efficiency. ARM's architecture is renowned for its low power consumption and high-speed processing capabilities, making it a favorite among developers focusing on portable devices.
- **8051 Microcontroller:** was created by Intel in the 1980s. It is an 8-bit microcontroller capable of processing 8 bits of data at a time. It finds application in various embedded systems including robotics, remote controls, automotive, medical devices, telecommunication applications, power tools, and consumer appliances. Its enduring popularity underscores the 8051's reliability and ease of use in a wide range of applications.
- **AVR Microcontroller (Atmel's RISC Processor):** it was among the pioneering microcontroller families to use internal flash memory to store program content. It allows the program memory to be erased and rewritten with a new version. Furthermore, it is not necessary to remove the microcontroller from the board on which it is mounted. AVR microcontrollers are celebrated for their user-friendly nature, offering a seamless experience for both beginners and seasoned developers.

- **MSP Microcontroller (Mixed Signal Processor):** it is a type of microcontroller specifically designed for low-cost and low-power dissipation in embedded applications. MSPs are 16-bit mixed-signal processors for ultra-low-power RISC-based systems. Their unique blend of analog and digital capabilities opens up a world of possibilities for innovative embedded system designs.
- **STM32:** STM32 microcontrollers are produced by STMicroelectronics and are used in a wide range of applications, including industrial automation, consumer electronics, and automotive. They are known for their high performance, low power consumption, and extensive range of peripherals.

### Architecture Used by Each Family:

- **PIC:** PIC microcontrollers are based on the Harvard architecture where program and data busses are kept separate. Early versions of PIC microcontrollers use EPROM to store the program instruction but have adopted flash memory since 2002 to allow better erasing and storing of the code.
- **ARM:** The Arm architecture is a family of reduced instruction set computing (RISC) architectures for computer processors. The Arm CPU architecture is implemented by a wide range of microarchitectures to deliver software compatibility across a broad range of power, performance, and area points.
- **8051:** The 8051 microcontroller is a Harvard architecture 8-bit microcontroller. It has a RISC (Reduced Instruction Set Computing) architecture. It features a single accumulator, 16-bit program counter, and 8-bit data bus. It has 4KB of on-chip program memory (ROM). It also has 128 bytes of on-chip data memory (RAM) with a built-in memory controller.
- **AVR:** These microcontrollers are built using a modified Harvard Architecture. This means the Flash Program Memory space is on a separate address bus from the Static Random Access Memory (SRAM). There are two data buses, one that can access all data and the In/Out data bus with limited access to a small section of memory.

- **MSP:** The MSP430 is based on a 16-bit Reduced Instruction Set Computer (RISC) architecture, which allows for efficient instruction execution and minimal power consumption.
- **STM32:** The STM32 is a family of microcontroller ICs based on various 32-bit RISC ARM Cortex-M cores. STMicroelectronics licenses the ARM Processor IP from ARM Holdings. The ARM core designs have numerous configurable options, and ST chooses the individual configuration to use for each design.

### Differences between ARM Cortex-M4F and PIC16F877A:

| <i>Comparison</i>         | ARM Cortex-M4F   | PIC16F877A   |
|---------------------------|--|--|
| <i>Architecture</i>       | 32-bit ARM architecture  | 8-bit architecture   |
| <i>Performance</i>        | Runs at higher clock speeds (up to 168 MHz)                                    | Runs at lower clock speeds (up to 20 MHz)  |
| <i>Floating Point</i>     | Includes FPU – as shown by the F in the model – for efficient math operations. | Lacks a hardware FPU, and primarily handles integer operations.                        |
| <i>Memory</i>             | Supports larger memory configurations.   | Limited memory (up to 368 bytes of RAM and 14 KB of flash).                            |
| <i>Peripheral Support</i> | Supports more advanced peripherals and interfaces. (DMA, USB, CAN)             | Supports fewer and simpler peripherals. (basic timers, ADC, and UART)                  |
| <i>Power Efficiency</i>   | Designed for low-power consumption with various low-power modes.               | Low power consumption but fewer power modes compared to the M4F                        |
| <i>Development Tools</i>  | Supported extensively by modern IDEs and toolchains. (Keil, IAR, GCC)          | Supported by MPLAB IDE and Microchip's toolchain.                                      |
| <i>Applications</i>       | Used in complex applications like motor control, and audio processing.         | Used in simple control applications like home automation and basic sensor interfacing. |

