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MICROCONTROLLER FAMILIES

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EMBEDDDED SYSTEM

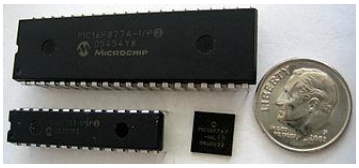
The different microcontroller families

Introduction

Microcontrollers (MCUs) are compact integrated circuits designed to govern a specific operation in an embedded system. They come in various families and brands, each with distinct features, architectures, and applications

Microcontroller Families

1.PIC Microcontrollers



- **Brand**: Microchip Technology
- **Architecture**: 8-bit, 16-bit, and 32-bit
- **Application**:
    - Consumer electronics (e.g., televisions, DVD players, gaming consoles)
    - Automotive systems (e.g., engine control units, airbag systems, anti-lock braking systems)
    - Industrial automation
    - Smartphones, audio accessories, video gaming peripherals, and advanced medical devices

PIC is a family of microcontrollers made by Microchip Technology, derived from the PIC1640 originally developed by General Instrument's Microelectronics Division. The name PIC initially referred to Peripheral Interface Controller, and is currently expanded as Programmable Intelligent Computer

2. AVR Microcontrollers

- **Brand**: Atmel (now part of Microchip)
- **Architecture**: 8-bit and 32-bit
- **Applications**:

  AVR microcontroller is mainly used in an embedded system for the operation of high-speed signal processing

- Touch screens
- Home automation
- Medical devices
- Defense
- Automobiles
- LED Matrix Interfacing
- UART communication between Arduino Uno and ATmega8

AVR is a family of microcontrollers developed since 1996 by Atmel, acquired by Microchip Technology in 2016. These are modified Harvard architecture 8-bit RISC single-chip microcontrollers. AVR was one of the first microcontroller families to use on-chip flash memory for program storage, as opposed to one-time programmable ROM, EPROM, or EEPROM used by other microcontrollers at the time.

AVR microcontrollers find many applications as embedded systems. They are especially common in hobbyist and educational embedded applications, popularized by their inclusion in many of the Arduino line of open hardware development boards.

3. ARM Microcontrollers

- **Brand**: Various manufacturers (e.g., STMicroelectronics, NXP, Texas Instruments)
- **Architecture**: 32-bit and 64-bit
- **Applications**:

- **Consumer Electronics**: ARM processors are widely used in smartph ones, tablets, and other portable devices due to their low power cons umption and high performance.

- **Automotive Industry**: They are used in automotive systems for engin e control units, infotainment systems, and advanced driver-assistance systems (ADAS).
- **Industrial Automation**: ARM microcontrollers are employed in indus trial control systems, robotics, and automation equipment for their re liability and efficiency.

- **Internet of Things (IoT)**: ARM-
  based microcontrollers are popular in IoT devices, such as smart ho
  me appliances, wearable technology, and sensor networks3.
- **Medical Devices**: They are used in medical equipment like patient m
  onitoring systems, diagnostic devices, and portable health monitors.

4.MSP430 Microcontrollers

- **Brand**: Texas Instruments
- **Architecture**: 16-bit

MSP430 is a 16-bit microcontroller123that has a number of special features not commonly available with other microcontrollers, including:

- Complete system on-a-chip, including LCD control, ADC, I/O ports, ROM, RAM, basic timer, watchdog timer, UART, etc.
- Extremely low power consumption, only 4.2 nW per instruction, typical1
- Rich addressing mode, concise 27 kernel instructions, and a large number of analog instructions
- Digitally controlled oscillator (DCO) that converts low power modes to active mode in less than 6μs
- 16-bit registers and a large number of on-chip data memory
- Highly efficient look-up table processing instructions

5. 8051 Microcontrollers

- **Brand**: Various (Intel, Silicon Labs, NXP)
- **Architecture**: 8-bit

8051 is one of the first and most popular microcontrollers also known as MCS-51. Intel introduced it in the year 1981. Initially, it came out as an N-type metal-oxide-semiconductor (NMOS) based microcontroller, but later versions were based on complementary metal-oxide-semiconductor(CMOS) technology. These microcontrollers were named 80C51, where C in the name tells that it is based on CMOS technology. It is an 8-bit microcontroller which means the data bus is 8-bit.

Therefore, it can process 8 bits at a time. It is used in a wide variety of embedded systems like robotics, remote controls, the automotive industry, telecom applications, power tools, etc.

PIC16F877A vs. ARM Microcontrollers(Cortex-M4)

1. Overview of PIC16F877A

- **Architecture**: 8-bit
- **Clock Speed**: Up to 20 MHz
- **Memory**:
  - Flash: 14 KB
  - RAM: 368 Bytes
  - EEPROM: 256 Bytes
- **I/O Ports**: 33 I/O pins
- **Features**:
  - Integrated ADC (10-bit)
  - Timer modules (3)
  - PWM outputs
  - Serial communication (USART)
- **Power Consumption**: Low power modes available

2. Overview of ARM Cortex-M4

- **Architecture**: 32-bit
- **Manufacturer**: Various (e.g., STMicroelectronics, NXP, Texas Instruments)
- **Clock Speed**: Up to 180 MHz (varies by model)
- **Memory**:
  - Flash: Up to 1 MB (depending on the model)
  - RAM: Up to 128 KB (or more)
- **I/O Ports**: Varies by specific implementation (up to 168 pins)
- **Features**:
  - 12-bit ADC (or higher)
  - Floating-point unit (FPU)
  - Digital signal processing (DSP) capabilities
  - Multiple communication interfaces (I2C, SPI, CAN, USB)

- **Power Consumption**: Highly optimized for low power with various sleep modes.

3. Comparison of Features

Feature	PIC16F877A	ARM Cortex-M4
Architecture	8-bit	32-bit
Clock Speed	Up to 20 MHz	Up to 180 MHz
Flash Memory	14 KB	Up to 1 MB
RAM	368 Bytes	Up to 128 KB (or more)
ADC	10-bit	12-bit (or higher)
DSP Capabilities	No	Yes
I/O Ports	33	Up to 168
Development Tools	MPLAB IDE	Various (Keil, IAR, STM32)
Power Consumption	Low	Highly optimized
Applications	Basic control tasks	Complex, resource-intensive tasks