**Report 1**

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**سكشن:1**

**رقم تسلسلي:5**

**Microcontroller Families**

**1-ARM Cortex-Based MCUs**

ARM Cortex cores are popular across a wide range of applications due to their balance between performance and power efficiency. Major categories include:

Cortex-M Series: Designed for embedded systems with low power requirements, such as IoT devices and smart home applications.

Cortex-R Series: Real-time processing, used in automotive safety systems and industrial control.

Cortex-A Series: Higher performance, intended for more complex applications like mobile devices and multimedia systems.

**2-AVR Microcontrollers**

AVR MCUs, developed by Atmel (now Microchip Technology), are known for their simplicity and are widely used in educational tools and hobbyist projects such as Arduino.

8-bit AVR: Simple, cost-effective, and widely used in small-scale embedded applications.

32-bit AVR: Offers higher performance but is less common compared to ARM-based alternatives.

**3-PIC Microcontrollers**

Produced by Microchip Technology, PIC microcontrollers are found in applications ranging from industrial automation to consumer electronics.

PIC (8-bit): Low-cost and versatile for small-scale applications.

PIC (16-bit): Features higher processing power and digital signal processing capabilities.

PIC (32-bit): Suitable for complex applications, such as motor control and communication.

**4-8051 Microcontrollers**

The 8051 architectures, introduced by Intel, is one of the oldest MCU families still in use. It remains popular in simple embedded systems.

8051 Variants: Known for their robustness and simplicity, they are often used in legacy systems and consumer devices.

**5-MSP430 Microcontrollers**

Texas Instruments’ MSP430 family is designed for ultra-low-power applications. They are commonly found in battery-powered devices such as wearables and medical instruments.

**6-RISC-V Microcontrollers**

RISC-V is an open-source Instruction Set Architecture (ISA) gaining traction due to its flexibility and potential for innovation. Manufacturers like SiFive produce RISC-V MCUs for low-power IoT applications.

**Comparison between PIC16C65A and TM4C123GH6PM Microcontroller**

**1- Architecture**

**PIC16C65A**:

**Core**: 8-bit Harvard architecture

**Processor**: PIC16 (from the PIC microcontroller family by Microchip)

**Instruction Set**: Reduced Instruction Set Computing (RISC)

**Clock Speed**: Up to 20 MHz

**Instruction Cycle**: 4 clock cycles per instruction cycle

**TM4C123GH6PM**:

**Core**: 32-bit ARM Cortex-M4F architecture

**Processor**: ARM Cortex-M4 with a floating-point unit (FPU)(optional)

**Instruction Set**: ARM Thumb (RISC)

**Clock Speed**: Up to 80 MHz

**Instruction Cycle**: 1 clock cycle per instruction

**2-Memory**

**PIC16C65A**:

**Flash Program Memory**: 12 KB

**Data Memory (RAM)**: 192 bytes

**EEPROM**: No internal EEPROM

**Instruction Size**: 14 bits

**TM4C123GH6PM**:

**Flash Program Memory**: 256 KB

**Data Memory (SRAM)**: 32 KB

**EEPROM**: 2 KB

**Instruction Size**: 32 bits

**3- Performance**

**PIC16C65A**:

**Bit Size**: 8-bit

**Performance**: Suitable for simple control applications, limited by the 8-bit architecture and slower clock rate. Due to slow clock rate, it does not support DSP.

**TM4C123GH6PM**:

**Bit Size**: 32-bit

**Performance**: Significantly higher performance due to the 32-bit architecture, faster clock rate, and support for floating-point operations and support DSP.

**4-Pins**

**PIC16C65A:**

**Number of Pins: 40 pins (for DIP package)**

**Pin Functions:**

The PIC16C65A is a general-purpose 8-bit microcontroller with the following pin configurations:

**1-Power Pins:**

Vdd: Power supply voltage (typically 5V)

Vss: Ground

**2-Oscillator Pins:**

OSC1/CLKIN: Clock input

OSC2/CLKOUT: Clock output

**3-I/O Pins:**

PORTA (RA0 - RA5): General-purpose I/O pins, can be used for digital input/output. Some of these pins also function as analog inputs (AN0 - AN4).

PORTB (RB0 - RB7): 8-bit general-purpose I/O port with interrupt-on-change feature on PORTB pins.

PORTC (RC0 - RC7): Another 8-bit general-purpose I/O port, can be used for digital input/output.

**4-Peripheral Pins:**

T0CKI: External clock input for Timer0

MCLR: Master Clear pin (reset input)

SS/AN3: Slave Select pin for SPI communication and analog input (AN3)

PGD/PGC: Programming Data and Clock pins used for in-circuit programming

**5-Communication Interface Pins:**

TX/RC6: Transmit pin for UART communication

RX/RC7: Receive pin for UART communication

SDI/SCK/SS: SPI communication pins

**6-Interrupt Pins:**

INT/RB0: External interrupt pin

**7-Timer Pins:**

Some of the I/O pins can also function as inputs/outputs for the timer modules**.**

**TM4C123GH6PM:**

**Number of Pins: 64 pins**

**1-Power Pins:**

VDD: Power supply voltage (typically 3.3V)

GND: Ground

VREF: Voltage reference pin for ADC

**2-Oscillator Pins:**

XTAL0: Crystal input

XTAL1: Crystal output

**3-I/O Pins:**

Ports (PORTA to PORTF): The TM4C123GH6PM has 6 GPIO ports (A, B, C, D, E, F) with up to 43 GPIO pins that can be configured as input/output. Each pin can serve multiple functions such as UART, SPI, I2C, PWM, etc.

**4-Communication Interface Pins:**

UART (8): Multiple UART channels for serial communication (PA0, PA1, PB0, PB1, PC4, PC5, etc.).

SPI (4): Supports 4 SPI channels with pins such as SSI0Clk, SSI0Tx, SSI0Rx.

I2C (4): Multiple I2C interfaces (pins like PB2/SCL, PB3/SDA).

USB Pins: The microcontroller has dedicated pins for USB communication.

**5-PWM Pins**:

PWM Generators: Several pins are available for Pulse Width Modulation (PWM) outputs, such as PF0, PF1, PF2, PF3, and PA6.

**6-Timer Pins**:

TIMER0 - TIMER5: Dedicated pins are available for the timers that can be configured for different input/output operations.

**7-Analog Pins:**

ADC Pins: 12-channel ADC with dedicated pins such as PE3, PE2, PE1, PE0, etc.

**8-Interrupt Pins:**

The microcontroller supports multiple interrupts, and any GPIO pin can be used as an external interrupt source.

**9-JTAG/SWD Pins:**

Dedicated pins for JTAG (PD0, PD1, PD2, PD3) or Serial Wire Debug (SWD).

**10-Special Function Pins:**

NMI (Non-Maskable Interrupt): Available on some GPIO pins.

CAN: The device supports the CAN communication protocol with dedicated pins.

**5-Power**

**PIC16C65A**:

**Operating Voltage**: 4.0V to 5.5V

**Power Consumption**: lower than TM4C123GH6PM due to simpler architecture and slower speeds

**TM4C123GH6PM**:

**Operating Voltage**: 3.0V to 3.6V

**Power Consumption**: Higher power consumption, but it supports advanced power modes like hibernation and sleep for power savings

**6-Special Features**

**PIC16C65A**:

**Low Power Modes**: Sleep mode

**TM4C123GH6PM**:

**Floating-Point Unit (FPU)**: Yes

**Low Power Modes**: Sleep, deep sleep.

**Hardware Division & DSP Support**: hardware support for integer division and Digital Signal Processing)

**7- Applications**

**PIC16C65A**:

Simple control applications

Basic sensor interfacing

Industrial automation, embedded control

**TM4C123GH6PM**:

High-performance embedded systems

Real-time control applications

Motor control, data acquisition, advanced communication