Embedded Systems

Assignment_1

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A Comprehensive Comparison of TM4C123GH6PM and PIC16F877A Microcontrollers

➢ Introduction

In the world of embedded systems, microcontrollers serve as the heart of many applications, providing the processing power and control necessary for a wide range of devices. Among the many options, two microcontrollers stand out due to their unique architecture and capabilities: the TM4C123GH6PM and the PIC16F877A.

In this document we are going to compare the two devices across many aspects of view. This analysis will provide the reader with a solid foundation of knowledge, enabling an informed decision based on a clear understanding of the differences between these two devices.

➢ Manufacturer Information

- **TM4C123GH6PM - Texas Instruments**
  Texas Instruments **(TI)** is a leading global semiconductor company that designs and manufactures analog, digital signal processing (DSP), and embedded processing chips. **TI** is known for its robust line of microcontrollers and processors, designed for industrial, automotive, and consumer electronics applications.
  The TM4C123GH6PM is part of the **Tiva C Series**, which is widely used for high-performance, real-time embedded applications. This series is based on ARM Cortex-M architectures that we will mention in the next section.

- **PIC16F877A - Microchip Technology**
  Microchip Technology is an American manufacturer specializing in microcontrollers, mixed-signal, analog, and flash-IP integrated circuits. Microchip's PIC microcontrollers are known for their ease of use, affordability, and wide adoption in educational applications.
  The PIC16F877A belongs to the **PIC16F** family, one of the most popular **8-bit** microcontroller series in the world.

➢ Architecture

- **TM4C123GH6PM, ARM Cortex - M4**
  The TM4C123GH6PM is powered by the ARM Cortex-M4 processor, a 32-bit processor built on **RISC** (Reduced Instruction Set Computing) architecture.

- **PIC16F877A, 8-bit PIC Microcontroller**
  The PIC16F877A is based on Harvard architecture with an 8-bit RISC core.

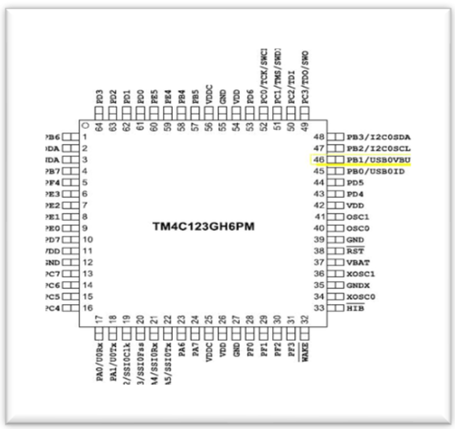
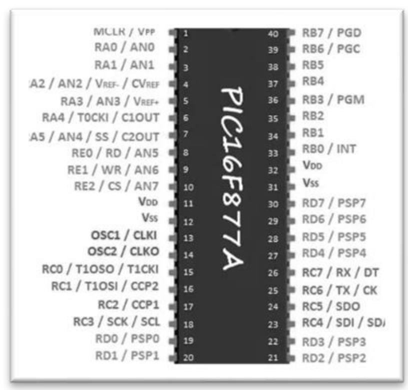
- **Key Features of both**

Feature	TM4C123GH6PM	PIC16F877A
Core Architecture	32-bit ARM Cortex-M4, RISC Based	8-bit PIC RISC architecture
Instruction Set	Thumb-2 (16-bit and 32-bit instructions)	35 simple instructions
Floating Point Unit (FPU)	Yes (hardware-based)	No
DSP Instructions	Yes (includes MAC & Saturated Arithmetic)	No
Harvard Architecture	Yes	Yes
Clock Speed	Yes	Yes
Code Size Optimization	Thumb-2 improves code size efficiency	Simple, minimal instruction set
Power Efficiency	Power-efficient modes and Sleep States	Low-power, simple architecture

- **Area of Application**

Application Area	TM4C123GH6PM	PIC16F877A
Real Time Systems	Ideal for high-performance real-time control systems	Limited to basic timing control
Low-Power Applications	Efficient power management for advanced low-power designs	Naturally low-power due to simple 8-bit architecture
Educational Projects	Suitable for advanced education in embedded systems and real-time applications	Widely used for basic learning in embedded systems

➢ I/O Ports

Aspect	TM4C123GH6PM	PIC16F877A
GBIO Pins	The TM4C123GH6PM has up to 43 GPIO pins, which can be configured as input or output, with **internal** pull-up/pull-down resistors.	The PIC16F877A offers 33 GPIO pins that can be used as input or output with programmable control for analog or digital functions.
USB	Full-speed USB 2.0	No USB support
UART Modules	8	1
Timers	6 general-purpose 16/32-bit timers, 2 watchdog timers	3 timers (1 16-bit, 2 8-bit)
Ports Pic.		

➢ Memory

- **TM4C123GH6PM – Memory Overview**
  Flash Memory: The TM4C123GH6PM comes with 256 KB of Flash memory, used to store the program code.
  SRAM: It has 32 KB of SRAM, used for data storage during runtime.

- **PIC16F877A – Memory Overview**
  Flash Memory: The PIC16F877A has 14 KB of Flash memory. It is much smaller than the TM4C123GH6PM but sufficient for basic applications.
  SRAM: It includes 368 bytes of SRAM, a much smaller RAM space primarily for variable storage during program execution.

➢ Interrupts

- **TM4C123GH6PM – Interrupt's Types**

  - **External Interrupts**: The TM4C123GH6PM supports multiple external interrupts that can be triggered by GPIO pins. This allows for responsive designs that react to external events.
  - **Internal Interrupts:** Various internal peripherals can trigger interrupts, such as timers, ADC, PWM, and communication modules (UART, SPI, I2C).
  - **Nested Vectored Interrupt Controller (NVIC):** The Cortex-M4 core features an NVIC that supports Nested Interrupts, Dynamic Priority Level, Vector Table, and Masking (masking specific interrupts to manage critical tasks effectively).

- **PIC16F877A – Interrupt's Types**

  - **External Interrupts**: The PIC16F877A provides two external interrupt pins (INT and RB0/INT), allowing external events to trigger interrupts.
  - **Internal Interrupts:** Internal peripherals like timers and the ADC can also generate interrupts. However, the range of internal sources is more limited compared to the TM4C123GH6PM.

➢ Conclusion

The TM4C123GH6PM and PIC16F877A microcontrollers serve different application needs. The TM4C123GH6PM, with its ARM Cortex-M4 architecture, offers advanced features like larger memory, floating-point support, DSP, and sophisticated interrupt handling, making it ideal for complex applications like IoT and robotics. In contrast, the PIC16F877A, with its simpler 8-bit design, is well-suited for basic tasks, and educational projects. The choice between the two depends on specific Project requirements, balancing performance and complexity with Cost Effectiveness.