# 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.

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| 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 |

* **Key Features of both**
* **Area of Application**

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| --- | --- | --- |
| 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**

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| --- | --- | --- |
| **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. | TM4C123GH6PM: Supply Voltage Questions - Arm-based microcontrollers forum -  Arm-based microcontrollers - TI E2E support forums | PIC16f877A Microcontroller : Datasheet, Working & Its Applications |

* **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.**