FACULTY OF ENGINEERING
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SUMMER TRAINING REPORT 2025

EMBEDDED SYSTEM

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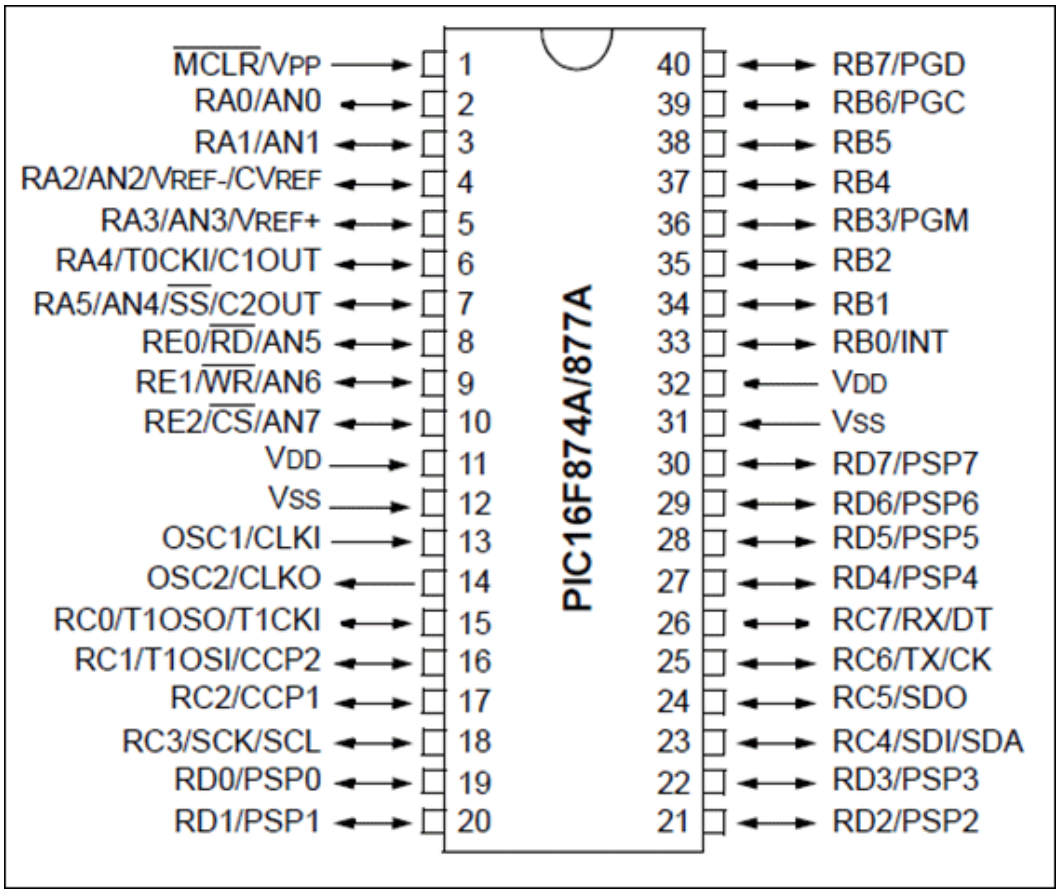
Introduction: This report provides answers to some questions about the PIC16F877A microcontroller, such as its pin description, core architecture, general troubleshooting, and comparison with the ATMega328P. a) Pin Description of PIC16F877A

a) Pin Description of PIC16F877A

- **PORTA (RA0-RA5): The Analog Input Port.**
  Primary Use: Connecting analog sensors (like temperature sensors or potentiometers) for the Analog-to-Digital Converter (ADC).
- **PORTB (RB0-RB7): The Interrupt & Programming Port.**
  Primary Use: Connecting buttons and switches, using its built-in interrupt-on-change and internal pull-up resistor features. Also used for programming (RB6 & RB7).
- **PORTC (RC0-RC7): The Communication Port.**
  Primary Use: Handling serial communication protocols. Its pins are dedicated to UART (RX/TX), SPI (SDI/SDO/SCK), I²C (SDA/SCL), and generating PWM signals.
- **PORTD (RD0-RD7): The 8-Bit Data Port.**
  Primary Use: General-purpose digital I/O. It can also be configured as an 8-bit Parallel Slave Port to communicate directly with a microprocessor's data bus.
- **PORTE (RE0-RE2): The Control Pin Port.**
  Primary Use: Provides three extra digital I/O pins. Its main function is to serve as the read (RD), write (WR), and chip select (CS) control signals when PORTD is used in Parallel Slave Port mode
- **Power & Clock:** Pins VDD (11), VSS (12), OSC1/CLKIN (13), OSC2/CLKOUT (14).
- **Reset:** MCLR/Vpp (1) (Active LOW, must be pulled to VDD).



b) Main Architectural Block Functions

ALU (Arithmetic Logic Unit): The heart of the CPU calculator. It does all the arithmetic and logical operations with the WREG (Working Register) and memory data.

Status Register: An 8-bit register to hold flags set by the ALU, such as Carry (C), Digit Carry (DC), and Zero (Z). These flags are very important for decision-making in code (e.g., conditional branching).

Program Counter (PC): A 13-bit register holding the memory address of the next instruction to be fetched by the CPU.

Flash Program Memory: Non-volatile (8KB) memory for storing the firmware program. It is reserved and separate from data memory (Harvard Architecture).

Instruction Register & Decoder: The Instruction Register holds the opcode being executed. The Instruction Decoder decodes this opcode to control signals that tell the rest of the MCU what to do with the instruction.

c) Troubleshooting: LED on RA4 Not Flashing

Most probable reason for a non-working LED on RA4 is its open-drain output mode.

Issue: Pin RA4 can only pull the output to ground (LOW/sink current) or place it in a high-impedance state (Hi-Z). It cannot source a high voltage (source current).

Faulty Circuit: When the LED is placed between the pin and GND, it has no current path to light when the pin is placed in the Hi-Z state.

Solution:

Hardware: Connect anode of LED to VCC (+5V) through a current-limiting resistor (~330Ω). Connect cathode to RA4.

Software: LED will now light up when RA4 is LOW (0) and extinguish when set HIGH (1). The code logic must also be reversed accordingly (LED = 0 to turn ON).

d) Evaluation: ATMega328P vs. PIC16F877A

Characteristic	PIC16F877A	ATMega328P	Advantage
Program Memory	8 KB Flash	32 KB Flash	ATMega328P
RAM	368 Bytes	2 KB	ATMega328P
I/O Pin Count	33	23	PIC16F877A
Power Consumption	Very Low (nA sleep)	Low (µA sleep)	PIC16F877A
Core Performance	20 MHz (5 MIPS)	20 MHz (~20 MIPS)	ATMega328P
Development Ecosystem	MPLAB X	Arduino IDE/Platform	ATMega328P

Two examples where ATMega328P is a better choice:

Complex Data Processing: Projects like a sensor data logger requiring large arrays for data filtering and storing. The ATMega's increased RAM (2KB compared to 368B) is a requirement and the larger Flash provides more space for code.

Rapid Prototyping with Libraries: Projects using community libraries like a Wi-Fi IoT device parsing JSON data. The ATMega's greater processing power and the sheer Arduino library ecosystem largely accelerate development.