

# Embedded Systems Interfacing

## The First Flight

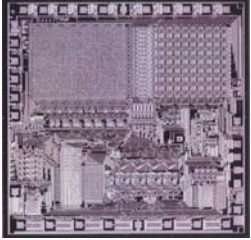
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Embedded Systems Interfacing

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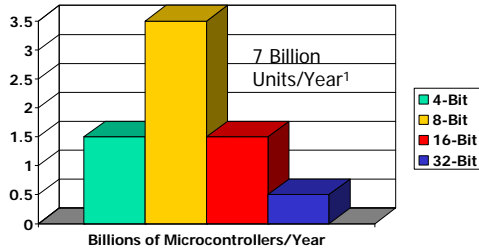
## First Microcontroller -- 1971

- **Computer on a Chip – TMS1000**
  - 1024 Bytes Program ROM
  - 64 Bytes Data RAM
  - 4 Bits Input
  - 8 Bits Output



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## Why Microcontrollers?



7 Billion Units/Year<sup>1</sup>

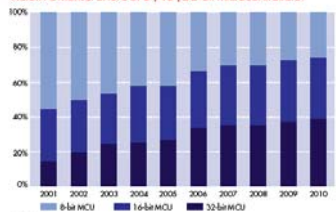
Billions of Microcontrollers/Year

November 2006 -- Steve Sanghi CEO Microchip  
<sup>1</sup> All vendors combined

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## Why 16-Bit PIC24F?

Relative market share of 8-, 16-, 32-bit microcontrollers.



iSuppli Research Reports, 2007

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## Overview

- Tools
- Program step by step
  - Output pattern
  - Control port direction (in or out)
  - Digital & Analog Ports
- Tools Demo

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## Tools

- MPLAB IDE
  - Free at [www.microchip.com](http://www.microchip.com)
  - Version 8.10
  - Contents
    - Color sensitive editor
    - Builder (maker)
    - Simulator
    - Programmer Interface
    - On-Line Help

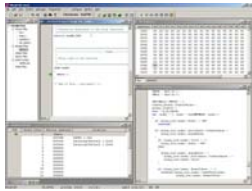


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# Embedded Systems Interfacing

## Tools

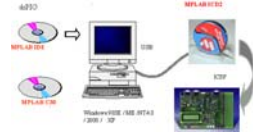
- MPLAB SIM
  - Part of MPLAB IDE
  - Contents
    - Breakpoints
    - Single Step
    - Step over/out
    - Animate
    - Watch Window
    - Logic Analyzer
    - Stopwatch



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## Tools

- MPLAB C30
  - Used for Embedded C
  - Free student edition at [www.microchip.com](http://www.microchip.com)
  - Version 3.11
  - Contents
    - GNU based
    - Compiler
    - Assembler
    - Debugger



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## Code: Step-By-Step

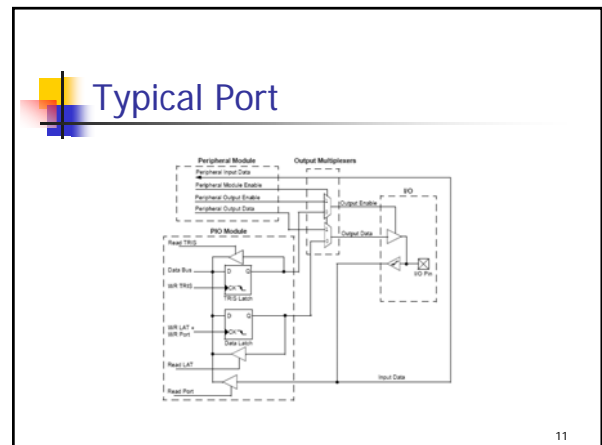
- #define of PIC24FJ128CA010 Ports
 

```
#include <p24fj128ga010.h>
```
- Empty main()
 

```
int main(){
    return(0);
}
```
- Assign value to Port A
 

```
PORTA = 0xff;
```

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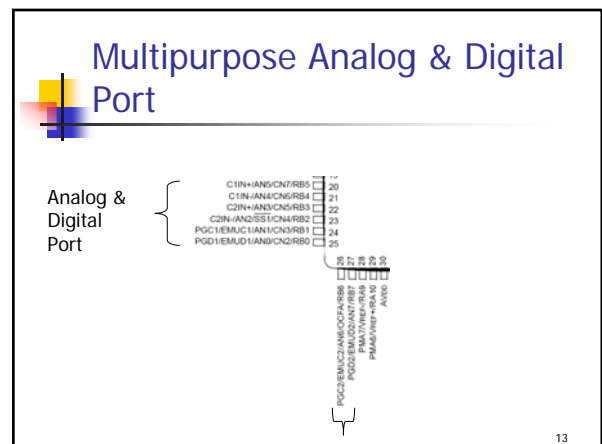


## Listing 1

```
#include <p24fj128ga010.h>

int main(){
    TRISA =0;           // all PORTA pins output
    PORTA=0xff;
    return (0);
}
```

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# Embedded Systems Interfacing

## Analog & Digital Ports

REGISTER 28-5: AD1PCFG: A/D PORT CONFIGURATION REGISTER

Upper Byte:							
RW-0	RW-0	RW-0	RW-0	RW-0	RW-0	RW-0	RW-0
PCFG15	PCFG14	PCFG13	PCFG12	PCFG11	PCFG10	PCFG9	PCFG8
bit 15							

Lower Byte:							
RW-0	RW-0	RW-0	RW-0	RW-0	RW-0	RW-0	RW-0
PCFG7	PCFG6	PCFG5	PCFG4	PCFG3	PCFG2	PCFG1	PCFG0
bit 7							

bit 15-0 PCFG15-PCFG0: Analog Input Pin Configuration Control bits  
1 = Pin for corresponding analog channel is configured in Digital mode, I/O port read enabled  
0 = Pin configured in Analog mode, I/O port read disabled, A/D samples pin voltage

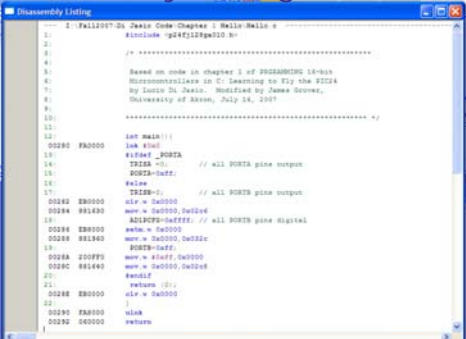
Legend:  
R = Readable bit      W = Writable bit      U = Unimplemented bit, read as 0  
- = Value at POR      1 = Bit is set            0 = Bit is cleared      x = Bit is unknown

## Listing 2


```
#include <p24fj128ga010.h>

int main(){
    TRISB=0;           // all PORTB pins output
    AD1PCFG=0xffff;   // all PORTB pins digital
    PORTB=0xff;
    return (0);
}
```

## Disassembly Listing



## Memory Usage Gage



## Listing 3


```
#include <p24fj128ga010.h>

int main(){
#ifdef _PORTA
    TRISA = 0;           // all PORTA pins output
    PORTA=0xff;
#else
    TRISB=0;           // all PORTB pins output
    AD1PCFG=0xffff;   // all PORTB pins digital
    PORTB=0xff;
#endif
    return (0);
}
```

## Embedded C

- C and not Java or C++
  - No classes – inheritance, methods, etc.
  - Must declare variable before first executable statement in function
- Embedded C without OS
  - No file system
  - No console
  - No printf or scanf (at least initially until helper functions of open, close, read and write are discussed)

## Embedded Systems Interfacing




### Food for thought . . .

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- How many embedded computers can you identify within the lecture room?
  - Part of room resource
  - On person

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### Homework

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- Chapter 1
  - Exercise 3, except use MPLAB SIM and Logic analyzer.

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