

# **PIC Microprocessor Basics**

©MiSci  
BEG,RSTP,DH,CV

Preliminary Draft For Discussion  
01-05-2014

# Controller Design Options

Personal Computer

Tablet

Raspberry Pi

Arduino

TI-430

Beagle Bone

PIC

FPGA

# Design / Development Considerations

Power

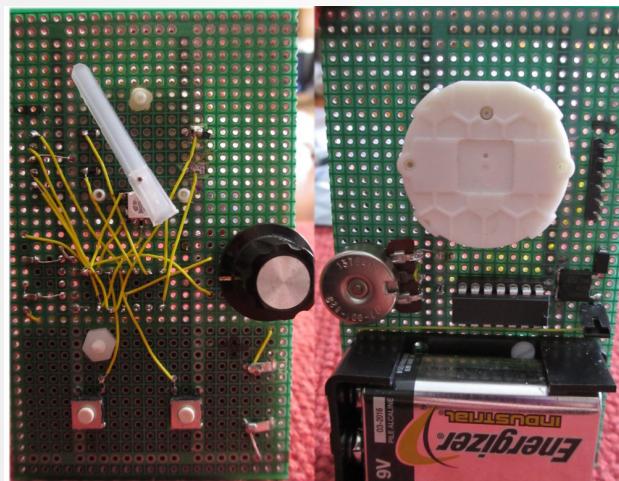
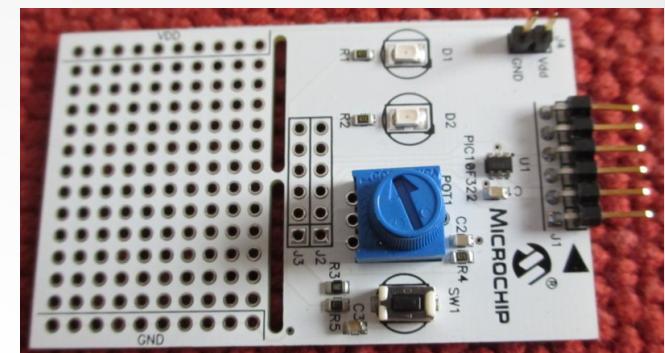
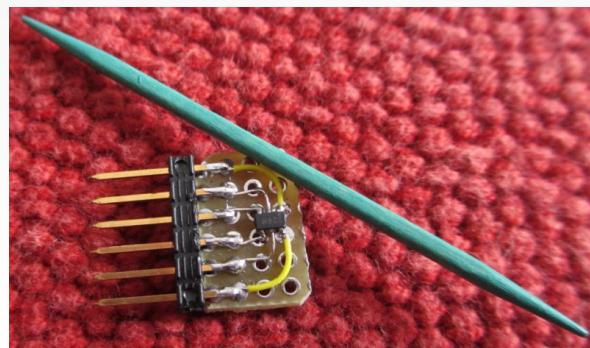
Cost

Size

External Components

Support

# PIC Sightings



# Coding Options

Assembler vs Compilier

Mnemonics vs Machine Code

Why Machine Code?

# PIC 12F1822/16F1823 Instruction Set (49 Instructions)

## BYTE-ORIENTED FILE REGISTER OPERATIONS

ADDWF  
ADDWFC  
ANDWF  
ASRF  
LSLF  
LSRF  
CLRF  
CLRW  
COMF  
DECFSZ  
INCF  
IORWF  
MOVF  
MOVWF  
RLF  
RRF  
SUBWF  
SUBWFB  
SWAPF  
XORWF

## BYTE ORIENTED SKIP OPERATIONS

DECFSZ  
INCFSZ

## BIT-ORIENTED FILE REGISTER OPERATIONS

BCF  
BSF

## INHERENT OPERATIONS

CLRWDT  
NOP  
OPTION  
RESET  
SLEEP  
TRIS

## BIT-ORIENTED SKIP OPERATIONS

BTFSZ  
BTFSZS

## LITERAL OPERATIONS

ADDLW  
ANDLW  
IORLW  
MOVLB  
MOVLP  
MOVLW  
SUBLW  
XORLW

## CONTROL OPERATIONS

BRA  
BRW  
CALL  
CALLW  
GOTO  
RETFIE  
RETLW  
RETURN

## C-COMPILER OPTIMIZED

ADDSR  
MOVIW  
MOVWI

# PIC 16F1823 Features

2K Words Program Memory

256 Data Bytes

128 8 bit Registers (SRAM)

12 I/O's

8 ADC Channels

8 CapSense Channels

2 Comparators

1 EUSART

1 MSSP (I2C/SPI)

1 Capture/Compare/PWM (ECCP) Full Bridge

Up to 32MHZ Clock

16 level stack

Watchdog Timer

Low Power

10 bit ADC, 8 channels

Analog Comparator

5 bit DAC

Fixed Voltage Reference

11 I/O and one Input Pin

25ma Source/Sink Capable

2-8 bit Timers

1-16 bit Enhanced Timer

MSSP with I2C, SPI, RS-232

Continous Wave Source

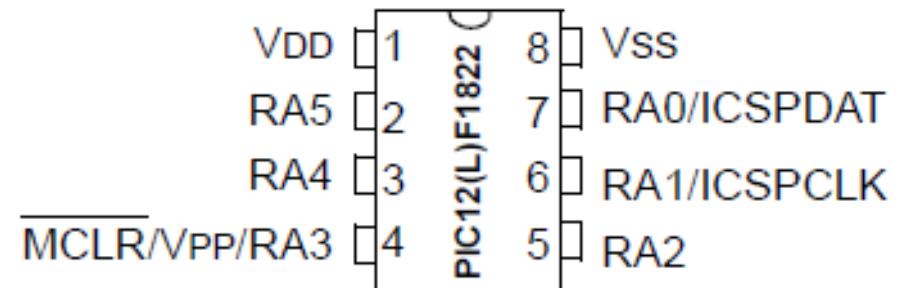
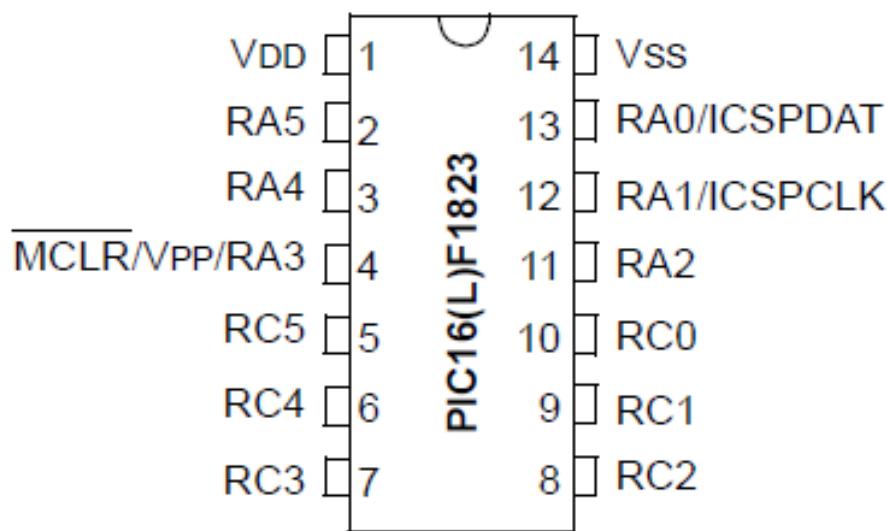
Hardware PWM

Capacitive Sense 8 channels

Programmable S-R Flip Flop

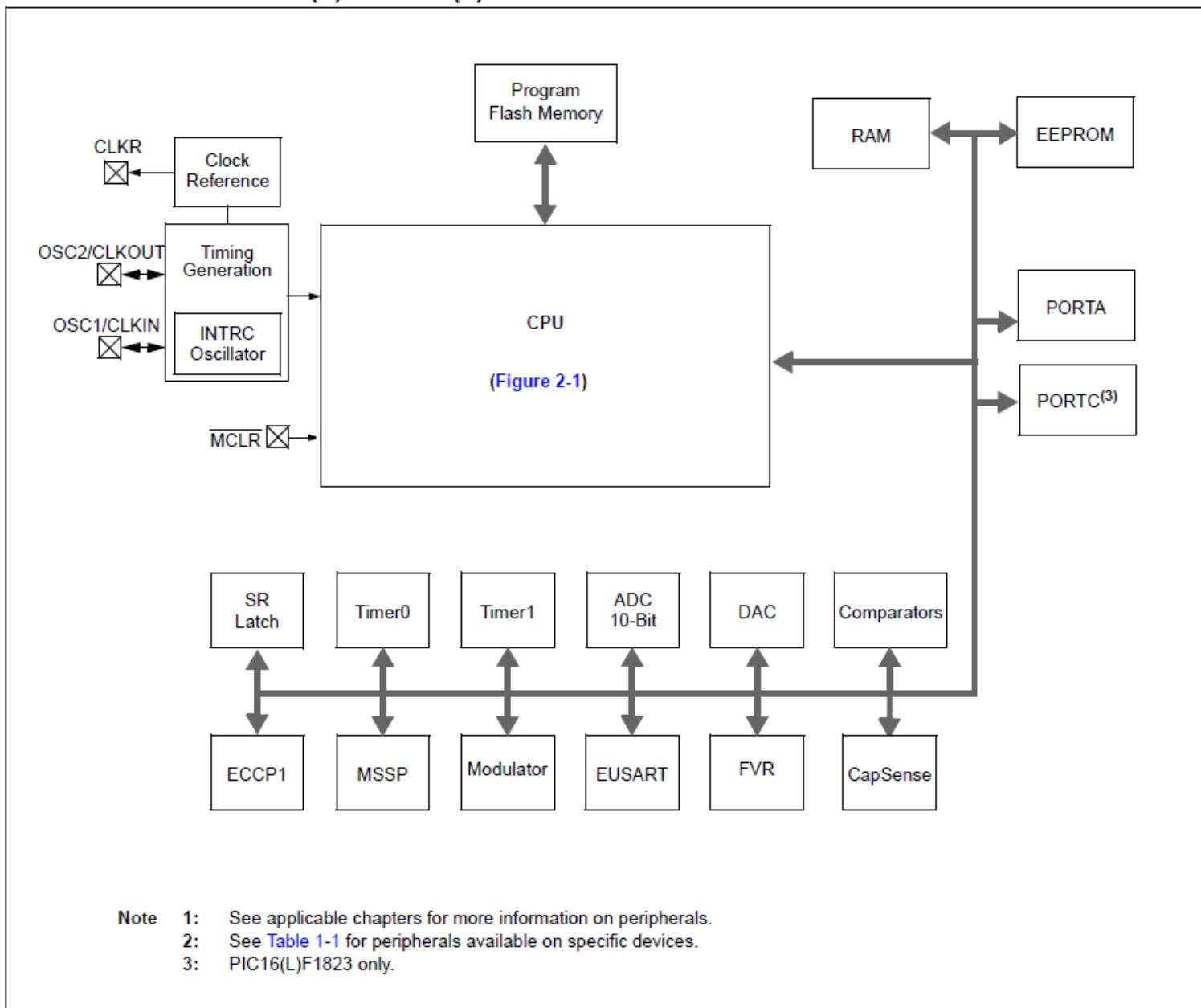
Note: 12F1822 has the same core CPU with less IO Pins

# Package Examples



# Block Diagram

**FIGURE 1-1: PIC12(L)F1822/16(L)F1823 BLOCK DIAGRAM**



# Example Pin Function List

Name	Function	Input Type	Output Type	Description
RA0/AN0/CPS0/C1IN+/ DACOUT/TX <sup>(1)</sup> /CK <sup>(1)</sup> /SDO <sup>(1)</sup> / SS <sup>(1)</sup> /P1B <sup>(1)</sup> /MDOUT/ICSPDAT/ ICDDAT	RA0	TTL	CMOS	General purpose I/O.
	AN0	AN	—	A/D Channel 0 input.
	CPS0	AN	—	Capacitive sensing input 0.
	C1IN+	AN	—	Comparator C1 positive input.
	DACOUT	—	AN	Digital-to-Analog Converter output.
	TX	—	CMOS	USART asynchronous transmit.
	CK	ST	CMOS	USART synchronous clock.
	SDO	—	CMOS	SPI data output.
	SS	ST	—	Slave Select input.
	P1B	—	CMOS	PWM output.
	MDOUT	—	CMOS	Modulator output.
	ICSPDAT	ST	CMOS	ICSP™ Data I/O.
RA1/AN1/CPS1/VREF+/C1IN0-/ SRI/RX <sup>(1)</sup> /DT <sup>(1)</sup> /SCL/SCK/ MDMIN/ICSPCLK/ICDCLK	RA1	TTL	CMOS	General purpose I/O.
	AN1	AN	—	A/D Channel 1 input.
	CPS1	AN	—	Capacitive sensing input 1.
	VREF+	AN	—	A/D and DAC Positive Voltage Reference input.
	C1IN0-	AN	—	Comparator C1 or C2 negative input.
	SRI	ST	—	SR latch input.
	RX	ST	—	USART asynchronous input.
	DT	ST	CMOS	USART synchronous data.
	SCL	I <sup>2</sup> C™	OD	I <sup>2</sup> C™ clock.
	SCK	ST	CMOS	SPI clock.
	MDMIN	ST	—	Modulator source input.
	ICSPCLK	ST	—	Serial Programming Clock.

# Instruction Examples

Mnemonic, Operands	Description	Cycles	14-Bit Opcode				Status Affected	Notes
			MSb		Lsb			
<b>BYTE-ORIENTED FILE REGISTER OPERATIONS</b>								
ADDWF f, d	Add W and f	1	00	0111	dfff	ffff	C, DC, Z	2
ADDWFC f, d	Add with Carry W and f	1	11	1101	dfff	ffff	C, DC, Z	2
ANDWF f, d	AND W with f	1	00	0101	dfff	ffff	Z	2
ASRF f, d	Arithmetic Right Shift	1	11	0111	dfff	ffff	C, Z	2
LSLF f, d	Logical Left Shift	1	11	0101	dfff	ffff	C, Z	2
LSRF f, d	Logical Right Shift	1	11	0110	dfff	ffff	C, Z	2
CLRF f	Clear f	1	00	0001	1fff	ffff	Z	2
CLRW -	Clear W	1	00	0001	0000	00xx	Z	
COMF f, d	Complement f	1	00	1001	dfff	ffff	Z	2
DECF f, d	Decrement f	1	00	0011	dfff	ffff	Z	2
INCF f, d	Increment f	1	00	1010	dfff	ffff	Z	2
IORWF f, d	Inclusive OR W with f	1	00	0100	dfff	ffff	Z	2
MOVF f, d	Move f	1	00	1000	dfff	ffff	Z	2
MOVWF f	Move W to f	1	00	0000	1fff	ffff		2
RLF f, d	Rotate Left f through Carry	1	00	1101	dfff	ffff	C	2
RRF f, d	Rotate Right f through Carry	1	00	1100	dfff	ffff	C	2
SUBWF f, d	Subtract W from f	1	00	0010	dfff	ffff	C, DC, Z	2
SUBWFB f, d	Subtract with Borrow W from f	1	11	1011	dfff	ffff	C, DC, Z	2
SWAPF f, d	Swap nibbles in f	1	00	1110	dfff	ffff		2
XORWF f, d	Exclusive OR W with f	1	00	0110	dfff	ffff	Z	2
<b>BYTE ORIENTED SKIP OPERATIONS</b>								
DECFSZ f, d	Decrement f, Skip if 0	1(2)	00	1011	dfff	ffff		1, 2
INCFSZ f, d	Increment f, Skip if 0	1(2)	00	1111	dfff	ffff		1, 2
<b>BIT-ORIENTED FILE REGISTER OPERATIONS</b>								
BCF f, b	Bit Clear f	1	01	00bb	bfff	ffff		2
BSF f, b	Bit Set f	1	01	01bb	bfff	ffff		2
<b>BIT-ORIENTED SKIP OPERATIONS</b>								
BTFSC f, b	Bit Test f, Skip if Clear	1 (2)	01	10bb	bfff	ffff		1, 2
BTFSS f, b	Bit Test f, Skip if Set	1 (2)	01	11bb	bfff	ffff		1, 2

# Number Basics

Binary, Hex, Octal, Decimal

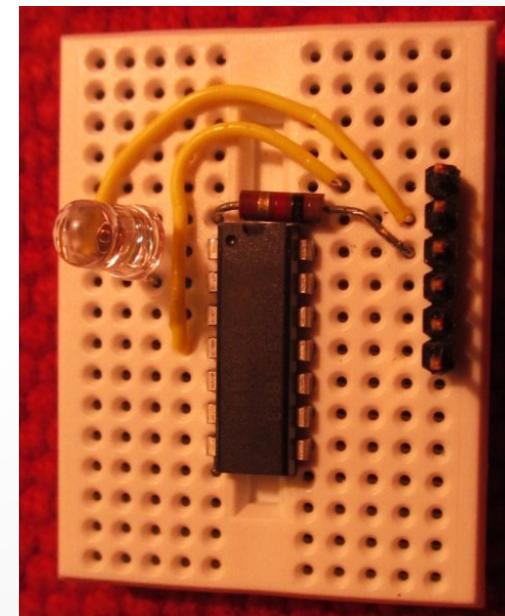
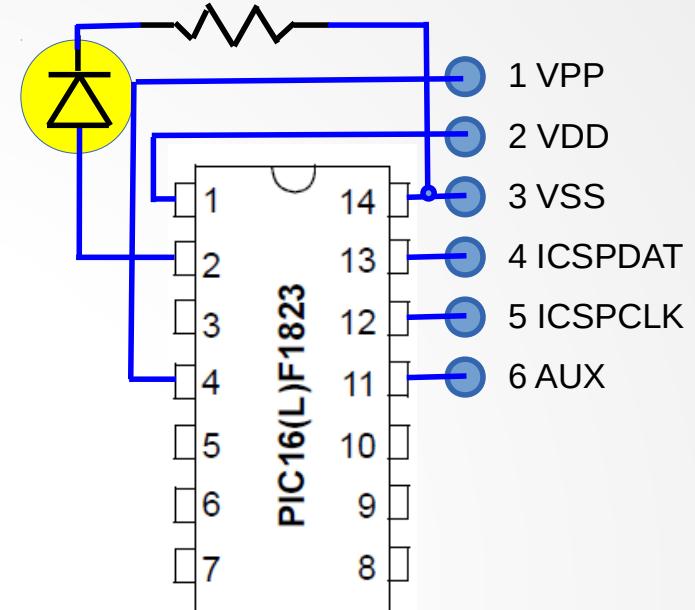
Decimal Numbers with no exact Binary Representation

Divide by 2,4,...

# Simple PIC Assembler Program

## LED Flasher

```
BANKSEL TRISA          ;  
;Set RA5 as output and set RA<4:0> as inputs  
MOVLW b'00011111'      ;  
    ;00----- ; reserved  
    ;--0---- ; TRISA5  
    ;--1--- ; TRISA4  
    ;--1--- ; TRISA3  
    ;----1-- ; TRISA2  
    ;----1- ; TRISA1  
    ;-----1 ; TRISA0  
  
MOVWF TRISA  
  
main_loop  
    BANKSEL PORTA          ;  
    BSF    PORTA,LED0  
    call   WAIT_200MS  
  
    BCF    PORTA,LED0  
    call   WAIT_200MS  
  
    goto  main_loop
```



# PIC Programmer and CPU



Microchip PicKit 2 Clone with internal program memory.

PIC 16F1823 in a DIP 14

Digikey Partnumber PIC16F1823-I/P-ND

\$1.12 (25+)

# Programimg Software

gpasm, gutils assembler

pk2cmd, Pic Programmer

Plain text editor (Like vi, emacs, wordpad)

Optional, MPLAB-X IDE

# Acronyms and References

IDE - Integrated Development Environment

Microchip

<http://www.microchip.com/>

GPUTILS

<http://gutils.sourceforge.net/>

DigiKey

<http://www.digikey.com>

Random PIC Projects

<http://picprojects.org.uk/projects/picprojects.htm>