EDL: Practical PIC Tutorial

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Overview

1. Overview of PIC families
2. Hardware Design
3. Programming
4. System Example I: Simple LED Flasher
5. System Example II: Wireless Video Sensor

PIC Families

	PIC16	PIC18	PIC24/dsPIC	SX-28/48
Speed	20MHz 5 MIPS	40MHz 10 MIPS	80MHz 40 MIPS	75 MHz 75MIPS
Memory	256-4K Flash Program 32-256 bytes SRAM	64K Flash Program 4K SRAM	256K Flash Program 30K SRAM	4K Flash Program 262 bytes Banked Registers
Peripherals	ADC/UART/I2C/USB	ADC/USB/I2C/SPI/ UART/TCP/IP...etc	ADC/USB/I2C/SPI/ UART/TCP/IP/PWM/ AC97...etc	I/O Pins Only
Programming	ASM*	ASM/C I/O Libs	ASM/C I/O Libs, Signal Processing Libs	ASM*
Notes	8-bit	8-bit	16-bit dsPIC includes additional math capabilities (ie. single instruction MAC)	8-bit Very fast, Very Simple

*3rd Party C Compilers Exist

Useful Integrated Peripherals

- ADC - 10 or 12-bit up to 1MSPS
- Timer/Counter
- Analog Comparator
- UART
- General Purpose I/O Lines

PIC Architecture

- RISC Instruction Set
  - 8 and 16-bit
- Hardware memory mapped to registers
  - Device Configuration
  - Port/Peripherial/Communications

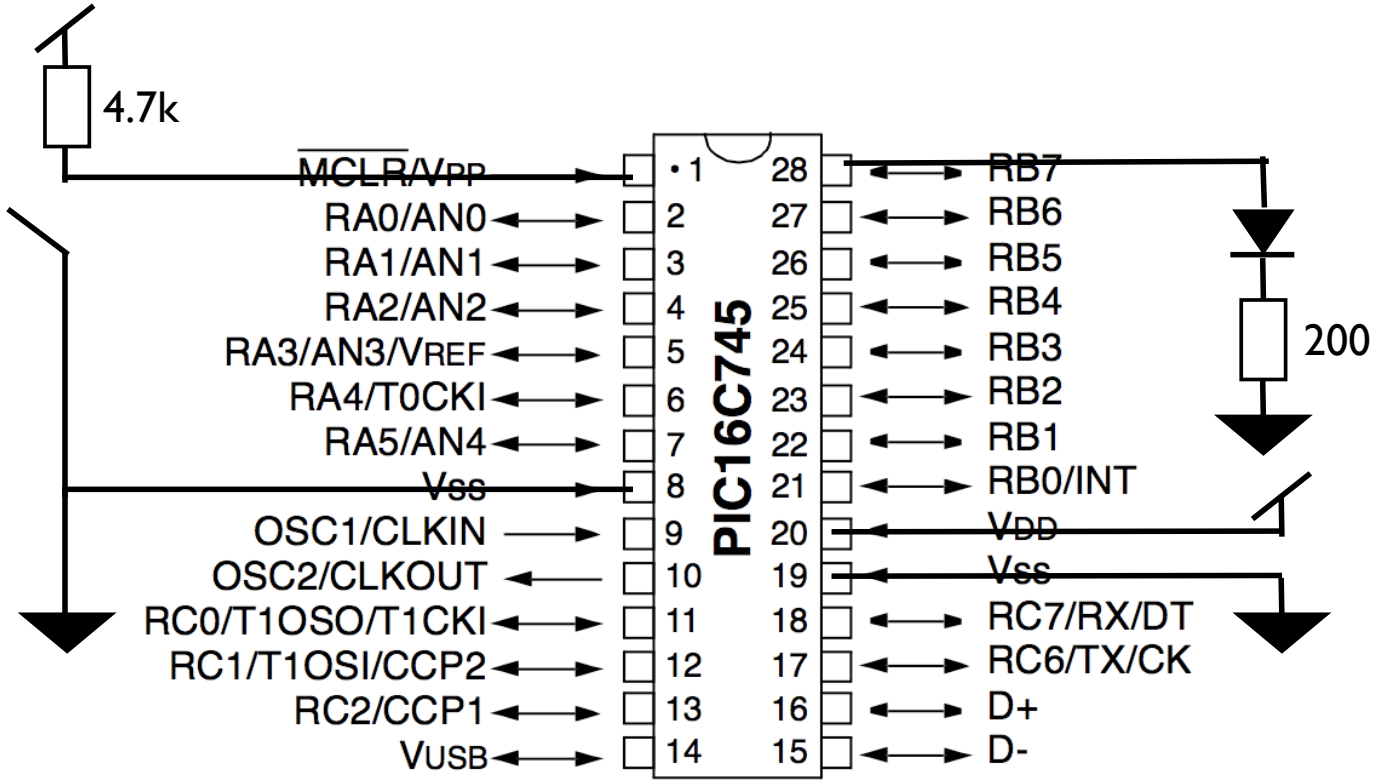
Tools You Need

- Circuit Board
  - Custom PCB
  - Demo Board
- MPLAB Programmer
- MPLAB Assembler / C Compiler
  - Downloadable

Clocking the PIC

- All PICs need oscillators to execute instructions
  - Internal (not available on all models) up to 8 MHz
  - External up to 40 MHz, 75 MHz on the SX
  - 16-Bit PICs have internal frequency multipliers and PLLs
- Instruction Cycle
  - PIC16/18 - 4 clocks/instruction
  - PIC24/dsPIC - 2 clocks/instruction
  - SX - 1 clock/instruction

Simple LED Flasher

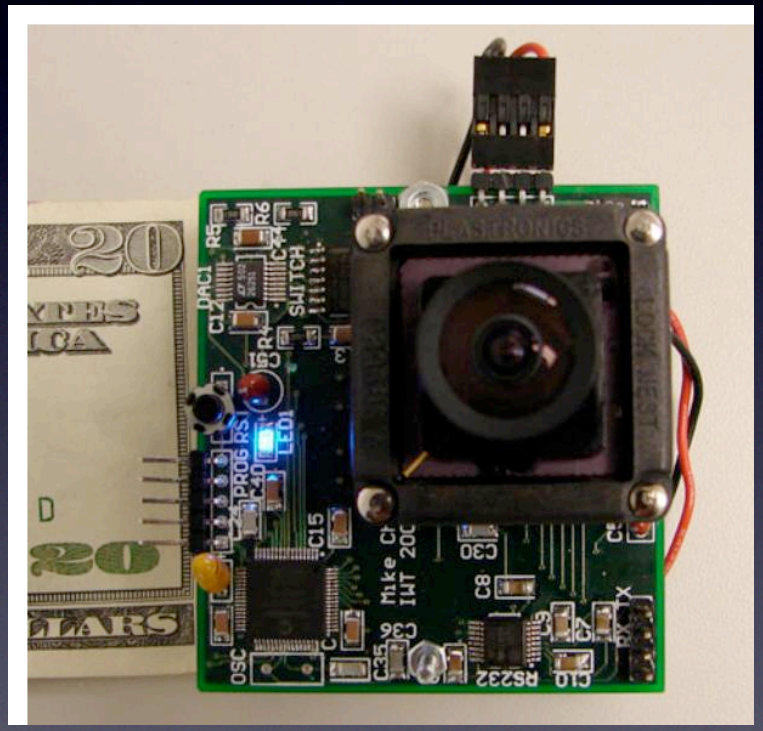


```
;LED Flasher
     LIST p=16C745      ;tell assembler what chip we are using
     include "P16C745.inc"      ;include the defaults for the chip
     __config 0x3D18            ;sets the configuration settings
                        ;(oscillator type etc.)

     org  0x0000        ;org sets the origin, 0x0000 for the 16F628,
                        ;this is where the program starts running
     movlw    0x07
     movwf    CMCON             ;turn comparators off (make it like a 16F84)

     bsf       STATUS,  RP0      ;select bank 1
     movlw    b'00000000'        ;set PortB all outputs
     movwf    TRISB
     movwf    TRISA             ;set PortA all outputs
     bcf       STATUS,  RP0      ;select bank 0

Loop
     movlw    0xff
     movwf    PORTA             ;set all bits on
     movwf    PORTB
     nop               ;the nop's make up the time taken by the goto
     nop               ;giving a square wave output
     movlw    0x00
     movwf    PORTA
     movwf    PORTB             ;set all bits off
     goto      Loop         ;go back and do it again

     end
```

Wireless Video Sensor

- Design Requirements

1. Low power - 4 AA Batteries
2. Compact - Size of 4 AA Batteries
3. Low bandwidth - 1 Kb/sec
4. Internal image processing/ compression



Specs

- dsPIC33
  - 40 MHz (20MIPS)
  - 16 KB RAM for 90x90 Image
  - DCT based image/video compression (Transform, Entropy Coding)
  - Image processing, gamma correction, histogram equalization
  - Internal ADC/UART
- MPLAB C30
  - Prototype algorithms on PC (gcc)
  - Easy integration with MPLAB C30 (also gcc based)

C Differences

- 100% ANSI C Compliant
  - even printf works - writes to UART1 (nice for debugging)
- Device headers include
  - Register names
  - Configuration bits
- Can use registers as 16-bit variables or by bit field
  - LATA = 0xFFFFFF - writes to entire register
  - LATAbits.LATA5 = 1 - sets bit 6 of LATA high

Initialization - main.c

```
#include <p33J128GP706.h>   //headers for dsPIC33J1280GP706
_FOSCSEL (FNOSC_FRCPLL);
_FOSC(FCKSM_CSDCMD & OSCIOFNC_OFF & POSCMD_NONE); //internal RC w/ PLL

int main()
{
     PLLFBD=18;                          //Configure multiplier
     CLKDIVbits.PLLPOST = 0;             //Post-Scaler
     CLKDIVbits.PLLPRE = 0;              //Pre-Scaler
     OSCTUN = 0;                         //Tune RC Oscillator

     while(OSCCONbits.LOCK!=1);          //Wait for PLL to Lock

     while(1)                            //Run whatever it is I need
       run_camera();
}
```

Setup UART - comm.c

```
void init_uart()
{
   int uartConfig1 = UART_EN & UART_IDLE_CON & UART_IrDA_DISABLE & UART_MODE_SIMPLEX &
   UART_UEN_00 & UART_EN_WAKE & UART_DIS_LOOPBACK & UART_DIS_ABAUD & UART_UXRX_IDLE_ONE &
   UART_BRGH_FOUR & UART_NO_PAR_8BIT & UART_1STOPBIT;

   int uartConfig2 = UART_INT_TX & UART_SYNC_BREAK_DISABLED & UART_TX_ENABLE &
   UART_INT_RX_CHAR & UART_IrDA_POL_INV_ZERO;

  int uartBRG = 39;

  OpenUART1(uartConfig1, uartConfig2, uartBRG);
}

void write_packet(char* packet_p)
{
  int c;
  for(c=0; c<PACKET_SIZE; c++)
   {
     while(!U1STAbits.TRMT);
     U1TXREG = *packet_p++;
   }
}
```

Read Image - imager.c

```
#define LATBbits.LATB2 ROWCLK
#define LATBbits.LATB3 COLCLK
#define LATBbits.LATB4 RESET
unsigned char picture[XRES*YRES];


void image_out(unsigned char* pic)
{
   int y,x;
   for(y=0; y<YRES; y++)
   {
      for(x=0; x<XRES; x++)
      {
        AD1CON1bits.SAMP = 1;
        ROWCLK = 1;
        AD1CON1bits.SAMP = 0;
        while(!AD1CON1bits.DONE);
        *(pic++) = 255-ADCBUF0>>2;
        ROWCLK = 0;
      }
      RESET = 1;
      COLCLK = 1;
      delay_us(10);
      RESET = 0;
      COLCLK = 0;
   }
}
```

UART Interrupt

```
volatile int rcv_index=0;
unsigned char rcv[2];

void __attribute__((__interrupt__)) _U1RXInterrupt(void)
{
  unsigned char temp = U1RXREG;
  if(temp==0xFF)
  {
    config1 = rcv[0];
    config2 = rcv[1];
  }
  else
    rcv[index++] = temp;

  IFS0bits.U1RXIF = 0;
}
```

Some Advice

- Write to LAT registers not PORT
- Be careful with C optimization options
- Beware of I2C
- Using MPLAB C30?
  - 16-bit int, emulated floating point, limited dynamic memory allocation
- dsPIC33 peripheral libraries incomplete

Resources

- www.microchip.com
  - datasheets, C manual, tutorials, web seminars, MPLAB ASM, MPLAB C student edition
- www.parallax.com
  - free book on ASM programming, SX-Key assembler, virtual peripherals, SX BASIC (you should not be using this...)