# firefly 16F88 tutor

Assembly Instructions
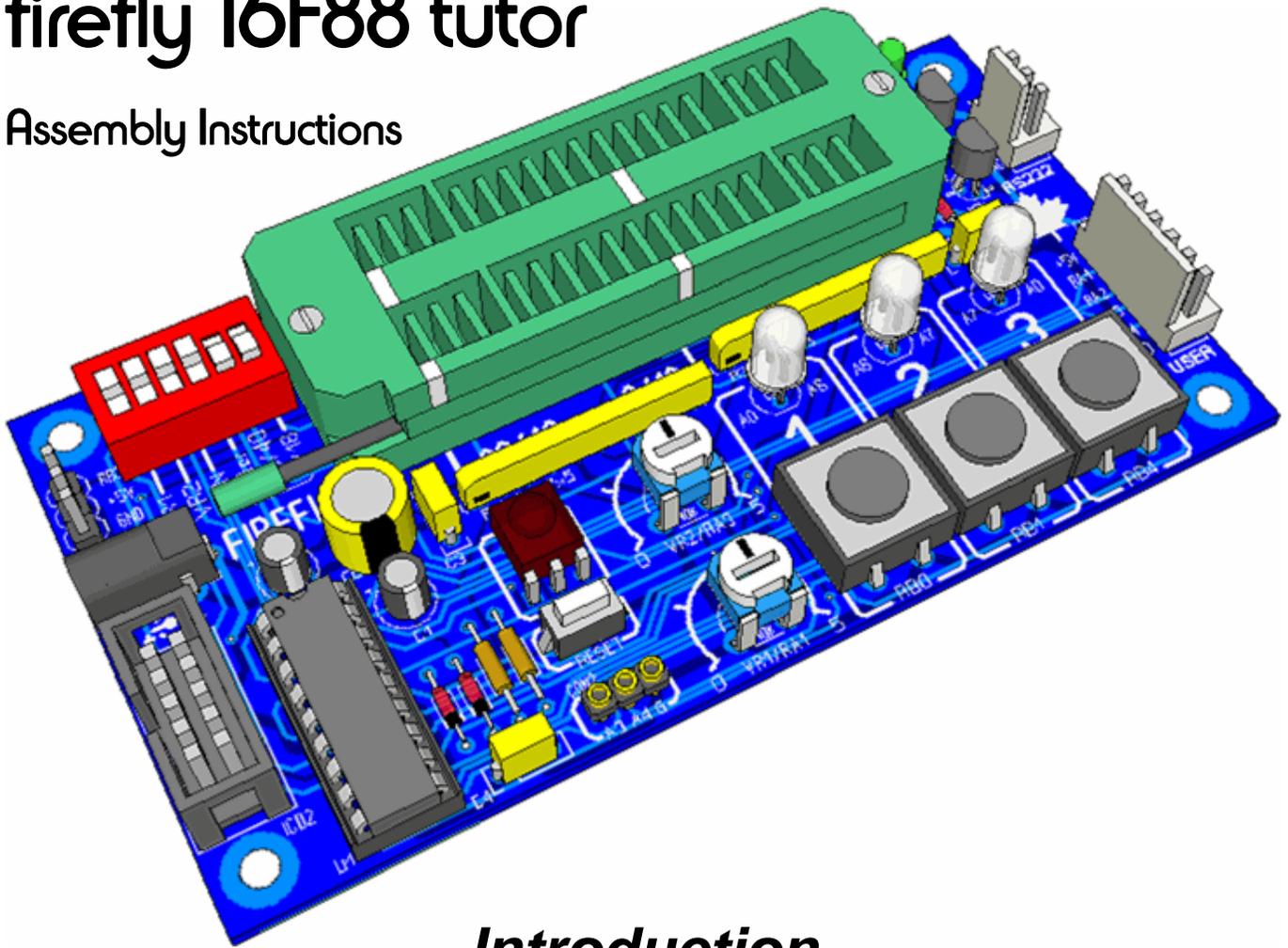
Introduction

I was surprised at how many people wanted to get into microcontroller programming but had no idea what to do for their first project let alone how to even program one. Secondly even though ICP is available there is still a demand for ZIF (Zero Insertion Force) programming sockets. So I combined two kits into one. Firefly can be built as a 16F88 trainer, a PIC ZIF programming socket or both. The Firefly was designed as a PIC tutor companion kit to the Inchworm ICD2.

16F88 tutor highlights

- Microchip PIC16F88 * *see page 2 for more information on the 16F88*
- 3 dual color Red / Green LEDs
- 3 User pushbuttons (two sizes available)
- 2 Variable resistors for 0-5V
- 38KHz InfraRed sensor
- RS232 connector with inverting transistors *(requires optional DE9 to 3pin cable adapter)*
- User I/O port for external expansion
- 3 pin servo style connector
- 3 hole iButton / 1-wire and quick test socket
- ZIF socket for programming 8/14/18/28/40 pin Flash PICs
- Mode switch, Reset switch, 1.3mm 5VDC power jack & Inchworm ICD2 connector
- 107mm x 57mm PCB; Hammond 1591B mountable or Inchworm stackable

Why the PIC16F88…

The PIC16F88 is the current king of the 18pin 16F series PICs. It is a very powerful micro just packed with internal peripherals. Although there are literally hundreds of PICs to choose from the 16F88 stood on top of the pack for one reason more than any other…

It has the hardware debugger built in.

Whether you're new with PICs or old school, when you're working with any microcontroller there will be a time when you wish you could see what that little black box was thinking on the inside. Well that's what a debugger lets you do; you can set breakpoints *stop a running program* and see exactly what the processor sees. You can even modify the data. Difficult programming bugs can be spotted and wiped out with relative ease and as a learning tool the mysteries of the internal workings are quickly revealed.

|	16F84A	16F628A	16F88
Flash	1024	2048	4096
RAM	68	224	368
EEPROM	64	128	256
Internal Osc	No	2 speed	8 speed
A/D	No	No	7 @ 10bit
Timers	1	3	3
USART	No	Yes	Yes
PWM	No	Yes	Yes
Comparators	No	2	2
Self Flashing	No	No	Yes
Debugger	No	No	YES

Circuit Description

The Firefly was designed to be built

Necessary Tools *(not included in kit)*

As with any electronic kit the following tools are essential:

- Low wattage fine tip soldering iron <50W
- Resin core solder
- Wire cutters or side cutters (small)
- Needle nose pliers (small)
- Slotted screwdriver (small)
- Phillips screwdriver (small)
- Multimeter (this really is a must for any electronics project)
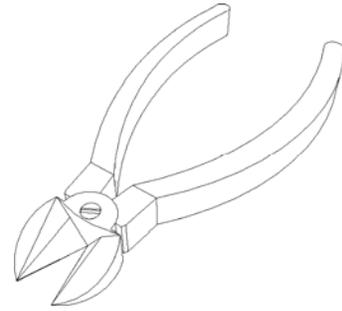
Assembly

Traditionally it's easiest to assemble a circuit board with the lowest profile and/or smallest parts first.

Install 5% resistors R2,R4,R5

Small signal diodes D1 thru D3 (Red 1N4148)
Note: diodes use a colored band to denote polarity
SIP resistors R1 (4.7K),R3 (100ohm)
IC socket for U1 *(notice notch orientation)*
Transistors Q1 (2N3906) / Q2 (2N3904)
Power Led LED1 (green)
Leds LED2,3,4 (Dual Color RED / GREEN)
Note: LEDs use a flat side indicating polarity
Capacitors C3, C4, C5 *(note lead spacing)*
Capacitors C1,C6 (4.7uF)
Capacitor *(note polarity)* C2 (33uF)
Switches SW1,SW5 *(note pin 1 on SW5)*
Switches SW2,SW3,SW4 *(one of two sizes will fit)*
Connectors CON1,CON2,CON3,CON4,CON5
(Use the Firefly cover illustration as a guide)
1.3mm coax 5V power jack P1
Optional install ZIF socket. *(The holes on Firefly rev F are too small for a 3M ZIF see text for info)*
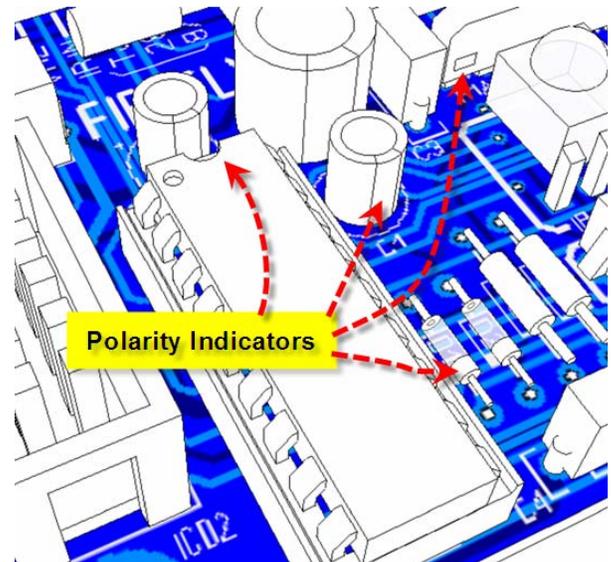
Initial Testing

Before installing IC1 (PIC16F88) apply power to the board, this is best done by attaching an ICD2 such as the Inchworm to the ICD2 connector (CON5). Measure for +5V (USER connector pins +5V & GND).

Final Assembly

Make sure the board is unpowered then install U1. I've included a demo program "Blinky 16F88" near the end of this document for testing the LEDs
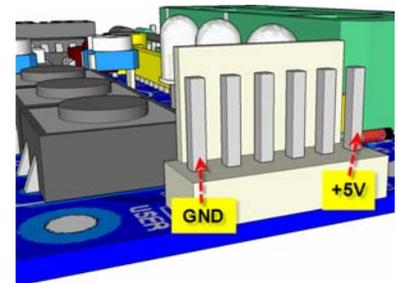
Parts List FIREFLY

Capacitors

2	C1,6	4.7uF 6.3V (10uf may be substituted)
3	C2	33uF 6.3V (22uf thru 47uf may be used)
3	C3,4,5	0.1uF

Resistors ¼W (tan body, 4 color bands)

1	R2	22K	Red, Red, Orange, Gold
1	R4	1K	Brown, Black, Red, Gold
5	R5	330	Orange, Orange, Brown, Gold
1	R1	4.7K	SIP 10pin 5 independent resistors
1	R3	100	SIP 10pin 5 independent resistors
2	VR1,VR2	10K	10K Trimpots

Semiconductors

3	D1,2,3	1N4148 Diode
3	LED1,2,3	5mm RED/GREEN dual color LED (2 lead)
1	IR1	TSOP34838 38KHz IR detector
1	Q1	2N3906 PNP (EBC)
1	Q2	2N3904 NPN (EBC)
1	U1	PIC16F88
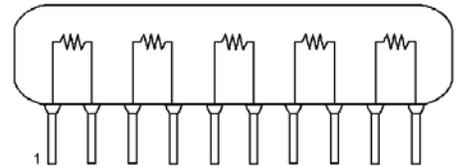
Switches

1	SW1	Small pushbutton
3	SW2,3,4	Pushbutton (Small or Large see text)
1	SW5	DIP Switch 6 position

Connectors

1	CON1	6pin Berg connector	+5V,RA1,RA2,RA3,RA4,GND
1	CON2	3pin machine socket	RA3,RA4,GND
1	CON3	3pin Berg connector	TX,RX,GND
1	CON4	3pin Pin connector	RB3,+5V,GND
1	CON5	ICD 2x5 PCB Male	ICD2
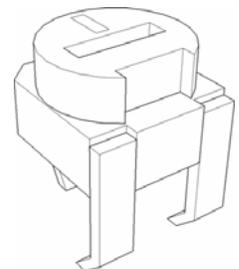
Miscellaneous

1	18-pin	IC Socket
1	P1	1.3mm PCB RA Coax Jack

Optional Accessories

1	Enclosure	Hammond 1591B (112mm x 62mm) or 1591BC clear lid
1	5VDC Adapter	5VDC 1.3mm center positive coax AC adapter
1	3pin RS232 Cable	See text for building instructions

Parts required for Firefly Z (ZIF) option*

1	J1	40Pin 3M Textool adapter (may require modification)

To build a "Firefly Z" ZIF only option just SW5, CON5 & C3 are required (see text for more info)

The Firefly is designed
for use with the
INCHWORM ICD2

Half duplex RS232 level inverter / converter
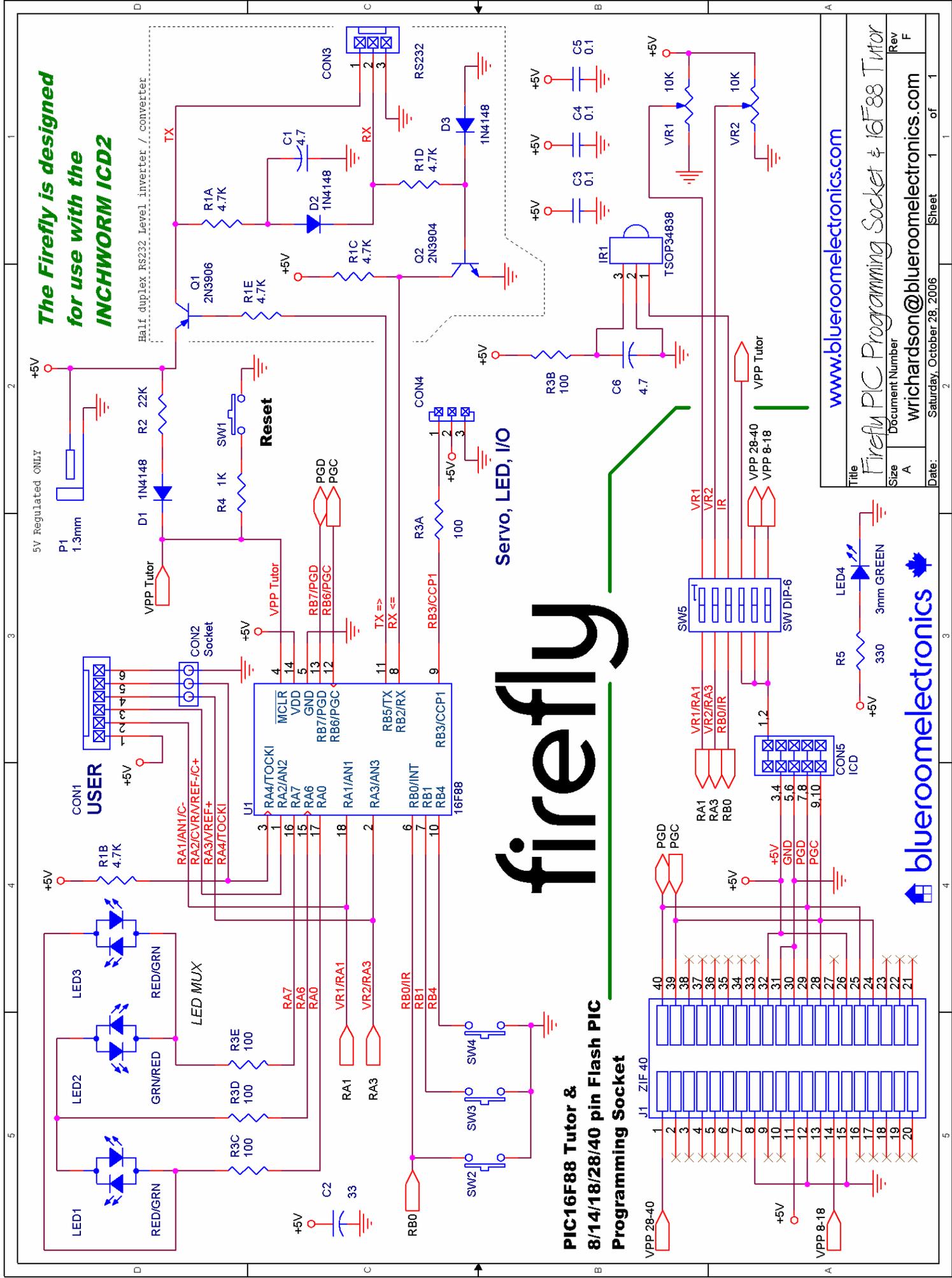
firefly

firefly

PIC16F88 Tutor &
8/14/18/28/40 pin Flash PIC
Programming Socket

Servo, LED, I/O

LED MUX

USER

Socket

Reset

5V Regulated ONLY

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Document Number
wrichardson@blueroomelectronics.com

Title
Firefly PIC Programming Socket & 16F88 Tutor

Size A
Date: Saturday, October 28, 2006

Rev F
Sheet 1 of 1
Sheet 2

Components referenced:
CON3, RS232, TX, RX, C1 4.7, D2 1N4148, R1A 4.7K, Q1 2N3906, R1E 4.7K
R1D 4.7K, D3 1N4148, R1C 4.7K, Q2 2N3904
C5 0.1, C4 0.1, C3 0.1
VR1 10K, VR2 10K
IR1 TSOP34838, R3B 100, C6 4.7, VPP Tutor
R2 22K, D1 1N4148, SW1, R4 1K, VPP Tutor
CON4, R3A 100
PGD PGC, RB7/PGD RB6/PGC
TX =>, RX <=, RB3/CCP1
P1 1.3mm
CON2, CON1
R1B 4.7K
RA7 RA6 RA0, VR1/RA1 VR2/RA3, RB0/IR RB1 RB4
LED1 LED2 LED3, RED/GRN GRN/RED
R3C 100, R3D 100, R3E 100
C2 33
SW2 SW3 SW4
RB0
RA1 RA3

U1 16F88:
4 MCLR, 14 VDD, 5 GND, 13 RB7/PGD, 12 RB6/PGC
11 RB5/TX, 8 RB2/RX, 9 RB3/CCP1
3 RA4/TOCKI, 16 RA2/AN2, 15 RA7, 17 RA6, 18 RA1/AN1, 2 RA3/AN3
6 RB0/INT, 7 RB1, 10 RB4
RA1/AN1/C-, RA2/CVR/VREF-/C+, RA3/VREF+, RA4/TOCKI

SW5 SW DIP-6
VR1/RA1, VR2/RA3, RB0/IR
VR1, VR2, IR
VPP 28-40, VPP 8-18
VPP Tutor

LED4 3mm GREEN
R5 330

CON5 ICD
PGD PGC, GND, PGD, PGC
RA1, RA3, RB0
3,4 5,6 7,8 9,10 1,2

J1 ZIF 40 (pins 1-40 / 21-40)
VPP 28-40, VPP 8-18

Mounting instructions for the optional 1591BC (Hammond Clear Case Lid)

The Hammond 1591BC clear plastic case lid is an inexpensive way to protect the solder side (bottom) of your kit. The Inchworm PCB is 107mm x 57mm and has been designed to mate with Hammond 1591B case or 1591BC case lid. If your kit included the 1591BC lid then you should also find four additional #6-32 ¼" machine screws. Although the 1591BC was designed as a lid; it also happens to work great as a project base.
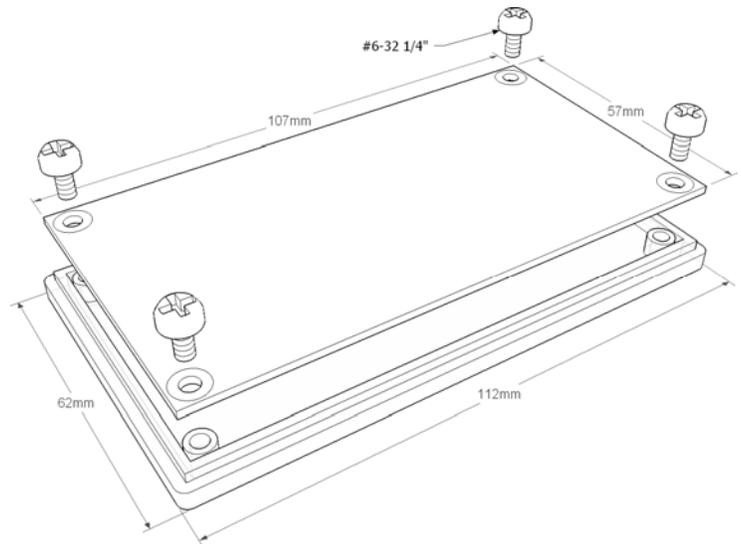
```
        LIST p=16F88
        INCLUDE "p16f88.inc"
        ERRORLEVEL 0, -302


        __CONFIG _CONFIG1, 0x2F30
        __CONFIG _CONFIG2, 0x3FFC

movlf  macro  x,y                 ;MACRO movlf <literal>, <register>
        movlw  x                  ;W = literal
        banksel  y                ;make sure it's in the right bank
        movwf  y                  ;register = W
        endm

        cblock 0x20               ;start of general purpose registers
        Delay_Count               ;delay loop counter
        endc

        org    0x000              ;this is where the program starts running
Init    movlf  0x07, CMCON        ;turn comparators off (make it like a 16F84)

Red1    movlf  b'01000000', PORTA ;LED1 RED
        movlf  b'10111110', TRISA
        call   Delay

Red2    movlf  b'10000000', PORTA ;LED2 RED
        movlf  b'00111111', TRISA
        call   Delay

Red3    movlf  b'00000001', PORTA ;LED3 RED
        movlf  b'01111110', TRISA
        call   Delay

Green3 movlf  b'10000000', PORTA ;LED3 GREEN
        movlf  b'01111110', TRISA
        call   Delay

Green2 movlf  b'01000000', PORTA ;LED2 GREEN
        movlf  b'00111111', TRISA
        call   Delay

Green1 movlf  b'00000001', PORTA ;LED1 GREEN
        movlf  b'10111110', TRISA
        call   Delay

        goto   Red1               ;repeat forever

Delay  nop                       ;32KHz Clock (default internal OSC speed)
        decfsz  Delay_Count, f
        goto    Delay
        return

        END                       ;end statement for mpasm
```

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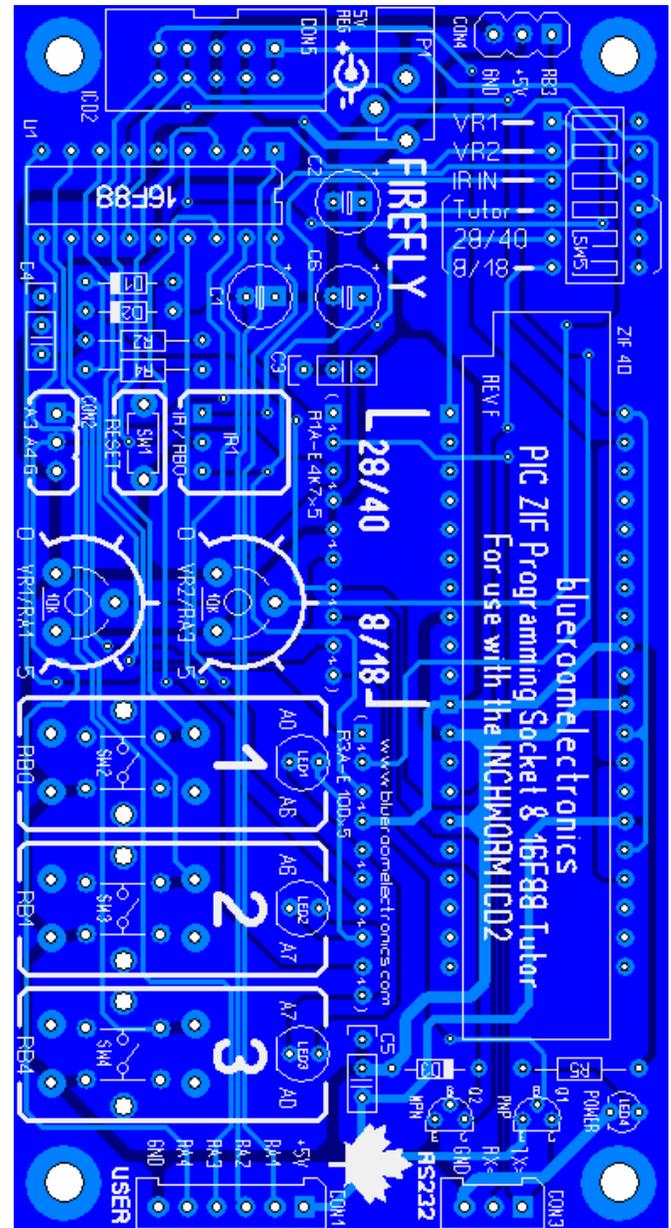
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🏠 **blueroomelectronics** 🍁

4550 Dufferin St. Toronto
Ontario, Canada
Tel (416) 897-1962
sales@blueroomelectronics.com
http://www.blueroomelectronics.com

Info and all other inquiries info@blueroomelectronics.com

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