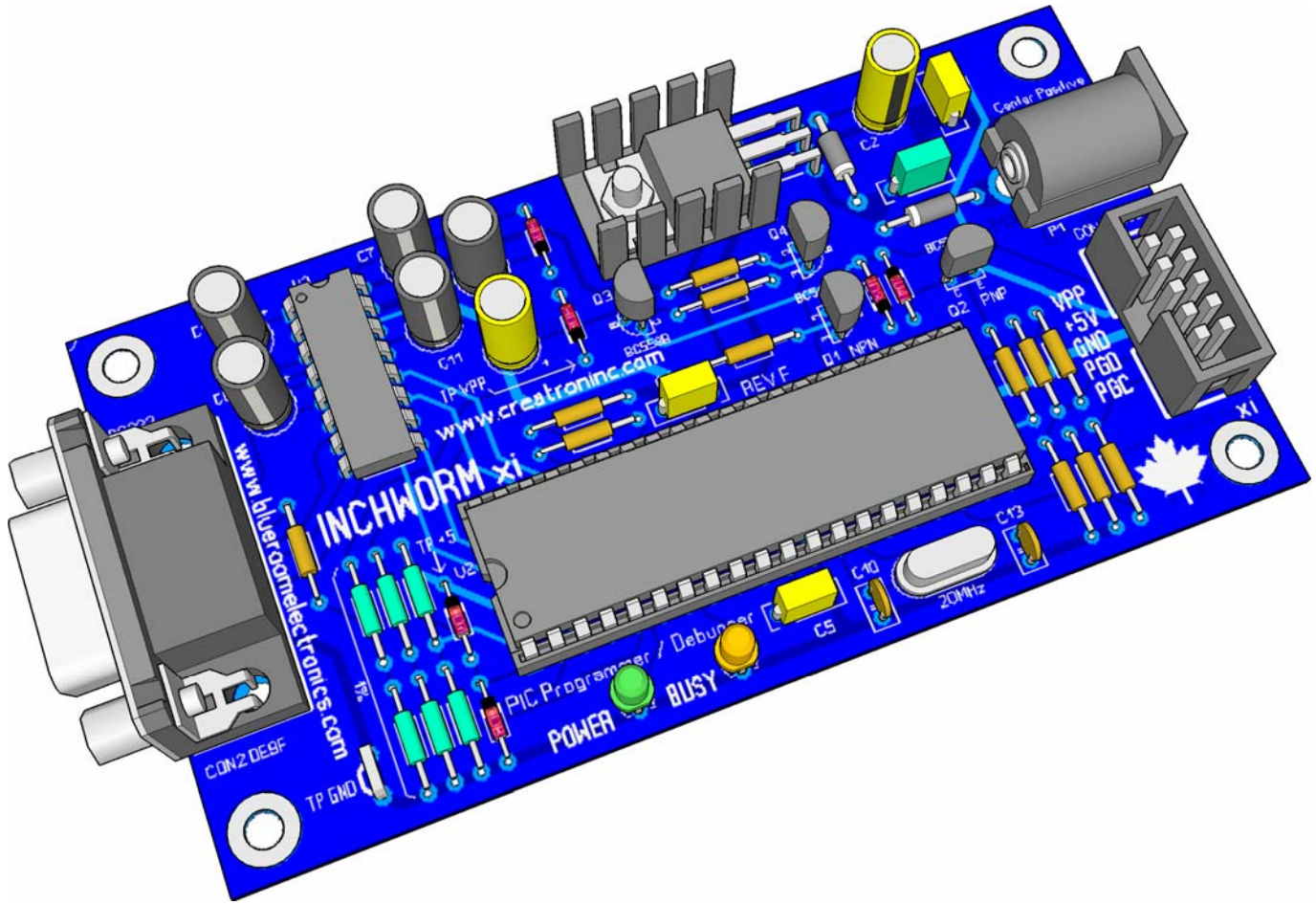


# Inchworm ICD2 Assembly Instructions



## Introduction

The Inchworm is both a Microchip® PIC™ programmer and debugger. It can program the majority of FLASH based PICs including the 16F and 18F series microcontrollers. It uses Microchips own MPLAB™ IDE and had been tested with MPLAB 7.41 *latest version as of this writing*. Also included is an extremely useful *you'll wonder how you programmed without it* debugger. Although the debugger mode is not built-in on all 16F series PICs *the smaller (less than 18pin) PICs often require a special ICD version*; it is available on all 18F and dsPIC microcontrollers. The debug mode allows you to set a breakpoint(s) in your program. When the program stops you can view and even modify internal registers on the PIC.

Unlike many other inexpensive PIC programmers the Inchworm...

- Is both a Debugger and Programmer
- Always supports the latest PICs (MPLAB will update the firmware)
- Can power target (5V @ 500ma) or be target powered
- Uses an inexpensive 2.5mm center positive 9VDC - 12VDC @ 500ma wall adapter

What it can't do

- VPP voltage is not programmable; it is set to approximately 12.5V
- It works with 5V only targets
- +5V on ICD connector is not switchable

## Circuit Description

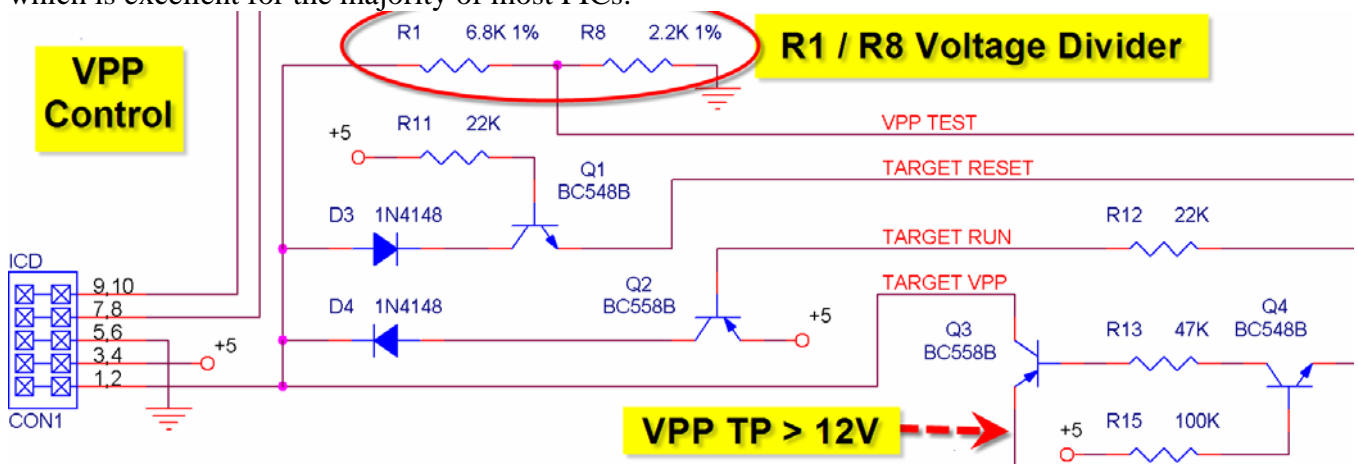
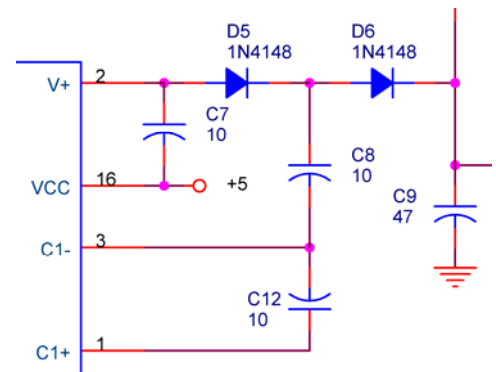
The Inchworm was designed to be easy to assemble and use. It only contains three ICs as almost all of the work is done inside the 16F877A *that's the beauty of microcontrollers*.

The other ICs include U1 a LM7805 voltage regulator and U3 an RS232 level converter with a built in switched capacitor voltage doublers.

VPP > 12V is generated from 5V using the MAX232s' own internal voltage doublers.

Diode D5 and capacitor C8 act as part of a voltage multiplier circuit. In a lossless circuit there would be approximately 15V at the cathode of D5 but because of voltage drops both internally to the MAX232 and across D5 (approx 0.7V) the voltage is actually closer to 14V. D6 rectifies and C9 filters the voltage down to approx 13.5V

Additionally Q3 switches target VPP on or off drops the voltage an additional 0.7V to the final VPP target voltage of roughly 12.5V which is excellent for the majority of most PICs.



VPP control is done with transistors Q1 thru Q4. Diodes D3 & D4 prevent reverse current from flowing into transistors Q1 & Q2. Transistor Q4 and resistors R15 & R13 act as an emitter follower limit the amount of current allowed to flow through Q3. Also shown is a typical voltage divider (*the Inchworm has a total of three R1/R8, R3/R10 and R16/R17*) that connect directly to analog inputs RA0, RA1, RA3 on U2. Lastly DTR controls U2s reset, since RS232 levels are generally greater than the 5V permitted the pin is clamped using diodes D7 & D8 and current is limited by R18.

The majority of the work is done inside the 16F877A microcontroller (U2). In a nutshell it does all the accurate timing for VPP levels and serially clocking data (*PGC & PGD*) into the target PIC.

The +5V power supply is a typical LM7805 design. Diode D2 insures correct polarity from the power adapter and diode D1 acts as protection for the regulator.

## Firmware Notes

Your Inchworm kit includes a preprogrammed 16F877A. You can *and should* program a spare 16F877A just in case you damage your original. The 16F877A "ICD2\_BOOTLOADER\_A.HEX" can be downloaded from [www.blueromelectronics.com](http://www.blueromelectronics.com). If you damage the 16F877A you can order another preprogrammed one from one of the sources on the back cover of this document or you could hand assemble a 16F877A programmer from one of the many designs you can find searching the web. Searching the internet for "JDM PIC Programmer" should provide many results.

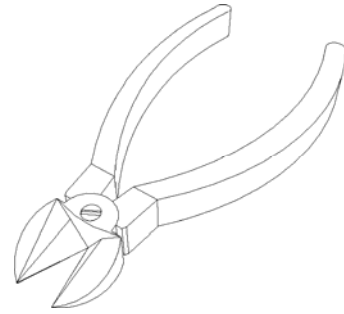
*Note: If your Inchworm has a 16F877-20 you must use different bootloader firmware*

*"BL010101.HEX" and can be found in the MPLAB ICD2 directory when you install MPLAB.*

## 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)
- Wire strippers
- Multimeter (this really is a must for any electronics project)



## Assembly

Traditionally it's easiest to assemble a circuit board from smallest to largest part.

Install 1% (blue epoxy) resistors R8, R17, R3, R10, R1, R16

Install remaining 5% resistors (tan epoxy)

Power diodes D1, D2 (Black 1N4001)

Switching diodes D3 thru D8 (Red 1N4148)

*Note: diodes use a colored band to denote polarity*

IC sockets U2 and U3 (notice notch orientation)

Crystal Y1 and capacitors C10, 13

Transistors Q1, Q4 (BC548B); Q2, Q3 (BC558B)

*Note: LEDs use a flat side indicating polarity*

LED1 (green / power), LED2 (amber / busy)

Capacitors C1, C3, C4, C5 (note lead spacing)

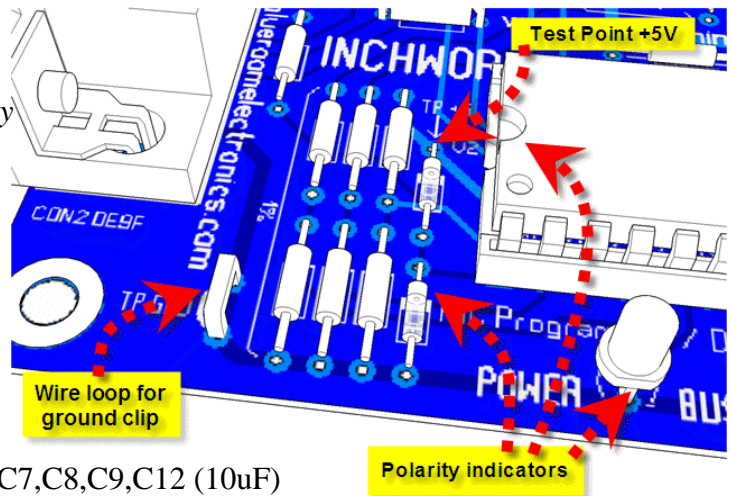
Connectors CON1, CON2 (note the notch)

2.5mm coax power jack P1

U1 and heatsink (test fit before soldering)

Capacitors (note polarity) C2, C9 (47uF) then C6, C7, C8, C9, C12 (10uF)

*Optionally you can install a small wire loop at TP GND for testing*



## Initial Testing

Before installing ICs U2 and U3 apply power to the board using a typical wall AC adapter rated between 9 – 15 VDC @ 700ma to 1500ma. The green POWER LED (pictured above) should glow. If you have a multimeter test for +5V using **TP +5** and >+12V using **TP VPP**

*(Note: TP VPP should not be above 15V).*



## Final Assembly

Remove power before inserting U3 (MAX232) and U2 (PIC16F877A). It is **very important** to insert the ICs carefully (*don't bend the pins*) and in the proper orientation (*notice the notch on the IC*). ICs inserted in the wrong direction when power is applied will usually damage the IC. If you're unsure look at the main illustration on page one of this document. You're now ready to apply power. If the POWER LED does not light immediately unplug the power and recheck all ICs are properly inserted.

Optional: The Inchworm can be mounted in a Hammond 1591B case bottom half, this will protect both the bottom of the PCB and your desk from damage.

*Note: you must file or trim the top lip of the 1591B case directly under the DE9 serial connector approx 0.1" (2.5mm) to insure a proper fit.*

## Parts List INCHWORM

### Capacitors

1	C1	0.33uF 25V
2	C2,9	47uF 25V
3	C3,4,5	0.1uF
5	C6,7,8,11,12	10uF 16V
2	C10,13	33pF

### Resistors 1/4W 5% Carbon (tan body, 4 color bands)

5	R2,4,7,9,14	330	Orange, Orange, Brown, Gold
1	R18	1K	Brown, Black, Red, Gold
2	R5,6	4.7K	Yellow, Green, Red, Gold
2	R11,12	22K	Red, Red, Orange, Gold
1	R13	47K	Yellow, Green, Orange, Gold
1	R15	100K	Brown, Black, Yellow, Gold

### Resistors 1/4W 1% Metal Film (blue body, 5 color bands)

2	R8,17	2.2K 1%	Orange, Orange, Black, Brown, Brown
2	R3,10	4.7K 1%	Yellow, Green, Black, Brown, Brown
2	R1,16	6.8K 1%	Blue, Grey, Black, Brown, Brown

### Semiconductors

2	D1,2	1N4001 Diode
6	D3,4,5,6,7,8	1N4148 Diode
1	LED1 (POWER)	3mm GREEN LED
1	LED2 (BUSY)	3mm AMBER LED
2	Q1,4	BC548B NPN
2	Q2,3	BC558B PNP
1	U1	LM7805 TO-220
1	U2	PIC16F877A (ICD2_BOOTLOADER_A.HEX)
1	U3	MAX232 or equivalent

### Crystals

1	Y1	20MHz Crystal
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### Connectors

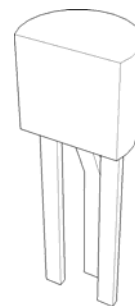
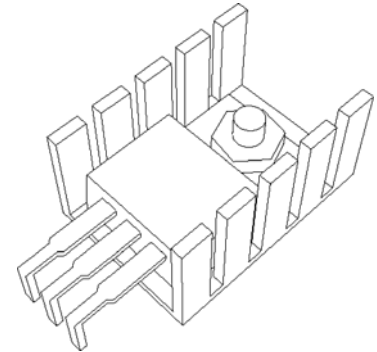
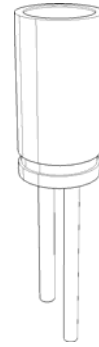
1	CON1	ICD 2x5 PCB Male
1	CON2	DE9 RA Female
1	P1	2.5mm Coax Jack

### Miscellaneous

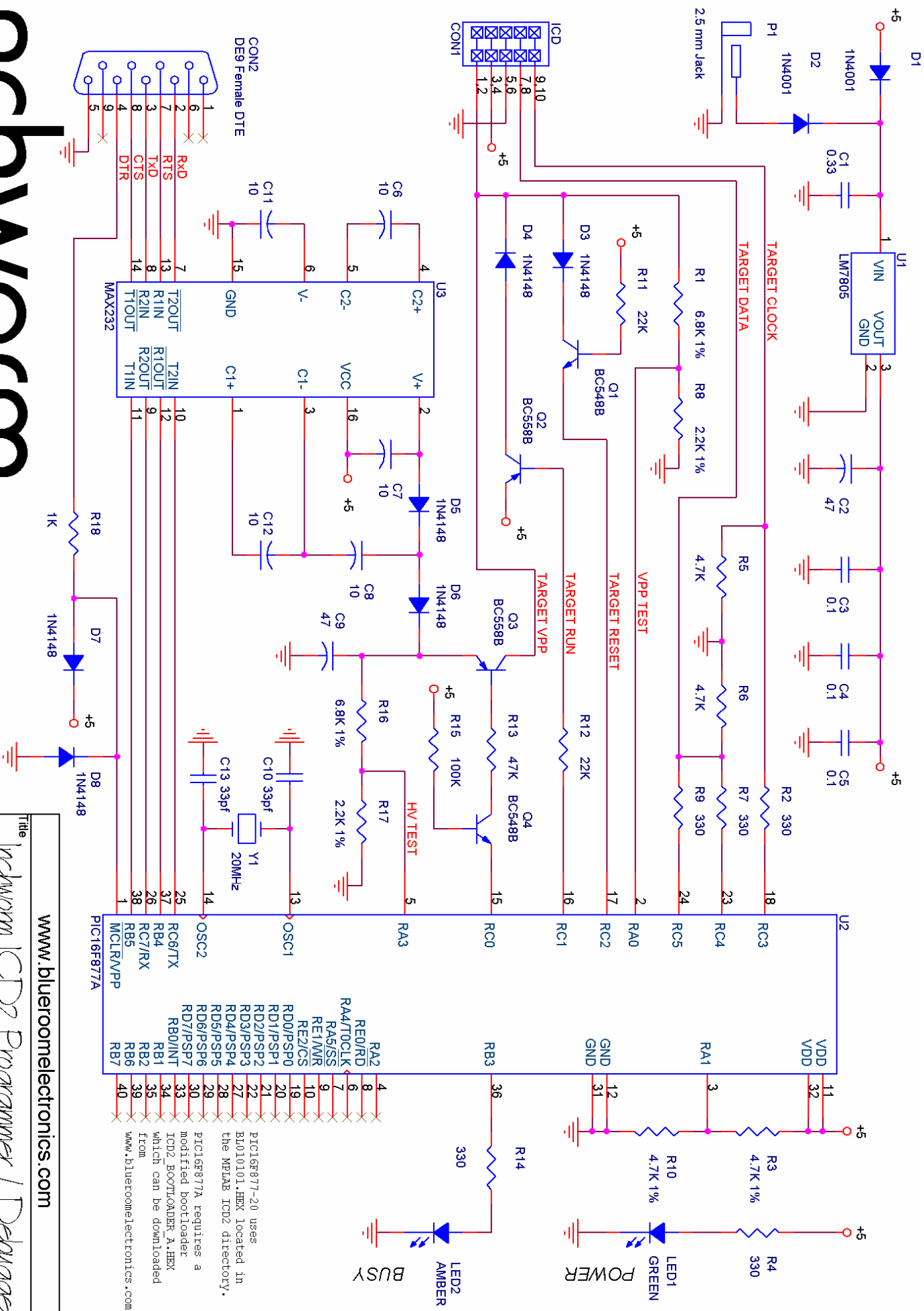
1	40-pin	IC Socket
1	16-pin	IC Socket
1	Heatsink	TO-220 style
lea	Screw, Nut & Lockwasher (for LM7805 and heatsink)	

### Optional

1	Enclosure	Hammond 1591B (112mm x 62mm)
1	9-15VDC Adapter	9-15VDC 2.5mm coax AC adapter @ 750ma
1	5-pin	Berg connector
8"	10-conductor	ribbon cable
1	10-pin	IDE female crimp connector







# inchworm

www.bluroomelectronics.com	
Title	inchworm ICD2 Programmer / Debugger
Size	Document Number
A	wrichardson@bluroomelectronics.com
Rev	E

PIC16F877-20 uses  
BD010101.HEX located in  
the MPLAB ICD2 directory.

PIC16F877A requires a  
modified bootloader  
ICD2\_BOOTLOADER\_A.HEX  
which can be downloaded  
from  
www.bluroomelectronics.com

## ***Building the ICD Cable***

There are many types of ICD cables, this first one is a traditional cable.

### ***Traditional***

***New “i” type*** (designed for blueromelectronics projects)

## A Brief Introduction to MPLAB® IDE

Before you begin you will need to download and install Microchips MPLAB IDE from [www.microchip.com](http://www.microchip.com)

MPLAB IDE is a very powerful tool a few notable features are:

- Macro Assembler and Simulator
- Programmer and Powerful Debugger
- Third party compiler integration

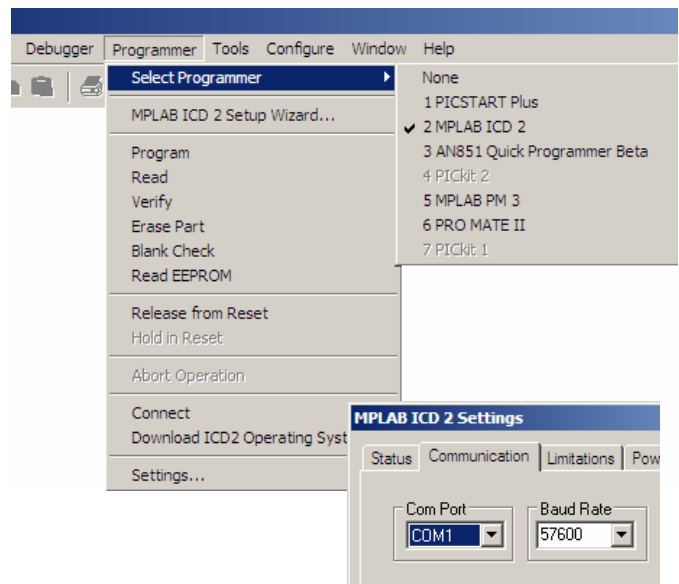
Tutorials and full documentation (*beyond the scope of this document*) can be found on the Microchip web site.

## Connecting Your Inchworm

The Inchworm connects to your Windows™ based computer through an RS232 port. If your computer does not have a RS232 serial port (*a laptop computer for example*) you will need a USB to RS232 adapter. These are common devices and can be purchased at most computer retailers.

Notes:

- You can only use COM1 or COM2 *this may change, read the MPLAB readme*
- You must disable the (COM1 or COM2) FIFO buffer from Windows™
- Choose Select Programmer and choose 2 MPLAB ICD 2
- Select Settings... and select your Com Port (either COM1 or COM2)
  - If you get communication errors try changing the Baud Rate to 19200
- You may have to Download ICD2 Operation System.
  - This feature can be set to automatic.



## Supported PICs Device Support List with MPLAB IDE version 7.40

### Debugger & Programmer Support

#### All dsPIC30Fxxxx and 18Fxxxx series PICs

PIC16F737	PIC16F747	PIC16F767	PIC16F777	PIC16F818	PIC16F819
PIC16F87	PIC16F88	PIC16F870	PIC16F871	PIC16F872	PIC16F873
PIC16F873A	PIC16F874	PIC16F874A	PIC16F876	PIC16F876A	PIC16F877
PIC16F877A	PIC16F913	PIC16F914	PIC16F916	PIC16F917	PIC16HV785
PIC16F946					

#### The following PICs require a special -ICD debug version with header

Note: These special ICD PICs do not lose any I/O when used with the ICD; they also include a small PCB with ICD2 (Microchip) RJ-6 header.

PIC10F2xx	PIC12F5xx	PIC12F6xx	PIC16F627A	PIC16F628A	PIC16F648A
PIC16F684	PIC16F687	PIC16F688	PIC16F689	PIC16F690	PIC16F716
PIC16F785	PIC16F505	PIC16F630	PIC16F636	PIC16F639	PIC16F676

#### PICs with Programmer Support Only

Note: These tend to be older PICs, they all have modern replacements.

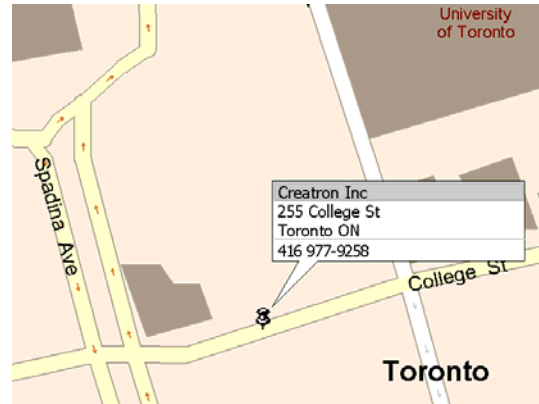
PIC16F72	PIC16F73	PIC16F74	PIC16F76	PIC16F77	PIC16F84
PIC16F84A	PIC16F505	PIC16F54	PIC16F57	PIC16F59	PIC16F627
PIC16F628					

**The Inchworm and other [bluroomelectronics](http://www.bluroomelectronics.com) projects are available at.**

### Retail Sales



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