USB PIC Prog – Compact Hardware Implementation

Summary

Based on the original "thru-hole" design (rev. 0.3.2) a compact version of the programmer hardware has been developed, including a new approach to link the ZIF socket which accommodates the different PIC versions without the need to change connectors.

Project Scope

The complete programmer's hardware will fit in a compact size enclosure, which can be easily transported (in a small bag or even pocket), or just stay next to the desktop / laptop computer, without occupying much desktop space. The design should also be aesthetically attractive, so it will not disturb a nicely arranged desktop setup.

In order to break with the traditionally "square box" design of standard project enclosures, a new design has been selected, as can be seen on Figure 1.

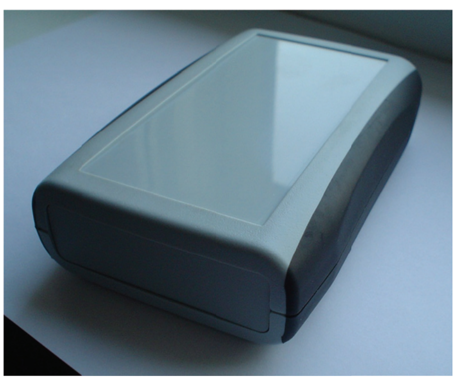

Figure 1 – Enclosure used to accommodate the hardware main board (including the USB sub-board) and the ZIF socket board (PACTEC Model 87836-510-508, PPLX Kit, Grey w/ Black Sides, external dimensions 121.9 x 78.7 x 33 mm).

Circuit Schematics

The circuit schematics have been redrawn in order to design a new printed circuit board (PCB), adequate for the space constraints of the chosen cabinet. The USB connector (type B) has been placed in a separate sub-board, in order to simplify the physical layout, since it needs to fit precisely in a hole cut in the enclosure, just protruding 1 mm to the outside. Figure 2 shows the main board schematics.

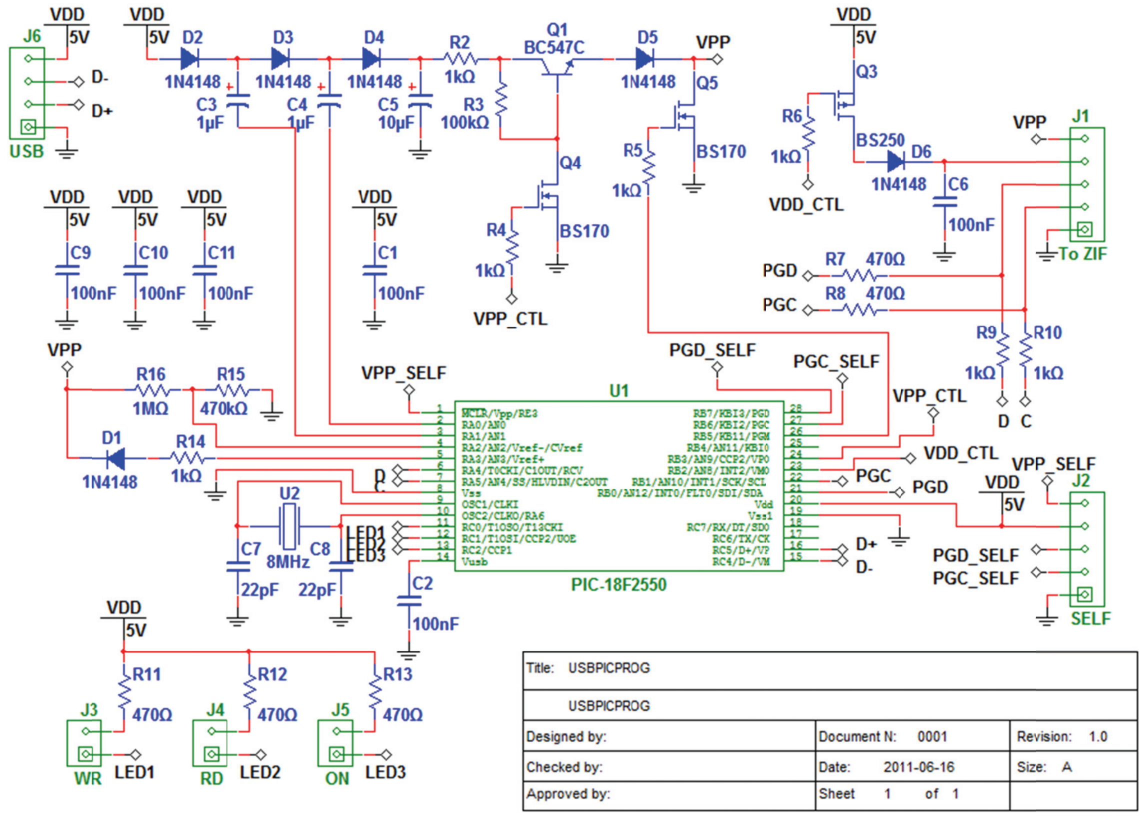

Figure 2 – Main board circuit schematics

Besides rearranging the components layout, this design is exactly the same as rev. 0.3.2 of the original hardware.

What is completely new is the design of the ZIF socket board. The original design considered using multiple connectors, each linked differently to the ZIF socket, to program the different PIC families. This new design has just one connector, and an array of switches to perform the same function. With this approach, the final design is more compact, and there are no loose cables or exposed connectors. Figure 3 shows the ZIF socket board schematics.

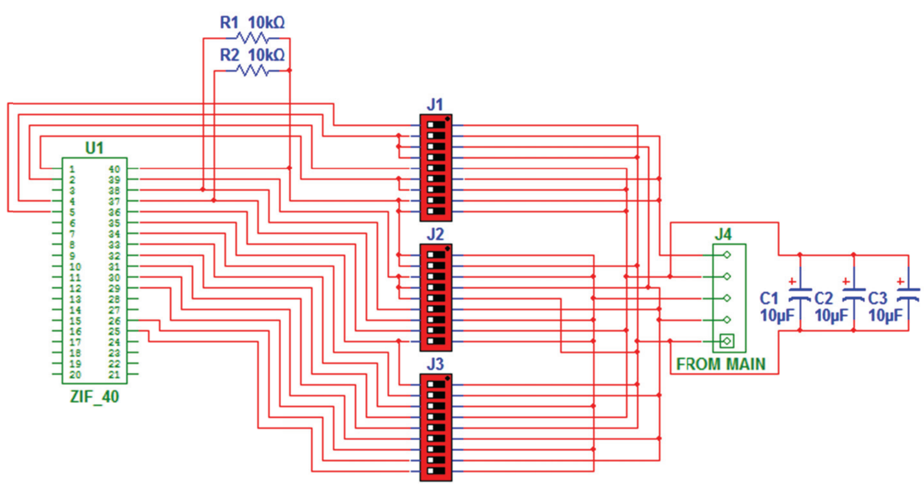

Figure 3 – ZIF socket board schematics. An array of 27 keys (arranged in 3 groups) replaces the connectors.

Note the three added capacitors, between VDD and GND, each made of tantalum, marked 10uF / 6.3V. These are SMD components, and are intended to suppress any electrical noise that may affect the +5V line, which may interfere with the programming sequence, giving random errors.

In order to know the position of each key when programming a particular PIC family, the table shown in Figure 4 has been created, and should be kept close to the hardware for reference.

SW	K	dsPIC40P	dsPIC28P	K	dsPIC18P	PIC28-40P	K	PIC18P	PIC12F_8-14P	K	PIC10F_8P	I2C_EE	K	SW
		P2	P3		P4	P5		P6	P7		P8	P9		
	1	OFF	OFF	1	OFF	OFF	1	ON	OFF	1	OFF	OFF	1	
	2	OFF	OFF	2	OFF	OFF	2	ON	ON	2	OFF	OFF	2	
	3	OFF	OFF	3	OFF	OFF	3	OFF	OFF	3	ON	OFF	3	
	4	OFF	OFF	4	OFF	OFF	4	OFF	OFF	4	OFF	ON	4	
S1	5	OFF	OFF	5	OFF	OFF	5	OFF	OFF	5	ON	OFF	5	S1
	6	ON	ON	6	ON	ON	6	OFF	OFF	6	OFF	OFF	6	
	7	OFF	OFF	7	OFF	OFF	7	OFF	ON	7	OFF	OFF	7	
	8	OFF	OFF	8	OFF	OFF	8	OFF	OFF	8	ON	OFF	8	
	9	OFF	OFF	9	OFF	OFF	9	OFF	OFF	9	OFF	ON	9	
	1	OFF	OFF	1	OFF	ON	1	OFF	OFF	1	OFF	OFF	1	
	2	OFF	OFF	2	OFF	OFF	2	OFF	ON	2	OFF	OFF	2	
	3	OFF	OFF	3	OFF	OFF	3	OFF	ON	3	OFF	OFF	3	
	4	OFF	OFF	4	OFF	ON	4	OFF	OFF	4	OFF	OFF	4	
S2	5	OFF	OFF	5	OFF	OFF	5	OFF	OFF	5	ON	OFF	5	S2
	6	OFF	OFF	6	OFF	OFF	6	OFF	ON	6	OFF	ON	6	
	7	OFF	OFF	7	OFF	OFF	7	OFF	OFF	7	ON	ON	7	
	8	OFF	OFF	8	ON	OFF	8	ON	OFF	8	OFF	OFF	8	
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	2	OFF	OFF	2	ON	OFF	2	ON	OFF	2	OFF	OFF	2	
	3	OFF	OFF	3	ON	OFF	3	OFF	OFF	3	OFF	OFF	3	
	4	ON	ON	4	OFF	ON	4	OFF	OFF	4	OFF	OFF	4	
S3	5	ON	ON	5	OFF	ON	5	OFF	OFF	5	OFF	OFF	5	S3
	6	OFF	ON	6	OFF	OFF	6	OFF	OFF	6	OFF	OFF	6	
	7	OFF	ON	7	OFF	OFF	7	OFF	OFF	7	OFF	OFF	7	
	8	ON	OFF	8	OFF	OFF	8	OFF	OFF	8	OFF	OFF	8	
	9	ON	OFF	9	OFF	OFF	9	OFF	OFF	9	OFF	OFF	9	

Figure 4 – PIC family selection matrix. Each group of keys is marked as S1 through S3, while each key is numbered from 1 to 9. Below each PIC family name, the original connector name (P2 through P9) has been kept for back-reference.

So basically, if a PIC-16F628A (PIC18P) is to be programmed, S1 - Keys 1 and 2 will be ON, S2 – Keys 8 and 9 will be ON, and S3 – Key 2 will be ON. All the rest will be OFF.

If the user changes of PIC family frequently, a good advice is to leave ALL keys in the OFF position after using the programmer, just to avoid errors due to incorrect family selection when using it next time, until the habit of verifying the key configuration before programming is made.

One may wonder why the keys are arranged in three groups; the answer is simple: three 9-key DIP Switches have been used (Grayhill, Series 78, Model 78B09 with Raised Slides). Using a “raised slide” version is fundamental to allow an easy manual change of each switch (no tools needed).

Printed Circuit Boards (PCB)

The PCB for each section has been redesigned in order to fit the selected enclosure, as explained before. Figure 5 shows the PCB of the USB connector sub-board.

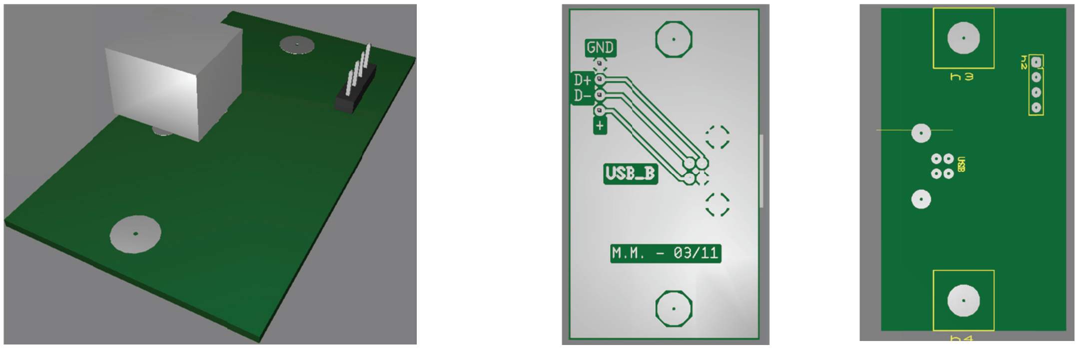


Figure 5 – USB connector sub-board; just the USB B-type connector, a 4-pin linear header and two screw holes.

The main board is slightly more impressive, but still an "inside the box" type of board. See Figure 6.

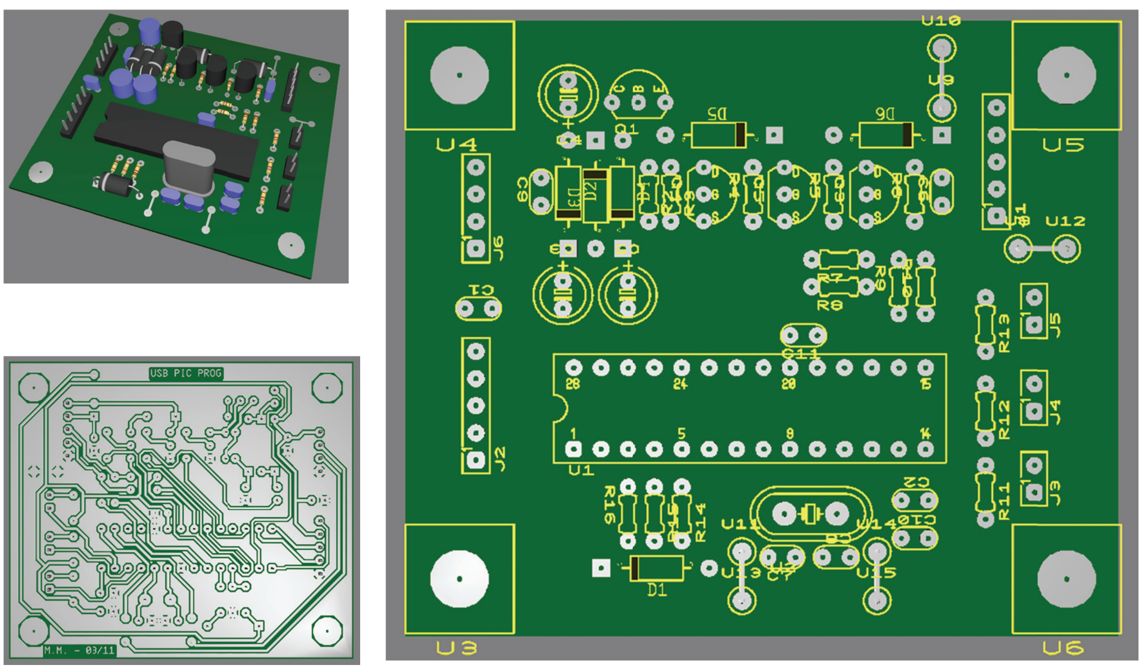


Figure 6 – Main board; overall layout and components placement.

In the appendix at the end of this article you may find the actual size PCB drawings and silkscreen, so do not worry if some references are not clear in the above figures.

These two boards will be mounted inside the enclosure. The USB connector requires special care, since it must fit exactly in a hole cut in the enclosuse front panel. Figure 7 shows the separate parts and the final result when mounted together.

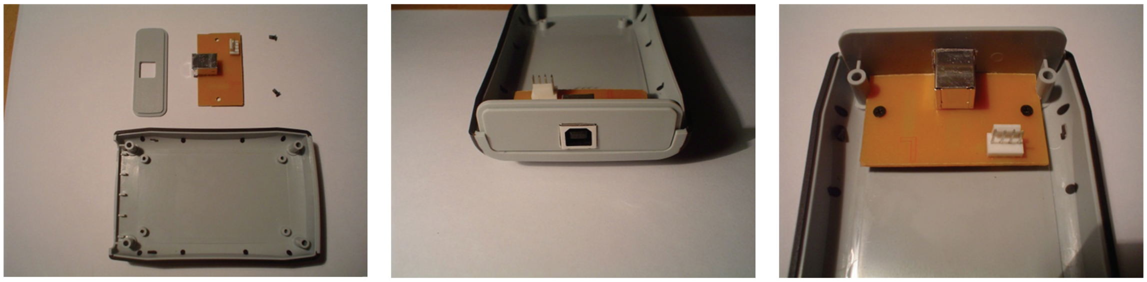


Figure 7 – Component parts and final placement of the USB sub-board.

The main board goes just next to the USB sub-board, as shown in Figure 8.

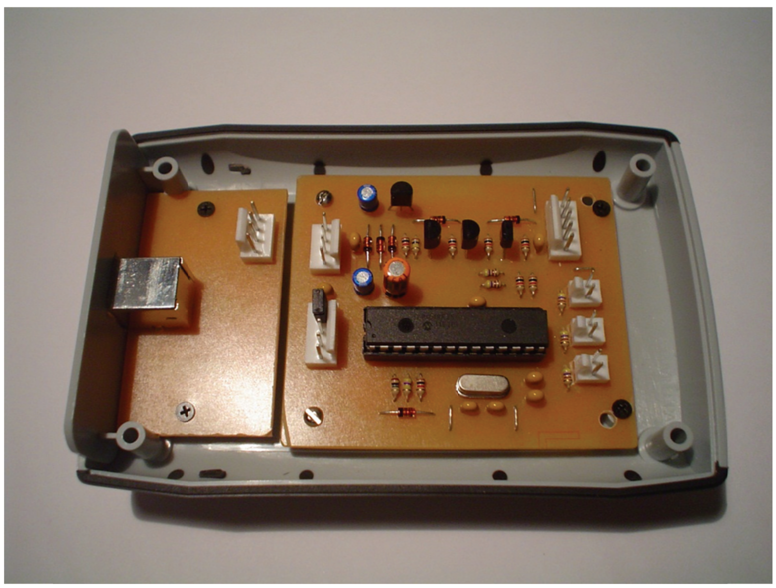
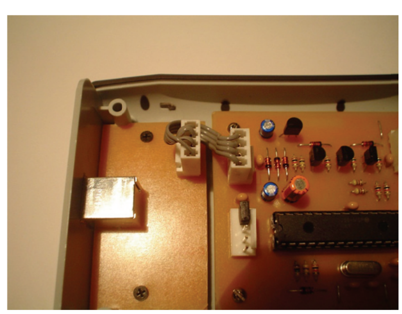


Figure 8 – Main board placed inside the enclosure; note the additional screw holes on the right side of the board, to fit the case bosses. The original holes were intended for a different setup.

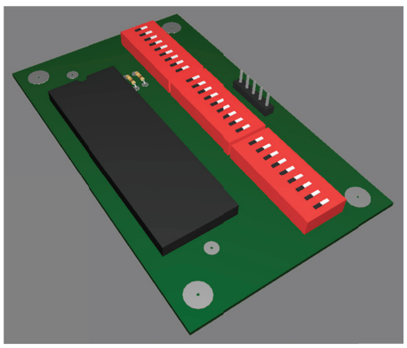
The two boards are connected with a 4-wire flat cable (Figure 9). The jumper between VPP_SELF and VDD is already in place; there will be no need to remove this part in the future.

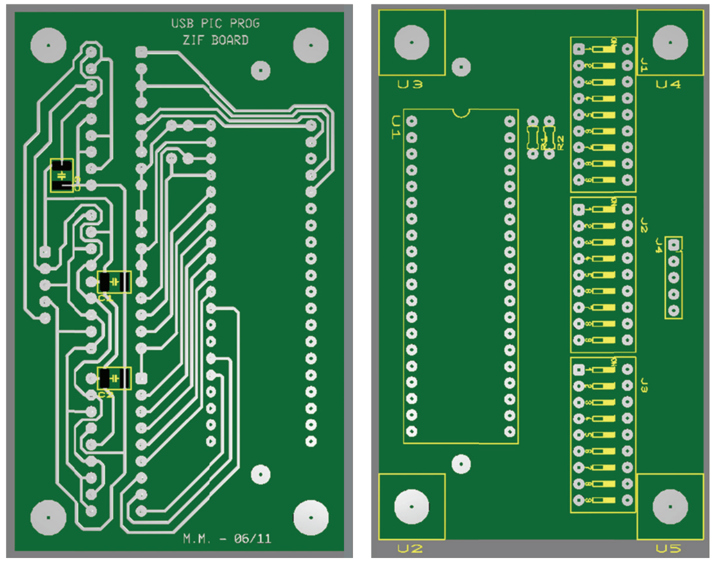
Figure 9 – Main board and USB sub-board are connected by a 4-wire flat cable.



The ZIF socket board is where the true value of this design resides. This board will be exposed, mounted out of the box so much care must be exercised when building it. It would have been possible to put it inside the enclosure, cutting large holes for the ZIF socket and the switches to be accessible at the top of the unit. The decision, however, was to make an innovative design, and this is the reason why the board is exposed. Figure 10 shows the PCB of the ZIF socket board.

Figure 10 – ZIF socket board PCB. Capacitors C1~C3 are mounted on the copper side; resistors R1 and R2, as well as connector J4 will also be mounted on the copper side, despite being shown on the component side.





Since it will be fully visible, this board will be carefully cut and all sides must be perfectly straight. Dimensions are also extremely important, since it will fit on a recessed portion of the top side of the enclosure. This board is 82 x 50 mm. As mentioned on the legend of Figure 10, only the ZIF socket and the switches go on the component side; all other parts go en the copper side. This allows the component side (visible side) to be clean from components other than those required for the user interaction. This also lets us stick a printed silkscreen, which gives a much professional finish to the design. Figure 11 shows the silkscreen design.

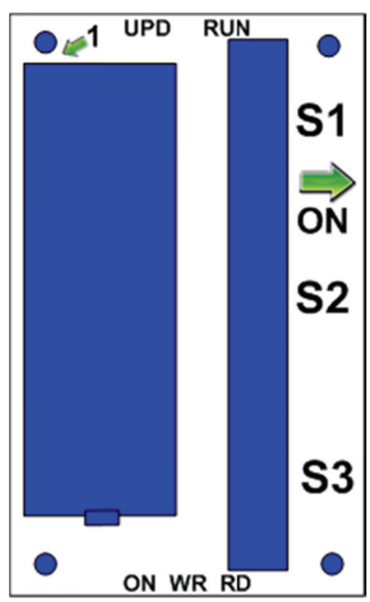


Figure 11 – ZIF socket board silkscreen.
This design is printed in self-adhesive paper, which is later covered with transparent adhesive film.
Blue parts are carefully cut and removed, the protective back layer of the paper is removed exposing the adhesive, and it is carefully glued in place in the PCB.

The silkscreen is glued to the PCB right before mounting the ZIF socket and the switches. The cut areas have been calculated so they just go below the components, so no bare PCB is visible. The last step of this process is to carefully mount and solder the top components. The final result should be similar to Figure 12.

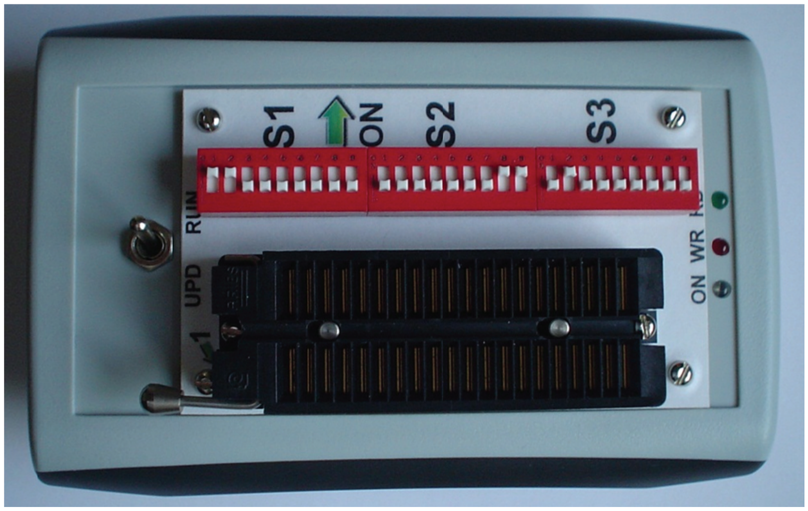


Figure 12 – ZIF socket board finished and in place on top of the enclosure. The silkscreen design also includes indications about components that are outside the board, mounted on the actual plastic of the box, such as the LEDs and the "Update / Run" switch. This contributes to create a seamless transition between the board and the enclosure surface.

There is an additional step before achieving the pleasant look of Figure 12; the top side of the enclosure must be cut so the copper side of the board, with the SMD components and connector, lays flat on the surface and access is granted to the main board. This cut is a rough one, it will be completely hidden, and it is big enough to expose all the copper side; care should be exercised, however, not to cut the angles were the board screws will be secured. Figure 13 shows the inner side of the top panel.

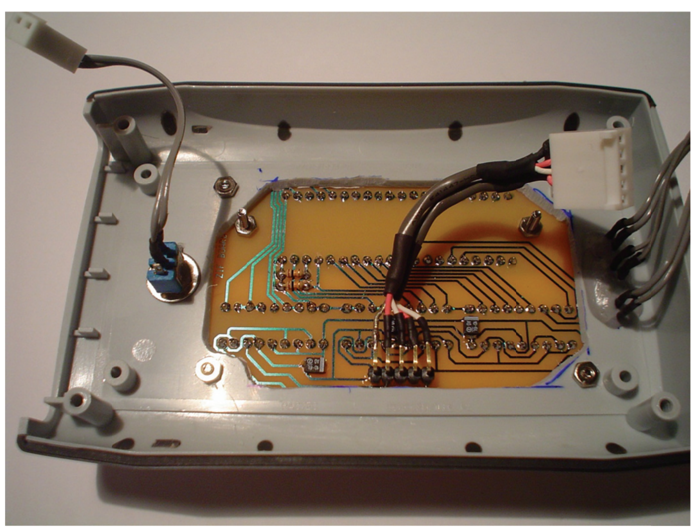
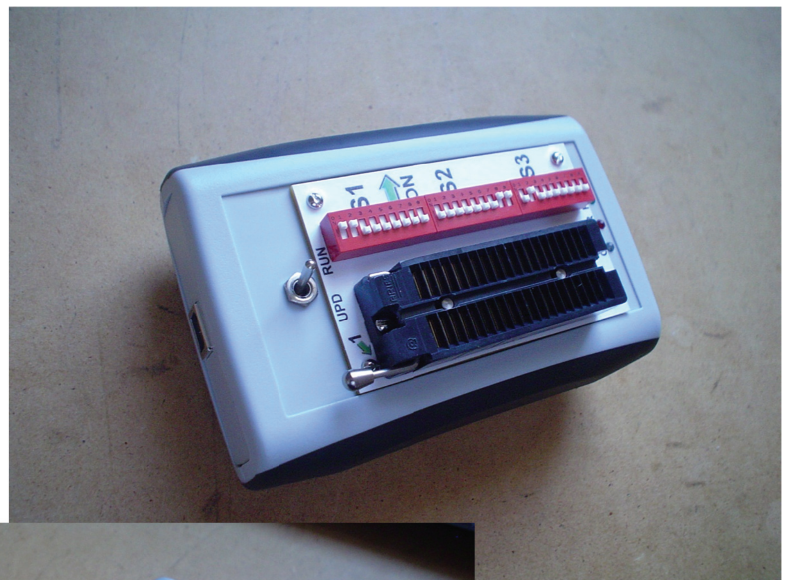


Figure 13 – Inner side of top panel. The large cut exposes the copper area and SMD components, as well as the connector that links to the main board (shielded). R1 and R2 are also mounted on this side.

Figure 13 also reveals the additional components mounted on the box; the three status LEDs (covered by grey plastic to keep them in place) and the “Update / Run” switch. This switch replaces one of the original jumpers; OFF means “jumper disconnected”, so the unit is in Firmware Update Mode. The ON condition simulates “jumper connected”, so the unit is in Normal Run Mode. There is no need to open the unit to update the firmware.

Once all the connectors are firmly locked in place, the unit can be closed and it is ready to run (provided the internal PIC has been loaded with the proper firmware using another programmer, as it is extensively explained in the original documentation). There is just a single connector on the front panel, the USB, and the rest of the controls are on the top panel.

The result is a compact, portable and attractive design, with the full functionality of the original idea.



Marcelo Maggi (mmaggi@hotmail.com) – June, 2011

Appendix

Printed Circuit Boards (actual size) and Silkscreens:

- USB sub-board
- Main board
- ZIF socket board

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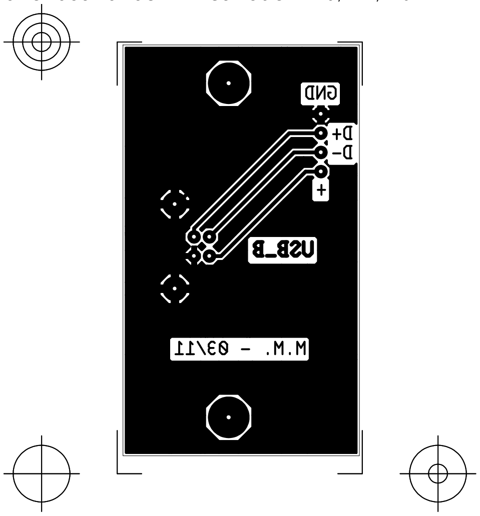

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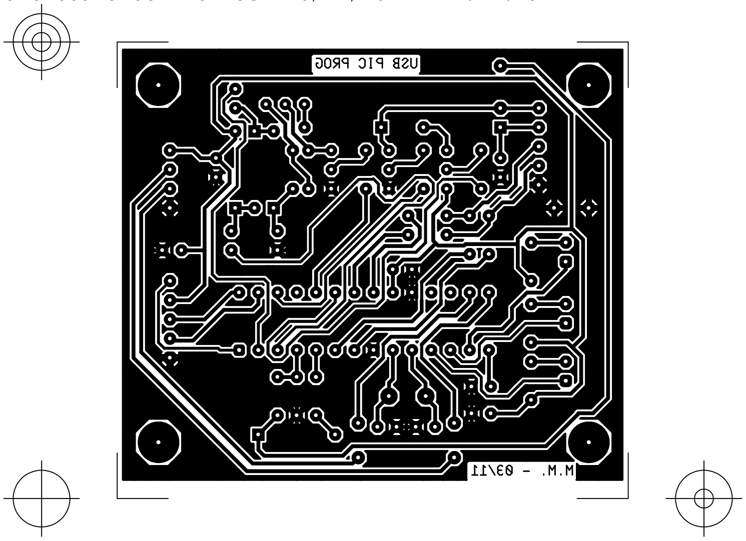

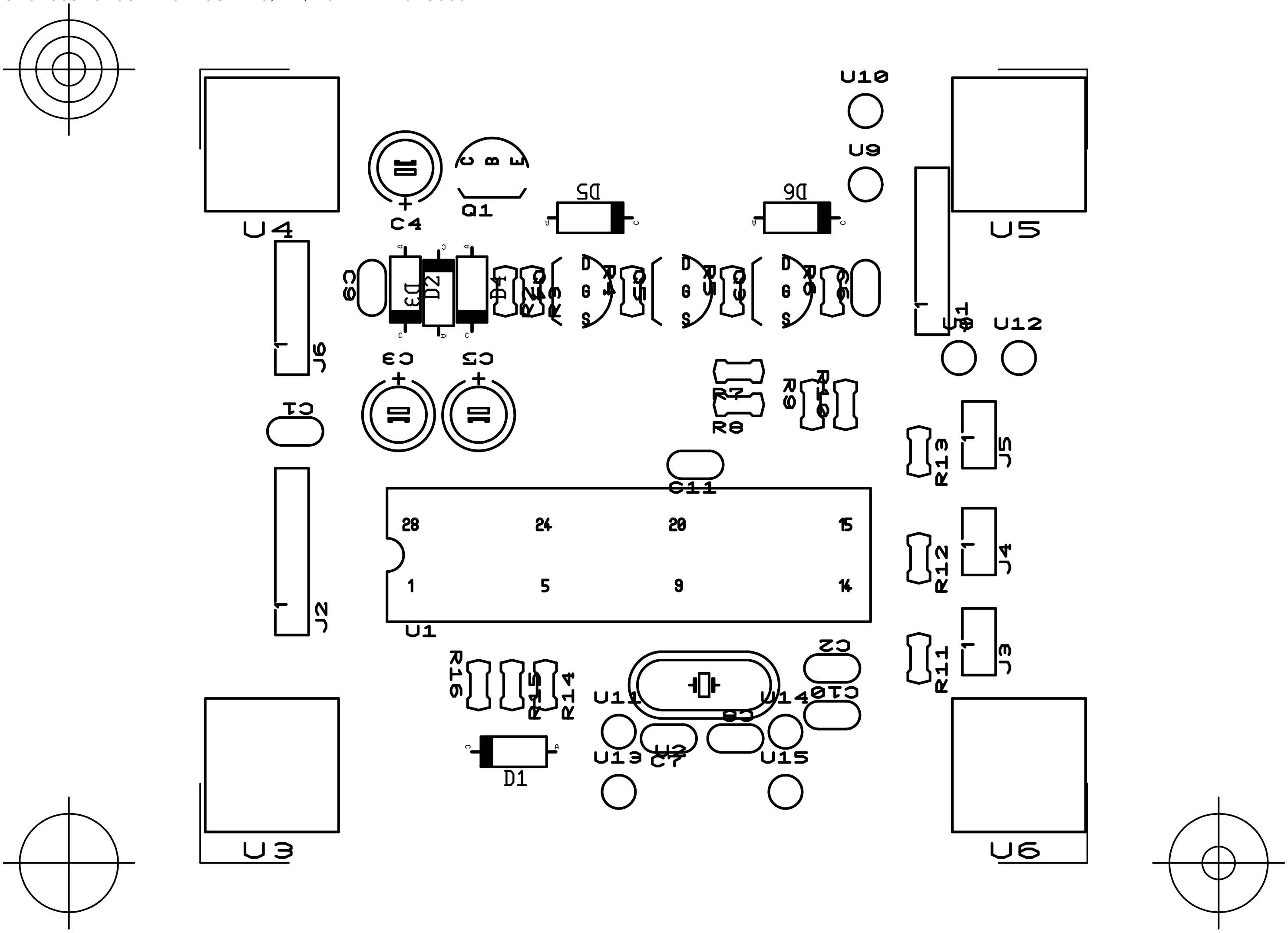
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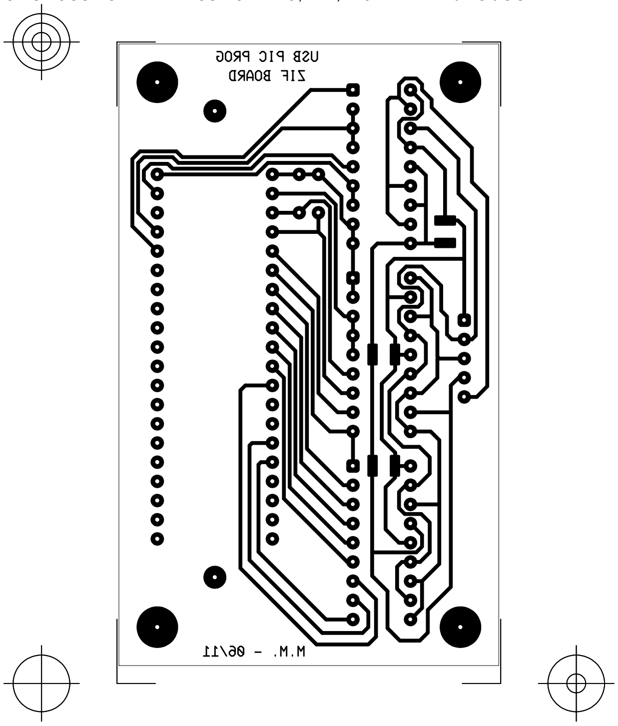
USB PIC PROG
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