Good Idea to Working Electronic Model

by Jan H. Lichtenbelt, March 2011

Abstract

Seeing an idea manifest itself into a fully working creation is always satisfying, however so many good ideas go to waste due to restraints like time, cost and quality. Jan offers some possible solutions to help see those sparks of creativity become reality.

Requirements

Software:

- Any version of Flowcode V3 or V4 for PICmicros

Hardware:

- 18 pin PIC microcontrollers
- EB006 PICmicro multiprogrammer E-block
- EB005 LCD E-block (or other which does not use port pins 6 and 7)
- PICkit2 or PICkit3 (optional)

1. Introduction

Everybody meets the problem of having an idea and then needing to have a working model directly, not only to test the idea but also to use the electronics in practice. The principle for hobbyist and professional are the same, based on three main issues: quality, cost and time. Although hobbyists seem to have more time available, nothing is more frustrating than ending with no results after some time. This article may offer some solutions to realise your creative ideas.

The hardware solutions shown in this document are special for 18 pins microchip microcontrollers like: PIC16F54, PIC16F627A, PIC16F628A, PIC16F648A, PIC16F716, PIC16F818, PIC16F819, PIC16F84A, PIC16F87, PIC16F88 , PIC16HV540, PIC18F1220, PIC18F1230, PIC18F1320 and PIC18F1330 [1].

Microchip offers a prototype/patch board EB 016/EB017 [2] without a microcontroller and a demo board with a 20pin microchip to be programmed by means of a PICkit 2 or 3 [3], which comes close to the solution given in this document. During this document the differences will become clear.

If you are interested in different microcontrollers of the PIC 18 family, a good alternative are the Matrix ECIO devices, these are USB programmable microcontrollers 18F2455 and 18F4455 [4].

2. Idea

When realising an idea, you will encounter many obstacles (constrains) but also unexpected possibilities. Take the time to do some research, it can prevent not only disappointment, but it may open up new and unforeseen possibilities and in general, try to find support in case your knowledge is insufficient.

For example, an idea results in the conclusion that you need a microcontroller for your working electronic model. This means you have to take care of both hardware and software.

3. Software

Compared to your PC, a simple microcontroller will have much more specialised possibilities. The most effective use of a microcontroller is programming with a language closely related to the internal workings of the microcontroller. This means using the assembler language, the language which is based on bit and bytes programming. However, this will take more time and the debugging possibilities are relatively poor, but you have to try it at least once in your life!

To prevent the assembler problems, higher languages have been developed, like Basic, C, etc, etc. The disadvantage of these higher languages will always be that they are less effective in memory usage and processing time. The advantage is that it is closer to our perception and moreover, the debugging possibilities are much better. However, always remember that whatever you choose: In all cases, a working model without any error messages, can give you completely wrong results!

I choose to use Matrix Multimedia's FLOWCODE [5] to program a microcontroller. This is a good choice, because it simplifies the C-language especially for electronic usage. This is not the only advantage, also the very good (Forum [6]) support of Matrix Multimedia ensures that the choice of the software and hardware of this firm is not a gamble but a good investment with increased quality and a reduction in time and possibly costs.

4. Hardware

The choice of hardware depends on the phase of the project, but also on available tools at home or in the laboratory. In the test phase you will probably use the PICmicro MCU multiprogrammer EB-006 board with Flowcode software, but how to go on after the test phase has been ended with success? Of course you can use the EB-006 with some additional E-Blocks in your working model. Using the E-block in the working model is perhaps not the cheapest solution but more important is the fact it will take up a lot of space, because the E-blocks are not made to be the most compact of electronics. This space may not always be available.

One alternative is to use a multi-component general board specifically for *18 pin* microcontrollers. In my experience it is advisable to debug by the means of an LCD screen, this leads me to develop a standard board for a PIC16F88 microcontroller or equivalent. On this board must be a power supply (optional) and 9-pins sub-D connector for LCD screen or other electronics connected to the board and at last with many pads for additional on-board electric components as possible. The size of the standard board is determined by the power supply, the 18 pins IC and 9 pins SUB-D connector and is just 55 x 55 mm, see below.

5. Working models

I personally use the 18 pin microcontroller, PIC16F88 the most, and I have made 3 general boards for this controller and other microcontrollers with equivalent pins. Through my own personal experience I have found that a LCD screen is always useful in the testing phase. Therefore I always add a 9-pin Sub-D connector to all my working boards, but even when the test phase has been completed, I find that in most cases the microcontroller has to be re-programmed for a reason. I have found 3 solutions: 1) take the microcontroller out of the board and re-program the controller in the EB-006 block. This will probably result in pin breaking after about 10 times. An alternative is in-series programming by means of 2) an IN-Circuit Serial Programming ICSP™ connector [7,8] or 3) the sub D connector. These last two solutions need some additional space on the board.

Option	Board power	Programming the microcontroller	Advantage	Disadvantage
1	Vin ≥5 Volt	Exchange the microcontroller to EB006 board and back, by hand	Simple with maximum space for extra electronics.	Possible physical damage of the microcontroller
2 / 3	Vin ≥ 5 Volt	By means of cable connector to EB006 board or PICkit 2/3	In series on board programming with connector: 2) with ICSP™ 3) SUB-D9	Precaution necessary for disconnecting pins during programming: 2) B6, B7 and A5/Vpp 3) A5/Vpp

6. Difference with the PICkit demo board

Microchip also offers a *20 pin* demo board to be programmed by means of a PICkit 2 or 3 [3], which comes close to the boards shown in this document, except the number of pins. Both can be programmed by means of Flowcode 4. Special connections can be made by means of additional connectors. However there are differences between them, as shown in the table below.

	IC pins	Power supply	Connectors	Programming	Additional
PICkit demo board	20	External	- power (regulated 5 voltage needed) - All 20 pins available	By means ICSP™ of PICkit 2 or 3	- 4 LED's on board and potentiometer for ADC - Professional board - size 53 x 89 mm
Board Version 1.3	18	On board	- power (any Vac or Vdc >= 5 Volt) - sub-D for LCD - All 18 pins available	Only in the E-block EB006	- LCD connection for debugging and actual working status. - Simple one layer board - size 55 x 55 mm with 3 M3 fixing holes
Board version 2.1	18	On board	- power (any Vac or Vdc >= 5 Volt) - All 18 pins available, B-pins preferable by means of sub-D	With E-block EB006 or PICkit2/3 by means on-board ICSP™ connector	- LCD connection for debugging and actual working status. - External MCLR via Sub-D - Simple one layer board - size 55 x 55 mm with 3 M3 fixing holes
Board version 3.1	18	On board	- power (any Vac or Vdc >= 5 Volt) - All 18 pins available	With E-block EB006 or PICkit2/3 by means of sub-D connector	- LCD connection for debugging and actual working status. - External MCLR via Sub-D - Simple one layer board - size 55 x 55 mm with 3 M3 fixing holes

Remark: Flowcode can be used to program both by means of EB006 block and by means of PICkit2/3 see [10]

Pay attention!! On board programming or ICSP™ needs special care for the three pins used during programming: RA5/Vpp/MCLR pin, RB6 and RB7.
If RA5 if used as input, care has to be taken to disconnect during programming. If RA5 used as MCLR an additional resistor of 470 Ohm or Schottky diode must be used as shown in the figure.
RB6 and RB7 must be disconnected from other electronics. This is automatically be done with board V3, see scheme.
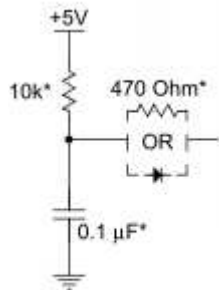
In case of using the EB-006 for programming the on board power supply SHLOULD BE OFF, while using the PICkit2/3 the on board power supply should be on.

All three boards has a sub-D connector with RB0 until RB5 on pins 1 until 6 and Vss=ground on pin 9, in agreement with E-blocks.
Additional pin 8 has Vdd=5 Volt. This makes e.g. possible to connect a LCD to this sub-D. Board V2 and V3, and to some extend board V1, has the possibility of external reset by means of pin 7 of the sub-D connector.

7. Conclusion

On the path from idea to working electronic model, there are many problems to be solved. This is an interactive process which can result in a good solution if some conditions are fulfilled. Programming and programming board are common sense today, but I was missing an easy to use end-board for 18 pins microcontrollers, which includes a power supply and a LCD connector . The LCD is used not only for debugging reasons but also to show data during a working process. If you can produce a simple one side board (PCB) yourself [11], you will find a good and simple solutions in this document. If you do not have this possibility, the Microchip 20 pins board [3] can be a solution.

8. Electrical schemes and component lay-outs

On the next pages the 3 electronic boards are shown more in detail. Both schematic electronics and component lay-out are given. The lay-out were produced by means of the Print-Layout 5.0 program [9]. Because the file format (.lay) is not very common I put the layers (copper and component side) in the Picture chapter 10. On request the original files are available.
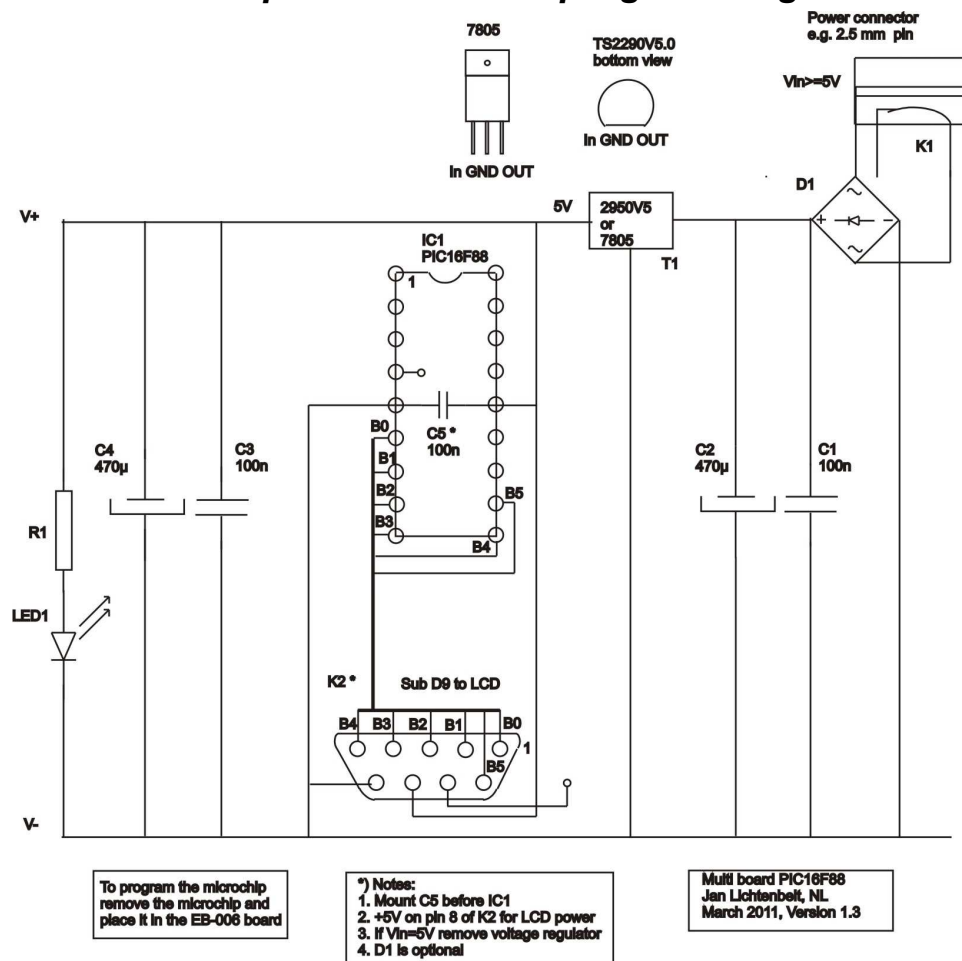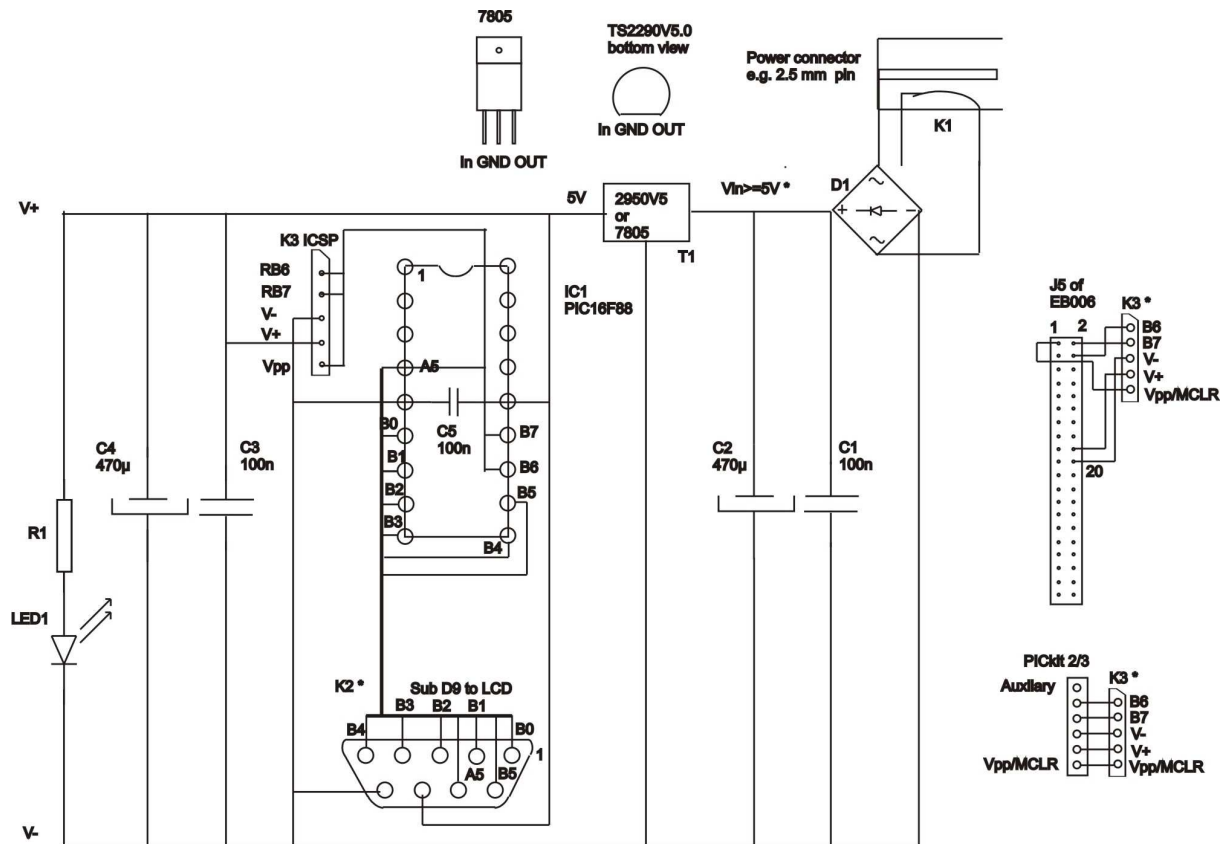
Version 1: Simplest board with programming on EB006 board

Option	Board power	Programming the microcontroller	Advantage	Disadvantage
1	Vin ≥5 Volt	Exchange the microcontroller to EB006 board and back, by hand	Simple with maximum space for extra electronics.	Possible physical damage of the microcontroller
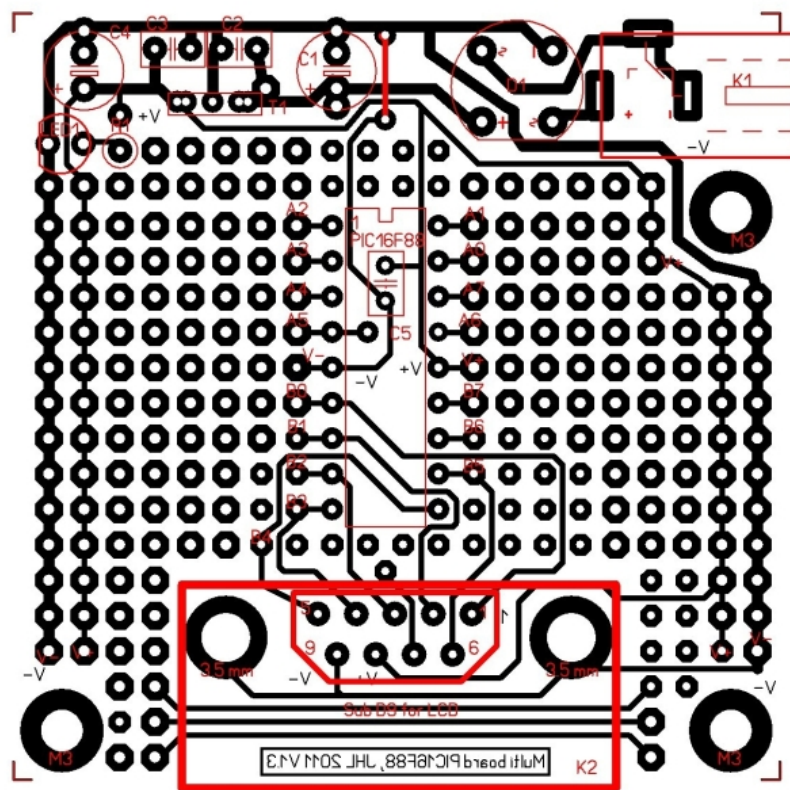
Size: 55 x 55 mm (above picture scale is not 1:1)

Remark: This board can be powered both by Vdc and Vac. The layout differs from version V2 and V3 in a way that the use of screw driver makes it possible to remove the IC. A small version of C5 will be mounted under the IC.

Version 2: Board with programming by means of Sub-D connector

Option	Board power	Programming the microcontroller	Advantage	Disadvantage
2	Vin ≥ 5 Volt	By means of cable connector to EB006 board or PICkit 2/3	In series on board programming with connector with ICSP™	Precaution necessary for disconnecting pins during programming B6, B7 and A5/Vpp
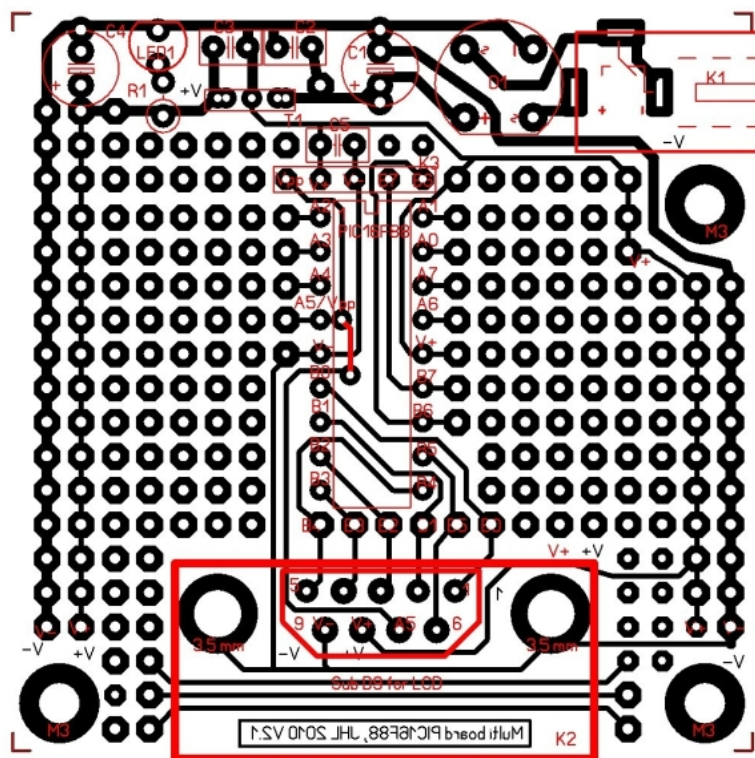
Size: 55 x 55 mm (above picture scale is not 1:1)

Remark: Mount first the short circuit under the IC.

Version 3: Board with programming by means of ICSP™ connector
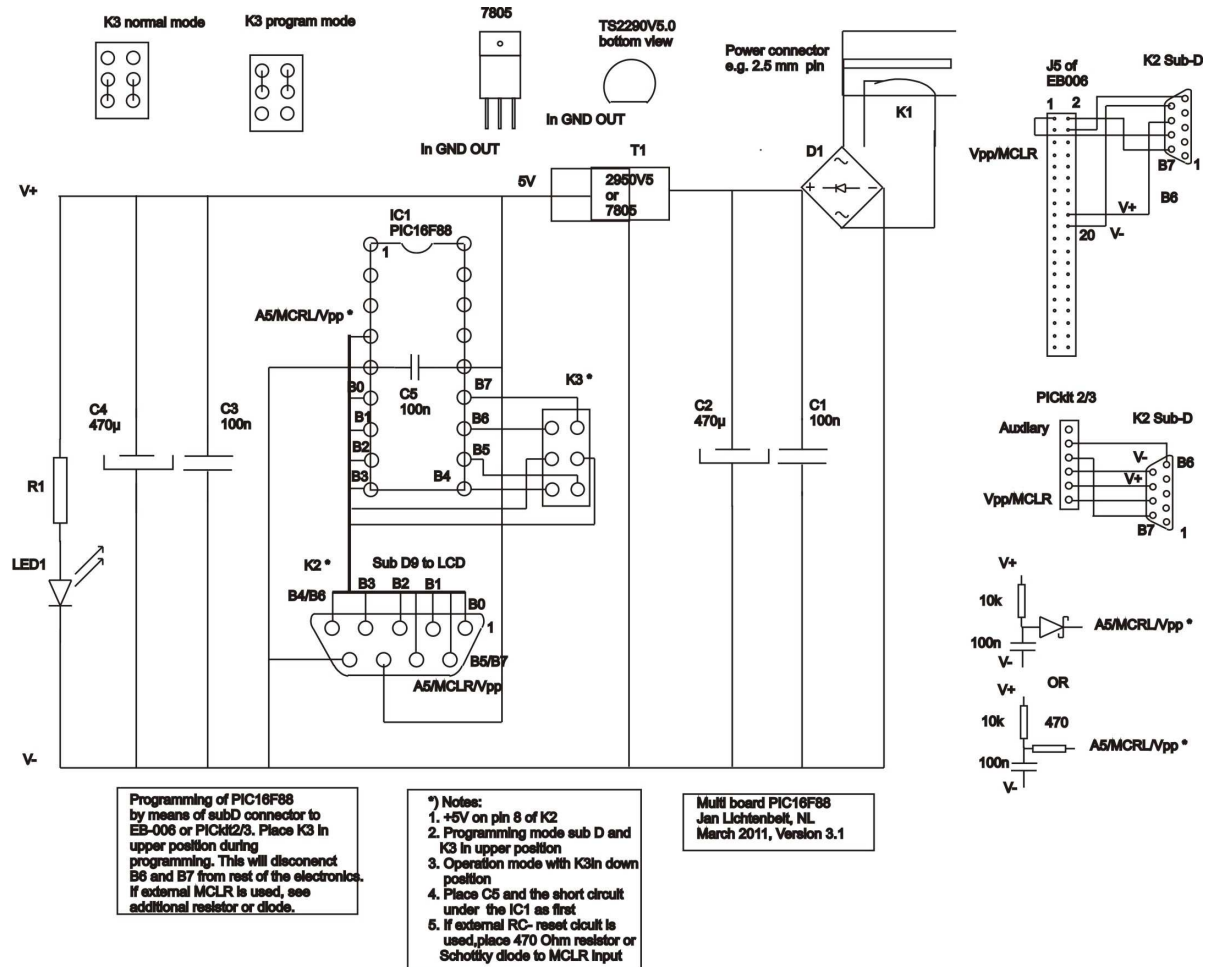
Option	Board power	Programming the microcontroller	Advantage	Disadvantage
3	Vin ≥ 5 Volt	By means of cable connector to EB006 board or PICkit 2/3	In series on board programming with connector SUB-D9	Precaution necessary for disconnecting pins during programming A5/Vpp
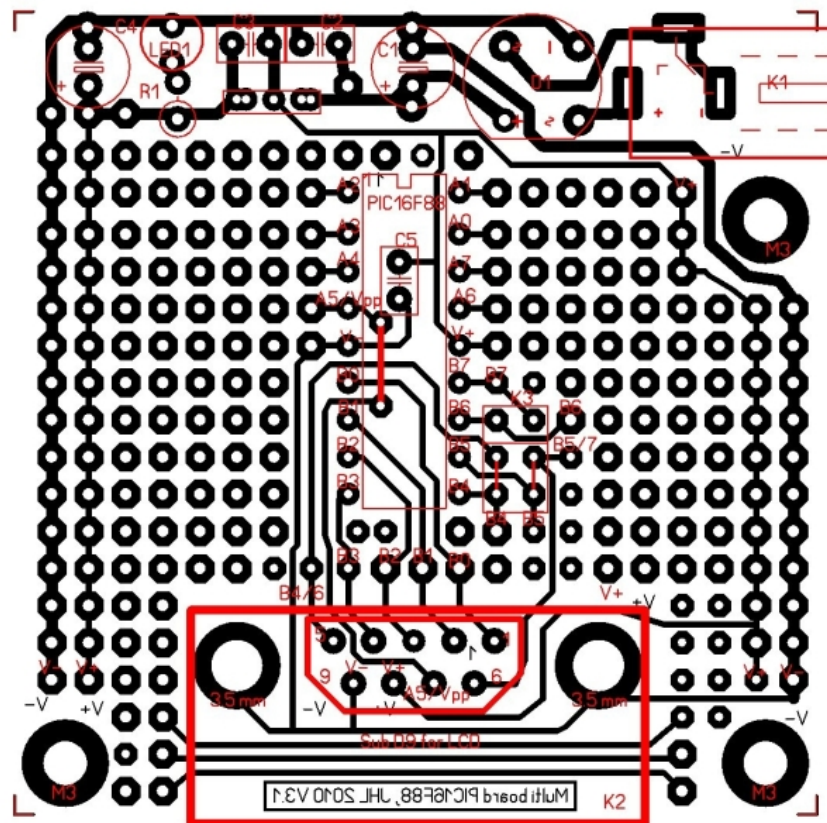
Size: 55 x 55 mm (above picture scale is not 1:1)

Remark: Place the red coloured short circuit as first, before the IC. A small version of C5 will be placed under the IC.

9. Pictures

9.1 Microchip boards and controllers

Microchip Low Pin Count Demo Board. For 20 pin PIC microcontrollers (Part# DM164120)

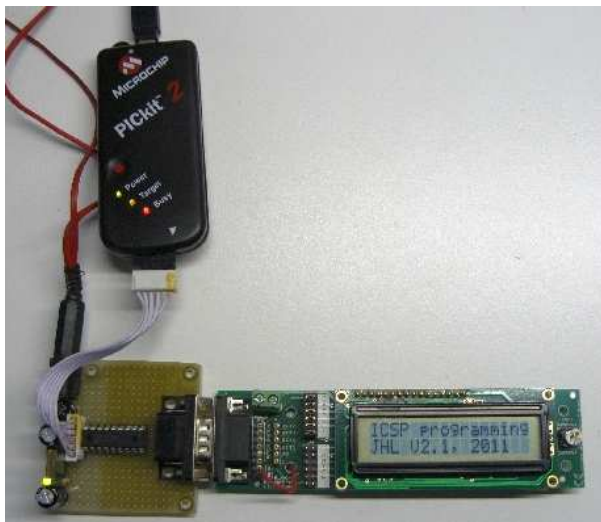Microchip PICkit 2 and 3 Microcontroller Programmer (Part# PG164120 and PG164130)

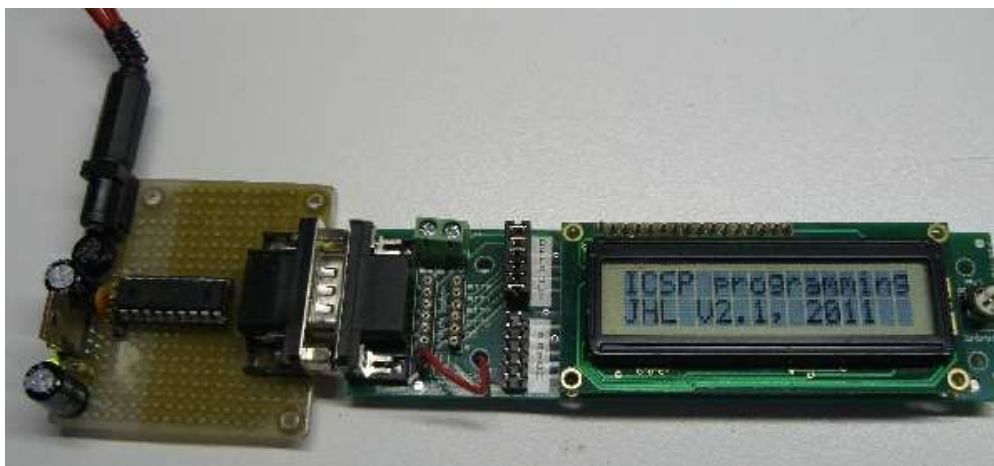Microchip E-blocks: USB Multiprogrammer EB006 and LCD board EB005
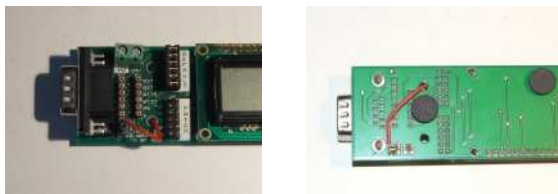
Additional connection for LCD board EB005 powering at pin 8
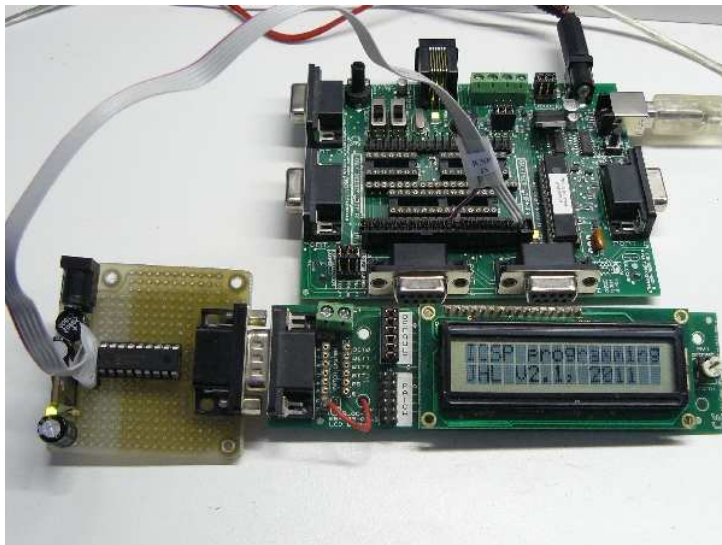
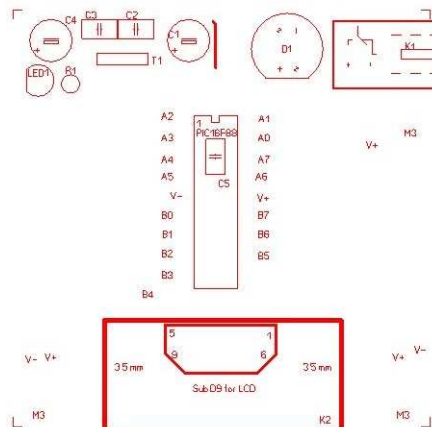Version 2. Programming the 16PIC88 with EB006 block


Version 2. Programming the 16PIC88 with PICkit2

Versions2: Stand alone working board with internal oscillator and internal MCLR

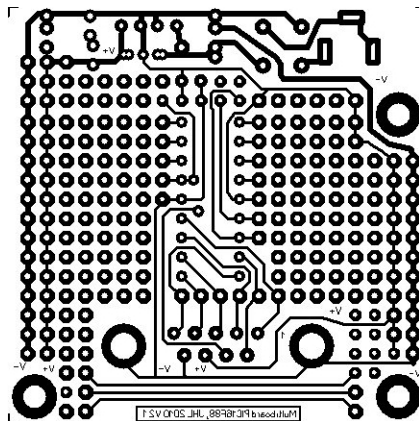Version 3. Programming the 16PIC88 with EB006 block

Version 3. Stand alone working board with internal oscillator and internal MCLR
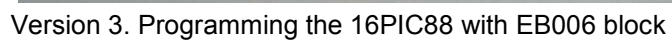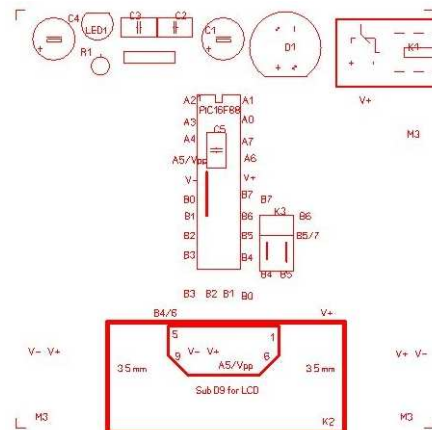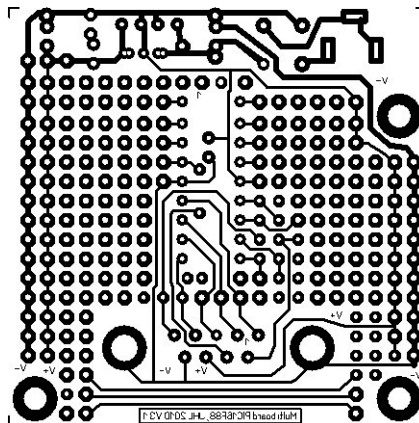
9.2 Copper- and component side of the 3 boards

Version 1.3 layout scale 1:1 (copper side is 55 x 55 mm). Copy the picture into a picture viewer program and print in high resolution on a transparent.
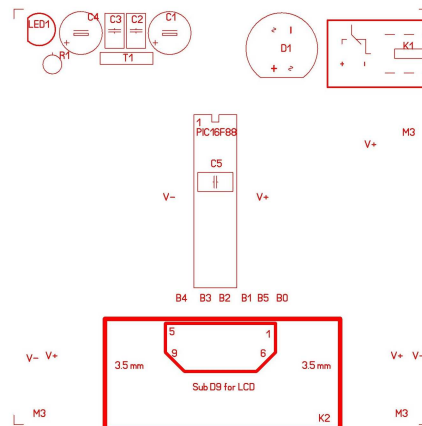
Version 2.1 layout scale 1:1 (copper side is 55 x 55 mm). Copy the picture into a picture viewer program and print in high resolution on a transparent.

Version 3.1 layout scale 1:1 (copper side is 55 x 55 mm). Copy the picture into a picture viewer program and print in high resolution on a transparent.

10. References

1. 8-bit, 18 pins microcontrollers in the PIC 16 and PIC 18 family (A)
2. Matrix Multimedia's E-blocks circuit boards (B)
3. Microchip's PICkit 3 In-Circuit Debugger/Programmer uses in-circuit debugging logic incorporated into each chip with Flash memory to provide a low-cost hardware debugger and programmer. PICkit 3 and PICkit 3 user guide and the 20 pins demo board "Low Pin Count User Guide" (A)
4. Matrix's ECIO devices are USB programmable microcontrollers with 29 and 40 pin footprint (C)
5. Graphical programming language, Flowcode v3 or v4 from Matrix. (D)
6. Matrix Multimedia user forums (E)
7. In-Circuit Serial Programming (A)
8. See figure 15-13 of the PIC16F88 datasheet for the programming connections (A)
9. Sprint-Layout 5.0 is a cheap and simple software to create layouts for single-sided, double-sided or even multilayer PCBs (Printed Circuit Boards). If required, the layout can be exported to the GERBER and EXCEL-LON format. (F)
10. Making PCB yourself see e.g. this overview. (G)

11. Links

(A) http://www.microchip.com/

(B) http://www.matrixmultimedia.com/eblocks.php

(C) http://www.matrixmultimedia.com/ecio.php

(D) http://www.matrixmultimedia.com/flowcode.php

(E) http://www.matrixmultimedia.com/mmforums/index.php

(F) http://www.abacom-online.de/uk/html/sprint-layout.html

(G) http://www.technick.net/public/code/cp_dpage.php?aiocp_dp=guide_pcb