Protoshield Plus
for Arduino and Genuino
(Ver. 3.5)
User Manual

INDEX

NOTE:

Some pictures contained in this manual, may be different from the board revision in your hands (at time of writing the current version is rev. 3.5), this does not affect the functionality of the board described in this manual.

1. Technical Specifications

- It works with:
  - ARDUINO/GENUINO UNO
  - ARDUINO LEONARDO
  - ARDUINO YÚN
  - ARDUINO NANO
  - ARDUINO/GENUINO MICRO
  - ARDUINO MINI[1]
- Predisposition for LCD 1602[2] module
- PCF8574 I/O expander provided on-board (I2C communication with LCD with just 2 pins)
- 5 PUSHBUTTONS provided on-board
- RST button, for resetting program, provided on-board
- 2x solderless bread-boarding areas 740 contact points each (total 1480 points)
- More than 400 soldering pads for additional prototyping parts
- IN, OUT and POWER pins replicated near the bread-boarding area for easy connection
- 2x OUTPUT LEDs provided on-board
- 1x potentiometer with knob provided on-board
- Predisposition for a servo connection
- Predisposition for an external 7-9VDC power supply
- Predisposition for an additional ICSP connector to use NANO and MICRO with standard shields
- Predisposition for using standard 2.54 pitch breadboard to create your own shield (see pag. 37)
- Dimensions in mm: 185x205x30[3] (HxWxH)

[1] Required USB to Serial Adapter

[2] Depending on the kit version, LCD 1602 can be provided or not with the board

[3] 185x205x45 with LCD 1602

2. Layout

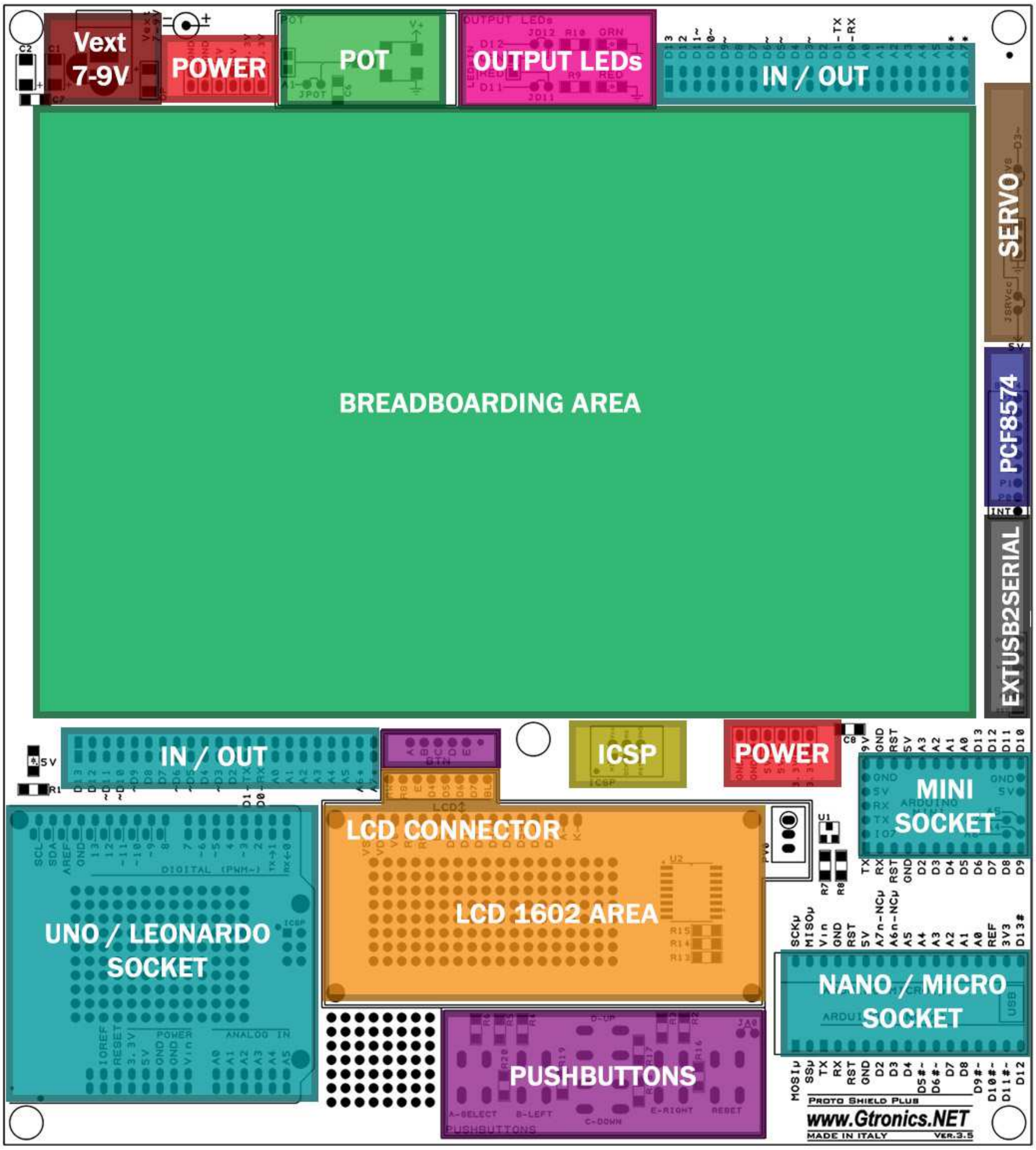


Fig. 1 – Layuot of the PROTOSHIELD PLUS

Please note that the PROTOSHIELD PLUS works with just one model Board at time (i.e. you can't plug the UNO and the NANO at the same time).

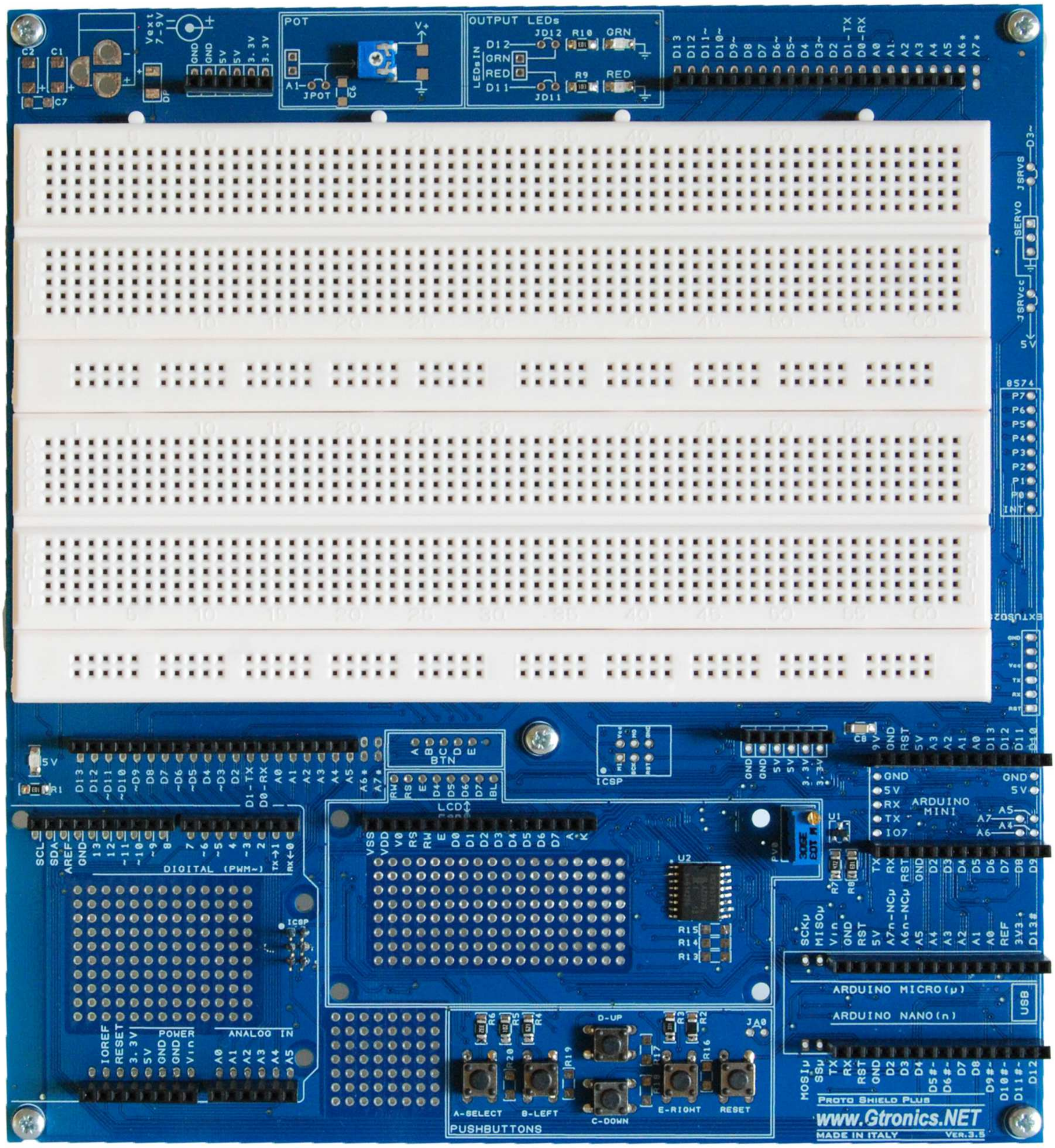


Fig. 2 – Top view of the PROTOSHIELD PLUS

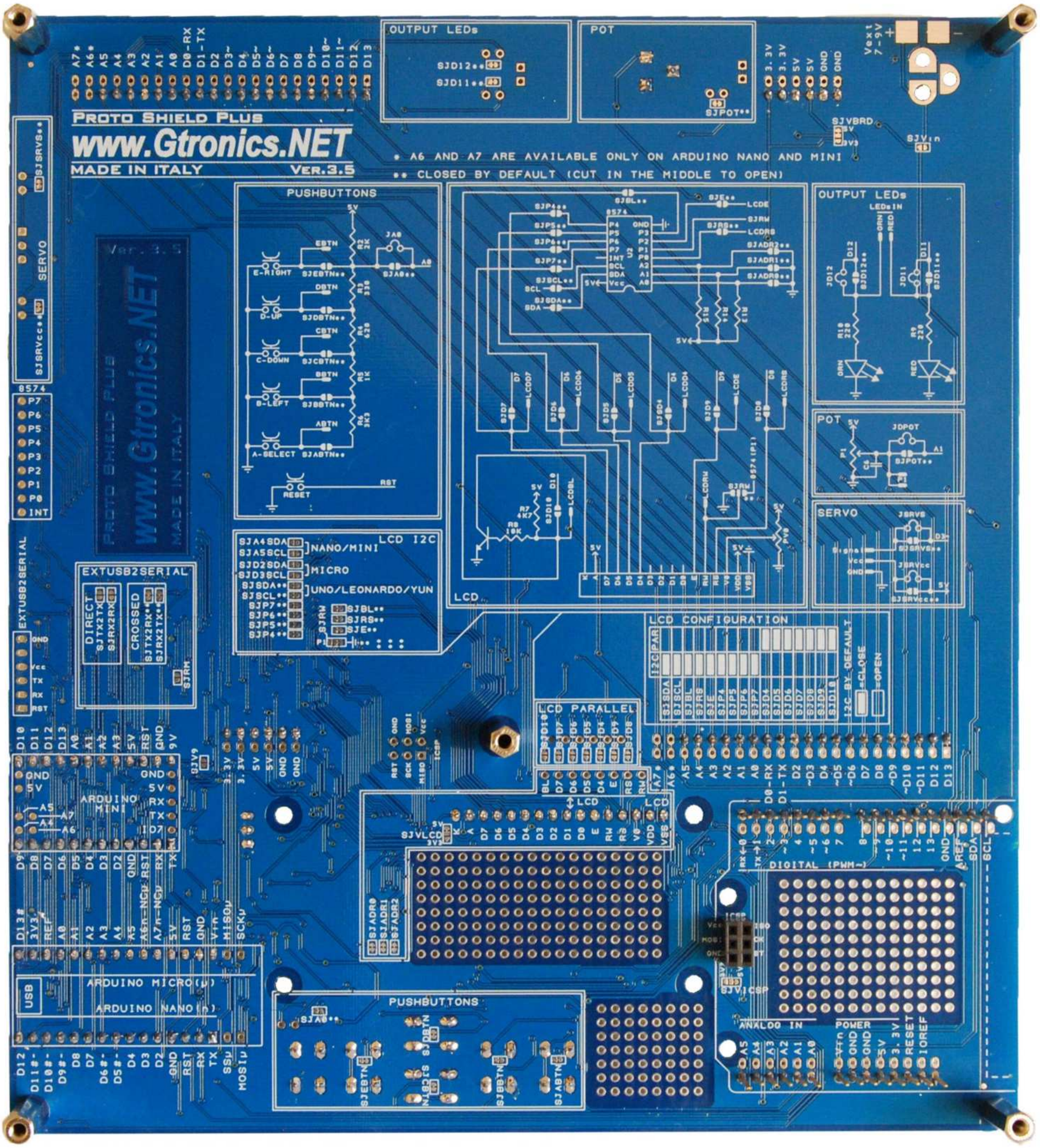


Fig. 3 – Bottom view of the PROTOSHIELD PLUS

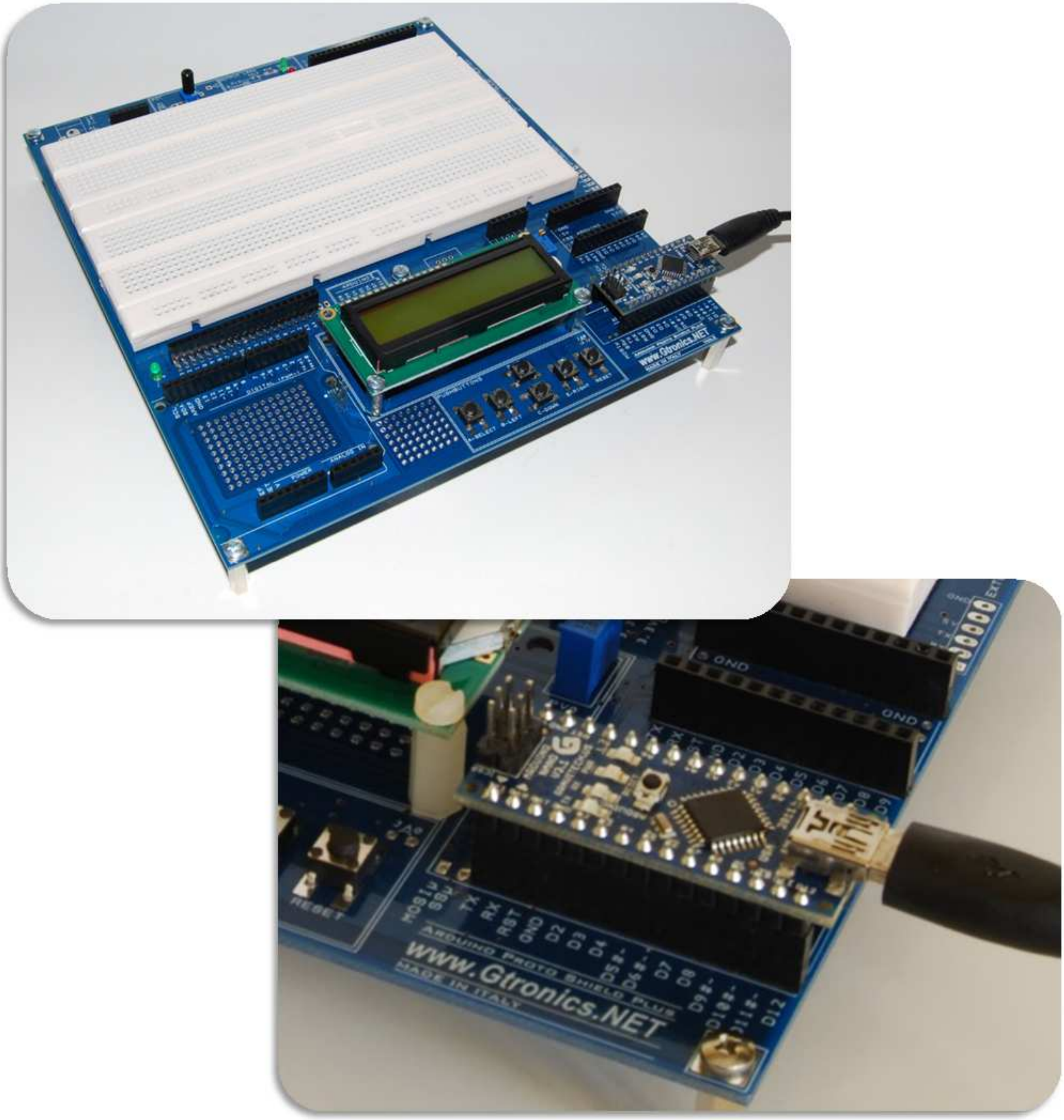
3. Using the PROTOSHIELD PLUS with Arduino / Genuino UNO, LEONARDO or YÚN

Using the PROTOSHIELD PLUS is just like any other shield: plug your Arduino or Genuino board into the UNO / LEONARDO SOCKET.
Connect the UNO, LEONARDO or YÚN by means of a USB cable to your PC and start using it.
If you are using YÚN, you can connect over wifi.

4. Using the Protoshield Plus with Arduino NANO

Plug the NANO board in the MICRO / NANO SOCKET (pay attention to pin alignment and orientation).

Connect the NANO board by means of a USB cable to your PC and start using it.

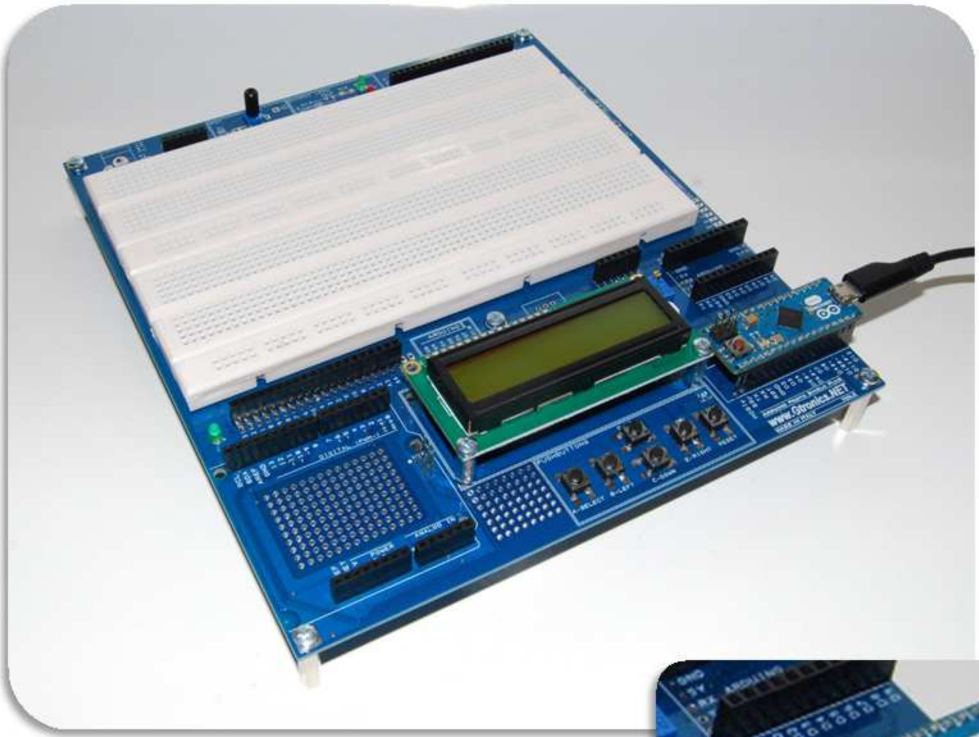


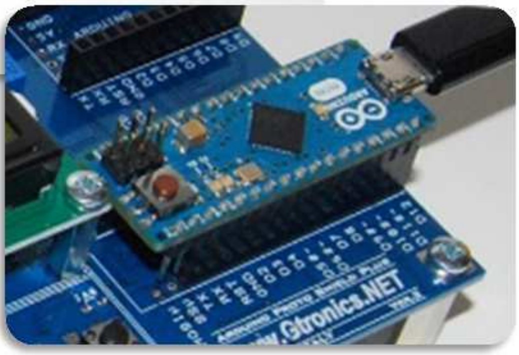
5. Using the PROTOSHIELD PLUS with Arduino / Genuino MICRO

Plug the MICRO board in the MICRO / NANO SOCKET (pay attention to pin alignment and orientation).

MOSI, SS, SCK and MISO pins remain unconnected.

Connect the MICRO board by means of a USB cable to your PC and start using it.

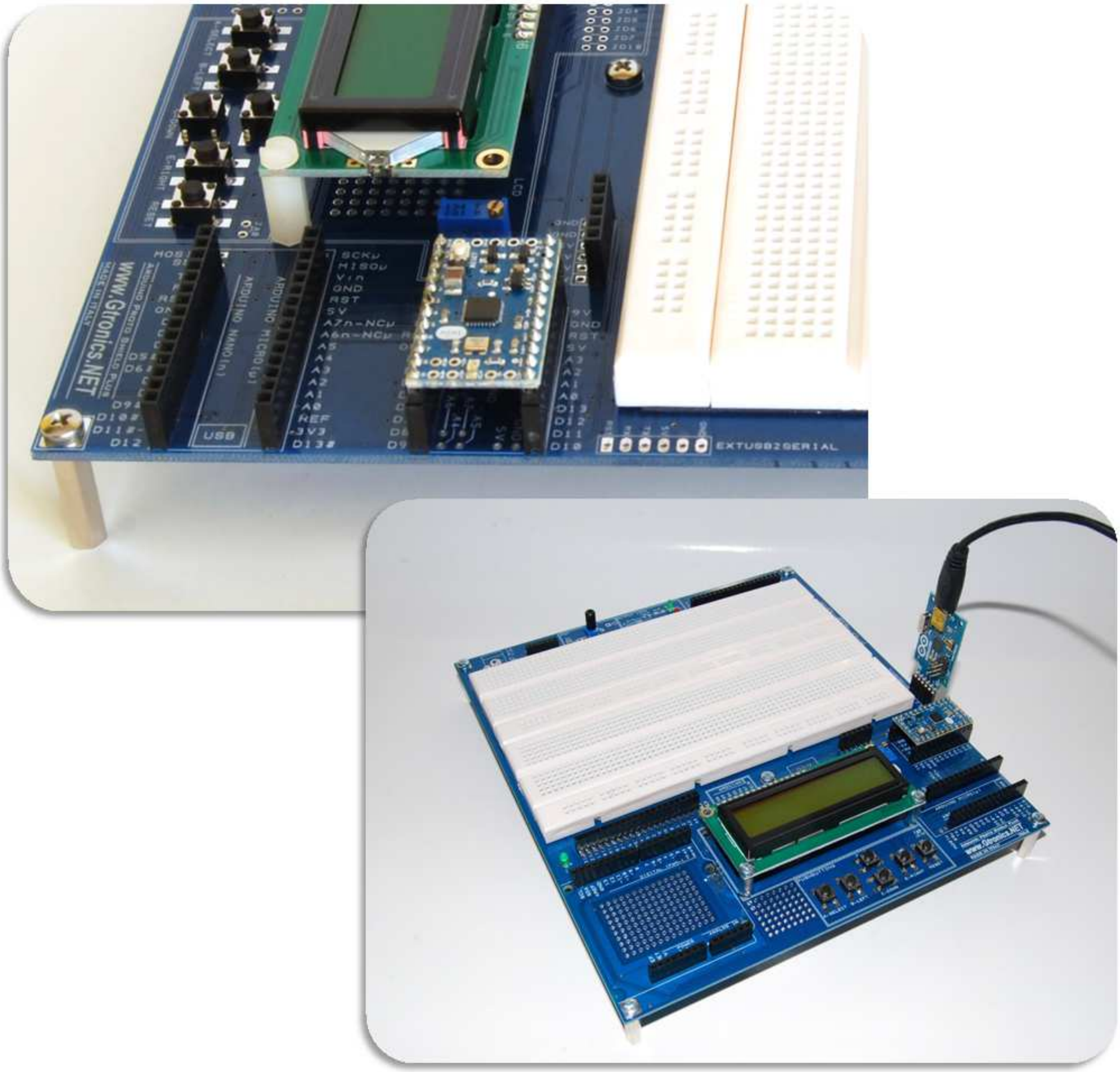




6. Using the PROTOSHIELD PLUS with Arduino MINI

The MINI board needs an USB to serial adapter to communicate with the IDE.

The next pages show how to use the PROTOSHIELD PLUS with an USB to serial Adapter and the MINI board.



6.1. Using the official USB2SERIAL LIGHT adapter to work with Arduino MINI

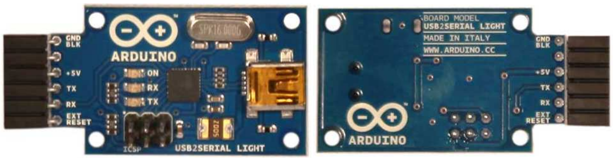
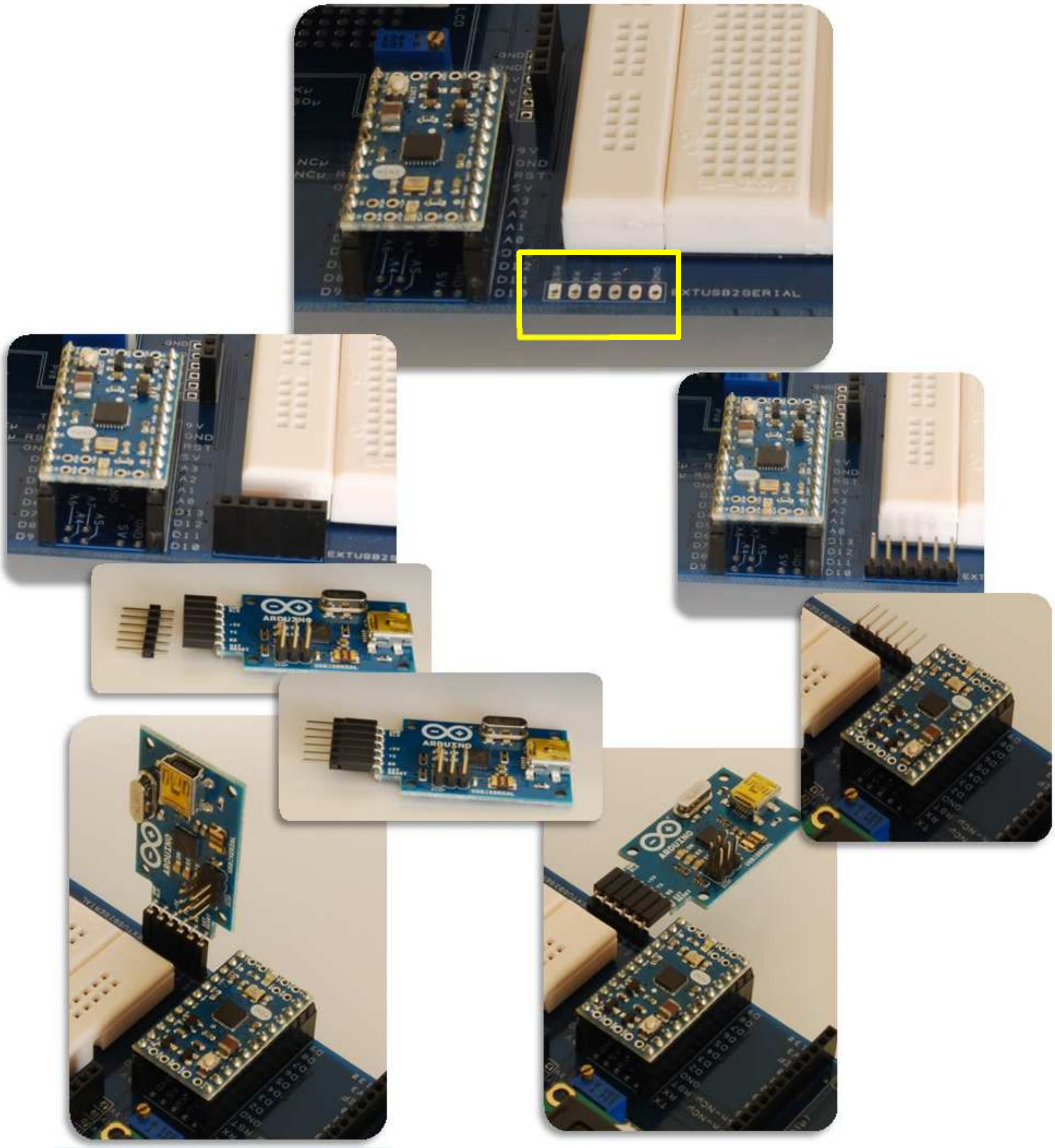


Fig. 4 – the official USB2SERIAL LIGHT adapter from the Arduino.cc store

The USB2SERIAL LIGHT adapter must be connected to the EXTUSB2SERIAL SOCKET of the **PROTOSHIELD PLUS** . To plug the USB2SERIAL LIGHT adapter into the board you can chose the solution that better fits your needs. Below are some examples.



6.2. Using third-party USB to SERIAL adapters to work with Arduino MINI

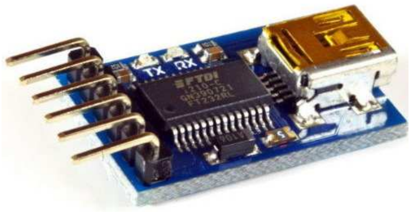
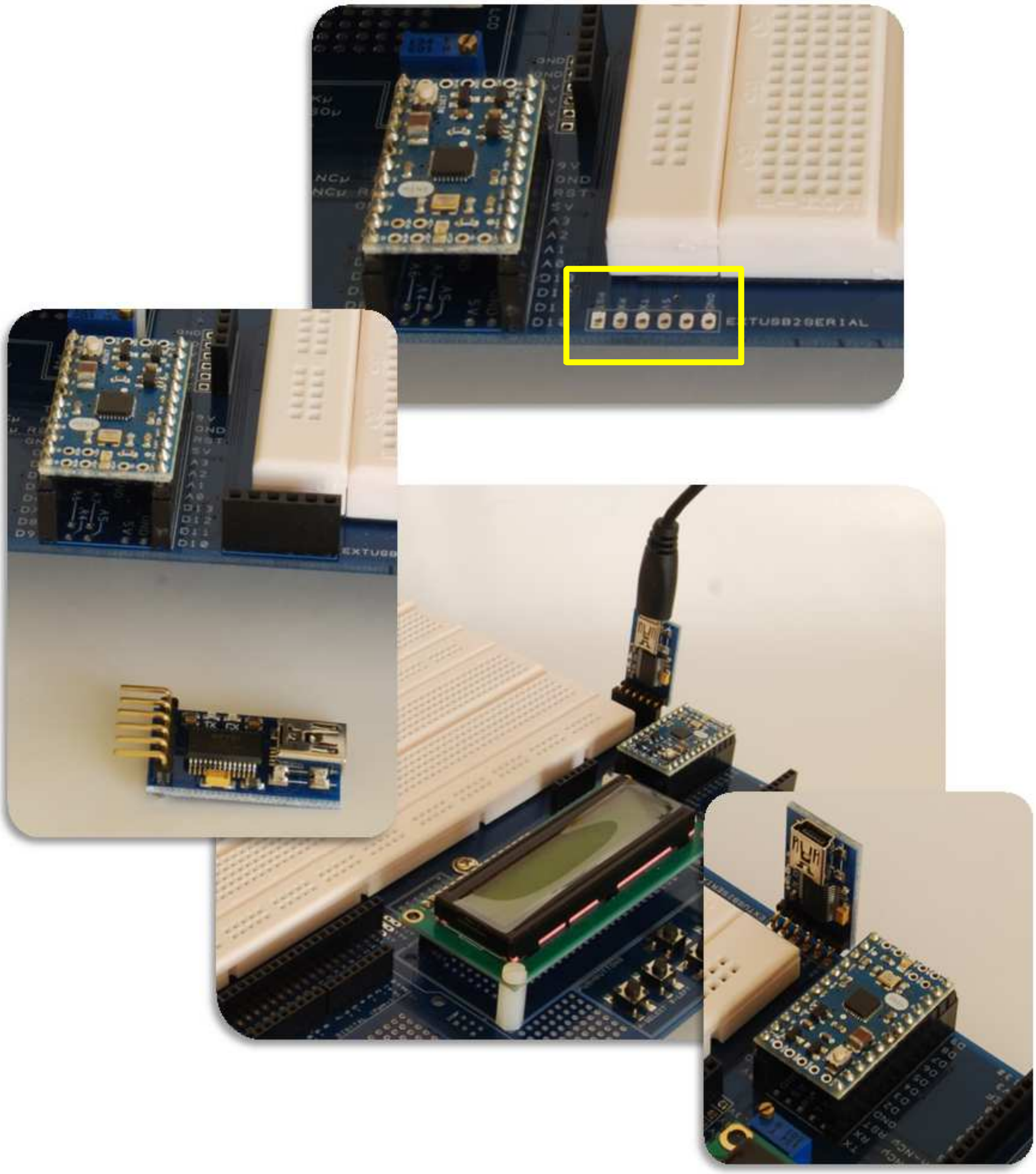


Fig. 5 – A third-party USB2 to SERIAL adapter from e-bay

The USB to SERIAL adapter must be connected to the EXTUSB2SERIAL SOCKET of the PROTOSHIELD PLUS . To plug the USB to SERIAL adapter into the board you can chose the solution that better fits your needs. Below are some examples.



6.3. Turning the UNO board into an USB to SERIAL adapter to work with Arduino MINI

First you need a UNO board with the ATmega328 28 pins DIL package (not the SMD version).

Remove the ATmega328 chip from its socket.
Plug the UNO board into the PROTOSHIELD PLUS.
Now the UNO performs the communication with the Arduino MINI.
"Arduino MINI" must be selected in the *Tools→Board* menu of the Arduino IDE.
From *Tools→Serial port* menu select the COM port associated to the UNO board (since it is the serial communication channel).

6.4. Swapping TX / RX signals

By default TX and RX signal are connected in CROSSED configuration.
This means:
RX pad on the EXTUSB2SERIAL connector connects to the Arduino MINI TX pin (SJTX2RX is closed).
TX pad on the EXTUSB2SERIAL connector connects to the Arduino MINI RX pin (SJRX2TX is closed).

C8 is the 0,1uF capacitor needed with the USB to SERIAL adapters to reset Arduino while uploading sketches.

If for some reason, due to third-party USB to SERIAL adapter, you need to connect EXTUSB2SERIAL TX pad directly to Arduino MINI TX pad and EXTUSB2SERIAL RX pad directly to Arduino MINI RX pad you have to swap to DIRECT configuration:

1. Open SJTX2RX and SJRX2TX (by cutting them in the middle)
2. Close SJTX2TX and SJRX2RX

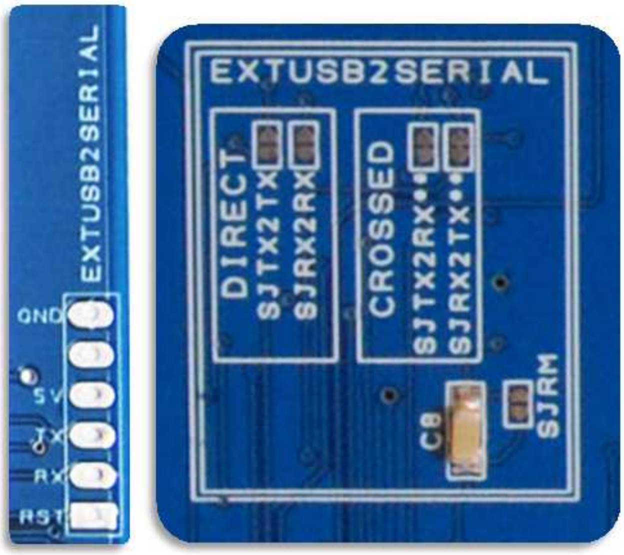
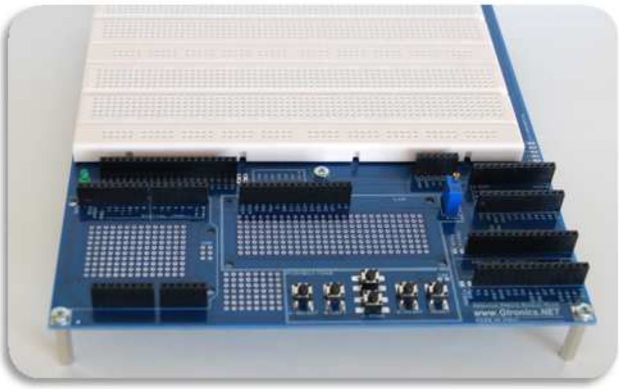
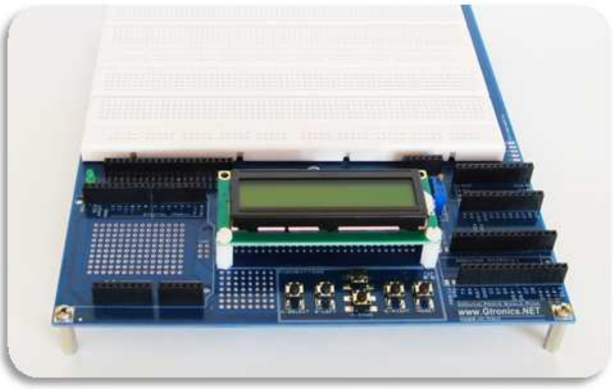


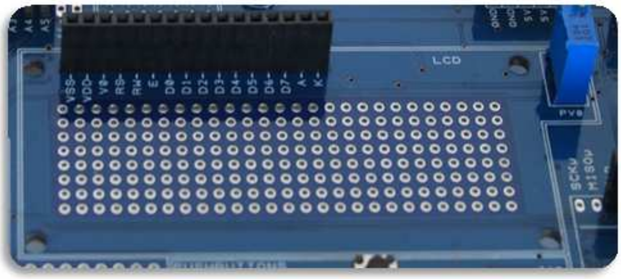
Fig. 6 – EXTUSB2SERIAL connector and jumper configuration for CROSSED / DIRECT connection

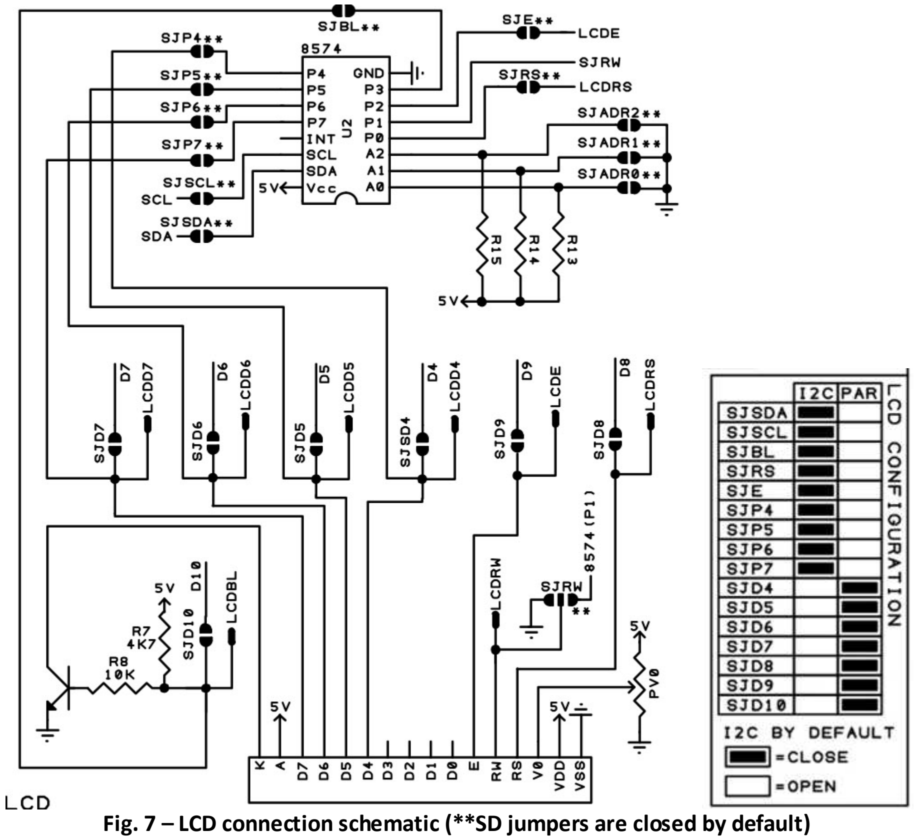
7. LCD CONNECTOR

The LCD connector is predisposed to connect a 16pin LCD.
The LCD can be used in I2C (default) or parallel configuration.
PV0 adjusts the LCD contrast.
The on-board PCF8574 (I2C I/O expander) drives the LCD by default.









	I2C	PAR
SJSDA	■	
SJSCL	■	
SJBL	■	
SJRS	■	
SJE	■	
SJP4	■	
SJP5	■	
SJP6	■	
SJP7	■	
SJD4		■
SJD5		■
SJD6		■
SJD7		■
SJD8		■
SJD9		■
SJD10		■

I2C BY DEFAULT
■ =CLOSE
□ =OPEN

Fig. 7 – LCD connection schematic (**SD jumpers are closed by default)

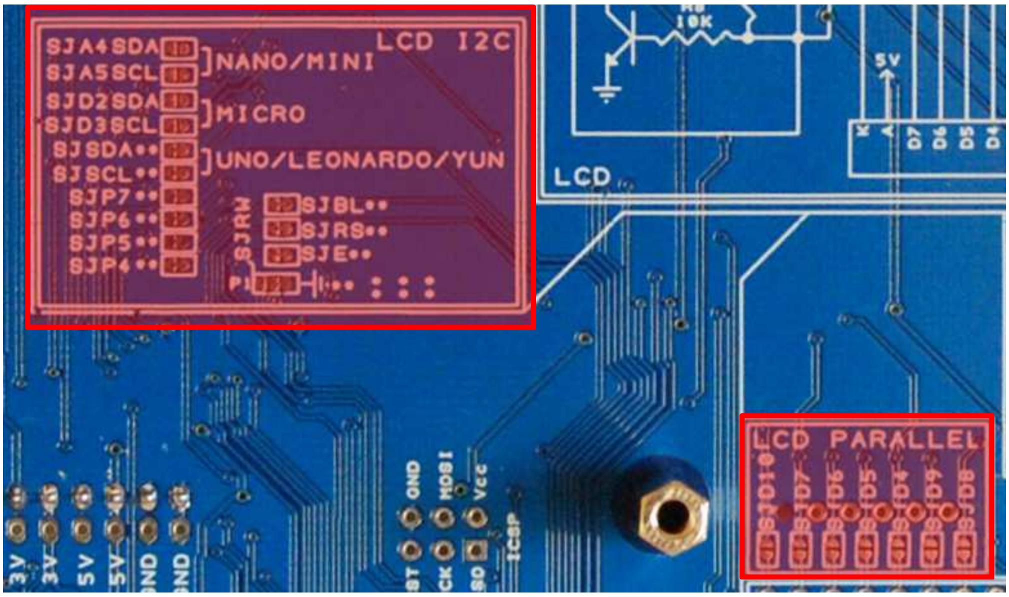


Fig. 8 – Jumpers used to select the LCD configuration

7.1. Using the LCD with I2C configuration

Since I2C configuration is by default, connecting a LCD 1602 does not require any additional wiring.
Signal connections are the same used in the LCD I2C adapter of wide spread use.
It is required to download and install the *LiquidCrystal_I2C* library to use the Protoshield Plus with this configuration.
Refer to the sketch *APSP_demo_I2C* in the *Sample Projects.zip* file (visit http://www.gtronics.net/en/products/arduino-proto-shield-plus).
Depending on component availability, the I/O expander 8574 could be the PCF8574 or the PCF8574A.
Use the sample project *APSP_demo_I2C* (download *APSP_Sample_Projects_V3.zip* from www.gtronics.net website) to find out which version is your one.
Both versions perform the same, the only difference is the base address of the I2C communication.
Since A0, A1 and A2 of the PCF8574 connects to ground by default (by means of SJADR0, SJADR1 and SJADR2), the default address is set to 0x20 (PCF8574) or 0x38 (PCF8574A).
The SCL and SDA (the pins that perform the I2C communication) pinout is slightly different depending on the Arduino boards. Thus, you have to select the proper configuration depending on the board you are using.
The Jumpers that configure the I2C connection are: SJSCL, SJSDA, SJD3SCL, SJD2SDA, SJA5SCL and SJA4SDA.
Following are the different configurations.
With I2C configuration, SJD4, SJD5, SJD6, SJD7, SJD8, SJD9 and SJD10 must be OPEN (default configuration).

7.1.1. Using I2C configuration with UNO[4] / LEONARDO / YÚN boards

SJA4SDA	= OPEN
SJA5SCL	= OPEN
SJD2SDA	= OPEN
SJD3SCL	= OPEN
SJSDA	= CLOSE
SJSCL	= CLOSE

Default configuration.

7.1.2. Using I2C configuration with MICRO boards

SJA4SDA	= OPEN
SJA5SCL	= OPEN
SJD2SDA	= CLOSE
SJD3SCL	= CLOSE
SJSDA	= OPEN
SJSCL	= OPEN

Since SJSDA and SJSCL come closed by default, cut in the middle to open them.

[4] Old version of the UNO board (i.e. previous to R3 version) does not have SCL and SDA pins on the connector, in case refer to §7.1.3 to configure I2C connection.

7.1.3. Using I2C configuration with NANO / MINI boards

SJA4SDA	= OPEN
SJA5SCL	= OPEN
SJD2SDA	= CLOSE
SJD3SCL	= CLOSE
SJSDA	= OPEN
SJSCL	= OPEN

Since SJSDA and SJSCL come closed by default, cut in the middle to open them.
On the MINI board, SCL and SDA signals are mapped on A5 and A4, therefore you must connect these two pins of the MINI to the PROTOSHIELD PLUS if you want to use the MINI board with I2C connection.

7.1.4. Changing the address of the I2C communication

It is not very usual but in case that you want / need to change the address of the 8574 chip, you have to install R13, R14 and R15 Pull-up resistors.
Refer to the PCF8574 datasheet to configure the base address, open or close SJADR0, SJADR1 and SJADR2 (cut in the middle to open them) in order to fit your needs.

7.2. Using the LCD with parallel configuration

Configure jumpers as follows:

SJA4SDA	= OPEN
SJA5SCL	= OPEN
SJD2SDA	= OPEN
SJD3SCL	= OPEN
SJSDA	= OPEN
SJSCL	= OPEN
SJBL	= OPEN
SJRS	= OPEN
SJE	= OPEN
SJP4	= OPEN
SJP5	= OPEN
SJP6	= OPEN
SJP7	= OPEN
SJD4	= CLOSE
SJD5	= CLOSE
SJD6	= CLOSE
SJD7	= CLOSE
SJD8	= CLOSE
SJD9	= CLOSE
SJD10	= CLOSE

Since the *LiquidCrystal library* makes use of digital pins 4, 5, 6, 7, 8, 9 and 10, be sure to reserve these pins for the LCD if you want to use it in parallel mode.
Refer to the sketch *APSP_demo* in the *Sample Projects.zip* file (visit http://www.gtronics.net/en/products/arduino-proto-shield-plus).

7.2.1.Using different pins for the parallel mode

This is useful if your application requires a parallel connection but you want to use different pins than 4, 5, 6, 7, 8, 9 and 10.
Open SJD4, SJD5, SJD6, SJD7, SJD8, SJD9 and SJD10 and use LCDRW, LCDRS, LCDE, LCDD4, LCDD5, LCDD6, LCDD7, LCDBL (see **Fig. 9**) to connect your desired signals to the LCD.

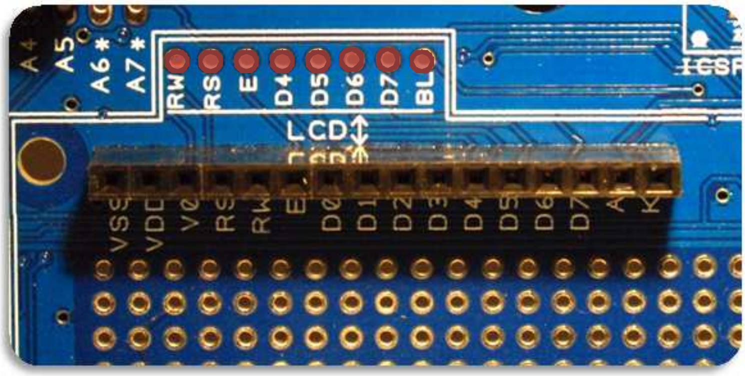


Fig. 9 – Connect your desired signals to pads marked in red

8. PCF8574 I2C I/O expander

If you do not need to use the LCD or you want to use it in parallel configuration, you can use the on-board 8574 as a general-purpose I/O expander.
All the I/O pins of the 8574 are available on the right side of the PROTOSHIELD PLUS (see **Fig. 10**).
Refer to the sketch *APSP_PCF8574_IOexpander* in the *Sample Projects.zip* file (visit http://www.gtronics.net/en/products/arduino-proto-shield-plus).

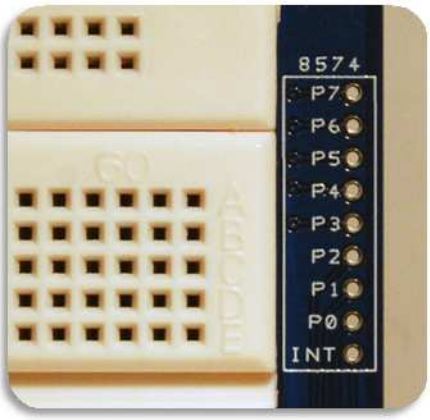


Fig. 10 – The 8574 pins used for general-purpose I/O

9. PUSHBUTTONS

The **Protoshield Plus** comes with five push buttons provided on-board.

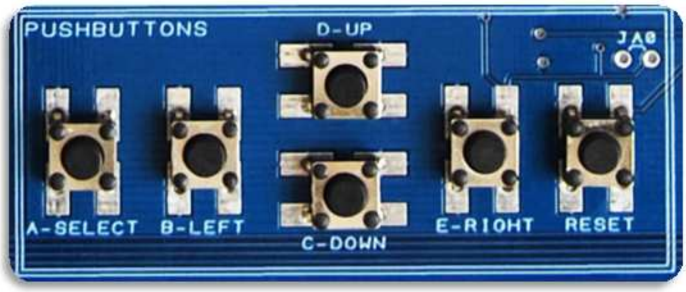


Fig. 11 – Five pushbuttons and the reset button

Signal connections are the same used in the Arduino LCD shield of wide spread use: PUSHBUTTONS A-SELECT, B-LEFT, C-DOWN, D-UP and E-RIGHT connects by default to A0 input pin (by means of SJA0). The RESET button resets the Arduino program.

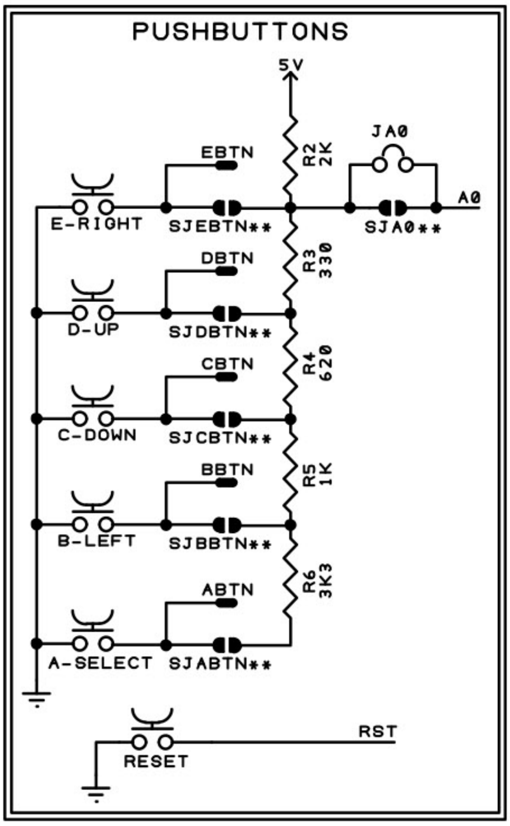


Fig. 12 – PUSHBUTTONS connection schematic (SJA0 closed by default)

If you want to connect the PUSHBUTTONS to a different analog input pin (different from A0) or you want to use them with digital input pins, see the following pages.

9.1. Using the PUSHBUTTONS with a different analog input pin

Cut SJA0 (see **Fig. 13**) in the middle to disconnect the PUSHBUTTONS form A0 input pin and connect your desired A*x* input pin to the JA0 pad shown in red in **Fig. 14**

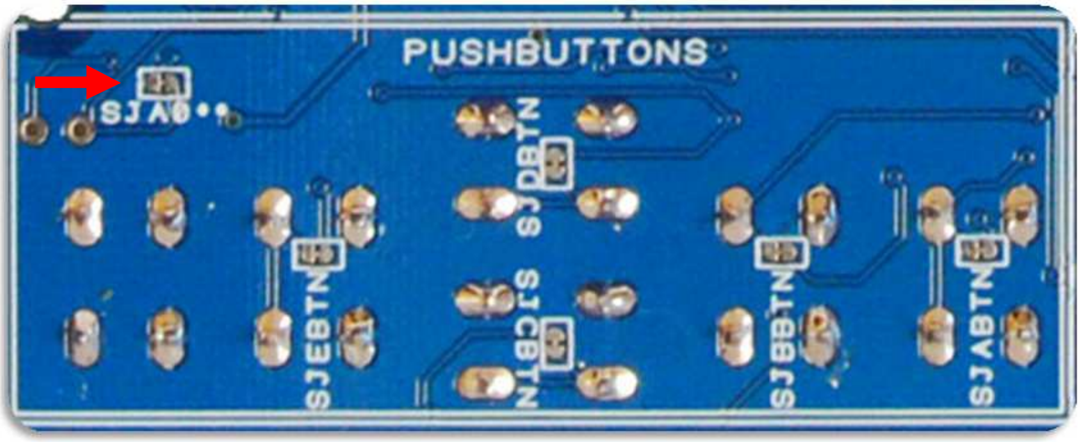


Fig. 13 – Cut SJA0 in the middle to disconnect PUSHBUTTONS form A0 input pin

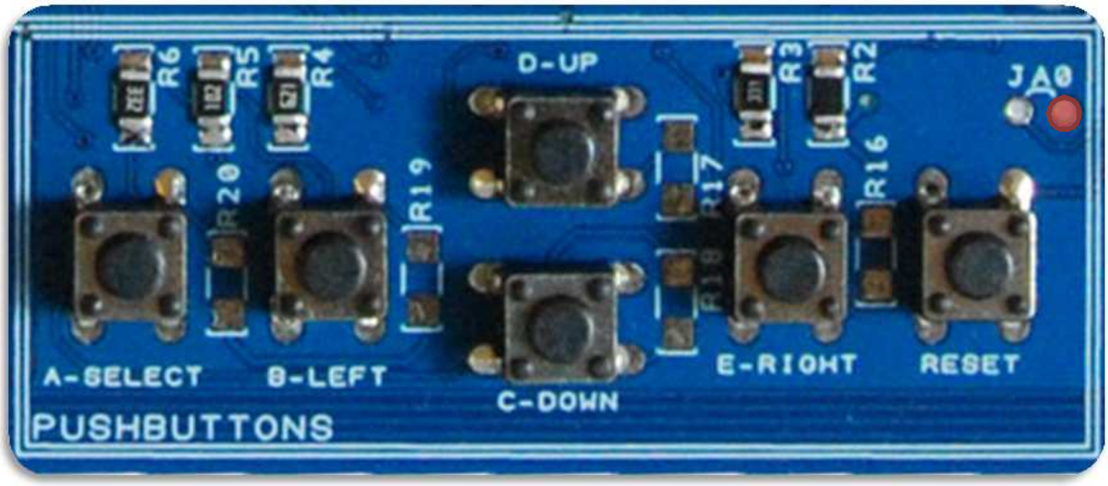


Fig. 14 – Connect your desired A*x* input pin to the pad marked in red

9.2. Using the PUSHBUTTONS with digital input pins

Referring to the figure below, cut SJA0, SJABTN, SJBBTN, SJCBTN, SJDBTN and SJEBTN in the middle to disconnect the PUSHBUTTONS form A0 input pin.
Connect BTN A, B, C, D and E pads to your desired digital pins (rember to configure the internal pullup in order to let it work properly).

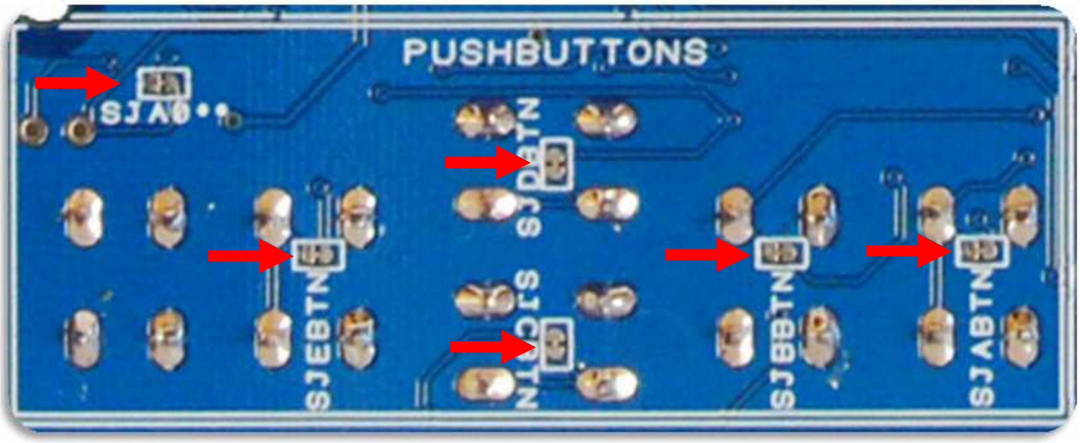


Fig. 15 – Cut SJA0 in the middle to disconnect PUSHBUTTONS form A0 input pin

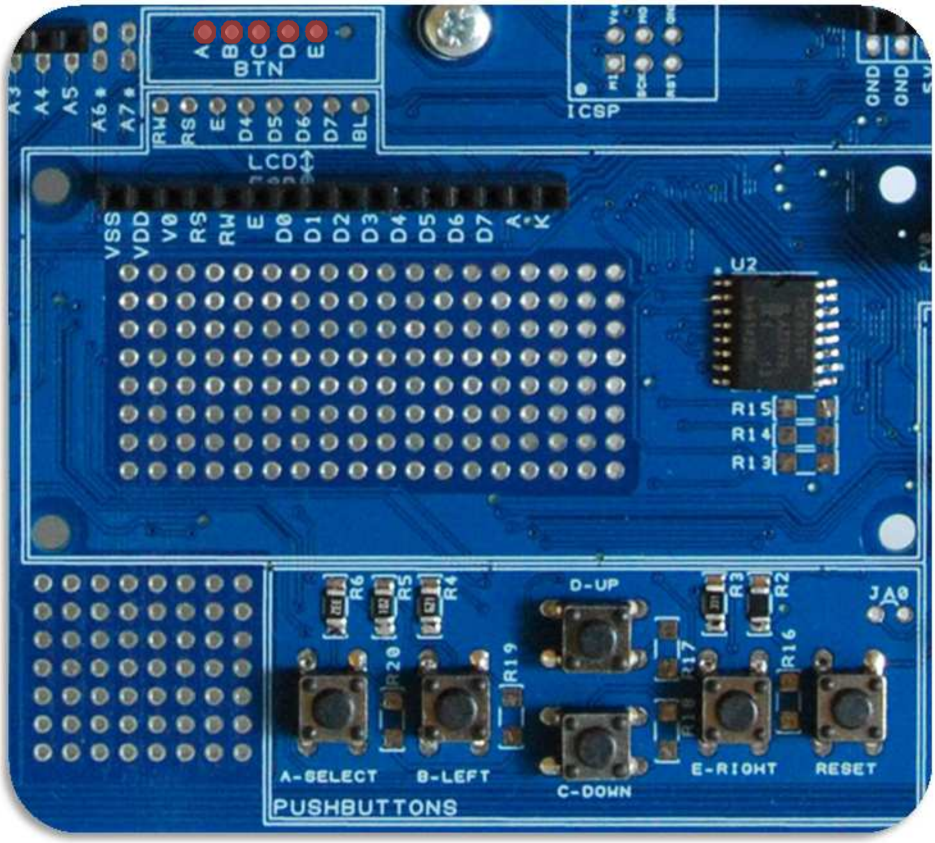


Fig. 16 – BTN A, B, C, D and E pads

10. OUTPUT LEDS

Two OUTPUT LEDs (GRN and RED) are provided on-board.
GRN connects by default to digital pin 12 (by means of SJD12).
RED connects by default to digital pin 11 (by means of SJD11).

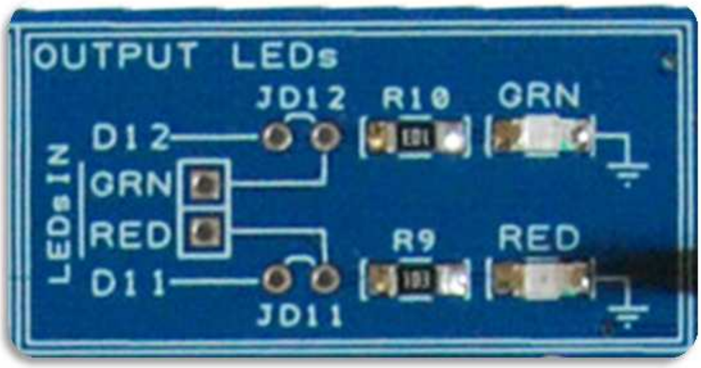


Fig. 17 – OUTPUT LEDs

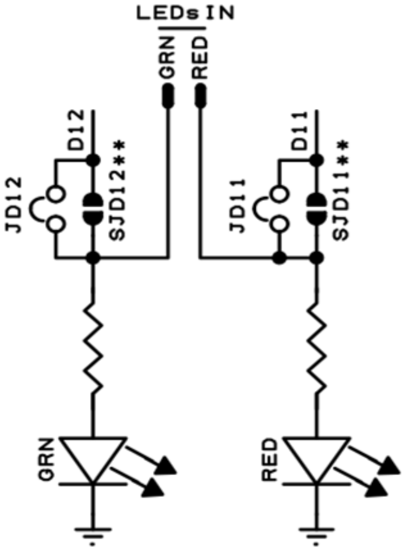


Fig. 18 – OUTPUT LEDs connection

If you want to connect OUTPUT LEDs to different digital pins (different from 11 and 12), see the following pages.

10.1. Using the OUTPUT LEDs with different digital pins

Cut SJD12 and SJD11 (see **Fig. 19**) in the middle to disconnect D11 and D12 pins from the OUTPUT LEDs.

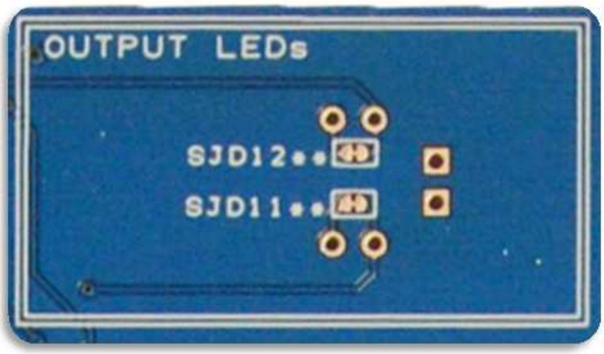


Fig. 19 – SJD12 and SJD11

Connect the digital pin you want to drive GRN LED to the GRN LEDs IN pad (marked in green in **Fig. 20**). Connect the digital pin you want to drive RED LED to the RED LEDs IN pad (marked in red in **Fig. 20**).

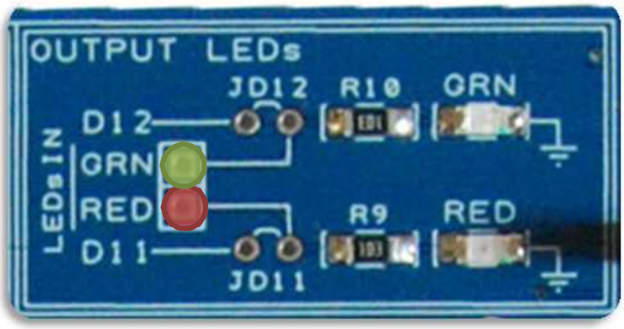


Fig. 20 – OUTPUT LEDs

11. POT

The POT is a general-purpose potentiometer with knob. It is useful to set a desired reference voltage.
P1 terminal connects to analog A1 (by means of SJPOT, closed by default).
C6 (shown in **Fig. 22** and **Fig. 23**) is a predisposition for a capacitor (1206 SMD case). It is intended to filter the reference signal in case that your application requires it.

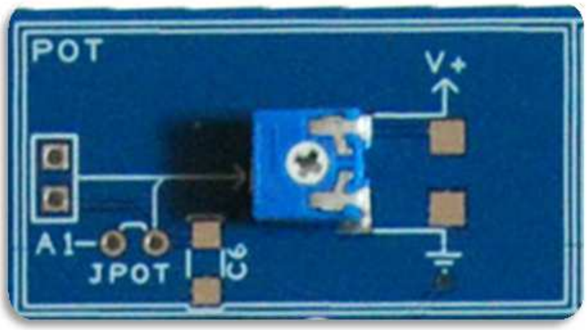


Fig. 21 – POT top board view

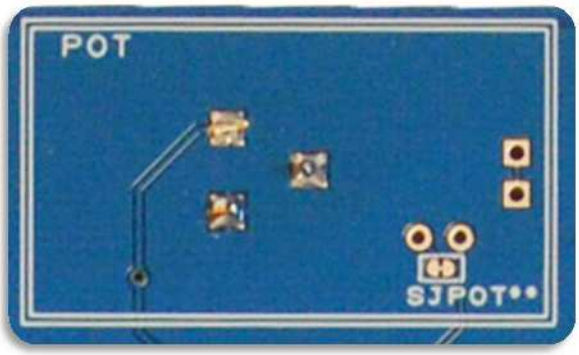


Fig. 22 – POT bottom board view

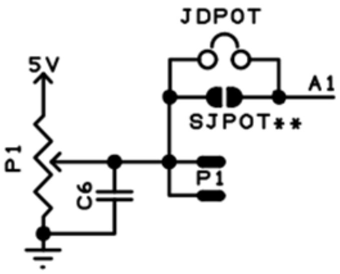


Fig. 23 – POT schematic diagram (SJPOT closed by default)**

If you want to connect the POT to a different analog pin (different from A1), see the following pages.

11.1. Using the POT with a different analog pin

Cut SJPOT (see **Fig. 24**) in the middle to disconnect A1 from the P1 POT terminal.
The central pin of the potentiometer connects to the two pads marked in red in **Fig. 25**.
Connect one of these pads to the desired A*x* pin.

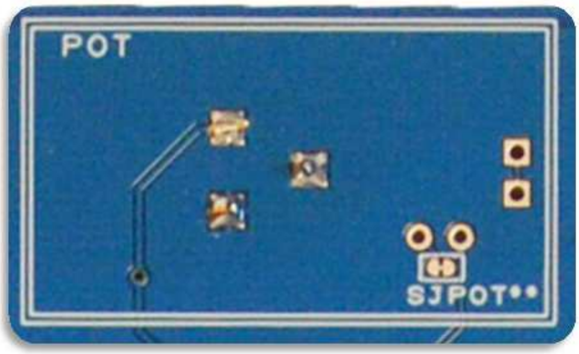


Fig. 24 – POT bottom board view

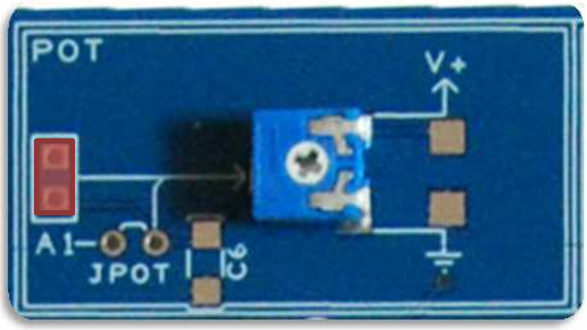


Fig. 25 – POT pads

12. SERVO

The SERVO predisposition (see **Fig. 26**) is useful if you want to quickly experiment with a standard **5V** hobby servo.
To connect a servo you need to solder a standard 2,54mm 3 pins single row male header (not provided with the board).
Servo Power Supply connects by default to 5V (by means of SJSRVcc, closed by default).
Servo control signal connects by default to digital pin 3 (by means of SJSRVS, closed by default).

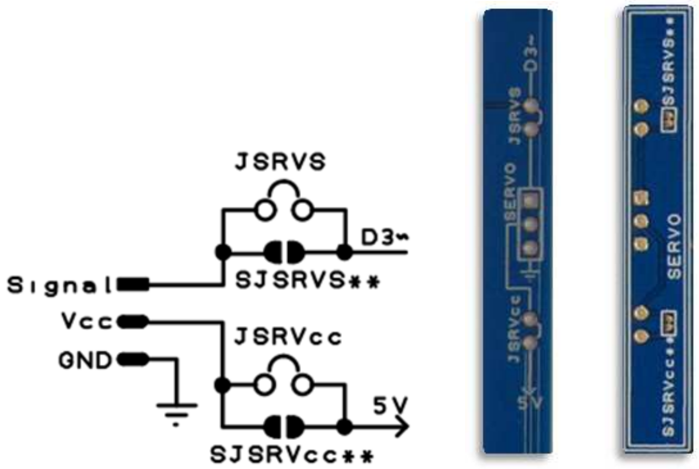


Fig. 26 – SERVO predisposition: schematic diagram, top and bottom board view

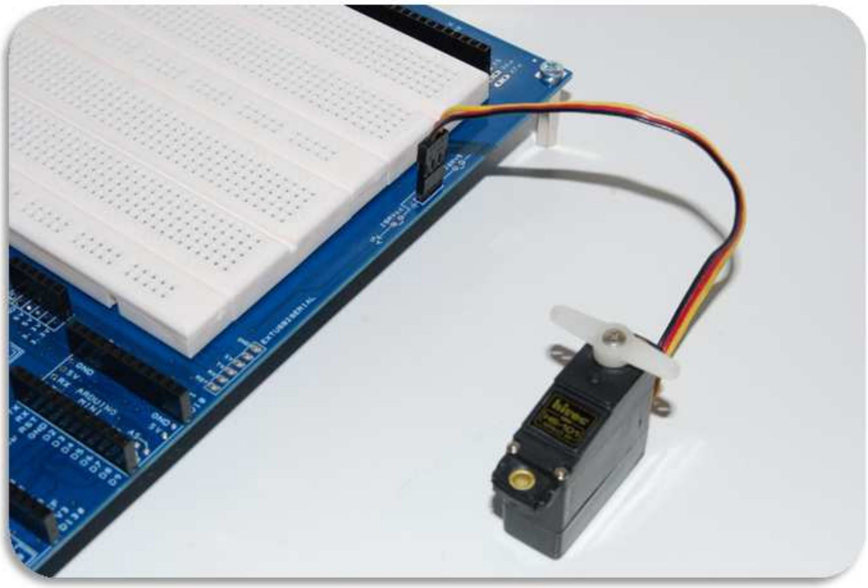


Fig. 27 – A standard hobby servo connected to the SERVO header

If you want to connect the SERVO signal to a different digital pin (different from D3) and / or you want to power it from an external power supply, see the following pages.

12.1. Using the SERVO with a different digital pin

Cut SJSRVS (see **Fig. 28**) in the middle to disconnect D3 pin from the SERVO signal pad.
Connect your desired PWM Digital pin to the pad shown in yellow in **Fig. 28**.

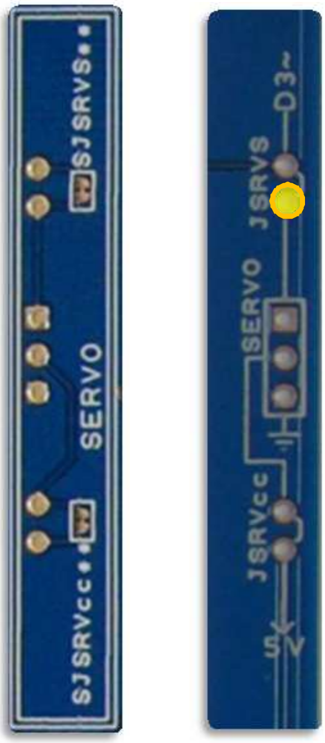


Fig. 28 – SERVO bottom and top board view

12.2. Powering the SERVO with an external power supply

Cut SJSRVcc (see **Fig. 29**) in the middle to disconnect 5V from the SERVO power pad.
Connect your external power supply ground (GND) to a free GND pad of the **PROTOSHIELD PLUS**.
Connect the positive pole of your external power supply to the pad shown in red in **Fig. 29**, **be sure that SJSRVcc is OPEN** to avoid damage on the Arduino / Genuino board.

CHECK YOUR SERVO SPECIFICATIONS in order not to damage the servo.

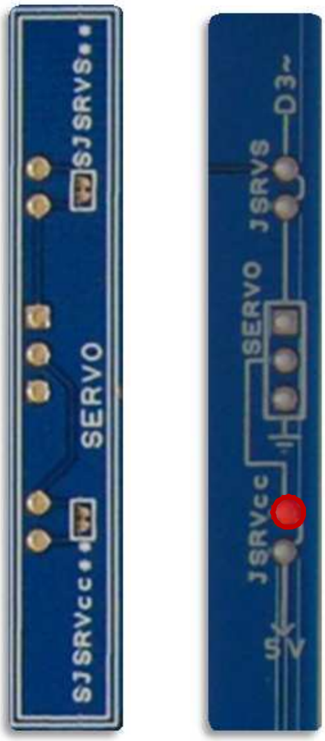


Fig. 29 – SERVO bottom and top board view

13. EXTERNAL POWER SUPPLY

An external 7 to 9 VDC power supply can be provided by means of a 2.1mm power jack (see **Fig. 30**).
If you do not have the 2.1mm jack you can use the two power pads on the bottom of the board (see **Fig. 31**).
The 2.1mm power jack is not provided with the **PROTOSHIELD PLUS** and it must be purchased and soldered separately.
The external power supply connects to Arduino / Genuino Vin by means of SJVin or DP (protection diode), see **Fig. 32**.
Some capacitors could be added using C1, C2 or C7 pads.

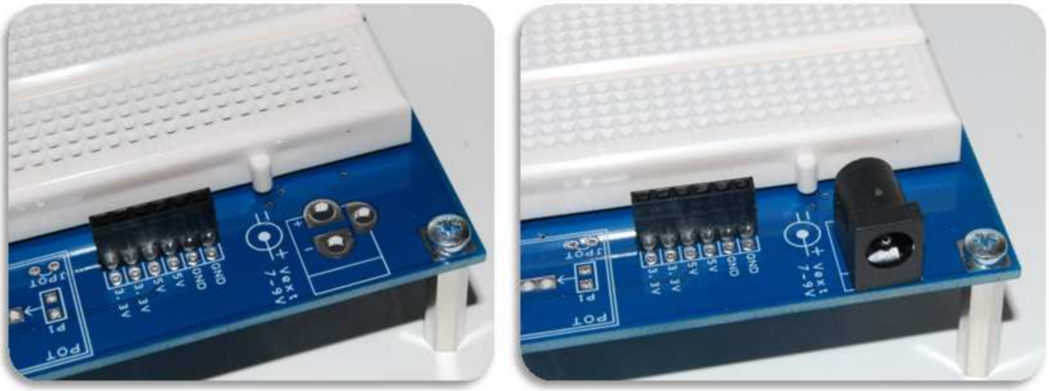


Fig. 30 – 2.1mm power jack

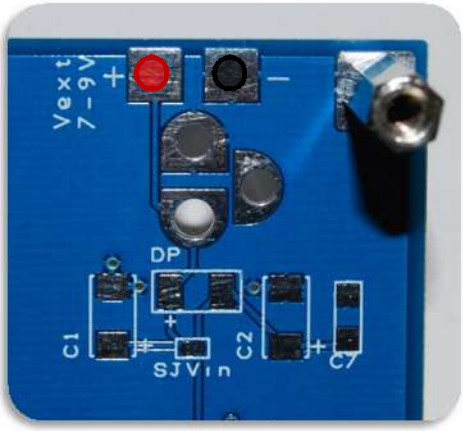


Fig. 31 – External power pads on the bottom of the board

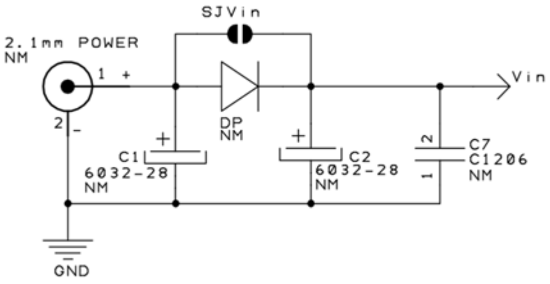


Fig. 32 – Schematic of the external power supply

14. USING ADDITIONAL SHIELDs

Additional shields can be added simply inserting them into the UNO / LEONARDO socket (see **Fig. 33**).
Just check pins used by the shield in order to avoid conflict with pins used by the Protoshield Plus.

i.e. if you are going to use a shield that use A0, you will probably need to open SJA0 in order to disconnect the Protoshield Plus Pushbuttons from A0 pin.

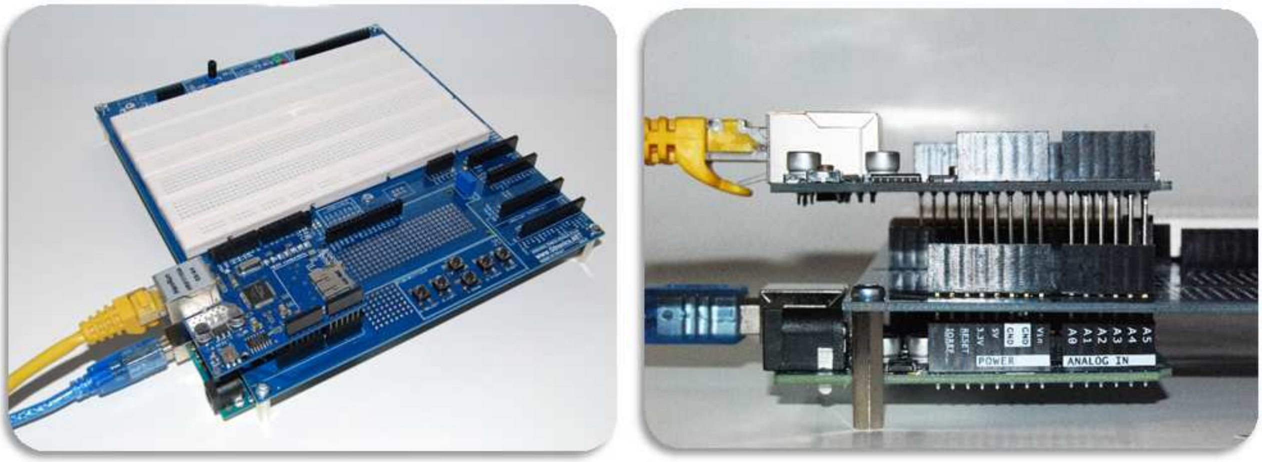


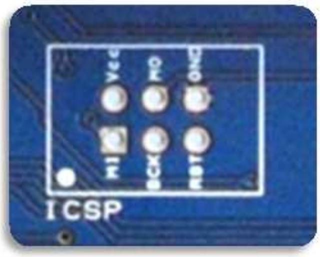
Fig. 33 – Example with a third-party Ethernet shields

Summary of Pins used by the Protoshield Plus :

A0 = used for pushbuttons
A1 = used for POT
D11 = used for Red LED
D12 = used for Green LED
D3* = used for SERVO

Notes:
* not to be considered if the SERVO is not connected

14.1. USING ADDITIONAL SHIELDs with Arduino NANO (and MICRO)



The ICSP connector (see **Fig. 34**) allows you to connect an Arduino NANO to the PROTOSHIELD PLUS and make it work with a standard shield (see **Fig. 35**).
The 6 wires flat cable and the 2x3 2,54mm pins male header (shown in **Fig. 35** and **Fig. 36**) are used as an example.
They are not provided with the PROTOSHIELD PLUS (they must be purchased separately).

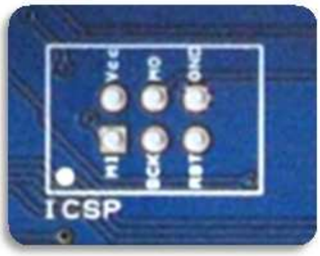


Fig. 34 – ICSP connector on the PROTOSHIELD PLUS

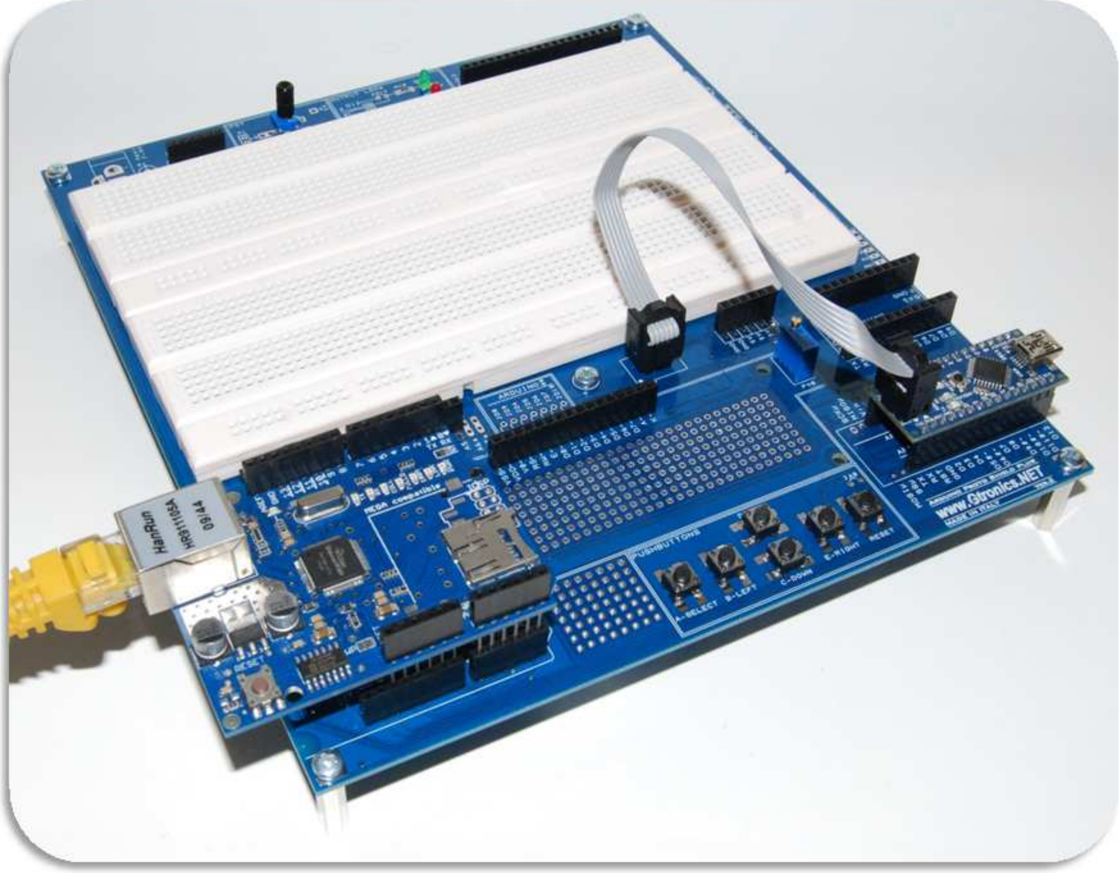


Fig. 35 – Arduino NANO used with a third-party Ethernet Shield

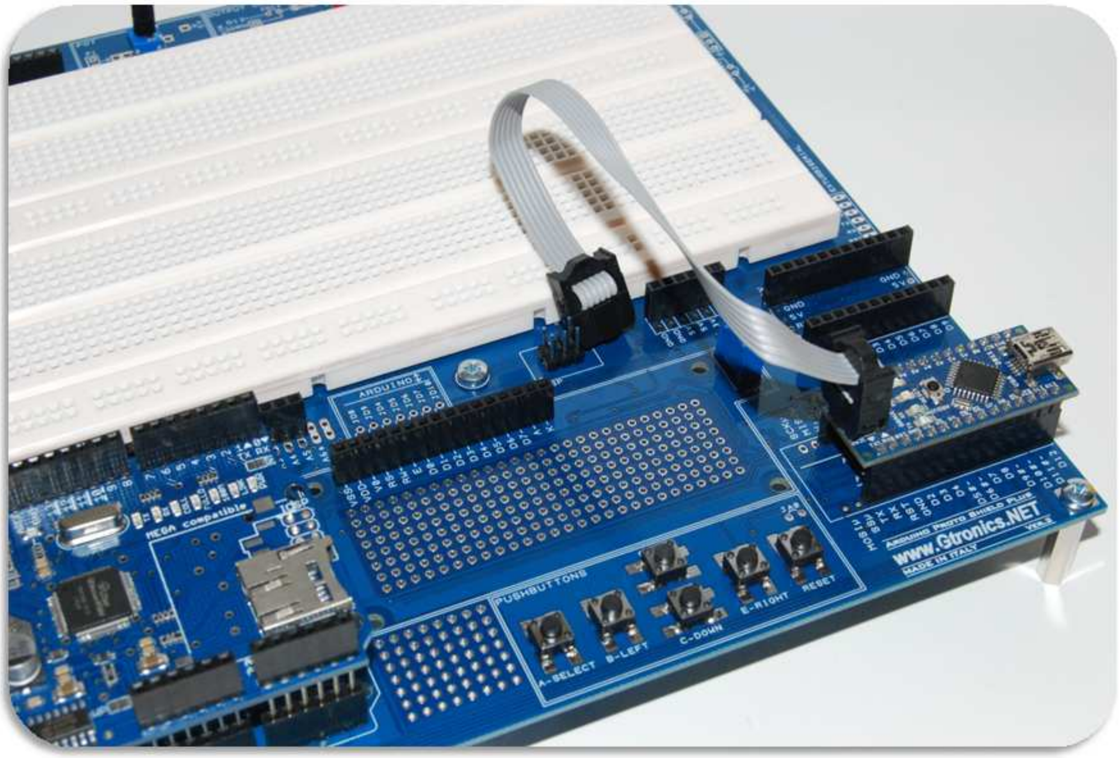


Fig. 36 – The 6 wires flat cable and the 2x3 2,54mm 6 pins male header

Routing of signals on UNO and NANO boards differs from LEONARDO and MICRO boards, these differences in some cases make some shields not compatible with LEONARDO and MICRO boards (commonly when ICSP and SCL and SDA pins are used to communicate with the shield).

If you are planning to use a shields with LEONARDO or MICRO boards, please check on Arduino / Genuino official documentation about compatibility.

In some cases, rerouting is needed to ensure properly behavior of the shields.

15. CREATING YOUR OWN SHIELDs with 2.54 pitch breadboard

It is well known that one of the four I/O connector (highlighted in red in **Fig.** 37) of the UNO board is not in standard 2.54 pin pitch.

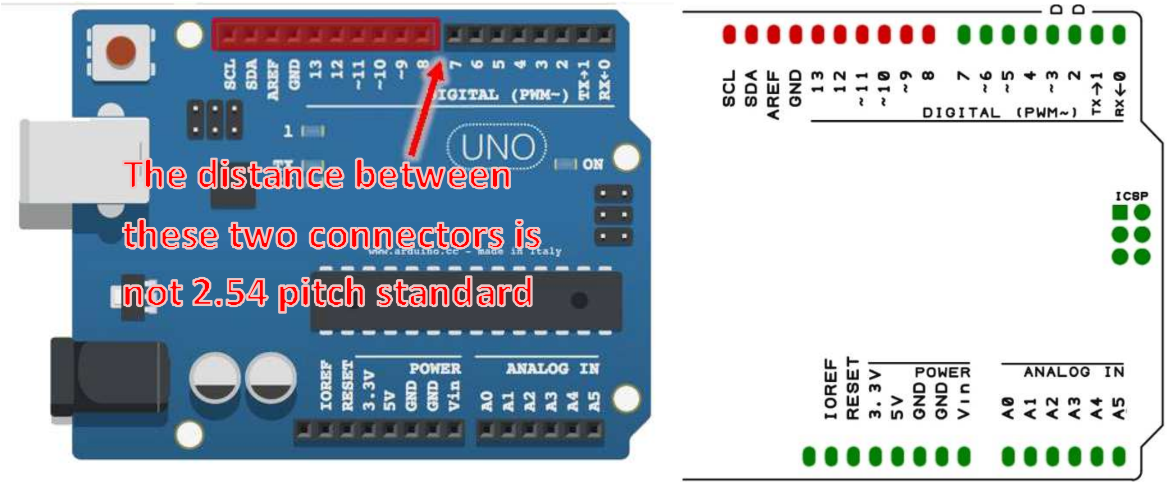


Fig. 37 – Highlighted in RED the not-standard 2.54 pin pitch connector of the UNO board (in GREEN all the other standard 2.54 pitch pins)

Thus if you want to create your own shield, using a standard 2.54 pitch breadboard, you have to exclude that connector or bent pins or find some other trick to use the I/O lines 8 to 13 (see **Fig.** 38)

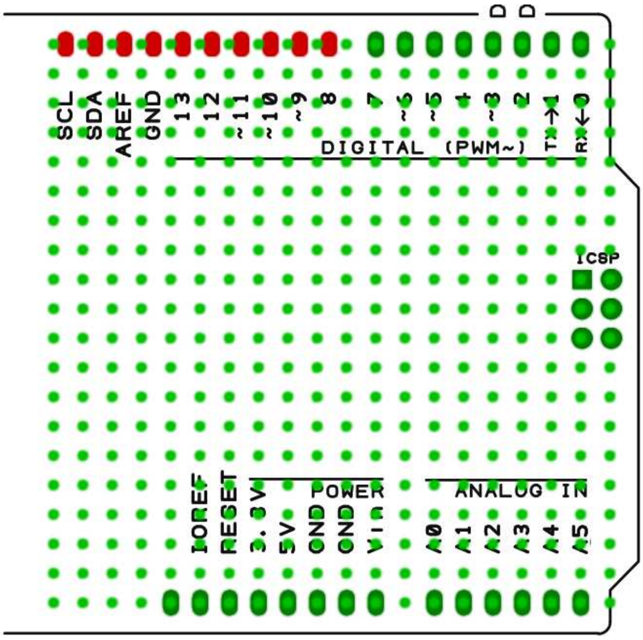


Fig. 38 – In LIGHT GREEN, a standard 2.54 pin pitch breadboard (in RED the resulting misaligned connector)

The UNO socket of the **PROTOSHIELD PLUS** provides additional holes (see **Fig.** 39) to let the user mount a connector that will fit the a 2.54 pitch breadboard (see **Fig.** 40).
It is up the user to mount a male or female connector depending on its own needs.

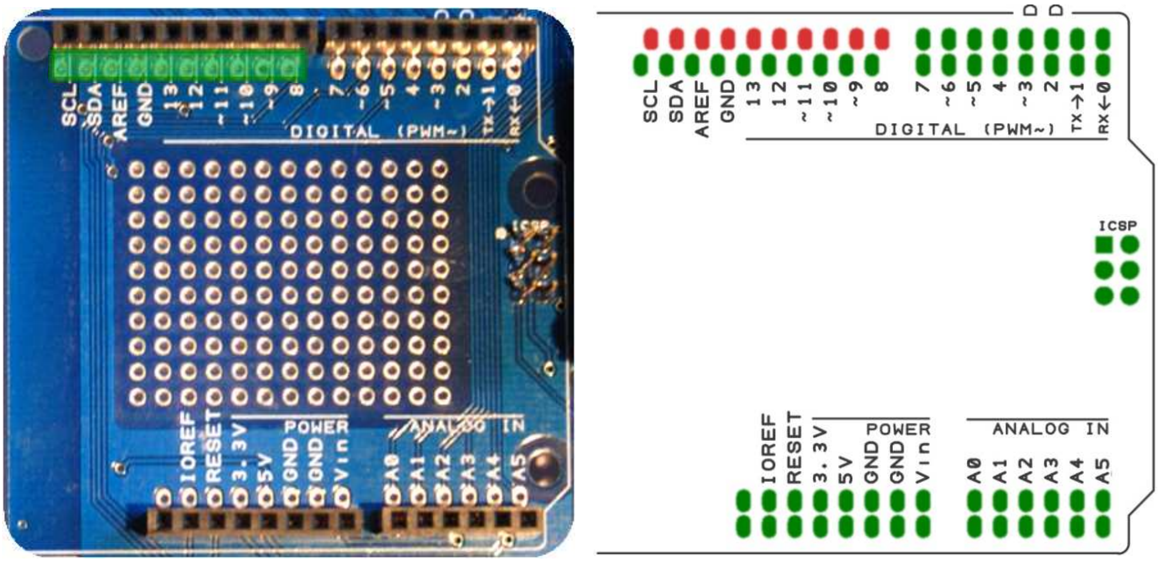


Fig. 39 – Highlighted in GREEN the additional 2.54 pin pitch connector of the UNO socket of the PROTOSHIELD PLUS

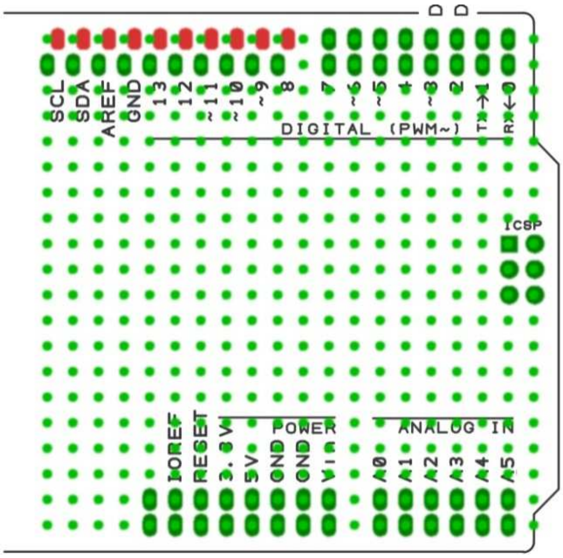


Fig. 40 – In LIGHT GREEN, a standard 2.54 pin pitch breadboard
(the additional connector fits it)