

I2C Backpack

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Keywords:	LCD, I2C
Library	https://github.com/PTSolns/PTSolns_I2CBackpack or Arduino® IDE library: <i>PTSolns_I2CBackpack</i>

1 DESCRIPTION

The *I2C Backpack* interfaces the common 1602 and 2004 LCDs to a microcontroller via the I2C protocol. It is called a "backpack" as it is intended to be soldered right onto the back of the LCD. Onboard the *I2C Backpack* is a boost converter as well as a logic level shifter. This allows the user to connect an LCD to either a 3.3V or a 5V microcontroller.

The user can connect the I2C and power wires either directly to the onboard 4-pin screw terminal or via the onboard QWIIC® connector. This makes it convenient to easily daisy-chain other modules and sensors that also use the I2C protocol. The *I2C Backpack* has LCD contrast and LCD backlight control via onboard potentiometers. The board has eight configurable addresses.

To use the *I2C Backpack* the user should install the *PTSolns_I2CBackpack* library. Various examples and documentation can be found in the library package.

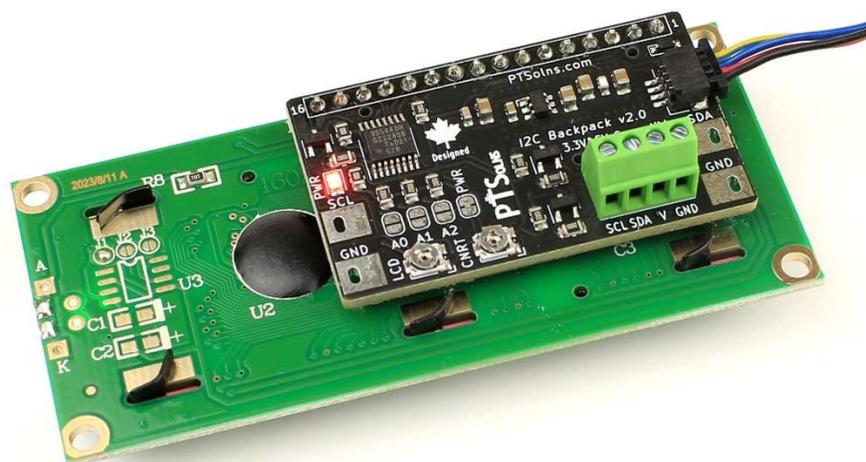


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2 DOCUMENT REVISION HISTORY

Current document revision is Rev 0.

3 PRODUCT OVERVIEW

The following subsections provide an overview of the *I2C Backpack*.

3.1 Voltage Compatibility and Logic Levels

The *I2C Backpack* has an onboard boost converter that increases the input voltage from 3.3V to 5V, which is required for the common 1602 and 2004 LCDs. Furthermore, the I2C logical levels are shifted onboard using a Logic Level Shifter (LLS). With these features, the *I2C Backpack* can be used with a microcontroller that runs on 5V (E.g. the Arduino® Uno R4), or one that runs on 3.3V (E.g. the Raspberry Pi® Pico W). Both 3.3V and 5V input voltages as well as logic levels are accepted.

3.2 QWIIC® and Screw Terminal Input

There is a QWIIC® connector as well as a 4-pin screw terminal onboard the *I2C Backpack*. The user can choose either of these to interface the PCB with their microcontroller of choice. These are shown in Figure 1.

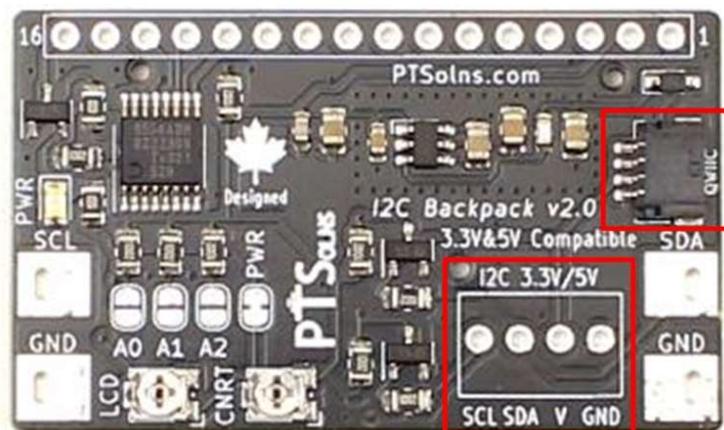


Figure 1: QWIIC® Connector and Screw Terminal for I2C Input.

3.3 LCD Contrast Control

Onboard the *I2C Backpack* is a potentiometer that can be turned to adjust the LCD contrast. This is shown in Figure 2.

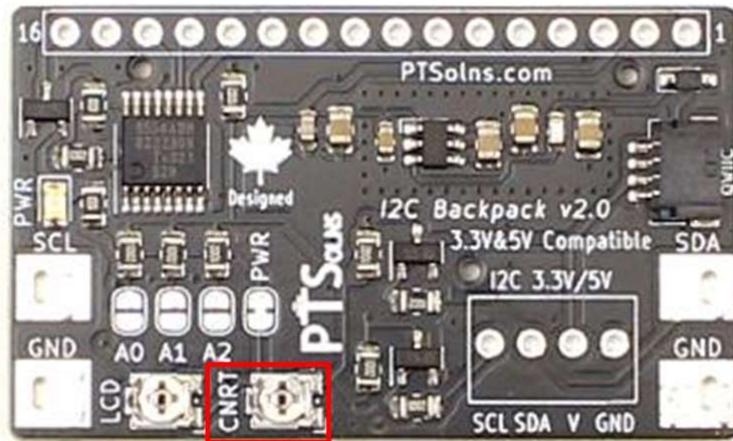


Figure 2: LCD Contrast Control via Potentiometer.

3.4 LCD Backlight Control

Onboard the *I2C Backpack* is a potentiometer that can be turned to adjust the LCD backlight. This is shown in Figure 3.

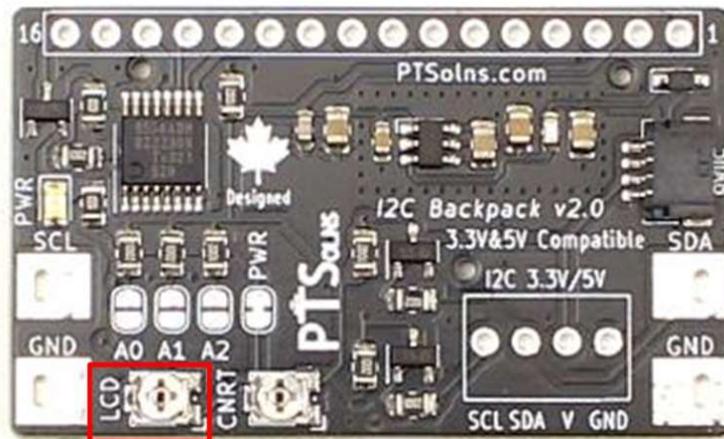


Figure 3: LCD Backlight Control via Potentiometer.

3.5 Device Addresses

Onboard the *I2C Backpack* is the PCA9554A I/O expander. The expander has eight configurable addresses, with default address 0x3F. The addresses can be configured by closing respective jumper pads marked A0, A1 and A2, as seen in Figure 4.

The following is the configuration table, with the three jumper pads A0, A1, and A2 configured as OPEN by default.

Table 1: Address Device Configuration Table

A0	A1	A2	Address
Open	Open	Open	0x3F (default)
Closed	Open	Open	0x3E
Open	Closed	Open	0x3D
Closed	Closed	Open	0x3C
Open	Open	Closed	0x3B
Closed	Open	Closed	0x3A
Open	Closed	Closed	0x39
Closed	Closed	Closed	0x38

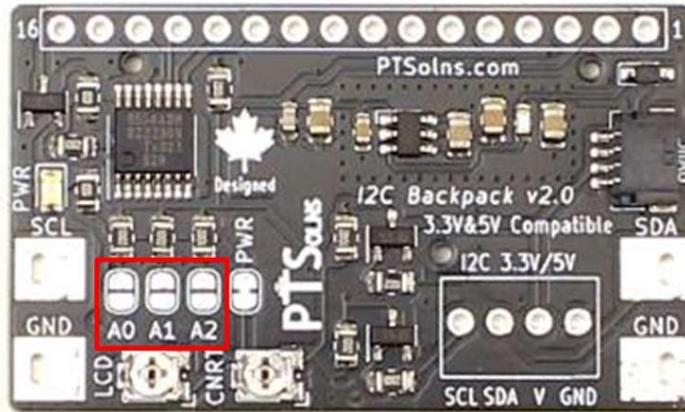


Figure 4: Device Address Selection.

3.6 Testing Pads

For convenience of testing and connecting an oscilloscope, there are large test pads for the SDA and SCL signals of the I2C bus available onboard the *I2C Backpack*. This can be seen in Figure 5.

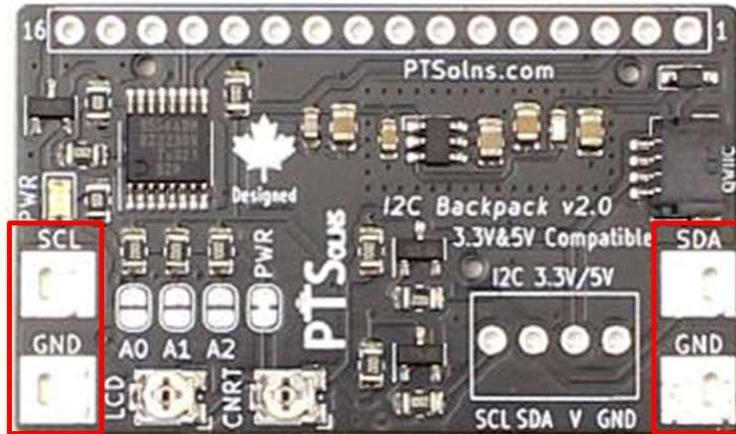


Figure 5: Testing Pads for SCL and SDA Signals.

3.7 Onboard Power LED

An onboard LED indicates if the *I2C Backpack* is powered or not. There are jumper pads, which is closed by default, that can be cut to disable the power LED. These are shown in Figure 6.

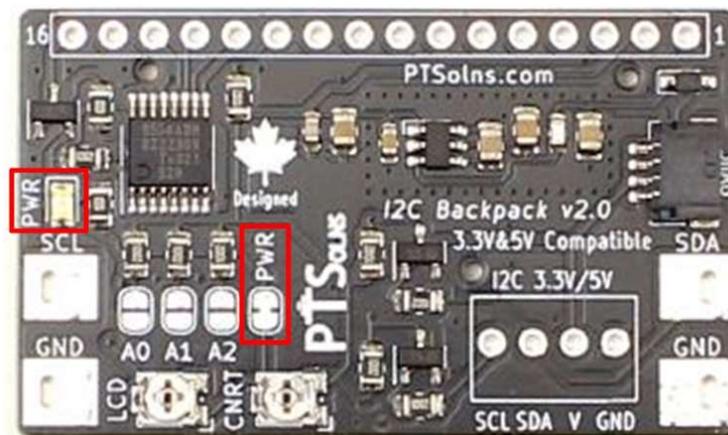


Figure 6: Power LED and Power Bridged Jumper Pads.

3.8 Mark of Authenticity

Authentic PTSolns products have a black solder mask color and are marked with the “PTSolns” logo in white silkscreen printing. The “Canadian Designed” symbol, consisting of the Canadian Maple Leaf with the word “Designed” underneath, can also be found on the PCB in white silkscreen printing. The “PTSolns” trademark and the “Canadian Designed” symbol can be seen on the back or underside of the *I2C Backpack* as shown in Figure 7.

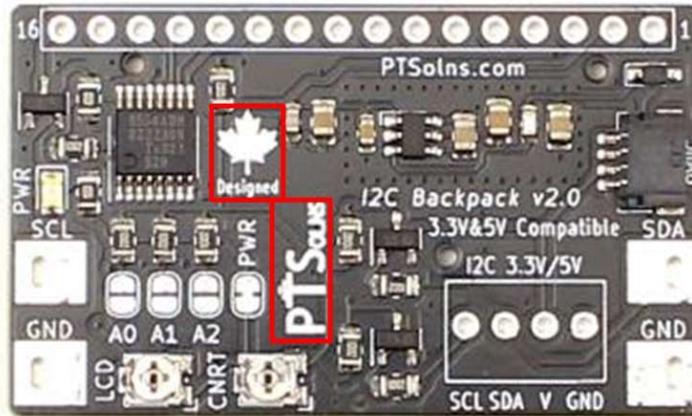


Figure 7: The "Canadian Designed" and "PTSolns" symbols found on authentic PTSolns products.

4 GETTING STARTED

The *I2C Backpack* requires a library in order to use the board. This section outlines the required details to get started.

4.1 Installing the Library

The *I2C Backpack* library can be download from GitHub here:

https://github.com/PTSolns/PTSolns_I2CBackpack

Or alternatively, by downloading the library, called `PTSolns_I2CBackpack`, within the Arduino® IDE environment and loading the corresponding example sketch.

Various examples are included in this package, including:

- Hello World,
- Setting the device address,
- LCD backlight control,
- Basic LCD controls,
- QWIIC® sensor and LCD example,
- And more

To submit a bug or improvement relating to the library, please submit an issue on the GitHub repository.

4.2 Assembly

The *I2C Backpack* requires some assembly (soldering) of through hole (THT) components. The following assembly instructions are recommended, but the user may find some alternations advantageous in their design.

- | | |
|------------------|--|
| Assembly Step 1) | Solder the 4-pin screw terminal to the front side of the PCB. The front side is the side where all the other surface mount components are located. Take note which orientation the screw terminal opens as this may be important to your design. Most common orientation is such that the screw terminal opens away from the 1x16 pin row. |
| Assembly Step 2) | Solder the 1x16 pin male header to the back side of the PCB. The back side should have no other components on it. |
| Assembly Step 3) | Solder the other side of the male header, which should now be connected to the rest of the PCB as done in Step 2, to the back of LCD. |

If the screw terminal is not soldered on first, as explained in Step 1, but rather after the two steps corresponding to the soldering of the male header, then it will not be possible to add the screw terminal afterwards.

Two important notes are printed onto the back of the *I2C Backpack*, as can be seen in Figure 8, which the user can consult for assembly tips. They are as follows:

- Tip 1) "Solder screw terminal first, then header."
- Tip 2) "If you can read this after assembly *Backpack* is backwards."

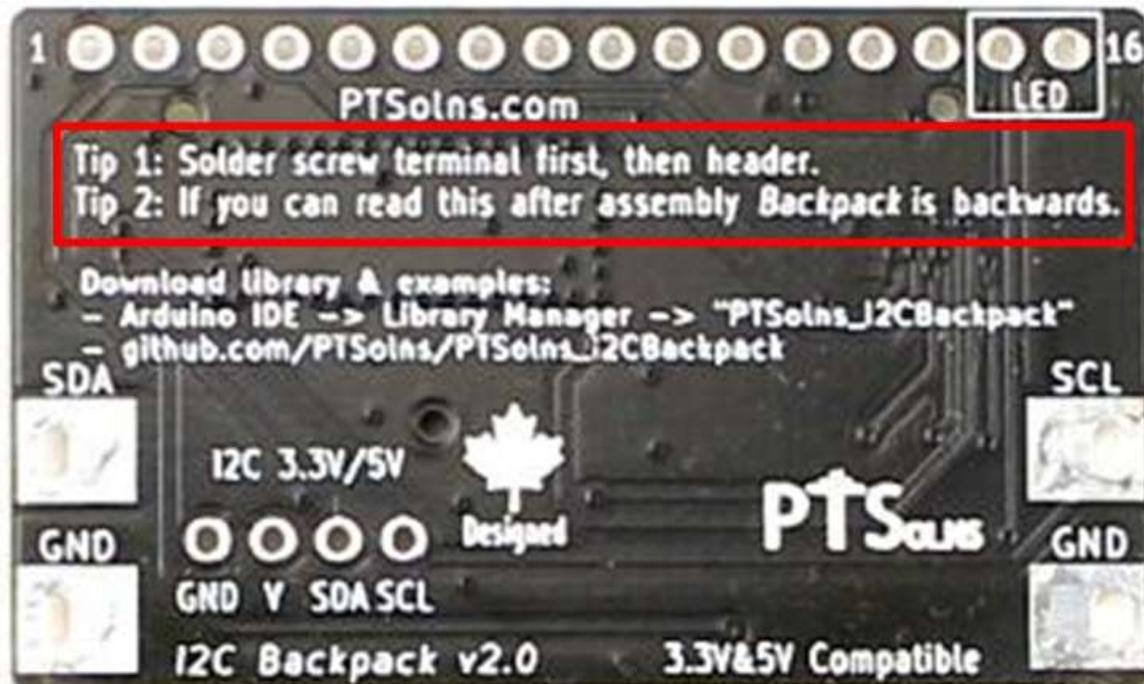


Figure 8: Assembly Tips.

4.3 Connecting I2C Bus

The *I2C Backpack* interfaces a microcontroller to the common 1602 or 2004 LCD via the I2C protocol. This is convenient as it reduces the number of wired connections the user needs to make to get started with their LCD. Once the PCB is assembled onto the back of an LCD, the user connects the two wires used for I2C and two more for power (input voltage and ground), totalling only four wired connections. This can be done in two input methods:

- 1) Use the onboard QWIIC® connector, or
- 2) Use the 4-pin screw terminal (see Assembly Step 1 in previous section)

Although the *I2C Backpack* accepts both 3.3V and 5V in either of the two input methods, the user should be careful to not simultaneously connect a 3.3V source into one of the input methods, while connecting 5V into the other. This can cause a current to flow from the 5V source, through the connectors on the *I2C Backpack*, to the 3.3V source, which can result in damage to that module.

5 PHYSICAL PROPERTIES

Details of the *I2C Backpack* as they relate to the physical properties are outlined in this section.

5.1 Physical Specifications

The physical specifications of the *I2C Backpack* are outlined in Table 2, as well as Figure 9.

Table 2: Physical Specifications of the *I2C Backpack*.

	Description	Value	Reference
PCB	Length	44.8 mm	Figure 9
	Width	26.8 mm	Figure 9
	Thickness	1.6 mm	Figure 9
	Corner radius	1.0 mm	Figure 9
	Weight (with components)	6 g	--
	Color	Black	--
	Silkscreen	White	--
	Lead free HASL-RoHS surface finish		--
	FR-4 base		--
Through Holes	LCD connection	16	Figure 9
	Pitch for LCD connection	2.54 mm/0.1 in	Figure 9
	I2C connection	4	Figure 9
	Pitch for I2C connection	2.54 mm/0.1 in	Figure 9

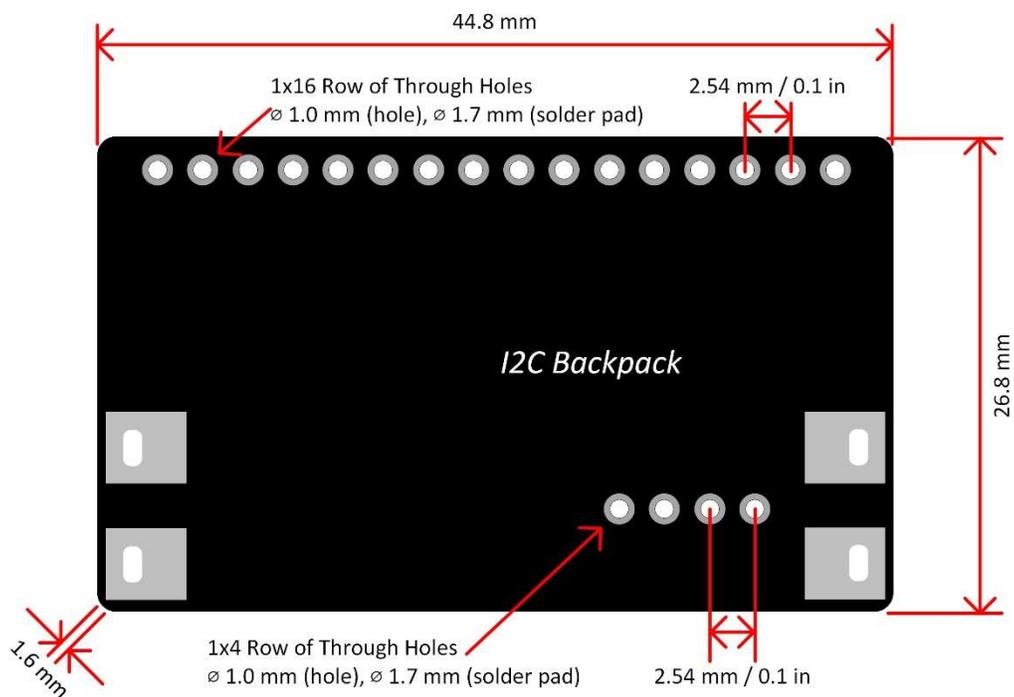


Figure 9: *I2C Backpack* Dimensions.

6 RESOURCES

The following is a non-exhaustive list of references that may be relevant or useful to the user.

1. The *PTSolns_I2CBackpack*, can be downloaded from GitHub:

https://github.com/PTSolns/PTSolns_I2CBackpack

Or alternatively, by downloading the library, called *PTSolns_I2CBackpack*, within the Arduino® IDE environment and loading the corresponding example sketch.

2. Arduino® IDE:

<https://www.Arduino®.cc/en/software>