# Rucksack LCD Controller Board

An improved serial, I^{2}C and SPI Backpack Kit
(with optional wifi expansion)
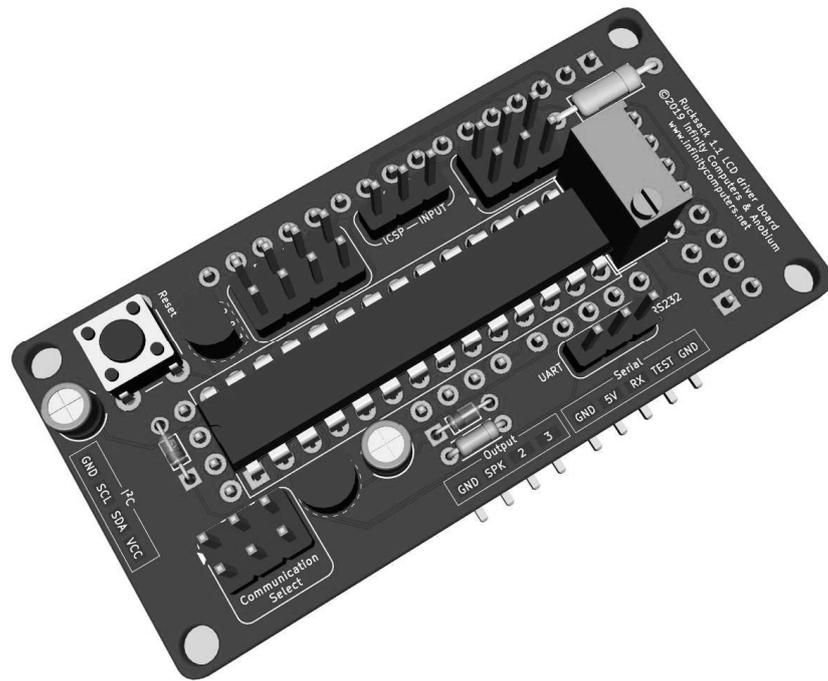
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OVERVIEW

The purpose of the Rucksack board is to provide an easy-to-use interface to many existing commercially-available LCD displays. It is loosely based on the now-defunct K107 board[1], but offers significant improvements.

Designed around the ubiquitous Atmel ATmega328P chip and running our updated firmware, it becomes trivial to control an LCD display using serial, I^2C, SPI, or – with the optional wifi expansion board – MQTT messages sent over a wireless network.

COMPATIBILITY

LCD controller like the HD44780 IC or clones of this IC are support. This display parameters cover 16 x 1, 16 x 2, 20 x 4 and 40 x 4 LCD displays.

Support for other controllers may be added in the future – ask us.

The Rucksack board can be connected

1. A standard RS232 serial port (12V inverted serial) or to any standard USB UART adapter (e.g. the FT232, CH340G or CP2104 chipsets).
2. I^2C slave device.
3. SPI slave devices,
4. WIFI expansion board

Serial: When connecting to RS232, you MUST change the Serial Select jumper to RS232 mode to avoid potential damage to the board.[2]

The serial input will also work with pretty much any microcontroller with a UART; such as the popular Atmel AVR, Microchip PIC, or PICAXE microcontrollers.

I^2C: When connecting to I2C Rucksack will operate as a slave device.

The board runs at 5V, and so does its I2C port. To interface with a 3.3V I2C host, you must use level shifters.

SPI: When connecting to I^2C Rucksack will operate as a slave device.

**WIFI**: When connected expansion board is connect then wifi network can be used to send MQTT protocol.

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[1] By Russ Ferguson, Brian Riley and Peter Anderson.

[2] Also, if you don't, it simply won't work.

HARDWARE

BOARD LAYOUT

Here are both sides of the board before assembly:
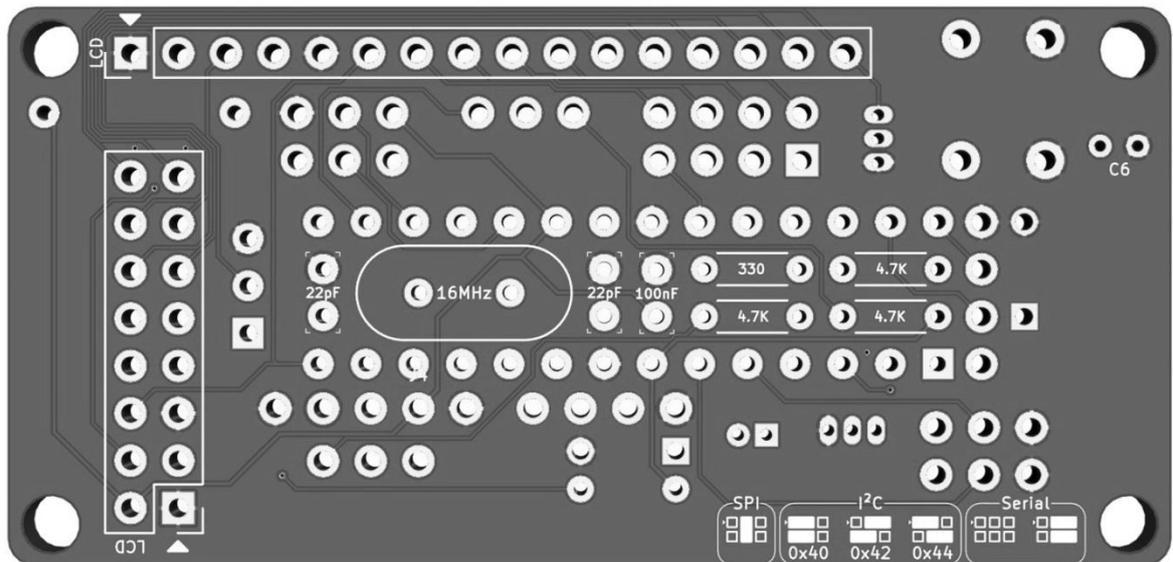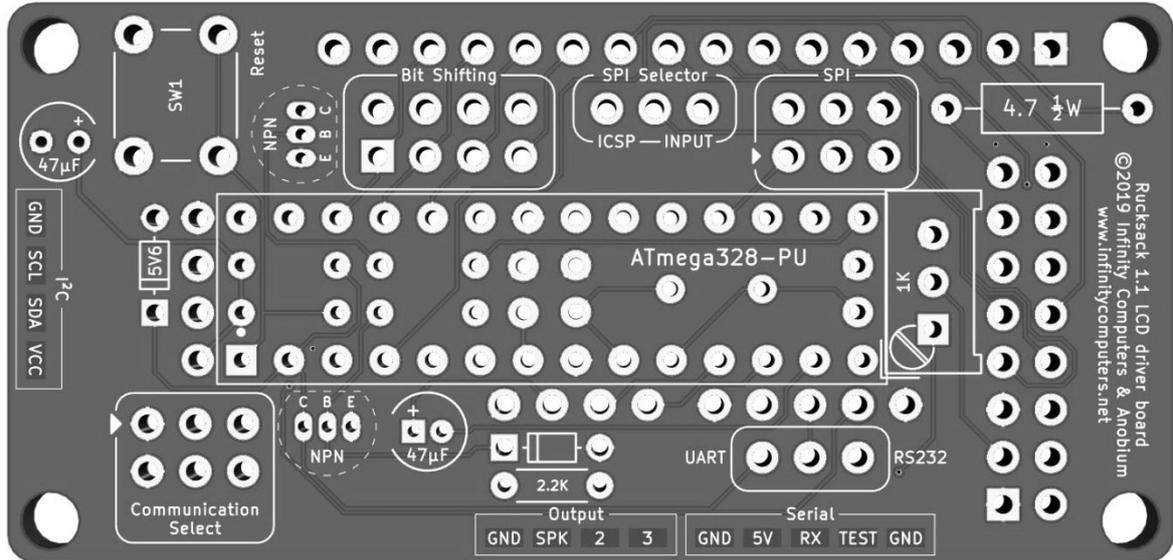
The board again, after assembly:
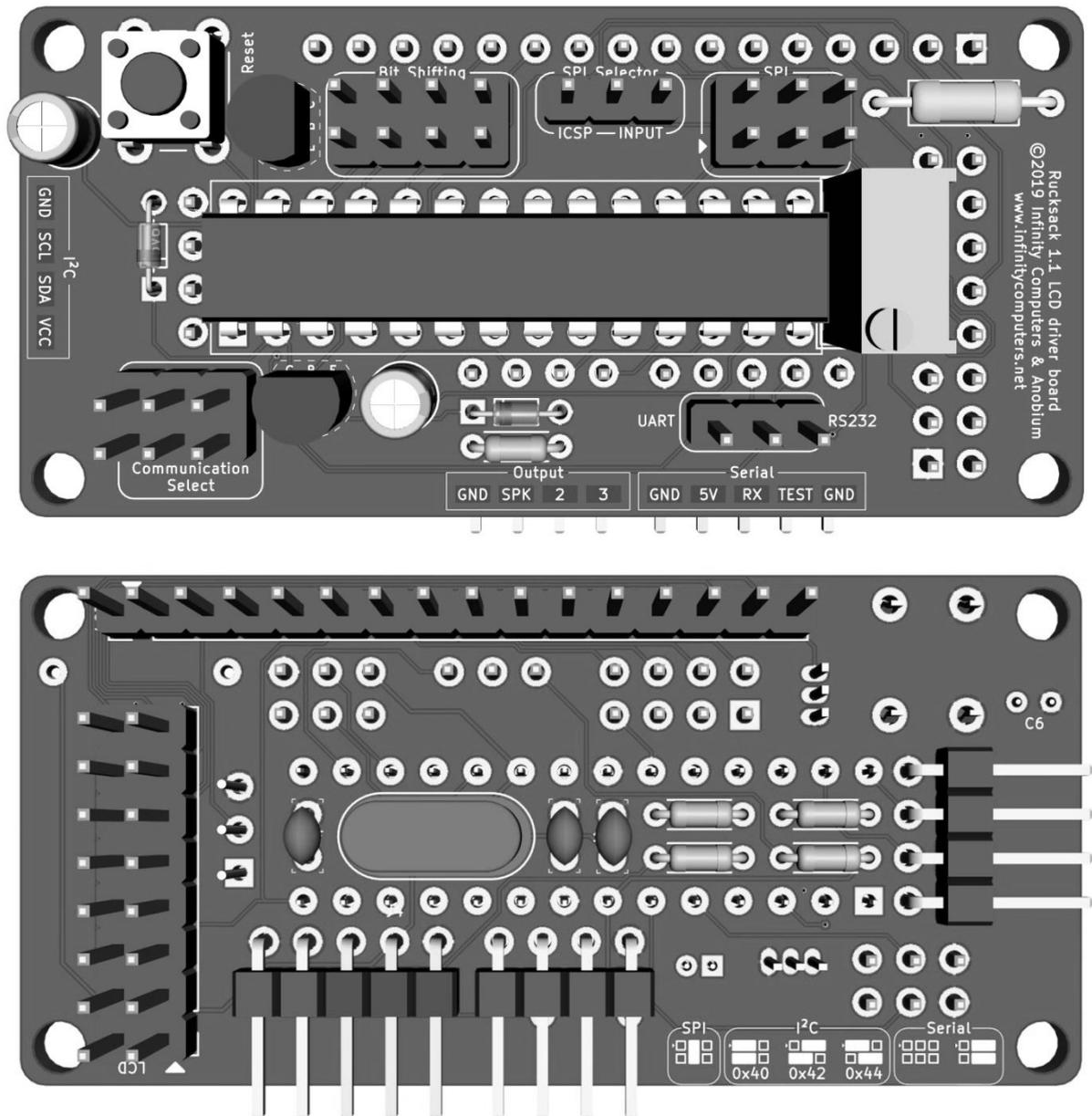
The serial, I^{2}C and output pins are on the back, but the labels for them are on the front.

The reverse of the board offers two LCD connectors – 1x16 and 2x8. Use whichever is appropriate for your LCD. Pin 1 is marked on both connectors with an arrow.

BILL OF MATERIALS

| Item	Qty	Picture	Markings or other notes
Capacitor, 100nF, ceramic disc	1		"104"
Capacitor, 22pF, ceramic disc	2		"22"
Capacitor, 47µF, electrolytic	2		
Diode, small signal	1		
Diode, small signal, zener, 5.6V	1		"5V6"
Transistor, bipolar, NPN, EBC	2		e.g. S8050, 2N3904
Resistor, ⅛W, 330Ω	1		
Resistor, ⅛W, 4.7K	3		
Resistor, ⅛W, 2.2K	1		
Resistor, ½W, 4.7Ω	1		
Potentiometer, multi-turn, 10K	1		
Tactile button, 6x6x4mm	1		
ATmega328P, DIP-28	1		
Crystal, 16MHz	1		
Pin header, male, straight, 1x03	2		
Pin header, male, straight, 2x04	1		
Pin header, male, straight, 1x04	1		
Pin header, male, straight, 1x16	1		
Pin header, male, straight, 2x08	1		
Pin header, male, straight, 2x03	2		
Pin header, male, angled, 1x05	1		
Pin header, male, angled, 1x04	1		
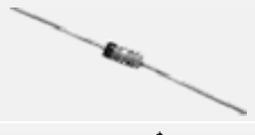
ASSEMBLY

Anyone with a basic modicum of soldering experience should have no difficulty in assembling this board.

The best way to go about it is as follows:

1. Rear components, except pins

2. Front components, except microcontroller(/socket) and pot

3. All vertical pins

4. All horizontal pins

5. Microcontroller(/socket) and pot

It is advisable to solder small components, such as resistors, before larger ones.

The coloured bands on metal-film resistors (the blue ones) are difficult to read with the human eye. Instead of squinting, simply measure them with a multimeter.[3]

Note that the ATmega328P microcontroller will sit stand proud of the board, due to the presence of components underneath it. If this bothers you, use a socket.

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[3] Don't have a multimeter? Get one. It's the single most useful tool you could possibly have for electronics work.

USAGE

POWER

The board runs on 5 volts. This must be provided on the serial header, the SPI header or the I²C header; whichever is most convenient. It is also acceptable to back-power the board from the LCD pins, if desired and feasible.

Do not overvolt or undervolt the board. Of course there is some wiggle room,[4] but excessive overvolting will almost certainly result in damage; and undervolting in erroneous operation.

CONNECTIONS AND PINOUTS

The Communication Select pins tell the unit which communication protocol to use. These are covered in the next section. If left unpopulated, serial will be assumed by default.

For serial communications, RX on the board should connect to TX on the host. A ground connection must also be provided. The baud rate depends on the firmware installed in the chip.

The UART/RS232 pins above the serial connection are for a selection jumper. If omitted, serial will not function. When connected to a computer's RS232 serial port, RS232 mode should be selected. In all other cases,[5] UART mode should be used. The jumper may be left in place even when using other communication protocols.

IMPORTANT: RS232 ports generally run at around 12 volts. Connecting RS232 to the Rucksack without moving the jumper to the RS232 position is not recommended. The board does have overvoltage protection on that line, but prolonged connection to an RS232 port whilst in UART mode is simply asking for trouble.

When using SPI, a jumper should be placed on the "Input" side of the SPI Selector, or else SPI will not operate. This jumper may be left in place even when using other communication protocols. The "ICSP" option should only be used when intending to reprogram the Rucksack's own ATmega328P microcontroller with new firmware.[6]

Some LCD displays expect some of their data on pins 11-14 instead of pins 7-10. For these displays, add four vertical jumpers to the Bit Shifting header, thus:
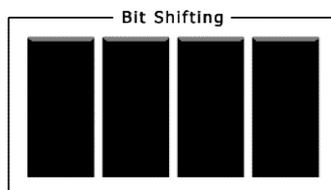
Alternatively, if you are using a cable – rather than connecting the LCD directly – simply wire the cable to suit the application.

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[4] The ATmega328P datasheet specifies 4.5V to 5.5V as the acceptable tolerance range.

[5] Actually some PICAXE chips use inverted serial, so will require RS232 mode to be selected. Your mileage may vary.

[6] This practice is discouraged, and may cause the device to stop working.

CONFIGURATION

You must instruct the Backpack as to which communication protocol you are using (serial, I²C, SPI) by setting the Communication Select jumpers. If you omit these jumpers, it will default to serial mode.

Instructions for their use are printed on the back of the board, but a detailed explanation is also given here.

A filled box indicates the presence of a jumper, whilst an empty box indicates the absence of same. Pin 1 is indicated by an arrow, both on the board and in the reference.

Use serial

Use serial

Use SPI

Use I²C with address 0x40 (= 64 decimal)

Use I²C with address 0x42 (= 66 decimal)

Use I²C with address 0x44 (= 68 decimal)
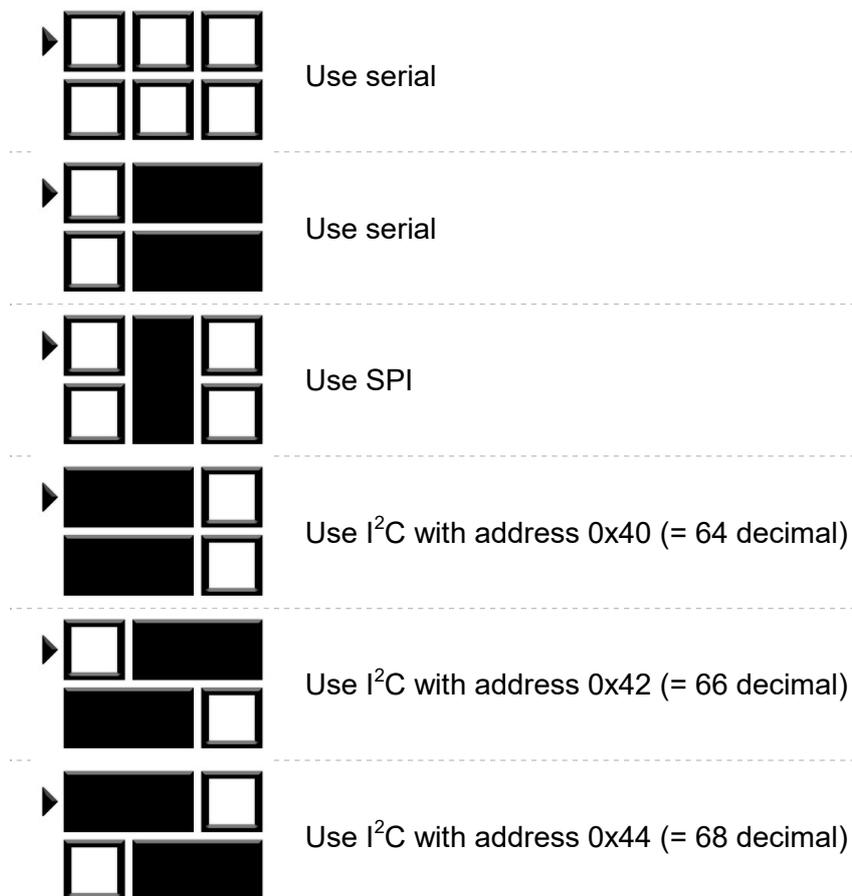
It is advisable to disconnect the power before adjusting the configuration jumpers. If you wish to change them whilst power is applied, you must press the reset button afterwards (or power cycle the unit) to apply the changes.

On displays that allow it, you can change the contrast by adjusting the potentiometer with a small screwdriver.

Brightness adjustment, where supported by the display, is done in software rather than in hardware.

EXPANSION WITH WIFI

WIFI EXPANSION BOARD

This expansion board (sold separately) is built around the popular Espressif ESP8266 wifi module. It sits on top of, and plugs into, the main Rucksack board; and allows messages to be sent to the LCD wirelessly using the lightweight MQTT protocol.
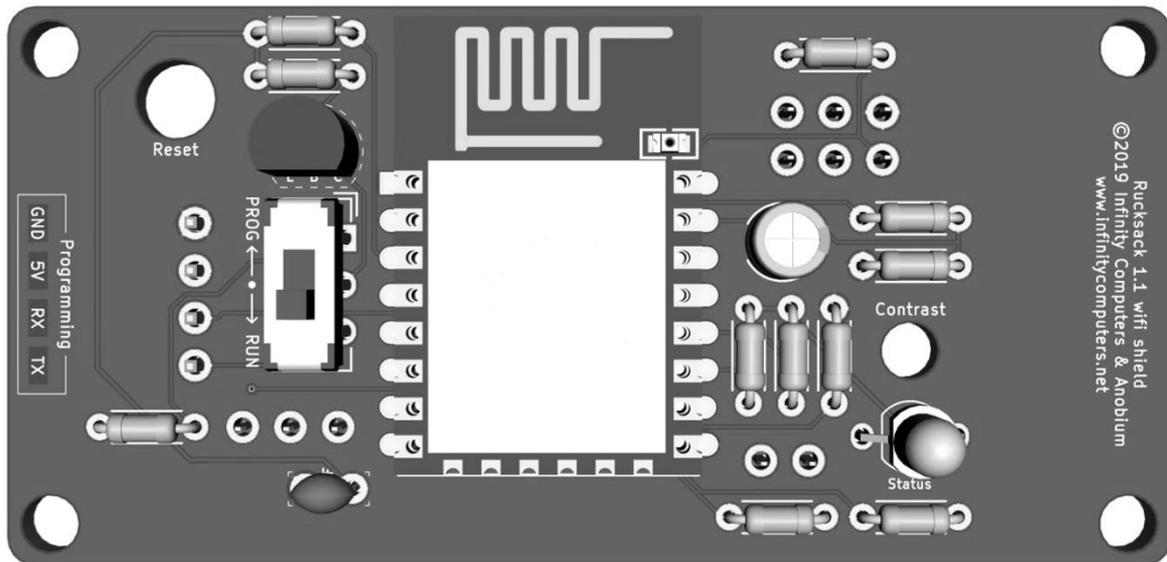
Instructions on assembly and usage of this board are outside the scope of this document.