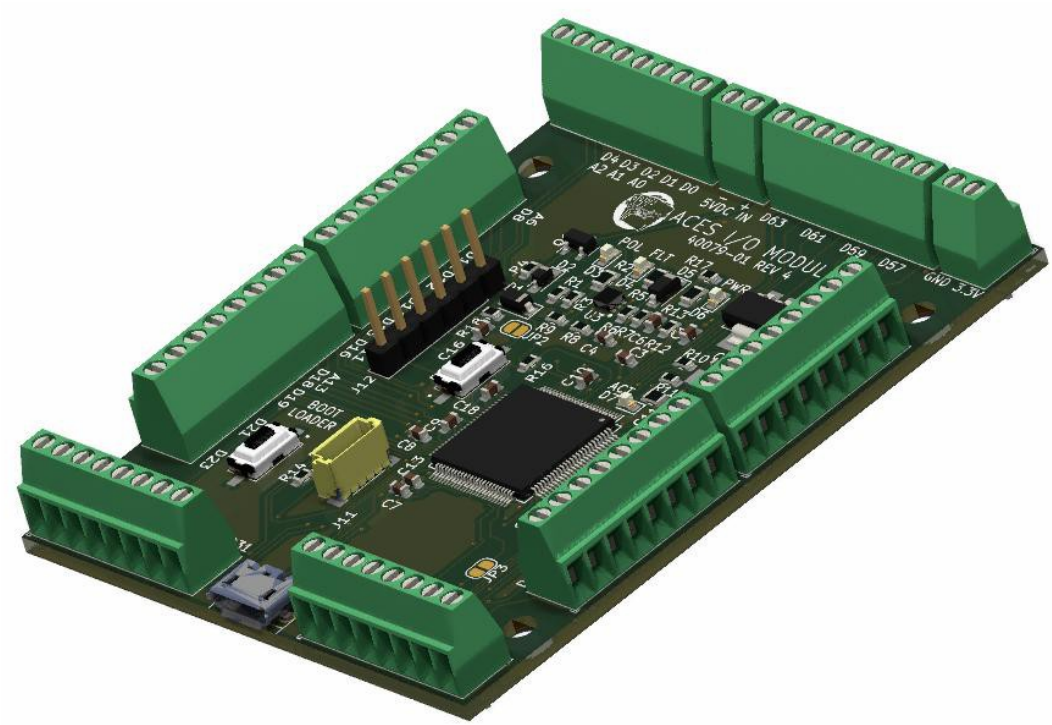
ACES Simulation

Input Output Module

User Manual

V 0.5

27. Feb. 2023



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2 Description

The ACES product line consists of simple, easy-to-use USB devices and software intended for use in personal recreational flight simulators. The ACES Cockpit Software Suite (CSS) provides a set of applications for transferring information between input/output (I/O) devices and several popular flight simulation programs. The ACES stepper and mini-stepper modules implement a plug and play connection to the ACES CSS to drive stepper and mini-stepper based simulated flight instruments and gauges.

The ACES Input Output Module is also plug and play with the ACES CSS. The input output module provides the simulation enthusiast with the ability to import switch, encoder or analog input data to the simulation software. It also provides a way to use simulation data to drive outputs such as LEDs.

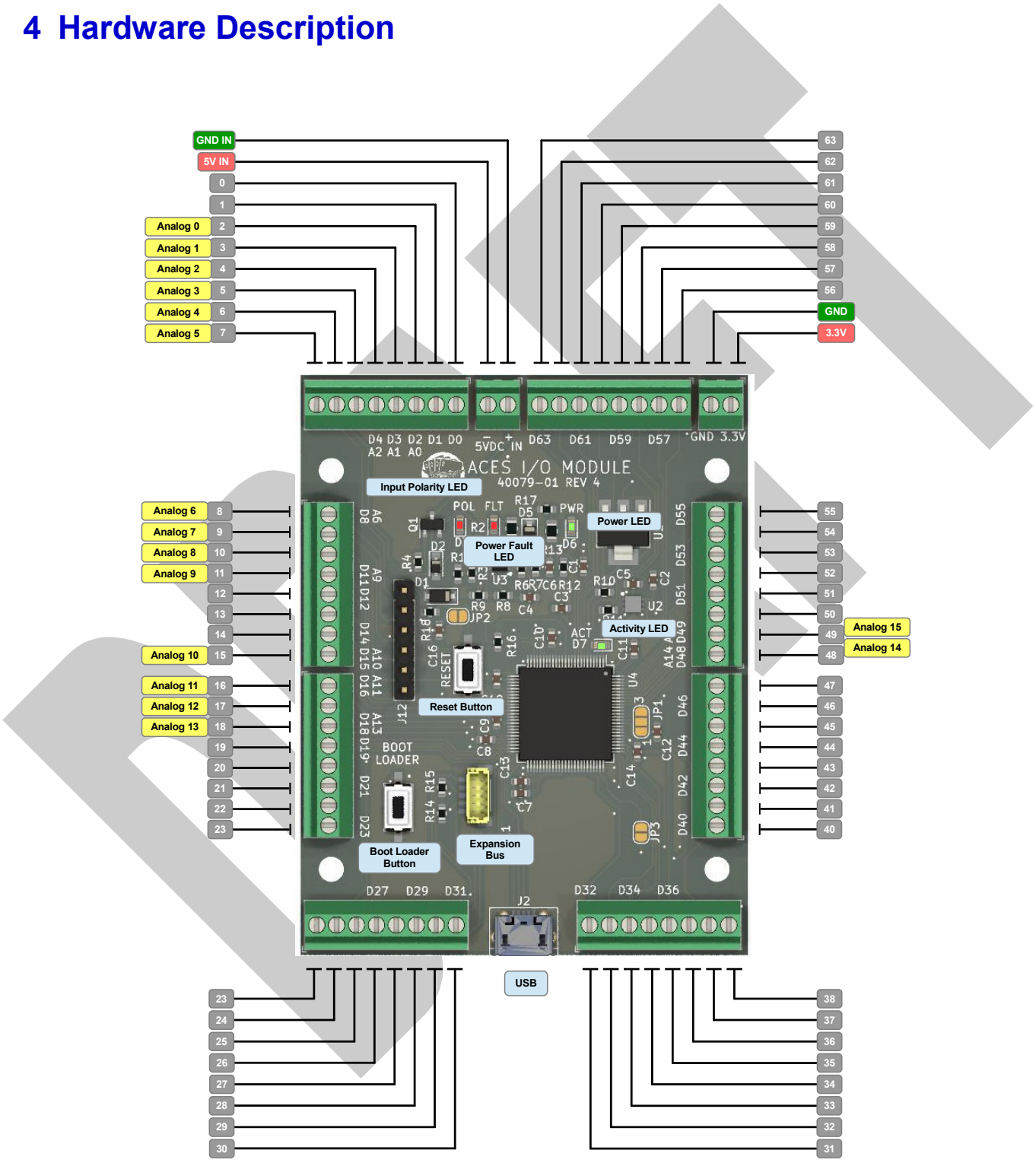
The input output module provides 64 I/O pins. Each pin can be configured as either an input or an output. All I/O pins are 5V tolerant when configured as digital inputs or outputs. Additionally, 16 of these pins can be configured as 12-bit analog inputs. The input output module also allows for up to 25 pairs of these pins to be configured as quadrature encoder inputs.

In case there is need for additional I/O the ACES input output module includes an extension connector with can be used to connect ACES expansion modules.

3 Features

- 64 digital inputs with pull-up resistors (5V tolerant)
- 64 digital outputs (3.3V)
- 16 analog inputs (12-bit, 3.3V)
- 25 encoder pair inputs
- Extension bus for connecting ACES expansion modules
- Plug and play with the ACES Cockpit Software Suite
- Protection from reversed polarity input voltage

4 Hardware Description



I = Input, O = Output, I/O = Input or Output

Pin	Type	Description
5V IN	I	5V DC input power to the module
GND IN	I	GND input to the module
0	I/O	General purpose digital input/output (5V tolerant)
1	I/O	General purpose digital input/output (5V tolerant)
2	I/O I	General purpose digital input/output (5V tolerant) Analog input 0 (3.3V reference)
3	I/O I	General purpose digital input/output (5V tolerant) Analog input 1 (3.3V reference)
4	I/O I	General purpose digital input/output (5V tolerant) Analog input 2 (3.3V reference)
5	I/O I	General purpose digital input/output (5V tolerant) Analog input 3 (3.3V reference)
6	I/O I	General purpose digital input/output (5V tolerant) Analog input 4 (3.3V reference)
7	I/O I	General purpose digital input/output (5V tolerant) Analog input 5 (3.3V reference)
8	I/O I	General purpose digital input/output (5V tolerant) Analog input 6 (3.3V reference)
9	I/O I	General purpose digital input/output (5V tolerant) Analog input 7 (3.3V reference)
10	I/O I	General purpose digital input/output (5V tolerant) Analog input 8 (3.3V reference)
11	I/O I	General purpose digital input/output (5V tolerant) Analog input 9 (3.3V reference)
12	I/O	General purpose digital input/output (5V tolerant)
13	I/O	General purpose digital input/output (5V tolerant)
14	I/O	General purpose digital input/output (5V tolerant)
15	I/O I	General purpose digital input/output (5V tolerant) Analog input 10 (3.3V reference)
16	I/O I	General purpose digital input/output (5V tolerant) Analog input 11 (3.3V reference)
17	I/O I	General purpose digital input/output (5V tolerant) Analog input 12 (3.3V reference)

Pin	Type	Description
18	I/O I	General purpose digital input/output (5V tolerant) Analog input 13 (3.3V reference)
19	I/O	General purpose digital input/output (5V tolerant)
20	I/O	General purpose digital input/output (5V tolerant)
21	I/O	General purpose digital input/output (5V tolerant)
22	I/O	General purpose digital input/output (5V tolerant)
23	I/O	General purpose digital input/output (5V tolerant)
24	I/O	General purpose digital input/output (5V tolerant)
25	I/O	General purpose digital input/output (5V tolerant)
26	I/O	General purpose digital input/output (5V tolerant)
27	I/O	General purpose digital input/output (5V tolerant)
28	I/O	General purpose digital input/output (5V tolerant)
29	I/O	General purpose digital input/output (5V tolerant)
30	I/O	General purpose digital input/output (5V tolerant)
USB	I/O	Data transfer to/from computer
31	I/O	General purpose digital input/output (5V tolerant)
32	I/O	General purpose digital input/output (5V tolerant)
33	I/O	General purpose digital input/output (5V tolerant)
34	I/O	General purpose digital input/output (5V tolerant)
35	I/O	General purpose digital input/output (5V tolerant)
36	I/O	General purpose digital input/output (5V tolerant)
37	I/O	General purpose digital input/output (5V tolerant)
38	I/O	General purpose digital input/output (5V tolerant)
39	I/O	General purpose digital input/output (5V tolerant)
40	I/O	General purpose digital input/output (5V tolerant)
41	I/O	General purpose digital input/output (5V tolerant)
42	I/O	General purpose digital input/output (5V tolerant)
43	I/O	General purpose digital input/output (5V tolerant)
44	I/O	General purpose digital input/output (5V tolerant)
45	I/O	General purpose digital input/output (5V tolerant)
46	I/O	General purpose digital input/output (5V tolerant)

Pin	Type	Description
47	I/O	General purpose digital input/output (5V tolerant)
48	I/O I	General purpose digital input/output (5V tolerant) Analog input 14 (3.3V reference)
49	I/O I	General purpose digital input/output (5V tolerant) Analog input 15 (3.3V reference)
50	I/O	General purpose digital input/output (5V tolerant)
51	I/O	General purpose digital input/output (5V tolerant)
52	I/O	General purpose digital input/output (5V tolerant)
53	I/O	General purpose digital input/output (5V tolerant)
54	I/O	General purpose digital input/output (5V tolerant)
55	I/O	General purpose digital input/output (5V tolerant)
3.3V	O	3.3VDC reference output; this pin is intended to be used as the reference voltage for potentiometers connected to analog input pins on the module.
GND	O	GND reference output
56	I/O	General purpose digital input/output (5V tolerant)
57	I/O	General purpose digital input/output (5V tolerant)
58	I/O	General purpose digital input/output (5V tolerant)
59	I/O	General purpose digital input/output (5V tolerant)
60	I/O	General purpose digital input/output (5V tolerant)
61	I/O	General purpose digital input/output (5V tolerant)
62	I/O	General purpose digital input/output (5V tolerant)
63	I/O	General purpose digital input/output (5V tolerant)
Expansion Bus	N/A	Expansion port for connecting ACES add-on devices. The expansion port connector for the ACES devices is a 5-pin JST connector with a 1 mm pitch.

4.1 Status LEDs

The ACES Input Output Module has the following status LEDs:

- POL – If this LED is illuminated the input power to the module is connected with the wrong polarity. This means the positive wire is connected to the negative terminal and vice versa. Immediately remove power and correct the input power connections.
- FLT – If this LED is illuminated it means there is a fault with power to the module. It can be caused by the following conditions.
  - The input voltage is too high (above 5VDC). The module runs from 5VDC. Do not connect any power supply with higher voltage output than 5VDC. Connecting more than 5VDC as input power may damage the module. Immediately remove power and connect a 5VDC power supply to the module input.
  - The current draw through the module is too high due to the load on the 3.3V reference voltage pin. Remove external power loads connected to the 3.3V reference until the FLT LED goes out. Review all connected potentiometers to ensure they are not drawing too much current. A typical potentiometer value is 10K Ohms.
  - The current draw through the module is too high due to too many LEDs activated simultaneously. Reduce the number of active LEDs until the FLT LED goes out. Alternatively, you may connect some LEDs using an open collector design as described later in this manual for connecting a relay, or using an LED driver.
- PWR – This LED indicates the ACES Input Output Module is properly powered.
- ACT – This LED flashes to indicate activity (data transfer to/from) the module. When the module is in boot loader mode, this LED flashes slowly.

4.2 Reset Button

The reset button is used to reset or reboot the module.

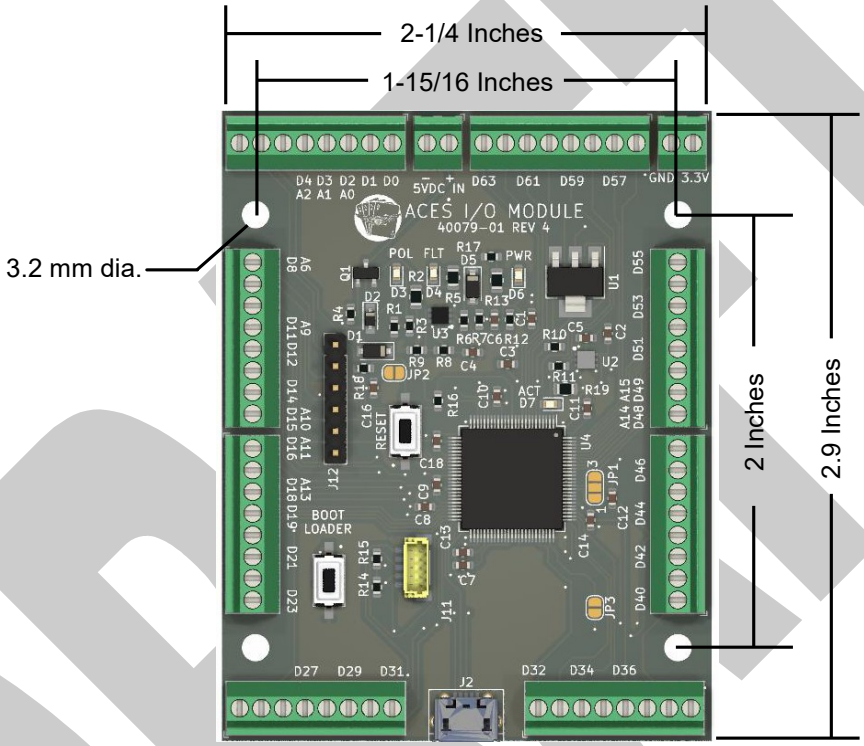
4.3 Boot Loader Button

Pressing and holding the boot loader button while pressing the reset button will put the module into boot loader mode. In boot loader mode, the module awaits a download of new firmware.

Release the boot loader button then press the reset button to exit boot loader mode and restart normal operational mode for the module. Cycling power will also return the module to normal operating mode.

5 Technical Specifications

5.1 ACES Input Output Module Dimensions



5.2 Electrical Characteristics - Maximum Ratings

The following table lists the maximum ratings for the ACES Input Output Module. Exceeding these ratings may cause permanent damage to the module and/or connected equipment.

Symbol	Parameter	Min	Max	Unit
V_{IN}	Input voltage with respect to the GND pin	4.5	7	V
V_{IO}	Voltage on any general purpose digital / analog pin with respect to the GND pin: When V_{IN} = 0V: When V_{IN} = 5V:	 -0.3 -0.3	 +4.0 +6.0	 V V
$I_{MAXSINK}$	Maximum current sunk by all I/O pins	0	200	mA
I_{MAXSRC}	Maximum current sourced by all I/O pins	-	200	mA
I_{SINK}	Maximum output current sunk by any I/O pin	0	25	mA
I_{SRC}	Maximum output current sourced by any I/O pin	-	25	mA

5.3 Electrical Characteristics

Symbol	Parameter	Min	Typ	Max	Units
V_{IN}	Supply voltage	4.5	5	5.5	V
V_{IL}	Digital Input Low Voltage	0	-	0.66	V
V_{IH}	Digital Input High Voltage: Pins with digital/analog capability: Pins with digital only capability:	 2.64 2.64	 - -	 3.3 5.5	 V V
V_{OL}	Digital Output Low Voltage: with I_{OL} = 3 mA: with I_{OL} = 6 mA:	 - -	 - -	 0.4 0.8	 V V
V_{OH}	Digital Output High Voltage: with I_{OL} = -3.0 mA: with I_{OL} = -6.0 mA:	 3.3 3.2	 - -	 - -	 V V

5.4 Power Supply for the ACES Input Output Module

The ACES Input Output Module requires 5VDC input power. The maximum current draw for the Input Output Module is 800 mA. The module can tolerate up to 7VDC without damage but this is not recommended due to heat dissipation and the red FLT LED will illuminate. Providing input voltages above 7VDC will prevent the module operating and may permanently damage the module.

6 Installation

The ACES Input Output Module is plug and play with the ACES Cockpit Software Suite (CSS). Once the ACES CSS is installed, no additional software needs to be installed to support the Input Output Module.

- Connect a USB cable from the Input Output Module to the computer.
- Apply power to the Input Output Module.
- Boot the computer and start ACES Cockpit Builder. The module will be automatically detected by the ACES software and ready for configuring to your I/O points. See the ACES CSS documentation for details.

7 Input Output Module Configuration Options

The I/O pins on the ACES Input Output Module are configured via the Cockpit Builder application which is part of the ACES Cockpit Software Suite. Refer to the Cockpit Builder documentation for details on how to configure the pins for your simulator. The sections below provide information on how typical peripherals are connected as I/O devices.

7.1 Digital Inputs and Outputs

Any of the 64 I/O pins on the ACES Input Output Module can be configured as digital input or output. All pins have a weak pull-up resistor and are 5V tolerant. Each output pin can sink or source up to 25 mA, with the limitation that all pins combined source or sink no more than 200 mA.

7.2 Analog Inputs

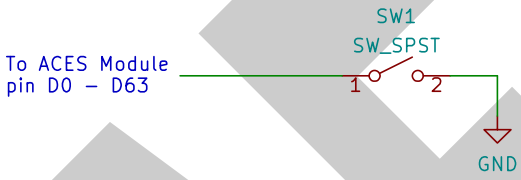
Analog input functionality is available on the A0 through A15 pins of the ACES Input Output Module. The analog input conversion has a resolution of 12 bits. The analog input reference voltage is available on the 3.3V Ref pin. It is intended to be used as the reference voltage connected to a potentiometer (typically 10 K Ohms) that is then connected to the analog input pin on the module. Note that although when in digital mode, the pin is 5V tolerant, when in analog mode, the voltage on the pin must not exceed the 3.3V reference voltage.

7.3 Quadrature Encoder Inputs

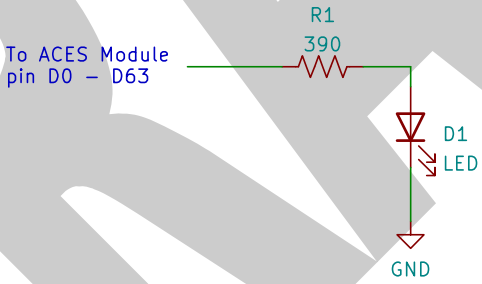
The ACES Input Output Module supports up to 25 pairs of quadrature encoder signals. The A and B signals of 25 encoders can be connected to any digital input and are intended for hand-driven rotational encoder devices with quadrature signal frequencies up to 1 kHz.

8 Connecting Common Peripherals to ACES Input Output Module

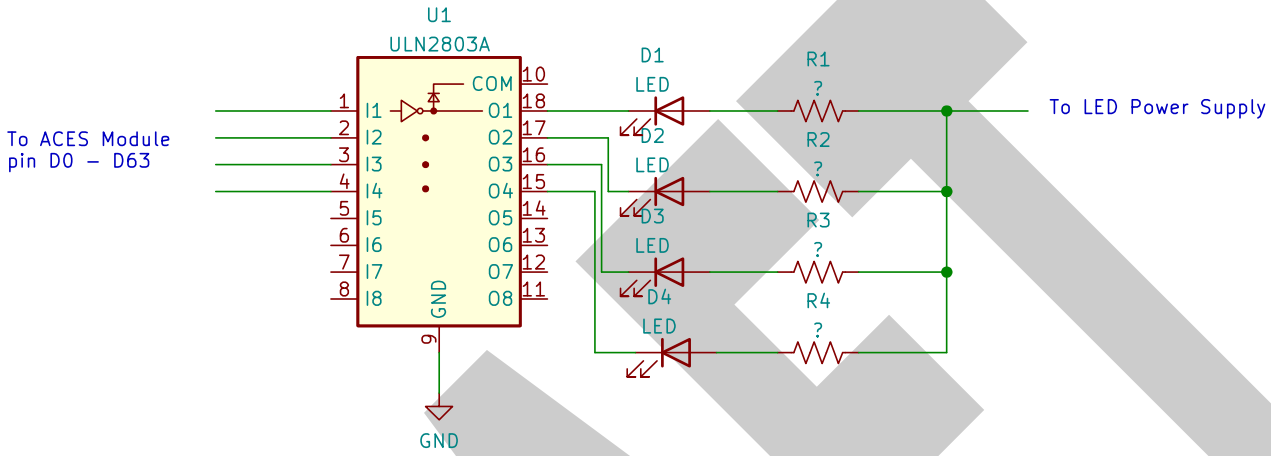
Switches:



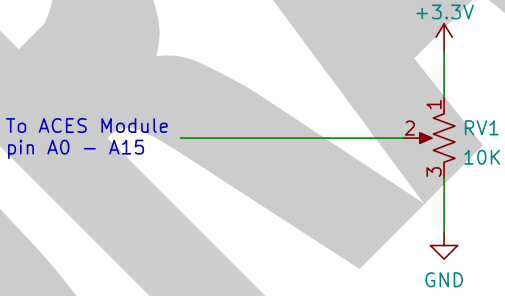
LEDs:



High Current LEDs:



Potentiometers:



Rotary Encoder Switch (quadrature encoder):