The intent of this document is to provide the basic information required to get a sainSmart relay board up and running. The following information applies to the 8 relay model and 16 relay model.

Power Supply

Without a power supply the relay board will not do anything. Here is the power consumed by sainSmart relay boards:

16 relay board 12 Volts DC @ 500 milliamps
8 relay board 12 Volts DC @ 250 milliamps
These values reflect the power a board consumes when all relays are energized.

Note:
500 milliamps = 0.500 amps
250 milliamps = 0.250 amps
Milliamps can be abbreviated as "ma." Therefore 250 milliamps = 250 ma = 0.250 amps.

It is recommended that you do not operate a power supply right up to the rated maximum. Consider the use of a 12 volt DC power a supply that is rated 1.5 - 2 times the current ratings shown.

A wall wort style power supply or other 12 VDC supply with enough current capacity will be fine. If you want to use a transformer, diode bridge & filter cap and build your own power supply, that will work as well.

To connect power to the board look for a blue 2 terminal connector in one corner of the board. There are screws on top of the connector. Turn a screw counter clockwise to expand the hole under the screw. Insert a bare wire into the hole then turn the screw clockwise to secure the wire in the terminal. The negative terminal is on the left marked "GND". The positive terminal is on the right marked "12V".

Note: The screws can come out of the connector. Make sure the screws are threaded into the connector a couple turns.

Tip: If your power supply comes with a connector on the cable, get a mating connector. Attach/solder a positive and negative lead on the new connector. Use the new leads to connect the board's power. This allows you to easily disconnect power from the board. It is good practice to disconnect power from your board while you working on it, connecting/disconnecting wires, mounting the board, etc.

If you look on the row of header pins, there are two pins marked "5V". On the other end of the header there are two pins marked "GND". These pins are a courtesy 5 volt DC supply. You can use this to power other devices. E.g. Raspberry Pi, Arduino, PIC, etc. If you are going to use the 5 VDC supply, be sure to account for this additional load when choosing your power supply.

Input Pins

There is a row of pins on one edge of the board marked "Low-level Input" 1 - 16. These pins trigger the corresponding Relay 1-16. The term "Input" is a bit misleading. We go through how the input pins work.

Figure T1 is a conventional circuit that turns on a lamp. There is a 5 VDC power supply, an On/Off switch and a 5 VDC lamp. Closing the switch completes the circuit. Current flows through the switch, through lamp and returns to the negative terminal. You see the lamp light up.

Figure T2 modifies Figure T1. The switch is on the negative side of the lamp. Closing the switch produces the same results. Current flows through the lamp, through the switch and goes to the negative terminal. You see the lamp light up.

Figure T2 closely represents the sainSmart input. The point where you see "Low-level input" in Figure 2, that is the equivalent point as the "Low-Level input" on your relay board.

Experiment: Power up your board with 12 VDC. Take a wire and make a jumper connection from Input 1 to the GND pin on the header. When you make this connection, you will hear Relay 1 click and see the Relay 1 red LED light up. The jumper wire acts as the switch seen in Figure 2. Alternative: You can connect Input 1 to any negative terminal (or ground point) along the power supply and you will hear Relay 1 click and see the LED light up.

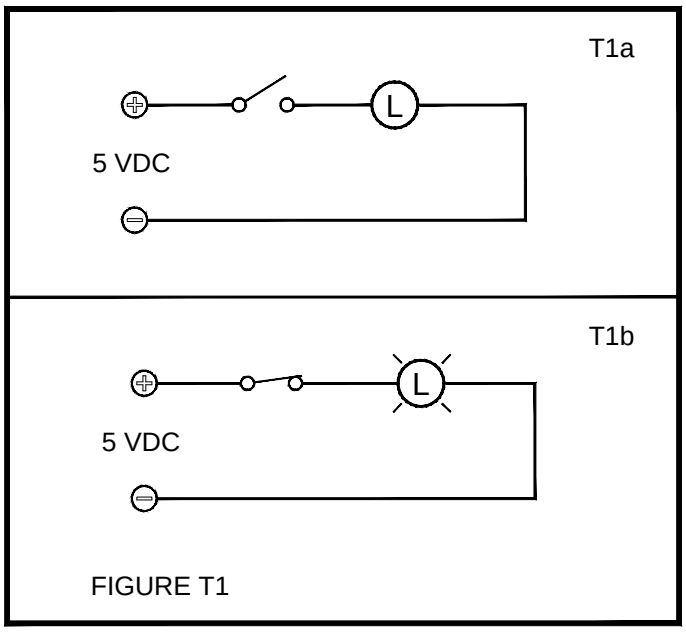

FIGURE T1

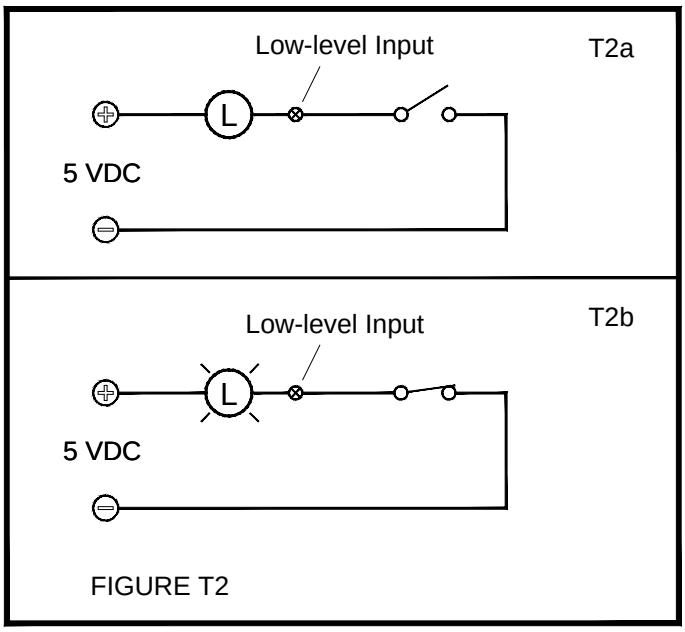

FIGURE T2

It is that simple, switch (short) an input pin to ground and the relay will engage, for as long as the path to ground is maintained.

Notice there is a +5 VDC that powers the LED in Figure 2. Where and how do you connect the 5 VDC on the board? You do not. The board supplies this voltage. This explains how you can trigger a relay with a single wire.

For the balance of this document, we will not show +5 VDC source or the LED. All you need to consider are the input pins.

The signal from the Input Pin to ground is about 5 VDC and is very low current. This allows you to use virtually any type of switch you like. Toggle switch, push button, position switch, motion sensor, etc. Any switch that closes when the desired relay activation happens should work.

One restriction you might encounter is the frequency of On-Off-On-Off relay cycles. About one switch a second and you should be OK. If you are looking to switch more frequently, consider solutions other than an electro-mechanical relays. E.g. Solid state devices.

Figure T3. This is an example triggeering 7 relays. We are using 2 momentary push buttons, 2 toggle switches and 3 controls pins on your favorite controller.

* Press the push button and the associated relay engages. Release the button, the relay disengages.

* Throw the toggle switch to the On position, the associated relay engages. Put the toggle switch in the Off position, the relay disengages.

* Your controller pulls the input pin to ground, the relay engages. Your controller releases the pin from ground, the relay disengages.

What if your control device provides a voltage as trigger? How do you interface an output voltage with a board looking for a switch to ground?

Figure T4. sainSmart suggests using a transistor as a switch to pull the relay board's input pin to ground. You can make a switch with 1 transistor and 2 resistors. The 2N2222a transistor is very common and inexpensive. The resistors can be ¼ watt and also easy to aquire. Build the circuit as shown. Apply a control voltage at the point where the 2.2K and 10K resistors connect and your relay will trigger.

In practice, the value of the resistors is not critical. You can use anything close in value. 1.5K to 3.0K for R1 and 8K to 15K for R2 should work. Same for the transistor. Virtually any NPN transistor should work. If you use different values of resistors or a different transistor, mock up a test circuit and verify the functionality.

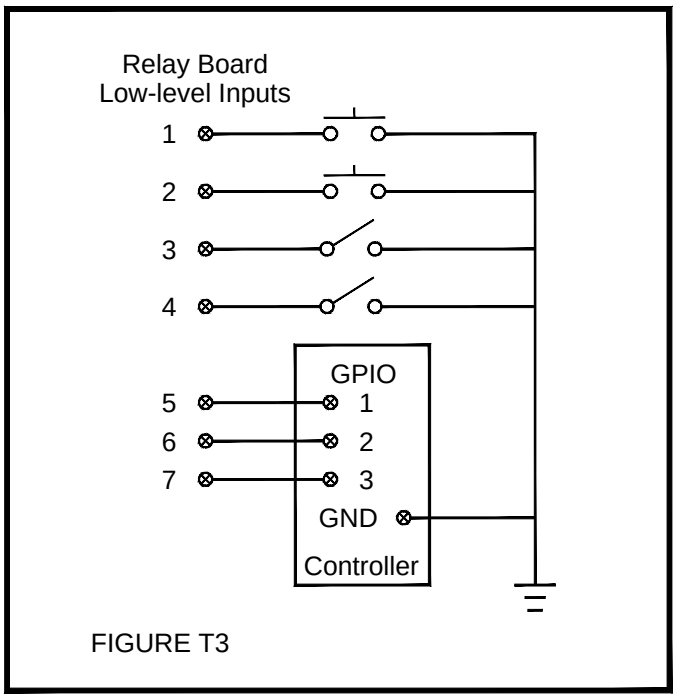

FIGURE T3

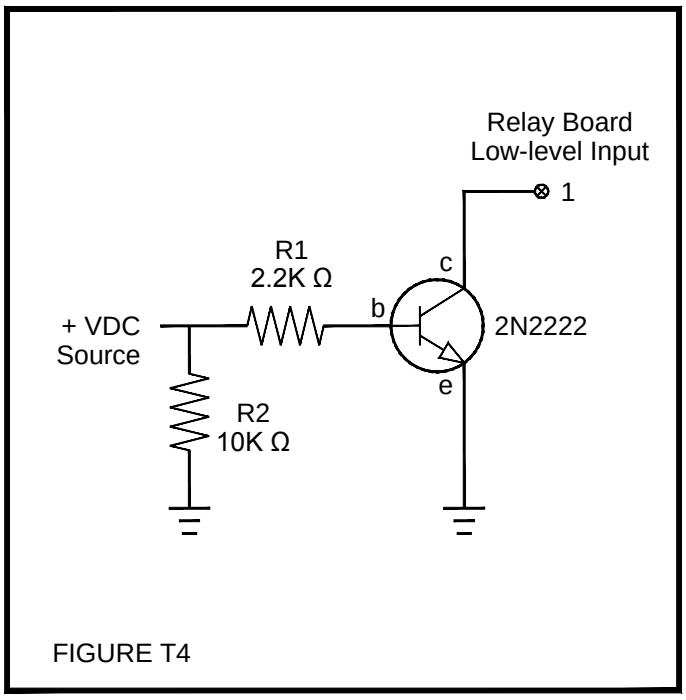

FIGURE T4

Hint: Make sure the ground of your trigger voltage device and the ground of your relay board are connected.

Relay 101

Next we look at what you can do with the relay output section of the sainSmart relay board.

Figure R1a. This figure shows a basic relay. There is a coil, 3 terminals marked Com (Common), NC (Normally Closed) & NO (Normally Open) and a toggle switch.

When a relay has no voltage applied to the coil (i.e. not energized) there is a connection from Com to NC terminal. There is no connection from Com to NO.

Figure 1b. When the toggle switch is closed, a voltage is applied to the relay coil and the coil turns into a magnet. The magnet pulls the NC connector up and makes a connection from Com to NO terminals.

Note: The connection from Com to NC is now an open connection.

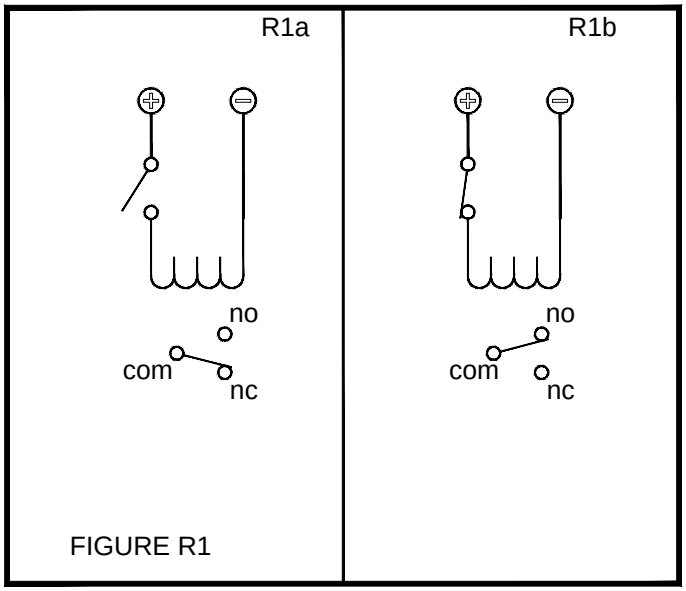

FIGURE R1

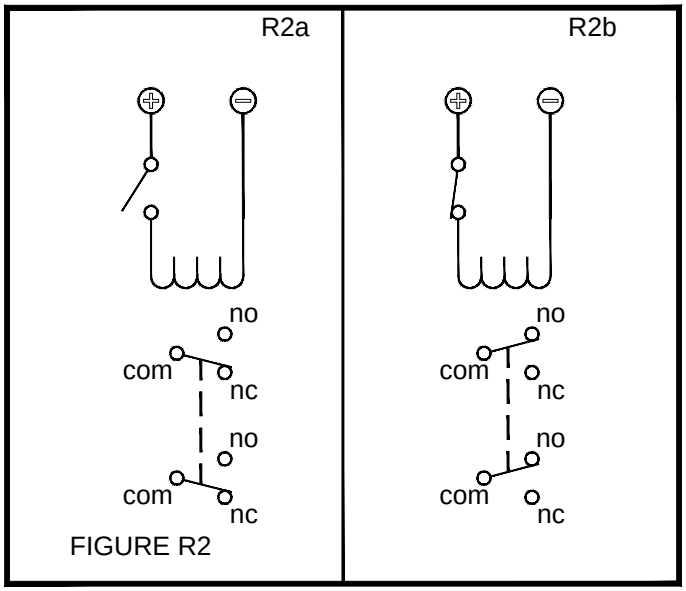

FIGURE R2

Figure R2a. We see 1 relay coil and two sets of Com, NC & NO contacts. The dashed line indicates that the two sets of terminals will switch in unison. This is known as a DPDT (Double Pull, Double Throw) relay. When you energize the coil, both NC contacts get pulled up and each makes a connection between Com & NO. Note: The two sets contacts are isolated from each other. E.g. You can switch 120VAC on contact set #1 and audio level signals on contact set #2.

The relays on the sainSmart relay boards are SPDT configuration, as shown in Figure R1. Ground Input Pin #1 and Relay #1 will go from Figure R1a to Figure R1b. Remove the ground connection from Input #1 and the connection from Com to NC is restored.

There is a bunch of electronic components between the input pin and the relay contacts. You do not need to be distracted by all of that. For the balance of this document we will ignore the relay voltage & relay coils. We will consider only the input pins and the corresponding relay contacts.

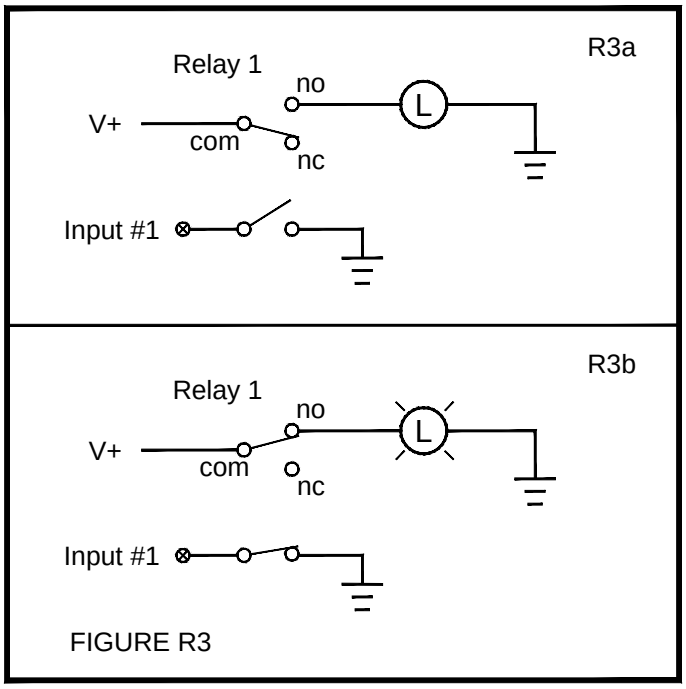

Figure R3: Turn On a device
Ground the input pin
The device goes from Off to On

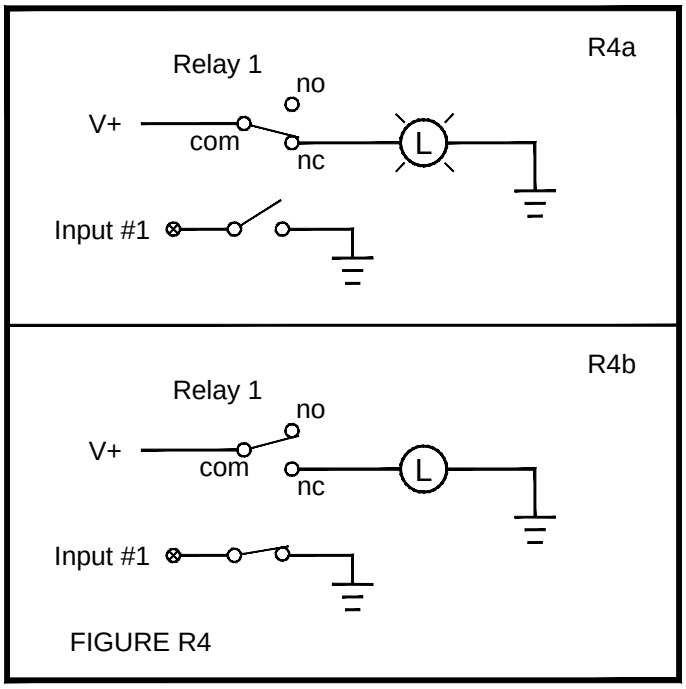

Figure R4: Turn Off a device
Ground the input pin
The device goes from On to Off

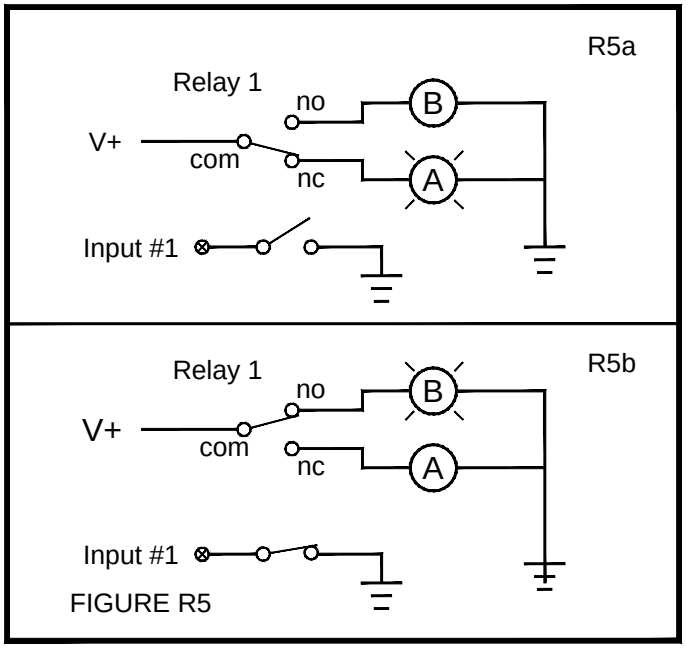

Figure R5: Turn Off Device A & turn On Device B

Device A & B are connected as shown
Ground the input pin
Device A goes goes Off
Device B goes goes On

Note: Device A and Device B must have compatable signal requirements. E.g. Device A cannot have a 5 VDC input and Device B have a 120 VAC input.

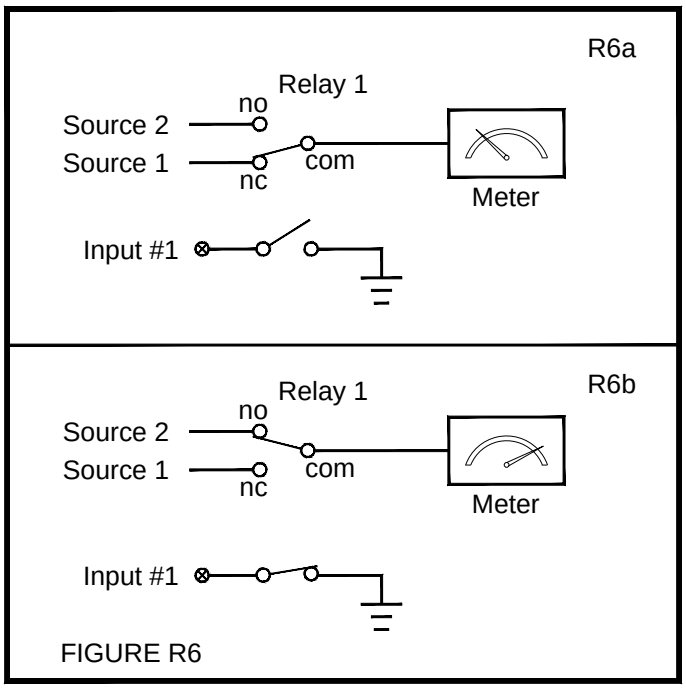

FIGURE R6

Flip the relay contacts as shown in Figure 6.

In this example we send 1 of 2 signals to a common destination.

There is a meter that will measure 1 of 2 sources. Source 1 and Source 2 and the meter are connected as shown.

Ground the input pin, the meter goes from measuring Source 1 to measuring Source 2

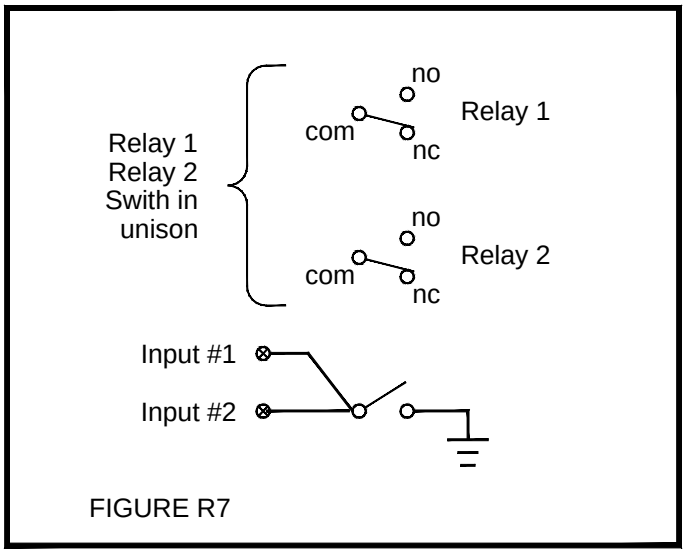

FIGURE R7

Figure 7: DPDT Relays

Some applications require a DPDT relay. Refer to Figure R2 for an example of a DPDT relay.

The sainSmart boards use SPDT relays, you can make a DPDT relay by using 2 two relays.

Ground Input #1 & Input # 2 using the same switch. When the switch closes, Relay 1 & Relay 2 will activate in unison.

Physical connection to the relay outputs terminals is the same type of screw terminals used for the power supply.

Each relay has three screw terminals. The center of the three terminals is the Com relay contact. The terminal on the right is the NC relay contact. The terminal on the left is the NO relay contact. It is suggested that you take a couple minutes, grab a meter and verify that you understand how these terminals and relay contacts are configured.

Appendix A: Input Pins

The information provided in the section regarding the input pins stands. This appendix is for those who are looking for more information regarding the input pins.

The input pins on the sainSMART relay board are part of a device called an opto isolator. Opto isolators are the little square ICs closest to the input pins.

Grounding an input terminal causes an Light Emitting Diode" (AKA LED) that is inside the opto isolator to light up. The light from the LED turns on the base of photo transistor, which in turn, energizes the relay coil.

In the application of the sainSmart relay board, it is useful to understand the advantages of opto isolators.

#1: Isolation
a) The "connection" from the LED to the rest of the circuitry in the sainSMART board is literally a beam of light. This gives you a high level of electrical isolation between the control device and the relay board. You will encounter fewer problems that can come with longer distances between the control device and the relay board.

#2: Low trigger current.
a) The signal out of the input pin is about 5 VDC and very low current.
b) Wire gauge (as in small, skinny, thin wires) becomes less of a problem You can use smaller wires than would required if you were to switch a relay coil directly.
c) Distance is less of a factor. You can go further with a given wire gauge.

Note: The 16 relay board was tested using a 2.0K ohm resister from input pin to ground and the relay triggered. 2.0K ohms represents a considerable length of copper wire. It is fair to say, in most practical applications, distance and wire gauge is not likely to be a limitation in realizing your design. Note: Always test, experiment and verify before you finalize your design.

Appendix B: Interfacing with other devices.

How do I interface my Arduino, Raspberry Pi, PIC, BCS 460, Acme XYZ, etc to this relay board?

This document does not provide support for other devices. What the sainSmart relay board wants to see an "open collector" or a method to "pull to ground" the board's input pins. This is common among control devices and solid state logic schemes. With this information it should be easy to interface a sainSmart relay board with virtually any control device available.

Appendix C: Example Deployment

Figure A3 is an example deployment of the sainSmart relay board.

The board is powered by a 12 VDC power supply. Note the same power supply is used to power the relay board and various devices controlled by the board. Remember: Ensure your power supply can handle load.

* The controller gets power from the courtesy +5 VDC off the relay board.
* Relay #1 turns a motor on and off.
* Relay #2 & #3 reverses the polarity of the motor. This reversal is accomplished by a single switch.
* Relay #4 turns on a solenoid with a push button switch.
* Relay #5 turns on a 5 VDC lamp, using the board's +5 VDC courtesy power supply.
* Relay #6 will start/stop a pump as determined by the controller.
* Relay #7 opens a valve and closes another valve as determind by the controller.
* Relay #8 turns on actuator. The trigger is a voltage source and uses a transistor to switch Input Pin #8 to ground.

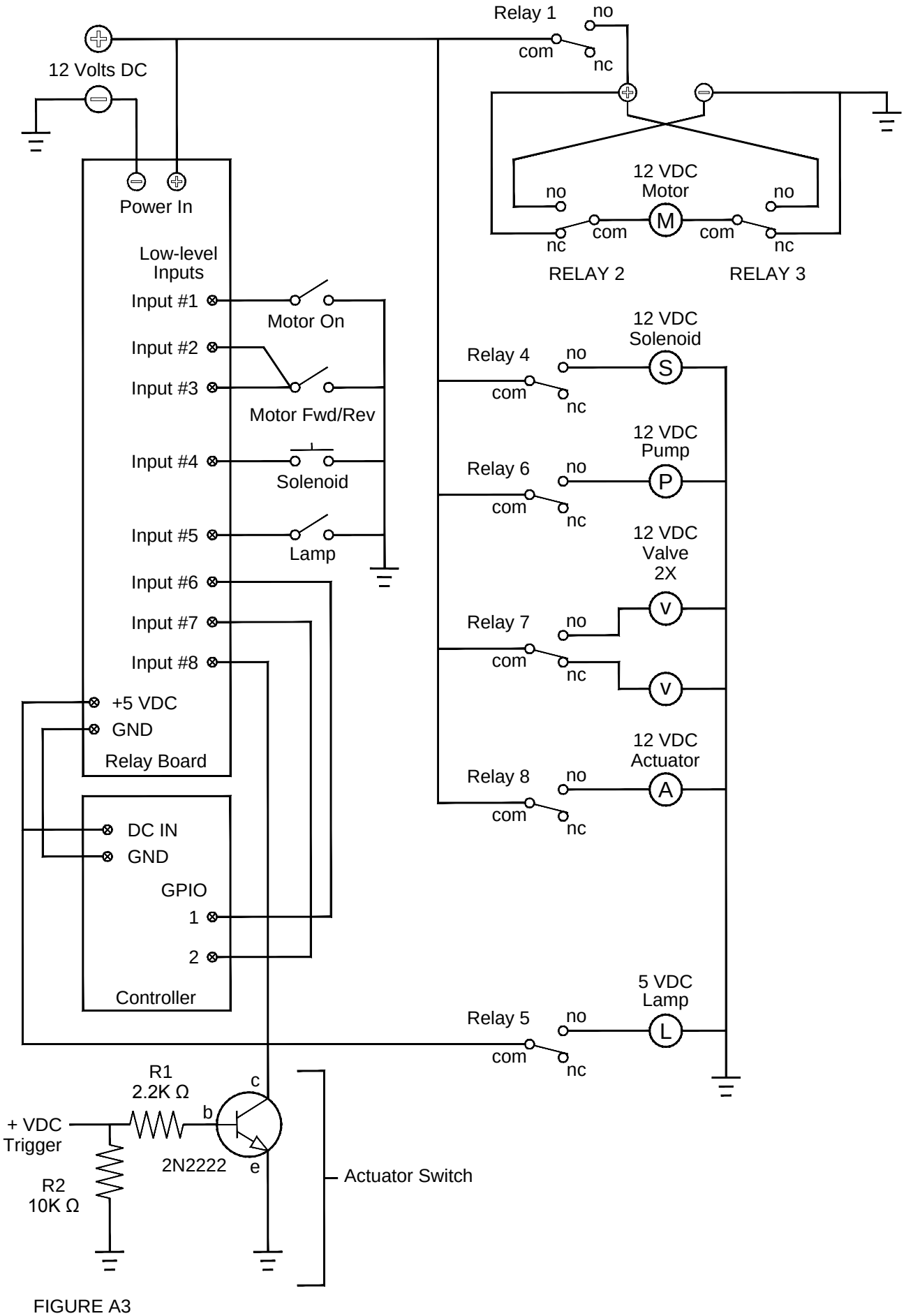
12 Volts DC
Power In
Low-level Inputs
Input #1
Input #2
Input #3
Input #4
Input #5
Input #6
Input #7
Input #8
Motor On
Motor Fwd/Rev
Solenoid
Lamp
+5 VDC
GND
Relay Board
DC IN
GND
GPIO
1
2
Controller
Relay 1
no
com
nc
12 VDC Motor
M
RELAY 2
RELAY 3
Relay 4
12 VDC Solenoid
S
Relay 6
12 VDC Pump
P
Relay 7
12 VDC Valve 2X
V
Relay 8
12 VDC Actuator
A
Relay 5
5 VDC Lamp
L
R1 2.2K Ω
+ VDC Trigger
R2 10K Ω
2N2222
b
c
e
Actuator Switch

FIGURE A3