OPP Populate Gen2 Boards
Assembly Document

(Project: Populate Gen2 Boards)

Project # : Not applicable
P/N: Not applicable
Rev 0.06

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DATE			

Revision History

Version	Primary Author(s)	Description of Version	Date Completed
0.01	Hugh Spahr	Initial version	03/08/16
0.02	Hugh Spahr	Fixed solenoid board pinout	03/29/16
0.03	Hugh Spahr	Added surface mount incandescent info, new version of interface board	04/22/16
0.04	Hugh Spahr	Added more info on through hole incandescent boards. Fixed pictures overwriting text in PDF version.	06/07/16
0.05	Hugh Spahr	Added wiring diagrams at end of document.	06/13/16
0.06	Hugh Spahr	Added sections for modifying the PSoC 4200 processor board. Added pictures for connecting multiple boards together. Added instructions for programming cards.	06/19/16

Table of Contents

1 Purpose

The OPP Populate Gen2 Boards provides a description of how to populate Gen2 boards, and how to connect them to the PSoC 4200 microprocessor board. The populate document includes the following wing boards:

- Gen2 Solenoid Driver Wing (Product ID 1013)
- Gen2 Incandescent Wing (Product ID 1014 and1017) (Future)
- Gen2 Input/Neo Wing for support of Neopixels (Product ID 1015) (Future)
- Gen2 Interface Wing (Product ID 1016)

2 Product Overview

Populate Gen2 Boards contains the assembly instructions for OPP boards. This document describes the assembling the wing cards, and connecting them to the microprocessor board.

3 Applicable Documents

None

4 Terms, Definitions & Acronyms

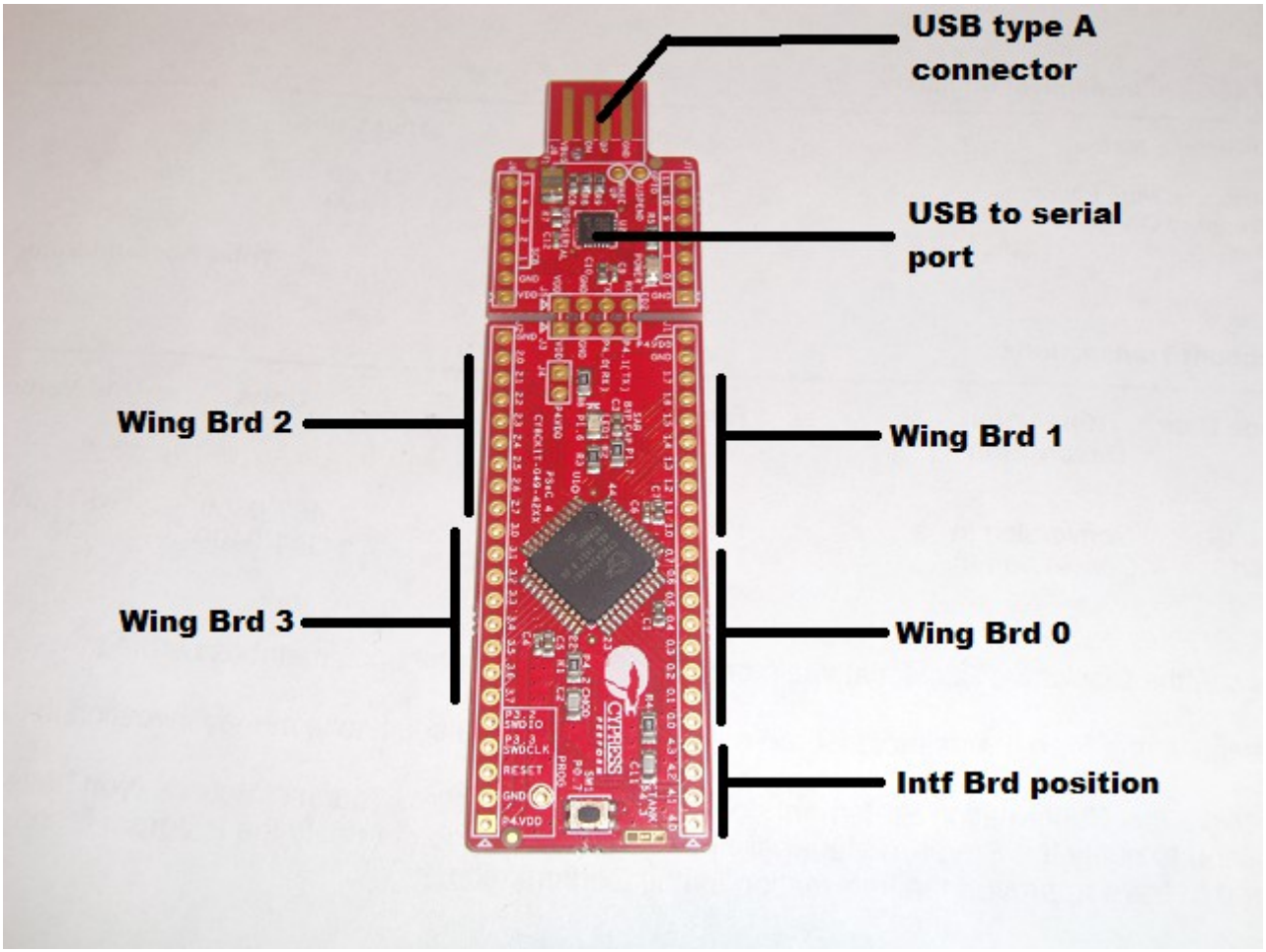
OPP Open Pinball Project

5 Assembly Overview

An OPP assembly contains a PSoC 4200 microprocessor board and up to four wing cards. Each wing board. This document will describe how to assemble the wing cards and then solder the wing cards to the processor board.

6 Board Assembly Pictures

6.1 Microprocessor Board

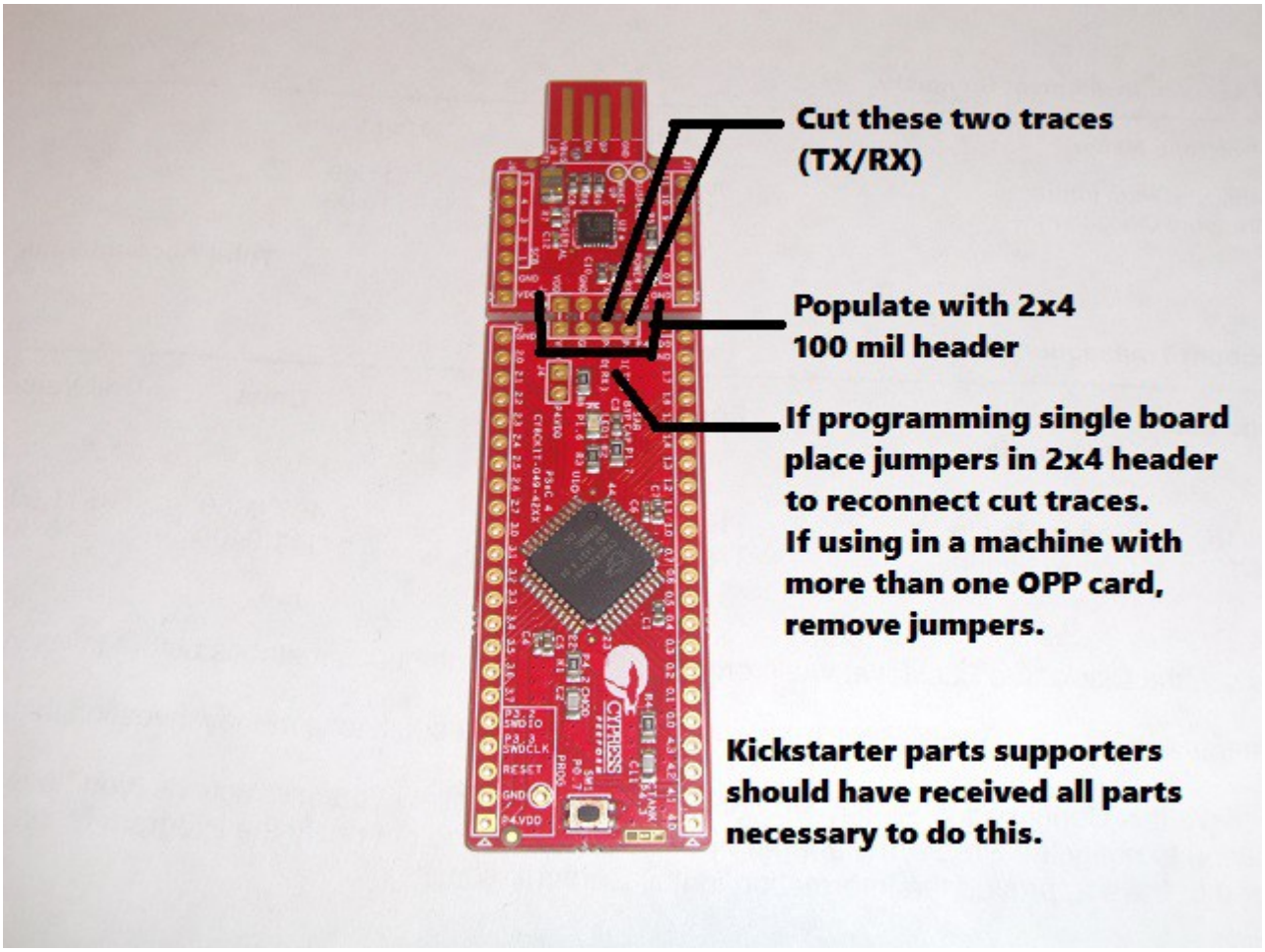


6.1.1 Microprocessor Board Modifications

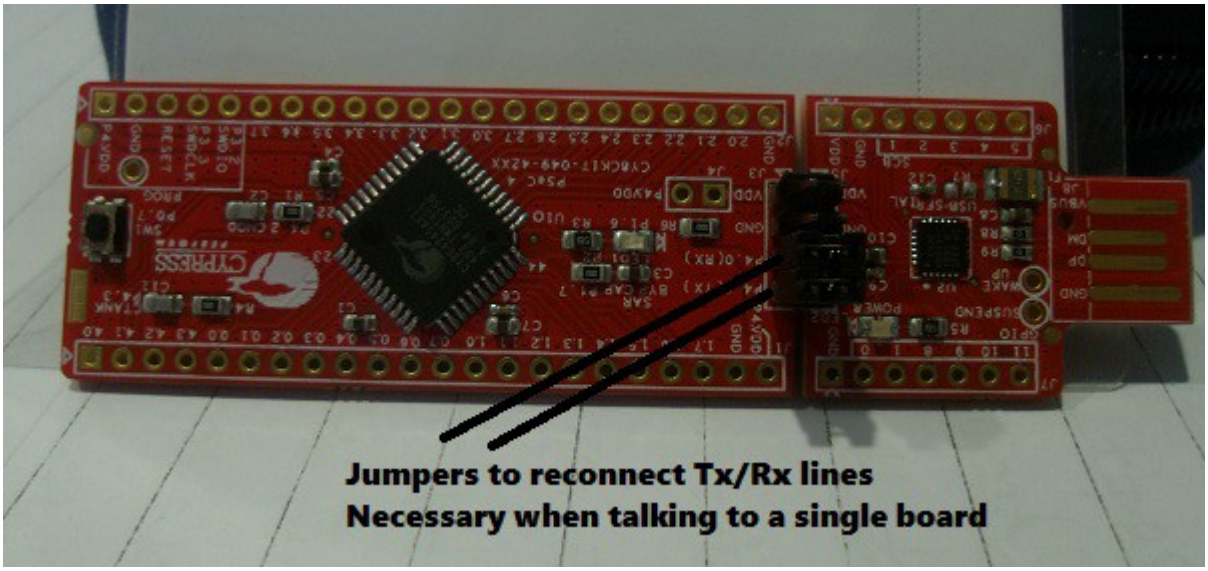
To make things easier, the processor board should be modified slightly. This will allow the boards to be easily switched between single processor mode, and running multiple cards in a pinball machine.

On the PSoC 4200 board, with the USB to serial section of the board on the top, cut the the right two traces (tx and rx). The traces are on the top side of the board. I always use a continuity meter to make sure the traces are cut because they can't be reached after soldering on the connector. Solder a 2x4 100 mil header between the USB-serial section and microprocessor section. When I want to program an individual card, put two jumpers to reconnect the traces that have been severed. When running in the machine with multiple cards, you pull off the jumpers because otherwise the USB-serial port would be driving Rx, and the other board in the chain would be driving Rx and it wouldn't work.

6.1.2 Microprocessor Board Before Modifications



6.1.3 Microprocessor Board After Modifications



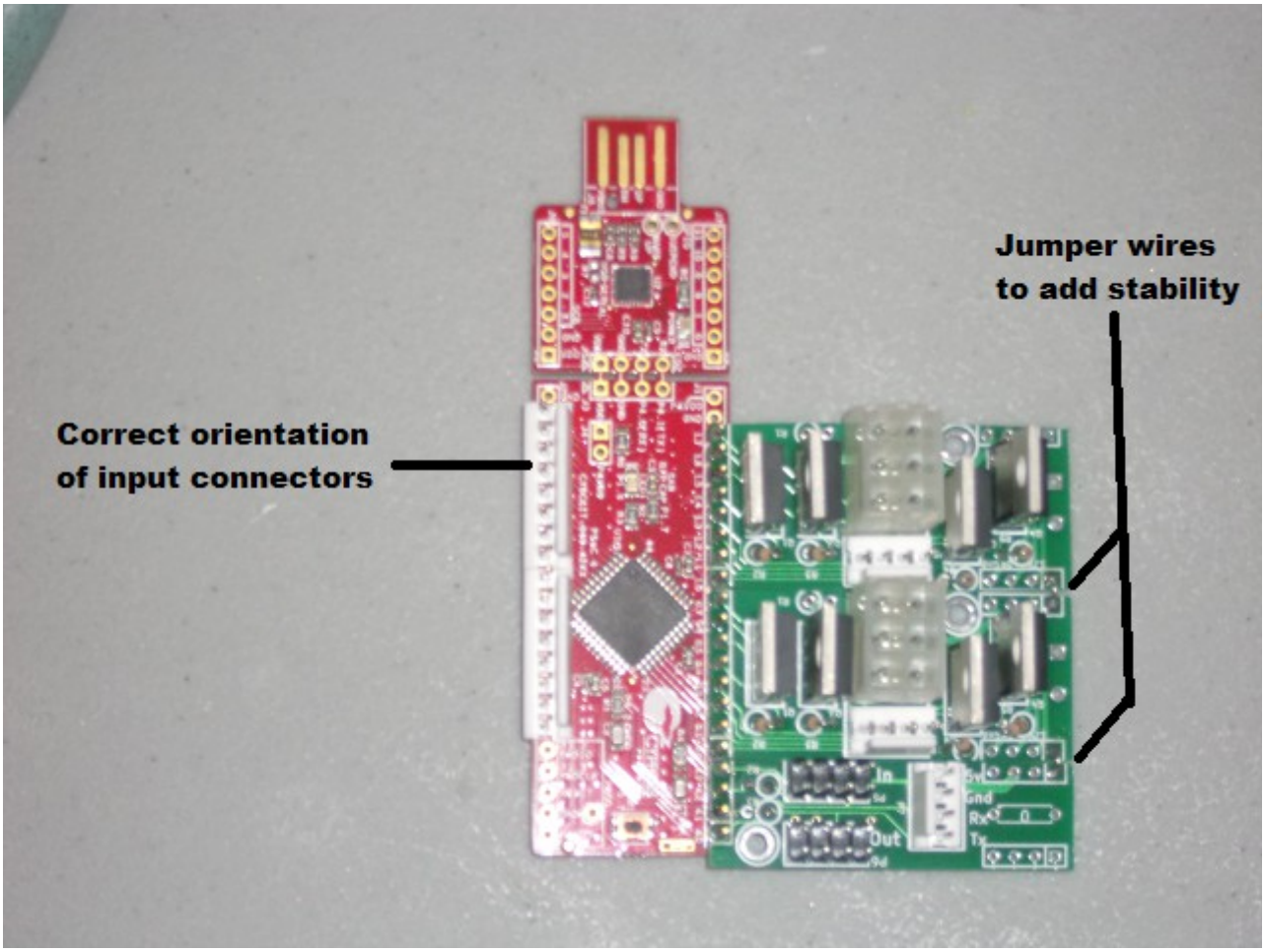
6.1.4 Linux Installation

When using the PSoC 4200 with Linux the USB is incorrectly identified as using the cytherm driver. To get it to work properly, you must blacklist the cytherm driver.

1. add "blacklist cytherm" to /etc/modprobe.d/blacklist.conf
2. run depmod -e or restart

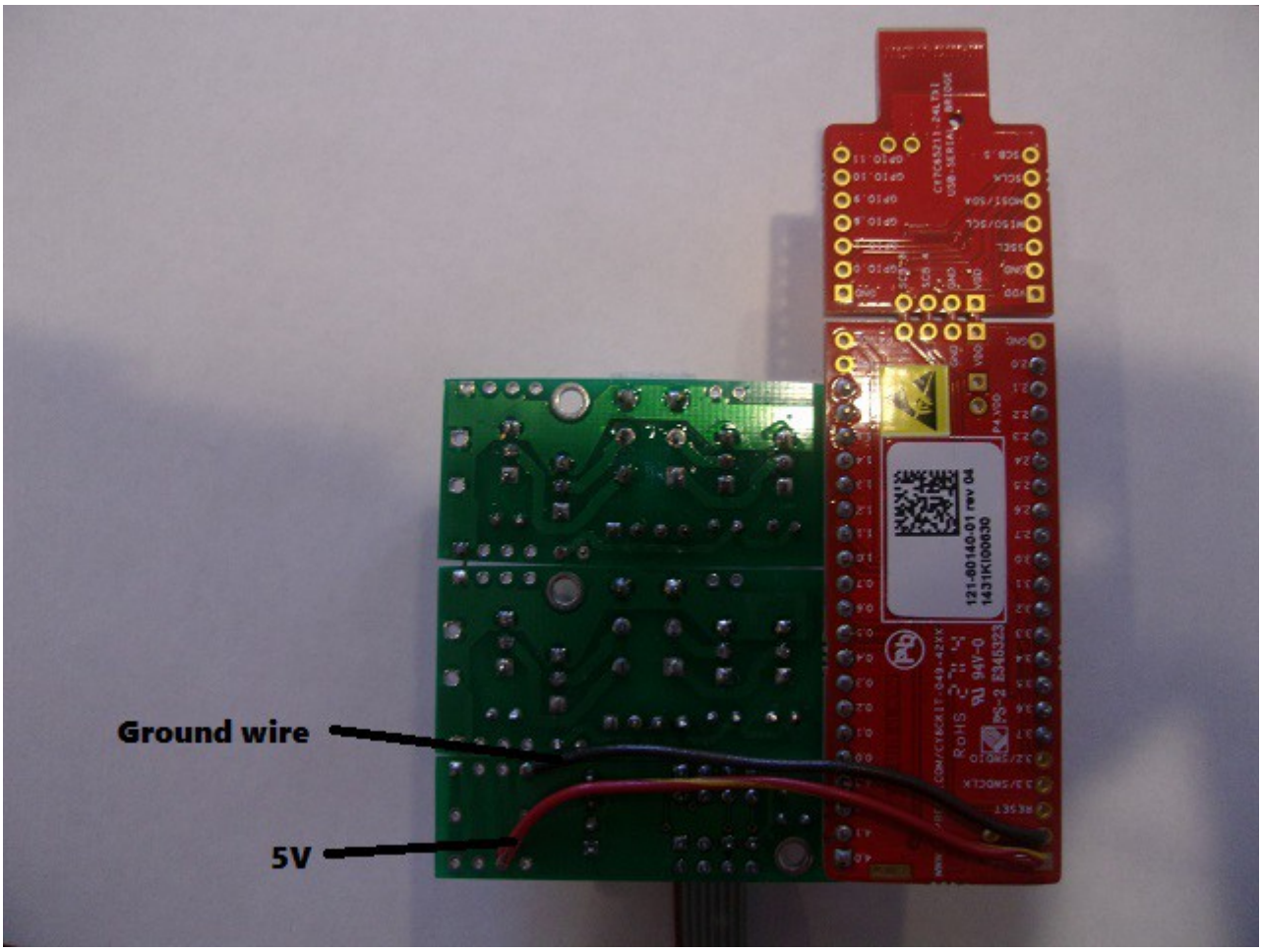
After that use /dev/ttyACM0 as the serial port. (Try higher numbers if that is not working).

6.2 Assembled Example



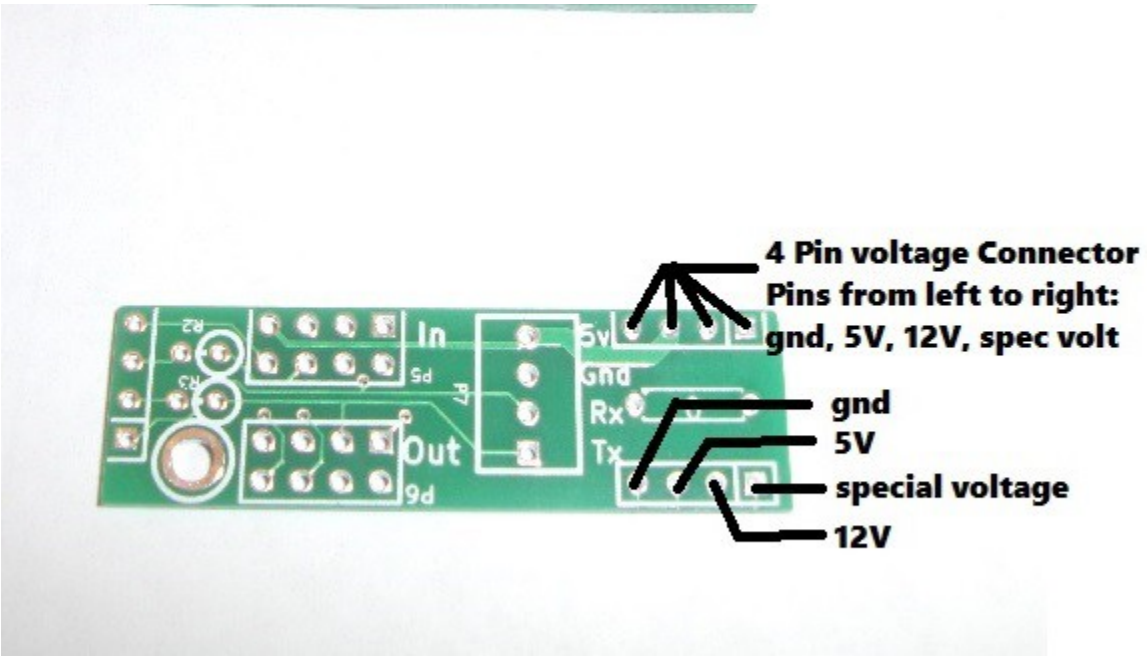
Note: The input connectors are always oriented so the plastic friction lock is closest to the microprocessor (the large square chip on the red PSoC 4200 development board).

6.3 Getting Voltage from Intf Card to Processor



Voltage is distributed using the ribbon cables between cards. This only brings the voltage to the interface card. That voltage must then be wired to the processor board itself. This picture illustrates the wires needed to be 5V and ground to the processor card.

6.4 Four Pin Voltage Connectors

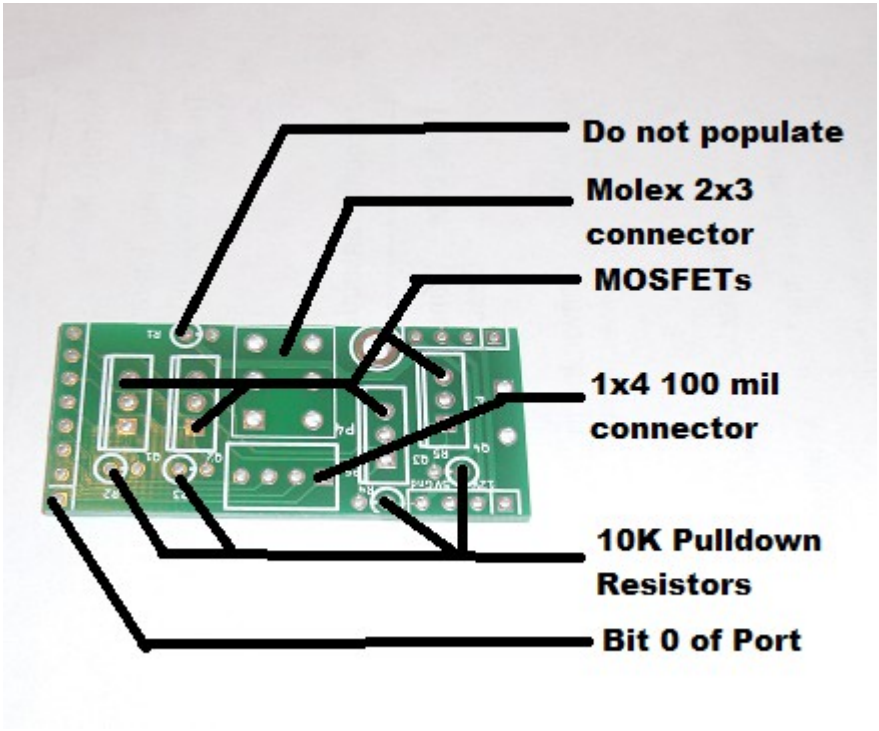


Each wing board has two 4 pin voltage connectors. These provide supplemental voltages to the wing cards including ground, 5V, 12V, and a special voltage. The 4 pin voltage connectors are placed so that jumper wires can easily be added between wing cards which provides voltages, and mechanical stability. The special voltage is used for different purposes depending on the type of card. In most cases it is connected to the high current ground (solenoid and low side switched incandescent boards). In a high side switched incandescent board, it is attached to the bulb voltage. Note: Attaching the bulb voltage to ground will short the power supply and cause issues.

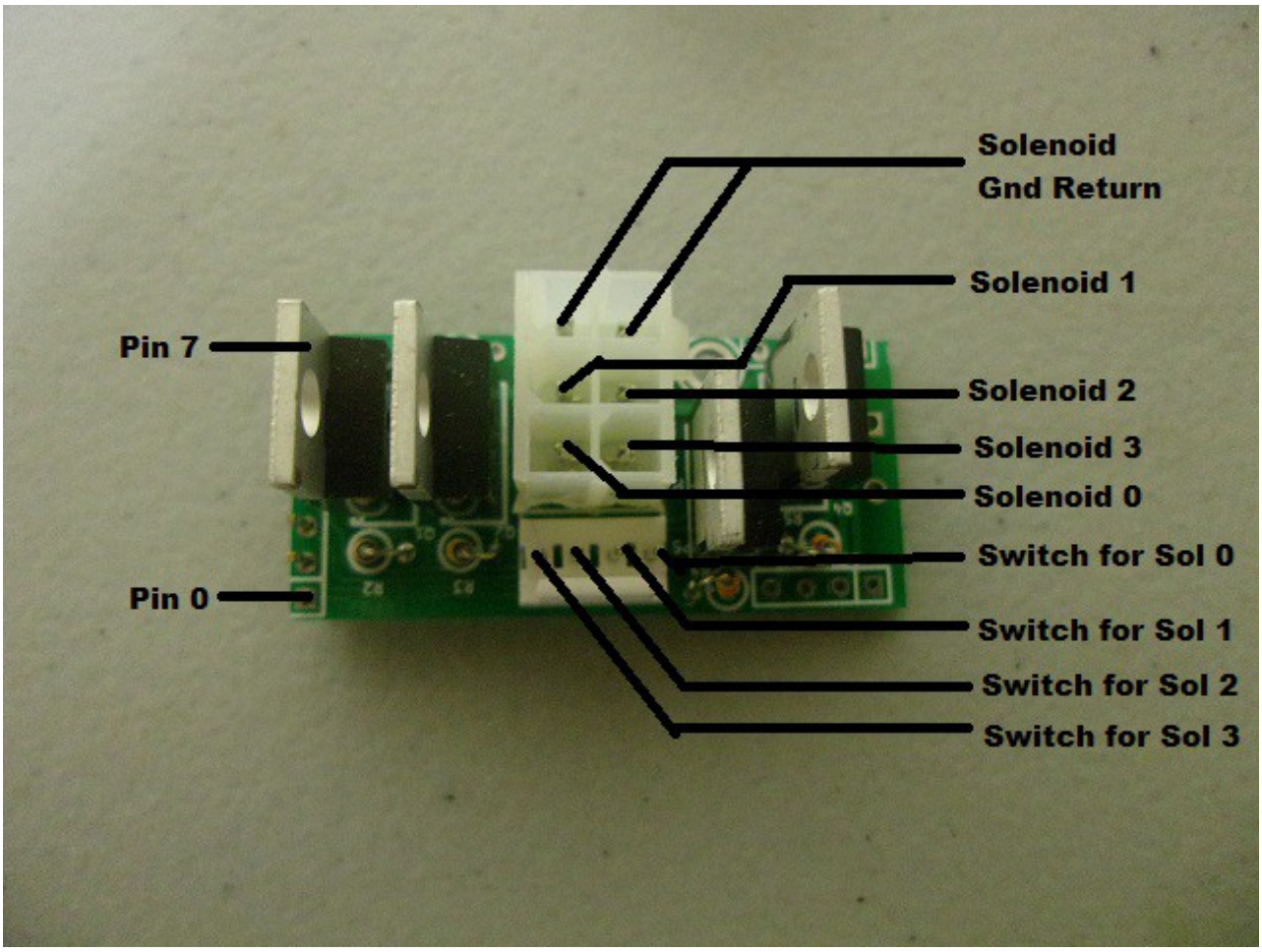
6.5 Solenoid Wing

The solenoid wing board supports 4 solenoids. The card acts as a low side switch, so each solenoid can be powered with a different voltage.

6.5.1 Unpopulated Solenoid Board



6.5.2 Populated Solenoid Board



Note 1: Molex connectors have rectangular holes, and holes with the top corners of the rectangles filled in to insure connectors aren't plugged in incorrectly. The picture above shows the molex connector with the flat part (or bottom) of the connector to the right. (An example of a rectangle with the top corners can be seen on the bottom right pin.) Make sure the orientation is correct for the connector.

Note 2: The four pin connector, should be oriented with the friction lock towards the bottom of the card.

6.5.3 Used 4 pin voltage connector pins

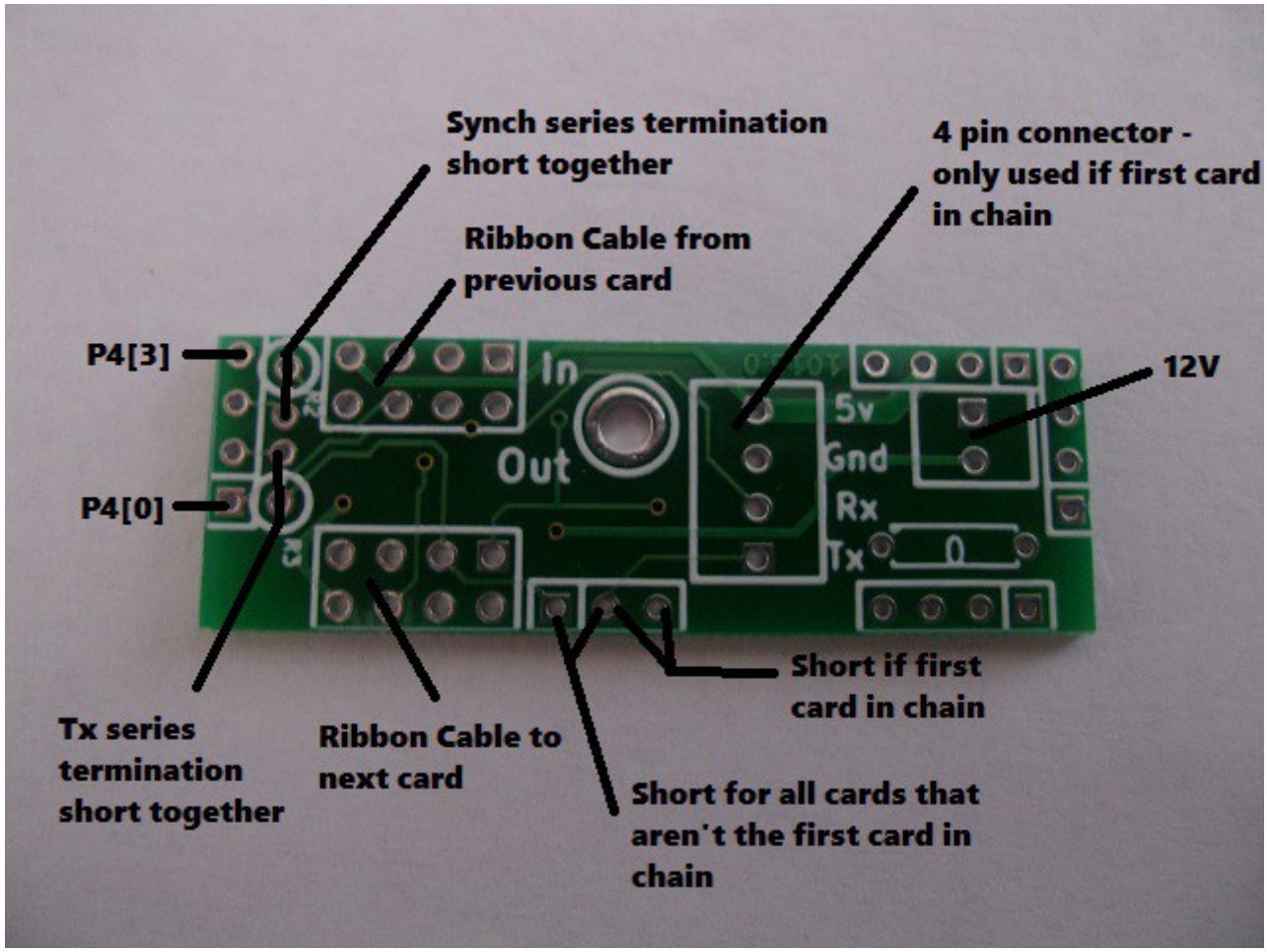
The ground on the 4 pin voltage connector is used to provide a weak pull down resistor so solenoids don't fire when the is not booted. The special voltage on the 4 pin voltage connector is connected to the solenoid high current ground.

6.5.4 Order to populate components

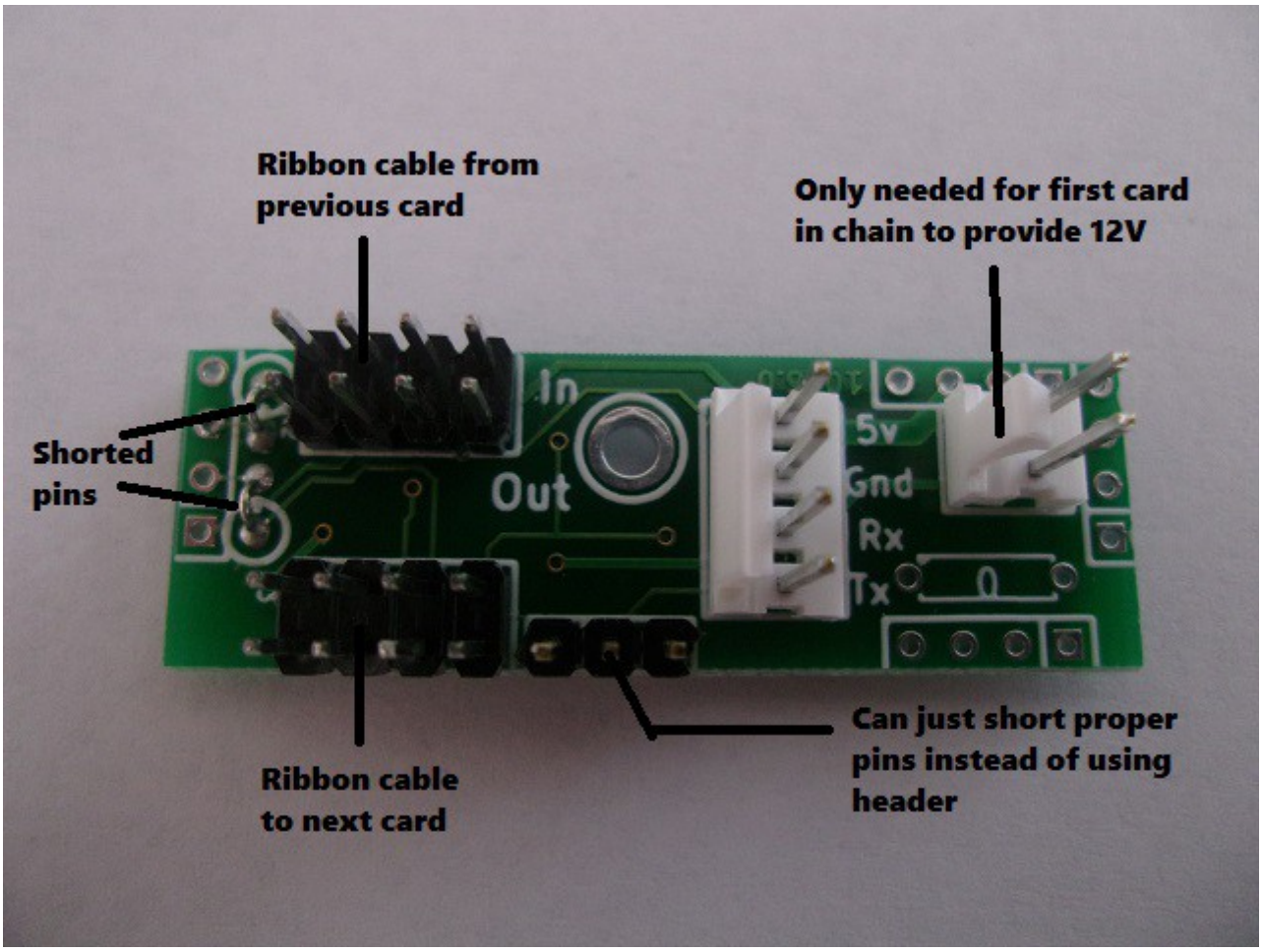
When populating this board, it is easiest to first populate shortest components, and then move onto taller components. First populate the pull down resistors. Next populate the 4 pin 100 mil spaced connector. Next populate the 2x3 pin Molex connector. Finally populate the MOSFETs.

6.6 Interface Board (New version)

6.6.1 Unpopulated board



6.6.2 Populated board



Note: The four pin connector, should be oriented with the friction lock towards the left side (processor side) of the card.

6.6.3 Used 4 pin voltage connector pins

Ground and 5V are usually provided by the ribbon cable, or the 1x4 pin 100 mil header if this is the first card in the chain. 12V is only needed if using incandescent boards configured as high side switches. 12V is either provided by the ribbon cable, or should be provided by adding a locking header to the first card in the chain. The special voltage on the 4 pin voltage connector is connected is not used on this card.

6.6.4 Order to populate components

When populating this board, it is easiest to first populate shortest components, and then move onto taller components. First populate the shorted pins. The rest of the components can then easily be populated all at once. (Place components in board, then, using a piece of card board, flip the board upside down, and solder all the through hole pins).

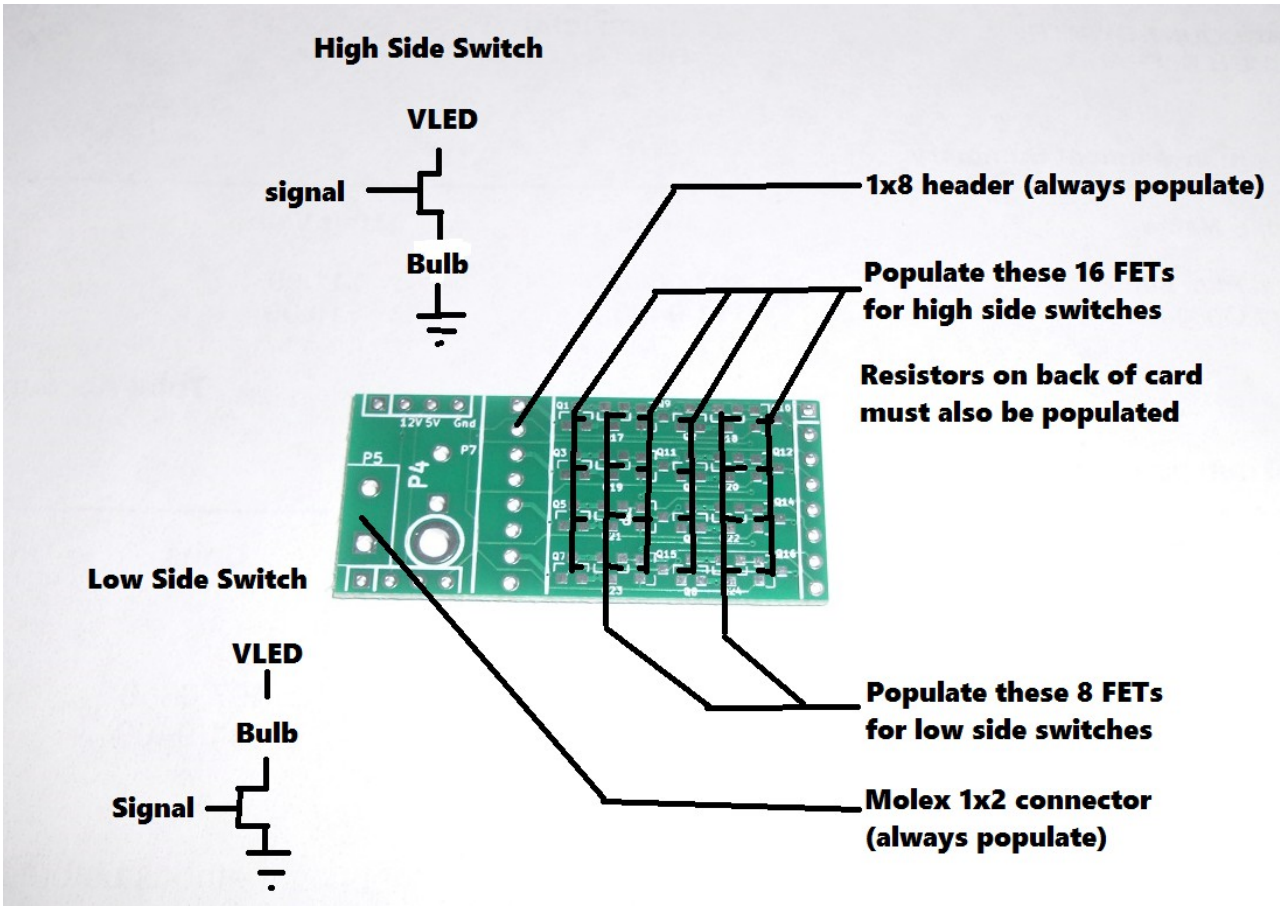
6.7 Surface Mount Incandescent Board

The surface mount incandescent board can be populated in two different ways: as a high side switch, or a low side switch.

When populated as a high side switch, the card connects or disconnects the bulb voltage (up to 9V) from the bulb. The other lead from the bulb is always connected to ground to complete the circuit. To wire a bulb in the high side configuration, the bulb voltage is connected to the 2 pin Molex connector on the incandescent card. Each of the 8 pin 100 mil connections are attached to one connection of the bulb, and the second connection of the bulb is attached to the bulb ground. When populated as a high side switch 16 MOSFETs must be populated, and the 8 resistors on the back must be populated. Note: pinball machines that use a common ground braid for the bulbs must use this configuration of the card.

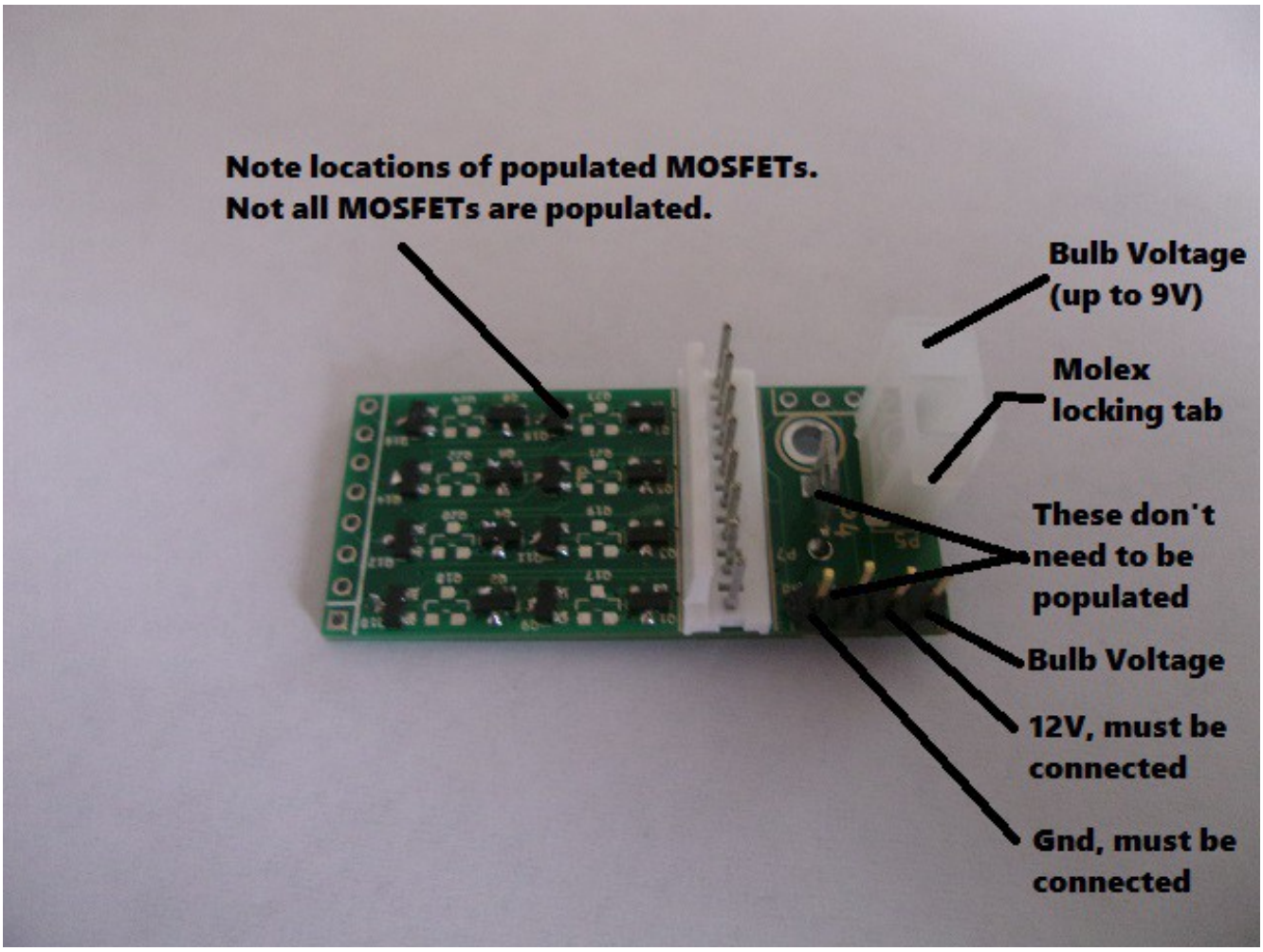
When populated as a low side switch, the card connects or disconnects the ground from the bulb. The other lead from the bulb is always connected to the bulb voltage (up to 12V). To wire a bulb in the low side configuration, the bulb voltage is connected to one side of each of the bulbs. The other side of the bulb is connected to the 8 pin 100 mil connection. In this configuration, the 2 pin Molex connector becomes the bulb ground. When populated as a low side switch, only 8 MOSFETS are populated. Note: most white woods would use this configuration of the card.

6.7.1 Unpopulated board

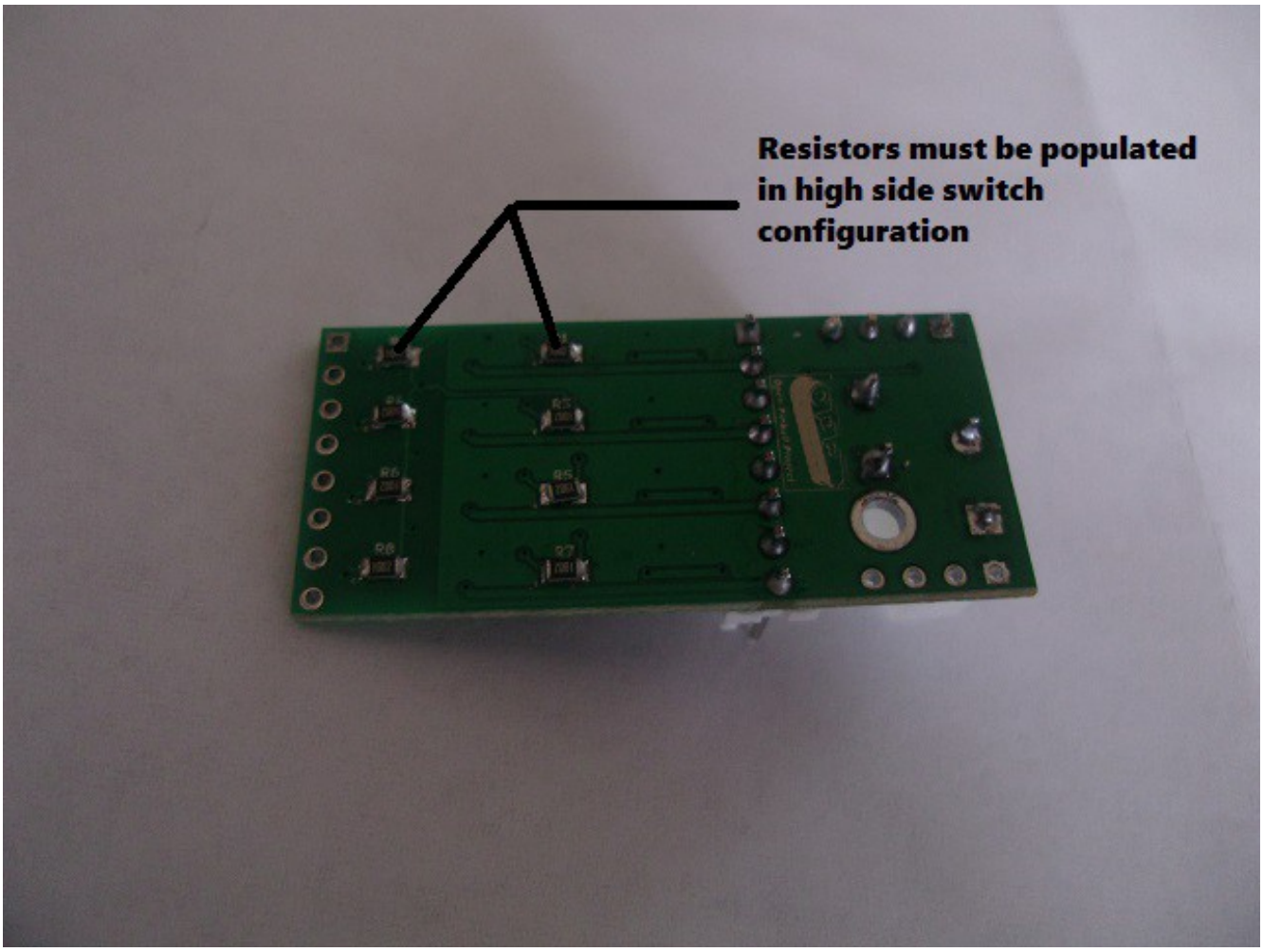


6.7.2 Populated High Side board

6.7.2.1 Front



6.7.2.2 Back



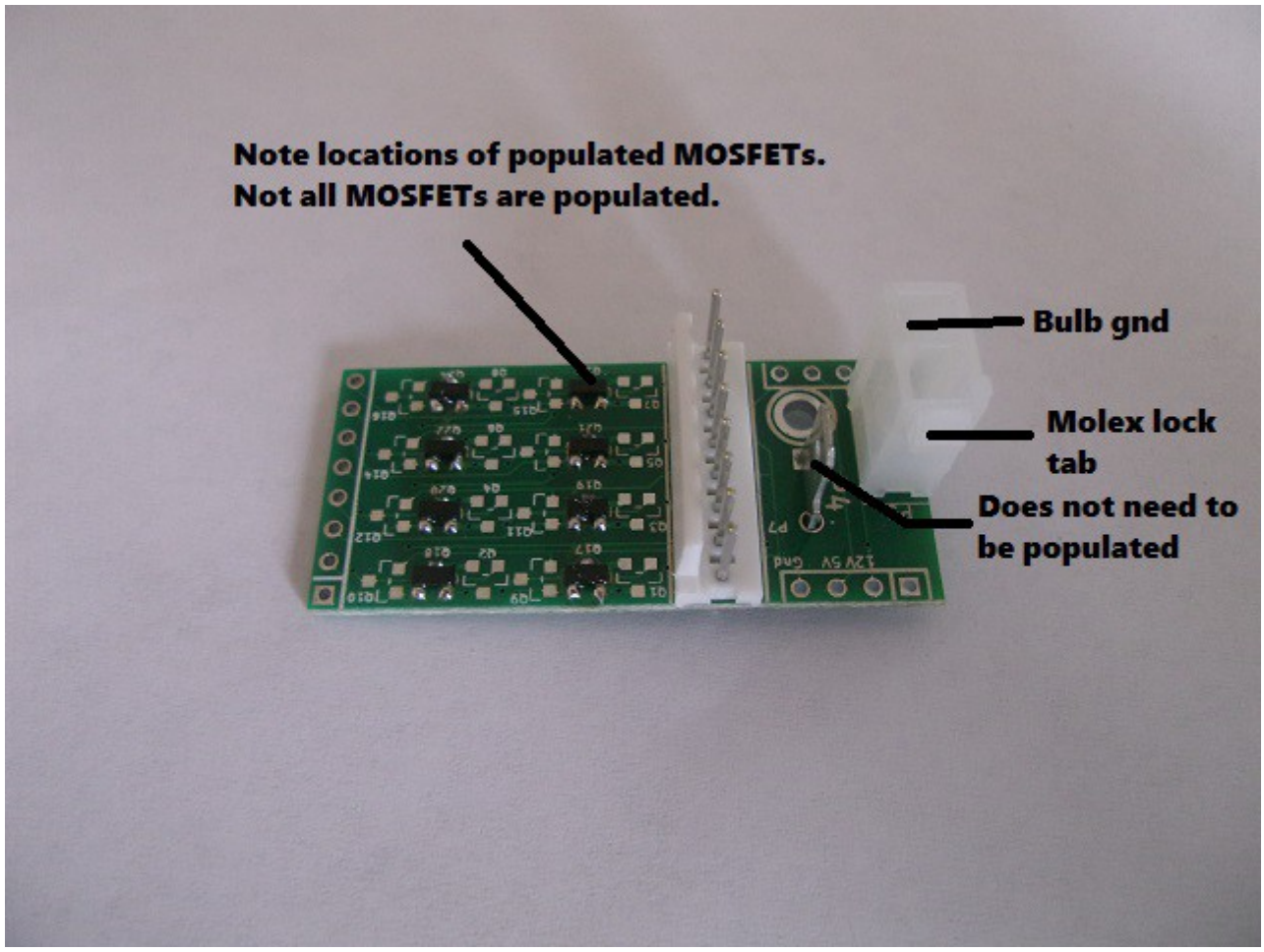
6.7.2.3 Used 4 pin voltage connector pins

The ground and 12V on the 4 pin voltage connector are used to control the MOSFETs. The special voltage on the 4 pin voltage connector is connected to the bulb voltage.

6.7.2.4 Order to populate components

When populating this board, it is easiest to first populate shortest components, and then move onto taller components. First populate the surface mount components. Next populate the 1x8 pin 100 mil connector. Finally populate the 1x2 pin Molex connector.

6.7.3 Populated Low Side board



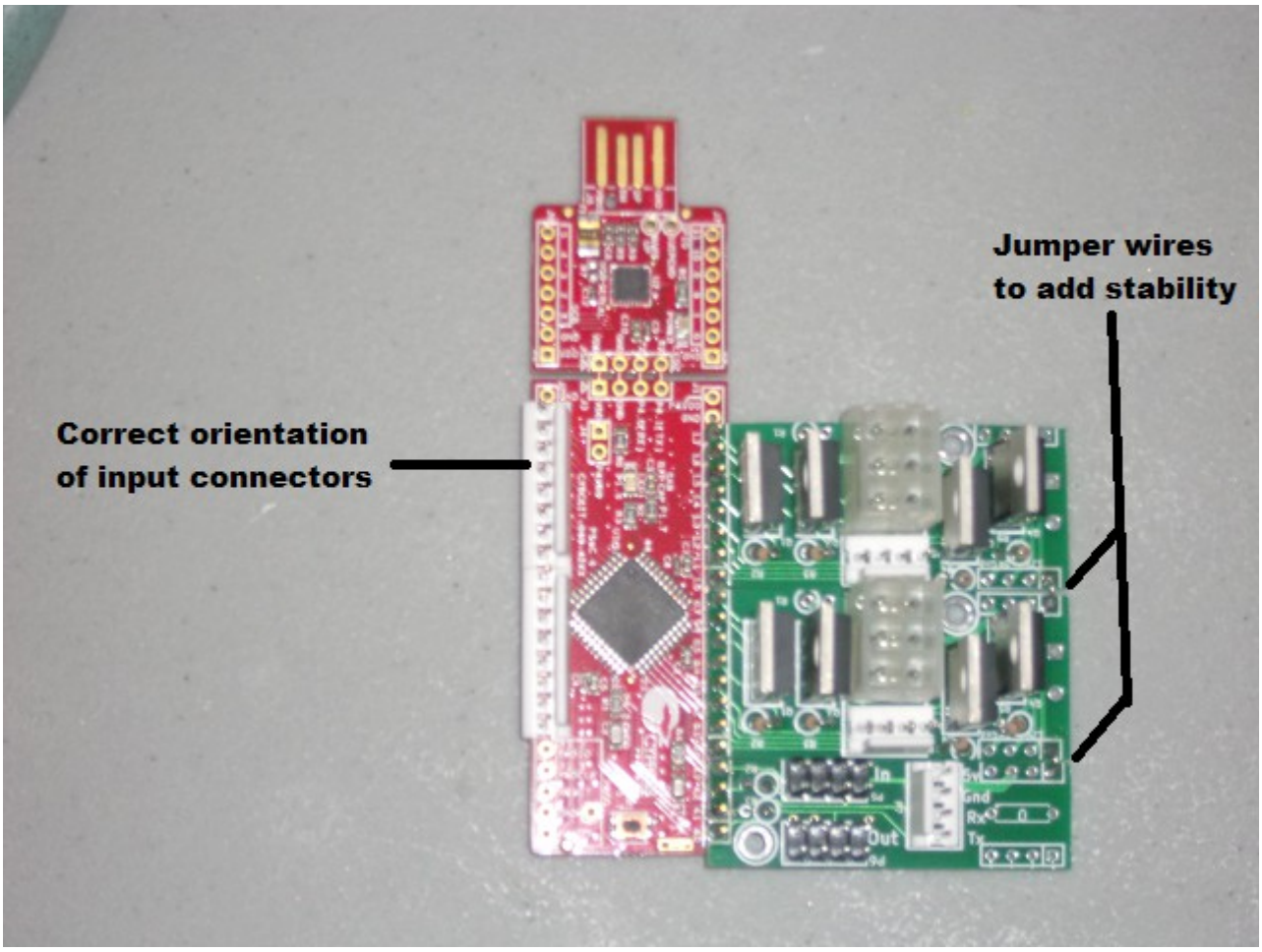
6.7.3.1 Used 4 pin voltage connector pins

The special voltage on the 4 pin voltage connector is connected to the bulb ground. No other pins are used.

6.7.3.2 Order to populate components

When populating this board, it is easiest to first populate shortest components, and then move onto taller components. First populate the surface mount components. Next populate the 1x8 pin 100 mil connector. Finally populate the 1x2 pin Molex connector.

6.8 Input connectors

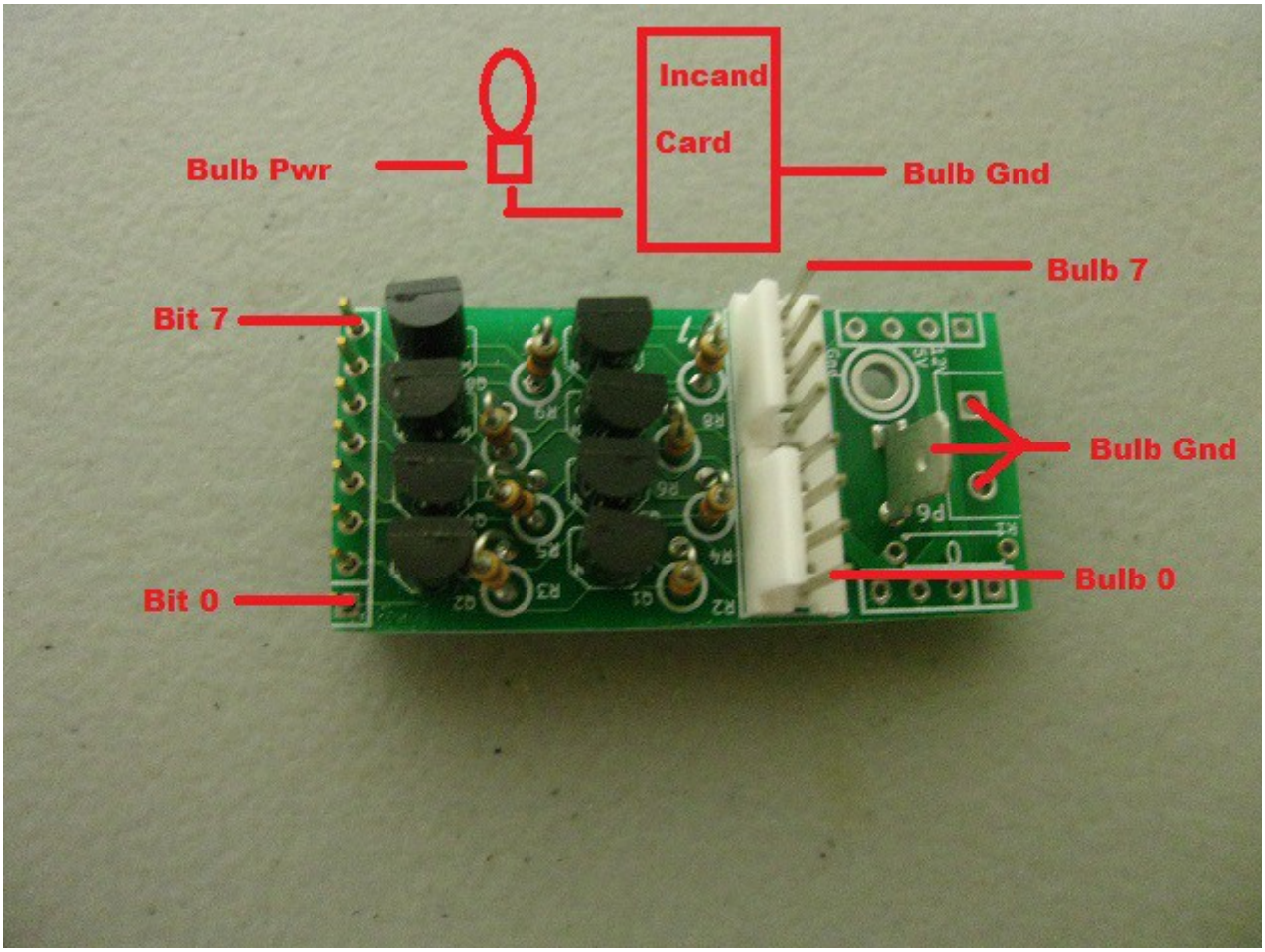


Note: The input connectors are always oriented so the plastic friction lock is closest to the microprocessor (the large square chip on the red PSoC 4200 development board).

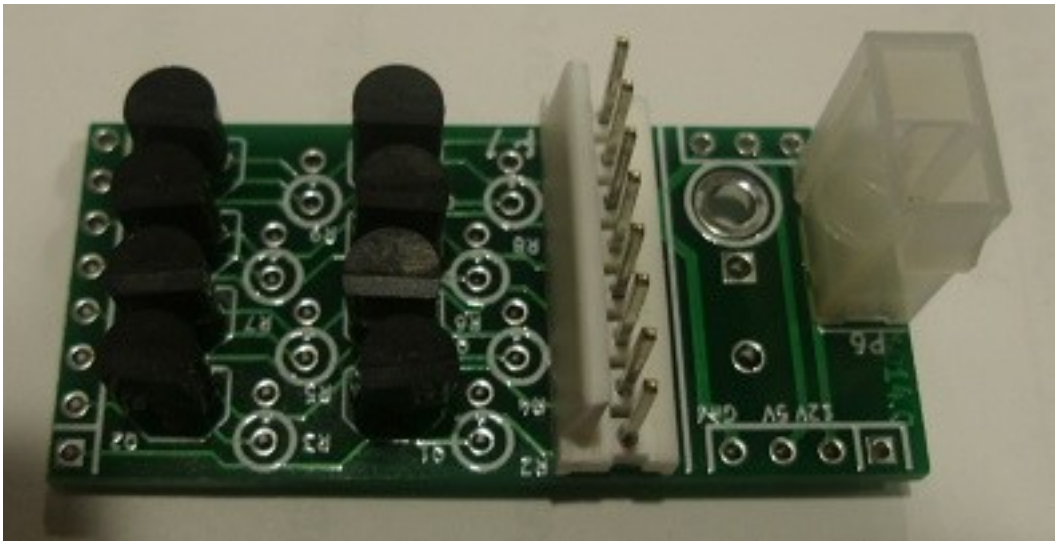
6.9 Incandescent Wing (Through-hole)

!!! Warning !!! If populating this board using 2N7000 MOSFETs, the MOSFETs must be rotated 180 degrees. That means that the round part of the MOSFET will be towards the top of the board. The silkscreen will not match!

6.9.1 Incandescent Wing (Through-hole) with BS170



6.9.2 Incandescent Wing (Through-hole) with 2N7000



Note: This version of the incandescent card can only be used as a low side switch. (Low side switch means that the MOSFET connecting one side of the bulb to ground so that current can flow). Many pinball machines have a common ground braid. In that case, a high side switch must be used.

Note 2: The pull down resistors are not necessary on this board. Do not bother populating the 10K through-hole resistors.

6.9.2.1.1 Used 4 pin voltage connector pins

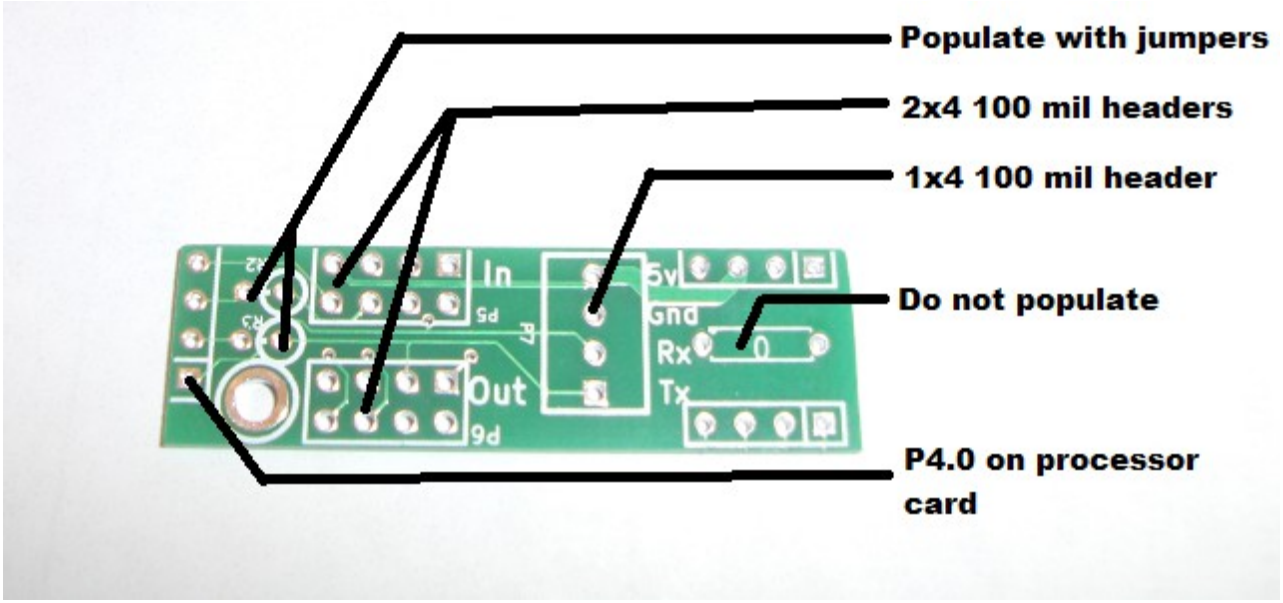
The special voltage on the 4 pin voltage connector is connected to the bulb ground. No other pins are used.

6.9.2.1.2 Order to populate components

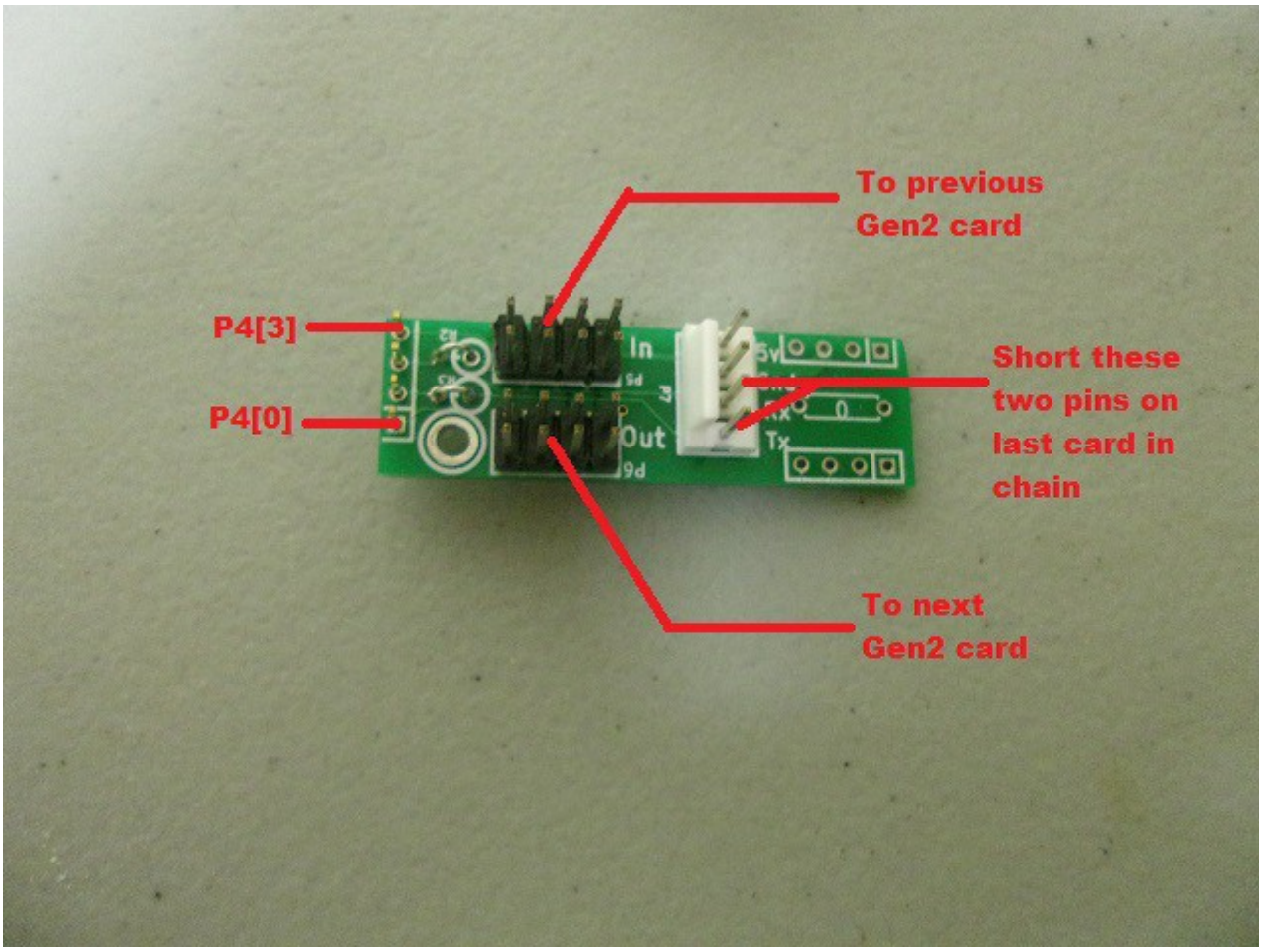
When populating this board, it is easiest to first populate shortest components, and then move onto taller components. First populate the TO-92-3 MOSFETs. Next populate the 1x8 pin 100 mil connector. Finally populate the 1x2 pin Molex connector.

6.10 Interface Board (Old version)

6.10.1 Unpopulated board



6.10.2 Populated board

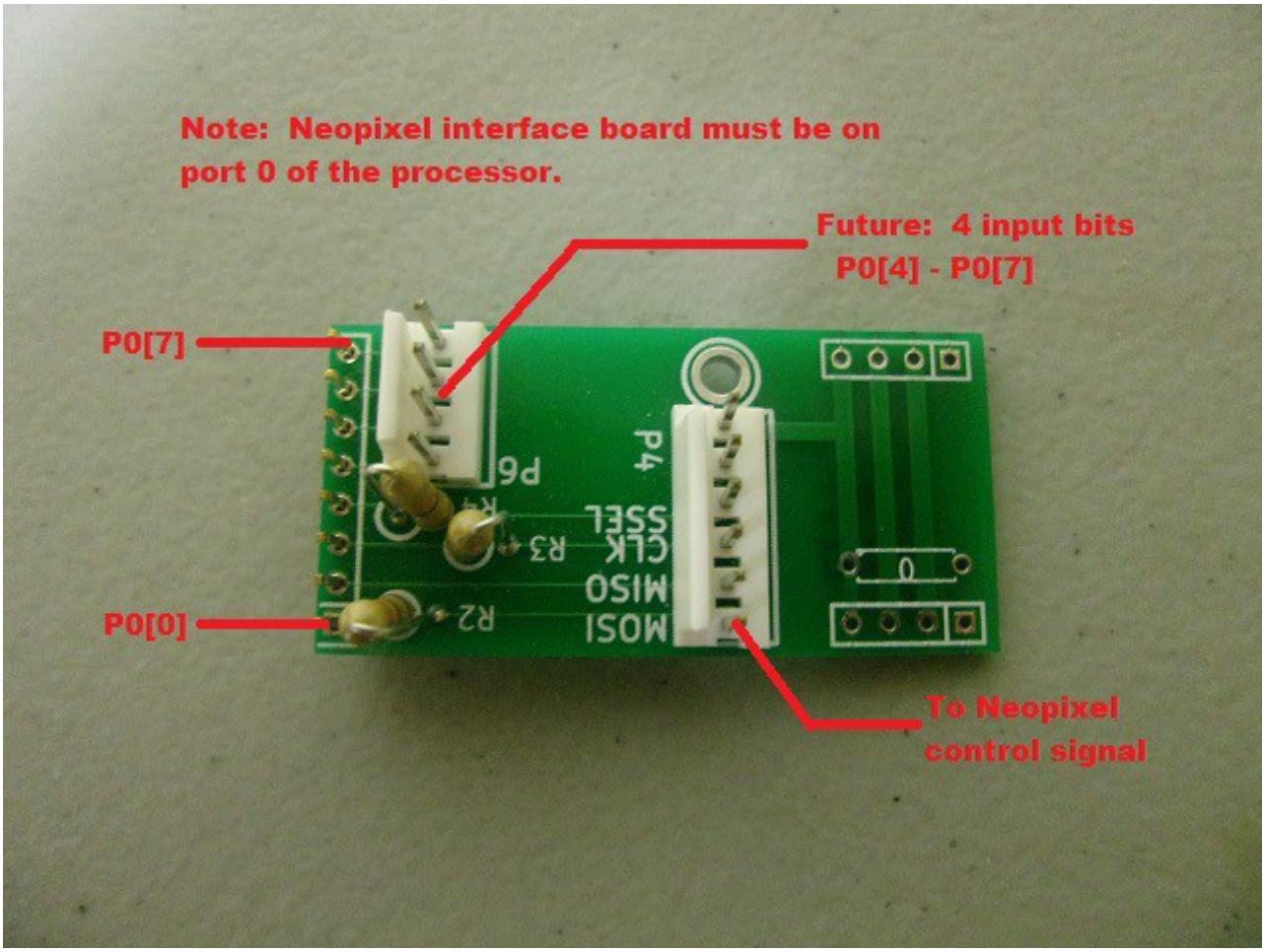


Note: The four pin connector, should be oriented with the friction lock towards the left side (processor side) of the card.

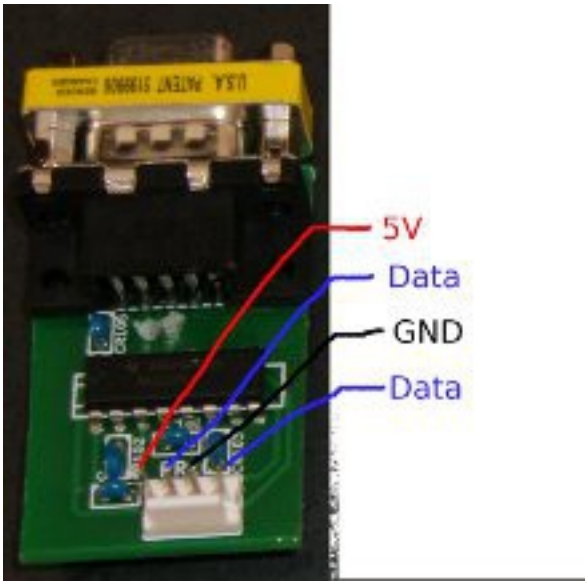
6.10.3 Used 4 pin voltage connector pins

Ground and 5V are usually provided by the ribbon cable, or the 1x4 pin 100 mil header if this is the first card in the chain. 12V is only needed if using incandescent boards configured as high side switches. 12V is either provided by the ribbon cable, or should be provided by adding a locking header to the first card in the chain. The special voltage on the 4 pin voltage connector is connected is not used on this card.

6.11 Input/Neo Wing

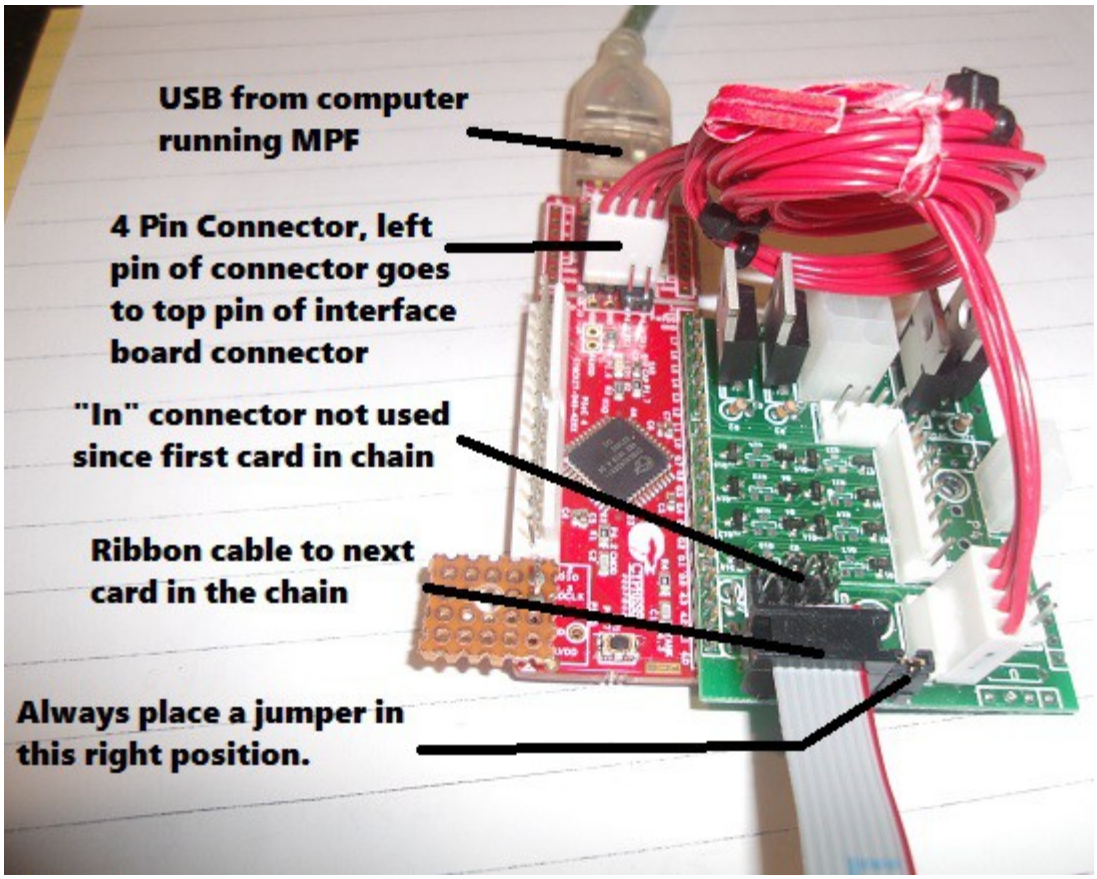


6.12 RS232 Interface

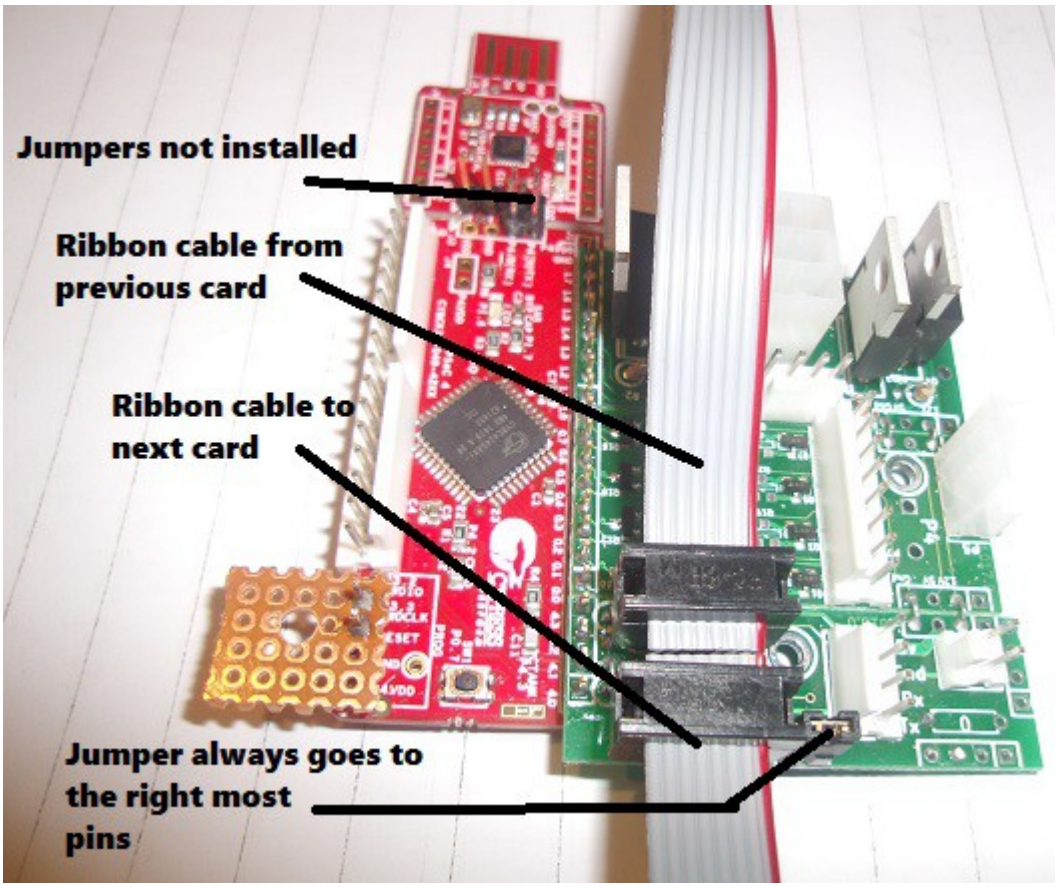


7 Connecting Multiple Cards Together

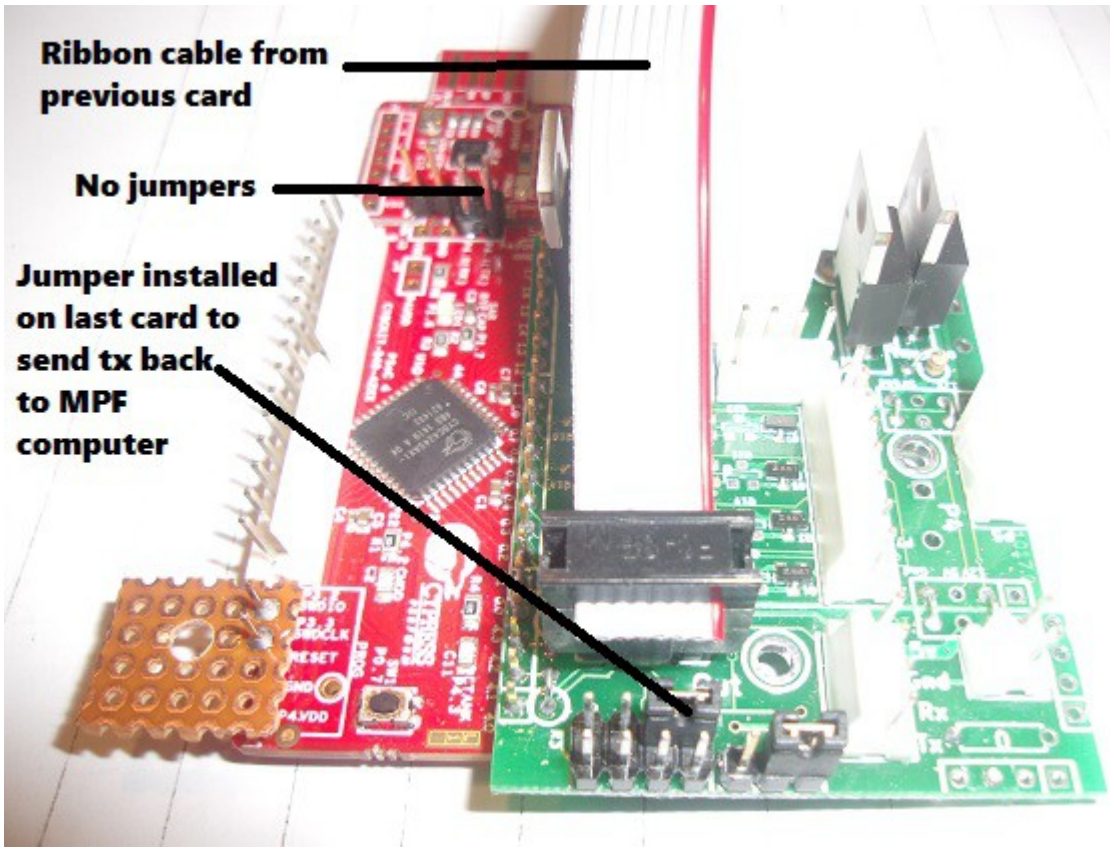
7.1 First Card



7.2 Middle Cards



7.3 Last Card



8 Programming Cards

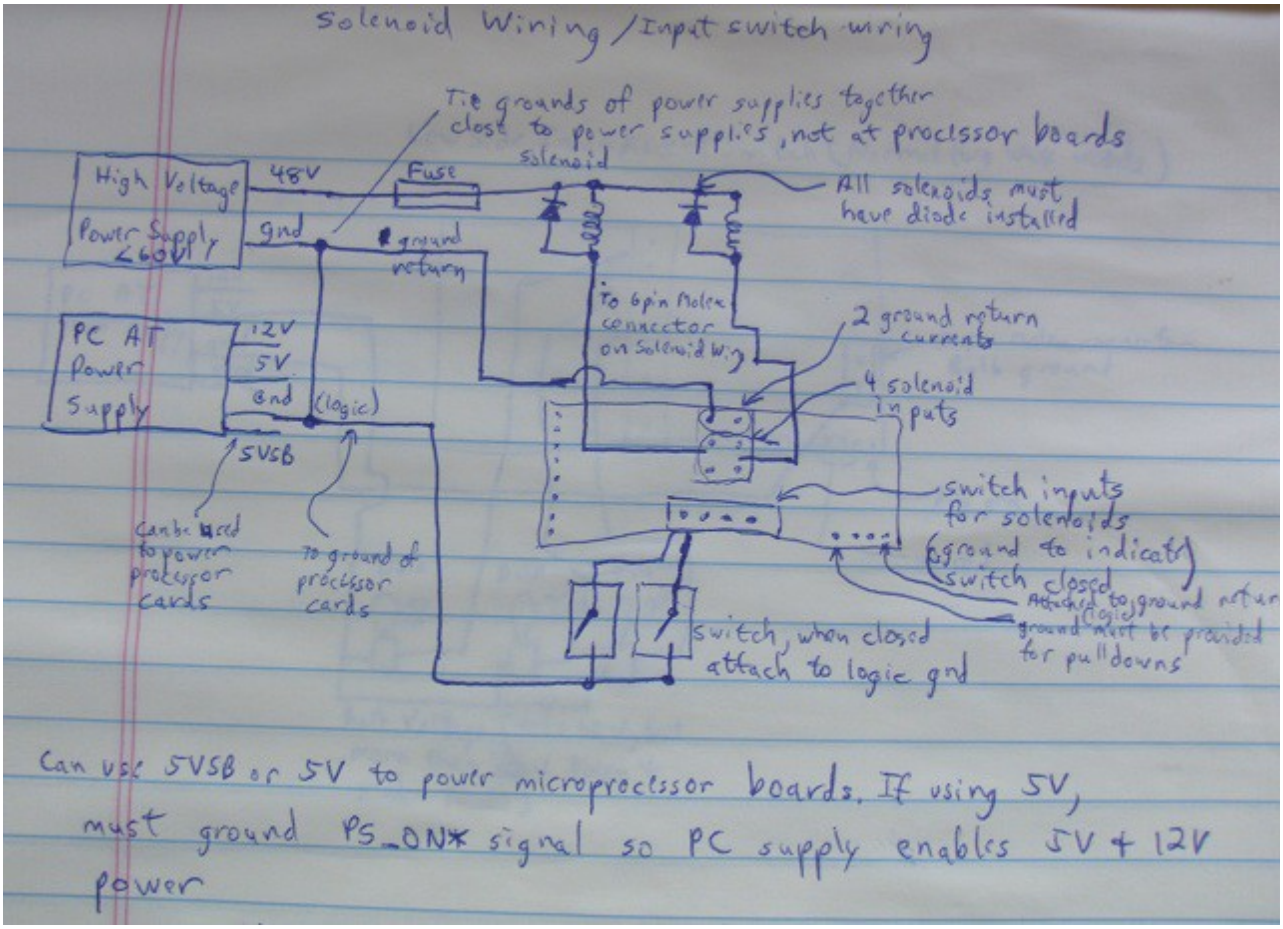
Here are the steps to program cards with a configuration so white woods can be tested without connecting to a computer or using MPF.

1. Download the latest version of the open-pinball-project repository which is located at https://svn.code.sf.net/p/open-pinball-project/code/trunk. The rest of the instructions assume that the root of the repository is open-pinball-project.
2. Change directory to open-pinball-project/Python/cyflash
3. Plug in the board while holding the button to put the board into bootloader mode. (The LED should flash rapidly). Run the command: c:\Python27\Python.exe -m cyflash.__main__ --serial COM5 --serial_baudrate 115200 ..\..\Creator\Gen2Images\Gen2.rev0.1.0.0.cyacd. Wait for the command to complete successfully.
4. Unplug the board, and plug the board while holding the button to put the board into bootloader mode. (The LED should flash rapidly). Run the command: c:\Python27\Python.exe -m cyflash.__main__ --serial COM5 --serial_baudrate 115200 ..\..\Creator\Gen2Images\Gen2.rev0.1.1.0.cyacd. (Note: This is a different version of code than the previous command). Wait for the command to complete successfully.

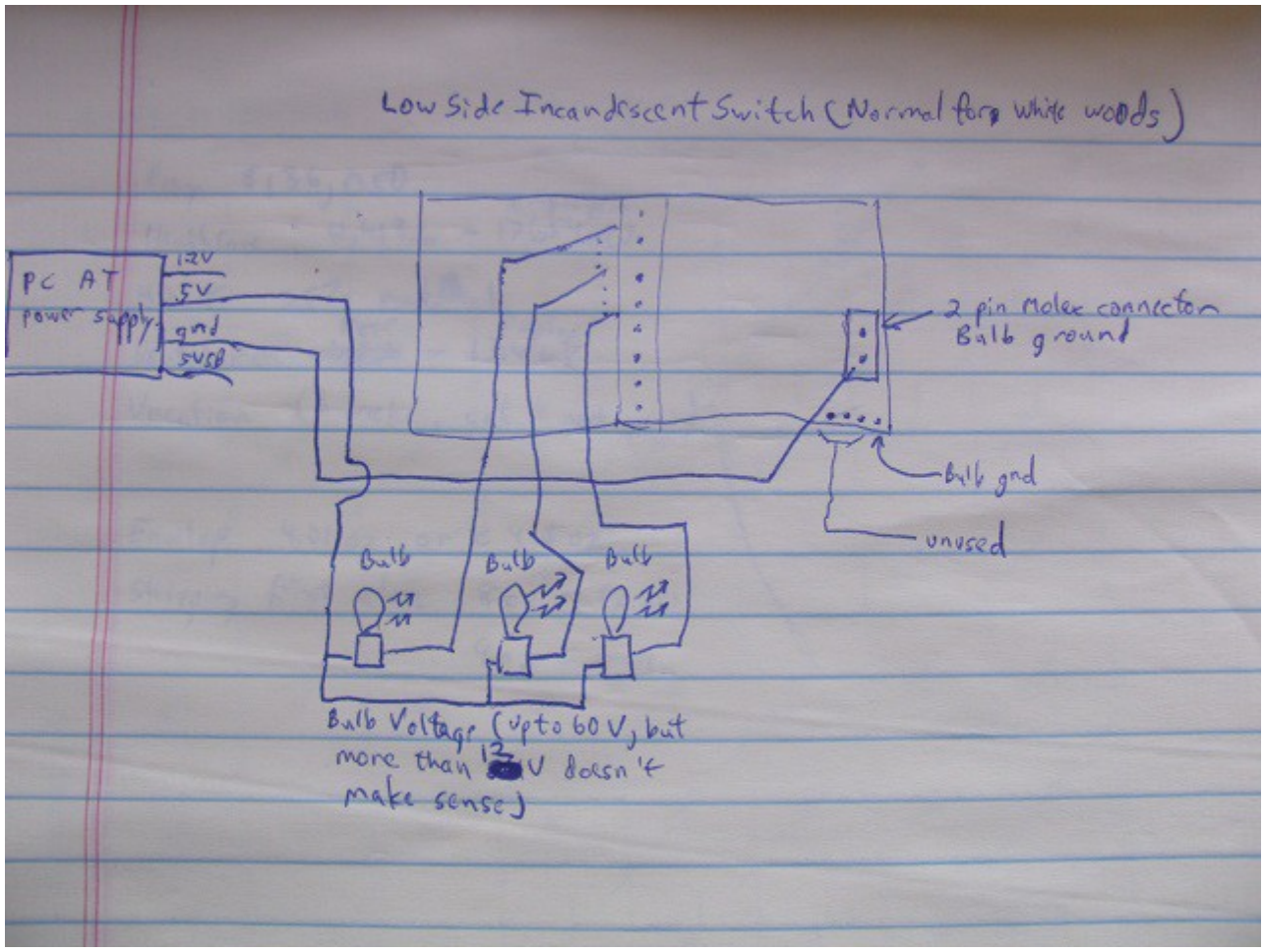
5. Change directory to open-pinball-project/Python/Gen2Test.
6. Unplug the board, and plug the board in. (Note: Do not hold the button in so the code jumps to the application).
7. Run the command: c:\Python27\python.exe Gen2Test.py -port=COM5 -eraseCfg. This erases the configuration and prepares the card for a new configuration. Note: Do not unplug the card at this point, or you will need to start the whole process again.
8. Run the command: c:\Python27\python.exe Gen2Test.py -port=COM5 -saveCfg -loadCfg=mdCfg. This will load the mdCfg file into the memory and save it to flash.
9. Verify configuration was saved. Unplug the board and plug the board in. Run the command: c:\Python27\python.exe Gen2Test.py -port=COM5. This will display the current configuration of the wing cards.

9 Wiring Diagrams and Suggestions

9.1 Solenoid/Input Wiring



9.2 Low Side Incandescent Wiring



9.3 High Side Incandescent Wiring