Very Kerbal Controller

Design Document

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# System Overview

# Physical Design

# Electrical Design

## General Design Concepts

The electrical design was based on the following basic concepts:

* Maximise use of parts on hand, or choose minimum cost approaches
* All inputs to use Pull-Up resistors so that all inputs are consistent and the internal Pull-Ups in the Arduino can be used
* Connectivity setup to minimise wiring runs. Panel segments grouped to nearby components.

## Power Supply Design

The power supply was driven by the highest required voltage which is 12VDC required by the LED strips. The two step down voltages were then chosen as follows:

* 5VDC was required for the fan as this was an existing part and buying a 12VDC fan was unnecessary cost. A fan is $5-$10 whereas a 7805 regulator is $1.
* 8VDC was not strictly required as the Arduino will accept 12VDC in the Japan Jack. However some online reading of temperature testing indicated the on-board voltage regulator can get quite warm at 12VDC. The 7808 regulator therefore provides an intermediate drop to spread the heat. 8VDC was chosen only because it’s the next 78XX regulator above the Arduino’s minimum 7.25VDC input.

The regulators are bolted directly to the rear plate for heat dissipation, but give the low current this is not really required.

The fan is a 3 wire type however the third wire (tach) cannot be used when the input power is PWM switched as you are also switch power to the sensor. Therefore it is not connected.

Required current was based on 54 LEDs at 20mA which is approximately 1A, plus maximum of 500mA for the Arduino. Allowing for other loads like the fan a 2.5A supply allows room for growth.

### Potential Changes

Replace the fan with a 12VDC fan and remove the 5VDC conversion. Also either use a 2 wire fan or, if speed sensing is required, a 4 wire fan. For a 4 wire fan the PWM transistor can be removed and the PWM signal connects directly to the 4th wire.

## Input Sensing

All digital inputs are grounds via Pull-Up resistors, either internal for direct connections to the Arduino or external resistors for the extenders. This results in sensing 5V, or HIGH, when the switch is off but this can be reversed in the code to give a more readable output.

All switches used N -1 inputs where N is the number of switch position. E.G. a 12 position switch uses 11 inputs and if all 11 inputs are off it must be at position 12.

All analogue inputs, except the voltage sensor, are powered from the Arduino 5VDC supply.

The voltage sensor at A0 is to allow the code to sense the source of input power because the Vin pin will show the current input voltage. If the Japan Jack is powered the USB power supply is cut off and Vin is equal to the Japan Jack voltage, otherwise it is the USB voltage.

However this means that if Vin is connected to A0 and the Japan Jack is > 5VDC then the Arduino will be damaged. Therefore a simple voltage divider scales the sensed voltage to ensure it is always less than 5VDC, in this case A0 will be 1/3 of the input voltage.

### Potential Changes

The interrupt pins on the MCP23017 extenders are currently not used. If they were connected to digital inputs on the Arduino they would allow the extender to flag a change on an input to the Arduino so the Arduino would not need to poll the inputs all the time.

## Driving Outputs

To drive the 12VDC lights the ULN2803 Darlington arrays are used, though as there are 9 lights per side a 9th switching channel was created with a simple NPN transistor. A diode from this resistors collector the test switch replicates the common connection in the Darlington array. A base resistor, and a pull down resistor is required for this transistor whereas in the Darlington Array they are built in.

The ground of the driver arrays is PWM dimmed using another NPN however this creates a potential issue. This PWM transistor also requires a base resistor and a pull down resistor.

When only some lights are active, there is a path to ground for those lights back through the LOW signals switch off the other lights, as outputs are low impedence. This is prevented by adding diodes between the extender and the Darlington array forcing the PWM to ground path to be used.

An alternative would be to use High Side switch and place the dimming transistor on the power side of the LEDs but I am not confident with this approach and it would require 12V to go via the circuit board rather than direct to the lights.

# Software Design

## Software Architecture

## Arduino Code

### Python Code