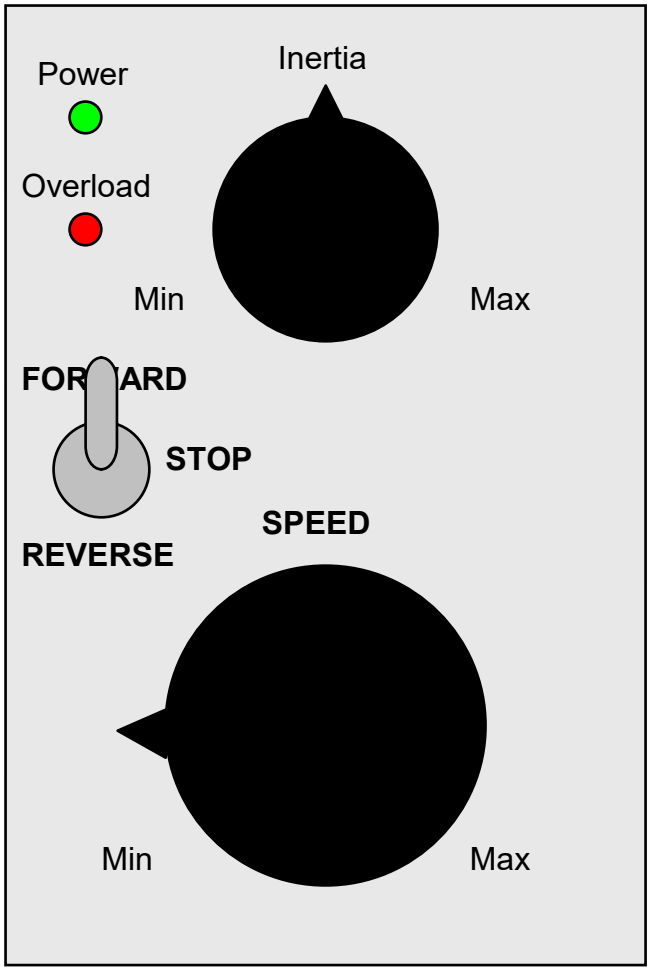
# Train Speed Controller

IPK180917

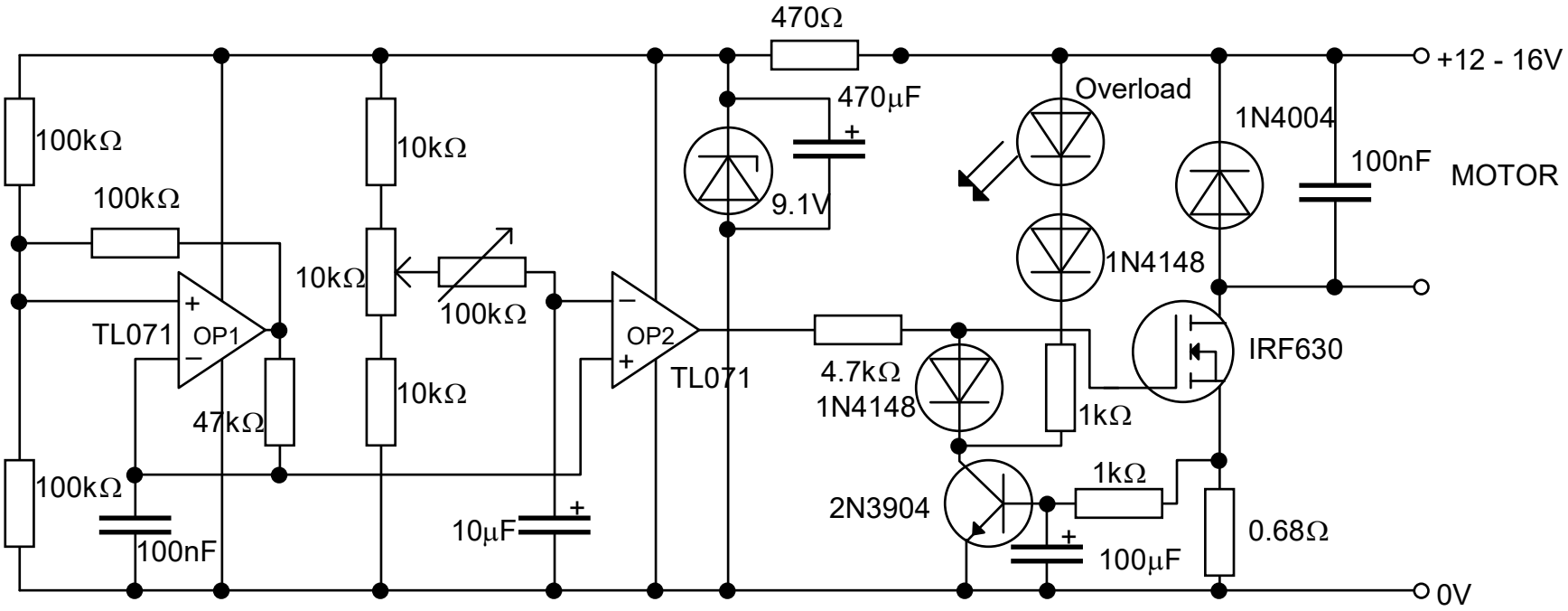
## Specification

Uses pulse width modulation (PWM) to provide continuous variation from zero to full power
Operates from 10 - 16V
Will supply currents up to 1.5A after which it current limits.
Has a Forward and Reverse switch to change the direction of travel
Has a Load/Inertia control to imitate the effect of the weight of the train.
Has an overload indicator - when circuit current limits.

## Possible layout of control panel



## Circuit diagram

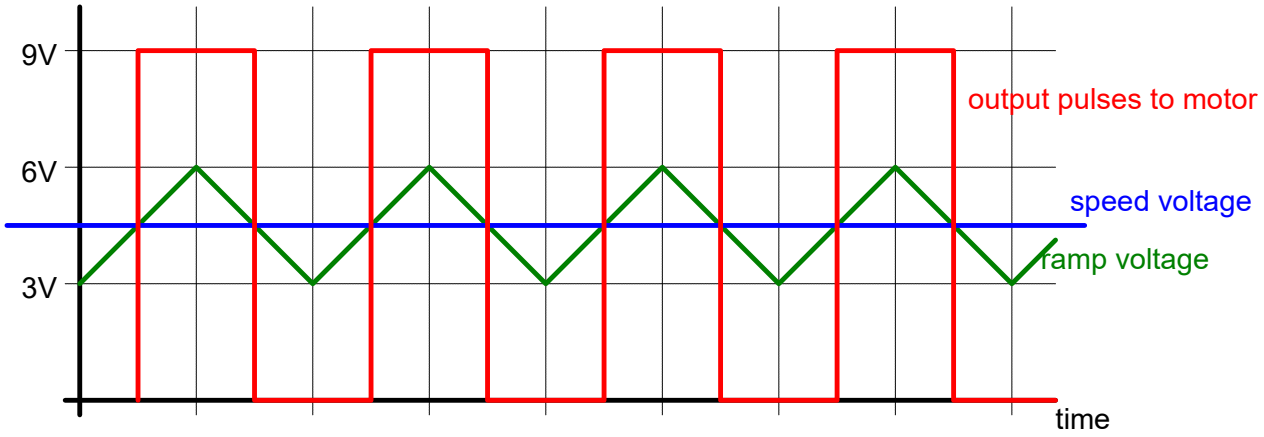



NOTES:-

The op-amps can be replaced with any op-amps with a very high input impedance.
The IRF630 can be replaced with any high current MOSFET. It should be mounted on a heatsink.
The current at which the output limits when overloaded can be altered by changing the 0.68Ω resistor.

## How it works

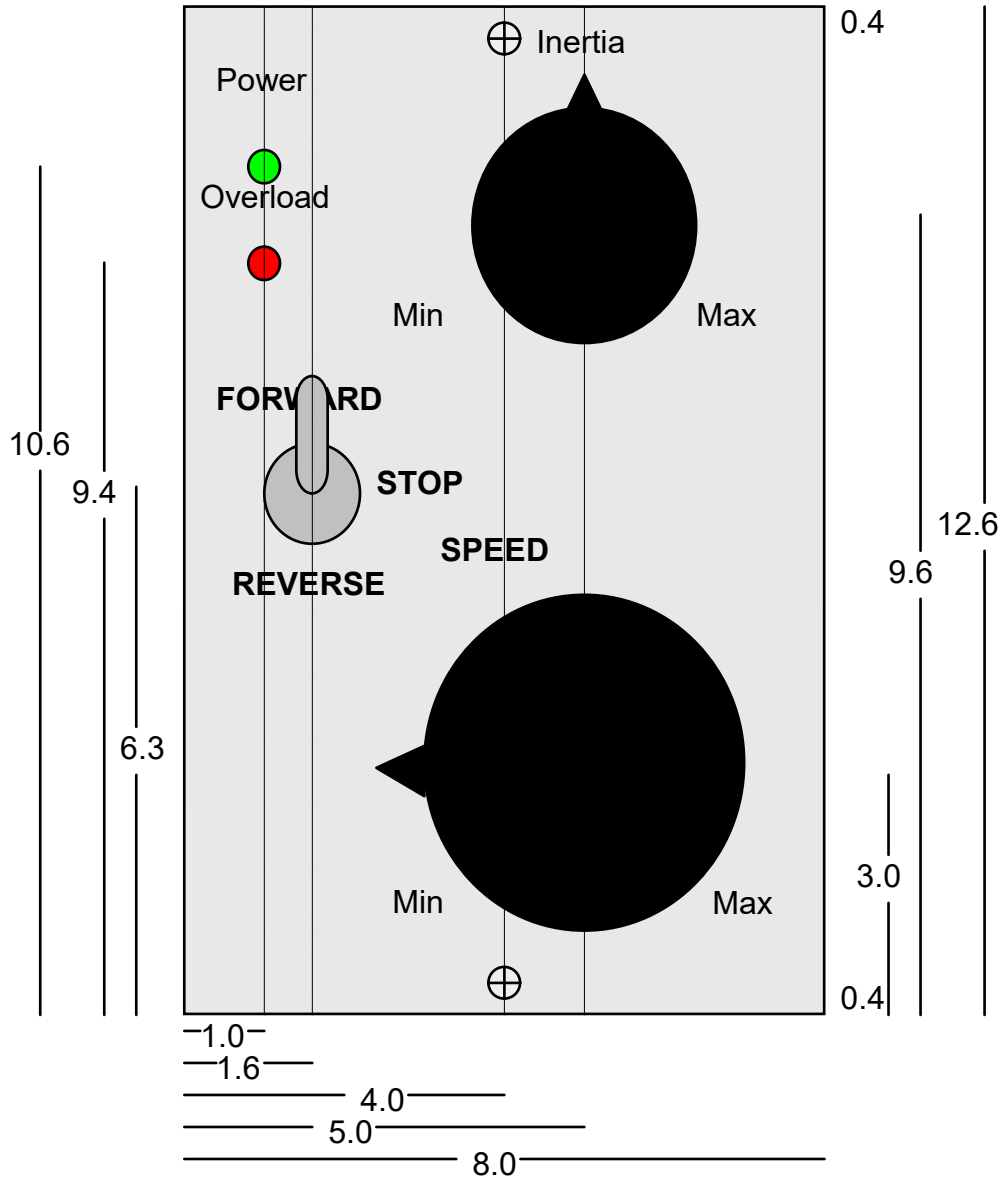
OP1 functions as an inverting Schmitt trigger with switching voltages of 3V and 6V. The input is connected to a 100nF capacitor which charges / discharges through the 47kΩ resistor. The voltage across this 100nF capacitor ramps up and down between 3V and 6V at a frequency of 150Hz.
OP2 functions as a comparator. The non-inverting input of OP2 is connected to the ramp voltage and the inverting input is set by the 10kΩ variable resistor (Speed control). When the ramp voltage is larger than the speed control voltage, the output of OP2 goes high, switching on the MOSFET which gives a pulse of current to the motor.




The 100kΩ variable resistor controls the rate at which the voltage on the inverting input of OP2 can change as the speed control is adjusted. It acts to simulate a train being fully laden (100kΩ) and unladen (0Ω). It is optional and can be replaced with a wire connection.
Overload protection. When the current passing through the motor is sufficient to produce a voltage across the 0.68Ω resistor to switch on the 2N3904, the transistor conducts and clamps the input to the gate of the IRF630 towards 0V which limits the current pulses produced by the IRF630. The 2N3904 also switches on the Overload LED to show that the circuit is in overload mode.

# Appendix 1

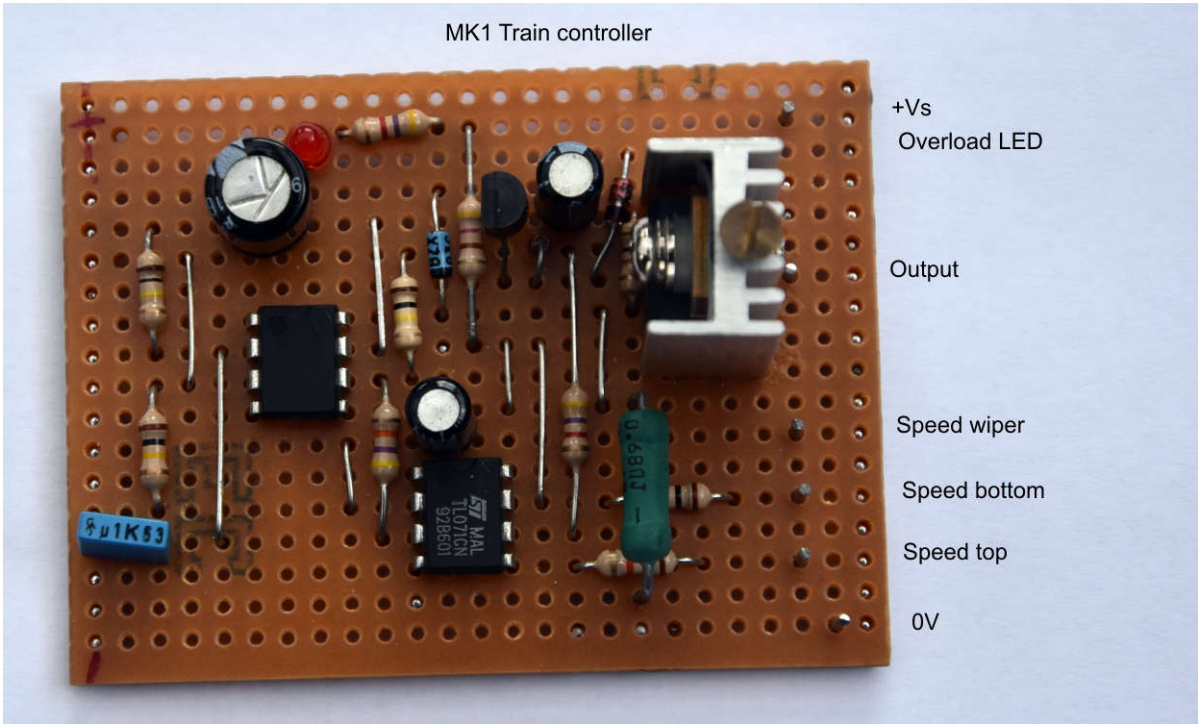
Control panel measurements - all in cm.



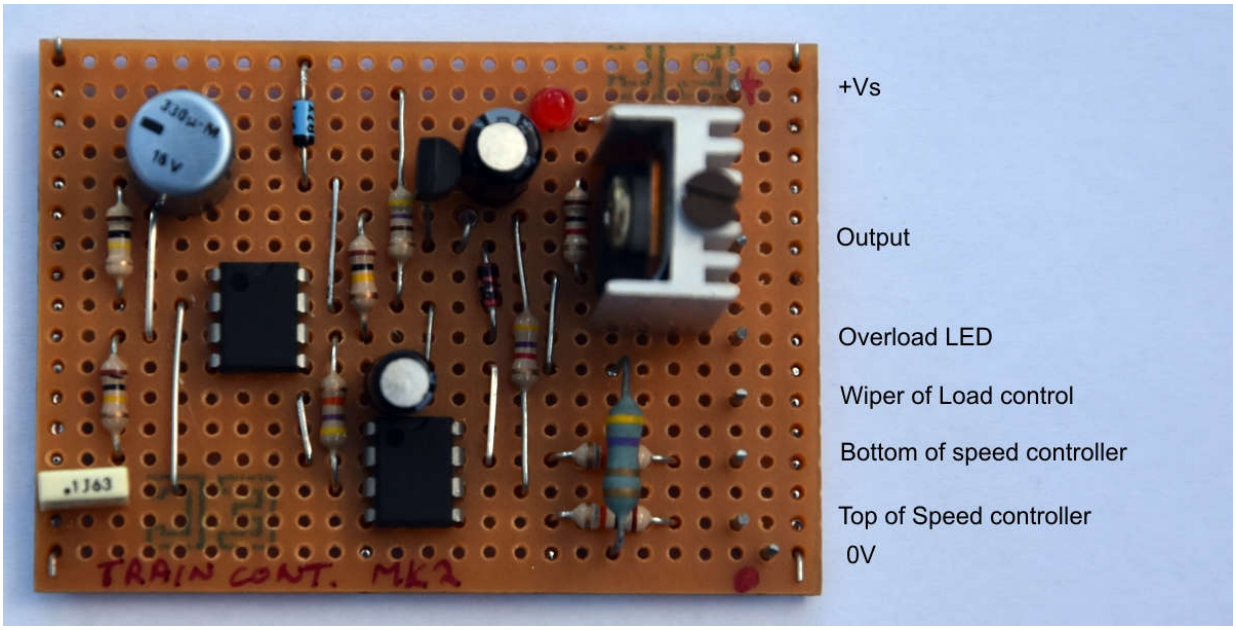
# Appendix 2

## Circuit board layouts

The original layout.  The connection to the overload LED is hidden behind the heatsink.

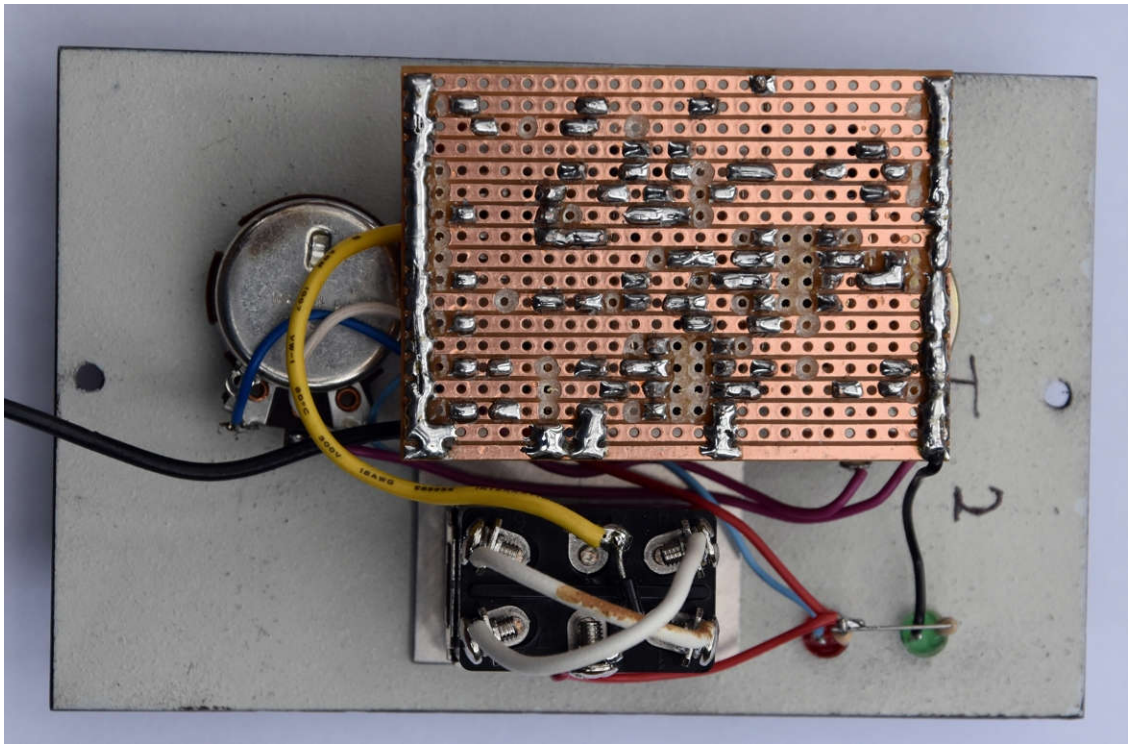



The improved layout.  This circuit board is slightly smaller and the output to the Overload LED is in a more convenient place.



# Appendix 3

Photograph showing the circuit board mounted on the control panel



Front view of the control panel of one controller.  The green LED is a 'power on' indicator, and the red LED is the Overload indicator.

# Appendix 4

View of finished controller showing possible labelling


The third unused panel is for future expansion