APPS

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# Introduction

The APPS is a circuit which processes the signals from the accelerator pedal. It scales the signal appropriately for the motor controllers and performs the necessary plausibility checks required by the rules. It also provides necessary trail braking functionality.

# Relevant Rules (2020)

# Block Diagram

## IO

# Circuit Layout

The circuit can effectively be broken down into two primary sections, Signal Processing and Implausibility Detection. Within these sections the circuit is broken down further into the block diagram shown in fig x. A brief explanation for each block is provided below.

## Signal Filtering

A low pass filter and pulldown resistor is used on the inputs from the pedal to eliminate any high frequency noise and satisfy the requirement for pulldown or pullup resistors on inputs.

## Signal Scaling

The motor controllers require an input ranging from 0 – 5 V. As such each signal from the pedal must be scaled to this range. Differential Amplifiers are used to do this by effectively chopping of the minimum offset and stretching the output such that a 0% input outputs 0 V and 100% input outputs 5 V.

## Averaging

A pair of matched resistors are used to take the average of both scaled signals. This voltage is then put through a buffer

## Boundary Check

The Boundary check block exists to fulfil rule x. It does this by comparing the filtered inputs from the pedal to high and low voltage values that are outside of the expected window of inputs using voltage comparators. Each input has its own set of comparators as each input has a different expected input range. Should any input be outside of the expected range, a fault signal will be generated.

## Tolerance Check

The tolerance check block exists to satisfy rule y. To do this it takes each scaled output and subtracts one from the other and then compares this value to a voltage representing 10% travel, 250 mV in the case of a 5 V circuit. Should the difference be higher than this tolerance, a fault signal is generated. This process is repeated, this time taking the reverse difference, as the circuit is incapable of generating a negative voltage for the difference output.

## Trail Braking

The trail braking block monitors the brake switch signal and the averaged, scaled accelerator signal. Should the accelerator signal read above 25% whilst the brakes are active, an implausibility will be output. This implausibility will remain until the accelerator signal reads below 5% travel regardless of whether the brakes are active.

## Fault Delay

The fault delay block exists to satisfy rule z. It monitors the fault signals from both the Boundary and Tolerance Check blocks and outputs a fault signal should either fault persist for more than 100 ms. This block protects against any noisy outputs from the involved fault blocks.

## Output Gate

The output gate passes the processed signal to the output stage if there are no faults or implausibility’s. It does this using an analogue switch requiring an ok signal from both the fault delay and trail braking blocks. Should the gate be shut, the output will be pulled down to 0 V.

## Output Processing

The output stage utilises a buffer and capacitor to help mitigate any noise that may be generated on the ouput line. A Zener diode and small current limiting resistors are implemented to protect the output from a short or over-voltage inputs.

# Calibration

The resistors required in the amplifier to achieve this are dependant on the minimum and maximum inputs of each pedal signal according to the following equation:

The generated Vmin for each amplifier should match the minimum input voltage for the matching accelerator input.

# A Note on Buffers

Op-Amp buffers are used extensively throughout the circuit to ensure no unwanted interactions between resistor networks occur. These buffers could be removed to reduce component count provided the magnitudes of interacting resistor networks are chosen appropriately.