



## Controller For Model Trains

Most model railway controllers have the unfortunate characteristics of giving instant starts and stops to the train which would be very unnerving for the model passengers. The circuit described gives a steady acceleration or deceleration on speed changes, and the speed and acceleration controls do not interact.

The power supply is 12V split by R8 and R9 so it appears to the op amps as a  $\pm 6$  V supply. Voltages in this description are referenced to the 6 V centre tap. IC1 and IC2 together form a unity gain inverting amplifier, with the gain determined by R1 and R2. The slope of IC2's output, is determined by C1 and R3/RV2. The output of IC1 will thus take up one of three states: +6 V (hard positive), 0 V (balanced), -6 V (hard negative) dependent on the output voltage being more positive than equal to or more negative than the out-

put voltage set by RV1. The output voltages will thus ramp up or down at a constant rate until it is equal in magnitude (but opposite in sign) to the voltage on RV1. This is summarised on the waveform drawing.

Voltage b drives buffer amplifiers IC3 and IC4 to give a push pull 12 V drive to the motor for forwards and reverse. Note that the feedback resistors R5 and R7 are taken from the transistor emitters to compensate for the transistor  $V_{be}$  drops. The motor should have some current cut-out or limit connected in series with it to protect the transistors.

In use RV1 sets the speed, and RV2 the acceleration. It gives a very realistic train control, although much more skill is needed to stop a train accurately at a station platform. In this respect it is very close to driving a real train.