Features bi-directional control without a reversing switch:

Bipolar model train controller

This simple train controller is ideal for both N gauge and 00/H0 gauge model railways. It is fully overload protected, and features smooth speed and direction control with a single knob. Estimated cost of all components, including the case is only about $25.

by DAVID EDWARDS

As you have probably guessed from the name we have given this project, it is based on the use of complementary transistors, in this case BD262 and BD263 power Darlingtons. The circuit is essentially a bipolar emitter follower.

As you can see from the circuit diagram, the only active devices used are the Darlingtons themselves. Overload protection and indication is provided by two light emitting diodes (LEDs). The unit can supply positive and negative voltages variable from 0V to about 20V, with the output current limited to a maximum of 1A.

The output voltage is determined by the setting of the 1k potentiometer, which forms the loco speed and direction control. When the control is centred, there is no output voltage, and the loco remains stationary. When it is rotated clockwise, the output voltage increases, driving the train in one direction, while anti-clockwise rotation produces movement in the opposite direction.

The neat appearance of the prototype can be seen in this photograph. One or other of the LEDs will light in an overload condition.

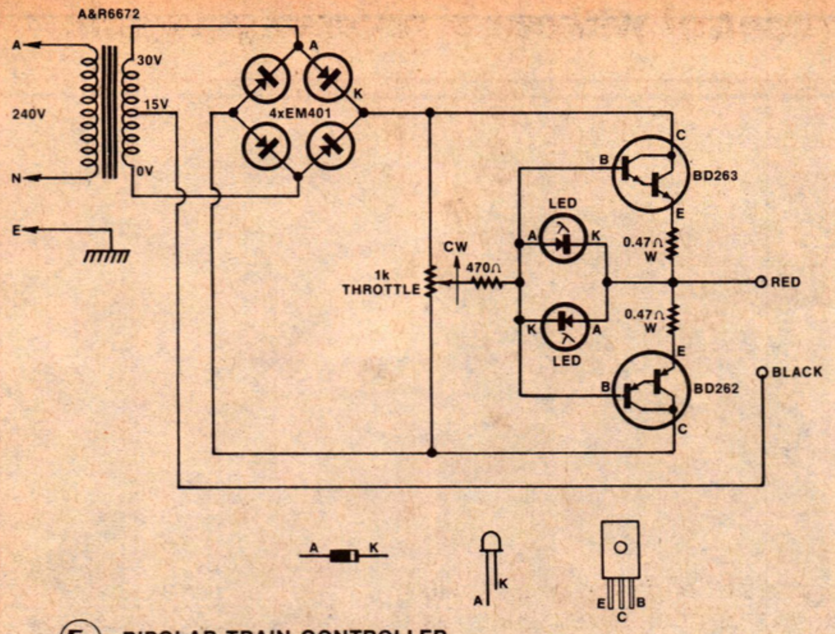
Operation of the circuit is as follows: the voltage at the wiper of the potentiometer is passed to the bases of the transistors by the 470 ohm resistor. This will forward bias one Darlington transistor, and cut off the other one.

The forward biased Darlington transistor operates as an emitter follower, and supplies current to the load (in this case the loco) via the 0.47 ohm emitter resistor. The emitter follower action applies local negative feedback, and tends to keep the voltage applied to the train constant, irrespective of the load current. So the loco tends to have improved "pulling power", even at low speeds.

In normal operation, the combined base-emitter drop of the conducting Darlington (1.2V), and the voltage produced across the 0.47 ohm resistor is less than 1.7V, and so the LED does not emit. (The LEDs are connected in inverse parallel, so that one or the other will tend to be forward biased whatever the output polarity.)

In an overload situation, however, the voltage drop produced in the 0.47 ohm resistor will increase as the load current increases. When the output current reaches 1A, the combined voltage across the LEDs will rise to 1.7V, and the forward biased LED will start to conduct.

As the LED starts to conduct, it will emit, giving a visible indication of the



BIPOLAR TRAIN CONTROLLER 2/MC/-

ABOVE: As you can see from the diagram, the circuit of the controller is very simple.

overload condition. But more importantly, it will bleed some of the base current away from the Darlington, and hence it will limit the output current. The purpose of the 470 ohm resistor is to limit the current to the LEDs and the transistors to a safe value, particularly at either extreme of the potentiometer.

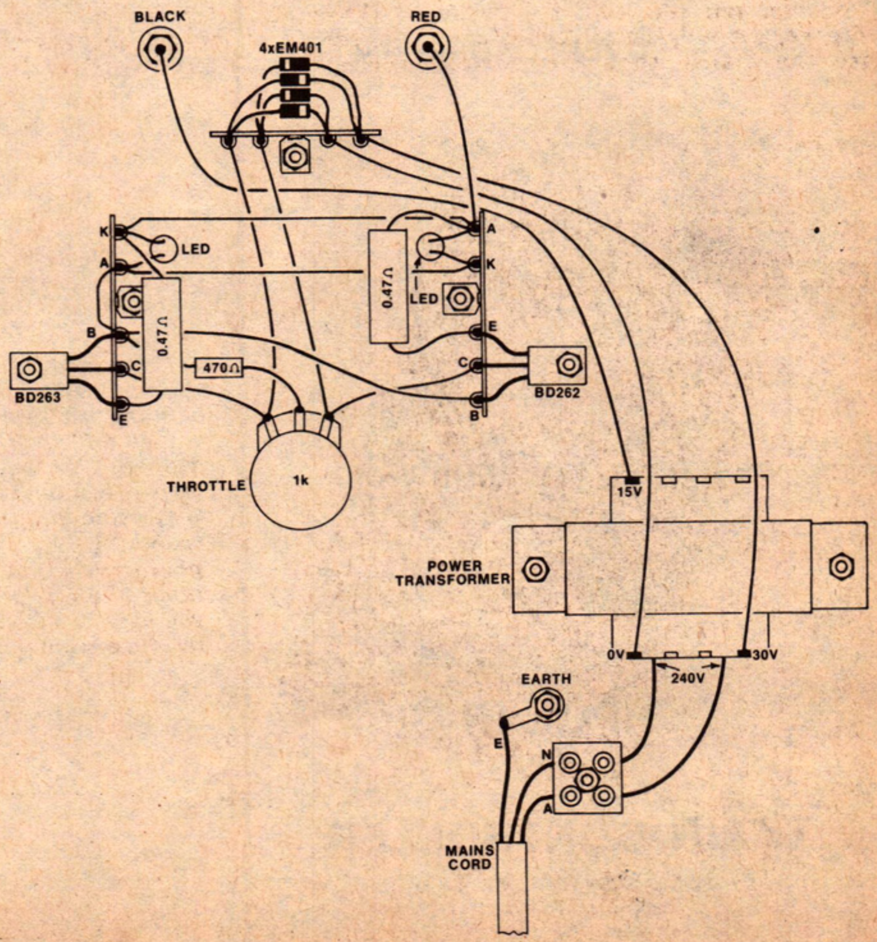
The required positive and negative power supplies are derived from a 30V centre tapped transformer with a 1A rating, via a bridge rectifier. No filter capacitors are required, as ripple on the output is actually beneficial to the operation of the train — the AC components help to overcome "stiction".

We constructed the prototype in an extruded aluminium case, measuring 152 x 101 x 76mm. This was a Horwood case, code number 34/6/DS, and is available from a number of suppliers. The prototype case came from Radio Despatch Service, of 869 George Street, Sydney, NSW 2000. The extruded aluminium tube, which forms the major part of the box, is fitted with two removable end plates, and is also split in two lengthwise.

This latter feature is most important, as it greatly facilitates assembly of the components into the case. The transformer we used was an A & R type 6672; an equivalent transformer is also available from Dick Smith stores. All other components should be readily available from your local electronic store. The LEDs can be any red type, and are not critical. The types supplied with the plastic mounting clips are the most suitable from a constructional point of view, as well as being cheaper.

The 0.47 ohm resistors should be 5W ceramic-cement types. The 470 ohm resistor can be a standard ½W part.

BELOW: Even inexperienced constructors should be able to build the controller, by following this wiring diagram explicitly.



PARTS LIST

- 1 Horwood case, 34/6/DS, 152 x 101 x 76mm
- 1 1k linear potentiometer
- 1 knob
- 2 red light emitting diodes, with mounting hardware
- 1 BD262 PNP power Darlington transistor, with mounting hardware
- 1 BD263 NPN power Darlington transistor, with mounting hardware
- 4 EM401 silicon diodes
- 2 0.47 ohm 5W resistors
- 1 470 ohm ½W resistor
- 2 terminals, 1 red, 1 black
- 1 mains transformer, 30VCT @ 1A
- 4 rubber feet
- 1 mains flex, plug, grommet, cord clamp and terminal block
- 3 6-way tagstrips

Solder, hookup wire, solder lugs, insulated sleeving, machine screws and nuts.

NOTE: Resistor wattage ratings and capacitor voltage ratings are those used for our prototype. Components with higher ratings may generally be used provided they are physically compatible.

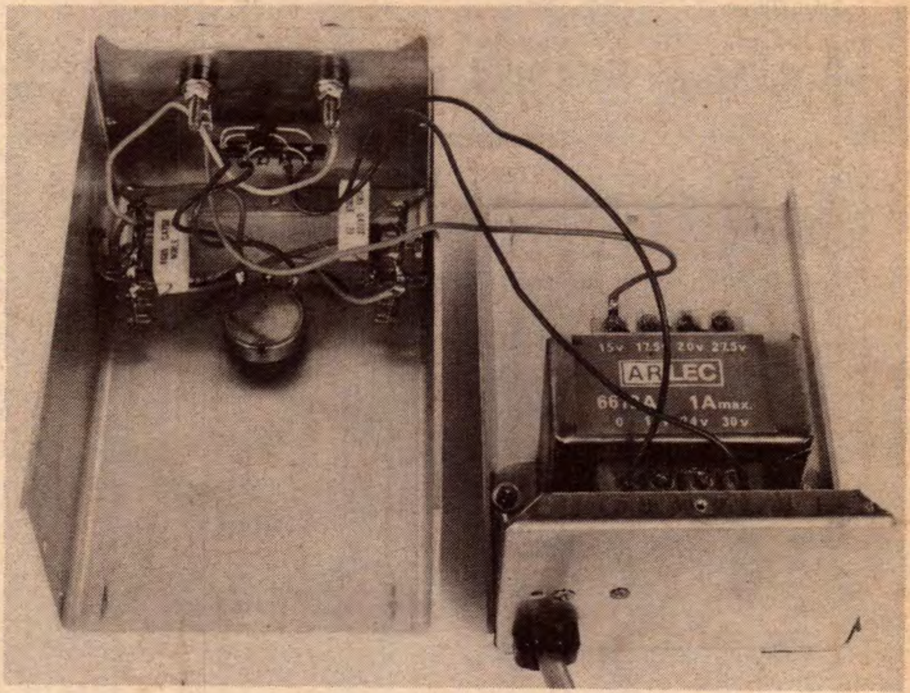
Bipolar train controller

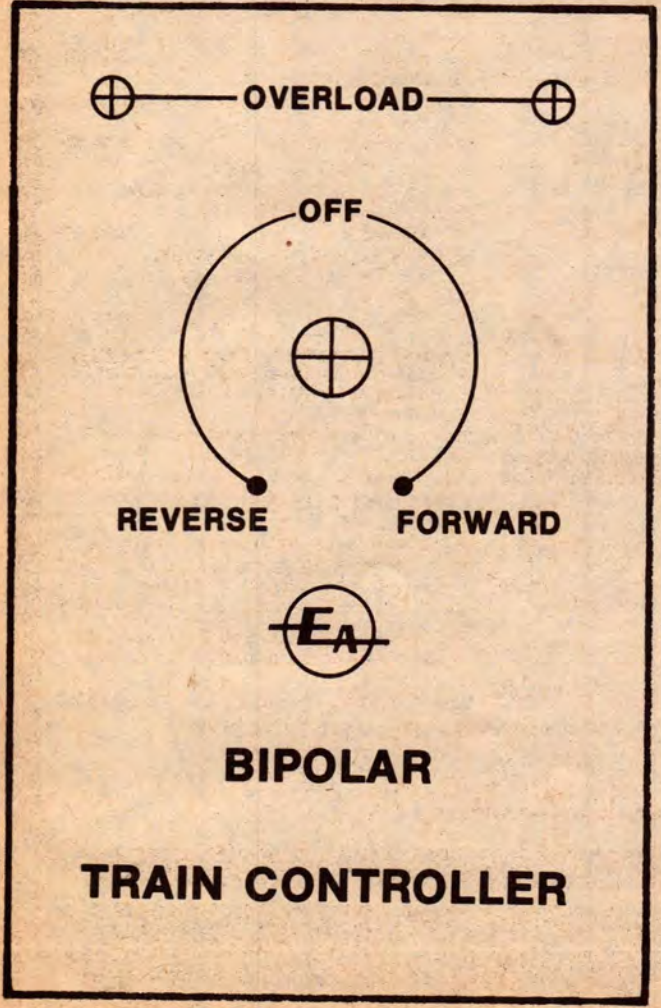
RIGHT: In this photograph, you can see how the case splits into two sections, with only three wires between them.

Make sure that you obtain insulated mounting kits with the transistors, as these must be insulated from the case. Three lengths of 6-way tagstip are also required, to form a mechanical support for the wiring and small components.

We made a front panel for the prototype from photosensitive aluminium. The artwork we used is reproduced full size with this article, and may be used directly, or copied. Use it as a guide to mark the positions of the three holes required in the front panel.

Construction of the unit should not prove difficult. Use the exploded wiring diagram as a guide, and complete all the mechanical assembly first. The mains cord must be securely grommetted and clamped at the entry point to the case, and the earth lead connected directly to a solder lug bolted securely to the case chassis.





LEFT: This actual sized reproduction of the front panel can be used directly if required. Commercial panels should be available in due course.

The active and neutral leads are terminated in a two-way terminal block, and then are routed directly to the primary of the transformer. The rectifying diodes are mounted on a small tagstip positioned between the two output terminals. The remaining two tagstips are used as shown to mount the LEDs, power transistors and emitter resistors. The 470 ohm resistor is wired directly between the pot wiper and the base of one transistor. You will need to insulate the leads with plastic sleeving.

Care will be required to mount the appropriate transistor in the correct location (the BD263 goes on the left, as in the diagram), and to wire the LEDs into circuit correctly. Follow the diagram explicitly.

Once you have completed the unit, double check all wiring, and then switch on. Use a voltmeter to check that the output voltage can be controlled by the knob, and that both positive and negative output voltages can be obtained.

If all is OK, connect up to a train, and give the unit a practical test. The LEDs should illuminate (only one at a time) when an overload is applied. If you have a suitable ammeter, connect it directly across the output, and check that the maximum output current is about 1A, in both directions.

If you wish to increase the output current capability, insert a 1N914 silicon diode in series with each LED and use diodes with a higher current rating for the bridge rectifier. 1N5408 types are suitable.