Dremel 400 Digital Modification

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In about 2005, I bought a Dremel high speed grinder model number “400 Digital” with electronic speed control. This is the bottom one in the picture on the right. The upper one is a model 3000 bought last year.

You can see the rather oddly shaped body with the display and buttons. The + and – buttons are to set the speed and the on/off slide switch turns the motor on and off.

Unfortunately, the electronics failed last year. The display would flicker and then blank, and it wouldn’t turn on. I spoke to Audrey Myles (you will know her from the Bosch stand where she demos Dremels.) She said it wasn’t Dremel’s best model and was withdrawn a couple of years after being launched. It has a rather strange shape as well and doesn’t fit into some of the attachments. No spares are available and she advised that I replace it with a newer model, which I did with the Model 3000 shown above.

When I complained to John Speedy about the failed unit, he suggested that I just bypass the speed control and use it at full speed.

Being an electronics engineer, of course, I had to pull it apart to see if it could be repaired. Dremels are quite simple machines, with a universal motor, controlled by triac speed control circuit. This model has a PIC micro-controller that responds to the buttons, updates the display and controls the speed by varying the phase angle of the triggering circuit to the triac. Most of the circuit board was surface mount components, which are difficult even to identify, let alone work on. There were a couple of small electrolytic capacitors, which if they were to fail, would cause the symptoms I saw. I replaced those with no success.

I decided to take John’s advice and disconnected the speed control circuit and bypassed the triac, so the machine now just runs at maximum speed. A Chinese-made external speed control was bought to allow the speed to be reduced as required.

The on/off switch still serves to turn it on and off, but the rest of the circuit has been bypassed and deactivated.

Speed controls for universal motors are easy to make, as they just reduce the average voltage seen by the motor. Universal motors are found in most low-cost portable power tools intended for

operation on 230V AC mains. The field winding is wired in series with the armature winding and brushes are used to excite armature. These motors are quite simple, and have a good power to weight ratio for portable power tools. They run very fast and are usually very noisy. Aside from the brushes that are easily replaced, there is little to go wrong. Unless you have complicated electronics…

The speed control circuit reduces the AC mains voltage seen by the motor. A phase angle trigger circuit is used to vary the proportion of the AC cycle that is passed onto the motor by the triac, thereby controlling the speed. A lamp dimmer works on the same principle by varying the voltage seen by lamp.
Incandescent (filament) lamps present a simple resistive load. A universal motor presents a combination of a resistive and inductive load. This can confuse some triac control circuits used in lamp dimmers which is why a more specialised circuit is used for motor speed control.

(A triac is a semiconductor switch that is used to regulate AC power. It is a four-layer device that has a sensitive gate input which can be triggered to turn it on for the duration of the AC half cycle. The point in the half cycle that is triggered determines that amount of power passed to the motor. So, by triggering the triac early in the half cycle, more power is passed to the motor, conversely, later triggering reduces the power.)

The external speed control box shown is designed to deal with inductive loads, but is still quite simple. A digital display indicates the voltage seen by the motor – it is only a guide, because the circuit is simple and doesn't read correctly if the motor is disconnected. This speed controller is not designed to work with induction motors such as found in larger stationary machines. A much more complex circuit that can vary the frequency seen by the motor is required for controlling the speed of an induction motor.

I intend to use the Dremel "400 ~~digital"~~ with the bypassed electronics, and the external speed control circuit with a flexible shaft. I expect it will provide many more years of service.