



# CONTROLLING POWER

In this instalment of Workshop we look at the construction of a digital-to-analogue converter to add onto our user port system. The addition of this simple device will enable us to control analogue devices from the user port and produce digitally synthesised sound.

For this project we have opted to use a ready-made digital-to-analogue converter on a chip, although it is possible to build a circuit from discrete components. This reduces a complicated process to a relatively simple circuit.

The analogue output from this chip, the DAC chip, is buffered with an amplifier on a second chip. The output from this is fed directly to one output and through a capacitor and level control to the other output.

**Step One:** Cut the case to accommodate the two system bus connections. An outlet socket may also be cut for use in future projects.

**Step Two:** Cut the veroboard to size (30 holes by 16 strips). Now make the track cuts as shown in the diagram. Solder the chip sockets in place first, then the wire links. The two capacitors should be put in position next. It does not matter which way around they are fitted. If you wish to fit the bus extension socket, then solder this in place now and fit the ribbon cable.

**Step Three:** Fit the four sockets into the case, with the potentiometer. Make the connections between these with the tinned wire. Finally, make the three flying leads to the circuit board.

**Step Four:** Plug in the two chips and the converter is complete. Note that the two chips do not plug in the same way around: the D/A converter chip should be positioned so that the notch is to the left when viewed from above, with the male bus connector uppermost; the amplifier chip's notch should go to the right.

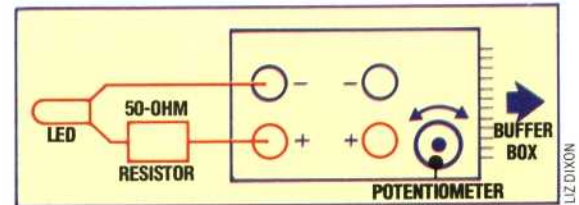
Once you have built the digital-to-analogue converter and carefully checked all the connections, you can test the unit. The D/A converter will convert any eight-bit binary value placed in the user port data register into a voltage. This voltage is output from the unit in two ways. At the DC (direct current) output socket pair, a DC voltage in the range 0 to +2.5v is obtainable, corresponding to digital user port values from 0 to 255. The other output pair is to enable us to simulate an AC (alternating current) output. The overall voltage level is controlled by a potentiometer and can be adjusted to suit the required input to another piece of apparatus.

In order to test the unit, we can devise a simple

experiment to alter the brightness of an LED. To do this the following steps should be carried out: **Step One:** An LED, of the type used in the original buffer box, (see page 523), should be connected in series to a 50-ohm resistor.

**Step Two:** The D/A converter unit should be connected directly to the buffer box, which in turn should be connected to the user port and have power supplied to it in the usual way.

**Step Three:** The LED and resistor circuit should be connected across the DC output sockets on the D/A converter box and this program run:



```

10 REM **** CEM64 D-TO-A TEST PROGRAM ****
20 DDR=56579:DATREG=56577
30 VL=127
40 POKE DDR,255:REM ALL OUTPUT
50 POKE DATREG,VL
60 PRINT VL
70 GET A#
80 IFA#<>"Z" AND A#<>"X" THEN 70
90 IF A#="X" THEN DV=1
100 IF A#="Z" THEN DV=-1
110 VL=VL+DV
120 IF VL<256 AND VL>=0 THEN 50

```

```

10 REM **** BBC D-TO-A TEST PROGRAM ****
20 DDR=%FE62::DATREG=%FE60
25 value=127
30 ?DDR=255:REM ALL OUTPUT
40 REPEAT
55 ?DATREG=value
57 PRINTvalue
60 A#=%GET#
62 IF A#<>"Z" AND A#>"X" THEN 60
65 IFA#="X" THEN dv=1 ELSE dv=-1
67 value=value+dv
70 UNTIL (value>255 OR value <0)

```

This simple program dedicates all eight user port lines to output by placing 255 (i.e. 1111111) in the data direction register. An initial value of 127 is then placed in the user port data register. By pressing the Z or X keys, the value in the data register is either decremented or incremented correspondingly. The program is terminated when the value in the data register falls outside the range 0 to 255.

By increasing the *digital* value present in the data register we can produce increasing *analogue* voltages supplying the LED. As the voltage increases to an acceptable level, the LED will start to glow, dimly at first, and then more brightly as the voltage is further increased, until maximum brightness is achieved when the value 255 is present in the user port data register.

If your LED fails to light, try reversing the connections to the D/A converter box, before checking any further for possible faults. Unlike a normal bulb, which lights no matter which direction the current flows in, an LED will only light when the current is flowing in one particular direction.

## Extract The Digit

The digital-to-analogue converter shown here features an excessively large potentiometer stalk. This is unnecessary, and should be trimmed to accommodate a control knob. Readers may well appreciate that in shopping for electronic components you must often take what you can get and make it fit



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