EDITION 1

Assembly Manual

Mini 1.5V to 9V DC Converter

(PCB and components only)

K-3231

DICK SMITH ELECTRONICS

ACN 000 445 956

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This tiny project allows you to replace those expensive 9V batteries with more cost-efficient 1.5V cells. It uses only three components and is smaller than the 9V battery it replaces.

Back in the November 1990 issue of Silicon chip, we published our smallest project ever (DSE Cat.No.K-3230). It used just three electronic components and allowed a 1.5V cell to replace a more expensive 9V battery. You could use any type of 1.5V cell as well - either AA, C, D, N or AAA.

Of course, the bigger the cell, the longer it lasted.

There was just one drawback – the unit was larger than a 9V battery which meant that it could not be fitted inside the device to be powered. This revised unit overcomes that problem by using a much smaller toroid core and a revised PC board. It now measures just 17 x 43 x 16mm which means that it will fit comfortably inside a 9V battery compartment.

The new toroid core is cheaper than the original unit too, which means that the new unit costs a few dollars less than the previous version.

Circuit diagram

Fig.1 shows what's inside the TL-496, while Fig.2 shows the circuit details.

At the heart of the circuit is IC1 which is a TL496CP switching inverter. We gave a detailed explanation of how this IC works in the November 1990 issue, so we'll just briefly cover the circuit operation here.

Inside IC1 is an oscillator that drives a switching transistor at a rate that depends on the load current. The higher the load current, the higher the switching frequency, which can be anywhere from a few Hertz up to 2kHz.

This internal transistor alternately switches the current through inductor L1 on and off. When the transistor is on, current flows and energy is stored in the inductor. When the transistor turns off, the voltage across L1 rises and the inductor dumps its stored energy into the 220µF capacitor.

An internal feedback and voltage regulator circuit ensure that the output is maintained at 9V. The maximum output current which can be drawn from the circuit is about 40mA. At this current, a typical 9V battery would not last long at all.

By contrast, a 1.5V alkaline D-cell will last for about 20 hours, despite the considerably higher input current required.

Note that because the circuit steps the voltage up six times (from 1.5V to 9V) and because the circuit is not 100% efficient, the current consumed goes up by a factor of twelve (eg, if the load current is 2mA, the input current is 25mA).

Putting it another way, the circuit is about 50% efficient, since the input current goes up by a factor of twelve, not six. Even so, it is still cheaper to use the converter than a 9V battery.

Construction

The PC board for this project is coded SC11111921 and measures 43 x 17mm. Fig.3 shows the assembly details.

The inductor consists of two layers

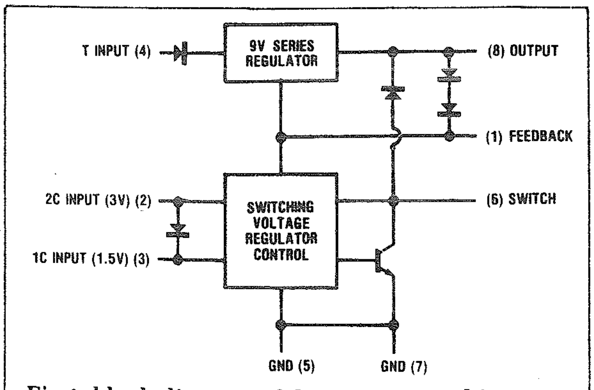
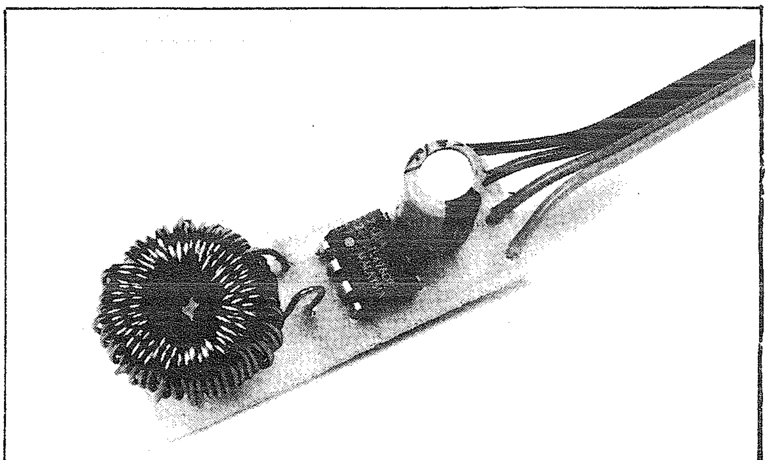


Fig.1: block diagram of the TL496 switching converter IC. It uses a variable-frequency oscillator to drive a switching transistor.

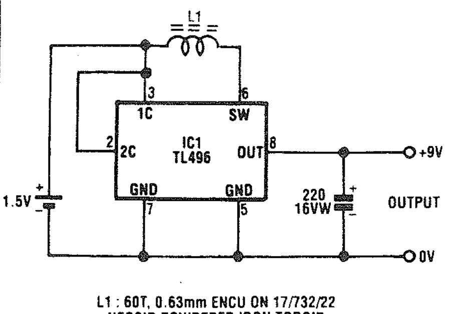


Parts List

1 PC board, code SC11111921, 43 x 17mm
1 Neosid 17-732-22 toroid core, 14.8 (OD) x 8 (ID) x 6.35mm (H)
1 Hookup wire
2 metres of 0.63MM enamelled copper wire

Semiconductors
1 TL496 DC converter (IC1)

Capacitors
1 220uF 16/25 PC electrolytic



1.5V TO 9V DC CONVERTER

Fig.2: in addition to the IC, the final circuit uses an inductor, a single capacitor & a 1.5V battery. The circuit can also be powered from a 3V supply, in which case the connection to pin 3 is deleted.

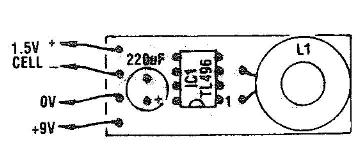


Fig.3: install the parts on the PC board as shown here. The inductor (L1) consists of 60 turns (approx.) of 0.63mm ECW on a small toroid core.

of 0.63mm diameter enamelled copper wire (ECW). To wind the inductor, first take a 2-metre length of wire and thread it half-way through the toroid core. The first layer is now wound using one end of the wire, followed by the second layer using the other end.

Keep the turns tight and as closely spaced together as possible. There should be about 60 turns total, although the exact figure is not critical.

Clean and tin the ends of the leads carefully before soldering the inductor to the board. The external leads to the 1.5V battery can be wired to a suitable 1.5V battery holder (optional).

When the assembly is complete, install the battery and measure the output voltage from the board. It should be very close to 9V.

Exercise extreme caution if you intend soldering a battery snap connector to the output terminals, to mate with an existing snap connector. In this case, you will have to connect the red lead to the negative (-) terminal of the board and the black lead to the positive (+) terminal to ensure correct polarity at the battery snap terminals.

Alternatively, you can use output terminals that have been salvaged from a discarded 9V battery. Check the output polarity carefully with your multimeter before connecting the project to any equipment.

Depending on your situation, you can use either an AA, C or D-size battery with the circuit. Table 1 shows the expected input currents for loads ranging from 0.1mA to 40mA. A D-size cell will last longer than AA or C cells, especially for high input currents, while alkaline cells will last longer than carbon zinc types.

Finally, you can modify the unit so that it functions as a 3V to 9V converter by cutting the track between pin 2 and pin 3 of the TL496 and also cutting the track between pin 3 and the coil (positive input side). Then place a small link from pin 2 to the coil (positive input side). This will not make the circuit any more efficient but because the input current is halved, will approximately double battery life.

TABLE 1

Load Current	Input Current
no load	50uA
0.1mA	1mA
0.5mA	6mA
1mA	12mA
2mA	25mA
5mA	65mA
10mA	134mA
20mA	250mA
40mA	460mA

Notes & Erratas