9V Plugpack Doubler

This simple circuit develops +18V or -9VDC from a 9V plugpack

by LEO SIMPSON

While DC plugpacks with nominal outputs of 9V can substitute for batteries in many applications, they are not suitable for circuits requiring balanced positive and negative supplies, or 15 to 18 volts DC. This simple circuit can be used to develop either a negative 9V DC rail or 18V DC from a plugpack.

Using this approach, circuits using op-amps which require positive and negative rails can be run from a 9V DC plugpack rather than using two 9V batteries.

The ideal approach in designing a voltage multiplying circuit is to use a high frequency inverter based on a transformer, as these are very efficient. But since we intend the circuit to be run from a plugpack, efficiency is not a major consideration. We have power to burn, relatively speaking. So our doubler circuit employs the ubiquitous timer IC, 555.

The 555 is connected to operate as a free-running oscillator producing a square wave of close to 50% duty cycle. It runs at the fairly high frequency of about 31kHz (31168Hz calculated) to minimise ripple problems and enable the use of a small coupling capacitor to the rectifier system.

The rectifier is a half-wave voltage doubler which produces approximately 18VDC from the square wave output of the 555. Alternatively, by re-arranging the diodes the circuit can be made to deliver minus 9VDC, which is handy for op-amp circuits requiring positive and negative supplies.

Readers may wonder how it is that a simple circuit like this can virtually double the input voltage without the need for an intervening transformer. This can be explained by reference to figure 1. In this diagram, the 555 is shown simply as a DPST switch which rapidly toggles its output between the positive and negative supply rails.

With the 555 output connected to the negative rail, capacitor C1 is charged, via diode D1, to the value of the positive rail (say 9V). Then, with the 555 output switched to the positive supply, the negative end of C1 is suddenly jacked up by the value of the positive supply (to say 18V). C1 can then deliver a substantial current pulse to C2 via diode D2.

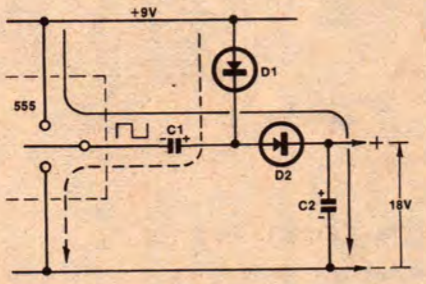


FIG. 1

Long arrows on Fig. 1 show the directions of current flow for the two halves of this charging cycle.

A number of repetitions of this cycle will charge C2 up to a positive voltage which is almost twice the amplitude of the square wave input from the 555. Perhaps this mechanism of operation is better explained by the alternative title for this rectifier configuration, "diode pump".

So if it makes it easier to understand, think of this diode configuration as a "diode pump". C1 and the diodes can be thought of as gradually pumping C2 up to twice the input voltage swing.

Fig. 2 shows the alternative connection of the "diode pump" to obtain a negative output voltage. When the 555 output is positive C1 is charged by diode D1. Then, with the 555 output negative, C1 is discharged via diode D2, which charges C2. By this means, C2 develops a negative voltage.

In the above explanation we have neglected the effects of voltage losses in the 555 and in the rectifier diodes. There are also charging losses in the two capacitors. It may seem that our complete circuit also ignores these losses. After all, it starts with a nominal 9V plugpack and ends with 18VDC output.

This is explained by the fact that most plugpacks have very poor regulation. While they may deliver 9V at their rated load, their output voltage rises considerably

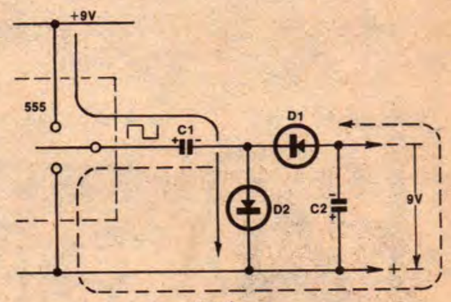


FIG. 2

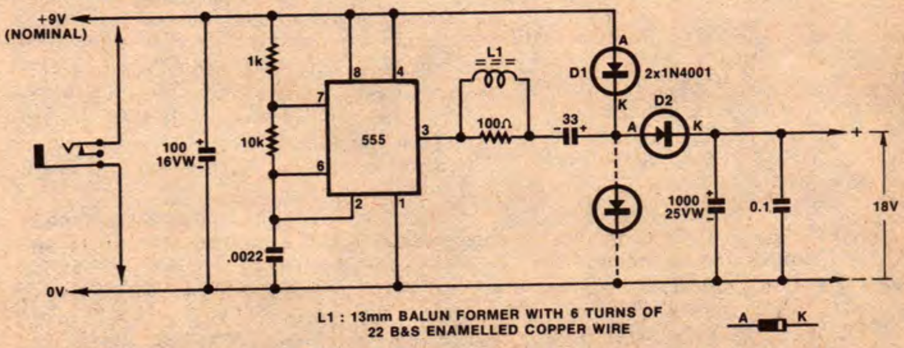
when lightly loaded. So when used with this circuit, typical 9V plugpacks will deliver 11 to 12VDC, which is enough to produce 18VDC at the output of the doubler.

Maximum load on the 18V output is about 20 milliamps, and the same figure applies for the -9V version.

Unloaded, the current drain of the doubler circuit from the plugpack is about 10 milliamps.

An inductor shunted by a 100 ohm resistor is connected in series with the rectifier system. This removes the switching transients produced by the rapid switching of the 555. A 1000uF capacitor connected across the output provides very good filtering and produces a DC output which has far less hum and noise than the roughly filtered input from the plugpack source.

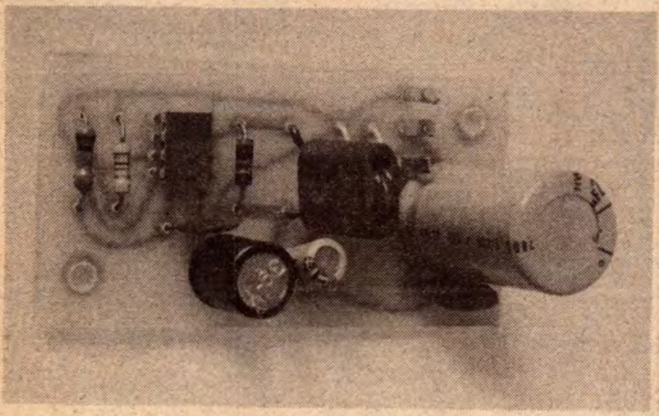
All the components are accom-



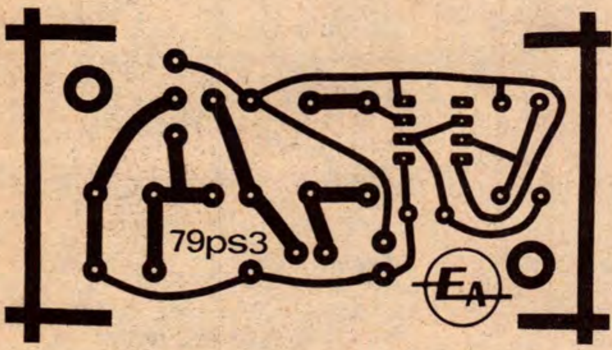
9V PLUGPACK DOUBLER

2/PS/-

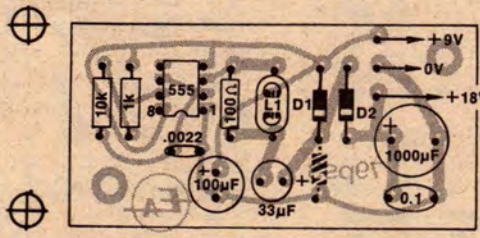
9V PLUGPACK DOUBLER



This shows the Doubler PCB wired for +18VDC.



At left is the actual size artwork for the PCB.



Diodes and capacitors should be connected as shown in Figures 1 & 2 to obtain +18V or -9VDC.

PARTS LIST

1 PCB, 70 x 35mm, code 79ps3
1 555 timer IC
L1: 6 turns of 22 B&S enamelled copper wire on a 13mm balun former
1 x 10k, 1 x 1k, 1 x 100 ohm, all ¼W resistors
1 x 1000uF/25VW PC electrolytic
1 x 100uF/16VW PC electrolytic
1 x 33uF/16VW PC electrolytic
1 x 0.1uf/100VW metallised polyester
1 x .0022uF/100VW metallised polyester

Note: Component ratings are as used in our prototype. Components with higher or lower ratings may be used, provided their ratings are not exceeded and that they will fit into the PCB.

modated on a small PCB measuring 70 x 35mm and coded 79ps3. Assembly is a straightforward matter.

The inductor is a standard 13mm balun former wound with six turns of 22 gauge enamelled copper wire. If a negative output version of the circuit is required, reverse the polarity of diode D2 and the two associated capacitors (33uF and 1000uF) and change D1 to the position shown dotted on the PCB component diagram.

We should register a note of caution on the circuit. If the intended use is for powering low level circuitry, it may be necessary to keep the doubler PCB well away for the circuit in question, otherwise interference may result. Alternatively, shielding the doubler PCB may be the solution.