

TALKING ELECTRONICS®

\$1.80★

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Issue No 11

2 'Add-ons' for the TEC-1

★ 8x8 DISPLAY

★ RELAY DRIVER BOARD



DUAL POWER SUPPLY
BLACK JACK
FM BUG

Editorial...

Vol. 1 No: 11.

Understandably, the introduction of a computer kit for under \$100 created quite a reaction. In the weeks following the release of issue 10, orders came thick and fast.

But we soon found some supply problems creeping in. Many of the chips used in the computer became difficult to obtain. And obviously the omission of any one component makes a kit useless. One of the factors causing this is the Worldwide rise in demand for components. It began in the U.S. and has increased dramatically over the past few months. It has come to the stage of almost completely exhausting supplies of some components. And we suffered.

As you know, the business world has wound itself down to the lowest level possible during the recent years of minimal trading and no-one is holding surplus stocks.

But now it looks like the tide has turned. Everything is getting into gear. So don't be left behind.

If you have been waiting for a project which will teach you about the actual workings of a computer, the TEC-1 is the answer. If you further delayed your purchase pending the scope of the project, I hope this issue will allay your fears. The TEC-1 is not a one-off, half-finished, one-issue-and-it's-forgotten project. It's a continuing fully-fledged applications machine.

Behind the scenes we have been working frantically on "add-ons", programming details and presentation which will make the TEC-1 a perfect demonstrator for both school and personal use. We have now completed (nearly) NINE add-on boards, making the TEC-1 one of the most universal micro projects on the market.

The fact that we chose the Z80 chip and Machine Code programming takes us far ahead of anything else on the market. The Z80 is the lowest priced, most advanced, processor available and after only a few hours experimenting with loading the programs from last issue, a number of readers have phoned to say how much they have learnt.

It's an ABSOLUTE learning tool.

And THE most interesting fact about Machine Code programming has never ever been mentioned before.

Once you remember some of the Z80 codes, you can read the program just like a sentence in English.

Some of the add-ons already in the final stages of development include a speech board, additional memory, video display board and EPROM burner, remote control keyboard, in/out port expansion including CTC to give real-time capabilities, latch board with 24 outputs per board and a latch board with 16 buffered outputs and one 8-bit input (1 byte). The latest request, from Allan Bolton, was to be able to examine the registers. In an hour or so, Ken had re-written the monitor program to be able to do this. Such is the universality of a computer. Its possibilities are endless.

To date we have delivered nearly 1,000 computers to our readers. If you haven't got into computers yet, now's your chance.

Otherwise YOU'LL be needing the special disk put out by APPLE computers!

Colin Mitchell.

PUBLISHER

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TALKING ELECTRONICS is designed by Colin Mitchell of CPW INDUSTRIES, at 35 Rosewarne Ave., Cheltenham, Victoria, 3192. Australia. Articles suitable for publication should be sent to this address. You will receive full assistance with final presentation. All material is copyright however up to 30 photocopies is allowed for schools and clubs.

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TECHNICAL

Ken Stone

ARTWORK

Ken Stone

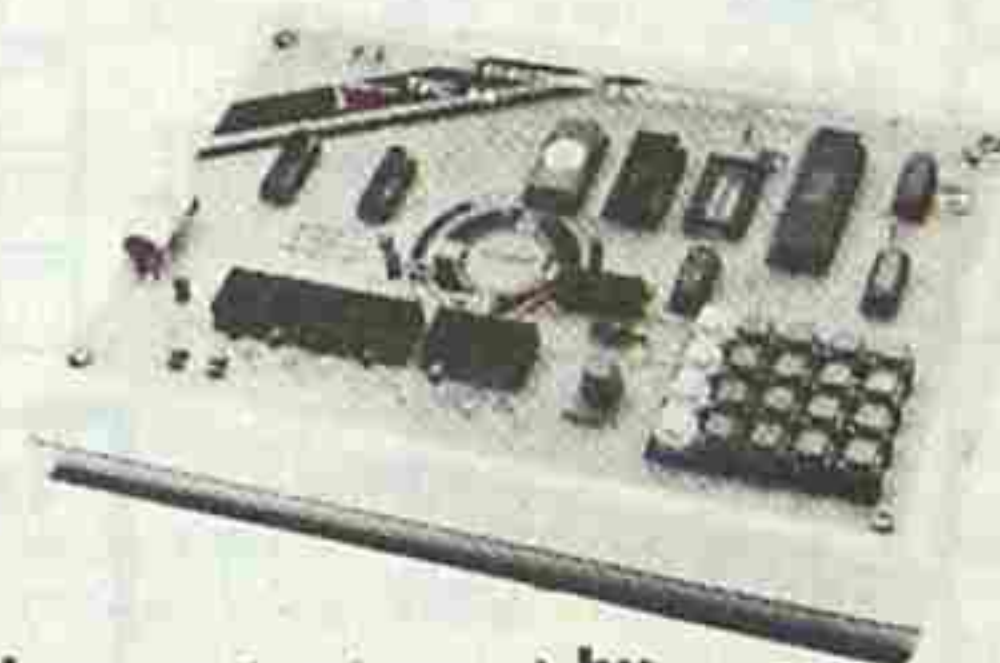
ENQUIRIES

10 Minute queries will be
answered on 584 2386 9am - 6pm.

ADVERTISING

Talking Electronics: (03) 584 2386

COMING!
Look out for our next model, the TEC-1A. It has the regulator under the PC and two new display drivers. Either model will fit onto the computer case and these are available from TE for \$19.50 incl. post and packing.

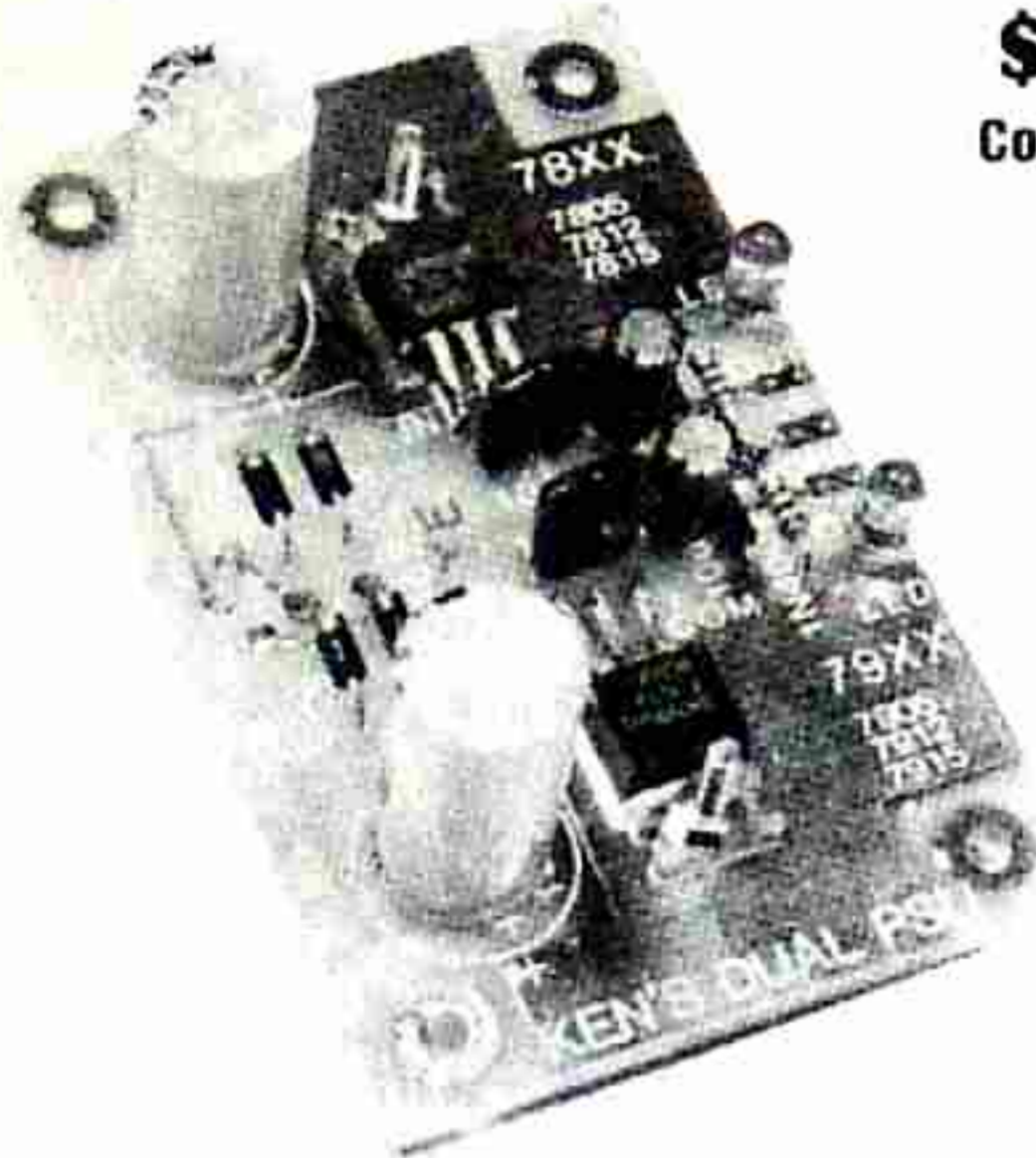


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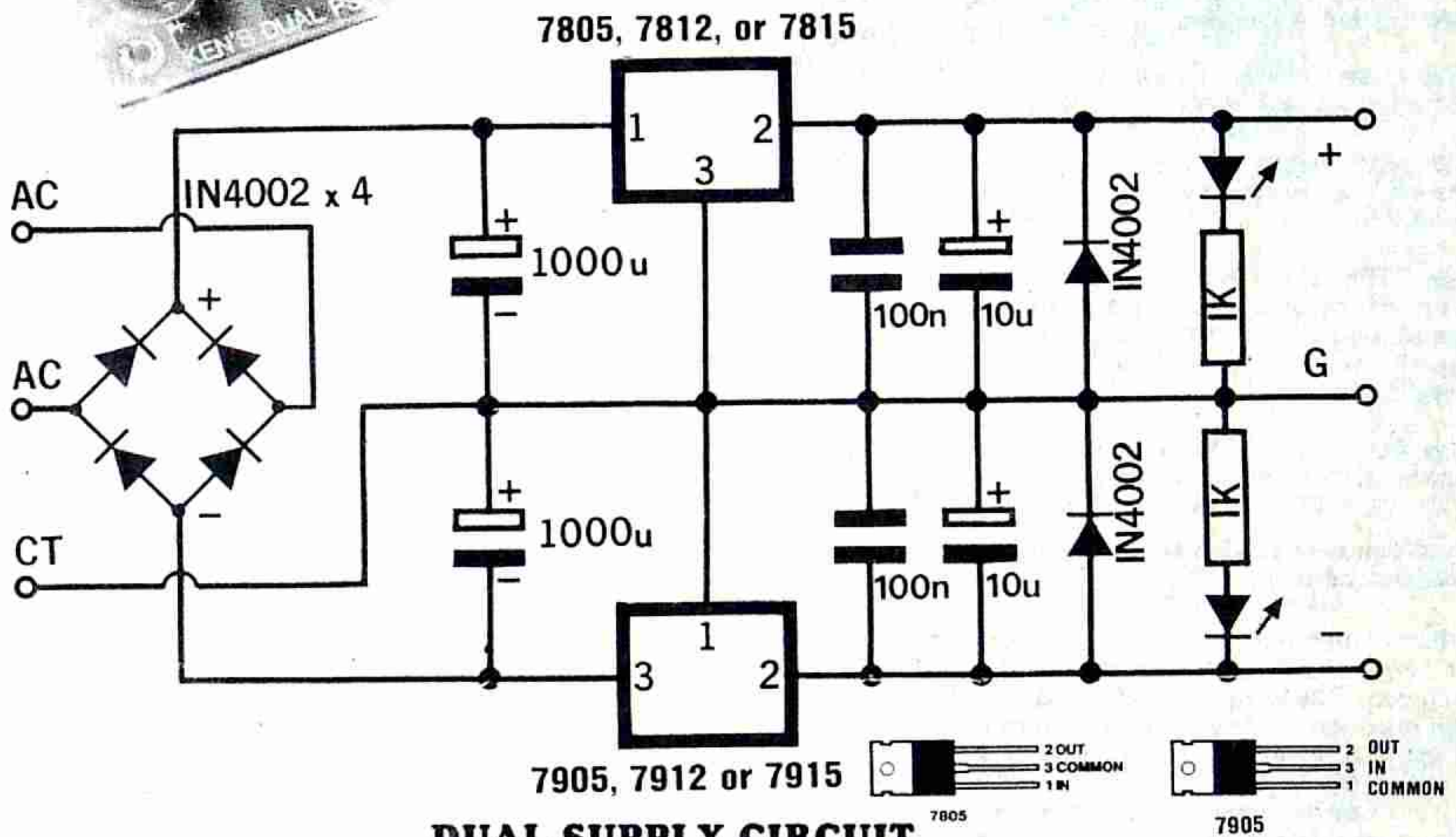
KEN'S

DUAL POWER SUPPLY



\$6.90
Components

\$3.30
PC Board



DUAL SUPPLY CIRCUIT

'Necessity is the mother of invention.

That's how this project came to be.

It's a simple 500mA power supply providing a positive and negative rail with an output voltage which is governed by the voltage of the regulator you use.

The PC layout is somewhat simplified by the fact that the board acts as the heatsink. It will dissipate a total of 5 watts for a rise of 75°C. This equates to 2.5 watts per regulator and will give a 600mA output when the voltage-difference between input and output is 4 volts.

If this voltage difference increases, the output current must be reduced to prevent overheating. If you don't understand this, it is discussed later in the article.

The main need for a simple dual power supply was born when Ken began designing synthesiser projects for future issues of TE. These were basically audio projects and they required both positive and negative rails.

As no dual supply is readily available on the market at a low price, he had to assemble one on Matrix board each time he needed a supply. After producing more than 7 of these, he decided it was time to present a PC design for TE. He could then take a PC board from stock and run up a supply in double-quick time.

This project is the result of specific needs and also fills a gap for a simple dual supply using the minimum of components.

PARTS LIST

- 2 - 1k ¼watt
- 2 - 100n ceramic or greencap
- 6 - 1N 4002 diodes
- 2 - 10mfd 16v electrolytics
- 2 - 1000mfd 25v electrolytics
- 1 - 7815 regulator (positive)
- 1 - 7915 regulator (negative)
- 2 - 3mm red LEDs
- 2 sets nuts and bolts
- small amount of thermal grease
- 15cm hook-up wire, 6 colours
- 1 - DUAL PSU PC BOARD
- 1 or 2 - 2155 transformers or 6672 transformer (see text).

It is mainly designed as a +15v and -15v circuit but can be used as a single 5v or 15v supply. It can even be used with different value regulators however this is not recommended as the power lost in the lower-voltage regulator will determine the maximum current.

Because there are a number of options for output voltages, it is necessary to know what you are doing and what parts will be required, before starting.

We will cover 4 possibilities and show which transformer is required. If you use the wrong transformer or the wrong tapings, you will fail to get the full voltage and current.

The two transformers we have selected are the 2155 and 6672.

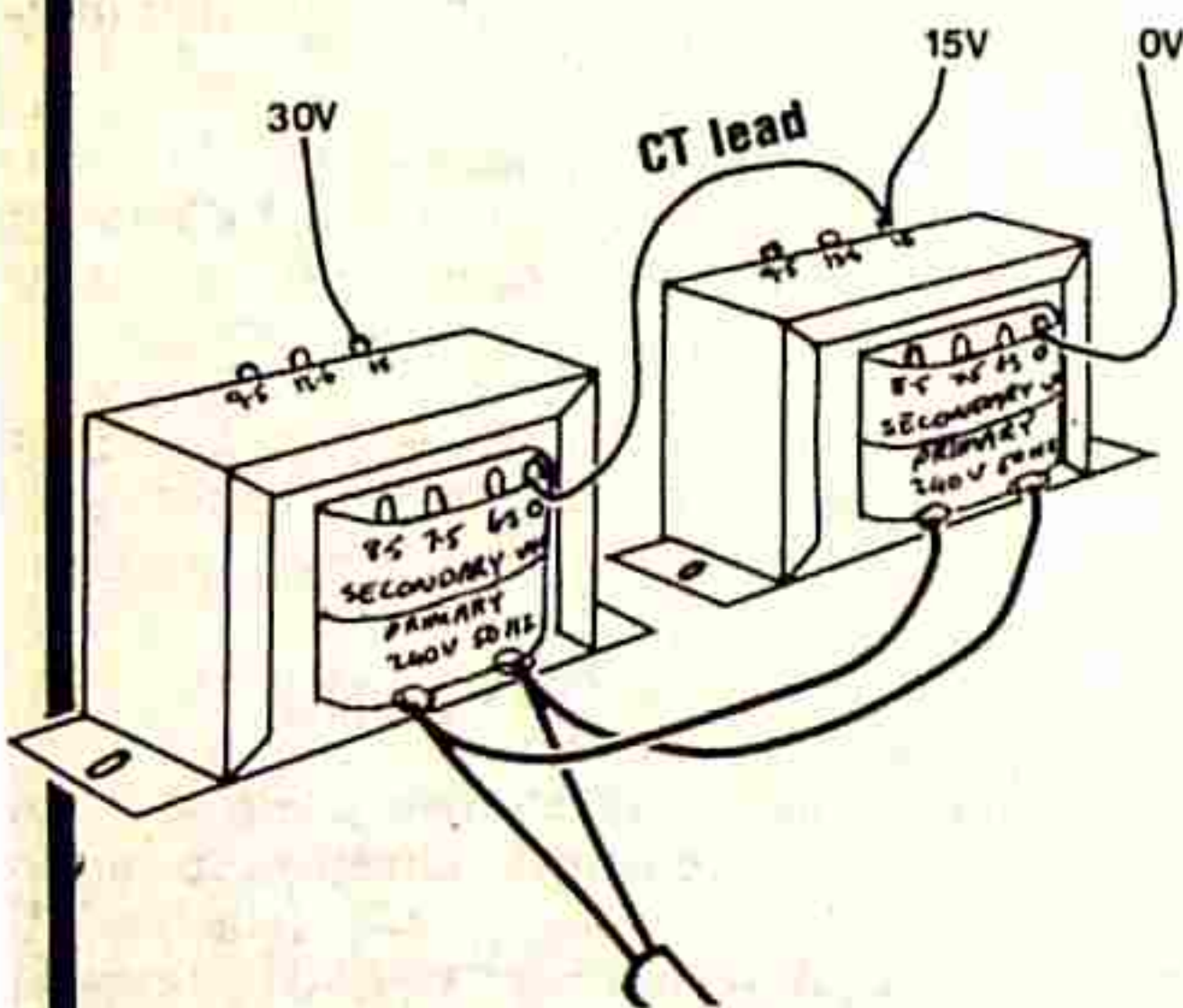
Although they are not ideal designs, they are the cheapest and most readily available.

The 2155 is a 15v type, rated at 1 amp. These are AC values and later in the text you will see how this current rating must be reduced for DC conditions.

The 6672 is a 30v type @1 amp. Again, these are AC values.

In effect, two 2155's are equal to one 6672 transformer.

When using two 2155's, they must be connected as shown in the diagram. This is called PHASING and will produce a transformer equal to a single 30v winding. When phasing is correct, the voltage between the 0v tap on one transformer and the 15v tap on the other will be 30v. If the phase is incorrect, the output voltage will be zero across these terminals.



PHASING TWO 2155 TRANSFORMERS

To produce the correct phasing, the 240v inputs on each transformer are connected in parallel and the secondary terminals are connected in series. We are assuming that the primary and secondary of both transformers are wound in the same direction.

HOW THE CIRCUIT WORKS

The 4 diodes form a full-wave bridge rectifier but the operation of this bridge and the transformer is a little different to normal.

If we take the case of plus and minus 5v using a single 2155 transformer, we can explain the operation as follows:

Take the positive half of the supply. The 7805 sees the transformer as two separate windings and receives a pulse of energy from one of the windings and one of the diodes near the 7805 during the first half of the AC cycle. During the second half of the cycle, the other winding supplies energy to the 7805 via one of the lower diodes.

At the same time, the alternate winding of the transformer is supplying power to the negative regulator via the other two diodes in the bridge.

This means both windings of the transformer are delivering throughout the cycle and two of the diodes are in use at any one time.

+15v -15v MODE

This is the most useful mode for this project. It provides an ideal positive and negative rail voltage for op-amps and other dual-rail chips.

To supply this voltage you will need two 2155's or a 6672 transformer. See the notes on phasing two 2155's to obtain the 0v - 15v - 30v outputs.

SINGLE +15v SUPPLY

In this mode a single 2155 transformer will be needed and one link must be made on the board as follows:

The two lower diodes are connected at their anodes and this point is connected to the CT hole on the board with a jumper wire.

The 0v and 15v tapings of the 2155 are connected to the other 2 input lines. The output is taken from the +ve and ground terminals.

SINGLE 5v MODE

This mode requires a single 2155 transformer plus the link as described in the previous mode. The 0v and 7.5v tapping on the 2155 are used for this mode to prevent the positive regulator overheating.

+5v -12v MODE

Whenever two different voltage regulators are used in this circuit, the lower voltage regulator will have a considerably reduced output current. This is due to the input voltage to the board being high to suit the other regulator. It is not possible to adjust the taps so say 7.5v for the lower voltage regulator and 12.5v for the high regulator. This is because the regulators take it in turns to receive a pulse of energy from each winding.

In this case the 12.5v winding on two 2155's must be used. This gives a very high voltage differential across the 5v regulator and will limit the output current to:

$$= \frac{2.5}{12.5\sqrt{2} - 5}$$

$$= \frac{2.5}{12} \text{ Amp}$$

$$= 210 \text{ mA}$$

AN OVERALL LOOK AT THE PC BOARD

This dual power supply project uses a double-sided PC board. This enables the regulators to be bolted directly onto the PC board so that no additional heat-fins are required for currents up to 500mA.

This provides a slight saving in cost and leaves your supply of heatsinks for high current applications.

The input to the board is designed for a centre-tapped transformer. You may not think a 2155 has a centre tap but this can be created by connecting the 7.5v tap to the CT connection on the PC board. When using a 6672, the centre voltage terminal is the 15v tap. The zero-volts and highest voltage tap are each taken to holes near the 'AC' identification. This gives us 3 input lines as found on a centre-tapped transformer.

The positive regulator goes in the 78xx position and the negative regulator in the 79xx position. They cannot be reversed or swapped over!

Nor will the board work with 2 positive or 2 negative regulators. You will notice the 'IN, COMMON and OUT' terminals are in different positions for the positive and negative regulators. This makes them non-operational in the wrong location.

The 100nF capacitor prevents high frequency oscillations from occurring. The 10mF electrolytic on the output provides a small amount of filtering.

The resistor and LED provide an indication of the size of the output voltage and when the power is applied.

The two diodes across the output are extremely important. They provide short-circuit protection in case the positive lead is connected to the negative terminal. If this were to occur, the current limiting inside the regulators would not detect the short and both would be damaged if the diodes were not present.

The way they operate is very clever.

The lower diode becomes forward biased when the positive is connected to the negative and thus it forms a short-circuit to turn on the 7815. The same occurs with the upper diode and the 7915. Thus we save two regulators from being destroyed for the cost of a couple of diodes.

CURRENT RATING

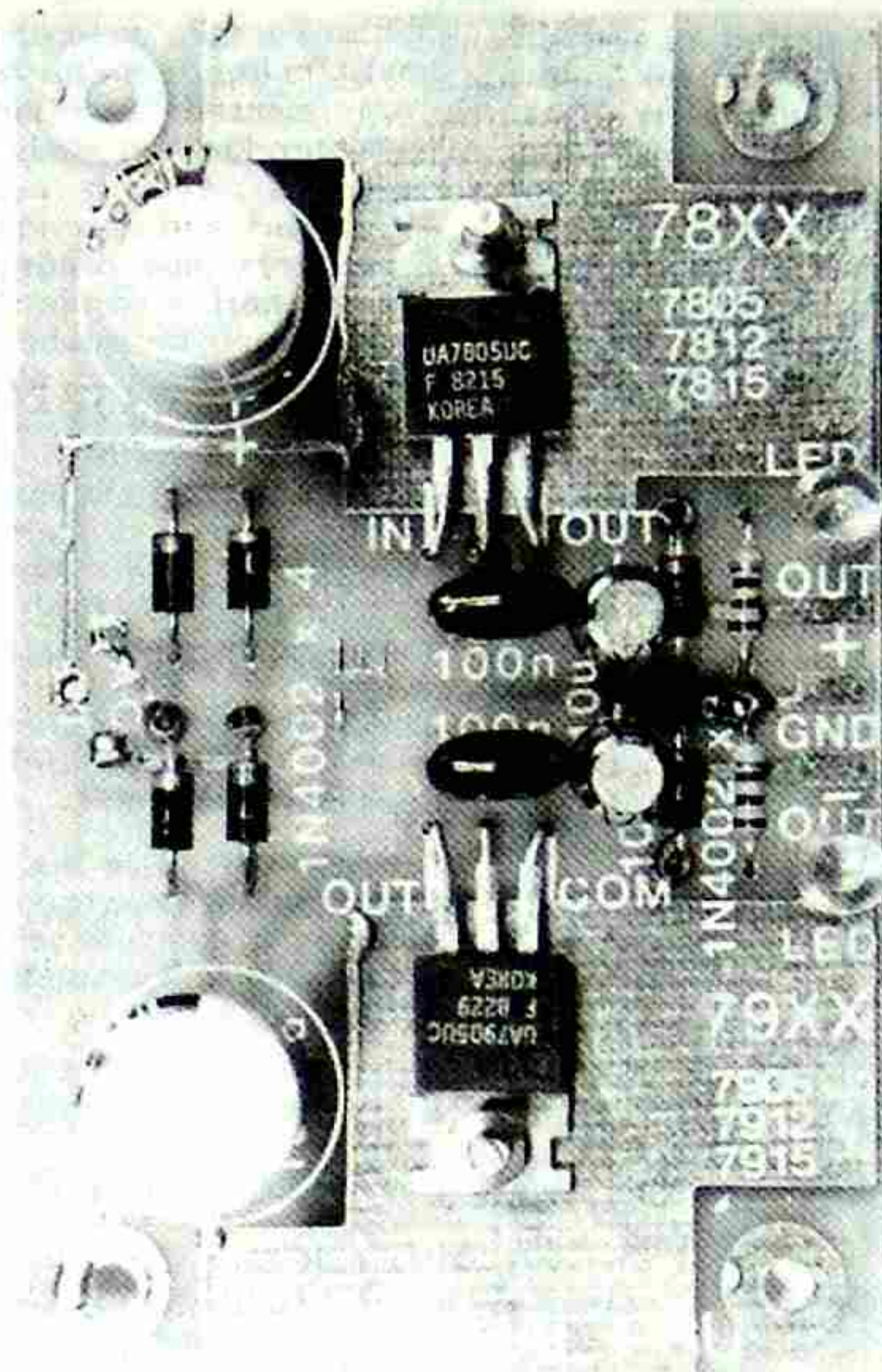
We consider the maximum current is 600mA for each of the regulators. This maximum coincides with two other design factors. They are:

1. The maximum current rating of the transformer and the maximum wattage which can be safely dissipated by the regulator and its heat fin.

We obtained the max. dissipation by loading our prototype until the temp of the regulator reached max. We then reduced the current and re-tested the temp of the regulator. You can generally judge the correct temp of the regulator by feeling it with your fingers. You should be able to touch it for at least 5 seconds. At this temp, the output current was measured as well as the voltage across the input and output terminals. These are the results:

Input voltage: 9v
Output voltage: 5v
Current: 625mA.

This gives $(9 - 5) \times .625 = 2.5$ watts. This is the power lost in the regulator and it must be transferred to the heat fin to prevent the regulator from over heating.



The complete layout with 7808 and 7905 fitted.

The other factor which determines the maximum current available at the output of a power supply is the rating of the transformer. We hear so much about the rating of a 2155 as being 15v at 1 amp. But little do we realize this rating is an AC value.

Working out the DC current rating is quite complex and we will approach it in a simple way.

The power rating of a 2155 is obtained by multiplying the secondary volts by the current. This gives $15v \times 1 \text{ amp} = 15VA$. This is 15 volt-amps but for a simple discussion we can call it 15 watts. This is the power rating of the transformer.

Now let's see what happens when we connect the transformer to a full-wave bridge rectifier circuit. The DC voltage which appears across the bridge circuit is $15\sqrt{2}$ volts DC. We readily accept and appreciate the higher voltage which appears across these circuits but fail to take into account the fact that the current rating must be reduced by the same ratio to maintain the value of 15 watts.

This means the output current must be reduced by the ratio:

$$\frac{15}{15\sqrt{2}}$$

This gives us 700mA max for the DC condition. This is a far cry from the 1 amp we so readily accept and expect.

The transformer will deliver higher currents if the load is increased however the output voltage will fall with the result that the regulator may drop out of regulation.

This will mean you will have to use a higher voltage tapping and the energy lost in the heatsink will increase dramatically.

When using the 7.5v tapping and drawing 600mA, this project will operate very reliably for long periods of time.

HEATSINKING

We have determined that the maximum power dissipation for each rail of the power supply will be 2.5 watts. When this amount of energy is being dissipated by the regulator and PC heatsink, the regulator is still cool enough to be touched on its plastic case with your finger.