solar powered receiver

ıe sky's the limit as far as fuel costs are concerned and, like Atlas, we e all finding it increasingly difficult to shoulder the burden. One ›nsolation: when Earth's resources are finally depleted, we will still be ıle to turn to the Mother of all energy, the sun.
owly but surely, solar cells are at last coming down in price, so that ıe of these days 'sun-powered' radios, kitchen equipment, heating stems, etc. are going to be economically viable.
evelopments in technology have always fascinated hobbyists and ientists alike and readers are invited to participate in an experiment ıd build a solar powered receiver.

'sound from the sun'

The need to save energy has become a daily part of our lives, not least because of the huge publicity given to it. The media are really going to town and so is the government, what with the advertisement campaigns on television, radio and in the newspapers. The effects are sometimes quite astonishing. The notion 'room temperature', for instance, seems to have dropped to a sub-zero level. People are reluctant to open the curtains in the morning for fear of losing precious warmth.
Contrary to what might be expected, the result is a vicious circle. For now that less energy is being consumed, gas and electricity companies are losing money and are therefore forced to put up their rates. The consumers then react by 'tightening the belt' even further, so that the prices go up again . . . etc. . . . etc.
The fact remains: the world's resources are being exhausted and at an alarming rate. There's only one thing for it, new substitutes will have to be found. One of the main alternatives currently being tried out on a large scale is solar energy. Developments have not yet reached the stage where the 'big' domestic appliances, such as washing machines and central heating systems, can be powered with solar energy, but the 'small' ones can and this also includes radios. The design described here provides a low-cost portable receiver that can be powered with surprisingly few solar cells.

Low power

Solar cells are now readily available in all sorts of shapes and sizes, although the smaller kind tend to be triangular. It is unfortunate that the really effective ones are very expensive. What's more, each cell can only generate about 0.5 . . . 0.6 volts, which must be taken into account when designing a solar powered receiver.
The circuit's current consumption and power supply voltage will therefore both have to be very low.
One design that goes a long way towards meeting these requirements is the medium wave receiver published in March (Elektor 71, p. 3-32). This receiver already has a current consumption low enough for it to be powered with solar energy. Unfortunately, however, the audio amplifier in the circuit requires a rather high supply voltage, which means an awful lot of solar cells would have to be connected in series for it to work!
Let's forget about the audio amplifier for the moment and look at the receiver section. The prospects here are much more favourable. The ZN 414 IC from Ferranti which is at the heart of the receiver fits the bill perfectly. The IC's supply voltage range is between 1.2 and 1.6 volts and only requires 0.3 mA. In other words, two or three tiny solar cells are all that is needed.

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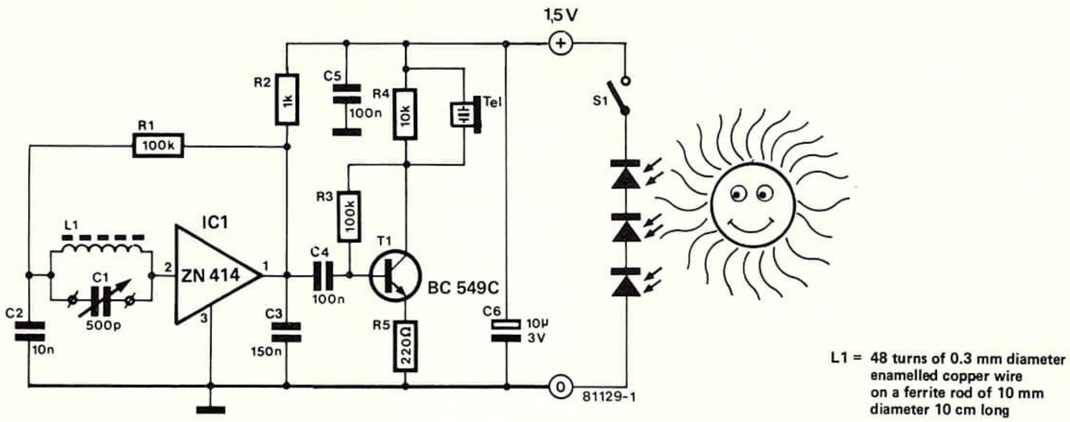
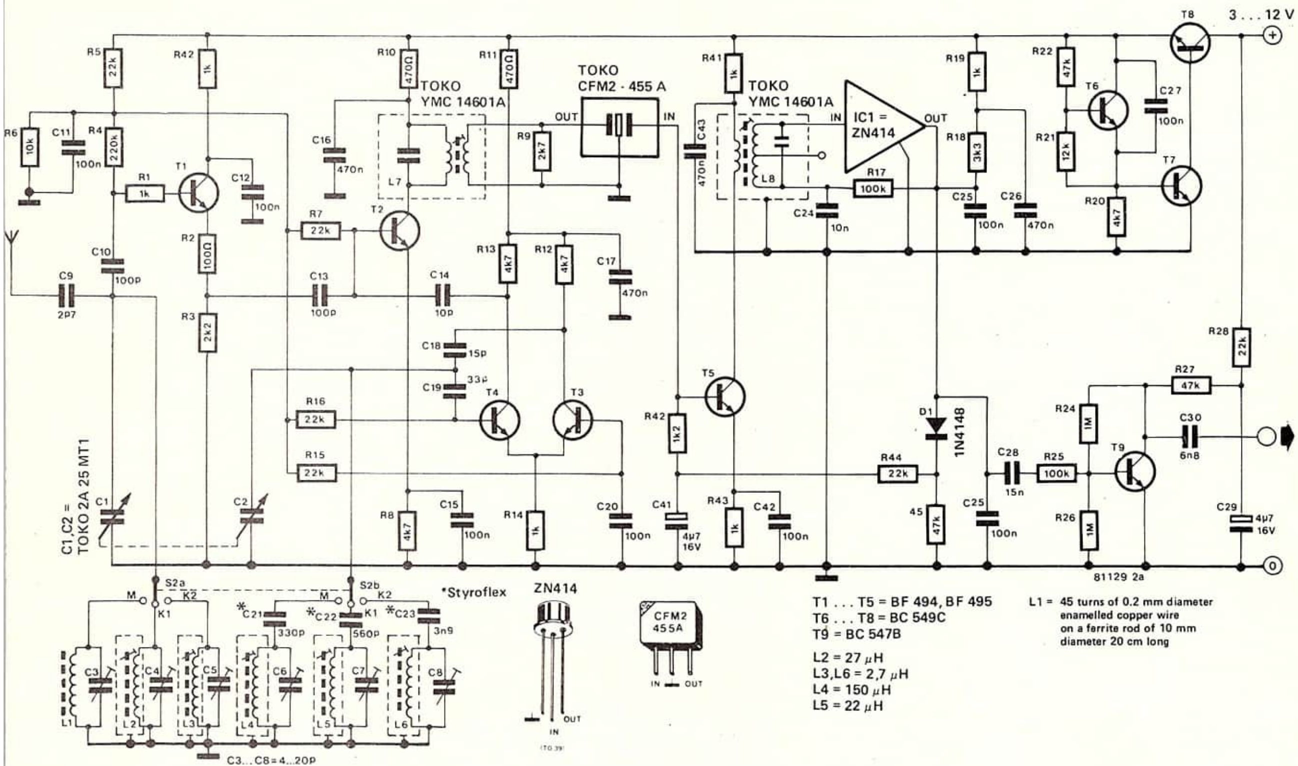


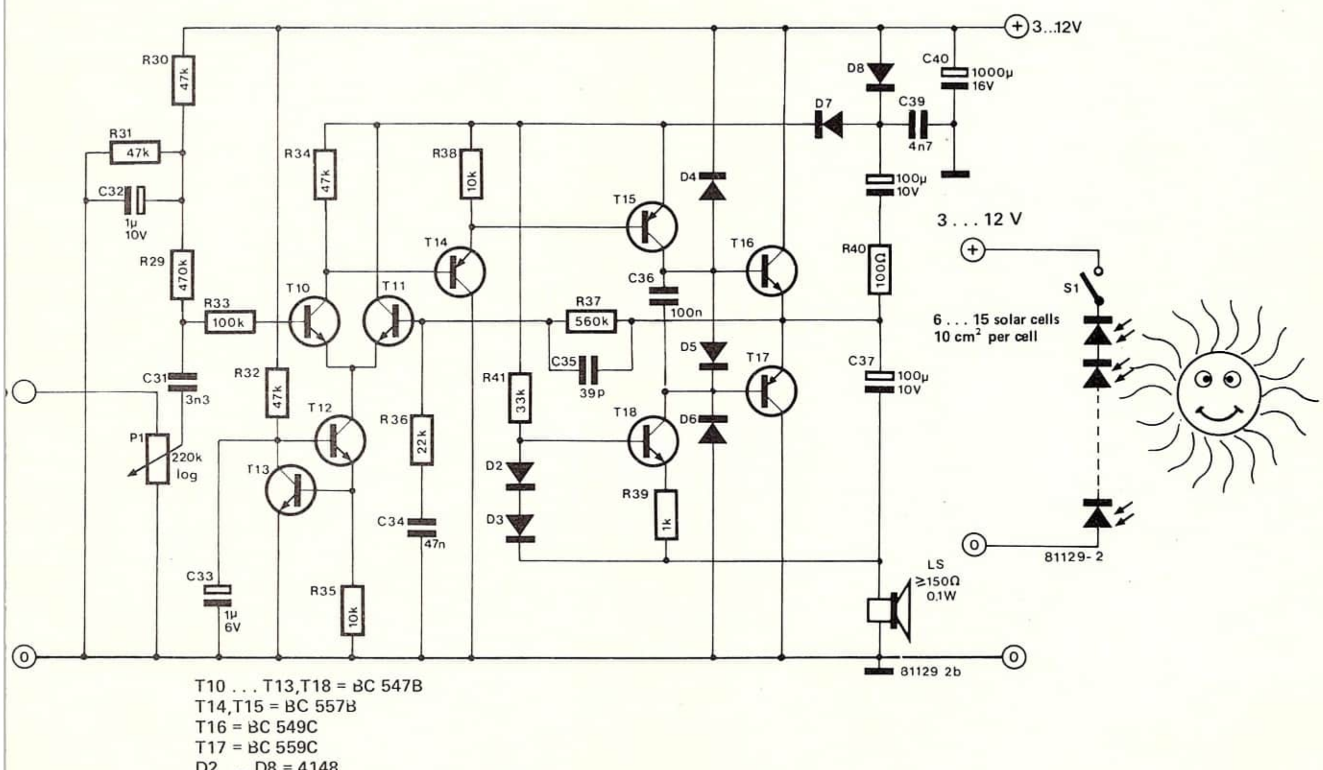
Figure 1. A solar cell receiver design for beginners. The circuit includes a ZN 414 IC, a single transistor that acts as an audio amplifier and a hig impedance crystal ear-phone.

Figure 1 shows a simplified version of the MW receiver which includes an ear-phone. Its current consumption is very low (less than 0.5 mA) and even on an overcast day the circuit provides a reasonable reception using the cheaper kind of solar cells. Provided three cells are used which, when combined together, produce about 1.5 . . . 1.6 V, the components may have the values indicated in figure 1. If the output of the cells reaches as high as 0.6 volts each, the third one may be omitted — only then it is advisable to lower the resistance of R2 to 470 Ω. The ear-phones must be high impedance crystal types, as otherwise T1 will be overloaded and the receiver will not function.
As can be seen from figure 1, this MW set needs very few components and yet it leads to a fully 'self-sufficient' radio.

Medium and short wave superhet

Obviously, a set that is run on only two or three solar cells is bound to have a flaw somewhere. You can hardly expect to drive a first-class receiver on a power supply of 1.5 V!
Readers who are prepared to dig a little deeper into their pockets and buy six cells can build a much better design that only requires a supply of 3 volts. The prototype constructed at Elektor did in fact look (and sound!) very promising. The circuit diagram is shown in figure 2. The receiver covers one medium wave band and two short wave bands. The first of the latter extends from 1.7 to 5.1 MHz and includes the popular 'fishermen's' frequency range. The second range is situated between about 5.1 and 15 MHz, and includes the 49 metre band (= at around 6 MHz). The prototype had a sensitivity of about 2 µV.
What kind of receiver is it? Well, basically, it is an ordinary superheterodyne with a few tricks here and there in the circuit to ensure low power operation with a minimum current consumption. Provided the volume is not turned too high, the whole receiver should not need more than 5 or 6 mA — which could get the circuit mentioned in the Guinness Book of Records!
Now let us take a closer look at figure 2. First of all, the audio amplifier. Regular readers will recognise it to be the 'ulp amp' published in last year's Summer Circuits' issue (circuit no. 55). The amplifier is constructed with ordinary transistors and operates at any supply voltage level between 3 and 12 volts. It will produce about 100 mW maximum power. The design of the output stage, which has no quiescent current adjustment, ensures that current consumption is extremely low (1.5 mA) which makes it eminently suitable for the solar cell power supply.
Now what about the actual receiver section?
The power supply voltage here is stabilised in the circuit around T6 . . . T8. Again, any voltage between 3 and 12 volts may be applied. Transistor T1 amplifies the RF input signal and S2 allows the tuned circuit to be switched from one frequency range to another. The local oscillator is built up around T3 and T4 and can, of course, be switched between the three frequency ranges with the aid of the same switch (S2b). Transistor T2 mixes the oscillator and the input signals, after which the 455 kHz IF signal is filtered by means of a ceramic filter (Toko CFM 2-455 A). The IF signal is then amplified and demodulated inside the ZN 414.
Time to go into a few more details.
The RF amplifier T1 is an ordinary amplifier stage which is biassed at an unusually low level. There's nothing extraordinary about the oscillator T T4, except that it is not usually cluded in receivers at this particu spot. The design selected is fai reliable at the low supply voltage a yet capable of producing a sufficien powerful oscillator signal. This oscilla has the added advantage that it o requires a single pole switch to sel the various frequency ranges. The os lator coils (L4 . . . L6) do not have ta The mixing stage T2 and the filt following it are quite straightforward. As for IC1, this was discussed in de in the article on the MW receiver p lished in March. Since the IC used, t ZN 414, consumes very little curre there was no need to look for a m economical component. Its automa gain control, however, has been adapt to suit the more serious nature of t present design. After all, the solar c receiver needs to be of a much hig quality than its MW counterpart (whi remember, was meant to teach buddi electronics enthusiasts how to bu thier first radio!) and the straightf ward version shown in figure 1.
Normally speaking, the AGC's ran would only be about 20 dB which certainly not enough for a good recei This is remedied by deriving an a ditional control voltage from the outp of IC1 by way of D1, R44 and R45, a result of which T5 will be 'cut off', th is to say, it will stop conducting, in t presence of powerful signals. Thanks this modification the AGC now has very reasonable range of about 50 dB.
All in all, the circuit is very cost-effect and although it looks rather comp cated at first it should be easy enou to build. The only really expensi items are of course the solar cells, b rumour has it that in the near futu these too will be available at a mu lower cost.





gure 2. A sophisticated triple wave band receiver which can be powered with solar cells. Inspite of the large number of transistors used, current ınsumption will only be about 5 mA.