Exploring Radio

by Graham Dixey C. Eng., M.I.E.R.E.   Part 4

Introduction

This radio makes use of the very versatile ZN414 radio chip but, unlike the little personal receiver, whose construction was described in the last issue of 'Electronics', this one has a rather more 'gutsy' output. This is obtained by the use of an audio amplifier chip, the TBA820M. This has a power capability of up to about 1.2 watts of audio power, depending upon the supply voltage and the choice of speaker. It is quite happy with any supply voltage between 3V and a maximum value dependent upon the speaker impedance, as follows.

4 ohm speaker – 9V maximum
8 ohm speaker – 12V maximum
16 ohm speaker – 16V maximum

However, in this design, the d.c. supply has been set at 9V so that any speaker with a coil impedance of 4 ohms or greater can be used. The prototype, shown in Photo 1, used an 8 ohm speaker and gave excellent results. The recommended value of supply voltage should be adhered to because it is related also to the design of the d.c. feed to the ZN414.

A further feature of this receiver is that it is dual waveband, with a choice of either medium-wave or long-wave listening selected with a slide switch. Photo 2 shows the fully assembled pcb.

The Ferrite Rod Aerial

Two separate coils are wound on a 100mm long ferrite rod. The medium wave coil consists of 55 turns of 30 swg enamelled copper wire (E.C.W.). These should be 'close wound', i.e. no gaps between turns. This coil should be wound fairly close to one end of the rod so as to leave plenty of room for the long wave coil. The latter consists of 250 turns which are 'scramble wound'. This means

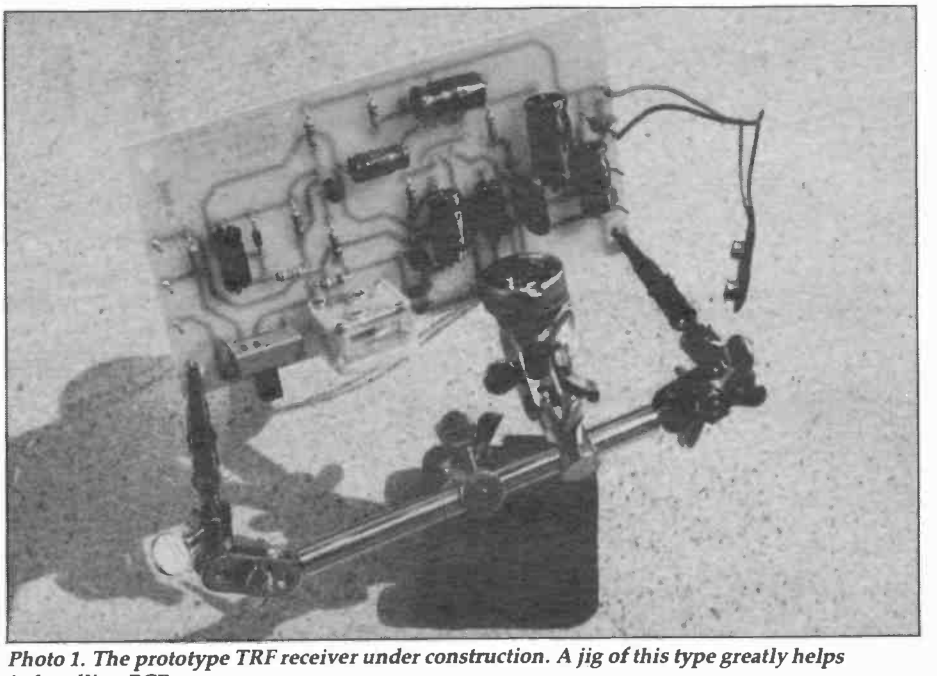

Photo 1. The prototype TRF receiver under construction. A jig of this type greatly helps in handling PCBs.

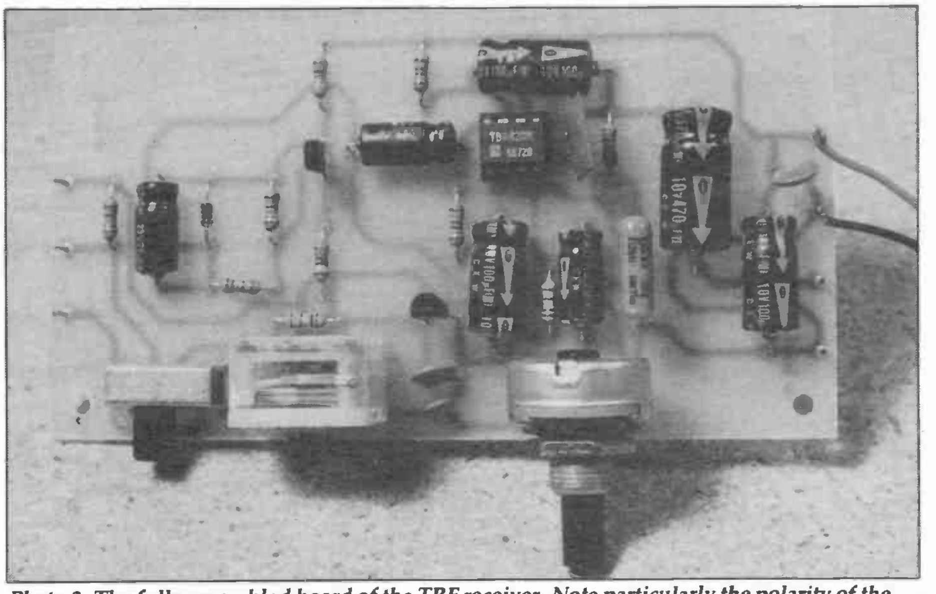

Photo 2. The fully assembled board of the TRF receiver. Note particularly the polarity of the electrolytic capacitors and the placement of other components.

that all attempts at neatness are cast aside (they're impossible anyway without a coil winding machine) and the turns are simply wound tightly over each other. If two or three centimetres of space are allowed for this coil and the turns, as they are laid on, are wound on first in one direction and then in the other, the general result should be a fairly uniform coil with just a hump in the middle (see photograph 3). The coils can be secured with short lengths of PVC tape but, in the example shown, 'superglue' was used instead. The usual precautions should be observed when using this adhesive, of course.

The Radio-Frequency Section

Looking at Figure 1 you can see that each of the coils is selected as required by a slide switch. A 220k resistor is connected across the long wave coil to improve the frequency response. Tuning is by a 150pF variable capacitor, which is provided by using the 'aerial' section of an AM Varitune tuning capacitor assembly. The input stage is decoupled by the usual filter consisting of a 100k resistor and a 10nF ceramic disc capacitor (R2 and C1). A 100nF ceramic disc decouples the output of the ZN414. This output connection also serves as the d.c. feed point for the ZN414 and is provided by a drive circuit, based around the ZTX300 transistor TR1. The supply voltage is dropped from 9V to 4.7V by R6, this value being stabilised by the zener diode ZD1. The emitter resistor, R5, of TR1 also sets the level of the Automatic Gain Control (A.G.C.) for the ZN414.

Photo 3. Compare the neatness of the medium wave coil (secured with glue) and the 'scramble wound' long wave coil (secured with a piece of PVC tape).

The Audio Amplifier

The output of the ZN414 is developed across the volume control RV1 and is coupled to the input of IC2 by C4. This chip has a number of discrete components associated with it, which establish its operating conditions and ensure its stability. The arrangement shown was found to be completely stable and gave an output of acceptable quality, bearing in mind the limitations of the fairly restricted bandwidth of a.m. transmissions anyway. The audio output is coupled to the speaker through a 470μF capacitor, C10. The d.c. supply to the receiver is decoupled by the capacitors C11 and C12.

General Comments

In the case of the capacitors C11 and C12, some readers may wonder why a small value capacitor (C12 = 100nF) should be included in parallel with a very large value capacitor, in this instance C12, which is 100μF. This is a situation which occurs in many circuits where high frequencies or high speeds (i.e. digital circuits) are used. The low value capacitor will invariably be specified as a 'ceramic disc' type while the larger capacitor will be found to be of a totally

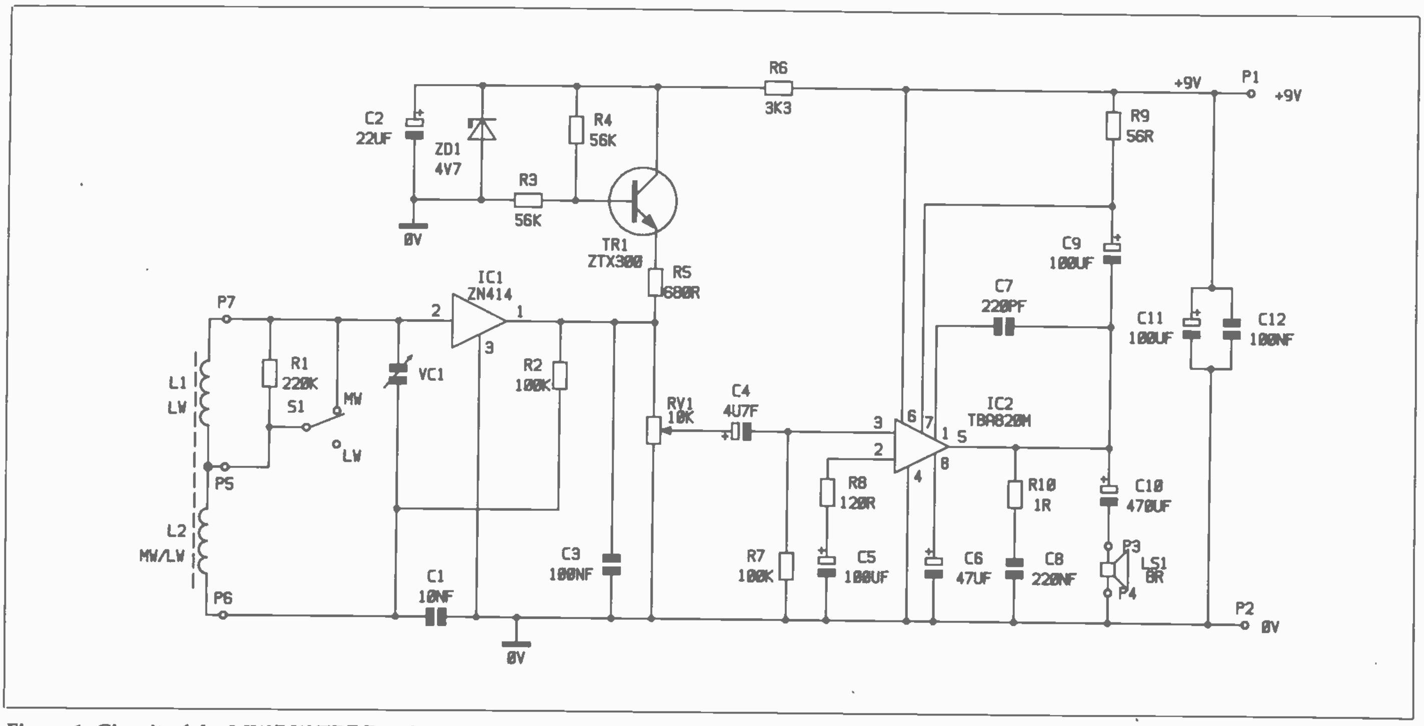

Figure 1. Circuit of the MW/LW TRF Receiver.

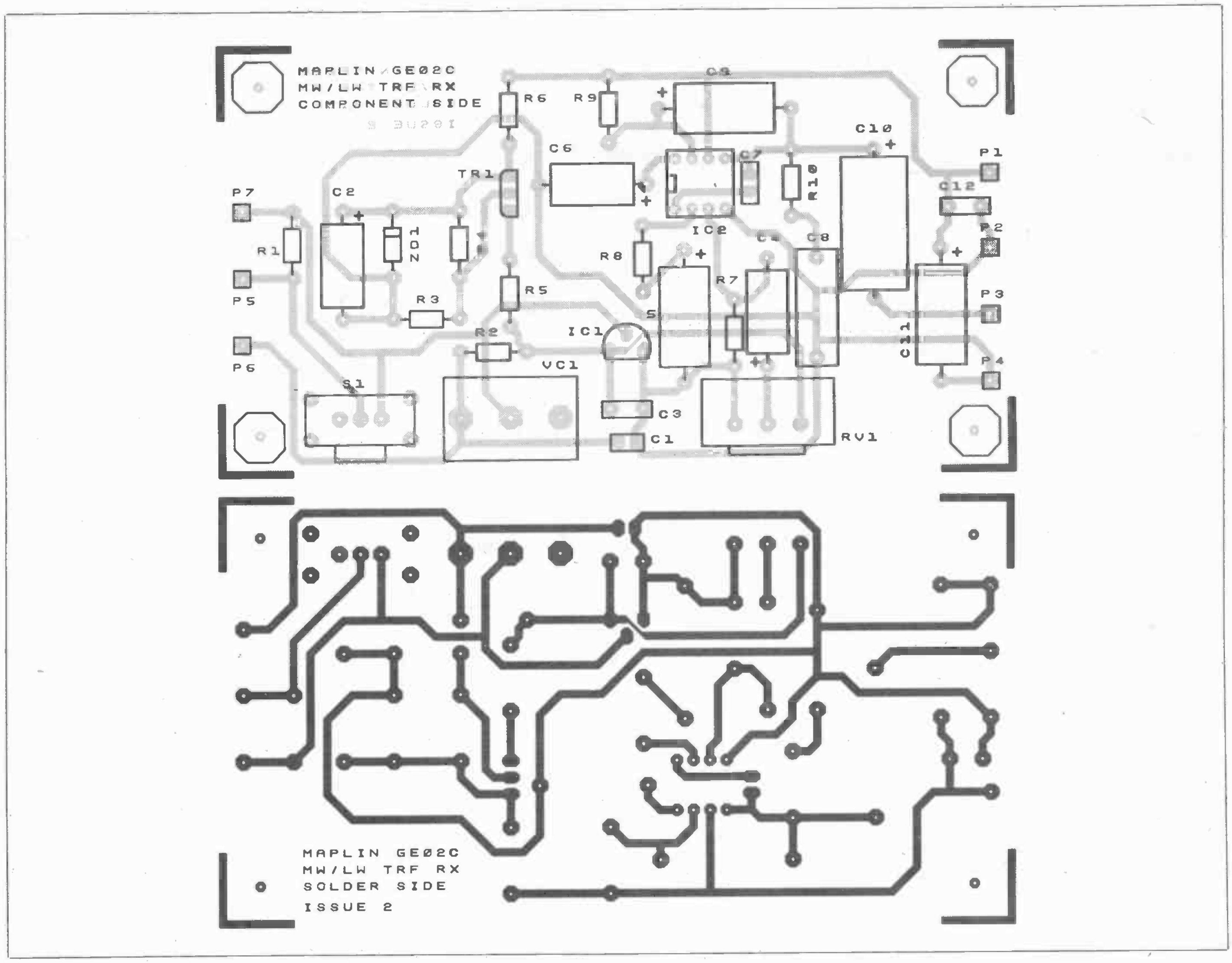

Figure 2. Layout of the PCB.

different type, as in this case where it is an electrolytic. At high frequencies capacitors should be as 'pure' as possible, that is they should exhibit only the properties of capacitance and nothing else. However, because of the way in which electrolytics are made (and this also applies to polyester capacitors), they also have a certain amount of 'self-inductance'. While this would have little effect at audio frequencies, its presence at radio frequencies would prevent the capacitor from acting effectively as a decoupling or r.f. 'bypass' capacitor, simply because it would have too much reactance to the radio signal. For this reason, whenever a ceramic disc capacitor is specified in a circuit, it should never be replaced by a polyester type, just because the value is the same in both cases. One 100nF capacitor is not necessarily the same as another 100nF capacitor!

Assembling and Testing the Receiver

The availability of a PCB for this project, see Figure 2, will ensure both ease of construction and instant success when the power is applied for

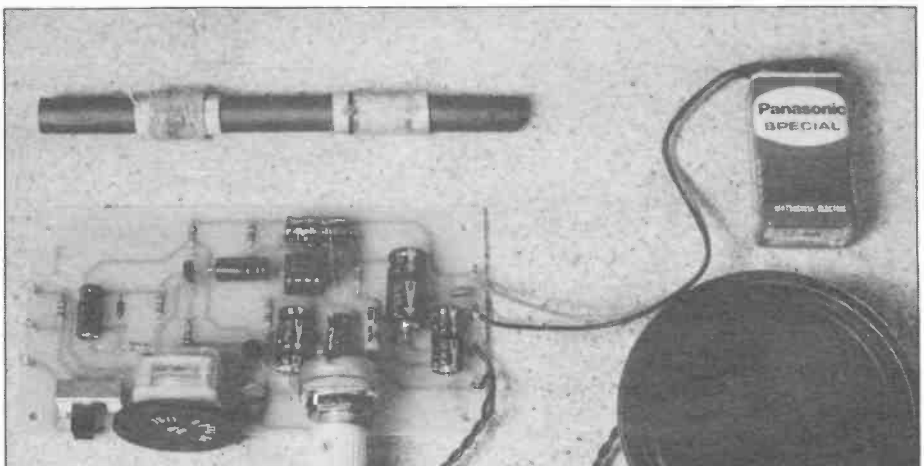

Photo 4. The completed TRF receiver, shown here with the fully assembled 'alternative' ferrite rod aerial.

the first time. It is merely assumed that the builder will check the following.

(a) the components are inserted in the correct places in the board.
(b) the polarity of the zener diode and the electrolytic capacitors is observed.
(c) the base connections of the ZN414 and ZTX300 are correctly noted and these components wired in correctly; check and double check before applying power.
(d) the TBA820M is plugged into its base the correct way round.
(e) all soldered joints are made cleanly without any dry joints or 'bridges' between adjacent tracks.

Having observed all of the foregoing points, the power can be applied and the result should be a working radio, Photo 4 shows the completed unit. The only controls are the waveband switch, the tuning capacitor and the volume control, all of which will obviously now be checked.

Should the situation be less than happy, the voltage checks shown in Table 1 can be made. These were made on the prototype, under 'no signal' conditions with a 20k/volt multimeter on the 10V d.c. range. Visual checks should also be made on the components in case one is incorrectly placed.

The readings obtained in practice may differ slightly from those in Table 1 but large variations from these values will indicate a fault condition.

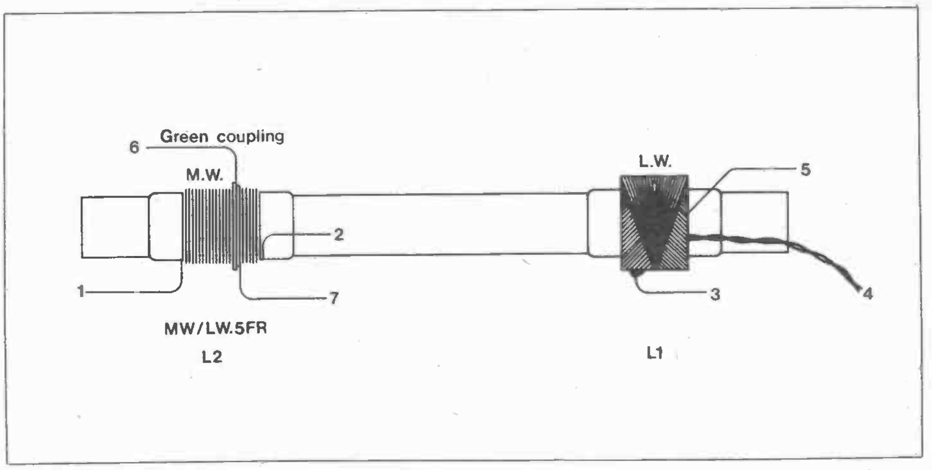

Figure 3. Ferrite rod aerial connections.

Test Point	Voltmeter Reading
Collector of TR1	4.0V
Base of TR1	1.65V
Emitter of TR1	1.2V
Output pin of ZN414	0.85V
Input pin of ZN414	0.6V
Pin 1 of TBA820M	0.6V
Pin 2	0.5V
Pin 3	0V
Pin 4	0V
Pin 5	4.15V
Pin 6	9V
Pin 7	8.8V
Pin 8	5.6V

Table 1.

An Alternative Ferrite Rod Aerial

The ferrite rod aerial specified at the start of this article gives an adequate performance on medium waves but not such a good performance on long waves. This situation can be improved by using a proprietary aerial assembly, such as the one available from Maplin Electronics, and it is listed as an alternative component in the Parts List. It can be used merely by disregarding both the small green coupling coil and the tap on the long wave coil. A drawing of this aerial assembly is included, see Figure 3, and it will be seen that all that needs to be done is to connect the two coils in series by strapping connecting wires 2 to 3 (and taking this junction to pin P5 on the board); wire 1 then goes to pin P6 and wire 5 goes to pin P7. This assembly has the further advantage that it is possible to move the coils along the rod to find the best position; they can then be fixed with a blob of glue.

MW/LW TRF RECEIVER PARTS LIST

RESISTORS: All 0.6W 1% Metal Film

R1	220k	1	(M220K)
R2,7	100k	2	(M100K)
R3,4	56k	2	(M56K)
R5	680Ω	1	(M680R)
R6	3k3	1	(M3K3)
R8	120Ω	1	(M120R)
R9	56Ω	1	(M56R)
R10	1Ω	1	(M1R)
RV1	10k Lin Pot	1	(FW02C)

CAPACITORS

C1	10nF Ceramic Disc	1	(YR73Q)
C2	22μF 25V Electrolytic	1	(FB30H)
C3,12	100nF Ceramic Disc	2	(YR75S)
C4	4μ7F 100V Electrolytic	1	(FB18U)
C5,9,11	100μF 10V Electrolytic	3	(FB48C)
C6	47μF 16V Electrolytic	1	(FB38R)
C7	220pF Ceramic	1	(WX60Q)
C8	220nF Polyester	1	(BX78K)
C10	470μF 10V Electrolytic	1	(FB71N)
VC1	AM Varitune	1	(FT78K)

SEMICONDUCTORS

TR1	ZTX300	1	(QL46A)
ZD1	BZY88C4V7	1	(QH06G)
IC1	ZN414	1	(QL41U)
IC2	TBA820M	1	(WQ63T)

MISCELLANEOUS

L1,2	Ferrite Rod 810	1	(YG20W)
LS1	8Ω Speaker	1	(YW53H)
S1	Slide Switch R/A	1	(FV01B)
	PP3 Battery Clip	1	(HF28F)
	EC Wire 30 swg	1	(BL40T)
	Pin 2145	1 Pkt	(FL24B)
	PCB	1	(GE02C)
	Hook-up Wire	1 Pkt	(BL00A)
	8-pin DIL Socket	1	(BL17T)

ALTERNATIVE

L1,2	Ferrite Rod Aerial	1	(LB12N)

The following item is available,
but is not shown in our 1988 catalogue:
MW/LW TRF Receiver PCB, Order As GE02C
Price £3.95