The Dipper

Tim Walford G3PCJ describes his latest project...a dip meter which is designed to work from low frequencies up through to the h.f. bands. It's a versatile instrument, which will eventually include an optional digital frequency counter - making it even more versatile!

Welcome to the Dipper project! No, this is not about those delightful little birds associated with rivers – interesting as they are! Instead, the Editor, **Rob G3XFD**, has encouraged me to produce a modern version of the traditional valved grid dip oscillator, which would suit readers and help with future projects.

The Dipper has two modes of operation, firstly, when it's oscillating at a radio frequency (r.f.), to detect and indicate the unknown resonance point of a tuned circuit loosely coupled to the Dipper's own tuned circuits. Secondly, when not oscillating it can be used to absorb and indicate the frequency of some external source of r.f., such as a transmitter.

The design uses either ready-wound standard value moulded inductors to cover the range of about 180kHz* to over 30MHz, or your own 'specials'. The heading photograph shows the Dipper complete with its battery, etc.

***Note**: The Editor's opinion, based on his own experience, is that the lower frequency coverage increases the dipper's versatility. It's rare to see a dip meter with coverage below 1.6MHz nowadays and the Editor and I think the extra coverage will be very useful.

This article describes the Dipper itself. A second article will describe a specially designed matching frequency counter. (See panel on page 42 for details of both kits).

Principle of Operation

Let's now take a look at the principles of operation. The various stages are shown in the block diagram, **Fig. 1**, with the full circuit in **Fig. 2**.

Basically speaking, in the project's circuitry there's a free running r.f. oscillator that's connected to a sensitive r.f. voltmeter. This is arranged such that when r.f. energy is either 'sucked out', or injected into the Dippers resonant circuit, the changes in the r.f. voltage is displayed on the meter.

The r.f. oscillator in this dip meter has to cover a very wide frequency range so it's necessary to change the inductors using plug-in coils. And although the eight ready-made coils all have ferrite cores, nevertheless, sufficient magnetic field escapes outside the cores to be able to couple to unknown circuits.

However, after completing the project with the supplied inductors, you can substitute your own air-cored coils. These will much improve the sensitivity, allowing looser (desirable) coupling to the unknown circuit. Incidentally, the coils have only two connections making it much easier to build your own!

The oscillator uses two source coupled 2N3819 j.f.e.t. transistors. This allows Tr1 to be switched off by S1 for the absorption mode, while still allowing Tr2 to buffer the resonant circuit and drive the r.f. detector. At low frequencies, the gain of the oscillator loop is reduced, leading to stronger 'dips'.

The source of Tr2 has a low

● The prototype *PW* Dipper as designed and built by Tim Walford G3PCJ. This dip meter, especially aimed at PW readers and home constructors, will be available as a kit. An add-on frequency counter project is to be published in *PW* and another kit will also be available.

- With A Difference!

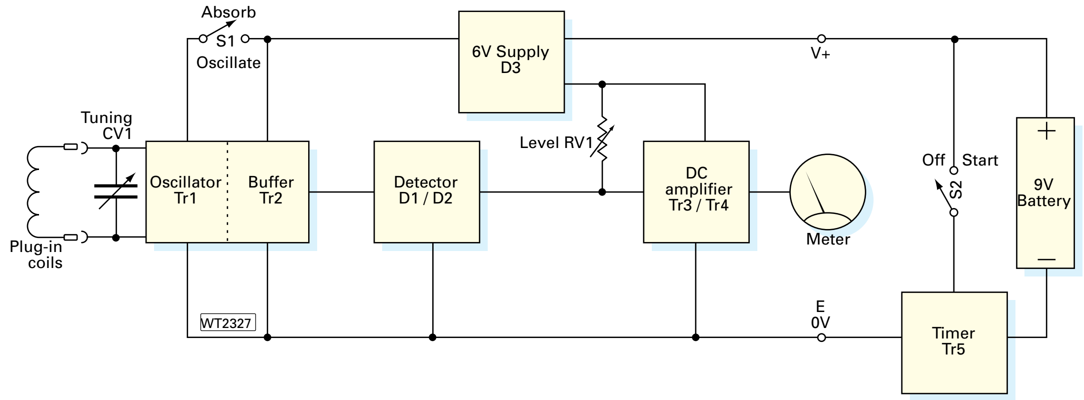

Fig. 1: Block diagram of the G3PCJ designed *PW* Dipper. The author provides a comprehensive description of the design within the text.

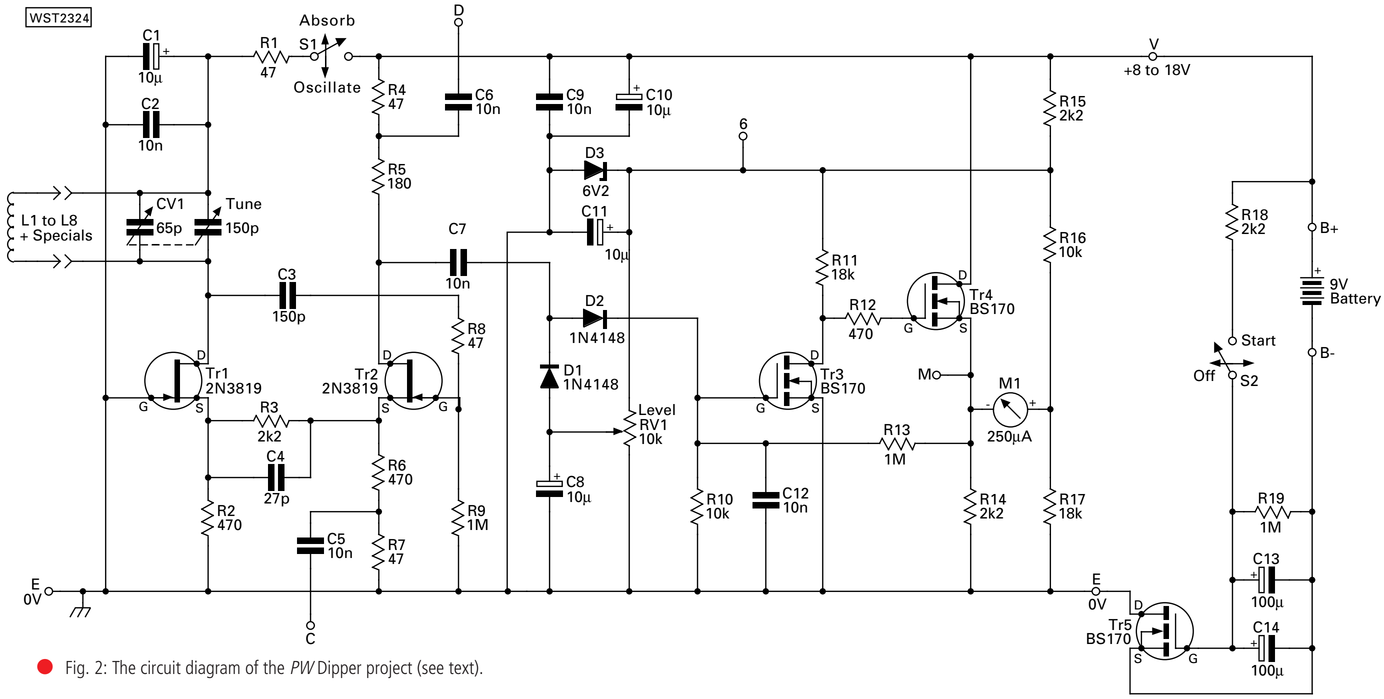

Fig. 2: The circuit diagram of the *PW* Dipper project (see text).

impedance output at point C; this can be connected to a counter indicating frequency for either mode. The r.f. detector itself is fed from the drain of Tr2 but the drain load is split, so that an external load connected to point D can influence the output r.f. voltage (more comments on this point later!).

A full wave r.f. detector, D1/2, is incorporated in the circuit, with a steady forward d.c. bias. This is used so that it can respond to small r.f. voltages below the 'knee' of the diode 'V/I' characteristic.

In practice it's necessary to cater for the wide range of r.f. voltages (high when oscillating, or low when absorbing). This brings the requirement to have a d.c. offset control, RV1, to set the detector's d.c. output level to within the input range of the following d.c. amplifier.

Meter Amplifier

A meter d.c. amplifier is included to improve sensitivity, partly for 'dipping' with the standard ferrite cored coils, but is especially helpful for absorption work with low level external r.f. sources. The amplifier uses two BS170 m.o.s.f.e.t. transistors Tr3 and 4 in a feed-back pair to provide high gain and low output impedance for driving the meter.

The amplifier has a level inversion, so the meter is connected on one side to a 'fixed' positive voltage above the normal amplifier mid-output level. So, when the r.f. level decreases as energy is 'sucked' out of the oscillator's tank circuit (causing the amplifier output to go positive), the actual meter reading actually then decreases in true dipper fashion.

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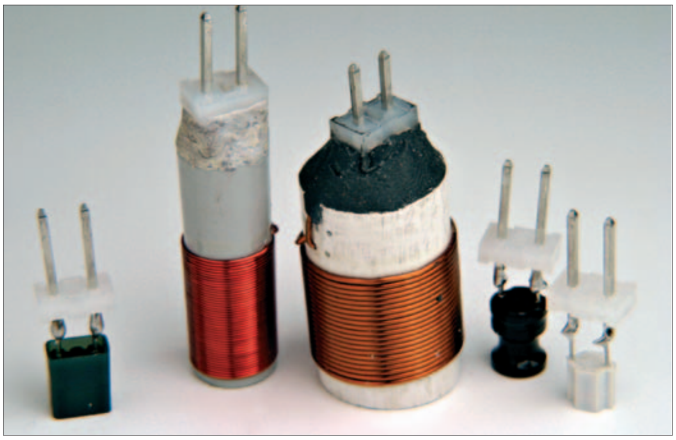


Fig. 3: Two alternative Dipper coils (centre) made by G3PCJ, both of about 9μH, together with examples of the standard coils prior to finishing with 'two part' synthetic resin putty (see text).

L1 (μH)	Markings	F(min) (MHz)	F(max) (MHz)
1	1R0	11.0	37.0
3	3R3	6.0	20.0
10	100	3.6	11 .0
33	330	1.9	6.0
100	101	1.1	3.3
330	331	0.610	2.4
1000	102	0.360	1.0
3300	332	0.1850	0.440

Table 1: Table, indicating the useful overlap between coil ranges achieved in the prototype PW Dipper (see text).

Finally, to make the dip meter easy to use, an integral battery is desirable - but they can go flat quickly if you forget to turn the equipment off! Hence the inclusion of Tr5 as a timer to keep it running for only about 4 minutes after the **On** button is released!

The zener diode, D3, provides a steady 6V supply for the critical circuits. This is to cater for the wide supply range of 8 to 18V required for battery or bench supplies.

Building The Dipper

Using printed circuit board (p.c.b.) material for the 'chassis' of the Dipper, makes it easy to mount the meter and the battery on opposite sides of the board. These are held in place by wire straps passing over the top of the meter face, and then around the battery. The wires are then soldered to pads where they pass through the p.c.b.

Next, the tuning capacitor CV1 is fitted at the opposite end of the p.c.b. However, before fitting the tuning knob, nine calibration marks should be made every 22.5° for the 180° rotation of CV1's shaft. The socket for the plug-in coils is then mounted on the end furthest from the meter.

Electrical assembly starts with the timer and zener reference, followed by the meter amplifier, which is easily checked with the meter and the meter level control RV1. Finally, the oscillator section is built and tested.

You'll need to choose an inductor whose likely coverage will include a frequency that you can easily monitor, preferably with a general coverage receiver having digital frequency readout. I used the standard 10μH coil, which should include the 7MHz band, and possibly others! It actually covered 3.6 to 11MHz indicating the typical 3:1 range for each coil. **Table 1** indicates the useful overlap between ranges achieved in the prototype.

Air Cored Inductors

Although the Dipper will work quite satisfactorily with the standard ferrite cored coils, air cored inductors will allow more field to escape and couple with the unknown circuit. In fact, they'll often produce the same strength 'dip' but at about double the separation between coils.

When the project is working satisfactorily using the standard coils, as I've already suggested, you can experiment with your own 'specials'. To help, the photograph, **Fig. 3**, shows two alternatives I made, both of about 9μH, together with examples of the standard coils prior to finishing with 'two part' epoxy putty.

The resin-putty material can be moulded into the ends of the coil formers and over the soldered joints to secure the coil to the two pin plug. But only use it when you are

Fig. 4: Close up view of the Dipper meter and front panel (see text).

sure all is correct, as it sets rock hard!

Small diameter formers make it easier to couple with awkwardly placed coils but they do require many more turns! Incidentally, it's worth noting that the Dipper will work beyond the above frequency limits - both higher and lower - if you use smaller or larger inductor values respectively.

However, please bear in mind that you may find that the dipper will not oscillate over the full swing of CV1. This is because of the excessive LC ratios that are implied at both frequency extremes.

Frequency Calibration

If you plan to eventually use your dipper with a counter, accurate frequency calibration wont be required. On the other hand, without a counter, you'll need to draw up a table of frequency for all coils, for each of the 22.5° markings of the rotation of CV1. If necessary, you then are able to interpolate between these markings.

When you're ready to begin the calibration process, using a general coverage receiver whose antenna is near the dipper, you should listen for a strong carrier signal from the oscillator and record its frequency at each marker line position of CV1.

Start the calibration process using the largest inductor whose frequency range you can receive. **Note:** don't forget your domestic broadcast band radios, as well as any Amateur band receivers as possible tuning calibration aids.

In desperation, assume that any un-calibrated point is 1.75 times the value on the range immediately below! Harmonics can also be used with care – don't forget to divide the receiver's frequency by the probable harmonic number. The dipper's own harmonics will have a much higher tuning rate when you alter CV1. For example, the third harmonic of the top 1μH standard coil is likely to be heard near 90MHz on Band II f.m. radio, so you will have to divide the readout by three.

Using The Dipper

For most purposes, inductive coupling between the unknown resonant circuit and the Dipper gives best results. Start with the tightest or closest coupling that you can manage – always keeping the axes of the two coils parallel.

For each range you may need to adjust RV1 to have a comfortable meter reading (a close up view of the meter is provided in **Fig. 4**) before slowly sweeping the tuning when the coils are close together. Try the inductors inside each other, or end-to-end, or side-by-side.

Having a very rough idea of the probable unknown frequency will much reduce the number of coils that have to be tried with the unknown! When you have found a dip, gradually increase the separation of the coils and check that the dip does disappear!

The frequency readout will be most accurate with the least coupling; be aware that with very tight coupling, the unknown circuit may determine the frequency of oscillation causing a sudden jump in the meter reading as the frequencies or coils are separated.

You can also use the Dipper to measure the value of unknown inductors or capacitors, by resonating them with your own known 'standard' component; but then you have to do a little maths! When using the Dipper as an absorption wavemeter, you can couple to output resonant circuits of the transmitter, or add a whip antenna to increase the pick up from the transmitter's antenna.

The Dipper has extra facilities provided at point D. It can act as a simple signal generator, with a 50Ω output of roughly 400mV p-p permitting standard 50Ω switched attenuators to be connected here for lower output levels.

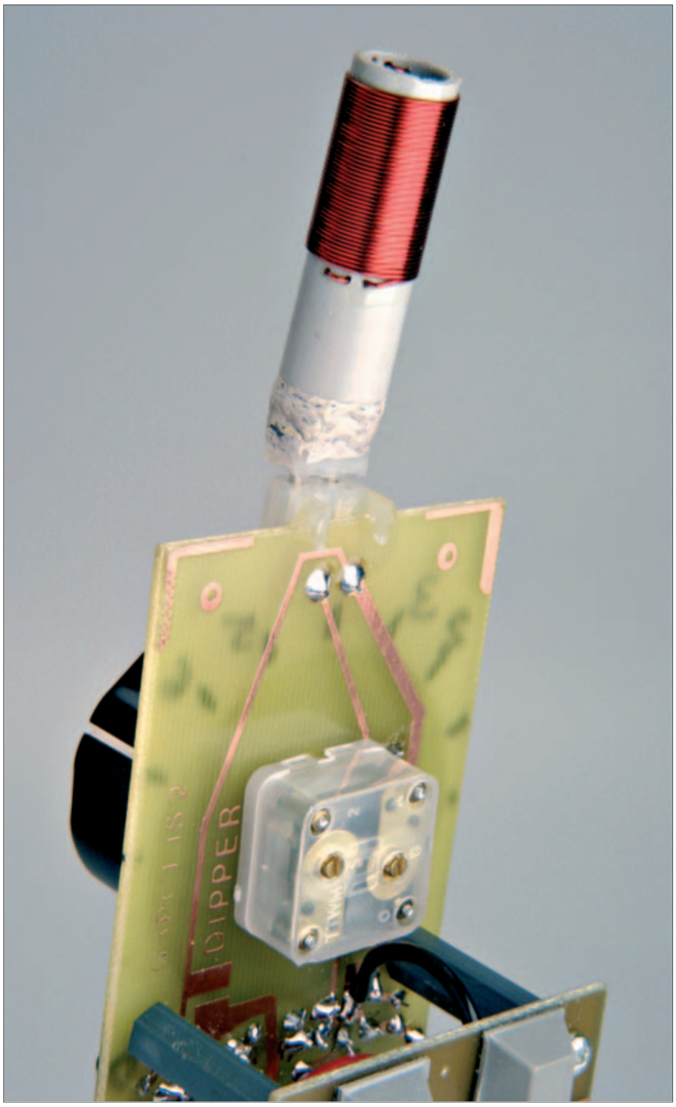


Fig. 5: Rear view of the 'open chassis' style Dipper (built using p.c.b. material) showing a home-made coil and the main tuning capacitor (see text).

The waveform is not sinusoidal, so the harmonics can be used to extend its upper frequency range. Furthermore, the impedance presented across R4 will affect the r.f. level fed to the detector – see what happens if you short D to the E line! This allows you to directly connect to other circuits, whose impedance varies with frequency, such as antennas or small link windings on difficult toroidal inductors, which are often used in resonant circuits.

Coupling an antenna feeder directly to point D (and E) will allow you to directly measure the antenna's resonant frequency. (Do such tests as quickly as possible). The kit instructions explain all aspects rather more fully.

In short, this is a extremely versatile instrument, which is much enhanced with the dedicated counter. And this will be the next stage of the project. Watch this space!

PW

Buying Your Dipper Kit

A complete kit for the Dipper is available from Walford Electronics. The kit includes the 50 x 160mm p.c.b., meter, battery, tuning capacitor, knobs and all parts to build as in the heading photograph (but without the optional frequency display). Eight standard value factory-made coils are included with two spare plugs for your own special coils. The price is £44.

The specially designed three digit counter (to be featured in *PW* as a separate, add-on project), will indicate the frequency as XY.ZMHz, and will mount below the Dipper, uses a 50 x 160mm p.c.b. and will cost £35. If ordered together, the price is discounted to £74. Post and packing is £2. Please send your orders with a cheque direct to **Walford Electronics, Upton Bridge Farm, Long Sutton, Langport, Somerset TA10 9NJ**. Further information is available on the Walford Electronics website at **www.users.globalnet.co.uk/~walfor**

Discovering Your Dipper

Earlier this year Tim Walford G3PCJ presented his design for a 'Dipper With A Difference'. Continuing the theme Tim now explains just how versatile this much neglected simple instrument is!

Fig.1: The PW Dipper and counter

The Editor tells me that a number of readers have asked about how to use a 'dipper' – so he gave me the title 'Discovering Your Dipper'. However, I'm left wondering....does he really know something about the organised chaos that presently conceals what's actually on my bench including my dipper!

Dip meters are actually simple instruments with many uses – these range from tuning resonant circuits and antennas, measuring components, acting as signal generators, to looking for unwanted harmonics. Most constructors should have one!

Active Oscillator

The basis of all the dipper instruments is that when an 'active' oscillator is coupled to a second 'passive' circuit resonant at the same frequency, radio frequency (r.f.) energy is extracted from the active circuit. This causes a change in voltages that can be indicated on a meter.

In practice the changes maybe either in d.c. conditions as in a classic valved grid dip oscillator or in r.f. levels as is the case for the 'Dipper With A Difference' (DWAD), published in the March 2004 *PW*. For both types of instrument, the meter reading goes down when the two circuits are tuned to the same frequency - hence the informal name of 'dipper'.

When it comes to using your dipper, for determining the resonant frequency of the unknown circuit, maybe all that's needed, or that information can be used in further calculations. And although I shall write in terms of using the DWAD (see side panel and **Fig. 1**), the techniques can be used with any 'dipping' style instrument irrespective of whether it uses valves or semiconductors.

Incidentally, a digital readout of frequency, such as that described in the May 2004 *PW* for the DWAD, is a great asset. It will help you avoid all the hassle of calibration and scale/frequency charts!

However, the key to effective use of any dipper is mastery of the coupling techniques between the resonant circuits. So, let's take a look at those techniques.

Inductive Coupling

In my experience, inductive coupling between the coils of the two circuits is much more likely to be successful than capacitive coupling. So, I would always attempt this approach first when investigating an unknown circuit.

Initially, I recommend that you should practice the technique of using the instrument while it's oscillating to energise the unknown circuit. (The following points about coupling technique do also apply when absorbing energy from an active circuit, but that comes later!).

You should start by trying to achieve high or 'tight' coupling to make certain that you do have a definite dip. The magnetic flux linkages will be greatest when one inductor is physically inside the other as shown for the ideal situation in **Fig. 2**.

It doesn't matter whether the unknown circuit's inductor is inside or outside that of the instrument! If this is not possible because the coils are similar sized or inaccessible, the next best situation is generally aligned 'end to end' as in **Fig. 3 provided** the actual windings are close to each other. If this doesn't give a good dip then try the 'side by side' approach as in **Fig. 4**.

The approach, shown in **Fig. 5** is not recommended for inductive coupling, and is that actually used for capacitive coupling. Note that the 'r.f. hot' ends of both coils are closest together - just like the small capacitor linking the two parallel resonant circuits in a receiver front-end filter.

Note: The guidance applies directly for air-cored coils but is also generally the best approach if either or both have ferrite slug cores. Incidentally, despite the ferrite core, sufficient field will escape to permit satisfactory coupling, although the sensitivity will be reduced implying a less pronounced dip for a given physical separation.

Toroids: Coupling to toroidal inductors needs a special technique which will be explained later. First, let's get some practice in!

Practice Your Techniques

To gain the essential experience it's a good idea to practice the coupling and frequency sweeping techniques using a known test circuit. So to start, I suggest you dig a variable capacitor (never throw them away!) out of your junk box and connect it to both ends of a moderately sized inductor. I used 11 turns of 16s.w.g. enamelled wire close wound initially on a 25mm diameter broom handle – the exact number of turns is not important!

You can use any stiff insulated wire or a single core of the pvc covered copper cable used for permanent mains wiring. When released the turns will 'spring out' a little so you can remove the wood.

The thick wires will stay in place adequately when soldered to the capacitor – as in **Fig. 6**. I have purposely not made a very tidy job of this to show that coil winding is easy and quite adequate for this experiment!

My variable capacitor was 500pF unit but a smaller one will be fine, provided you start tests at say 10MHz instead of 5MHz. **Note:** Dippers often work best in the 2 to 20MHz range, which is where I suggest you start experimenting.

The broom coil shown in my photograph resonated at 5MHz with about 400pF. Its size allows you to see what happens when one inductor is inside the other!

Once you've made your test coil set the Dipper to oscillate at about 5MHz. Adjust the meter reading control so that the needle shows nearly full scale.

At this stage, place the Dipper and test circuit on the bench so the separation does not alter if your hands are unsteady. Later when you're more proficient, you'll be able to just 'wave' the instrument near to the unknown circuit!

Next, bring the two coils together, preferably one inside the other, and then alter the test tuning capacitor – not the **Dipper tuning**! This makes it much easier to detect the dip because there's no variation due to large changes in the Dipper's frequency – you'll find that they seldom have a constant reading from end to end of any tuning range!

Assuming that the frequency ranges overlap, there will be a noticeable dip in the meter reading as you sweep the variable test circuit across the frequency of the Dipper. It maybe that the reading jumps back up as you tune beyond the dip (in either direction). Don't worry - this is quite normal with tight coupling, because the frequency is temporally being determined by the test circuit until it cannot control it anymore, when the frequency jumps back to that of the Dipper.

As you increase the separation of the coils, the strength of the dip will decrease, and also the tendency of the test circuit to determine the frequency. With care when using air-cored coils, you might just be able to detect a dip with a separation well over 25mm.

Altering Dipper Frequency

Now we'll practice altering the Dipper's frequency instead! Having found a frequency where the tuning overlaps as already described, I suggest you carefully alter both tuned frequencies so that the dip is now in the middle of the Dipper's tuning range for that coil.

Next, you should then try sweeping the Dipper's frequency - and you'll almost certainly need to first increase the coupling to find the dip again. Then, as before, gingerly separate the dipper and test coils to the point where the dip is still definite but quite small.

Get used to sweeping the Dipper frequency in both directions and carefully observe the rate of change of the meter. It's the rapid meter changes up and down, getting smaller with larger separation, as you sweep the Dipper frequency that indicates the coincidence of the tuned frequencies.

The frequency at the centre of a small dip is that of the unknown resonant circuit. Try sweeping the Dipper's tuning knob faster or slower to see if this makes it easier to detect the dip. Practice this method with different coupling methods and separation.

Note: You'll find that it's harder to find the proper dip setting if it's on either end of a particular coil's tuning range. With this in mind it'll be better to change to the next range and get the dip in the middle of the tuning range - this will make dip detection easier and more accurate.

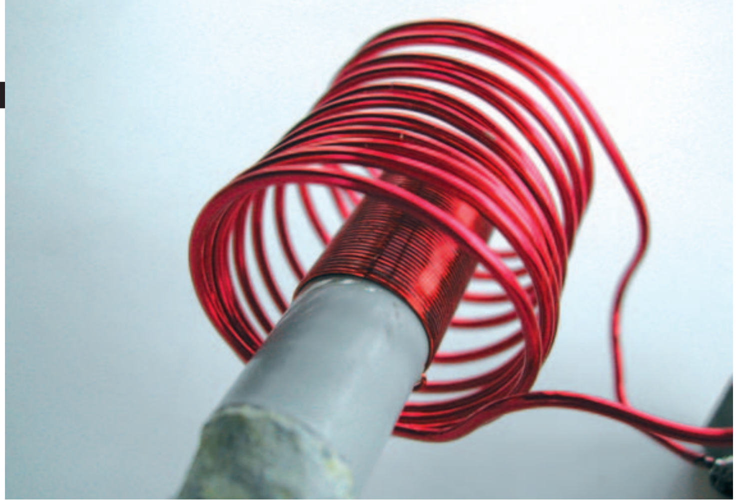


Fig.2: Inductors inside each other (see text).

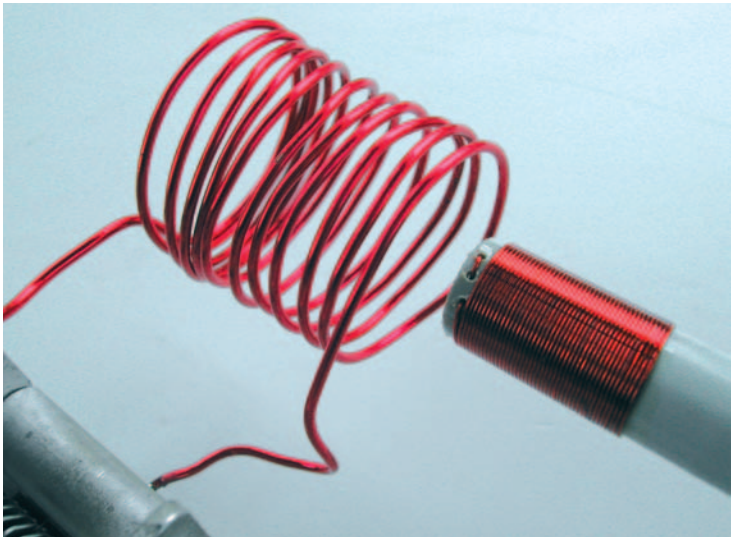


Fig.3: End to end coupling (see text).

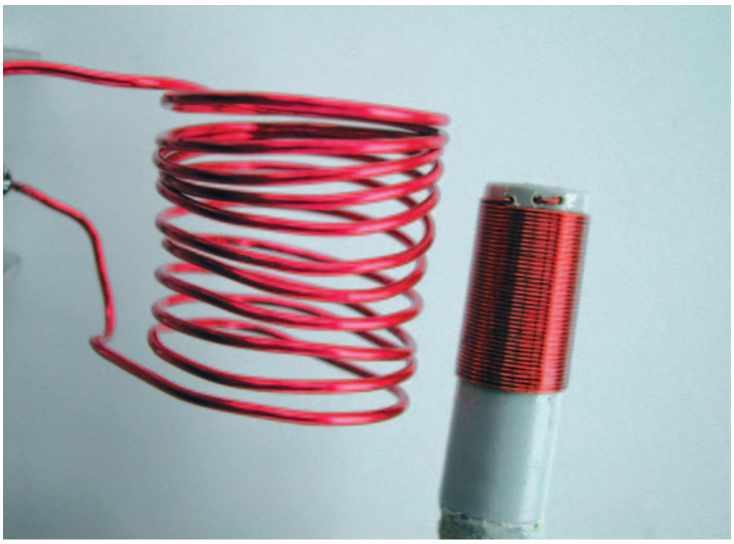
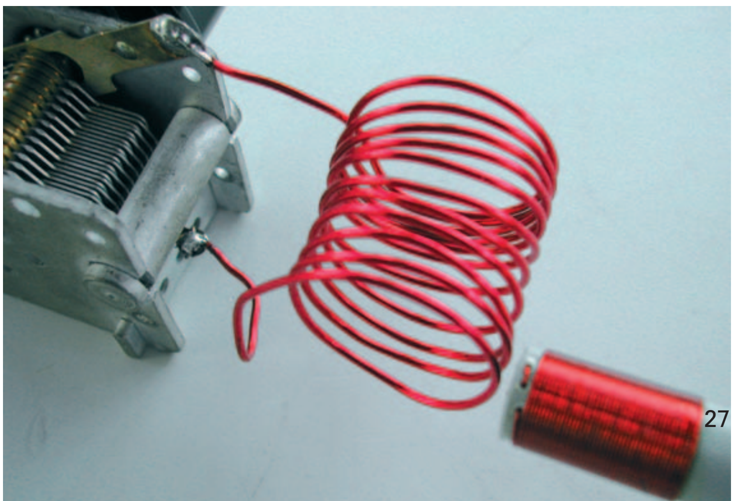


Fig.4 (above): Side by side coupling (see text). Fig.5 (below) Capacitive coupling (see text).



Guess The Frequency

From what I've already discussed, you'll soon realise that 'sweeping' an unknown circuit with a lot of coils to find the resonant frequency will be very time consuming indeed! Hence my suggestion that you should try to guess the likely frequency first - by inspection or otherwise!

'Guessing the frequency' isn't as difficult as you might think. This experience, especially in my case, comes after many years examining resonant circuits. However, a good clue is knowledge of the rig's physical layout, operating band, type (direct conversion or superhet) and intermediate frequency or local oscillator scheme.

If possible you should read or guess the value of the particular coil's resonating capacitor(s). There is a rough rule of thumb for selecting resonating capacitors to suit your own coils – their value in pF should be 1.5 times the operating wavelength in metres!

So, an 3.5MHz receiver front-end filter would have 120pF capacitors. Despite this, modern designs tend to use less L and more C! Turning the rule of thumb around, it gives the very rough frequency in MHz as one 30th of the capacity in pF. This will get you in the right part of the spectrum – at worst you should only need to search with two other coils - either side of the most likely coil!

You should, if possible, closely examine the unknown coil. If it has lots of turns this will suggest low frequencies, while a few wide spaced will of course indicate very high frequencies. **Note:** If the coil is enclosed in a 'can' (Screen can) then it has to be treated in the same way as a toroidial inductor, employing a direct connecting link.

Checking Toroids

Let's now look at checking those toroidial inductors (and it's not as difficult as many constructors imagine). Here the first thing to bear in mind is that the special shape of a toroid inductor means that almost no field escapes from the core. This means that (generally) a small extra winding has to be added. This needs to be only a couple of turns and can be made from plastic covered hook-up wire.

The DWAD (March 2004) has a special output (**Point D**) to which the extra winding can be directly connected. For other instruments without this special facility, a few turns need to be wound over the dipper's coil and the two link windings coupled together.

Please now take a look at **Fig. 7**. This shows a winding of 12 turns on a red T68-2 toroid which is resonated by a 180pF silver mica capacitor. Two turns (twice through the middle of the toroid core) have been added to the toroid with a thin blue wire which is then wound three times around the Dipper's inductor, with the ends joined together to form a loop.

When I carried out this test, a quick tune of the dipper's frequency showed a moderate dip at 10MHz. However, the coupling can be reduced by using less turns on either link winding. If the unknown resonant circuit is in a metal can then you should connect its low impedance winding to point D, or to the few link turns over the instrument's coil.

The low impedance winding often can be identified by measuring the resistance between all connections on the inductor. **Note:** the lowest resistance is usually also the lowest impedance winding.

Incidentally, bearing in mind that an antenna is actually a resonant circuit, it's convenient to mention at this point that the same approach used for the toroid inductors can be used to measure the antenna's resonant frequency. The centre of the dipole is connected, if necessary by a low impedance feeder or coaxial cable, direct to the D output of the Dipper or to a few turns wound over the instrument's relevant coil for the desired band.

At the antenna's resonant frequency it will radiate***(see note below)** more of the instrument's r.f. energy and the meter reading will go down. If the resonant frequency is too low, then gingerly prune short lengths off both dipole ends - but take care as they are not easily put back! Pruning an end fed antenna with a Dipper is only for the really experienced!

***Note:** When carrying out these checks, please bear in mind that you will be transmitting a QRP level signal via the antenna. Try to carry them out as quickly as possible - there are no awards for QSOs achieved with dip meters! **Editor**.*

Another approach for toroids is to extend one wire of the resonating capacitor (**Fig. 8**) so that a few turns can be added over the instrument's coil in series with the unknown main winding. This forms a coupling coil but its inductance will add to that of the main coil so the resonant frequency will be lower than without the extra loop. Use as few extra turns as possible. For the T68-2 example above, with two turns on the Dipper, the resonant frequency went down from 10 to 9.7MHz.

Signal Generator

The dipper is extremely versatile - you can use it as a basic signal generator! In this situation the meter reading will be unimportant; and to help the *PW* Dipper has the special output D which can directly drive 50Ω loads whereas other instruments will need a link winding of a few turns around the relevant coil to provide the desired frequency.

The output amplitude can usually be reduced slightly by sliding the link coil away from the inductor tip towards the main body of the instrument. If this still provides too much signal (let's say for aligning the input stages of a receiver where very weak signals will be required) then I suggest you just drape a wire from the receiver's antenna terminal near to the dipper and either move it away or shorten it as required for a distinct but non-overloading signal.

Note: Beware that if the load is tightly coupled to the dipper, then adjustment of that load (as when tuning a filter) might 'pull' the oscillator's frequency slightly. Often a small change does not matter but it's wise to be alert to the possibility!

The mechanical construction and other variable effects due to link coils, etc., mean that most dippers will have poor frequency stability. Additionally, the oscillators in most dippers are not completely sinusoidal, which means there will be harmonics present which can be used to align v.h.f. receivers. Usefully, the third harmonic will give a very useful extension, but even if present, higher harmonics are not so easy to use.

Measuring Component Values

You can also use your dipper to find unknown component values. Inductor values, particularly, are frequently unknown and the technique is to resonate the unknown inductor by connecting a known capacitor across it.

The resonant frequency is measured with the dipper as above and the component value calculated from the standard formula for resonant circuits:-

From $f = \frac{1}{2\pi\sqrt{LC}}$ $\qquad 2\pi f = \frac{1}{\sqrt{LC}}$

$$(2\pi f)^2 = \frac{1}{LC} \qquad L(2\pi f)^2 = \frac{1}{C}$$

$$L = \frac{1}{C(2\pi f)^2} \qquad = \frac{1}{C(2\pi)^2 f^2}$$

$$= \frac{1}{(6.283)^2 Cf^2} \qquad = \frac{1}{39.5Cf^2}$$

To find the value of L (in μH), when C is expressed in pF and f in MHz, then the solution is as follows:

$$L = \left(\frac{1000\,000}{39.5Cf^2}\right) \qquad = \left(\frac{25\,316}{Cf^2}\right)\mu H$$

For most h.f. coils I suggest you start with the 220pF capacitor! For the example coil that I used in Fig. 6, the resonant frequency was 10MHz when resonated with the 180pF (= 0.00018μF) capacitor that I had to hand.

The result works out at 1.4μH but note that the turns were close together. So, the measured value will be appreciably higher than the theoretical value derived from the toroid's characteristics – which will assume the turns are spaced equally around the toroid's circumference.

It is quite a good experiment to see how the inductance changes when the turns are bunched up! The above approach is not recommended for really accurate measurements but is adequate for most Amateur Radio purposes.

Note: If you have to measure a capacitor, resonate it with a known inductor or even one you have just measured as above! (Just use similar mathematics as shown on previous page).

Absorption Wavemeter

When used as an absorption wavemeter the instrument's oscillator is initially turned off. The meter is then adjusted to be just above the zero end stop so that it can increase when some r.f. is found!

When used in the absorption mode your dipper should be coupled to the unknown signal source by any of the methods I've already described. You could, for example, bring the instrument's coil into the vicinity of a transmitter output stage (when operating into a dummy load). Take care though that you don't burn out the instrument on a high power transmitter!

Having found a strong upward meter kick from the transmitter's wanted fundamental as you sweep the tuning, you can read off its frequency on the counter or calibration charts. Then go hunting for the second and third harmonics!

The 2nd and 3rd harmonics should be very much lower in strength. This means that much tighter coupling will be needed but beware that the strong transmitter fundamental may cause the meter reading to slowly change as the tuning is altered.

The harmonics, if present, will cause relatively narrow meter upward blips. If the instrument has a counter, you should briefly turn the instrument so it will oscillate to indicate the unknown frequency.

Most dippers can be used to indicate relative changes in radiated field strength as you make antenna adjustments. However, because the indicator should be well separated from the antenna under test, the radiated signal may not be strong enough to get a reading without a small whip receiving antenna.

Usually a stiff wire of about 300mm length will prove an adequate antenna when it's directly connected to the hot (or high impedance) end of the instrument's coil; for the *PW* Dipper (this is the inductor side connected to the drain of Tr1).

You should be aware that the whip antenna will 'pull' the frequency slightly downwards in frequency, so you should tune slightly above the expected frequency. Often the physical separation of absorption wavemeter and transmitter/antenna means that two people are needed! The usual advice about minimising transmission time applies.

Many Hours Experimenting

That's enough experiments to keep you going for many hours! One final point though - when I did eventually discover my bench I found the special dipper shown in **Fig. 9** - it operated to over 450mm just proving that size does matter!

I hope you enjoy 'discovering your dipper'. They're exceptionally useful in the workshop. **PW**

Kits are still available for the Dipper at £44, and the associated three digit counter at £35. If ordered together, the price is discounted to £74. Post and packing is £2 extra. Please send any orders direct to **Walford Electronics at Upton Bridge Farm, Long Sutton, Langport Somerset TA10 9NJ**. For further information see their website at **www.users.globalnet.co.uk/~walfor**

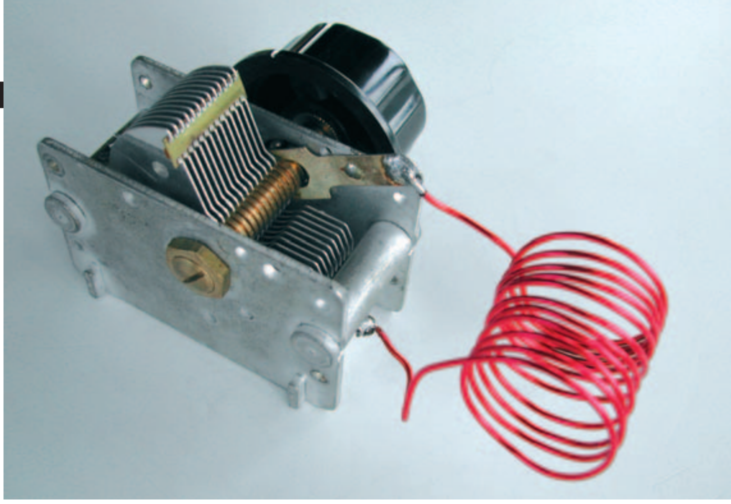


Fig.6: Testing L and C (see text).

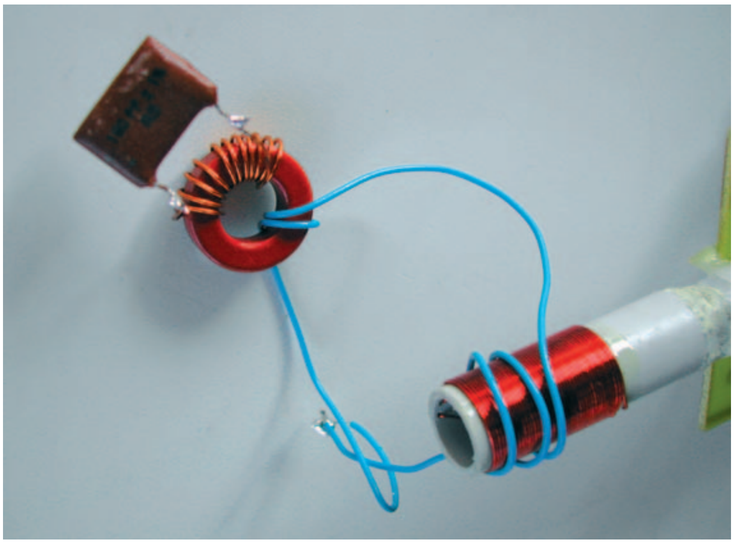


Fig.7: Link coupling to a toroid (see text).

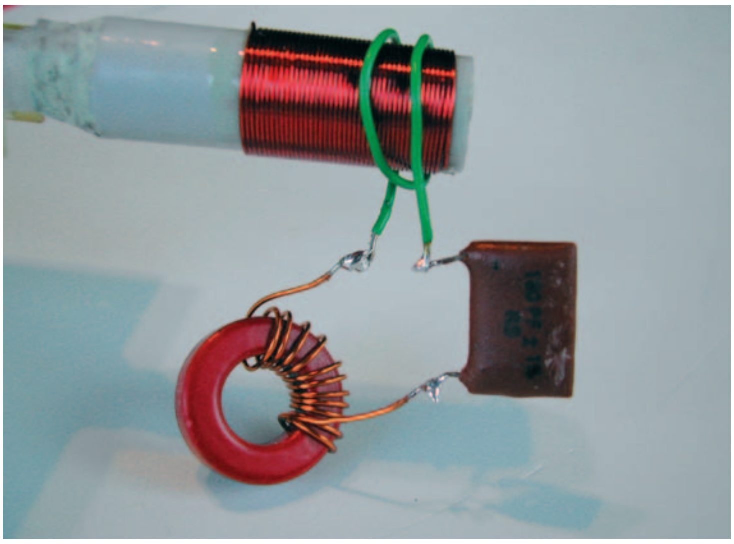


Fig.8 (above): Extra turns in series (see text).

Fig.9 (below): A giant dipper! (see text).

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THE TINY TIM 3.5MHz SSB TRANSCEIVER

PART 1

QRP SPECIAL

Tim Walford G3PCJ is a well known QRP enthusiast, and he's come up with a delightfully simple low powered s.s.b. transceiver for 3.5MHz using very straightforward techniques.

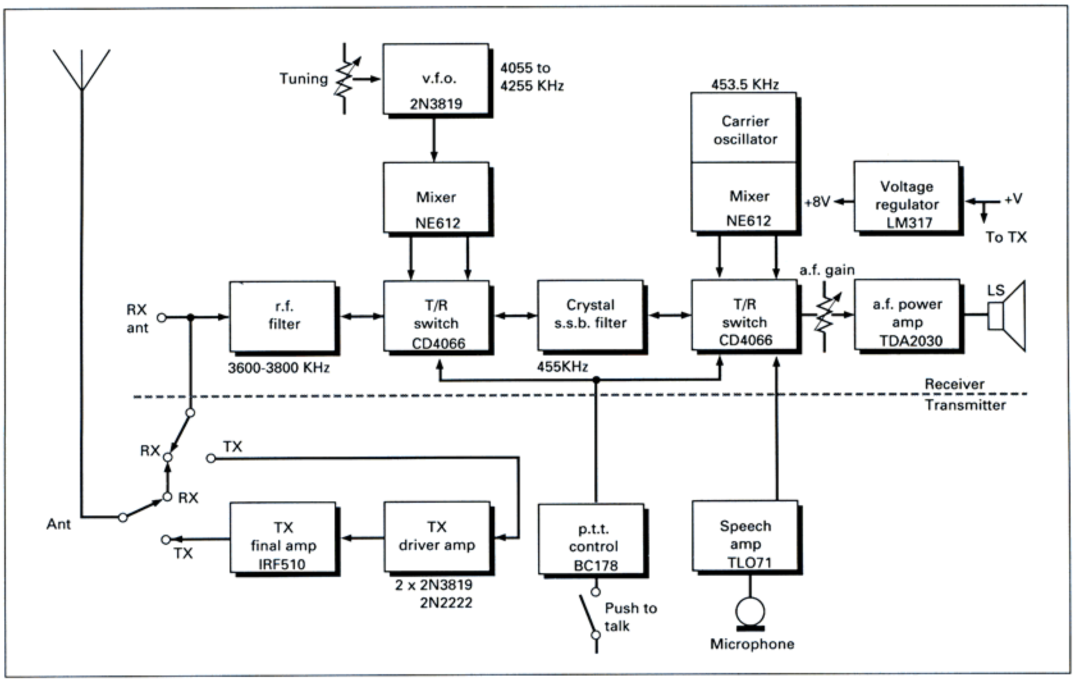


Fig. 1: Block diagram of the 'Tiny Tim' QRP s.s.b. transceiver for 3.5MHz.

The 'Tiny Tim' is a 3.5MHz single sideband 'phone **T**ransceiver **I**n **M**iniature (hence Tiny **TIM**!). My aim was to design a rig which is complete, simple yet effective, low cost, suitable for home construction and with an output of about 10 to 20W p.e.p.

The rig is a superhet using the filter method of s.s.b. reception/generation. In this way it avoids the main snag of extra QRM inherent in the simple direction conversion method which receives (and transmits) both sidebands.

The block diagram, **Fig. 1**, clearly shows how simple the transceiver is. You'll also see that the filter is used 'both' ways, another technique towards simplicity.

KEY TO SIMPLICITY

The key to the mechanical simplicity in the 'Tiny Tim' is the use of varactor diodes for tuning. The tuning range is 3.6 to 3.8MHz, and is provided by potentiometers.

Using potentiometers, allows the use of p.c.b. copper clad material for the front panel. This can then be soldered directly to the main board itself.

The transceiver provides audio output for a speaker or headphones. In use, it only requires an uncritical d.c. power supply in the range of 12 to 25V at 2A.

Operating on 12V d.c. the transceiver will provide 10 to 12W p.e.p. It's possible to run it with higher voltages, and up to about 35W p.e.p. output can be achieved. The transmitter output uses a robust f.e.t. with a high Q tuned matching circuit.

The design is suitable for most types of microphone. The transceiver also has built-in r.f. speech limiting or processing.

Setting up is relatively simple. A frequency meter is desirable, and you'll also need a 2A d.c. meter and an output power indicator.

Although primarily designed for s.s.b. 'phone operation, the transceiver can be used on c.w. If there's enough interest, this could be the basis of a future modification.

The complete transceiver only uses six i.c.s, seven transistors and a voltage regulator. My prototype measured 160 x 100 x 80mm.

The Tiny Tim is aimed at constructors with previous experience. I suggest you photocopy the circuit from the magazine page, and you can then cross off the parts as you fit them.

THE RECEIVER

I shall depart from the usual *PW* convention, by describing the receiver first. I'm doing it this way since the receiver can be built and used on its own, whereas the transmitter part of the project can't be used by itself.

The receiver, as can be seen in the circuit diagram, **Fig. 2**, is actually a simple superhet in which the incoming signals are converted to the intermediate frequency of 455kHz. They're then filtered, detected and the audio amplified for either the headphones or a loudspeaker.

The circuit appears more complicated than

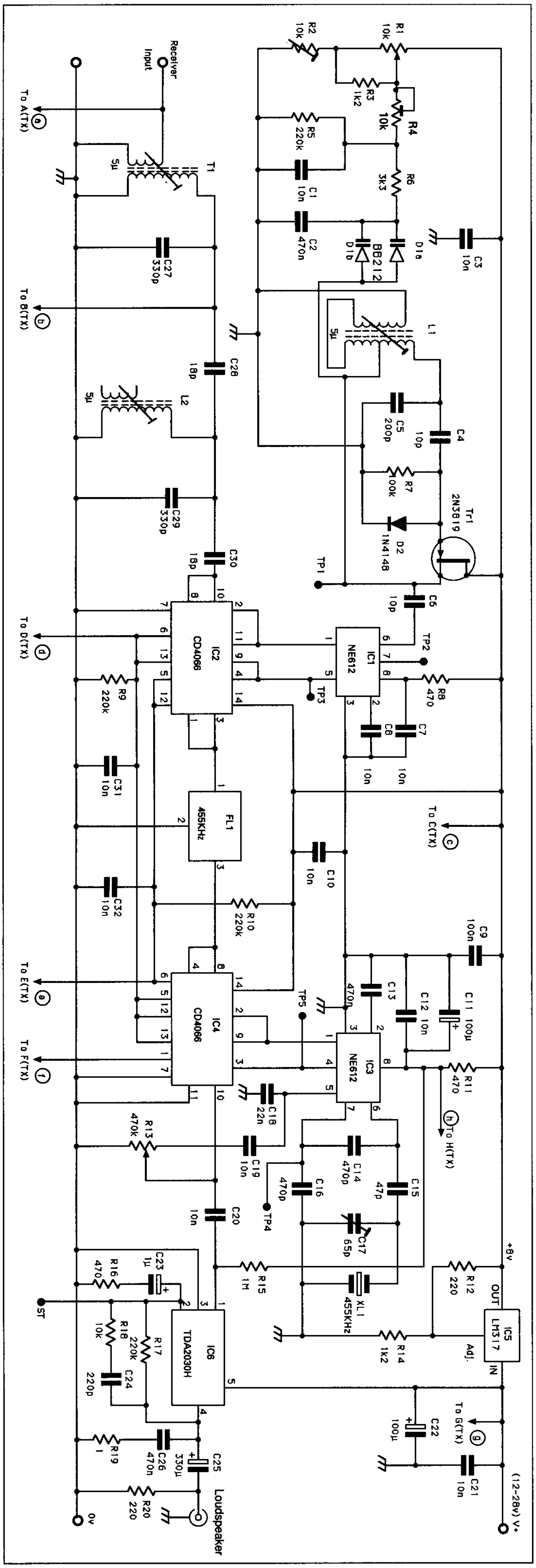


Fig. 2: Circuit diagram of the receiver section of the 3.5MHz s.s.b. transceiver.

you might expect. This is because electronic switches are included in the signal path to reverse the flow during transmission (more on this later).

Because of the two-way flow, I call the rig a 'bi-directional' superhet' If you only want to build the receiver, this circuit works on its own, provided you connect your antenna to the receiver antenna terminal.

INCOMING SIGNALS

Incoming signals are initially filtered in the double tuned r.f. filter T1 and C27 and L2/C29. These cover the 3.6 to 3.8MHz band without the need to retune.

Output from the second resonator is capacitively coupled to the NE612 first mixer i.c., IC1, at an impedance of 1.5kΩ. It's done through one section of the CD4066 quad electronic transmission gate, IC2

An LM317 voltage regulator, IC5, is used to provide a very stable +8V supply for the varactor diode and other circuits that can't withstand the intentionally wide range of main transceiver supply voltage (12 to 25V).

In this particular application the first mixer, IC1, is driven by an external v.f.o., Tr1, working in a Hartley configuration over the range of 4.055 to 4.255MHz. Special ceramic capacitors with a negative temperature coefficient compensate for temperature changes in the coil leading to a stable v.f.o.

The tuning varactor diodes, D1a and D1b, are connected across part of the coil. And to avoid slow motion drives (with all their horrible mechanical complexity) the tuning voltage is obtained from two potentiometers R1 and R4.

The potentiometers provide coarse and fine tuning control, rather like some older rigs had band-set and bandspread controls. Without this arrangement it would not be a TIM! However, in practice it's very easy to use.

THE MIXER

The output of the mixer (again at 1.5kΩ) is fed back through another transmission gate to the i.f. filter. The filter FL1, has excellent performance for its price, and removes unwanted signals and the other unwanted sideband.

The filter output is applied (through another transmission gate in the second 4066, IC4) to the second NE612 mixer which acts as a product detector. This NE612, IC3, uses its own oscillator section which is stabilised by the ceramic resonator XL1, which is pulled down from its nominal frequency of 455 to 435.5kHz.

Each NE612 mixer has about 15dB of gain, so this compensates for the lack of an i.f. amplifier. Audio output from the product detector is applied direct to the a.f. gain control. This is set at a higher impedance than normal to improve receiver muting on transmit.

The audio amplifier, IC6, is a TDA2030H and provides all the audio gain and low impedance output necessary for driving a loudspeaker. It's a cheap and very flexible device which is used in op-amp fashion.

In this particular application the audio amplifier i.c. remains active on transmit, so that c.w. enthusiasts can feed in a side-tone signal at ST on the IC6 negative input, while remaining unaffected by the receiver audio gain setting.

That's enough on the theory of the Tiny Tim for now. Next time, I'll describe the construction of the receiver and we'll proceed on to the p.c.b. aspect of the project.

SHOPPING LIST (FOR THE RECEIVER)

Resistors

Carbon Film 0.4W 5%

1Ω	1	R19
220Ω	2	R12, 20
470Ω	3	R8, 11, 16
1.2kΩ	2	R3, 14
3.3kΩ	1	R6
10kΩ	1	R18
100kΩ	1	R7
220kΩ	4	R5, 9, 10, 17
1MΩ	1	R15

Miniature p.c.b. mounted preset

10kΩ	1	R2

Rotary 'Normal' size potentiometer

10kΩ	2	R1, R4 (Linear)
470kΩ	1	R13 (Logarithmic)

Capacitors

Miniature Disc Ceramic

10pF		C4, 6 (NPO type)
18pF		C28, 30
47pF		C15
100pF	2	C5 (N150 types making C5, 200pF)
220pF		C24
330pF		C27, 29
470pF		C14, 16
10nF		C1, 3, 7, 8, 10, 12, 21, 31, 32

Miniature Polyester 5%

10nF		C19, 20
22nF		C18
100nF		C9
470nF		C2, 13, 26

Capacitors

Miniature Disc Ceramic

10pF		C4, 6 (NPO type)
18pF		C28, 30
47pF		C15
100pF	2	C5 (N150 types making C5, 200pF)
220pF		C24
330pF		C27, 29
470pF		C14, 16
10nF		C1, 3, 7, 8, 10, 12, 21, 31, 32

Miniature Polyester 5%

10nF		C19, 20
22nF		C18
100nF		C9
470nF		C2, 13, 26

Miniature Electrolytic (16V working)

1µF		C23
100µF		C11, 22 (C22 must be 35V if using a higher voltage p.s.u.)
330µF		C25

Rotary Trimmer Type

65pF		C17

Inductors

5µH	3	L1, 2 and T1 (Toko KANK3337 type)

Semiconductors

1N4148		D2
2N3819		Tr1
BB212	1	D1 (a and b)
CD4066	2	IC2, 4
LM317	1	IC5
NE612	2	IC1, 3
TDA2030H	1	IC6

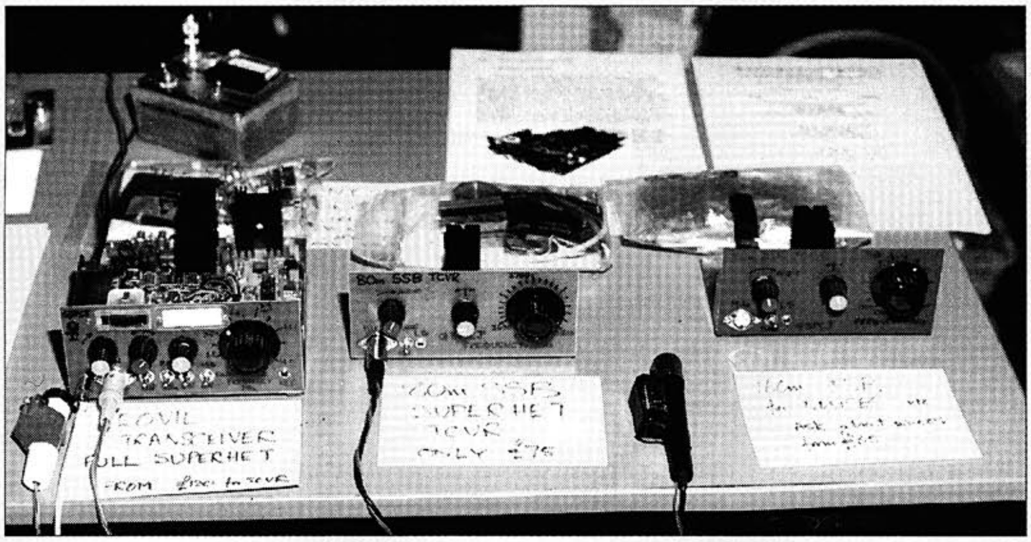
Miscellaneous

The filter FL1 is a CFJ455K5 type, and the resonator XL1 is a CSB455E, suitable connecting wire and cables, plus suitable plugs and sockets. Other constructional items will be needed to finish off the project.

An additional components list for the transmitter section of the transceiver, together with a combined miscellaneous list will appear in part two of the project.

TINY TIM KIT

A complete kit including the p.c.b. and additional components for the Tiny Tim will be available from G3PCJ for £75 inc p&p. For further details contact Tim Walford G3PCJ, Upton Bridge Farm, Long Sutton, Langport, Somerset TA10 9NJ. *PW*



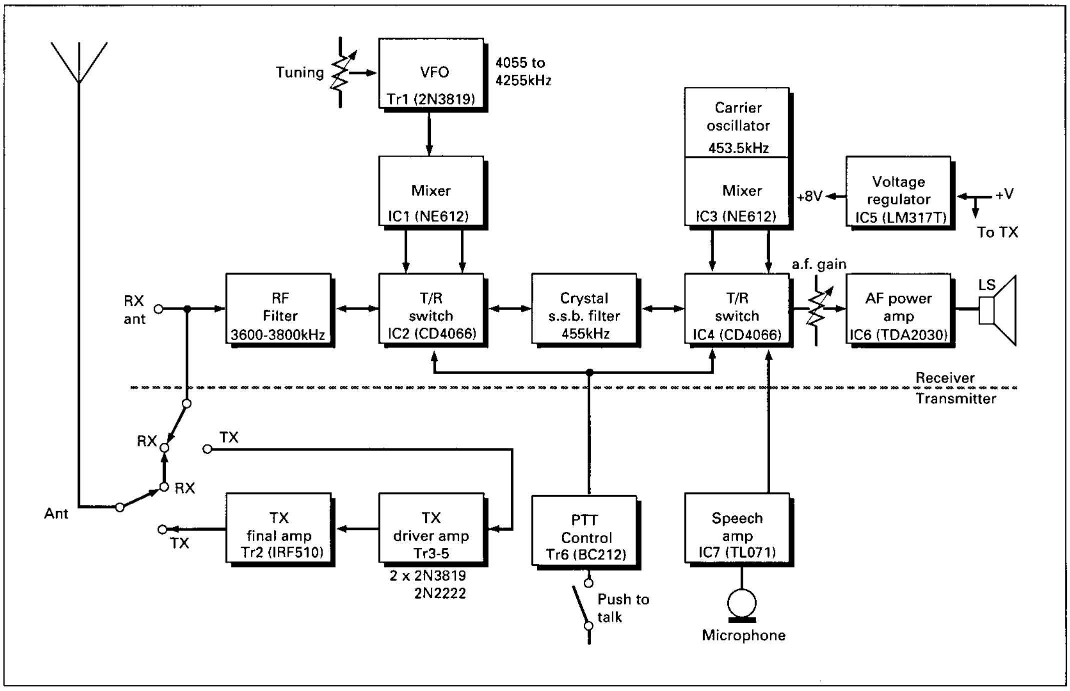
Tim Walford G3PCJ is a busy designer, and the 'Tiny Tim' prototype (Centre) is shown with his 'Yeovil' and other items at the 1993 Yeovil QRP Convention.

The Tiny Tim 3.5MHz Transceiver

Part 2

Construction

This month Tim Walford G3PCJ describes how to link the transmitter into the receiver he showed you last month.



Just to make life easier, the block diagram has been reproduced again. As you can see there is no separate s.s.b. generator for the transmitter, instead the signal flow through the receiver is reversed and fed to the transmitter r.f. amplifier. This is achieved primarily by the transmission gates, which act as switches between the r.f. and i.f. filter and the two mixer i.c.s. The input and output impedances of the NE612, IC1 & 2, are each 1.5kΩ. That is sufficiently close to the 2kΩ impedance of the i.f. filter to allow it to be connected to either the mixer input or output as required for transmission or reception. Relays could be used to do this, but transmission gates are cheaper, smaller, neater, more reliable and have negligible power consumption!

The speech amplifier, IC7, will work with practically any type of microphone. Output from the speech amplifier is fed to the product detector IC3 that acts as a balanced modulator on transmit. It generates the double sideband carrier at 453.3kHz. After going back through the transmission gate, IC4, the i.f. filter removes the unwanted sideband from the signal. The single sideband signal then goes to the r.f. mixer, IC1, via IC2. The mixer, IC1, converts the frequency up to 3.5MHz. The r.f. filter, comprising T1, L3, C27, C28, C29 and C30, removes the unwanted mixer image (as it also does on receive). The transmission gates are controlled by the two signals on points D and E.

Resistor R10 keeps line E high (at +8V) on receive whether or not the transmitter parts are fitted. On receive, line D is low at 0V via resistor R9. On transmit, both lines change so that line E is low and line D high.

The p.t.t. switch, which grounds the p.t.t. line, turns on Tr6 thus energising the two relays used for changing over the transmitter output and changing lines D and E. The transmitter signal leaves the r.f. filter at a high impedance point requiring the use of an f.e.t., Tr5,as the next stage. This operates in the common source mode. Its drain load is the 10kΩ Drive Level pre-set, R27, that allows the r.f. gain to be adjusted so that clipping does not occur in the final r.f. amplifier.

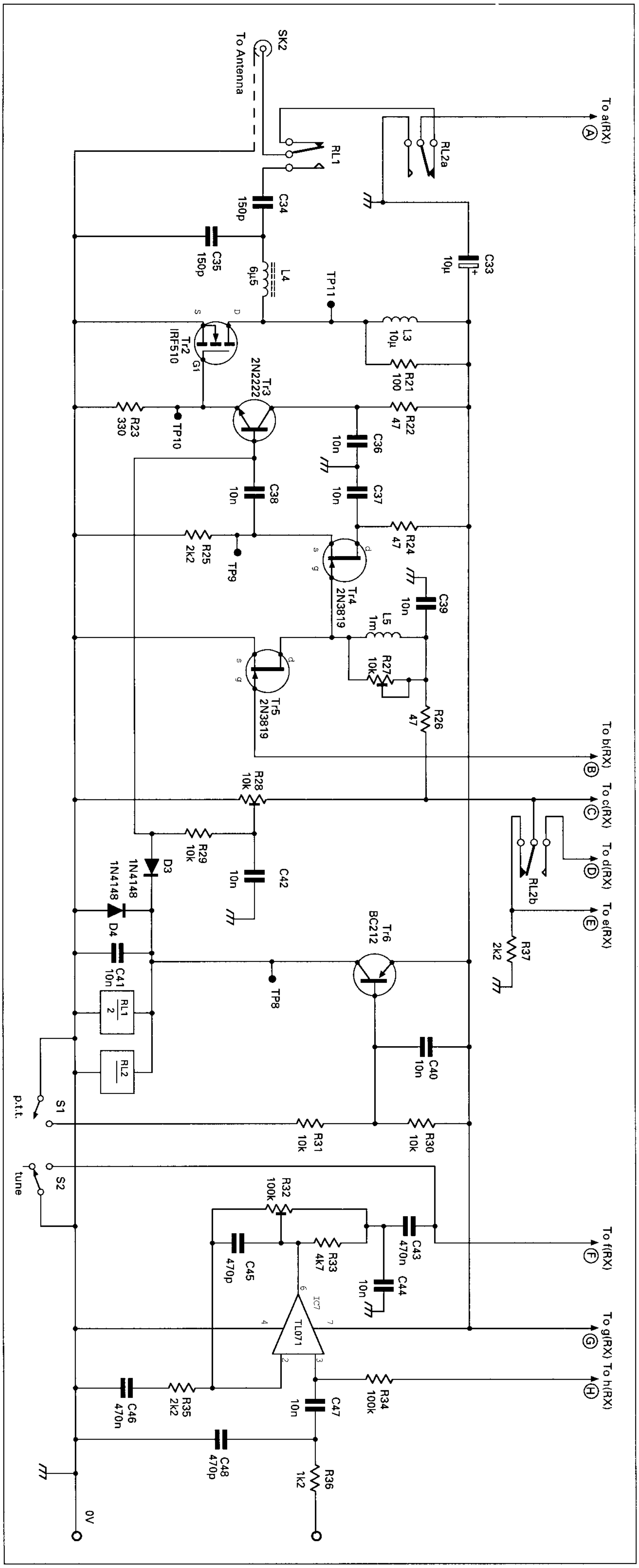
A 1mH r.f. choke is used in parallel with the pre-set resistor R27 to keep the drain d.c. voltage at +8V. This choke has to be of very good quality (high Q at 3.7MHz) in order to reduce the potential (and required) gain. Again an f.e.t., Tr4, is required to act as a buffer to drive the next stage, Tr3, which is an emitter follower. It is used to give a very low impedance drive to the output f.e.t. gate to overcome its high capacitance.

To achieve 10 to 12W p.e.p. on 12V supplies, Tr2, the IRF510 output stage, needs a drain impedance of 12.5Ω. I wanted a tuned output stage with a Q of 12, so that output low pass filters would not be required. The solution adopted is an LC network. It needs high voltage capacitors that, luckily, come with a 1% tolerance, so there is a very good chance that the output inductance, L4, will have the right number of turns on it first time!

The mic gain control, R32, in the speech amplifier is advanced to the point where signal clipping occurs in the output of the r.f. mixer, IC1. This provides r.f. speech compression or higher 'talk power' The troublesome harmonics this produces are safely removed by the bandpass r.f. filter following the mixer. The drive control is used to make certain r.f. clipping does not occur in the final output stage. Clipping in this stage usually causes splatter and a 'wide' transmitted signal that cannot be cleaned up.

The maximum output power increases as the square of the supply voltage, so if your d.c. supply can produce say 20V, then you will be able to obtain about 25W p.e.p. Bear in mind, that to get this higher output power, you will need to increase the r.f. drive to the final stages as well as using a 20V supply. Supply voltages up to 25V can be tolerated, but transmitter output power is really limited by the heat dissipation of Tr2 - 18 to 20V is a sensible upper limit after you have got it going and checked it out on 12V.

Due to factors beyond our control, we were not able to describe building the project in this part. But we will do so in the next part of the Tiny Tim Transceiver.



Shopping List

The Tiny Tim transmitter is built on the receiver's p.c.b., so you will need the following additional components for this section of the transceiver.

Resistors

Metal film miniature 1W 5%		
100Ω	1	R21
Metal film 0.4W 5%		
47Ω	3	R22, 24, 26
330Ω	1	R23
1.2kΩ	1	R36
2.2kΩ	3	R25, 35, 37
4.7kΩ	1	R33
10kΩ	3	R29-31
100kΩ	1	R34
Miniature p.c.b. mount trimmer		
10kΩ	2	R27, 28
100kΩ	1	R32

Capacitors

630V Polystyrene 1%		
150pF	2	C34, 35 (Farnell part no. 427 41501)
Miniature polyester		
10nF	2	C44, 47
470nF	2	C43, 46
Miniature disc ceramic		
470pF	2	C45, 48
10nF	7	C36-42
Miniature electrolytic 35V working		
10µF	1	C33

Inductors

6.5µH	1	L4 (33t of 0.56mm (24s.w.g.) wire on a T68-2 toriodal core)
10µH	1	L3 (Toko 3.5A coil)
1mH	1	L5 (High *Q* r.f. choke)

Semiconductors

Diodes		
1N4148	2	D3, 4
Transistors		
2N2222	1	Tr3
2N3819	2	Tr4, 5
BC212	1	Tr6
IRF510	1	Tr2
Integrated Circuits		
TL071	1	IC7

Miscellaneous

Two 12V (720Ω BT53/3 style) d.p.c.o. relays (Farnell part no. 150-547), one T68-2 toriodal core for L4, 24s.w.g. enamelled copper wire for L4, coaxial sockets as necessary, miniature toggle switch (d.p.d.t.), a TO220 5.8°C/W vertical heatsink for Tr2 (Farnell part no. 117-007). Other items will be neccessary to complete the project.

Farnell Electronic Components, Canal Road, Leeds, West Yorkshire LS12 2TU. Tel: (0532) 636311. Minimum order £5 plus carriage and packing.

Tiny Tim Kit

A complete kit including the p.c.b. and additional components for the Tiny Tim will be available from G3PCJ for £75 inc P&P. For further details contact Tim Walford G3PCJ, Upton Bridge Farm, Long Sutton, Langport, Somerset TA10 9NJ. **PW**

Fig. 4: The transmitter section of the Tiny Tim cannot work without the receiver section. Note the p.t.t. switch is part of the microphone.

The Tiny TIM 3.5MHz SSB Transceiver Part 3

In the third part of the 'Tiny TIM' project, Tim Walford G3PCJ describes the building and setting up of the receiver.

Our apologies go to readers for the non-appearance of Part 3 of the 'Tiny TIM' in the September issue of PW. This was directly due to the Editor (rather inconveniently!) going off to hospital. Sorry about that! G3XFD

The PW production prototype Tiny TIM as built by Tex Swann G1TEX and tested on air by G3XFD. The front panel uses p.c.b. material (see text).

In this section, I'll assume you have purchased a ready drilled main p.c.b. This a continuous ground plane of copper (0 volts or earth) on the top or component side, with the tracks beneath.

The rig's front panel also uses copper clad p.c.b. board. It has the labels, etc., printed on the front with a continuous ground plane on the back. The back of the front panel will be soldered (at a later stage) to the front edge of the main p.c.b.

So, let's start assembling the receiver. Don't forget, that when you're inserting components, be careful not to push them too far into the board. The leads, if pushed too far, may make contact with the ground plane at the edge of the isolation holes, and shouldered components, such as integrated circuits need particular care.

It can be difficult to solder some parts to the ground plane, particularly where an earth connection is required. To help, you will find that an earthy track leads to a component that can be soldered to the ground plane easily (such as resistors and disc ceramics).

You should only solder both sides of the board where this is possible. The illustration featuring the p.c.b., shows by means of crossed circle symbols where you should solder on the top as well as the bottom.

The p.c.b. has provision for Veropins to be inserted at the test points. You may also place ICs 1 to 4 in sockets if you wish.

Testing By Stages

I recommend that you build and test by stages. You should always switch off when adding and soldering components.

Start with the +8V regulator IC5 and its resistors R12 and 14 and decoupling capacitors C21, 9 and 22.

Now connect your supply to the V+ , being very careful about the polarity. Then use a voltmeter to check that +8V is available on the +8V pad, with respect to 0V/earth.

The next stage is to assemble the audio amplifier stage around IC6. Bolt the i.c. direct to the p.c.b. without any insulating washer.

Now fit R11, 15, 16 to 20, C11, 12, 20, 23 to 26. When you've completed this, connect up your loudspeaker temporarily.

You can now switch the unit on. As you do so, there may be a slight 'thump' in the speaker (this is normal). It's now time to carry out the 'finger' test. Applying your finger to the amplifier input at R15/pin 1 of IC6, should produce a loud hum if all is well.

Next, switch off and install the product detector IC3. Then fit C17, the capacitors C14, 15, 13, 16, 18 and 19. Finally, there's the ceramic resonator XL1 to be fitted.

Checking The Oscillator

If you have a means of checking the oscillator is working, test it with a high impedance probe at test point 4. And if you can measure the frequency, adjust C17 so that it is 453.5kHz, otherwise leave it at mid position.

There's little that you can test easily in the next part until you have the v.f.o. fitted. This requires the front panel, so you might as well install this part while it is easier.

So, it's best to install both transmission gates IC2 and 4, the filter FL1, the resistors R9 and 10 and C10, 31 and 32. You can also fit the bandpass filter T1 and L2, C27, 28, 29 and 30.

Although the filter can be peaked up with a signal generator, it's quite easy to do on received signals. So, it's perhaps best left until later.

Now you can fit the first mixer chip, IC1, and all of the v.f.o. components. This stage comprises Tr1, D1 and 2, L1, R3, 5, 6, 7, and C1, 2, 4, 5a , 5b, 6, 7, and 8.

Front Panel

Now it's time to fit the front panel as described earlier. Drill out the holes in the front panel p.c.b. material for the various controls and sockets.

The heading photograph on page 22 and Fig.3 illustrate the mounting method. Once assembled, you can solder the front panel to the main p.c.b.

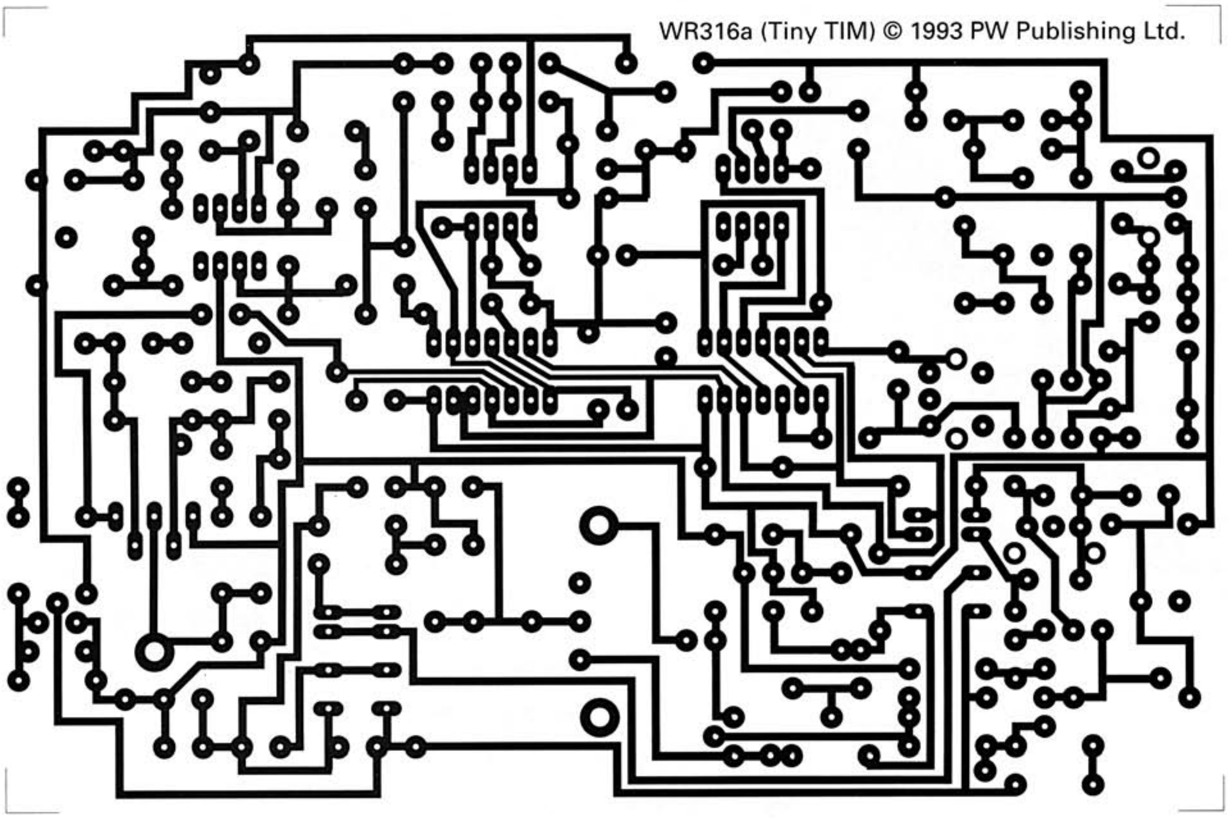
You can now install the front panel controls. Start by mounting the controls R1, 4 and 13 and the loudspeaker jack socket.

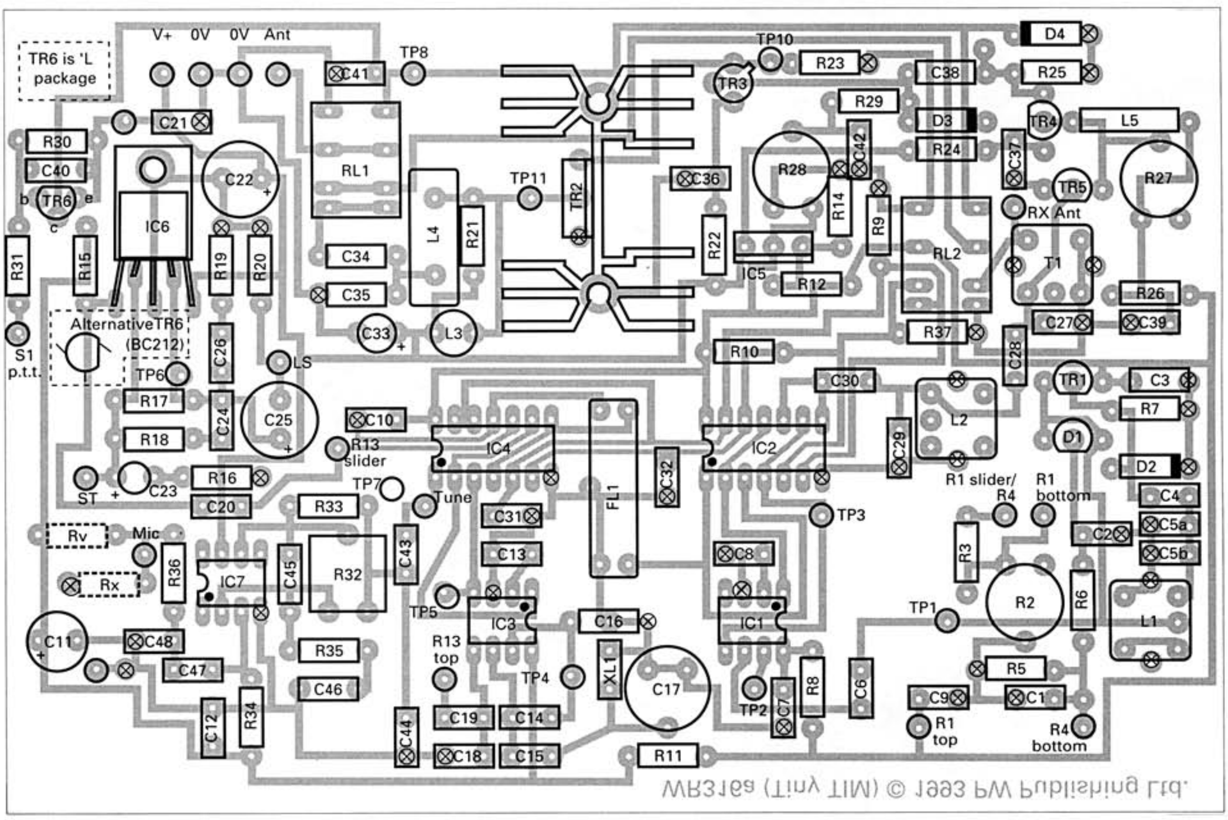
The next job is to solder connecting wires from the variable controls to the appropriate p.c.b. pads. Don't forget to make holes for the microphone connections and the **Tune** control switch.

By now, there should not be any receiver components left, if all is well with my instructions and your construction! So, if all is well, it's time to switch

Fig. 1: (Top) The p.c.b. track layout of the Tiny TIM project.

Fig. 2: (Bottom) Component overlay and groundplane diagram.





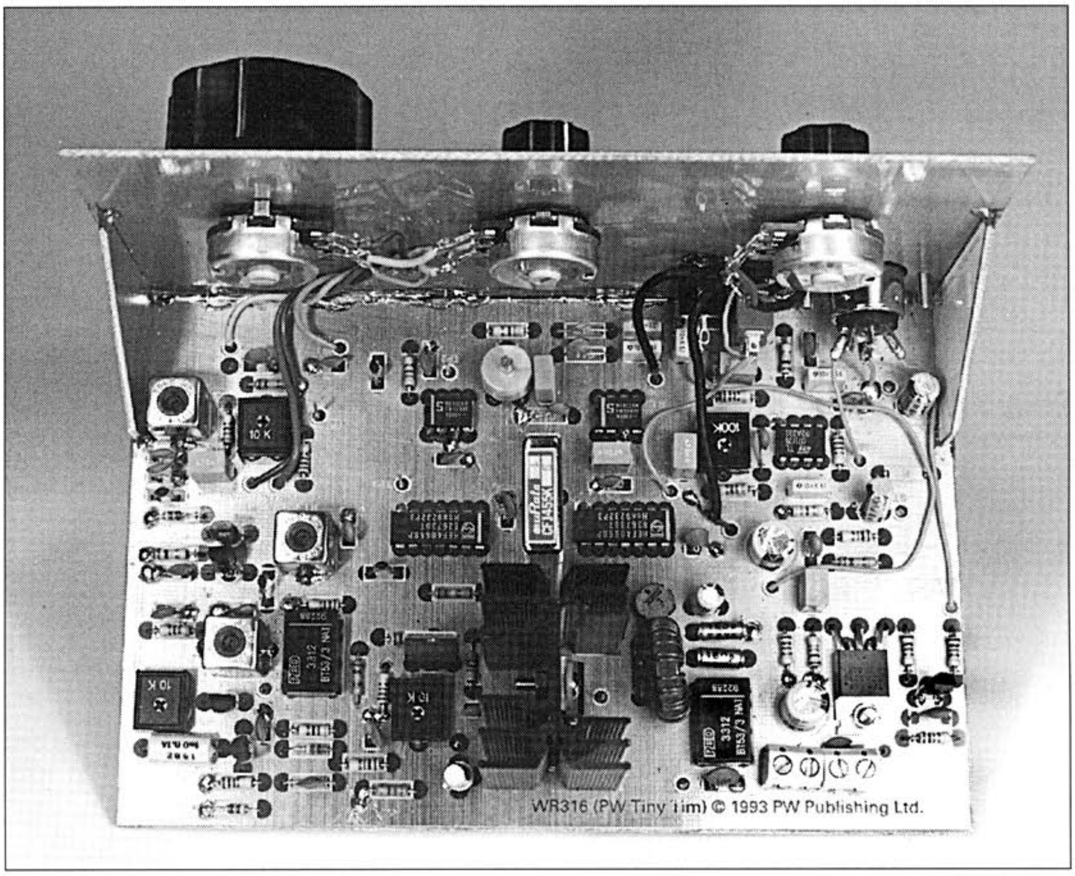


Fig. 3: Rear view of the *PW* production prototype Tiny TIM, showing the neat and very practical design approach by its designer Tim Walford G3PCJ. The main tuning control potentiometer is on the far left of the front panel, with the fine tuning control in the centre and the audio gain control on the right. The soldered seam running along the bottom of the front panel (made from double-sided p.c.b. material) secures the panel to the main p.c.b. (see text). For strengthening purposes, it is essential that the p.c.b. side cheek pieces are incorporated.

the receiver on, to set up the v.f.o. coverage. Fit the large tuning knob so that the cursor mark is opposite 3.8MHz at the top (fully clockwise position).

Using a high impedance probe on your frequency meter, and connect it to test point 2. First set the fine tuning control to mid position and then put the coarse control to fully clockwise for the 3.8MHz mark. Then adjust the v.f.o. coil for a frequency of 4.255MHz.

Now turn the coarse control anticlockwise to the 3.6MHz mark and then adjust R2 for 4.055MHz. There will be some interaction between these two, so it's best to repeat the adjustments.

Next, you can peak up the r.f. filter, as you should be able to receive signals with the antenna connected to the receiver input pad on the p.c.b. Choose a steady transmission near 3.7MHz and adjust the cores of L2 and 3 for maximum loudness. And again, you should repeat each adjustment in turn.

If you don't have a frequency meter or counter, you might be able to listen to the oscillators on a general coverage receiver. Otherwise, you'll have to adjust the carrier oscillator by C17 by listening to many signals and adjusting it until you obtain the most natural sound for most of them!

Setting Up The VFO

If you don't have a digital frequency counter or a calibrated receiver, then you can set up the v.f.o. by ear and by hand. Setting the v.f.o. can be done successfully by listening to stations on the band. You can use RSGB news, known RTTY stations or any known frequency transmissions. Then adjust the L1 and R2 until the amateur (European) phone transmissions just fill the tuning range.

If you have a crystal marker generator this can also be used. But be careful when changing from 1MHz or 500kHz markers to 100kHz once since you might skip 3.9 or 3.6MHz!

It might be best to set the v.f.o. initially to 4.455MHz and using the 4MHz marker (core of L1 well out). You should then work down carefully with the core of L1 to 3.8MHz.

You should now have a working receiver. The next stage is the final completion and setting up of the transmitter.

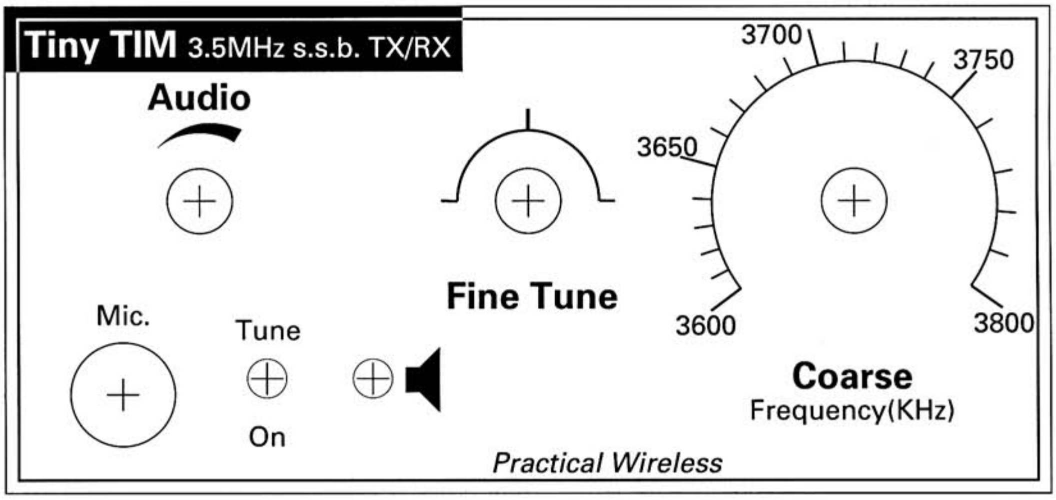


Fig. 4: Front panel layout for the simple transceiver. For ease of construction, the panel uses copper clad p.c.b. material.

Construction

The PW Tiny TIM Part 4

The Completed PW prototype Tiny TIM (Transceiver In Miniature) 3.5MHz s.s.b. project, designed by Tim Walford G3PCJ.

*This month Tim Walford G3PCJ completes the description of his s.s.b. **T**ransceiver **I**n **M**iniature 3.5MHz project, and explains how you should finish off the transmitter section.*

Now you've completed the receiver it's time to start work on the transmitter section. But before you begin, I suggest it's a good idea to turn all preset resistors fully anticlockwise before fitting them to the p.c.b.

Fit the microphone socket and the **Tune** switch and wire them up to the board. Then install the two relays, RL1 and 2, resistors R30 and 31, C40, 41, D3, 4 and Tr6 which controls the change-over switching.

Turn on and listen for the relays clicking over as you operate your p.t.t. switch, (it needs to ground the p.t.t. line). The receiver should also be silent while on transmit.

Now install the transmit pre-amplifier R23-26, C37 - 39, L5, Tr4 and 5. If you have another 3.5.MHz receiver you can listen to this rig to check this part.

When the **Tune** switch is closed during transmit (which severely unbalances the balanced modulator) r.f. is produced for tuning up purposes. Advance the drive preset R27 a little and you should be able to hear this rig's carrier on another receiver if its antenna wire is nearby when you close the **Tune** and p.t.t. switches.

Radio Frequency Components

Install all the other radio frequency components R21 - 23, C34-36, R28, C42, L3, Tr2 and 3. Now wind 33 turns of 24s.w.g. wire tightly onto the T68-2 toroid for L4.

Leave 50mm spare at each end in case the turns need altering and solder it in place temporarily. Fortunately, the modern enamelled wire (with a slightly pink coloured enamelling) needs only a very hot iron to burn off the insulation.

However, take care as the fumes given off by the burning enamel are irritating. Make sure your work place is well ventilated.

The output f.e.t. has to have its tab isolated from the heatsink. So to isolate it, put the thin heatsink washer between the tab and heatsink (preferably with a dab of heatsink compound if available). The nut and bolt (if metal) also need isolating by the small shouldered bush that fits snugly into the hole in the f.e.t.'s tab.

Now you can fit the heatsink, making certain the wide side of the central part can accommodate the output f.e.t. Tr2.

The source lead of the f.e.t. should only be soldered on the top of the p.c.b. And since a good direct earth connection is required, you should not solder it on the underside in case it has to be changed!

The drain and gate should be soldered underneath as normal. Remember to check whether any earthy part you are fitting needs to be soldered on both sides.

Connect up your power meter (set to read power out) and feed this to your dummy load (or a known 50Ω antenna feeder). Put a 2A meter in the positive d.c. supply lead. Check the **Tune** switch is off and that R28 is fully anticlockwise.

Switch on and go to transmit. The supply current will rise a little from the receive value about 50mA when you press the p.t.t. switch, mainly due to the relays.

Slowly advance the preset R28 (while on transmit) till the supply current rises to 400 to 500mA. There should be negligible r.f. output and the current should fall back, on going to receive.

Tune Switch

Turn on the **Tune** switch, then advance the drive preset R27 so that on transmit about 3 to 5W p.e.p. is being produced. Next adjust the two cores of T2 and L2 for max output at a frequency near 3.7MHz.

Then adjust the drive preset R27 for just below maximum output. This should be about 12W p.e.p. if using 12V supplies.

If you are using a higher supply voltage watch out that the heatsink doesn't get too warm - go to receive for a while! If you can't get 12W p.e.p. (on 12V) into a known 50Ω load, you can try one more or less turns on L4, but it's not likely to need altering. If all is well fit L4 with short leads.

You can now fit all the speech amp parts, R32-36, C43 - 48, IC7 and the wiring to the microphone input (including any extra parts for your type of microphone - see later).

With the **Tune** switch off, go to transmit and whistle into the microphone. Now adjust the microphone gain preset R32 for the point just below maximum output.

Increasing the microphone gain further will increase the degree of clipping. This is best done in the light of other station's comments or with an oscilloscope and two tone audio generator. Your 'Tiny TIM' is now ready for on air use!

Good antenna matching is always important to get the best out of any transmitter. This rig needs a 50Ω unbalanced load, so if you're connecting it to a dipole, I recommend you use a balun.

It's better to use a link coupled resonant matching unit which will help reduce out of band signals. An output low pass filter should not be needed.

If you become seriously stuck, you'll have to seek assistance with more sophisticated test gear. Don't forget to check for solder whiskers and that devices are correctly oriented! The circuit diagrams contain typical voltages on the test points for guidance.

Speech Amplifier

The speech amplifier is designed for microphone impedance of 100Ω and outputs down to 1mV. Crystal microphones can be used without extra parts.

Dynamic microphones will need a resistor across the input to earth in the position Rx on the p.c.b. Typical values being 470 to 680Ω.

Electret microphone inserts sometimes need a few kΩ to a low positive supply. If you don't know the value required try 2.2kΩ in position Rv on the p.c.b. layout.

If your chosen microphone needs a positive supply with no extra resistors, take a lead from the left hand pad of Rv to one of the unused pins in the microphone. No isolating capacitor is needed.

Incidentally, you can use any type of socket to suit whatever microphone you have. But you need to know its pin connections and modify the front panel to make it fit (this is best done before it's soldered to the main p.c.b.).

Personally, I suggest the DIN five pin 180° type because it's the cheapest! Some 'communication' style microphones have their own amplifier. These need a few kilohms to earth, so I suggest trying a 4.7k7Ω resistor in position Rx.

Don't use the +6V for microphones with their own amplifier. Invariably they have their own battery (replace it regularly regularly). However, you can use the +8V supply with suitable dropping resistor(s), if you have to power it.

Primarily For Phone

Although the 'Tiny TIM' is designed primarily for 'phone use, it can be used for c.w. For use with the key, you'll need a separate tone oscillator and a means of keying it, the output being applied to the mike input.

Sidetone from the keyer can also be fed into the audio amplifier at the ST pad on pin 2 of the 2030 amplifier. The audio stage remains active on transmit for this purpose.

You should perhaps unplug the microphone and connect the c.w. circuits instead to the microphone socket. This will avoid what I thought was a serious problem with the keyer. It turned out to be the microphone picking up bench vibrations from my key!

The v.f.o. and r.f. bandpass filter may need retuning for your preferred band segment. You shouldn't need to do any mods to the p.c.b.

With a bit of ingenuity you can also add receiver incremental tuning (r.i.t.). A narrow c.w. audio filter can also be added immediately prior to the audio gain control.

Some Extra Sensitivity

Anyone using a particularly short antenna may find that some extra sensitivity would be useful. This can be achieved by increasing the audio gain of the TDA2030 stage.

Halving the value of R16 will double the audio gain, etc. But to keep the same low 300Hz bandwidth you will need to double the value of C23. A value of about 2μF should be about right.

I suggest you carry out modifications to the amplifier with caution. This is because it increases the risk of audio breakthrough on transmit from microphone to loudspeaker when the audio gain control is at maximum. You may be able to use 150Ω for R16 and 3.3μF for C23.

Good luck! I hope that you get as much fun out of your 'Tiny TIM' as I have had in designing and using it.

However, I can't close without saying a big thank you to the members of the Yeovil ARC who tolerated my experiments. And thanks to all those numerous article writers who unwittingly contributed many ideas towards the development of the transceiver.

PW

Radio Diary

*Practical Wireless and Short Wave Magazine in attendance.

***October 29/30:** The 22nd Annual Leicester Amateur Radio, Electronics & Computer Exhibition will be held at the Granby Halls, Leicester. All the usual attractions and facilities. **Frank G4PDZ on (0533) 871086.**

November 6 & 7: The Seventh North Wales Radio & Electronics Show will be held at the Aberconwy Conference Centre, Llandudno. Doors open at 10am on both days. Admission £1, children under 14, 50p. **B. Mee GW7EXH on (0745) 591704.**

November 7: Bishop Auckland Radio & Computer Rally will be held at Spennymoor Leisure Centre. Doors open 11am, 10.30am for disabled visitors. All the usual stalls, bar and catering facilities. **M. J. Shield G0PRQ on (0388) 766264.**

November 7: Donegal TIR Cornaill Amateur Radio Society will hold its annual radio rally at Jacksons Hotel, Ballbofey, Co. Donegal, Eire. Large trade presence is expected, Bring & Buy, leisure facilities on site. Special accommodation rates will be available in Jacksons Hotel. **Ken McDermott EI4DW, QTHR on 010-353 74 31109.**

November 13: AMS 7 The All Micro Show, Electronics Fair & Radio Rally will be held at Bingley Hall, Stafford (Signposted from Junction 14 of M6). Large trade presence. Bar, refreshments & free parking. **Sharward Services on (0473) 272002.**

December 5: Leeds & District Amateur Radio Society will be holding its rally at Allerton High School, King Lane, Leeds. Four large main halls, talk-in on S22, catering facilities. **Richard Tillotson G7HUE on (0532) 552344 or FAX (0532) 393856.**

December 12: Centre of England Christmas Radio, Satellite, Computer & Electronics Rally is being held at the Sports Connexion Centre, Leamington Road, Ryton on Dunsmore Coventry A45/A423. Doors open at 11am, 10.30am for disabled visitors, admission £1. Over 80 traders, Bring & Buy, talk-in on S22. Bar and hot food all day, ample free parking. Christmas special 'Spot The Cracker' on many of the trade stands to win a prize. **Frank Martin on (0952) 598173.**

If you're travelling long distances to rallies, it could be worth 'phoning the contact number to check all is well, before setting off.