# FIDELITY 1000 MOD

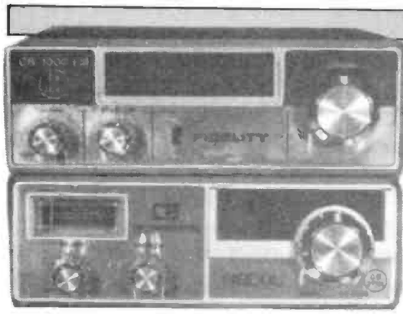



**Photo 1. The two guises of the CB1000 rig**

*Legal 27MHz CB rigs are turning up cheap nowadays. So why not modify them to 10 metres? "Why not, indeed?" asks Roger Alban.*

When the British government decided to legalise CB in the UK, the specification published, MPT 1320, was deliberately made very different from that used by American CB sets. The idea behind this was to put UK manufacturers in the running to produce home-grown CB rigs, rather than have the market flooded with cheap imports.

However, the specification caused a number of design problems, mainly associated with the PLL chips required to produce the appropriate frequencies. At the time, the available custom-designed chips for CB, like the LC7120, were suitable only for the US spec. Secondly, to achieve the specified frequencies, an additional crystal oscillator had to be used because the PLL chips available could not operate with inputs on their Fin pins higher than 5MHz.

## MM55108N To The Rescue

There was, however, one rather obscure PLL chip, the MM55108N, which did not need an additional crystal oscillator for down-mixing, the problem being overcome by dividing the reference frequency by two and then tripling it externally using a tuned circuit, the resultant frequency then being appropriate for injection into the down-mixer. However, because the chip was, relatively speaking, rather elderly, this frequency could not be handled on-chip, so the down-mixer had to be external.

One feature of this PLL chip is that the divide-by-N chain is programmed via an on-chip ROM (read only memory); the channel number is used to decide what N is programmed into the chain. Also, the ROM has an address line linked to the send/receive line, so a different N is used for send and receive.

The same PCB, using the MM55108N, was used in a number of ostensibly different CB rigs, including the Fidelity CB1000 and the GECOL sets. As a result, the mod described here should be possible on a number of different rigs, although in the author's experience the Fidelity is much the most common. The front panels of the Fidelity and GECOL rigs are shown in **Photo 1**, and other versions would be similar in lay-out.

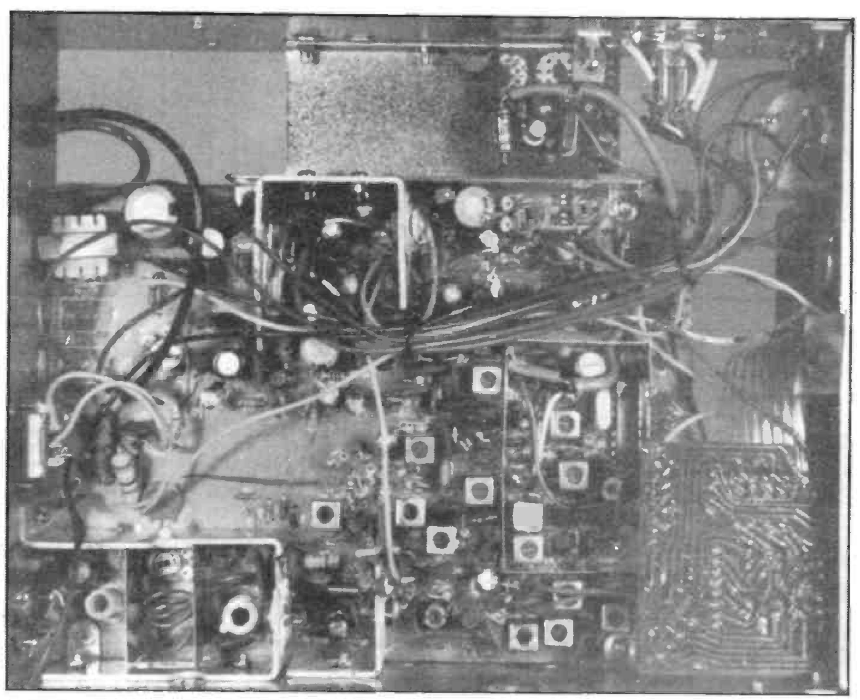
However, to make a positive identification, it is necessary to remove the speaker cover and examine the component lay-out of the PCB. **Photo 2** shows the interior of a modified rig, so ignore the small piece of Veroboard shown attached to the side panel and you should have a pretty good idea of what to look for. In this photograph, the top lid of the PLL box, located on the component side of the PCB near the front panel, has been removed.

## Frequency Generation

To understand the mod, we must first understand how the rig generates the required frequencies. A block schematic diagram is shown in Fig. 1. If you can't follow this explanation, do not worry too much because it will not prevent you from carrying out the mod; however, you may find it difficult to deal with any problems that may or may not come up.

A reference crystal oscillator operating at 10.24MHz is fed into the input of the fixed value reference dividing register. The reference frequency is first divided by a factor of 2, and then by a factor of 1024 to produce a 5kHz reference frequency which is fed to the phase detector. The output from the phase detector consists of a varying DC

**Photo 2. General view of the internal component placement**



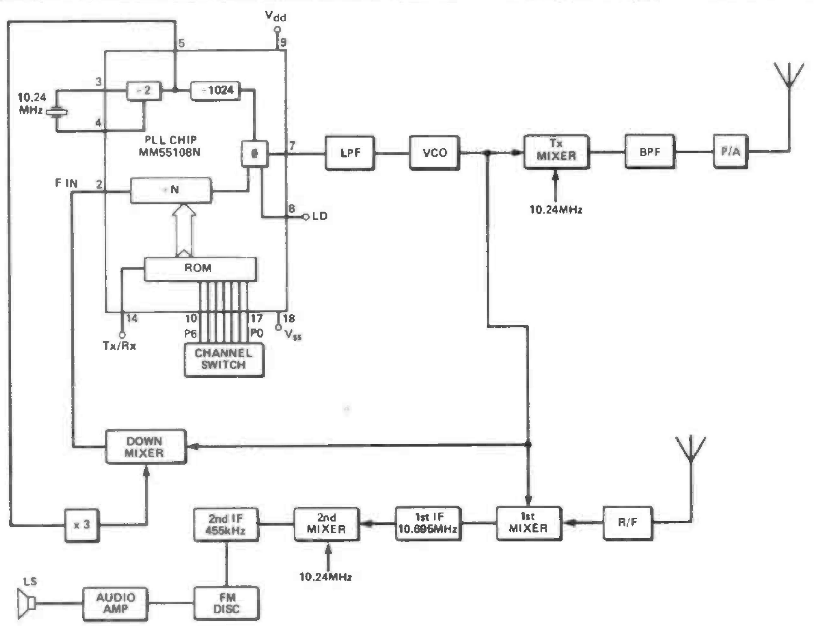



**Fig. 1 Block diagram of the standard rig**

component superimposed upon a 5kHz signal. The unwanted AC component is filtered out by a low pass filter, and the DC component is fed to a varicap diode which forms part of the VCO tuned circuit.

A small sample of the output frequency of the VCO is fed to the input of the down-mixer where it is mixed with a frequency of 15.36MHz. This stable fixed frequency signal is obtained by taking from pin 5 of the PLL chip half the reference oscillator frequency (5.12MHz) and tripling it to arrive at the required 15.36MHz. The output from the down mixer, which is Fvco − 1.5 x Fref, is fed via a low pass filter to Fin, the input to the programmable divided-by-N chain, on pin 2 of the PLL chip. The value of the logic levels applied to the programme lines will determine the value of N. The output from the programmable divider is fed to the other input of the phase detector.

The loop is said to be locked when both inputs to the phase comparator are at the same frequency, ie, 5kHz. On transmit, the output from the VCO is fed to the input of the transmit mixer where the VCO signal is mixed with a sample of the reference crystal oscillator frequency to produce the required transmit frequency. On receive, the output of the VCO is injected into the receiver first mixer to produce the first IF frequency of 10.695MHz.

To help illustrate the frequency relationships which exist within the design of the set, let us suppose that the set is operating on channel 20 in the transmit mode. From the handbook, the operating frequency for the set on channel 20 will be 27.79125MHz. The VCO will be operating at a frequency of 27.79125MHz minus 10.24MHz which equals 17.55125MHz. The output frequency from the down mixer which is fed into Fin will be 17.55125MHz minus 15.36MHz which equals 2.19125MHz. For the loop to be locked, the output from the programmable divider must be 5kHz, the same frequency as the reference input of the phase comparator. Threfore the value of N will have to be 2.19125MHz divided by 5kHz which equals 438.25.

This value for N must be wrong because we cannot have a value for N which is not a whole number. Let us assume that the true value of N is 438. The value of Fin will be 438 x 5kHz which will be 2.19MHz. The VCO will be operating at a frequency of 2.19MHz plus 15.36MHz which equals 17.55MHz. The transmitter frequency will be 17.55MHz plus 10.24MHz which equals 27.79MHz, 1.25kHz lower than the required frequency. This error in operating frequency is within the limits set by the UK specificaton of ±1.5kHz, paragraph 14.1.3., MPT 1320.

When the set is in the receive mode, the frequency of the VCO will be different because the output of the VCO is now fed into the receiver first mixer. The frequency of the VCO on channel 20 receive will be 27.79125MHz minus 10.695MHz which equals 17.09625MHz. The value of Fin will be 17.09625MHz minus 15.36MHz which equals 1.73625MHz. For the loop to be locked the corresponding value of N for the programmable divider output to be 5kHz will be 1.73625MHz divided by 5kHz which equals 347.25. Again, we must have a whole value for N.

Let us assume that the correct value of N is 347. The value of Fin will be 347 x 5kHz which equals 1.735MHz. The VCO will be operating at 1.735MHz plus 15.36MHz which equals 17.095MHz. The receiver frequency will be 17.095MHz plus 10.695MHz which equals 27.79MHz which is 1.25kHz low. This error in receiver frequency is again within the terms of the UK specification.

## 10 Metre Operation

The question that now needs to be answered is: how do we convert this set to operate on the 10 metre band? The frequency injected into the down-mixer will have to be changed if we are to alter the operating frequency range of the set, but to what value? Let us again assume that the set is to operate on channel 20. For channel 30 to correspond to the 10 metre calling frequency of 29.60MHz, this being the author's standard practice, then channel 20 will have to correspond to an operating frequency of 29.50MHz.

On transmit, the VCO will be operating at a frequency of 29.50MHz minus 10.24MHz which equals 19.25MHz. Remember that the value of Fin will not be changed, ie. it will continue to operate at a frequency of 2.19MHz. Therefore the value of the frequency required to be injected into the down mixer to obtain this value of Fin will be 19.26MHz minus 2.19MHz which equals 17.07MHz. Therefore if we build a 17.07MHz crystal oscillator and inject this frequency into the down mixer we should be able to operate this set on the 10 metre band.

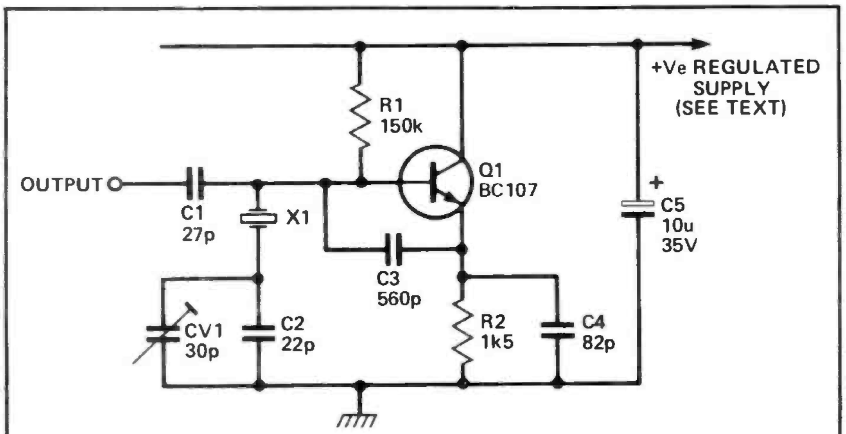
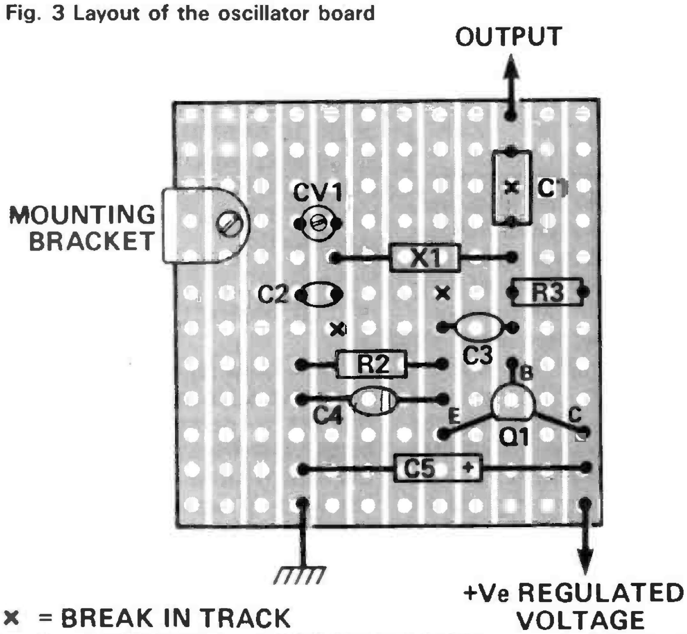



Fig. 2 Schematic of the add-on oscillator board

Fig. 3 Layout of the oscillator board




Let us check the calculation of the crystal oscillator frequency by calculating the receiver frequencies. On channel 20 receive, the value of N will be 347 as previously calculated for the un-modified set. The value of Fin will be 347 x 5kHz which equals 1.735MHz. The VCO will be operating on a frequency of 1.735MHz plus the frequency of the new crystal oscillator of 17.07MHz which equals 18.805MHz. The receiver will be tuned to a frequency of 18.805MHz plus 10.695MHz which equals 29.50MHz, the same operating frequency as the transmitter. Hence we have proved the calculation.

The difference in the value of N between transmit and receive will remain the same irrespective of the channel selected. The logic values required to produce the correct values of N for transmit and receive for each of the 40 channels is stored within the ROM, which forms part of the PLL chip. The ROM is addressed by seven programme lines P0 through to P6 and an additional programme line to select the different address for transmit and receive. One now starts to appreciate how useful and versatile this PLL chip is!

## Before conversion

A start can now be made on the conversion of this set to operate on the FM portion of the 10 metre band, but before taking the soldering iron to the set it would be wise to first verify that it is functioning correctly and is free of any faults which could upset the modification. To carry out the modification work detailed below you will need an oscilloscope capable of resolving a 20MHz signal, a digital counter capable of measuring frequencies as high as 30MHz, and a stable signal generator capable of operating at 29.5MHz.

The first item that must be constructed is the down-mixer crystal oscillator. The circuit diagram of the crystal oscillator is shown in Fig. 2. The crystal X1 should operate in the fundamental mode at a frequency of 17.07MHz. When ordering this, ensure that the manufacturer is asked to supply a crystal that operates with about 30pF of capacitance in parallel and that it is supplied in a HC18u holder so that it can be soldered directly onto the crystal oscillator board.

The oscillator uses a Colpitts circuit and the operating frequency of the crystal can be altered by adjusting CV1. The transistor Q1 is a BC107. In fact, most of the

Photo 3. Close-up of the crystal oscillator board

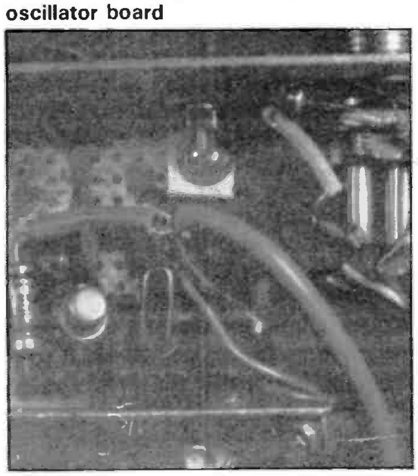
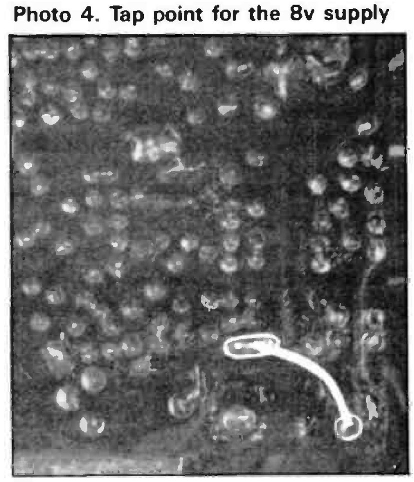


Photo 4. Tap point for the 8v supply



components with the exception of the crystal were obtained from the junk box which kept the cost of the modification down to the price of a new cyrstal.

The circuit was constructed on a small piece of Veroboard and the component layout as used by the author is shown in **Fig. 3.** A small L-shaped bracket can be used to attach the Veroboard to the side wall of the set. The exact location of the board can be seen in **Photo 3;** it is mounted on the right hand side wall of the set just behind the microphone socket. The required regulated 8V supply is obtained from the main PCB. **Photo 4** shows the take off point, which is the emitter of Q9, the 8 volt voltage regulating transistor.

**Location of the 68pF capacitors across L4, 5 and 6**

The output of the oscillator is coupled via miniature coaxial cable into the centre tap of the frequency tripling tuned circuit comprising L202 and C204. You will need to un-solder C209 and remove it from the PCB. This will prevent the output from pin 5 reaching the centre tap of L202. Inject the crystal ocsillator output directly into the centre tap of L202 by connecting the inner conductor of the miniature coaxial cable to the point on the PCB where C209 was connected to the centre tap of L202. Be careful when using the soldering iron as the PCB track in this area of the circuitry is quite narrow and can be easily damaged. The outer braid of the coaxial cable can be soldered to the side wall of the screened PLL compartment. If it is your intention to replace the lid on the PLL compartment after the modification has been completed, the thin coaxial cable can be threaded under the screen side wall as shown in **Photo 5.**

The operating frequency of the tripling tuned circuit will now be increased in frequency from 15.36Mhz up to 17.07MHz. For the tuned circuit to become resonant at this higher frequency it will be necessary to remove C204.

On some sets you will find a screen plate attached to the track side of the PCB immediately below the PLL compartment. This screen plate must be removed by unsoldering the feet attaching it to the PCB.

Attach a 1.5pF capacitor to the 'hot' end of L202 and use this capacitor to couple the oscilloscope to the tuned circuit. Adjust the tuning core of L202 to obtain maximum signal amplitude on the oscilloscope. Adjust CT1 on the crystal oscillator board to obtain the correct operating frequency of 17.07MHz. The crystal oscillator should now be operating at the correct frequency with L202 resonant at this new frequency.

Remove the 1.5pF capacitor. Attach the oscilloscope to pin 8 of IC202. You will find that a test pin is provided on the PCB inside the PLL screened compartment. Pin 8 is the output of the PLL lock detector. Adjust the tuning core of the coil of the VCO tuned circuit, L201, until pin 8 is at logic level 1 on channel 20 transmit. Also check that pin 8 is at logic level 1 for channels 1 and 40. The best setting of the oscilloscope to observe the logic level is with the Y amplifier switched to DC and the gain set at 2 volts per division, and the timebase speed set to 0.2mS per division.

If pin 8 does not remain at logic level 1 on channel 20 in the receive mode, then CT202 will require to be adjusted. Check to ensure that pin 8 remains at logic level 1 on receive for channels 1 and 40 also. If not, re-adjust CT207 to achieve this result. The phase lock loop should now be locked on transmit and receive.

## Transmitter Tuning

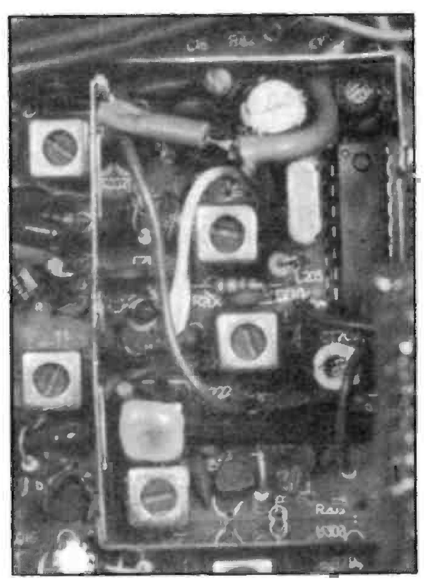
On transmit the output of the VCO is fed to the band pass filter. To tune this filter successfully it will be necessary to remove the internal 82pF capacitors which can be found in the base of the coil formers of L4, L5, and L6. These should be replaced with 68pF capacitors which can be soldered onto the track side of the PCB beneath the base of each coil former. Carefully un-solder L4, L5, and L6 one at a time; you will *not* need to remove the screen can. The internal capacitors are located on the undersides of the coil formers. With a sharp knife cut the leads and remove the capacitors from the bases. Re-solder the coil formers back onto the PCB and add the external 68pF capacitor across the coil L4, L5 and L6, keeping the wires as short as possible.

The band pass filter should be tuned with a dummy load connected to the aerial socket of the set. With the set on channel 20, key the microphone and adjust the cores of L4, L5, and L6 for maximum output power. If you find it difficult to tune the band pass filter, you will need to connect the oscilloscope to C55 and adjust L207, L4, L5, and L6 for maximum signal.

With an RF wattmeter or SWR meter reading forward power and a 50 ohm dummy load connected to the aerial socket, adjust the tuning cores of L207, L4, L5, L6, L7, L8, and L9 for maximum output power. If you find it difficult to tune L7, you may find it helpful to remove the 10pF capacitor C105 which is in parallel with L7.

On one set modified, difficulty was experienced in turning the core of L9 which eventually resulted in the core being damaged. If this happens to you, you will need to remove the coil from the PCB and replace it with a rewound coil

**Photo 5. Detail of the PLL area**



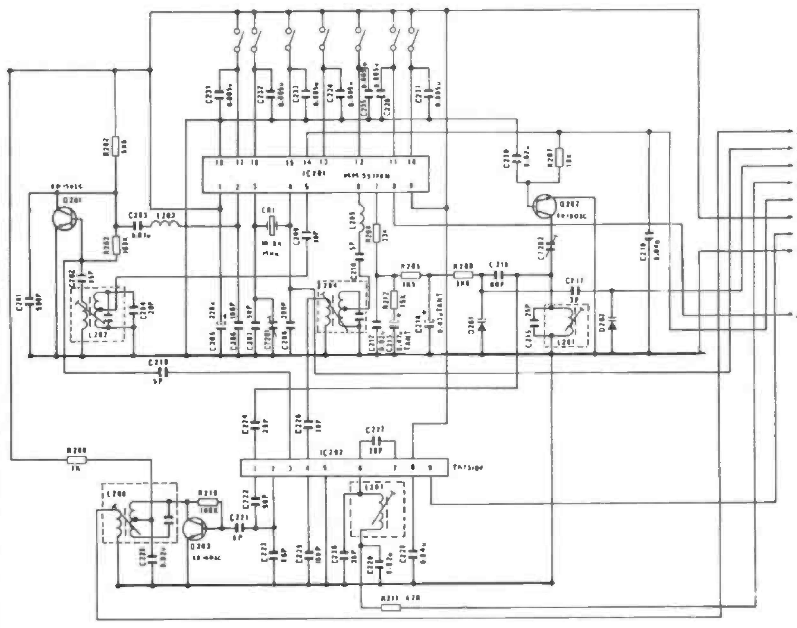


Fig. 4 Circuit diagram of the CB1000 PLL section

## Components List

**RESISTORS**

| | |
|---|---|
| R1 | 150k |
| R2 | 1k5 |

**CAPACITORS**

| | |
|---|---|
| C1 | 27p |
| C2 | 22p |
| C3 | 560p |
| C4 | 82p |
| C5 | 10u 35V electrolytic |
| CV1 | 30p trimmer |

**SEMICONDUCTOR, ETC**

| | |
|---|---|
| Q1 | BC107 or similar |
| X1 | 17.07MHz crystal — see text, veroboard, wire, miniature coaxial cable. |

consisting of 5 turns of 20swg wound on a coil former which accepts a 6mm dia core.

Check the power level on channel 1 and channel 40. If the power output is not constant between channels 1 and 40, you will need to readjust the band pass filter cores to obtain an even output power over the entire 40 channels. You will probably find that the maximum power output is in the region of 3.5 watts. Only on one set has the author been able to achieve an output power of 4 watts! After tuning the transmitter for maximum output power adjust VR4 so that the needle of the S/RF meter on the front panel indicates the RF power reading on the wattmeter.

Finally, on channel 20 check the output frequency of the transmitter. It should be 29.50MHz. If not, readjust CT1 on the crystal oscillator board to achieve this output frequency. The transmitter should now be fully tuned.

### Receiver Tuning

With a signal generator attached to the aerial socket inject a frequency of 29.30MHz on channel 20. The injected signal should be frequency modulated with a signal of 1KHz to cause the deviation to be +/—1.5KHz. The output of the signal generator should be increased until the S-meter reads about S3. Now adjust the tuning cores of L1, L2, and L3 for maximum reading on the S-meter.

Reduce the output from the signal generator to again obtain an S-meter reading of S3. Readjust the tuning cores of L1, L2, and L3 to obtain a maximum S-meter reading. Now set the output of the signal generator to 100mV and adjust VR2 to obtain an S-meter reading of S9. The set should now be fully tuned.

Finally, with the station main receiver check for unwanted signals on transmit by tuning the main receiver 10kHz either side of the carrier frequency. If you are satisfied that the transmit signal is clean, replace the screen covers above and below the PLL circuitry and replace the covers of the set.

### Spurii

When modifying a CB rig to operate on the amateur 10 meter band there will always be problems with spectrum purity because the rig is using mixes of frequencies different to those originally chosen by the set designer. The main problem encountered by the author here was an unwanted signal appearing on transmit around 1MHz from the carrier frequency. For example, when the set is operating on channel 30 transmit, i.e. carrier frequency 29.6MHz, the unwanted frequency was at 28.48MHz. Due to the closeness of the unwanted frequency to that of the carrier, the unwanted frequency is amplified by the transmitter stages. Fortunately the unwanted signal was 25db down on the carrier, and this can be further reduced with the use of a high Q tuning unit and resonant antenna.

This particular unwanted signal is generated by an unfortunate mix of frequencies on transmit between the VCO frequency and the reference frequency which is injected into the transmitter mixer. The unwanted frequency is derived by taking the second harmonic of the VCO and subtracting the reference frequency of 10.24MHz. After the reader modifies this set for use on 10 meters it is recommended that the unwanted frequency is at least 25db down on the carrier.

### And The Results?

Signal reports received while using the set indicate that the audio quality is good. The author has found that the performance of the receiver section is particularly good; this is probably his most sensitive conversion to date, being capable of resolving signals as low as 0.1uV. The set has been used satisfactorily as the main station 10 metre rig as well as mobile, and it has now found a permanent home in the author's car where it gives good results when used in conjunction with a centre-loaded modified CB mobile antenna — but that's another story. With an output power of only 3.5 watts, mobile contacts over a distance of 12 miles have been achieved.

73 G4NXV