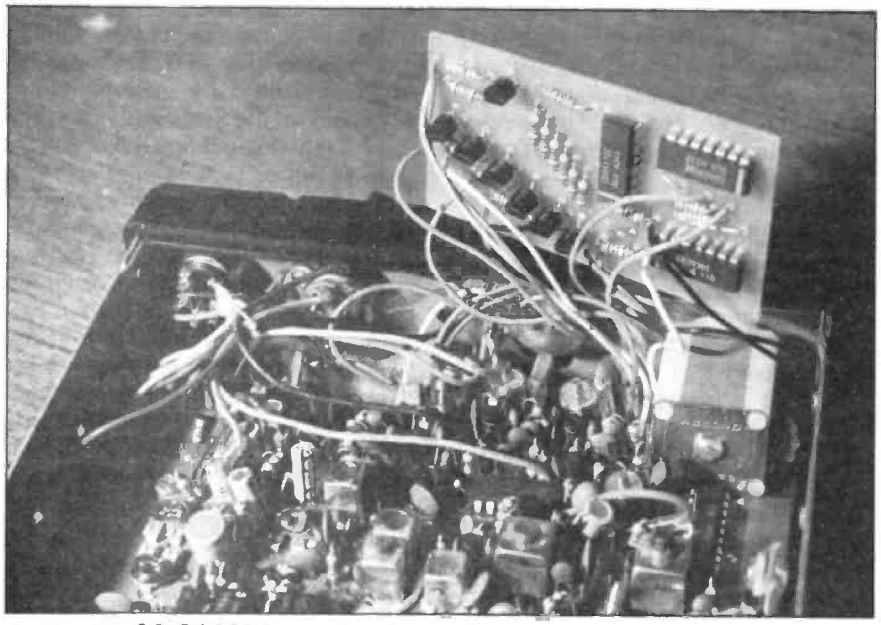
Converting CB Displays

You can make your converted CB rig give a direct frequency readout on 10m. David Silvester, G4TJG, tells how.



A number of magazines have published articles on the conversion of both illegal AM and legal FM CB rigs for use on the 10 metre amateur band using frequencies from 29.300 to 29.700MHz. Most tend to use the system where the CB units original channel 1 represents 29.310MHz, easing the calculation of frequency from the channel number. The author felt that for a small outlay, the display could be made to read the frequency directly, ie the calling channel of 29.600MHz becoming 60 on the display.

The PLL System

The CB rig chosen for conversion was the DNT M40FM, since this was freely available at all of the radio shows the author visited. This rig uses the MC145106 phase-locked-loop chip, containing not only the phase detector but also the counter for the reference frequency of 10.24MHz and the divide by n counter for the voltage controlled oscillator, see Fig. 1. A few comments should be made about the PLL circuit since it contains some unusual features. The divide by n counter receives from the channel switch binary 168 to 207 to control the receive VCO over the necessary frequency range. This range is 10.695MHz below the received frequency. The output frequency of the VCO is too high to be connected directly to the MC145106 chip. Hence the output is mixed with the receive crystal oscillator output to produce a frequency in the acceptable range — these frequencies are 1.68 to 2.07MHz.

On transmit, the transmit-receive switch causes a number of changes to the PLL loop. First, the transmit VCO and transmit crystal oscillator are brought into use; but as the output of the transmit VCO is *doubled* before being amplified a number of other changes to the loop need to be made. The transmit-receive switch also doubles again the division ratio of the 10.24MHz reference oscillator to give 5kHz frequency steps. The divide by n counter is increased by the addition of 256, ie from 424 to 463.

By changing the transmit and

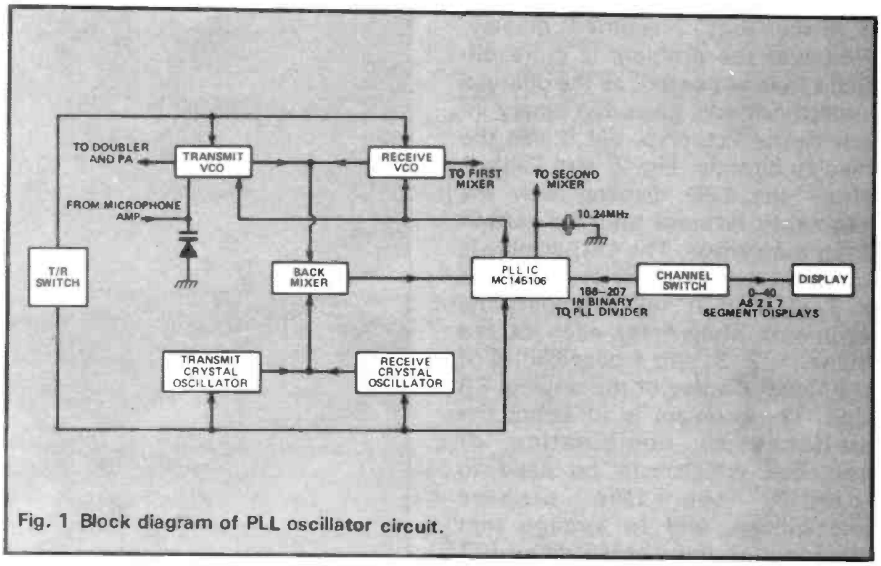


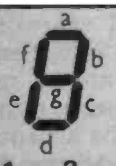
Fig. 1 Block diagram of PLL oscillator circuit.

receive crystals, it is possible to change the frequency range of the rig. For anyone wishing to alter the DNT rig these changes are:-

1. Receive oscillator from 15.2262 to 16.935MHz
2. Transmit oscillator, for simplex from 11.6806 to 12.535MHz, for duplex (−100kHz on transmit) to 12.485MHz.

Because of circuit capacitances, the frequencies of the crystals required are 16.932, 12.533, and 12.483MHz but they are finally tuned to the frequencies given above. The rig will also need to be retuned slightly but this is easy to do given the excellent diagrams supplied with the standard rig.

Fig. 2



	0	1	2	3	4
a	1	1	0	0	1
b	1	0	0	0	0
c	1	0	1	0	0
d	1	1	0	0	1
e	1	1	0	1	1
f	1	1	1	1	0
g	1	1	0	0	0

Table 1. Binary output from channel switch to drive display segments (Fig. 2).

The Display

With these alterations, a receive frequency of 29.600MHz shows as 30 on the display. To obtain a display of 60, we need to add 3 to the 'tens' 7-segment display. However the problem is more difficult than expected, as the channel switch not only gives the binary input to the PLL chip, but drives the display directly. **Fig. 2** and **Table 1** show the LED display with the segments lettered and the output from the switch. The LED display is of the common anode type so that in Table 1, a '0' will illuminate the segments shown for each of the blank, 1, 2, 3, and 4 possibilities of the 'tens' display of the original CB unit. The problem is to select the switches or combination of switches which can be used to identify the five display possibilities, and to arrange that the input to the display driver IC3 will give outputs over the newly required range of 3 to 7.

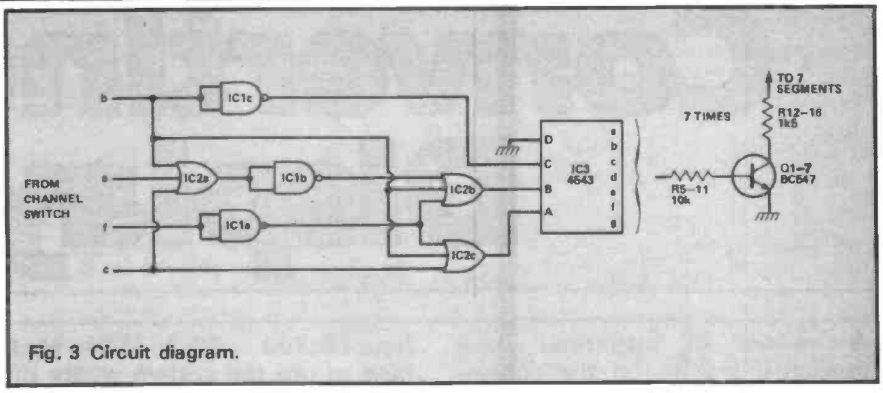


Fig. 3 Circuit diagram.

Circuit Design and Operation

It was decided that the easiest way to convert the switching of the 7 segments of the original display was to select specific combinations of the lines a to g and to use these to supply the inputs of the 4543 display driver, **Fig. 3**. The author chose the following combinations:-

f at '0', identifies old 4 and with b at '0' gives new input of 7. b, c and a all '0', gives old output 3 equals new input 0. b='0' and c='1', gives old output 2 equals new input 5. a, b, and f all at '0', gives old output 1 equals new input 4. b='1', indicates old blank and gives new input of 3.

The circuit is extremely simple and uses the outputs from the a, b, c, and f switches to drive the inputs of the logic circuitry. The display driver selected was the 4543 since no other circuit was easily available, which will drive the display directly and produce a 6 with segments a, c, d, e, f, and g illuminated to match the display produced by the unconverted unit's 7-segment LED. Both of the original switch sections operate the display by shorting the LED cathodes to earth through 1.5k ohm resistors. To achieve the necessary voltage drive to the logic chips, all of the inputs ie the a, b, c, and f lines are connected to the positive power supply by 10k ohm resistors, which hold the inputs positive when the switch elements are open circuit. These are not shown in Fig. 3. A secondary problem is that the 4543 display driver is designed for use with low power LCD displays, and, for safety, the driver's outputs were connected through seven resistor, transistor, resistor combinations to prevent overloading of the IC's output.

The PCB was mounted in the prototype with the trackside upwards in the upper part of the DNT M40FM, near the front panel.

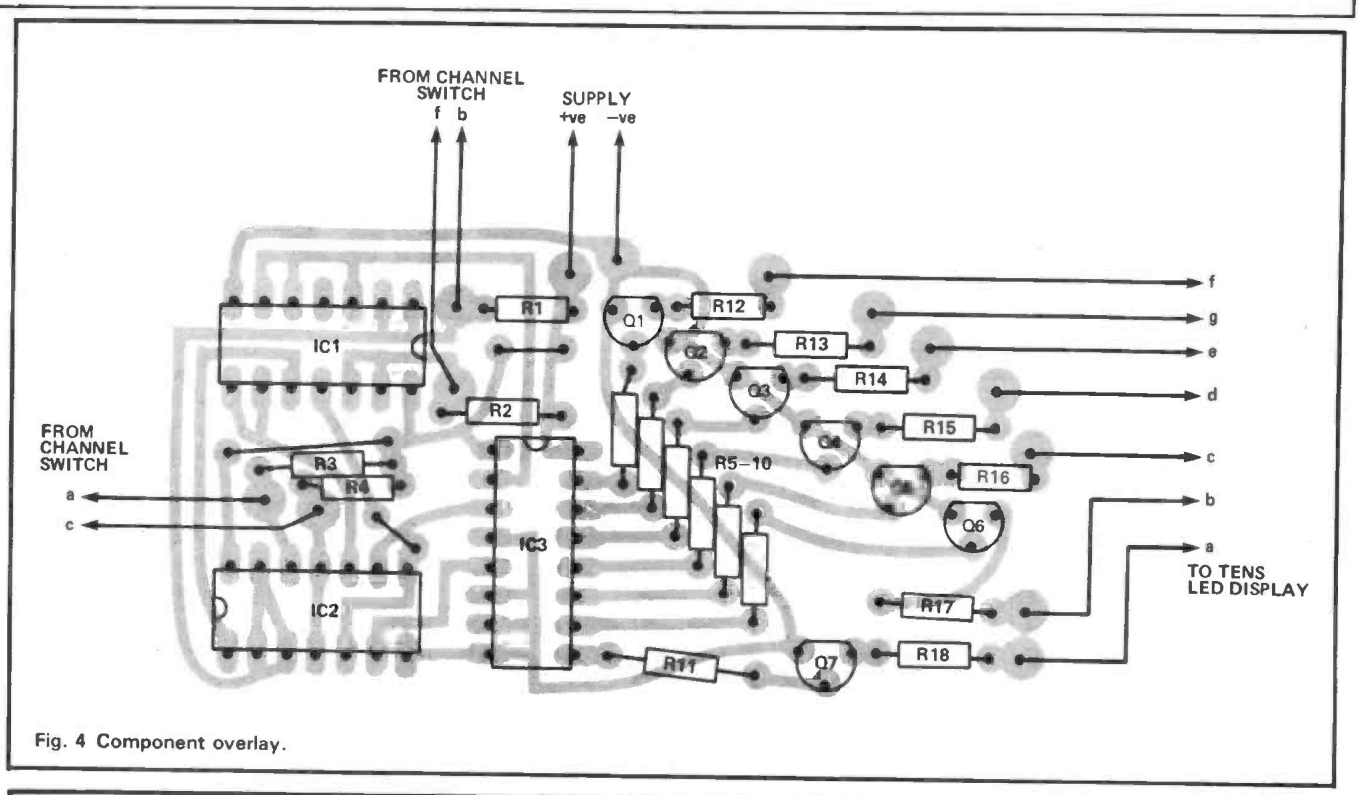
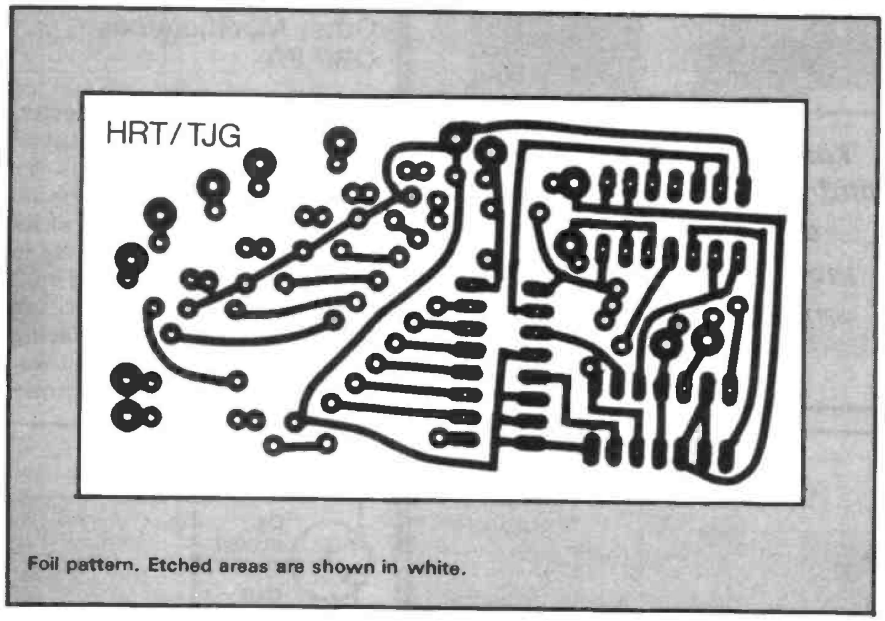


Fig. 4 Component overlay.



Foil pattern. Etched areas are shown in white.

Fig. 4. shows the completed PCB layout which was sufficiently small for placing inside the converted rig. After constructing the unit, the following conversions will need be made to the display area of the rig.

Installing The Unit

The switch positions corresponding to the LED display lines a to g will need to be identified. In some cases, the lines a and d will be connected together — as when displaying blank to 4 in the original CB application these display elements will be illuminated at the same time. This applies *only* to the switch — there are two resistors for the two display element (ie one each). Also the wires for the a to f lines to the 'tens' 7-segment display will need to be identified. Remove the resistors between the switch and all of the tens LED elements and replace with wires to connect the LED to the new PCB's output connections. A fine pointed soldering tip is almost essential for this work. In addition, add an additional 4 wires to the a, b, c and f switch positions, to give the input to the PCB. The 'pull-up' resistors are on the PCB so no components need to be added to the rig.

Final Comments

There is no reason why any ex-CB rig converted to 28MHz so that old channel 30 equals 29.600MHz and having the display driven directly from the channel switch cannot be modified in this fashion. It would be possible for a more enterprising amateur to add the 29, decimal point and final 0 to give a full 29.600 frequency display. The only other change necessary will be the alteration of R12 to R18 to the same value as that used in the directly driven display.

Components Listing

RESISTORS

R1-4	1.0k ohm
R5-11	10k ohm
R12-18	1.5k ohm

All resistors are carbon film, 0.33W 5%

SEMICONDUCTORS

IC1	4093 CMOS logic
IC2	4075 CMOS logic
IC3	4543 CMOS logic
Q1-7	BC547 or any T092 plastic transistor with Vec more than 15V and Hfe more than 10