# BETTER PERFORMANCE FOR YOUR HEATH SB650

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**The Heathkit Frequency Display Model SB650 has proven to be one of those little luxuries that quickly turns into a necessity! The ability to accurately net to a frequency by sight alone will be appreciated by any ham who has ever kept a sked.**

However, after some months of operation, several flaws became apparent in my unit which appeared to be not faults as such, but characteristic of the model in general. Conversations with several other SB650 owners confirmed this to me, and led me to investigate ways of improving its performance. In particular, the problems encountered were:

1. Overheating which led to an incorrect count whenever the unit was operated at an ambient temperature slightly higher than normal room temperature.
2. Occasional random variations in the last digits exceeding that specified by the manufacturers.

In addition, I felt that a further decade of resolution would be an advantage (i.e. to obtain a readout resolution to a 10 Hz instead of 100).

The solutions I have come up with to these problems are separate and do not rely one upon the other. For that reason I will describe them separately even though they can be tackled all together if so desired.

Heathkit specify a Maximum Ambient Operation Temperature of +40 degrees C. (112 degrees F). They also recommend against setting the SB650 on top of heat producing equipment such as receivers, transmitters, etc. Even when such advice is complied with, the average ham operating area can get quite hot, and it only takes (say) the summer sun shining through a window on the unit to lead to problems. I have measured an interior air temperature of over 155°F under these conditions, and certain components, notably the power transformer, get too hot to even touch! The cause of the overheating is obvious at a glance; the unit is enclosed in a double shield with no provision for ventillation at all. Even though it draws only 15 watts, with such good thermal insulation it is no wonder the unit gets so hot.

Heathkit engineers have obviously utilised a double shield for a purpose. However, I have had no trouble with RFI to or from the SB650 since I carried out the following modifications.

As can be seen from Fig 1 the power transformer is mounted on a bent strip of copper or aluminium bus-bar which is attached to a regular finned aluminium heat sink. The bus-bar is thermally insulated from the chassis by the use of a sheet of fish paper and no part of the box or back panel is allowed to come into contact with the bus-bar/heatsink combination.

The bus-bar (3⅜" L x 2¼" W x ¼" thick) can probably be obtained as scrap from a local electrical contractor while the heatsink is a Wakefield Engineering Inc. No. 641K[1]. Cut 9/16" off one side of the heatsink, and file the corners round so that it will fit easily into the outer case. Now remove a notch 15/16" H x ⅝" W from the bottom corner of the other side so as to preserve clear access to the LMO socket.

Remove the rear panel of the SB 650 and cut off the right hand end to match the heat sink. Now perforate the panel with ⅜" holes above and below the chassis to allow a reasonable degree of airflow. The regulator integrated circuit IC1 is re-located onto the bottom of the heatsink and re-connected to the original wires which are fed below the chassis via

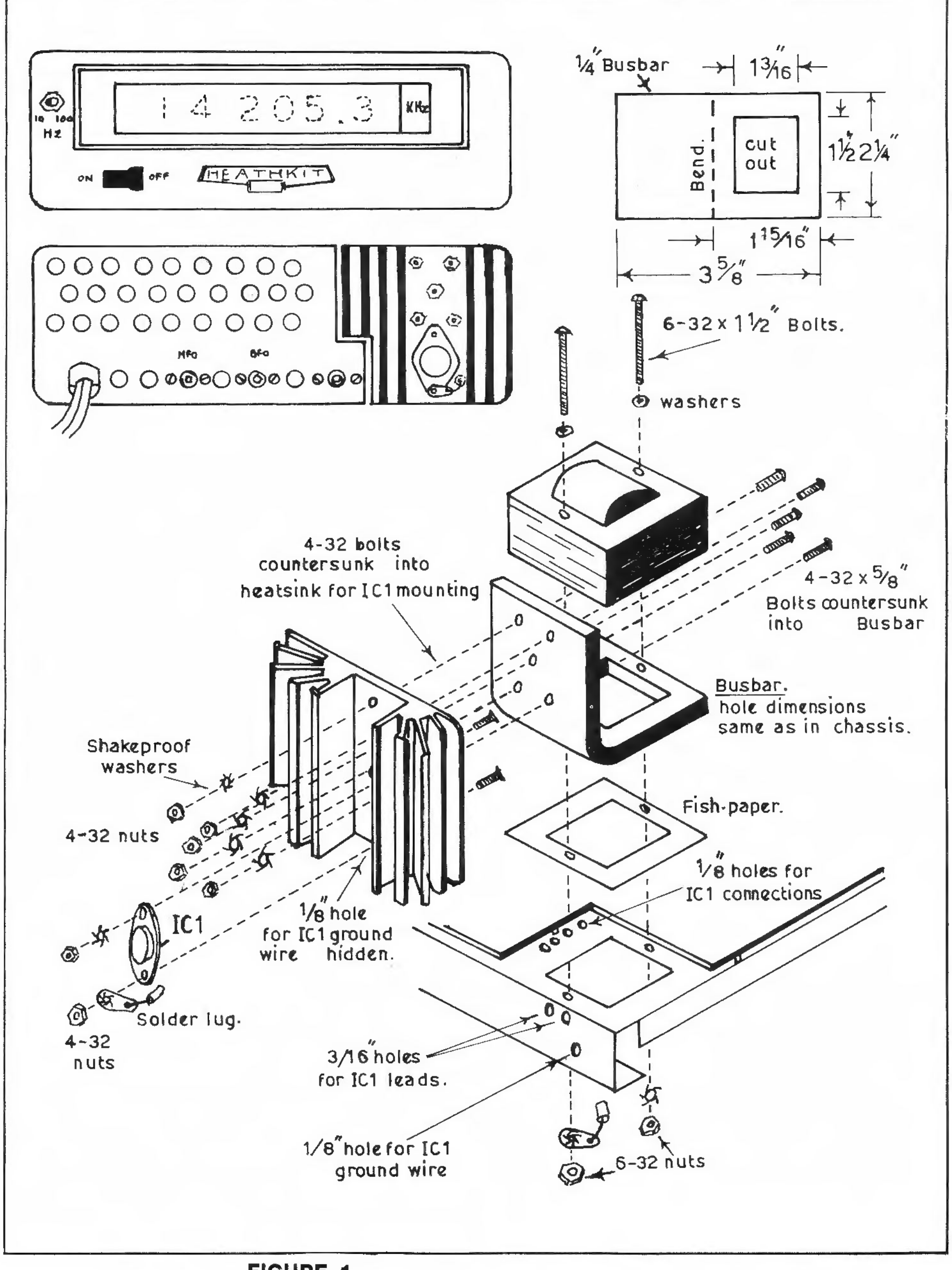


**FIGURE 1**

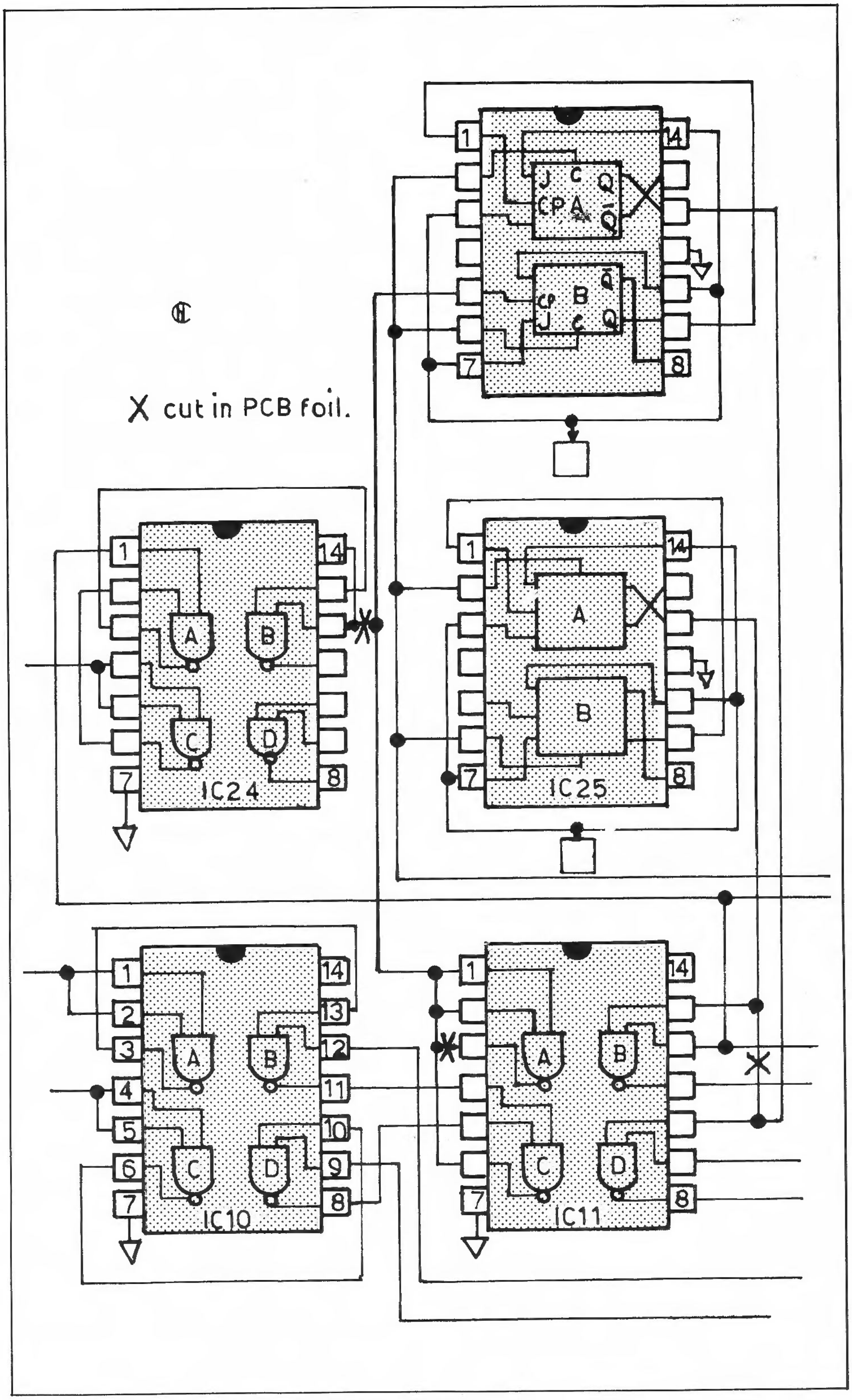


FIGURE 2A

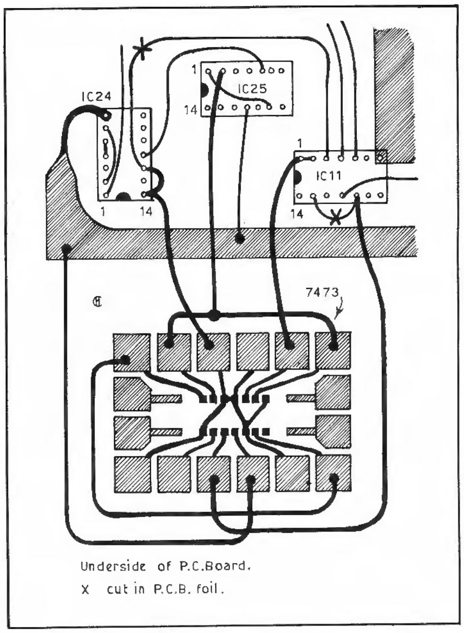


FIGURE 2B

four ⅛" dia. holes drilled alongside the power transformer.

In order to ensure a good *electrical* (as opposed to *thermal)* chassis connection for IC1, I put under its lower mounting nut a solder lug connected to a wire which passed through the heat sink and rear of the chassis (via a small hole drilled for the purpose) and grounded to another solder lug under the closest transformer mounting nut.

I recommend the use of silicon grease wherever good thermal contact is required. I used International Rectifier Silicon Heat Sink Compound No. SH 119-C.

The difference in the interior temperature of my SB 650 after these modifications was incredible and I have had no overheating problems since. However, the key to success in this matter lies with the use of the fish paper. The first time I tried, I took no particular measures to isolate the heat sink from the chassis and the results were disappointing.

When I first built the SB650, I was surprised to note that the readout would on occasion jump by as much as 500 cycles. For some time I assumed that the cause of this was other than the counter. Then one day when I was using the SB650 as a straight frequency counter (by using only the HFO input) an odd thing occurred. Whenever I fed in a frequency ending with a 9 tending to a 0 the last digit would "blur" and show all 10 figures simultaneously! When I re-connected the HFO and LMO inputs I discovered that the readout was jumping up and down by 500 cycles.

The reason this effect is not often noticed in normal use is that the HFO oscillator in all Heathkit SSB rigs is crystal controlled and it is unlikely that its frequency will fall onto a number ending in between 9 and 0.

If you have experienced this fault with your SB650 (probably on one band only) you can correct the situation by slightly retuning the HFO oscillator plate coil for that band. However, I wanted to see if I could find a permanent cure for this problem. A close look at the schematic reveals that in order to count the frequencies involved, Heath have used a divide by 4 scaler.

To compensate for the reduction in frequency of the inputs, they have used a clock period of 4 times the expected rate. The readout is still correct, but the counters only have to work at ¼ of the speed!

Now although the scaler (IC25 Dual J-K

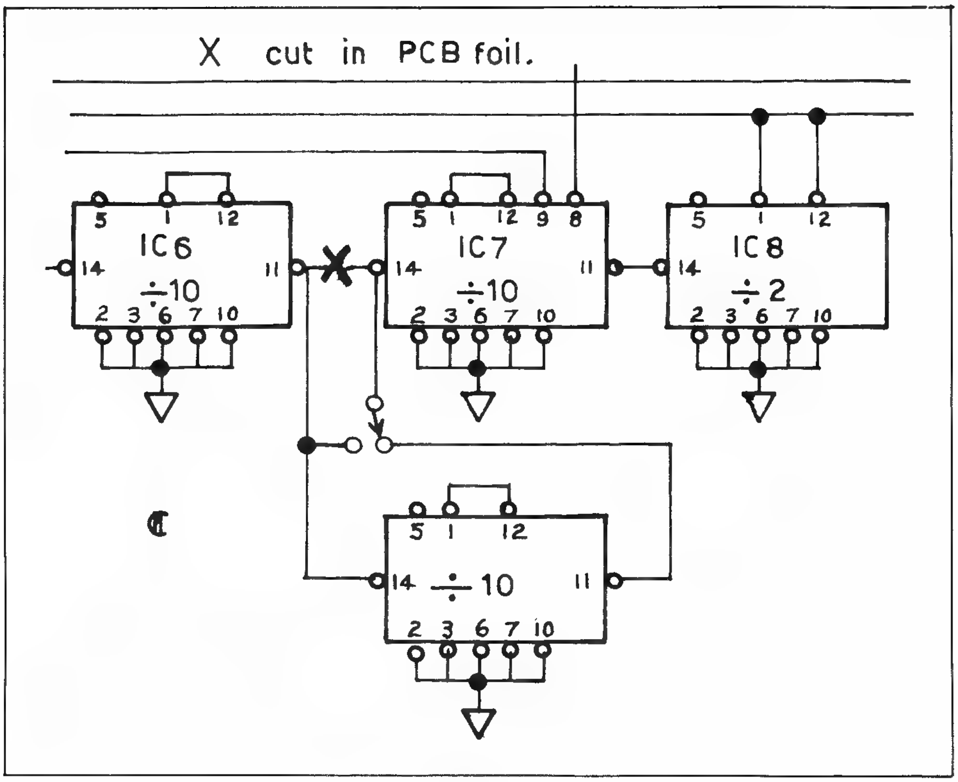


FIGURE 3A

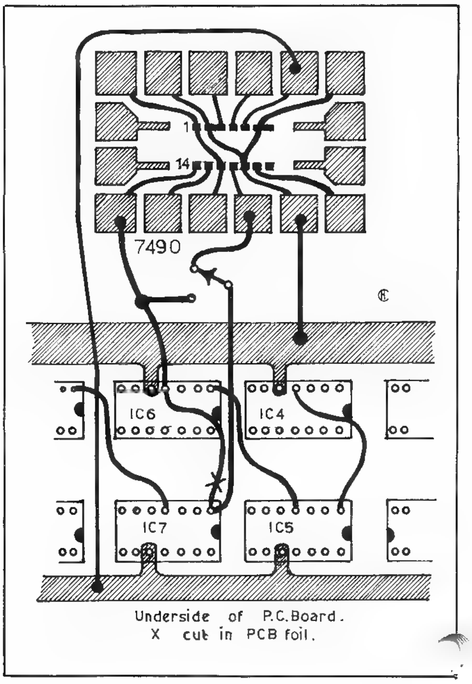


FIGURE 3B

flip flop) is reset at the end of every *complete* counting cycle, it is not reset after each up or down count. So if there is still a count "left over" in the scaler at the end of the up-count, it is still there when the scaler starts counting for the down-count.

To confirm this I connected two up-down counters (and their decades) in parallel as per IC-12; however, on one of these decades, I tied the count-down input to + 5 Volts (as specified in up-down counter SN74192N spec. sheets[2]). I then fed a signal into the HFO input of the SB650 while terminating the LMO and BFO inputs. The result was that sometimes the two decades read the same digit and sometimes the normally connected decade showed one count *lower* than the other.

I therefore concluded that a stray count was getting from the count-up circuitry into the count-down circuitry. To overcome this I undertook the modification shown in Fig 2 which in effect gives the down-counting circuitry a different divide by 4 scaler from the up-counting circuitry.

This modification worked perfectly as expected right from the beginning. The fact that it makes such a difference in the final digit stability (in both the "normal display" mode and "frequency counter" mode using only the HFO input) is proof that it should have been included in the original design.

The extra duel J-K flip flop is a SN7473, mounted on a 14 pin dual-in-line socket soldered onto a small PC board 1½" x 2⅛" (available from Tandy Electronics cat. no. 276-1803).

The PC board may be installed alongside IC11 on spacers from the chassis. The schematic and connection diagram for this modification are shown on Fig 2. The foil on the PC board has to be cut only twice, not three times as you would expect from the schematic!

The final modification is the most straight-forward of the three (see Fig 3). It involves the insertion of another divide by 10 counter between IC6 and IC7 (both divide by 10 counters) in the clock circuitry. This increases the cycle time to 1.6 secs. and the resolution to 10 Hz. The IC is an SN7490. A double pole, double throw, centre off, switch when mounted to the left of the display on the front panel may be used to select either 100 Hz or 10 Hz resolution. The centre off is useful for "freezing" a readout for recording purposes.

For those who consider the extra effort worth it, the spare set of switch contacts may be used for changing the decimal point. A small hole may be drilled through the light shield between the 2nd and 3rd decades to the right behind which a NE-2 neon may be mounted. Use a black felt tipped marking pen to blacken the edges of the hole.

The physical mounting of the extra IC poses a bit of a problem. I mounted mine underneath the chassis on the circuit board shield using the same IC socket and PC board as used in the modification above.

Although I am not particularly happy about the long leads I used to allow the circuit board shield to be opened, I have had no trouble with this circuit. In fact the modification worked immediately and has proved very handy.

I strongly recommend these three modifications to any Heathkit SB650 owner who wants increased accuracy and reliability from his unit.

**REFERENCES**


1. Wakefield Engineering Inc., Audubon Road, Wakefield, Mass. 01880. Semiconductor Cooling Div.
2. Or ref. Page 72 of Heathkit SB650 Assembly Manual, last sentence.


# CRYSTAL SELECTION FOR THE FT101B

Ray Johnson VK2AVR

**FOR FIXED FREQUENCY OPERATION**

A much simpler method of choice than that given in the handbook follows:

1. Select desired frequency and note the reading of the tuning dial — black scale only.
2. Subtract the dial reading from the high value of the internal VFO (9200 kHz). This gives the mean value of the crystal.