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QST Issue: Aug 1972
Title: Heath Frequency Display Model SB-650
Author: Richard Baldwin, W1RU

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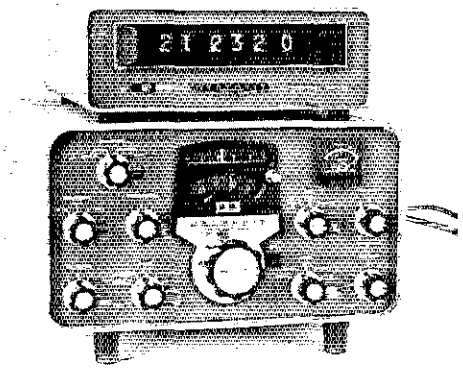
Heath Frequency Display Model SB-650



UNTIL YOU'VE TRIED IT and found that you like it, you have no idea how satisfying it is to be able to read your receiver (or transmitter) frequency continuously to one tenth of a kilohertz. You can come up to a band edge and *know* with a high degree of precision right where you're tuned. You can slide up to the edge of a phone-band segment and *know* whether you're getting too close. You don't have to worry whether the fiduciary on your dial is set properly, because the frequency readout is given by display tubes which are independent of the dial mechanism.

In the past couple of years there have been a number of digital frequency counters described in the literature, and most of them have been fairly noble projects. But now Heath has come along with its SB-650 Frequency Display. About six hours' work with a (very small) soldering iron will have you in business.

The Circuit

This unit is matched to the rest of the Heath line not only in decor but also electrically, of course. Basically the display requires three separate frequency inputs from a Heath receiver or transceiver, i.e., from the linear master oscillator (LMO), the high-frequency oscillator (HFO), and the beat-frequency oscillator (BFO). A small amount of energy from each of these three circuits is fed to a multiplexer-sequencer whose timing is controlled by a clock/frequency-divider unit to produce a 160-millisecond "inspection period." This is further broken down into four subperiods of 40 milliseconds each. During the first subperiod, the energy from the HFO is fed to an up/down counter which counts the HFO in an upward direction. During the next 40-millisecond period, the BFO energy is permitted to reach the up/down counter, where it is counted down and thus subtracted from the HFO count. During the third sub-period the LMO is permitted access to the up/down counter, which again counts down and subtracts the LMO frequency from the previous remainder. What we have left is the operating frequency. During the fourth subperiod, this count is then transferred from the storage registers of the up/down counter to the display tubes, where the operating frequency is displayed to a tenth of a kilohertz and to an accuracy determined by the accuracy of the 1000-kHz crystal-oscillator clock. Since each inspection period is completed in 160 milliseconds, the frequency count is updated six times a second.

The Input Circuit

In order to prevent loading of the oscillator circuits in the Heath receivers (which would degrade the overall sensitivity), a MOSFET is incorporated as a high-impedance input amplifier. Three amplifiers, each similar to the one shown in Fig. 2, are used to drive the digital-logic circuitry which counts and displays the actual resultant frequency.

The input of each amplifier is adjustable to allow sampling only as much energy as necessary to provide drive to the multiplexer portion of the counter. The model tested required less than 20 mV pk-pk for proper operation at 28 MHz. No spurious responses were noticed in the receiver as a result of the display unit, and the sensitivity was unaffected.

The Kit

The completed SB-650 consists of 35 ICs and six transistors. Remembering Art Buchwald's "How much is that in dollars?" tempts us to ask "How much is that in tubes, or transistors?" Well, in tubes it would probably be impossible, certainly from any practical standpoint. In transistors, not impossible, but rather difficult. For example, one of the simpler ICs in this unit is used to provide the

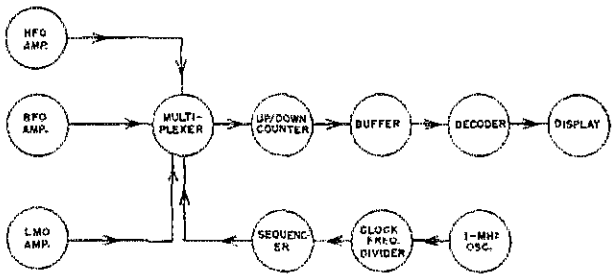
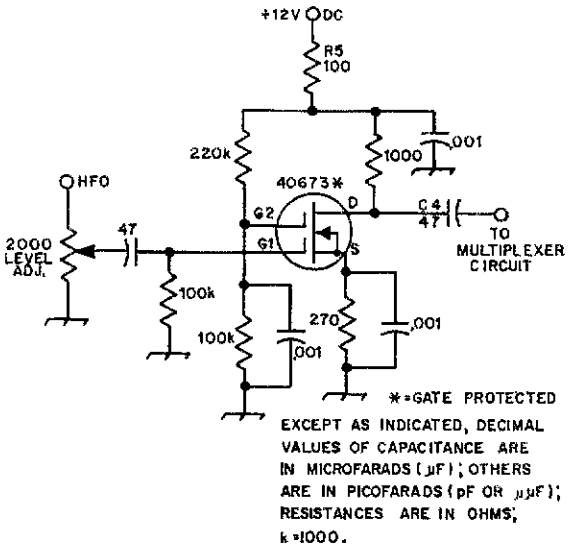


Fig. 1 — Block diagram of the SB-650.

Fig. 2 — Typical input circuit to provide isolation between the display unit and the three oscillators in the Heath SB receiver.

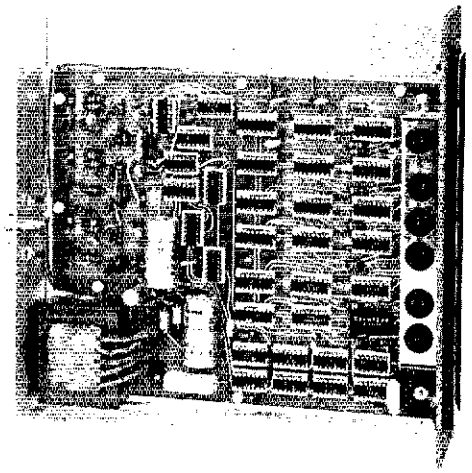


regulated five volts needed at various points in the circuit. This one IC is the equivalent of 19 transistors and four diodes. Thus, without ICs, it would take several hundred transistors and diodes to accomplish what is done here with a rather small handful of parts. And because it is such a small handful of parts, the kit goes together easily, in something like six hours from the time the package is opened until the first frequency readout is displayed.

As usual, the Heath instructions are clear and concise. We ran into only one small problem. The instructions on page 36 of the manual mustn't be overlooked. The way the booklet is laid out, it appears that the three instructions relating to the installation of a choke in the SB-400 and SB-401 exciter apply only if you have an SB-300 or '301 receiver, but this isn't true. If you have any one of the Heath SB series of receivers and are using the SB-400 or '401 to transceive, that choke (part of the kit) must be installed in the exciter.

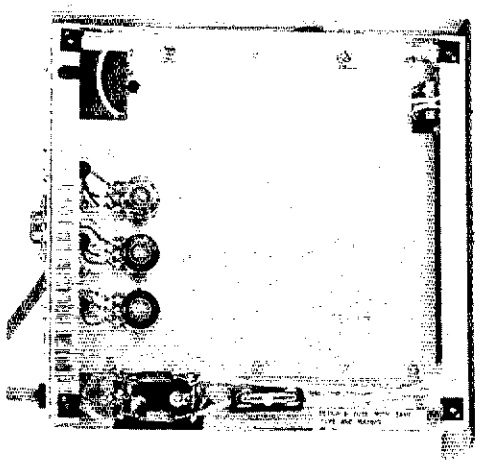
Heath emphasises that a small-tip soldering iron should be used. We repeat that admonition. If you haven't played with ICs before, you're going to find that the distance between pins is exceedingly small, and it takes care to avoid an inadvertent bridge between IC pins or across some of the circuit-board leads.

This kit may be built (as with all of the Heath products) without actually knowing a blessed thing about the theory of operation. However, Heath provides an excellent description of how the circuit operates, and supplements it with many block diagrams and equivalent circuits. Particularly intriguing are the functional block diagrams of the various ICs, truth tables for the logic in each portion of the circuit, and the pictorial presentations of the significant wave shapes that should be found at the various IC pins. If a 100-MHz bandwidth oscilloscope is available, it may be used to gain a complete understanding of what is going on in the circuit. It may take only six hours to put the kit together, but you can spend easily another six hours just puzzling out how it works. If you want more background on frequency counters, we refer you to MacLeish in *QST* for October, 1970, while a look at Hall, *QST* for November, 1971, will provide good background information on digital ICs. — *WIRU.*



Top view ▲

▼ Bottom view



Heathkit Model SB-650 Frequency Display

Dimensions (HWD) and Weight: 4 × 10 × 10-1/4 inches, 4-1/2 pounds.
Power Requirements: 105-125 or 210-250 V ac, 50-60 Hz.
Power Consumption: 15 watts.
Price Class: $180.
Manufacturer: Heath Company, Benton Harbor, Michigan.