3624 PROM ICs can be used on the MCEM-8080 pc board. The 3624 is a bipolar PROM with 512 × 8 organization and is the standard device furnished with the MCEM-8080 microcomputer system. Up to four 3624s can be used on the circuit board with production pc boards jumpered for use with this IC. An 8308 ROM can also be used in the HAL MCEM-8080. This is a mask-programmed version of the 8708 EPROM IC.

Bus Indicators and Control

A number of LED indicator lamps and switches are installed along the front edge of the MCEM-8080 pc board to permit evaluation and control of the processor operation. All of the 8080A microprocessor address buses are displayed on 16 LEDs with the lamps grouped in four-lamp sets, four sets total. Each group of LEDs represents a single hexadecimal (HEX) character, 0 through F_{16}. An illuminated lamp indicates a logic-1 condition. The least significant bit is represented by the right-hand lamp within any of the four-lamp clusters. In a like manner, the right-hand group of four LEDs represents the least significant HEX character.

Eight LEDs, in two, four-LED sets, are used to indicate the state of the processor data bus. And four more LEDs located on the far left end of the pc board indicate the state of I/O read, I/O write, memory-read and memory-write signals from the microprocessor. An illuminated LED indicates which of these operations is in progress.

If you're a glutton for punishment, you can use the manual-data switches and the break-point register switches to manually load programs into the computer (a tedious if not monumental task for even the most simple of programs). Run/stop, manual reset, single step and memory write and output-write switches are also located on the MCEM-8080 pc board.

Connectors for Peripheral and Accessory Interface

There are three connectors used on the basic MCEM-8080 circuit board. These connectors are used for I/O interface, power input, and connection to the universal processor bus. Mating connectors for each are furnished with the MCEM.

I/O connections to the MCEM-8080 are made through a 36-pin pc-board edge connector located on the left edge of the board. All three parallel I/O ports of the 8255 IC are available on this connector as well as connection for serial data. The form of serial data to be used can be selected with jumper wires on the circuit board.

Power connections to the MCEM are made through the 12-pin edge connector located in the upper right-hand corner of the circuit board. Power requirements for the MCEM-8080 are ±12 and +5 volts. And direct connection to the computer address, data and control lines can be made through the 40-pin, universal processor bus (UPB) connector located in the lower right-hand corner of the circuit board. A mating connector and attached ribbon cable are supplied for use of this feature. Connection of options such as additional memory and a keyboard/video display unit is made through the UPB connector.

Several months of using the MCEM-8080 have brought two factors to light for the review: (1) the HAL microcomputer is a versatile and useful accessory in the ham shack, and (2) unless you plan to use the MCEM for only one control or one function, opting for the recently announced BASIC program in EPROM (a review of this feature will appear in a future Product Review) is a must. Some applications of the HAL MCEM-8080 include, but are not limited to, contest logging, real-time tracking of the moon (or any other satellite for that matter), plotting propagation trends and most important of all, playing Star Trek! – *WA6GVC*

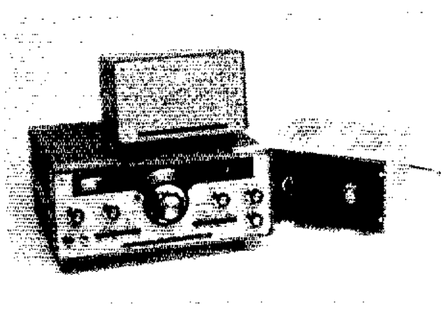
THE HEATH MODEL HW-104 SSB TRANSCEIVER

If you feel that there is something familiar about the designation HW-104, perhaps you are thinking of the "brother," SB-104. That model was reviewed in October, 1975, *QST*. While there are similarities, there are also some differences between the units – some are cosmetic, some are functional.

As for a basic description of the HW-104, it is a 100-watt, solid-state five-band transceiver. It will operate in either the ssb or cw modes, and may be powered from an external 12-V supply (HP-1141) or from a portable source such as an automobile battery.

Circuit Analysis Receiver

An examination of the circuitry of the HW-104 shows that the receiver is of the double-conversion type. Signals going into the front end of the unit must first pass through a band-pass filter before being applied to the first mixer. The lack of an rf amplifier stage ahead of the mixer helps to keep things from falling apart in the presence of very strong in-band signals. In practice this has been found to work quite well; 20-meter cw or sideband stations were copied from the ARRL laboratory, which is only a few dozen feet from W1AW antennas, and this was done while the Headquarters station was transmitting bulletins on all bands, including 20 meters. Stations that were S3 or better could be copied within five or six kHz of the W1AW transmitting frequency.



From the first mixer stage (a dual-gate MOSFET) the signal is routed through a filter at the high i-f of 8.65 MHz. The injection to the first mixer is crystal controlled, coming from an oscillator that involves diode switching to select the crystal corresponding to the band of interest. The second mixer (another dual-gate MOSFET) receives its injection from the VFO and produces an output at 3395 kHz. Crystal-filter circuitry follows next in the lineup. The normal filter offered with the transceiver is of the ssb variety, 2.1-kHz selectivity. An optional filter is offered as a kit that can be added either during initial construction or at a later date. This filter provides better cw selectivity, 400 Hz, and should be given serious consideration if you expect to do even a modicum of cw work with the transceiver. In this writer's opinion, the slight expense and small amount of time needed to install the cw filter and associated circuitry is amply repaid in operating convenience.

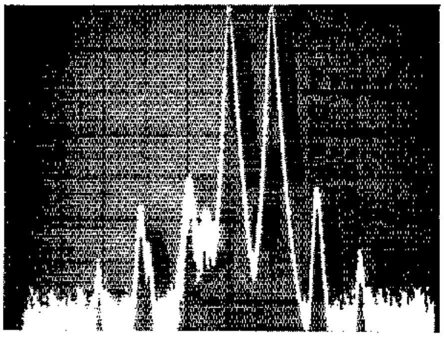


Fig. 1 – Two-tone test for IMD products. The 3rd-order products are approximately 40 dB down from full output. Calibration is 1-kHz/division horizontal, 0.1-kHz bandwidth filter and 10-dB/division vertical. Output frequency was 7 MHz and the power output was 100 watts.

I-f amplifier stages follow the filter, and here the circuitry involves both discrete devices (bipolar and MOSFET) and integrated circuits. Diodes are used in a product detector to translate the i-f signal into audible intelligence. The detector is followed by an IC that serves as an audio preamplifier with some built-in frequency-response shaping and by some husky bipolar transistors to drive a 4-ohm speaker with 4.5 watts (and that's loud!).

An agc detector, amplifier and associated circuitry come into the picture in the i-f stages, all of which makes the operation of the receiver quite smooth on either ssb or cw. The time constant of the agc has two ranges, fast or slow, selective from the front panel. The same switch has a position to disable the circuit for weak-signal work.

Transmitter

To follow the sequence of events through the transmitter, it is necessary to start with the audio board, which accepts the input from the microphone (or phone patch) and applies part of it to a balanced modulator, part to VOX and T-R control circuitry. For cw, a key will also activate the VOX and control circuits and a sidetone oscillator as well, thus enabling one to hear what is being sent. Output from the balanced modulator (diodes again) is then routed through the crystal filter and on to an i-f amplifier and buffer. The i-f at this point is the same as that of the receiver, 3395 kHz.

A balanced mixer (more diodes) is employed to heterodyne the i-f to the band that has been selected. For transmitter operation, the VFO output is mixed with the HFO signal, and the product of that action is applied to the aforementioned balanced mixer as an injection signal. Between the mixer and the antenna terminal you'll find a bandpass filter, amplifier, another filter, another amplifier (driver) and another filter if the switch is in the low-power position. For high-power operation an additional amplifier is connected between the driver and the last band-pass filter. There is an alc detector in both the driver and the power-amplifier stages. The alc-voltage works through an amplifier and is applied to the transmitter i-f amplifier, resulting in very effective control of drive to the output stages.

Construction

No difficulties were encountered in constructing the HW-104, at least none that were not the fault of the writer. This is an advanced construction project, and should be treated with much respect. Instructions are very well thought out, and should be followed explicitly – even to the detail of which part of the kit to unpack first. In spite of the very detailed construction information and the procedure for checking each module or board as it is assembled, I managed to leave one resistor out of the VFO, and to get two diodes in backward on an oscillator board. Fortunately, the step-by-step troubleshooting procedure and the voltage test-point drawings helped to find the goofs in reasonably short order.

The tedious part of the assembly was the seemingly endless array of pc boards that make up the bulk of the circuitry for the HW-104. It was a welcome relief to be able to put the last board aside and start the mechanical assembly of the shields and framework of the transceiver. Once at that point, things seemed to happen much faster. An approximate total of hours spent on assembly and testing comes to 60. As we have done many times before, we'll point out, even emphasize, the importance of following the detail of the instructions, one step at a time. The drawings are excellent and they cover the assembly from all angles. If your electronic expertise is even mediocre, you have an excellent chance to assemble successfully a modern transceiver that can hold its own in the best of crowds.

Operation

This part of the review could be summed up in one word – comfortable. But there are many things that go into a concise description like that. The controls are in convenient locations and therefore make it easy to adapt oneself to their use. The dial, while not useful for hair-splitting like its digital brother, is accurate enough for all but the most demanding of operators. This writer had no trouble in finding the frequency of the 20-meter liaison station for the HK1TL uhf expedition,[1] for example, just by "eyeballing" the pointer after calibration at the nearest 25-kHz marker. Speaking of markers, the combination of 100-kHz and 25-kHz points makes it very easy to ascertain the band edge and to find a particular spot in between. A convenient WWV (15 MHz) position on the band switch makes it easy to check the accuracy of the crystal calibrator.

Frequency drift was never a problem on any mode or for any use (the receiver has been used as a tunable i-f for EME reception on 432 MHz). Similarly, sensitivity was found to be adequate, although the absolute numbers as indicated in the noise-floor measurement leave something to be desired. On-the-air reports have been good, both as to ssb quality and cw keying characteristic. In connection with cw, I could find but one fault with the unit: When using cw break-in (VOX) mode, the first closure of the key produces a very loud and annoying "blap" from the speaker or headphones. Time has not permitted an analysis of the circuit to see where this might be coming from, but it is high on my list of priorities to remove that particular noise.

A very useful feature, and one that is seen on more equipment of late, is a low-power output position from the transmitter. This is almost essential if one is to drive a transmitting converter to a vhf or uhf band, as many do for working through the OSCAR satellites. To see how this scheme would work with the somewhat common i-f of 28 MHz, the HW-104 was connected to a 2-meter transverter that provided 50-watts output, while at the same time I listened on the OSCAR part of 10 meters with another receiver (an SB-303). The proper antennas were connected to both sets of equipment, and there were no birdies evident from the transmitter, and no change in 10-meter noise level was noticed when the transmitter/transverter combination was turned on. The same sort of thing was tried in reverse, using an SB-401 transmitter (modified for 2-watts output) to drive the transverter, and utilizing the HW-104 transceiver to listen on 10 meters. The results were the same – indicating that it is indeed possible for a 28-MHz transmitter and a 29-MHz receiver to coexist in peaceful harmony (at least if the transmitter output is clean and at a low-power level). One important thing to note here, however: Neither the low-power output stage nor the high-power final stage of the HW-104 likes to "look" into a reactive load. If the antenna or transverter is not reasonably close to 50-ohms resistive, internal circuitry will hold the power output down to a level that is safe for the transistors, which might not be enough to do what you intended. For odd-ball antennas or weirdo transverter input circuitry, a matching device of some sort is definitely in order.

In discussions of the HW-104, two questions inevitably come up, "How do you like the rig?" and "Would you build another one?" The answers are short – "Great!" and "You bet!" – *W1SL*

[1] Morris, "Tiera Luna para Colombia," *QST*, October, 1976.

The Heath HW-104 Solid-State SSB Transceiver

Dimensions (HWD): 7-1/4 × 14-1/2 × 16 inches.
Power requirements: 13.8-V dc, 2-A receive, 21-A transmit at 100-W output.*
Power output: In excess of 100 watts on all bands (cw), 100-watts PEP (ssb).*
Low-power output: 1.5 watts 40 through 10 meters, 1.0 watt on 80.*
Receiver sensitivity: Between 0.5 and 0.8 μV for 10 dB S+N/N ratio on all bands.
VFO stability: Drift approx. 90 Hz per hour after 30-minute warmup.*
Frequency coverage: 3.5 to 29 MHz (29.7 MHz with HWA-104-1 accessory) amateur bands, plus 15-MHz WWV (receive only).
Dial accuracy: Marked at 5-kHz intervals; can be calibrated at 100- and 25-kHz points.
Receiver noise floor: −125 dBm; blocking dynamic range, 94 dB; IMD dynamic range, 71 dB.*†
Manufacturer: Heath Company, Benton Harbor, MI 49022.
Price class: $490, kit form.
*Measured in ARRL laboratory.
†For testing methods see Hayward, "Defining and Measuring Receiver Dynamic Range," *QST* for July, 1975; also, DeMaw, "His Eminence – the Receiver," *QST* for June, 1976.

HAL FYO KEY

To a cw operator, his (her) keyer is a very personal thing. If the editor will forgive me for being rather personal in this product review, I hope you the reader will too. There just doesn't seem to be any other way to attack the subject.

When I was a *very* poor college student several years ago [We presume he means financially, not academically! – Ed.], my roommate, also a ham, and I scraped up a tankful of gasoline and wheeled off to the annual Cincinnati Hamfest (then a stag event). In the process of marching down lane after lane of flea market we became separated, neither of us paying any attention since we had no money to spend. The one exception to our poverty status was the fifty-dollar backup my roomie, K9FRZ, had stuffed behind his girl friend's picture. That was his beer money 'til Christmas, but would be used in case we found one single item at the flea market: an FYO paddle.

I found the FYO that day. Someone was peddling a keyer (the brand has long ago escaped me) along with a double-lever FYO model, and he wanted fifty bucks for both. I didn't have a cent to my name, and there were three or four other wandering hams around the table, all looking at the FYO I was sure. I couldn't find Jim, couldn't buy the paddle out from under the others, and I was paralyzed. Somehow I guaranteed that a sale was imminent, the unknowing FYO owner said he'd hold on to the device, and I took off looking for those fifty beer dollars. Jim and I returned shortly thereafter, he purchased the FYO, and we left. Anything after that would have been anti-climactic.

The original FYO paddle was designed by Joe Hills, W8FYO, in the early sixties. The