Product Review

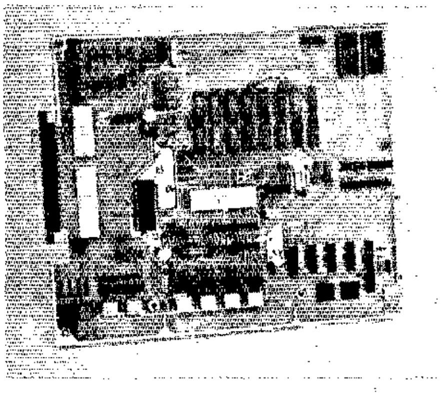
HAL MCEM-8080 Microcomputer

You rush past the wife and head straight for the ham shack; it's late and you've only got five minutes to get set up for your EME schedule with VK3A–. "Darn, I wish I'd left work a little earlier tonight," you grumble to yourself as you furiously search through a stack of computer printouts looking for the one with this week's information on where the moon will be lurking tonight. Time moves along and it's your turn to call, but you still haven't got the dish moved into place. In fact, you don't even know where "in place" is because you can't find the correct printout. "Eureka!" you shout. "I've found the printout!" As you quickly calculate the position of the moon, you realize *you've got the printout for last week*, and a quick glance at the chronograph indicates you won't be talking to VK3A– this week. And since it's the last time the moon will be in the right place for an EME path from your location to Australia until next summer – you're out of luck!

"Oh nuts, I wish I had my own computer so I wouldn't have this problem every time I'm running late for an EME schedule," you pine to yourself. Take heart, the time has come when you *can* have your own computer as an integral part of your ham station! And not only can it keep track of the moon, but it can even control the station antenna steering mechanism so you don't have to go looking for that old-fashioned printout (you still have to do some number crunching to find out the location of the moon, *after* you find the correct printout!).

The development of the large-scale integration (LSI) microprocessor IC has made the home computer a reality. And many experimenters, who up until now had to rely on sophisticated hand-held calculators to do the mathematics and the armstrong method for equipment (machine) control, can get both features in a microcomputer. With the development of the microprocessor chip, microcomputers began to appear in the electronics marketplace, at an unbelievable rate, and they did so in many different configurations and with many design concepts. One of the more popular microprocessor chips is the Intel 8080, and a look at microcomputer advertisements indicates that the 8080 is still the first choice of some microcomputer systems manufacturers.

HAL Communications has made the choice of the Intel 8080A for use in the MCEM-8080 microcomputer system. The 8080A (latest version of the LSI microprocessor IC) is an eight-bit microprocessor IC with a set of 73 instructions. The execution time of these instructions varies from 2 to 9 μs. Intel's 8080A microprocessor IC contains all of the circuitry necessary to address the memory, address input/output (I/O) devices, and manipulate data. The MCEM-8080 microcomputer system is contained on a single pc board (double-sided) and can be used for program development or for specific control applications (such as steering our EME enthusiast's



antenna system). The pc board contains the microprocessor IC, its timing and control circuitry, both read-only-memory (ROM) and random-access-memory (RAM) ICs, and timing and control for I/O interfacing.

Other System ICs

Several ICs are used to support the 8080A and provide some of the necessary circuit functions which make the processor usable as a computer. The type 8228 system controller IC is used both to decode signals from the 8080A and generate the required bus-control signals and to buffer the 8080A data-bus signals. It will also support a single vector interrupt. Timing signals are provided by the 8224 IC with an 18-MHz crystal used with the device to generate the 2-MHz processor timing signals, power-on reset signal and ready-line synchronization pulses.

The standard MCEM-8080 provides for either synchronous- or asynchronous-serial data interface. The software monitor supports asynchronous serial I/O in either Baudot (5-unit) or ASCII (8-unit) codes. A type 8251 universal synchronous/asynchronous receiver/transmitter (USART) IC is used to input and output serial data and a programmable communication interface IC, type 8255, provides parallel data interfacing. A type 555 timer IC is used to generate the serial-data baud rate. The data rate is screwdriver adjustable on the circuit board. The actual 555 clock frequency is four times the baud rate in the ASCII mode and 16 times the baud rate in the Baudot mode.

Two operational amplifiers (both halves of a type 1458 IC) are used as RS-232 drivers and receivers. The serial output of the 8251 USART is directly converted to a ±5-volt signal with –5 volts representing the mark signal condition and +5 volts as space. The output impedance of the circuit is approximately 400 ohms. For input data, an operational amplifier is used as a sense amplifier and level converter. Input voltages greater than +1.0 volt are interpreted to be in the space condition and those less than +1.0 volt as mark. The input impedance is approximately 2700 ohms. This input will properly sense TTL-level signals, as well as EIA RS-232C signals.

Current-loop signals with either 20- or 60-mA mark currents can also be connected to the MCEM-8080. Two optical-isolator integrated circuits are used to convert between the floating current-loop circuit and the RS-232 levels. These sensors are separated so that one can be used for data input and the other for output (separate current loops – full-duplex operation). The two circuits can also be series connected to provide both data input and output on a single current-loop circuit (half-duplex operation).

RAM, ROM or (E)PROM It

The basic MCEM-8080 circuit board is available with 1024 (1 k) bytes of random-access memory (RAM). This memory can be used by the user's programs, but the lower 64 bytes are required for the software monitor program. Additional RAM can be installed on the MCEM-8080 circuit board in the field, but the company recommends factory installation of the ICs. There is space on the circuit board for an additional 1-k RAM, extending the total on-board memory to 2 k. All RAM ICs should be type 8102A-4, a device featuring an access time of 450 ns or less. The use of slower RAM devices is not recommended in the MCEM-8080 microcomputer as they may cause improper operation of the system. Within the processor memory space, the standard 1-k bytes of RAM occupy locations 0 through 1023_{10} (0 through $3FF_{16}$ in hexadecimal). The optional 1-k bytes of RAM are at locations between 1024_{10} and 2047_{10} (400_{16} to $7FF_{16}$ hex). And the software monitor uses RAM locations between 0 and 63_{10} (0 to $3F_{16}$).

Several read-only-memory device options can be used in the MCEM-8080 microcomputer circuit. The system is provided with circuit-board space for 4-k bytes of erasable programmable read-only memory (EPROM) or 2-k bytes of bipolar programmable read-only memory. When the choice of device type to be used has been made, appropriate jumper connections have to be made on the MCEM-8080 pc board. Four socket locations are provided for the ROM – all four ROMs must be of the same type. The ROM occupies consecutive memory locations starting at $32{,}768_{10}$ (8000_{16}).

Either a type 8708 or 8704 EPROM IC or

HAL Communications MCEM-8080 Microcomputer

Power requirements: ±12-V dc and +5-V dc, available from HAL MCEM-PS power supply.
Programming format: Machine language (hexadecimal) for basic microcomputer.
Price class: $375 at the time of this review.
Manufacturer: HAL Communications Corp., Box 365, 807 East Green Street, Urbana, IL 61801.

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*

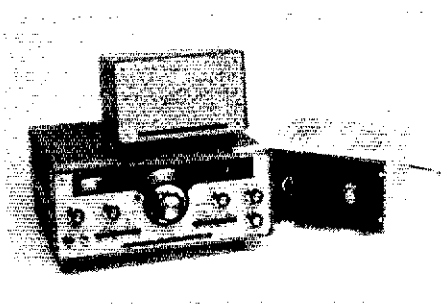
THE HEATH MODEL HW-104 SSB TRANSCEIVER

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

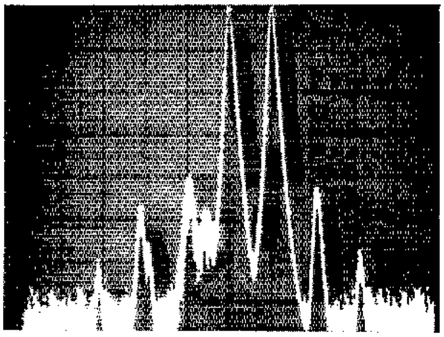


Fig. 1 – Two-tone test for IMD products. The 3rd-order products are approximately 40 dB down from full output. Calibration is 1-kHz/division horizontal, 0.1-kHz bandwidth filter and 10-dB/division vertical. Output frequency was 7 MHz and the power output was 100 watts.

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.

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