KB2LJJ Radio Mods Database

IC-735

HF All Band Transceiver

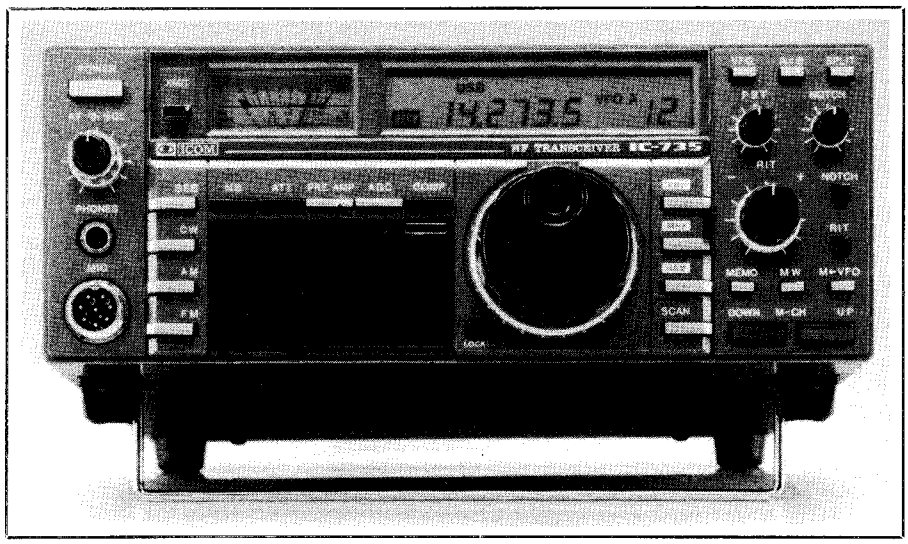
General Coverage Receiver

Product review from QST

Conducted By Bruce O. Williams, WA6IVC
Assistant Technical Editor

ICOM IC-735 HF Transceiver

ICOM has entered the small, full-featured transceiver market with the IC-735. This compact, low-profile radio has plenty of features for convenient, casual HF operation. It competes directly with the Kenwood TS-430S (reviewed in March 1984 *QST*), and the Yaesu FT757GX (December 1984).



ICOM IC-735 HF Transceiver/General-Coverage Receiver, Serial No 1257

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Frequency range: Receive—100 kHz to 30 MHz; transmit—1.80000-1.9999, 3.40000-4.0999, 6.9000-7.4999, 9.9000-10.4999, 13.90000-14.4999, 17.9000-18.4999, 20.9000-21.4999, 24.4000-25.0999, 27.9000-29.999 MHz.	Receive—as specified; transmit—as specified.
Modes of operation: SSB, CW, AM, FM.	As specified.
Frequency display: 5/16-inch liquid crystal digital display.	As specified.
Frequency resolution: 10 Hz, 1 kHz	As specified.
Transmitter:	*Transmitter Dynamic Testing*
Power output: 100-W SSB, CW, FM; 40-W AM.	160 m, 107 W; 80 m, 115 W; 40 m, 117 W; 30 m, 117 W; 20 m, 120 W; 17 m, 120 W; 15 m, 123 W; 12 m, 125 W; 10 m, 120 W. (AM output was not measured.)
Spurious signal and harmonic suppression: Better than 50 dB.	See Fig 3.
Third-order intermodulation distortion: Not specified.	See Fig 4.
Keying waveform: Not specified.	See Fig 5.
Receiver:	*Receiver Dynamic Testing*

		80 m	*20 m*
Receiver sensitivity: Less than 0.15 μV for 10 dB (signal + noise)/noise	Minimum discernible signal (noise floor), (dBm):	(Preamp –127/–134	out/in) –126/–133
Receiver dynamic range: Not specified.	Blocking dynamic range (dB):	Noise limited	Noise limited
	Two-tone, 3rd-order intermodulation distortion dynamic range (dB):	90/92	85/88
	Third-order input intercept (dBm):	8/4	1.5/–1

Receiver recovery time: See Fig 6.	
S-meter sensitivity (μV for S9 meter reading): Not specified.	RF amplifier out/in: 160 m, 64/22; 80 m, 52/16.5; 40 m, 52/16.5; 30 m, 52/16.5; 20 m, 52/17; 17 m, 50/19; 15 m, 52/21; 12 m, 54/21; 10 m, 58/21.
Squelch sensitivity: FM, 0.3 μV.	0.25 μV (preamp on).
Receiver audio output at 10% total harmonic distortion: 3 W.	As specified.
Color: Gray.	
Size (height, width, depth): 4¼ × 9¾ × 10¾ inches.	
Weight: 11 lb.	

Receiver Features

The '735 uses a triple-conversion (70 MHz, 9 MHz and 455 kHz) scheme to receive SSB, CW, AM and FM signals from 100 kHz to 30 MHz. There are three ways for a signal to enter the IC-735 receiver. Normally signals pass around the RF attenuator and preamplifier to enter what ICOM calls a "direct-feed mixer." When the preamplifier is activated, about 10-dB of gain is provided ahead of the mixer. When the RF attenuator is selected, incoming signals are reduced by 20 dB. Various combinations of the preamplifier and attenuator switches allow four possible mixer-input levels over a 30-dB range. In addition, receiver input and output jacks on the rear panel allow connection of an external receiver or an unswitched outboard preamplifier. See Fig 1.

Receiver selectivity varies with the emission mode. The –6 dB bandwidths are 15 kHz for FM, 6 kHz for AM and 2.3 kHz for SSB and CW. Optional 9-MHz IF filters are available for either a 500- or 250-Hz CW bandwidth. There are no optional SSB filters available. The '735 does, however, include passband tuning for SSB and CW modes and a notch filter. (A narrow setting of the passband tuning nearly equals the performance of the 500-Hz CW filter in the test radio.) Adjacent signals can be reduced up to 28 dB by the notch filter. The noise blanker includes a threshold adjustment from the front panel. This feature is seldom seen in contemporary transceivers, and I feel that any additional control given the operator is worthwhile. Operators can also adjust the receiver audio character with a tone control that is reachable with a screwdriver through an access hole in the case. An audio squelch is provided to reduce unnecessary receiver noise in the shack.

Transmitter Features

Transmit frequency coverage for the IC-735 is shown in the specification table. The HAM tuning-rate switch together with the main tuning knob select the desired band on the amateur frequencies. Sideband selection is automatic—USB on 10 MHz and all bands above 10 MHz, and LSB on 7 MHz and all lower bands. One chooses between sidebands by pressing the SSB-mode switch.

Output power can be adjusted from 10 to 100 W using the RF POWER control. An internal three-speed fan cools the transmitter. The fan always operates during transmissions, but never during reception. When the PA temperature is below 50 °C, the fan operates at low speed. Fan speed increases to medium when the PA temperature exceeds 50 °C and to high when the PA temperature exceeds 90 °C. According to the manual, the '735 can

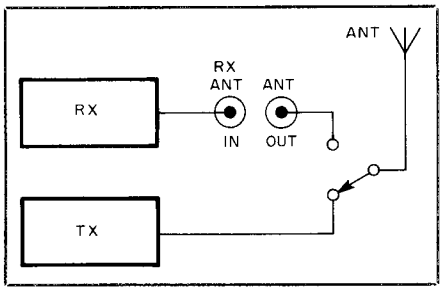


Fig 1—Antenna TR connections for the IC-735. RX ANT IN and ANT OUT are connected by a jumper for normal operation. An external preamplifier connected in place of the jumper needs no TR-switching provisions. An external receiver is controlled by the IC-735 TR circuitry when it is connected to the ANT OUT jack.

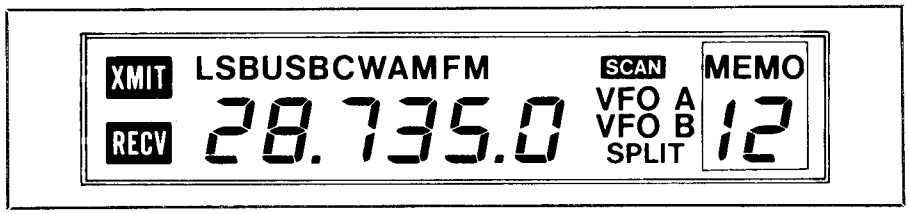


Fig 2—A layout of the IC-735 LCD showing all indicators.

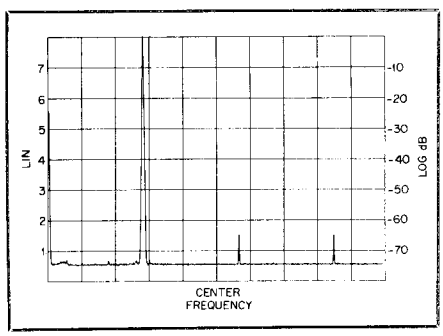


Fig 3—Spectral display of the IC-735. Vertical divisions are each 10 dB; horizontal divisions are each 10 MHz. Output power is approximately 100 W at a frequency of 28 MHz. All spurious emissions are at least 65 dB below peak fundamental output. The IC-735 complies with current FCC specifications for spectral purity.

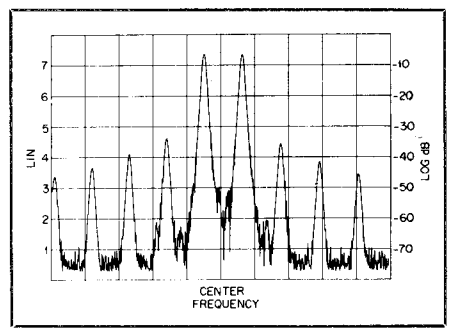


Fig 4—Spectral display of the IC-735 output during transmitter two-tone intermodulation distortion (IMD) test. Third-order products are 33 dB below PEP, and fifth-order products are 39 dB down. Vertical divisions are each 10 dB; horizontal divisions are each 1 kHz. The IC-735 was being operated at rated input power on the 20-meter band.

transmit continuously for long periods with no reduction in power, as long as ambient temperature is 25 °C or less. The unit is designed to operate with an SWR of 1.5:1 or less. According to the operating manual, output power is reduced as SWR increases above 1.5:1, but it is possible to damage the transmitter by operating with a high SWR.

During AM transmissions, the carrier must be adjusted to 40% of the normal output level. The speech processor may be used during AM transmissions. No reduction of output power is necessary during FM transmissions. An optional 88.5-Hz tone unit (UT30) is available for use with tone-access repeaters. The tone is active when transmitting in the FM mode.

Front-Panel Controls

The most used controls are grouped at the center and right of the front panel. At the top right-hand corner are the VFO controls, VFO, A=B and SPLIT. If the VFO button is pressed during memory operation, frequency control is transferred to the VFO that was in use when memory operation began. Another press of the same button transfers control to the other VFO. The A=B button equates the frequency and mode of the second VFO to that of the VFO currently displayed. A=B has no effect during memory operation. When the SPLIT switch is pressed, "SPLIT" appears on the frequency display, and subsequent transmissions take place on the frequency/mode of the second VFO. This allows convenient cross-mode contacts. A second press of the switch cancels split operation.

Below the VFO buttons are two knobs that set the passband tuning (PBT) and notch-filter frequency (NOTCH). The instruction manual describes two different PBT actions. In CW mode, PBT varies the receiver bandwidth from 2.3 kHz (maximum clockwise rotation) to 800 Hz (maximum counterclockwise rotation). In the SSB mode, a detent at the 12 o'clock position corresponds to maximum bandwidth (2.4 kHz), and knob rotation shifts the IF filter center frequency up to 1.8 kHz above or below its normal frequency. PBT does not function during AM or FM operation.

The large knob at the right side of the front panel is the RIT frequency control, with a range of ±800 Hz. To the right of the RIT knob are two on/off push-button switches for the NOTCH and RIT features.

Memory controls, all push-button switches, are grouped at the lower right of the front panel. MEMO transfers frequency/mode control of the transceiver to the memory indicated on the display. The current frequency and mode are written into the memory indicated on the display when the MW (memory write) switch is pressed. When in the VFO mode, a press of the M>VFO button transfers the contents of the displayed memory to the active VFO. When in the memory mode, the M>VFO button transfers the display frequency and mode to the VFO that was in use prior to memory operation. (Since the operator may tune away from a recalled memory frequency without affecting the memory contents, the information transferred need not be the same as the contents of the active memory.) A pair of memory-channel (M-CH) switches (DOWN and UP) change the memory number on the display. When under VFO control, only the memory number changes; in the memory mode, frequency, mode and memory number change to match the selected memory.

The main tuning knob on the IC-735 serves several purposes. A column of buttons to the right of the knob determines the tuning rate. With no button selected, the tuning steps are 10 Hz each. Pressing the KHZ button changes the rate to 1-kHz steps. The MHZ step rate serves as a band switch for general-coverage reception, while the HAM rate switches from one amateur band to the next as the main tuning knob is rotated. When the HAM rate is selected in the SSB mode, the appropriate sideband for each band is automatically selected. Tuning speed varies not only with the selectable step rates, but also with the speed of knob rotation. That is, as the rotation speed increases, so does the number of steps per rotation.

At the bottom of the button column is the SCAN switch, which starts or stops transceiver scanning. (Note that transceiver scanning is different than tuning with the scanning microphone, which is discussed later.) In all scanning modes, the receiver halts when it comes to a signal. Dependent on the scan-timer switch setting, inside the radio, the scan may resume after about 10 seconds or may halt completely. Once the scan continues, it will halt at signals only if the RECV indicator was off (squelch closed) when the scan resumed. An internal jumper selects either a slow- or fast-scan rate. Programmed scan limits are stored in memories 11 and 12. The programmed scan begins at the lower of the two limits and scans to the upper limit at either 10-Hz or 1-kHz steps as determined by the step-rate switches. Scanning can be stopped by again pressing the SCAN button, by transmitting or moving the tuning knob.

A memory scan selects all memories, in sequence, regardless of mode. It is initiated by pressing the SCAN button while in the memory mode. Memories with different modes than the displayed memory are excluded from the scan by pressing the dial-lock button before initiating the memory scan.

It is possible to tune the IC-735 with a scanning microphone. Scan operations and the microphone scan occur at the same jumper-selected rate. I used only the slow-scan rate. At the slow rate, it is possible to stop the scan before passing a signal. The step rate of the scanning microphone is either 10 Hz or 1 kHz, depending on the step-rate switches on the front panel. It is interesting that the dial lock inhibits tuning from the knob, but not from the scanning microphone buttons.

The '735 is one of the first HF transceivers to use a liquid-crystal display. Fig 2 shows the display with all indicators active. The frequency digits are 5/16-inch high. The brightness of the pleasant green display backlight is adjustable through a cabinet-access hole, and the display is easily visible under any conditions

of ambient lighting. The display does not show the offset effect of RIT nor the on/off status of the notch filter.

The meter, to the left of the display, shows signal strength during receive and power output (PO) or ALC level during transmit (selectable by a front panel METER switch). When PO is selected, the meter can function as a reflectometer. A three-position, rear-panel switch selects the PO, SET or SWR function. Sensitivity of the reflectometer is not variable—the transmitter power-output level is adjusted to obtain full-scale meter deflection with the switch in the SET position. Reflected power may then be directly read by switching to SWR.

Controls that are less often used are grouped under the meter on the left side of the front panel. They include: noise blanker (NB on/off), ATTenuator (on/off), PREAMPlifier (on/off), AGC (slow/fast) and speech COMPressor (on/off). Below these buttons is a small recessed compartment with a smoke-colored plastic door. I have large fingers and found the door a nuisance. ICOM had foreseen this problem, however, and made the door removable. This compartment houses a switch panel with 12 separate controls—six sliding potentiometers and six push buttons. The sliding controls are: noise-blanker threshold (NB LEVEL), RF GAIN, RF POWER, VOX GAIN and DELAY, and MICrophone GAIN. The MIC GAIN control also functions as a SPEED control when using the optional electronic keyer. Push-button controls are: AM and CW filter (WIDE/NARROW), METER (ALC/PO), VOX (ON/OFF), break-in keying (BK-IN, FULL/SEMI) and keyer mode (ELEC KEY/ MANUAL), which selects the optional electronic keyer.

A group of four push buttons to the left of the switch panel select the mode of emission (SSB, CW, AM and FM). Pressing the SSB button initiates the single-sideband mode with the appropriate sideband selection (LSB under 10 MHz, USB on 10 MHZ and above). Subsequent presses of the SSB button will cycle the sideband selection between LSB and USB.

At the left edge of the front panel are: a push-button POWER switch, concentric AF GAIN and squelch (SQL) controls, a ¼-inch PHONES jack and an eight-pin MICrophone connector.

Rear-Panel Controls and Connectors

On the rear panel are several controls and connectors: SO-239 antenna connector; transverter output (30 mV, phono jack); antenna output (phono jack); receiver antenna input (phono jack); compressor-level adjustment; external speaker (1/8-in phone jack); microphone-tone adjustment; AM carrier-level adjustment; key jack (¼-in, three-conductor phone jack); anti-VOX adjustment; accessory jack 1 (for phone patch or AFSK connections, 8-pin DIN jack); meter switch (power out, set or SWR reading); accessory jack 2 (for connection to ICOM transmatches with automatic bandswitching, 7-pin DIN jack); ALC (phono jack); 6-pin power connector; remote (1/8-in phone jack for computer control of IC 735); send (PTT line, active low); and ground terminal (spring clip).

In addition to the previously mentioned backlight dimmer and AF-tone adjustments, there are cabinet-access holes for sidetone volume and tuning-knob drag adjustments. With the cabinet removed, one can select output power (100 W/ 50 W), 25 kHz marker-generator on/off, scan-timer on/off or move a jumper to select fast- or slow-scan rate.

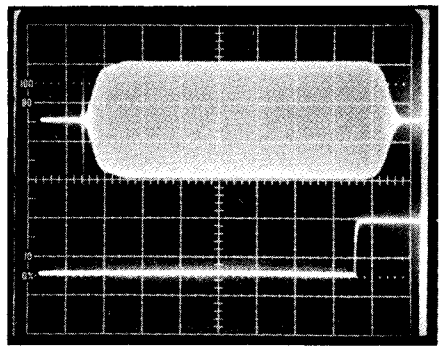


Fig 5—CW keying waveform of the IC-735. The lower trace is the actual key closure; the upper trace is the RF envelope. Each horizontal division is 5 ms. The very faint spike at the beginning of the envelope is discussed in the text.

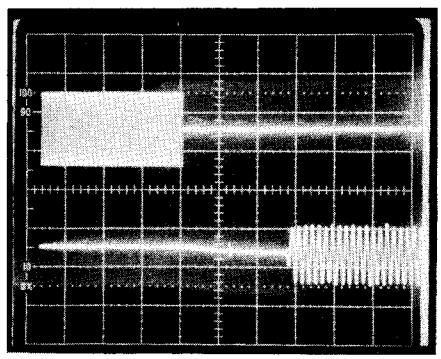


Fig 6—Receiver recovery (turnaround) time. The upper trace shows the key opening; the lower trace shows receiver audio output. Horizontal divisions are each 5 ms. There is an approximate 14-ms delay before receiver recovery.

Operation

This radio reminds me of the early days of scientific calculators. The '735's capabilities can be somewhat intimidating, but a few days spent reading the manual and practicing various operations opens new realms of convenience and control. The 46-page instruction manual gives complete explanations for all normal operations. It does not, however, give any information about use of the remote-control capabilities of the IC-735.

I found the VFO and memory controls exceptionally easy to use, and powerful. Each memory has the flexibility of a VFO; essentially, the radio has 14 VFOs. Mode scanning was very helpful during the WØORE/ Challenger space-shuttle flight, when I used this feature to monitor various WA3NAN frequencies for shuttle communications. Normal noise conditions limit the effectiveness of the audio squelch, and therefore the scan operations in the SSB, CW and AM modes (except for the scanning microphone). Under quiet conditions, however, the functions are useful.

The optional IC-EX243 keyer was installed in the test radio. I am very happy with the keyer, but there are two aspects of its operation that are potentially inconvenient. Keyer speed is adjusted by means of the MICrophone GAIN/SPEED control on the front panel. The control is a sliding potentiometer in a recessed compartment. At my normal keying speed (15 to 25 WPM), I found the control somewhat difficult to adjust. Also, those who work both CW and phone must readjust the control each time they switch modes. CW weighting is adjusted during the installation of the keyer. When the keyer is switched off, one paddle may be used to hold the transmitter on while a matching network is adjusted.

My other radios do not offer full-break-in operation. Because the relay closures in those radios do not follow the key action exactly, I normally operate with a long VOX delay that maintains the transmit mode throughout a word. I found break-in operation with the IC-735 a pleasure. The TR relay is very quiet and not at all distracting. Break-in operation is effective up to about 35 WPM, where the space between dots becomes less than the AGC time constant.

A photo of the keying waveform (Fig 5) shows a very faint spike at the beginning of the RF envelope. This could cause a key click of extremely short duration if the spike were present on the air. I asked about clicks during every CW contact and received nothing but excellent reports.

The IC-735 performed flawlessly for me. It is a pleasure to operate. It is a lightweight, but feature-packed rig. The ICOM IC-735 is available from ICOM America, Inc, 2380 116th Ave, NE, Bellevue, WA 98004, tel 206-454-8155. Price class: IC-735, $849; IC-EX243 keyer, $50; FL-32 500-Hz filter, $60.—*Bob Schetgen, KU7G*

HEATH GC-1000: "MOST ACCURATE CLOCK"

Our lives all revolve around one common element—time. Every day we hear or ask the question, "What time is it?" When asked this question, most of us will glance at a $3.94 mail-order-special timepiece and blurt out some sort of a reply. After such an encounter, do you ever wonder what time it really is?

If you own the Heath GC-1000, you probably will never again have to wonder. Why? Because the GC-1000 automatically sets itself to the National Bureau of Standards time signals whenever a strong signal can be received from WWV on 5, 10 or 15 MHz. The unit is modifiable to use WWVH by changing one resistor and two capacitors during construction. The clock will run on either 117- or 234-V ac. If the power source fails, an external 12-V dc source can keep the clock running accurately. Even if such a source is not available, the GC-1000 will reset itself automatically when power is restored if an adequate WWV signal is received. An optional RS-232-C output is available to supply chronograph information to your computer at speeds between 110 and 9600 bauds.

NBS Time Information

The National Bureau of Standards' stations (WWV in Colorado, WWVH in Hawaii) transmit time signals continuously on frequencies of 5, 10 and 15 MHz. The RF receiver in the clock scans these three frequencies and locks on to the strongest signal. A binary-time code is included in the transmissions. This code consists of one-minute-long strings of binary data made up of several sets of pulses. Each set of pulses represents one digit of informa-

tion. The position of the digit in the code determines whether the digit represents an hour, a minute or a second. Time-code pulses are sent once each second, so that in the one-minute time frame enough information is sent to convey current hour, minute, second and day of the year.[1] Using this mechanism, the GC-1000 automatically calibrates itself to NBS.

Time Display

The most easily observed difference between the GC-1000 and most other digital clocks is in the time display. In addition to hours and minutes, seconds and tenths of seconds are displayed. If the clock has not set itself within the past 24 hours, the tenths-of-seconds display is dimmed. When the clock is running in the standard (12-hour) format, two LEDs indicate whether the time is AM or PM. These LEDs are extinguished in the 24-hour format.

In addition to the actual time display, six status LEDs are situated in two rows of three on the right side of the front panel. The top three LEDs (5, 10, or 15 MHz) indicate which WWV frequency is being monitored. The three lower LEDS indicate: CAPTURE (green), if the receiver is locked on WWV; DATA (amber), signifying that digital time information is being received; or HI SPEC (green) indicating that the clock has just calibrated itself and is accurate to within 10 milliseconds.

The Bottom Panel

Two DIP switches located on the bottom panel are used to: Select the time zone (including Daylight Savings Time); set the 12- or 24-hour format; activate or lock out each of the three WWV frequencies; and set the receiver propagation delay for distances of up to 3600 miles from WWV. In addition, UTC 1 (corrected UTC) can be selected to adjust the clock automatically in 0.1-second increments to make up for the slight variations in the earth's movement. When the variation exceeds 0.7 second, NBS initiates a "leap second," usually on June 30 or December 31, to get things back in line. With the GC-1000, there's no need to reset for a leap second—this is done automatically!

[1]Information on the exact format of the timing code can be obtained from the *NBS Time and Frequency Users Manual,* NBS Special Publication 559. A copy may be purchased from: US Department of Commerce, National Bureau of Standards, Washington, DC 20234.

Documentation

The 91-page manual supplied with the kit is used during assembly, testing and alignment. These instructions lived up to what I have learned to expect from Heath—all steps, from assembly through final testing, are clearly spelled out.

Construction

Most of the components used in the GC-1000 are contained on four PC boards. One of these, the three-channel scanning receiver, is factory assembled, tested and aligned. This board simply plugs into the main circuit board with an edge-type connector. The three remaining subassemblies, (display, tone decoder and main circuit board) must be "stuffed" and soldered. The tone decoder and display boards, like the receiver, plug into the main circuit board. Construction took about 8 hours, with an additional 20 minutes required for initial test and calibration.

Initial Test and Calibration

The internal microprocessor provides three modes to aid in unit calibration. The first mode checks all the LED segments in the time display. The second mode calibrates the 1000-Hz tone decoder used in WWV reception, and the third mode is used to align the 1200-Hz tone decoder used for WWVH reception. Only an insulated screwdriver, supplied with the kit, is required to perform these three adjustments. These constitute the entire calibration for the GC-1000. Four no 6-32 machine screws attach the cabinet to the electronic assembly. Finally, the 54-inch telescoping antenna is attached, and you're ready to tell time.

Operation

The Heath GC-1000 has been in service at W1OD for almost a year now, with no problems. The clock sits atop my transceiver. Although the presence of full-legal-limit RF approximately 6 inches from the unit does prevent the clock from calibrating itself to WWV while I'm operating, the internal 3.6-MHz oscillator keeps the time display accurate. This oscillator is electronically trimmed: Every time the clock aligns itself to WWV, the oscillator "remembers" the correction direction and adjusts its frequency accordingly. The 54-inch telescoping antenna will not provide a reliable WWV signal at my QTH, so an external antenna is used.

If you take pride in knowing what time it really is, the GC-1000 is definitely for you. Available from Heath/Zenith Computers & Electronics. Price class: GC-1000 Most Accurate Clock kit, $230; assembled and tested, $425. GCA-1000-1 RS-232-C Output Accessory, $50.—*Mike Kaczynski, W1OD*

New Books

THE COMMODORE HAM'S COMPANION

by Jim Grubbs, K9EI. Published by QSKY Publishing, PO Box 3042, Springfield, IL 62708. First edition, 1985. Soft-bound volume, 8½ × 5½ inches, 160 pages. $15.95 plus $2.50 for shipping and handling.

Whether you already own a Commodore 64™ or VIC 20™ computer or are thinking of buying one, you're sure to have a need for information on how to use it effectively in your hamshack. The 14 chapters in this book are designed to do just that, as well as provide you with some guidelines concerning the purchase of one of the many Commodore computers. The chapters are brief and cover a lot of territory.

Off the top, the pros and cons of the many Commodore machines are discussed. According to Jim, over 100,000 hams already own either a VIC 20 or a C64. That alone should give you some indication of why Amateur Radio equipment manufacturers and software developers favor those machines. If you don't already have a computer, you might consider this oft-quoted rule: Find the software that'll do the job you want to do, then buy the machine to run the software. (It's usually frustrating to try to do it the other way around.)

The software—communications, log keeping, MSO, FAX, grayline, and so forth—and hardware (RTTY/CW modems and TNCs) for use with the Commodore machines are discussed in several chapters. Other chapters cover computing by telephone and the information services and magazines that are available for Commodore users. A multiple-page listing of Commodore software and/or hardware suppliers is given in an appendix. Two other appendixes provide you with the addresses of about 20 different magazines and a glossary of terms. A bibliography of over 60 magazine articles pertaining to use of the Commodore computers and radio is also included.

Throughout the book are strewn tips and hints and tidbits of information that Commodore users are certain to feast on. Next to the "power on" switch, this is one item ham-oriented Commodore users will want to have.—*Paul K. Pagel, N1FB*