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Macrotronics RM1000 Radio Modem

Microwave Modules, Ltd. MMS-1 and MMS-2

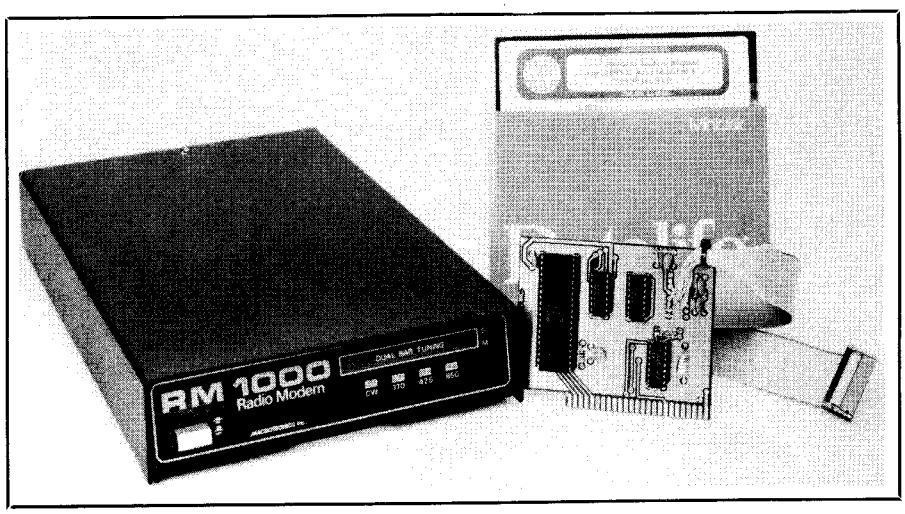
Product Review

Conducted By Paul K. Pagel,* N1FB

Macrotronics RM1000 Radio Modem

This Morse/RTTY modem, with the proper software and interface package, can be used with several different types of personal computers: the Atari® 400, 800, 1200, 600XL and 800XL, the Apple® II, II+ and //e, TRS-80® microcomputer models I, III and 4, and the IBM® PC. Provision is made for 40- and 80-column use only with the IBM PC. For the purposes of this review, the RM200 (Apple computer) software and interface were used.

The RM1000 will send and receive CW up to 135 WPM, Baudot at 60, 66, 75 and 100 WPM, and ASCII at 75 and 110 bauds. ASCII operation offers operator selection of 6, 7 or 8-bit code, even, odd or no parity, and has the ability to ignore or respond to parity errors. Other RTTY features include diddle (none, slow, fast), UT4 delay (a selectable, inter-character delay), 170, 425 and 850-Hz shift selection, and narrow-shift CW ID. The operator can toggle these functions on and off: USOS (UnShift On Space), word wrap-around (on receive) and the CW ID. Carriage returns and line feeds may be ignored if desired. The CW receiving-speed algorithm is adaptive, and a key-down toggle for tune-up is provided.



Description

Operator's Manual

The spiral-bound operator's manual is 65 pages. It is augmented by a separate schematic diagram and an 8½ × 7¼ inch (opened) reference card.[1] The latter contains a list of the RM1000 operating commands. With the reference card at the operating position, you can generally avoid having to look to the operator's manual for help. Should you require the assistance of the manual, the reference card also lists the page numbers on which a description of the function in question may be found.

The large, fold-out schematic diagram has a main-board parts-layout drawing on the opposite side of the sheet. No schematic diagram for the interface board is supplied, and no PC-board patterns, overlays or parts list for the main or interface boards are provided. Diodes, capacitors and resistors (except for potentiometers) are not identified by component numbers on the schematic diagram or PC board. There are no alignment instructions given. This information would be of assistance in troubleshooting and/or modification procedures. The schematic diagram copy was a bit weak in spots, but Macrotronics readily supplied another.

If you follow the manual from page one, you'll have the RM1000 in operation quickly. You should, however, read (or at least scan) the manual from cover to cover first. Then, backup the software on another disk (see the last page of Chapter 3). Chapter 4, "Detailed Interfacing," gives you the interconnection information for some Kenwood, Yaesu and ICOM rigs.

Before preparing any cables, note that the pinout of J2 (AFSK and PTT connections) on page 46 is incorrect. Pin 1 should be labeled pin 3, and vice-versa. Since these pins connect to normally open relay contacts that are floating, no problems should be encountered. Also, the AFSK LO and AFSK HI labels should be swapped. The latter two labels are shown incorrectly on the back panel, too. A minor error occurs on page 31: The WRU (Who aRe yoU) message prompt appears in the upper window, not on status line 2.

Getting Physical

The RM1000 is enclosed in a black, two-piece, slide-apart cabinet. It's an attractive unit; the black case is color-coordinated with the blue and silver identification labels and the red, yellow and green LED displays and indicators. There is only one control on the front panel: the ON/OFF switch. Modem control is handled from the keyboard. The rather spartan, yet attractive, panel gives the operator a sense of freedom.

A dual LED tuning bar on the right-hand side of the front panel displays the level of the incoming space and mark signals. Below the tuning bar are four LEDs labeled CW, 170, 425 and 850. The red CW LED blinks in unison with incoming Morse code when the signal is within the passband of the modem CW filter. Each of the other indicators — 170, 425 and 850 (green, yellow and red, respectively) — are lit, and remain so, once a particular RTTY shift is selected, regardless of the mode of operation.

Connections to and from the modem are made at seven rear-panel jacks and plugs. Two of these are 5-pin DIN types. One is used to attach the external wall transformer to the modem. The second provides AFSK, ground and PTT interconnections. Three 1/8-inch jacks are used for CW KEYING (output), AUDIO IN and HAND KEY (input) hookups. A 5-pin header plug supplies SCOPE MARK, SCOPE SPACE, GROUND, RS 232 IN and RS 232 OUT access. The remaining plug is a two-row, 40-pin connector labeled COMPUTER PORT. This is where the umbilical cord to the computer attaches. At the computer end of this cord is a second piece of hardware that is computer dependent. For the Apple computer, it consists of a small, double-sided PC board containing four ICs and a few other components. The main ingredient of this interface board is a 6522 VIA (Versatile Interface Adapter). In addition to providing computer/modem interfacing, the 6522 is used as a time-of-day (real-time) clock. This clock uses the ac-line frequency as a reference and must be reset during the next operating period if the computer is shut off.

All versions of the modem, except for the TRS-80 model, will work without modification on 50- or 60-Hz power lines. A simple IC change on the interface card (swap a 7490 for the 7492) converts the TRS-80 for proper operation on 50-Hz lines. This change affects the clock frequency-divider chain.

A CW THRESHOLD potentiometer is the only rear-panel control. It is used to adjust the noise threshold of the modem during CW reception and maximize noise immunity. (A software-controlled noise threshold is also provided; its adjustment is described in the operator's manual.)

Next to the CW THRESHOLD potentiometer is another ¼-inch hole. This hole might be used for modification purposes, such as adding an FSK output jack.

Inside the modem is a single double-sided PC board that contains the majority of the circuitry. A small PC board attached to the mother board at the front of the modem carries the LED displays. One empty 14-pin DIP socket exists. It accepts an SPST DIP relay (optional) for those who wish to use FSK in place of AFSK.

Electrical

The audio input stage output level is amplitude limited, thus providing a fixed amount of gain for the following active filters. There are three filters: one each for the mark and space RTTY signals, and a separate one for CW. (Some modems use the RTTY space filter on CW.) The RTTY space filter center frequency is shifted by keyboard commands using CMOS quad digital bilateral switches. These switches select trimmer potentiometers set for space filter frequencies of

[1]mm = in × 25.4.

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2295, 2550 and 2975 Hz. Signals are sampled at the filter outputs and sent to the mark-hold and tuning indication circuits. Filter output is ORed and sent to the computer.

The CW filter consists of two stages of tuned band-pass filters. These filters are stagger tuned for an overall bandwidth of about 100 Hz and a center frequency of 900 Hz (±150 Hz) (the manual incorrectly states this frequency to be 1 kHz). Two potentiometers (R1 and R2) allow for filter center-frequency adjustment. Another potentiometer, R3, acts as the CW THRESHOLD adjustment. R3 is adjusted for best noise immunity; the procedure is outlined in the manual. The incoming CW audio signal is changed into a digital signal by means of a comparator, fed to a missing-pulse detector, a buffer, and on to the sidetone and tuning LED stages and the computer.

A crystal-controlled clock is used to generate the AFSK tones. Audio tones are generated only when the modem is in the transmit mode. On its way out, the clock signal is fed through a divide-by-two stage, two programmable divide-by-N stages, another divide-by-two stage and a buffer. The divide-by-N stages are programmed according to inputs received from SHIFT SELECT, RTTY (state) and CW ID lines.

An SPST DIP relay is used to key the PTT line. Another relay is used to key the CW output line. Macrotronics specifies that a maximum of 90 V at 10 mA can be handled by the relay contacts. Chassis (cabinet) ground and PC-board ground are isolated. The output levels from AFSK LO and AFSK HI on the review unit are hefty; I measured 180 mV at pin 5 and 560 mV at pin 4 with the AFSK ADJUST (gain) potentiometer, R14, set for minimum output. Consequently, the microphone gain control on my transceiver was barely open. The manufacturer informed me that a change has been made in later-model units to decrease the levels at these two ports.

Software

The HELLO program is structured so that, from a cold start, the program name and copyright are billboarded and the program halts. You are then prompted to "BRUN RM1000." I think this step is unnecessary; the program should display the copyright and then do the BRUNning itself. The program can be altered easily. With DOS present, LOAD the HELLO program and alter line 230 accordingly — 230 PRINT CHR$(4); "BRUN RM1000" — that will accomplish the "self-booting."

The disk backup procedure in the manual assumes that you've already run the RM1000 program and have stored some information (messages, codes speeds, etc.) in RAM. At this point, typing ESC-OB BSAVEs the program in RAM *on the original program disk* as "RM1000/COPY." You're then instructed to make a duplicate of this disk and file the original in your archives. Following a program RENAMEing procedure on the duplicate disk, you're ready to go. If you don't follow this procedure, and BSAVE the RAM data on a blank (initialized) disk, you won't have the proper HELLO program to prompt you (or the computer, if you've changed line 230) to "BRUN RM1000." (Most of the software consists of a binary program that is $3E00 (almost 16 K) bytes long and loads at address $0800.) Because I have an aversion to doing *anything*, with a new program before backing it up, I used the Apple COPYA program to make a backup copy of the original RM1000 disk files, then proceeded with the backup procedure outlined in the manual.

It is impractical to mention all the features the software offers. Let me say that the features are plentiful; some of them were mentioned earlier. Other features include the ability to SAVE messages and text to disk, LOAD them from disk, activate four separate WRU functions, send copy to a printer and call a "review" window. You can prepare up to 16 messages that are dynamically allocated in memory. Messages can even be placed within other messages. Modem control commands can be embedded in text or messages. Messages and received or transmitted information are saved on disk as text files. The data within these text files are stored in *hexadecimal* form. As such, they are *not* directly usable with Apple's word-processing program, Apple Writer II. If you wish to use the files outside the modem program, a conversion routine must be employed, unless your word-processing program accepts such text files.

"Upside-down" and normal receive and transmit RTTY modes can be selected separately or in tandem. Rather than showing the inverted receive or transmit mode (or both) as inverse letters (as the manual implies), normal and inverted modes are shown on status line 1 as NORM and INVT, respectively, within parentheses. Transmission speed can be altered without interrupting the flow of information.

The software is aided by the 6522 on the interface card. Both clocks of the 6522 are used for loop timers, thus freeing the software from having to do this. Among other things, this permits the software to perform disk I/O routines without interrupting the time-of-day clock. Reception and transmission are inhibited, however, during disk access.

Macrotronics has informed me that the software does not support many printer interface cards. The Apple and Epson® printer interface cards are supported, but the Grappler™ and (I discovered) the Microtek cards are not. If your card is similar in operation to the Apple or Epson cards, you're all set. Otherwise, you'll not be able to get hard copy using the existing system unless you can devise a way to do so.

Operation

General

If you start the program with your transmitter and RM1000 on, the PTT line will be keyed, so it's best not to turn on the modem until the program has finished loading. Before program configuration, the program asks for the slot number in which the interface card has been placed. Following program configuration, the slot number request is bypassed. Should you change slot assignments, you'll have to reconfigure the program. The second prompt requests your call sign, a hyphen and the start time for the clock.

You can bypass both requests by answering the prompt with RETURN if you do not need or want the ID included in the program. In this case, the clock will start at zero. A second option is ID entry and clock start at zero. Entering a hyphen followed by the clock time starts the clock timing from your initialization figures when you press RETURN and, of course, leaves the ID message blank.

Those, like me, who are used to the relatively standard split-screen display with a "Times Square" transmitted-message scroll in the middle will find Macrotronics has taken a different tack. Basically, the on-air screen consists of an "edit" window at the top of the screen, followed by a pair of status lines and a "dialogue" window. Six lines of transmit text appear in the edit window. This is the display area for the transmit buffer. The status lines indicate: receive or transmit mode, mark/space polarity (normal or reverse), Morse or RTTY operation, transmit and receiving speeds, RTTY shift, carriage width, carriage-return/line-feed status and the time. Below the status lines, the dialogue window displays received and transmitted text. The receive and transmit modes are indicated by inverse letters separating the text. Text scrolls upward and disappears immediately beneath the bottom-most status line. (I'd prefer to have a blank line between the status line and the scrolling-text window.)

The review window allows you to take a peek at received or transmitted text that has passed by the normal or "on-air" screen. This is a feature *all* RTTY software should have — but doesn't! Within the confines of the review window, you can move the cursor about and mark text for transfer to a message (and save the message to disk), or tell the printer where to start printing. (The Atari and IBM PC software versions allow you to edit text within the review window.) Cursor moves are done with CONTROL key commands. Carriage returns and line feeds are represented by the letters "M" and "J," (not in inverse display); their placement describes their function, however. The transmit type-ahead buffer and the review window may be cleared by a keyboard command, but you can't do the same for the normal (on-the-air) transmit/receive window.

A "break" mode is included for rapid answers to questions you might receive while preparing text for later transmission. The prepared text is unaffected. You can interrupt outgoing data with the break mode to insert a comment. When you are finished, the software will pick up the transmission from the point at which you interrupted it.

The software commands make operating a pleasure. You don't have to toggle back and forth between a bunch of menus to get the function you want. With the handy reference card, "remembering" the commands is easy. By embedding control commands in your transmitted text, you can have the modem automatically toggle from transmit to receive, change speeds, etc. Although you can change modes from the keyboard during transmit, all you'll accomplish is locking up the program.

CW

This is the default mode of the program. The supplied program initializes at a transmit speed of 20 WPM. You can configure the program to initialize at a different speed if you desire. During receive, an adaptive algorithm compensates for speed changes. CW keying is accomplished using the VOX feature of your transmitter; the PTT line is not keyed by the modem during CW operation.

Tuning in a CW signal takes a gentle hand on the receiver or transceiver tuning knob, as the CW filter is quite sharp. There are three indicators to watch when tuning in a CW signal: the space and mark (S and M) DUAL BAR TUNING display and the CW LED. The object is to tune in the signal so that a maximum number of segments are illuminated on the S and M DUAL BAR TUNING indicator in conjunction with synchronized flashing of the CW LED. While that may, at first, sound like it's difficult to accomplish, it isn't — as long as you tune slowly. The receive algorithm performs well, but as with *all* the other CW receiving programs I've tried, none can match the trained ear/brain combination for copying under adverse conditions. Until the "pros" who send

Morse with an accent and play "music" (to their ears) learn how to send properly, we'll not get perfect copy — with or without computers — even with signals that are 30 dB over S 9! If you think your fist is "machine-perfect," try sending to the RM1000 (via the HAND KEY input) and see what prints on the screen.

The CW prosigns the software provides are K, $\overline{KN}$, $\overline{SK}$, $\overline{AR}$ and $\overline{AS}$. For many operators these will be sufficient. A number of special characters are included in the Morse character table, including the plus sign and the ampersand. I would prefer seeing more prosigns substituted for these seldom-used special characters. There are a couple of errors in the character table, too. Appendix B lists a "TM" as the keyboard character to send $\overline{AR}$; actually, it should be the "@" sign. The second error involves the percent sign. On transmit, it is sent as $\overline{WRN}$ (·--·-·-·); during receive, the software responds to $\overline{WR}$ (·--·-·) and errs if $\overline{WRN}$ is input.

A number of the special-character Morse code equivalents (including the percent sign) in Appendix B are not internationally accepted. When I inquired about that, I was told there was to have been a standard established among equipment manufacturers regarding these symbols. The standard never took hold, but Macrotronics retained the agreed-on structure.

RTTY

Tuning in a Baudot or ASCII RTTY signal is quite easy using the DUAL BAR TUNING indicator. Simply tune for a maximum deflection on the M and S indicators. If you think you *really* need a scope to tune in an RTTY signal, the hookups are there. Speed and mode (Baudot/ASCII) changes are made quickly using the ESCAPE key commands offered by the software. In the RTTY mode, tuning in a CW signal will light the CW LED if the note is properly centered in the modem filter passband, but the output will be gibberish. The receiver/transceiver audio can be kept to a level that is almost inaudible in the speaker, yet the modem responds properly.

Some Comments

I contacted Macrotronics to make them aware of the areas I thought required attention. Quick and positive action on the part of the manufacturer resulted in the writing of an addendum sheet. I was told that the addendum would be mailed to all RM1000 owners who had sent in their warranty cards. Macrotronics informed me that they prefer RM1000 owners not attempt realignment or servicing of their units; that's why the circuit information is minimal.

If your unit is one that has too high an AFSK output level (as does the review unit), a single resistor change will decrease the level to a more manageable one. The change involves substituting a 200-kΩ resistor for the first series resistor in the fixed output attenuator (a 10-kΩ resistor presently resides there). This modification will be made free of charge by Macrotronics.

Potential purchasers of the RM1000 should be aware that no connectors (other than the 5-pin header socket) are supplied with the modem. An optional connector package is available from Macrotronics, or the connectors may be purchased at a local electronics parts outlet. (Radio Shack stocks the necessary connectors.) Three 1/8-inch, two-conductor plugs and a single 5-pin DIN plug are required. The review RM1000 did not have the 5-pin header socket in the package, but one was obtained from the manufacturer. Some of you may have observed that the two 5-pin DIN plugs can be inserted into the wrong jack — the ac power source can be plugged into the PTT/AFSK socket, and vice-versa. No damage will occur if this is done.

The wall transformer can be used on 117- and 234-V mains. A slide switch on the back of the transformer selects the proper voltage. The manual cautions that a piece of tape should be placed over the switch to avoid accidental movement to the incorrect position. I would prefer to have a small switch plate (similar to those found on some transceivers, for instance) mounted on the transformer to lock the switch in place.

Macrotronics informed me that TS-520 transceiver owners must modify the RM1000 CW keying circuit. The modification is simple — wiring a transistor switch on a DIP header and plugging it in — and information is available from the manufacturer.

All the RTTY/CW modems I'd used prior to the RM1000 use the Apple game I/O port for interfacing. With an external game-port adapter attached to the outside of the computer, it's easy to connect or disconnect the modem by simply flipping the lever on the adapter ZIF (zero-insertion-force) socket. With the RM1000, the interface card must be plugged into one of the computer mother-board slots and, instead of a four-wire cable, there's a 20-conductor cable between the computer and the modem. The trade-off is in how the modem is controlled. With the other modems, front-panel switches control the operation of the modem. As mentioned earlier, there *are* no modem-control switches (except an ON/OFF push button); modem control is managed from the keyboard. It's a different approach, and I like the idea.

The RM1000 is available from Macrotronics, Inc., 1125 N. Golden State Blvd., Turlock, CA 95380, tel. 209-667-2888. Price classes: RM1000, $240; FSK option, $10; software and interface card/cables: Atari 400, 800, 1200, 600 and 800 XL, $60; TRS-80 Models I, III and 4 and Apple II, II+ and //e, $100; IBM PC 40/80 column, $150. Add $4 shipping within the U.S. — *Paul K. Pagel, N1FB*

MICROWAVE MODULES, LTD., MMS1 AND MMS2

☐ As better Amateur Radio instructors will tell you, aural presentation and immediate feedback are keys to a student successfully learning the Morse code. Microwave Modules's Morse code trainers do both nicely. The Morse Talker (MMS1) and Advanced Morse Trainer (MMS2) are sophisticated, self-contained training devices that help students increase their Morse code reception speed and, with the MMS2, improve sending ability. What sets the MMS1 and MMS2 apart is synthesized-voice feedback (referred to as "Talkback" by Microwave Modules): Both units literally *tell* you what characters they've sent; the MMS2 also can tell you what characters you've sent — or quite convincingly announce that your fist is rusty by blurting out a tone suspiciously reminiscent of a raspberry. A more objective critic would be hard to find!

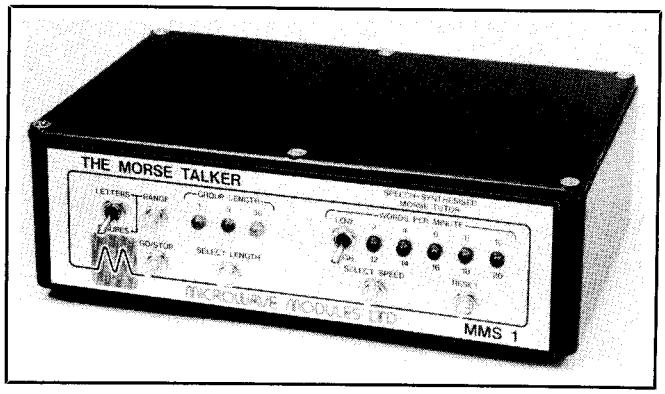
The MMS1 and MMS2 share many features. Each is well constructed on fiberglass PC boards containing two microprocessors, two memory ICs and associated circuitry, and each is housed in a rugged, die-cast aluminum box roughly the size of a large paperback book. The boxes are painted flat black and rest atop four low-profile rubber feet. The attractive front panels consist of aluminum strips that are securely glued to the front of the boxes, though the corners of the panels tend to pull away from the box and are physically sharp. (Had they been rounded before assembly, there would not be a problem.)

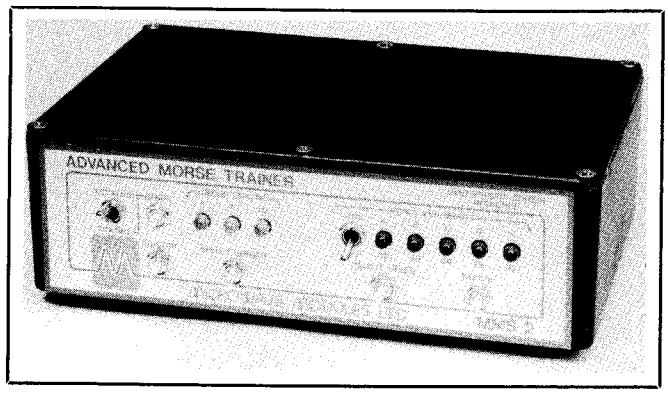
Front panel toggle and push-button switches select various options and LEDs that indicate the chosen code speed and character-group length. On the back panel of each unit are 5-pin DIN power connectors (an external power source of 9- to 13.8-V dc at 350 mA minimum is needed), two 3.5-mm mini-phone jacks for connecting 8-ohm headphones or an external speaker (a small internal speaker is provided) and a straight key or keying device (a keyer is not included in either the MMS1 or MMS2), and a phono jack for hooking up a tape recorder to make practice tapes. Both units are reverse-polarity protected and have readily accessible external RESET switches. Neither unit has its own on/off switch; turning them on and off is achieved by connection to, or removal from, an external power source.

The basic function common to the MMS1 and MMS2 is random code practice in a variety of speeds and formats. Code speed is selected by stepping through the range of speeds from the low speed at turn on; this is done using a toggle switch to set low- or high-speed range and then repeatedly pushing the SPEED SELECT button while watching which of a string of five LEDs is lit. In the MMS1, code speeds range from 2 to 20 WPM in 2-WPM increments; an optional EPROM (not available in the review unit) can be purchased to extend the range to 12 to 48 WPM in 4-WPM increments. In the MMS2, the code speed ranges from 6 to 32 WPM in 2-WPM increments to 16 WPM, and 4-WPM increments between 16 and 32 WPM. At speeds less than 12 WPM, characters are sent at 12 WPM and between-character spacing is adjusted for the overall selected speed. This (a variation of what is called the Farnsworth method) forces the newcomer or slow-code student to recognize characters by their rhythm patterns and avoid the beginner's trap of counting dots and dashes. At 12 WPM and above, normal character spacing is used.

Other available options concern the size and composition of the random groups that will be sent. Six character ranges can be selected using a combination of toggle switch and pushbutton: A-F, A-M, A-U, A-Z, 0-9 and 0-Z (all numerals and letters). Punctuation and common procedural signs are not available. Unlike other options, the chosen character ranges are not indicated by LEDs; instead, the units literally *tell* you what range you've selected as you step through the sequence. Be prepared for a few wide-eyed stares from the uninitiated — this is usually the point where the synthesized voice first speaks.

The third option, length of random-code groups, is selected by stepping through the four choices with a push-button switch. When the GROUP LENGTH 1 LED is lit, the MMS1 and MMS2 (after you've also pushed the GO/STOP button) will send one character at the selected speed and from the selected range, pause, tell you verbally what was sent, pause again, send another character, and so on. When the GROUP LENGTH 5 LED is lit, a single group of five random characters is sent before you're told what they were, then another five, etc. When the GROUP LENGTH 50 LED is lit, 10 groups of five random characters each are sent, followed by a synthesized-voice discourse on what they were, followed by another 10 five-character groups, and the sequence is repeated. When all GROUP LENGTH LEDs are extinguished, the voice synthesizer is disabled and continuous five-character, random-code groups are sent with no





Microwave Modules MMS1 and MMS2

Manufacturer's Specifications

	MMS1	*MMS2*
Speed Range	2-20 WPM in 2-WPM increments; 4-48 WPM with optional EPROM	6-32 WPM in 2-WPM increments to 16 WPM and in 4-WPM increments 16-32 WPM
Character group lengths	1, 5, 50 before Talkback	1, 5, 50 before Talkback
Letter/numeral ranges	A-F, A-M, A-U, A-Z, 0-9, 0-Z	A-F, A-M, A-U, A-Z, 0-9, 0-Z
Power requirements	9 to 13.8 V at 350 mA	
Power connector	5-pin DIN	
Audio output	250 mW into 8 ohms	
External speaker connector	3.5-mm mini-phone jack	
Tape recorder connector	Phono jack	
Morse key connector	3.5-mm mini-phone jack	
Size (HWD)	2 × 7 × 4¾ in†	
Weight	2 lb 2 oz.	
Synthesized Voice Talkback	Yes	Yes
Reads user's transmission	No	Yes

Manufacturer: Microwave Modules, Ltd., Brookfield Dr., Aintree, Liverpool L9 7AN, England.

†mm = in × 25.4; kg = lb × 0.454

Talkback. The single-character mode is suitable for learning the Morse code while the 5- and 50-character modes are intended for drill and increasing your speed. Continuous group mode is useful for increasing speed when you're secure in your knowledge of the code.

The MMS1 and MMS2 can be used as code-practice oscillators (CPOs) when hooked up to a straight key or bug. The feature that distinguishes the MMS2 from the MMS1 is the former's ability to read what you've sent and tell you immediately thereafter what the characters were (and what you failed to send clearly!). In single-character mode, the MMS2 can recognize well-sent letters and numbers, and tell you what it heard after each character. Send an A and the unit will say, "A." Send a C and the unit will say, "C." Send a C with a poor, sloppy rhythm (N N), however, and you're likely to be told, "N." Send a punctuation mark, prosign, an incorrect character or gibberish and you'll hear an embarrassing 80-Hz tone, the unit's not-so-subtle way of telling you it didn't recognize what you sent.

In GROUP LENGTH 5 mode, you'll have to send five characters before the MMS2 tells you how well you've done. Each time the unit recognizes a new character, the next LED in the string of five on the panel lights. Note that what you might intend to be a C, for example, if sent with poor rhythm, will probably be read as "N N," two characters. When five characters have been recognized, the MMS2 sounds a 400-Hz tone, reads back what it has received, tells you your approximate speed in words per minute and sounds a second 400-Hz tone to signal that it's ready to receive another group.

In GROUP LENGTH 50 mode (the most useful for realistic drill once you've tuned up the rhythm of your sending), you must send 50 characters before you're told what the MMS2 has received. As each successive character is read, another of the five LEDs lights in sequence; recognition of 50 characters causes cycling through the five LEDs 10 times. A 400-Hz tone again signals completion, the 50 characters received are read back, your approximate sending speed is announced, and a 400-Hz tone tells you the MMS2 is again ready. Word spaces are also recognized and included in the Talkback. Should you wish to hear again what the fifty characters were, push the REPEAT button for another recital. Note that although the MMS2 can read speeds through 32 WPM, during Talkback it states speeds only through 20 WPM. Thus, whether you're a 20-WPM "steady striker" or a 32-WPM "speed demon," the MMS2 will say, "20 WPM."

The Advanced Morse Trainer (actually, its recognition algorithm) proved to be demanding, fair and impartial. Good Morse code timing and rhythm are required, but not necessarily machine-sent precision. Well-sent code is rewarded with immediate positive feedback; poorly sent code is negatively reinforced with what you'll soon come to feel is an obnoxious bleep. If you've never been told by a machine that your performance is inadequate (particularly embarrassing to the CW "ace" who tries his fist out on the MMS2 at a club meeting!), believe me, you'll be motivated to clean up your fist quickly.

The MMS1 and MMS2 perform reliably and meet the manufacturer's claims. Though the operation of the units is not intuitively apparent, the instructions are complete, clear and concise — easily learned in a few minutes. The RESET button immediately cured any strange problems that were encountered, and problems were rare. Shortcomings are trivial, consisting mostly of features I would like to see incorporated into the units. Neither unit has a volume control. In some situations, the audio from the internal speaker was too loud (late-night practice while others in the apartment tried to sleep); in others (noisy environment or for large groups), too soft. These situations can be accommodated by using headphones or an external audio amplifier and speaker — but a volume control would be a more convenient solution. The internal speaker is adequate but, as it is mounted on the bottom face of the enclosure, it is most effective when the unit is set unobstructed on a flat surface. Keying is good, and the Morse characters are crisp and well timed. The synthesized voice, which at first encounter sounded a little strange, soon became familiar. No one during the review had problems with the voice after the first 30 seconds of listening.

The only limitation of any real consequence is the lack of punctuation and prosigns. For all Morse code test elements in the U.S. (5-WPM Element 1A, 13-WPM Element 1B and 20-WPM Element 1C), they are required; moreover, these characters are often roadblocks to students simply because they're heard infrequently. Although Microwave Modules claims to cover only the 26 letters of the alphabet and 10 numerals, punctuation and prosigns would be a valuable addition.

The Microwave Modules Morse Talker and Advanced Morse Trainer are sophisticated, effective and novel Morse code instructors. ARRL Hq. staffers found the MMS2 transmission and Talkback addictive. Straight keys and bugs, long since forsaken for the latest in electronic memory keyers, were dusted off and put through their paces. Several people regained excellent fists immediately; a few others, however, after a rude awakening, kept coming back to scrape the barnacles off their long-idle straight-key fists. At a Murphy's Marauders (a New England contest club) meeting the proficient CW contesters left the MMS2 in the dust; those needing the practice (phone operators?) found the unit potentially useful. *Everyone* agreed that the MMS2's transmission and Talkback were a lot of fun. The moral of the story? The MMS1 and MMS2 are best suited to those who know code at slow speeds and want to upgrade, and the latter is an ideal way to improve less-than-32-WPM fists.

The MMS1 and MMS2 are available from Spectrum International, P.O. Box 1084, Concord, MA 01742, tel. 617-263-2145. Price classes: MMS1, $225; MMS2, $300. Shipping charges: U.S., $5.50; Canada and Mexico, $6.50; other areas, $7.50. — *Steve Place, WB1EYI*