

MORSE ACADEMY
OPERATION MANUAL
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Morse Academy is distributed to Radio Amateurs by
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Morse Academy is a Morse code teaching program incorporating Computer Aided Instruction (CAI) that is extremely useful in teaching the code. It is designed to help students who have no knowledge of the code or computers. Operation is simple with functions selected by a single key. Different sessions are provided to allow students to vary the way they learn the code. Testing is automated to allow the student to spend more time on learning, and less on the tedious task of checking the result of a session. Morse Academy includes:

- on-line HELP for each session (F1 key)
- option settings that can be saved on diskette or disk so they are not lost when power is turned off
- the ability to edit and sequence the character set used in all sessions
- the ability to generate random Novice, General, and Extra test sessions for practice
- the ability to create, save, and reload text for replay
- the ability for the student to input his copy via the keyboard during the Proficiency session and have it automatically compared with the generated text at the end of the session
- the ability to save all computer generated text for later printing (F10 key)
- the ability to select your own desired character weightings (frequency of occurrence of characters)
- the saving of the history of mistakes from the last Receiving Game for optional use in computing character weighting
- the optional ability to allow the Receiving Game to reorder the character set in worst-to-best sequence
- the optional generation of Morse Prosigns in contexts that helps a student understand their meaning
- the ability to adjust the code sending speed for the variances of different PC's
- support for ADLIB compatible music synthesizer cards, the Disney Sound Source Adapter, RS232 ports or an external tone generator via the printer port

Morse Academy's features help a student learn the code. Some are designed for instructors accompanying the student thru the short odyssey to code proficiency. Computer feed back while learning Morse code helps a student, so it is relatively painless with Morse Academy. But it's still true that some hard work is needed to learn the code. Developing copying skills takes an effort by the student and the devotion of time to the process.

If you have suggestions to improve Morse Academy, my contact information is:

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Installation on a Floppy Disk System

Before performing the copy operation you must format a new disk onto which you can copy Morse Academy. You do not need to make this a system diskette, but you may find it more convenient to have DOS on the same diskette when starting the system. The first time you use Morse Academy you should carefully follow the steps listed below. Afterwards you will only need step 3 to use the program. Follow these steps:

Step 1. Format a blank diskette

Put a new diskette in drive B. Then type either

```
A>FORMAT B:
```

or

```
A>FORMAT B: /S
```

depending on whether you want the MA diskette to have a copy of DOS or not.

Step 2. Copy the MA diskette to a newly formatted diskette

Replace your DOS diskette in drive A with the Morse Academy master. Put the newly formatted diskette in drive B.

```
A>COPY A:*. * B: <Enter>
```

Step 3. Execute Morse Academy

Remove the Morse Academy diskette in drive A and store it. Mount the new diskette with Morse Academy files copied on it (from drive B) into drive A. (MA will actually operate on any drive) Type the following to execute Morse Academy.

```
A>MA <Enter>
```

Follow the instructions displayed on the screen.

Installation on a Hard Disk System

The first time you use Morse Academy you should carefully follow the steps in this section. Afterwards you will only need Step 3 to use the program. There is the possibility of unforeseen problems. It is recommended that before starting you make a backup copy of the diskette to insure you always have a readable copy. Follow these steps to load MA onto drive C:

Step 1. Create a Directory to hold Morse Academy

```
C>C: <Enter>      (make sure you are on drive C)
C>CD\ <Enter>     (make sure you are in the root directory)
C>MD MA <Enter>   (create the MA directory)
C>CD MA <Enter>   (change to the MA directory)
```

Step 2. Put the MA diskette into drive A and copy all its files to the hard disk

```
C>COPY A:*. * C: <Enter>
```

Step 3. Execute Morse Academy

```
>CD\MA <Enter>
>MA <Enter>
```

Follow the instructions displayed on the screen.

Operation under Windows 3.1

If MA is executed as a DOS program under Windows, it should run in EXCLUSIVE mode. MA depends on the system timer and doesn't share resources well with other programs. Operating MA in normal foreground mode will cause it send CW with incorrect timing and/or key clicks.

The file MA.PIF is included with MA files. Using the Program Manager create an icon referencing MA.PIF. Clicking on this icon will correctly execute MA.

Operation under Windows 95/NT

MA can be executed as a DOS program from the DOS Command prompt. A shortcut to MA is created as follows:

- Step 1. Click the right mouse button with the cursor located in a blank area of the desktop screen.
- Step 2. Select NEW, then SHORTCUT
- Step 3. Use BROWSE to change to the MA folder and double click on MA.EXE.
- Step 4. Select NEXT and then FINISH to complete the process.

Windows NT does not allow modification of clock interrupt timing, a feature used by MA to provide accurate timing of CW. (Using the X option under DOS, allows speeds up to 100 wpm to be accurately timed). However Windows NT only supports standard DOS clock timing. Under Windows NT, MA should ONLY be executed using the /1 option:

```
MA /1
```

With Windows NT, the /1 option can be added to a short cut by modifying the shortcut properties.

- Step 1. Click the right mouse button with the cursor located OVER the MA shortcut ICON.
- Step 2. Select the PROGRAM page
- Step 3. Select add the to "cmd line:", and edit with keyboard
MA.EXE /1
[Note one space before the /1 option is mandatory]
- Step 4. Select APPLY, then OK

The same process can be used to add a student's name to the "cmd line:", e.g.

```
MA.EXE /1 joe
```

Individual ICON's for students can be created using the above processes.

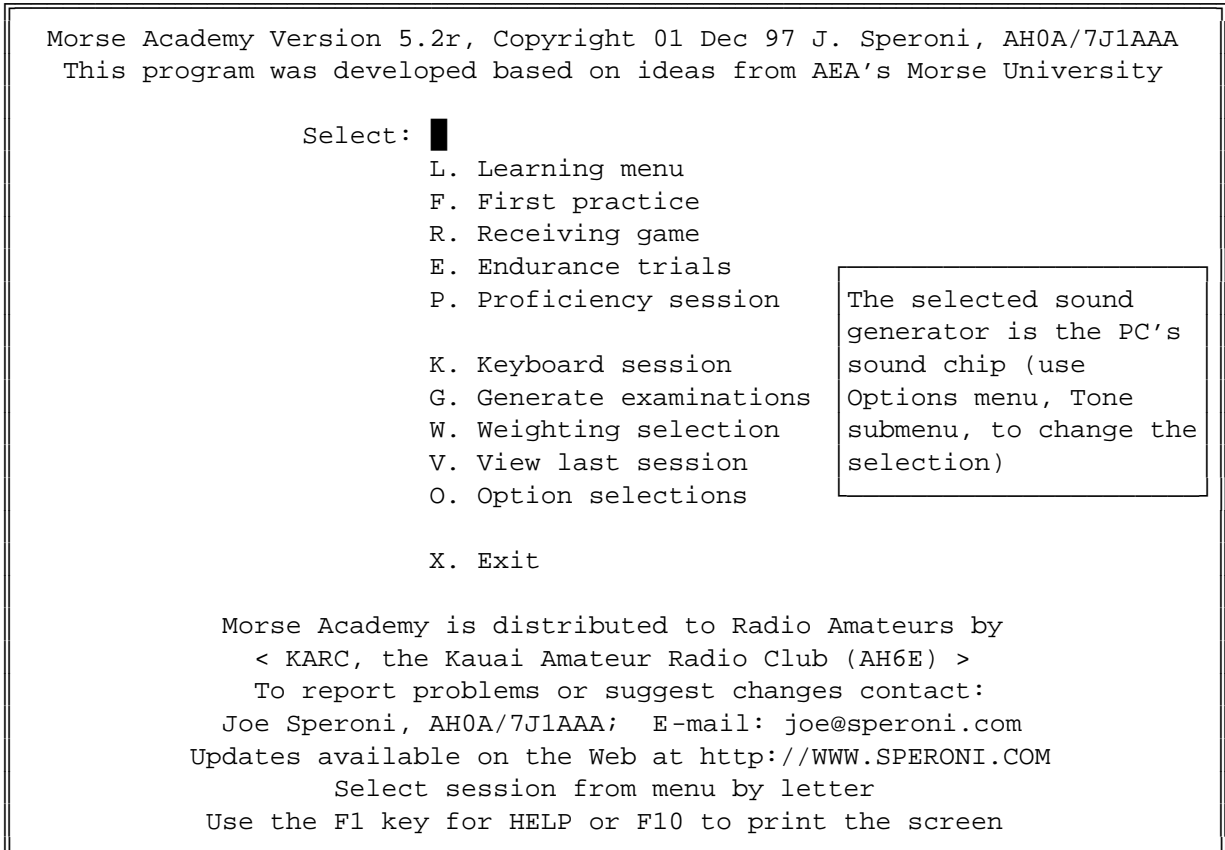


Figure 1. Morse Academy Main Menu

Morse Academy is based on Computer Assisted Instruction concepts from AEA's Morse University. The author thanks AEA, a company dedicated to support of amateur radio, for their help and encouragement in developing this program.

Operation is menu driven with a single key selecting the desired session:

(L)earning:	Selects characters, and provides a learning mode.
(F)irst practice:	Sessions to first introduce the code to students.
(R)eceiving game:	An interactive game to teach the Morse code.
(E)ndurance game:	An interactive game to increase copying skills.
(P)roficiency:	Generates actual code tests to improve skills.
(K)eyboard:	Used to send Morse practice text from disk files.
(G)enerate examinations:	Creates random tests for practice and testing.
(W)eightings:	Varies the frequency of occurrence of characters.
(V)iew sessions:	Displays prior session results.
(O)ptions:	Options for of tone, screen colors, etc.
e(X)it:	Proper way to terminate and SAVE CHANGED OPTIONS.

The ESC key serves as a STOP RUN key. Push it to return from a sub-session to a session, and again to the main menu. The ALT key is a European shift key, shown on the last of the screen of some menus as an UP-ARROW.

The F1 key can be used AT ANY TIME to display HELP. F10 prints the screen. A short help prompt is ALWAYS shown at the bottom of screens.

Morse Academy will support multiple students, and remember option settings for each. Separate OPTIONS and LOG files are maintained for each student. The student name is typed on the command line when executing MA:

```
MA      student_name
```

The student name can contain lower or upper case alphabetic characters and spaces. Lower case characters are treated as equal to their corresponding upper case character. If a new student name is typed, MA will give you the option to enter the new name into its student list, or exit from the program.

An existing student can be deleted using the D option:

```
MA/D    student_name
```

If the name is not registered, the request is rejected and MA exited. If registered, the student will be asked to confirm deletion before the name is removed from the active list, AND THE OPTIONS AND LOG FILES ARE DELETED. (DOS 5's UNDELETE command can restore them if they are mistakenly deleted).

MA assumes WPM inputs are single digits for 5, 6, 7, 8, or 9 WPM. The X option changes all inputs to be two digits to permit speeds up to 99 WPM.

```
MA/X
```

Use cursor keys (↑ or ↓) and INS/DEL to select and unselect characters
Hold INS/DEL key and use the cursor keys to select a block of characters

ARRL Standard Character Set

1 A	17 M	33 SK [+]
2 E	18 P	34 1
3 R	19 G	35 2
4 N	20 F	36 3
5 AR [*]	21 ,	37 4
6 T <Ins	22 W	38 5
7 I	23 B	39 6
8 O	24 BT [=]	40 7
9 S	25 J	41 8
10 D	26 /	42 9
11 H	27 K	43 0
12 C	28 Q	
13 U	29 X	
14 Y	30 V	
15 .	31 Z	
16 L	32 ?	

L. Lesson number 1
C. Character speed 18 WPM

Select options, ENTER to activate keyboard, or ESC to return to main menu

Figure 2. Learning Menu

This menu allows students to choose the characters they wish to learn. This can be done by typing the letter L followed by the lesson numbers to be learned (type the same number twice to select only one lesson). You can also include or exclude characters by using the INSERT or DELETE keys and moving the blinking cursor using the DOWN or UP cursor control keys. Characters selected have their two digit numeric sequence number shown in reverse video.

The character set and their order can be modified using Selection and Edit commands in the main menu (O)ption selections.

The (C)haracter speed key sets the average speed characters are sent. Morse Academy is set to send at a relatively fast character speed. The default character speed of 18 WPM is a good choice for students aiming for a code speed of 13 WPM. This may seem fast, but learning the individual characters at this rate with pauses between them makes it easier to progress. At faster average sending rates the character speed remains the same but the pauses between them shortens.

The ENTER key activates the keyboard and allows a student to associate a single keyboard key with the Morse code sound for it. Students can use this as another way to become familiar with characters as they are added to the practice sessions.

The Learning menu is the only one that controls the number of characters being learned. This selection applies to all sessions.

Quick keys can be used to select frequently used subsets, e.g. the alphabet, numbers, prosigns, etc. These keys are (E)rase all selections, (A)lphabet, (N)umbers, (P)unctuation, and (S) for pro(S)igns.

The ESC key can be pressed while in the keyboard activate mode (started with the ENTER key) to return to the Learning menu and a second time to return to the main menu.

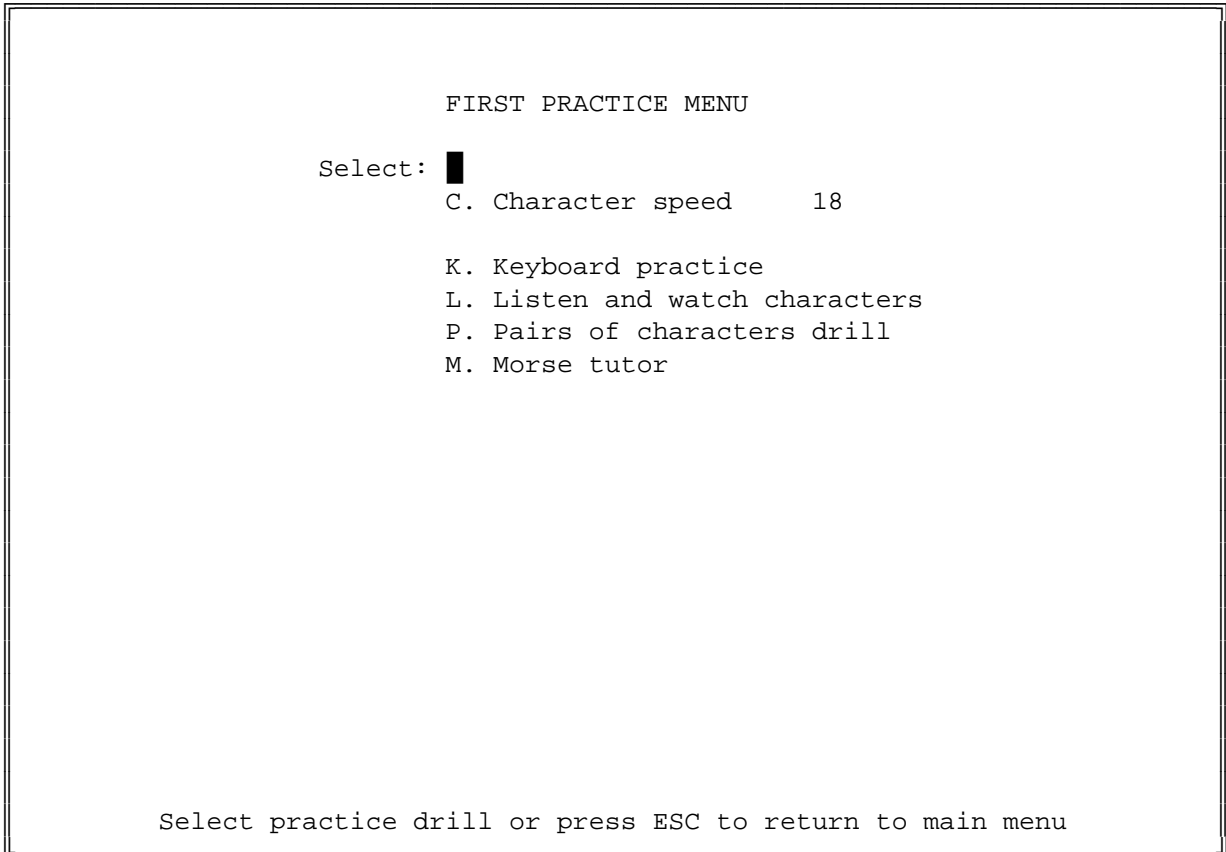


Figure 3. First Practice Menu

The First Practice session allows a new student to experiment or practice in various ways while learning the individual Morse characters. Four different ways of exploring the code are provided.

The (K)eyboard selection activates the keyboard and allows a student to associate a single keyboard key with the Morse code sound for it. Students can use this as another way to become familiar with characters as they are added to the practice sessions.

(L)isten and watch causes each character to be sent 4 times and displayed in full screen format. At first display occurs prior to sending the character in Morse code, with the time being decreased with successive repetitions. Characters being learned are sent in a random sequence, with the entire set being repeated until the session is terminated by ESC.

The (M)orse Tutor allows a student to practice his keyboard skills by having the computer send single characters and waiting until he responds on the keyboard. If correct, the next character is sent immediately. If not a short low tone is sounded and the character is re-transmitted. During this session the student should make an effort NOT TO LOOK at the keyboard. Use of a blindfold while a bit extreme, is recommended. Morse Tutor will help develop typing skills in combination with copying code, if an effort is made not to watch the keyboard.

The (C)haracter speed key selects the individual character transmission speed, and the (W)eight key the character weighting. The (D)isplay option allows selection of the transmitted text either "Before" it is sent or "After". If the "Before" option is selected, the character is displayed before transmitting the character for the time required to send a space between words. Errors are displayed using reverse video. The display can be disabled during transmission by setting this option to "Off".

The session starts after pressing the ENTER key and can be ended at any time by pressing ESC.

At the end of the session, the text sent is displayed and a summary of the student's reaction time in pressing the key for each character is given in milliseconds (thousandths of a second). By practicing keyboard skills the student can improve reaction time and improve performance in other sessions.

In (C)haracter pair drills character pairs that sound alike are constructed from the set being learned. The entire set of practice pairs is displayed and using the cursor keys the student can select one particular pair, or review them in sequence.

A drill begins by pressing ENTER. A full screen display of each character being reviewed is displayed three times. After this by pressing ENTER the student can practice the two characters for as long as he likes taking as long as he wishes to respond to each character. A correct answer will result in a message "correct, right, or yes" being displayed in the center of the screen and a short high pitch tone. An incorrect response causes the missed character to be displayed in full screen format, a long low pitch tone to be sounded, and then the repeat of the character in Morse code.

Once the student is comfortable with a given pair he can move to the next by pushing ESC. Morse Academy remembers the student's progress, so practice can be suspended and resumed at a later time.

Note ANY change to the selected character set (addition or deletion of characters) will cause the drill to restart at the beginning.

RECEIVING GAME

Select:

S. Starting speed	5 WPM
F. Final maximum speed	8 WPM
C. Character speed	18 WPM
D. Duration of game	3 Minutes
R. Resequencing	Off
U. Use	Fixed length groups
W. Weighting	Text
G. Group length	1

AR * SK + BT =

Select options, press ENTER to start, or ESC to return to main menu

Figure 4. Receiving Game Menu

The Receiving Game is an interactive game that allows a student to practice code by listening to a random group of 1 to 9 characters, typing the characters on the keyboard, and having the computer check if he or she is correct. If correct, a short high pitch tone is emitted. If wrong, a long low frequency tone sounds, the correct answer is displayed in the center of the screen with an indicator showing the character that caused the error and the incorrect student input displayed below it. This feedback allows students to learn characters thru repetition and correction.

The number of different characters used during the game is determined by the Learning menu. For the first Receiving Game, use the Learning menu to select just a few characters, say three. Then enter the Receiving Game, and select the (S)tarting speed, (F)inal maximum speed, (C)haracter speed, (D)uration of game, (W)eighting, and (G)roup size as desired before starting a game.

The (S)tarting speed key selects the initial average speed of the text sent. For every twenty correct responses the average sending speed is increased by one WPM, up to the (F)inal maximum speed.

The (C)haracter speed key selects the character speed. Morse Academy is designed to send characters relatively fast. The default character speed of 18 WPM is a good choice for students aiming for a code speed of 13 WPM. This may seem fast, but learning individual characters at this rate with pauses between them makes it easier to progress. At faster average sending rates the speed of characters remains the same but pauses between them shorten.

The (D)uration key sets the length of the session from 1 to 9 minutes.

The (U)se key selects sending of either fixed length random character groups, or short English words frequently used in CW QSO's. For new students random character groups is the recommended mode. Later, practice learning words at high speeds will give the student the ability to hear a word like a single character. [See (P)roficiency session for a explanation of the WORDS file].

The (W)eight key selects different frequency patterns of sending of characters. This allows the student to control the frequency of repetition of characters to stress those requiring more emphasis.

Random: Random weight (each character having the same frequency).
Text: Text weighting with the vowels occurring more frequently.
History: Characters missed in last Receiving Game are sent more frequently.
Student's: Student selected weighting.

Use the main menu (W)eighting session to display these selections graphically and to create a student's desired weighting.

The (G) size is the number of characters sent by the game in sequence without spaces between them. The size can be set for from 1 to 9 characters.

Values of 5 and 18 WPM, and 1 character groups are good choices for beginning students.

Start the game with the ENTER key and it will randomly generate the letters A, E, R, N, T, or the Prosign AR (If you have started with Lesson number 1). Continue to play the game until you're comfortable with these characters. With only a few characters, the character's sound and their position on the keyboard are quickly learned. The number of characters can be increased by adding a few each day. In just a few weeks the student will know all the characters and their positions on the keyboard.

A total of right and wrong answers is constantly updated on the screen and the score and time remaining shown as a bar graphs. The session ends when the duration expires, but it can be ended early by depressing ESC. The program signals completion by sending the Prosign SK (End of Final Transmission).

At the end of the game, the characters sent during the session are displayed on the screen, in order of the worst result. Each character is displayed with the number of incorrect responses, and the number of times the character was correctly copied. For example "F <4,11>" shows the student missed the letter F 4 times and copied it correctly 11 times. This allows the student to review the session and find which characters need more work.

The results of a Receiving Game can be used to re-sequence the characters in the Learning menu. Use the (R)esequence key to select this option. If this option is selected and the Learning menu is displayed after a full game is played, the characters will be displayed in order by the worst character, giving the student a history of the characters causing the most trouble.

Another important function of the Receiving Game is its remembering weightings corresponding to the characters missed during the game. The Weighting option in all menus can be used to select the HISTORY weighting. Selecting HISTORY weighting will allow the student to repeat troublesome characters requiring practice.

NOTE: Resequencing and historical weighting occur only if the receiving game goes to completion, i.e. the ESC key is NOT used to terminate early.

After the student is comfortable with single letters, but early in his training, the group size should be set to 2 (and later 3 and higher), so memory (copying behind the text) can start to be developed. This can not be over emphasized. Skills in copying depend very much on getting confidence in copying longer sequences.

Mix sessions between the Receiving Game and Proficiency testing to develop the ability to write characters as well as input them on the keyboard. When the Receiving Game becomes too easy try switching to the Endurance Trials to get practice in copying long character sequences without an error. Students can adjust the mix of sessions to match free time and the pace of learning. You should make an effort to spend at least 30 minutes every other day practicing. With only a little effort Morse code skills will come easily.

Endurance trials send characters or words continuously until the student errors. The (S)tarting, (F)inal maximum speed, and (C)haracter speeds can be set before each session. The (U)se key selects the mode desired. Code is sent as continuous random characters, in random length groups of random characters, or as short English words. The (W)eight key selects the desired weighting. Use the ENTER key to start the session. A complete session is fourteen trials but it can be ended at any time by pressing ESC.

During a trial the number of characters received correctly is continuously displayed. At the end of a trial the characters sent just before an error are displayed, followed by a character in reverse video showing the expected correct one that caused the trial to stop. During an Endurance trial the reason for an error is often not the last character sent, but one of those preceding the error. A character that causes the student to pause and think can be the real reason for an error even if it is correctly copied. So much time passes trying to recall a problem character that even a simple one following will be missed. Examining the characters preceding the error will give the student information about the characters requiring more work.

The computer displays the incorrect response in reverse video in the last column (either the character input or the phrase TIMED OUT indicating a failure to respond within the time allowed.) The expected character is also shown in reverse video. By comparing the reverse video columns and examining preceding characters, the student can determine the reason for the error.

For every 20 correct inputs, Morse Academy increases the sending speed by 1 WPM up to the (F)inal maximum speed so the student is made to advance. This challenge helps develop skills. Don't be concerned with the mistakes made when using the Endurance session. Mistakes are a natural part of learning.

A candidate for an FCC Amateur Radio license can copy one minute of code without error as an alternative to passing a quiz on the contents of a Morse transmission (70% is required). This game will help you perfect the skills to do that. To pass in this way a candidate would have to copy:

5 WPM	-	25 characters
13 WPM	-	65 characters
20 wpm	-	100 characters

Prosigns, punctuation, and numbers count as two characters when you sit the real examination. You have an advantage when copying the English text of a QSO style examination. Before submitting your test paper, you can go over the text and correct obvious errors from context, e.g. TSE RIG to THE RIG; CLEVELAND, O5IO to CLEVELAND, OHIO.

The Proficiency session sends character groups at selected speeds. This type of practice simulates actual text transmissions.

The (S)tart key sets the starting average speed of sending, the (F)inish key the final maximum speed, and the (C)haracter key the character speed. The character speed can't be set to a value less than the start or final speeds. When the character speed is set greater than the average sending speed, the timing between characters is adjusted, as needed, to maintain the desired average speed. The current average text speed, and elapsed time are constantly displayed during the session.

The (U)se key selects from four different modes:

The student can have fixed or random length code groups of random characters transmitted. The (G)roup length key selects the number of characters in each group in the first case, and the (W)eighting key from four possible character weightings - RANDOM, TEXT, STUDENT'S, AND HISTORY.

A third (U)se mode sends short English words. As a student advances, learning whole words at high speed can develop the ability to copy code as if it were a spoken language, recognizing words from the pattern of characters. One word students first learn to recognize this way is "THE". To develop this skill practice at high characters speeds. The words randomly selected by MA are in the file WORDS, separated by spaces (or any number of delimiters less than space). The file can be edited using the DOS editor. (maximum 2000 words).

For the above (U)se modes, the (D)uration key selects the length of the session and can be set from 1 to 9 minutes. If the start and final speeds are different, the session duration is divided into equal periods (the number of periods is Final-Start+1). The average code speed increases by 1 WPM after each period.

The last (U)se mode sends simulated QSO code tests from the Morse Academy files. When in this mode press ENTER to display the list of files. The cursor keys can be used to select the file to be loaded by positioning the reverse video block over the file name and pressing ENTER to select it. Starting the session with the ENTER key will cause the file's text to be sent. If one of Morse Academy's generated test is selected, a ten question fill-in-the-blank test and key can be printed out from the (G)enerate test session. (See the Generation session information for more details).

Code transmission begins when the ENTER key is pressed. It ends with the transmission of the Prosign AR (End of Transmission).

The student can copy the text on paper and compare the results displayed at the end of the session, or input directly on the keyboard and have the computer display both texts at the end of the session.

If the student inputs copy on the keyboard (rather than writing it on paper), at the end of transmission MA gives an opportunity to correct the text before comparing it to the computer generated text. This is what a student could do during an actual examination. The text input during transmission is displayed on the screen, and a prompt invites the student to edit it.

The active editing keys are the same used with the keyboard program: BACKSPACE, the cursor control keys UP ARROW, DOWN ARROW, RIGHT ARROW, LEFT ARROW, HOME, END, PAGE UP, and PAGE DOWN. The DELETE key functions to remove a character. The INSERT key toggles between insert and overlay modes. The insert state is shown in the upper right hand corner of the screen during editing. Editing is ended by pressing the ENTER key causing a comparison of the student's input text (as corrected) against the computer generated text.

Morse Academy compares the student's copy with the computer generated text, and shows differences in reverse video. Missing characters in the student's copy are shown as a "~". The texts are displayed on pairs of lines with the student's copy below the computer's. The compared text can be printed (use the F10 key) with blank lines inserted after each pair to allow easier manual comparison. Screen reverse video (the differences) is shown by printing a character "-" underneath each line pair.

The Proficiency session can be stopped at any time by pushing the ESC key. Parameters can then be changed and the session restarted or ESC pushed a second time to return to the main menu.

The keyboard session allows actual text to be prepared and sent for practice. It is possible to edit, save and reload text to and from diskette or hard disk. The function keys F2 thru F9 select program options.

F2 will toggle the keyboard between EDIT and SEND states. In SEND state the text on the screen will be sent in Morse code. Once the last character is sent (marked by the small square character at the end of the text), transmission ends. At any time during transmission of the code, pressing F2 causes sending to be suspended, and the EDIT state entered. If the Prosigns option (in the Options menu) is "On", whenever the program enters the Edit state it sends the Prosign AS (wait) to show suspension of code transmission. The cursor position displayed is the next letter to be sent. Pressing F2 again returns to the SEND state and causes code transmission to resume where it left off.

As a memory aid for the operator, line 23 is used to display the keys to send the Morse Prosigns. For example " AR * " means that the Prosign AR is sent using the "*" key on the keyboard.

The program MUST be in the EDIT state to use the F3 thru F9 program options. NOTE - the default mode is EDIT mode; you can only enter SEND mode by pressing F2 when in EDIT mode.

F3 allows the average speed of transmission to be set in words in minute.

F4 allows the character speed of code transmitted to be set in words per minute. If the speed selected is faster (it can't be slower) than the average code speed, delays are inserted between characters to cause the effective transmission speed to be equal to the average speed selected by F3.

At the end of the message, the elapsed time is displayed on line 22 along with an equivalent characters count (numerics, punctuation, and prosigns count as two characters). This information is used to compute and display the effective sending speed, i.e. $WPM=10*(Count)/(Seconds)$.

F5 clears the screen to allow the start of input of new text.

F6 allows the loading of previously saved text. Pushing the key displays a complete list of all saved files, and provides a prompt at the top of the screen requesting the name of the file to be loaded. If the file is available, the screen is cleared and the stored text displayed.

F7 allows the saving of screen text for later recall. If overwriting of a previously saved file is requested, the operator is given the opportunity to confirm that overwriting is desired.

F8 allows files to be deleted from the directory. The DOS file name wildcards * and ? can be used to delete groups of files. Deleting a .KB file will automatically cause the corresponding .TST and .KEY files to be deleted.

F9 displays character statistics and estimated time for the text displayed.

If you wish to add your own ASCII files, just copy them to the your MA diskette in the same sub-directory with the other .KB files, making sure that each file has an extension of ".KB". Morse Academy will automatically add them to its directory at the start of execution.

In EDIT state the following editing keys are active:

UP	- cursor up one line	DOWN	- cursor down one line
PAGE UP	- cursor to previous line	PAGE DN	- cursor to next line
LEFT	- cursor left one character	RIGHT	- cursor right one character
HOME	- cursor to home position	END	- cursor to end of text

The ENTER key inserts an end of line symbol (small triangle) at the cursor position and erases the remainder of the line.

The INSERT key toggles the keyboard mode between INS (insert) and OVR (overlay) states. The state is displayed on the right of line 24 of the screen. In OVR state input from the keyboard replaces text on the screen. In INS mode it is inserted into the text and the screen text scrolled to the right to allow space for the inserted character.

It is possible to embed in the text, information about the average speed of code to be sent and the character speed to be used during the transmission. This is done by preceding the text with a string of the form "<w,c,f>", where w is the average sending speed, c is the Farnsworth character speed. For example "<5,18,850>" causes the text to be sent at 5 WPM, with a character speed of 18 WPM, and at a tone frequency of 850 Hz. (either a colon ":" or comma "," can be used as a delimiter).

ESC ends the keyboard session and returns to the main menu.

Current generation parameter values			
Exam class	Novice	General	Extra
Element No.	1A	1B	1C
File Prefix	92-1A-	92-1B-	92-1C-
First test	01	01	01
Last test	20	20	20

Select: █

1. Group 1 default file element names (5 tests of each type)
2. Group 2 default file class names (10 tests of each type)
3. Group 3 default file year-element names (15 tests of each type)

C. Clear all file name and test number selections
E. Edit file names and test numbers (screen parameters only)
P. Print all tests and keys (1 copy of each)
S. Select one test for printing

Press ENTER to start test generation, or ESC to return to main menu

Figure 8. Generation menu

This session is used to generate files in the form of an QSO similar to the actual required FCC test. Three separate files are produced for each test generated: (1) a .KB file for direct use by the (P)roficiency or (K)eyboard sessions to send a test, (2) an ASCII .TST file for the written fill-in-the-blanks examination, and (3) an ASCII .KEY file for the key to be used in grading the examination. The ASCII files can be printed using this session or directly using DOS commands.

To simplify test generation three default groups are provided to generate tests with canned file names and numbers. Type 1, 2 or 3 to select the default naming:

Group	Novice	General	Extra
1	1A-01 thru 1A-15	1B-01 thru 1B-15	1C-01 thru 1C-15
2	NOVICE0 thru NOVICE9	GENERAL0 thru GENERAL9	EXTRA0 thru EXTRA9
3	92-1A-01 thru 92-1A-20	92-1B-01 thru 92-1B-20	92-1C-01 thru 92-1C-20

Pressing the (C)lear key cause all file names and numbers to be cleared.

The (E)dit key allows arbitrary file names and sequence numbers to be created for all classes of examinations. The cursor keys, the DELETE, and BACKSPACE key can be used for editing. The TAB or ENTER keys end editing for the current key. Pressing ESC terminates editing and adjusts the selections for a maximum name length of 8 characters (prefix plus number).

Pressing ENTER starts test generation. The process is rather complex and can take many seconds for each test. If the files names are the same as a previous generation, those tests will be overwritten and lost. DOS commands can be used to save those files and/or change their names. Generation can be terminated at any time by pressing ESC. The tests already generated will be saved.

The (K)eyboard program has a delete command (F8) which allows DOS wildcard symbols * and ?. Groups of tests can be deleted using these symbols, e.g. using the file name 1C* will delete all Extra class examinations (from default group 1); the file name 92-1C-1? will delete the files 92-1C-10 thru 92-1C-19 (from default group 3).

The (P)rint key causes all tests and keys to be printed. These are the ASCII text .TST and .KEY file extensions associated the .KB files. The .KB file is intended for use by Morse Academy to send the code and is not printed. These ASCII files can also be printed using the DOS PRINT command.

The (S)elect key allows the printing of a single test. After selection of the test to be printed, the operator can select the number of copies of the test and key to be printed.

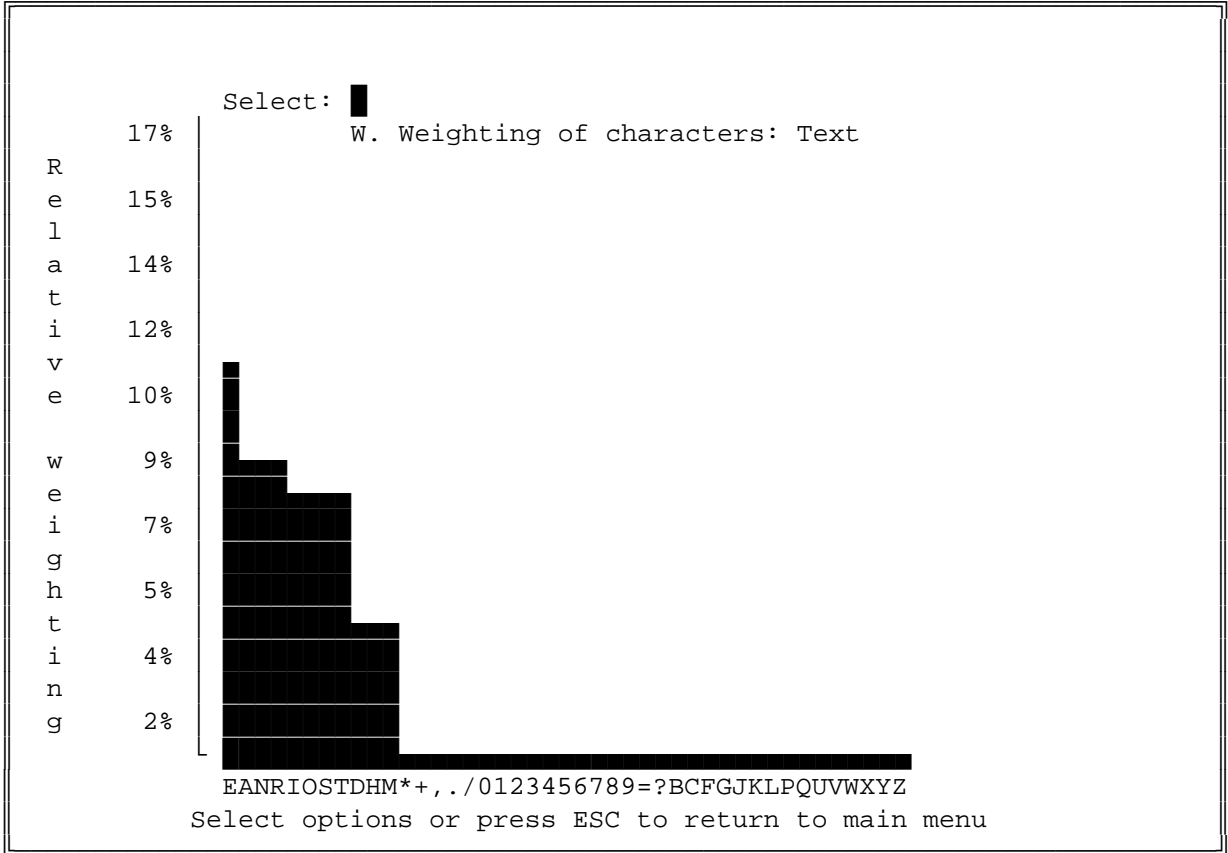


Figure 9. Weighting Selection Menu

The Weighting selections session allows the graphical display of characters by frequency of occurrence for the selected weighting. It also permits the student or instructor to set his own weightings to emphasize particular characters within the text sent.

The (W)eight key selects different frequency patterns of sending of characters and displays the result graphically. The graphical display is useful in helping the student visualize the effect of weighting on the frequency of transmission.

Weightings allow the student to control repetition percentages of characters to stress those that require more practice. Each time the key is pressed one of following four options is successively selected and graphically displayed:

- Random - the character weight will be random (each character having the same probability of being sent).
- Text - the character weight approximates that of English text with the vowels occurring more frequently. (This will cause the average speed to increase since these characters are short in Morse code.)
- History - the characters missed during the last complete Receive Game will be sent more frequently.
- Student's - the character weight set by the student will be used to control the frequency of selection.

When the Student's option is selected, three additional functions are provided to allow setting character weightings. These are:

- (I)nitialize - sets character weightings equal so all characters have an equal chance of being selected, i.e. random selection.
- (+) - requests the input of characters whose weightings are to be increased.
- (-) - requests the input of characters whose weightings are to be decreased.

The algorithm used to select weightings assumes the selected characters will be sent 67% of the time while the others being learned will occupy 33%. If only one character is selected it will be sent very frequently - two-thirds of time! If six characters are chosen then each will be sent 11% of the time and the remaining letters will be sent 33% of the time.

Weightings are displayed graphically so the student has a pictorial representation. The characters being learned are displayed as a bar graph showing the frequency of selection vertically by character horizontally.

ESC can be pressed while in (W)eighting edit mode to return to the sub-menu and again to return to the main menu.

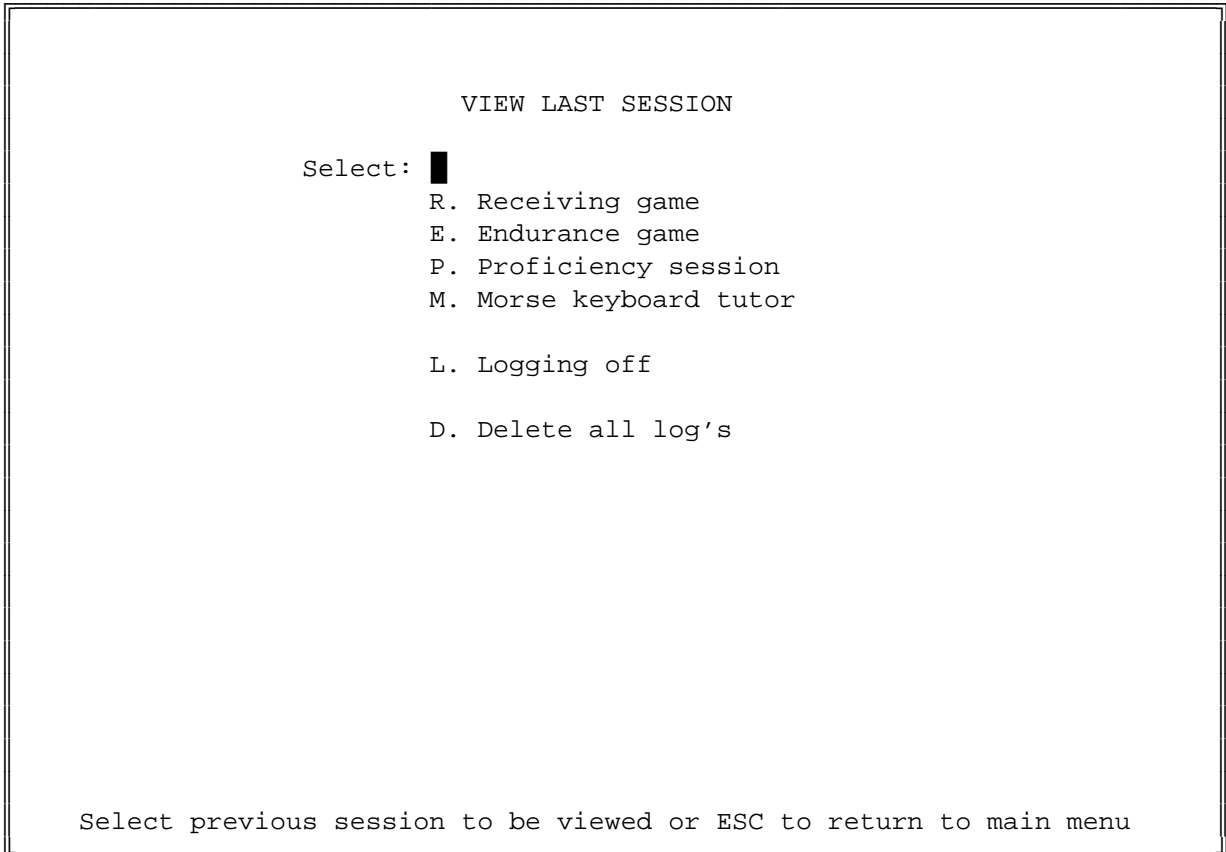


Figure 10. View Last Session Menu

Morse Academy remembers the text and statistics generated for the last (R)eceiving game, (E)duration, (P)roficiency, and (M)orse keyboard tutor sessions. The View menu allows the student to recall these previous sessions of computer generated code for review or printing.

Note that the total history log is cumulative and use over a long period will take up a lot of disk storage (even more critical for diskette only systems). Periodically you should use the File commands in the Option menu to copy the historical log to a diskette (for review by your instructor) and/or to clear it. If you know DOS commands you can do this directly by operating on the files LOG- α .VW, where α is R, E, P or M for the respective sessions.

The (L)ogging option allows the student to disable all logging, to select logging for the last session only, or to save each session in a cumulative log. Press "L" to cycle thru the three options.

The (D)elete option deletes ALL log history. Prior to executing this command Morse Academy will ask for confirmation of the command. Press ENTER to delete the log's, or ESC to cancel the command.

You can press the F10 key at any time to print the screen contents and save it for later review.

Pressing ESC at any time will cause Morse Academy to return to the main menu.

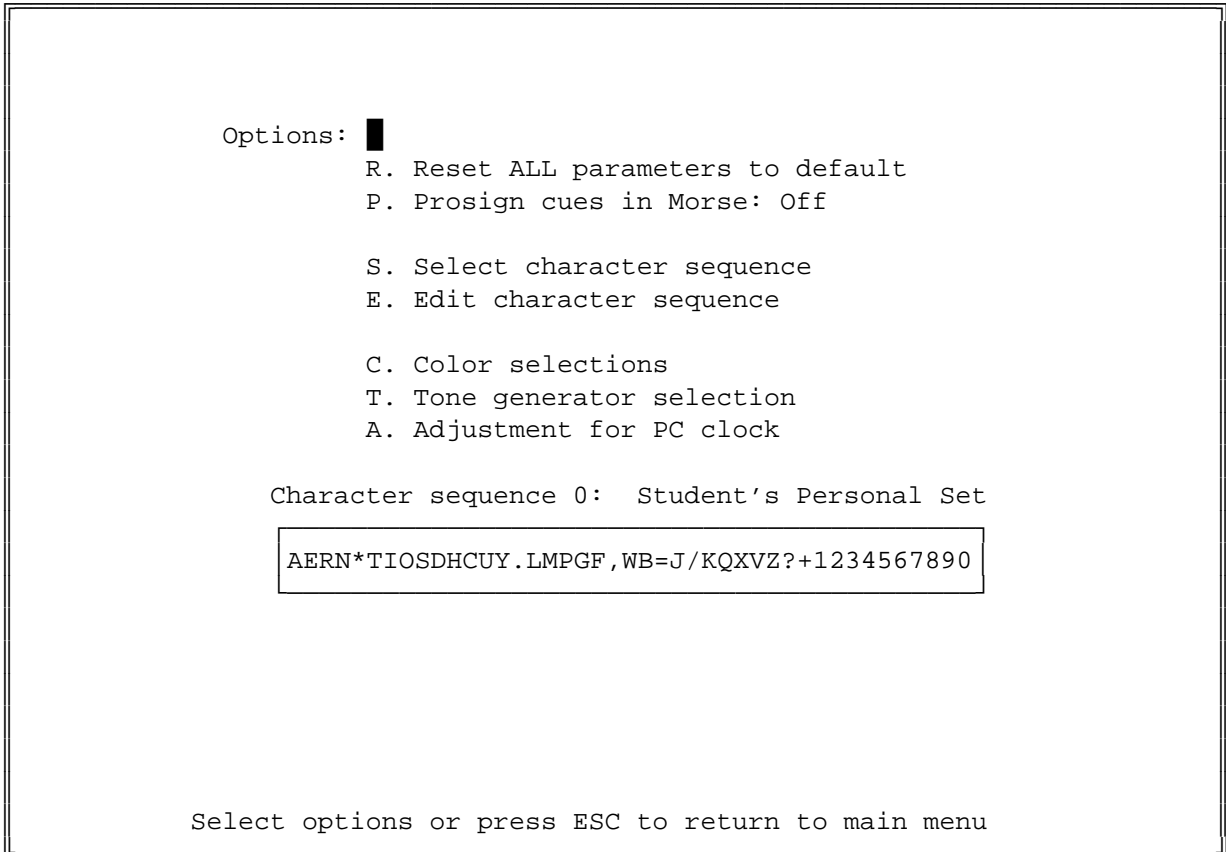


Figure 11. Option Selection Menu

The (O)ptions session allows the student or instructor to tailor parameters to make the sessions more effective. The default options supplied with Morse Academy are thought to be best for a new student so it is not necessary to use this session. But as students progress they may wish to learn about the options available, so they can adjust the program to their needs.

The (R)eset key causes Morse Academy to set all parameters to their default values for a new student. Prior to execution, confirmation is requested.

The (P)rosign Cues option allows the generation or suppression of Morse Prosigns automatically generated by Morse Academy to cue operation of the program.

By setting this option "On", the student can be introduced to the use of Morse prosign cues in a context that helps learning. For example MA will send K (go ahead) whenever the main menu is entered, BK (break) and BT (pause) during display of the HELP menus, and AR (end of transmission) or SK (final transmission) at the end of testing sessions. To allow easy identification the Prosigns are sent with a note 100 Hz higher than the code transmission. If it causes confusion to newer students, it may be preferable to suppress all Prosign usage. This can be done by setting the option to "Off".

The context options are:

- returning to the main menu causes sending the Morse letter "K" (Go ahead).
- entering HELP using the F1 function key or exiting it is cued by the Prosign "BK" (Break).
- Help continuation cued by the Prosign "=" (double dash, meaning pause).
- the suspension of sending of text during the Keyboard session (toggled with F2) is cued by the Prosign AS (wait).
- the completion of the Receiving game, Endurance and Proficiency sessions, and the Morse Keyboard tutor sessions are marked by the Prosign AR (End of Transmission).
- incorrect input or an input requiring confirmation causes "?" to be sent.

The (S)elect Character Sequence key allows the character set to be selected from those provided with the program. Repeatedly pressing this key will select from four different sets. The set number currently selected is displayed just above the box containing the sequence. The sequences are:

- Sequence "0" is your personal sequence that can be edited as you desire.
- Sequence "1" is the ARRL recommended sequence.
- Sequence "2" is the Morse Academy recommended sequence.
- Sequence "3" is the complete Morse Academy code set, including the special European characters rarely heard on the U.S. amateur bands.

When ESC is pressed, the character set being displayed will be copied to set "0" (your personal set). Be careful to select the set you want before ending this sub-session or you may have to reedit your personal set.

The (E)dit Character Sequence menu allows you to change the character sequence.

The active edit keys are:

HOME - sets the cursor to the beginning of the character string
END - sets the cursor to the end of the character string
LEFT - the cursor LEFT arrow key moves left one position
RIGHT - the cursor RIGHT arrow key moves right one position

If any character (contained in the string) is typed, it will first be sent in Morse to confirm the selection, and then inserted into the string at the position of the cursor with the remaining characters being re-sequenced as required. This allows the character string to be set in any desired order.

When you are finished editing and the sequence of the string is acceptable, press ESC to return to the sub-session menu and again to return to the main menu. The edited sequence will then be permanently stored in your Personal Sequence "0".

The (C)olor option allows setting colors for displaying Morse Academy's menus. Depending on your PC's display controller, up to any of 16 colors can be assigned to the characters, background, or the prompt line (bottom on the screen). The program will not allow the same value for characters and background since the text would not be visible.

The (A)djust option allows compensation for any inaccuracy in the PC's internal clock, which controls the code speed accuracy. It provides a means to increase or decrease an adjustment factor for the code speed. For the best results, use of a highly accurate external timepiece is recommended. The word PARIS sent 5, 10 or more times, can be timed to determine the accuracy of your PC corrected by the clock adjustment factor. Sub-menu options to adjust the clock are:

(↑) Increase sending speed (S) Sending speed input
(↓) Decrease sending speed (C) Character speed input
(T) Transmit PARIS five times

At completion of sending the PARIS message with the (T)ransmit key, a short high pitch (1800 Hz) note is sounded. This can be used to signal completion when doing timing with an external timepiece.

The (T)one generator option supports seven sound/signaling generators: the PC's internal sound generator, Morse Academy's external tone generator, an ADLIB compatible music synthesizer card (which includes the SoundBlaster series), the Disney Sound Source adapter (can be connected to either LPT1 or LPT2), the Tandy PC sound generator, and a visual signaling generator (screen blinking). Others may be added upon request from users. One of these is selected by typing the letter A through G shown in front of the description of the supported sound generator.

Selecting one of the generator's displays a sub-menu with options to control the tones generated. The active keys are:

- | | | | |
|-----|-------------------------|-----|-------------------------------------|
| (+) | Increase the tone 10 Hz | (V) | Selects session initiated |
| (-) | Decrease the tone 10 Hz | | random variable tones |
| (D) | Reset tone to 730 Hz | | (ranges \pm two 10 Hz deviations) |
| (S) | Sounds the current tone | (F) | Frequency differentiation |

(V)ariable tone selection can be used to have each session to start with a randomly selected tone, only slightly different from the current setting. Either 1, 3, or 5 different tones are chosen depending on the selected range of 0, plus or minus 10 or 20 Hz. Each time the (V) key is depressed the range advances. It is a good idea to use this option to get experience copying code with different frequency tones. Remember when you take your examination you may not have total control over the tone used by the examiner.

(F)requency differentiation causes dashes to be sent at a frequency 20 Hz lower than dots. This mode can help beginning students learn the difference between characters, but we don't recommend using it too long. Your amateur radio examination will not use this mode, so don't become dependent on it. Frequency differentiation applies only the Learning menu, Receiving game, and the Endurance session. For all other menus it is set off. Even if it is selected in the Receiving game or Endurance session, the differentiation is reduced by 2 Hz for every 5 correct answers, allowing the student a slow way to adjust to normal Morse code transmission.

If you have selected use of the Morse Academy external tone generator the options to change the tone are not available (+, or -). For details on how to construct an external tone generator for use with Morse Academy see Appendix C, "Construction Notes for an External Tone Generator". For information related to support of ADLIB compatible music synthesizer cards, see Appendix D, "ADLIB Compatible Music Synthesizer Card Support". For details on use of port keying, see Appendix E, "RS232/Parallel Port Keying Interface".

The port addresses, and the function codes to select the different tones used by the Morse Academy external tone generator are defined in the element PORT on the program diskette. The values in this file are important to the correct operation of these tone generators. Care should be taken to understand the meaning of each value before changes are made.

MORSE CODE ABBREVIATIONS USED IN AMATEUR RADIO QSO's

After you have advanced to the point of being able to copy some QSO's (message exchanges between two Amateur radio stations) you will find that many of the words in the text copied are abbreviations. To help you in learning to copy QSO's a list of commonly used abbreviations is printed below.

ABT	>ABOUT	OPR	>OPERATOR
ADDR	>ADDRESS	OT	>OLD TIMER
AGN	>AGAIN	PSE	>PLEASE
ANT	>ANTENNA	R	>RECEIVED SOLID OR YES
BCI	>BROADCAST INTERFERENCE	RCVR	>RECEIVER
BCNU	>BE SEEING YOU	RCVD	>RECEIVED
BK	>BREAK	RFI	>RADIO FREQUENCY INTERFERENCE
B4	>BEFORE	RPT	>REPEAT
CFM	>CONFIRM	RTTY	>RADIO TELETYPE
CK	>CHECK	RX	>RECEIVER
CL	>CLOSING STATION	SASE	>SELF ADDRESSED STAMPED ENVELOPE
CPY	>COPY	SIG	>SIGNAL
CQ	>CALLING ANY STATION	SKED	>SCHEDULE
CUL	>SEE YOU LATER	SRI	>SORRY
DLVD	>DELIVERED	SSB	>SINGLE SIDE BAND
DN	>DOWN	SVC	>SERVICE
DR	>DEAR	SWL	>SHORT-WAVE LISTENER
DX	>DISTANCE	TFC	>TRAFFIC (MESSAGES)
ES	>AND	TFX	>TRAFFIC (MESSAGES)
FB	>FINE BUSINESS	TKS	>THANKS
FER	>FOR	TNX	>THANKS
FREQ	>FREQUENCY	TU	>THANK YOU
FRM	>FROM	TVI	>TELEVISION INTERFERENCE
GA	>GO AHEAD OR GOOD AFTERNOON	TX	>TRANSMITTER
GB	>GOODBYE	UR	>YOUR
GE	>GOOD EVENING	URS	>YOURS
GM	>GOOD MORNING	VY	>VERY
GN	>GOOD NIGHT	VFO	>VARIABLE FREQUENCY OSCILLATOR
GND	>GROUND	WKD	>WORKED
HI HI	>LAUGHING	WKG	>WORKING
HR	>HERE	WL	>WILL
HV	>HAVE	WPM	>WORD PER MINUTE
HW	>HOW	WRK	>WORK
K	>GO AHEAD	WRKED	>WORKED
LID	>POOR OPERATOR	WX	>WEATHER
MSG	>MESSAGE	XCRV	>TRANSCEIVER
NCS	>NET CONTROL STATION	XMTR	>TRANSMITTER
NIL	>NOTHING	XTAL	>CRYSTAL
NR	>NUMBER	XYL	>WIFE
NW	>NOW	YL	>YOUNG LADY
OB	>OLD BOY	Z	>UNIVERSAL COORDINATED TIME (UTC)
OM	>OLD MAN	73	>BEST REGARDS
OP	>OPERATOR	88	>LOVE AND KISSES

Q-SIGNALS FREQUENTLY USED IN AMATEUR COMMUNICATIONS

The following "Q signals" are common in Amateur communications. The list is far from exhaustive, but knowing just these few can increase the understanding of exchanges between radio amateurs.

Code	Meaning	Example of usage
QRL	ARE YOU BUSY?	QRL? (Is this frequency in use?)
QRM	IS MY SIGNAL BEING INTERFERED WITH?	UR RST IS 599 WITH QRM (your signal is Readability 5, Strength 9, and Tone 9 with interference)
QRN	ARE YOU TROUBLED BY STATIC?	UR RST IS 579 WITH QRN (your signal is Readability 5, Strength 9, and Tone 9 with static)
QRP	SHALL I DECREASE TRANSMITTER POWER?	I AM RUNNING QRP 5 WATTS (I am running low power 5 watts)
QRQ	SHALL I SEND MORE QUICKLY?	PSE QRQ (Please speed up)
QRS	SHALL I SEND MORE SLOWLY?	PSE QRS (Please slow down)
QRT	SHALL I STOP SENDING?	I HAVE TO GO QRT NOW (I have to stop now)
QRU	HAVE YOU ANYTHING FOR ME?	I AM QRU (I have nothing more to say)
QRV	ARE YOU READY?	DO YOU QRV ON 20 MTRS? (Do you operate on 20 meters)
QRX	WHEN WILL YOU CALL AGAIN?	PSE QRX (Please standby until I call)
QRZ	WHO IS CALLING ME?	QRZ? (Who is calling me?)
QSB	ARE MY SIGNALS FADING?	UR 569 WITH QSB (Your signal is Readability 5, Strength 6, and Tone 9 with fading - signal strength up and down during the transmission)

QSL	CAN YOU ACKNOWLEDGE RECEIPT?	PSE QSL VIA THE BURO (Please send me your QSL card by mail via the QSL bureau)
QSO	CAN YOU COMMUNICATE WITH ... DIRECT?	TNX FOR THE QSO (Thanks for this radio contact)
QSP	WILL YOU RELAY TO ... ?	PSE QSP MY NEW CALL TO BILL (Please tell bill that my new call sign is)
QST	GENERAL CALL TO ALL AMATEURS!	QST QST QST (General call preceding message addressed to all Amateurs and ARRL members. Also the name of the monthly magazine published by the ARRL for all Radio Amateurs)
QSY	SHALL I CHANGE FREQUENCY?	PSE QSY UP 5 AND CALL ME (Please increase your frequency by 5 Kilohertz and call me)
QTH	WHAT IS YOUR LOCATION?	MY QTH IS LOS ANGELES (The location of my station is Los Angeles)

Operation of the Morse Academy designed external tone generator is controlled with parameters on the first line in the file PORT. It contains five numbers. The first value is the port used to control the Morse Academy tone generator. The default setting 888 (378 Hex) is for LPT1, the standard printer port. If your PC has additional printers, it can be set to other ports by editing the ASCII file PORT.

Printer	<—Port Number—>	
	Hex	Decimal
LPT1	378	888
LPT2	278	632
LPT3	3BC	932

No testing has been done with communications ports, but logically keying those ports would seem to be possible with the coding provided in Morse Academy. Those hardware ports are:

Serial	<—Port Number—>	
	Hex	Decimal
COM1	3F8	1016
COM2	2F8	0760

The program is written to support sending four different tones needed for the full support of Morse Academy sessions:

Frequency	Purpose	Hex	Decimal
0 Hz	Keyer off	FF	255
300 Hz	Low pitch long tone for error	FE	254
730 Hz	Keyer on	FD	253
1800 Hz	High pitch short tone for success	FC	252

The choice of frequencies and function codes is arbitrary and can be changed to accommodate other hardware implementations. These four values are stored immediately after the port address in the element PORT in the Morse Academy directory. They can be modified to support other hardware designs.

The author would prefer that any hardware built for Morse Academy support all four frequencies so the full functionality of the program is preserved. There are however many approaches to providing the necessary keying, and many different possible uses. Although the author has not confirmed it, the simplest circuit may be to drive a Keyer or transceiver thru a diode directly from the parallel port, e.g. connect the anode of the diode to the positive side of the Keyer, the cathode to pin 2 of the parallel port, and pin 25 to the Keyer ground. This works only with Keyers that operate by closing a +5 volts to ground at less than 10 mA. To prevent excessive current flow a 100 ohm resistor in series with the diode is recommended.

SAMPLE CIRCUIT

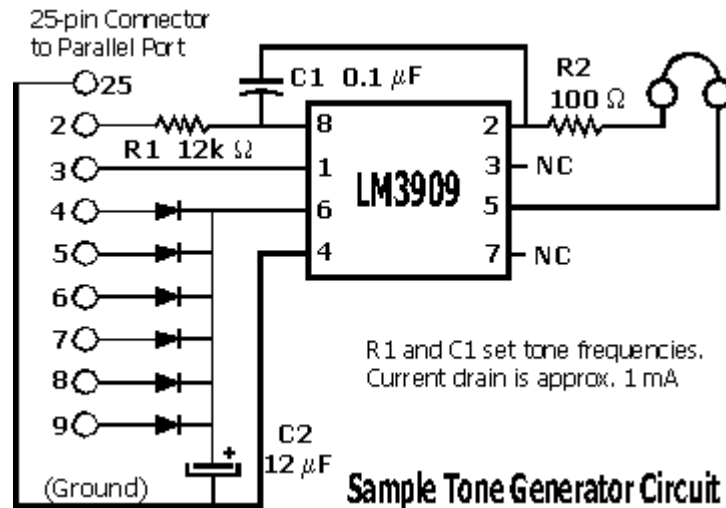
To debug the program, a simple circuit was designed which fits onto a circuit card about one inch square. Power was taken from the parallel port. This is the reason that all function codes indicated above had the high bits set. The top six bits were set to have their power output in parallel to drive the circuit. Care must be taken in the design to not overload the PC's outputs. Drawing excessive current will damage the port driver chip. The pin assignments for the 25 pin parallel port are:

Pin	Bit	Output
25	-	Ground
2	0	Function 0
3	1	Function 1
4	2	+5 volt power
5	3	+5 volt power
6	4	+5 volt power
7	5	+5 volt power
8	6	+5 volt power
9	7	+5 volt power

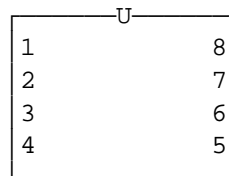
An alternative design could have used three master bits for tone selection using only five power supply pin outputs. A note of caution on use of the output pins as a power source. While the circuit can be designed to represent "Keyer off" as the absence of function bits, depending on the circuit you may still want to select all power bits to insure a constant voltage. Keying all bits may result in chirping.

The sample circuit uses a single sound manufactured by Radio Shack called a LED flasher that almost meets the three-tone requirement of Morse Academy. The part is an eight pin LM3909 - Radio Shack part number 276-1705. Only fourteen parts are required:

Part	Qty	Description
LM3909	1	LED Flasher Chip, Radio Shack P/N 276-1705
Socket	1	Eight pin IC socket
1N270	6	Germanium diode (or similar)
Resistor	1	¼ watt 100 Ω
Resistor	1	¼ watt 12,000 Ω
Capacitor	1	10 µf (electrolytic)
Capacitor	1	0.1 µf (mylar)
Connector	1	25 pin parallel port connector (male)
Connector	1	audio phone jack
Circuit board	1	about one inch square (length of 25 pin connector)



The LM 3909 pins are numbered counterclockwise from 1 to 8 starting with pin 1 at the upper left hand corner, as shown below:



In testing this circuit on various computers it was found that the tone frequencies are very sensitive to the parallel port output voltage. This is especially true for battery powered laptops and notebooks, where in some cases the tone off function actually generated a low frequency tone. Adjustment of the circuit values R1 and or C1 may be necessary to generate the proper frequencies. As a suggestion you might consider use of a variable resistor to be able to adjust the circuit for your particular computer's parallel port design. A different circuit design may be more appropriate to the wide range of computers on the market.

Morse Academy provides support for ADLIB compatible music synthesizer cards. The (C)hange command in the (T)one submenu of the (O)ptions menu allows selection a music synthesizer card.

The default I/O port address for ADLIB compatibles is 38xh. Morse Academy uses this value as the default port address. Some manufacturer's boards allow other port addresses so Morse Academy can set the address to other values. Addresses in the range 20xh-28xh and 30xh thru 3Fh are permitted. This covers beyond the range required for music cards currently being marketed. For example the SoundBlaster Pro card allows jumper selection of only two other addresses 22xh or 24xh, in addition to the defacto ADLIB standard of 38x.

Morse Academy performs all necessary initialization of the music synthesizer card. No other software or device driver is needed. Any ADLIB compatible card is satisfactory to send good audio quality Morse code.

Morse Academy supports RS232 and parallel port keying interfaces that are commonly used by other programs, e.g. the K1EA Contest Logging program. This interface is not the preferred one because it only supports a single frequency. The audio feedback tones of 300 and 1800 Hz for MA's games is not available. Still the ability to practice with the (P)roficiency session and generate examination tapes makes it desirable to support these interfaces.

The ports COM1 (3FCh), COM2 (2FCh), COM3 (3ECh), COM4 (2ECh), LPT1 (37Ah), or LPT2 (27Ah) can be selected for keying in the (O)ptions menu, when choosing the (T)one generator option E. The keyed port address is displayed in Hexadecimal. Morse Academy outputs a 1 to the port to close the key, e.g.

```

OUT    H3FC,1          (in BASIC)

mov    AL,1           (in MASM)
mov    DX,3FCh
out    DX,AL

```

To open the key a zero is output to the port.

The pin outs for keying are:

RS232 Ports	Pins 4 and 5 on a DB9 connector. Pins 7 and 20 on a DB25 connector.
	Minus nine (-9) volts indicates key open. Plus nine (+9) volts indicates key closed. (note voltages may vary from 6 to 12 volts, depending on the PC manufacturer)
Parallel Ports	Pins 1 and 17
	Zero volts indicates key open. Plus five (+5) indicates key closed. (note voltages may vary, depending on the PC manufacturer)

Direct connection of your PC to a transceiver is NOT recommended. Isolation is required between the PC and the equipment being switched. Interfaces such as that designed by Jim Talens (N3JT) are commercially available. Write to Jim Talens (N3JT), P.O. Box 19346, Washington, DC 20036.

The (O)ptions menu, (T)one submenu provides the signaling generator option G that uses screen blinking to send the Morse code. This form of signaling is used by the U.S. Navy for signaling between ships when other forms of communications is not available. This option has been added to Morse Academy because of several requests from hearing impaired persons who wish to learn the code.

There are many problems in using the PC screen to signal CW. To reduce the visual noise appearing on the screen care has to be taken to change the screen contents during times when the electron beam is not updating the screen image. The Morse Academy driver has been written to perform the screen update in the minimum number of CPU cycles possible while the beam is returning from the bottom to the top (HRI time). This restricts the maximum signaling rate to the screen refresh rate. For a 60 Hz non-interlaced screen, refresh occurs approximately every 16 milliseconds. At 10 WPM, where the sending time for a dot is 120 milliseconds, this means that an error of 15% can occur for one element. As the speed increases the error does also. High resolution non-interlaced monitors will perform better than interlaced types. LCD's used in laptop or notebook computers are very slow and are not suitable for visual signaling.

The eye can not easily handle signaling rates as fast as those as the ear. This fact combined with the larger error due to 16 ms timing increments make copying visual signaling difficult at high speeds.

More accurate visual signaling is possible using external hardware the PC's internal sound generator, e.g. Morse Academy's external tone generator, or the parallel or RS232 port's. (See appendix C and E for more information on methods of signaling).

Morse Academy was written to use the screen as a display of information while the student listened to the audio practice. Adapting it to display the same information and use the screen for signaling involved considerable modification. Hopefully any errors introduced as a result are minor. Still some sessions proved too difficult to modify and had to be dropped when using visual signaling, e.g. the (E)ndurance session. Depending on the response to this new mode of training, future developments may extend visual signaling to support all Morse Academy functionality.

User comments on the visual signaling option would be appreciated.

