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Introduction

The MFJ-413 and MFJ-417 Pocket Morse Code Tutors are microprocessor controlled devices that can help a beginner learn Morse code or an experienced Ham to increase code speed. The MFJ-413 generates the required characters for the FCC code exam. In addition to all the features of the MFJ-413, the MFJ-417 contains words commonly used in amateur radio and a random QSO generator to simulate "on the air" contacts. Also, the MFJ-417 has a non-volatile memory.

Note: All references to the non-volatile memory apply to the MFJ-417 only.

Battery

The Code Tutor uses a nine-volt battery (not included). MFJ recommends the use of alkaline (or rechargeable nicad) batteries to reduce the risk of equipment damage from battery leakage. Avoid leaving battery in this unit during periods of extended storage. Battery life will vary depending on usage, so always keep spares on hand. Remove weak battery immediately!

To install a nine-volt battery:

1. Turn off the power to the Tutor.
2. Slide battery cover from back of the Tutor.
3. Remove old battery (if one), and insert the new battery.
4. Slide battery cover back in place, then turn the Tutor on by turning the OFF/Volume control toward the buttons.

Important: Always make sure the power is off before removing and installing the battery.

Tone Control

The Tone control allows you to set the sidetone pitch in the range of approximately 300 to 1000 Hz. The sidetone is designed without harsh key clicks. It's a sine wave, instead of a harsh square wave. Every dot and dash has a rise and decay time of approximately 5 ms for smooth transition. This lets you concentrate on learning code without the distraction of harsh key clicks.

To change the pitch frequency:

1. Turn off the power to the Tutor.
2. Remove the two screws and the box's bottom cover.
3. Locate the small trimpot, between the OFF/Volume control and the headphones jack, on the circuit board.
4. Press and hold *all* three buttons while turning the power on until there's a beep. Release the buttons to start sending. Adjust the volume if so desired.
5. Using a small flat-headed screwdriver, adjust the pitch by turning the trimpot clockwise to increase pitch and counter-clockwise to decrease pitch.

- The new pitch takes effect after the character in progress is finished. Be very careful not to touch other components on the circuit board.
6. Turn off the power after setting the desired pitch frequency.
 7. Secure the battery cable between the post and the side of the box. Make sure the knot of the cable is located on the side of the post closest to the control panel.
 8. Re-assemble the box enclosure and secure it with the two screws.

Audio

The Tutor has a 3.5 mm headphones jack for audio output located on the control panel. This jack accepts both stereo and mono plugs.

Operation

When powered on, one of the Tutor's mode is selected. For the MFJ-417, all mode settings are automatically saved into non-volatile memory immediately before playback, ready to use the next time.

While turning the power on, the three button combinations have different functions. These functions/modes are discussed later.

Button ¹			Power-On Operation
Speed	Group	Set/Play	
			Reset all settings.
•			Enable Farnsworth mode.
	•		Enable interactive mode.
•	•		Enable Farnsworth and interactive modes.
		•	Instant play.
•		•	Perform self test.
	•	•	Recall previous/default settings.
•	•	•	Set tone control.

Note:

1. Button pressed and held in while turning the power on is indicated by a dot (•); blank space means the button is not pressed.

Speed Button

The Speed button allows you to set the code speed in the range of 3 to 60 WPM. Word-per-minute speed is based on the standard word "PARIS" which is 50 units in length. For standard timing, dot = 1 unit, dash = 3 units, intra-character space = 1 unit, inter-character space = 3 units, and word space = 7 units. The word "PARIS" is sent 10 times in one minute if the code speed is 10 WPM. Press the Speed button to increase the code speed. Each button press increases the code speed by one WPM and is confirmed with a beep.

- ① SPEED = 3 WPM

- ① SPEED = 4 WPM
- ② SPEED = 5 WPM
- ③ SPEED = 6 WPM
- ④ SPEED = 7 WPM
-
- Σ SPEED = 60 WPM

Code requirement is 5 WPM for the Novice and the Technician. Both General and Advanced levels have a code requirement of 13 WPM. Extra class has a 20 WPM requirement.

Group Button

The Group button adjusts the number of characters for a character group. The options are random length group or fixed length group ranging from one to eight characters per group. The random length generates variable length of up to eight characters per group. This option is only applicable to character sets.

To change the group length, press the Group button to increase the group length. Each button press increases the group length by one character and is confirmed with a beep.

- ① GROUP = RANDOM
- ① GROUP = 1-CHARACTER
- ② GROUP = 2-CHARACTER
- ③ GROUP = 3-CHARACTER
- ④ GROUP = 4-CHARACTER
- ⑤ GROUP = 5-CHARACTER
- ⑥ GROUP = 6-CHARACTER
- ⑦ GROUP = 7-CHARACTER
- ⑧ GROUP = 8-CHARACTER

Set/Play Button

The Set/Play button selects one of the characters, words, or QSOs set and plays it using the current settings. To select a set, press the Set/Play button. Each button press selects the next set as listed below as the active set and is confirmed with a beep. Playback starts if the button is released for more than one second; therefore, pause between button presses must be less than one second. For example, to play the third set *only*, press and release the Set/Play button three times. Approximately one second after the last button release, the Tutor starts sending code with the selected set. Holding the Set/Play button down for one second enables the Combine mode (discusses next).

At any time during sending or halting for interactive feedback, press and hold the Set/Play button for one second until there's a beep to repeat the current session. Replaying a session allows you to recopy the same code to check your accuracy.

The Beginner sets are designed for those who don't know code and need to learn the sounds of the characters. When combine mode (discusses next) is not enabled, each Beginner character set is first sent three times as listed, with a word space after each character, then it goes into random practice. This allows the beginner to learn the sound of each character before sending random code.

Beginner Sets:

❶	EISHTMO	letter1
❷	AWJNDB	letter2
❸	UVGZKRPX	letter3
❹	FCLQY	letter4
❺	12345	number1
❻	67890	number2
❼	., ? / + * =	punctuation & prosigns†

† Refer to "Morse Code Character Set" section for the prosigns' meanings.

For MFJ-417 Only. The Advanced sets are meant for those who want to increase code speed and are already familiar with all the characters. The Words set generates random words commonly used in amateur radio from its internal database of 500 different words. The QSOs set sends entire random QSOs (conversations between radio operators) which is the best way to study for a license test because it is the same format as the test!

Advanced Sets:

❽	WORDS	random words
❾	QSOs	random QSOs

Combine Mode

The Combine mode allows the user to combine Beginner sets together as one set. By combining sets, previously learned sets are combined with new sets to reinforce all that you have learned. When on, the current set is combined with all previous Beginner sets. When off, *only* the current set is selected as the active set. This mode applies only to the Beginner sets, except the first one (letter1 set).

To enable the combine mode, press and hold the Set/Play button for one second until there's a constant beep. Release the button to start sending the combined set. For example, press and release the Set/Play button once; then within one second, press and *release* the Set/Play button again to play *only* the second set. Press and release the Set/Play button once; then within one second, press and

hold the Set/Play button for one second to play the *combined* set of the first two Beginner sets.

Reset All Settings

When *no* button is pressed and held in while turning the power on, the Tutor resets all parameter settings to the followings:

- Farnsworth mode Off
- Interactive mode Off
- Combine mode Off
- Speed 3 WPM
- Group Random length
- Set First character set (EISHTMO)

Farnsworth Mode

When Farnsworth mode is enabled, characters (dots, dashes, and intra-character spaces) are sent at the Farnsworth speed (character speed) of 18 WPM, but the spacing between characters and words is increased to produce a slower overall code speed. This technique is useful for helping the novice learn the sounds of the code characters and avoid the tendency of counting individual dots and dashes. The Farnsworth speed is always greater than the overall speed. As a result, Farnsworth mode (if enabled) is automatically disabled when the overall code speed is set to 18 WPM or higher.

To enable the Farnsworth mode, press and hold the Speed button while turning the power on. The Tutor acknowledges with a beep and resumes with normal operation when the button is released.

Interactive Mode

The Interactive mode lets you control when to play a word/QSO, especially useful for beginners. Enabling interactive mode allows you to control when the Tutor will send the next word/QSO or repeat the previous word/QSO (a group of characters considers a word). For example, group length is set to one character per group and interactive mode is enabled, the Tutor will send one character then halt to await your instruction on what to do next. At this point, press the Speed button to send a new character or press the Group button to repeat the character. The Tutor sends code continuously without halting if interactive mode is disabled.

To enable the interactive mode, press and hold the Group button while turning the power on. The Tutor acknowledges with a beep and resumes with normal operation when the button is released.

When halt for interactive feedback,

- Speed button Sends next character group, word, or QSO.

- Group button Repeats previous character group, word, or QSO.
- Set/Play button Sends next character group, word, or QSO.

Instant Play

For MFJ-413. Press and hold *only* the Set/Play button while turning the power on starts a new session using the default settings listed below. The Tutor acknowledges with a beep and starts playback when the button is released.

- Farnsworth mode Off
- Interactive mode Off
- Combine mode On
- Speed 13 WPM
- Group 5-character per group
- Set All Beginner sets

For MFJ-417. Press and hold *only* the Set/Play button while turning the power on starts a new session using the previous settings. The Tutor acknowledges with a beep and starts playback when the button is released. This allows you to start playing without re-setting all the modes.

Recall Settings

For MFJ-413. Press and hold *both* the Group and the Set/Play buttons while turning the power on resets the Tutor to the default settings except the set parameter. It resets to the first character set, allowing you to select another set for practice using the default settings. This allows you to start a new session with a different set, without adjusting the code speed and group length. The Farnsworth and interactive modes are disabled; the code speed and the group length can be increased starting with the default settings listed below.

- Farnsworth mode Off
- Interactive mode Off
- Combine mode Off
- Speed 13 WPM
- Group 5-character per group
- Set First character set (EISHTMO)

For MFJ-417. Press and hold *both* the Group and the Set/Play buttons while turning the power on recalls all previous settings except the set parameter. It resets to the first character set, allowing you to select another set for practice without re-setting the other modes. This allows you to start a new session with a different set, without adjusting the code speed and group length again from the beginning. The Farnsworth and interactive modes are the same as before; the

code speed and the group length can be increased starting with the previous settings.

Self Test

A Self Test is included to perform testing of the buttons, the non-volatile memory circuitry and integrity, and the audio circuitry. At any time, turn off the power to stop the Self Test; however, power should NOT be turned off during steps involving the non-volatile memory as it could corrupt the memory.

For MFJ-413. This test is initialized by:

1. Turn off the power to the Tutor.
2. Press and hold *both* the Speed and the Set/Play buttons while turning the power on. The Self Test starts by sending the copyright message "COPYRIGHT 199X MFJ ENTERPRISES, INC. VERSION X.XX" at 13 WPM confirming the audio circuitry is working properly. Release the buttons before the message is finished.
3. Each button is automatically tested for shorts to ground.
4. Press the Speed button to test it for proper connection. The Tutor responds with a beep. Release the button.
5. Press the Group button to test it for proper connection. The Tutor responds with a beep. Release the button.
6. Press the Set/Play button to test it for proper connection. The Tutor responds with a beep. Release the button within one second.
7. When all is okay, a repetitive message "PASS" is sent at 13 WPM. However, if something is wrong a repetitive message such as "GROUP FAIL" is sent at a slower speed of 5 WPM.
8. Turn off the power after confirming the audio has good quality.

Failure Message Meanings:

- SPEED FAIL Speed button is shorted or improperly connected.
- GROUP FAIL Group button is shorted or improperly connected.
- SET FAIL Set/Play button is shorted or improperly connected.

For MFJ-417. This test is initialized by:

1. Turn off the power to the Tutor.
2. Press and hold *both* the Speed and the Set/Play buttons while turning the power on. The Self Test starts by sending the copyright message "COPYRIGHT 199X MFJ ENTERPRISES, INC. VERSION X.XX" at 13 WPM confirming the audio circuitry is working properly. Release the buttons before the message is finished.

3. Each button is automatically tested for shorts to ground.
4. Press the Speed button to test it for proper connection. The Tutor responds with a beep. Release the button.
5. Press the Group button to test it for proper connection. The Tutor responds with a beep. Release the button.
6. Press and *hold* the Set/Play button for one second. The Tutor responds with *two* beeps. Release the button. If the button is released before the second beep, the next three steps are skipped.
7. It then automatically tests the logic line Vpp (shown on the schematic).
8. The non-volatile memory circuitry is automatically tested. Notice this step resets the Tutor to its factory default settings for Instant Play.
9. The non-volatile memory integrity is automatically tested.
10. When all is okay, a repetitive message "PASS" is sent at 13 WPM. However, if something is wrong a repetitive message such as "GROUP FAIL" is sent at a slower speed of 5 WPM.
11. Turn off the power after confirming the audio has good quality.

Failure Message Meanings:

- SPEED FAIL Speed button is shorted or improperly connected.
- GROUP FAIL Group button is shorted or improperly connected.
- SET FAIL Set/Play button is shorted or improperly connected.
- VPP FAIL Logic line Vpp is not pulled low by a resistor.
- EEPROM FAIL Non-volatile memory circuitry is improperly connected.
- MEMORY FAIL Non-volatile memory integrity is bad.

Factory Default Settings:

- Farnsworth mode Off
- Interactive mode Off
- Combine mode On
- Speed 13 WPM
- Group 5-character per group
- Set All Beginner sets

Troubleshooting

Q. Why is there no beep when I press the buttons?

A. The battery is probably dead, replace it with a new one.

Q. Why is the sidetone changing during playback?

A. The battery is weak, replace it with a new one.

Technical Assistance

If you have any problem with this unit first check the appropriate section of this manual. If the manual does not reference your problem or your problem is not solved by reading the manual you may call *MFJ Technical Service* at **601-323-0549** or the *MFJ Factory* at **601-323-5869**. You will be best helped if you have your unit, manual and all information on your station handy so you can answer any questions the technicians may ask.

You can also send questions by mail to MFJ Enterprises, Inc., 300 Industrial Park Road, Starkville, MS 39759; by Facsimile to 601-323-6551; or by email to techinfo@mfjenterprises.com. Send a complete description of your problem, an explanation of exactly how you are using your unit, and a complete description of your station.

Morse Code Character Set¹

A	di-dah	•—	N	dah-dit	—•
B	dah-di-di-dit	—•••	O	dah-dah-dah	— — —
C	dah-di-dah-dit	—•—•	P	di-dah-dah-dit	•—••
D	dah-di-dit	—••	Q	dah-dah-di-dah	—•—
E	dit	•	R	di-dah-dit	•—•
F	di-di-dah-dit	••—•	S	di-di-dit	••••
G	dah-dah-dit	—••	T	dah	—
H	di-di-di-dit	••••	U	di-di-dah	••—
I	di-dit	••	V	di-di-di-dah	•••—
J	di-dah-dah-dah	•— — —	W	di-dah-dah	•— —
K	dah-di-dah	—•—	X	dah-di-di-dah	—••—
L	di-dah-di-dit	•—••	Y	dah-di-dah-dah	—•— —
M	dah-dah	— —	Z	dah-dah-di-dit	—•••
1	di-dah-dah-dah-dah	•— — — —	6	dah-di-di-di-dit	—••••
2	di-di-dah-dah-dah	••— — —	7	dah-dah-di-di-dit	—••••
3	di-di-di-dah-dah	•••— —	8	dah-dah-dah-di-dit	—••••
4	di-di-di-di-dah	••••—	9	dah-dah-dah-dah-dit	—•••••
5	di-di-di-di-dit	•••••	0	dah-dah-dah-dah-dah	— — — — —
Period	[.]	di-dah-di-dah-di-dah	•—•—•—	AAA	
Comma	[,]	dah-dah-di-di-dah-dah	—••— —	MIM	
Question Mark or Request for Repetition	[?]	di-di-dah-dah-di-dit	••—•••	IMI	
Fraction Bar	[/]	dah-di-di-dah-dit	—••—•	DN	
End of Message or Cross	[+]	di-dah-di-dah-dit	•—•—•	AR	
End of Work	[*]	di-di-di-dah-di-dah	•••—•—	SK	
Double Dash, Pause or Break	[=]	dah-di-di-di-dah	—•••—	BT	

Note:

1. FCC testing requirement consists the 26 letters, the 10 numerals, the period, the comma, the question mark, \overline{AR} , \overline{SK} , \overline{BT} and fraction bar [\overline{DN}].

Some CW Abbreviations

73	Best regards	NR	Number; near
88	Love and kisses	NW	Now
ABT	About	OM	Old man
AGN	Again	OP	Operator
ANT	Antenna	R	Are; received; roger
BK	Back; break	RCVR	Receiver
CPY	Copy	RIG	Station equipment
CQ	Calling any station	RITE	Right
CUL	See you later	RST	Readability, strength, tone report
CU	See you	SIGS	Signals
DE	From	SKED	Schedule
DEG	Degree	STN	Station
DX	Distance; rare station	TEMP	Temperature
ES	And; "&"	TKS	Thanks
FB	Fine business; excellent	TNK	Thank
FER	For	TNX	Thanks
FREQ	Frequency	UR	Your; you're; you are
GA	Good afternoon	U	You
GE	Good evening	WL	Well; will
GM	Good morning	WTS	Watts
GN	Good night	WX	Weather
HR	Hear; here	XCVR	Transceiver
HW	How	XMTR	Transmitter
K	Go ahead	XYL	Wife (ex-young-lady)
MSG	Message	YL	Young lady

Meaning of Q Signals

QRA	The name of my station is
QRL	Do not interfere, Frequency busy
QRM	Being interfered with
QRN	Static
QRO	Increase power, High power
QRP	Decrease power, Low power
QRQ	Send faster
QRR	I am ready for automatic operation
QRS	Send more slowly
QRT	Stop sending
QRU	I have nothing for you
QRX	I will call again at ..., wait
QRZ	Who is calling me, I am
QSB	Your signal is fading
QSD	Your keying is defective
QSK	I can hear you between my signals
QSL	I am acknowledging receipt
QSU	Reply on this frequency or mode
QSX	I am listening to ... on ... kHz
QSY	Change frequency, change to xmit on ... kHz
QTH	My location (home) is
QTR	The correct time is
QTS	I will send so my frequency can be measured
QUB	Here is the info you requested
QUM	The distress traffic has ended

Send a "?" after a Q signal to ask for information or an action.

Example: QRZ: station (call) is QRZ?: what is your station (call)?

SettingSaver™ Chart

Copy this chart and use it to record your settings.

Farnsworth Mode <input type="radio"/> On <input type="radio"/> Off	Farnsworth Mode <input type="radio"/> On <input type="radio"/> Off
Interactive Mode <input type="radio"/> On <input type="radio"/> Off	Interactive Mode <input type="radio"/> On <input type="radio"/> Off
Combine Mode <input type="radio"/> On <input type="radio"/> Off	Combine Mode <input type="radio"/> On <input type="radio"/> Off
Code Speed _____ WPM	Code Speed _____ WPM
Group Length _____ Char.	Group Length _____ Char.
Set _____	Set _____
Farnsworth Mode <input type="radio"/> On <input type="radio"/> Off	Farnsworth Mode <input type="radio"/> On <input type="radio"/> Off
Interactive Mode <input type="radio"/> On <input type="radio"/> Off	Interactive Mode <input type="radio"/> On <input type="radio"/> Off
Combine Mode <input type="radio"/> On <input type="radio"/> Off	Combine Mode <input type="radio"/> On <input type="radio"/> Off
Code Speed _____ WPM	Code Speed _____ WPM
Group Length _____ Char.	Group Length _____ Char.
Set _____	Set _____
Farnsworth Mode <input type="radio"/> On <input type="radio"/> Off	Farnsworth Mode <input type="radio"/> On <input type="radio"/> Off
Interactive Mode <input type="radio"/> On <input type="radio"/> Off	Interactive Mode <input type="radio"/> On <input type="radio"/> Off
Combine Mode <input type="radio"/> On <input type="radio"/> Off	Combine Mode <input type="radio"/> On <input type="radio"/> Off
Code Speed _____ WPM	Code Speed _____ WPM
Group Length _____ Char.	Group Length _____ Char.
Set _____	Set _____
Farnsworth Mode <input type="radio"/> On <input type="radio"/> Off	Farnsworth Mode <input type="radio"/> On <input type="radio"/> Off
Interactive Mode <input type="radio"/> On <input type="radio"/> Off	Interactive Mode <input type="radio"/> On <input type="radio"/> Off
Combine Mode <input type="radio"/> On <input type="radio"/> Off	Combine Mode <input type="radio"/> On <input type="radio"/> Off
Code Speed _____ WPM	Code Speed _____ WPM
Group Length _____ Char.	Group Length _____ Char.
Set _____	Set _____
Farnsworth Mode <input type="radio"/> On <input type="radio"/> Off	Farnsworth Mode <input type="radio"/> On <input type="radio"/> Off
Interactive Mode <input type="radio"/> On <input type="radio"/> Off	Interactive Mode <input type="radio"/> On <input type="radio"/> Off
Combine Mode <input type="radio"/> On <input type="radio"/> Off	Combine Mode <input type="radio"/> On <input type="radio"/> Off
Code Speed _____ WPM	Code Speed _____ WPM
Group Length _____ Char.	Group Length _____ Char.
Set _____	Set _____

Farnsworth Mode	<input type="radio"/> On <input type="radio"/> Off	Farnsworth Mode	<input type="radio"/> On <input type="radio"/> Off
Interactive Mode	<input type="radio"/> On <input type="radio"/> Off	Interactive Mode	<input type="radio"/> On <input type="radio"/> Off
Combine Mode	<input type="radio"/> On <input type="radio"/> Off	Combine Mode	<input type="radio"/> On <input type="radio"/> Off
Code Speed _____	WPM	Code Speed _____	WPM
Group Length _____	Char.	Group Length _____	Char.
Set _____		Set _____	

Schematic