

INTRODUCTION

Welcome to the world of effortless CW, with the MFJ-403 you'll have a professional sounding fist in no time! Whether you're a Novice or seasoned Extra, the MFJ-403 Pocket CW Keyer has the features you've been waiting for! Novices will appreciate the preset power-up defaults for plug-and-play operation. Extra's will enjoy the advanced features: Weight control from 25 to 75%, Iambic A and B operation, auto or semi-auto operation, full dot-and-dash memories, and immediate front-panel speed control from 3 to 65 WPM. The built-in sidetone generator and speaker are ideal for CW practice sessions or for radios lacking a CW sidetone.

The MFJ-403 keyer is compatible with any modern transceiver or QRP transmitter using positive keying. The 50-volt at 100-mA keying permits the use of many early vintage cathode-keyed transmitters. Its small size and battery operation are ideal for QRP or Field Day activities! CW has never been so enjoyable or effortless!

A *state-of-the-art* PIC12C671 microprocessor is the heart of the keyer! Learn the basics behind embedded controllers, and how they are revolutionizing the electronics field. The powerful PIC device permits advanced settings to be entered from the keyer paddles, using Morse characters! Powered by a common 9-volt transistor radio battery, the keyer is ready for action whenever you are! The microprocessor even senses inactivity, putting the keyer into a battery conserving sleep mode!

OPERATING INSTRUCTIONS

Dits, dahs, dots and dashes? Beginners often think of CW characters as being composed of strings of dots and dashes, the visual image conveyed when viewing Morse CW characters on the printed page. Experienced CW operators tend to think of CW characters as a *sound*, and hear *dahs* instead of dashes, and *dits* instead of dots when listening to CW characters. Both terms will be used interchangeably in the following text.

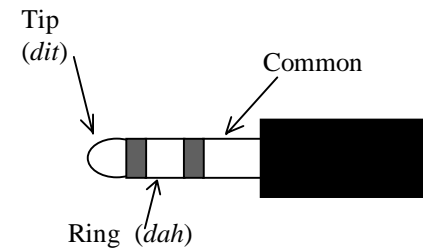
Determining Keyer speed: Hold the dash lever and count the number of dashes generated in a five-second period. The number of dashes roughly equals your CW sending speed.

Power requirements: The keyer is designed to operate from a 9-volt DC battery source. An alkaline battery will give long service, but always remember to turn the keyer power switch off when the keyer is not being used.

Keyer paddles: Most popular paddles will work well with the MFJ-403. Full enjoyment of the MFJ-403's features requires paddles that are capable of iambic

operation. We recommend the MFJ iambic paddles as being a good value. Iambic paddles can be recognized by the totally independent operation of the *Dit* (or “Dot”) and *Dah* (or “Dash”) paddles. Some CW operators refer to iambic paddles as “squeeze paddles”.

The paddles should be equipped with a three-wire interconnecting cable terminated in a 3.5mm stereo jack. Miniature shielded and balanced microphone cable is ideal for this. The common return is connected to the longest “ring” (shaft) of the stereo jack. The *Dah* paddle connection is made to the jack terminal for the smaller insulated ring. The *Dit* paddle is connected to the jack tip connection. If your paddles are equipped with a ¼” stereo jack, a suitable stereo adapter is available at most electronic or HI-FI shops. Reversed paddle wiring can be corrected by a function entry, more on this later. The paddles are connected to the Paddle jack on the MFJ-403.



3.5mm stereo jack. Refer to the connector packaging for wiring terminal details.

Linear controls: There are two linear controls. An internal trimpot R2 sets the sidetone monitoring level. The second control, Speed knob, sets the CW speed over a range of 3 wpm (words-per-minute) to 65 wpm. This is for good reason, the speed is most frequently adjusted.

Sidetone operation: The sidetone is tone keyed by the CW keyer. This permits you to monitor your keying and provides the aural “feedback” to assist in sending good CW. Many transceivers already provide for internal CW sidetone monitoring. If your transmitter does not have built-in sidetone monitoring provisions, the MFJ-403 will generate a sidetone for you. A built-in speaker lets you monitor the CW sidetone. Adjust the internal trimpot R2 to a comfortable listening level.

Default initial status: As soon as power is supplied and the MFJ-403 turned on by turning the OFF/Speed knob, the unit is ready for operation. A microprocessor program “subroutine” loads several operating parameters into the keyer at power up. These parameters are based on standard operating

practices, many of them may be changed to suit your preferences—more on this later. Commands entered via the Function switch are cleared when the power is removed.

Initially, the keyer assumes standard paddle wiring, that is *dit* key to the tip and *dah* key to the ring of the 3.5mm jack. Iambic operation is set to mode “A”. The sidetone frequency is set to 727 Hz. The CW weight is set to 50%, yielding the standard 1:3 *dit* to *dah* ratio. The keyer is in the automatic mode.

If CW operation is a new experience for you, consider running the keyer in its basic power-up configuration until you become comfortable with its feel and operation. Feel free to learn the more advanced features at your own pace.

Default settings at power on:

1. 727 Hz sidetone
2. Standard weight (50%, dot-dash-space ratio of 1:3:1)
3. Iambic A
4. Automatic
5. Standard paddle wiring (dot = tip, dash = ring)

Transmitter keying: The keyer output is through the Key Out jack, a RCA phono jack. You will need a cable to connect between the keyer and the CW keying jack of your radio. The operation instructions for your set should show what sort of connector is needed and its location on your radio. Many modern transceivers use RCA phono jacks for connecting accessories, in those cases ready-made cables for home entertainment devices may be used between the MFJ-403 and radio.

Keyer output specs: The keyer is designed for *positive keying output*. Most modern solid-state transceivers and QRP transmitters meet this requirement. Always check the owner's manual before attaching the keyer to a radio. The MFJ-403 will key positive voltages to 50-Vdc maximum. Keying current is limited to 100-mA maximum. Exceeding these limits may damage keying transistor Q1.

Use with vintage sets: Early tube transmitters and hybrid transceivers may not be compatible with the MFJ-403. If the transmitter uses grid-block keying (a negative key voltage), it can not be used with the MFJ-403. An example of a grid-block keyed transmitter is the Heathkit DX60. Check the ARRL handbooks for circuits for adapting keyers to grid-block keying.

Vintage novice transmitters commonly used cathode keying, a combination of high current and high voltage. The Heathkit DX40 used cathode keying, for example. In general, most cathode-keyed transmitters should be compatible with

the MFJ-403 keying circuit, so long as the 50Vdc and 100mA limits are not exceeded.

Dot-and-dash memories and Iambic keying: The dot and dash memories make sending CW easier. The memory allows the user to key a dot before the completion of a dash, and vica-versa. This feature maybe checked by setting the keyer to the lowest speed and tapping first the dash lever and then the dot lever before the completion of the dash. The keyer will generate a *dash dot* with perfect spacing. Test the dash memory in a similar manner. First tap the dot lever, and before releasing quickly tap the dash lever. The keyer will send the dot followed by the dash, again with perfect spacing.

Iambic paddles allow both paddles (or levers) to be depressed at the same time. Depressing (squeezing) both paddles simultaneously will generate a continuous stream of alternating dots and dashes. The first paddle contacted determines whether a dot or dash occurs first. CW characters such as **C**, **K**, **Q** and **R** are very easily generated with iambic paddles.

Special Functions

Note: All programmable special functions are lost when the MFJ-403 is turned off. The default settings are restored at power on.

Automatic mode: Early telegraphers used a mechanical device called a bug to send high-speed code. The bug would automatically send a string of *dits* when the dot paddle was depressed and held. Bugs did not generate strings of dashes, the dash had to be depressed once to generate each individual "dah". The MFJ-403 normally operates in the fully automatic mode. However, it may be set for "semi-automatic" operation, to emulate the sound and feel of a mechanical bug.

Weight: A 3:1 ratio between dit's and dah's is considered to be optimum. Some operators prefer slightly different ratios; and the MFJ-403 weight is adjustable from 25 to 75% to suit those preferences. The power-on default is 50%, or 3:1.

Sidetone frequency: The default sidetone is about 727 Hz. The sidetone may be programmed from 300 to 1000 Hz to suit individual tastes.

Reverse: Reverses the sense of the left and right paddles. Useful when the paddle is shared by both left and right handed operators.

Iambic mode: Either mode A or B may be selected. Mode A is default. When a squeeze is released during an element (dot or dash), type "B" adds the opposite element. Type "A" just finishes the element in progress and does *not* produce a following alternate element. For example, in Type "A" Iambic, a squeeze release during the "dah" in the letter A will produce "di-dah" (A). In Type "B" Iambic, a squeeze release during the "dah" in the letter A will produce "di-dah-dit" (R).

Using the Function switch: The Function switch customizes the keyer to your preferences. To set or change a setting, depress the Function switch. The keyer acknowledges by sending the Morse CW character for the letter **F** (*di-di-dah-dit*).

Keyer functions are entered via the keyer paddles. If an invalid character is entered, the keyer responds with two beeps. Multiple functions may not be entered at one time. That is, each function must be individually entered and preceded by pressing the Function button. A valid entry is acknowledged by a single beep. The transmitter key line is disabled during programming. The function mode maybe exited at any time by pressing the Function switch. The keyer confirms the exit with two beeps.

Command Character	Functions
A	Automatic. Toggles between automatic and semi-automatic mode.
I#	Iambic. Sets Iambic mode A or B, where # represents A or B.
R	Reverse. Reverses the sense of the dot and dash paddles.
T	Tone. Dash paddle raises the sidetone frequency. Dot paddle lowers. Both paddles together exits.
W##	Weight. ## represents weight value between 25 and 75 percent.
X	Xmit (Tune). Gives continuous key-down for adjusting transmitter or antenna tuner. Tapping either paddle exits tune mode and releases the key line.

Note: An alternating series of dots and dashes are sent to the sidetone monitor while the T command is active to assist in setting the desired sidetone frequency.

TROUBLE SHOOTING

Keyer dead: Dead battery. Make sure the OFF/Speed knob is turned on.

Sidetone distorted, erratic operation: Weak battery. RF getting into keyer, use shielded leads.

Can't enter function mode: Make sure to firmly depress the Function button.

Keyer gives error beeps on function entry: Code characters must be perfectly formed, with proper timing. Invalid command prefix or suffix.

THEORY OF OPERATION AND SPECIFICATIONS

Theory of operation:

The MFJ-403 features the powerful PIC12C671 microcontroller. This tiny eight-pin integrated circuit contains the programming and basic power of a microprocessor chip. CW speed is set via R1, a 10K-ohm potentiometer, that controls the voltage input to pin 7 of U1 (PIC chip). Pin 7 is an analog-to-digital input for the PIC processor. Programming subroutines scan the digitized setting of R1, and adjust the speed accordingly.

Keyer paddle activation is also sensed by the PIC chip. All dot-and-dash memories, Iambic operations, and sidetone generation and sidetone frequency are under the control of the PIC12C671 device.

Power to the PIC controller is regulated at 5 volts by IC U3, a low-power 5-Vdc regulator IC. The sidetone signal from the processor is amplified by U2, a linear audio amplifier IC. U2 is powered directly from the 9-volt battery. Transistor Q1 is a silicon-gate TMOS switching FET, and is used to key the transmitter. The maximum FET ratings are 50 Vdc at 100 mA .

Specifications:

- Voltage requirements.....Internal 9-volt transistor battery
- Keyer speedTypically 3 to 65 WPM
- Sidetone level50-mW max., adjustable internal trimpot
- Sidetone frequency727 Hz default, adjustable 300 to 1000 Hz
- Keying limitsPositive keying. 50 volts at 100 mA max.
- CW generation.....Iambic A or B, Automatic or Semi-automatic
- MemoryDot Dash memory
- Weight.....50% default, adjustable 25 to 75 percent

SCHEMATIC