MFJ

Nano-Size Keyer/Paddle ™

Model MFJ-402

INSTRUCTION MANUAL

CAUTION: Read All Instructions Before Operating Equipment !

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VERSION 0A

Introduction

Welcome to the world of effortless CW. With the MFJ-402 you will have a professional sounding fist in no time! Whether you are a Novice or seasoned Extra, the MFJ-402 Keyer/Paddle has the features you have been waiting for! Novices will appreciate the preset power-up defaults for plug-and-play operation. Extras will enjoy the advanced features: Weight control from 25 to 75%, Iambic A and B operation, automatic or semi-automatic operation, full dot and dash memories, and speed control from 5 to 60 WPM (words per minute).

The MFJ-402 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 3-volt lithium battery, the keyer is ready for action wherever you are! The microprocessor even senses inactivity. Leave it sitting and the keyer goes 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 3-volt lithium battery (DL2430, CR2430, or equivalent). To put a battery in the keyer, unscrew the four screws on the bottom and remove the cover. Next, slide the 3-volt lithium battery into the battery slot positive (+) side up. Finally, place the cover back on the keyer and secure with the screws.

Speed control: The speed trimpot sets the CW speed over a range of 5 to 60 WPM. Speed is one of the most frequently adjusted parts of your keyer, and is

accessed from the bottom of the keyer. Use a small flat-head screwdriver and rotate right to increase speed.

Default initial status: As soon as power is supplied to the MFJ-402, 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.

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

Transmitter keying: The keyer output is through the Key Out cable. The Key Out cable is a cable extending from the back of the keyer with 3.5 mm plug on the end. Connect this cable to the CW keying jack of your radio. The operation instructions for your set should show what sort of connector you need and its location on your 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-402 will key positive voltages to a 50 Vdc maximum and current to a 100 mA maximum. Exceeding these limits may damage the keying transistor Q1.

Use with vintage sets: Early tube transmitters and hybrid transceivers may not be compatible with the MFJ-402. If the transmitter uses grid-block keying (a negative key voltage), it cannot be used with the MFJ-402. An example of a grid-block keyed transmitter is the Heathkit DX60. Check the ARRL handbooks for circuits designed to adapt 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 are compatible with the MFJ-402 keying circuit, so long as the 50 Vdc and 100 mA 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 vice-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, depress the dot lever, hold, quickly tap the dash lever, and release. 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 paddle that contacts initially determines whether a dot or dash occurs first. CW characters such as **C, K, Q** and **R** are very easy to generate with iambic paddles.

Special Functions

Note: All programmable special functions are lost when the MFJ-402's battery is removed. 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. However, the bugs did not generate strings of dashes, the dash had to be depressed manually to generate each individual "dah". The MFJ-402 normally operates in the fully automatic mode, but it may be set for "semi-automatic" operation. This causes it to emulate the sound and feel of a mechanical bug.

Iambic mode: Select mode A or B, whichever you prefer. Type A is the default mode. When you release a squeeze during an element (dot or dash), it just finishes the element in progress and does *not* produce a following alternate element. On the other hand, type B adds the opposite 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).

Reverse: This reverses the sense of the left and right paddles. It is useful when both left and right-handed operators share the paddle. The standard connection dits with the left paddle and dahs with the right paddle.

Weight: A 1:3 ratio between dits and dahs is considered optimum. Some operators prefer slightly different ratios; and the MFJ-402 weight is adjustable from 25 to 75% to suit those preferences. The power-on default is 50%, or 1:3.

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

Enter keyer functions via the keyer paddles. If you enter an invalid character, the keyer responds with two beeps. A single beep acknowledges a valid entry. Entering multiple functions at one time is not permissible. That is, each function must be individually entered, preceded by pressing the Function button. The function mode maybe exited at any time by pressing the Function switch. The keyer confirms the exit with two beeps.

Command Character	Function
A	**A**utomatic. Toggles between automatic and semi-automatic mode.
I#	**I**ambic. Sets Iambic mode A or B, where # represents A or B.
R	**R**everse. Reverses the sense of the dot and dash paddles.
W##	**W**eight. ## represents weight value between 25 and 75 percent.
X	Carrier Tune (**X**mit). Gives continuous key-down for adjusting transmitter or antenna tuner. Tapping either paddle exits tune mode and releases the key line.
Y	Pulse Tune. Gives a string of dots for adjusting transmitter or antenna tuner. Tapping either paddle exits tune mode and releases the key line.

Troubleshooting

Keyer dead: Dead battery. Replace with a new 3-volt lithium battery.

Erratic operation: Weak battery. RF is getting into keyer.

Cannot enter function mode: Make sure to firmly depress the Function button.

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

Theory of Operation and Specifications

Theory of operation:

The MFJ-402 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, which 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.

The PIC chip also senses keyer paddle activation. All dot-and-dash memories, Iambic operations, speed and weight are under the control of the PIC12C671 device.

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 3-volt lithium battery (DL/CR2430)
Keyer speed	Typically 5 to 60 WPM
Keying limits	Positive keying. 50 volts at 100 mA max
CW generation	Iambic A or B, Automatic or Semi-automatic
Memory	Dot Dash memory
Weight	50% default, adjustable 25 to 75 percent

Morse Code Character Set

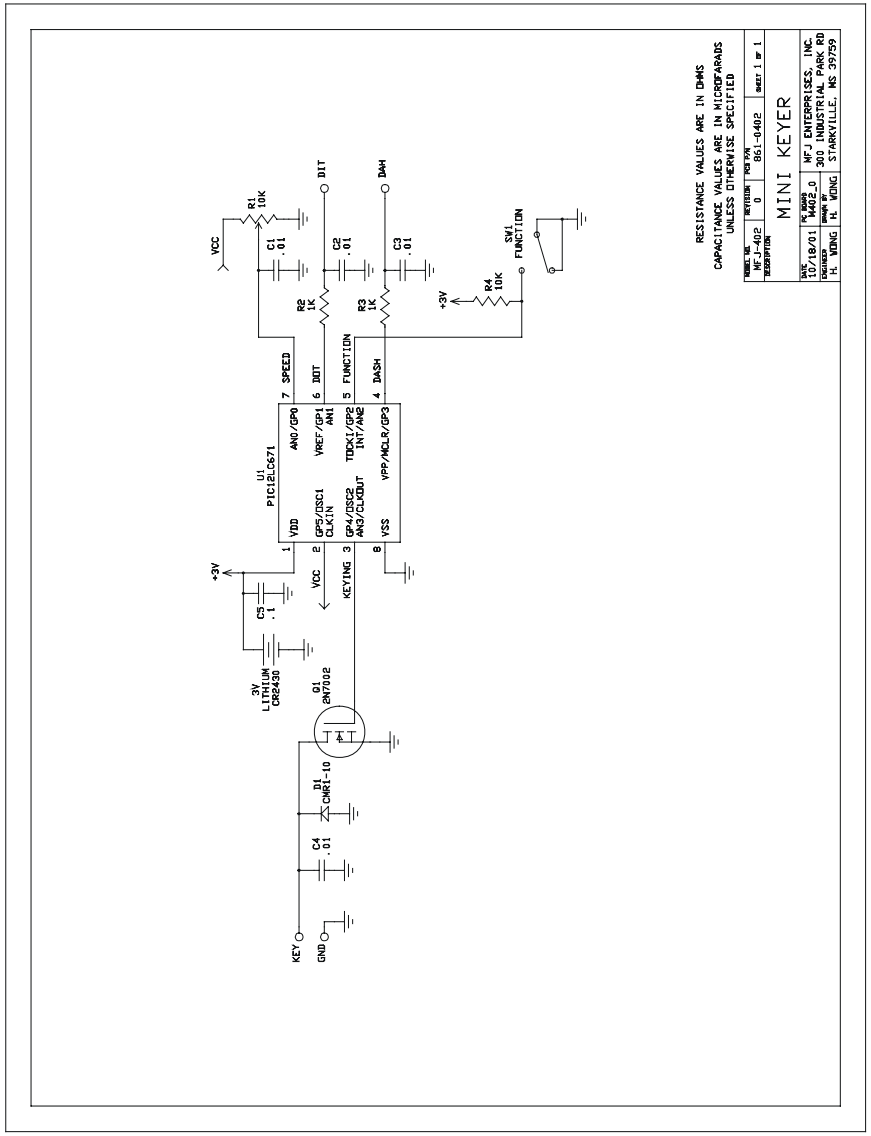
A	di-dah	• –	N	dah-dit	– •
B	dah-di-di-dit	– • • •	O	dah-dah-dah	– – –
C	dah-di-dah-dit	– • – •	P	di-dah-dah-dit	• – – •
D	dah-di-dit	– • •	Q	dah-dah-di-dah	– – • –
E	dit	•	R	di-dah-dit	• – •
F	di-di-dah-dit	• • – •	S	di-di-dit	• • •
G	dah-dah-dit	– – •	T	dah	–
H	di-di-di-dit	• • • •	U	di-di-dah	• • –
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	• – • – • –	$\overline{\text{AAA}}$
Comma	[,]	dah-dah-di-di-dah-dah	– – • • – –	$\overline{\text{MIM}}$
Question Mark or Request for Repetition	[?]	di-di-dah-dah-di-dit	• • – – • •	$\overline{\text{IMI}}$
Fraction Bar	[/]	dah-di-di-dah-dit	– • • – •	$\overline{\text{DN}}$
End of Message or Cross	[+]	di-dah-di-dah-dit	• – • – •	$\overline{\text{AR}}$
End of Work		di-di-di-dah-di-dah	• • • – • –	$\overline{\text{SK}}$
Double Dash, Pause or Break	[=]	dah-di-di-di-dah	– • • • –	$\overline{\text{BT}}$
Semicolon	[;]	dah-di-dah-di-dah-dit	– • – • – •	$\overline{\text{KR}}$
Colon	[:]	dah-dah-dah-di-di-dit	– – – • • •	$\overline{\text{OS}}$
Apostrophe	[']	di-dah-dah-dah-dah-dit	• – – – – •	$\overline{\text{WG}}$
Quotation Mark	["]	di-dah-di-di-dah-dit	• – • • – •	$\overline{\text{AF}}$
Hyphen or Dash	[-]	dah-di-di-di-di-dah	– • • • • –	$\overline{\text{DU}}$
Underline	[_]	di-di-dah-dah-di-dah	• • – – • –	$\overline{\text{IQ}}$
Dollar Sign	[$]	di-di-di-dah-di-di-dah	• • • – • • –	$\overline{\text{SX}}$
Left Parenthesis	[(]	dah-di-dah-dah-dit	– • – – •	$\overline{\text{KN}}$
Right Parenthesis	[)]	dah-di-dah-dah-di-dah	– • – – • –	$\overline{\text{KK}}$
Wait		di-dah-di-di-dit	• – • • •	$\overline{\text{AS}}$
Understood		di-di-di-dah-dit	• • • – •	$\overline{\text{SN}}$
Starting Signal		dah-di-dah-di-dah	– • – • –	$\overline{\text{KA}}$
Error		di-di-di-di-di-di-di-dit	• • • • • • • •	$\overline{\text{HH}}$
Paragraph	[¶]	di-dah-di-dah-di-dit	• – • – • •	$\overline{\text{AL}}$
Invitation to Transmit		dah-di-dah	– • –	K

1. FCC test requirement consists the 26 letters, the 10 numerals, the period, the comma, the question mark, $\overline{\text{AR}}$, $\overline{\text{SK}}$, $\overline{\text{BT}}$ and $\overline{\text{DN}}$.

Schematic


RESISTANCE VALUES ARE IN OHMS
CAPACITANCE VALUES ARE IN MICROFARADS
UNLESS OTHERWISE SPECIFIED
MINI KEYER
MFJ ENTERPRISES, INC.
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VCC
DIT
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DASH
KEYING
KEY
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CMR1-10
PIC12LC671