

# MFJ

## *EmComm Emergency Communications System.*

*Model MFJ-706*



### INSTRUCTION MANUAL

CAUTION: Read All Instructions Before Operating Equipment

## MFJ ENTERPRISES, INC.

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## Introduction

The MFJ-706 is an all in one box built for the Icom IC-706 transceiver that allows it to become a emergency communication station. Just connect the antenna of your choice and a power source and you are ready to operate. The built in voltage conditioner allows full power SSB operation from limited power source such as a vehicle accessory plug. The built in antenna tuner lets you rapidly tune any antenna automatically: unbalanced or single-wire. MFJ's exclusive *InstantRecall*<sup>™</sup>, *IntelliTune*<sup>™</sup> and *AdaptiveSearch*<sup>™</sup> algorithms give you fast automatic tuning with more than 2500 non-volatile *VirtualAntenna*<sup>™</sup> memories. .

The tuner includes a highly efficient switching L-network with wide matching capability, 1.8 to 30 MHz coverage, a radio interface port, and heavy-duty 10 amp/1000 volt relays. It is rated at 200 watts SSB/CW.

A maximum of 256 values of inductance and 256 values of capacitance are available. With the capacitance switched between the input and output side, this provides a total of 131,072 L/C tuning combinations. The nominal tuning ranges are 0 to 24  $\mu$ H and 0 to 3900 pF.

The MFJ-706 learns and remembers. When you push the tune button on the IC-706, it automatically adjusts for minimum SWR and remembers the frequency and tuner settings, safely stored in non-volatile memory. The next time you operate on that frequency (or close to it), the tuner settings are instantly restored and you're ready to operate in milliseconds.

When you push the tune button, MFJ's *InstantRecall*<sup>™</sup> checks its memory to see if you have operated on that frequency before. If so, tuning is instantaneous and you're ready to operate. If not, MFJ's *IntelliTune*<sup>™</sup> algorithm (based on MFJ's famous SWR Analyzer technology) kicks in. It measures the complex impedance of your antenna. Next, it calculates the components it needs and instantly snaps them in. Finally, it fine-tunes to minimize SWR, and you're ready to operate -all in a fraction of a second.

If the antenna impedance is not within the tuner's measurement range, MFJ's *AdaptiveSearch*<sup>™</sup> algorithm goes into action. Frequency is measured and relevant components values are determined. Only those values are searched for fast tuning. If it still cannot find a match, the search is performed again using a different search pattern.

The tuners enter a "sleep" mode when idle and when no transmit signal is present, turning off the microprocessor clock to avoid the generation of spurious signals.

## Features

- Onboard 3/8 HF antenna mount for use with mobile antennas.
- Coax connector for using external mounted antennas.
- Front mounted antenna selector switch.
- Independent tuner memories for each antenna port.
- Microphone storage slot under radio.
- Automatically matches antennas from 6 to 1600 ohms impedance (SWR up to 32:1)
- Tune in less than 15 seconds, usually less than 5 seconds
- Over 2500 non-volatile memories for tuner settings
- Highly efficient switching L-network matching circuit
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## Specifications

- Impedance matching range: 6 to 1600 ohms
- SWR matching range: up to 8:1 for < 50 ohms and up to 32:1 for > 50 ohms
- Capacitance range: 0 to 3961 pF nominal (256 values)
- Inductance range: 0 to 24.86  $\mu$ H nominal (256 values)
- Relay rating: 10 amp 1000 volts
- Relay electrical life: 100,000 operations
- Relay mechanical life: 10 million operations
- Memory endurance: 1 million erase/write cycles
- Memory data retention: > 200 years
- Power requirements: 12 - 15 volts DC

† Specifications and design are subject to change without notice.

## Fast Start

### WARNING

- **Never operate Onboard HF and VHF/UHF antenna at the same time. This will damage your transceiver.**
- **Do not touch the 3/8 antenna or antenna mount or the counterpoise wire when transmitting on this port. Serious RF burns can result.**
- **Disconnect all antennas from the MFJ-706 during lightning storms.**
- **Always tune with low power (2-10 watts) by pushing the tune button on the IC-706. Apply maximum power only after tuning up.**
- **Do not transmit with a high SWR for extended periods of time.**



1. The MFJ-706 comes pre-assembled at the factory for easy initial setup. You will need only a #2 Phillips screwdriver to mount your radio.
2. Remove the front radio cover, the handle plate and the access plate on top of the unit. You will use the Icom supplied mounting screws that came with your radio to secure it into the MFJ-706. Disconnect the microphone and face of the radio

from the body of the IC-706 before you begin. This will make mounting easier and prevent any scratches to the face.

3. Before you slide the radio into place, you must first connect the HF and VHF/UHF coax connectors from the MFJ-706 to the back of your radio. The HF connector comes from the tuner box located on the bottom of the unit. It is labeled HF and should be connected to the top connector (HF connector) on your IC-706. The VHF/UHF connector comes from the top mounted SO-239 and is labeled VHF/UHF. This connector should be connected to the bottom (VHF) connector. Make sure that these connections are tight as they will not be easily accessible when the radio is mounted.
4. Slide the radio in place from the front of the MFJ-706. Make sure the rest of the connectors are pushed to the back of the unit so they do not interfere with the mounting of the radio. You may lay the unit on its side to prevent having to hold the radio in place while attempting to align the holes. There are two fiber spacers glued to the side of the MFJ-706. Be careful not to dislodge these when sliding the radio into place. Slightly pushing the sides of the unit apart will help when inserting it.
5. When you have the unit aligned, hand insert the Icom mounting screw in all four places. If the radio is aligned correctly, the CW volume and pitch controls should be accessible from the right side of the unit.
6. Verify that the two remaining connectors are not caught between the bottom of the radio and the end plate at the back of the IC-706. You may secure the radio mounting screws with the #2 Phillips screwdriver if they are free.
7. Connect the remaining main power plug and the tuner interface connector to your IC-706. Pay close attention to these as they will only go one way.
8. Double check all your connections and verify that they are secure and correctly inserted.
9. Reinstall the access panel and handle plate. Make sure to use the thumb screws for the access plate. You may need to access the back of the radio in the field.



## Controls

1. On/Off This is the main power switch for the MFJ-706. Pushing this button will begin to charge the capacitors in the voltage conditioner. No operation of the radio will be possible while the charge light is lit. Make sure that the power switch on the IC-706 is turned off when charging the capacitors. Attempting to operate the radio during the charging cycle will greatly extend the charge time and could damage the charging circuit.

2. HF antenna selector switch This switch controls which antenna port is selected by the tuner for operation and is accompanied by a single or double beep. When the selector switch is in the onboard position, the top mounted 3/8" coupler and the counterpoise post are connected to the tuner. Use this port to mount a HF whip or other mobile HF antenna and a counterpoise wire. The HF antenna use should be close to resonance at the band in which you intend to operate. **CAUTION** Do not transmit with high power when using an onboard antenna. Follow all safety guidelines for limiting exposure to RF radiation. It is best to use the remote head cable when using the onboard antenna so that the operator can be located away from the transmitter. When the selector switch is in the external position, the coaxial connector on the bottom rear of the unit is selected. Use this port when a remote or outside antenna will be connected using 50 ohm coaxial feedline.

3. IC-706 tune button This button, although not located on the MFJ-706, is what controls the tuner operation. When the IC-706 is turned on, the tuner is powered up as well. The tuner is initially in standby mode. To activate the tuner and begin the tune sequence, push the tune button on the IC-706 (make sure you have an antenna connected to the correct port). After the tuner has finished, the red light on the tune button will be illuminated. Pressing the button again will turn off the light and place the tuner into bypass mode. Bypass mode is also selected when you change bands on the IC-706.

## Operation

Using your IC-706 in the MFJ-706 will allow you much more versatility in where and when you operate. Powering your EmComm station can be done by connecting the power cord to an automobile accessory plug or an available power supply with an accessory plug on it. Connect your onboard or external antenna and select the appropriate port for that antenna. Turn the unit on and wait for the charge light to turn off. This will normally take about 30 seconds or less. Once the light is off, turn on the radio and select the frequency that you wish to operate. Once you have determined that the frequency is clear, push the tune button on the IC-706. Once the tuner is finished a series of beeps will communicate the result of the tuning process.

**Note:** *During the automatic tuning process, the tuner will make some buzzing noise. These are the relays switching at a very high rate and is normal. Do not be alarmed.*

When the automatic tuning is completed, a series of beeps indicate the tuned SWR where one beep indicates an SWR of 1.5 or less, two beeps indicate an SWR of 1.6 to 2.0, three beeps indicate an SWR of 2.1 to 2.5, and four beeps indicate an SWR of 2.6 to 3.0. For SWR above 3.0, “SWR” (di-di-dit di-dah-dah di-dah-dit) will be sent in CW and indicates that the tuner was not able to tune the load below 3:1 SWR

## Miscellaneous

### Antenna Memory

The “memory resolution” is the width of frequency spectrum that the tuner recognizes as being the same as a tuned frequency already in memory. The memory resolution is approximately 0.1 percent of the lower frequency of each amateur band. For example, the memory resolution on the 40-meter band (7000 to 7300 kHz) is 7 kHz; if the tuner has memorized a setting for 7050 kHz, it will automatically call up this setting for any frequency from 7047 to 7053 kHz. Memory resolution is smaller at lower frequency to accommodate the higher antenna Q and larger at higher frequency where the antenna Q is lower. The memory resolutions for the HF amateur bands 160 through 10 meters are:

Meter	Frequency Range (kHz)	Memory Resolution (kHz)
160	1800 – 2000	2
75/80	3500 – 4000	4
60	5330.5, 5346.5, 5366.5, 5371.5 and 5403.5	5 memory locations
40	7000 – 7300	7
30	10100 – 10150	10
20	14000 – 14350	14
17	18068 – 18168	18
15	21000 – 21450	21
12	24890 – 24990	25
10	28000 – 29700	28

Table 1. Memory Resolution.

The memory resolution for non-amateur frequency bands between 160 and 10 meters is approximately 0.2 percent of the lower frequency of each band. There are over 2500 memory locations.

### **IntelliTune™ Algorithm**

When the tuner cannot find an appropriate setting in its memory, it begins its calculation function. It measures the complex impedance of the antenna (load) at the transmitting frequency, then it calculates the LC components needed for a match. Then it fine-tunes the components for minimum SWR. If the tuner cannot calculate the load impedance, it proceeds to an adaptive search algorithm for tuning.

### **LC Limits**

The upper limits of inductance (L) and capacitance (C) are factory-limited according to frequency and maximum power rating; i.e., higher frequencies need less inductance and less capacitance when the L-network is properly tuned. These limits are built into the MFJ-706 to prevent matching of extreme load impedance outside the tuner's specification, which may result in excess voltage and/or current across the tuner's components.

### **Morse Code**

If not enough power is applied for tuning (less than two watts); "QRO" (dah-dah-di-dah di-dah-dit dah-dah-dah) will be sent in CW. Increasing the input power above two watts ends this message. If the antenna has a very high swr and the transceivers foldback circuit prevents it from transmitting more than two watts, you will have to adjust the antenna for a closer match.

When input power is too high, the tuner enters a self-protection mode by bypassing the tuner. The tuner will not allow any of its relays to change. This feature prevents damage to your tuner.

If too much power is applied when tuning, the tuner will cease the tuning routine and send "QRP" (dah-dah-di-dah di-dah-dit di-dah-dah-dit) on CW. This occurs when the forward power exceeds 75 watts and the SWR is greater than 3.0, or when the forward power exceeds 125 watts regardless of the SWR.

If the tuning process is activated under these conditions, the tuner will not start the tuning. It will send the appropriate code on CW.

### **Grounding Hints**

To minimize RFI, single wire feedlines (such as used with Windom or longwire antennas) should be kept away from other wiring. Radiation will be minimized if the single wire feeder runs parallel and reasonably close to the wire that connects the tuner to the outdoor ground. The antenna feed wire should be adequately insulated to prevent arcing or accidental contact.

For safety, please use good DC and RF grounds. It is particularly important to have a good RF ground when using a single wire feeder. When using a single wire feeder, the tuner needs something to "push" against in order to force current into the single wire feedline. If a good RF ground is not available, RF will usually find its way back into the power line (RFI), transmitter audio circuits (RF feedback), or the operator (RF burns).

Metal water pipes and ground rods provide good DC and AC safety grounds, but they are often inadequate for RF grounding. Ground rods by themselves are almost useless for dependable RF grounding.

RF grounds work much better when "spread out" over a large area, especially when they employ multiple connections directly to the equipment ground point. Metal water pipes, heating ducts, and fences may work (especially if they are connected together with multiple wires), but the best RF grounds are radial systems or multi-wire counterpoises. Radials and counterpoises provide large, low resistance surfaces for RF energy.

RF and lightning travel on the surface of conductors. Braided or woven conductors have high surface resistance to lightning and RF. Ground leads for RF and lightning should have wide smooth surfaces. Avoid the use of woven or braided conductors in RF and lightning grounds unless the lead needs to be flexible.

## Antenna System Hints

### Location

For the best performance, an end-fed longwire wire antenna should be at least one quarter-wavelength long at the operating frequency. Horizontal dipole antennas should be at least a half-wavelength long and located as high and clear as possible. While good RF grounds help the signal in almost any transmitting installation, it is extremely important to have good RF grounds with long wire or other Marconi-style antennas.

### Matching Problems

Most matching problems occur when the antenna system presents an extremely high impedance to the tuner. When the antenna impedance is much lower than the feedline impedance, an *odd quarter-wavelength* feedline converts the low antenna impedance to a very high impedance at the tuner. A similar problem occurs if the antenna has an extremely high impedance and the transmission line is a multiple of a half-wavelength. The half-wavelength line *repeats* the very high antenna impedance at the tuner. Incorrect feedline and antenna lengths can make an otherwise perfect antenna system very difficult or impossible to tune.

One example where this problem occurs is on 80 meters when an odd quarter-wave (60 to 70 feet) open wire line is used to feed a half-wave (100 to 140 feet) dipole. The odd quarter-wave line transforms the dipole's low impedance to over three thousand ohms at the tuner. This is because the mismatched feedline is an *odd multiple* of 1/4 wavelength long. The line *inverts* (or teeter-totters) the antenna impedance.

A problem also occurs on 40 meters with this same antenna example. The feedline is now a multiple of a half-wave (60 to 70 feet) and connects to a full-wave high impedance antenna (100 to 140 feet). The half-wave line repeats the high antenna impedance at the tuner. The antenna system looks like several thousand ohms at the tuner on 40 meters.

This places enormous strain on the tuner components, since voltages can reach several thousand volts. This can cause component arcing and heating.

The following suggestions will reduce the difficulty in matching an antenna with a tuner:

- Never center feed a half-wave multi-band antenna with a high impedance feedline that is close to an odd multiple of a quarter-wave long.
- Never center feed a full-wave antenna with a feedline close to a multiple of a half-wave long.
- If this tuner will not "tune" a multi-band antenna, add or subtract 1/8 wave of feedline (for the band that won't tune) and try again.
- Never try to load a G5RV or center fed dipole on a band below the half-wave design frequency. If you want to operate an 80-meter antenna on 160 meters, feed either or both conductors as a longwire against the station ground.

To avoid problems matching or feeding any dipole antenna with high impedance open wire lines, avoid the following lengths.

160 meters dipole:    Avoid 130, 260 ft  
80 meters dipole:    Avoid 66, 135, 190 ft  
40 meters dipole:    Avoid 32, 64, 96, 128 ft

Some slight trimming or adding of feedline may be necessary to accommodate the higher bands.

#### **WARNING**

**To avoid problems, a dipole antenna should be a full half-wave on the lowest band. On 160 meters, an 80 or 40 meters antenna fed the normal way will be extremely reactive, with only a few ohms of feedpoint resistance. Trying to load an 80 meters half-wave dipole (or shorter) antenna on 160 meters can be a disaster for both your signal and the tuner. The best way to operate 160 meters with an 80 or 40 meters antenna is to load either or both feedline wires (in parallel) as a longwire. The antenna will act like a "T" antenna worked against station ground.**

## FULL 12-MONTH WARRANTY

MFJ Enterprises, Inc. warrants to the original owner of this product, if manufactured by MFJ Enterprises, Inc. and purchased from an authorized dealer or directly from MFJ Enterprises, Inc. to be free from defects in material and workmanship for a period of 12 months from date of purchase provided the following terms of this warranty are satisfied.

1. The purchaser must retain the dated proof-of-purchase (bill of sale, canceled check, credit card or money order receipt, etc.) describing the product to establish the validity of the warranty claim and submit the original or machine reproduction of such proof of purchase to MFJ Enterprises, Inc. at the time of warranty service. MFJ Enterprises, Inc. shall have the discretion to deny warranty without dated proof-of-purchase. Any evidence of alteration, erasure, or forgery shall be cause to void any and all warranty terms immediately.
2. MFJ Enterprises, Inc. agrees to repair or replace at MFJ's option without charge to the original owner any defective product provided the product is returned postage prepaid to MFJ Enterprises, Inc. with a personal check, cashiers check, or money order for **\$10.00** covering postage and handling.
3. MFJ Enterprises, Inc. will supply replacement parts free of charge for any MFJ product under warranty upon request. A dated proof of purchase and a **\$8.00** personal check, cashiers check, or money order must be provided to cover postage and handling.
4. This warranty is **NOT** void for owners who attempt to repair defective units. Technical consultation is available by calling (662) 323-5869.
5. This warranty does not apply to kits sold by or manufactured by MFJ Enterprises, Inc.
6. Wired and tested PC board products are covered by this warranty provided **only the wired and tested PC board product is returned**. Wired and tested PC boards installed in the owner's cabinet or connected to switches, jacks, or cables, etc. sent to MFJ Enterprises, Inc. will be returned at the owner's expense unrepaired.
7. Under no circumstances is MFJ Enterprises, Inc. liable for consequential damages to person or property by the use of any MFJ products.
8. **Out-of-Warranty Service:** MFJ Enterprises, Inc. will repair any out-of-warranty product provided the unit is shipped prepaid. All repaired units will be shipped COD to the owner. Repair charges will be added to the COD fee unless other arrangements are made.
9. This warranty is given in lieu of any other warranty expressed or implied.
10. MFJ Enterprises, Inc. reserves the right to make changes or improvements in design or manufacture without incurring any obligation to install such changes upon any of the products previously manufactured.
11. All MFJ products to be serviced in-warranty or out-of-warranty should be addressed to **MFJ Enterprises, Inc., 300 Industrial Park Rd, Starkville, Mississippi 39759, USA** and must be accompanied by a letter describing the problem in detail along with a copy of your dated proof-of-purchase and a telephone number.
12. This warranty gives you specific rights, and you may also have other rights, which vary from state to state.



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