

MFJ

***300 Watt IntelliTuner™
Remote Automatic Antenna Tuner
MFJ-993BRT***

INSTRUCTION MANUAL

CAUTION: Read All Instructions Before Operating Equipment

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DISCLAIMER

Information in this manual is designed for user purposes only and is not intended to supersede information contained in customer regulations, technical manuals/documents, positional handbooks, or other official publications. The copy of this manual provided to the customer will not be updated to reflect current data.

Customers using this manual should report errors or omissions, recommendations for improvements, or other comments to:

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NOTES

The Basics

Introduction

The MFJ-993BRT 300 Watt IntelliTuner™ is a comprehensive remote automatic antenna tuning unit.

The MFJ-993BRT lets you rapidly tune almost any unbalanced or single-wire antenna automatically. Balanced feedlines may be used with an MFJ-912 1.5 kW 4:1 balun connected to the MFJ-993BRT antenna output.

MFJ's exclusive *InstantRecall*™, *IntelliTune*™ and *AdaptiveSearch*™ algorithms give you fast automatic tuning with more than 2,500 non-volatile *VirtualAntenna*™ memories. The memories permit virtually instantaneous tuning when a previously tuned frequency is sensed by the MFJ-993BRT.

The tuner includes a highly efficient switched-L network with wide matching capability, 1.8 to 30 MHz coverage, and heavy-duty high current/high-voltage relays. The MFJ-993BRT is rated at 300 watts PEP SSB 150 watts CW and will match impedances from 6 to 1600 ohms (SWR up to 32:1).

A maximum of 256 values of inductance and 256 values of input capacitance. This provides a total of 131,072 L/C tuning combinations. The nominal tuning ranges are 0 to 24 μ H and 0 to 3900 pF. And once a match is found, the matching network values can be displayed so you may design your own fixed matching network if desired.

Like all MFJ *IntelliTuners*™, the MFJ-993BRT learns and remembers. When you transmit, 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) and antenna, these tuner settings are instantly restored and you're ready to operate in milliseconds.

When you key your transmitter, MFJ's *InstantRecall*™ 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*™ algorithm (based on MFJ's famous SWR Analyzer technology) kicks in. It measures the complex impedance of your antenna. Next it calculates the components needed 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*™ 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 target SWR can be set at 1.0 through 2.0. The minimum power to tune is approximately five watts. 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

- Automatically matches antennas from 6 to 1600 ohms impedance (SWR up to 32:1)
- Handles 300 watts PEP SSB, 150 watts CW
- Tunes in less than 20 seconds, usually less than 5 seconds
- Over 2,000 non-volatile memories for tuner settings
- Highly efficient switched-L network matching circuit
- 1.8 to 30 MHz continuous frequency coverage
- Adjustable target SWR from 1.0 to 2.0
- Adjustable SWR threshold from 0.5 to 1.5

Specifications

- Impedance matching range: 6 to 1600 ohms resistive. The reactive tuning range is a function of the maximum inductance (24uHy) and maximum capacitance (3900pf) available for a given frequency or band. The MFJ-993BRT will tune the following end-fed antenna lengths:
 - 90-foot or longer antenna on 160 meters
 - 25-foot or longer antenna on 80-meters
 - 8-foot or longer antenna on 40-10 meters.

Note: The optional MFJ-2904 external inductor extends the MFJ-993BRT tuning range to 160 meters for popular 43-foot verticals.

- SWR matching range: up to 4:1 for < 50 ohms and up to 32:1 for > 50 ohms
- Minimum power for tuning: 5 watts
- Maximum power while tuning: 100 watts with foldback, 20 watts without foldback
- RF power limit: 300 watts PEP SSB, 150 watts CW
- Frequency range: 1.8 to 30 MHz continuous coverage
- Capacitance range: 0 to 3908 pF nominal (256 values)
- Inductance range: 0 to 24.86 μ H nominal (256 values)
- Relay contact ratings: 16 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: > 100 years
- Power requirements: 12 - 15 volts DC supplied via MFJ-4117 Bias-Tee on coaxial input 2.1x5.5mm coaxial plug center pin positive
- Current consumption: 1.4 amps or less
- Dimensions (approx.): 10-1/4 x 2-1/2 x 14 in. (261 x 64 x 356 mm) (width/height/depth) including connectors and mounting brackets
- Weight (approx.): 3.5 lb (1.60 kg)

† Specifications and design are subject to change without notice.

Installation

WARNING

- Never operate the tuner with its cover removed. Contact with the components inside the tuner while transmitting will result in painful RF burns.
- Locate the tuner so that the antenna terminals are not accessible during operation. The single wire connection will have high voltage while transmitting.
- Do not mount in a position that will put it under water at any time.
- Do not mount it in a place that will allow sprinklers or water hoses to spray the weather seals or connectors
- Always tune with low power (10-20 watts recommended). Apply maximum power only after tuning up.
- Never exceed tuner specifications.

1. Mount the tuner in a convenient place relative to the antenna. Mount it in such a way that it will not come in contact with people, pets, or shrubbery. The Wire terminal will have high RF voltages on it in use. These voltages can cause serious RF burns if the terminals are touched when transmitting.
2. The tuner can be mounted vertical or with the plastic cover up. Do not mount with the cover face down. Water may accumulate and seep into the tuner.
3. Connect the tuner to the transceiver, the amplifier, the MFJ-4117 Bias Tee (note the orientation of the Bias TEE) and the antenna with 50-ohm coaxial cables capable of handling the RF power levels expected. See Figure 1 .

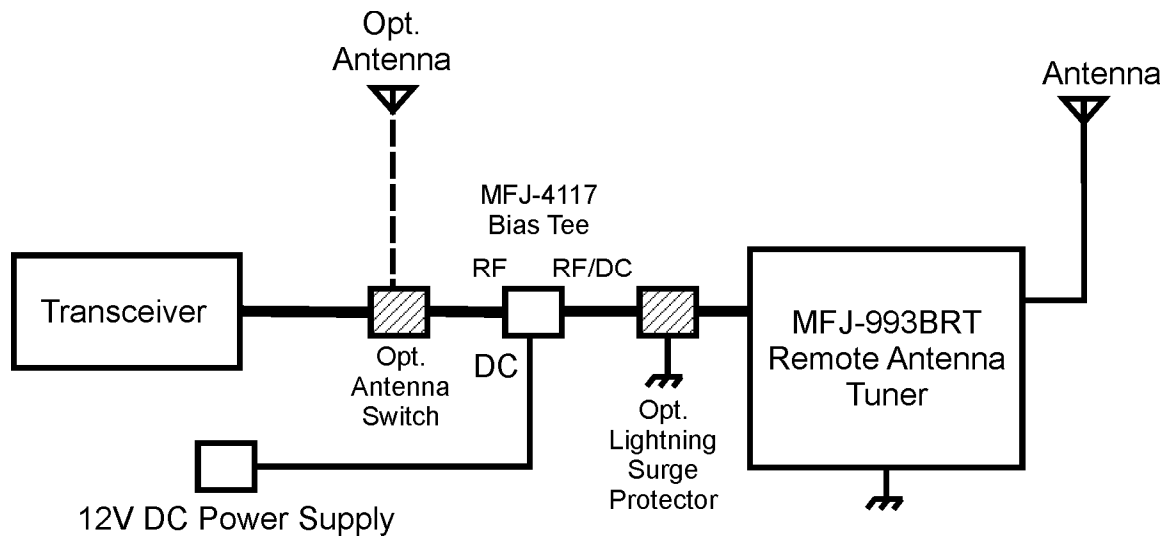


Figure 1: Basic Connections

4. Connect the antenna to the tuner. Random wire or single wire line antennas should be connected to the WIRE binding post on the back of the tuner. Do not connect WIRE and coax ANTENNA at same time! Both are connected in parallel. Run the antenna connected to the wire terminal away from the tuner and not routed near the front cover to reduce the chance of RF getting into the tuner and causing it to go into bypass mode.

Note: Route all single and random wire antennas safely to prevent RF burn hazard. For balanced feedlines, connect an MFJ-912 1.5 kW 4:1 balun to the antenna connector output of the MFJ-993BRT.

Note: When the UHF RF output connector is not used, it should be covered so dirt and/or moisture does not accumulate in the connector. A dirty open connector is susceptible to arcing under severe SWR conditions.

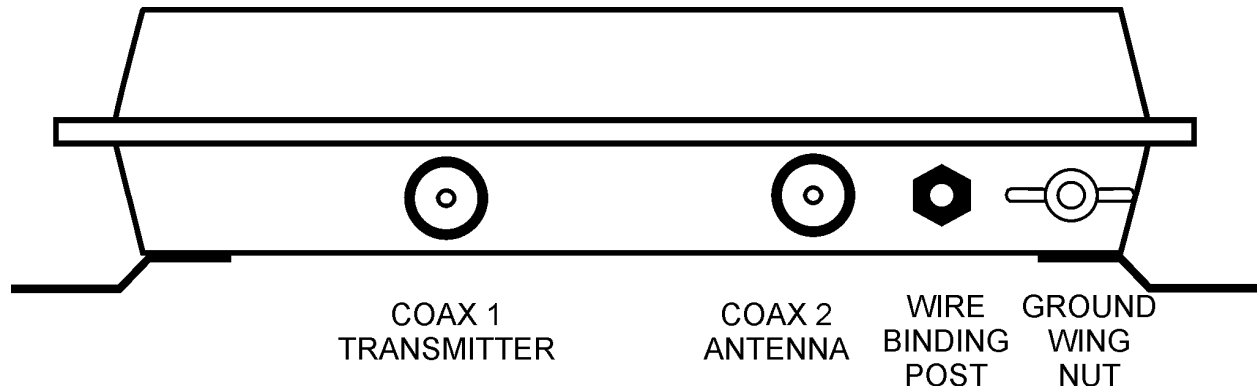


Figure 2: Side View of Connectors

5. Connect a wire from a MFJ-993BRT GROUND wing nut to an adjacent antenna ground point. See "Grounding Hints" on page 24. A good ground is important for the best operation of the antenna and to reduce the chance of RF interfering with the tuner operation and causing the tuner to go into bypass mode.
6. If a Lightning Surge Suppressor is used in line with the feed line to the tuner make sure it is the type that will pass DC such as the MFJ-272 as DC power is supplied through the feed line.
7. Connect a 12-15V power supply to the DC input of the MFJ-4117 BIAS TEE to supply power to the tuner. The station supply or an MFJ-1316 will work. The supply needs to be capable of supplying 1.4A. The use of a regulated supply is not mandatory but is recommended for best performance. An optional 12 volts DC 1.5 amp power supply, the MFJ-1316, is available from MFJ Enterprises, Inc.

WARNING:

Applying greater than 18 volts to the MFJ-993BRT can result in permanent damage.

8. If an optional local antenna switch is used place it **before** the BIAS TEE (the RF side not the RF/DC side) to prevent the chance of shorting out the DC line with the switch.

Note: The MFJ-993BRT is not designed to be placed AFTER remote antenna switches. Some antennas and antenna switches have DC continuity between the center pin and shield which will short out the power supply when switched to those positions

Note: When the tuner power is OFF, the tuner is in bypass mode and RF from the transmitter goes directly to the antenna with no matching. When turned on, the tuner powers up in bypass mode.

Operation

1. Turn on the MFJ-993BRT power via the MFJ-4117 Bias TEE. With power off the Tuner is in Bypass mode. With power on the MFJ-998 wakes up in bypass mode until RF is supplied to the tuner.
2. Initial Tuneup:
 - a. Transmit a low power signal (5 to 20 watts). Any amplifier must be OFF LINE! Wait while the tuner finds a tuning solution for that frequency. Verify that the SWR is below the target SWR (default 1.5:1) with an in-shack SWR meter.
 - b. Once the tuner has found a tuning solution you are ready to operate at high power.
 - c. You can repeat the initial tune up on other frequencies and bands so the tuner will memorize the settings for those frequencies and bands.
 - d. If the tuned SWR is higher than you prefer (though it will be within the SWR window of the retune function) turn off the MFJ-993BRT for 2-seconds. Then turn it back on and tune again.
3. Normal Tuneup
 - a. Transmit a low power signal (5 to 20 watts).
 - b. The tuner will check the frequency and set the tuner for the settings for that frequency if memorized and quickly tune to those settings.
 - c. If the frequency is not memorized or the SWR is outside the tuning window then the tuner will retune as in the initial tuneup.

Note: The MFJ-993BRT will sometimes not tune when changing bands. This can occur if the MFJ-993BRT tuning solution for the previous band results in a very high SWR on the new band. This very high SWR can reflect all input power from your transceiver. The solution is to simply cycle power to the MFJ-993BRT when changing bands. This drops the MFJ-993BRT to bypass prior to tuning so some forward power is sensed thus permitting a tune to occur.

4. Once the MFJ-993BRT completes tuning, you can increase power up to 300 watts PEP or 150 watts CW.

Note: When attempting to tune, the MFJ-993BRT will not tune and will bypass itself when the forward power exceeds 75 watts and the SWR is greater than 3.0, or when the forward power exceeds 125 watts while tuning regardless of the SWR.

WARNING

Never tune with high power.

Always use low power (5 to 20 watts) when tuning. Tuning with high power will cause voltages and currents that may exceed the component ratings or present antenna loads that can damage an amplifier or radio during the tuning process.

WARNING:

Do not turn the power on and off rapidly, otherwise the tuner setting memory can be corrupted and the unit will have to be reset to factory defaults. Leave the tuner off for 1 to 2 seconds before turning it back on.

Note: During the tuning process, the tuner will make noise as the relays switch at a very high rate. This is normal. Do not be alarmed.

Tuning Resolution

Meter	Frequency Range (MHz)	Memory Resolution
160	1.800-2.000	2
75/80	3.500-4.000	4
60	5.3305, 5.3465, 5.3665, 5.3715, and 5.4035	5 memory locations
40	7.000-7.300	7
30	10.100-10.150	10
20	14.000-14.350	14
17	18.068-18.168	18
15	21.000-21.450	21
12	24.890-24.990	25
10	28.000-29.700	28

Figure 8 Tuning Window Resolution Chart

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.

Tuner settings are stored in memory. Refer to Figures 15 and 16 for the on-screen Memory indicator. Defaults are memory banks 1A ON. To clear the antenna memory bank, turn off the power to the tuner, then press and hold both [TUNE] and [C-UP] buttons while turning on the power. A DELETE BANK message will appear. "Total Reset" erases both antenna memories and returns all tuner settings to their factory default states. To achieve this, turn power off, press and hold [TUNE], [C-UP] and [L-UP] buttons while turning on the power. A TOTAL RESET message will appear.

Transceiver Foldback Circuit

Any in-line amplifier must ALWAYS be bypassed prior to tuning. Modern transceivers with solid-state finals usually have a foldback circuit to protect the final transistors from high SWR, which can damage or destroy them. A foldback circuit detects the SWR during transmit and reduces the output power as the SWR rises above a preset threshold, usually 2:1. The higher the SWR the lower the power is set to prevent damage. If your transceiver has a foldback circuit, you can simply key down and tune at any power level from 5 to 100 watts. If your transceiver does not have a foldback circuit, you must manually set the power level to 20 watts or less for tuning. At higher power levels, the reflected power occurred during tuning can damage your transceiver and causes component arcing which can damage the relays in the tuner. Check your transceiver owner's manual to see if yours has a foldback circuit. The use of the AM mode normally will drop the radio to around 20 to 40 watts or so. This is a convenient way of reducing power and supplying a continuous carrier for tuneup.

Grounding Hints

To minimize RFI, single wire feedlines (such as used with true 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.

A good earth ground and RF ground should always be connected to the case of the MFJ-993BRT. A wing-nut post marked GROUND is provided for ground connections. 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 as 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 underground water pipes and ground rods may provide good DC and AC safety grounds, but they are often inadequate for RF grounding. RF grounds work much better when "spread out" over a large area. 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.

There are a number of articles in the technical literature that can advise on how to properly ground the antenna system for both lightning and RF signals.

Antenna System Hints

Location

For the best performance, an end-fed 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 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 halfwave 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, 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.

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.

To avoid problems matching or feeding any dipole antenna with high impedance open wire lines, keep the lines around these lengths. [The worst possible line lengths are shown in brackets]: 160 meters dipole: 35-60, 170-195 or 210-235 feet [Avoid 130, 260 ft] 80 meters dipole: 34-40, 90-102 or 160-172 feet [Avoid 66, 135, 190 ft] 40 meters dipole: 42-52, 73-83, 112-123 or 145-155 feet [Avoid 32, 64, 96, 128 ft] Some slight trimming or adding of feedline may be necessary to accommodate the higher bands.

Appendices

Resetting the Tuner

Each time the tuner is powered off, the microprocessor saves all memories and configurations to nonvolatile memory ready to be used the next time the unit is turned on and transmit power is applied. If the tuner is not working properly, even on initial power on, try resetting to the factory defaults.

Resetting requires removal of the cover and the switch board to gain access to the switches. The components inside are static sensitive so make sure you are grounded to reduce the chance of a static discharge to the switch board or the microprocessor portion of the board. Also there are no display or meter functions available to give any visual prompts.

Factory Defaults

The unit is shipped with the following default settings:

- Main Menu Digital Wattmeter
- Setup Menu Target SWR
- Inductance 0 μ H
- Capacitance 0 pF
- Antenna 1
- Tuning Mode Automatic
- Target SWR 1.5
- Auto Tune SWR 0.5 above target SWR
- Amp Bypass SWR 2.0
- Meter Range Auto range
- Peak Hold On
- Memory Bank 1A
- IntelliTune On
- SWR Beep Off
- Beep On
- Refresh Off
- Radio Interface Off
- Push Tune <0.5s To Bypass
- Sticky-Tune On

Factory Default Reset

To reset the tuner to these defaults:

1. Turn off the power to the tuner.
2. Press and hold both the [TUNE] and [L-UP] buttons while turning the power on.
3. Release the buttons after 2 or 3 seconds.
4. Resume with normal operation.

Note: Resetting to factory defaults does not erase the antenna memories.

Note: If the MFJ-993BRT is not behaving properly or acting erratic, try resetting the tuner to factory defaults.

Total Reset

To erase both antenna memories and reset to factory defaults, press and hold down the [TUNE], [C-UP] and [L-UP] buttons while turning the power on. Press the YES [C-DN] button to delete both antenna memories and reset factory defaults, or press the NO [L-DN] button to cancel. Release the button to resume normal operation. Remember that both antenna memories will be lost!

Delete Entire Antenna Memory

To delete the entire antenna memory turn off power to the tuner, and then press and hold both the [TUNE] and [ANT] buttons while turning the power back on. Press the YES [C-DN] button to delete the antenna memory or press the NO [L-DN] button to cancel. Release the button to resume normal operation.

List of Accessories

- MFJ-912: 1.5 kW 4:1 balun
- MFJ-2904: 160 Meter Tuning Range Extender for 43-foot Verticals
- MFJ-1316: 12 VDC 1.5 amp power supply
- MFJ-5409: 6 feet long RS-232 cable, female DB-9 to male DB9 connector
- MFJ-5803: 3 feet long RG-58 A/U 50-ohm coax cable with a PL-259 connector on each end
- MFJ-5806: 6 feet long RG-58 A/U 50-ohm coax cable with a PL-259 connector on each end
- MFJ-5818: 18 feet long RG-58 A/U 50-ohm coax cable with a PL-259 connector on each end

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 **\$12.00** 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 un-repaired.
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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