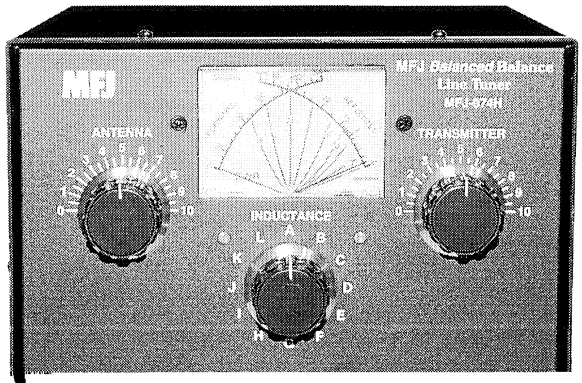
MFJ

Balanced Line Tuner

Model MFJ-974B/974HB



Installation

> ***CAUTION***
>
> Locate the tuner so the rear is not accessible during operation. Extremely High Voltages are present on the terminals during operation.

1. Place the tuner in a convenient location at the operating position. With random wire or balanced feedlines, the feed through insulators may have high RF voltages. These voltages can cause serious RF burns if the terminals are touched when transmitting. **Be sure to locate the tuner so these terminals and antenna wires cannot accidentally be contacted during operation.**
2. Install the tuner between the transmitter and the antenna. Use a 50-ohm coaxial cable (such as RG-8/U) to connect the transmitter to the connector marked **TRANSMITTER** on the rear of the tuner.
3. Connect the antenna feedline to the tuner as follows:

> **Warning: The tuner could be damaged if the Coax / Wire switch is not properly set. Improper selection will result in loss of radiated power.**

   A. Coaxial feedlines connect to the coax connector labeled **ANTENNA.** Select the ***Coax / Wire*** option on the front of the tuner.

   B. Random wire or single wire line antennas should be connected to the top red connector on the back of the unit. Select the ***Coax / Wire*** option on the front of the tuner. Connect the *ground terminal* on the rear of the tuner to a suitable earth ground.

> **Special Note: The tuner must be connected to a suitable RF ground when a random or single wire antenna is connected.**

   Note: Route all single and random wire antennas safely to prevent RF burn hazard.

   C. Balanced feedline (open wire, twinlead, or twin-axial line) is connected to the **BALANCED LINE** terminals.

4. A ground post is provided for an RF ground connection.

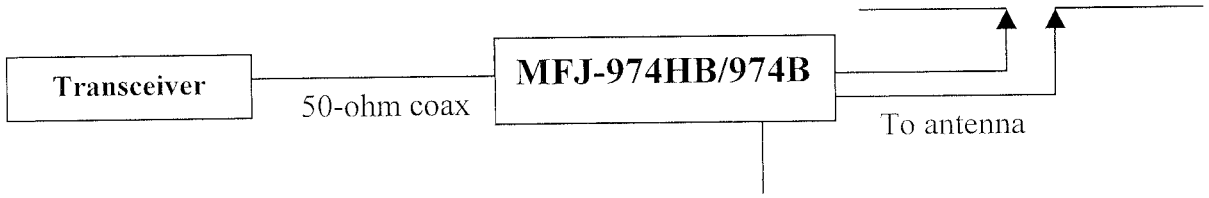


Figure 1
Block Diagram

Operation

The MFJ-974H uses three inductors for maximum efficiency. A 2½-inch diameter high-Q air-wound inductor is tapped for flexibility and is used on frequencies from 3.5 to 30 MHz. For 160 Meters (**MFJ-974HB** only) an additional inductance, made of Teflon™ insulated wire wound on two powdered-iron cores, is switched in by the front panel **160 METER** pushbutton. Front panel inductor switch position L automatically selects a 6-Meter only inductance (bypassing the larger air-wound coil). Inductance switch position A is the greatest inductance, position L the least. The inductance decreases as the knob is rotated clockwise.

The **ANTENNA** and **TRANSMITTER** capacitors have *maximum capacitance* at setting 0 and *minimum capacitance* at setting 10.

Maximum tuner efficiency is achieved with the most capacitance (settings closest to 0) and the least possible inductance (higher letters of the alphabet). This efficiency translates into best power handling, broadest bandwidth, and least power loss. The goal is always to operate the tuner at the lowest Q for the LC (inductance/capacitance) circuit.

When necessary to increase the tuner's matching range, set the **ANTENNA** or **TRANSMITTER** control to a higher number, or dial in a lower letter on the **INDUCTOR** switch, but remember that this lowers the efficiency and power handling capability of the tuner.

Adjustment Procedure

1. If the exciter or transmitter must be tuned, do it into a 50-ohm dummy load.
2. Set the **ANTENNA, INDUCTANCE,** and **TRANSMITTER** controls at the settings in the Suggested Tuning Chart on Page 9. At these settings signals (or at least some noise) should be audible in your receiver.
3. Place the **POWER** switch in the **LO** position.
4. Transmit at low power (20 or 25 watts should suffice).
5. Rotate the **ANTENNA** and **TRANSMITTER** controls for maximum forward power and minimum reflected power (ideal). If full forward power and zero reflected power cannot be obtained, turn the **INDUCTOR** one letter lower in the alphabet and try again. If this does not achieve a match, turn the **INDUCTOR** control *two* letters lower and try.

   Note: *Never* change the **INDUCTOR** setting while power is applied to the tuner!
6. Once full forward power and zero reflected power are achieved, *always* try advancing the **INDUCTOR** setting by one letter (higher) and tune for a match. If a match can be achieved at two different **INDUCTOR** settings, the "higher letter" (lower inductance) setting is better.
7. Adjust transmitter to full output and touch up the tuner settings if needed.
8. For quick retuning of the tuner, record the **INDUCTOR** and **CAPACITOR** settings for each band (see the Logged Tuning Chart, Page 10).

Note: Maximum power handling is achieved when both the **ANTENNA** and **TRANSMITTER** controls are set at the lowest possible number, and the **INDUCTOR** control is set at the highest possible letter that permits matching the antenna. Following this guideline will ensure maximum power handling capability and efficiency, and the smoothest tuning.

WARNING:

- ***Never* operate the tuner with the top removed. Contact with the components inside the tuner while transmitting will result in painful RF burns.**
- ***Never* rotate the INDUCTANCE switch while transmitting. Doing so may permanently damage the switch.**
- **Locate the tuner so that the rear terminals are *not accessible* during operation. The balanced line connectors may have high voltage on them while transmitting.**
- ***Disconnect* all antennas from the tuner during lightning storms.**
- ***Always* tune with low power (i.e. less than 100 watts). Apply maximum power only after tuning up.**
- **Be sure to adjust the SWR before transmitting at full power. Do *not* transmit with a high SWR for extended periods.**

Opera

While this tuner is designed to have as large a tuning range as possible, there are limits to the tuning range of the capacitors. Some antennas may require more or less capacitance than is available. In these cases, the SWR may not be reduced to 1:1. If the SWR is higher than the limits of your rig, try changing the length of the antenna or feedline to bring the impedance within the tuning range of the tuner.

When adjusting the tuner, use the lowest number on the **ANTENNA** and **TRANSMITTER** controls and the highest letter on the **INDUCTOR** control that produces a good SWR. This will reduce tuner losses and increase the power rating of the tuner.

In Case Of Difficulty

If the tuner fails to tune, please **double check** all connections and follow the tuning procedures again.

Be sure you are using *enough inductance* (low enough inductance letter) and have the *capacitors open far enough* (higher front panel numbers).

If the tuner arcs at the rated power levels, please **double check** all connections and follow the tuning procedures again. The power rating of this tuner is 300 watts PEP RF power. Be sure you are using the *least amount of inductance* (highest number) and the *greatest capacitance* (lowest number) possible that still allows matching the load on the operating frequency.

Note: If this tuner arcs when operating on the 160 meter band, it may be necessary to reduce transmitter output power.

If you are still unsuccessful, but the tuner does adjust and operate when used with a dummy load or another antenna, please read the **Antenna System Hints** section.

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).

Caution

For operator safety a good outside earth ground or water pipe ground should always be installed and connected to the case of the MFJ-974HB/974B. Make certain the safety ground also connects to the transmitter and other station accessories. A wing nut post marked GROUND is provided for ground connections.

Water pipes and ground rods provide good DC and AC safety grounds, but they are often inadequate for RF grounding because they are single conductors. 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. 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 center-fed 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 length (60 to 70 feet) of open wire line is used to feed a half-wave (100 to 140 foot) 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 foot) 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 balun and the insulation in 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 any 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, 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.

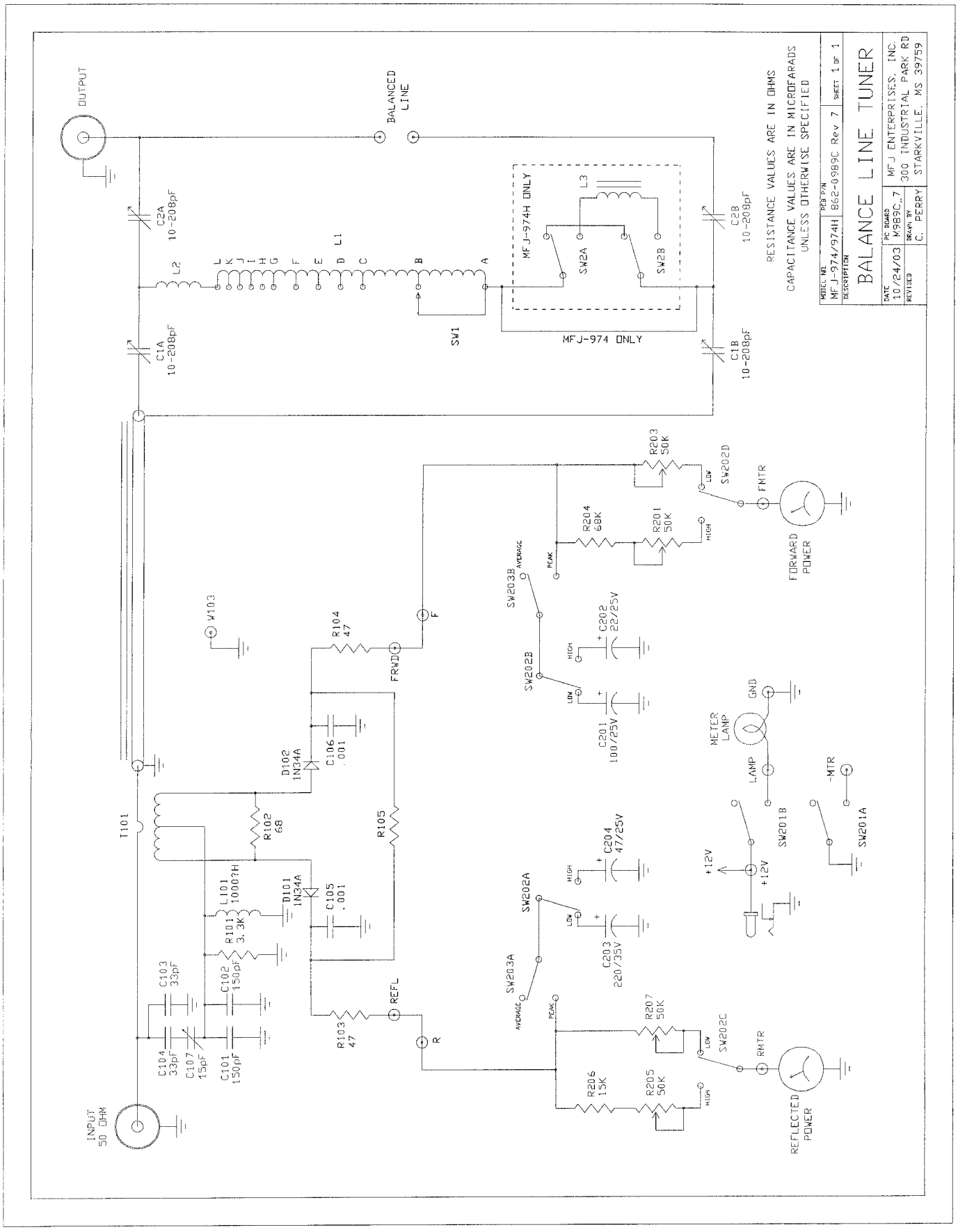
WARNING!

To avoid problems, a dipole antenna should be a full half-wavelength on the lowest band. On 160 Meters, an 80- or 40-Meter antenna fed the normal way will be extremely reactive, with only a few ohms of feedpoint resistance. Trying to load an 80-Meter halfwave 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-Meter 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.

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 **662-323-0549** or the *MFJ Factory* at **662-323-5869**. 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 (FAX) to 662-323-6551; 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.


OUTPUT
BALANCED LINE
C2A 10-208pF
C2B 10-208pF
C1A 10-208pF
C1B 10-208pF
L1
L2
L3
SW1
SW2A
SW2B
MFJ-974H ONLY
MFJ-974 ONLY
RESISTANCE VALUES ARE IN OHMS
CAPACITANCE VALUES ARE IN MICROFARADS
UNLESS OTHERWISE SPECIFIED
MODEL NO. MFJ-974/974H
PCB P/N 862-0989C Rev 7
SHEET 1 OF 1
DESCRIPTION
BALANCE LINE TUNER
DATE 10/24/03
PC BOARD M989C_7
REVISED
DRAWN BY C. PERRY
MFJ ENTERPRISES, INC.
300 INDUSTRIAL PARK RD
STARKVILLE, MS 39759
INPUT 50 OHM
T101
W103
D102 1N34A
D101 1N34A
L101 1000uH
R102 68
R101 3.3K
R104 47
R105
R103 47
C106 .001
C105 .001
C103 33pF
C102 150pF
C104 33pF
C107 15pF
C101 150pF
FRWD
REFL
F
R
SW203B
SW202B
SW202A
SW203A
C202 22/25V
C201 100/25V
C204 47/25V
C203 220/35V
R203 50K
R204 68K
R201 50K
R207 50K
R206 15K
R205 50K
SW202D
SW202C
FMTR
RMTR
FORWARD POWER
REFLECTED POWER
METER LAMP
GND
LAMP
+12V
SW201B
-MTR
SW201A
AVERAGE
PEAK
HIGH
LOW

Suggested Tuning Chart For Balanced Antennas

Frequency (MHz)	Antenna	Inductance	Transmitter	Load
1.8	0	L	2	25
1.8	0	B	0	50
1.8	2	L	0	600
2.0	2.5	L	3.5	25
2.0	4	B	3	50
2.0	4	L	2.5	600
3.5	2	E	3.5	25
3.5	0	E	0	50
3.5	0	E	0	600
3.75	1.5	E	3	25
3.75	2	E	2	50
3.75	2	E	1.5	600
4.0	0	F	0	25
4.0	1	F	0	50
4.0	1	F	1	600
7.15	0	I	2.5	25
7.15	1	I	0	50
7.15	1.5	I	1.5	600
10.1	0	K	2.5	25
10.1	1	K	0	50
10.1	0	K	1	600
14.2	3	L	4	25
14.2	4	L	3	50
14.2	4	L	3	600
18.1	6.5	L	7.5	25
18.1	6	L	6	50
18.1	7	L	7	600
21.2	7.5	L	7.5	25
21.2	7.5	L	7.5	50
21.2	7	L	7.5	600
24.9	8.5	L	8.5	25
24.9	8.5	L	8.5	50
24.9	9	K	8	600
28.5	8.5	L	9	25
28.5	9	L	9	50
28.5	8.5	L	8	600
50.1	7.5	A	2.5	25
50.1	7	A	6.5	50
50.1	7	B	8.5	600

Logged Tuning Chart

Use the chart below to log values for your station. You may want to copy this chart and post it by your tuner.

Frequency (MHz)	ANTENNA	INDUCTOR	TRANSMITTER
1.8			
3.5			
7			
10.1			
14			
18			
21			
24			
28			
50			

LIMITED 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 under warrantee provided the product is returned postage prepaid to MFJ Enterprises, Inc. with a personal check, cashiers check, or money order for **$7.00** covering postage and handling.

3. This warranty is **NOT** void for owners who attempt to repair defective units. Technical consultation is available by calling the Service Department at 662-323-0549 or the MFJ Factory at 662-323-5869.

4. This warranty does not apply to kits sold by or manufactured by MFJ Enterprises, Inc.

5. 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.

6. Under no circumstances is MFJ Enterprises, Inc. liable for consequential damages to person or property by the use of any MFJ products.

7. **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.

8. This warranty is given in lieu of any other warranty expressed or implied.

9. 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.

10. All MFJ products to be serviced in-warranty or out-of-warranty should be addressed to:

    MFJ Enterprises, Inc.,
    300 Industrial Park Road
    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.

11. This warranty gives you specific rights, and you may also have other rights which vary from state to state.