MFJ-8100 World Band Receiver

Instruction and Kit Assembly Manual

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MFJ-8100 Receiver Features

- Five separate tuning ranges between 3.5 and 22 MHz.
- Smooth 6:1 vernier-reduction tuning dial
- Sensitive FET RF amp and detector stages
- Dual headphones for sharing the fun
- Use economical "personal stereo" headphones or speakers
- Smooth, well-engineered regeneration circuit
- True choice of AM-CW-SSB reception
- Excellent reception even with a few feet of wire antenna

+ VERY IMPORTANT PLEASE READ:

Your receiver carries MFJ's respected *No Matter What*™ guarantee specifically to the extent that you may return the entire kit UNASSEMBLED for credit or refund. If you have never built an electronics kit before, PLEASE study this book carefully before unpacking the small parts. Once you have begun soldering parts, neither MFJ or any dealer can accept the return of the kit for any reason whatsoever.

MFJ-8100 World Band Receiver
Instruction and Kit Assembly Manual

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Introduction No. 1:
For Radio Beginners

You're about enjoy a versatile shortwave receiver which employs a circuit concept that is as classic as the 1920's but which uses modern engineering that takes advantage of the advanced capabilities of today's electronic components.

This shortwave radio is designed to let you listen to a great variety of international broadcasts. You can choose from five different frequency "bands" so that you can count on hearing SOMETHING at any hour of day or night. Also, this receiver lets you hear a generous sampling of ham radio signals (both Morse code "CW" and voice "SSB" communications), plus many other government and commercial transmissions.

Even if you have never worked with electronic parts before, you can successfully build this receiver by carefully following all the directions in this book. Step by step, we'll show you how to build it and how to enjoy it. Before you start building however, please read the notice on page 2 so that there is no misunderstanding about your rights as a valued MFJ customer.

Just a Bit of History . . .

The "regenerative receiver" moved the world of radio reception and broadcasting beyond the limits of crystal sets useful only for hearing a strong local signal. For over a decade, these magical, whistling, squawking, glowing boxes were the norm for home listening as well as for the first generation of radio hams.

Receiver design evolved swiftly. The "superheterodyne" became the norm during the 1930's. Regenerative receivers, often called "Gennies," were left to tinkerers and beginners. Even though these receivers were simple and quite sensitive, they had a number of shortcomings: instability, touchiness, difficulty in separating strong stations, a tendency to generate interference to other receivers, and a general reputation for making odd sounds that resembled everything from pigs to motorboats.

However, the sheer SIMPLENESS of the regenerative circuit remained attractive to experimenters and beginners. In fact, as recently as the 1960's, one company marketed a $14 kit for building a complete transceiver using only one vacuum tube: half of the tube served as a regenerative receiver, and the other half was a low-power crystal-controlled transmitter. In addition, many thousands of engineering careers as well as ham radio licenses were launched with the building of "my first shortwave radio" from do-it-yourself regenerative receiver kits offered by the major radio companies of several decades ago. (The fondest dream BACK THEN of most of these radio builders was to be able to afford to move up to a "superhet communications receiver." Their fondest memory TODAY is that very first receiver kit.)

From the late 1970's through the '80's, as consumer electronics and new ham radio equipment became more sophisticated so very rapidly, interest declined not only in regenerative receivers, but also in kit-building and even in shortwave radio listening. One or two generations of Americans simply missed out on the thrill and satisfaction of building *and understanding* a simple radio set which could receive signals from anywhere in the world.

Back to Today . . . and the Future!

Your MFJ-8100 is a much better receiver than the "classic" radio sets which attracted several generations of Americans to the excitement of radio and electronics. In fact, its basic performance is superior to many of the simplest superhet receivers which were considered such a great step beyond one's first regenerative set.

The reason why this receiver works so well is because there is much more precision in today's engineering designs and the manufacturing of electronic parts. We looked carefully at the practical problems associated with yesteryear's technology, and we used TODAY'S know-how and components to solve the problems.

A Simplified Explanation of How It Works

When you're ready, please explore the technical explanation of your receiver in "Introduction No. 2." In the meantime, you can peek at the schematic diagram and picture the receiver in three basic sections:

A. Detector-Oscillator (Q1,Q2)
B. RF amplifier (Q3)
C. Audio amplifier (IC1)

To put it very simply, a detector converts radio energy from an antenna into audio energy, i.e., a sound which you can hear. A detector can be as simple as a crystal diode, which is the heart of the simple "crystal radio." If you've ever heard unwanted radio signals on a stereo, telephone, PA system or intercom, you can assume that some part of those devices has acted as a detector to convert a nearby CB, taxi or broadcast signal into intelligible sound. (This process of detection is also referred to as demodulation.)

In the following explanation, the words regeneration, feedback and oscillation all mean approximately the same thing.

By itself, a detector can interpret or demodulate only very strong signals such as a nearby AM radio station. However, the process of regeneration can make a detector much more sensitive by turning the detector into an "oscillating amplifier." The regeneration circuit repeatedly feeds the detected signal back to the input which boosts its strength many hundreds of times. This feedback process must be carefully controlled, which is the function of the regeneration control.

The frequency of oscillation is determined by the choice of inductors (bandswitch) and the setting of the tuning capacitor. If the oscillator is tuned to 10.1 MHz, for example, any radio signal on that frequency will be boosted and detected in the regeneration process. The resulting output from transistor Q2 is a low-level audio signal which is boosted to comfortable listening level by the LM386 integrated circuit amplifier.

The RF amplifier serves two purposes. It boosts the RF signals from the antenna to the detector, and it minimizes the amount of oscillator RF going back out to the antenna.

Again, we hope you'll also look at the somewhat more technical explanation of how your MFJ-8100 Receiver circuit works. If any terminology used in this book is unfamiliar to you, please check the "Some Helpful Word & Abbreviations" section.

Introduction No. 2:
For Experienced Hams, Enthusiasts or Engineers

Why use a REGENERATIVE circuit for a kit new for the 1990's? A fair question, but the MFJ-8100 is not like any regenerative HF receiver you've ever used before!

Our GOAL determined the design and circuitry of this receiver. We wanted the following features:

- Good reception of *both* shortwave AM and CW-SSB
- Ease of kit-construction for newcomers
- Reasonable price
- A quality look and feel
- Relatively simple circuit
- No critical alignment requirements
- Low parts count, yet not dependent on specialty IC's
- Purposeful choice of tuning ranges for SWLing anytime.

Satisfactory AM-CW-SSB listening and circuit simplicity were our primary goals. Despite the popularity of NE602-type "direct conversion" circuits among today's experimenters and some kit vendors, direct conversion is *not* satisfactory for *enjoyable* listening to AM shortwave broadcasts. Merely nulling the carrier does not result in true listenability. Similarly, a multi-band superhet with BFO could not fit our goals of simplicity and economy.

To meet our goals, we chose to refine the regenerative concept as much as possible, using contemporary design concepts and component characteristics. Our first goal was to "tame" the regeneration process itself to minimize the instability and unwanted oscillations so typical of traditional regenerative circuits -- and so that even a beginner can enjoy and understand the use of the Regeneration Control. The result of our re-design is an HF SWL receiver with better performance than many low-end factory-built superhets of yesteryear.

Some highlights of our design efforts:

- Significantly reduced RFI back through antenna, a chronic regenerative receiver shortcoming, through use of carefully designed RF amplifier stage.
- Effective RF filtering between detector and audio sections of the receiver.
- Simplified L-C tuning; notice that there are 5 band switch positions but no coil taps or second windings!
- Elimination of antenna trimmer so critical in most regenerative designs. We replaced the traditional trimmer with an RF gain pot that has little effect on frequency or regeneration.
- Manageable, "tame" regeneration control circuit. Regeneration begins smoothly with no pop and has a comfortable adjustment range.

The result, we think, is a receiver design which bridges the classic simplicity of regeneration to the performance demands of the 1990's. Here's how we did it:

In brief, the circuit uses RF regeneration and high levels of DC feedback. Notice that the antenna is coupled directly to the source of RF amplifier FET Q3 rather than through the L-C tuning network. Direct coupling of the drains of Q1 and Q3 isolates the L-C circuit from the antenna input, enhancing stability and greatly minimizing RF oscillator output to the antenna. Such RFI has been a serious problem in traditional regenerative circuits which permitted the oscillating detector to behave as an unstable but potent QRP transmitter.

R4 reduces the Q of L1 (10 μH) for smoother regeneration. The SW1 bandswitch selects a combination of simple inductors. For example, the total inductance for Band A is L1+L2+L3+L4+L5. The inductance for Band E is only L5. And so forth.

Air variable C1 uses its 50 pF range and mechanical vernier reduction to provide smooth "bandspread" in parallel with C3 and trimmer C5 which perform the traditional "bandset" function.

Trimmer pot R20 ensures adjustability for smooth regeneration over all tuning ranges, regardless of individual FET characteristics.

C17, C9, C10 and R9 form a low pass filter to block RF from the audio amplifier and provide basic audio filtering.

Volume Control R2 varies OUTPUT rather than low-level input to the LM386 audio amplifier. This approach further isolates the RF stages from variations in the audio section.

The LM386 (IC1) circuitry employs all recommended options for maximum gain and protection from self-oscillation.

To prolong useful battery life, R13 limits current draw by the LED (CR1) to minimum reasonable visibility as an on/off indicator.

Schematic Diagram

Receiver Controls and Connections

Most of the controls are self explanatory. However, it is very important to understand the correct use of the Regeneration Control and the two internal trimmer adjustments of the receiver.

BANDSWITCH (SW1)
This quality rotary switch selects any one of the 5 tuning ranges from A to E indicated on the tuning scale.

TUNING (C1)
The Tuning knob controls an air-variable capacitor (C1) which also has a built-in 6:1 vernier reduction drive to which the dial pointer is attached. This reduction permits very smooth tuning. The frequency markings on the dial scale must be understood to be approximate due to the 10% tolerance ratings of the fixed inductors (L1 through L5).

PUSH SWITCH (SW2) AND LED. INDICATOR (CR1)
While the purpose of the on/off switch and LED is obvious, remember to turn your receiver OFF when not in use. A weakened battery degrades receiver performance.

REGENERATION (R1)
Because understanding and controlling regeneration is at the heart of your receiver's performance, we've provided a separate section on its use. In brief, it controls receiver sensitivity and adjusts between AM broadcasts and CW-SSB.

VOLUME (R2)
This potentiometer performs the normal function of any volume control. Of interest to the technically-minded, it controls the output of the LM386 audio IC, rather than the input, which enhances the stability of the regenerative detector.

RF GAIN (R19)
This trimmer potentiometer is adjustable with a small screwdriver. Maximum gain is clockwise when viewing the rear panel. A good normal setting is 3/4 of its full rotation. If you are using a marginal antenna (5 to 10 feet of wire indoors), keep R19 at its maximum setting. If you are using a very good antenna (a long, high outdoor wire or ham antenna), keep R19 at about 2/3 or so of its range. If your listening interests require frequent RF gain adjustments, install an external 10K control in series with your antenna.

REGENERATION RANGE TRIMMER (R20)
Ordinarily, this trimmer is adjusted only after kit construction or in the unlikely event that any of the FET transistors are replaced. This adjustment assures smooth regeneration over all five of the tuning ranges. See Construction Phase 5.

DIAL CALIBRATION TRIMMER (C5)
This one-time internal adjustment is made with a miniature screwdriver in order to assure that the frequency markings on the front panel are as accurate as reasonably possible.

EARPHONE JACKS (J2,J3)
These two jacks accept 1/8" (3.5 mm.) stereo plugs as used in "Walkman" type headphones or mini-speaker systems. The audio output is monaural; the two jacks are wired in parallel to permit the use of two headphones.

Note: If a mono 1/8" plug is used for any reason, it must NOT be pushed all the way in, or it will short out the audio.

ANTENNA CONNECTOR (J1)
This binding post permits easy hookup of any wire, or a banana plug may be inserted in its end. 10 to 20 feet of ordinary hookup wire (also called "bell wire") provides good basic reception, even when installed indoors. See the section on Antennas in this book for more information.

GROUND CONNECTION
For casual operation, a ground connection is optional. However, a wire from this connector to a ground rod or cold water pipe will reduce unwanted noise and interference from nearby electrical devices or AC wiring and may boost receiver sensitivity. Attach the wire between the two washers, then tighten the wing nut.

Understanding and Using the Regeneration Control

In theory, your receiver's Regeneration Control adjusts the level of feedback or self-oscillation of the FET detector section (Q1 and Q2). In practice, this control is like a "joystick" for managing and optimizing receiver performance. Your ability to handle this "joystick" saves you many dollars over today's cost of receivers which perform similar functions "automatically." In fact, you might even get more control over receiver performance in varying situations than may be possible with more elaborate receivers.

With the control turned fully to the left (counter clockwise), the receiver is virtually silent. "Regeneration" begins at a certain point as you turn the control clockwise. The exact point varies not only from band to band but even as you tune within a given band. Regeneration begins as an audible increase in background noise followed by a soft hiss. The hiss, or any signals that may be on frequency, increases as you continue to turn clockwise. If you go too far, the signal becomes distorted, or the receiver begins to squeal (oscillate).

Always use the LEAST amount of regeneration necessary for good reception of a given signal.

As a rule, the best reception of AM shortwave broadcast signals occurs just BEFORE full regeneration. If you hear a whistle (carrier) along with an AM signal, turn the control back slightly until the carrier disappears.

When there are a number of very strong shortwave AM broadcasts in a given band, such as is common in the early evening, you will find it possible to tune them in one after the other with the regeneration control set "way back" and requiring virtually no adjustment. In other words, you would tune from station to station just as if using any other type of shortwave set.

When the receiver is adjusted for good AM reception, CW signals will sound like hisses. Advancing the regeneration control slightly will bring in the familiar beeping associated with CW, RTTY (radio teletype) or similar signals.

The regeneration control can also serve as a fine tuning control, permitting slight adjustments of CW pitch for the most pleasing sound, or best clarity in a SSB voice signal. After you've had some practice with using the regeneration control, it will become second nature, giving you a sense of real control over the performance of your receiver.

Tuning SSB (Single Sideband) Voice Signals

SSB signals are all those voice signals which sound like Donald Duck unless they are tuned in very exactly. They have no background carrier as do AM broadcast signals.

On modern ham radio transceivers, tuning SSB is made so easy by means of internal filters that many licensed ham operators are not aware of the basic technique for tuning in SSB signals on receivers without such filters.

The first fact to know about any given group of SSB signals is whether they are Upper Sideband (USB) or Lower Sideband (LSB). In ham radio communication, LSB is used on 1.8 through 7.3 MHz, and USB is used for all higher frequency bands (14, 18, 21, 28 MHz.)

The best band to practice SSB tuning with your receiver is the "75 Meter" band, 3.8 to 4.0 MHz, doing so in the evening when the signals are strong and plentiful. Notice that the band is spread out on the dial more than the other amateur bands, which permits easier tuning. These are all LSB (lower sideband signals).

Think to yourself: for LOWER sideband, tune DOWN.
for UPPER sideband, tune UP.

In practice, this means that you would "approach" the LSB signal by tuning from higher frequency (right) to lower (left), from higher voice pitch to lower pitch. Here's how to do it step by step:

1. Pick out a strong, high-pitched Donald Duck voice.
2. Turn the tuning knob ever so slightly to the left.
3. If the pitch of the voice went DOWN slightly, you're heading in the right direction.
4. SLOWLY tune left, slightly more until the voice is clear.

Reverse this process to tune UP (to the right) for USB signals on the bands above 7 MHz.

The Regeneration Control often can be used to do the last touch of fine tuning to bring the voice in clearly. If signals are exceptionally strong, it may be necessary to reduce the RF gain level (rear panel).

SSB transmissions are used by embassies and agencies of various governments, so you might find interesting voice signals on other than ham frequencies. Check with a Shortwave Listener (SWL) or listings in *Popular Communications* Magazine for more details.

Some Helpful Words and Abbreviations

Throughout this instruction manual, we use plain English as mush as possible. But there's no way around using common electronics terms and abbreviations where appropriate. We simply try to avoid "jargon" that is unnecessary. The following mini-glossary was compiled as a help to beginners working on *this* kit. Our descriptions are *not* intended to be complete definitions. For a very clear, fun and economical explanation of electronics parts and how they work, see *Getting Started in Electronics*, by Forrest Mins III, No. 276-5003, at any Radio Shack store.

Alignment: One-time adjustment of internal controls in a radio circuit. (See also: Trimmer).

AM: Amplitude Modulation

Band: a related group of frequencies (i.e. 40 Meter Band = 7.0 to 7.3 MHz).

Board (PC board): short for "printed circuited board" or circuit board.

Bridge, Solder: the unintentional joining of two or more points on the solder-side of a printed circuited board.

Carrier: the steady tone or whistle that is the foundation of a AM or FM voice signal. In most receivers, the carrier is not even heard, because regeneration or a BFO or direct-conversion is required to convert the carrier energy into an audible tone.

Cold (solder-joint): A defective solder connection resulting form using too little heat. The joint looks like a ball and is not shiny.

CW (Continuous Wave): refers to Morse Code signals.

DC: direct current (example: battery voltage in contrast to house hold AC from the wall outlet.) DC sometimes refers to "direct conversion" receivers; see below.

Detector: the section of any radio that changes radio energy into audio energy intended for listening.

Direct Conversion: a popular type of simple receiver for CW-SSB which needs no regeneration control, but which does not permit pleasant listening to AM shortwave broadcast, because the carrier (see above), as well as the voice modulation, can be heard.

Electrolytic (capacitor): a capacitor containing an acid or salt paste (electrolyte) and is generally polarized with a positive and negative side. Correct polarity *must* be observed when installing electrolytic capacitors.

FET: "Field Effect Transistor"

Ground: Refers to all points and surfaces in an electronic device which are connected to the -DC side of the power supply or battery. A "ground plane" of a circuit board is the large area of copper plating that is common to ground. "Earth ground" refers to water pipes or metal grounding rods in direct contact with Earth.

IC, Integrated Circuit: A tiny plastic rectangular block with 6, 8, 14, or more pins, containing a silicon "chip" which provides the equivalent of dozens, or hundreds, of individual transistors and resistors.

Install: in modern kit building, this ward means

1. Select correct part
2. Insert it in its circuit board position, close to the board, oriented correctly.
3. Solder all points
4. Trim or nip away excess wire lengths

K: abbreviation for 1000 ohms. (10K = 10,000 ohms).

KHz: KiloHertz, a thousand hertz

MHz: MegaHertz, a million hertz

Inductor: A coil or loop or wire used in electronic circuits.

Oscillator: see Regeneration

pF: "picofarad", a tiny unit of capacitance.

megaohm: one million ohms

Regeneration, Regenerative: a method of boosting the performance of a simple detector by feeding the detected signal back to the input of the detector for further amplifying. This oscillation process must be controlled carefully through the use of a regeneration control.

RF: Radio Frequency Energy, in contrast to audio or DC.

RTTY: "Radio Teletype"

SSB, Single Sideband: a method of voice transmission which eliminates the carrier (whistle) which you hear in an AM broadcast if the regeneration control is turned too far to the right.

Tolerance: the manufacturing accuracy for electronic (and other) parts. Tolerance ranges from 20% down to better than 1% of the value marked on the part.

Toroid: a type of coil consisting of wire wrapped around a donut-shaped form, such as L5 in this receiver.

Trimmer: a miniaturized variable resistor or capacitor used for occasional circuit adjustments.

µF: "microfarad", the usual unit of capacitance.

µH: "microhenry", a unit of inductance.

WWV: U.S. government broadcasting service which provides exact time by voice announcement each minute on very exact frequencies such as 5, 10, 15, and 20 MHz.

MFJ-8100 Parts Lists

Please check and organize your kit parts before soldering.

FIXED CAPACITORS

1 - 33pF disc [C6]
1 - 47pF monolithic (marked 47 or 470) [C3]
1 - 75pF disc [C16]
2 - .0033µF polystyrene (rectangular) [C9,C17]
4 - .01µF disc (marked 103Z) [C7,C8,C21,C28]
5 - .1µF DISC (marked 104Z) [C2,C4,C10,C11,C15]
1 - 1µF electrolytic [C18]
1 - 10µF electrolytic [C14]
1 - 22µF electrolytic [C12]
1 - 100µF electrolytic [C13]
1 - 470µF electrolytic [C19]

RESISTORS

1 - 10 ohm (brown-black-black) [R17]
1 - 15 ohm (brown-green-black) [R12]
1 - 22 ohm (red-red-black) [R11]
2 - 1K ohm (brown-black-red) [R6,R9]
1 - 2.2K ohm (red-red-red) [R13]
4 - 10K ohm (brown-black-orange) [R3,R4,R5,R8]
1 - 1M ohm (brown-black-green) [R7]

INDUCTORS

1 - 10µH molded (brown-black-black-silver) [L1]
1 - 3.3µH molded (orange-orange-gold-silver) [L2]
1 - 1µH molded (brown-black-gold-silver) [L3]
1 - .47µH molded (yellow-violet-silver-silver) [L4]
1 - T-52-2 iron powder toroid and wire to make L5

SEMICONDUCTORS

3 - FET (field-effect transistor, type J310) [Q1,Q2, Q3]
1 - LM386 audio amplifier IC [IC1]
1 - LED (light emitting diode) [CR1]

CONTROLS & CONNECTORS

1 - Air-variable tuning capacitor [C1]
1 - 5-30pF trimmer capacitor [C5]
1 - 10K ohm trimmer potentiometer (marked 103B) [R19]
1 - 100K ohm trimmer potentiometer (marked 104B) [R20]
1 - 250 ohm potentiometer (volume control) [R2]
1 - 10K ohm potentiometer (regeneration control) [R1]

2 - PC-mount 1/8" stereo phone jack [J2,J3]
1 - Insulated binding post (antenna) [J1]
1 - PC-mount push-button switch (DC on/off) [SW2]
1 - 5-position rotary switch (bandswitch) [SW1]

HARDWARE & MISCELLANEOUS

1 - Pre-drilled printed circuit board
1 - 9-volt battery snap connector
1 - 9-volt battery bracket with foam adhesive strip
1 - Aluminum chassis (bottom section)
1 - Aluminum cover
2 - 4-40 machine screws
2 - 4-40 standoff spacers
2 - 4-40 self-locking machine nuts
1 - 10-32 machine screw (for ground connector)
2 - 10-32 self-locking machine nuts
2 - 10-32 steel washers
1 - 10-32 wing nut
3 - 3/8" hex panel nuts (to mount controls and SW1)
3 - 3/8" steel washers (for controls and SW1)
2 - Instrument knobs for controls
1 - Pointer knob for band switch
1 - Larger (1.25") knob for tuning
1 - Pointer assembly for tuning capacitor
8 - Pan-head phillips screws for cabinet assembly
4 - Rubber bumper feet (self-adhesive)
1 - Set of hookup wires for jumper, winding L5
1 - Wire-tie to secure battery snap wires
1 - Instruction/Assembly manual

REQUIRED, NOT SUPPLIED

9-volt alkaline or heavy-duty battery
Low impedance stereo headphones ("Walkman" type)
Antenna wire

MINIMUM TOOLS REQUIRED

Soldering iron (20 to 30 watts)
Rosin-core solder intended for electronics work
Diagonal cutters or wires nippers
Small or medium phillips screw driver
Pliers or set of nutdrivers
Miniature jeweler-type flat blade screwdriver to adjust C5
Set of Allen hex wrenches (1/16" & 5/64)

"X-Ray View" of Printed Circuit Board

Before You Start Building !

Your receiver is designed to work perfectly as soon as correct construction is completed. Before we get started, let's explain exactly what we mean by "correct" construction. If you understand potential and typical problems *before* you build, chances are that you won't make those classic mistakes which can frustrate electronic kit builders.

There are just 5 possible building mistakes which will cause your receiver not to work:

1. **Installing a WRONG part.**
   Example: Using a 10 ohm resistor in place of 10K ohm(10,000 ohms)
2. **Installing certain parts BACKWARDS.**
   Example: Reversing the (+) and (-) sides of an electrolytic capacitor, or pointing the flat side of a transistor in the wrong direction.
3. **Faulty SOLDER connection.**
   Example: "cold" connections or solder "bridges".
4. **OMITTING a part, solder connection or wire.**
   Example: if it's supposed to be there and isn't, we have a problem!
5. **Positioning the part close to the board prevents interaction with other parts.**

If you watch out for just these 5 pitfalls, you will build your receiver *right* the first time and start enjoying its worldwide receiving capabilities right away.

Your receiver kit is designed to be very easy and satisfying to put together. If a word or construction detail is unclear to you, check the glossary we complied for you or compare the imprinting on the circuit board to the directions, or show it to a knowledgeable radio friend.

Take the time to really EXAMINE and understand the circuit board. We don't want to insult your intelligence by explaining that the parts are inserted on the TOP ("component side"), which also illustrates component outlines and numbers, with all soldering done on the BOTTOM (solder side), where you see silver circles ("pads") and a transparent green coating. However, we must point this out to everyone simply because some eager kit builders indeed have tried to solder all the parts on the wrong side, with disastrous results!

Again before you start soldering, be certain that you understand the MFJ policy on kits explained on page 2 of this book. Once you begin construction, you truly OWN this receiver kit!

STEP-BY-STEP KIT CONSTRUCTION

You'll build your receiver in six phases in this order:

1. Small parts associated with bandswitch and tuning
2. Transistor RF amplifier and detector section
3. IC audio amplifier
4. Controls, switches, jacks
5. Testing and initial adjustment
6. Final Assembly into cabinet

To make construction go as smoothly as possible, please follow our published order for installing all parts.

DOUBLE CHECKING: The directions use two sets of check boxes. Check off the first box after you have completed that step. Use the other boxes for double-checking your work before operating you receiver.

Construction Phase 1 (Steps 1-1 through 1-10)

Our goal here is simply to get started--and to be sure that there won't be any mix-up between the small molded inductors (L1,L2,L3,L4) and the resistors which they resemble. Correct selection and installation of the inductors is essential to correct tuning of your receiver. If you mix them up, what you hear will not correspond to the tuning dial. If you put a resistor in the place of an inductor, you won't receive at all!

Remember that our word INSTALL means:

1. **Insert the correct part into the correct position.**
2. **Make sure it is pressed as far into its holes as it reasonably can go.**
3. **Solder all points.**
4. **Trim away excess wire lengths, if any.**

1-1. Identify the four molded inductors. They are visibly larger than resistors. The color stripes are on a BLUE body. The 4th band is silver or gold. When we describe each one, we identify the first 3 stripes.

1-2. Install L1, 10µH (brown-black-black).

1-3. Install L2, 3.3µH (orange-orange-gold). Be sure *not* to insert it in the position for R4 between L1 and L2. (Also, be very sure not to mistake it for L4 which has yellow-violet-silver bands.)

1-4. Install L3, 1.0µH (brown-black-gold).

1-5. Install L4, .47µH (yellow-violet-silver).

Note: The L5 inductor for Band E is a wind-it-yourself "toroidal coil" (don't worry: it's easy!) which we'll make and install in Phase 5 so that it is not subjected to bumping and bending during other assembly.

1-6. Install R4, 10K (brown-black-orange). Its position is between L1 and L2.

1-7. Install C4, .1µF (body marking: 104Z), near L1.

1-8. Install R13, 2.2K (red-red-red). (This is a current limiting resistor for the LED power indicator.)

1-9. Install C3, 47pf (body marking: 47 or 470).

1-10. Install C5, the miniature trimmer capacitor, making sure the to orient its body shape just like the circuit board outline. Before soldering , adjust the tuning screw so that its slot is pointed just like the outline on the board.

We've accomplished something important; we got started, and we've made sure that this receiver will tune correctly.

Construction Phase 2 (Steps 2-1 through 2-20)

The parts in Phase 2 are the heart of your receiver; working together with the tuning circuit begun in Phase 1. Building this section is simply a matter of identifying and installing the parts correctly. This phase includes all three FET transistors and one electrolytic capacitor, all of which are to be installed in one correct way only. You really can't go wrong; simply position the transistors and electrolytic capacitors exactly as illustrated, right on the board.

2-1. Install R5, 10K (brown-black-orange).

2-2. Install C7, .01µF (body marking 103M).

2-3. Install C18, 1µF electrolytic. Notice that the negative (-) side is clearly marked on the capacitor, and that the (+) position is marked on the PC board.

2-4. Install R3, 10K (brown-black-orange).

2-5. Install R6, 1K (brown-black-red).

2-6. Install R17, 10 ohm (brown-black-black).

2-7. Install C6, 33pF (body marking 33K).

2-8a. The locations for all three FET transistors (Q1, Q2, Q3) are imprinted clearly on the PC board. Notice the flat and rounded sides of the imprints, corresponding exactly to the shape of the transistors viewed from the top. We'll install all 3 transistors in the following steps. (1.) Simply press each one into its 3 holes as far as it can reasonably go, (2.) gently bend the leads outward to secure it, (3.) solder all three connections, and clip away the excess wires.

Note: All three transistors are identical (Siliconix J310).

2-8b. Install transistor Q1, per 2-8a (above).

2-9. Install transistor Q2, per 2-8a (above).

2-10. Install transistor Q3, per 2-8a (above).

2-11. Install R7, 1M ohm (brown-black-green).

2-12. Install C17, .0033µF (body marking 332K).

2-13. Install C8, .01µF (marked 103M).

2-14. Install R8, 10K (brown-black-orange).

2-15. Install C21, .01µF (marked 103M).

2-16. Install C28, .01µF (marked 103M)

2-17. Install C2, 01µF (marked 104Z)

2-18. Install R20, the 100K ohm regeneration trimmer (104B).
This trimmer is identical in size and shape to the R19 RF gain control near the antenna jack. Be sure that its marking includes "104B" as the last four digits, with the "4" as especially important.

2-19. Install R19, the 10K ohm RF gain control, near the rear corner of the PC board. Its marking includes the digits "103B".

2-20. Install C16, 75pF (body marking 75J), near R19.

Construction Phase 3 (Steps 3-1 through 3-20)

The following group of parts form the audio amplifier circuit which boosts the signal from the FET transistors to useful listening volume.

3-1a. Examine the 8-pin socket for the LM386 IC and notice the rectangular notch at one end. This notch should be oriented in exactly the same direction as imprinted on the board (toward C14). Press the socket pins into their 8 holes so that the socket rests flat on the board. You may wish to slightly bend two or more pins after insertion so that the socket won't slip out.

3-1b. After making sure that all 8 pins are clearly visible on the bottom of the board, solder each connection carefully. Be sure not to let the solder tip touch two pins at the same time, which would cause unwanted "solder bridges".

3-2a. In step 2-3 above, you installed the first of the 5 electrolytic capacitors used in the receiver. The remaining 4 are of this amplifier section. We'll install all of them now, so that the importance of correct (+) and (-) positioning stays fresh in mind.

3-2b. Install C19, 470µF per 3-2a (above).

3-3. Install C13, 100µF per 3-2a (above).

3-4. Install C14, 10µF per 3-2a (above).

3-5. Install C12, 22µF per 3-2a (above).

3-6. Before proceeding, please *double-check* the polarity correctness for all 5 electrolytic capacitor!

3-7. Install R11, 22 ohms (red-red-black).

3-8. Install R12, 15 ohms (brown-green-black).

3-9. Install C15, .1µF (marked 104Z).

3-10. Install C11, .1µF (marked 104Z).

3-11. Install C9, .0033µF (body marking 332K).

3-12. Install R9, 1K (brown-black-red).

3-13. Install C10, .1µF (marked 104Z).

About the Jumper Wires
Several lengths of hookup wire are installed on the top side of the board between points marked W1, W2, etc. The purpose of such "jumper wires" is to make efficient connections across circuit traces on the solder side of the PC board in situations where running a circuit board trace would not be efficient.

3-14. Solder a 1" jumper from W1 to W2 (see page 17).

3-15. Solder a 1" jumper from W3 to W4 (see page 17).

3-16. Solder a 1" jumper from W5 to W6 (see page 17).

3-17. Solder a 4.5" jumper from W7 to W8 (see page 17).

3-18. Solder a 3.5" jumper to ANT near R19. (In the final assembly phase, the other end is soldered to the Antenna binding post.)

3-19a. Examine the LED (CR1). Like electrolytic capacitors and transistors, this diode is a one-way-only part. The longer lead is the anode. Also, the cathode side is identified by a slightly flattened side of the bulb. The anode side is nearest the 5-position bandswitch (SW1).

3-19b. Install LED CR1 per 3-19a and the following:
Insert the LED with anode side toward SW1.
Slide it into holes as far as it will go.
Solder both leads and nip excess lengths.
Gently bend bulb forward 90º.

3-20. Carefully insert the LM386 IC into the socket, making sure that the notched or dotted end is toward C14 and the center of the circuit board.

Construction Phase 4 (Steps 4-1 through 4-14)

4-1. Installing the larger parts will seem easier because the connections are less delicate and further apart from each other. However, it is very important for a good final fit into the cabinet to seat these jacks, switches and controls squarely onto the board before soldering. In each case, insert the part as far into its holes as it will go and make sure it does not slip during soldering.

Also, some of these connections will require more soldering heat than you need for small parts. **Be sure** to get the connection itself hot enough to melt the solder.

4-2. Install headphone jack J2 per 4-1 (above).

4-3. Install headphone jack J3 per 4-1 (above).

4-4. Install SW2, the power on/off push-button switch per 4-1.

4-5. Install R2, the 250 ohm volume control per 4-1.
It is clearly stamped "250" on its back.

4-6. Install R1, the 10K ohm regeneration control per 4-1.

Note on C1: The rotor (moveable) section of C1 is electrically common with the frame and therefore the four bottom pins which are soldered to the receiver ground plane. The stationary section (stator) has 4 solder lugs, but only the two rear ones are used. The front lugs should be bent out of the way or clipped off before installation.

4-7 Install C1, the air-variable tuning capacitor.
Handle it carefully and re-read 4-1 before soldering. Notice that a total of 6 solder connections are made; the 4 pins from the frame plus the rear lugs from each side.

4-8. Install SW1, the rotary bandswitch.

4-9. Install the battery snap connector, making sure that the red (+) wire goes to point BATT+ and the black (-) wire to point BATT-. The receiver will not work and might be damaged if these wires are reversed. These wires may be strapped to the circuit board using the wire tie through the two large holes between the two jumper wires previously installed.

4-10a. Coil L5 consists of 8 turns of insulated hookup wire wound around the donut-shaped red toroid form. Correct winding of this coil is essential to correct tuning of Band E. The wire should be as tight as possible, with the spacing of the turns as even as possible.

A turn is one complete "lap" around the toroid. The winding begins and ends with a half-turn to form its mounting leads. Therefore, it appears at first to have 9 turns. In fact, if you count 8 complete loops plus a short lead on each side for mounting, you have wound it correctly.

4-10b. Wind L5 per 4-10a. Work with confidence; if you discover that you didn't do it quite right, it's not hard to un-wind and try again.
Note: remember that the red toroid form is made of powdered iron. Therefore, handle it with reasonable care so as not to crack or crush it. In other words, don't assume that it's as though as a steel washer!

4-10c. Install L5 in its position near L3 and L4. Use care to mount it as tightly against the board as possible. If it wiggles easily, you will experience unstable reception on Band E.

4-11. Double-check the correctness of your work in step 1-1 through 4-10!

4-12. Check the solder-side of the board for bits of wire or solder trapped between connections and also for excess wire lengths that need to be trimmed.

4-13. Review the quality of all solder connections. Are they all shiny and cone-shaped? Did you miss any soldering points? Touch up any questionable solder point by reheating the connection with a very clean soldering iron tip.

4-14. Use the double-sided adhesive strip to secure the 9-volt battery bracket in the large open area between C1 and the back of the PC board.

Construction Phase 5 (Steps 5-1 through 5-11)

Testing and Initial Adjustment

Congratulations! If you performed Steps 1-1 through 4-13 successfully, your finished MFJ-8100 is already a working shortwave receiver!

To be assured of satisfactory receiver performance, PLEASE continue following our step-by-step directions.

5-1. Set SW2 in its "out" (off) position. Install a fresh 9-volt alkaline or heavy-duty battery.

5-2. Plug a personal stereo headphone into J2 or J3. Be sure that your headphone works; Test it first with any personal stereo gadget in your household!

5-3. Temporarily attach knobs to the band switch and regeneration control.

5-4. Set the front panel controls as follows:
Bandswitch to Band C
Regeneration Control fully counter-clockwise.
Volume: midway to 3/4 of its turning range
Tuning: mid-range

5-5. Make a temporary connection of your antenna or a 10-20' length of any kind of wire to the short antenna wire near the RF gain control.

5-6. Set the RF Gain trimmer to about 3/4 fully clockwise (as viewed from the rear of the PC board).

Note: The following tests verify basic receiver performance before installing the PC board into the cabinet. Because the PC board groundplane and control housing are not yet grounded to the aluminum panel, you will experience phenomena during these test that will *not* occur after complete assembly. In particular, the regeneration control knob will be sensitive to hand capacitance. In other words, you can expect changes in frequency and gain when touching the knob, shaft, PC board ground, etc.

5-7. Push the DC power switch to its ON position. The LED should glow. (If it does not, turn off the switch immediately and re-check both the LED and the battery snap wires for correct polarity.)

Before proceeding, it would be a good idea to re-read our full explanation of the use of the Regeneration control. Also, look ahead to Step 5-10 regarding adjustment of trimmer R20. In order to do that adjustment, you first need to experience exactly what "regeneration" sounds like, which we'll do in 5-8!

5-8. With the controls set per 5-4, you should be pleased to hear virtually nothing right now except a faint background hiss! Now, start turning the Regeneration control slowly clockwise. At some point in this turning, you'll start to hear "something" (depending on where the tuning dial is set). Turning just slightly beyond that point will bring in a very distinct hiss or whistle or perhaps a recognizable radio signal. After adjusting the volume control to a comfortable level, try rotating the Tuning capacitor. You should hear radio signals of various kinds.

5-9. Experiment with Tuning and Regeneration controls on Bands B, C, and D. If it's after dark, Bands A and B should be very active. In broad daylight, B and E will have more activity, and Band A will be quieter. Reception on Band E may require Step 5-10 below.

5-10. Perform a preliminary adjustment of regeneration trimmer R20 as follows:
Turn power OFF.
Set Bandswitch to the E position (furthest right).
Turn Regeneration fully clockwise.
Set Tuning for maximum capacitance (both sets of plates meshed to left side
Turn power ON.

Now, use a small screwdriver (or just your finger on the plastic wheel) to adjust trimmer R20 to the point where regeneration just begins, with all other controls set as specified above. (This adjustment will be touched up after the receiver is assembled into its cabinet.)

5-11. Take one last look at the quality of all solder connections!

Construction Phase 6 (Step 6-1 through 6-19)

Final Assembly

The receiver circuit board is designed for a precision fit into its custom aluminum cabinet. To prevent both aggravation and possible damage, please follow our assembly steps in order. **Please do not install any parts ahead of time.**

6-1. Arrange all remaining hardware parts so that you can look them and over and visualize how they fit together.

6-2. Mount the two 4-40 screws and threaded spacers *loosely* in the two slotted holes in the cabinet bottom. For now, keep the screw tips flush with the top of the spacers.

6-3. Attach the four self-adhesive bumper feet to the bottom of the cabinet in a symmetrical pattern.

6-4. Slip the PC board into the cabinet front-first, guiding the control shafts into their respective panel holes. As you press the rear of the board down, pull very *gently* on the rear panel to permit the phone jacks to slide into position.

6-5. As you settle the rear of the board, adjust the two screws and spacers to match the PC board holes.

6-6. Gently bending the lead wires as needed, guide the LED bulb into its panel hole. Use a small screwdriver blade or soldering tool to press the bulb forward.

6-7. Use finger pressure to make sure that the two front panel controls and switch are pressed forward against the front panel.

6-8. Attach the three panel washers and control mounting nuts (finger-tight only, for now).

6-9. Tighten the two 4-40 mounting screws, treating the threaded spacers as nuts. Install the self-locking nuts onto the screw lengths extending through the PC board holes.

6-10. After making sure that everything lines up square and attractively, tighten the three panel nuts, taking great care not to scratch the front panel.

6-11. Turn the Tuning capacitor to the left until the plates are visibly meshed. Press the dial pointer, black washer first, (pointing exactly left) onto the capacitor shaft. Move it all the way to the second shaft section nearest the panel. Start by pressing very firmly and evenly.

Note: The hardest part installing these friction-fit dial pointers is getting it started. Try tapping it on using a 3/8" wrench socket or nut-driver to apply even pressure. After you get it over the end of the tuning shaft, gentle and even tapping pressure will move it into place more easily.

6-12. Install the four panel knobs with the Allen wrenches and flat screwdriver. Be sure to align the pointer stripes of the knobs before tightening.

6-13. Recheck the LED for best positioning through the front panel.

6-14. Attach the rear antenna binding post. The split washer goes against the inside of the rear panel.

IMPORTANT: *Do not* over-tighten the mounting nut, or it will strip the threads of the connector's body.

6-15. Solder the antenna wire to the tip of the antenna connector.

6-16. Install the Ground terminal hardware in this order: (1.) screw through rear panel, (2.) nut #1, (3.) nut #2 (tighten nuts), (4.) two washers, (5.) wingnut. (Any ground wire is attached between the two washers.)

Final adjustment of trimmer R20:

6-17. Connect battery, headphones and antenna. *Repeat* steps in 5-10 to ensure proper operation of Regeneration control.

6-18. Refer to the following section "Dial Calibration Adjustment of Trimmer Capacitor C5" to make a one-time adjustment of trimmer C5.

6-19. Install the top cover of your receiver using the eight self-tapping screws. Before doing so, make sure your have installed a fresh alkaline or heavy-duty 9V battery.

Dial Calibration Adjustment of Trimmer Capacitor C5

Trimmer capacitor C5 is provided to help you match actual tuning to the panel calibration as closely as is reasonably possible. Adjustment consists simply of matching a signal of known frequency to its correct position on the dial. The reference signal can be generated with test equipment, or it can be a distant station of known frequency, or you can listen for the regenerative oscillator on another nearby receiver.

The precision broadcasts of Station WWV at 10.0 and 15.0 and 20.0 MHz are the most easily identifiable reference signals. First, try for the 10.0 MHz transmission. With the bandswitch set to C, tune carefully from 10 MHz down to the far left of the scale and back up to the midpoint. WWV is recognizable by its pulsing tone (one second spacing) and voice announcements each minute giving the "Universal Coordinated Time". If necessary, look for it on bands C (10 MHz), D (15 MHz), and E (20 MHz). As soon as you have identified WWV on one of these bands, make a *small* adjustment of C5 with a miniature screwdriver or alignment tool. Then re-adjust the Tuning knob until you have determined whether adjusting C5 moved WWV closer to or further away from the desired point on the dial.

Repeat adjustment of C5 and the Main Tuning until the dial pointer is on the correct frequency for WWV.

If you cannot find WWV on any of the three bands, try again at other times of the day. One of these three frequencies (10, 15, or 20 MHz) should be loud and clear anywhere in the continental USA at any time of day or night. 10 MHz is best for late afternoon and evening.

Note to Hams or Experimenters

A very easy method for adjusting C5 is to listen for the MFJ-8100's oscillator on a nearby receiver or transceiver. Even with no antenna wire connected to the MFJ-8100, the oscillator is easily heard within a range of 10-15 feet.

Procedure:

1. Tune C1 to a specific frequency (e.g. 3.6 MHz, range A).
2. Tune other receiver to 3.6 MHz.
3. Listen to the MFJ-8100 and adjust Regeneration Control to the point where you know that regeneration has just begun. (The receiver must be oscillating (regenerating) for this method to work.)
4. Adjust trimmer C5 until you hear the oscillator signal. Adjust further for very lowest audible tone (zero beat).

If you are using your own test signal from a signal generator or other RF source, simply set the bandswitch and tuning dial to the test signal frequency and adjust C5 until you hear the signal.

While a single adjustment of C5 can be made using any reference frequency, it's a good idea to use your test equipment or other receiver to verify approximate tuning accuracy on all 5 bands. If one or more bands are drastically wrong, be sure to check for correct inductor values and good solder connections of the inductors.

If your find Band E (17.5-22.0 MHz) to have very inaccurate tuning, try moving the windings on L5 closer together or further apart.

Again, please *remember* that the dial markings are simply intended to be a *general guide* for casual listening! Despite your best efforts and our own, the accuracy of the tuning dial is dependent on the manufacturing tolerance of the five inductors.

Using and Enjoying Your Receiver

To get maximum satisfaction from your new shortwave receiver, we encourage you to develop good familiarity with the sections of this manual:

- Antenna Considerations
- Regeneration Control
- Band Switch and Tuning Ranges
- Audio Notes

However, let's say it all as briefly as possible:

1. The better the antenna, the better the reception. In general, 20 to 30 feet of wire will give good results.
2. The use of the Regeneration Control is learned through experience. It controls the sensitivity of the receiver and distinguishes between AM broadcasts and CW-SSB.
3. The tuning ranges are set up so that you can expect to find something interesting at any time of day or night. Bands A and B are most active in the evenings. Band C has something happening all the time. Bands D and E assure a variety of daytime reception but also can be busy at night.
4. The audio circuit is designed for one or two pairs of "Walkman" type stereo headphones or mini speakers. Other speaker options are mentioned in audio section.

IMPORTANT: The internal 9 volt battery will provide many hours of satisfying listening provided that you turn the receiver OFF when not in use! This "advice" may seem ridiculously obvious, but remember that battery replacement requires removing and replacing the 8 cabinet screws and that leaving the receiver on overnight will indeed run down the battery. If you wish, the battery snap wires can be re-routed to the battery clamp mounted outside on the rear panel. Or, the receiver may be powered by larger external batteries in the 6 to 12 volt range. 4 to 8 "D" cells in plastic battery holders available from Radio Shack will provide months of service.

Note: If a DC voltage other than 9 volts is used, readjustment of trimmer C5 will be required for correct frequency indications.

Setting Up a Useful Shortwave Antenna

The reason why we provided a "universal binding post" antenna connector (plus separate ground connector) is to make it as easy and economical for you as possible to try out different antenna setups. By "universal," we mean that you can insert a "banana"-style plug or make various styles of connection with a simple bare wire.

Your receiver is so sensitive that even a few feet of wire strung indoors will provide reception of stronger signals, particularly at night. 20 to 30 feet of wire is much better. Therefore, you can count on good reception even if you are limited to keeping the antenna indoors as might be required in apartment complexes, condos, etc.

Stringing all or part of your antenna outdoors is always better. An ideal antenna for this receiver would consist of 25 to 100 feet of wire outdoors, as high as is safely possible. Such antennas are called "random long wires" and also work fine in most attics. (Foil-backed insulation or metal roofing will reduce the usefulness of an attic as antenna space.)

Your antenna can be horizontal, vertical or a combination of both. It can be tubing or pipe as well as wire. The wire can be bare or insulated. It could be something not intended to be an antenna such as a gutter, fence, flagpole or metal roof. In fact, radio hams and serious SWL's have experimented with thousands of imaginative antenna ideas.

VERY IMPORTANT: Use care and common sense when putting up outdoor antennas. Be certain that your wires or your ladder cannot come into contact with electrical power lines. **You can be <u>KILLED</u> by accidental contact with power lines.**

<u>Note</u>: Stranded copper wire is normally used for making antennas. It may be bare or covered with plastic insulation. "Bell wire" available in any hardware store is perfectly suitable.

Your Receiver's Audio Circuit

Many ways to listen in!

The LM386 audio amplifier IC circuit is designed to provide ample volume to not one but two headphone jacks. We used stereo jacks because today's economical personal music headphones are as inexpensive as were the bulky "basic headphones" of yesteryear. Your receiver provides two headphone jacks to make it very easy for two people to listen together.

The amplifier circuit provides sufficient output for moderate speaker volume. Miniature speaker systems designed for "Walkman" and similar personal stereo devices will plug right into J2 or J3 and work very well. However, please remember that the amplifier is

specifically designed for headphone operation. If you prefer room-level speaker volume for long listening sessions, we recommend an external amplifier as discussed below.
If you use personal FM, cassette or CD players, you probably also know all about those compact "amplified speakers" designed specifically to plug into the stereo jack of compact personal stereos. These speaker setups have a built-in amplifier circuit and their own separate batteries. Any of these devices should work well with your receiver. Radio Shack carries a variety of amplified speaker pairs as well as several monaural utility amplifiers. Even though stereo jacks are used, remember that the receiver audio output is monaural.

An external amplifier can also be a rewarding do-it-yourself construction project. One-half to 2 watts will provide generous and ample speaker volume. In fact, if building this receiver has kindled your interest in building something on your own, you could get started by duplicating the same LM386 audio circuit used in this receiver. Use the same parts values and physical positioning as we did. The volume control may be omitted, since you already can control the receiver's volume. The amplifier will operate on 6 to 15 volts DC. All needed parts are available at Radio Shack stores. You'll get plenty of volume for any size of utility or communications speaker. (AUTHOR'S NOTE: I have fully tested this use of a second identical LM386 IC circuit with speaker and can recommend it highly to all who can't confine all this listening excitement to one or two headsets!)

IMPORTANT: A monaural 1/8" plug will "fit" the receiver's stereo jacks. HOWEVER, the plug must NOT be pushed all the way into the jack, because it will short out the audio output. If you have reason to use a mono plug, insert it just far enough for the tip to make firm contact with the first section inside the jack.

About the 5 Tuning Ranges of Your Receiver

The purpose of the following information is to give newcomers a general idea of what to expect to hear in each of the 5 frequency ranges tuned by your receiver.

First, please understand that the frequency markings on the tuning dial can be only *approximate*. They indicate the "general neighborhood" of major frequency bands and have an accuracy only within a few hundred KHz. (If you are wondering what it would take to make the dial perfectly accurate, imagine an adjustable trimmer capacitor AND an adjustable coil for EACH band! The process of making these many adjustments is called alignment and also requires the use of frequency measuring equipment far more costly than the receiver.)

Whenever you hear a broadcast of special interest to you which you would like to be able to find again, make a note of the time, frequency band, and approximate dial position. In fact, such notes are called a "Shortwave Listening Log."

Range A: 3.5 to 4.3 MHz.

The primary purpose of this tuning range is to make it very easy for you to listen to ham radio stations at night on what is known as the 80/75 Meter band. From 3.5 to 3.8 MHz, you'll hear mostly Morse Code signals. From 3.8 to 4.0 MHz, you will hear SSB voice conversations from all around the nation. You'll hear both sides of most conversations. You may hear occasional shortwave broadcasts mixed in among the hams in the 3.9 to 4.0 MHz region and possibly in the 90 Meter band, 3.2 to 3.4 MHz.

Range B: 5.85 to 7.40 MHz.
The main purpose of this tuning range is to give you lots of strong shortwave broadcasts in late afternoon and throughout the night on the 49 meter band, 5.95 to 6.2 MHz. The 40 meter ham radio band is 7.0 to 7.3 MHz, and you will also hear foreign broadcasts among the ham CW and SSB signals.

Range C: 9.5 to 12.00 MHz.
This band lets you tune all of the popular 31 meter broadcast band, 9.5 to 9.9 MHz. You can also find the WWV time standard signal at 10.0 MHz (or on Band D at 15.0 MHz.) The 30 meter ham band (CW and RTTY only in the USA) is at 10.1 to 10.15 MHz. This tuning range is generally busy 24 hours a day.

Range D: 13.2 to 16.4 MHz.
On the 20 Meter ham band (14.0 to 14.35 MHz), you can hear strong CW and SSB voice signals from around the world throughout the day and well into the evening. This is the most active and crowded of the international ham radio bands. You also are able to tune the 21 Meter shortwave broadcast band (13.6 to 13.8 MHz), and all of the 19 Meter band (15.1 to 15.6 MHz). Station WWV at 15.0 MHz provides precision time and frequency information. The 19 Meter band is very good in the morning hours of winter and the late afternoon hours of summer.

Range E: 17.5 to 22 MHz.
This tuning range is provided to assure good listening variety during daylight hours. It includes the 16 Meter broadcasting band (17.55 to 17.9 MHz), the 17 Meter ham band (18.068 to 18.168 MHz, and the 15 Meter ham band (21.0 to 21.45 MHz). Station WWV also broadcasts on 20 MHz.

Shortwave Listening in General

In addition to the specific "bands" highlighted above, you'll hear thousands of other shortwave signals. Many will be military or government Morse code transmissions, plus very "odd" noises of weather FAX, wire service and other data transmissions. You can also hear government or military SSB voice transmissions and even an occasional unlicensed "pirate" station.

A rule of thumb is that the lower frequency ranges (A, B, C) are most active during the late afternoon, evening and through the night. The higher frequencies (D and E) generally are most active during daylight hours.

See the conclusion of this book for information on getting more information!

In Case of Difficulty

Your receiver is designed to work perfectly as soon as correct construction is completed. Let's review those 5 possible building mistakes which will cause your receiver not work:

1. **Installing a WRONG part.**
   Example: Using a 10 ohm resistor in place of 10K ohm(10,000 ohms)
2. **Installing certain parts BACKWARDS.**
   Example: Reversing the (+) and (-) sides of an electrolytic capacitor, or pointing the flat side of a transistor in the wrong direction.
3. **Faulty SOLDER connection.**
   Example: "cold" connections or solder "bridges".
4. **OMITTING a part, solder connection or wire.**
   Example: if it's supposed to be there and isn't, we have a problem!
5. **Positioning the part close to the board prevents interaction with other parts.**

If your receiver does not work, review all construction steps carefully. Let somebody else go over your work and the steps.

Following are minor problems which are easy to solve:

One band seems identical to an adjacent band.
Check the soldering of all the inductors.

Extremely weak volume on all bands.
Test your headphones on a personal stereo and compare them to one or more other headphones. It is very possible for inexpensive headphones to become defective. Also, make sure that the battery is in good condition.

Steady, high-pitched squeal or whistle.
Regeneration control is turned too far clockwise.

Regeneration inoperative on some bands, especially D and E.
Incorrect adjustment of trimmer R20. Review Sections 5. If regeneration was previously fine but now no longer works, the probable cause is a weak battery.

CW signals all sound chirpy or wobbly.
Replace the battery, it is too weak to operate both the regenerating detector and the audio amplifier.
Receiver works fine sometimes, but is erratic especially when it is bumped or moved.
Look for a loose solder connection.

Very strong signals are impossible to tune in well.
Reduce the setting of the internal RF Gain control.

CW signals wobble slightly if the receiver is bumped.
This is a normal characteristic for a simple oscillator. If the wobbling or instability is extreme, toroid control L5 is installed too loosely and should be tightened up.

We have designed this book and the receiver itself to assure that you can build it successfully and enjoy using it as soon as construction is completed. If, after building your receiver, double-checking all assembly steps and going over the preceding trouble-shooting suggestions, you and are still having a problem, please contact *MFJ Techincal Service* at 601-323-0549 or the *MFJ Factory* at 601-323-5869. Before calling, be prepared to explain your exact difficulty as clearly as possible. 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 601-323-6551; 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.

If needed, your receiver can be repaired by MFJ provided that it has been completely assembled, using rosin-core solder only. A starndard service fee plus S & H will be charged for repair. Please call for current pricing. Defective units should be shipped to:

MFJ Enterprises, Inc.
300 Industrial Park Road
Starkville, MS 39759

MFJ will verify repairs on any unit requiring more than the minimum service fee covers with the owner of the unit by phone.

Your Notes

Notes for Radio Hams and Experimenters

This receiver has a single intended purpose: to help newcomers, young and old alike, to enjoy tuning the sheer magic of shortwave radio. You'll quickly gain the skill of finessing the regeneration control to choose AM shortwave broadcasts, SSB or CW/RTTY. The MFJ-8100 just might be the very best regenerative receiver ever designed, but it is not intended to be all things to all people.

The MFJ-8100's PC board is a very roomy "platform" which may seem to invite countless modifications. However, please remember the original purpose of the receiver before "hacking". It's a beginner's first shortwave receiver, designed for the most popular SWL broadcasts plus a SAMPLING of our ham bands. If you expect to pass it on as a gift or resell it, it would be prudent to accomplish any desired modifications on the outside of the receiver itself. For example, the function of the RF gain control can be duplicated with a pot at the antenna connector with no drilling required. Similarly, alternative DC power, additional audio amplification or audio filtering can be provided externally. If you change any values in the L-C tuning in order to try a band of special interest, be sure to note such changes in this manual. Remember that changing C3 or any inductance affects the tuning range of ALL the bands.

[Author's Hint: To save you time as well as wear and tear on the PC board, here's what my own curiosity showed: reducing C3 can easily bring in 12 and 10 Meters on Band E. However, attempts to increase this capacitance beyond 220 pF without ALSO increasing total inductance are pointless if you're looking for good 160 Meter performance.]

While it's not intended as a communications receiver, the very fact that the MFJ-8100 covers all or part of so many different popular CW bands might intrigue some QRP enthusiasts interested in multi-band portable trans-receiving. The author conducted a few simple tests using an HW-9 for transmitting, side by side with the MFJ-8100 on 30, 20, 17 and 15 meters. You will want T-R switching to short the receiver antenna input to ground and also to mute the audio. Plan on a separate keying sidetone. Frequency spotting must be done with a very low RF level. Receiver stability when switching the antenna input is amazingly good even at 21 MHz. While the MFJ-8100 is not represented as a communications receiver, you indeed can have some multi-band QRP fun with it. And FUN is exactly what this great new receiver is all about!

Look at it this way. If you take your multi-band QRP mini-transmitter and MFJ-8100 on a trip and happen not to work DX or anybody else, you can still dial up BBC, VOA, Moscow, and many other places of our ever-shrinking global community!

Conclusion

If you really enjoy shortwave radio listening, you'll probably yearn for and eventually get a more elaborate receiver. You might even work on getting a ham radio license and setting up a station for transmitting and receiving. As the years go by, we have a hunch that you'll always remember the first thrills of listening to your MFJ-8100. And, because it's rugged, compact, and far more sophisticated than the first receivers of yesteryear, we suspect you'll actually keep it and keep on listening to it when nobody else is looking!

LEARNING MORE

The purpose of your Receiver and the details provided in this instruction manual are to help you become better acquainted with radio communications and electronics: as a hobby, as a possible profession, or both.

Among the hundreds of publications available, we are pleased to recommend the following as especially helpful for radio newcomers and people of any age who are young at heart!

Getting Started in Electronics
by Forest Mims III (Radio Shack)

Now You're Talking: Discovering the World of Ham Radio
(ARRL, Newington, CT 06111, also sold by Radio Shack)

Shortwave Listener's Guide for Apartment/Condo Dwellers
by Ed Noll, W3FQJ (1991, MFJ Edition No. 36)

The Wonderful World of Ham Radio
by Richard Skolnik, KB4LCS (1990, MFJ Edition No. 35)

Or, if you'd like just one copy of one magazine that's all about ALL the signals you may hear on your MFJ-8100, you can find the latest issue of POPULAR COMMUNICATIONS at any serious magazine stand. It's a fascinating publication. Happy listening!

Circuit Component Index

Part Number	Value/Description	Step No.	MFJ Part No.
C1	Air-variable, tuning	4-7	204-5050
C2	.1 uF	2-17	200-2017
C3	47 pF	1.9	205-0021
C4	.1 uF	1-7	200-2017
C5	5-30 pF trimmer	1-10	204-0013
C6	33 pF	2-7	200-2016
C7	.01 uF	2-2	200-2015
C8	.01 uF	2-13	200-2015
C9	.0033 polystyrene	3-11	201-0008
C10	.1 uF	3-13	200-2017
C11	.1 uF	3-10	200-2017
C12	22 uF electrolytic	3-5	203-0013
C13	100 uF electrolytic	3-3	203-0015
C14	10 uF electrolytic	3-4	203-0012
C15	.1 uF	3-9	200-2017
C16	75 pF	2-20	200-1011
C17	.0033 polystyrene	2-12	201-0008
C18	1 uF electrolytic	2-3	203-0006
C19	470 uF electrolytic	3-2	203-0004
C21	.01 uF	2-15	200-2015
C28	.01 uF	2-16	200-2015
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R6	1K	2-5	100-3100
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J3	Stereo 1/8" jack	4-3	601-4010
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SW2	DC on-off push-button switch	4-4	504-0022