JOVE

RJ1.1 Receiver Kit

Assembly Manual

2012

Receiver Kit and Manual
developed for NASA JOVE Project
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Radio JOVE

You are about to embark on building a short-wave receiver which will pick-up radio signals from the planet Jupiter and also from the Sun. This receiver contains over 100 electronic components and pieces of hardware. Fabrication will include the handling of small, delicate, electronic parts, most of which will be mounted and soldered on a printed circuit (PC) board.

The radio uses many different types of electronic components, with each part performing a different job. However, before discussing these components and what they do, we will look at the overall receiver (depicted in the block diagram in Figure 1).

CONSTRUCTION TIME ESTIMATES

Part Identification	approx. 1 hr.
Receiver Construction	approx. 9 hrs.
Testing and Alignment	approx. 1 hr.
Total Time	approx. 11 hrs.

THEORY OF OPERATION

Radio signals from Jupiter are very weak - they produce less than a millionth of a volt (1 microvolt, 1μv) at the antenna terminals of the receiver. These weak radio frequency (RF) signals must be amplified by the receiver and converted to audio signals of sufficient strength to drive headphones or a loudspeaker. The receiver also serves as a narrow filter, tuned to a specific frequency to hear Jupiter while at the same time blocking out strong earth based radio stations on other frequencies. The receiver and its accompanying antenna are designed to operate over a narrow range of short-wave frequencies centered on 20.1 MHz (megahertz). This frequency range is optimum for hearing Jupiter signals.

Antenna

The antenna intercepts weak electromagnetic waves which have traveled some 500 million miles from Jupiter to the Earth. When these electromagnetic waves strike the wire antenna, a tiny RF voltage is developed at the antenna terminals. Signals from the antenna are delivered to the antenna terminals of the receiver by a coaxial transmission line.

RF Bandpass Filter and Preamplifier
Signals from the antenna are filtered to reject strong out-of-band interference and are then amplified using a junction field effect transistor (JFET). This transistor and its associated circuitry provide additional filtering and amplify incoming signals by a factor of 10. The receiver input circuit is designed to efficiently transfer power from the antenna to the receiver while developing a minimum of noise within the receiver itself.

Local Oscillator and Mixer
The local oscillator (LO) and mixer perform the important task of converting the desired radio frequency signals down to the range of audio frequencies. The local oscillator generates a sinusoidal voltage wave form at a frequency in the vicinity of 20.1 MHz. The exact frequency is set by the front panel tuning control. Both the amplified RF signal from the antenna and the LO frequency are fed into the mixer. The mixer develops a new signal which is the arithmetic difference between the LO and the incoming signal frequency. Suppose the desired signal is at 20.101 MHz and the LO is tuned to 20.100 MHz. The difference frequency is therefore 20.101-20.100 = .001 MHz, which is the audio frequency of 1 kilohertz. If a signal were at 20.010 MHz it would be converted to an audio frequency of 10 kHz. Since the RF signal is converted directly to audio, the radio is known as a direct conversion receiver.

Low Pass Filter
To eliminate interfering stations at nearby frequencies, we use a filter which is like a window a few kilohertz wide through which Jupiter signals can enter. When listening for Jupiter or the Sun, the radio will be tuned to find a "clear channel." Since frequencies more than a few kilohertz away from the center frequency may contain interfering signals, these higher frequencies must be eliminated. This is the purpose of the low pass filter following the mixer. It passes low (audio) frequencies up to about 3.5 kHz and attenuates higher frequencies.

Audio Amplifiers
The purpose of the audio amplifiers following the low-pass filter is to take the very weak audio signal from the mixer and amplify it enough to drive headphones directly, or to drive an external amplified speaker assembly.

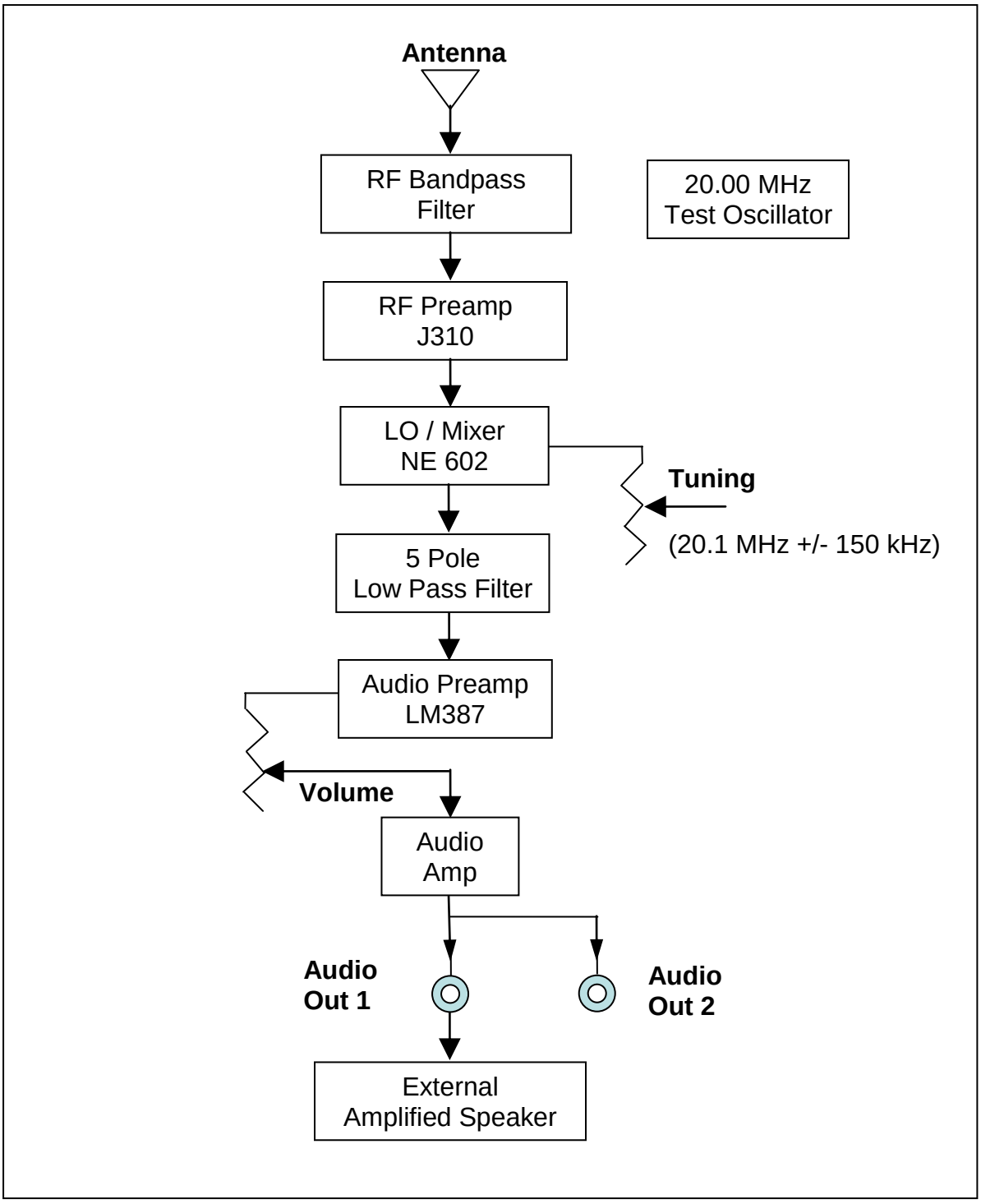


Figure 1. JOVE receiver block diagram

COMPONENTS

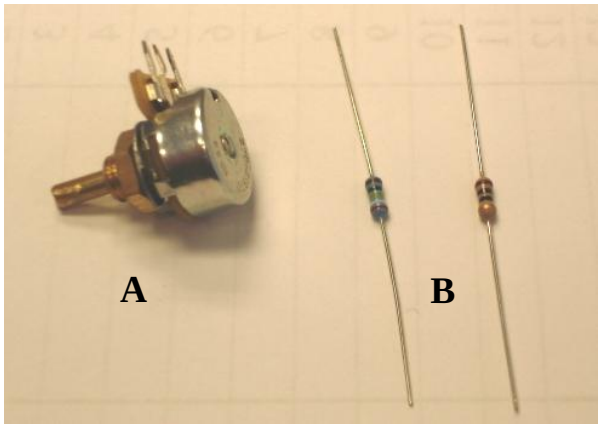
The JOVE receiver uses many different electronic components (Figure 2) including wires, resistors, capacitors, inductors, diodes, transistors and integrated circuits. Each performs different functions.

Wires are made of conducting metal—they direct the flow of electrical current from one place to another. Since wire is a good conductor, it has a low resistance to the flow of electricity. The printed circuit (PC) board used in this kit uses traces of copper etched on an insulating fiberglass back plane in place of individual wires.

Resistors conduct electrical current, but they are designed to impede the flow of electrons. This characteristic of resistance limits the amount of current flow according to Ohm's law. Resistors dissipate electrical power by generating heat. The value of a resistor is given in Ohms (Ω), while its maximum power dissipation is given in watts. There are fixed resistors and variable resistors. Two variable resistors are used in this kit—one as the volume control and the other as the tuning control. The fixed resistors in this kit have several different values of resistance, but they are all 1/4 watt size. See Appendix B for reading resistor value color codes.

Capacitors appear as an open circuit to direct current (DC) but pass audio and radio frequency signals. The value of a capacitor is given in Farads (F), although it is most common to use capacitors with values in the range of microFarads (μF) or picoFarads (pF). Since the capacitor is physically made of two conducting plates separated by a very thin layer of insulation it is possible for an electrical voltage to arc between the plates and destroy the capacitor. For this reason capacitors have a maximum voltage rating. Capacitors store energy in the electrical field between the plates but do not dissipate power like resistors.

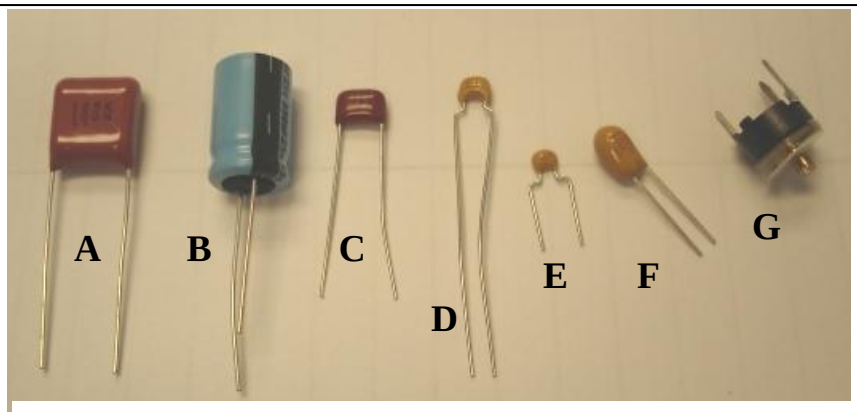
Inductors are simply coils of wire which pass direct current and have the property of resisting changes in current flow. The value of inductance is the Henry (H), although it is most common to use coils whose inductance is measured in milliHenries (mH), or microHenries (μH). Inductors store energy in the magnetic field surrounding the coil. When inductors and capacitors are used together they form a resonant circuit which swaps energy between the magnetic field of the



Resistors

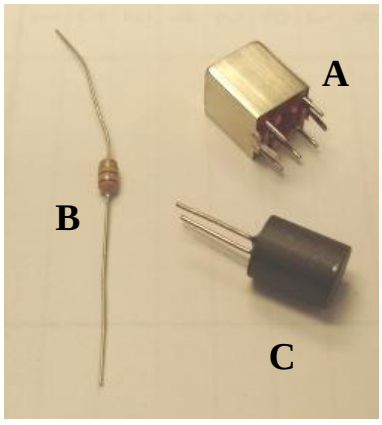
A – Variable Resistor (Tuning Control)

B – Fixed Resistors



Capacitors

A – Metal Polyester
B – Electrolytic
C – Metal Film
D – Disc Ceramic
E – Dipped Ceramic
F – Tantalum
G – Variable Capacitor



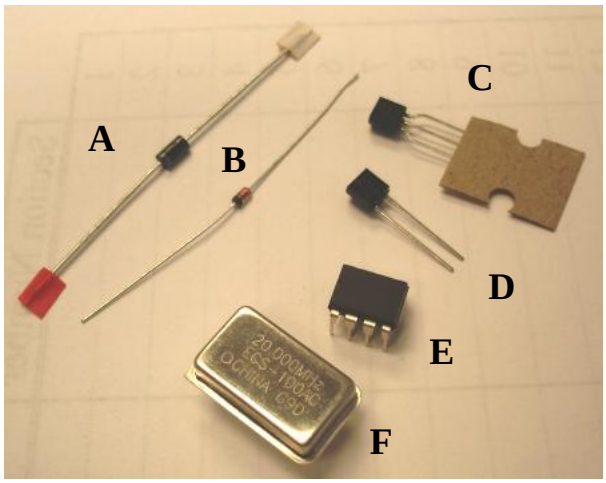
Inductors

A – Variable Inductor (silver can)

B – Fixed Inductor

C – Fixed Inductor (black cylinder)

Figure 2. Components



Solid State Devices

A – Diode 1N4001

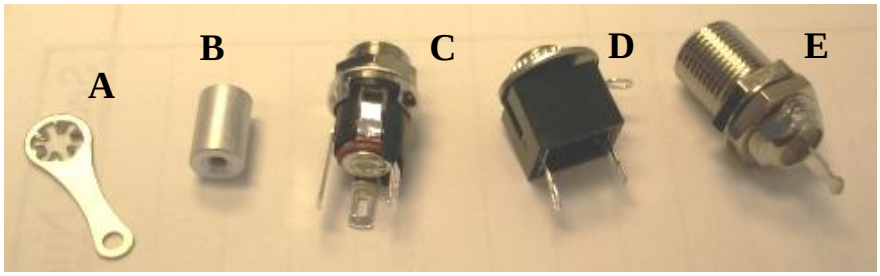
B – Diode 1N914

C – Transistor 2N-3906

D – Varactor Diode MV-209

E – Integrated Circuit SA-602

F – Oscillator Module



Connectors and Hardware

A – Solder Lug

B – Spacer

C – 2.1 mm Power Connector

D – 3.5 mm Stereo Audio Jack

E – Chassis Coaxial Connector

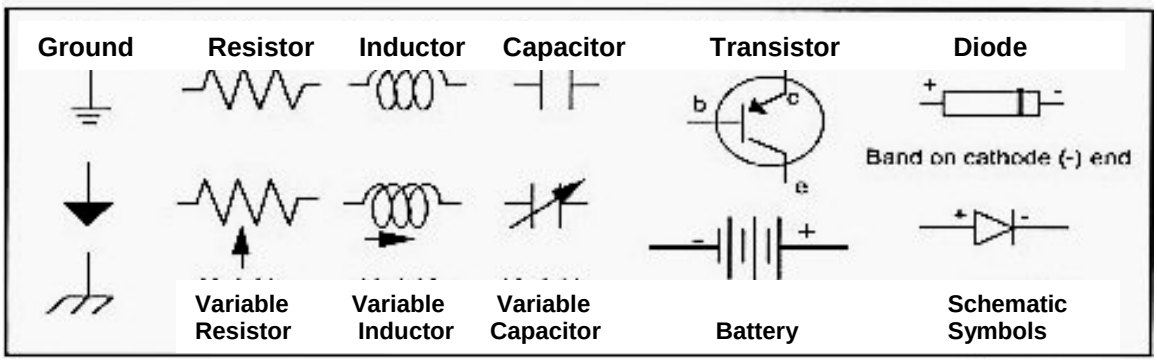


Figure 2. Components, continued

inductor and the electric field of the capacitor. This has the effect of forming a resonant circuit - which is tuned to a certain audio or radio frequency - much as an organ pipe is resonant at a particular audio frequency. Such a circuit acts like a filter - selecting only a narrow range of desired frequencies and rejecting others. Resonant circuits often use variable capacitors or variable inductors which must be adjusted for optimum performance at the desired frequency.

Resistors, capacitors, and inductors are used to route signals and DC voltages within a circuit and to select or reject certain frequencies by filtering. Certain capacitors (electrolytic type) have a (+) and (-) terminal and must be installed with the proper orientation in a circuit. Resistors, inductors, and non-electrolytic capacitors may be installed in any orientation.

Diodes are solid state devices which allow current flow in one direction only. The diode has an anode (+) and a cathode (-) and must be installed with the proper orientation.

Transistors are generally three—terminal solid state devices used to amplify signals. Bipolar transistor terminals are known as the base (b), emitter (e), and collector (c). A small signal injected into the base will appear amplified at the collector. Another type of transistor is the field effect transistor (FET). The terminals of this device are known as the gate (g), source (s), and drain (d). The transistor requires power to amplify signals so there is always a connection to a source of DC power.

Integrated Circuits are often made up of hundreds of transistors, diodes, and resistors all interconnected to perform specific functions. This kit uses three integrated circuits (ICs), each with 8 pins. The orientation of the IC in the circuit is important as each pin has a different use.

CIRCUIT DIAGRAMS

We have already seen a block diagram of the JOVE receiver, which shows the radio as a group of functional blocks connected together. While this type of diagram does not show individual components like resistors and capacitors, it is useful in understanding signal flow and the various functions performed within the radio.

The next level of detail is the schematic diagram. A schematic is used to represent the wiring connections between all of the components which make up a circuit.

The schematic diagram uses symbols for each of the different components rather than pictures of what the components actually look like. The symbols and pictures of several of the components used in this kit are seen in Figure 2. A schematic diagram of the complete receiver is seen in Figure 3. On this schematic, the part types are numbered sequentially. For example, inductors are denoted L1 through L7, and resistors are denoted R1 through R31.

Signal flow as shown in the schematic is as follows. The signal from the antenna connector (J2) is coupled to a resonant circuit (bandpass filter L1, C2, C3) and then to the J-310 transistor (Q1), where it is amplified. The output of the J-310 goes through another resonant filter (L3, C6) before being applied to the resonant input circuit (L4, C9, C10) of the SA602 integrated circuit (IC1), which serves as the local oscillator and mixer. The center frequency of the local oscillator is set by inductor L5 and adjusted by the tuning control R7. The audio output from IC1 passes through the low-pass audio filter (L6, L7, C20, C21, and C22). The audio signal is next amplified by IC2 (an LM387) before going to the volume control R15. The final audio amplifier stages comprise IC3 (another LM387), and the output transistors Q2 (2N-3904) and Q3 (2N-3906). After the receiver has been assembled, the variable capacitors C2 and C6 and variable inductors L4 and L5 will be adjusted to tune the receiver for operation at 20.1 MHz.

Another useful representation of the circuit is a PC board layout diagram (Figure 4). This is a pictorial representation showing the actual parts placement on the printed circuit board. This X-ray view from the component side of the board shows the components as rectangles or circles, and the trace side of the board as faint gray areas. A similar PC layout diagram (Figure 5) just shows the components, without the X-ray view of the traces. This view of the components is identical to the component outlines marked on the actual PC board

An exploded view (Figure 7) shows the PC board and the enclosure, with connectors and controls mounted on the front and rear panels of the box.

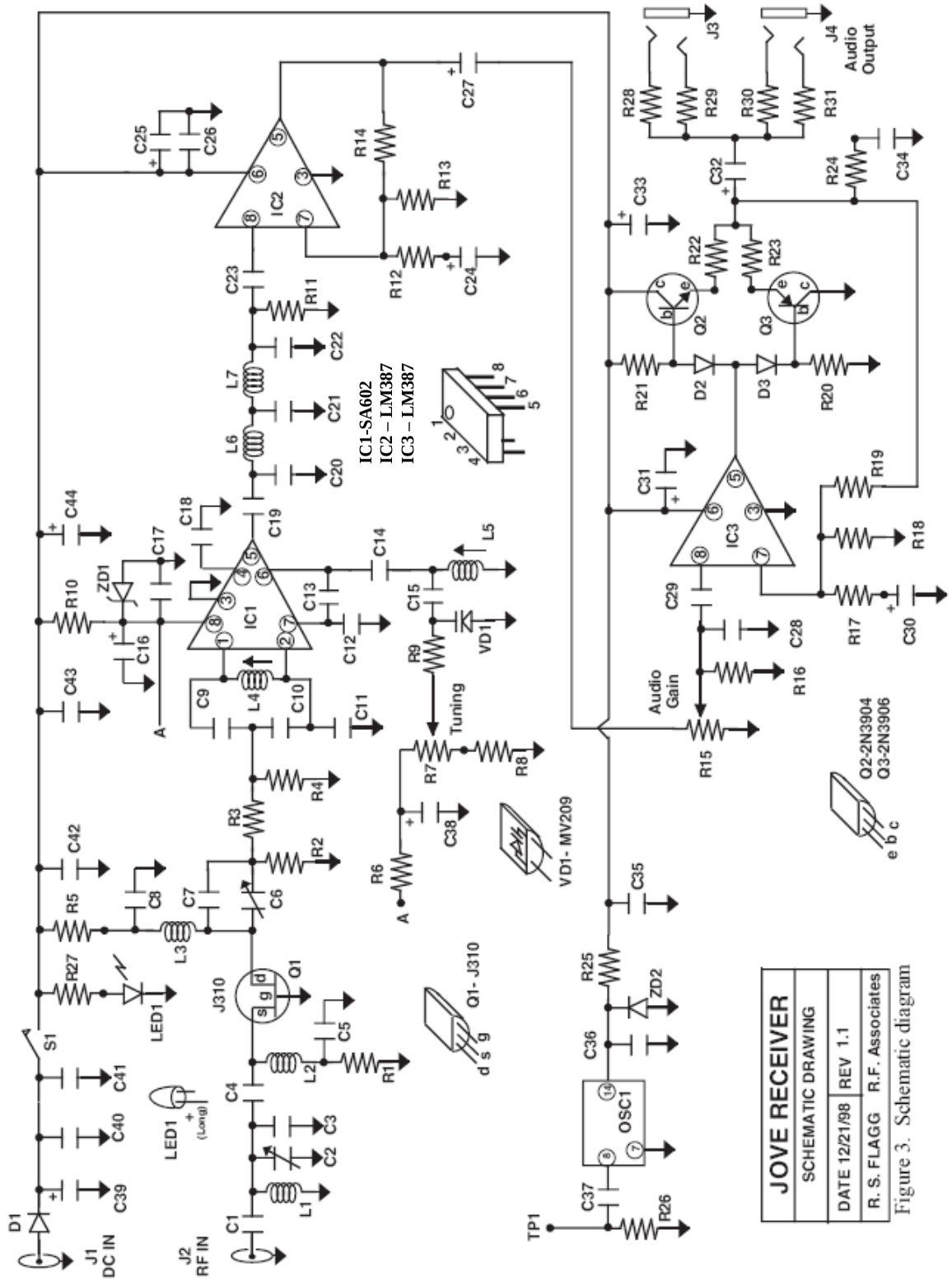


Figure 3. Schematic diagram

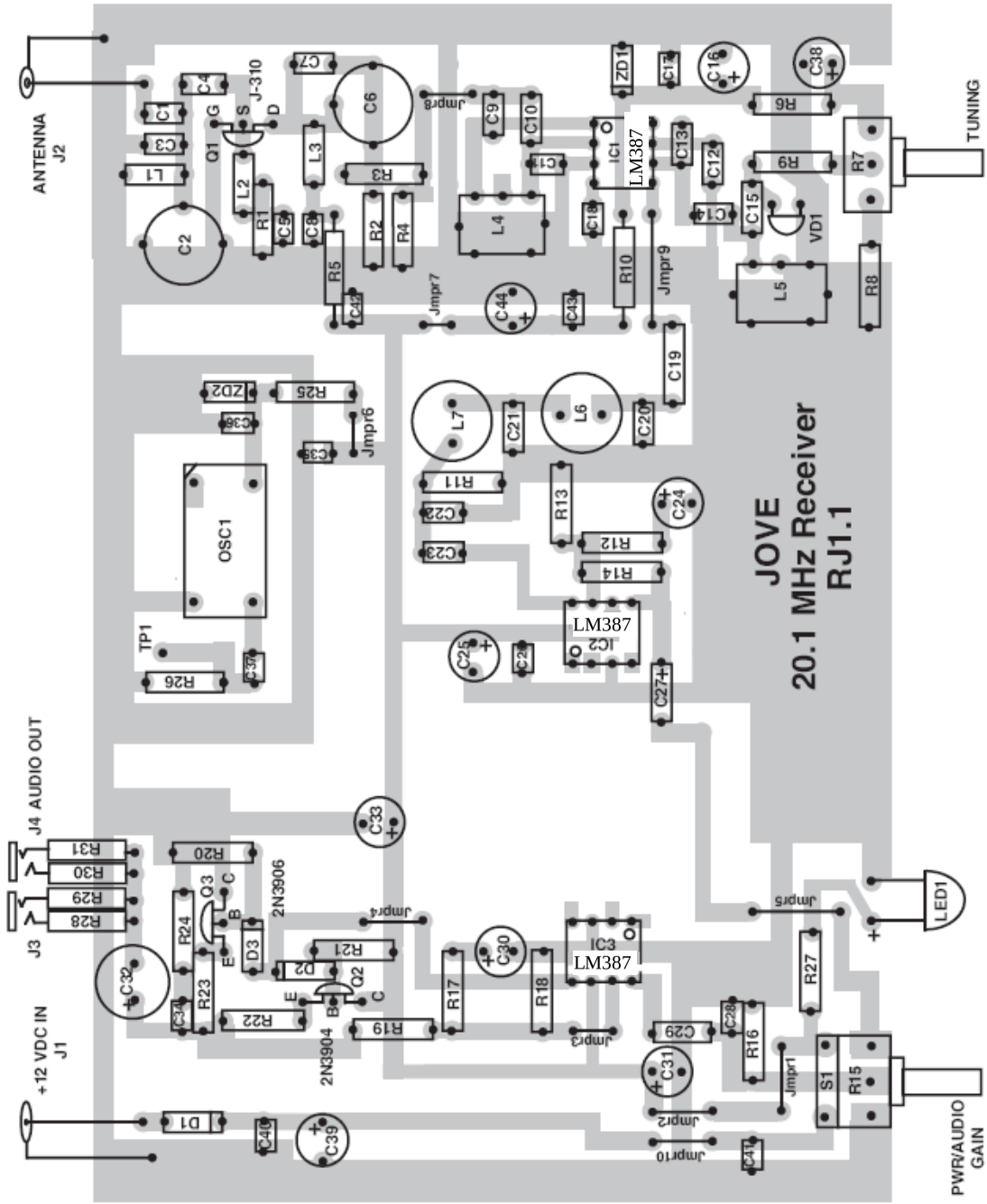


Figure 4. X-ray view of PC board from component side

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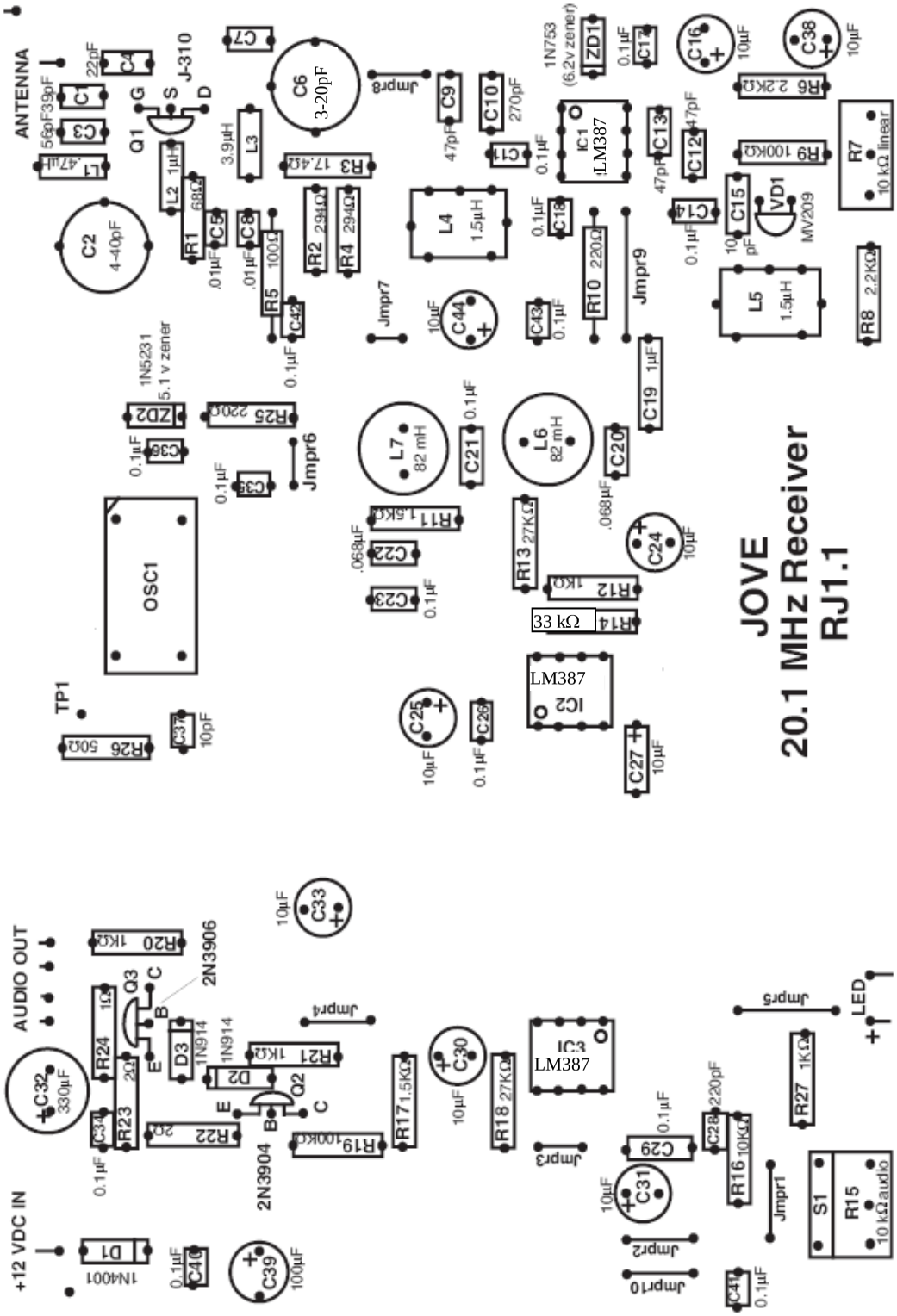


Figure 5. PC board - component side

Figure 5. PC board - component side

The parts list (Table 1) identifies each component by its value and part number. As you begin construction the first step will be to identify each component and check it off on the parts list to make sure that you have received all of the parts. This table is an important link between the bag of parts which you have received and installing those components in the right place in the radio as shown by Figures 4, 5, and 6.

Although this is a complicated project, it can be built successfully. You are urged to take great care to install the right parts in the right places on the PC board. Before soldering make sure you have the right component. Also be sure the orientation is correct—electrolytic capacitors, transistors, integrated circuits and diodes must be installed with the correct orientation.

TOOLS

(Radio Shack parts numbers follow many of the items)

- Soldering Iron (RS 64-2071; 40 Watt) or or 40-Watt Weller WLC100 or Velleman 50W Soldering Station (part # VTSS5U; check Amazon.com)

[NOTE: A small wattage soldering iron or soldering pencil (25-30 watts) is ideal for building the receiver but is not big enough for the larger wires and joints in the antenna. A 50 watt soldering iron, or a higher wattage (100-150 watts) soldering gun is best for the antenna, although if you are patient you may get by with a 40 watt iron (make sure the solder flows throughout the wire strands). A variable wattage iron (25-50 watts) like the Velleman 50W Soldering Station is recommended since it can be used for both the receiver and antenna. If you purchase a simple soldering iron with no stand, please obtain a stand to hold the hot iron. Another advantage of purchasing a soldering station is that it includes a stand for the hot iron. Whatever soldering equipment you purchase clean and tin the tip frequently for best performance.]

- Solder, rosin core 60/40 (.050 in., RS64-006 or .032 in., RS 64-005)
- Wire Cutters and Wire Strippers (RS 64-080 Wire Stripper and Nippy Cutter)
- Diagonal Cutters, 5 inch Nippy Cutter (RS 640-0064)
- Long Nose Pliers (RS 640-0062)
- Phillips screwdriver (with small tip)
- Small Crescent wrench or 3/8” and 7/16” open wrenches
- *Allen wrench (hex) 1/16 inch
- *Sandpaper
- *Plastic tool for adjusting variable inductors
- *Plastic tool for adjusting variable capacitors

* These tools are included with the kit

SOLDERING

Key to successful fabrication of this JOVE receiver kit is your ability to solder. It is important that each solder joint be made correctly—heating the joint so that the solder flows and joins the component lead to the solder pad, without applying so much heat that the component is damaged. See Appendix A for a guide to good soldering techniques, or see our videos Online: http://radiojove.gsfc.nasa.gov/telescope/soldering.htm.

THE WORK AREA

Select a work area with good light and an electrical outlet. The area should be large enough for a comfortable work space for a couple of people, a soldering iron, tools, the instruction manual, and the kit parts. Keep the work space clean so parts don't get lost.

IDENTIFYING PARTS

Check the parts you have received against the list in Table 1 (JOVE Parts List). With the aid of the capacitor sorting sheet, Figure 2, and appendix B, make absolutely sure you have identified each part correctly. Each part in the kit has a designation (for example resistor R1, or capacitor C21). Each part has a manufacturers designation printed on the part as to the value of the part. Resistor values are designated by colored bands (see appendix B). Capacitor designations are more complex and often contain "too much" information – such as manufacturers date codes and lot numbers.

Ceramic Capacitors often have numbers and letters on both sides. In the parts list we show only the information printed on the "front side" of the capacitor – the side that tells the value of the capacitor along with information related to the tolerance, temperature stability and voltage. As an example, C1 which is a 39pf ceramic capacitor, could have either 390/A1J or 39J printed on the front side (depending on the manufacturer). The zero in 390 is a multiplier (10 to the zero power which is 1), so the value is 39pf. The letter J is for 5% tolerance.

Electrolytic capacitors usually have the the value in microfarads as well as a maximum voltage rating. These caps are polarized – there is a positive and negative lead. The long lead is positive (+).

Radio JOVE Receiver Kit
Capacitor Sorting Sheet

NOTE: On occasion the markings on a capacitor or the color of a capacitor will differ from those shown below. It is recommended that you sort the easily identified parts first and then determine the part number match for the remaining capacitors.

The markings on the front side of the capacitor are shown in brackets (390/A1J or 39J). The kit part number is also shown – for example C1.

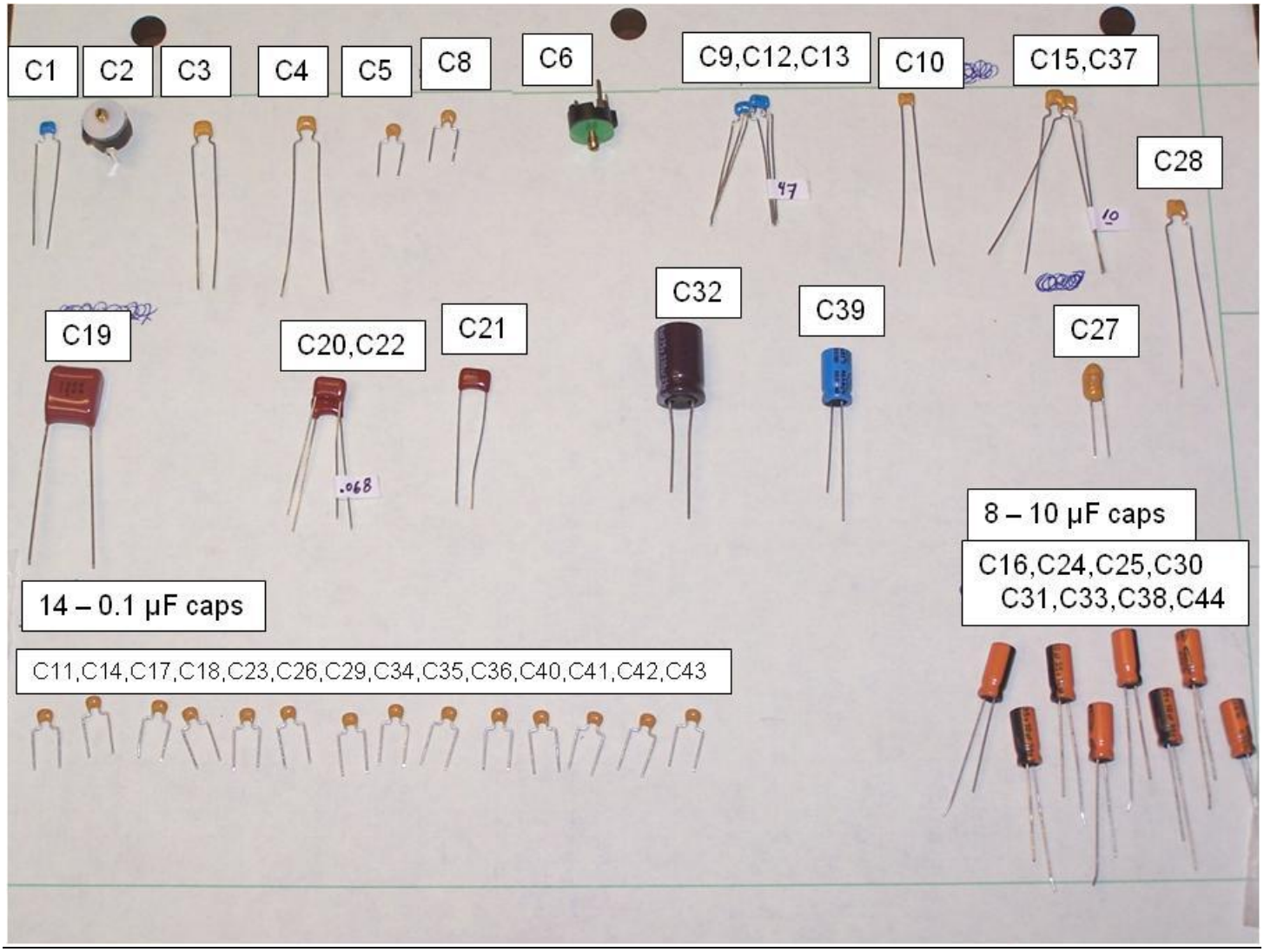


Table 1
JOVE Receiver Parts List

Actual marking found on component is shown in parentheses ( ). See capacitor sorting sheet for reference. Two columns of check-off boxes are provided: use one for parts identification, and the other, for installation.

CAPACITORS	*Note polarity on all electrolytic capacitors*		
C1	39 pF, ceramic (390/A1J or 39J)		
C2	4-40 pF, variable (white)		
C3	56 pF, ceramic (560/A1J or 56J)		
C4	22 pF, ceramic (220/A1J or 22J)		
C5	.01 μF, ceramic (103)		
C6	3-20 pF, variable (green)		
C7	not used		
C8	.01 μF, ceramic (103)		
C9	47 pF, ceramic (470/A1J or 47J)		
C10	270 pF, ceramic (271/A1J)		
C11	0.1 μF, ceramic (104)		
C12	47 pF, ceramic (470/A1J or 47J)		
C13	47 pF, ceramic (470/A1J or 47J)		
C14	0.1 μF, ceramic (104)		
C15	10 pF, ceramic (100/A1J or 10J)		
C16	10 μF, 25 vdc, electrolytic, long lead is +		
C17	0.1 μF, ceramic (104)		
C18	0.1 μF, ceramic (104)		
C19	1 μF, metal polyester (105K/100A)		
C20	0.068 μF, 5% metal film (18L/683)		
C21	0.1 μF, 5% metal film (17L/104)		
C22	0.068 μF, 5% metal film (18L/683)		
C23	0.1 μF, ceramic (104)		
C24	10 μF, 25 vdc, electrolytic, long lead is +		
C25	10 μF, 25 vdc, electrolytic, long lead is +		
C26	0.1 μF, ceramic (104)		
C27	10 μF, 35 vdc, tantalum, marked lead is +		
C28	220pF, ceramic (221/A1J)		
C29	0.1 μF, ceramic (104)		
C30	10 μF, 25 vdc, electrolytic, long lead is +		

C31	10 μF, 25 vdc, electrolytic, long lead is +		
C32	330 μF, 25 vdc, electrolytic, long lead is +		
C33	10 μF, 25 vdc, electrolytic, long lead is +		
C34	0.1 μF, ceramic (104)		
C35	0.1 μF, ceramic (104)		
C36	0.1 μF, ceramic (104)		
C37	10 pF, ceramic (100/A1J or 10J)		
C38	10 μF, 25 vdc electrolytic, long lead is +		
C39	100 μF, 25 vdc electrolytic, long lead is +		
C40	0.1 μF, ceramic (104)		
C41	0.1 μF, ceramic (104)		
C42	0.1 μF, ceramic (104)		
C43	0.1 μF, ceramic (104)		
C44	10 μF, 25 vdc electrolytic, long lead is +		

DIODES	*Note polarity*		
D1	1N4001		
D2	1N914		
D3	1N914		
LED1	light emitting diode (LED), red, long lead is +		
VD1	MV209, varactor diode		
ZD1	1N753, 6.2 v, zener diode, 400 mw		
ZD2	1N5231, 5.1v, zener diode, 500mw		
INDUCTORS	*Do Not Confuse L1, L2, L3 with Resistors*		
L1	0.47 μH, (yellow, violet, silver, silver)		
L2	1 μH, (brown, black, gold, gold)		
L3	3.9 μH, (orange, white, gold, gold)		
L4	1.5 μH, adjustable inductor, (silver can)		
L5	1.5 μH, adjustable inductor, (silver can)		
L6	82 mH, fixed inductor, (black cylinder)		
L7	82 mH, fixed inductor, (black cylinder)		
INTEGRATED CIRCUITS			
IC1	SA602AN, mixer / oscillator		
IC2	LM387, audio preamplifier		
IC3	LM387, audio preamplifier		
OSC1	20.000 MHz crystal oscillator module		

RESISTORS	**Some resistors have 4 color bands, and others 5; see Appendix B for help or use a ohmeter to confirm resistance values**		
R1	68 ohm (blue, gray, black, gold)		
R2	294 ohm (red, white, yellow, black, brown)		
R3	17.4 ohm (brown, violet, yellow, gold, brown)		
R4	294 ohm (red, white, yellow, black, brown)		
R5	100 ohm (brown, black, black, black, brown)		
R6	2.2 Kohm (red, red, red, gold)		
R7	10 Kohm linear potentiometer		
R8	2.2 Kohm (red, red, red, gold)		
R9	100 Kohm (brown, black, yellow, gold)		
R10	220 ohm (red, red, brown, gold)		
R11	1.5 Kohm (brown, green, red, gold)		
R12	1 Kohm (brown, black, red, gold)		
R13	27 Kohm (red, violet, orange, gold)		
R14	33 Kohm (orange, orange, orange, gold)		
R15	10 Kohm potentiometer /switch		
R16	10 Kohm (brown, black, black, red, brown) or (brown, black, orange, gold)		
R17	1.5 Kohm (brown, green, red, gold)		
R18	27 Kohm (red, violet, orange, gold)		
R19	100 Kohm (brown, black, yellow)		
R20	1 Kohm (brown, black, red, gold)		
R21	1 Kohm (brown, black, red, gold)		
R22	2 ohm (red, black, gold)		
R23	2 ohm (red, black, gold)		
R24	1 ohm (brown, black, gold)		
R25	220 ohm (red, red, brown, gold)		
R26	51 ohm (green, brown, black, gold)		
R27	1Kohm (brown, black, red, gold)		
R28	10 ohm (brown, black, black, gold)		
R29	10 ohm (brown, black, black, gold)		
R30	10 ohm (brown, black, black, gold)		
R31	10 ohm (brown, black, black, gold)		
R32	51 ohm (green, brown, black, gold)		

TRANSISTORS			
Q1	J-310, junction field effect, (JFET)		
Q2	2N-3904, bipolar, NPN		
Q3	2N-3906, bipolar, PNP		
HARDWARE/MISC			
E1	Enclosure 5x7x2		
PCB1	Printed Circuit Board		
J1	Power Jack, 2.1 mm		
J2	F female chassis connector		
J3	3.5 mm stereo jack, open ckt		
J4	3.5 mm stereo jack, open ckt		
spacers (2)	0.375 inch spacer, 4-40 thread		
K1, K2	Knob, 1/8 inch shaft		
P1	2.1 mm plug with 72 inch cord		
Screw (5)	4-40 thread, 1/4 inch long		
Lock washer (5)	#4		
Flat washer (2)	#4		
Nut (1)	4-40		
Solder Lug(1)	#4		
Wire	6 in. red and 6 in. black and 18 in. bare wire		
Feet (4)	Rubber adhesive feet		
OTHER MATERIALS			
Allen Wrench	1/16 inch for knobs		
Sandpaper			
Tuning tool	White – for tuning inductors L4, L5		
Tuning tool	Black – For tuning capacitors C2 and C6		
AC Adapter	Jameco 12 volt power adapter (500mA) *Only included for USA, Mexico, and Canada orders*		

NOTE: Be careful about the orientation of the IC components – make sure to read and pay attention to the installation directions starting on page 23.

WIRING THE PC BOARD

The PC board will be populated in an order that will give you a chance to sharpen your soldering skills. You will install simple resistors and capacitors first, before getting to the transistors and integrated circuits which may be damaged by excess heat.

Mounting the Components

Mount the components as close to the board as possible without putting excessive strain on the leads. Some component lead spacings will match the board hole spacing and the component will mount flush with the board. In other cases, the component leads must be formed to align with the holes. Hold the component body in your fingers and form the leads with the needle nose pliers. Don't grasp the component with the pliers.

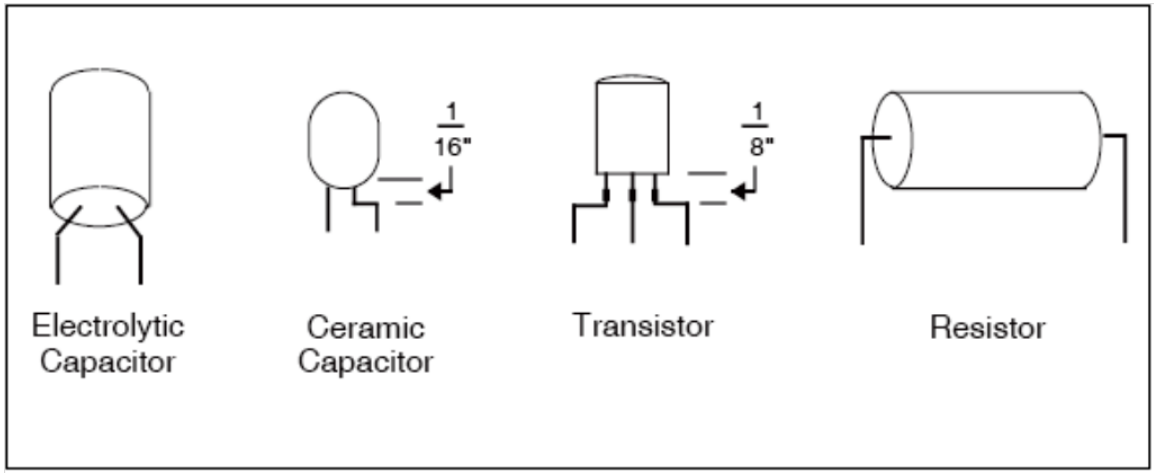


Figure 6. Forming the component leads to match up with PC board hole spacings

When forming the leads of the small ceramic capacitors leave at least 1/16 inch between the body of the capacitor and any bends. The capacitor body may fracture if the leads are overstressed.

When forming the leads of transistors always make bends farther than 1/8 inch from the transistor body. Some transistor leads show a crimp mark, near the transistor body. Never bend leads closer to the transistor than this crimp mark..

When you are cutting leads, shield the cut with your hand, or aim the work down, to prevent the cut wire from flying into someone's face.

Be very careful to use the correct component values. It's a lot easier to double check before soldering, than it is to have to unsolder and replace a part. *Refer to Appendix A for soldering techniques.*

After each component is soldered-in, make a check mark on the parts list (Table 1) and the PC parts layout diagram (Figure 5). As you go through the assembly procedure put a check mark in each ☐ after completing the step. Several photographs of the completed PC board are included near the end of the manual (Figure 20).

The following assembly sequence is recommended. Read each step completely before performing that step. *See Figure 2 and the capacitor sorting sheet for parts identification.*

The term "install" means to identify the part, form the leads, insert the component leads in the PC board, solder, and trim away the excess lead.

1. ☐ Inspect the PC board by looking at it from the component side while holding it up to a light. Compare traces and hole patterns with Figure 4 in this manual, making sure that all holes are drilled and that the trace patterns match.

2. ☐ Using the bare wire in the main parts bag and needle nose pliers, install the jumper wires J1 through J10. A simple way to do this is to (1) thread the two holes for the jumper wire with the long piece of wire, (2) allow about ¼ in. extra out the bottom of the holes, (3) bend the wire to hold it into place, (4) snip off the long excess wire. Repeat this for all jumper wires and the long wire gets progressively shorter. Solder all jumper wires into place, and cut off any excess wire.

3. ☐ Install fixed resistors R1 through R27. You can do this one resistor at a time, or you may prefer to insert several resistors (spreading the leads slightly on the trace side of the board to hold the resistors in place) and then soldering several resistors. Don't insert all the resistors before soldering, or you will have a forest of leads that will interfere with soldering. Small groups of half a dozen or so will work well. While soldering, you can lay the PC board on a flat surface to help hold the resistors in place.

4. ☐ Install inductors, L1, L2, and L3. *See Figure 2 for parts identification*

5. ☐ Install the three IC sockets. Each socket has a small notch in one end. The socket must be mounted so that the notch is near the pin 1 dot on the IC outline printed on the component side of the PC board. Insert the socket pins into the PC board and place the board on a flat surface so the socket is pushed flush against the board. Solder one pin, and check to see that the socket is flush with the board before soldering the remaining pins.

6. ☐ Install fourteen 0.1μF dipped ceramic capacitors. [C11, C14, C17, C18, C23, C26, C29, C34, C35, C36, C40, C41, C42, C43] These capacitors are not polarized and can be installed in either orientation.

7a. ☐ Install eight 10μF, 25vdc electrolytic capacitors, [C16, C24, C25, C30, C31, C33, C38, and C44]. *Carefully observe the polarity and proper orientation.* Each capacitor has a vertical band with minus signs running from top to bottom along one side. The lead nearest this band is the negative lead of the capacitor. The PC board is marked with small + signs denoting the correct placement of the + lead for each electrolytic capacitor. The + lead is the long lead.

7b. ☐ Install C32, C39. Note that the positive (+) leads are long.

8. ☐ Install C27, then <u>install remaining capacitors</u>. Note that the tantalum leads of C27 are equal length. The + lead is marked on the body.

9. ☐ Install inductors, L4, L5, L6, and L7. Solder all pins and mounting tabs on L4 and L5.

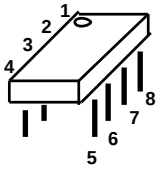
10. ☐ Install the tuning control potentiometer (variable resistor R7), and the audio gain potentiometer / on-off switch (R15/S1). Solder one pin and then check to make sure that the part is properly aligned and seated before soldering the remaining pins. *Make sure that the solder pins are fully seated in the PC board holes and that the control shafts are parallel to the plane of the PC board.*

11. ☐ Install transistors, Q1-Q3. *Note the orientation (see Fig. 4 or 5).*

12. ☐ Install diodes D1, D2, D3, VD1, ZD1, and ZD2. *Note the orientation*. The band on the diode must match up with the band marked on the PC board.

13. ☐ Install the test oscillator OSC1. Note three of the four corners are beveled while the corner near pin 1 is square. The PC board shows the orientation of OSC1 by denoting pin 1 as the square corner.

14. ☐ Install one end of each fixed resistor R28-R31 on the PC board. Leave about ¼ inch of lead between each resistor and the board. The other end of each resistor will be soldered later to the audio jacks (see Figure 13).



15. ☐ Plug the integrated circuits (ICs) into their sockets. The IC *must be* plugged into the socket with the pin 1 mark (usually a small dimple or circle in the corner of the IC case) near the notch in the socket. Be careful inserting the IC into the socket – it is easy to have one pin fold up under the IC. The easiest way is to register the IC pins along one side of the socket so that they are just inside the socket holes. Then using your fingernail, or a flat object like a screwdriver blade – push the IC pins on the opposite side inward until they align with the socket holes. Once all the pins are aligned, push down firmly until the IC seats completely in the socket. All the pins should be in the same depth. If you accidentally bend one of the IC pins, remove the IC from the socket (by inserting a thin blade under the IC and gently prying up) and carefully straighten the IC pin before reinserting into the socket. When removing an IC from the socket, pry a little on one end, and then switch to the other end. Use caution as you pull the IC out of the socket – it is easy to end up with the IC plugged into your finger!

16. ☐ Carefully examine every solder joint that you have made. If possible, use a bright light and a magnifying glass. Most problems are caused by bad solder joints. Look for solder bridges and joints that do not bond the component lead to the PC board trace. Make sure that every component lead is soldered. All solder joints should be bright and smooth. Make sure that there are no cut wires stuck to the board. Double check the polarity and orientation of all electrolytic capacitors, transistors, and diodes.

    Note that the LED will be installed later.

    This completes assembly of the PC board.

ASSEMBLY of the ENCLOSURE

The receiver enclosure comprises 6 aluminum plates, 4 lengths of extruded channel, and 8 small Phillips screws. Panels have been pre-punched with holes for controls, connectors and mounting screws. Plastic film covers the outside (visible side) of each panel. The exploded view (Figure 7) shows how the panels will be assembled in the following steps.

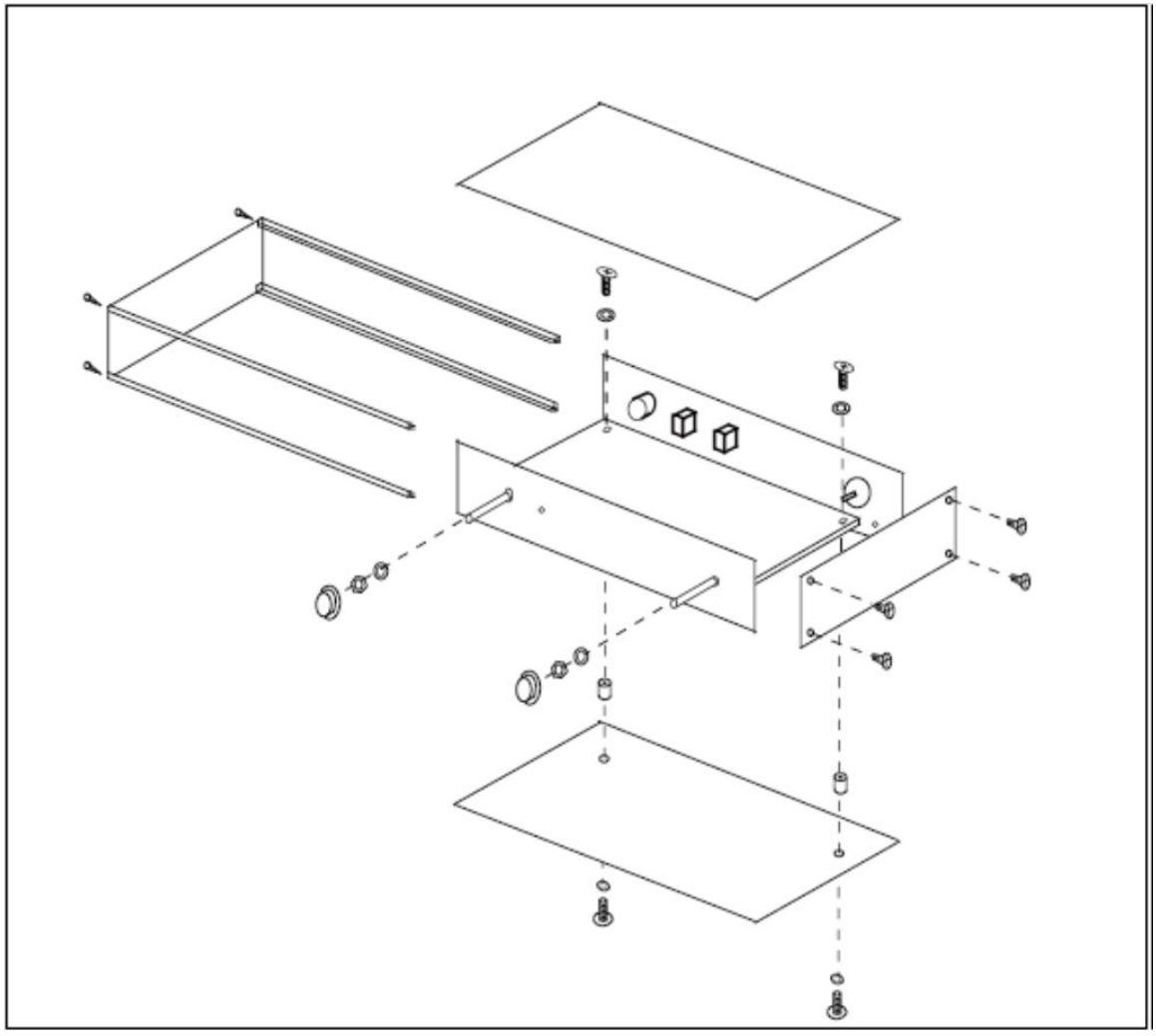


Figure 7. Exploded view of the enclosure and PC board

PREPARING the ENCLOSURE PANELS

1. ☐ Peel the thin plastic film coating from each panel.

2. ☐ Using the supplied sandpaper (or a fine file), remove the sharp edges and corners from each panel. Be careful not to mar or scratch the panel surface.

3. ☐ Mount the power connector, two audio jacks, the antenna connector, and a solder lug to the rear panel (Figure 8). Power and audio connectors are passed through the panel from the "inside" with washers and nuts located on the decal side of the panel. The F-coax connector is inserted from the decal side with washer and nut on the inside. Tighten the nuts firmly with a crescent wrench or pliers.

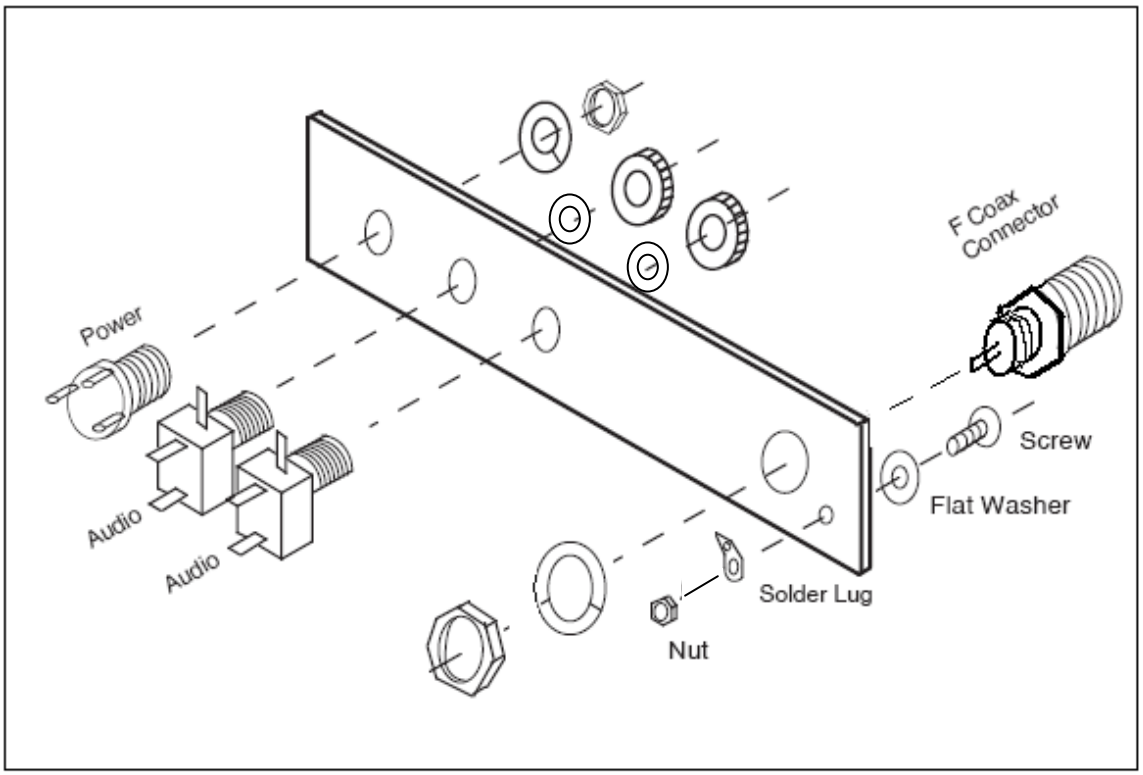


Figure 8. Rear panel assembly

WIRING the REAR PANEL

1. ☐ Prepare two 2 inch red wires and two 2 inch black wires by stripping 1/4 inch of insulation from both ends of each wire. While holding the wire with the needle nose pliers, strip the insulation with the diagonal cutters or a knife, taking care not to nick the wires. Twist the wire strands together and tin the wires (heat with the soldering iron and apply a small amount of solder to hold the strands together).

2. ☐ Install a red wire on the center pin of the antenna connector on the back panel. Install a black wire on the solder lug adjacent to the antenna connector on the back panel. Make a good mechanical joint before soldering.

3. ☐ Solder resistor (R32) between the center pin of the antenna connector and the adjacent solder lug. Use the minimum necessary lead length. This resistor simulates the antenna during testing and will be removed after testing and alignement.

4. ☐ Thread a bare wire through the ground tab of audio jack (J3) and solder one end to the ground tab of J4. Also solder this wire to the ground tab of J3. Insert the end of this bare wire into the top tab of the power connector but do not solder (see Figure 9).

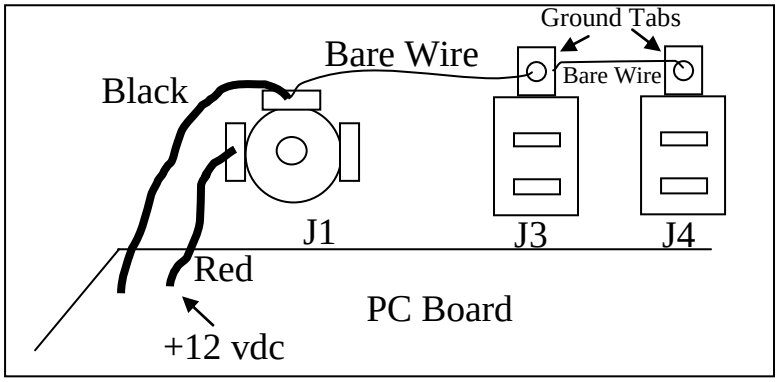


Figure 9. Rear panel wiring of power and audio connectors.

5. ☐ Attach the remaining 2” black wire to the top lug of the power connector (inserting it into the same hole as the bare wire from J3) and solder. Make sure that no wire strands of the black wire come in contact with the left-hand lug of the power connector.

6. ☐ Install the remaining 2” red wire to the left hand lug of the power connector. Make sure that no wire strands of the red wire come in contact with the top lug of the power connector.

MOUNTING the PC BOARD to the FRONT PANEL

1. ☐ Mount the PC board to the front panel. Simply slip the potentiometer shafts through the front panel holes and apply the lock washers and nuts. Tighten nuts.

2. ☐ Form the leads of LED1 and insert the LED into the front panel hole from the rear such that the LED leads extend to the PC board mounting holes. The longer of the LED leads goes in the + hole. Solder in place, then trim the extra leads after soldering.

3. ☐ Install the two knobs. Align them so that when the control is turned full counterclockwise, the index mark is near the 7 o’clock position (Figure 10). Once the knob set screw is tightened down, the full counterclockwise rotation and the full clockwise rotation of the knob index mark should be equal-spaced from the 6 o’clock position.

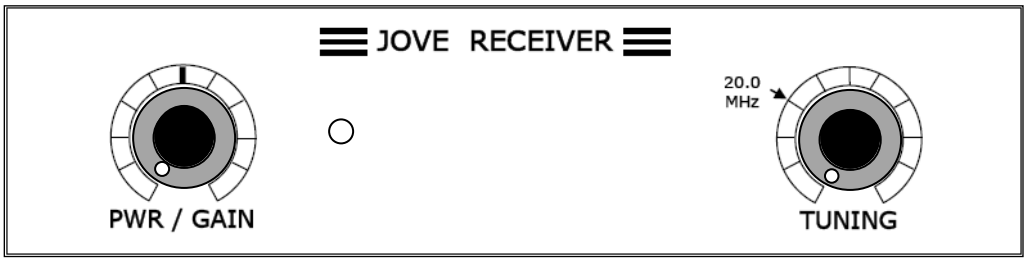


Figure 10. Jove receiver front panel with knob alignment.

4. ☐ Install two spacers (Figure 11) below the rear corners of the PC board using 1/4 inch long, 4-40 screws and lock washers.

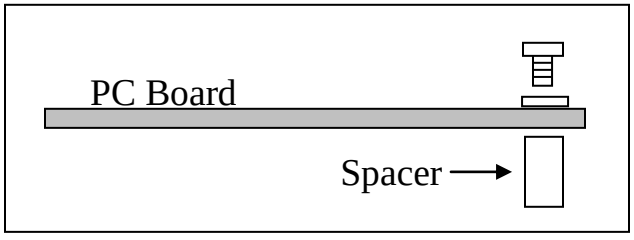


Figure 11. Spacers mounted to the bottom of the PC board

ASSEMBLE the ENCLOSURE

1. ☐ Partially assemble the enclosure using one end panel, the four extruded channel pieces, and four screws. Tighten screws just enough to maintain shape. See Figure 12.

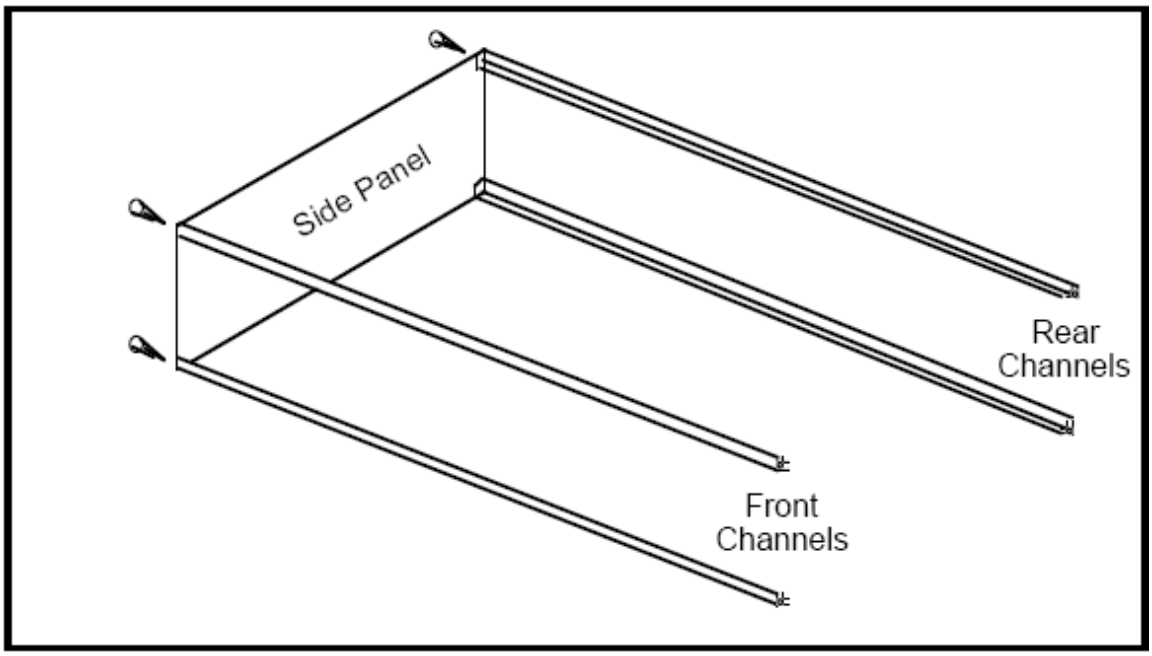


Figure 12. Partial assembly of the enclosure.

2. ☐ Slide the front panel with the attached PC board into the front channel guides, moving it back until it is flush with the side panel. If the panel gets crooked in the guides it may jam and refuse to slide along the grooves. If the panel jams, loosen the screws slightly.

3. ☐ Slide the rear panel into the rear channel guides, moving it back until it is flush with the side panel. Be sure that the panel is installed "right side up." Bend the red and black wires on the power connector up so they do not hit the components on the PC board.

4. ☐ Mount the right side panel to the four channel guides with four screws. Tighten all 8 enclosure screws enough to maintain the enclosure shape. The enclosure now includes the front panel, rear panel, and both side panels supported by the channel guides.

5. ☐ Install the red wire attached to the center pin of the antenna connector to the antenna hole on the PC board. Install the black wire attached to the solder lug adjacent to the antenna connector on the back panel to the ground hole on the PC board adjacent to the screw hole in the corner. The location of these wires on the PC board is easily seen in the X-ray view (Figure 4).

6. ☐ Install the red wire from the power connector to the PC board hole labeled +12 vdc (Figure 13). Install the black wire from the power connector to the ground hole on the PC board adjacent to the screw hole in the corner. The location of these wires on the PC board is easily seen in the X-ray view (Figure 4).

7. ☐ Complete installation of resistors R28, R29, R30 and R31 as shown in Figure 13. Leave a little extra lead length so that the resistor leads are not taut. First solder R29 and R31 on the bottom tabs of the two audio connectors. Then solder R28 and R30 to the top horizontal tabs as shown in Figure 13. Trim excess lead wires after soldering.

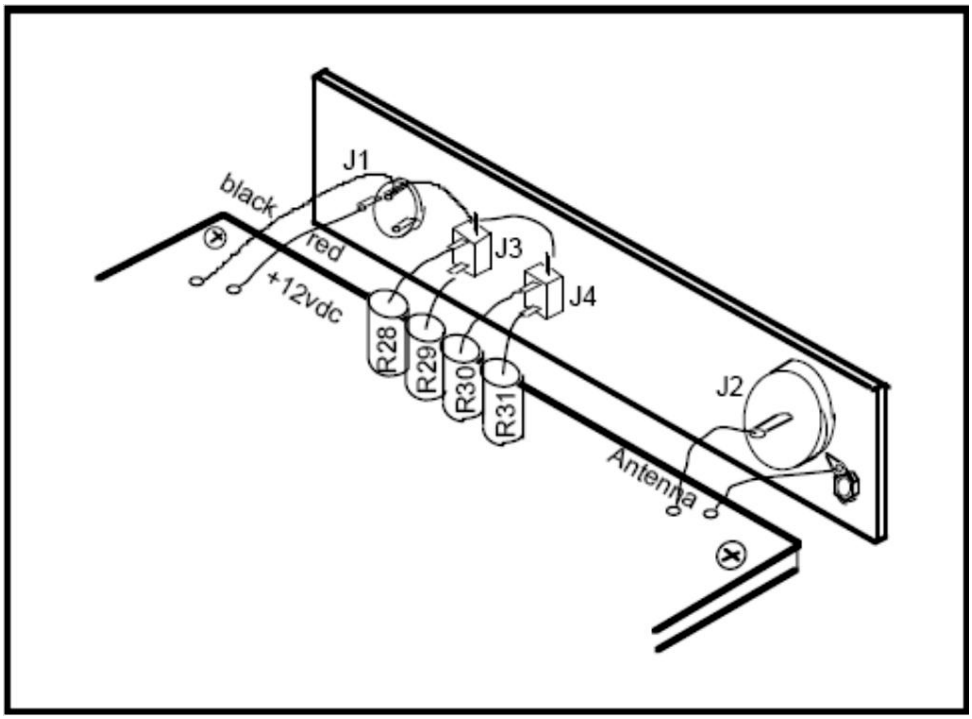


Figure 13. Rear panel wiring (resistor R32 not shown)

Before installing the bottom panel make one more visual inspection of the trace side of the PC board.

13. ☐ Remove the right side panel, slide in the bottom panel and attach it to the spacers with 1/4 inch 4-40 screws, flat washers and lock washers (Figure 14). The bottom panel holes are not equidistant from the edges - the hole on the TUNING control side is closer to the right edge than the hole on the VOLUME control side is to the left edge. You may need to flip the bottom panel if the holes do not line up with the spacers. Reattach the right side panel. Attach the four rubber feet to the corners of the bottom panel. At this point the enclosure is complete except for the top panel.

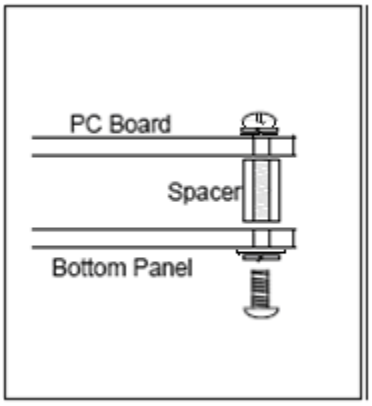


Figure 14. Mounting the spacers to the bottom panel

TESTING AND ALIGNMENT

Make a final visual check to be sure all transistors, integrated circuits, diodes and electrolytic capacitors are properly installed – in the correct locations with the right orientations. Before performing any of these procedures read through the whole test section and get clearly in mind the steps which you plan to follow.

Power and Audio Connections

1. ☐ The receiver requires 12 volts DC which may be obtained from an AC adapter, a well regulated power supply, or from a battery (Figures 15 and 16). Current drain is approximately 60 milliamps (ma). The Jameco® AC adapter (supplied with US orders) is the recommended power source for indoor use. Switching power supplies are not recommended as many of these units generate undesirable radio noise. A linear, regulated supply is preferred.

The kit is also supplied with a power cord that has a female plug on one end and stripped leads on the other end. This cord can be used to power the Jove receiver from a 12 volt regulated DC power supply or a 12 volt battery. Notice that the cord has a colored stripe or tracer, along one of the wires. This is the wire that is connected to the center conductor of the plug and must be connected to the (+) side of the power source (Figure 15).

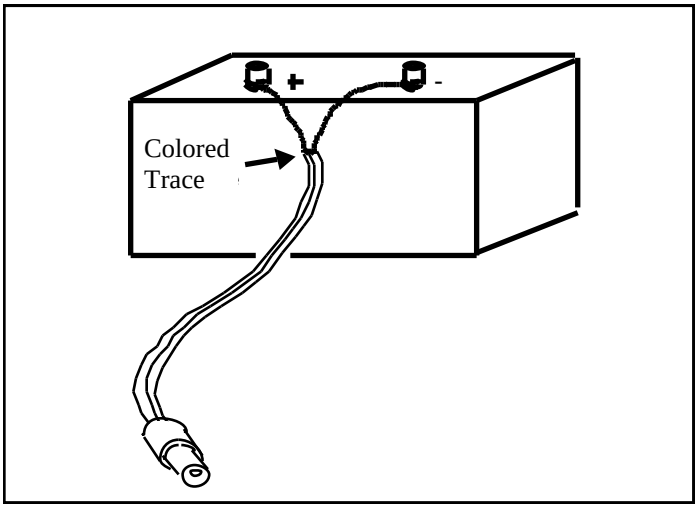


Figure 15. Wiring the power plug to a battery - the colored tracer goes to the + side of the supply.

2. ☐ Before connecting power turn the JOVE receiver power switch OFF. Connect either headphones or an amplified speaker (Radio Shack 277-1008 or 40-218, or equivalent) to one of the audio output jacks on the receiver rear panel. These jacks accept 3.5 mm (1/8 inch) monaural or stereo plugs. Connect the JOVE receiver to the 12 volt power source as shown in Figure 16. First connect the power cord to the receiver and then plug the supply into the wall outlet. (It is not recommended to plug a live power plug into the receiver.)

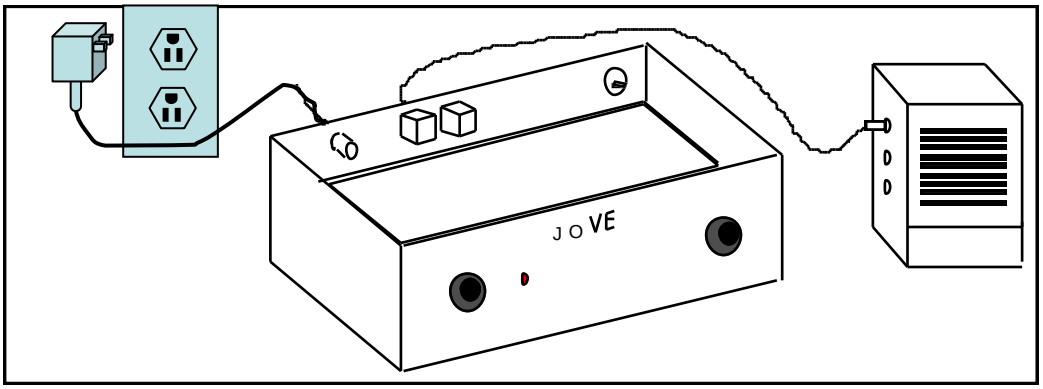


Figure 16. Test set-up, radio with the cover off
connected to the AC Adapter and the amplified speaker

3. ☐ If you are using an amplified speaker, turn it ON and adjust the volume control *on the speaker* up about 1/8 turn. If you are using headphones, hold them slightly away from you ear at first as there may be a loud whistle due to the internal test oscillator when you turn the receiver on. Turn the JOVE receiver ON. The front panel LED should light. Set the JOVE volume control to the 12 o'clock position. Allow the receiver to "warm-up" for at least two minutes.

[***NOTE: troubleshooting procedures are included at the end of the manual. Refer to these in case the receiver does not perform as expected during the tune-up procedure.***]

Tuning the oscillator

4. ☐ Set the TUNING control to the 20.0 MHz position. *Carefully* adjust inductor L5 (Figure 17) with the plastic tuning stick (hexagonal tip) until a loud low frequency tone is heard (set volume control as desired). Tune the slug about 3.5 turns clockwise to hear the tone. (Hint - Put a tape "flag" or a mark on the tuning stick to help count turns). We have observed that in some receivers as the slug in L5 is turned there are a couple settings that produce very weak tones and one much louder tone. It's the loudest one that you are looking for. The loudest tone will be

heard when you have turned the slug about 3.5 turns clockwise (from the slug position as it comes from the manufacturer). However, this setting can vary +/- half a turn or so. So don't necessarily jump at the first tone you hear and leave L5 set to that adjustment, particularly if it's not near 3.5 turns clockwise. The false tones in the vicinity of 1 to 2 turns are very weak - much weaker than the correct one. Use the tuning knob for fine adjustment after setting L5 to hear the loud tone.

Caution: Do not screw an inductor slug so far down that it bottoms out against the PC board. If the slug gets hard to turn as it reaches its end of travel the ferrite material could crack. By adjusting L5 to hear the tone, you are tuning the receiver to 20.00 MHz. The signal which you hear is generated in OSC1, a crystal controlled test oscillator built into the receiver. **Once L5 has been set, DO NOT readjust it during the remainder of the alignment procedure.** (When the receiver tunes 20.00 MHz with the knob set to the 20.0 MHz position it will tune 20.1 MHz with the knob centered on the 12 o'clock position.)

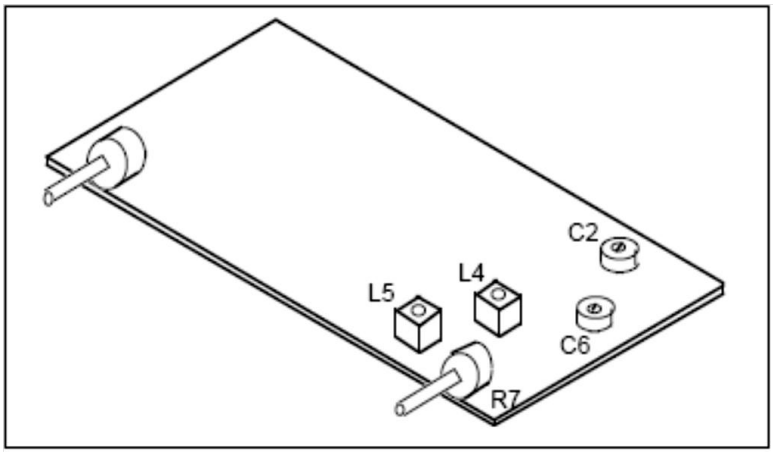


Figure 17. Locations of the variable capacitors and inductors

Tuning the radio frequency amplifiers

The following steps involve adjusting variable capacitors (C2 and C6) and variable inductor (L4) to obtain the maximum signal strength at the audio output.

At this point you must decide which of the following tune-up methods to use. Read thru the following brief descriptions of each method, make your choice, and then jump to the appropriate detailed instructions for your method. If you purchased a calibrated noise source such as the RF-2080 with your Jove receiver then consider options (C) and (D) – otherwise use either option (A) or (B).

Tune-up Methods

A. Tune-up by ear using the tone. Listening to the tone you will adjust C2, C6, and L4, to peak up the strength of the tone. This is the simplest method and if done with care it will produce good results.

B. Tune-up using the tone and Skypipe software. You will connect the audio output from the Jove receiver to the sound card of a computer running Radio SkyPipe software. SkyPipe will generate a plot showing the strength of the audio tone as you adjust C2, C6, and L4 for maximum. You should become familiar with Radio Skypipe basic operation before using this option.

C. Tune-up by ear using a noise source. You will connect the noise source to the receiver antenna terminal and adjust C2, C6, and L4 for maximum audible noise. (It is easier for many to recognize the peak level of noise than it is to discern the peak level of a tone. The noise signal covers the whole tuning range of the Jove receiver so you do not need to carefully keep the receiver tuned to the exact frequency producing the tone.)

D. Tune-up using a noise source and Skypipe software. You will connect the noise source to the receiver antenna terminal and connect the audio output from the Jove receiver to the sound card of a computer running Radio SkyPipe software. SkyPipe will generate a plot showing the strength of the noise as you adjust C2, C6, and L4 for maximum. You should become familiar with Radio Skypipe basic operation before using this option to tune-up the receiver.

Regardless of which of the four alignment methods you use, the adjustments to C2, C6, and L4 are quite sensitive, so take care to get the best response possible. If you are using method (A) or (B) make sure that the receiver stays tuned to the test oscillator during the alignment. The receiver may drift slightly in frequency just after turn-on, so you may need to wait for a few minutes after turn-on until the pitch of the output tone is steady, before doing the alignment. You may find that when you put your hand and the tuning stick into the receiver, the receiver changes frequency and the tone changes pitch. Try to position your hand so as to minimize this effect. Reminder: do not adjust L5 once the receiver has been set on frequency at the beginning of step 4.

At this point you must choose your tune-up method. Proceed to the detailed instructions for that method. Read your chosen method procedure completely thru before actually doing the tune-up.

Detailed Tune-up Instructions

A. Detailed tune-up by ear using the tone

While listening to the tone, you will adjust C2, C6, and L4 for maximum signal strength (Use the plastic tuning tool with the hex end for L4 and the plastic screwdriver with the flat blade end to adjust the capacitors). Try to keep the pitch constant by carefully adjusting the tuning control. By keeping the pitch constant it will be easier to determine when it is loudest. Reduce the receiver volume control as necessary to keep the tone at a comfortable volume. C6 will have the greatest effect so you should start with C6. Next adjust C2, and then L4. There is usually some interaction between these adjustments so it is a good idea to go back and touch up each one again, making sure that you still have the maximum signal level.

After you have completed the tune-up, turn the receiver off and turn off (or unplug) the power supply. Snip Jumper 6 and separate the wires to disable the test oscillator (OSC1). Remove the 51 ohm resistor (R32) which you connected between the antenna jack center pin and ground. (If for some reason you failed to install this resistor during the construction phase you must do so now and repeat this tune-up procedure).

The final step is to remove a receiver side panel and install the top cover. Replace the side panel and tighten up all the screws in each side panel. It is important to have all the enclosure panels installed to make sure that the only radio signals entering the receiver are coming in the antenna terminal. This completes the receiver tune-up. Congratulations! Proceed to the manual section titled On the Air Testing.

B. Detailed tune-up using the tone and Skypipe software.

You will use Radio SkyPipe software which provides a graphical plot (strip-chart recording) of signal strength. As you tune C2, C6, and L4 you will see the trace moving up and down as signal strength varies. Before using this software as an aid in tuning up the receiver you should spend some time getting familiar with the basic operation of the program. Extensive help files accompany the program.

Connect an audio cable (3.5mm stereo) between one of the Jove receiver audio outputs and the computer sound card input. You can use either the *mic* or *line* input. The line input is the less sensitive of the two but is normally satisfactory.

Connect headphones or an amplified speaker to the remaining Jove receiver audio output jack. Alternatively you may chose to set up the computer sound card mixer panel so that you can hear the audio being sent from the receiver to the computer.

While listening to the tone, you will adjust C2, C6, and L4 for maximum signal strength (Use the plastic tuning tool with the hex end for L4 and the plastic screwdriver with the flat blade end to adjust the capacitors). Try to keep the pitch constant by carefully adjusting the tuning control. By keeping the pitch constant it will be easier to determine when it is loudest. Reduce the receiver volume control as necessary to keep the Skypipe trace on screen and so that the tone is at a comfortable volume. C6 will have the greatest effect so you should start with C6. Next adjust C2, and then L4. There is usually some interaction between these adjustments so it is a good idea to go back and touch up each one again, making sure that you still have the maximum signal level.

After you have completed the tune-up turn the receiver off and turn off (or unplug) the power supply. Snip Jumper 6 and separate the wires to disable the test oscillator (OSC1). Remove the 51 ohm resistor (R32) which you connected between the antenna jack center pin and ground. (If for some reason you failed to install this resistor during the construction phase you must do so now and repeat this tune-up procedure).

The final step is to remove a receiver side panel and install the top cover. Replace the side panel and tighten up all the screws in each side panel. It is important to have all the enclosure panels installed to make sure that the only radio signals entering the receiver are coming in the antenna terminal. This completes the receiver tune-up. Congratulations! Proceed to the manual section titled On the Air Testing.

C. Detailed tune-up by ear using a noise source

Turn the receiver off and remove the 51 ohm resistor (R32) which you connected between the antenna jack center pin and ground. Snip Jumper 6 and separate the wires to disable the test oscillator (OSC1). Connect the noise source (most likely the RF2080) to the receiver antenna input using the short coaxial jumper cable. Turn the RF2080 and the receiver on and set the receiver tuning knob to the 12 o'clock position. Adjust the volume control to hear the noise. While listening to the noise, you will adjust C2, C6, and L4 for maximum signal strength. (Use the plastic tuning tool with the hex end for L4 and the plastic screwdriver with the flat blade end to adjust the capacitors). Reduce the receiver volume as necessary to

keep the noise at a comfortable volume. C6 will have the greatest effect so you should start with C6. Next adjust C2, and then L4. There is usually some interaction between these adjustments so it is a good idea to go back and touch up each one again, making sure that you still have the maximum signal level.

After you have completed the tune-up, turn the receiver off and turn off (or unplug) the power supply.

The final step is to remove a receiver side panel and install the top panel. Replace the side panel and tighten up all the screws in each side panel. It is important to have all the enclosure panels installed to make sure that the only radio signals entering the receiver are coming in the antenna terminal. This completes the receiver tune-up. Congratulations! Proceed to the manual section titled On the Air Testing.

D. Detailed tune-up using a noise source and Skypipe software.

Turn the receiver off and remove the 51 ohm resistor (R32) which you connected between the antenna jack center pin and ground. Snip Jumper 6 and separate the wires to disable the test oscillator (OSC1). Connect the noise source (most likely the RF2080) to the receiver antenna input using the short coaxial jumper cable.

Connect an audio cable (3.5mm stereo) between one of the Jove receiver audio outputs and the computer sound card input. You can use either the *mic* or *line* input. The line input is the less sensitive of the two but is normally satisfactory.

Connect headphones or an amplified speaker to the second Jove receiver audio output jack. Alternatively you may chose to set up the computer sound card mixer panel so that you can hear the audio being sent from the receiver to the computer.

Turn the RF2080 and the receiver on and set the receiver tuning knob to the 12 o'clock position. Adjust the volume control to hear the noise.

Adjust C2, C6, and L4 for maximum signal strength (Use the plastic tuning tool with the hex end for L4 and the plastic screwdriver with the flat blade end to adjust the capacitors). Reduce the receiver volume control as necessary to keep the Skypipe trace on screen and so that the noise is at a comfortable volume. C6 will have the greatest effect so you should start with C6. Next adjust C2, and then L4.

There is usually some interaction between these adjustments so it is a good idea to go back and touch up each one again, making sure that you still have the maximum signal level.

After you have completed the tune-up turn the receiver off and turn off (or unplug) the power supply.

The final step is to remove a receiver side panel and install the top cover. Replace the side panel and tighten up all the screws in each side panel. It is important to have all the enclosure panels installed to make sure that the only radio signals entering the receiver are coming in the antenna terminal. This completes the receiver tune-up. Congratulations! Proceed to the manual section titled On the Air Testing.

ON THE AIR TESTING

Testing the Receiver and Antenna Together

Before making your first observations of the Sun or Jupiter it is a good idea to set up the antenna and receiver to confirm that everything is working properly. For this test you can set up either a single dipole or the dual dipole array.

With no antenna connected, and the receiver audio gain control set between the 12 and 2 o'clock positions, you may hear a slight hissing sound in the headphones (or loudspeaker if you are using an amplified speaker). With the antenna connected, the static sound should increase significantly. (There is usually a loud crackling sound as the antenna connector is being screwed on).

If your Jove receiver is connected to a computer running Radio-SkyPipe you should see a significant increase in the background trace when the antenna is connected. The trace should rise sharply as you tune across stations. The SkyPipe trace is normally set at a level of about 1000 on the vertical scale. This level is set using the receiver volume control and the software record volume control found on your computer. The receiver audio control should be set near the 12 o'clock position for solar observations and may be run around the 2 o'clock position for Jupiter observations

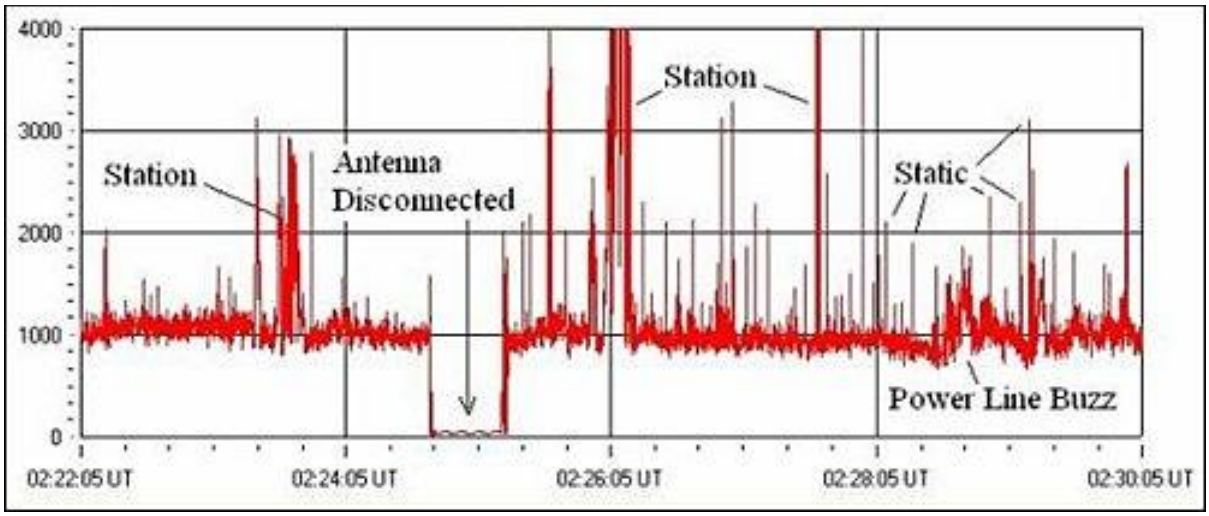


Figure 18. Example Radio Jove output using Radio-Skypipe display software

With the antenna connected you should hear background static (this is galactic background radiation - caused by relativistic electrons spiraling in our galactic magnetic field). As you tune the receiver dial you may hear stations. When listening for Jupiter or the Sun you should tune to a clear frequency between the stations. You may also hear pops and snaps due to distant lightning. (If there is nearby lightning don't set up your antenna and receiver).

If you do not hear a significant noise increase when you connect the antenna either there is a short or open circuit in the antenna wiring or the receiver is not working correctly. You can trouble-shoot the antenna by hooking up the individual dipoles directly to the receiver (bypassing the power combiner). If either dipole individually produces the desired receiver noise increase then the problem must lie with the other dipole, the power combiner, or the lead-in coax. If you are unable to obtain the noise increase with either dipole individually, or connected together as a pair, then the problem must lie with the receiver (or its power supply or some audio cabling, perhaps between the receiver and the computer or audio amplifier).

The noise that you hear with the antenna connected should have a steady hissing static sound (except for stations and an occasional static pop or crash). If there is a raucous buzzing sound (which may be intermittent) it is probably due to arcing on a nearby power line. It is important that the power supply for the receiver and speaker system produce a clean DC voltage.

TROUBLESHOOTING

Welcome to the Jove receiver troubleshooting section. Hopefully the suggestions and information presented here will lead to a quick fix and have your receiver on the air in short order. Troubleshooting is a systematic and logical process. The course of your troubleshooting depends upon the nature of the problem. The more you know about the receiver and the better you understand the signal flow the easier the procedure will be. Be sure to write down what you do and what the results are. It is easy to get confused and remember voltage measurements incorrectly. Write it down as you go along.

Cold Solder Joints and Solder Bridges

The most likely source of trouble is a cold solder joint. The starting point is therefore to remove the bottom panel and carefully inspect each solder joint. You should look very carefully at every joint – preferably under a bright light with a magnifying glass.

Make sure that the joint is shiny and that solder has flowed between the component lead and the trace. Also check for solder bridges – connections between adjacent pins that are formed when solder bridges the gap between pins forming a conductive path.

IC Orientation

Double check that the integrated circuits are installed correctly (the right IC in the right socket, properly oriented).

Right parts in the right places with the correct orientation.

Obviously the radio will not work properly if parts have been put in the wrong locations. Double check your work. Make sure that all electrolytic capacitors, transistors, and diodes are installed with the proper orientation.

LED doesn't light when power applied

If the red LED does not light when you turn the power switch on then the logical places to look include the power supply itself, is it putting out 12 volts? Inspect the few components between the power jack and the LED. Is diode D1 oriented correctly? Is the polarity of the LED correct?

Voltage Test Points
Figure 20 and Figure 21 indicate several voltage test points on the PC board. You should measure DC voltages at these test points and compare them to the nominal voltages listed on the schematic. Measure the voltages using a DC voltmeter – preferably a digital meter for better accuracy. Connect the black probe to ground (the ground lug next to the antenna terminal is a good ground point). Check the various test points with the red probe, being careful to touch only the test point with the probe tip. Careless probing can result in temporary short-circuits which can damage the receiver. You should expect a few percent difference between your measurement and the listed values. Large discrepancies indicate a problem in the vicinity of the circuit being tested.

Signal Injection
You can do some testing with your finger. Your body acts as an antenna for signals radiated from the power lines (60 cycles in North America). If you touch pin 8 of IC3 you should hear a loud buzzing sound (that is the sound of 60 cycles). If you live near a strong AM radio station you may even hear the station. The buzzing sound (or radio station) tells you that the signal injected from your finger has traveled thru IC3, and the output transistors Q2 and Q3. If you hear the sound you can conclude that this section of the circuit is probably OK. If you hear nothing, then there is likely a problem between the input of IC3 and the audio output.

Assuming that IC3 and Q2 /Q3 are working properly you can go back to the previous stage of the audio amplifier circuit and test to see that a signal is getting from the input of IC2 to the audio output. Turn up the volume control and touch pin 8 of IC2. If the circuits between the input of IC2 and the audio output are working you should hear the 60 cycle buzz or (or a local radio station).

I hear a broadcast station all over the dial.
Depending on your geographic location you may hear a loud station that is everywhere on the dial. Fortunately this problem does not happen very often. It is caused by a strong short-wave station overloading the receiver. This interference is sometimes heard in daylight hours during times of maximum sunspot activity, but has seldom been a problem during Jupiter observations at night. You may experience this type of overload for a few minutes or a few hours when propagation conditions are just right. If the problem persists during daylight attempts to monitor the Sun you may contact the receiver designer at rf@hawaii.rr.com for information on a filter that has proven successful in eliminating this interference source.

HELP! – if it still doesn't work

If you need to ask one of the Jove team for assistance it is much easier for us to help if you have documented exactly what the problem is, what measurements you have made, and their results. A report of "my radio doesn't work – what do you think is wrong" is pretty useless. On the other hand a report like "I tried to align the receiver using the test procedure but tuning C6 didn't effect the output signal level. All voltages were normal" can be very helpful.

If you have been unsuccessful in getting your receiver working by this point please feel free to contact either Richard Flagg or Wes Greenman for assistance. Our email addresses are on the Jove website at http://radiojove.gsfc.nasa.gov/contacts.htm.

As a last resort you can make an arrangement with either Flagg or Greenman to trouble shoot and repair your receiver for a flat fee of $25 plus shipping (flat fee assumes that you have followed instructions with reasonable accuracy and have not butchered the receiver).

Figure 19. Views of completed JOVE RJ1.1 receiver

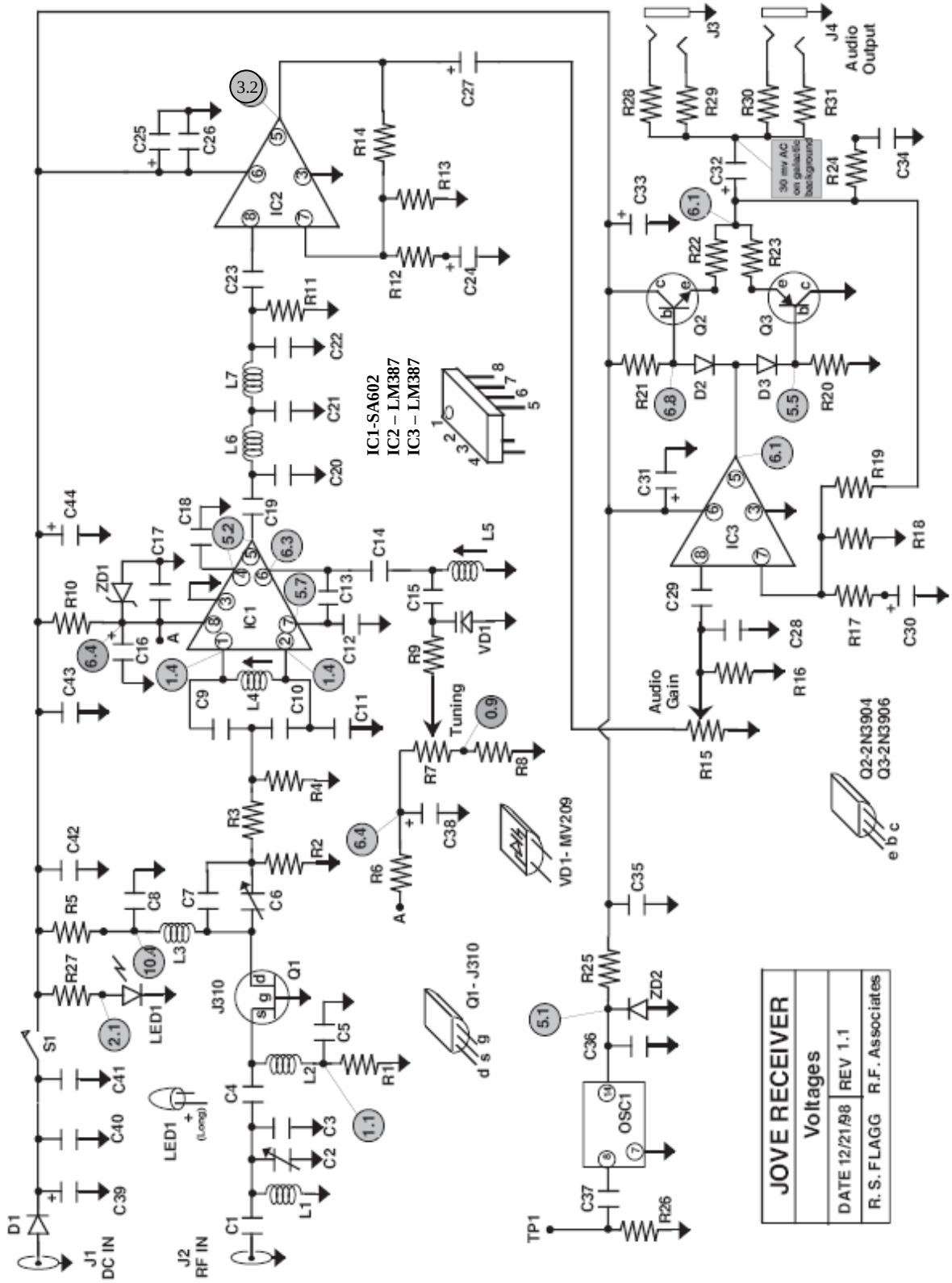


Figure 20. JOVE receiver schematic with DC voltages

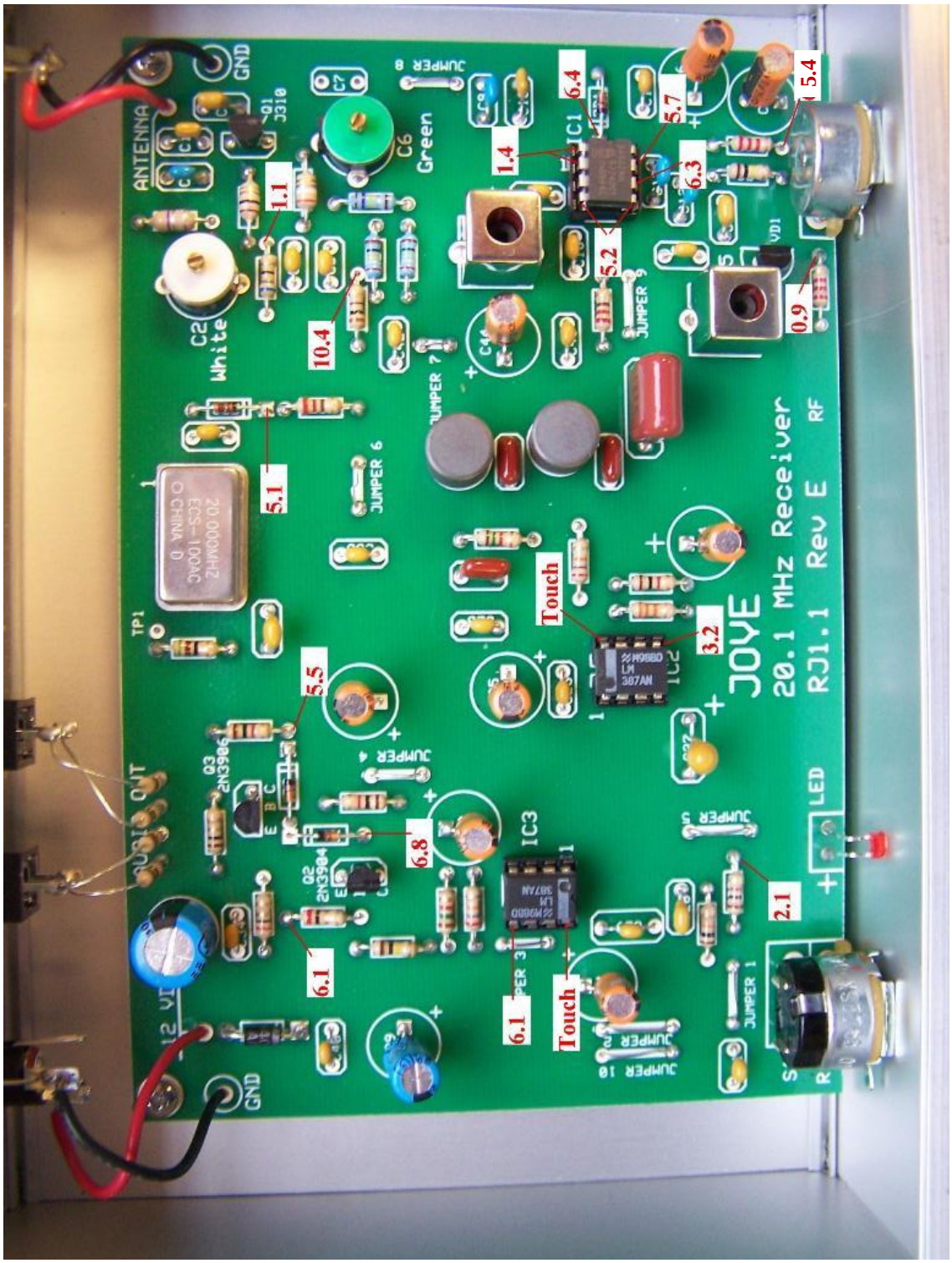
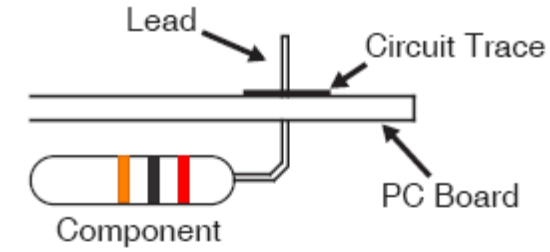


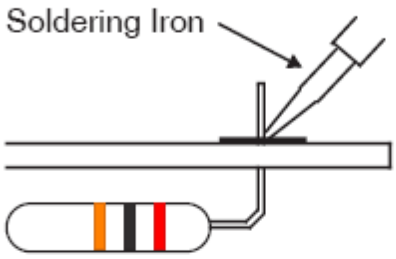
Figure 21. JOVE receiver board with DC voltages for testing

Appendix A
Soldering Techniques

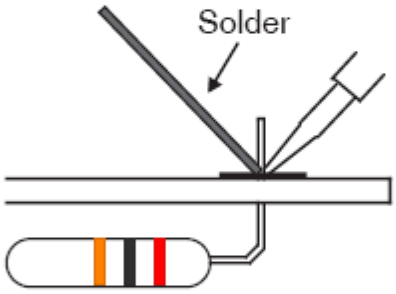
Use a 15-25 watt soldering iron and 60/40 rosin core solder, 0.032" diam.



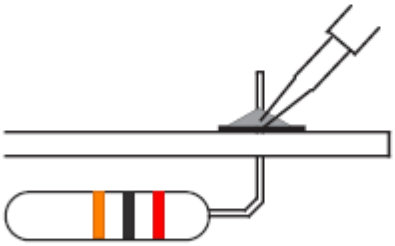
1. Wipe the hot iron tip on a wet sponge and tin the tip (melt a small amount of solder on the tip). This step is not necessary prior to every solder joint but should be done whenever there is a build-up of residue on the tip.



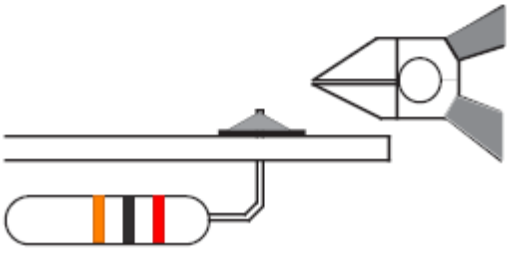
2. Touch the tip of the iron firmly to the junction of the circuit trace and the component lead, heating both for between 1 and 2 seconds. The iron tip should remain in contact with the joint through step 4.



3. Apply solder to the pre-heated joint. As the solder melts, feed a small amount (approximately 1/4") into the pool of molten solder forming at the junction of the solder trace and lead. This should take no more than 1 second.



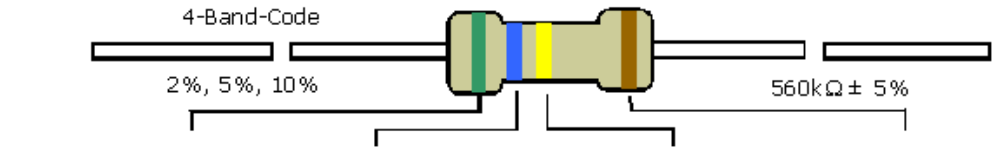
4. Remove the solder and continue to heat the joint for another second or until the solder is melted, keep to a minimum the time the joint is heated, while making sure the solder is melted. The finished solder joint should be shiny and flow in contact with the component lead.



5. Cut the component lead flush with the top of the solder joint. Be sure the cut-off wire does not fall on the board shorting out other connections.

Appendix B
Resistor Color Code Guide

We use both the 4 and 5-band varieties of resistors.



COLOR	1st BAND	2nd BAND	3rd BAND	MULTIPLIER	TOLERANCE	
Black	0	0	0	1Ω		
Brown	1	1	1	10Ω	± 1%	(F)
Red	2	2	2	100Ω	± 2%	(G)
Orange	3	3	3	1KΩ		
Yellow	4	4	4	10KΩ		
Green	5	5	5	100KΩ	±0.5%	(D)
Blue	6	6	6	1MΩ	±0.25%	(C)
Violet	7	7	7	10MΩ	±0.10%	(B)
Grey	8	8	8		±0.05%	
White	9	9	9			
Gold				0.1	± 5%	(J)
Silver				0.01	± 10%	(K)

An Example

ABC D

A. First significant figure of resistance in ohms
B. Second significant figure of resistance in ohms
C. Decimal multiplier
D. Resistance tolerance in percent (gold = 5%, silver = 10%)

Using the resistor above as an example:

A = yellow = 4, B = violet = 7, C = Orange = 10^3 = 1000, D = gold = 5%
The resistor value is 47,000 Ohms and it has a 5% tolerance.
The multiplier 1000 is also known as kilo (k), so the resistor is 47 kOhms.
If the multiplier were blue = 10^6 = 1,000,000 [mega (M)], then the resistor value would be 47 MOhms - pronounced 47 mega-Ohms.

APPENDIX C

Jove 1.1 Receiver Specifications

Since this receiver is normally built as a kit it is not possible to guarantee specifications – which depend upon how well the tune-up was performed. However, the following specifications are typical.

GAIN – The gain depends upon the setting of the audio gain control. With max clockwise gain (volume) setting the receiver gain is > 100 dB.

BANDWIDTH – the audio low pass filter response is down 3 dB at 3.5 kHz. Since the receiver is a direct conversion type the equivalent RF bandwidth is 7 kHz.

NOISE FIGURE – 6dB or better

TUNING – Tuning information is presented for 3 receivers below. These receivers use the new Jove receiver front panel (summer 2010). Tuning knob position refers to the radial tick marks printed around the tuning knob – where position 1 is the full CCW position mark. Position numbers increase as the knob is rotated clockwise.