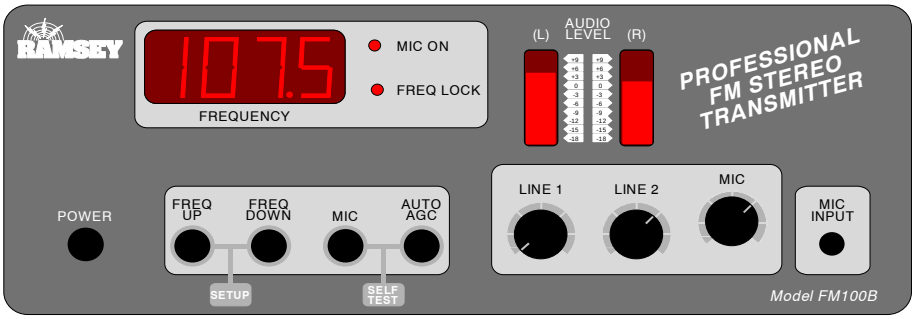
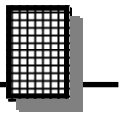
PROFESSIONAL FM STEREO TRANSMITTER

Ramsey Electronics Model No. FM100B

Here's the ultimate radio transmitter for all of you home brew DJs out there! This all-in-one stereo transmitter has all the features you will ever need for transmitting a school radio station, around your yard, or even around the block.
Use the optional high power configuration for extra boost when transmitting outside of the US!

- **2 Line inputs and one mic input-plus a built in mixer!**
- **New Line output for monitoring your show!**
- **PLL Crystal controlled for rock solid frequency**
- **Left and right channel peak hold indicators and large LED frequency display**
- **Built in power supply, just plug it in! Now operates from 85-264VAC (47 - 63 Hz) without jumpers!**
- **25 mW output standard, optional 1W configuration for operation outside the US!**
- **Auto AGC microphone muting function for cool talk-overs**
- **Rugged steel enclosure for years of service**





RAMSEY TRANSMITTER KITS

- **FM25B Synthesized Stereo FM Transmitter**
- **MR6 Model Rocket Tracking Transmitter**
- **TV6 Television Transmitter**

RAMSEY RECEIVER KITS

- **FR1 FM Broadcast Receiver**
- **AR1 Aircraft Band Receiver**
- **SR2 Shortwave Receiver**
- **SC1 Shortwave Converter**

RAMSEY HOBBY KITS

- **SG7 Personal Speed Radar**
- **SS70A Speech Scrambler**
- **BS1 "Bullshooter" Digital Voice Storage Unit**
- **AVS10 Automatic Sequential Video Switcher**
- **WCT20 Cable Wizard Cable Tracer**
- **LABC1 Lead Acid Battery Charger**
- **IG7 Ion Generator**
- **CT255 Compu Temp Digital Binary Thermometer**
- **LC1 Inductance-Capacitance Meter**

RAMSEY AMATEUR RADIO KITS

- **DDF1 Doppler Direction Finder**
- **HR Series HF All Mode Receivers**
- **QRP Series HF CW Transmitters**
- **CW7 CW Keyer**
- **CPO3 Code Practice Oscillator**
- **QRP Power Amplifiers**

RAMSEY MINI-KITS

Many other kits are available for hobby, school, Scouts and just plain FUN. New kits are always under development. Write or call for our free Ramsey catalog.

FM100B PROFESSIONAL STEREO TRANSMITTER INSTRUCTION MANUAL
Ramsey Electronics publication No. MFM100B Revision 1.4b
First printing: January 2002

Ramsey Publication No. MFM100B
Price $10.00

KIT ASSEMBLY
AND INSTRUCTION MANUAL FOR

FM100B PROFESSIONAL STEREO TRANSMITTER

TABLE OF CONTENTS

RAMSEY ELECTRONICS, INC.
590 Fishers Station Drive
Victor, New York 14564
Phone (585) 924-4560
Fax (585) 924-4555
www.ramseykits.com

INTRODUCTION TO THE FM100B

First we will begin with a little history of stereo transmitters at Ramsey Electronics in order to give you an idea of how we arrived at the development of the FM100B as our latest stereo transmitter. We have many people call us each day asking questions about our earlier versions of transmitters such as the FM25B and the FM10A. Most are questions concerning drifting, sound quality, and transmitting distance. The tunable FM10A was a great product for a low-cost entry into the world of micro-power transmitters. The FM25B was the next step up offering a rock solid stable frequency just like professional stations. The latest step was to create a transmitter that not only has a rock solid frequency, but also all the features you would find in a commercial station.

In answer to customer research and comments, here is the result of months of design and years of stereo transmitter experience. The FM100B has all of the features needed to run a professional sounding radio station. It includes extensive audio filtering to prevent high frequency audio interference, AGC (Automatic Gain Control) with the microphone to prevent overloading distortion, a frequency display with easy frequency adjustment, 2 line inputs, 1 microphone input, PLL controlled, CD quality transmission, and more. In other words we pulled all the stops to bring you a top quality product that will satisfy even the most discriminating user.

Due to demand from our neighbors down south and wherever else it is legal, we have allowed for a special component section to be added to give you 1 watt of RF output. Simply install a few parts along with a good quality antenna and bingo, you're on the air for miles around.

We are happy to bring you this truly professional product that will give you many years of fun, reliable use, and enjoyment knowing that you have built it yourself.

CIRCUIT OPERATION

Here is where we get into a little circuit analysis. If you just want to plug it in and start broadcasting you can skip this section and read the FCC regulations at the end. Otherwise read on to learn how the FM100B works. We will reference the schematic often as we analyze the circuit.

Let's begin with the power supply. It is arguably the most important part of the FM100B. Instead of having you build a discrete power supply which can be difficult and bulky, we decided to include a very versatile switching power supply which is pre-built for you. These power supplies have several advantages over conventional supplies; they are lightweight for their power output, they are efficient (usually better then 80% efficiency), and they will operate anywhere from 85 VAC to 264 VAC without setting any jumpers! This means the European folks will be just as happy as the U.S. folks!

The only drawback with this power supply is that our particular unit only generates +/-12 VDC. We need +5 VDC for some of the digital parts so it was necessary to add a voltage regulation stage to step down the positive supply voltage. This is performed with VR1, C1, and C2. These parts bring down the +12V to a very smooth +5V for our digital components.

Now let's move on to the display circuit. It was designed in a very specific way in order to reduce the introduction of noise in our final transmission. We needed a display that produced as little noise as possible but was also easy to read. LED displays provide the best choice for visibility, but we couldn't use normal display drivers that are multiplexed. Multiplexing means that all of the digits are never on at the same time. Each one is turned on in turn at a high enough rate so that to your eye it looks as if all are lit at the same time. The switching between the displays produces more noise than we want to deal with, so we chose a method where all the displays are constantly lit. While this may not be the most efficient method of lighting a display, it is the least noisy. U11, the MM5451 is a large serial shift register made specifically for driving LED segments.

By itself, the display wouldn't do much without a smart device to send it some meaningful data. In this case we are using a Motorola microcontroller (U1) to do the job for us. This microcontroller performs most of the operations on the unit such as checking for button presses, setting the transmitting frequency, checking the PLL voltage for lock, muting audio lines at the appropriate times, as well as updating the display.

When the frequency is changed, we access U2, a serially programmed PLL (Phase Locked Loop) and stereo modulator IC. When the frequency needs to be set, the information is sent serially to U2. This information is a string of binary data (1's and 0's) that is sent one bit at a time to U2. The frequency information takes 16 bits of data and is fairly straight-forward. You may think

that all this data transfer would take a long time. The fact is that the whole process from the time you press a frequency control switch until the data is completely sent is less than 1/100th of a second!

So how does this PLL and VCO (Voltage Controlled Oscillator) work in our FM100B? While there are not a lot of parts surrounding U2, there is a lot going on inside behind the scenes. In order for you to understand what goes on behind the scenes, a little PLL theory wouldn't hurt.

Let's say for example we want to generate 100.9 MHz. Our microcontroller will send a digital code to U2 equivalent to 1009 plus some configuration bits. This number is moved into a divider inside of U2 were it divides down our current operating frequency. The operating frequency is what our Voltage Controlled Oscillator circuit consisting of C7, L1, C8, D1 and an oscillator inside of U2 are running at. There are some more parts in our oscillator that come into play, but we will only consider these for now (the rest are for modulating the signal with audio and our multiplex information). This VCO frequency is sampled and then divided by the divider value of 1009. It is then compared to a reference frequency generated by X2 (7.6 MHz) divided by 76 which is 100 kHz.

If the desired frequency is less than the reference frequency, U2 sends negative going pulses out of pin 7. This in turn increases the voltage on the collector of Q4 (we will get back to this) causing an increase in the voltage across diode D1 (the main varactor diode in our oscillator circuit). As the voltage across the varactor increases, it causes a decrease in capacitance (Increasing reverse bias essentially increases the distance between the capacitor's plates by increasing the depletion region in the diode ($C = kA/d$). The decrease in capacitance causes an increase in U2's RF oscillator ($f_o = 1/[2 \pi (LC)^{½}]$), bringing the FM100B's output frequency back on frequency. If the desired frequency is higher than the reference, pin 7 has positive going pulses and the collector voltage of Q4 is driven lower. If the frequency is just right then pin 7 idles (basically disconnecting itself from the circuit) so it will cause no change in the voltage on D1. The voltage changes on pin 7 are filtered by R21, C23, R26, C28, R22, Q3, and Q4 to provide a steady, noise free tuning voltage for D1. The group of components around Q3 and Q4 is called an Integrator. They sum together those positive and negative going pulses from pin 7. In this way the output frequency of U2 is "locked" to that desired by the microcontroller.

While the PLL is constantly adjusting itself to stay on the desired frequency, U1 is polling the voltage present on the collector of Q4 to determine whether or not the PLL is locked. The voltage is sampled at the junction of the voltage divider R37 and R40. This divider will take the +12V range that is used in the PLL circuit and convert it to a +5V range. U1 cannot handle voltages over 5V so this division makes it compatible. U1 (through digital math) then converts the numbers back to 0-12V on the display. To determine if the loop is locked, U1 performs some math to see if the tuning voltage matches the current requested

frequency while also helping you to determine if you have L1 adjusted properly! Normally if the PLL is locked and L1 is tuned properly, we know what the control voltage will be to achieve the requested frequency by characterizing the PLL loop voltage versus frequency. If we had requested 108.0 MHz, we know the PLL control voltage should be around 8.9 VDC to be locked. If it is not within that range, the locked LED will not light on the display.

What are all those additional parts in the VCO for? These allow our composite stereo or mono signal from pin 5 of U2 to be placed on our carrier signal (the frequency you selected). By adding an extra variable capacitor D2 (another varactor diode) along with C9 into the VCO circuitry, the composite signal is fed in to the VCO at a specific level after dividing it by R6 and R7. As the audio swings positive and negative, the frequency goes up and down at the same rate the audio does. This is in turn called frequency modulation (FM) due to the frequency shifting back and forth with reference to your audio signal!

In order to get our locked signal out over the air we have to boost the output of our VCO a bit. To do this we use a fancy new part we call the GAL5. This is actually a very well-matched (RF-wise) amplifier with several transistors inside that give us plenty of RF gain without unwanted signals being added in. It by itself has enough gain to give us our 25 mW output (R3 turned fully CW for full output). It also provides plenty of level for some further amplification with the export model (FM100BEX).

Because our amplifier is not truly linear, it introduces some harmonics. Harmonics are multiples of the primary frequency. The primary one we are trying to get rid of is the second harmonic (F x 2) which in our case winds up in the aircraft band. It is extremely important for us not to interfere with ANY other transmissions in ANY band. The best filter for the job is the low-pass filter consisting of L3, C63, C59, C67, L4, C64, L5, and C68. This has an upper cutoff frequency at 110 MHz to prevent anything above from getting out onto the antenna and over the air.

U2 (the BA1415 FM stereo transmitter IC) is what does all the work of creating your stereo subcarrier as well doctoring your audio signals for transmission. This new version of stereo modulator chip (the old one was a BA1404) has some impressive capabilities and fantastic sound as compared to the older versions. For one it contains a limiter to prevent over-modulation, as well as the pre-emphasis circuitry and some low pass filtering on the audio. It is basically an entire professional transmitter on a chip! All of the required low-pass audio filtering we wanted could not be performed within the chip so we added some more external filtering to give it an even better, richer sound.

Now that we are done with the RF section, let’s look into the audio circuitry starting at the inputs and going forward to U2. We are going to take a closer look at the microphone amplifier, audio mixer, audio switcher, and peak hold meters to find out the purpose of each. For ease of description we will only

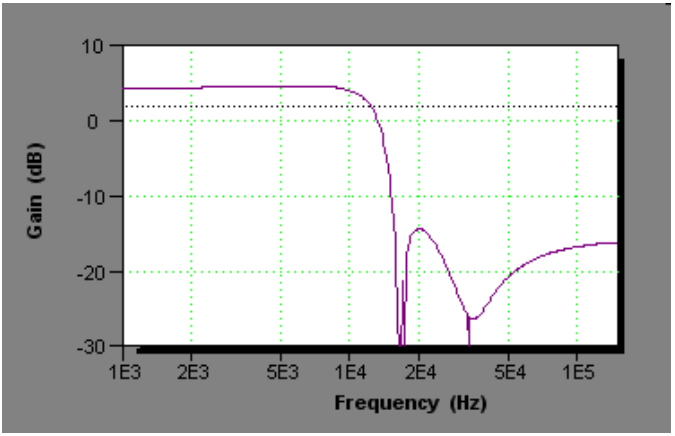
consider the Right channel due to the Left channel being practically identical.

Right off you will see we have two sets of RCA input jacks for the two channels of audio we are able to mix together. This audio passes right through the front level controls so that we can control the audio level for proper mixing and distortion-free sound. U5:A is the right-channel audio summing amplifier. It takes Line 1 and adds it to Line 2 giving you an amplified output on U5:A pin 1.

This summed or “mixed” output then goes through R52 before encountering Q7. Q7 acts like an open switch when it’s off or a closed switch shorting out the audio to ground (so it doesn’t go beyond this point) when it’s on. Q7 is controlled by a combination of U1 (the microcontroller) and U13 (the AGC amplifier for the microphone). U1 enables or disables the Auto AGC feature of the FM100B. The Auto ACG feature works by U12 detecting a level of audio from the microphone, and if loud enough, U13, set up as a level detector, mutes the audio coming in by turning on Q7 and Q8. We will get back to the microphone circuit in a minute.

If the AGC circuit is off, audio continues to U5:D (another summing amplifier). This stage sums the audio from the microphone circuit and the audio from our current line input signal together. The level of microphone audio mixed in is controlled by R16. Notice that there is another transistor (Q2) on the microphone line. This works just like Q7 and allows U1 to mute the microphone signal when necessary.

Once mixed, the sum of the audio from the two RCA jacks and the microphone audio enters the low-pass filter. Filtration is provided by a complex mix of two low-pass notches and a regular low-pass filter to achieve a steep cutoff frequency. A notch at 19 kHz prevents any higher frequency audio components from interfering with our stereo multiplexing signals. If you look at the schematic you will see a section boxed off to indicate where these filters are located. You can see there are quite a few parts involved! The components were chosen to keep a nice bright sound as well as maintaining good stereo separation. I won’t



list the part numbers here since they are easy to spot in the boxed off area.

The graph shows the low-pass response of the audio filter. You can clearly see the two notches that combine together to give a nice sharp low pass response.

Part of the output of U4:D (the output of the low pass filter) is monitored by the level indicators. IC U7:B, D5, R71 and C69 comprise a peak hold detector. Part U7:B and D10 make up a real diode, meaning there is no .7 volt drop that is normally associated with a diode. Because the diode is accounted for in the feedback of the opamp its forward voltage drop is nullified. The “real diode” will charge C69 quickly on positive going signals without discharging it on the negative swings. The discharge cycle (or rate) is left solely up to R71. The larger the value, the longer the time the peak hold function is. The voltage on the peak hold is then observed by using an LM3915 bargraph display driver (U9) and a ten segment LED bargraph. This part is pretty self explanatory, it’s really just a voltage meter with a log scale instead of a linear one.

The rest of the audio from U4:D enters U2 (the stereo modulator IC) and is converted to RF for transmission. This audio can also be monitored on J6’s RCA audio monitor output which is at line level by this point. You can use a tape recorder on these or a headphone amplifier to hear what you are transmitting before it goes out over the air!

Now we can go back to the microphone amplifier. U12 is a microphone conditioner IC. It has a feature that we use in the FM100B that really help us out by eliminating a lot of manual work. This is the AGC or Automatic Gain Control. This prevents us from overloading the audio circuitry when we get excited and yell into the microphone. When the amplitude of the signal coming from the microphone increases, the gain of the microphone amp decreases to keep its output relatively the same over varying input levels.

U13 is the voice detection IC. Voice detection is used to make the Auto AGC feature of the FM100B. Essentially pin 7 of U13 goes high when there is a varying signal level seen on the microphone (as compared to the constant level of background noise). When pin 7 goes high, it turns JFETS Q7 and Q8 on making them act like voltage controlled pots. The more they are turned on, the less resistance is seen from source to drain. This has the effect of muting the audio from the line level inputs and allowing only the microphone to be heard when there is an active voice signal detected.

U1 (the microcontroller) has the ability to override this feature by turning on transistor Q5 and pulling the gate inputs of Q7 and Q8 low. This prevents them from turning on no matter what the output of U3 tries to do. The microcontroller can also mute the microphone audio by setting the MIC_MUTE line high. This turns on Q2 and grounds out all the microphone audio. R30 and C25 smooth out the switching transitions so that there is very little popping heard like is apparent in most switches. This MUTE line is also used to turn on the microphone line when the speaker sounds a tone to prevent it from being

transmitted over the air.

The whole process of filtering, mixing, and level detecting is repeated in the left channel as well. This completes the basic analog circuit description of the FM100B. If you are interested in more detail of how it works, there are many good books and magazines which deal with circuitry of this sort in smaller manageable circuits which can help you delve further in what is going on.

MICROCONTOLLER DESCRIPTION

The coding of the microcontroller is mostly set up to simply process the changing of the frequency and monitoring the VCO voltage. As you will see, the codes logistics lay out in an easy to follow pattern.

Let's look at a sample code operation. We will start with two given conditions:

- The unit is powered up
- The unit has been set in setup mode. In this state the far right decimal point is blinking and your frequency may be changed.

1. A user presses the FREQ UP button.
2. The microcontroller stops scanning the LD (Lock Detect) line and sees what key the user has pressed.
3. It's a Frequency key? Is the unit in setup mode?
4. Yes. Increase the frequency value in RAM by 100 KHz.
5. Send the appropriate divide by N to U2 along with the rest of the required data.
6. Decode the display digits and update the display for the new frequency.
7. Mute the microphone.
8. Send a confirmation beep to the user.
9. Un-mute the microphone.
10. Wait for key release (if no key release, repeat process from step 4).
11. Continue polling LD and updating status indicators.

We hope all of this information will help you better understand about what is going on inside the FM100B. This should give you some insight if for some reason you have assembly troubles or something isn't working properly when you finish building the unit. Remember most projects like this are made up of many smaller ones. All you have to do is break them down to understand them better. Now on to building!!!

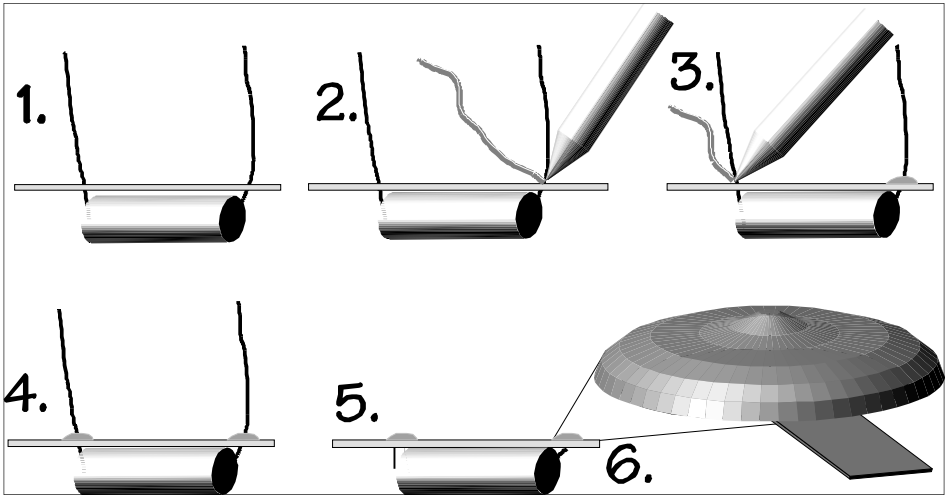
RAMSEY "LEARN-AS-YOU-BUILD" ASSEMBLY STRATEGY

Be sure to read through all of the steps, and check the boxes as you go to be sure you didn't miss any important steps. Although you may be in a hurry to see results, before you switch on the power check all wiring and capacitors for proper orientation. Also check the board for any possible solder shorts, and/or cold solder joints. All of these mistakes could have detrimental effects on your kit - not to mention your ego!

Kit building tips:

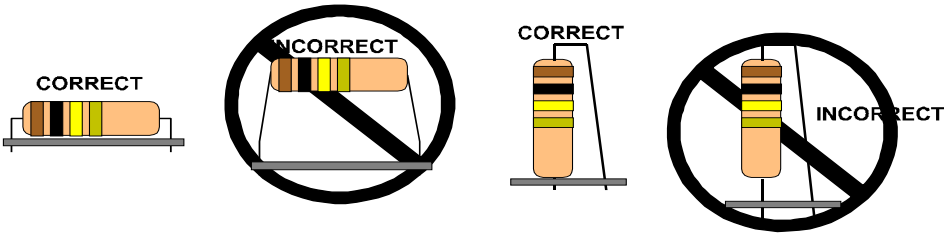
Use a good soldering technique - let your soldering iron tip gently heat the traces to which you are soldering, heating both wires and pads simultaneously. Apply the solder on the iron and the pad when the pad is hot enough to melt the solder. The finished joint should look like a drop of water on paper, somewhat soaked in.

Mount all electrical parts on the top side of the board provided. The top side is clearly marked with the word "TOP", you can't miss it. This is the side that has little or no traces on it, but is covered with mostly copper. When parts are installed, the part is placed flat to the board, and the leads are bent on the backside of the board to prevent the part from falling out before soldering (1). The part is then soldered securely to the board (2-4), and the remaining lead length is then clipped off (5). Notice how the solder joint looks on close up, clean and smooth with no holes or sharp points (6).



Since this is a “professional” transmitter, we sincerely hope you put this together in a professional manner. This project will not work as well as you wished if you just slap it together without following good assembly techniques and follow all instructions. No matter how clear we may think our manual is, if you have any questions give us a call at the factory. We will be happy to help you with any problems you may run into.

This is a mixed signal project meaning there is digital, audio, and RF circuitry all in one unit. As with all RF circuitry, we want to mount the parts AS LOW AS POSSIBLE to the board. A 1/4” lead length on a resistor not mounted close to the board can act as an inductor or an antenna causing all sorts of problems in your circuit. Be aware though that there are stand up components in your circuit. They don’t need to be squished to the board. Keep the portion of the resistor closest to the board mounted right on the board.



For each part, our word "Install" always means these steps:

FM100B ASSEMBLY

- ☐ 1. Pick the correct part value to start with.
- ☐ 2. Insert it into the correct PC board location. Make sure the part is mounted flush to the PC board unless otherwise noted.
- ☐ 3. Orient it correctly. Follow the PC board drawing and the written directions for all parts - especially when there's a right way and a wrong way to solder it in. (Diode bands, electrolytic capacitor polarity, transistor shapes, dotted or notched ends of IC's, and so forth.)
- ☐ 4. Solder all connections unless directed otherwise. Use enough heat and solder flow for clean, shiny, completed connections.

Let’s begin by sorting out our components and cross-checking them against the parts list to make sure we have received everything.

IMPORTANT NOTE! The surface mount parts in your FM100B have been preinstalled for you. Please do not call the factory for your missing parts; simply turn the board over and you’ll find them soldered into place.

FM100B PARTS LIST

Semiconductors

- ☐ 2 MV2105 Varactor Diodes (In TO-92 case, 2 pins) (D1,2)
- ☐ 4 2N3904 NPN General purpose transistors (Q1,3,4,5)
- ☐ 3 BS170 JFET Transistors (Q2,7,8)
- ☐ 5 1N4148 Switching Diodes (orange glass body, black stripe) (D3,4,5,6,9)
- ☐ 1 7805 +5V Voltage Regulator (VR1)
- ☐ 1 MC68HRC908JK1CP Microcontroller with sticker on top (U1)
- ☐ 1 BH1415F Stereo Modulator IC **Pre-installed!** (U2)
- ☐ 3 LF347N Quad Opamps (U4,5,8)
- ☐ 1 GAL5 **Pre-installed!** (U6)
- ☐ 1 LM358 Dual Opamp (U7)
- ☐ 2 LM3915 Semi-log bargraph drivers (U9,10)
- ☐ 1 MM5451 Serial Shift Register LED driver (U11)
- ☐ 1 SSM2165-1S Microphone conditioner (U12)
- ☐ 1 LMC662CN CMOS Dual operational amplifier (U13)

Resistors (5% - fourth band is gold, only listed in Section D)

- ☐ 1 10 ohm resistor (brown-black-black) (R12)
- ☐ 2 100 ohm resistors (brown-black-brown) (R26, R99)
- ☐ 1 120 ohm large 1 Watt resistor (brown-red-brown) (R58)
- ☐ 11 1K ohm resistors (brown-black-red) (R15,17,20,34,38,53,62,80,88,96,97)
- ☐ 5 4.7K ohm resistors (yellow-violet-red) (R22,28,33,39,41)
- ☐ 25 10K ohm resistors (brown-black-orange) (R1,2,3,4,7,9,13,19,27, 35,48,49,52,54,57,59,67,70,78,79,81,84,85,94,111)
- ☐ 2 18K ohm resistors (brown-gray-orange) (R63,89)
- ☐ 7 22K ohm resistors (red-red-orange) (R5,21,43,51,69,73,98)
- ☐ 1 27K ohm resistor (red-violet-orange) (R112)
- ☐ 2 12K ohm resistor (brown-red-orange) (R6,113)
- ☐ 2 39K ohm resistors (orange-white-orange) (R61,87)
- ☐ 8 47K ohm resistors (yellow-violet-orange) (R14,30,37,40,71,90,91,110)
- ☐ 4 100K ohm resistors (brown-black-yellow) (R10,18,68,95)
- ☐ 1 220K ohm resistors (red-red-yellow) (R11)
- ☐ 1 470K ohm resistor (yellow-violet-yellow) (R23)

Resistors (1% - fifth band is brown, only used in Section D)

- ☐ 2 3.32K ohm resistors (orange-orange-red-brown) (R66,93)
- ☐ 4 10.0K ohm resistors (brown-black-black-red) (R55,56,82,83)
- ☐ 2 51.1K ohm resistors (green-brown-brown-red) (R65,92)
- ☐ 2 61.9K ohm resistors (blue-brown-white-red) (R60,86)
- ☐ 4 82.5K ohm resistors (gray-red-green-red) (R46,47,76,77)
- ☐ 4 121K ohm resistors (brown-red-brown-orange) (R44,45,74,75)

Ceramic disk capacitors (Std)

- ☐ 1 2.2 pF ceramic capacitor (marked 2.2) (C89)
- ☐ 1 4.7 pF or 5 pF ceramic capacitor (marked 4.7 or 5) (C66)
- ☐ 3 10 pF ceramic capacitors (marked 10) (C4,7,9)
- ☐ 1 27 pF ceramic capacitor (marked 27) (C67)
- ☐ 2 33 pF ceramic capacitors (marked 33) (C21,27)
- ☐ 1 39 pF ceramic capacitor (marked 39) (C63)
- ☐ 1 47 pF ceramic capacitor (marked 47) (C68)
- ☐ 1 75 pF ceramic capacitor (marked 75) (C64)
- ☐ 2 150 pF ceramic capacitors (marked 151) (C33,38)
- ☐ 9 0.001 uF ceramic capacitors (marked 102) (C8,12,30,36,43,46,59,65,114)
- ☐ 2 0.0033 uF ceramic capacitors (marked 332) (C32,37)
- ☐ 8 0.01 uF ceramic capacitors (marked 103) (C5,26,41,44,49,84,86,88)
- ☐ 1 0.047 uF ceramic capacitors (marked 473 or .047) (C23)
- ☐ 5 0.1 uF ceramic capacitors (marked 104) (C10,11,17,42,50)

Ceramic capacitors (5% - small yellow bodies used in Section D)

- ☐ 2 22 pF capacitors (marked 22) (C61,79)
- ☐ 2 56 pF capacitors (marked 56) (C55,74)
- ☐ 4 68 pF capacitors (marked 68) (C47,57,70,76)
- ☐ 2 82 pF capacitors (marked 82) (C56,75)
- ☐ 2 180 pF capacitors (marked 181) (C62,80)
- ☐ 2 680 pF capacitors (marked 681) (C54,73)
- ☐ 2 0.0022 uF capacitors (marked 222) (C60,78)

Electrolytic capacitors

- ☐ 1 1 uF electrolytic capacitor (C20)
- ☐ 29 10 uF electrolytic capacitors (C1,2,3,14,15,18,19,22,25,29,35,39,40, 48,51,52,53,58,69,71,72,77,81,82,83,85,87,110,113)
- ☐ 1 22uF electrolytic capacitor (C112)
- ☐ 1 47 uF electrolytic capacitors (C28)
- ☐ 1 100 uF electrolytic capacitor (C45)

Variable Resistors

- ☐ 1 1K ohm trimmer (Orange-topped marked 102) (R36)
- ☐ 1 10K ohm single potentiometer (marked 10K or 103) (R16)
- ☐ 2 10K ohm dual potentiometers (Black with long post) (R42,72)

Inductors

- ☐ 1 Adjustable shielded metal can coil or similar (L1)
- ☐ 3 4 turn wire-wound inductors (L3,4,5)
- ☐ 1 2.2 uH inductor (like a fat resistor with red-red-gold-silver bands) (L7)
- ☐ 1 13 turn air core inductor (L8)

Display Indicators

- ☐ 2 MAN6910 Dual high efficiency seven segment displays (DISP1,2)
- ☐ 2 10-segment bargraph displays (DISP3,4)
- ☐ 2 Small red LEDs (D7,8)

Connectors

- ☐ 1 3-pin Molex connector (J1)
- ☐ 2 4-pin Molex connectors (J2,3)
- ☐ 4 5-pin 0.1” center connectors (J4,8,10,11)
- ☐ 1 Stereo jack, 3.5 mm for microphone (J5)
- ☐ 1 RCA jack module (J6)
- ☐ 1 Chassis mount BNC connector and mounting nut (J7)

Miscellaneous

- ☐ 5 Push-button switches (S1,2,3,4,5)
- ☐ 1 Mini speaker (SP1)
- ☐ 1 7.6 MHz Crystal (X2)
- ☐ 1 8” piece of black 18 AWG with Molex pin pre-crimped
- ☐ 1 7” piece of thin RG-174/U coax with BNC connector
- ☐ 1 Whip antenna (ANT1), low power version only.
- ☐ 1 +/-12V Switching Power Supply (PS1)
- ☐ 1 RF coil tuning tool

Case and knob parts

- ☐ 5 Push button switch caps
- ☐ 3 Set screw knobs
- ☐ 1 Bottom case half with pre-attached membrane panel
- ☐ 1 Top case half
- ☐ 17 4-40x1/4” board mounting screws
- ☐ 4 4-40x5/8” standoffs
- ☐ 6 6-32x1/4” self tapping black case screws
- ☐ 2 4-40x1/2” self tapping black machine screws
- ☐ 1 Fuse holder with hardware
- ☐ 1 1 Amp fuse
- ☐ 1 110 Volt line cord with plug and pre-installed Molex pins
- ☐ 1 Line cord grommet (black plastic - MP5P4)
- ☐ 1 Antenna grommet (black rubber ring)
- ☐ 4 Rubber leg pads
- ☐ 1 4-40 Kepnut

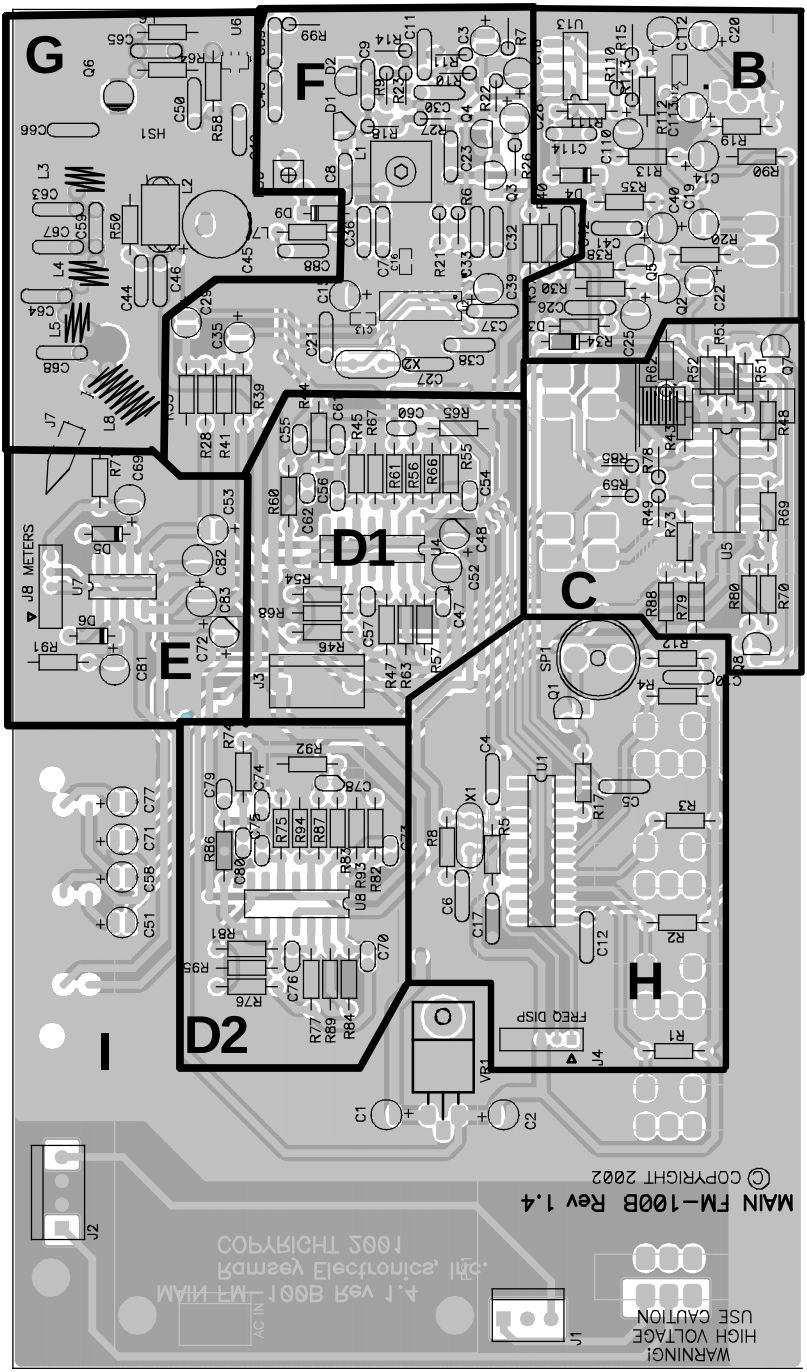
Other Equipment (Not included)

- ☐ 1 Pencil type soldering iron (30-40 Watts) Don’t use a solder gun!
- ☐ 1 Roll of fine 60/40 solder (less than .045” diameter)
- ☐ 1 Sensitive voltmeter or DMM
- ☐ 1 An FM radio for testing
- ☐ 1 Audio sources such as a tape deck, CD player, or microphone
- ☐ 1 Egg carton or grapefruit holder to sort out parts in.

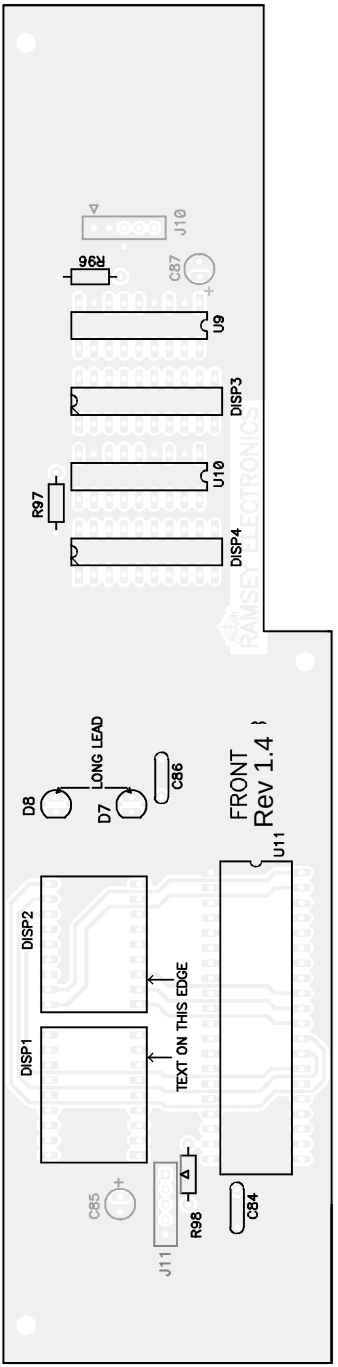
PROJECT ASSEMBLY

Here we go! To make assembly easier and to stick by the “Learn As You Build” strategy, we will section off the project into different major circuit groups. We will begin with the smaller display board to perfect your assembly skills before we continue with the more crowded sections of the board. Following is a list of all the sections in the manual that we will be going into:

SECTION LAYOUT ON MAIN BOARD



DISPLAY BOARD PARTS LAYOUT DIAGRAM



Parts Layout

Note: Light Gray components are mounted on the reverse side of the board.

A. DISPLAY BOARD

We will begin with the display board oriented in the direction shown. Be sure not to confuse the sides of the board where the parts go. On the board you will see the side marked FRONT which is where most parts are mounted. We will begin with lower parts and work up to the higher ones. Don't use sockets for these parts since they need to fit between the front panel and the PC board.

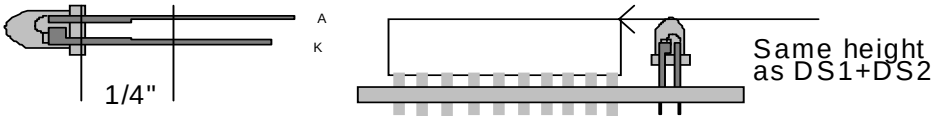
Note that only in section D (the audio LPF) of this kit will all four color bands be listed for the standard 5% resistors. Do not use any of the five color band resistors unless specifically instructed. These are the tighter tolerance parts that are needed only in certain sections.

- ☐ 1A. Install R98, a 22K ohm resistor (red-red-orange). This resistor sets the current to each of the display segments and LEDs driven by U11. Lowering the value of this resistor increases the brightness of the display (the display will draw more current however). This resistor was selected for best brightness/current trade-off.
- ☐ 2A. Install C84, a 0.01 uF ceramic capacitor (marked 103). This capacitor prevents the current set pin from doing odd things like oscillating by itself.
- ☐ 3A. Install C86, another 0.01 uF ceramic capacitor (marked 103).
- ☐ 4A. Install R96, a 1K ohm resistor (brown-black-red)
- ☐ 5A. Install R97, another 1K ohm resistor (brown-black-red).
- ☐ 6A. Install U9, one of the LM3915 Semi-log bargraph driver ICs. Make absolutely sure before soldering that you have installed all 18 pins into the appropriate holes. Verify that the notch or dot indicating pin one is facing the same direction shown in the Parts Layout Diagram. Solder all 18 pins and then check for any possible solder bridges when you're done.
- ☐ 7A. Install U10, the other LM3915 Semi-log bargraph driver. Again make sure all 18 pins are through the board and that the IC is in the correct orientation.
- ☐ 8A. Install U11, the MM5451 40 pin IC. Again make sure the notch is in the same direction as shown on the Display Board Parts Layout Diagram and that all 40 pins are through the board before soldering. This IC drives all the individual segments of the display without multiplexing it (which would add noise to the system!).
- ☐ 9A. Install DISP3, one of the ten segment bargraph displays. You will notice a small divot or notch on one corner of the bargraph indicating where pin 1 is. This will be installed in the same orientation as the notch in the parts layout diagram. Solder all 20 pins.

☐ 10A. Install DISP4, the other 10 segment bargraph display. Make sure to align this in the same way as before and solder all 20 pins.

☐ 11A. Install DISP1, one of the two digit displays. Notice how there is no indication of pin 1 on these. You want to orient the display so that the lettering on the one side faces towards U11. It should be positioned so that the Decimal Point is closest to U11. Solder all 18 pins.

☐ 12A. Install DISP2, the other two digit display. Again orient the lettering towards U11 before soldering all 18 pins.



☐ 13A. Install D7, one of the small red LEDs. Notice that if you look straight at the LED there is a flat side. This indicates the Cathode side of the LED. The Cathode side is also indicated by the shorter of the two leads. Make sure to install the flat side or the shorter lead in the same way as shown in your diagram. They only light up if they are installed correctly. Before soldering though, this and the next LED are the only parts that we do not mount flush to the PC board. In this case we want to mount them so the lens of the LED is at the same height as DISP1 and DISP2. These LEDs will eventually be lining up with holes in the front panel. Once the height is set, bend the leads to hold the LED in place, then solder. (**Note:** Some builders prefer to temporarily install the front panel on the case and line up D7 and D8 flush with the front panel overlay. This increases the viewing angle of the indicator when it is tight to the display.)

☐ 14A. Install D8 in the same fashion, making sure it is at the same height and orientation as in the previous step.

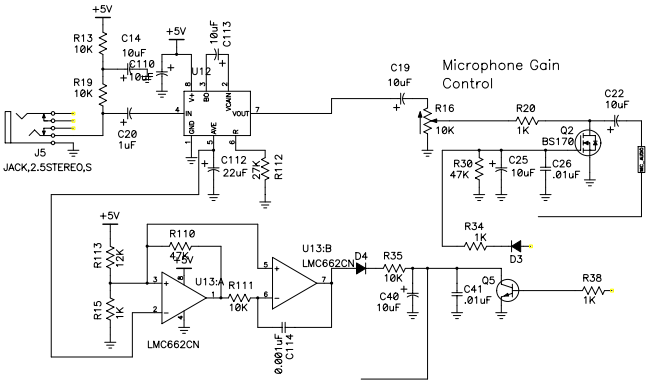
Now would be a good time to check all of your solder connections for opens and bridges on the back side of the board. The next few steps will be to install the components that are mounted on the rear side of the front panel (two jumper headers and two electrolytic capacitors). These parts are shown in light gray instead of black on the Display Board Parts Layout Diagram.

☐ 15A. Install J11, a five pin jumper block (shorter leads soldered onto the board). Again make sure you are putting them on the opposite side of the board from where the rest of the parts have been located. This jack is where the numeric display gets its power and the data for display values.

☐ 16A. Install J10, another five pin jumper block. This is where the power for the bargraphs is applied and the signal levels for the bargraphs are sent for display (mount it on the backside like J11).

- ☐ 17A. Mark pin 1 of J10 and J11 with a marker on the rear side of the display board so that later wiring will be a bit easier.
- ☐ 18A. Install C87 (a 10 uF electrolytic capacitor) on the rear side of the display panel. Notice this is the first capacitor of this type. You want to be sure that you pay close attention to the polarity markings on this part and all subsequent electrolytic capacitors. In most cases the negative (-) side is marked on the capacitor, while the positive side (+) is marked on the parts layout. If you fail to mount this component correctly, the part can fail as well as prevent proper operation of your project. We will be installing many more of these later in the project so be sure and remember this!
- ☐ 19A. Install C85 (another 10 uF electrolytic capacitor) on the rear side of the front panel. Watch that orientation again!

Great job! We have just completed the display board and we are almost ready to move on. First we want to check our display board to make sure there are no solder bridges or cold solder joints. Next, check the orientation of your parts for correct installation.

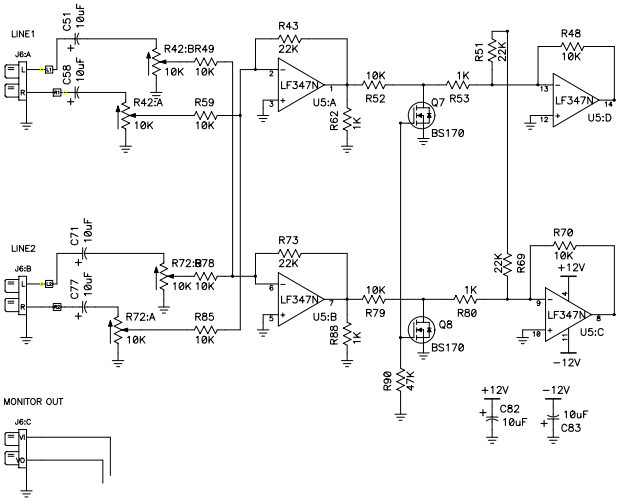


B. MICROPHONE AMPLIFIER

- ☐ 1B. Orient the board so that the jacks and switches would be right in front of you if they had been installed yet and the Revision number and other information is on the righthand side. .
- ☐ 2B. Install R13, a 10K ohm resistor (brown-black-orange).
- ☐ 3B. Install R19, a 10K ohm resistor (brown-black-orange).
- ☐ 4B. Install R112, a 27K ohm resistor (red-violet-orange).
- ☐ 5B. Install R113, a 12K ohm resistor (brown-red-orange).
- ☐ 6B. Install R15, a 1K ohm resistor (brown-black-red).
- ☐ 7B. Install R110, a 47K ohm resistor (yellow-violet-orange).
- ☐ 8B. Install R111, a 10K ohm resistor (brown-black-orange).
- ☐ 9B. Install C114, a 0.001 uF ceramic capacitor (marked 102).
- ☐ 10B. Install R35, a 10K ohm resistor (brown-black-orange).
- ☐ 11B. Install R20, a 1K ohm resistor (brown-black-red).
- ☐ 12B. Install R38, a 1K ohm resistor (brown-black-red).
- ☐ 13B. Install R30, a 47K ohm resistor (yellow-violet-orange). This resistor sets the restore time for the “soft switch” when the microcontroller turns the microphone audio on and off.
- ☐ 14B. Install R34, a 1K ohm resistor (brown-black-red). The silkscreen for this part and the next one are confusing because of where they are on the board. It looks like the silkscreen for R34 says R3 but it is the correct position, the 4 was simply cut off.

- ☐ 15B. Install D3, one of the 1N4148 diodes. This is identified by not only the text on the diode, but also by the orange glass body with one black stripe on the end. Yes, this is the correct position on the board for D3! Install the diode in the same orientation as shown in the Parts Layout Diagram. Diodes only conduct in one direction so make sure to install it correctly!
- ☐ 16B. Install D4, another 1N4148 type diode. Again check orientation!
- ☐ 17B. Install Q5, a 2N3904 NPN transistor. These look very much like the BS170, so you will need to identify them by the text on the flat side. Install in the same orientation as shown with the flat side as reference.
- ☐ 18B. Install Q2, a BS170 JFET transistor. Again use the flat side for installation orientation.
- ☐ 19B. Install C20, a 1 uF electrolytic capacitor. Watch your polarity by making sure the stripe indicating the negative side of the capacitor is not inserted in the hole marked with the positive sign on the PC board.
- ☐ 20B. Install C113, 10 uF electrolytic capacitor. Remember to watch the polarity!
- ☐ 21B. Install C19, a 10 uF electrolytic capacitor. Polarity!
- ☐ 22B. Install C40, a 10 uF electrolytic capacitor.
- ☐ 23B. Install C22, a 10 uF electrolytic capacitor.
- ☐ 24B. Install C25, a 10 uF electrolytic capacitor.
- ☐ 25B. Install C14, a 10 uF electrolytic capacitor.
- ☐ 26B. Install C112, a 22uF electrolytic capacitor.
- ☐ 27B. Install U13, LMC662CN CMOS Dual operational amplifier IC. Again, be sure it is seated flush with the PC board before soldering all leads.
- ☐ 28B. Install C26, a 0.01 uF ceramic capacitor (marked 103).
- ☐ 29B. Install C41, another 0.01 uF ceramic capacitor (marked 103).
- ☐ 30B. Install C110, a 10uF electrolytic capacitor. Remember to watch polarity.

We will hold off on the installation of R16 and J5 until later (these will just get in the way while we put together the rest of the board). In the mean time this completes the microphone section. Before we continue we should check over the part orientation for your diodes, capacitors, the IC, and the transistors. If we check in small sections it will be easier to find mistakes.



C. AUDIO MIXER

While it is not completely seen, the audio mixer also involves some of the microphone section we just completed. This mixer section consists of out two pairs of summing amplifiers, and some of the Auto AGC circuit. We will hold off on the two big dual pots until later so do not install these in this section.

- ☐ 1C. Install R88, a 1K ohm resistor (brown-black-red).
- ☐ 2C. Install R73, a 22K ohm resistor (red-red-orange).
- ☐ 3C. Install R79, a 10K ohm resistor (brown-black-orange).
- ☐ 4C. Install R80, a 1K ohm resistor (brown-black-red).
- ☐ 5C. Install R70, a 10K ohm resistor (brown-black-orange).
- ☐ 6C. Install R69, a 22K ohm resistor (red-red-orange).
- ☐ 7C. Install R48, a 10K ohm resistor (brown-black-orange).
- ☐ 8C. Install R51, a 22K ohm resistor (red-red-orange).
- ☐ 9C. Install R53, a 1K ohm resistor (brown-black-red).
- ☐ 10C. Install R52, a 10K ohm resistor (brown-black-orange).
- ☐ 11C. Install R43, a 22K ohm resistor (red-red-orange).
- ☐ 12C. Install R62, a 1K ohm resistor (brown-black-red).
- ☐ 13C. Install R78, a 10K ohm resistor (brown-black-orange). Note this resistor is mounted in a stand-up fashion.

☐ 14C. Install R85, a 10K ohm resistor (brown-black-orange).

☐ 15C. Install R59, a 10K ohm resistor (brown-black-orange).

☐ 16C. Install R49, a 10K ohm resistor (brown-black-orange).

☐ 17C. Install U5, one of the LF347 quad low noise opamps. Make sure the dot or tab indicating pin 1 is installed in the same orientation as the tab shown on the Parts Layout Diagram. Solder all 14 pins after making sure each pin has been inserted into the board.

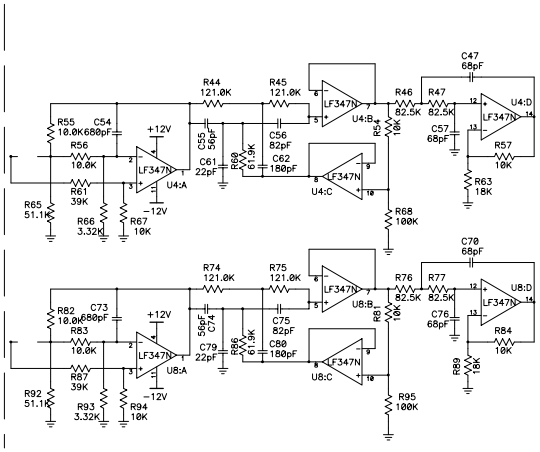
☐ 18C. Install Q7, a BS170 FET. Make sure the flat side of the transistor is in the same orientation as shown on the Parts Layout Diagram.

☐ 19C. Install Q8, another BS170 FET. Again check orientation. Note that these are the transistors that can mute the audio when the Auto AGC function is enabled.

☐ 20C. Install R90, a 47K ohm resistor (yellow-violet-orange). R90 sets the recovery time for the audio to resume after an Auto AGC function. If you wish to customize the recovery time, lower this value to speed it up or raise it to slow it down. It is located way over on the right hand side of the board.

It's time to take an eyeball break before we move on to the next section of our project! Not including the pots that will be used for control, the mixer and microphone sections are now complete. This would be a good time to go through and check your work for good assembly practice. Check for solder bridges, cold solder joints, and improperly oriented devices. A common practice among engineers and techs here at the factory when you can't find a mistake is to get up, take a short break and come back with a new perspective. You would be surprised how many problems you can find when you do this.

Onward!



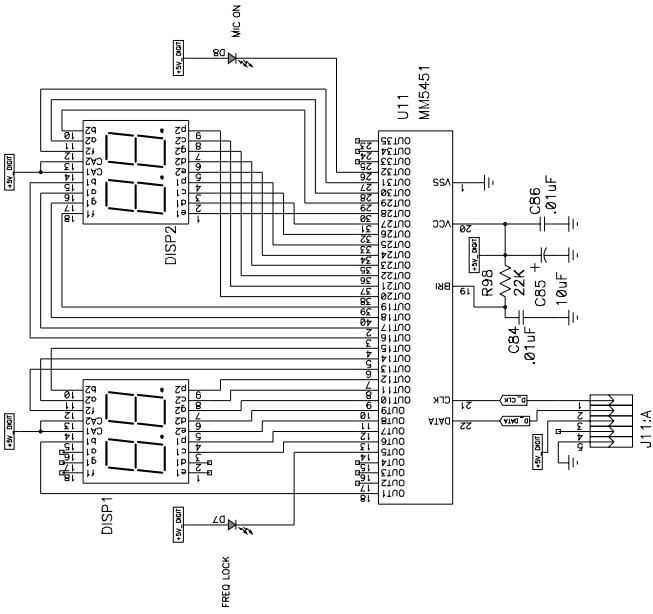
Low Pass Filters

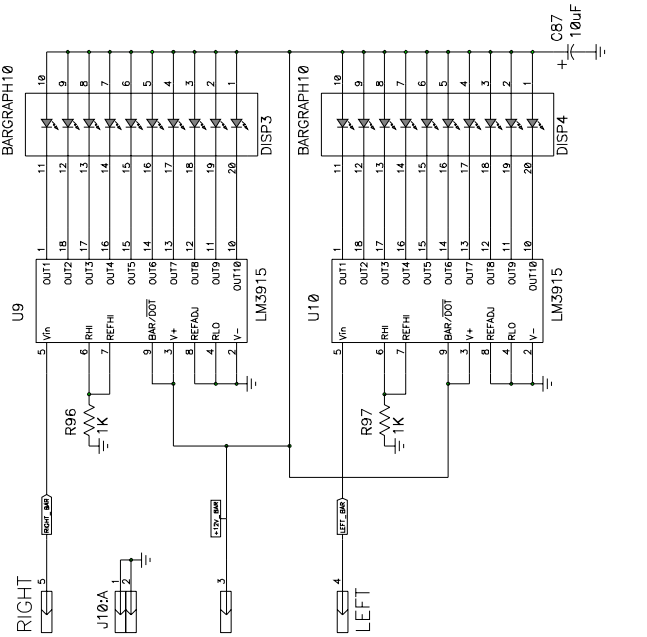
D. LOW PASS AUDIO FILTERS

Note that we will be installing all of our precision parts in these next few steps. The 5% and 1% components are listed together so follow the steps closely! 1% values are used so the filters are well matched on the Left and Right channels (these have 5 bands).

- ☐ 1D. Locate the center of the board where this group of parts is to go. We will begin on the left side of this area.
- ☐ 2D. Install R76, an 82.5K ohm 1% resistor (gray-red-green-red-brown).
- ☐ 3D. Install R95, a 100K ohm 5% resistor (brown-black-yellow-gold).
- ☐ 4D. Install R81, a 10K ohm 5% resistor (brown-black-orange-gold).
- ☐ 5D. Install R77, an 82.5K ohm 1% resistor (gray-red-green-red-brown).
- ☐ 6D. Install R89, an 18K ohm 5% resistor (brown-gray-orange-gold).
- ☐ 7D. Install R84, a 10K ohm 5% resistor (brown-black-orange-gold).
- ☐ 8D. Install R82, a 10.0K ohm 1% resistor (brown-black-black-red-brown).
- ☐ 9D. Install R93, a 3.32K ohm 1% resistor (orange-orange-red-brown-brown).
- ☐ 10D. Install R83, a 10.0K ohm 1% resistor (brown-black-black-red-brown).
- ☐ 11D. Install R87, a 39K ohm 5% resistor (orange-white-orange-gold).
- ☐ 12D. Install R94, a 10K ohm 5% resistor (brown-black-orange-gold).
- ☐ 13D. Install R75, a 121K ohm 1% resistor (brown-red-brown-orange-brown).
- ☐ 14D. Install R92, a 51.1K ohm 1% resistor (green-brown-brown-red-brown).

DISPLAY SCHEMATIC





- ☐ 15D. Install R74, a 121K ohm 1% resistor (brown-red-brown-orange-brown).
- ☐ 16D. Install R86, a 61.9K ohm 1% resistor (blue-brown-white-red-brown).
- ☐ 17D. Install C76, a 68 pF 5% ceramic capacitor (marked 68). All ceramic capacitors in this section are the small yellow 5% type that don't look like a disk. Use an eye loupe to carefully read the numbers on their side before installing them; the 5% body styles all look alike!
- ☐ 18D. Install C70, a 68 pF 5% ceramic capacitor (marked 68).
- ☐ 19D. Install C73, a 680 pF 5% ceramic capacitor (marked 681).
- ☐ 20D. Install C78, a 0.0022 uF 5% ceramic capacitor (marked 222).
- ☐ 21D. Install C75, an 82 pF 5% ceramic capacitor (marked 82).
- ☐ 22D. Install C74, a 56 pF 5% ceramic capacitor (marked 56).
- ☐ 23D. Install C80, a 180 pF 5% ceramic capacitor (marked 181).
- ☐ 24D. Install C79, a 22 pF 5% ceramic capacitor (marked 22).
- ☐ 25D. Install U8, one of the LF347N quad opamps. This IC handles the filtering for the Left channel audio with these surrounding parts. Make sure all 14 pins are through the board before soldering (It's easy to accidentally fold over a pin while installing it).
- ☐ 26D. Install R46, an 82.5K ohm 1% resistor (gray-red-green-red-brown).
- ☐ 27D. Install R68, a 100K ohm 5% resistor (brown-black-yellow-gold).
- ☐ 28D. Install R54, a 10K ohm 5% resistor (brown-black-orange-gold).
- ☐ 29D. Install R47, an 82.5K ohm 1% resistor (gray-red-green-red-brown).
- ☐ 30D. Install R63, an 18K ohm 5% resistor (brown-gray-orange-gold).
- ☐ 31D. Install R57, a 10K ohm 5% resistor (brown-black-orange-gold).
- ☐ 32D. Install R55, a 10.0K ohm 1% resistor (brown-black-black-red-brown).
- ☐ 33D. Install R65, a 51.1K ohm 1% resistor (green-brown-brown-red-brown).
- ☐ 34D. Install R66, a 3.32K ohm 1% resistor (orange-orange-red-brown-brown).
- ☐ 35D. Install R56, a 10.0K ohm 1% resistor (brown-black-black-red-brown).
- ☐ 36D. Install R61, a 39K ohm 5% resistor (orange-white-orange-gold).
- ☐ 37D. Install R67, a 10K ohm 5% resistor (brown-black-orange-gold).

☐ 38D. Install R45, a 121K ohm 1% resistor (brown-red-brown-orange-brown).

☐ 39D. Install R44, a 121K ohm 1% resistor (brown-red-brown-orange-brown).

☐ 40D. Install R60, a 61.9K ohm 1% resistor (blue-brown-white-red-brown)

☐ 41D. Install C57, a 68 pF 5% ceramic capacitor (marked 68).

☐ 42D. Install C47, another 68 pF 5% ceramic capacitor (marked 68).

☐ 43D. Install C54, a 680 pF 5% ceramic capacitor (marked 681).

☐ 44D. Install C60, a 0.0022 uF 5% ceramic capacitor (marked 222).

☐ 45D. Install C56, an 82 pF 5% ceramic capacitor (marked 82).

☐ 46D. Install C61, a 22 pF 5% ceramic capacitor (marked 22).

☐ 47D. Install C62, a 180 pF 5% ceramic capacitor (marked 181).

☐ 48D. Install C55, a 56 pF 5% ceramic capacitor (marked 56).

☐ 49D. Install U4, another LF347N opamp. This opamp and the surrounding parts handles the Right channel audio filtering. Check all 14 pins before soldering.

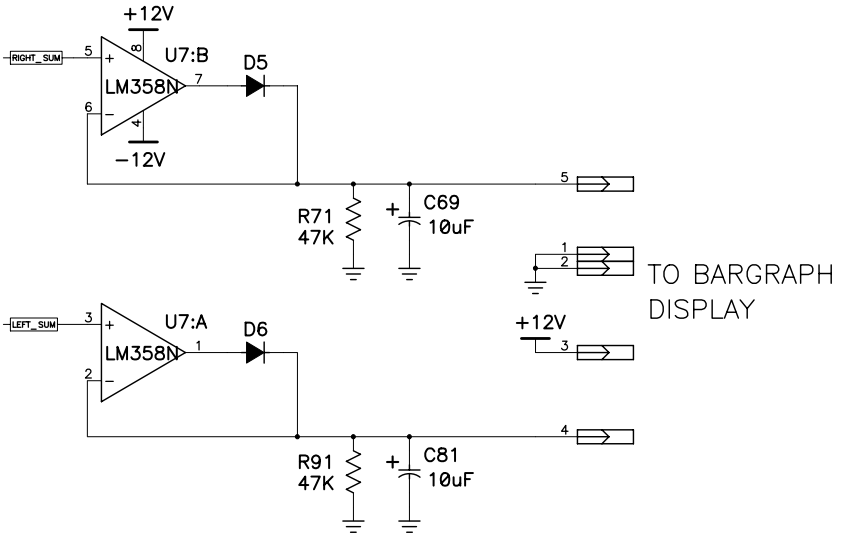
☐ 50D. Install C52, a 10 uF electrolytic capacitor. Check orientation before soldering as these are polarity sensitive!

☐ 51D. Install C48, another 10 uF electrolytic capacitor.

☐ 52D. Install C72, yet another 10 uF electrolytic capacitor.

☐ 53D. Install C53, one more 10 uF electrolytic capacitor.

Check your work up to this point to be sure you didn't make a mistake. It is much easier to check your work in small manageable groups than all at once. Again check for solder bridges and cold solder joints. Especially check around the pins of the ICs for solder bridges since it is a common occurrence.



E. BARGRAPH PEAK HOLD

In this section we will be installing the parts that monitor the peak audio levels and holds them for a long enough period so that we can see the value on the meters (this section is located toward the back of the board). We will also be installing a few capacitors that are actually part of the mixer section (for convenience we decided to install them here).

☐ 1E. Install R91, a 47K ohm resistor (yellow-violet-orange).

☐ 2E. Install R71, another 47K ohm resistor (yellow-violet-orange).

☐ 3E. Install D6, a 1N4148 type diode (orange glass body with black stripe on one end). Make sure this diode is installed in the correct way with the stripe on the same end as shown in the Parts Layout Diagram. This diode and its surrounding circuitry rectifies the audio signal into a DC level. Capacitor C81 then holds this level for a long duration. The resistance of R91 then determines how long C81 holds its charge (the less the value the less time C81 holds the charge). This is seen on the bargraph meters when you have a single pulse like a drum beat.

☐ 4E. Install D5, another 1N4148 type diode (orange glass body with black stripe on one end). Again check orientation before soldering. This is the rectifier for the other channel.

☐ 5E. Install U7, a LM358 opamp. Make sure to orient it in the same direction as shown in the Parts Layout Diagram. Check all 8 pins to be sure they are through the board before soldering any of them!

☐ 6E. Install C81, a 10 uF electrolytic capacitor. Check polarity!

☐ 7E. Install C69, a 10 uF electrolytic capacitor.

☐ 8E. Install C83, a 10 uF electrolytic capacitor. Don't get confused the closely spaced "+" marks on the board for C72, 82, and 83. All three should face the same direction.

☐ 9E. Install C82, a 10 uF electrolytic capacitor.

☐ 10E. Install J8, a 5 pin jumper header. Make sure and leave the longer leads facing up, with the shorter ends soldered to the board. This is where the connection is made to the front panel.

☐ 11E. Install C51, a 10 uF electrolytic capacitor.

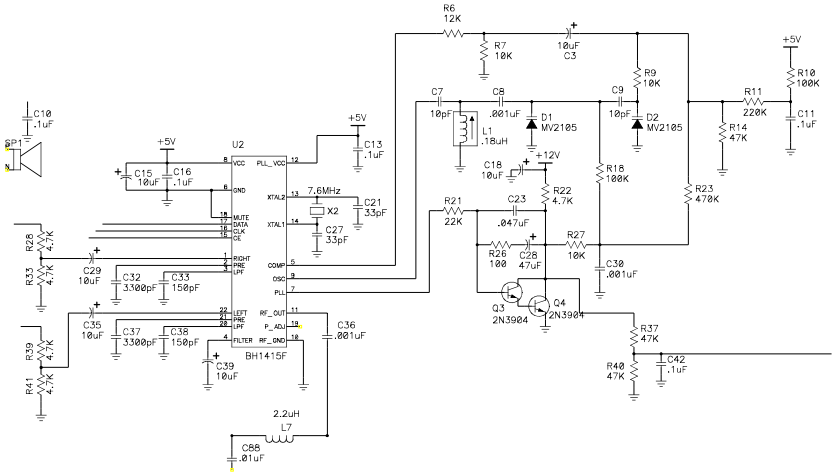
☐ 12E. Install C58, another 10 uF electrolytic, remember to check polarities!

☐ 13E. Install C71, a 10 uF electrolytic capacitor.

☐ 14E. Install C77, the last 10 uF electrolytic capacitor in this section.

Well that's it for the peak hold circuits and the 15 KHz low pass filter. Quick and painless, wasn't it? We have to go back now and check all our work to make sure that we didn't install anything in the wrong way or have any soldering errors such as bridges and cold solder joints. When you're done, go grab a soda (preferably caffeinated) and give yourself another eyeball break!

Our next section is the toughest of the whole kit so make sure you have all of your skills primed and ready for the true test!



F. TRANSMITTER

This is where we definitely want to have clean soldering skills and proper mechanical mounting of parts. If you need a review, shoot back to the start of the manual in the “STRATEGY” section for tips, especially for surface mount assembly. Make sure all your parts are flush to the board and not waving in the breeze. You will not only lose performance if parts aren’t installed correctly, but your kit may not work at all! Have patience and follow all directions and you should have no trouble at all.

☐ 1F. Install R33, a 4.7K ohm resistor (yellow-violet-red).

☐ 2F. Install R28, a 4.7K ohm resistor (yellow-violet-red).

☐ 3F. Install R41, a 4.7K ohm resistor (yellow-violet-red).

☐ 4F. Install R39, a 4.7K ohm resistor (yellow-violet-red).

☐ 5F. Install C29, a 10 uF electrolytic capacitor (orientation, don’t forget!)

☐ 6F. Install C35, a 10 uF electrolytic capacitor.

☐ 7F. Install C21, a 33 pF ceramic disk capacitor (marked 33).

☐ 8F. Install C27, another 33 pF ceramic capacitor (marked 33).

☐ 9F. Install C38, a 150 pF ceramic capacitor (marked 151).

☐ 10F. Install C37, a 0.0033 uF ceramic capacitor (marked 332).

☐ 11F. Install C33, a 150 pF ceramic capacitor (marked 151).

☐ 12F. Install C32, another 0.0033 uF ceramic capacitor (marked 332).

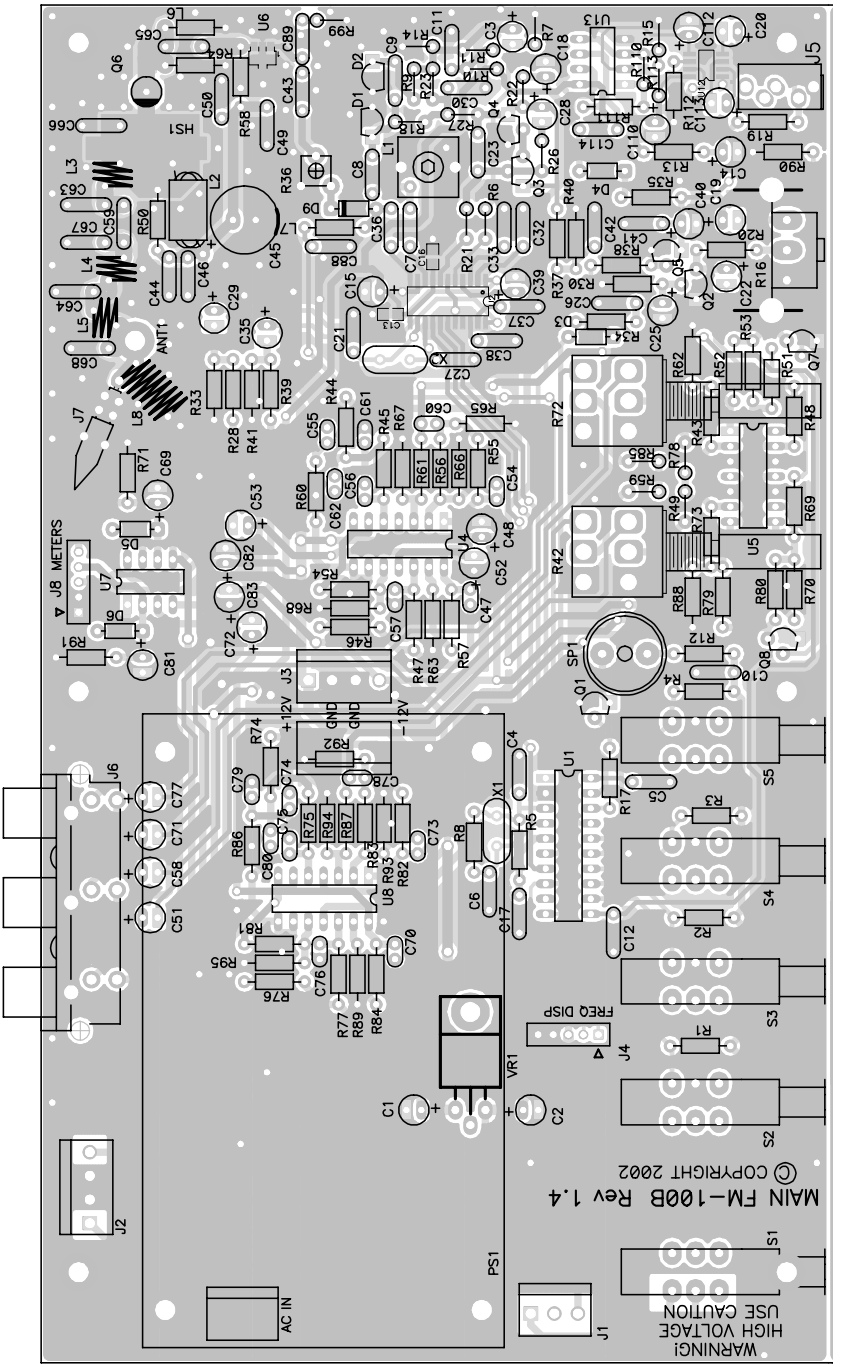
- ☐ 13F. Install R6, a 12K ohm stand-up resistor (brown-red-orange).
- ☐ 14F. Install R21, a 22K ohm stand-up resistor (red-red-orange).
- ☐ 15F. Install C7, a 10 pF ceramic capacitor (marked 10).
- ☐ 16F. Install C36, a 0.001 uF ceramic capacitor (marked 102).
- ☐ 17F. Install X2, the 7.6 MHz crystal. This is the crystal which generates the reference frequency for our transmissions.
- ☐ 18F. Install C15, a 10 uF electrolytic capacitor. Again check orientation!
- ☐ 19F. Install C39, a 10 uF electrolytic capacitor.
- ☐ 20F. Install Q3, a 2N3904 NPN transistor. Pay close attention to where the flat side is pointing upon installation.
- ☐ 21F. Install Q4, another 2N3904 NPN transistor. If you look closely at the schematic for this section you will see these two transistors form what is called a Darlington Pair. This gives us the current gain we need for the phase locked loop to work properly. Note the flat side in the opposite direction from Q3.
- ☐ 22F.Install R37, a 47K ohm resistor (yellow-violet-orange).
- ☐ 23F. Install R40, a 47K ohm resistor (yellow-violet-orange).
- ☐ 24F. Install C42, a 0.1 uF ceramic capacitor (marked 104).
- ☐ 25F. Install R26, a 100 ohm stand-up resistor (brown-black-brown).
- ☐ 26F. Install R22, a 4.7K ohm resistor (yellow-violet-red).
- ☐ 27F. Install R7, a 10K ohm resistor (brown-black-orange).
- ☐ 28F. Install C23, a 0.047 uF ceramic capacitor (marked 473 or .047).
- ☐ 29F. Install R27, a 10K ohm stand-up resistor (brown-black-orange).
- ☐ 30F. Install R18, a 100K ohm stand-up resistor (brown-black-yellow).
- ☐ 31F. Install C28, a 47 uF electrolytic capacitor. Again note orientation.
- ☐ 32F. Install C18, a 10 uF electrolytic capacitor. Orientation.
- ☐ 33F. Install C8, a 0.001 uF ceramic capacitor (marked 102).
- ☐ 34F. Install D1, one of the MV2105 varactor diodes. These look a lot like transistors because they are in TO-92 type cases, but they only have two leads. This makes it easy to orient them properly to the flat side as shown in the board layout. D1 is the primary tuning diode.

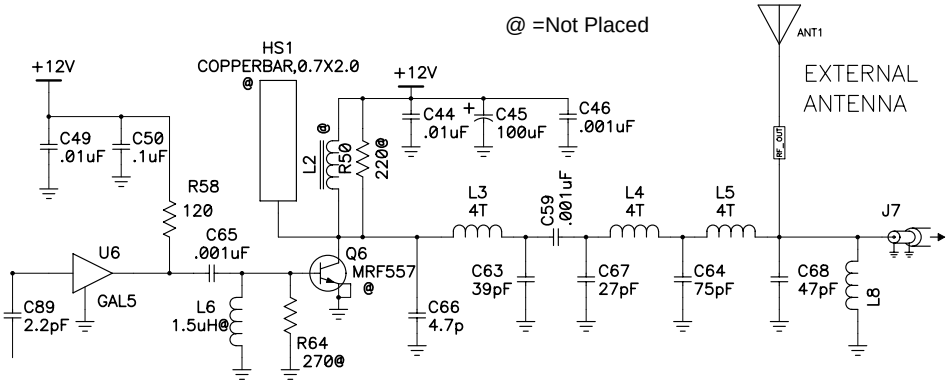
- ☐ 35F. Install D2, the other MV2105 varactor diode. Again note orientation. This diode provides our modulation.
- ☐ 36F. Install C9, a 10 pF ceramic capacitor (marked 10).
- ☐ 37F. Install R9, a 10K ohm stand-up resistor (brown-black-orange).
- ☐ 38F. Install R23, a 470K ohm stand-up resistor (yellow-violet-yellow).
- ☐ 39F. Install C30, a 0.001 uF ceramic capacitor (marked 102).
- ☐ 40F. Install R14, a 47K ohm stand-up resistor (yellow-violet-orange).
- ☐ 41F. Install C11, a 0.1 uF ceramic capacitor (marked 104).
- ☐ 42F. Install R10, a 100K ohm resistor (brown-black-yellow).
- ☐ 43F. Install R11, a 220K ohm stand-up resistor (red-red-yellow).
- ☐ 44F. Install C3, a 10 uF electrolytic capacitor. The '+' sign indicates the positive lead and the negative lead is marked by a stripe or a band on the part itself. The positive lead (it is also the longer of the two) should be placed in the hole marked with the '+' sign. Proper orientation of this part will ensure proper operation of your VCO and therefore your whole kit.
- ☐ 45F. Install R36, a 1K ohm trimmer potentiometer. The top is orange and marked 102. This pot is used to adjust your RF level to minimum requirements to prevent interference.
- ☐ 46F. Install C43, a 0.001 uF ceramic capacitor (marked 102).
- ☐ 47F. Install L1, the large metal can inductor with the tunable slug. Make sure the pins are through the holes before soldering into place.

Whew! That was a lot of steps. Definitely check all of your work up to this point for orientation mistakes. Double check all of your electrolytic capacitors to be sure the positive symbols are on the opposite side of the negative stripe. Also make sure there are no solder bridges or cold solder joints. Lastly check your surface mount components with an eye loupe or magnifier to see if there are any solder blobs where there shouldn't be.

If there are no problems up to this point it is time to move on! Now we are on to easier stuff with less steps. Be careful with your assembly, you wouldn't want to get this far and then make a mistake causing the project not to work. With soldering iron in hand, on to the next section!

MAIN BOARD PARTS LAYOUT





G. TRANSMITTER AMPLIFIER

This section covers the transmitter section of the standard FM100B. If you purchased the High Power version, you will be installing the added components right after these steps before you move on to the Microcontroller section. U6 has already been installed for you.

☐ 1G. Install C88, 0.01 uF capacitor (marked .01, 103 or 10nF).

☐ 2G. Install D9, IN4148 glass diode. Be sure to match the band on the diode with the polarity band on the PC board.

☐ 3G. Install L7, 2.2 uH inductor (looks like a fat resistor with red-red-gold-silver bands).

☐ 4G. Install R99, 100 ohm resistor (brown-black-brown).

☐ 5G. Install C89, 2.2 pF (marked 2.2).

☐ 6G. Install C49, a 0.01 uF ceramic capacitor (marked 103).

☐ 7G. Install R58, a 120 ohm large 1 Watt resistor (brown-red-brown). This resistor will run a bit hot but don't worry; this is normal and well within the ratings of the component. Place the component in the holes in a stand-up fashion to increase the part's heat dissipation abilities. The body of the part should be closest to U6 and off the circuit board by about 1/16" to avoid physical contact with the amplifier.

☐ 8G. Install C50, a 0.1 uF ceramic capacitor (marked 104).

☐ 9G. Install C65, a 0.001 uF ceramic capacitor (marked 102).

☐ 10G. Install C66, a 4.7 pF or 5 pF ceramic capacitor (marked 4.7 or 5).

☐ 11G. Install L3, one of the pre-wound 4 turn inductors.

☐ 12G. Install C63, a 39 pF ceramic capacitor (marked 39).

☐ 13G. Install C59, a 0.001 uF ceramic capacitor (marked 102).

☐ 14G. Install C67, a 27 pF ceramic capacitor (marked 27).

☐ 15G. Install L4, a 4 turn pre-wound inductor.

☐ 16G. Install C64, a 75 pF ceramic capacitor (marked 75).

☐ 17G. Install L5, the last of the 4 turn pre-wound inductors.

☐ 18G. Install C68, a 47 pF ceramic capacitor (marked 47).

☐ 19G. Install C44, a 0.01 uF ceramic capacitor (marked 103).

☐ 20G. Install C46, a 0.001 uF ceramic capacitor (marked 102).

☐ 21G. Install C45, a 100 uF electrolytic capacitor. Pay very close attention to the orientation of this large capacitor, it must be installed correctly!

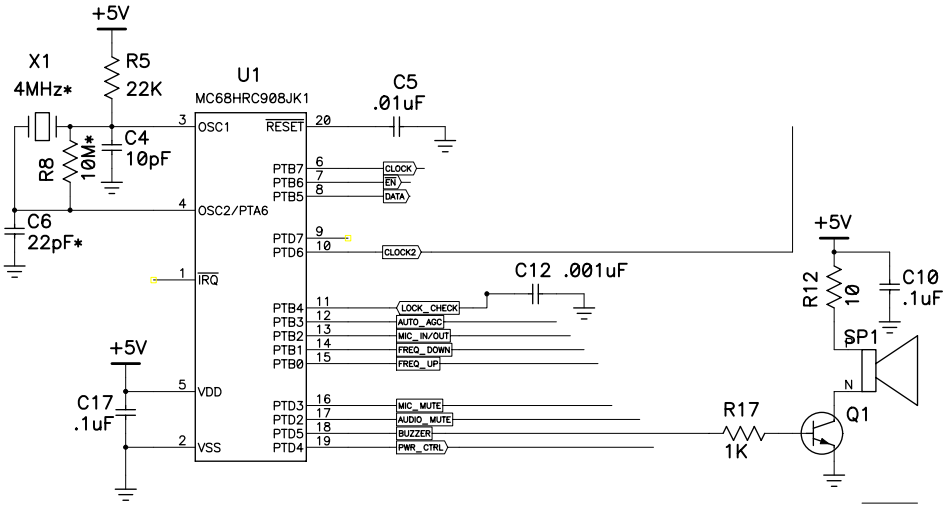
☐ 22G. Install L8, 13 turn air core inductor.

☐ 23G. Install the whip antenna with the provided screw (Std. version only).

☐ 24G. Solder the whip antenna screw in place on the bottom side of the board. This may take a bit of time due to the heat that must be transferred from your soldering iron to the large metal area you are working on. This will allow you to remove the antenna at a later time while keeping the mounting screw captured (Std. version only).

☐ 25G. Remove the whip antenna until the later casing instructions (be careful, it's hot!).

Jump to the High Power Manual (FM100BEX) if you have purchased that version. Install the High power parts before moving on to Section H.



H. MICROCONTROLLER

Although the microcontroller interconnects and controls the entire circuit. This section deals with the parts which are fairly exclusive to the controller itself. We'll wait until later to install the switches because they get in the way while we're installing the rest of the parts. Note that components C6, R8, and X1 are not installed (these holes are provided for future use only if needed should a different microcontroller be used). The current version of U1 does not require or operate with these three parts installed so leave these positions open.

☐ 1H. Install C17, a 0.1 uF ceramic capacitor (marked 104).

☐ 2H Install R5, a 22K ohm resistor (red-red-orange).

☐ 3H. Install C4, a 10 pF ceramic capacitor (marked 10).

☐ 4H. Install C12, a 0.001 uF ceramic capacitor (marked 102).

☐ 5H. Install C5, a 0.01 uF ceramic capacitor (marked 103).

☐ 6H. Install R17, a 1K ohm stand-up resistor (brown-black-red).

☐ 7H. Install Q1, a 2N3904 NPN transistor. Note the flat side for installation.

☐ 8H. Install R4, a 10K ohm resistor (brown-black-orange).

☐ 9H. Install C10, a 0.1 uF ceramic capacitor (marked 104).

☐ 10H. Install R12, a 10 ohm resistor (brown-black-black).

☐ 11H. Install SP1, the mini speaker. Make sure the + terminal (labeled on

the bottom side of the speaker) is facing towards C10 and away from Q1. This is where confirming tones are sounded when a button is depressed.

- ☐ 12H. Install R1, a 10K ohm resistor (brown-black-orange).
- ☐ 13H. Install R2, a 10K ohm resistor (brown-black-orange).
- ☐ 14H. Install R3, a 10K ohm resistor (brown-black-orange).
- ☐ 15H. Install J4, a 5-pin connector. Solder the short end to the board. This is where the display power and signals are sent for the front panel.
- ☐ 16H. Install the 20 pin IC socket for U1. If the socket has a notch in one end, install it in the same position as shown on the Parts Layout Diagram to prevent confusion later.
- ☐ 17H. Install U1, the IC with the sticker labeled FM100B into the socket. Find the dot or notch on one end of the chip and orient it as shown in the Parts Layout Diagram. If your chip has a large “1” on one end (signifying pin 1), this end is oriented as though it were a notch. It should be placed at the end of the socket closest to R17. This is the “brains” of your unit that keeps track of all the button presses, the frequency lock, and the rest of the circuitry. Be sure all 20 pins are firmly in the socket and none are bent under.

Take another break and check all of your work for soldering and part installations for possible problems before we move on to the Jacks and Switches.

I. JACKS AND SWITCHES:
Our project will now begin to look complete as we install the jacks and switches. There are only a few more sections to go so don't lose your momentum. In a few more minutes you'll be on the air!

Before we install them, you'll need to modify all but one of the push button switches so that they are momentary contacts instead of latching. To do this there is a little metal latching mechanism on the front topside of the switch. The end of the metal latch furthest from the button end is gently lifted up and out to the side while the other end remains in place to keep the spring there.

☐ 1I. Modify switches S2, 3, 4, 5 as previously instructed. Leave one of the five provided switches in its default latching state.

☐ 2I. Install S1, the only unmodified switch from the prior step. Make sure when mounting all of your switches that they are pressed firmly to the board so that they will align properly in the case holes when completed.

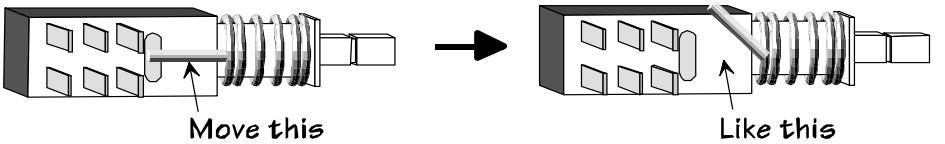
☐ 3I. Install S2, the FREQUENCY UP switch.

☐ 4I. Install S3, the FREQUENCY DOWN switch.

☐ 5I. Install S4, the MIC IN switch.

☐ 6I. Install S5, the AUTO AGC switch.

☐ 7I. Install R42, one of the dual 10K ohm potentiometers. Install this part so that its shaft is perfectly parallel to the PC board before soldering. It is easy enough to reheat the pads and adjust the pots so they align properly to the holes if you make a mistake.



☐ 8I. Install R72, the other dual 10K ohm potentiometer. Make sure the post is parallel with the PC board before soldering.

☐ 9I. Install R16, the 10K ohm single potentiometer (marked 10K or 103). Solder all three pins as well as the two mounting lugs for a solid connection.

☐ 10I. Install J5, the 3.5 mm microphone jack. Solder all 5 pins.

☐ 11I. Install J1, the three pin Molex connector. Make sure and mount the short ends in the PC board and orient the jack so that the locking header mounts toward the center of the board.

☐ 12I. Install J3, the four pin Molex connector. This is where the +-12VDC is plugged in from our power supply.

☐ 13I. Install J2, the other 4-pin MOLEX connector. This is where the 85-264VAC is plugged in from the line cord.

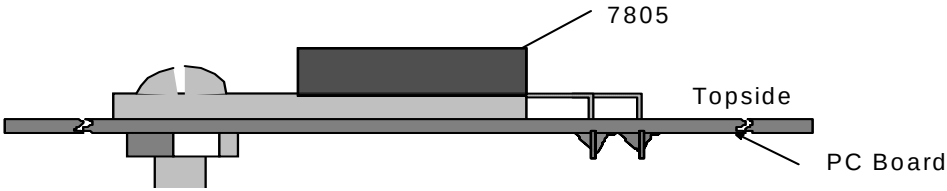
☐ 14I. Install J6, the stereo RCA jack module. Make sure and mount this so the back is square in relation to the PC board and that the jack is mounted flush to the PC board.

That takes care of all of the jacks and switches. Now we want to give the unit a thorough check over with the most picky eye that you possess (right or left eye, it's up to you). We have installed quite a few parts up to this point and chances are you may have made a mistake somewhere along the line. Even the best kit assemblers are known to make mistakes when putting their kits together. Avoid simple mistakes like a solder bridge or a part installed backwards (whoops!) by just simply looking over the boards for obvious errors. We just want to make sure you don't need to send back the unit for something that could be easily found and repaired on your own. To assist you in checking your project out, have an associate check your work for you. You may be surprised what they can point out for you!

J. POWER SUPPLY

In order to simplify operation for users around the world, the power supply module used in the FM100B operates over a wide range of voltages. If you already own or have built the older FM100 series you will remember that the power supply section was quite loaded with parts. Now we provide the whole power supply already built and ready to go. Where is the fun in that? Well this power supply can do a lot more than our old one could. It can be run from a variety of line voltages (85-254 VAC) so it will easily work in Europe as well as the US without changing any jumpers! The only portion we need to build is the 5V regulator section which is composed of three parts!

- ☐ 1J. Install C1, a 10 uF electrolytic capacitor. Note orientation of where the plus symbol and the negative stripe of the capacitor are located.
- ☐ 2J. Install C2, the last of the 10 uF electrolytic capacitors. Orientation again.
- ☐ 3J. Install VR1, the 5V voltage regulator (marked 7805). Use one of the #4-40 1/4" screws and a lock nut to hold down the regulator flush to the board as shown.



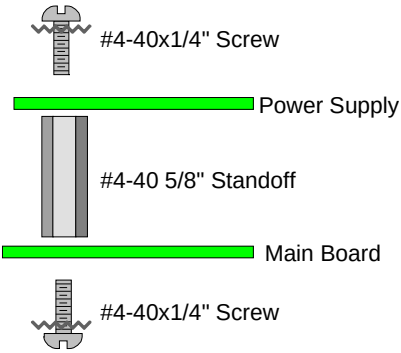
Take a moment to check the components you just installed (especially their orientation). The next step is to mount the power supply to the main board before the final wiring of the unit takes place. **Please note that the switching power supply contains high voltages!** The large capacitor on the board is charged with rectified line voltage so at any time it may have a charge of over 200V DC on it (with plenty of current capability)! Once the unit is energized, don't go anywhere near this supply. The traces on the back of the power supply module are also potentially lethal! Make sure any of the parts located on the main board of the FM100B (especially under the power supply module) are soldered close to the board. The destruction will be catastrophic should you energize your FM100B with any of the electrolytic capacitors (C1, 51, 58, 71, or 77 in particular) or any other component touching the bottom of the power supply module! **Verify that you have a minimum of 1/8" spacing between the bottom of the power supply module and the top any standing components on the FM100B main board after you mount the assembly.**

☐ 4J. Locate the 4 #4-40x5/8” standoffs and 8 of the #4-40x1/4” screws (with captured star washers).

☐ 5J. Install the 4 standoffs in the holes as shown below on the main board.

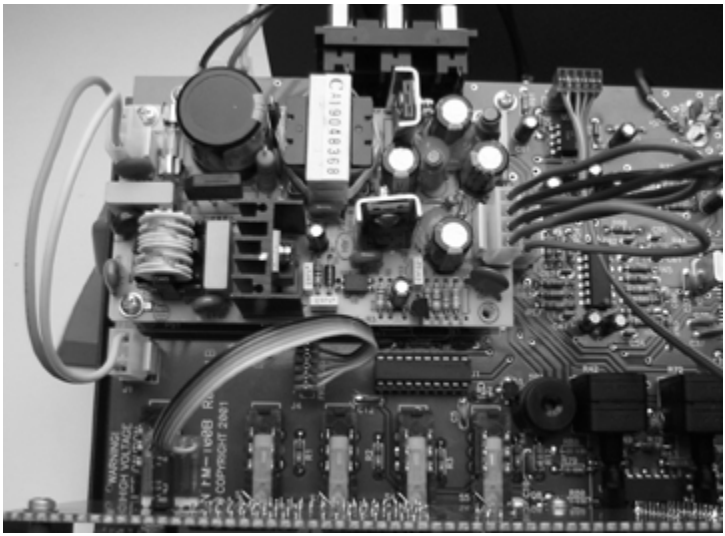
☐ 6J. Once installed, place the power supply on the standoffs and use the remaining 4 screws to mount the power supply module. Note the orientation of the jacks on the power supply. It should be the same as shown below in reference to the main board.

☐ 7J. Use the pre-made 4-pin to 4-pin Molex wire jumper to connect between the power output on PS1 to the connector on the main board (J3). Do not twist the cable, the wires should be a one to one match. The locking headers should snap them into place.

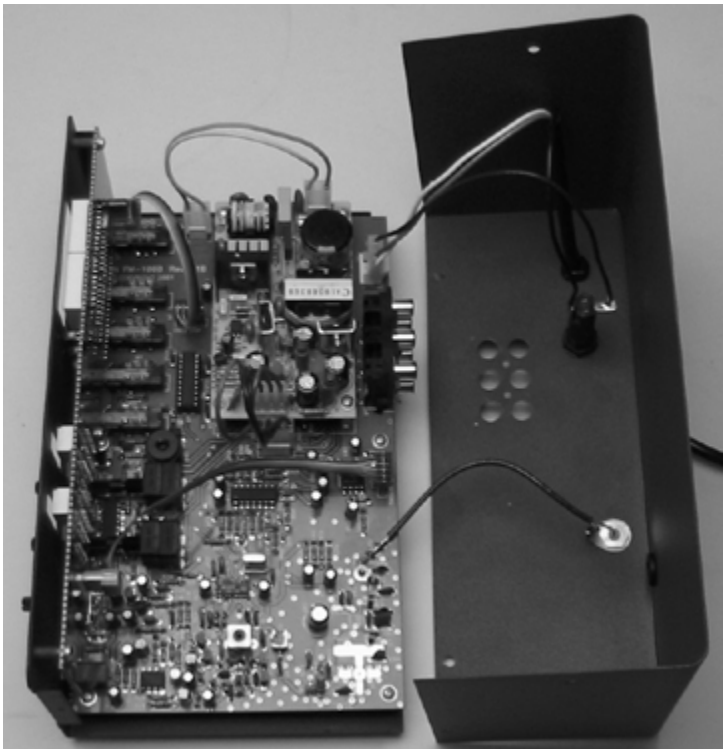


☐ 8J. Use the pre-made 3-pin to 3-pin Molex wire jumper (note that only two wires are used) to go between J1 and the AC IN jack of the power supply. Orientation is not as critical here but use the locking headers as a guide.

PS1 POWER SUPPLY WIRING CLOSE-UP



REAR PANEL WIRING PICTURES



AC Input and RF Output

Fuse Wiring Close-up

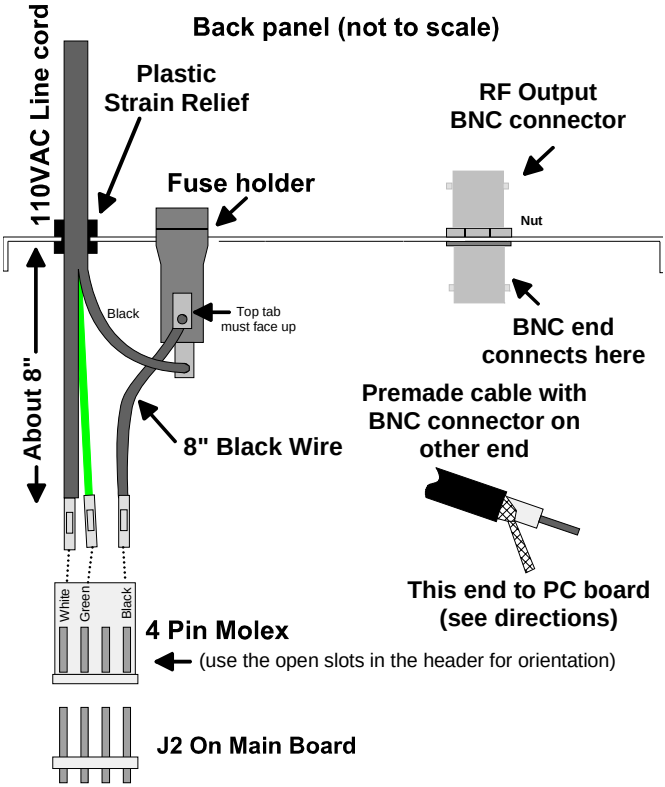
K. REAR PANEL WIRING

☐ 1K. Find the parts for the AC line entry shown in the diagram below.

☐ 2K. Thread about 8" of the line cord through the 'AC Input' hole on the back of the case so there is a little extra length to play with inside the case.

☐ 3K. Insert the plastic strain relief on the line cord that goes through the 'AC Input' hole. Use a pair of pliers or vise grips to squeeze the strain relief and position it. Make sure the plug end is on the silk screen side of the panel, and the Molex end of the line cord is on the non-silk screen side (inside the case).

☐ 4K. Your 110VAC line cord has three wires; black, white, and green. The black wire does not have a factory installed Molex pin on it; this is the HOT side of the power connection. Strip and tin the end of the black wire.



☐ 5K. Locate the female Molex connector and insert the white line cord wire (as shown above) into the header jack. Notice there is a small catch tab on one side of the pin. Insert the pin into the Molex jack so the tab faces the side with the slotted holes (you'll hear a small "click" if properly installed).

☐ 6K. Install the center green wire and pin into either of the center holes of the Molex jack. Make sure it clicks into place. Both the center holes are connected together on the PC board.

☐ 7K. Install the 8” black piece of line cord wire with the pre-attached Molex pin into the other side of the Molex jack. See the diagram for clarification.

☐ 8K. Install the fuse holder in the back of the case so that the cap is on the silkscreened side of the panel (the vertical solder tab should face upward). Mount the plastic nut from the rear side of the fuse holder to secure it in place (make sure the plastic nut is tightened well on the inside so it doesn’t become loose later).

☐ 9K. Bend the pre-tinned end of the 8” piece of black wire into a quarter loop so that it holds onto the vertical solder tab of the fuse holder. Solder the wire to the vertical tab.

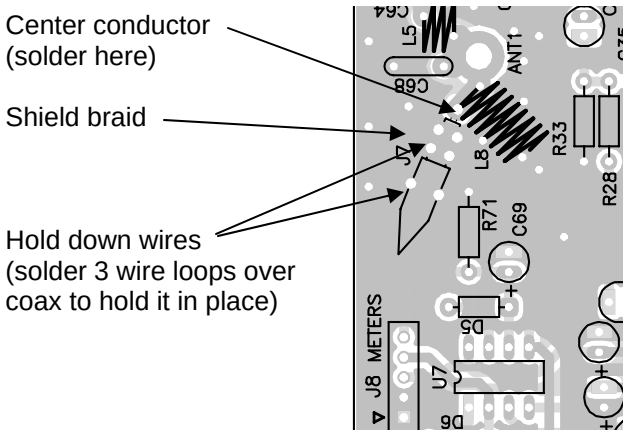
☐ 10K. Bend the end of the black wire tinned in step 4L into a quarter loop so that it holds to the other tab of the fuse holder. Solder this wire in place.

☐ 11K. Wrap the exposed solder tabs of the fuse holder with electrical tape to avoid accidentally touching the ‘Live wires’ while you tune your transmitter.

☐ 12K. Make sure the 1 Amp fuse is installed in the fuse holder.

☐ 13K. Locate the chassis mount BNC connector. Mount it to the rear panel using the included hardware.

☐ 14K. Locate your 7” piece of thin coax. Lay it down on the PC board in the J7 position. The center conductor solders to the point next to L8. It is marked “ANT1” Next use three scrap pieces of lead to mount the stripped end of the cable to the RF Output on the main board indicated by the silkscreen label J7. The leads should loop over the coax to hold it in place. The stripped shield braid should sit on the board in the unmasked portion of the board between the silkscreen writing for J7 and L8. It needs to be grounded to the PC board at this position.



- ☐ 15K. Plug in the “AC Input” Molex plug onto the Molex strip labeled J2. The locking header holds it snugly in place.

- ☐ 16K. Take the other end of the coax that you soldered to the board in step 14K and connect the BNC connector to the BNC barrel you placed on the rear panel in step 13K.

That takes care of that! We’re almost ready to plug it in the wall and give her a run. But first we want to check everything we have done up to this point very closely. Especially the circuitry involved with the line voltage connections. Check and double check your wiring against that shown in the diagram and pictures. Also make sure that the two high voltage connections are to either side of the Molex plug and not in the center. The green wire of the line cord is Earth ground, not a high voltage connector. It can be connected to either of the center pins of J2.

Be very careful around these connections. **When we plug it in they will always be live! Especially be careful of the power switch S1. The top pins on the switch are connected directly to the ones mounted in the PC board so line voltage (117 VAC) will be present on those as well!**

When you have completely finished the unit and it’s up and running, you may want to coat these connections with nonconductive 100% silicone (such as tub sealant). Be careful to not get it inside the switch movement however or you won’t have a good switch any longer!

L. PC BOARD MOUNTING

In order to test the unit it is much easier to have the PC boards mounted in the case assembly. This keeps down the possibility of wires crossing or metal objects shorting out across the back of the PC board (not to mention the live AC circuitry).

MAIN BOARD MOUNTING

- ☐ 1L. Mount the main board to the bottom of the case making sure the holes line up with the standoffs in the bottom. Note that you will be installing 5 board screws; the screw under the power switch is not used.
- ☐ 2L. Using the shorter pre-made 5 wire jumper cable, connect from J4 to J11. Make sure pin 1 of J4 is connected to pin 1 of J11 (J11 pin 1 is closest to DISP1). Verify your orientation of the connectors by looking at the mark you made previously indicating pin one.
- ☐ 3L. Using the other pre-made 5 wire jumper cable, connect from J8 to J10. Again make sure that pin 1 of J8 is connected to pin 1 of J10 (J10 pin 1 is the top pin closest to R96).
- ☐ 4L. Connect the 4 pin Molex connector from the rear panel to J2 on the main board. You can then set the cover in place without having to screw it down until your initial tests are made.

FRONT PANEL MOUNTING

- ☐ 5L. Align the front panel display PC board with the holes in the front panel assembly.
- ☐ 6L. Check the LEDs for proper installation height and positioning. If they are misaligned, now is a good time to correct that.
- ☐ 7L. Using 3 of the #4-40x1/4” screws, mount the board securely to the front panel.
- ☐ 8L. Admire your work up to this point. (WOW!)

Now we are getting somewhere! Is it ever tempting to plug it in. But wait, flip the page first!

M. FINAL TESTING AND CALIBRATION

We're almost ready to plug it in. We will need the following equipment to give it a true test.

- An audio source such as a CD player or tape deck.
- A microphone with the appropriate jack (3.5 mm Mono).
- A receiver (preferably digital tuner).
- The tuning tool sent with your kit.

☐ 1M. Make sure the power switch is off. Plug in your FM100B to line power.

☐ 2M. Turn on the FM100B. All of the used digits of the display should light (like this 1.8.8.8.), the speaker will beep, and then go to some frequency.

☐ 3M. The FREQ LOCK light may or may not light. We will get to that later.

☐ 4M. Press both frequency buttons (FREQ UP and FREQ DN) at the same time and hold them in for three seconds to enter the frequency set mode. The FM100B will confirm your mode selection with 3 short beeps and the far right decimal point will begin to flash. Note that the far left decimal point will also flash if the unit is in stereo mode.

☐ 5M. Press FREQ UP or FREQ DN until the display shows 108.0 MHz (if it does not already).

☐ 6M. Press both frequency buttons again and hold until you hear the triple beep confirmation. This means the settings have been saved in Flash.

☐ 7M. Press both the auto AGC and the Microphone buttons. Your display should now show the voltage of the PLL's voltage controlled oscillator.

☐ 8M. Using the included plastic tuning tool, adjust L1 until the lock LED lights. This should be around 8.9 VDC.

☐ 9M. Press both the Mic and AGC buttons to switch back to the standard frequency display (you can toggle this way to the PLL voltage display mode at any time to see where the unit is set).

☐ 10M. Press and hold both the FREQ UP and FREQ DN buttons again until it gives you the confirmation beep and the far right decimal point flashes.

☐ 11M. While watching the lock LED, run the frequency from 88.0 MHz to 108.0 MHz. The lock LED may occasionally flash off while switching but it should come back on and stay locked for the entire frequency range. If it does not, you may need to gently adjust L1 a bit to bring the entire range in better (the rollover lock time from 88.0 MHz to 108.0 MHz = 20 sec or so).

- ☐ 12M. Now is a good time to choose a frequency. Consult the “Choosing a Frequency” section of the manual for this.
- ☐ 13M. If you press the Auto AGC key while in setup mode you can toggle the stereo mode on and off. When the far left decimal point is blinking, stereo mode is on. When it is off, you are in mono mode. You can set this now and it will be saved with your frequency settings.
- ☐ 14M. After you have set your frequency, press both FREQ keys. You should hear three short beeps to confirm the data has been written.
- ☐ 15M. Turn off the power and wait ten seconds before turning it back on. Verify that the unit comes up to the correct frequency you set it for and that the FREQ LOCK LED lights within 20 seconds or so.
- ☐ 16M. Tune your receiver to the same channel you have chosen. Verify that there is a signal present and that the stereo light on the tuner is on if you selected stereo operation in the prior steps.
- ☐ 17M. Plug your microphone into the microphone jack and crank up the microphone gain.
- ☐ 18M. Press the MIC button and verify that the MIC LED turns on.
- ☐ 19M. Talk into the microphone; you should hear sound from the receiver and the LED meters should indicate sound in both channels.
- ☐ 20M. Connect your audio source to either input RCA Line 1 or Line 2 jacks.
- ☐ 21M. Play some tunes through the unit and make sure the controls on the front are working for each channel respectively.
- ☐ 22M. Press the AUTO AGC button once, the MIC ON LED should blink rapidly. This indicates that the AUTO AGC mute function is enabled.
- ☐ 23M. Talk into the microphone and verify that the music mutes while you talk.
- ☐ 24M. Press the AUTO AGC button again to turn it off. Talk into the microphone and verify your voice is now mixed with un-muted music.
- ☐ 25M. The LED meters should be indicating the music level at this point. Use the front panel controls to set your levels. The 0 dB mark is a good average starting point.
- ☐ 26M. Use the provided tuning tool to adjust your RF output power control (R36) as needed for your intended coverage area; turn clockwise for maximum power. Set this only as high as needed.
- ☐ 27M. Consult the troubleshooting section should you have any problems.

N. FINAL CASE UP

- ☐ 1N. Install the rubber antenna grommet in the top of the case so the antenna does not short-out to the metalwork.
- ☐ 2N. Connect your BNC cable to the rear panel external antenna jack.
- ☐ 3N. Install the top case half using the 6 provided #6-32x1/4" black self tapping screws.
- ☐ 4N. Install one small sheet metal screw into each of the holes for the RCA jacks on the back panel. This prevents physical damage to the RCA jacks.
- ☐ 5N. Use the four sticky pad feet on the bottom of the case in each corner.
- ☐ 6N. Install all five switch buttons on the end of each switch.
- ☐ 7N. Use the set screw knobs on both of the line level controls and the microphone control.

You are finished! Now enjoy your project. Remember, read through and thoroughly understand your FCC rules and regulations before broadcasting.

TROUBLESHOOTING

PROBLEM: Nothing happens at all when I turn it on.
SOLUTION: Check your fuse. If it is blown you will want to check section K for rear panel wiring or section J for the power supply. Use a volt meter to check your power supply voltages. Verify that there is +12, and –12 volts on the output of the power supply and +5V on the output of VR1. Also check U1 pin 3 for a 4 MHz +/- 1 MHz clock signal with an oscilloscope or frequency counter.

PROBLEM: Everything works, but only some or no lights light up on the front.
SOLUTION: Check section A and make sure you put your LED displays in the correct way. Also check your 5 wire jumpers for correct installation.

PROBLEM: I can't get the FREQ LOCK LED to light and I can't pick up the signal on the receiver.
SOLUTION: You will definitely want to check your parts placement in section F for misplaced components. If the PLL voltage display shows 0V or greater than 9.9V then the VCO may not be oscillating. Make sure the crystal is 7.60 MHz. Check around L1, Q3, Q4, U2, D2, and D1.

PROBLEM: One channel is out completely, other one sounds OK.
SOLUTION: More than likely there is a short somewhere in any one of the

audio sections. These are usually a bugger to find without a signal tracer or an oscilloscope. Inject a signal into both sides and trace through the circuit. Compare one channel to the other all the way through the circuit until one side is not present.

PROBLEM: Very distorted sound.
SOLUTION: Turn down your level controls. If that does not help, check your power supply voltages. If a negative or positive supply is not there, the signal will be lousy.

PROBLEM: Still lots of AC hum in the audio.
SOLUTION: Make sure it's not coming from your other components in combination with this unit. Some components don't deal with RF very well. We once had a CD player that wouldn't even play with low power RF nearby. Try using ferrite beads around the audio connectors. You can find the beads in computer accessory magazines and electronic magazines. You may be also overloading your receiver. Try moving the transmitter and receiver further apart or turn R3 CCW to decrease your output power.

PROBLEM: The unit doesn't store last frequency.
SOLUTION: Don't forget to get out of setup mode by pressing both frequency buttons to set the frequency before shutting off the power.

PROBLEM: Unit doesn't transmit very far, less than 100'.
SOLUTION: Try spreading out the windings of L3, L4, and L5 a little. This will lessen their inductance and change the tuning of the lowpass filter. Otherwise check assembly in section G.

PROBLEM: I just can't get the darn thing to work! It's Ramsey's fault.
SOLUTION: Give us a call at (585) 924-4560. While some problems can be answered on the phone, others cannot. Read the warranty information in the manual for information on how to send your unit in. Upon its return it will be fully functional according to our specifications.

The Ramsey Kit Warranty

Please read carefully BEFORE calling or writing in about your kit. Most problems can be solved without contacting the factory.

Notice that this is not a "fine print" warranty. We want you to understand your rights and ours too! All Ramsey kits will work if assembled properly. The very fact that your kit includes this new manual is your assurance that a team of knowledgeable people have field-tested several "copies" of this kit straight from the Ramsey Inventory. If you need help, please read through your manual carefully. All information required to properly build and test your kit is contained within the pages!

1. DEFECTIVE PARTS: It's always easy to blame a part for a problem in your kit, Before you conclude that a part may be bad, thoroughly check your work. Today's semiconductors and passive components have reached incredibly high reliability levels, and it's sad to say that our human construction skills have not! But on rare occasions a sour component can slip through. All our kit parts carry the Ramsey Electronics Warranty that they are free from defects for a full ninety (90) days from the date of purchase. Defective parts will be replaced promptly at our expense. If you suspect any part to be defective, please mail it to our factory for testing and replacement. Please send only the defective part(s), not the entire kit. The part(s) MUST be returned to us in suitable condition for testing. Please be aware that testing can usually determine if the part was truly defective or damaged by assembly or usage. Don't be afraid of telling us that you 'blew-it', we're all human and in most cases, replacement parts are very reasonably priced.

2. MISSING PARTS: Before assuming a part value is incorrect, check the parts listing carefully to see if it is a critical value such as a specific coil or IC, or whether a RANGE of values is suitable (such as "100 to 500 uF"). Often times, common sense will solve a mysterious missing part problem. If you're missing five 10K ohm resistors and received five extra 1K resistors, you can pretty much be assured that the '1K ohm' resistors are actually the 'missing' 10 K parts ("Hum-m-m, I guess the 'red' band really does look orange!") Ramsey Electronics project kits are packed with pride in the USA. If you believe we packed an incorrect part or omitted a part clearly indicated in your assembly manual as supplied with the basic kit by Ramsey, please write or call us with information on the part you need and proof of kit purchase.

3. FACTORY REPAIR OF ASSEMBLED KITS:

To qualify for Ramsey Electronics factory repair, kits MUST:

1. NOT be assembled with acid core solder or flux.
2. NOT be modified in any manner.
3. BE returned in fully-assembled form, not partially assembled.
4. BE accompanied by the proper repair fee. No repair will be undertaken until we have received the MINIMUM repair fee (1 hour labor) of $50.00, or authorization to charge it to your credit card account.
5. INCLUDE a description of the problem and legible return address. DO NOT send a separate letter; include all correspondence with the unit. Please do not include your own hardware such as non-Ramsey cabinets, knobs, cables, external battery packs and the like. Ramsey Electronics, Inc., reserves the right to refuse repair on ANY item in which we find excessive problems or damage due to construction methods. To assist customers in such situations, Ramsey Electronics, Inc., reserves the right to solve their needs on a case-by-case basis.

The repair is $50.00 per hour, regardless of the cost of the kit. Please understand that our technicians are not volunteers and that set-up, testing, diagnosis, repair and repacking and paperwork can take nearly an hour of paid employee time on even a simple kit. Of course, if we find that a part was defective in manufacture, there will be no charge to repair your kit (But please realize that our technicians know the difference between a defective part and parts burned out or damaged through improper use or assembly).

4. REFUNDS: You are given ten (10) days to examine our products. If you are not satisfied, you may return your unassembled kit with all the parts and instructions and proof of purchase to the factory for a full refund. The return package should be packed securely. Insurance is recommended. Please do not cause needless delays, read all information carefully.

PROFESSIONAL FM STEREO TRANSMITTER KIT
Quick Reference Guide

REQUIRED TOOLS

- Soldering Iron Ramsey WLC100,
- Thin Rosin Core Solder Ramsey RTS12
- Needle Nose Pliers Ramsey RTS05
- Small Diagonal Cutters Ramsey RTS04

<OR> Complete Soldering Tool Set RS64-2801

ADDITIONAL SUGGESTED ITEMS

- Optivisor Magnifier Headband Ramsey OPMAG
- Helping Hands Holder for PC Board/Parts Ramsey HH3
- Desoldering Braid Ramsey RTS08

Price: $10.00
Ramsey Publication No. MFM100B
Assembly and Instruction manual for:
RAMSEY MODEL NO. FM100B

TOTAL SOLDER POINTS
822

ESTIMATED ASSEMBLY TIME
Beginner ..... 24 hrs
Intermediate ..... 18 hrs
Advanced ..... 10 hrs

RAMSEY ELECTRONICS, INC.
590 Fishers Station Drive
Victor, New York 14564
Phone (585) 924-4560
Fax (585) 924-4555
www.ramseykits.com