

FM STEREO TRANSMITTER

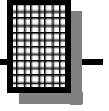


Ramsey Electronics Model No.

FM10A

Own and operate your own FM Stereo broadcast station. Definitely not a toy, the FM-10A has an exceptional transmission range... and the audio quality puts your favorite radio station to shame. See why this is one of our most popular kits!

- **Great for transmitting your tape deck or CD player throughout the house, yard or even your car.**
- **Powerful enough for college or neighborhood radio stations - in use all over the world.**
- **Fantastic audio quality sounds better than most stations on the dial. And we'll tell you why!**
- **Easily connects to the line-level outputs on any tape deck, stereo system or CD player.**
- **Some users hook up one channel to the scanner and the other to their two way radio. Now you can hear what's going on around town up to several blocks away from your house with a simple stereo receiver... and adjust the volume of each individually with your balance control!**
- **Add a mike-mixer and tape or CD deck for a "PRO" sounding radio station.**
- **Operates on 1.5 to 15 volts, using a crystal controlled subcarrier.**
- **Tunable anywhere in the 88-108 MHz FM band.**
- **Clear, concise instructions guide you step by step.**



PARTIAL LIST OF AVAILABLE KITS

RAMSEY TRANSMITTER KITS

- FM25B FM Stereo Transmitter
- AM1, AM25 AM Transmitters
- TV6 Television Transmitter
- FM100B Professional FM Stereo Transmitter

RAMSEY RECEIVER KITS

- FR1 FM Broadcast Receiver
- AR1 Aircraft Band Receiver
- SR2 Shortwave Receiver
- AA7 Active Antenna
- SC1 Shortwave Converter

RAMSEY HOBBY KITS

- SG7 Personal Speed Radar
- SS70A Speech Scrambler
- MX5, MX-10 Mixers
- MD3 Microwave Motion Detector
- PH14, 15, 16 Peak hold Meter Kits
- TFM3 Tri-Field Meter Kit
- STC1 Stereo Transmitter Companion

RAMSEY AMATEUR RADIO KITS

- DDF1 Doppler Direction Finder
- HR Series HF All Mode Receivers
- QRP Series HF CW Transmitters
- 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.

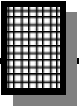
FM STEREO TRANSMITTER KIT INSTRUCTION MANUAL

Ramsey Electronics publication No. MFM10A Revision G

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KIT ASSEMBLY AND INSTRUCTION MANUAL FOR

FM10A FM STEREO TRANSMITTER

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INTRODUCTION

The Ramsey FM10A is a true STEREO FM broadcast transmitter, which any person may build and use in accordance with the rules of your nation's telecommunications authority. For U.S. residents, that authority is the Federal Communications Commission (FCC). The FM10A's low-power broadcasting capability and other practical uses can be fun and interesting for people of all ages, but the FM10A is definitely not a toy. We will refer to the FCC regulations frequently in this manual and provide you with some information necessary to enjoy the FM10A's capabilities in accordance with the law.

Typical uses for the FM10A include the following:

- Extension of home stereo system - without wires.
- Listening aid for auditoriums, churches.
- Student-operated school radio station.
- College dorm favorite music broadcast service.
- Short-range, two-channel experiments and demonstrations.

We think you will be very pleased with the transmitting range, audio quality, frequency stability and stereo channel separation of this build-it-yourself FM stereo transmitter. If you follow our assembly directions carefully and use your FM10A in accordance with applicable FCC rules, a whole new world of sharing music, news and views with friends and neighbors awaits you.

Since the sharing of music and information is vital to the culture of our late-20th-century global community, we realized that our FM10A low-power FM Stereo Transmitter kit was certain to attract worldwide interest among hobbyists, students and "pioneers." While the use of the FM10A may need to be limited to "wireless stereo extensions" in some USA households (to comply with FCC Rules, Part 15), we have seen it serve very well as a serious, though simple, broadcast station for remote villages throughout the world where low cost AM-FM receivers are available to people of all economic levels. After you're done building your kit, sitting back and listening to your handiwork, consider this: many other FM10A's just like yours are faithfully relaying news and information to listeners in remote parts around the world. The FM10A is most definitely not a toy!

CIRCUIT DESCRIPTION

A quick glance at the Schematic Diagram shows that the custom FM stereo transmitter IC (U1) is at the heart of the FM10A. The control of U1 is determined by its surrounding circuitry. Potentiometers R1 and R4 allow for adjustment of input level. Resistors R3 and R6 set the pre-emphasis characteristics (75uS for USA and 50uS for Europe). R7 permits adjustment of stereo balance. L1 and C16 form an adjustable resonant circuit to set the carrier operating frequency. Diodes D1,2 and 3 regulate the voltage to U1 at 2.1 volts DC, though Q1 may be operated safely up to 12-15 VDC. The RF output of Q1 feeds both the on-board whip antenna and J3 for an external antenna.

SCHEMATIC DIAGRAM

PARTS LIST

CAPACITORS

- 4 10 pf disc capacitor (marked 10 or 10K) (C7,8,14,15)
- 1 18 pf disc capacitor (marked 18) (C16, see note below)
- 1 22 pf disc capacitor (marked 22) (C16, see note below)
- 1 27 pf disc capacitor (marked 27) (C16, see note below)

NOTE: Selecting 18, 22 or 27 pf for C16, establishes the FM-band frequency adjustment range. See "Choosing an Operating Frequency."

- 1 220 pf disc capacitor (marked 220 or 221) (C9)
- 8 .001 μ F disc capacitor (marked .001 or 102 or 1 nf)
(C6,10,12,13,17,18,20,21)
- 2 .0047 μ F disc capacitors (marked 472) (C1,4)
- 4 4.7 to 10 μ F electrolytic capacitors (C2,3,5,11)
- 1 470 μ F electrolytic capacitor (C19)
- 1 1000 μ F electrolytic capacitor (C22)

RESISTORS

- 2 270 ohm [red-violet-brown] (R9,R13)
- 1 470 ohm [yellow-violet-brown] (R8)
- 1 4.7K ohm [yellow-violet-red] (R11)
- 3 10K ohm [brown-black-orange] (R3,R6,R10)
- 2 15K ohm [brown-green-orange] (R3,R6)
- 1 150K ohm [brown-green-yellow] (R12)
- 1 100K yellow trimmer potentiometer (marked 104) (R7)
- 2 1K yellow trimmer potentiometer (marked 102) (R1,R4)

SEMICONDUCTORS

- 3 Glass bead diodes (similar to 1N4148) (D1,2,3)
- 1 2SC2498 or 2SC2570A NPN VHF transistor (Q1)
- 1 18-pin DIP Custom FM Transmitter integrated circuit (U1) with matching socket

HARDWARE AND MISCELLANEOUS

- 1 38 KHz crystal (small silver cylindrical "can" with 2 small leads), taped to a piece of paper.
- 1 Shielded inductor coil (L1) (small square silver "can")
- 1 Ramsey FM10A Printed circuit board
- 1 Plastic alignment screwdriver
- 1 PC board mounted push-button switch
- 3 RCA-type PC-mount jacks (J1,2,3)
- 1 2.5 mm phone jack (J4)
- 1 9-volt battery hold-down clamp
- 1 9-volt battery snap connector

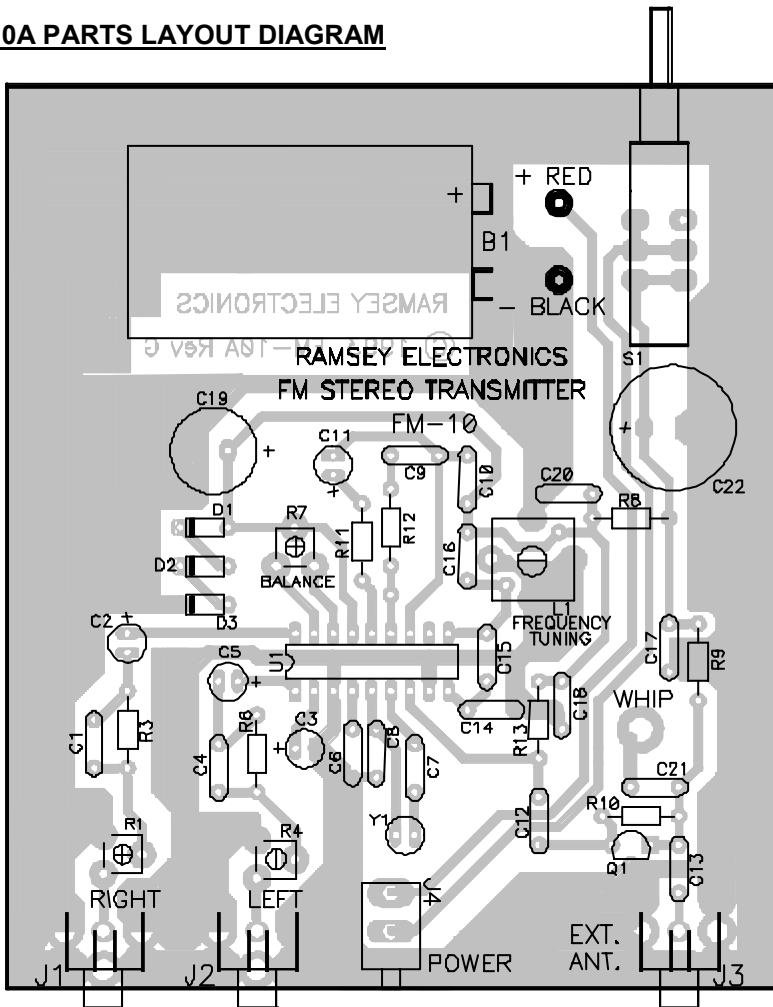
REQUIRED, NOT SUPPLIED:

- 9-volt alkaline or heavy-duty battery
- Shielded stereo audio cables
- Line-level output audio source (such as a tape deck or CD player)
- External antenna, small gauge coax and RCA plug, OR PC board mounted telescoping whip antenna (included with the Ramsey CFM case and knob set.

OPTIONAL

- Ramsey FM10A case and knob set (CFM), or your own enclosure
- LED "power on" indicator and 1K resistor
- Audio switching-mixing accessories of your choice

FM10A PARTS LAYOUT DIAGRAM



ASSEMBLY INSTRUCTIONS

Building your FM10A Stereo Transmitter

The following FM10A step-by-step assembly and adjustment directions are written with newcomers in mind. While many Ramsey kits are purchased by experienced hobbyists and ham radio operators, our instructions presume that this stereo transmitter could be your first ever kit project.

Ramsey Electronics Kit instruction manuals are designed around our "Learn as You Build" philosophy. To the extent that it is reasonably possible, we like to help you see why a given part goes into its PC board holes, as well as showing you how to do it. Our "Learn as You Build" assembly strategy works very well with our simpler kits, such as receivers and ham transmitters, where we can guide you through the schematic diagram from the antenna to the speaker. When a multi-function IC "chip" is the heart and soul of one of our kits, as is the case in this FM10A stereo transmitter, we try to make a reasonable compromise between following the signal path and just getting all parts in properly so you can enjoy your kit as soon as possible!

So, you can expect the following directions to be a nice blend of "Learn as You Build" and "Let's get these parts in right and as quickly as possible!"

First assembly steps

Use the boxes to check off your progress.

- Check all received parts against the Parts list on page 6. The parts list describes the various markings that may be found on the kit parts.

Since you may appreciate some "warm-up" soldering practice as well as a chance to put some "landmarks" on the FM10A PC board, we'll first install some "hardware" components, to make the up-down, left-right orientation of the PC board as clear as possible.

In ALL the following instruction steps, our word "INSTALL" means this:

- Insert the part, oriented correctly, into its correct holes in the PC board.
- If helpful, gently BEND the part's wire leads or tabs to hold it in place, with **the body of the part snugly against the top "component side" of the PC board.**

- SOLDER ALL wires or pins of the part, whether the two wires of a resistor or the 18 pins of an IC socket.
- Nip or "trim" all excess wires extending beyond each solder connection, taking care that wire trimmings do not become lodged in PC board solder connections.

Enough said. . . Let's get building!

- 1. Install S1, the DPDT push-button switch. It fits correctly only one way. Ensure that the white plastic switch extends out over the edge of the printed circuit board. Solder all six pins.
- 2. Install J1, the Right Channel input jack. Solder all 4 points of the jack securely.
- 3. Install J2, the Left Channel input jack. Solder all 4 points of the jack securely.
- 4. Install J3, the RF output (antenna) jack. Solder all 4 points of the jack securely.
- 5. Install J4, the 2.5 mm phone jack (external DC input). Solder all 3 pins.
- 6. Install the 18-pin DIP socket supplied with your kit. There is no right or wrong direction to this socket, but the U1 IC itself certainly needs to be inserted correctly (later). Taking care of this socket early in the project will help you with positioning additional parts and will fine-tune your soldering technique. Before soldering, make sure the socket body is flush against the PC board, and that all 18 pins have been inserted. Solder all 18 pins and then CAREFULLY check to ensure you have not caused any "solder bridges" between pins.
- 7. Now that the IC socket has your prime attention, carefully insert the FM transmitter IC (U1) into the socket, taking gentle care that ALL 18 pins get into their proper holes. The orientation of the notched end, as shown on the Parts Layout Diagram is **critically** important.

Progress Note: The preceding steps have secured a sufficient number of components to your PC board to make general orientation around the board much clearer for installing additional parts. Further parts will be installed in three phases or groupings.

Wiring the audio input circuits

We encourage you to peek at the schematic diagram and learn the functions of the following parts. However, the sequence of installation is in the order of convenience and speed. If you wish, insert the parts groupings as one operation, then solder and nip all connections.

- 8. Install R1, one of the small yellow trimmer potentiometers marked "102". Don't confuse it with R7 which is marked "104".
- 9. Install R4, the other yellow trimmer marked "102". These two trimmers will allow you to adjust the input level.
- 10. Install C1, .0047 μF (marked .0047 or 472). If you are building your kit for use in North America or Japan, resistors in steps 11 and 12 are installed as printed. For use in Europe, Russia and some other countries, use 10K ohm resistors in steps 11 and 12. These resistors set the pre-emphasis characteristics for the FM10A. Pre-emphasis is a technique used in FM transmitters to increase the high frequency signal to noise ratio. If you desire a "brighter" sound you may use the 10K ohm resistors rather than the 15K ohm parts.
- 11. Install R3, 15K [brown-green-orange].
- 12. Install R6, 15K [brown-green-orange].
- 13. Install C4, .0047 μF (marked .0047 or 472).

Electrolytic capacitors have a right and wrong way to be installed. Usually, capacitors have a black strip which indicates their (-), negative lead and the PC board or Parts Layout Diagram will show the (+), positive side of the capacitor's installation hole. Be sure to place the (+) capacitor lead into the PC board (+) hole and the (-) lead into the (-) hole. Observe correct polarity when installing the following three electrolytic capacitors:

- 14. Install C2, 4.7 or 10 μF . Don't forget... the proper orientation is noted on the PC board or Parts Layout Diagram.
- 15. Install C5, 4.7 or 10 μF . Observe correct polarity.
- 16. Install C3, 4.7 or 10 μF . Remember correct polarity.

Diodes also have a right and wrong way to be installed. The cathode (banded) ends face toward the outside of the PC board, away from the IC circuitry. Observe correct polarity when installing the following three diodes.

- 17. Install glass bead diode D1.
- 18. Install glass bead diode D2.
- 19. Install glass bead diode D3.
- 20. Install R7, the small yellow trimmer potentiometer marked "104".
- 21. Install C19, the 470 μF electrolytic. Be sure to position for correct polarity.
- 22. Install C11, 4.7 to 10 μF electrolytic. Observe polarity.
- 23. Install R11, 4.7K [yellow-violet-red].
- 24. Install R12, 150K [brown-green-yellow].
- 25. Install C9, 220 pf [marked 220 or 221].
- 26. Install C10, .001 μF [marked .001 or 102 or 1nf].
- 27. Install C22, the large 1000 μF electrolytic capacitor. Observe polarity.
- 28. Install R8, 470 ohms [yellow-violet-brown].
- 29. Install C20, .001 μF (marked .001 or 102 or 1 nf).

RF amplifier and final components

- 30. Install shielded slug tuned coil L1. The larger tabs secure the shield can to the ground foil connections, while the two thin leads are the coil connections. If you find that the coil lead wires do not line up with the PC board holes, simply "pull" the coil insert from the shield can, rotate it a quarter-turn and insert back into the can. Make sure L1 is squarely against the top of the PC board before soldering, solid installation of L1 is essential to the frequency stability of your transmitter.
- 31. Install C15, 10 pf (marked 10 or 10K).
- 32. Install C14, 10 pf (marked 10 or 10K).
- 33. Install R9, 270 ohms [red-violet-brown].
- 34. Install C17, .001 μF (marked .001 or 102 or 1 nf).

35. Install R10, 10K ohms [brown-black-orange].

The following two capacitors have the identical functions of coupling the RF output from the collector of Q1 to the RF output jack (J3) and also the mounting point provided if you wish to use an on-board whip antenna.

36. Install C13, .001 μ F (marked .001 or 102 or 1 nf).

37. Install C21, .001 μ F (marked .001 or 102 or 1 nf).

38. The 3 holes for Q1, the 2SC2498 or 2SC2570A RF power amplifier transistor, should now be quite clear. Press the transistor into place firmly but gently, so that its body is as close to the board as reasonably possible. Observe correct placement of the flat side.

39. Install R13, 270 ohms [red-violet-brown].

40. Install C12, .001 μ F (marked .001 or 102 or 1 nf).

41. Install C18, .001 μ F (marked .001 or 102 or 1 nf).

42. Install C6, .001 μ F (marked .001 or 102 or 1 nf).

43. Install C8, 10 pf (marked 10 or 10K).

44. Install C7, 10 pf (marked 10 or 10K).

45. Install Y1, the small silver "can" crystal. Be especially careful when installing this part as its leads are very small. You may elect to put a small "dab" of glue on the part to relieve stress and to keep it firmly attached to the PC board.

46. Install the battery snap connector (without battery); The red wire is positive and the black wire is negative.

47. Install the battery hold-down clamp, using a scrap component lead wire looped through the PC board holes and soldered.

48. OPTIONAL: If you purchased the Ramsey case, hardware and whip antenna set, you may now install the telescopic whip. The antenna is attached to the PC board at the hole labeled "WHIP" using the small screw provided.

At this point, all PC board components except C16 have been installed. Before proceeding, this would be a good time for you or a friend to double-check your work.

FM10A frequency range selection

Capacitor C16 sets the frequency range of the FM10A. Values for C16 are as follows:

Desired Transmitter Frequency Range C16 Value

Lower end of FM band..... (88-94 MHz)	27 pf
Middle portion of FM band... (91-100 MHz) ...	22 pf
High end of FM band (95-108 MHz) ...	18 pf

If you are not sure "where" you wish to place your FM transmitter in the FM band, we suggest you solder an initial "trial" C16 capacitor with a **small** amount of lead-length to spare, so that it is easy to salvage and replace. This will enable you to properly test your FM10A and then at a later point, you may change C16 as desired.

49. Install C16, either: 18, 22 or 27 pf.

CHOOSING AN OPERATING FREQUENCY

[A] It really is NOT sufficient to just "check" the FM band for an empty frequency, using the FM portable radio closest at hand. It is your responsibility to carefully research what FM stations can be listened to with a good system within the transmitting range of your FM10A. This is especially important in the low end of the FM broadcast band (88-92 MHz), where there are numerous medium power National Public Radio stations perhaps outside your own town, but which your neighbors may enjoy receiving, using a good receiver and outdoor antenna. Interfering with such reception is a direct violation of federal law. The most reliable way of finding a truly open frequency on the FM band is to check the band with a very good FM receiving system using an external antenna. If you do not have access to such a radio, most modern car radios (with exterior antenna) are very sensitive and usable to help you know what stations your neighbors really can be receiving on a particular frequency.

[B] In choosing an operating frequency, remember that most "digital-tuning" receivers, whether portable, mobile or hi-fi, are designed to tune in 200 KHz increments and therefore might not receive well a signal operating between these pre-tuned standard broadcasting frequencies. In order to comply with Part 15 of FCC regulations, it is your responsibility to determine carefully that your operation will not cause interference to broadcast reception. Please study Appendix A of this manual before using your FM10A.

ADJUSTING YOUR FM10A TRANSMITTER

Keep all tests very brief until you have carefully chosen an open operating frequency in the FM broadcast band.

1. Transmitting Frequency:

After finding a suitable "open" frequency in the 88-108 MHz FM band, adjust L1 with the plastic alignment screwdriver until you hear the carrier frequency on a nearby FM radio. No audio input is needed to make this first adjustment, you can simply listen for a "quieting" in the normal background noise "hiss."

2. Audio Connection:

Adjust both Left and Right level potentiometers (R1, R4) to full counter-clockwise rotation. This is the minimum level position. Then increase them **slightly**. The best audio input for both testing and general operation are the stereo "line-level outputs" of a cassette deck or CD player. Most stereo systems have a variety of auxiliary output jacks of which one or more are line-level outputs.

Hooking up an audio source to your FM10A is really quite simple. However, there are some general rules:

- A terribly distorted sound is a sign of too much audio level. Simply rotate the level potentiometers, R1 and R4, CCW to reduce the level. Make sure you rotate each one about the same amount to maintain proper stereo balance.
- Stereo LP turntables are low-level output and will require the use of a preamplifier for proper audio input to the FM10A.
- NEVER connect the FM10A audio inputs to speaker outputs of a high power stereo system; such a connection will destroy the IC chip.
- Consider using a mike mixer for professional "radio station" sound. It will allow you to easily fade, mix and switch between various audio sources.

3. Stereo balance:

Adjust R7 for correct stereo balance. The better your ear for music and your understanding of quality audio devices and interconnections, the better will be the performance of your FM10A.

USING THE FM10A WITHIN THE HOME

A most practical use for the FM10A would be to connect it to the main stereo system within a large home so that whatever is playing on the main system can also be tuned-in on portable FM radios in other rooms, the garage or out in the yard.

This connection consists of using shielded audio cables to connect the auxiliary "line audio" output of your cassette deck, CD player or other stereo device to the audio inputs of the FM10A. Consult the literature that came with your stereo equipment.

Even if you intend only this limited convenience use of the FM10A for your own home and family, it is still your responsibility, in accord with Part 15 of the FCC Rules, to ensure that this operation does not cause interference to your neighbors.

POWER SUPPLY CONSIDERATIONS

The FM10A is designed to operate from a single 9-volt battery mounted on the PC board. For prolonged operations, note from the schematic diagram that replacing R8 with a jumper wire will permit operation from a 1.5V or 3.0V DC source such as D cells. Diodes D1, D2 and D3 regulate the voltage to U1 at 2.1 volts. Note, however that reduced voltage will also affect the collector voltage and therefore the output power of Q1.

Whether an alternative AC adapter can be used depends on the quality of the adapter and its ability to suppress unwanted AC-line hum. Various plug-in adapters and power supplies in the 6 to 12 volt range may be tried, but make sure the unit has DC output (positive tip) and is not merely a transformer relying on rectifier circuitry within the device for which it was originally supplied as an accessory.

L.E.D. "POWER ON" INDICATOR

Since the transmitter consumes power and emits RF whenever it is turned on, a visual "on the air" indicator is desirable and is a fun enhancement of your completed kit. If you are designing the FM10A setup for use by youngsters, a flashing indicator is easily provided using our BL-1 "LED Blinky" kit. Voltage for a standard LED is easily taken from the unused top terminals of S1. The inner pin nearest the black lead of the battery cable is the +9 volt pin. The ground can be taken from the black battery terminal, or the case of any of the jacks, but it CANNOT be the antenna. This positive DC must be connected to the anode (longer wire) of the LED. Use a 1K resistor in series with either wire of the LED. The cathode lead is connected

to the negative battery wire. The resistor is omitted if you are using a 1.5 volt battery for prolonged short-range operation.

EXPERIMENTAL "BROADCASTING" PROJECTS

To use the FM10A successfully as a "broadcasting" service to interested listeners in a school or immediate neighborhood, most of your effort will be concentrated on smoothly "managing" or mixing the audio signals fed into the transmitter input. Operation of the transmitter itself consists simply of the following:

- 1. Correct construction and adjustment.
- 2. Carefully checking for an open frequency between 88-108 MHz in accordance with FCC Rules, Part 15.
- 3. Setting up a suitable antenna.
- 4. Connecting the audio source to the Left and Right input jacks.
- 5. Turn on the transmitter while you intend to be "on the air" and turn it off when you are finished.

Explaining how to build a simple audio "mixing" panel or box, which is at the heart of any studio operation, is beyond the purpose of this instruction manual. We do recommend that you design and build this mixing system yourself, for several reason:

- 1. Parts to do so are readily available at Radio Shack.
- 2. It would be an excellent class, family or Scout project.
- 3. Commercially-made stereo mixing consoles, while much less expensive today than a decade ago, will cost much more than did your FM10A kit!
- 4. The more home-built your complete setup, the more it is in conformity with the spirit of FCC Part 15 regulations.

If you are designing the FM10A and its mixing inputs to serve as an educational and entertaining toy for your children, we suggest that the FM10A PC board be incorporated with the mixing circuits into a durable, non-hazardous enclosure. If infants and very young children are likely to "examine" this magical box when their siblings are not looking, it is better not to use a whip antenna, due to the hazard of eye damage. Also, remember that any broken whips from radios, cordless phones, etc. can become dangerously sharp.

Although many sources exist for audio mixers, the Radio Shack No. 32-1105 is the least expensive commercial device currently available. Bear in mind that specifications and model numbers for such accessory equipment can change from year to year. Also, some home-entertainment audio equipment includes simple mixing capabilities which will permit you to fade and "cue" music and microphone inputs. Ramsey now sells the MX-5 and MX-10 mixer kits (and wired and tested units!) and the Stereo Transmitter Companion (STC-1) for a "radio station" quality home broadcasting set-up.

ANTENNA IDEAS

The simplest, yet very effective, antenna for the FM10A consists of a "dipole", set up either horizontally or vertically, and connected to the transmitter output jack through a few feet of coaxial cable (either RG-58, RG-59 or miniature RG-174, available at Radio Shack and other sources). Correct dipole lengths for major sections of the 88-108 MHz band are:

88 MHz, each side: 2.7 feet; 5.4 feet total
98 MHz, each side: 2.4 feet; 4.8 feet total
108 MHz, each side: 2.2 feet; 4.4 feet total

You can see that there is not a great difference in antenna length from 88 to 107 MHz. Some antenna designers have the view that an "approximate" dipole such as 2.5 ft. on a side will do fine, while others believe it is worth the effort to calculate the length for your exact frequency, using the simple formula of Length (of one side, in feet) = $234/\text{Frequency in MHz}$.

If the dipole is installed vertically, the end connected to the center conductor of the coax should be the upper (higher) end. If young children will be around the set-up, a flexible wire antenna is preferable, rather than rigid tubing.

A "ground plane" antenna can be quite effective. A ground plane consists of one vertical element, the same length as one side of a dipole, connected to the center conductor of the coax. Four "radials" are connected to the shielded side of the coax at a 90 to 135 degree angle to the vertical element. The dipole formula is also used to calculate the length of the radial; since radials should be slightly longer than the main element, use 240 rather than 234 in your calculations.

If you are equipped to make the field strength measurements required by Part 15 FCC rules, and if you think it would be best to aim or "focus" your signal in a narrower direction, you can consult an antenna handbook and design a suitable gain antenna. See Appendix A concerning FCC field strength limitations. An FM- VHF TV receiving antenna could be modified for such a purpose. Ramsey now has the TM-100 Tru-match FM broadcast antenna, ideally suited for your FM10A

Ham radio books and magazines are filled with antenna principles and ideas which can be adapted to your application. Also, you may wish to look at Radio Shack book No. 62-1083 on antennas.

ANTENNA ALTERNATIVES

If your situation involves a single large building or multi-level home where reception from the FM10A antenna tends to be uneven because of walls and other VHF path obstacles, you might set up the FM10A's output in a "carrier-current" configuration. If you know how to do correctly, then do so - safely. If not, you can show your FM10A and this book to a licensed radio engineer and negotiate with that person for a safe installation which will feed your signal through interior wiring of your home or building. Do not attempt such an installation unless you know exactly what to do and not to do. Also, because such an installation is beyond the original purpose of this kit and the safety standards intended for all Ramsey kits, and because we have not tested the FM- 10A in such an installation, we cannot provide further details for such an installation.

TROUBLESHOOTING GUIDE:

If your FM10A does not work at all, re-check the following:

- correct orientation of U1 (see PC board parts layout diagram)
- correct polarity of all electrolytic capacitors,
- Correct orientation of diodes D1,2,3,
- correct orientation of Q1 transistor,
- correct value of C16,
- all solder connections.

Hints:

- Frequency drift is usually caused by a weak battery or operation at large temperature extremes.
- Erratic or unstable operation is caused by faulty solder joints or cable connections.
- Standard 2SC2498 replacements: ECG10 or SK9139, may be found at most local electronics parts dealers.

APPENDIX A: FCC RULES AND INFORMATION

The Rules of the FCC (Federal Communications Commission) and your kit built FM Stereo Transmitter.

An interim explanation of applicable FCC regulations supplied as a personal assistance to FM10A builders, by Dan F. Onley (K4ZRA)

It is the policy of Ramsey Electronics, Inc., that knowing and observing the lawful use of all kits is a first responsibility of our kit user-builders. We do not endorse any unlawful use of any of our kits, and we do try to give you as much common sense help about normal and lawful use as we can. Further, it is the policy of Ramsey Electronics, Inc., to cooperate with all applicable federal regulations in the design and marketing of our electronics kit products. Finally, we urge all of our overseas customers to observe the regulations of their own national telecommunications authorities.

In all instances, compliance with FCC rules in the operation of what the FCC terms an "intentional radiator" is always the responsibility of the user of such an "intentional radiator".

To order your copy of FCC rules part 15, call the US Government, Superintendent of Documents, at 202-512-3238, or fax at 202-512-2250. To order the correct document, ask for "CFR Title 17: Parts 1 to 19." The cost is \$24.00, Master Card and Visa accepted.

In the United States, this is how the FCC regards your transmitter kit:

Licensed FM broadcast stations and their listeners have ALL the rights! Your use of a device such as the FM10A kit MAY have some limited privileges in locally-unused band space.

Unlicensed operation of small transmitting devices is discussed in "Part 15" of the FCC Rules. These Rules are published in 100 "Parts," covering everything imaginable concerning the topic of "Telecommunications." The six books containing the FCC Rules are section 47 of the complete Code of Federal Regulations, which you are likely to find in the Reference section of your Public Library. If you have questions about the legal operation of your FM10A or any other kit or home-built device which emits RF energy, it is your responsibility to study the FCC regulations. It is best if YOU read (and consult with a lawyer if you are in doubt) the rules and do not bother the understaffed and busy FCC employees with questions that are clearly answered in the rules.

Here are the primary "dos and don'ts" picked from the current FCC Rules, as of May, 1990. This is only a **brief look** at the rules and should not be construed to be the absolute complete legal interpretation! It is up to you to operate within the proper FCC rules and Ramsey Electronics, Inc. cannot be

held responsible for any violation thereof.

1. In the past, no "two-way communications" use of the 88-108 MHz FM broadcast band was permitted. This prohibition does not appear in the current edition of Part 15. Previous editions of Part 15 discussed "wireless microphones" (such as Ramsey FM-1, FM-4, etc.), while the June 23, 1989, revision eliminates this discussion in favor of more detail regarding computer and TV peripherals and other modern electronic conveniences. However, it is not immediately clear that the 1989 revision of the FCC Rules Part 15 necessarily "cancels" previous regulations. Laws and rules tend to remain in force unless they are specifically repealed. Also, FCC Rule 15.37 discusses "Transitional Provisions for Compliance with the Rules," and states in item (c): "There are no restrictions on the operation or marketing of equipment complying with the regulations in effect prior to June 23, 1989."

2. It is the sole responsibility of the builder-user of any FM broadcast-band device to research and fully avoid any and all interference to licensed FM broadcast transmission and reception. This instruction manual gives you practical advice on how to do a good job of finding a clear frequency, if one is available.

3. For some frequency bands, the FCC sets 100 milliwatts (0.1 watt) as the maximum permitted power output for unlicensed, home-built transmitting devices, and that the combined length of your antenna and feedline (coaxial cable or other) must not exceed 10 feet. The technical standards for 88-108 MHz are very different, primarily concerned with band width and RF field strength.

4. FCC Rules do not differ for "stereo" or "monaural" transmissions.

5. Broadcasting on the grounds of a school (AM emissions only) is specifically permitted and encouraged between 525 and 1705 KHz under Part 15.221. Use our AM-1 AM radio broadcast kit for this use.

6. FCC Rule No. 15.239 specifically addresses operation in the 88-108 MHz FM broadcast band for which your FM10A transmitter kit is designed. However, this Rule does not, by itself, tell you everything you need to know about using a device of this kind. Therefore, we are noting a series of Part 15 regulations which should be observed:

- a. The transmitter must NEVER be tuned to a frequency above 108 MHz, specifically the band 108-121.94 MHz, FCC Rule 15.205 lists this band as restricted, due to potential interference with aircraft navigation equipment.
- b. The "bandwidth" of your transmission is limited to 200 KHz, centered on the actual operating frequency. Since 200 KHz is enough spectrum

space for several different FM stations, this is a "generous" limitation designed to accommodate cruder FM devices. Properly built and adjusted, the FM10A kit operates well within this limit. In fact, its signal should sound no "wider" than any other FM station when listening on an ordinary FM radio.

- c. FCC Rule 15.215(a) says: "Unless otherwise stated, there are no restrictions as to the types of operations permitted under these sections." This general provision appears to leave you free to use your FM stereo transmitter in a manner similar to operations of an FM broadcasting station, or to use it for any other non-interfering, practical application.
- d. FCC Rule 15.5: General conditions of operation: "(b) Operation...is subject to the conditions that no harmful interference is caused and that interference must be accepted that may be caused by the operation of an authorized radio station, by another intentional or unintentional radiator, by industrial, scientific and medical equipment, or by an incidental radiator. (c) The operator of a radio frequency device shall be required to cease operating the device upon notification by a Commission representative that the device is causing harmful interference."
- e. The most specific FCC regulation of 88-108 MHz FM Broadcast band unlicensed operation is that the "field strength" of the signal must not exceed 250 microvolts/meter at a distance of 3 meters from the transmitter (FCC rule 15.239). If you have any concern about this emission limit, have your device checked by a technician with accurate measuring equipment. Remember that the "field strength" of a signal is determined as much by the antenna as by the RF output of the transmitter itself.

APPENDIX B: UNDERSTANDING LEGAL "FIELD STRENGTH"

A "microvolt" is one-millionth of one volt and designated " μV " in the following explanations.

The new FCC Part 15 Rules specify a maximum "Field Strength" of your transmitted signal. Since it is unlikely that you have the equipment to carry out accurate field strength measurements in microvolts, it is useful to understand at least the theory of field strength so that you can understand both what you can expect from such transmitters, and what limits the FCC intends.

Previous limits on nonlicensed FM-broadcast band devices were defined as a maximum field strength of $40\mu\text{V}$ per meter measured at a distance of 15 meters. The June 1989 revised rule specifies a maximum of $250\mu\text{V}$ per meter, but measured at 3 meters from your antenna. Both limitations are the same in practice. " $250\mu\text{V}$ per meter" means that an accurate field-strength meter with a 1-meter antenna may indicate a maximum signal field strength of $250\mu\text{V}$ (In contrast, non-licensed operation from 26.96 to 27.28 MHz is limited to a field strength of $10,000\mu\text{V}$ per meter at 3 meters).

In all cases, the field strength of a signal decreases in direct proportion to the distance away from the antenna. Power decreases by the square of distance: for every doubling in distance, the signal power is quartered, but the field strength voltage is only halved. Using this theory, we can construct a simple chart to show the maximum permitted performance of a non-licensed FM band transmitter. The theoretical figures assume a simple 1 meter receiving antenna in all cases and do not take into consideration that reception can be greatly enhanced with larger, multi-element antennas and preamplifiers. In the following chart, the field strength (theoretical minimum) gets even stronger as you move from the edge of these circular boundaries toward the antenna:

This "exercise in meters and microvolts" demonstrates that the FCC clearly intends to limit the theoretical range of non-licensed devices operating in this band. It also shows the potential for causing interference at a home down the street from you. But it also shows that you can legally put out quite a good signal over wider areas than you might have imagined.

For other kinds of radio services, the FCC restricts such factors as transmitter power or antenna height, which cannot really limit the possible "range" of a transmission under good conditions. By restricting the maximum field strength at a specific distance from your antenna, the FCC clearly plans for your signal to "die out" at a specific distance from your antenna, no matter what kind of transmitter power or extra-gain antenna you are using. On the other hand, the FCC standards do make it legal and possible for you to

DISTANCE FROM TRANSMITTER ANTENNA			
METERS	FEET	FIELD STRENGTH (μV)	TOTAL RECEPTION AREA
3	10	250	314 FT
6	20	125	1256 FT
12	39	63	4800 FT
24	78	31	19113 FT
48	157	15	1.8 ACRES
96	315	7.5	7.2 ACRES
192	630	3.8	28.6 ACRES
384	1260	1.9	11.4 ACRES
768	2520	.95	458 ACRES
1536	5036	.5	1830 ACRES

broadcast on a school campus, campground or local neighborhood, as long as you do not cause interference to broadcast reception.

“Why talk about acres”?

There are three reasons to translate our look at "field strength" into "acres".

- (1) The first one is easy: the numbers would get too cumbersome if we discussed your possible signal coverage in terms of square feet or square meters.
- (2) It's very easy to see that your signal can easily and legally serve a school campus or wilderness campground.
- (3) And, if we remember that typical urban single-family home sites run from 1/4 to 1/2 acre on the average, it should become extremely clear that your obligation to avoid interfering with broadcast reception can easily involve hundreds of homes, before adding apartments!

In fact, the most significant distance in the above chart is the 1.9 μV signal strength permissible at 1260 feet (about 1/4 mile), covering a circular area of about 114 acres. A quick glance at stereo FM receiver specifications shows typical sensitivity of 1.7 μV before considering high-gain antennas or preamplifiers. Your non-licensed signal can provide serious competition to a public broadcast station fifty miles away, a station which someone in your neighborhood may have set up a special antenna to enjoy.

Calibrated "field strength meters" such as described in the ARRL Radio Amateur's Handbook can detect signals down to about 100 microvolts. To measure RF field strength below such a level, professional or laboratory equipment and sensitive receivers are required. A "sensitive" receiver responds to a signal of 1 or even .5 microvolt "delivered" to the receiver input by antenna. If the antenna is not good, the receiver cannot respond to the presence of fractions of a microvolt of RF energy.

SUMMARY

The present edition of Part 15 of the FCC rules does not provide detailed guidance on ALL aspects of using a low-power transmitter such as the FM10A. The main point is that you may not cause any interference whatsoever to licensed broadcast services and that you must be willing to put up with any interference that you may experience.

In addition to operations not requiring authorization, you also have the option of writing a clear and polite letter to the FCC Engineer-in-Charge of your local district, describing your intended operation. Mention the operating frequency and planned hours of operation. This could be a good step to take if your project is on behalf of a school, Scout or community group.

If you become further fascinated with the service rendered by low-power broadcasting, other FCC regulations explain how to apply for a license or other authorization which may permit you to upgrade your FM10A or other equipment to accomplish any objective which the FCC sees to be in the public interest and not interfering with other authorized uses of the radio spectrum.

Lawful use suggestions for the FM10A

1. Build and adjust this kit strictly according to the published instructions.
2. Use the whip antenna supplied with the Ramsey case set, CFM.
3. Do not modify your kit in any way.

4. Check your intended operating frequency very carefully, as clearly explained in this instruction manual, to ensure you will not cause interference to reception of licensed broadcasting.
5. If you receive ANY complaint about your transmissions interfering with broadcast reception, stop or change your operation IMMEDIATELY.
6. If you are contacted by the FCC regarding use of this device, cooperate fully and promptly.
7. Do your own homework and research to understand and comply with present and future FCC rulings concerning devices of this kind.
8. Do not use made-up "station call signs" to identify your transmissions. Only the FCC has the authority to issue such call signs. Use some other way to identify your transmitting activity, such as "This is Stereo 90.5, Seabreeze School Student Music Radio," and so forth.
9. Identify the location and purpose of your transmissions from time to time. This is common courtesy toward other persons who may hear your signal. The FCC is toughest about clandestine transmission which cost time and money to track down.
10. Do not assume that the mere fact that you purchased this kit gives you any specific right to use it for any purpose beyond generating a low-level RF signal which is barely detectable beyond the perimeter of your personal dwelling space.

Finally, the FCC Rules call for the posting of printed notices on devices intended for non-licensed operation under Part 15 Rules. You will find such notices written up for the front or back of the instruction manual for nearly any computer or video accessory that you have seen in recent months. Consult the Part 15 Rules for the exact wording of such notices. Following is a text for such a notice which responds to FCC rule making intentions:

NOTICE:

The radio-frequency "intentional radiator" device which may be constructed from kit parts supplied by us is intended and designed by Ramsey Electronics, Inc. to conform to applicable provisions of Part 15 of FCC Rules. The individual kit-builder and all users of this device assume responsibility for lawful uses conforming to FCC Part 15 Rules. Operation is subject to the following two conditions:

[1] This device may not cause harmful interference, and
[2] this device must accept any interference received, including interference that may cause undesired operation.

Final comment

A well-informed person will see today's FCC Rules to be evolving and progressively less-restrictive. Even though today's technology is far more complex than what was possible at the time of the Communications Act of 1934, the FCC rules are becoming more relaxed, giving radio experimenters more and more opportunities to explore many frequency bands, using many communications modes, with no need for a formal license of any kind. A thorough study of Part 15 of the FCC Rules, which is completely beyond the purpose of this kit manual, will show you many legal uses of radio transmitting devices which do not require licensing, either amateur or commercial.

To provide more personal and club radio-learning opportunities, and to cut down on administrative costs, today's FCC permits far more non-licensed activity than at any time in previous history. On the other hand, today's FCC enforcement actions get bigger fines and real prison terms for scofflaws! From CB (now 3 bands of it, for varying applications) to easy entry-level Amateur Radio with long-term licensing, to numerous unlicensed Part 15 operations, the FCC is beginning to look out for the interest and good plans and intentions of private citizens and school-community groups as never before in radio communications history. Learn the rules...observe them...and have fun in radio!

If you enjoyed this Ramsey kit, there're plenty more to choose from in our catalog - write or call today!

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, however, customer satisfaction is our goal, so in the event that you do have a problem, take note of the following. 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 (1/2 hour labor) of \$25.00, 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.

FM10A STEREO TRANSMITTER KIT

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REQUIRED TOOLS

- Soldering Iron (Radio Shack #RS64-2072)
- Thin Rosin Core Solder (RS64-025)
- Needle Nose Pliers (RS64-1844)
- Small Diagonal Cutters (RS64-1845)
- <OR> Complete Soldering Tool Set (RS64-2801)

TOTAL SOLDER POINTS

125

ESTIMATED ASSEMBLY TIME

Beginner 3.5 hrs
Intermediate 2 hrs
Advanced 1.5 hrs

ADDITIONAL SUGGESTED ITEMS

- Soldering Iron Holder/Cleaner (RS64-2078)
- Holder for PC Board/Parts (RS64-2094)
- Desoldering Braid (RS-2090)

Manual Price Only: \$5.00

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Assembly and Instruction manual for:

**RAMSEY MODEL NO. FM10A FM STEREO
TRANSMITTER**

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