

220 MHZ FM RECEIVER KIT

Ramsey Electronics Model No.

FR220

Keep an "ear " on the local repeater action from your easy chair with this simple and fun to build FM receiver. Tunes the entire 220 MHz band. Ideal way to "audition" before buying a rig!

- **Tunes any 5 MHz portion of the 220 to 240 MHz band.**
- **Excellent receiver for new Novice classes!**
- **Excellent performance, less than 1 uV sensitivity.**
- **Tuned input, low noise preamp stage.**
- **True Dual-conversion superhet design with 2 pole Ceramic High IF and 6 pole Ceramic low IF filters!**
- **Front Panel Volume, Squelch, and Tuning controls.**
- **Excellent receiver for beginners and seasoned pros!**
- **Informative manual answers questions on theory, hook-ups, and uses - enhances resale value, too!**
- **Add our case set for a finished 'Pro' look. Cases match all Ramsey products.**
- **Clear, concise assembly instruction carefully guides you to a finished kit that works the FIRST time!**



PARTIAL LIST OF AVAILABLE KITS

RAMSEY TRANSMITTER KITS

- FM10A FM Stereo Transmitter
- FM25B Synthesized FM Stereo Transmitter
- AM25 Synthesized AM Transmitter
- AM1 AM Transmitter

RAMSEY RECEIVER KITS

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

RAMSEY HOBBY KITS

- SG7 Personal Speed Radar
- SS70 Speech Scrambler
- TT1 Telephone Recorder
- SP1 Speakerphone
- MD3 Microwave Motion Detector
- TFM3 Tri-Field Meter
- LC1 Inductance-Capacitance Meter

RAMSEY AMATEUR RADIO KITS

- 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.

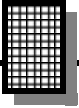
FR220 FM RECEIVER KIT INSTRUCTION MANUAL

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KIT ASSEMBLY AND INSTRUCTION MANUAL FOR

FR220 FM RECEIVER KIT

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INTRODUCTION

Because all but the most expensive scanners skip over the 220 MHz band, and most Ham rigs are 144 or 440 MHz, 220 is the long forgotten child. This nifty little receiver will allow you to check out 220 at a very affordable price! When you see how uncrowded the band is, and it's excellent VHF propagation characteristics, we're sure you'll order our 220 MHz transceiver and join in.

This receiver is a good project for amateurs wishing to become more familiar with 220 Mhz FM before choosing a transceiver, or for those active on 220 who want an inexpensive receiver to take on trips, keep in a briefcase or to watch for band openings.

Most Ramsey Electronics can be classified as "Skill Level 1" if we use the old Heathkit[®] guidelines for ease of assembly. That means that our kits are intended to be successful for first-time kit builders. This FR220 FM Receiver is best regarded as a "Skill Level 2" project, and should not be taken lightly, even by experienced, licensed radio amateurs.

Still, this step-by-step manual is written with the beginner in mind, because we are well aware of the fascination with 220 MHz and its maze of repeaters holds for newcomers, which means this could be your very first kit project. The same holds true for those who just want to peek in on LOW VHF public service communications without the cost of a scanner. To be honest, we'd like to see first-time builders start out with an easier kit such as the Ramsey HR-40 Forty Meter receiver before assembling the FR220, but we are confident that you can construct the FR220 successfully if you follow this manual carefully and patiently.

Before beginning the project or even studying the circuit description, it is worthwhile to develop some prior respect for how much receiver is packed onto the circuit board. The nine semiconductor devices (diodes, transistors and IC chips) give the equivalent of about 30 or more transistors and diodes. And, in addition to four inductors, a crystal and two ceramic filters, there are nearly 60 capacitors and resistors. Surely, all that should result in a decent receiver! You could easily spend twice the money plus hours of time trying to gather the equivalent parts from catalogs and still need to make your own circuit board.

BUILDING YOUR FR220 KIT

There are just over 200 solder connections on the FR220 printed circuit board. That means your work could be 99% excellent and you could STILL have 2 or 3 cold solder points or solder bridges. Since this circuit is more sophisticated than a direct-conversion HF receiver or a simple transmitter, a beginner or casual amateur could have a harder time tracing a problem due to a poor solder connection. Therefore, PLEASE take us seriously when we say that good soldering is essential to the proper operation of your receiver!

- Use a 25-watt soldering pencil with a clean, sharp tip.
- Use only rosin-core solder intended for electronics use.
- Use bright lighting. A magnifying lamp or bench-style magnifier may be helpful.
- Do your work in stages, taking breaks to check your work.
- Carefully brush away wire cuttings so they don't lodge between solder connections.

FR220 CIRCUIT DESCRIPTION

VHF signals from the antenna are amplified through the tuned input circuit (L1,C3 and L2,C4) by Q1, a microwave bipolar transistor. Q1's output is fed to the input of the SA602 IC, an efficient single-package (8-pin DIP) mixer-product detector-oscillator. The tunable oscillator section of the SA602 is aligned to operate at 10.7 MHz higher than the signal fed and amplified by Q1. For example, to receive 222-227 MHz signals, the oscillator must tune 232.7 to 237.7 MHz in order for the SA602's mixing capability to produce a steady 10.7 MHz output signal to the rest of the circuit. The oscillator frequency is determined by L3 and its associated capacitors, and varied by the varactor tuning network using D1 and varied by R1.

The output from pin 4 of the SA602 passes through a ceramic 10.7 MHz filter, amplified by transistor Q2 and applied to input pin 18 of U2. Q3 provides AFC (automatic frequency control) by keeping the local oscillator of U1 from drifting away from an incoming signal. This is accomplished by tuning the varactor circuit in the direction opposite the drift.

The MC3359 IC has an internal oscillator controlled by the 10.245 MHz crystal. The 10.245 MHz signal is mixed with the 10.7 MHz input from U1 to convert down to the low IF of 455 KHz. The 455 KHz IF is filtered by FL2 and then amplified by a limiting amplifier in U2. Audio demodulation takes place in the quadrature detector, with L4 adjusting the detector.

The audio modulation is detected in U2, and the background noise is used to control the squelch. U3 amplifies the audio output from pin 10 of U2 to a practical level for speaker or headphone operation. Pin 16 of U2 will ground the input of U3 when the squelch is closed.

L4, a 455 KHz IF coil, permits adjustment of the 90-degree voltage-current phasing ("quadrature") of FL2's output to the FM detector demodulator (pin 8 of the MC3359).

PARTS LIST

Inductors

- 2 small 4 turn coils (L1,L2)
- 1 slug-tuned 3 \bar{E} turn coil (L3)
- 1 shielded transformer coil marked LB 53303 HK (L4)

Semiconductors and IC's

- 1 2SC2570A or 2SC2498 transistor (Q1)
- 3 2N3904 transistor (Q2,Q3,Q4)
- 1 SA602 8-pin IC (U1)
- 1 MC3359 18-pin FM receiver IC (U2)
- 1 LM386 8-pin audio amplifier IC (U3)
- 1 Varactor diode, BB405 [small black body with white band] (D1)
- 1 1N914/1N4148 signal diode (D2)

Special Components

- 1 10.245 MHz Crystal (Y1)
- 1 10.7 MHz ceramic filter [brown, molded, 3 leads] (FL1)
- 1 455 KHz ceramic filter [black, square] (FL2)

Fixed Resistors

- 1 2 ohm [red-black-gold] (R22)
- 3 270 ohm [red-purple-brown] (R6,9,20)
- 1 470 ohm [yellow-purple-brown] (R5)
- 2 1K ohm [brown-black-red] (R11,12)
- 3 10K ohm [brown-black-orange] (R7,17,19)
- 1 18K ohm [brown-gray-orange] (R18)
- 1 33K ohm [orange-orange-orange] (R14)
- 4 47K ohm [yellow-purple-orange] (R4,8,13,21)
- 1 100K ohm [brown-black-yellow] (R16)
- 1 470K ohm [yellow-purple-yellow] (R15)
- 1 1 megohm [brown-black-green] (R10)

Capacitors

- 1 2 or 2.2 pf (C2,12)
- 4 4.7 or 5 pf (C1,5,9,10)
- 2 10 pf (C3,4)
- 1 22 pf (C19)
- 1 27 pf (C11)
- 2 100 pf [marked 100 or 101] (C6,22)
- 1 220 pf [marked 220 or 221] (C18)
- 6 .001 uf [marked .001 or 102 or 1nf] (C7,8,20,23,24,25)
- 8 .01 uf [marked .01 or 103 or 10nf] (C13,16,17,21,26,28,29,31)
- 1 .1 uf [marked .1 or 104] (C34)
- 1 1.0 uf electrolytic (C27)
- 3 4.7 or 10 uf electrolytic (C15,30,36)
- 4 100 to 220 uf electrolytic (C14,32,33,35)

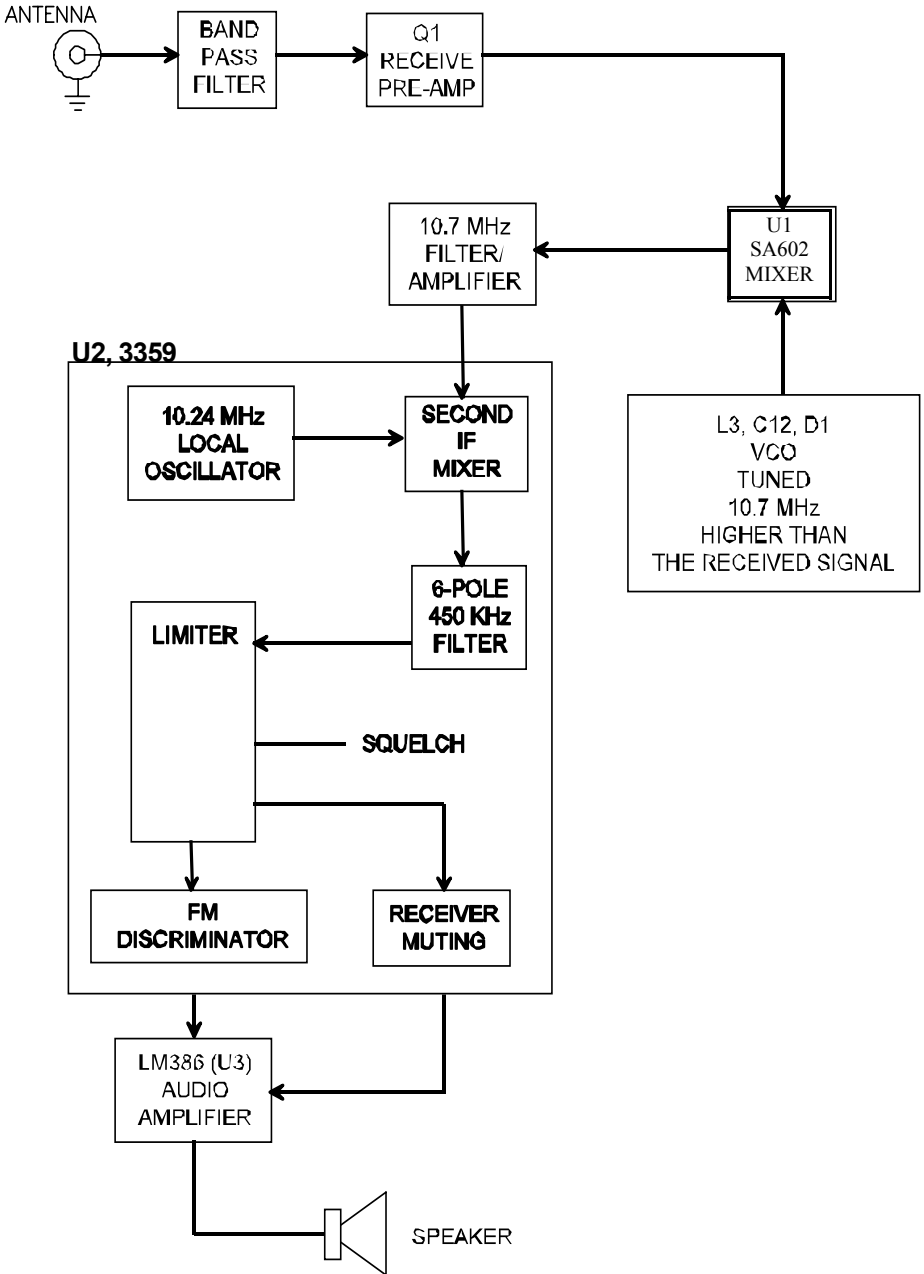
Controls and Hardware

- 1 Printed circuit board
- 3 10K ohm potentiometer (R1,R2,R3)
- 1 DPDT push switch (S1)
- 1 PC mount RCA jack (J1)
- 1 PC mount subminiature speaker jack (J2)
- 1 9-volt battery bracket (B1)
- 1 9-volt battery snap-on clip

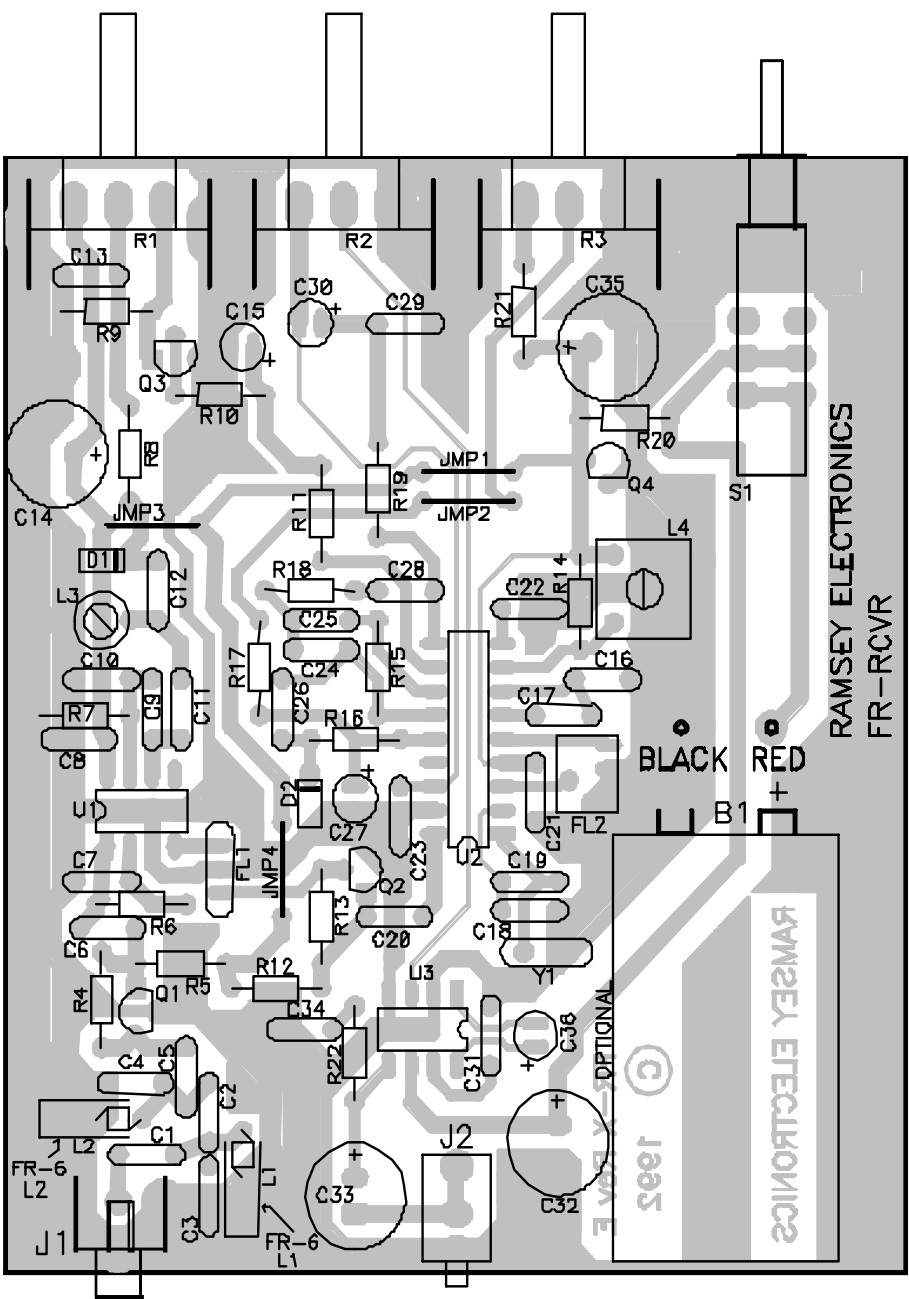
REQUIRED, NOT SUPPLIED

- 1 9-volt alkaline battery
- 1 VHF antenna with cable terminated in RCA-style plug or adapter
- 1 Speaker or headphones

FR220 BLOCK DIAGRAM



FR220 PARTS LAYOUT DIAGRAM



NOTE CONCERNING THE AUDIO OUTPUT JACK

Your receiver kit is supplied with a standard subminiature 2.5 mm (3/32") audio jack, which mates with commonly available earphone plugs and adapters available at Radio Shack, such as 274-290 (plug) or 274-327 (adapter for 1/8" mono plug). If you prefer to use another size and style jack, we suggest that you still install the original jack and then wire your own jack in parallel with it rather than rough up the PC board to accommodate your jack.

SEMICONDUCTOR REPLACEMENT DATA

U1 SA602	Contact Ramsey Factory
U2 MC3359 (Motorola)	ECG860 or SK7731
U3 LM386 (National)	available at Radio Shack, other suppliers
Q1 2SC2498 or 2570	ECG10 or SK9139
Q2,3 2N3904	available at Radio Shack, other suppliers
D1 BB405	contact Ramsey Factory
D2 1N4148	available at Radio Shack, other suppliers

RAMSEY "Learn-As-You-Build" KIT ASSEMBLY:

We have a twofold "strategy" for the order of the following kit assembly steps. First, we install parts in physical relationship to each other, so there's minimal chance of inserting wires into wrong holes. Second, whenever possible, we install in an order that fits our "Learn-As-You-Build" Kit building philosophy.

FOR EACH PART, OUR WORD "INSTALL" ALWAYS MEANS THESE STEPS:

1. Pick the CORRECT part value to start with.
2. Insert it into the CORRECT PC board location.
3. ORIENT it correctly, which means: PLEASE follow the PC board drawing and the written directions for ALL parts where 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. Don't be afraid of ANY pen-style soldering iron having enough heat to damage a component.
5. Trim or "nip" excess wire lengths after soldering.

NOTE: Save some of the longer wire scraps nipped from resistors and capacitors. These will be used to form wire jumpers (JMP1, etc.) to be soldered in just like parts during these construction steps.

Now, let's start building!

- 1. Press S1 firmly into its six holes and solder all six pins. The switch fits the board only one way. Ignore the other set of six solder connectors on the switch.
- 2. Install J1, the RCA-style antenna jack. Solder all 4 points.
- 3. Install J2, the subminiature phone jack. Solder all three points. Be gentle and patient in inserting, so as not to damage the solder tabs.
- 4. Install controls R1, R2 and R3. Insert the three PC mounted controls into their positions. Check that the controls are pressed in firmly and straight against the top of the board. Solder the three center pins and then the two larger mechanical mounting tabs. Use enough solder for a solid connection.

Also, if you plan to use an enclosure other than the custom Ramsey enclosure and knob kit, you may wish to locate the controls differently than provided by the PC board. In this case, the control lugs are wired to the PC board using your own insulated hookup wire, kept as short as possible for neat installation.

FURTHER COMPONENT INSTALLATION

All "directions" on the PC board (i.e.: right, left, above, below and so forth) assume orientation of your board as shown in the parts layout diagram. Therefore the rear of the board (connectors) is the lower end, and the front (controls) is the upper end.

1. ANTENNA INPUT AND TUNED RF PREAMPLIFIER

- 5. Install C1, 4.7 or 5 pf disc capacitor.
- 6. Install C2, 2 or 2.2 pf.
- 7. Install C3, 10 pf.
- 8. Install L1, a small 4 turn wire coil. Gently stretch the coil just enough so that it's two wire leads fit firmly into the PC board holes. Solder both leads securely. This coil is designed to permit additional stretching or compressing as part of the alignment process.
- 9. Install C4, 10 pf.
- 10. Install L2, the other 4 turn coil just like L1 above.
- 11. Install C5, 4.7 or 5 pf.
- 12. Clearly identify Q1, the 2SC2498 or 2SC2570A transistor. Do not confuse it with the other transistors supplied.
- 13. Position Q1 as shown on the PC board layout, with the flat side facing to the right, toward the middle of the board. Press the transistor snugly into the PC board so that only a minimum amount of wire lead is exposed above the board. In soldering, don't be afraid to use enough heat to make good clean connections.
- 14. Install R4, 47K, just to the left of Q1 [yellow-violet-orange].
- 15. Install C6, 100 pf (marked 100 or 101).

- 16. Install R5, 470 ohms [yellow-violet-brown].

2. SA602 OSCILLATOR-MIXER and VARACTOR TUNING

- 17. Install R6, 270 ohms [red-violet-brown].
- 18. Install C7, a .001 uf bypass capacitor (marked .001 or 102).

In installing the SA602 IC, you may wish to use an 8-pin DIP socket rather than soldering the IC directly to the board. Reasons for doing this might include the peace of mind of beginners afraid of damaging the IC, or experienced builders testing the merits of the SA602's cousin, the SE602. However, please be aware that we have seen more service problems with improper socket insertion than from soldering heat damage to IC's. Even if this is your first IC, don't be afraid to use enough heat to make 8 clean connections, but DO be sure to orient the end marked by a band or dot IC correctly. Before soldering, make sure that the IC or socket is perfectly flat against the top of the PC board.

- 19. Install U1, the SA602 in accord with the preceding directions.
- 20. Install the FL1 ceramic filter. This component is a brown, molded "blob" with 3 leads and may be installed either way.
- 21. Install jumper wire JMP4. Use a scrap component lead wire bent into a small loop that connects the two PC board holes. Jumpers act as "bridges" over PC board traces underneath.
- 22. Install C8, .001 uf (marked .001 or 102).
- 23. Install C10, 4.7 or 5 pf.
- 24. Install R7, 10K [brown-black-orange].
- 25. Install C9, 4.7 or 5 pf.
- 26. Install C11, 27 pf.
- 27. Installation of L3. It is important that the body of this coil be snug against the PC board for mechanical stability, which directly affects the frequency stability of the receiver. Make good, solid solder connections!
- 28. Install C12, 2 or 2.2 pf.

- ❑ 29. Install varactor diode D1, it has a small black body with white and green bands. The white banded end signifies the cathode side. It is important that you have correctly identified D1 as type BB405 and have not confused it with the common signal diode D2.
- ❑ 30. Install R8, 47K ohms [yellow-violet-orange].
- ❑ 31. Install R9, 270 ohms [red-violet-brown].
- ❑ 32. Install C13, .01 uf (marked .01 or 103 or 10nf).
- ❑ 33. Installation of C14. This is the first the electrolytic or "polarized" capacitors that you will install. This means these capacitors have a positive (+) and negative (-) side and therefore a right way and wrong way of installation. Ordinarily, only the negative side is marked on the capacitor body, a dark band with the (-) sign clearly shown. The value of C14 is not critical and may be any value from 100 to 220 uf.
- ❑ 34. Install C14, 100 to 220 uf, observing correct polarity.
- ❑ 35. Install C15, 4.7 or 10 uf, observing correct polarity.
- ❑ 36. Install jumper JMP1.
- ❑ 37. Install jumper JMP3.

PROGRESS SUMMARY

So far, you have wired the tuned input from the antenna, the RF preamplifier, and the SA602 mixer-oscillator, including the varactor tuning circuit. The work you have done has actually formed a simple receiver capable of tuning in VHF signals of all kinds and converting them to a low-level 10.7 MHz output to be amplified by Q2. This is a good time to review the steps completed so far before proceeding. Due to the many functions of the MC3359 FM receiver IC, further assembly steps will be in the order of easiest parts installation.

3. TRANSISTOR COUPLING & AFC CIRCUITS, VOLUME & SQUELCH CONTROLS

- 38. Install Q2, a 2N3904 transistor. Observe correct positioning of the flat side.
- 39. Install R13, 47K ohms (yellow-violet-orange).
- 40. Install C20, .001 uf (marked .001 or 102).
- 41. Install R12, 1K ohms (brown-black-red).
- 42. Install Q3, 2N3904 transistor.
- 43. Install R10, 1 megohm (brown--black-green).
- 44. Install R11, 1K ohms (brown-black-red).
- 45. Install R22, 2 ohms (red-black-gold).
- 46. Install C29, .01 uf (marked .01 or 103 or 10nf).
- 47. Install C30, 4.7 or 10 uf electrolytic, observe correct polarity.
- 48. Install R18, 18K ohms [brown-gray-orange].
- 49. Install C28, .01 uf (marked .01 or 103 or 10nf).
- 50. Install R19, 10K ohms [brown-black-orange].
- 51. Install jumper wire, JMP2.
- 52. Install C34, .1 uf (marked .1 or 104).
- 53. Install R21, 47K ohms (yellow-violet-orange).
- 54. Install C35, 100 to 220 uf electrolytic, observe polarity.
- 55. Install R20, 270 ohms (red-violet-brown).
- 56. Install Q4, 2N3904 transistor.

14. MC3359 FM IC and ASSOCIATED COMPONENTS

- 57. Install R17, 10K ohms [brown-black-orange].
- 58. Install R14, 33K ohms [orange-orange-orange].
- 59. Install C24, .001 uf (marked .001 or 102).

- 60. Install C25, .001 uf (marked .001 or 102).
- 61. Install C26, .01 uf (marked .01 or 103 or 10nf).
- 62. Install L4, the 455 KHz quadrature coil, soldering the two pins and the two mounting tabs.
- 63. Install U2, MC3359 IC. As in the case of the SA602 IC, you could choose to install an 18-pin IC socket rather than soldering the IC directly. Re-read the previous discussion of IC sockets offered for the installation of U1. Larger IC's such as the MC3359 require considerably more care in socket insertion. Notice that the end of the IC marked by a band or dot and must be oriented correctly as shown on the PC parts layout diagram. Solder each of the 18 connections carefully. Make sure you have good lighting as well as good technique to make sure that no solder "bridges" flow between the connections.
- 64. Install C22, 100 pf (marked 100 or 101).
- 65. Install C16, .01 uf (marked .01 or 103 or 10nf).
- 66. Install C17, .01 uf (marked .01 or 103 or 10nf).
- 67. Install C21, .01 uf (marked .01 or 103 or 10nf).
- 68. Install C18, 220 pf (marked 220 or 221).
- 69. Install C19, 22 pf.
- 70. Install Y1, the 10.245 MHz. crystal. No special procedure is required. Simply press the crystal firmly into its holes as far as it will go, and make good solder connections.
- 71. Install FL2, the 455 KHz filter. Its three leads are delicate, and fit in only one way.
- 72. Install C23, .001 uf (marked .001 or 102).
- 73. Install C27, 1 uf electrolytic, observe correct polarity.
- 74. Install D2, the 1N914/1N4148 signal diode, observe correct orientation of the banded cathode end. Be sure you correctly identified D2 and did not confuse it with the varactor diode already installed.
- 75. Install R16, 100K ohms (brown-black-yellow).

- 76. Install R15, 470K ohms (yellow-violet-yellow).

5. FINAL CONNECTIONS: THE LM386 AUDIO IC STAGE

You now have a working FM receiver ready for adjustment. The output of the MC3359 FM IC simply needs to be boosted to listening level. A few more connections, and your receiver will be ready for adjustment and testing! Now would be a good time to review some of your previous work and also to make sure you have on hand what you'll need for testing: antenna, fresh battery, earphone or speaker with correct plug or adapter.

- 77. Review the instructions for installing U1 and U2. Insert the LM386 IC with the band or dot oriented correctly. Solder the 8 connections.
- 78. Install C32, a 100 to 220 uf electrolytic, observe correct polarity.
- 79. Install C31, .01 uf (marked .01 or 103 or 10nf).
- 80. Install C36, 4.7 or 10 uf electrolytic, observe polarity.
- 81. Install C33, 100 to 220 uf electrolytic, observe polarity.
- 82. Install the battery snap terminal in the two holes below S1, making sure that the positive (red) lead is inserted into the (+) hole on the PC board.
- 83. The battery bracket may be attached in a variety of ways. A wire jumper can be passed through the two holes on the PC board, then both ends soldered on the underside of the board. You may prefer to use very small screws or even a double-sided mounting adhesive strip or glue. In using such methods, make sure that the battery will not block the PC board's mounting hole in its vicinity.

Wiring of the PC board is now complete. If you have the the patience, we suggest a short break. Then, take a magnifying lens and a bright light and examine all your solder joints, touching up any connection which appears less than perfect. Make sure all excess leads have been trimmed, and that there's not one bent back flat against the board, probably causing a short. Brush the solder side of the board with a stiff brush to make sure that no loose wire trimmings or solder drippings (tsk tsk) are lodged between connections.

TESTING, ALIGNMENT AND ADJUSTMENT

To prepare the FR220 FM VHF Receiver for reliable monitoring operation, you will need these basic tools:

- 1. A useful 220 MHz VHF signal source.
- 2. Hexagonal, non-metallic coil slug alignment tool for L3.
- 3. Small screwdriver to adjust L4.

1. Signal source: This signal can be from your test bench equipment or from a "live" source such as a local repeater. The "live" signals are best for fine-tuning, but they also have that VHF communications character of being fast and to the point. Good test bench signal sources include your own 220 MHz transceiver, if you are licensed to use it, a signal generator or grid-dip oscillator.

2. L3 Alignment Tool: If you do not already have a set of plastic or nylon coil alignment tools and do expect to try further Ham radio or electronic hobby projects, such tools are worth having and can be found inexpensively at any electronics store including Radio Shack. While a metal Hex key wrench can fit the coil slug, the metal itself would damage the coil inductance drastically and therefore should not be used. With patience and sandpaper, a useable tool might be formed from a wood or plastic rod.

ALIGNMENT PROCEDURE

- 1. Make sure the power switch is off.
- 2. Connect the antenna, earphone or speaker and battery.
- 3. Turn the slug of L3 until it is even with the top of coil the form.
- 4. Now, turn the slug of L3 clockwise 7 turns back into the form.
- 5. Turn the slug of L4 until it is flush with the top of the coil and then turn it 2 turns back into the coil.
- 6. Turn all three controls to the left, fully counterclockwise.

- ❑ 7. Turn the power ON.
- ❑ 8. Turn R2 (Volume control) until you hear some noise.
- ❑ 9. Adjust L4 for maximum noise in the speaker.

Further alignment now consists of adjusting the oscillator coil L3 to permit the tuning control (R3) to cover the 5 MHz segment between 222 and 227 MHz of primary interest to you.

If you are a beginner with no license or other equipment, any Ham operator with a 220 MHz transceiver should be willing to give you the test signal and extra help that you need. The FR220 is very sensitive, so operate the transceiver on low power on a simplex frequency no closer than across the room. An 8" piece of wire will be a sufficient receiving antenna for such tests. If you don't know any Hams, visit a friendly two-way radio service center to get close to the test signal you need!

If available in your area, TV channel 13 transmits the audio portion of its signal on 215.75 MHz. If you can tune some semblance of channel 13 audio on your receiver, you know that a slight adjustment of L3 will bring your receiver up into the 222 MHz ham band. You would turn the coil slug CCW to increase its resonant frequency. Do not expect to hear the TV channel's audio clearly, it's wideband FM (75 KHz) signal is too broad for our narrowband FM IF filter.

If TV channel 13 is not on in your area, you can use a TV set to receive the FR220's local oscillator signal. Connect the TV antenna to the FR220's antenna jack, enough signal will "leak" out the antenna jack and be picked up by the TV. You'll see the TV picture or sound go blank as you tune. Remember that if you tune the TV to channel 13, it is set to receive sound at 215.75 MHz, and if it is receiving the FR220, the FR220 is actually set to receive 205.05 MHz ($205.05 + 10.7 = 215.75$).

Other TV channels near the FR220's tuning range

- Channel 13 Video: 211.25 MHz Audio: 215.75 MHz
- Channel 12 Video: 205.25 MHz Audio: 209.75 MHz
- Channel 11 Video: 199.25 MHz Audio: 203.75 MHz

The small 4 turn coils are stretched or compressed when receiving a weak signal. Typically the coils are spread to about 1/4 inch width. Make this adjustment only when receiving a constant weak signal, this simple "tweak" will significantly perk up your reception!

RECEIVER SENSITIVITY

Your FM receiver features sensitivity under 1 uv. Radio hams constantly marvel at how an FR220 displayed at hamfests tunes in dozens of hand-held QSO's on the premises- without an antenna connected! You can expect to monitor local repeater and simplex transmissions easily, using a simple groundplane style antenna. The receiver also responds very well to the addition of a low-noise pre-amplifier such as the Ramsey SA-7, PR-2 or PR-20. The PR-20, 220 MHz preamp kit features High-Q tuned circuitry for a significant performance improvement. A new and versatile receiver accessory is the Ramsey AA-7 HF-VHF Active Antenna, which doubles as a preamplifier with other antennas in addition to the excellent performance of its own whip.

ADDING AN LED POWER "ON" INDICATOR

For many people, a pilot lamp to indicate "power on" is more than a nice touch. They expect it and depend on it, reminding us that "real radios glow in the dark!" Adding a simple LED power-on indicator to your Ramsey kit receiver is easy. All you need is the LED itself and a small 1K to 2.2K resistor.

Study the PC traces between the positive battery supply wire and the on-off switch. The unused connectors on top of your switch are an ideal point to get the + DC voltage needed for the anode (longer lead) of the LED. Plan where and how you wish to install the LED in your enclosure.

Locating the LED immediately above the on-off switch is logical and ideal. The simplest way to make a good installation is to drill a neat hole just slightly smaller than the diameter of the LED. Then, enlarge the hole a little bit at a time, just enough to let the LED be pressed in and held firmly. The resistor may be connected to either the anode or cathode of the LED, but the anode **MUST** go to + DC, with the cathode connected to the nearest common ground point. If you are wondering why we did not include these pennies worth of parts with your kit, you can believe any of the following reasons:

- (1) We wanted to stretch your battery budget: with the LED drawing about 6 ma, how long will your battery last if you leave your receiver on for a few days, just like we leave our computers and Ham or computer accessories on all the time?
- (2) We thought you'd have more fun planning and installing your own lamp that glows in the dark!
- (3) We could not decide which color you would like best!

THE RAMSEY ELECTRONICS CASE, KNOB & HARDWARE OPTION

Your finished receiver can be installed in a variety of enclosures of your own design and choosing. You might be planning to combine several Ramsey circuit boards in a single enclosure. Use of the inexpensive and attractive Ramsey case and knob kit will give your unit that finished look and increase its resale value. These sturdy black instrument cases are supplied with neatly-lettered front and rear panels, knobs, rubber feet and mounting screws.

OTHER ENCLOSURE RECOMMENDATIONS

While we believe that the Ramsey enclosure and knob option is a fine value for finishing off your Ramsey receiver or transmitter, we are happy to give you a couple of additional suggestions. If your first goal is economy and rugged portability, you will find that the circuit board can be mounted nicely in a standard VHS videotape storage box, which also gives room for a speaker, or earphone storage, and even a roll of antenna wire. The controls are easily mounted at one end of such a box. It may be necessary to cut away the molded posts which secure the tape cassette itself. These storage boxes come in several styles, so pick one that looks truly practical as a project enclosure.

To accomplish RF shielding, the most economical metal enclosure nicely suited for Ramsey amateur kit boards is Radio Shack No. 270-253A. This metal utility cabinet can accommodate both a receiver and transmitter board, plus speaker, with room for various refinements you might like to add.

FR-6 TROUBLESHOOTING GUIDE

The Ramsey FR-series FM receivers are among our most widely-used and popular kits. The circuit itself, assembly and use are "cut-and-dried." If your receiver does not work, there is an error in assembly or defective part. Following is some help in case you experience difficulty.

Problem: Receiver completely "dead"- no sound at all.

- ❑ Check the following: First, the cable or plug adapter leading to speaker or phones!
- ❑ Battery condition and battery wire polarity and soldering at S1 Connections associated with U3, the LM386 audio output IC

Problem: Receiver "hisses", but NO signals are heard, not even a signal generator 2 inches away.

First, you need to verify that the local oscillator (SA602, L3, etc.) is operating. Use another VHF receiver or a frequency counter to verify oscillator operation. Next, make sure that the 10.245 MHz crystal oscillator is running by tuning a general purpose HF ("shortwave") receiver to that frequency. If either oscillator is not running, re-check correctness of parts and solder joints associated with both oscillator circuits. Further signal-path tracing may be necessary to find your problem.

Problem: Very weak signals If Q1 is defective or incorrectly installed, very little signal energy will reach the SA602.

If Q2 is defective or installed incorrectly, very little of the SA602's 10.7 MHz output is getting to the MC3359. Also, be sure L4 is peaked correctly.

Problem: Considerable frequency drift or shifting

First, make sure that L3 is soldered securely to the PC board. If you plan to use the receiver "on the go", you may wish to secure the base of the coil to the board with reinforcing glue. If the receiver drifts, check all wiring and components associated with AFC Q3 and pin 11 of the MC3359.

Problem: Squelch does not function

Re-check all connections and components associated with pins 10 through 16 of the MC3359. Check polarity of C27 and D2. C27 sets the time constant for the squelch circuit.

SOME NOTES FOR ADVANCED USERS

Unlike Ramsey HF receivers and transmitters, the FR-series of VHF receivers do not offer much PC board space or real need for customization or other modifications. These receivers do what they are intended to do at the lowest price that we are aware of for a tunable VHF FM receiver with squelch, AFC and generous audio output. Therefore, while we are certainly interested in hearing about significant performance improvements, we do not recommend casual modification attempts.

However, there is one practical customization which could be undertaken by experienced VHF experimenters who wish to take advantage of the SA602's ability to accept a crystal resonator instead of the existing L-C tank circuit. The goal would be a one channel repeater monitor or dedicated packet receiver. Inductor L3 and associated capacitors would be replaced by the appropriate crystal tank components. Remember that the crystal oscillator should be planned to operate 10.7 MHz above the desired receiving frequency. Please do not attempt such a project unless you have a clear knowledge of oscillator design and have reviewed and understood the terms of your Ramsey Kit Warranty. We regret that the factory cannot offer any assistance in performing this or any other modification, so... you're on your own, but that's what experimenting is all about!

A helpful article on the Signetics NE602 IC, including a discussion of crystal-controlled oscillator configurations, was written by Michael A. Covington with acknowledged assistance from Signetics personnel, published with good circuit illustrations in Radio-Electronics magazine for April 1990 (Vol 61, No 4). It will help you understand your SA602.

A less complex approach to the same general goal, eliminating the expense of a crystal and the logistics of adding it to the PC board, is to "undo" the excellent tuning range we designed into your receiver! This would require selecting appropriate values for C9,C10 and C12 and reducing the effect of the varactor tuning to perhaps a 100 KHz swing

for fine tuning purposes only. Try reducing C12 to 1 or 2 pF for starters.

Finally, the only pin of the MC3359 not used in our circuit is pin 15, for scan control. Perhaps you will come up with some fascinating idea for it!

Again, please be sure that you understand your warranty, and that you understand your receiver and how to keep it working, before attempting any modifications.

If you've enjoyed this kit, be sure to check out the entire Ramsey kit line. We have a whole series of nifty synthesized VHF FM Transceiver kits that not only teach state-of-the-art technology, but are fun and easy to build, too! Call or write for our catalog.

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 (1/2 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.

FR220 220 MHz FM Receiver Kit
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REQUIRED TOOLS

- Soldering Iron Ramsey WLC100
- Thin Rosin Core Solder Ramsey RTS12
- Needle Nose Pliers Ramsey MPP4 or RTS05
- Small Diagonal Cutters Ramsey RTS04
- <OR> Technician's Tool Kit TK405

TOTAL SOLDER POINTS

232

ESTIMATED ASSEMBLY

TIME

Beginner6.8 hrs
Intermediate3.9 hrs
Advanced2.9 hrs

ADDITIONAL SUGGESTED ITEMS

- Holder for PC Board/Parts Ramsey HH3
- Desoldering Braid Ramsey RTS08
- Digital Multimeter Ramsey M133

Price: \$5.00

Ramsey Publication No. FR220

Assembly and Instruction manual for:

RAMSEY MODEL NO. FR220 220 MHz FM RECEIVER KIT

