# AIRCRAFT RECEIVER KIT

Ramsey Electronics Model No.   AR2

A new and improved version of our popular Aircraft Receiver kit, this new model features an LCD display, scan function, and increased sensitivity, all in a rugged metal enclosure. Rivals professional units costing much more and you have bragging rights because you built it yourself!

- **Tunes the entire 118 - 136 MHz Air band**

- **Operates on 12 to 15 VDC**

- **Scan function "finds" the signals for you; no more laborious tuning to find a transmission**

- **Memory locations make it easy to refind your local favorites**

- **Listen to control towers, centers, and planes en-route**

- **Very sensitive; picks up planes 100 miles away!**

- **Great project for all pilots and flight students**

- **Clear, concise step-by-step instructions carefully guide you to a finished kit that not only works - but you'll learn too!**
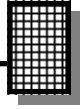
PARTIAL LIST OF AVAILABLE KITS:

RAMSEY TRANSMITTER KITS
- **FM10A, FM25B, FM30, FM Stereo Transmitters**
- **FM100B, FM35 Professional FM Stereo Transmitters**
- **AM1, AM25 AM Broadcast Band Transmitters**

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**
- **SS70C Speech Scrambler/Descrambler**
- **TT1 Telephone Recorder**
- **SP1 Speakerphone**
- **MD3 Microwave Motion Detector**
- **PH14 Peak hold Meter**
- **LC1 Inductance-Capacitance Meter**

RAMSEY AMATEUR RADIO KITS
- **HR Series HF All Mode Receivers**
- **DDF1 Doppler Direction Finder Kit**
- **QRP Series HF CW Transmitters**
- **CW7 CW Keyer**
- **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.
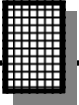
INSTRUCTION MANUAL FOR

AIRCRAFT RECEIVER

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INTRODUCTION TO THE AR2 AVIATION RECEIVER KIT

The Ramsey AR2 Aviation Receiver is a new design of our original Ramsey AR1 Aircraft Receiver. The AR1 has been built and loved for years by hobbyists with an interest in both aviation and electronics. The AR2 design takes the best of the AR1 and adds scanning functions, and a slick metal case for superior noise reduction. It is characterized by exceptional sensitivity, image rejection, signal-to-noise ratio and stability. It is designed for casual "listening in"- on both ground and air communication, for both commercial airlines and general aviation. The AR2 has been built by folks of all ages and skill levels, and in less time than it takes to fly solo!

118-136 MHz, WHAT YOU CAN EXPECT TO HEAR

A basic fact about the VHF Aviation Band which even licensed pilots can overlook or forget is that communications are in the AM mode, not FM, as in the case of the FM broadcast band immediately below it, and the VHF public service and ham bands immediately above it.

No matter where you live you will be able to receive at least the airborne side of many air traffic communications. You'll hear any aircraft you can see, PLUS planes up to 100 miles away and more, since VHF signals travel "line of sight." An airliner at 35,000 feet altitude is still line of sight to your antenna. Similarly, whatever ground stations you may hear are also determined by this "line of sight" characteristic of VHF communication. If there are no major obstacles between your antenna and an airport (tall buildings, hills, etc.) you'll be able to hear both sides of many kinds of aviation communication. Be prepared for them to be fast and to the point, and for the same airplane to move to several different frequencies in the span of a few minutes! Here's a brief listing of the most common types of services in the NAS (National Airspace System) with which pilots communicate:

Clearance Delivery
At most metropolitan airports a pilot communicates with the FAA on a frequency called "Clearance Delivery" to obtain approval or clearance of the intended flight plan. This communication is done before contacting ground control for taxi instructions.

Ground Control
From the control tower, ground movements on ramps and taxiways are handled on the "Ground Control" frequency.

Control Tower
Runway and in-flight maneuvers near the airport, usually within three miles (takeoffs, local traffic patterns, final approaches and landings) are on the "Control Tower" frequency.

ATIS – Automated Terminal Information System
ATIS, is a repeated broadcast about basic weather information, runways in use, and any special information such as closed taxiways or runways.

ASOS/AWOS – Automated Surface Observing System/Automated Weather Observing System
This system is similar to ATIS but usually located at un-towered airports.

Approach Control & Departure Control
These air traffic radar controllers coordinate all flight operations in the vicinity of busy metropolitan airport areas.

ARTCC – Air Route Traffic Control Center
When you hear a pilot talking with "Jacksonville Center" or "Indianapolis Center", you know the aircraft is really enroute on a flight rather than just leaving or just approaching a destination. A pilot will be in touch with several different "Regional Centers" during a cross-country flight.

CTAF – Common Traffic Advisory Frequency
Airports without control towers are controlled by the pilots themselves and they rely on the local CTAF frequency dedicated only to advisory communications between pilots and ground personnel such as fuel service operators. The people on the ground can advise the pilot on the status of incoming or outgoing aircraft, but the pilot remains responsible for landing and takeoff decisions. Typical CTAF frequencies are 122.7, 122.8 and 123.0 MHz. Unicom frequencies are used at manned towered airports for day to day businesses at 122.75, 122.85, and 122.95 MHz.

FSS - FAA Flight Service Stations
The FAA's network of Flight Service Stations keeps track of flight plans and provides weather briefings and other services to pilots. Some advisory radio communication takes place between pilots and a regional "FSS". If there is an FSS in your local area, but no airport control towers, the FSS radio frequency will stay interesting. Typical frequencies are 122.1, 122.6, and 123.6 MHz. Pilots always address the FSS by calling the FSS name followed by "Radio".

ELT – Emergency Locator Transmitters
Emergency and guard channels are used by airplanes in flight operations during an emergency or talking on official business and can be heard on 121.5MHz.

ACARS - Aircraft Communication Addressing and Reporting System
ACARS is a digital VHF radio data link which allows airline flight operations departments to communicate with the various aircraft in their fleet. ACARS is used by many civilian and business aircraft and is similar to "email for airplanes". Each aircraft has its own unique address in the system. Traffic is

routed via computers to the proper company, relieving some of the necessity for routine voice communication. With ACARS, routine items such as departure reports, arrival reports, passenger loads, fuel data, engine performance data, and more can be retrieved from the aircraft at automatic intervals. The transmission will sound like a short data burst to the ABM1 user.

THOSE FAST-TALKING PILOTS AND CONTROLLERS!

Aviation communication is brief but it is clear and full of meaning. Usually, pilots repeat back exactly what they hear from a controller so that both know that the message or instructions were correctly interpreted. If you are listening in it is hard to track everything said from a cockpit, particularly in big city areas. Just to taxi, take off, and fly a few miles, a pilot may talk with 6 or 8 different air traffic control operations, all on different frequencies, all within a few minutes! Here are the meanings of a few typical communications:

"Miami Center, Delta 545 Heavy out of three-zero for two-five."

Delta Flight 545 acknowledges Miami Center's clearance to descend from 30,000 feet to 25,000 feet altitude. The word "heavy" means that the plane is a jumbo jet such as 747, DC-10, etc.

"Seneca 432 Lima cleared to outer marker. Contact Tower 118.7."

The local Approach Control is saying that the Piper Seneca with the N-number (tail number) ending in "432L" is cleared to continue flying an instrument approach to the outer marker (a precision radio beacon located near the airport) and should immediately call the airport radio control tower at 118.7 Mhz. This message also implies that the approach controller does not expect to talk again with that aircraft.

"Cessna 723, squawk 6750, climb and maintain five thousand."

A controller is telling the Cessna pilot to set the airplane's radar transponder to code 6750, climb to and fly level at an altitude of 5000 feet.

"United 330, traffic at 9 o'clock, 4 miles, altitude unknown."

The controller alerts United Airlines flight #330 of radar contact with some other aircraft off to the pilot's left at a 9 o'clock position. Since the unknown plane's altitude is also unknown, both controller and pilot realize that it is a smaller private plane not equipped with altitude-reporting equipment.

ELECTRONICS & FLYING: DOING IT "BY THE NUMBERS"

A peek at the sample FAA "instrument approach" chart for medium-large airports shows that pilots deal with many vitally important numbers and must do so quickly. Among the numbers on that chart, can you find the air-ground communications frequencies which can be heard on the ABM1 receiver? Can you find frequencies for uses other than communications?

VOR/DME RWY 2L

AL-282 (FAA)

NASHVILLE APP CON
120.6 388.0
NASHVILLE TOWER
119.1 257.8
GND CON
121.9 257.8
CLNC DEL 126.05
ASR
ATIS 120.0

TANDS
BNA 25 DME

R-267

LIVINGSTON
108.4 LVT
Chan 21

ENROUTE FACILITIES

FEEDER FACILITIES

15 NM

R-011

2049

NASHVILLE
114.1 BNA
Chan 88

856

2049 1216 729 780

2700
201°(4.5)
(IAF)
BNA 3 DME

R-100 (IAF)

2049

BNA 4.5 DME

950± 1003

1490

2700

BNA 11 DME A/C

BNA11 DME

2000 NoPT to
BNA 4.5 DME

2700 NoPT
to BNA11 DME
021°(4)

156°

3000
081°
(31.8)

R-081

R-201

(IAF)
JOVAL
BNA15 DME

GRAHAM
111.6 GHM
Chan 53

SHELBYVILLE
109.0 SYI
Chan 27

R-316

3000
316° (26.5)

MSA BNA 25 NM

3100 2300

Remain
within 10 NM

2700

BNA 4.5 DME

201°

021°

2000

1440

MISSED APPROACH
Climb to 3000 via BNA
VORTAC R-011 to Tands
Int and hold.

BNA 3 DME

VORTAC

ELEV 599   TDZ/CL Rwy 2L

557

730

672

TDZE
599

679 2L

670

ELEV 599

REIL Rwy 20R
MIRL Rwy 2R-20L
HIRL Rwys 2L-20R and 13-31

726

CATEGORY	A	B	C	D
S-2L	980/24 381 (400-½)			980/50 381 (400-1)
CIRCLING	1060-1 461 (500-1)		1080-1½ 481 (500-1½)	1160-2 561 (600-2)

CAUTION: Brightly lighted building west of ALS Rwy 2L.
With inoperative ALS, Cat. D visibility becomes 6000 RVR.

Knots	60	90	120	150	180
Min:Sec					

VOR/DME RWY 2L   36°08'N – 86°41'W

CIRCUIT DESCRIPTION

Radio Basics:

We'll take the circuit section by section; the letters show which part of the block diagram we're explaining in each section.

The AR2 is a simple super-heterodyne receiver. A heterodyne receiver is a receiver that first converts the desired received frequency into an IF frequency, or Intermediate Frequency. Many radios are designed this way due to a variety of reasons, but primarily because it is easy to perform filtering and amplification on the IF signal rather than the RF signal because the IF is a single frequency or small band of frequencies, whereas RF is quite a bit wider and usually much higher in frequency than IF.

To create an IF frequency we use a mixer (**D**) to down-convert the band of interest to the single IF frequency. A mixer is a non-linear device, meaning it will distort the incoming signal with an applied signal. In the case of a mixer used on a radio this means you will have two different frequencies on the inputs, which results in four signals on the output. The received frequency is connected to one input and the local oscillator or LO is supplied to the other. On the output you will have these two important frequencies as well as the sum and difference between the two frequencies.

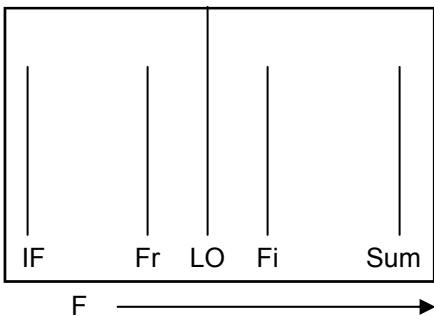IF   Fr   LO   Fi   Sum

F ————————————————————→

Figure 1

For example the aircraft band goes from 118MHz to 139MHz, and we plan to use an IF frequency of 10.7MHz, we need to have an LO of either 10.7MHz above the frequency we wish to receive, or 10.7MHz below. It is a matter of preference in which mixing byproduct you wish to work with, but in the case of the AR2 we use an LO of 10.7MHz above the frequency we wish to receive. This means that the LO needs to tune from 128.7MHz to 149.7MHz. This is called high-side mixing since the LO is above the frequency of interest. The LO is generated using a phase locked loop and voltage controlled oscillator on the AR2 (**J, D**).

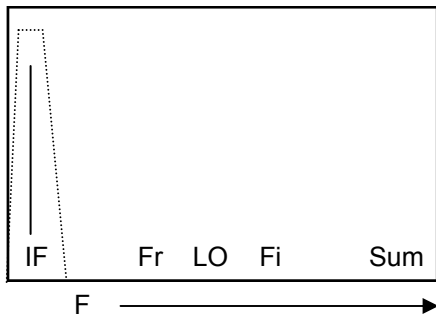Let's say for example that we wish to listen to the control tower at ROC (Rochester International Airport) at 118.300MHz. The LO frequency would

IF   Fr   LO   Fi   Sum

F ————————————————————→

Figure 2

have to be set at 118.300 MHz + 10.700 MHz or 129.000MHz. It would then be sent to the mixer and on the output there would be 129.000MHz (LO), 118.3MHz(Fr), 247.3MHz(Sum) and 10.700MHz (IF). (See Figure 1)

After the mixer we use a narrow-band filter (E) to reject everything but the 10.7MHz IF signal output from the mixer. This works well because 10.7MHz is far from the next highest frequency, 118.3MHz, so it's easy to reject everything but the signal of interest. However, there is another signal you can receive that is 10.7MHz *above* the LO frequency. This is called the image frequency, and can be a real hassle in radio designs. In this case we could receive not only 118.3MHz but also 139.7MHz (2x IF + Fr). In this case this "image" is only 700kHz outside the band of interest and is almost impossible to filter out.


IF   Fr LO Fi   Sum

F
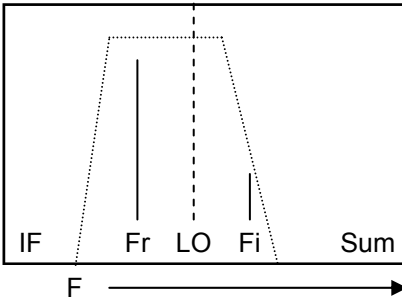
Figure 3

The AR2 reduces the reception of image frequencies by using good band-pass filters on the input to reject the image frequencies before they make it to the mixer (**A, C**). Figure 3 to the left shows what the RF input to the mixer looks like. Notice the Fi is greatly reduced by the input band pass filter, but not completely eliminated. The band pass filter certainly helps and gets rid of all but the strongest image signals outside the band.

Now that we have our filtered 10.7MHz IF at the output of the IF filter we can do some simple amplification on it (**F**), then send it to be demodulated into audio.

The IF signal is then sent to the AM detector part (**G**), where it is mixed down to yet another IF frequency of 450kHz by combining 10.7MHz with 10.25MHz. 450kHz is used due to the large array of components available at 450kHz, and it is also the frequency at which our particular AM demodulator works best. The signal is then amplified greatly to a consistent level using "slow" AGC within the detector part. The detector is able to receive quality AM signals in a 90dB range, since the AGC can amplify the signal up 90dB. The AGC is important in that all received signals within its range will be of the same audio amplitude. Otherwise weak signals would be very quiet, and nearby ones would be very loud. The reason it is "slow" is to allow changes in level due to audio to be left alone, but longer-term signal level changes due to distant signals and close signals to be compensated for.
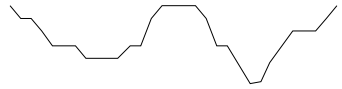
The 450kHz IF, now that it is a consistent level, is demodulated using a full-wave rectifier and filter to remove the 450kHz, and leave the AM level behind as shown.
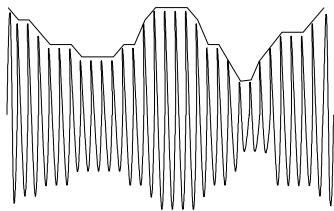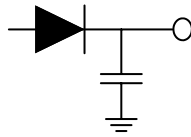
AM + 450kHz　　　　Detector +　　　　Audio Out

Since the AR2 is a relatively complex (and educational!) product, it's easiest to show you how things work by using a block diagram and explaining the different sections. This is a simplified block diagram, but is suitable for our needs.

Block A. RF band pass pre-filter. This is one of the two filters that helps reject image frequencies. Note the PCB layout has coils built right in! This makes for very precise, repeatable coils, and since the inductance for this design needed to be very small, this was a lot easier than installing a 1 ½ turn coil.
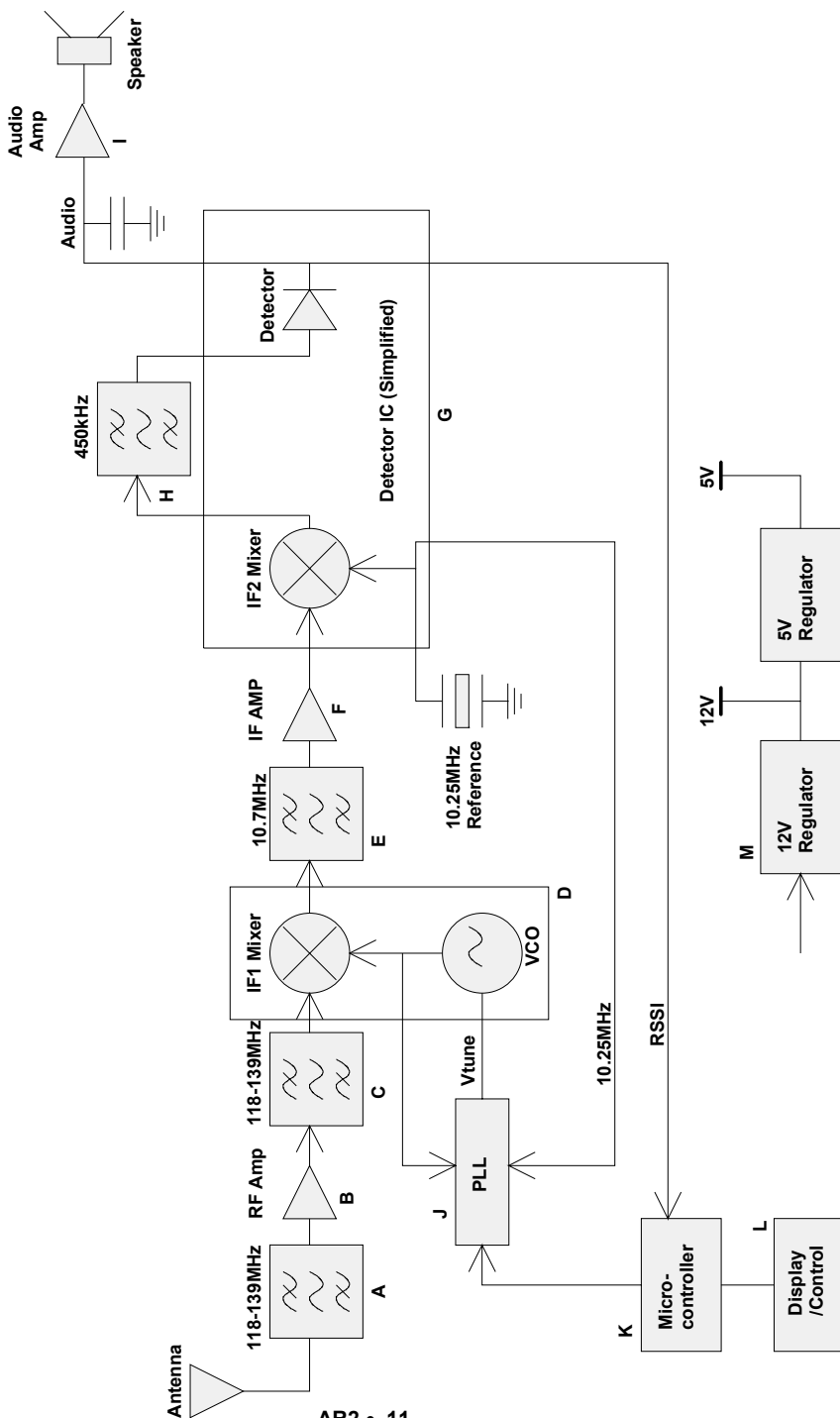
Block B. RF amplifier. This amplifier makes up for the "insertion loss" of the two filters, and increases the radio's sensitivity to weak signals. Insertion loss is defined as how much desired signal is lost by a filter or device.

Block C. RF band pass secondary filter. This section further reduces the possibility of image frequencies being received.

Block D. IF Mixer/VCO. This section consists of an NE602 mixer/oscillator that can be tuned using what is called a varactor diode in the oscillator section. A varactor diode is a reverse-biased diode that changes capacitance according to the reverse voltage. The higher the voltage, the wider the insulation (depletion layer) and the smaller the capacitance. Thus as the voltage goes up across the diode, so does the frequency! The tuned inductor sets the center frequency of our tunable band. We are limited to a little more than 21MHz, but we are never sure where this range is due to part variances. The coil allows us to get the 21MHz range centered in our band of interest so that the frequency will always remain locked throughout the band.

Block E. 10.7MHz IF filter. This is a special ceramic 10.7MHz filter for narrow-band AM. This helps in rejecting adjacent channels which are only 25kHz away. The filter is 13kHz wide, meaning 6.5kHz to either side.

Block F. This is a simple, single transistor IF amplifier. It has quite a lot of gain to make up for the insertion loss of the mixer/VCO as well as the 10.7MHz IF filter. This is the advantage of using a low frequency IF since a simple transistor amplifier works well here.

Antenna

A — 118-139MHz

B — RF Amp

C — 118-139MHz

IF1 Mixer — D

VCO

E — 10.7MHz

F — IF AMP

IF2 Mixer

H — 450kHz

Detector

G — Detector IC (Simplified)

10.25MHz Reference

Audio

I — Audio Amp

Speaker

J — PLL

Vtune

10.25MHz

RSSI

K — Micro-controller

L — Display /Control

M — 12V Regulator

5V Regulator

12V

5V

AR2 • 11

Block G.   This is the main detector, AGC, 2nd LO, reference oscillator, and filtering all wrapped into one part.

Block H. 2nd IF filtering. This section is for further attenuating adjacent signals. The goal is to reduce signals 25kHz away more than 90dB, or the range of the AGC of the detector component. Two cascaded 450kHz filters are used here on top of the 10.7MHz ceramic filter.

Block I. After the AM has been detected the small level of audio signal is amplified enough to drive a speaker to respectable volumes

Block J.   The Phase Locked Loop works in conjunction with the VCO (NE602 and varactor diode) and the reference 10.25MHz oscillator. The PLL part (U2, MC145170P2) has two dividers and some option registers for different designs that are usually set only once. One of the two dividers divides down the LO frequency from the VCO to make the channel step size 25kHz (N divider), and the other divides down the reference oscillator to the specific channel step size of 25kHz (C divider). The 25kHz is the reference comparator frequency, and the output of the PLL tries to make the VCO tune so that the output of it s divider is also "Locked" to 25kHz. A correction pulse is generated for each phase of the reference, and that is where phase locked loop comes from!

For example the PLL is programmed by the microcontroller to have a C value of 410. This means the reference clock of 10.25MHz is divided by 410 to give a divider output of 25kHz. This value remains constant throughout the AR2 circuit. To receive 118.3MHz we have to set the N value of the divider to give us 25kHz from the divided down RF of the LO frequency. Take (118.3MHz + 10.7MHz)/25kHz = N or 5160. Now the dividers are set up to request this LO frequency, however the VCO has not been tuned there yet. If there is any error between the "C" output and the "N" divider output, which there should be after switching the N divider, an internal comparator looks at the two 25kHz signals together then provides error correction pulses to tune the VCO to correct the difference.

For example the VCO frequency is too low, which results in 24.999kHz output at the N divider rather than 25kHz at the C divider. The PLL comparator output will then provide some high-going pulses to the PLL filter (U5:A and surrounding parts) to bring the tuning voltage up so the 25kHz divider outputs begin to come closer. Once the two frequencies match, small error pulses "tap" the VCO to keep it "phase locked" to the divided reference clock and make up for any environmental changes such as temperature and vibration.

The PLL filter removes the comparator error correcting pulses of 25kHz by low-pass filtering them. These tuning filters are also called integrators since they have no DC feedback. What results is a steady tuning voltage that allows the VCO to change smoothly from one channel to the next without 25kHz signals

being "imposed" on the VCO. It also provides some amplification to give the VCO 0-12V of tuning from a 5V PLL part.

Block K. The microcontroller is the "brains" of the entire project. This device programs the PLL to get the frequencies desired, handles the jog dial by interpreting it's pulses, and then writes the data to the displays. Quite a bit of coding is required to handle the scanning functions and the user interface, so don't underestimate what goes on inside this little device!

Block L. This is the display and the user control devices.

Block M. Power supply section.

A NEW ADDITION TO RAMSEY MANUALS

We've added a little something to our kit manuals starting with the one in your hands. When you see the little guy holding the light bulb to the left of this text you'll know that a Ramsey Kit Building Tip is right beside him. This idea came about as I was building the first prototype of the current revision PC board. Before a Ramsey kit ever makes it to you we've already built several prototypes and then we build the actual revision board that you have, proofing the manual and the parts/board/etc. all at the same time. We have different people build the kits and we take input from every builder, always striving to make your kit building experience as easy and pleasant as possible. During the construction process I noticed a few things that might prove to be helpful to a newcomer, things experienced kit builders might take for granted, and decided to write them down. These ideas or tips have been popped into the text as you build and marked with this little guy holding the light bulb. Get the idea?

Since a lot of the tips will be common to any kit building experience we'll be repeating them in subsequent manuals, however, if our kit customers keep coming across the same or similar text in the Assembly Steps they'll begin to gloss over them and stop reading all the text in each step. And that can prove to be fatal to your kit! We want to give you tips but we don't want anyone missing something important in the Assembly text and that's where the Idea Man symbol comes in. Once you've built a few dozen of our kits and you're an old hand at building you won't necessarily need every hint all the time but since they're clearly marked you can simply skip over them. You might miss some good jokes but that's up to you. We hope you find something useful, some 'back at the shop' wisdom as you read the hints and that they help you get to our goal of a well built kit that works the first time, every time.

AR2 PARTS LIST:

CAPACITORS
- ❐ 2 3.3 pF ceramic capacitors [marked 3.3] (C25,28)
- ❐ 1 5 pF ceramic capacitor [marked 5] (C23)
- ❐ 1 10 pF ceramic capacitor (C32)
- ❐ 2 22 pF ceramic capacitors(C24,38)
- ❐ 1 56 pF ceramic capacitor (C63)
- ❐ 1 62 pF ceramic capacitor (C54)
- ❐ 4 82 pF ceramic capacitors (C30,31,33,34)
- ❐ 4 100 pF ceramic capacitors (C1,2,3,6)
- ❐ 15 1nF disc capacitors (marked .001 or 102)
  (C10,12,15,22,26,27,29,35,37,39,42,53,55,56,65)
- ❐ 7 0.01 µF disc capacitors [marked .01 or 103 or 10nf]
  (C7,8,16,18,41,44,64)
- ❐ 2 20 nF ceramic capacitors [marked 20M] (C40,45)
- ❐ 14 0.1 µF disc capacitors [marked .1 or 104]
  (C11,13,17,19,20,36,43,46,47,49,51,57,68,69)
- ❐ 1 0.22uF ceramic capacitor (C60)
- ❐ 2 2.2 µF electrolytic capacitors (C58,59)
- ❐ 7 10 µF electrolytic capacitors (C5,9,14,21,50,62,66)
- ❐ 1 220 µF electrolytic capacitor (C67)
- ❐ 2 1000 µF electrolytic capacitors (C4,61)
- ❐ 1 35 pF trimmer capacitor [round red part with adjustment] (C48)

FIXED RESISTORS
- ❐ 1 2 ohm resistor [red-black-gold] (R39)
- ❐ 2 22 ohm resistors [red-red-black] (R28,35)
- ❐ 1 51 ohm resistor [green-brown-black] (R16)
- ❐ 1 150 ohm 1/2 watt resistor [brown-green-brown] (R10)
- ❐ 1 220 ohm resistor [red-red-brown] (R40)
- ❐ 1 330 ohm resistor [orange-orange-brown] (R29)
- ❐ 6 470 ohm resistors [yellow-violet-brown] (R1,2,3,9,13,32)
- ❐ 1 1K ohm resistor [brown-black-red] (R11)
- ❐ 1 2.2k ohm resistor [red-red-red] (R38)
- ❐ 3 2.7k ohm resistors [red-violet-red] (R23,36,41)
- ❐ 3 4.7k ohm resistor [yellow-violet-red] (R17,30,33)
- ❐ 5 10K ohm resistors [brown-black-orange] (R5,7,8,15,37)
- ❐ 1 22K ohm resistor [red-red-orange] (R18)
- ❐ 7 47K ohm resistors [yellow-violet-orange] (R12,20,21,22,24,25,34)
- ❐ 2 82k ohm resistors [gray-red-orange] (R19,26)
- ❐ 1 470k ohm resistor [yellow-violet-yellow] (R31)
- ❐ 1 2.2 megohm resistor [red-red-green] (R14)
- ❐ 1 10k ohm trimmer potentiometer [orange top marked 103] (R6)

SEMICONDUCTORS
- ❒ 1 1N4000 series diode [any value from 1N4000 to 1N4007] (D1)
- ❒ 1 2SC2570A NPN UHF transistor (Q1)
- ❒ 2 2N3904 NPN transistors (Q2,3)
- ❒ 1 LM7812 12 volt regulator (VR1)
- ❒ 1 78L05 5 volt regulator [looks like a transistor, marked 78L05] (VR2)
- ❒ 1 BB505 varactor diode [marked BB505. Orange body, black band] (D2)
- ❒ 1 BS170 N-channel FET (Q4)
- ❒ 1 SA602 8pin IC (U4)
- ❒ 2 LMC6482AIN Dual rail to rail opamps (U5,6)
- ❒ 1 LM386N Low voltage audio power amplifier IC (U8)
- ❒ 1 MC68HC908JK3CP programmed chip [with a sticker] (U1)
- ❒ 1 MC145170P2 Digital PLL IC (U2)
- ❒ 1 AG102 MMIC Gain block (U3) [preinstalled at the factory]
- ❒ 1 TDA1072AT (U7) [preinstalled at the factory]

INDUCTORS AND FILTERS
- ❒ 1 3.9 uH inductor (L8)
- ❒ 2 11 turn air coils (L1,2)
- ❒ 1 Shielded can coil, 0.18uH [metal body] (L7)
- ❒ 1 10.7 Mhz [brown molded, 3 leads] (FL1)
- ❒ 2 450 kHz filters [black cube] (FL2,3)

CONTROLS, HARDWARE & MISCELLANEOUS
- ❒ 1 10.25 MHz crystal [metal can] (X1)
- ❒ 1 421F201 IF transformer [metal can marked IF201] (T1)
- ❒ 1 20 pin socket [for U1]
- ❒ 1 BNC PC mount jack (J7)
- ❒ 1 2x8 line LCD display (DS1)
- ❒ 1 14 pin dual row connector for DS1
- ❒ 1 Rotary encoder (SW1)
- ❒ 1 Switch potentiometer (R4)
- ❒ 1 10k ohm panel mount potentiometer (R27)
- ❒ 1 3.5mm mono speaker jack (J8)
- ❒ 1 3.5mm stereo headphone jack (J9)
- ❒ 1 2.1mm DC power jack, positive tip (J4)
- ❒ 1 4 pin, dual pin row connector (J3)
- ❒ 1 8 pin, dual pin row connector (J5)
- ❒ 1 10 pin dual pin row connector (J1)
- ❒ 1 8 ohm speaker (SP3)
- ❒ 1 1/4" knob for SW1
- ❒ 2 1/8" knobs for R4, R27
- ❒ 4 1-64 X 1/4 inch screws and 1-64 hex nuts (for speaker)
- ❒ 7" length of twisted red and black wire for speaker

ASSEMBLY INSTRUCTIONS

In ALL PC board assembly steps, our word "INSTALL" means to do this:

- Insert the part, oriented or "pointed" correctly, into its holes in the PC board.
- If helpful, gently BEND the part's wire leads or tabs to hold it into place, with the body of the part snugly against the top side ("component side") of the circuit board.
- Solder ALL wires or pins of the part.
- Trim or "nip" all excess wire lengths extending beyond each solder connection, taking care that wire trimmings do not become lodged in solder connections.

Now that you have your parts all sorted and inventoried and your iron is hot you're ready to start. We'll begin with the ICs so that we can use the board to seat them flat on the PC board, then we'll move around the board installing parts in proximity to each other to make the locations easy to find. Check each step off as you complete it; this will help you to find a problem later if necessary. Ok, here we go!

First we need to separate the two circuit boards. They're easy enough to snap apart but once you've done that you should file down the nubs left behind from separating the boards. You can cut them and then file them if you wish.

We'll begin assembly with the small front panel PC board. Sort the parts for this board from the rest and we'll place the smaller components first to make it easier to fit the larger ones in.

- ☐ 1. Install C11, 0.1 µF disc capacitor (marked .1 or 104).

- ☐ 2. Install C8, 0.01 µF disc capacitor (marked .01 or 103 or 10nf).

- ☐ 3. Install R6, 10k ohm trimmer potentiometer (orange top marked 103). This part will be used to adjust the display contrast.

- ☐ 4. Install R7, 10K ohm resistor (brown-black-orange).

- ☐ 5. Install R8, another 10K ohm resistor (brown-black-orange).

- ☐ 6. Install R5, 10K ohm resistor (brown-black-orange). Seem familiar?

- ☐ 7. Install C10, 1nF disc capacitor (marked .001 or 102). This part must be mounted on the opposite side of the PC board from where you've been installing the parts so far. That will make it easier to fit the speaker into the front panel later.

☐ 8. Install C12, another 1nF disc capacitor (marked .001 or 102). This part also needs to be mounted on the opposite side of the PC board.

☐ 9. Install J6, one of the 8 pin dual row connectors. This part is placed from the back of the board, the side you've been soldering so far. The

Here at the shop we typically insert a number of parts through the board, bend the leads out so that they stay put, and solder a group of parts all at one time. Now you don't want a forest of leads to have to work through but 5 - 10 part groups seem to work well.

short pins are placed through the board and the black plastic that holds the pins together sits flat on the PC board. Make sure it's nice and flat or you'll have trouble connecting things later.

☐ 10. In the same way, install J2, the 4 pin dual row connector. You'll be glad you took the time to make sure this part is seated correctly when you go to solder the two PC boards together so take your time.

☐ 11. Let's prepare DS1 by soldering the 14 pin connector to the display PC board. The short pins are placed through the back side of the board where most of the traces are and soldered on the front where the display is. Seat the connector flat and solder one of the end pins. Then check the flatness and solder a pin on the other end, then continue on and solder all the pins. Just be careful not to get near the display with your hot soldering iron since it wouldn't be healthy for the display.

☐ 12. Now that the connector is soldered to the display board we can solder the display board to the front panel PC board. First you'll need to snap off the two metal tabs on the front of the part to make it ready to install. Be sure you grab the correct tabs; the ones on the bottom hold the display in place so you don't want to remove those! Grip one of the front tabs with your needle nose pliers and bend it back and forth until it comes off. Do the same for the other tab. It goes in through the front of the board where the pot is sticking out. Again, check flatness before soldering all the pins in place. This is the part of your kit that you'll see once it's in the case so you want to get it right and make it pretty.

☐ 13. Now we'll install SW1, the rotary encoder. This will be used to change modes when we finally finish your AR2 kit. For now place the part correctly through the board and make sure it's seated flat before you start soldering all the pins.

Let's move on to the larger main PC board and assemble the rest of the kit. And speaking of rest, take a break now and then, examine your work to that point and then just rest your eyes for a minute. Walking away from a kit in

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progress is not a bad thing and when you come back you'll have fresh eyes and renewed vigor to finish. Hey, we all like to take frequent breaks here at the factory . . . but management isn't as kind to us as you can be to yourself!

☐ 14. Install U6, one of the LMC6482AIN ICs. It's located near the center of the PC board. You'll see the PC board silkscreen shows a notch on one end of the part; this corresponds to the notch on the IC and shows you which way to place the part. Line up the notches, then make sure that all pins are through the board. With no other parts installed (other than surface mount) you can have the part sit flat on your bench and the board will hold it in place. That way the part will sit flat on the board. That's why we're putting the ICs in first! We typically solder the two corner pins, flip the board over to check placement, then solder the rest. Be sure to solder all 8 pins.

While you're clipping leads on the back side of the board you can also check the solder joints and immediately touch up any that don't look right. You're already looking at the connections closely and it's a good time to spot mistakes!

☐ 15. Install U8, the LM386 audio amplifier IC. It's located near the back of the board between the markings for J8 and J9. Again, line up the notch on the part with the notch marked on the board, make sure the part is seated flat, then solder all 8 pins.

☐ 16. In the same way, install U4, the SA602 mixer/oscillator chip. Be sure you have it placed correctly before soldering.

☐ 17. Install U5, the other LMC6482AIN. You know all about orientation and flatness by now so I'll just let you work and get it soldered in.

☐ 18. Install U2, an MC145170P2 PLL chip. Solder all 16 pins when you're sure you've got it oriented correctly.

☐ 19. Next we'll install the socket for our programmed chip, U1. It's the 'brains' of the entire kit. There should be a notch on the socket and while it doesn't really matter which way the socket is installed (as long as you plug the chip into in the right direction!) it's probably a good idea to place the notch to match the notch on the silkscreen.

☐ 20. Once all the pins on the socket are soldered insert the U1 IC into the socket; it's the one with a label. Insert it now so that you know where it is and it will be safe. It helps to gently 'roll' the chip on one side and then the other to keep the pins all lined up and push them in slightly. This makes it easier to insert the chip into the socket. Be sure that all pins are in and that none are bent under or sticking out before moving on to the next part.

Now we'll start installing the other components, starting at the front of the PC board and working our way around. This will make it easier to find the parts you're placing. There's no polarity on the disc capacitors or resistors. You can make the board look more professional by having all the writing on the caps and all the tolerance bands on the resistors point in the same direction. But the kit will work just as well no matter which way these parts face.

- ☐ 21. Install C18, 0.01 µF disc capacitor (marked .01 or 103 or 10nf).

- ☐ 22. Install R11, 1K ohm resistor (brown-black-red).

- ☐ 23. Install R15, 10K ohm resistor (brown-black-orange).

- ☐ 24. Install C24, 22pF disc capacitor (marked 22).

- ☐ 25. Install C20, 0.1 µF disc capacitor (marked .1 or 104).

- ☐ 26. Install C21, 10 µF electrolytic capacitor. This part has a polarity and must be installed correctly to work properly . . . and so that it won't explode! You'll note that one of the part's leads is shorter than the other and you'll see a stripe or band down one side of the part; this should correspond to the shorter of the two leads. The band and short lead denote the negative side of the cap. Ironically the board will show which way the positive, longer lead should be placed. Simply place the part, correctly oriented, into its position and push it down to board level. Then you can solder both leads.

Sometimes the '+' sign is difficult to see on the PC board silkscreen. You want to be sure you get the electrolytics in the right way so when in doubt, use the Parts Layout Diagram to be sure.

- ☐ 27. Install C37, 1nF disc capacitors (marked .001 or 102).

- ☐ 28. Install C32, 10 pF ceramic capacitor.

- ☐ 29. Install D2, BB505 varactor diode (marked BB505. Orange body with black band). This is another polarized part that must be installed correctly to work. You'll see a black band on the part and a white stripe on the PC board silkscreen. Line these two markings up and solder the part in.

- ☐ 30. Install C38, 22 pF ceramic capacitor.

- ☐ 31. Install R22, 47K ohm resistor (yellow-violet-orange). This part is installed in stand up fashion. That is, one lead will go straight into the board while the other is bent around to go back down into the other hole.

- ☐ 32. Install C19, 0.1 µF disc capacitor (marked .1 or 104).

- ☐ 33. Install Q1, 2SC2570A NPN UHF transistor. The part has a flat side

with the number on it and you'll see the outline showing where to place this flat side on the PC board silkscreen. Bend the center lead out to fit in the holes and push the part down close the circuit board without forcing. Solder the transistor.

- ☐ 34. Install R12, 47K standup ohm resistor (yellow-violet-orange).
- ☐ 35. Install C23, 5 pF ceramic capacitor (marked 5).
- ☐ 36. Install C43, 0.1 µF disc capacitor (marked .1 or 104).
- ☐ 37. Install C40, 20 nF ceramic capacitor (marked 20M).
- ☐ 38. Install R19, 82k ohm standup (gray-red-orange).
- ☐ 39. Install R20, 47K ohm standup resistor (yellow-violet-orange).
- ☐ 40. Install R24, another 47K ohm standup resistor (yellow-violet-orange).
- ☐ 41. Install R26, 82k ohm standup resistor (gray-red-orange).
- ☐ 42. Install C41, 0.01 µF disc capacitor (marked .01 or 103 or 10nf).
- ☐ 43. Install R25, 47K ohm resistor (yellow-violet-orange).
- ☐ 44. Install R21, 47K ohm resistor (yellow-violet-orange).
- ☐ 45. Install C44, 0.01 µF disc capacitor (marked .01 or 103 or 10nf).
- ☐ 46. Install C45, 20 nF ceramic capacitor (marked 20M).

Next we'll move over to the left on the other side of U1.

- ☐ 47. Install C13, 0.1 µF disc capacitor (marked .1 or 104).
- ☐ 48. Install C14, 10 µF electrolytic capacitor. Remember to orient the part correctly before installing.
- ☐ 49. Install C7, 0.01 µF disc capacitor (marked .01 or 103 or 10nf).
- ☐ 50. Install C6, 100 pF ceramic capacitor (marked 100 or 100K).
- ☐ 51. Install R13, 470 ohm resistor (yellow-violet-brown).
- ☐ 52. Install R14, 2.2 megohm standup resistor (red-red-green). 53.
- ☐ Install C36, 0.1 µF disc capacitor (marked .1 or 104).
- ☐ 54. Install R17, 4.7k ohm standup resistor (yellow-violet-red).
- ☐ 55. Install Q2, 2N3904 NPN transistor. The flat side must be oriented as shown on the PC board silkscreen and Parts Layout Diagram. Solder all

three leads.

☐ 56. Install C48, 35 pF trimmer capacitor (round red part with adjustment). This part can be installed either way.

☐ 57. Install C54, 62 pF ceramic capacitor (marked 62).

☐ 58. Install R18, 22K ohm standup resistor (red-red-orange). The silkscreen for this part is hard to see but you know it's in the area; use the Layout Diagram to locate it if you need to.

Be very careful with the red and orange color bands on resistors, and also the violet/brown bands. The colors are different from various manufacturers and are sometimes very close in color and easy to confuse. If you really can't tell, measure the resistor with an ohm-meter.

☐ 59. Install C22, 1nF disc capacitor (marked .001 or 102).

☐ 60. Install C39, another 1nF disc capacitor (marked .001 or 102).

☐ 61. Install C16, 0.01 µF disc capacitor (marked .01 or 103 or 10nf).

☐ 62. Install R9, 470 ohm standup resistor (yellow-violet-brown).

☐ 63. Install R28, 22 ohm resistor (red-red-black).

☐ 64. Install C46, 0.1 µF disc capacitor (marked .1 or 104).

☐ 65. Install L7, 0.18uH shielded can coil [metal body]. There is no polarity with this part so install it as it fits and solder all 4 leads.

☐ 66. Install C51, 0.1 µF disc capacitor (marked .1 or 104).

☐ 67. Install R32, 470 ohm standup resistor (yellow-violet-brown).

☐ 68. Install R34, 47k ohm standup (yellow-violet-orange).

☐ 69. Install FL1, 10.7 Mhz filter (brown molded, 3 leads).

☐ 70. Install C56, 1nF disc capacitor (marked .001 or 102).

☐ 71. Install Q3, 2N3904 NPN transistor. Follow the PC board silkscreen and Parts Layout Diagram for proper orientation of the flat side.

☐ 72. Install C35, 1nF disc capacitor (marked .001 or 102).

☐ 73. Install R16, 51 ohm resistor (green-brown-black).

☐ 74. Install C29, 1nF disc capacitor (marked .001 or 102).

☐ 75. Install C34, 82 pF ceramic capacitor (marked 82).

- ☐ 76. Install C28, 3.3 pF ceramic capacitor (marked 3.3).

- ☐ 77. Install L2, an 11 turn air coil.

- ☐ 78. Install C33, 82 pF ceramic capacitor (marked 82).

- ☐ 79. Install C27, 1nF disc capacitor (marked .001 or 102).

- ☐ 80. Install C55, 1nF disc capacitor (marked .001 or 102).

- ☐ 81. Install C50, 10 µF electrolytic capacitor. Remember to place the longer positive lead in the hole marked with a '+' sign.

- ☐ 82. Install C49, 0.1 µF disc capacitor (marked .1 or 104).

- ☐ 83. Install C57, another 0.1 µF disc capacitor (marked .1 or 104).

- ☐ 84. Install R35, 22 ohm resistor (red-red-black).

- ☐ 85. Install L8, 3.9 uH inductor (looks like a fat resistor with red-white-gold-silver bands).

- ☐ 86. Install R29, 330 ohm standup resistor (orange-orange-brown).

- ☐ 87. Install C47, 0.1 µF disc capacitor (marked .1 or 104).

- ☐ 88. Install X1, the 10.25 MHz crystal.

- ☐ 89. Install C42, 1nF disc capacitor (marked .001 or 102).

- ☐ 90. Install R23, 2.7k ohm standup resistor (red-violet-red).

- ☐ 91. Install C62, 10 µF electrolytic capacitor. Remember the polarity!

- ☐ 92. Install Q4, BS170 N-channel FET. This part is installed just like a transistor, placing the flat side as shown. Solder all three leads.

- ☐ 93. Install R30, 4.7k ohm resistor (yellow-violet-red).

- ☐ 94. Install C9, 10 µF electrolytic capacitor. I'm sure you remember that you need to place this part according to the silkscreen, right?

- ☐ 95. Install VR2, 78L05 5 volt regulator (looks like a transistor, marked 78L05). You install it just like a transistor too, orienting the flat side as shown on the silkscreen.

You'll always find electrolytic capacitors on the leads of a voltage regulator. They're there not only to filter the voltage coming out of the regulator but also to keep the part from self-oscillating.

- ☐ 96. Install C5, 10 µF electrolytic capacitor. Place the positive lead correctly.

- ☐ 97. Install VR1, the LM7812 12 volt regulator. The hole in the large metal part of the regulator is there so that you can attach the part to the board with a screw and nut. This provides a better heatsink for the regulator. Bend the leads down so that the part can lay flat on the circuit board, then solder the part in.

- ☐ 98. Install D1, the 1N4000 series diode (any value from 1N4000 to 1N4007). The white or gray band on the part should be lined up with the white band on the circuit board.

- ☐ 99. Install C3, 100 pF ceramic capacitor (marked 101).

- ☐ 100. Install C2, another 100 pF ceramic capacitor.

- ☐ 101. Install C1, the last 100 pF ceramic capacitor.

- ☐ 102. Install R1, 470 ohm resistor (yellow-violet-brown).

- ☐ 103. Install R2, 470 ohm resistor (yellow-violet-brown).

- ☐ 104. Install R3, the last 470 ohm resistor (yellow-violet-brown).

- ☐ 105. Install C4, 1000 µF electrolytic capacitor. This big electrolytic has the same type of markings as the smaller 10 µF caps and must be installed properly to work. The longer lead is still the positive and the shorter lead that corresponds to the band on the side of the part is the negative. Push the part all the way down to the circuit board for best stability before soldering.

- ☐ 106. In the same way, install C61, the other 1000 µF electrolytic capacitor. Check the board to be sure it's in the right way before soldering.

- ☐ 107. Install R40, 220 ohm resistor (red-red-brown).

- ☐ 108. Install C68, another 0.1 µF disc capacitor (marked .1 or 104).

- ☐ 109. Install R39, a 2 ohm resistor (red-black-gold).

- ☐ 110. Install C69, 0.1 µF disc capacitor (marked .1 or 104).

- ☐ 111. Install C66, the last 10 µF electrolytic capacitor. And this is the last time I'll remind you about the polarity. That'll be a pleasant break, won't it?

- ☐ 112. Install R31, 470k ohm resistor (yellow-violet-yellow).

- ☐ 113. Install R41, 2.7k ohm standup resistor (red-violet-red).

- ☐ 114. Install R33, 4.7k ohm resistor (yellow-violet-red).

- ☐ 115. Install C53, 1nF disc capacitor (marked .001 or 102).

- ☐ 116. Install R36, 2.7k ohm resistor (red-violet-red).

- ☐ 117. Install C65, 1nF disc capacitor (marked .001 or 102).

- ☐ 118. Install R37, 10K ohm resistor (brown-black-orange).

- ☐ 119. Install C58, 2.2 µF electrolytic capacitor. Remember polarity!

- ☐ 120. Install C59, the other 2.2 µF electrolytic capacitor. Again, place it correctly or it won't work when you fire up the kit.

- ☐ 121. Install C64, 0.01 µF disc capacitor (marked .01 or 103 or 10nf).

Wow, we're really getting close to the end now and the kit is shaping up nicely. Just a few more parts and you'll be ready to give it a final look-over for any less than perfect connections.

- ☐ 122. Install C60, 0.22uF ceramic capacitor.

- ☐ 123. Install C63, a 56 pF ceramic capacitor.

- ☐ 124. Install FL3, one of the 450 kHz filter [black cube]. This part only fits into the circuit board in one direction. And it's easier to install this one before FL2 so we'll do it that way.

- ☐ 125. Install FL2, the other 450 kHz filter [black cube].

- ☐ 126. Install T1, the 421F201 IF transformer [metal can marked IF201].

- ☐ 127. Install R38, 2.2k ohm standup resistor (red-violet-red).

- ☐ 128. Install R10, 150 ohm 1/2 watt resistor (brown-green-brown). This part is larger than the typical resistor and can handle more power than the standard 1/4 watt parts we've used in the rest of the circuit.

- ☐ 129. Install C15, 1nF disc capacitor (marked .001 or 102).

- ☐ 130. Install C17, 0.1 µF disc capacitor (marked .1 or 104).

- ☐ 131. Install C26, 1nF disc capacitor (marked .001 or 102).

- ☐ 132. Install C31, 82 pF ceramic capacitor.

- ☐ 133. Install C25, 3.3 pF ceramic capacitor (marked 3.3).

- ☐ 134. Install L1, 11 turn air coil.

- ☐ 135. Install C30, the last 82 pF ceramic capacitor.

- ☐ 136. Install C67, 220 µF electrolytic capacitor, and the last of the electrolytics. Follow the silkscreen as you've done for all the others and be sure it's installed correctly before soldering.

Now we'll install some of the larger connectors and parts, then we'll be ready for a final checkout of our assembly. And then . . . the moment of truth, applying power to your kit.

☐ 137. Install J7, BNC PC mount jack. Be sure the part is flat on the PC board before soldering. That will ensure a good fit when you assemble the case. Also, the ground leads on this part will require a bit more time so be patient when soldering them.

☐ 138. Install J9, 3.5mm stereo headphone jack. As with all the other jacks and connectors, make sure the part is flat before soldering.

☐ 139. Install J8, 3.5mm mono speaker jack.

☐ 140. Install J1, the last 8 pin dual row connector. Install the part so that the long pins will stick out the back and the short pins are soldered to the PC board. Slide the part onto the PC board and make sure that all the pins on both sides of the board line up with their pads before soldering any of them. Tack one pin, check the alignment top and bottom again, then solder the rest of the pins.

☐ 141. Install J4, 2.1mm DC power jack, positive tip. We mention the positive tip on this part as a reminder for when you connect power to the kit.

☐ 142. Next we'll place R4 into its holes but don't solder it in yet! First we'll place that part and the one next to it, R27, then we'll slide the PC boards together and solder the parts in later.

☐ 143. In the same way that you placed R4, place R27 into its holes on the board but don't solder it yet.

☐ 144. Take the red and black twisted pair wire and strip the wires on the end without the connector about 1/16 of an inch. Twist the strands of the wire and tin them by applying some solder to them.

☐ 145. Now take your speaker, SP1 and flip it onto its face so that the solder pads are showing on the backside. Nip the red tinned wire end so that it will fit onto the pad marked with a red dot on the back of the speaker and solder it there. You'll want to be sure that the wire does not short to the metal case of the speaker.

☐ 146. In the same way, solder the black tinned wire end to the other solder pad. The pads are separated by a black section so it's easy to see where the wires go. Again, don't short it out to the case of the speaker.

☐ 147. Locate your front panel and the bezel that goes with it. (The bezel is the plastic piece in which the front panel sits). Put the bezel aside for now. Next find the hardware for the speaker, the four 1-64 X 1/4 inch screws

and matching 1-64 hex nuts. Place the speaker into its position on the backside of the front panel between the power and squelch knobs with the speaker wires going up toward the top of the case. They're going to loop over the front panel when we connect it later. Attach the speaker to the front panel using the screws and nuts, screws coming in from the front panel and nuts on the backside to look nice and neat.

☐ 148. Place the front panel with the speaker into the bezel so that the bezel can be screwed to the case bottom. The bezel has a smooth side and a side with ridges on it. The smooth side is where you place your front panel and the ridged side fits into the case bottom; the ridges help align the bezel and panel.

☐ 149. Take the bottom of your case assembly and the front panel/bezel combo, along with the screws that hold the front panel to the case bottom. Screw the front panel assembly to the case bottom.

☐ 150. Once you have the front panel attached to the case bottom you can take your attached but not yet soldered PC boards and slide them into the case bottom. Carefully line up the switches and potentiometers so that they extend out through the front of the case. When everything is neat and right where you want it to be, take your soldering iron and solder one of the pins of either J5 or J3 (J5 is easier to get to). You'll note that J5 is labeled J6 on the front panel and J3 is labeled J2 on the front.

☐ 151. Check the alignment one more time because once you make the next solder connection it will be difficult to take the boards apart again. Make sure the front panel board is flat and not angled with respect to the main board, make sure the pots stick out enough and that everything is right, then solder a pin on J3 to hold things in place.

☐ 152. Slide the main board out of the case bottom carefully and continue to solder both sides of J3 and J5 until all connections are made.

☐ 153. Once the connections are soldered you can slip the board back into the case and plug the speaker in. If you're looking at the board so that you can read the silkscreen for SP1, the side of the connector with the red wire should be place to the left on the pin that's marked with a white arrow.

☐ 154. Now carefully slide the top cover into place, remembering to keep your speaker wires from getting pinched.

☐ 155. Take your rear panel bezel and plate, put them together as you did the front panel, and screw them into place.

You're finished! Well, just about. You still will want to check over your solder joints to be sure they're clean and well made. Take a look at the ICs to be

sure they're oriented correctly using the dot or notch on the part and the notch marked on the PC board. Then take a look at all of the electrolytics to be sure they're installed in the right way. Better to take a few minutes now than to have a part damaged or destroyed because you're in a rush to apply power.

ANTENNA CONSIDERATIONS

An antenna for your AR1C can be as simple as a 21" piece of wire or a fancy roof-mounted aviation antenna. Most folks near an airport will get plenty of in-the-air action from the wire, but if you're more than a few miles away, a decent roof-mount job is the way to go. A low cost TV antenna works well, even better if rotated 90 degrees (remember aircraft antennas are vertically polarized). If you really want to learn and experiment, check out any book on antennas from your local library or do a search on the internet; there's a wealth of information out there.

SETUP AND TESTING

It's time to apply power to your AR2, tune it up, and start listening in on pilots and air traffic controllers. You need:

- The AC adapter
- A diddle stick or other tuning device
- Your choice of antenna

1. Connect the AC adapter to your kit. If you're using a non-Ramsey adapter make sure the tip is positive.
2. Turn the Squelch pot counterclockwise.
3. Power 'on' your kit. If you don't see anything on the display, don't panic! You simply need to adjust the contrast pot. Turning it counterclockwise will increase the contrast and allow you to see the display. Once you have it where you want it you'll see that the unit has powered up in "Frequency mode". This means that you will use the tuning knob to change the frequency. We'll get into scanning and all the rest later.
4. Tune the AR2 for the high end of the aircraft band at 137.000 MHz. Turn the knob in either direction until you reach this frequency.
5. With your diddle stick or other non-metallic tuning tool, adjust L7 until the "U" on the right hand side of the display window turns into an "M".
6. Now tune the AR2 to 118.000 MHz, the low end of the band. Since you're at 137 MHz and the AR2 has a "wraparound" feature for frequency tuning you simply have to turn the tuning dial a couple of "clicks" to the right to be at 118 MHz.
7. Readjust L7 if necessary so that there is an "M" in the display window.

Here's where we separate the folks with test equipment from the folks who don't have any. Either way your AR2 will receive the entire aircraft band quite nicely but if you've spent money on a signal generator we're pretty sure you want to get some use out of it.

Regular Tuning Mode:

Without a signal source to work with you'll have to tune in a frequency and adjust C48 as best you can. It's not critical; you'll still receive signals quite nicely if you don't adjust it but it may make them clearer if you do. Turn the squelch pot clockwise slightly so that you're not hearing all that static, then wait for a signal that the AR2 can lock onto. If they're from a passing plane they'll tend to be brief so be prepared for that. When the AR2 is locked onto a signal simply take a tuning tool and adjust C48 for the clearest sounding audio. It's as simple as that.

Signal Generator Mode:

- Set your generator to your desired frequency within the aircraft band, 117.975 MHz to 137.000 MHz.
- Set the generator level to approximately –100 dBm output, 100% AM modulation, 1 kHz tone.
- Connect a BNC cable from the output of your generator to the antenna input on the AR2.
- Turn the squelch knob clockwise until the static just goes away.
- Tune the AR2 to the same frequency as the generator.
- You should be receiving the signal and hearing the 1 kHz tone.
- Take a tuning tool and turn C48 until the signal is clearest.
- That's it!

You're now ready to use your AR2, but you may want to familiarize yourself with some of the controls on the next couple of pages. You can simply let the AR2 scan until it locks onto something or you can set up the channels it will scan . . . it's all up to you.

The AR2 uses an advanced way to access the many useful features built in to the unit. What looks like a volume control at first glance is actually a jog dial. No, it doesn't go for a jog at the end of a long work day, instead it allows you to enter values digitally in a convenient way.

There are a few modes of entry of using the jog dial:
a. Turn clockwise and counter clockwise
b. Press the knob and turn
c. Press the knob briefly
d. Press and hold.

By pressing and turning the knob you can select the various modes of operation of the AR2. As you turn the knob while holding it in, the display will show the current selected mode. Release the knob to choose that selection.

The modes are as follows:

1. **Normal receive mode**. This mode operates much like the old AR1, allowing the jog dial to select frequencies within the aircraft band to listen to. The display shows both frequency and the field strength of the signal (RSSI).
2. **Lighting Control Mode.** This mode allows a user to access an external circuit to remotely control runway lights in small airports by keying the radio at the frequency to which the AR2 is set.
3. **Full Scanner Mode.** This mode operates like normal receive mode but will scan for the next frequency that opens the squelch when you press the knob briefly.
4. **Scanner 1 Mode.** This mode allows you to scan up to 20 frequencies saved in the Scanner 1 Setup mode.
5. **Scanner 2 Mode.** This mode allows you to scan up to 20 frequencies saved in the Scanner 2 Setup mode.
6. **Scanner 3 Mode.** This mode allows you to scan up to 20 frequencies saved in the Scanner 3 Setup mode.
7. **Scanner 4 Mode.** This mode allows you to scan up to 20 frequencies saved in the Scanner 4 Setup mode.
8. **Scanner Skip Mode.** This mode operates like Mode 2, except that it skips automatically to the next active frequency after a specified period of time that you've preset in the skip timer setup screen.
9. **Skip Scanner 1 Mode.** This mode allows you to scan up to 20 frequencies saved in the Scanner 1 Setup mode, only this will automatically skip to the next frequency after a specified time.

10. **Skip Scanner 2 Mode.** This mode allows you to scan up to 20 frequencies saved in the Scanner 2 Setup mode, only this will automatically skip to the next frequency after a specified time.

11. **Skip Scanner 3 Mode.** This mode allows you to scan up to 20 frequencies saved in the Scanner 3 Setup mode, only this will automatically skip to the next frequency after a specified time.

12. **Skip Scanner 4 Mode.** This mode allows you to scan up to 20 frequencies saved in the Scanner 4 Setup mode, only this will automatically skip to the next frequency after a specified time.

13. **Setup Scanner 1 Mode.** Allows you to save and delete frequency memories from scanner 1.

14. **Setup Scanner 2 Mode.** Allows you to save and delete frequency memories from scanner 2.

15. **Setup Scanner 3 Mode.** Allows you to save and delete frequency memories from scanner 3.

16. **Setup Scanner 4 Mode.** Allows you to save and delete frequency memories from scanner 4.

17. **Setup skip timer.** Allows you to select the amount of time to keep a particular frequency active before skipping to the next active frequency.

18. **Lighting timeout.** This allows setting of the time the lights in the Lighting Control mode are kept on before turning them back off again.

Receive Mode Controls:
Use the jog dial to select the current frequency. The faster you turn the knob, the faster the frequency will change due to a built in accelerator function.

Press and hold the jog dial for two seconds to save this as the default power on mode.

Lighting Mode Controls:
Use the jog dial to select the frequency you wish to use for remote keying control of the lighting system before entering Lighting Control Mode.

Press and hold the jog dial for two seconds to save this as the default power on mode.

Full Scanner Mode and skip mode.
Use the jog dial to select a frequency.

Press and release the knob to skip to the next active frequency.

Skipping to the next channel will occur after timeout in skip mode only.

Standard Scanner Modes 1-4 and skip modes:
Use the jog dial to select a frequency other than what is currently running.

Press and release the jog dial to skip to the next active memory

Press and hold the jog dial to prevent stopping at this frequency for the duration of the selection of this mode.

Skipping to next channel will occur after timeout in skip mode only.

Setup Scanner Modes 1-4
Use the jog dial to select frequencies

If the frequency is already in the list, a + sign will appear in the lower right to indicate it is already in the list. – if it is not.

Press and release the jog dial to add a frequency not in the list
Press and release the jog dial to remove a frequency from the list.

Press and hold the jog dial for two seconds to save your selections to FLASH.

Setup Skip Timer
Use the jog dial to select an appropriate time to stay on any particular frequency before skipping to the next.
Press and hold the jog dial to save the changes to FLASH.

Setup Lighting Timer
Use the jog dial to select an appropriate time out value which determines how long the lights are left on before shutting off.

Press and hold the jog dial to save the changes to FLASH.

TROUBLESHOOTING

Hopefully you'll never need this section! If you have a problem with your kit, don't panic. A sensible, logical approach and a clear head will usually point you to your trouble spot. The first thing to do is to look over the board again and check to be sure that:

- All parts have been installed unless you were instructed otherwise.
- All parts that have a polarity such as ICs, diodes, voltage regulators, and electrolytic capacitors are placed correctly. Check the silkscreen and/or Parts Layout Diagram if you're unsure.
- Check your solder joints for cold or intermittent connections as well as solder bridges . . .unintended connections between components. Touch up any less than perfect solder joints and check any questionable connections.

If you still have a problem after visual inspection you'll have to do some troubleshooting to find it. The second most common error we see (after poor solder connections) is misplaced components. It's especially easy to goof up on resistors with red and orange color bands; check those first. Taking the circuit in sections can help a lot, for instance, if your kit will not power up at all check the DC input jack and voltage regulators along with their capacitors. If you get no sound from the speaker try connecting an external speaker or pair of headphones; this will determine if your problem is simply the speaker or if you need to check over the entire audio section. Figure out what works and what doesn't and go from there.

If all else fails, check the inside back cover of this manual for instructions on how to send the kit in for repair. Hopefully you'll never get to that point but it's nice to know that there's someone out there to help you if you do.

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

CONCLUSION

We sincerely hope that you will enjoy the use of this Ramsey product. As always, we have tried to compose our manual in the easiest, most "user friendly" format possible. We value your opinions, comments, and additions you'd like to see in future publications. Please submit comments or ideas to:

Ramsey Electronics Inc.   or email us at techsupport@ramseymail.com
Attn. Hobby Kit Department
590 Fishers Station Drive
Victor, NY 14564
And once again, thanks from the folks at Ramsey!

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! However, customer satisfaction is our goal, so in the event that you do have a problem, take note of the following.

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 its 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.

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