

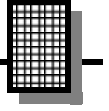
# 2 METER RF POWER AMPLIFIER KIT

**Ramsey Electronics Model No.**

**PA1**

*Give your handheld a big boost with this economical power amplifier kit. Thousands have built and enjoyed this kit; one magazine review even said, "probably the best bargain in Ham radio!"*

- **Works with any radio; mobile, fixed or handheld**
- **8 to 10 times the power gain: 10 watts out for every 1 watts in, 20 watts out for every 2 watts in, 30 watts out for every 3 watts in!**
- **Easy connection to a radio**
- **Operates on 12 - 14 volts DC, draws a maximum of 5 amps**
- **Just add a T-R relay, case, Pre-amp if desired and connectors**
- **Informative manual answers questions on theory, hookup and uses - enhances resale value, too!**
- **Maximum output of 35 - 40 watts, max drive of 8 watts**
- **Mounts in any small aluminum case, which then will act as a heatsink**
- **Yes, this is the amplifier that's been reviewed in all the Ham magazines!**
- **Clear, concise assembly instructions carefully guide you to a finished kit that works FIRST time!**



## PARTIAL LIST OF AVAILABLE KITS

### RAMSEY TRANSMITTER KITS

- FM10, FM25B FM Stereo Transmitters
- FM100 Super Pro FM Transmitter
- MR6 Model Rocket Tracking Transmitter
- AM1, AM25 AM Transmitters

### RAMSEY RECEIVER KITS

- FR1 FM Broadcast Receiver
- AR1 Aircraft Band Receiver
- SR2 Shortwave Receiver
- HFRC 10 MHz WWV Receiver
- SC1 Shortwave Converter

### RAMSEY HOBBY KITS

- SG7 Personal Speed Radar
- SS70A Speech Scrambler
- TG1 DTMF Tone Grabber
- BS1 "Bullshooter" Digital Voice Storage Unit
- AVS10 Automatic Sequential Video Switcher
- WCT20 Cable Wizard Cable Tracer
- MD3 Microwave Motion Detector
- ML Music Lights Kit
- LC1 Inductance-Capacitance Meter

### RAMSEY AMATEUR RADIO KITS

- HR Series HF All Mode Receivers
- 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.

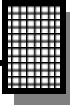
#### PA1 2 METER RF POWER AMPLIFIER KIT INSTRUCTION MANUAL

Ramsey Electronics publication No. PA1 Revision 1.1

First printing: December 1994



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## KIT ASSEMBLY AND INSTRUCTION MANUAL FOR

# 2 METER RF POWER AMPLIFIER KIT

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## PA1 AMPLIFIER

All of us at Ramsey say THANKS for your interest in building the world's most popular 2 Meter amplifier project. Successful construction and installation of your PA1 amplifier can give your handheld 2 Meter transceiver an RF power boost beyond the performance of many fixed and mobile units.

BEFORE you begin building your PA1, we ask you to read the warranty information on page 14 and think about a few details in advance:

The PA1 is a true "Ham Radio" kit project which presumes the expertise that goes along with your license. You need to know how to "tack solder", wind simple VHF coils per our directions, and how to finish your PA1 with suitable enclosure, connectors, T-R switching and I/O wiring.

The Ramsey RFS1 RF-sensing T-R switch kit is available as an easy companion kit for the PA1.

The Ramsey PR10 Low Noise Pre-amplifier Kit can be worked into your final T-R installation to boost those hard-to-copy signals.

We ask you to understand that the VHF Power Transistor that is the heart and soul of this circuit cannot be guaranteed beyond careful tests by BOTH the manufacturer and our technicians. Because this expensive transistor can be damaged by either incorrect soldering OR incorrect physical mounting, there can be NO warranty on this part unless your own additional test BEFORE ANY soldering and mounting shows a clear defect.

Use of a VHF power output wattmeter is essential to correct adjustment of the PA1.

If you decide, before beginning any assembly of your PA1 kit, that this project is not quite what you're ready for, you may return the complete, unassembled PA1 kit to the Ramsey factory.

OR, if you are ready to join the thousands of hams world-wide who enjoy the PA1 as the most economical possible HT improvement for the highly-popular 2 Meter band, we will be happy to guide you through every construction step in the spirit of the "Learn-As-You-Build" philosophy for all Ramsey Kit manuals for the new millenium.

## **KIT BUILDING TIPS**

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

Electrical part installation - when parts are installed, the part is placed flat to the board, and the leads are bent on the backside of the board to prevent the part from falling out before soldering. The part is then soldered securely to the board, and the remaining lead length is then clipped off.

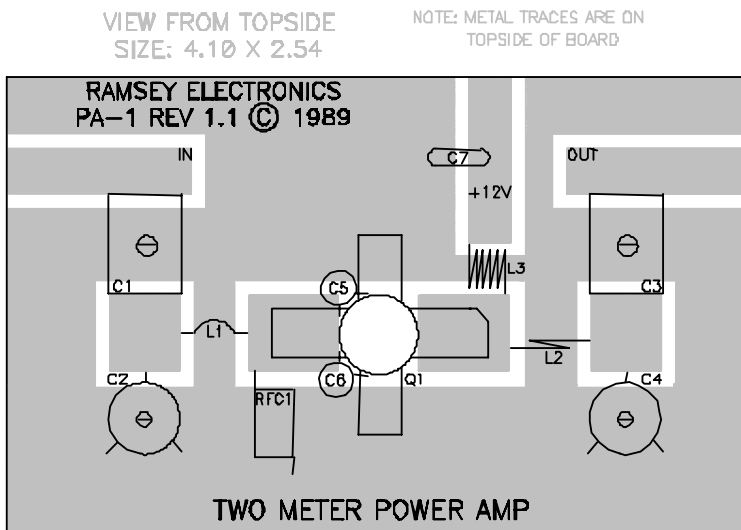
## **PA1 PARTS LIST:**

- 1 PA1 Printed circuit board
- 1 BLW40 or SD1272 RF Power Transistor
- 1 Length of pre-tinned #18 wire (for L1,L2)
- 1 Length of #18 enameled wire (for L3)
- 1 Length of #24 wire (for winding 6 hole RF choke ferrite bead)
- 1 6 hole RF Choke ferrite bead (black cylinder) (to be hand-wound)
- 2 100 pf mica compression trimmers (rectangle shaped) (C1,C3)
- 2 60 pf variable trimmer capacitors (round shaped) (C2,C4)
- 2 47 or 56 pf ceramic disc capacitors (C5,C6)
- 1 .01uf ceramic disc capacitor (marked .01 or 103 or 10 nf) (C7)

## ASSEMBLY DIRECTIONS:

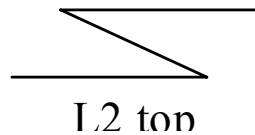
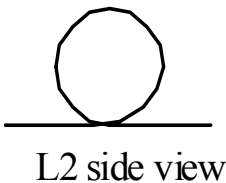
- ❑ 1. Simply EXAMINE the PA1 circuit board. Notice which way is up or down in accord with our published drawing. Notice that ALL components are surface-mounted (tack-soldered) to one side of the PC board. There are NO component-mounting holes!
- ❑ 2. Taking care that your soldering tip is clean, pre-tin all mounting pads on the board. You are using enough heat if the solder flows VERY easily and remains shiny. That is the only acceptable result. A smooth build-up of solder thickness is fine and will make parts installation even easier.
- ❑ 3. The power transistor will be installed as a later step. Right now, simply position it in place and observe how far its flat leads extend toward the input and output pads. Scribe a line into the tinned pads at each end of these two leads as a guide to the amount of pad space required by the transistor. **NOTICE THE ORIENTATION OF THE TRANSISTOR'S COLLECTOR LEAD!** Set the transistor aside for now, safely.
- ❑ 4. In installing the coils leading in and out of the transistor's pads, the idea is to stay on the other side of your marks, so that the transistor can be installed flat and neatly on the board.
- ❑ 5a. Examine C1, one of the mica compression trimmers. Neatly re-form the two outer tabs at right angles so they form "feet" which permit the trimmer to sit level in its correct position. Make sure the inner pins do not touch the PC board.

## PA1 PARTS LAYOUT DIAGRAM



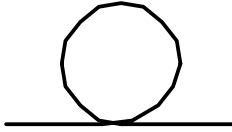


- 5b. Tack-solder C1, one of the Mica compression trimmer capacitors, using enough heat for a solid, good connection.
- 6. Install C3, the other compression trimmer, just like C1.
- 7a. Bend the leads of C2, the round trimmer capacitor, at right angles so that it can also sit in a level and flat position. The two leads at one end go to the ground plane, and the single lead goes to the pad with C1.
- 7b. Install C2.
- 8. Install C4, just like C2. Now that you are accustomed to how easy good tack-soldering can be, and you can see some finished work on your PC board, this is a good time to begin making and installing the three coils and RF Choke.
- 9a. Cut a 1" length of #18 tinned bare wire and form it as shown, making a gentle loop around a tool handle.
- 9b. Install L1 using a pair of needle-nose pliers to hold it as you solder it in place. Let L1 from 1" inch of bare wire one end cool before soldering the other.
- 10a. Use another length of #18 tinned bare wire to make a 1-turn 1/4"-diameter coil. Spread the turn itself to 1/4" and trim the leads to approximately 1/4". Bend the ends as needed so that the coil sits in position as shown on the board.
- 10b. Install L2 the same way as you did with L1 in step 9b.

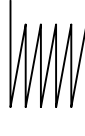




- ❑ 11a. Using the #18 enameled wire, wind a 5-turn coil for L3. The inside diameter is also 1/4", the turns should be close-wound, and the ends should be 1/4-inch long. Using a small knife or sandpaper, scrape the insulation from each end, tin the bare ends with solder, and gently bend the ends as needed so the coil sits in its position correctly and neatly.
- ❑ 11b. Install L3.

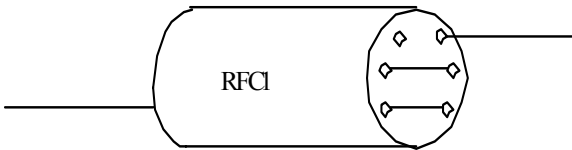


L3 side view



L3 top view

- ❑ 12a. The RF choke consists of a ferrite bead with 6 holes. It is easily made by passing or "lacing" 5 turns of the #24 bare wire through its holes. This will fill 5 holes with a lead coming out at each end. (Note that trying to fill the 6th hole would cause both wire ends to come out of the same end of the ferrite bead.) Trim the ends to 1/4" and bend as needed for neat installation.



- ❑ 12b. Install the RF choke.
- ❑ 13. Install bypass capacitor C7, .01 uf (marked .01 or 103 or 10 nf) from the DC voltage pad to the ground plane.

### **VERY IMPORTANT: PLEASE READ!**

The RF Power Transistor **MUST** be mounted to its heatsink (usually the metal case enclosure) **B-E-F-O-R-E** it is soldered to the circuit board. This is necessary for the sake of your investment as well as the health of the transistor. It is **VERY** easy to crack the transistor's case and break off the leads if you attempt to tighten the nut **AFTER** soldering. As has been explained, Ramsey Electronics' warranty on this transistor covers **ONLY** fresh, non-soldered units which prove to be electrically defective before any installation attempt.

So...NOW is the time to decide how you are going to enclose your PA1. If that decision is still to come and you wish to experiment with the performance of the PA1 before designing a finished accessory such a "docking booster", then

make a suitable HEATSINK for Q1 and install it before proceeding. A piece of heavy aluminum or copper the same size as the PA1 circuit board will work fine. Even when securing Q1 to such a heatsink, do not use too much force. Observe the correct orientation of Q1 on the actual circuit board when mounting it to the heatsink. The collector lead (output side) has a 45-degree cut that is plainly visible.

- 14. Pre-tin both the upper and lower surfaces of all four leads of power transistor Q1.
- 15. After reviewing the mounting information, mount Q1 to its heatsink or section of metal enclosure.
- 16. After double-checking the orientation of the collector lead, solder all four Q1 connections.
- 17a. The final circuit-wiring steps consist of the CORRECT installation of two small 47 or 56 pf disc capacitors. This step is more critical than many builders may realize, because excess lead-length of C5 and C6 will reduce power output and induce feedback! The bodies of C5 and C6 should fit snug against Q1 and you should see little or no capacitor wire lead at all!
- 17b. Install C5 in accord with 17a.
- 17c. Install C6, just like C5.

### **FINAL PC BOARD WIRING BEFORE TESTING:**

- 18. Solder the 12-volt DC power line connections.
- 19a. Use good-quality coax terminated to fittings for your own application.
- 19b. Install coaxial input and output lines.

Take a moment now to review your work. Touch up any solder joints that need to look smoother and shinier. This effort can actually improve performance as well as make you proud of your work and enhance the resale value of your amplifier. There should be NO evidence of excessive wire length or rough-looking solder joints.

## **INITIAL TESTING**

Required for testing:

- 1 to 5 watt 2 Meter transmitter or transceiver.
- 12 volt DC power source, 5 amp minimum.
- RF wattmeter suitable for VHF use.
- Correct cables and connectors.
- 50-ohm 30-50 watt dummy load (use antenna for testing only in accordance with appropriate frequency selection, transmission ID procedures).

DC voltage may be applied to the PA1 at all times. As a Class C amplifier, it draws current only with RF drive. For the first test, use just 2 or 3 watts of RF drive. NEVER exceed 8 watts!

Adjustment is accomplished by turning all 4 trimmers for maximum RF power output. However, to keep this procedure from becoming like trying to crack a combination lock, do it in this order:

1. Turn both compression trimmers (C1,C3) fully clockwise.
2. While turning C2 (RF input side), watch for a sudden peaking of RF output. C2 has the most direct and critical control over the driving of Q1.
3. After some power output is noted from peaking C2, then adjust both C3 and C4 for maximum output. Then readjust C1 and C2 as needed.

That's all there is to it! If you cannot get the proper amount of power output or gain, there is something wrong with the amplifier or test set-up that needs to be corrected before further tests are conducted.

## **TROUBLESHOOTING HINTS:**

The amplifier should produce at least 8 to 10 times power gain, for example: 2 watts in for 20 watts out. If the amplifier does not give you this gain, make sure:

C5 and C6 are tight, snug against Q1 with virtually no lead length.

Good RF wiring technique was used in hooking up the coax input and output leads - short lead length on the coax shields and center conductor wires.  
Proper adjustment of all trimmers.

At least 12 volts actually measured at the PC board power connection point.

Maybe an SWR problem? Change input and output coax lengths.

## **TRANSMIT-RECEIVE ["T-R"] SWITCHING CONSIDERATIONS:**

T-R switching of a single antenna with a 2 Meter transceiver and the PA1 RF amplifier may be accomplished in any of these ways:

- 1. Internal connections to your transceiver, making use of its built-in T-R switching circuit or relay.
- 2. External T-R relay controlled by transceiver microphone switch or relay line.
- 3. RF-activated T-R switch such as the Ramsey RFS-1 kit.
- 4. PIN-diode T-R switching.

You have to make your own decision about whether to tie into any of the internal circuitry of your transceiver. It depends on how comfortable you are in doing so, how dependent you are on factory or professional service, and the policy of the service center on modified equipment.

We developed the RFS-1, T-R relay kit exactly for those situations where PA1 operation is needed but there is reluctance to make additional connections in and out of a costly hand-held transceiver. The RFS-1 kit is very economically priced and includes a heavy-duty 12-volt relay. Sorry, but we cannot make the PC board or individual parts available separately from the entire RFS-1 kit.

The use of PIN diodes for T-R switching is discussed amply in recent editions of the ARRL Handbook and in ham radio magazine articles. A practical circuit requires two suitable PIN-diodes, RF chokes, bias supply and either a quarter-wave line or tuned circuit for receiver isolation.

## **CUSTOMIZING YOUR PA1 INSTALLATION:**

Since it's up to you to supply the enclosure, connectors and any desired operating conveniences, it's likely that each one of those thousands of PA1s in use today has its own personality. For some good ideas, take a look at "Turn Your HT into a 40W 2M Mobile Rig" by N8KDD in 73 Magazine, December 1989. The author's ideas are great, and we would only point out that his mention of the PA1 assembly instructions pertain to the simple sheets supplied prior to the publication of this manual. Also, we do find the relays supplied with the RFS-1 kit to be quite suitable for the application.

The economy of the PA1, or even the factory-wired PA10, makes it possible for you to set up permanent 40-watt rigs in various vehicles, at home, at the office, all with their own permanent antennas, all of them ready to make your 2 Meter HT or shirt-pocket wonder ever more versatile!

The hams at Ramsey Electronics thank you and hope you'll have as much fun using your amplifier as you had building it!

## **INSTALLATION NOTES:**

- 1. The best location for the relay is as close to the PA1 amplifier PC board as possible with a short solid connection from the relay contact to the amplifier input. If more than 1 inch, use coax.
- 2. All coax shields must be grounded with the shortest possible lead length to your metal chassis ground point!
- 3. One short, solid ground path to power amp PC board (or metal chassis or enclosure) is required.
- 4. Expect the relay to pull about 100 ma.
- 5. Miniature coax type RG-174 is ideal for all connections.

## **OPERATING NOTES:**

- 1. If the relay chatters, it is a sign of high SWR, which you will wish to resolve anyway by antenna system or amplifier output adjustments.
- 2. If the relay action is "sloppy", there may be insufficient RF to drive the RFS-1 circuit. This can occur when using a "low power" HT setting (5 watt ) to conserve the HT battery, while still transmitting a good 5 watts from the PA1. The RFS-1 may be made more sensitive by reducing the value of R2 to 1 or 2K ohms.
- 3. As designed, the RFS-1 will handle all input power levels safe for the PA1 RF amplifier itself, up to 8 watts drive.

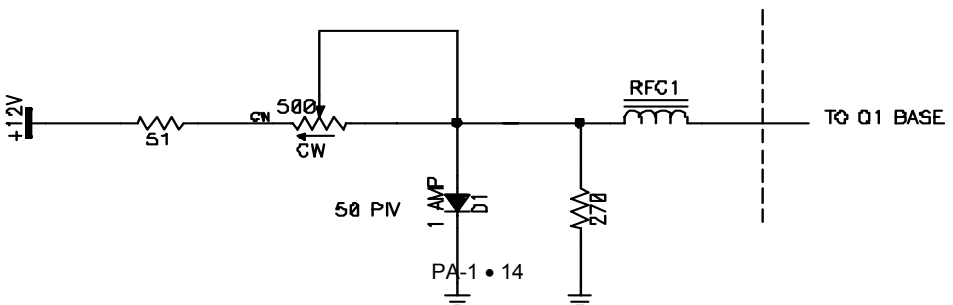
## A NOTE FOR EXPERIENCED BUILDERS ON LINEAR OPERATION FOR SSB, AND OTHER EMISSION TYPES:

Please undertake this conversion ONLY if you understand the theory and practice involved. Otherwise, please get help from another ham experienced in amplifier design. This conversion changes the power transistor from Class C to "biased on" Class B operation. The transistor is not under warranty as we've already explained, and improper configuration can easily damage it.

Linear operation configuration consists of applying 12 volts DC through a simple 4-part adjustable circuit, through the original RF choke to the base of RF power transistor Q1, carefully checking Q1's collector current right from the start.

### CONVERSION STEPS:

1. Lift the ground side of the RF choke.
2. Solder a 1 amp diode's cathode lead (banded end) directly to the emitter-ground connection of the RF power transistor. Keep this cathode very short so that the diode can temperature-track the transistor.
3. Connect the following to the lifted end of the RF choke, keeping all wires as short and neat as possible:
  - anode lead of diode
  - one end of a 270-ohm resistor
  - one end and center of a 500-ohm trimmer pot
4. Solder the other end of the 270 ohm resistor to the PA1 groundplane foil.
5. Connect the remaining end of the 500 ohm pot through a 51 ohm resistor to a neatly routed wire to the +12 volts DC input to the PA1.
6. Set up a 0-100 milli-ammeter or VOM to monitor Q1's collector current.
7. Keeping your tests short, adjust the 500 ohm pot for about 50 mA of collector current. Do not exceed 100 mA!



## **PA1 WARRANTY NOTICE:**

The PA1 kit is the only item in the entire Ramsey product line that is not covered under any warranty. Because of the variety of ways in which this kit can be constructed and mounted mechanically, we cannot offer any kit repair service. So, if this kit appears too complex for your abilities, please return it for a complete refund. The PA1 kit is designed for the advanced builder who appreciates the convenience of having all the hard-to-get parts available from one reliable source. Thousands upon thousands have successfully tackled this project and many have even written magazine articles detailing their efforts, thus earning enough to pay for their kit! The PA1 kit does not require superhuman skills to build, just proper care and techniques in assembly that RF circuitry demands.

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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

### **ADDITIONAL SUGGESTED ITEMS**

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

Price: \$5.00

Ramsey Publication No. PA1

Assembly and Instruction manual for:

*RAMSEY MODEL NO. PA1*

***2 METER RF POWER AMPLIFIER KIT***



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