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DZ COMPANY · LOVELAND, COLORADO

# DZKIT

## ASSEMBLY MANUAL



**HT-7**  
**40M AM HANDIE-TALKIE**

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## YOUR DZKIT 90-DAY FULL WARRANTY

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During your first ninety (90) days of ownership, DZ Company will replace or repair free of charge—as soon as practical—any parts which are defective, either in materials or workmanship. You can obtain parts directly from DZ Company by writing us, emailing us or telephoning us. And we'll pay shipping charges to get those parts to you—anywhere in the world.

We warrant that during the first ninety (90) days of ownership, our products, when correctly assembled, calibrated, adjusted and used in accordance with our printed instructions, will meet published specifications.

You will receive free consultation (except for the cost of your long distance phone call) on any problem you may encounter in the assembly or use of your DZKit product. Just drop us a line, email us, give us a call, or visit our website and click on "Support". That will give you access to free on-line support and a discussion group. Sorry, we cannot accept collect calls.

Our warranty, both expressed and implied, does not cover damage caused by the use of corrosive solder, defective tools, incorrect assembly, misuse, fire, customer-made modifications, floods or acts of God, nor does it include reimbursement for customer assembly or setup time. The warranty covers only DZKit products and is not extended to non-DZ allied equipment or components used in conjunction with our products or uses of our products for purposes other than as advertised.

If you are ever dissatisfied with our service—warranty or otherwise— or our products, please write or email the president, Brian Wood, W0DZ, and he will make certain your problems receive prompt, personal attention.

THE DZ COMPANY, LLC  
LOVELAND, CO 80537

# Assembly and Operation

Of the



HT-7 40M AM Handie-Talkie



DZ COMPANY  
LOVELAND, COLORADO

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3-24-09

HT-7

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## INTRODUCTION

In the early days of amateur radio, and continuing well into the 1960's, amplitude modulation (AM) was the mode of choice for phone communications. Its wide bandwidth (6kHz) and rich sound made ham radio sound like broadcast stations.

Eventually, with crowded bands and a desire for smaller rigs, AM gave way to single-sideband (SSB) operation. Radios had more sensitivity on SSB than with AM, so worldwide contacts became easier. AM was relegated to "calling frequencies" - just single frequencies in the large amateur phone bands where AM aficionados could still enjoy the fun of those old-style QSOs, which were typically long-winded, since VOX was not used and switching over from

transmit to receive took longer.

Now you can enjoy the fun of AM without spending an arm and a leg with your new HT-7 Handie-Talkie. Not only can you use it as a walkie-talkie, with limited range, but you can, with an appropriate outside antenna, talk to the "big guns" on the 40M AM calling frequency of 7.290MHz. Since the output power of the HT-7 is just 2 Watts, you may want to add an amplifier, but when band conditions are good, and the sunspot cycle cooperates, you will be amazed at how far 2 Watts will carry!

Thanks for trusting in DZKit to provide not only unique electronic products, but to give you hours of building fun too.



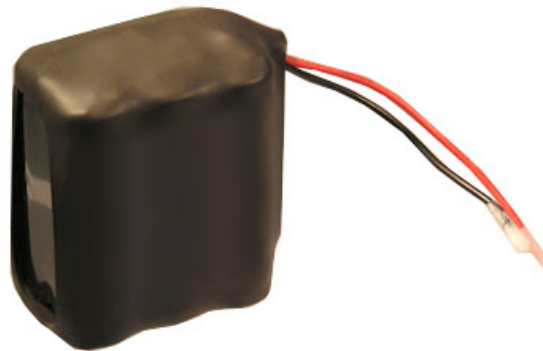
## AVAILABLE ACCESSORIES



HTA-3 Tuner. This is the "Ducker I/L" made by Miracle Antenna of Canada. Adds about 30dB of gain to your HT!



HTA-2 57" Extendable Whip. Also made by Miracle Antenna of Canada. Use with or without the HTA-2 tuner.



HTA-1 Battery Pack. Includes built-in overcharge, overdischarge, overdrain, short-circuit and reversed polarity protection. Weight: 10.4 oz (370g). Dimensions: 2.6" (66mm) x 2.1" (53mm) x 1.7" (43mm). Must be recharged using Lithium Ion charger only. Not for use with NiCd or NiMH chargers. Can be charged in use by connection of a 12VDC power supply, or go to [www.batteryspace.com](http://www.batteryspace.com) to order an inexpensive charger made for this battery.



## General Assembly Notes

1. As you tighten a screw, it is very important that you do not strip the threads. All screws should fasten smoothly without resistance. If a screw appears to be hard to fasten, something else is probably wrong—a cable could be in the way, you are trying to use the wrong size screw or something else is wrong. DO NOT FORCE SCREWS! Instead, inspect the assembly carefully and try to see why you are having difficulty. Abbreviations: PH = panhead. FH = flathead. M/S = machine screw.
2. All references to left and right, front and back are with the chassis in an orientation such that the speaker faces you and the text reads correctly from left to right.
3. Each circuit part has its own component number (R1, L4, Q3, etc.). R1 on one assembly will not be the same as R1 on a different assembly, so be sure you are looking at the right set of parts when comparing part numbers with the printed parts list. Check off each part at the beginning of each section to make sure all the parts are there. If you find any missing, give us a call or email us and we will rush a replacement to you.
4. Most electronic kits that are returned for service have poor soldering jobs. *Please* take a moment to familiarize yourself with proper soldering technique. And do not, under **ANY** circumstances, use corrosive (“acid-core”) solder! That will void your warranty and render your kit inoperative. Also be sure to avoid the use of products that may be called solder but are really glue. Soldering should only be done in an area with good ventilation and with a properly heated soldering iron.
5. Capacitors are identified by their type – disk, polystyrene, polypropylene, electrolytic, trimmer, etc.) and capacitance values are in microfarads ( $\mu\text{F}$ ) or picofarads ( $\text{pF}$ , often pronounced “puff”). Polarized types have the positive pin marked on the silkscreen and also have a square pad.
6. Inductors are represented either by their inductance in nanoHenries ( $\text{nH}$ ), microHenries ( $\mu\text{H}$ ), milliHenries ( $\text{mH}$ ) or by the number of turns in the coil if you are doing the winding.
7. Diodes are marked with a band on the cathode end. The PC boards have a bar silkscreened across one side of the component outline and a square pad which identifies the cathode.

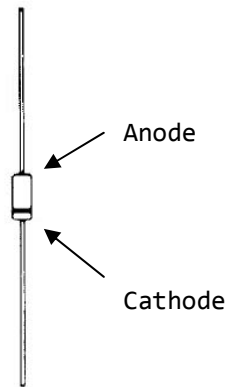


8. ICs have a notch, beveled side and/or a dot representing the side containing pin 1. When you hold an IC with the notch pointing up or the beveled side to your left, pin 1 is in the upper left corner. The silkscreened outlines on the board all have notches and pin 1 also has a square pad.

***It is CRITICAL that you mount polarized parts correctly! Double check your work to be sure that all such parts match the photos.***



IC – pin 1 (through hole part)



Diode



Electrolytic caps—negative terminal



Most kit builders find it helpful to separate the parts into categories for quick identification. Muffin tins and egg cartons serve this purpose admirably.



## KIT-BUILDING PROCEDURES

The steps involved in building a kit are listed below. Be sure to follow them and you will have a lot of fun building, aligning, testing and using your kit.

1. **Do a parts inventory.** Check off each part in the parts list to be sure you are not missing anything. Our method of bagging parts is different from all other kit vendors and will make the task much faster and less error prone. But despite our valiant efforts, mistakes can happen. If you are missing any parts, call or email us and we'll rush replacements to you immediately.
2. Do not remove parts from the bags until called for, to avoid mixing parts up.
3. **Pay attention to soldering techniques.** Keep your soldering iron clean by using a wet sponge, use appropriate heat and maintain heat long enough to make good solder joints. Solder problems are the number one cause of problems when building electronic products (not just kits!), so try extra hard to do it right.
4. **Take your time!** We know you want to get it done and start using it, but doing it wrong will only delay that moment. Before you start, set up a ventilated, static-free work area with enough room to build the kit. Prepare parts bins and get the tools you will need (needle-nose pliers, wire-cutter, wire stripper, Phillips head screw drivers, wrenches, soldering iron, solder, insulated tool, awl or other sharp-ended tool, scissors, magnifying glass, etc.) If you're tired, take a break. Enjoy building your kit!
5. **Make sure that you are loading the part that's called for in the right holes.** Once loaded, it can be hard to find a misloaded part. Be especially careful to load polarized parts (ICs, transistors, diodes, electrolytic capacitors) the right direction. If you are not sure about any step, call, write or email us!
6. Once you've done a step, **put a checkmark inside the parentheses.**
7. **After you have assembled a circuit board, take a moment (just one) to marvel at your handiwork, then spend a few more minutes critiquing it!** Check for solder bridges, unsoldered or insufficiently soldered connections, solder blobs (especially on insulated magnet wire used on toroids), loose screws and electronic parts, reversed polarized components, etc. Sometimes it helps to have a friend check your work.





## Safety First!

Your safety is of utmost importance to us. Please read this information before you get started, and remember these rules as you continue building and testing your kit.

1. Always have a healthy respect for electricity. Use a power supply with overcurrent foldback or crowbar protection so that in case of high currents the supply will shut down. Set the output current only as high as necessary for a given step.
2. When measuring voltages inside electronic equipment, it is generally a good idea to use only one hand, wear rubber-soled shoes and avoid areas with standing water. However, remember that slightly humid environments can prevent static electricity that could damage the electronic parts! Use a humidifier in dry climates.
3. Do not work on powered electronics by yourself if at all possible. Have a parent, spouse or friend nearby. If you must work alone, keep a telephone handy in the event you run into problems.
4. Soldering irons are hot. They can burn your skin and cause damage to workbenches and carpets. We recommend you use one with an automatic shutoff in case you forget to turn it off when you are done.
5. Do not work on electronic projects when you are tired. We know you want to finish it, but accidents are more likely when you are tired. Take breaks! Be careful!
6. Use proper ventilation in your work area. Solder contains tin and lead (or tin and silver), and solder fumes should not be allowed to “hover” near your work. Open a door or window, use a fan, and be cognizant of the potential dangers.
7. When clipping leads, use eye protection and/or be sure to direct the flying leads down into a nearby trash can. As you gain experience clipping component leads, you will learn how to clip them so that they fall harmlessly away from the board.
8. Be careful not to cut yourself when handling sharp objects such as connectors and sheet metal. Keep some tissues, bandages and antibiotic ointment nearby in the event of an injury.
9. This may sound obvious, but do not insert any parts in any portion of your body.
10. Use common sense in dealing with unfamiliar things. If you don't understand something, call us or ask a friend for help.



# SOLDERING INSTRUCTIONS

*Poor soldering accounts for almost 90% of all kit building problems.*

The photographs below show examples of the most common types of bad solder connections and a good one. If you locate any of these bad solder connections in your kit, correct them as described. Study this section carefully before you start building your kit.

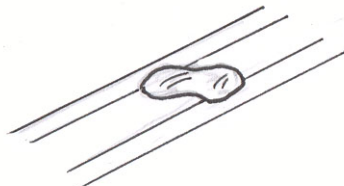
**Solder blob.** In this example, solder flowed onto a lead, but the heat was not maintained long enough for it to flow onto the circuit board pad. Solution: re-heat the connection, touching the iron to both the component lead and the pad at the same time.



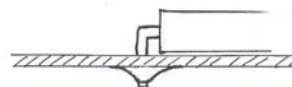
Use a good quality, variable temperature soldering iron with a conical, narrow tip, and set the temperature to 750 degrees F. Use thin, non-corrosive, rosin core solder to assemble your kit. Keep the sponge damp and wipe the tip on the sponge after each solder step.



**Solder bridge.** Solder that stretches from one trace or pad to another creates a short circuit. Solution: Hold the board upside down and reheat the area. The excess solder will flow down the soldering iron. Another solution is to use a “solder sucker” or solder wick to remove excess solder. Solder suckers work well one or two times on a given connection. If used too much, they can pull pads and traces off of PC boards.



A good solder connection looks like this. Solder flows evenly onto both the part and the PC board or chassis component. It is shiny and even, not lumpy and dull. The component lies flat on the board. Leads that are properly soldered can not be moved in the hole. You can find bad solder connections by measuring the resistance, using an ohmmeter, between the component’s lead (where it attaches to the body of the part) and the other end of the trace. If it reads infinity (or very high) the connection is open.





## STATIC PRECAUTIONS

Many of the components in your kit can be damaged by exposure to static electricity. Please read this page to familiarize yourself with the causes of and solutions to this problem.

When the climate is dry, you can generate thousands of volts simply by walking across a carpet. When you then touch a metal object you can feel the effects of this as you draw a spark! That same spark, often too small to see or feel, can destroy sensitive electronic components. You **MUST** take precautions when working with electronics to prevent damage.

The best solution is to outfit your workbench with anti-static devices – floormats, grounded soldering irons, and workmats with grounded wriststraps. If these are not practical for you, the very least you should do is to discharge yourself to ground after you sit down and before you touch any electronic items, by touching a grounded object such as the corner of a wall.

In a dry environment, simply standing up after sitting in a non-grounded chair can also charge you with electricity. If you stand up to stretch, for example, be sure to re-ground yourself before getting back to work. Don't wear insulated sole shoes and avoid Nylon, wool or other

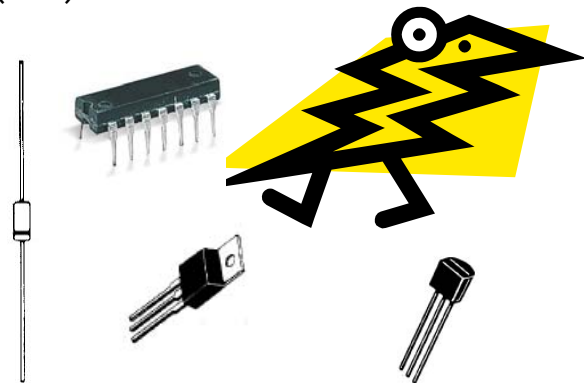
static-producing material in your clothing.

If your work area floor is carpeted, spray fabric softener on it using a hand spray bottle. Fabric softener is conductive and will bleed away carpet static for a few hours.

Don't use a plastic table unless you have a grounded workmat on it. Use a metal table if possible.

Cats are notorious for inducing static into your work area. Don't allow them anywhere near your workbench!

All electronic components are susceptible to static, but semiconductors and assembled boards containing semiconductors are the most prone to damage. These include diodes (including light-emitting diodes [LEDs]), transistors and integrated circuits (ICs).

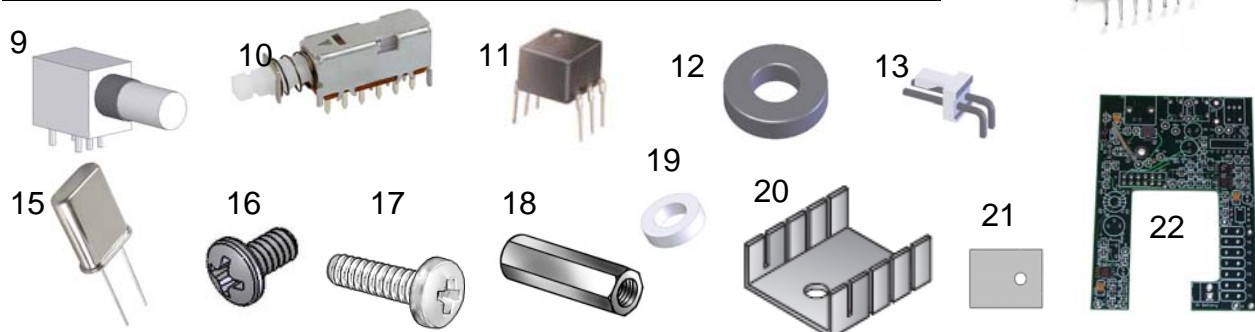
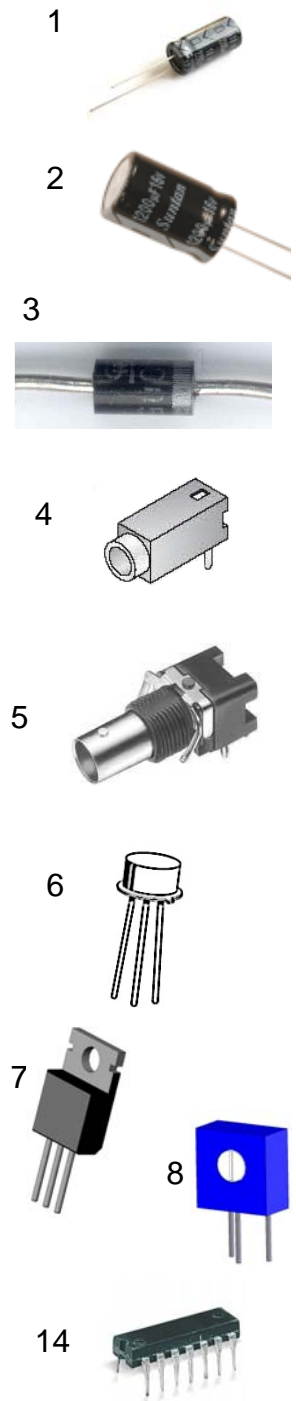


***You are a walking lightning bolt! Be careful!***



# HT-7-2 Board Parts

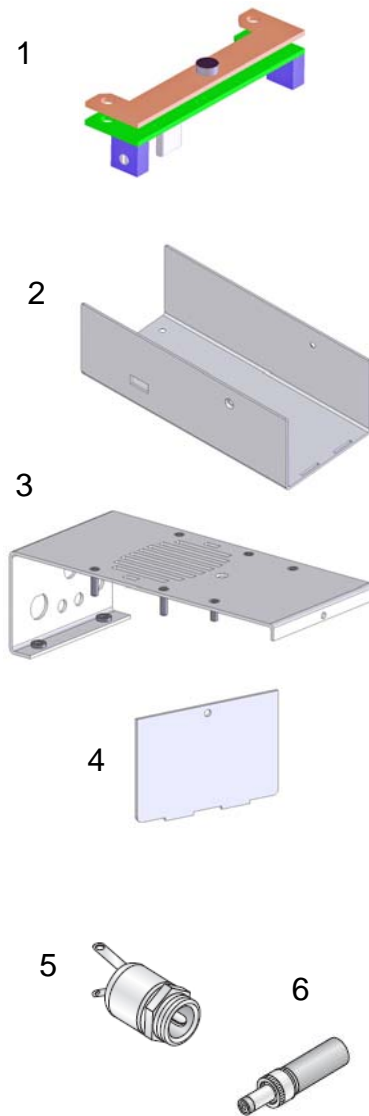
Item	Ref	Description	Qty
1	C2	10uF/25V	1
1	C26	22uF/16V non-polar	1
2	C12	330uF/16V	1
2	C6	470uF/10V	1
3	D3	1N5404	1
4	J1, J2	3.5mm mono minijack, right angle, PCB-mount	2
5	J3	BNC Jack, right angle, PCB-mount	1
6	Q2	2N5109 NPN Transistor	1
7	Q3	2SC2166C NPN RF Power transistor	1
8	RV2	10K trimpot - vertical	1
9	RV1	1K pot with switch	1
10	S1	4 pole double throw momentary switch	1
11	T1	T36-1	1
12	T2, T3	FT37-43	2
13	J4	2-pin right-angle MTA connector	1
14	U2	LM380 audio amplifier IC	1
15	Y1-Y7	7.287MHz HC49/U crystal	7
16		Screw - 4-40 x 1/4" PH Phillips M/S	1
17		Screw—4-40 x 3/8" PH Phillips M/S Plastic	1
18		Hex F/F spacer - 4-40 x 3/8"	1
19		#6 Nylon washer	1
20		TO-220 Heatsink	1
21		TO-220 insulator with adhesive backing	1
22		Partially loaded HT-7-2 board	1
		Red 26# magnet wire	12"
		Green 26# magnet wire	12"
		Bare wire	6"
		RG-178B/U coaxial cable	7"
		Heat shrink tubing	4"





# Chassis Parts

Item	Description	Qty
1	HT-7-1, -3 mic preamp/mixer boards (assembled)	1
2	Bottom chassis	1
3	Top chassis	1
4	End chassis	1
5	DC power jack - 5.5x2.5mm chassis mount	1
6	DC power plug	1
7	Hex key, .05"	1
8	PN41 switch button, gray	1
9	Speaker	1
10	S/N sticker	1
11	Snap rivet	1
12	Screw - 6-32 x 1/4" FH Phillips M/S Black	4
13	Screw - 6-32 x 3/8" PH Phillips M/S	2
14	Nut - 6-32 KEPS	5
15	Nut - 6-32 hex	1
16	#6 Solder lug	1
17	#6 Nylon washer	2
18	Angle bracket	2
19	Knob	1
20	2-pin female connector with 2" red/black wires	1
	Heat shrink tubing	4"
	Insulated hookup wire, white, black, 24AWG	12"
	Insulated hookup wire, red, orange, 24AWG	8"
	RG-178B/U coaxial cable	8"

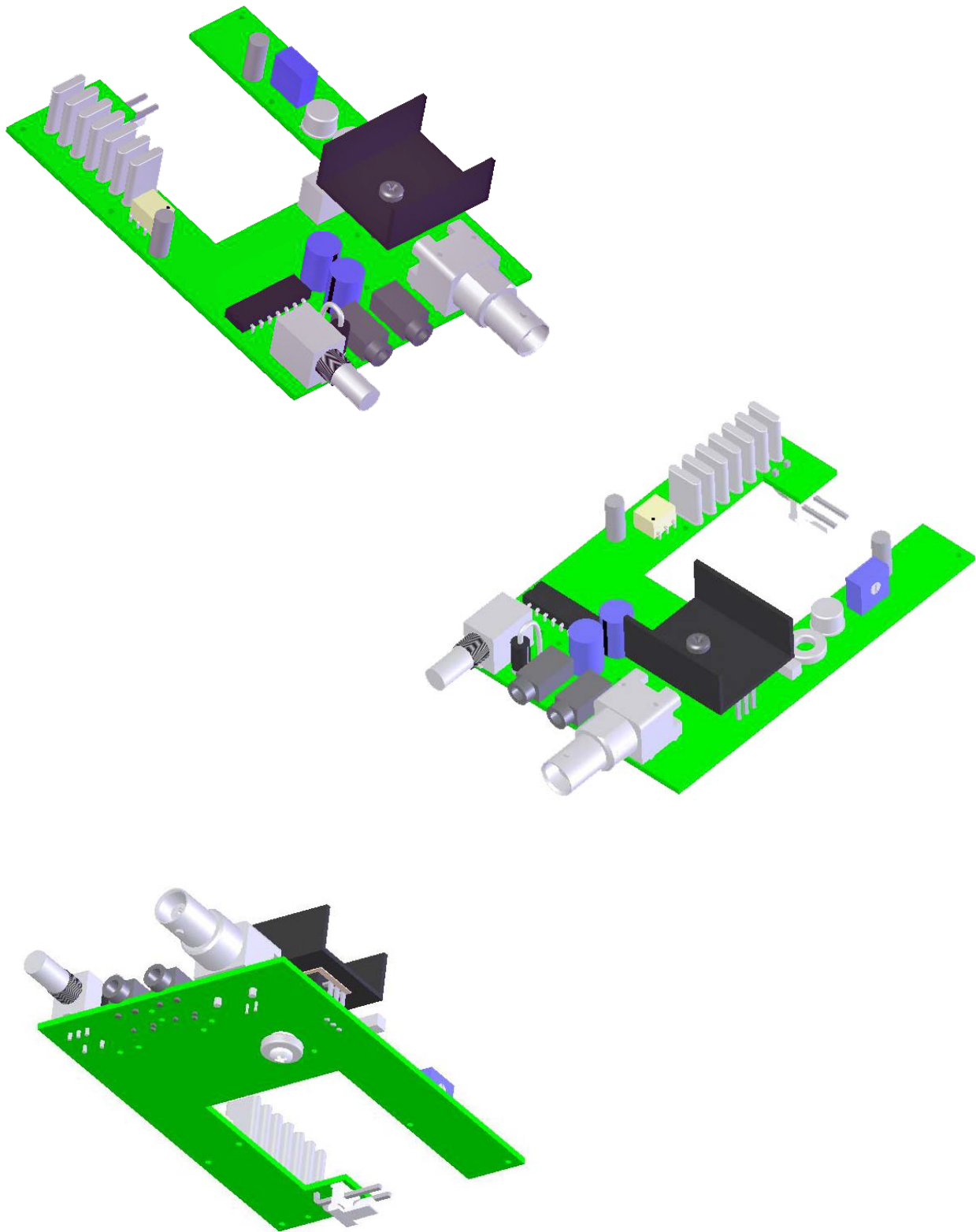




## STEP-BY-STEP ASSEMBLY - HT-7-2 Board

Refer to Pictorial 1 for the following steps.

- ( ) Load and solder the two mono minijacks, J1 and J2, where shown. Be sure they lie flat against the board. Be careful not to damage the plastic bodies with the soldering iron. Note that two of the tabs extending into the holes in the board are plastic, so do not apply solder to these.
- ( ) Load and solder RV1, the volume control. Be sure that it lies flat against the board.
- ( ) Load and solder the BNC connector. Be sure it lies flat against the board.
- ( ) Load and solder the 2-pin right-angle connector at J4. This connector mounts to the **bottom** of the board and extends out into the opening.
- ( ) Load and solder D3, the large 1N5404 rectifier. Insert the side with a band (the cathode) into the square pad with the part oriented vertically. Bend the anode lead down and into the other hole. Solder both leads and clip excess lead length.
- ( ) Load and solder RV2, the 10K trimpot. Clip excess lead length.
- ( ) Load and solder T1, the 6-pin DIP transformer. The pin marked with a dot must go into the square pad.
- ( ) Load and solder the seven crystals, Y1-Y7. Be sure they lie flat against the board. It does not matter which side the lettering goes on, but most builders prefer to line them up so that the text reads the same on all crystals. Clip excess lead lengths after soldering.
- ( ) Insert 3" of bare wire into the holes just below the "Y1" and "Y7" text to the right of the crystals. Place it so that you can solder it to the top of all the crystals. Solder the two ends, then solder it to the top of each crystal. Do not use any more heat than necessary.
- ( ) Load and solder the 330 uF electrolytic capacitor (C12). Be sure the black stripe is on the side with the round pad. The longer lead is the positive lead, and it goes in the hole with the square pad (also marked with a "+" on the silkscreen).
- ( ) Load and solder the 470uF ca-



Pictorial 1. Component placement on HT-7-2 Board

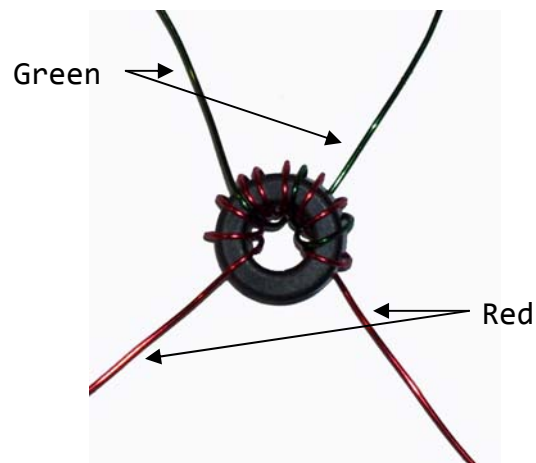




capacitor (C6) in the same manner as the previous capacitor.

- ( ) Load and solder the 10uF/25V electrolytic (C2) in the same manner as the previous two capacitors. This capacitor has a smaller radius.
- ( ) Load and solder the 22uF non-polarized capacitor (C26). The orientation of this capacitor does not matter even though one lead is longer.
- ( ) Load and solder U2, the 14-pin dual-inline package (DIP) IC. Be sure that pin 1 is placed in the square pad. The notch on the end of the part is closest to the edge of the board.
- ( ) Load and solder Q2, the transistor with the metal can. It can only be inserted one direction, but make sure the tab lines up with the marking on the silkscreen. Make sure this transistor lies flat against the board.
- ( ) Insert all 12" of the red magnet wire into an FT37-43 toroid core, leaving 2" outside. Wrap the wire nine times around the core, pulling tightly on each turn. Remember that each time you

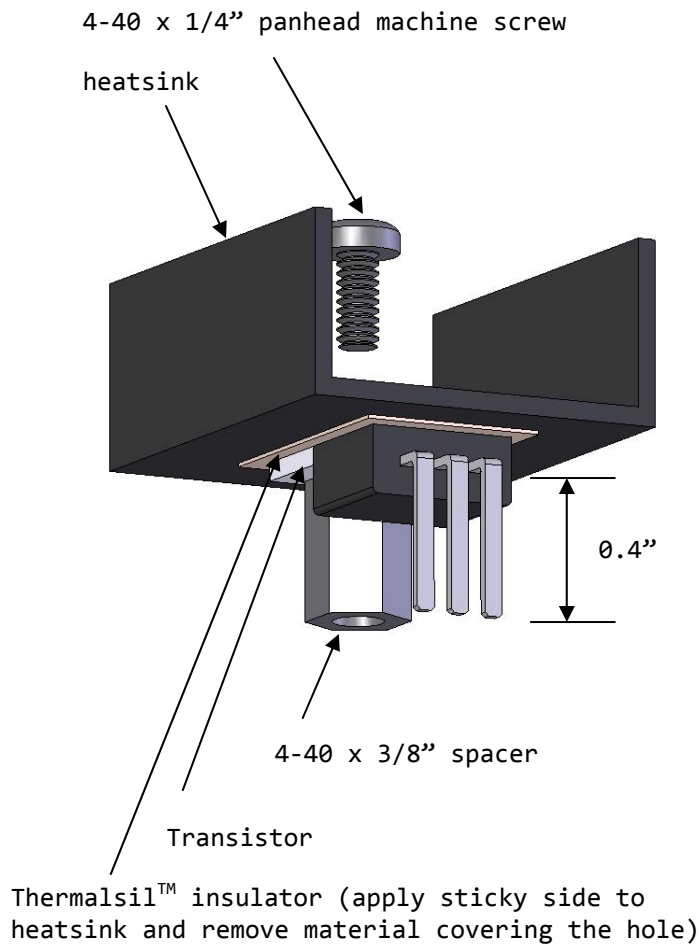
pass a wire through the center of the core counts as one turn. Spread the turns out evenly, covering about 2/3 of the toroid. Cut the excess lead off, leaving 2" outside so that the two leads have the same length. Save the remaining wire for use with T3. Wrap the 3-turn secondary using green magnet wire around the toroid, overlapping the primary as shown in Detail 1.



Detail 1. T2 winding

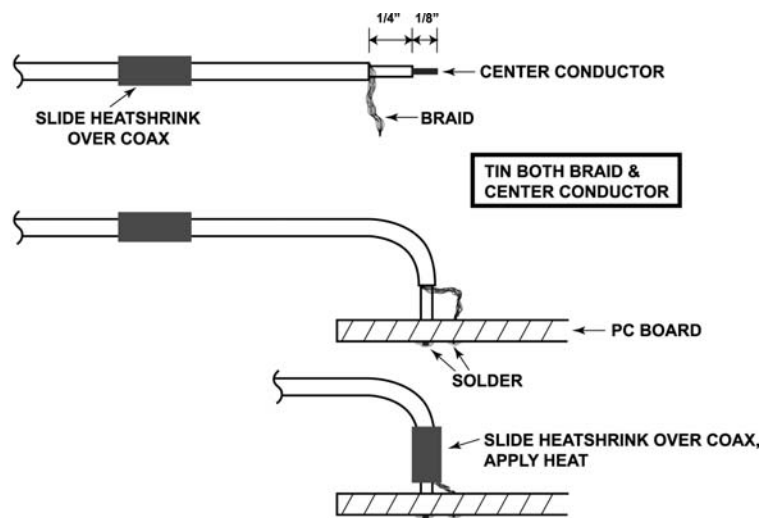
- ( ) Place T2 flat against the board and insert the primary (red) leads into the holes marked 1 and 2. Insert the green wires into the holes marked 3 and 4. Pull the wires tight from the bottom of the board so that the toroid lies as flat as possible. Cut the excess lead length





### Pictorial 2. Q3 preparation

Thermalsil is a trademark of Aavid Thermalloy, Inc.



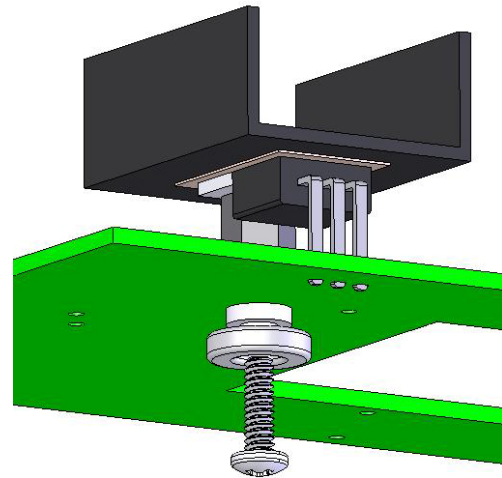
### Detail 2. Coaxial cable preparation



off, then remove the whole part from the board and tin the leads, removing the enamel from the wire.

- ( ) Re-insert T2 into the board and solder all four wires in their respective holes.
- ( ) Load and solder 4-pole double throw momentary switch S1. Make sure it lies flat against the board. Do not attach the plastic button to the end at this time.
- ( ) Wind toroid T3 in the same manner as T2, but use only three turns of red magnet wire for the primary and five turns of green wire for the secondary. Prepare its leads as with T2, and then solder it in place on the **BOTTOM** of the board, allowing 1/16" clearance between the toroid and the board. The red primary leads go into the holes marked T3-1 and T3-2 and the green secondary leads go into holes marked T3-3 and T3-4. The center of the toroid should be placed directly over the center hole.
- ( ) Prepare RF power transistor Q3 as shown in Pictorial 2.
- ( ) Insert Q3 into its holes from the top side of the board and line up the spacer with its hole. Solder the three leads

of the transistor and attach the spacer to the board using a 4-40 x 3/8" plastic panhead machine screw and a #6 Nylon washer placed between toroid T3 and the board as shown in Detail 3.



Detail 3. Q3 installation

- ( ) Cut two lengths of RG-178B/U coaxial cable to 3.5". Refer to Detail 3 for preparation of all coaxial cable assemblies.
- ( ) Solder the center conductors of one piece of prepared coaxial cable between pads labeled 'A' and connect the shields to 'GND'. Load this cable on the bottom of the board.
- ( ) Repeat the previous step, using pads 'B' and 'GND'.



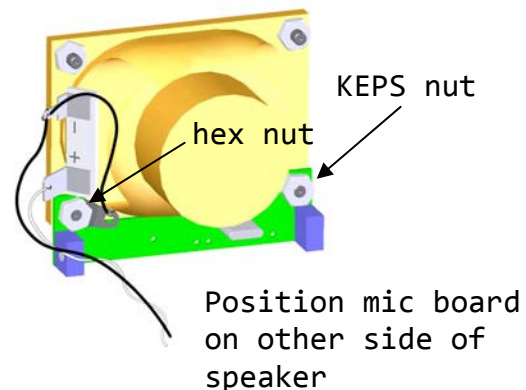
## STEP-BY-STEP ASSEMBLY - Chassis Integration

Refer to Pictorial 3 for the following steps.

Cut the stranded colored wires to the lengths shown below, strip the leads to 1/8", tin them and solder them as follows to the **top** of the HT-7-2 board:

- ( ) SPKR+ 5" [ White ] (strip/tin the loose end to 1/4")
- ( ) SPKR- 5" [ Black ] (strip/tin the loose end to 1/4")
- ( ) Twist the white and black speaker wires together, about 2 turns per inch.
- ( ) DCin+ 2" [ White ] (strip/tin the loose end to 1/4")
- ( ) DCIn- 2" [ Black ] (strip/tin the loose end to 1/4")
- ( ) Twist the white and black DCin wires together, about 2 turns per inch. Solder the white wire to the center pin of the DC power jack. Solder the black wire to the side pin on the DC power jack. Remove the nut and washer from the jack and save them.
- ( ) Sandwich the speaker between the electret mic board and the preamp/mixer board (HT-7-1) using two 6-32 x 3/8" screws, two #6 Nylon washers (between the speaker and the

HT-7-1 board), one 6-32 KEPS nut, one hex nut and one #6 solder lug. The solder lug must be positioned facing the speaker on the same side as the speaker's terminals. Be very careful not to damage the trimpots when tightening the nuts. See detail 4. **Note: the screws will be removed after testing, when the speaker and mic boards are permanently installed in the chassis.**



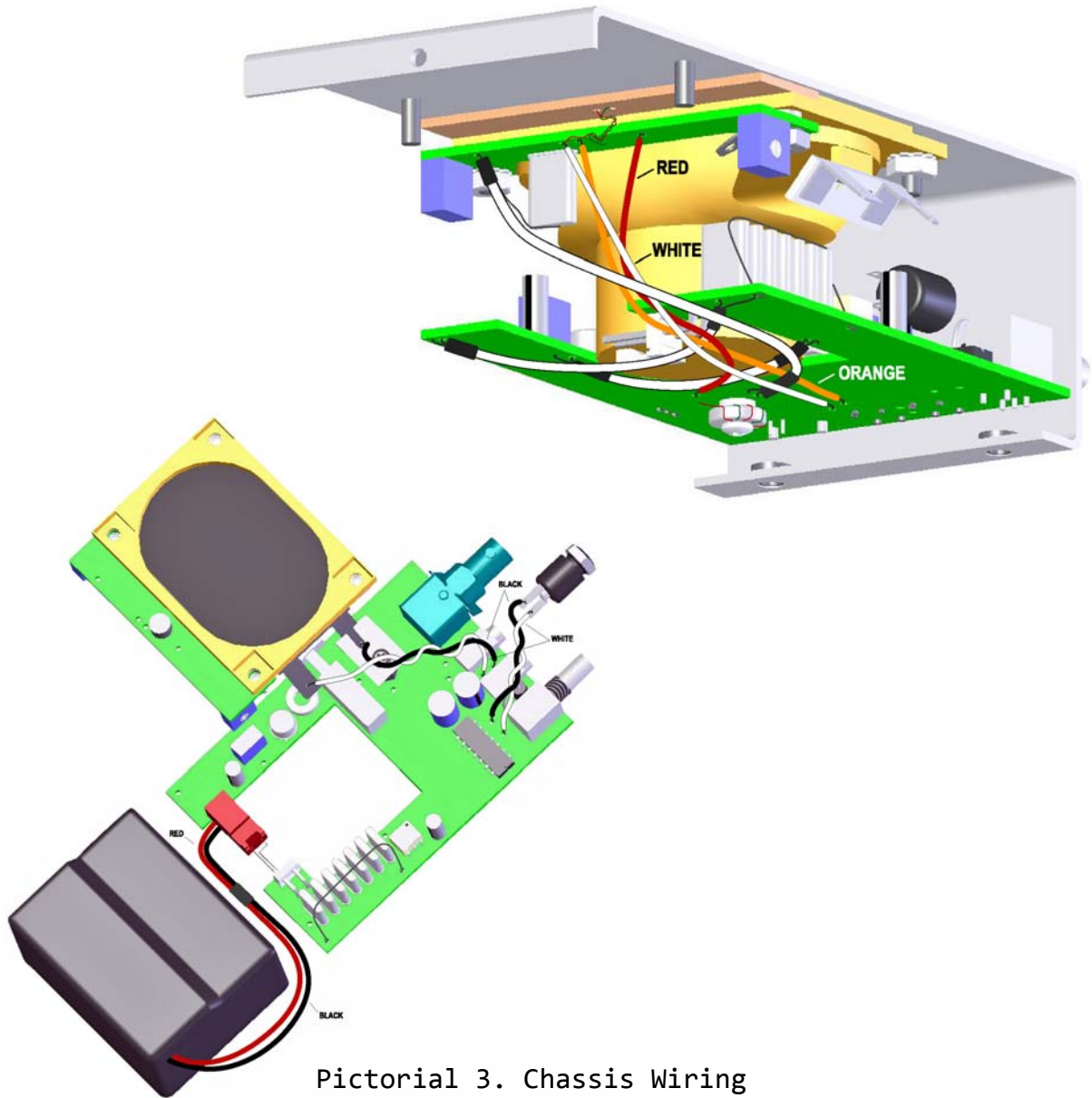
Detail 4. HT-7-1 mounting

Solder these wires to the **bottom** of the HT-7-2 board:

- ( ) Mic 5 1/2" [ White ]
- ( ) Amp 5 1/2" [ Orange ]
- ( ) Mic Pwr 5 1/2" [ Red ] **Note: Rev A boards have two other parts attached to this pad. Be careful not to dislodge them.**



- ( ) Strip and tin the center conductor to 1/8" and the braid to 1/2" on each end of the 8" RG-178B/U coaxial cable. Solder the center conductor to "RF in" and the braid to "GND". See Detail 2.
  - ( ) Cut a 2" length of black stranded wire, strip the ends to 1/4" and tin the ends. Solder one end to the solder lug. Attach the other end around the lug on the speaker marked with a "-" but do not solder it.
  - ( ) Find the twisted white/black wires going to SPKR+/- on the HT-7-2 board and solder the white wire to the + terminal on the speaker. Attach the black wire to the - terminal and solder the two black wires on this terminal.
  - ( ) Solder the three loose wires to the **bottom** of the HT-7-1 board as follows:
    - ( ) White: Mic (Be careful not to dislodge the magnet wire that connects this pad to the electret board)
    - ( ) Orange: Amp
    - ( ) Red: Pwr
  - ( ) Slide heat shrink tubing over the RG-178B/U coaxial cable. Solder the center conductor to "RF" on the **bottom** side of the board. Solder the loose bare wire that is attached to the crystal to the braid, then cut the bare wire near the point where it attaches to the crystal. Slide the tubing over the braid and apply heat until it shrinks over the connection. Resolder the bare wire to the crystal.
  - ( ) Rotate the volume control counterclockwise until it clicks (off).
  - ( ) If you will be operating the HT-7 from an internal battery, attach the battery wires to the provided 2-pin cable (CA1), which consists of a red and black wire crimped to an orange 2-pin Amp MTA connector. Strip the ends of the wires and those of the battery to about 1/4" each. Place heat shrink tubing over the insulated portion of the battery wires, then twist the wire ends together (red to red, black to black) and solder them. Then slide the heat shrink tubing over the soldered connections and heat them with a heat gun or soldering iron until the tubing shrinks over the connections. Plug the connector onto J4 on the HT-7-2 board.
- Important: The HTA-1 battery is protected internally from over-voltage and overcharge conditions. If you are using some other battery pack, be sure it can handle direct connection to a power supply.***



Pictorial 3. Chassis Wiring

- ( ) Position the boards away from each other to avoid short circuits during testing.
- ( ) If you will be operating the HT-7 from an external DC power supply, plug it into the connector on top of the unit using a 5.5mm plug (center pin positive). One such connector with a lock ring is provided in the kit.
- ( ) Set the voltage to +11.1VDC. If you have a current limit control, set it to 1A.
- ( ) Connect a 50 ohm dummy load or an antenna to the BNC jack.
- ( ) Rotate the power switch/ volume control to the middle of its range.



## STEP-BY-STEP ASSEMBLY - Tests and Adjustments

- ( ) Carefully measure the voltages below to be sure that you have wired everything correctly. These assume a battery or supply voltage of 11.1VDC and can vary about 10%. Refer to page 39 for help if your measurements are substantially different.
- ( ) Adjust RV2 on the HT-7-2 board to give a reasonable sound to the audio without feedback or excessive noise. If the gain is too high, you may start picking up short-wave stations or strong local AM broadcast band stations. If it is too low, the range of your HT may be limited.
- ( ) Press the PTT switch while monitoring your signal on a receiver tuned to 7.290MHz (AM). Adjust RV1 and RV2 on the HT-7-1 board for the best sound.
- ( ) Press the PTT switch and adjust trimmer capacitor C10 so that the signal amplitude peaks and audio sounds good when the receiver is set for exactly 7.290MHz.

Board	Transmit/Receive	Measurement point	Voltage (DCV)
HT-7-2	R/T	D3 cathode	11.1
HT-7-2	R/T	Q1 base	3.1
HT-7-2	R/T	Q1 emitter	2.4
HT-7-2	R/T	Q1 collector	6.8
HT-7-2	R/T	U3 pin 1	6.1 to 7.2*
HT-7-2	R	U3 pin 2	6.6
HT-7-2	T	U3 pin 2	8.0
HT-7-2	R/T	U3 pin 4	5.5
HT-7-2	R/T	U3 pin 8	11.1
HT-7-2	R	U1 pin 3	4.4
HT-7-2	R	U1 pin 7	8.8
HT-7-2	R	U4 pin 8	8.8
HT-7-2	R	U2 pin 14	11.1
HT-7-2	T	Q2 base	3.0
HT-7-2	T	Q2 emitter	2.3
HT-7-2	T	Q2 collector	9.0
HT-7-2	T	Q3 base	1.4
HT-7-2	T	Q3 emitter	0.6
HT-7-2	T	Q3 collector	10.9
HT-7-1	T	U1 pin 2	5.55
HT-7-1	T	U1 pin 3	5.55
HT-7-1	T	U1 pin 8	11.10
HT-7-1	T	U3 pin 1	11.10
HT-7-1	T	U3 pin 2	0.00
HT-7-1	T	U3 pin 3	5.00
HT-7-1	T	U2 pin 8	5.00

**Important:** When measuring voltages in transmit mode (PTT switch pushed in), keep transmissions short and/or connect a 50 ohm dummy load or an antenna to the BNC jack to avoid damage to the output transistor.

See page 40 for a component locator.

Blue measurements are on the HT-7-1 board!

\* Voltage is set by RV2 on the HT-7-2 board





## STEP-BY-STEP ASSEMBLY - Final Assembly

Refer to Photos 1 and 2 for the following steps.

- ( ) Turn the volume control to the off position.
- ( ) Disconnect the battery or external power supply.
- ( ) Remove the two 6-32 x 3/8" screws, Nylon washers and KEPS nuts holding the mic boards to the speaker.
- ( ) Remove and save the locknuts from the BNC connector and volume control pot, leaving the washers and/or lockwashers in place. Hold the HT-7-2 board with the silkscreened text facing you and the four connectors pointed up. Insert the speaker as far as it will go into the opening in the HT-7-2 board with the terminals facing to the right and the speaker cone facing you.
- ( ) Insert the HT-7-2 board into the top chassis. As you do so, place the electret mic board (HT-7-3) onto the two bottom speaker mounting studs and push down until the microphone locks into the opening. Then press the speaker onto all four mounting studs. Be careful not to tear the speaker cone on the studs as you position it.
- ( ) Attach the speaker to the inside of the top chassis using two 6-32 KEPS nuts on the two threaded studs closest to the top.



Photo 1. Final assembly

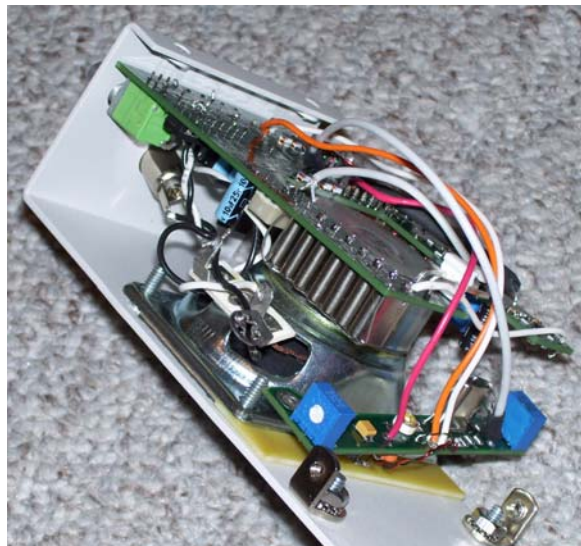


Photo 2. Final assembly



- ( ) Attach the HT-7-2 board to the top chassis using two hex nuts, one on the on/off/volume control and one on the BNC connector. Be careful not to scratch the chassis. Dress the wires neatly and position them away from the heat sink.
  - ( ) Insert the DC power jack into the top chassis opening labeled 10-12VDC IN. Attach the washer and nut on the outside and tighten the nut, being careful not to scratch the chassis.
  - ( ) Place a 1/16" Nylon washer over the two remaining longer studs.
  - ( ) Place the HT-7-1 board onto the studs.
  - ( ) Place the solder lug that is connected to the speaker over the stud so that the lug faces inward.
  - ( ) Tighten the assembly using a 6-32 hex nut on the side with the solder lug and a 6-32 KEPS nut on the other side. Be very careful when tightening these nuts not to damage the blue trimpots. Use needle nose pliers and make very slight turns until the nuts are tight.
  - ( ) Attach two 6-32 angle brackets to the top using two 6-32 KEPS nuts. Align the side with the non-threaded opening with the mounting studs. Exert pressure with one finger to keep the brackets from turning as they are tightened. Sand or file the paint off around the stud if necessary to help keep the bracket from turning.
  - ( ) Bend the speaker leads in so they do not protrude beyond the side of the HT-7-1 board.
  - ( ) Connect the battery (if present) to the 2-pin connector (J4). It will be necessary to flex the board slightly in order to get the connector on.
- Refer to Pictorial 4.
- ( ) Align the hole in the metal end piece with the hole in the top cover. Insert the plastic snap rivet into both holes until the rivet head is flush with the metal.
  - ( ) Insert the assembled top into the bottom chassis, compressing the PTT switch as you do so and allowing it to pop through the opening in the side. Secure the top to the bottom using four 6-32 x 1/4" black flathead machine screws.





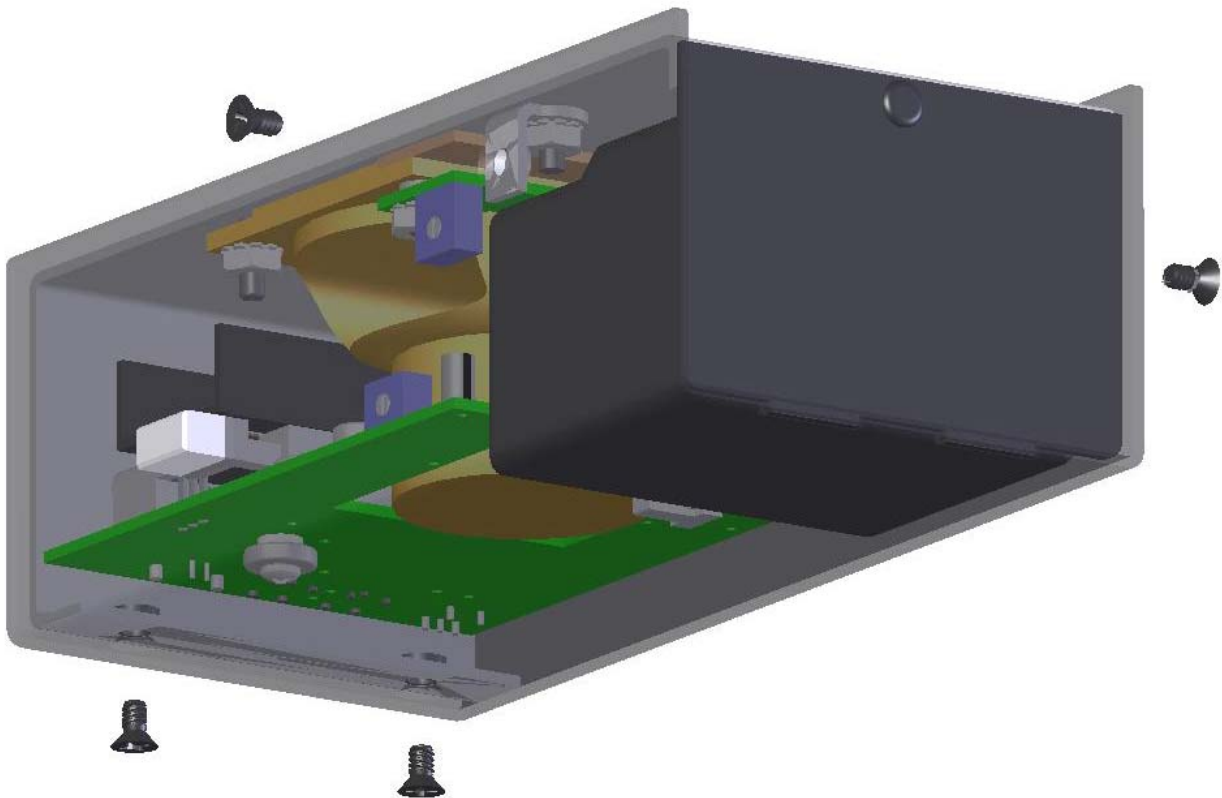
( ) Push the PTT switch button onto the switch until it locks into place. If the button sticks, the board is too high; check to make sure the lockwashers on the BNC connector and the washer on the volume control pot are on the *inside* of the chassis.

( ) Attach the knob to the volume

control shaft, aligning the white line on the knob with the "Off" label. Tighten the set screws using the provided .05" Allen wrench.

( ) Affix the serial number sticker wherever desired.

This completes assembly of your HT-7 handie-talkie.



Pictorial 4. Final assembly





## USING YOUR HT-7

Connect your HT-7 to an antenna, either the HTA-2 optional whip antenna (with or without the HTA-3 antenna tuner) or an external 40M antenna such as an Alpha-Delta DX-40. Always transmit into either an antenna or a 50 ohm dummy load. The output transistor can be damaged by transmitting into a poorly matched antenna or an open circuit. Connect an SWR-meter such as the DZKit HM-17 between the transmitter and the antenna to make sure your antenna is properly tuned. This can be a help even using the HTA-2 and HTA-3, so that you can see the effect of different tuner settings and antenna lengths. Keep transmissions short to avoid overheating the output transistor.

If you are using an outside antenna, you may need an adapter to connect the normal PL-259 coaxial connector to the BNC connector on the HT-7. These are commonly available at Radio Shack and other electronics stores.

If you are using the HTA-1 internal battery pack, make sure it is fully charged before using the radio. It can be charged outside of the HT by using an inexpensive Lithium Ion charger, or you can charge it inside the HT-7 by connecting a power supply set to 12V with a current limit of 4A to the power jack on the top of the HT-

7. Internal protection circuitry inside the battery pack will protect it from many improper voltage and current conditions. An external power supply can be used to power the HT-7 for home use even while the battery pack is installed, keeping it charged and ready to go for portable use.

If you want to use an external microphone instead of using the internal electret, plug it into the jack on the top of the unit labeled "Mic". This shorting style jack will disconnect the internal electret and remove DC voltage from the line. Any microphone can be used except ones requiring voltage sources (electrets). The HT-7 will operate fine with high or low impedance mics.

Connect a monaural headphone to the headphone jack if desired. Stereo headphones can be used too.

Operation of your HT-7 is very straightforward. Turn it on and adjust the volume to a comfortable level. Listen first, and if the frequency is clear, press the PTT button on the side of the unit and talk. Be sure to identify yourself using your call letters, even if merely talking to a fellow ham who's also using an HT-7.



## THEORY OF OPERATION

Refer to the schematics on pages 35-38.

### *Transmitter operation*

When the PTT switch, S1, is in the transmit position, supply power is routed to the transmitter circuits and not to the receiver circuits (HT-7-2 board, sheet 2 of schematics; 11.1V -> TXV).

Built-in electret mic M1 receives power from the 5V regulator U3 and is then fed to the main board where it is routed to the external microphone input via a shorting connector so that if no external microphone is plugged in, the internal electret microphone remains connected to the amplifier. The microphone preamp, U1, is an audio amplifier whose gain is controlled via RV2. The input impedance is set to 50K ohms (the parallel combination of R3 and R4, which also set the bias on the positive op-amp input to one-half of the supply. This is necessary since the op-amp operates with only a single positive supply. Capacitor C14 keeps the DC gain at one, via R5, while the AC gain can be set between 3 and infinity ( $1 + 100K/RV2$ ).

The output of U1 is coupled via C4 and resistor R6 to Gilbert cell double balanced mixer U2, which mixes the audio with RF from the 7.290MHz local oscillation

consisting of Q1, Y1 and related parts. The balance is upset by pot RV1, which allows the carrier to pass through the mixer along with the double sideband signal. The output of the mixer is fed to the main board.

On the HT-7-2 board, the AM signal is fed into PTT switch S1 at W9 (Sheet 2 of the schematic for the HT-7-2). When the PTT switch is pushed, the signal is routed to FIN (Filter Input) on Sheet 1. Q1 amplifies the signal to overcome the loss of the following crystal filter. The filter has an 1800 ohm input impedance, so this transistor also serves to match this impedance. The crystal filter is a 6kHz wide crystal lattice filter, which rejects all harmonics and unwanted mixing products from the AM signal.

The output of the filter, FOUT, is fed into variable gain RF amplifier U3, an Analog Devices AD603. The gain of this RF amplifier can be set from -10 to +40dB by changing the DC voltage on pin 1 to between 6.1V and 7.2V. This is done by pot RV2. In transmit mode, diode D5 and resistor R38 change the voltage on pin 2 to 8V, which keeps the gain of the AD603 at minimum, since no additional gain is needed in the transmit chain.



The output of this part, AOUT, is routed to the transmit amplifiers by PTT switch S1.

The transmit signal is amplified from about 20mW to about 200mW by transistor Q2. Resistors R24 and R25 bias the base of this transistor to 3.0V, which puts the emitter at 2.3V. The emitter resistors R28 and R29 cause about 45mA of collector current to flow (2.3V/51.7 ohms). Because of limiting resistor R27, the collector voltage is  $11.1V - (.045 * 47) = 9.0V$ . R26 and C32 provide a lot of negative feedback to keep the part from oscillating and to lower the input impedance. Normally, the input impedance of Q2 would be the parallel combination of its bias resistors (R24 and R25) in parallel with  $4.7 * \beta = 470$  ohms (the emitter resistor times the transistor's beta of about 100). Thus, the input impedance would be about 285 ohms. Feedback networks tend to lower the actual impedance. The AD603 has more than enough drive capability to handle this decrease in load impedance.

Q2's AC gain is the load impedance seen by the collector (as reflected by transformer T2), divided by the 4.7 ohm emitter resistance. RFC1 and C33 assure that the top side of T2 is at AC

ground. T2 has a 9:3 turns ratio, which causes an impedance step down to the next stage. The 2SC2166 final amplifier has a very low input impedance of about five ohms due to the grounded emitter configuration and the feedback network. That five ohms is reflected back to the collector by a factor of the square of the turns ratio, or 9, yielding a collector impedance of about 45 ohms. The gain of this stage is thus  $45/4.7$ , or almost 10. A voltage gain of 10 is equivalent to a power gain of 20dB ( $10 \log E^2$ ). In reality, the transistor operates at its maximum possible gain of about 11dB. This means that a base input signal of 600mVp-p results in a collector swing of about 6Vp-p.

The 2SC2166C final operates in much the same manner as the previous stage except that its output is fed to the antenna via a low pass filter with 50 ohms input/output impedance. The output transformer has a 3:5 turns ratio, so the 50 ohm filter load is reflected back as an 18 ohm collector impedance. With the collector current resting at about 386mA ( $.58V/1.5$  ohm), about 772mAp-p (386mApk, 273mArms) is available before saturating the transistor and causing distortion. With a collector impedance



of 18 ohms, and remembering that power is  $P = I^2 * R$ , the carrier power is thus  $0.273 * 0.273 * 18 = 1.34W$ . The voltage that must be developed to support this current is given by  $P = E * I$ , or  $1.34 = E * 0.273$ , and thus  $E = 4.9V_{rms}$ , or  $14V_{p-p}$ , well within the voltage available (twice the supply or  $22.2V_{p-p}$ ). This  $14V_{p-p}$  is then transformed by T3 to  $23V_{p-p}$  driving the 50 ohm filter load, or  $8.2V_{rms}$ . Ignoring the small power loss in the transformer, the available power is  $8.2^2/50 = 1.34W$ . Assuming Q3 has a gain of about 10, a  $14V_{p-p}$  output requires a  $1.4V_{p-p}$  input. That signal comes from the 2N5109 output stage, which was, as you recall, generating a  $6V_{p-p}$  signal. Transformer T2 stepped it down by a factor of 3 to produce the needed  $1.4V_{p-p}$  or more. Note – because of variations in transistor beta, your voltages may vary from this example by as much as 50%.

Total power in an AM signal with 100% modulation is 1.5 times the carrier power, so a carrier power of  $1.34W$  translates to a total AM power of  $2W$ . Note that it took about  $4W$  of DC power to create this ( $V_{ce} * I_c = (11-.58)*0.386$ ), resulting in an efficiency for this class A amplifier of 50%.

The output low pass filter is a 7-element Elliptical filter with a cutoff frequency of  $8MHz$ . This

frequency was chosen to get as close to  $7.29MHz$  as possible so as to eliminate harmonics while allowing for component tolerances so that the inductors and capacitors do not have to be adjusted.

#### *Receiver operation*

When the PTT switch, S1, is in the receive position, supply power is routed to the receiver circuits and not to the transmitter circuits (HT-7-2 board, sheet 2 of schematics;  $11.1V \rightarrow RXV$ ). The antenna, after passing through the same low pass filter as the transmitter, is fed through a high pass filter with a cutoff frequency of  $6 MHz$ . This keeps local AM broadcast and many shortwave broadcast stations from causing interference. The resulting  $6-8MHz$  signal is then fed to FIN, the same signal path taken by the transmitter. In this case, Q1 serves as not only an impedance matching circuit but also as a preamp. The output of Q1 is then fed into the  $6kHz$  crystal filter which passes only the  $6kHz$  range of frequencies centered at  $7.290MHz$ . The output, FOUT, is fed via PTT switch S1 to the receiver circuits starting at RX (HT-7-2 board, sheet 3).

U1 and U4 form a full-wave AM detector. Most AM detectors are simple half-wave diode detectors. This circuit was first proposed



by Rob Schenck, W2CU, on an online AM forum.

From Rob's description:

"This circuit is a variation of the classic "Precision Half Wave Rectifier" as described in many op-amp application notes as shown below [in Figure 1]:

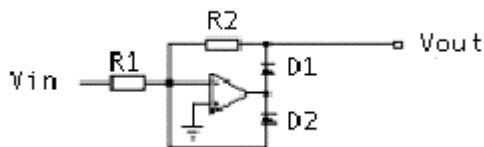


Figure 1. Half wave AM detector

"Its operation is based upon basic principles of operational amplifier circuits. An ideal op-amp has extremely high input impedance, extremely low output impedance, and extremely high gain. Note the operative word 'extremely'. The non inverting input (+) of the op-amp is connected to ground. Feedback is provided by the two paths R2+D1 and D2. The op-amp will drive its output pin to a voltage such that the inverting input (-) is at ground voltage. There will be a slight variation (a few millivolts) from 0 volts as a result of what is known as input offset voltage, a property of real op-amps. The inverting input is often called the summing junction, as the sum of the currents in

that node will be zero. Since virtually no current flows into the inverting input (-) of the op-amp itself, any current coming in through the input resistor R1 will be met by an equal and opposite current coming through either of the two paths of R2+D1 or D2.

"The I.F. input signal will produce an input current of:

$$I_{in} = V_{in}/R1$$

"During the negative half of the input AC waveform, the op-amp output will drive positive such that the current through R2+D1 will be equal and opposite the input current, or:

$$I_{in} = V_{in}/R1 = -I_{D1} = -I_{R2}$$

"The voltage developed across R2, and hence the output voltage as the left side of R2 is at ground potential, will be:

$$V = V_{out} = -I_{R2} * R2 = -V_{in}/R1 * R2$$

"By setting  $R1 = R2$ , the output voltage will be:

$$V_{out} = V_{in}$$

"Similarly, the positive going input cycle produces a feedback current through D2. Any non linear voltages developed across the



diodes is not relevant as the output is derived from the feedback resistor only.

“A full wave detector was desired for a 50 kHz IF application so that the ripple frequency out of the detector would be 100 kHz, and more easily filtered. In the full wave detector version of the circuit, a second feedback resistor is added to the D2 diode path to produce a voltage of the other half of the input waveform. A virtual ground at +6 Volts was created with R814/R815/C812, so that the circuit could operate from a single supply. Again, any nonlinear voltages developed

across the diodes are not relevant. The two rectified half waves are combined in the next two op-amp stages. The two outputs of the rectifier on R811 and R813, are connected directly to the non-inverting inputs of the op-amp stages so that there will be minimal loading to these outputs. U6A provides a gain of two to the signal voltage on R813. U6B provides a gain of two to the voltage on R811, and inverts and adds the output of U6A. The result is a full wave rectified signal at the output of U6B. Simple low pass filtering will remove the carrier energy which is at twice the ripple frequency.”

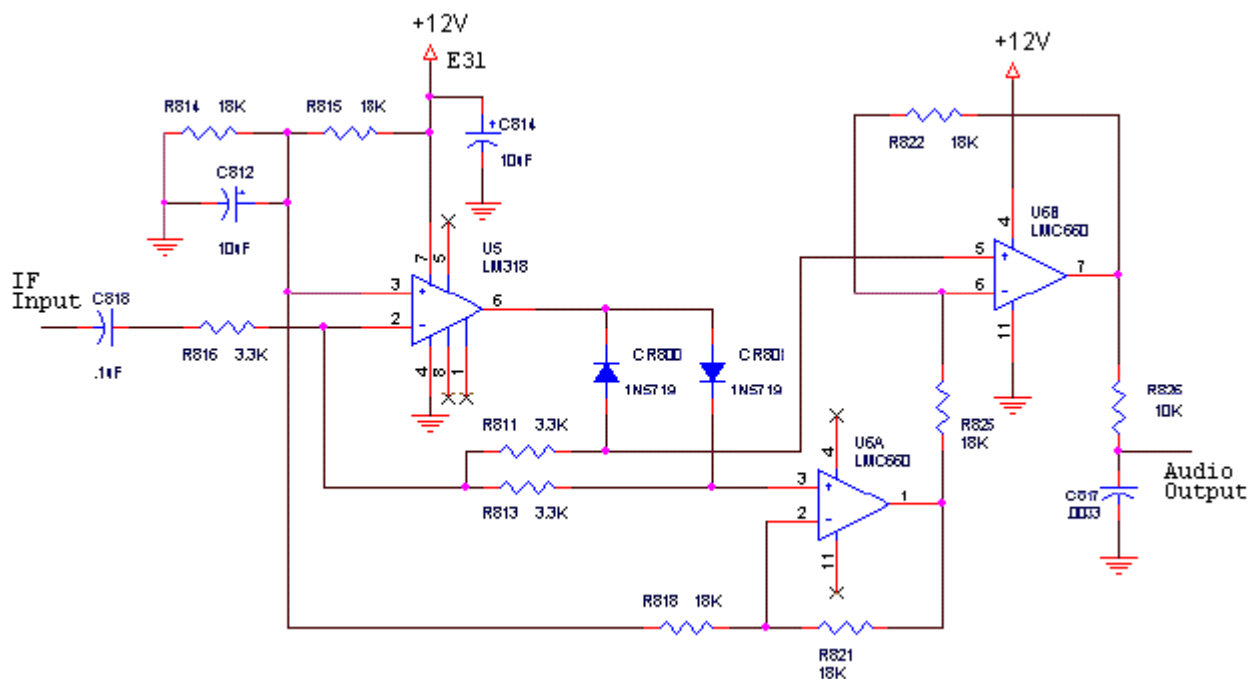


Figure 2. Full-wave detector described by K2CU





The HT-7-2 board schematic, sheet 3 (page 36), shows how we have implemented Rob's design. While his design was meant for 50kHz RF signals, today it is possible to use very high bandwidth op-amps to implement a full-wave detector directly at the operating frequency. The op-amps chosen for this are the Analog Devices AD8045, with a 1GHz gain-bandwidth product (GBW), and the AD826, a dual op-amp with a GBW of 50MHz.

The AD8045 needs a high GBW because it is used with a gain of 11 (the 470 ohm feedback divided by the 47 ohm input resistor, plus 1), so at 7MHz, almost 80MHz of GBW is needed. This gain assures that the diodes have enough signal to overcome their 300mV DC voltage drop.

Both op-amps are powered from a single supply, so they are biased at half the supply by R35 and R36. C2 assures that the positive input to the AD8045 is at AC ground. R8 assures that there is feedback around the op-amp in the region where neither D1 nor D2 are conducting, keeping it from operating in an undefined gain state. Its value is high so as not to affect the gain when the diodes are conducting.

Recall that an AM signal contains the carrier as well as the audio

information. Demodulation produces a signal that must be filtered to remove the carrier, leaving only the audio. R10 and C52 are used for this purpose. R7 provides a DC load for the AD826.

C50 couples the audio to the audio amplifier consisting of U2 and surrounding parts. RV1 is the volume control, which also has the on/off switch integrated with it.

Audio amplifiers require a great deal of current to handle instantaneous voice peaks. For this reason, a large 330uF electrolytic capacitor is placed across the supply leads. Although the entire transceiver draws only about 400mA on transmit and 10mA on receive, the supply must be able to handle current spikes as high as 1A! If the supply can't handle that much current, the audio will sound "fuzzy" as distortion is introduced into the output.

C6 couples the amplified audio to the speaker. Since the speaker load is 8 ohms, a large value capacitor is required so that its impedance is less than 1 ohm at audio frequencies of 300-3000Hz.

Diode D3 protects against reversed polarity.



## SPECIFICATIONS

Frequency: 7.290MHz, Amplitude modulation

Bandwidth: 6kHz

Output Power: approx. 2 Watts

Transmitter Spurious Output: <-45dB

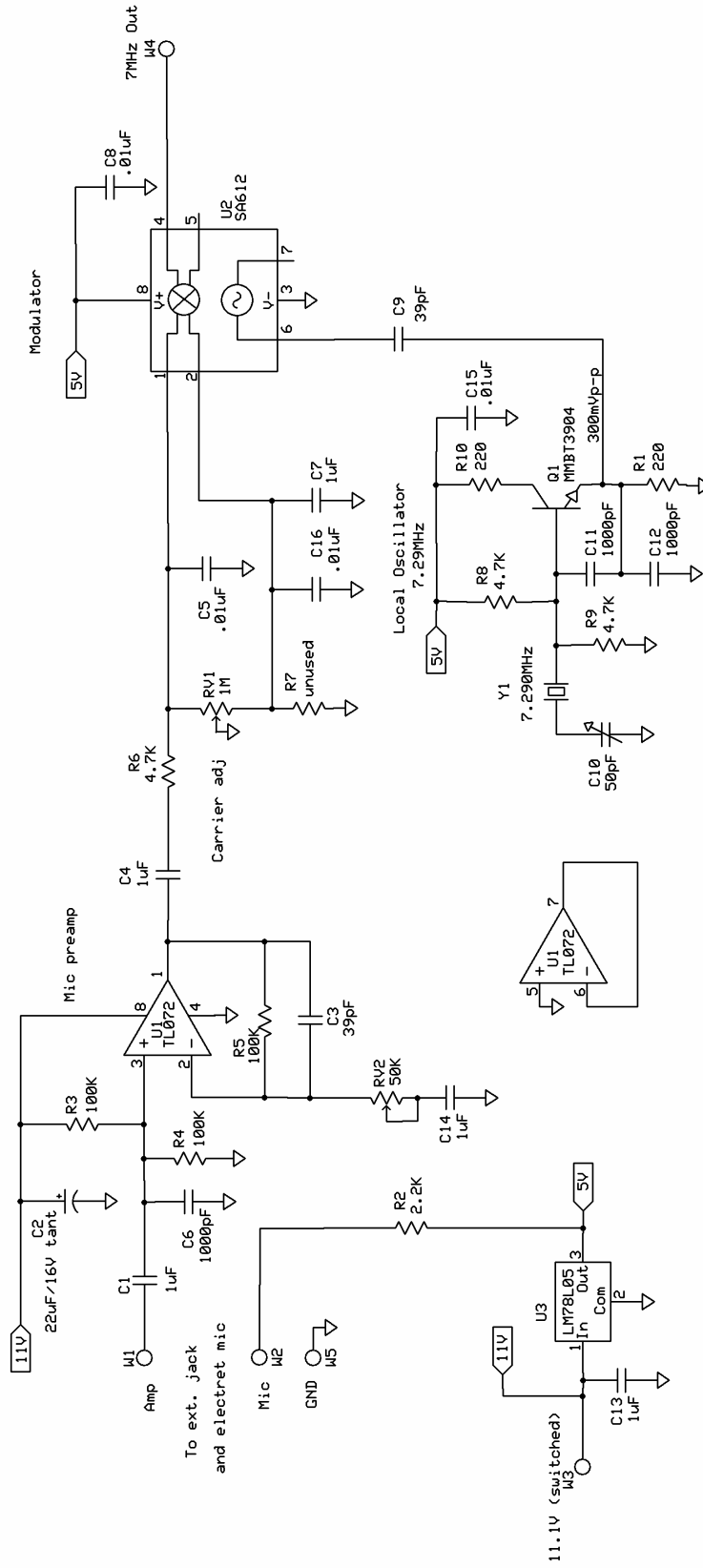
Transmitter IMD: <-20dB

Receive Sensitivity: 1uV

Power requirements: 10-12VDC, 50mA receive (average), 500mA transmit



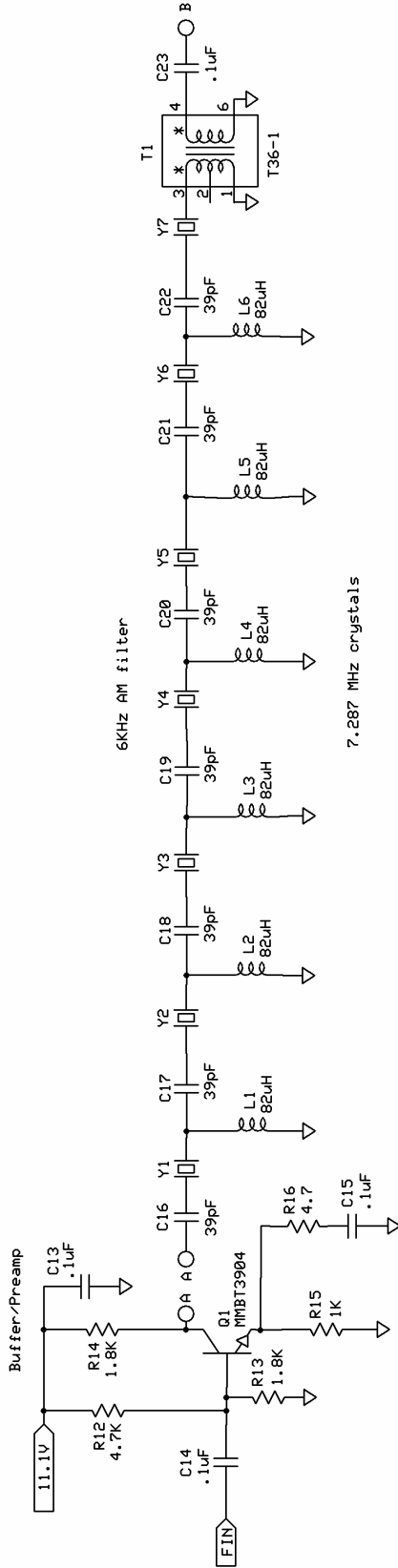
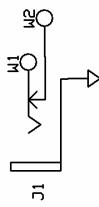
# SCHEMATICS



<b>The DZ Company, LLC</b>	
<b>HT-7-1 Board</b>	
Rev. B	Page 1 of 1
3/13/09	

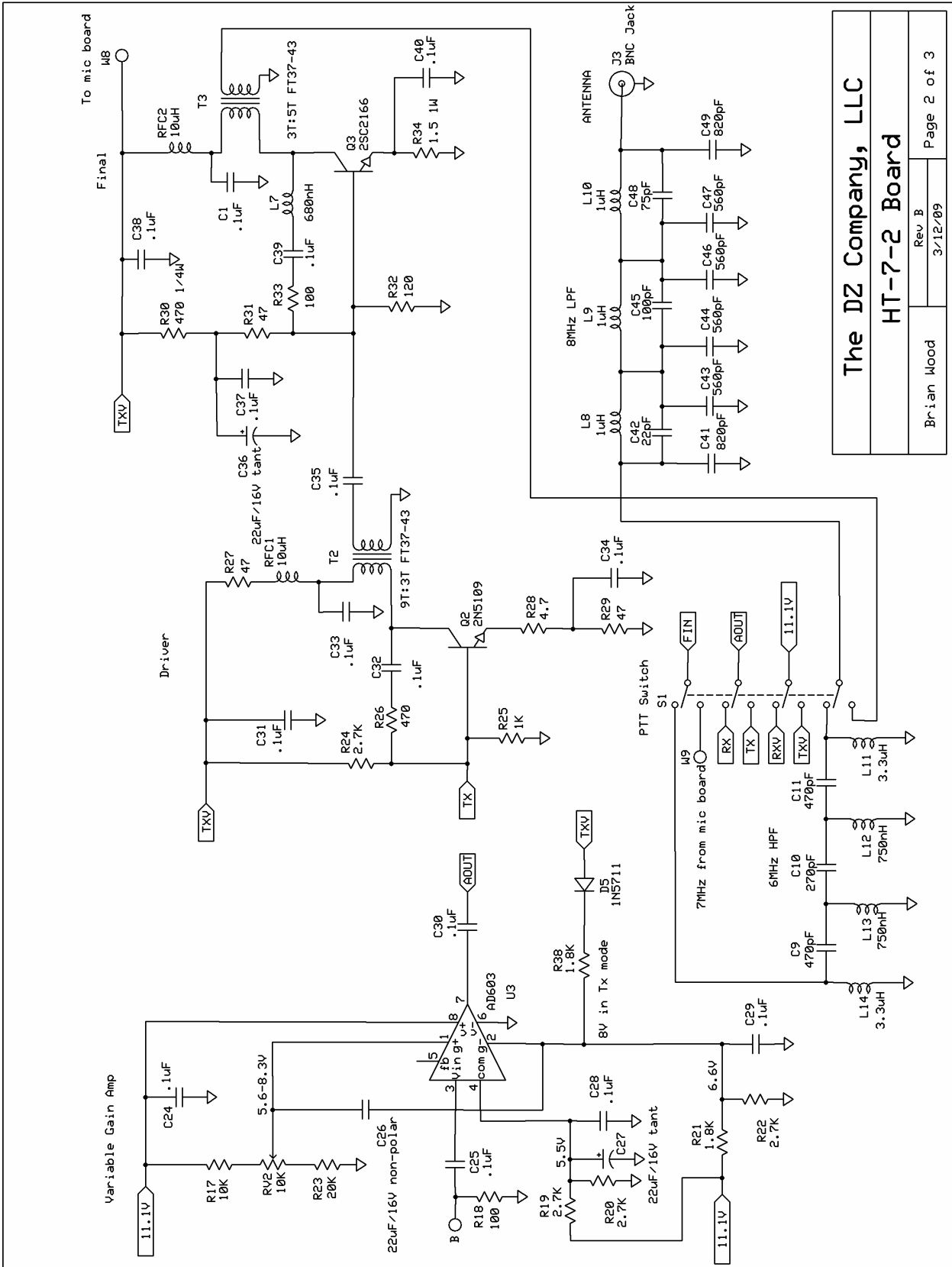


External mic audio to mic board

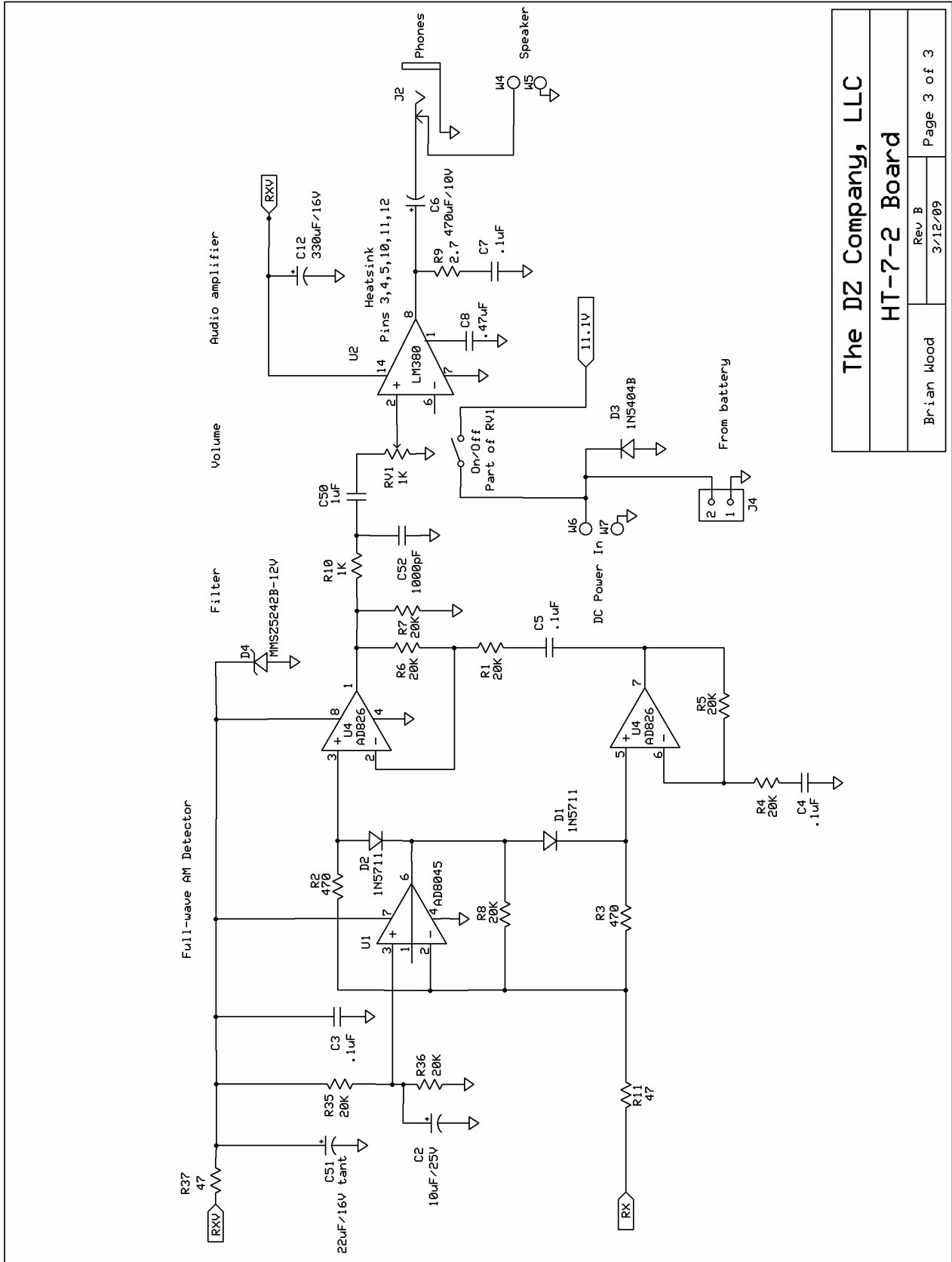


The DZ Company, LLC  
HT-7-2 Board

Brian Wood  
Rev B  
3/12/09  
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The DZ Company, LLC  
HT-7-2 Board  
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The DZ Company, LLC  
HT-7-2 Board  
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## TROUBLESHOOTING

Before calling or emailing us for service or help, please check the following things.

Problems with kits are almost always related to soldering. Check every connection carefully to make sure the parts and wires are fully soldered and the right wires are in the right holes.

Before starting any troubleshooting procedure, try to narrow the problem down to a specific area—is it transmit-related? Receive-related? Both? Is it a power supply problem?

Check to make sure that all parts and wires have been properly clipped so that no leads or wires are shorting each other or the chassis. Look carefully for shorted traces or pins.

Make sure that the power source (battery or external supply) is actually providing 10-12VDC.

Check all electrolytic capacitors to make sure they are inserted with the polarity band on the correct pin. Reversed electrolytic capacitors can draw excessive current, and they can even smoke!

Verify all voltages using the chart on page 22.

A review of the theory of operation may also help you determine where to look for problems.

If after going through these steps you still cannot resolve the problem, email us at [support@dzkit.com](mailto:support@dzkit.com) or call us at 970-667-7382, Monday-Friday, 8AM to 5PM.

Problem	Likely causes	Solution
No receive audio	No power	Check battery connections or external power supply
	Volume control pot	Check solder connections to RV1
	Speaker wiring	Check for reversed black/white wires
Can't measure 11.1V	Headphone jack	Replace headphone jack
	U2 reversed	Remove and replace U2
	RV1, PTT switch	Check soldering
Receiving AM broadcasts	D3 reversed	Remove and reinstall D3
	U3 pin 1 on HT-7-2 board out of range	Adjust RV2 so that voltage is 5.5 to 7.5VDC
Weak (or no) transmit signal	T2 and/or T3 reversed	Check T2 and T3 wiring, solder connections
	Incorrect wiring from HT-7-1 to HT-7-2 board	Verify wire colors as shown on page 21







## NOTES

Use this page to keep track of modifications, purchase information, service, or anything you like.





# DZ COMPANY

LOVELAND, COLORADO

***UNIQUE ELECTRONIC EQUIPMENT IN KIT FORM***