DZ COMPANY · LOVELAND, COLORADO

DZKIT

ASSEMBLY, SERVICE & USER'S MANUAL

SR-74 "SAGUARO" SHORTWAVE RECEIVER

DZ COMPANY CONTACT INFO

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YOUR DZKIT 1-YEAR LIMITED WARRANTY

During the first year after shipment, DZ Company will replace or repair free of charge—as soon as practical—any parts which are defective, either in materials or workmanship, and any incorrect or missing parts. 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 year after shipment, our products, when correctly assembled, calibrated, adjusted and used in accordance with our printed instructions, will meet published specifications. Once assembled, if the product fails to operate correctly, we will help you determine which subassembly requires service. If return is found to be necessary, you must then ship that subassembly, or whole unit if applicable, to the address below at your expense, and we will repair or replace it at our option and return it to you at no charge.

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 write us, email us, give us a call, or visit our website and click on "Support". That will give you access to free support. Sorry, we cannot accept collect calls.

Our warranty, both expressed and implied, does not cover damage caused by the use of acid-core solder, water-soluble flux solder (without appropriate washing), or any corrosive or conductive flux or solvent, 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.

This warranty applies only to the first owner of the product and is not extended to subsequent owners.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

THE DZ COMPANY, LLC
710 GROVE CT.
LOVELAND, CO 80537

Assembly, Operation and Troubleshooting

Of the

Saguaro SR-74 Shortwave Receiver

DZ COMPANY
LOVELAND, COLORADO

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PENDING:
This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

INTRODUCTION

The Saguaro SR-74 provides a unique twist on an old concept: shortwave listening. Shortwave radios of yesteryear first used super-regenerative circuits, which were tricky to operate. This was followed by the super-heterodyne concept, still in use today, in which oscillators, mixers, filters and amplifiers combine to turn an RF signal into audio.

Today, it's possible to sample the entire RF spectrum and do the entire radio – amplification, de-modulation and audio output streaming – all in software. The Saguaro does just that. RF signals from your antenna are fed directly into a "Software-Defined Radio" (SDR) that is commercially available (the SDRPlay RSP1A). It is controlled from on on-board computer called the "Raspberry Pi 4B," a Linux-based PC with a fast processor and either 4G or 8G of RAM. A DZKit-designed controller reads the pots and tuning knob and passes that data to the Raspberry Pi for control of the SDR. A program running on the Raspberry Pi provides the graphical user interface and controls the SDR.

We've also added an internal Morse Code practice monitor with adjustable speed, volume and pitch, and with Iambic, Ultimatic and Manual modes! Just plug a straight key or paddles into the back panel minijack.

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

Some famous shortwave radios from yesteryear

General Assembly Notes

1. Most screws in this kit are Phillips Panhead Machine Screws. For simplicity, we refer to them simply as "screws" unless a different style is used. These may be stainless steel or zinc-plated steel.
2. PC boards attach to the sheet metal using metric M3 screws with attached lock washers ("SEMS" screws), but there are some exceptions, which are explained in the steps.
3. As you tighten a screw, it is very important that you do not strip the threads. All screws should fasten smoothly. If a screw appears to be very 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. Screws with locking compound on them are normally a little harder to fasten.
4. A PC within arms reach of your workbench is useful in helping you locate the parts on the boards. The PCB layout files for all boards are on the included flash drive. To find the location of a part, simply install and run the "ExpressPCB" program (free download from www.expresspcb.com) and open the board you wish to work on. Press "Ctrl-F" to find a part, and then enter it in the box that pops up (e.g., "R1", without the quotes). The program will show you exactly where that part is located. Take a few minutes to familiarize yourself with this program before beginning construction. You can also find parts manually by just looking for the part on the silkscreen, but on dense boards, this can take a long time. We highly recommend using ExpressPCB to locate parts.
5. All references to left and right, front and back are with the chassis in an orientation such that the front of the radio faces you.
6. Each circuit part has its own component number (R1, C4, 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.
7. 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 (e.g., LePage's Liquid Solder, nothing more than metallic-grey colored airplane glue).

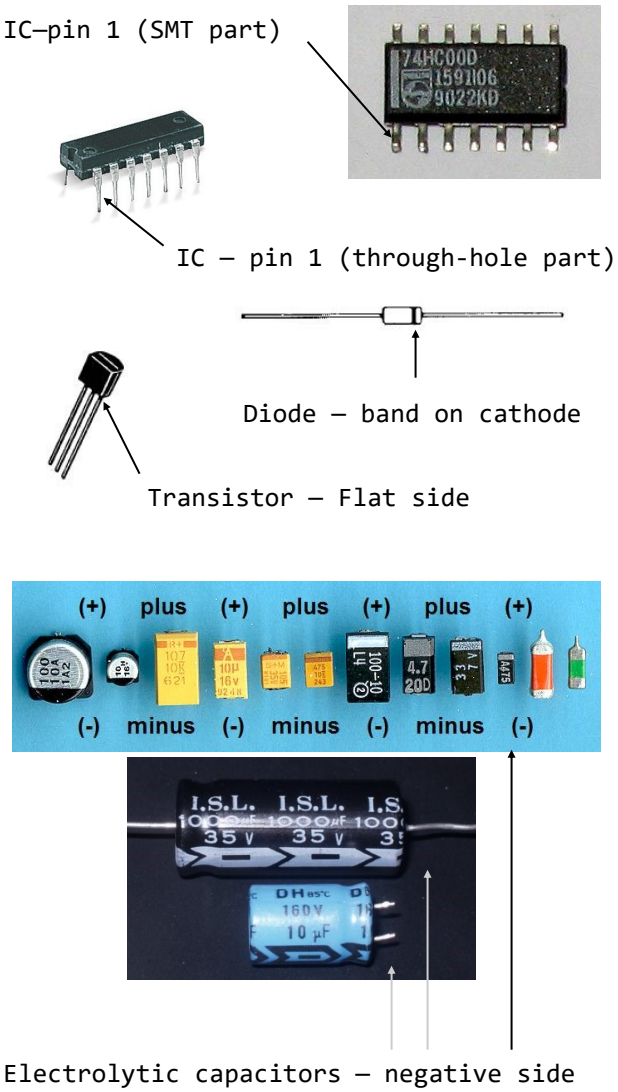
8. Soldering should only be done in an area with good ventilation and with a properly heated soldering iron.
9. Resistors are identified by their values in Ohms, Kilohms (K) or Megohms (M) and by color codes. Your kit uses resistors of several types. Axial leaded resistors have color coded bands on them. For 5% resistors, the first two bands represent the numeric value and the third band represents a multiplier, which is a power of 10. Thus, a 56 Ohm resistor is Green-Blue-Black. A 10KOhm resistor is Brown-Black-Orange, and so on. The fourth band is the tolerance – no band represents 20%, a silver band 10%, and a gold band 5%. Your Saguaro uses mostly one percent or better resistors, which have 4 bands for the value. A 4.75K resistor is Yellow-Violet-Green-Brown. We have placed resistors of given types in individual bags for you, but should they get mixed and you have trouble reading the color code, we recommend an inexpensive volt-ohmmeter be used to check the values. A fluorescent light is also useful to "bring out" the colors, and a magnifying glass is also handy.
10. Capacitors are identified by their type – disk, polystyrene, polypropylene, electrolytic, trimmer, etc. – and capacitance values are in microfarads (uF) or picoFarads (pF). Polarized types have the positive pin marked on the silkscreen and also have a square pad.
11. Inductors are represented either by their inductance in nanoHenries (nH), microHenries (uH), milliHenries (mH) or by the number of turns in the coil if you are doing the winding.
12. Diodes are marked with a band on the cathode end. The PC boards have a bar silkscreened across one side of the compo-

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

nent outline and a square pad which identifies the cathode.

13. Transistors have either a tab or a flat side that you can match to the silkscreened component outline. Most transistors will need to have their leads "sprung" a little to fit in the holes. Do so carefully to avoid breaking the leads off.
14. ICs have a notch, beveled side and/or a dot representing the side containing pin 1. When you hold an IC with the notch or the beveled side up, 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.
15. To insert an IC, rest the IC on its side on a hard surface Slowly roll the entire chip so that all the leads on that side are bent inward at once and the same distance. Do about half what appears to be required. Check the leads against the socket or PCB and then roll the other side inward the same way.

16. **It is CRITICAL that you mount polarized parts correctly! Double check your work to be sure that all such parts match the photos. See Detail 1.**



Detail 1. Identifying polarity of diodes, transistors, ICs and polarized capacitors.

Abbreviations and definitions of terms used in this manual:

PC = Personal Computer
PCB = Printed Circuit Board
PH = Panhead
FH = Flathead
M/S = Machine Screw (typically M2.5, M3, M5 sizes)
P/L = Patch lock (material added to threads to help screws stay in)
PCB-mt = Printed Circuit Board mounting
AMP MTA = Tyco Electronics connector with .1” pin spacing
IDC = Insulation Displacement Connector (MTA connectors are IDC type)
Ribbon cable = Flat cable with connectors on each end
Header = PCB-mounted connector
CA = Cable Assembly

A word about what lies ahead…

This manual is designed to allow you to build confidence in your kit-building ability as you go along. You start by adding parts to the chassis and then building and installing the controller board. You will then be able to turn on the power and measure some voltages before loading ICs that could be damaged if the voltages are wrong. This will give you confidence that the kit-building is progressing normally. You will also be able to use a PC to help you locate parts on the boards using the PCB layout files that we have included. The project concludes with integration of the circuit boards and cables into the chassis. So let’s get started!

NOTE: Your kit includes ten feet of specially formulated no-lead, no-clean Alpha Telecore solder. This should be enough to complete your kit. It uses a tin, silver and copper alloy, and a non-aggressive flux that does not require cleaning. ***DO NOT USE FLUX REMOVER OR WATER*** after building the circuit board. It will leave a gummy residue.

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, testing and using your kit.

1. **Check off parts as loaded**. Each board kit contains a list of parts used on that board. We have checked off each part on the right side of the page as it is inserted in the bag. As you remove a part from the bag and load it on the board, cross out its "reference designator" (e.g., "R1") on the left side of the page. Our method of bagging parts is different from all other kit vendors and will make the task much faster and less error prone. If you are missing any parts, call or email us and we'll rush replacements immediately.
2. **Parts have been pre-sorted.** Do not remove parts from the bags until called for, to avoid mixing parts up (especially resistors).
3. **Find a picture online.** The parts lists are also included on a flash drive that is shipped with your kit. Almost every part has a hyperlink to the vendor. Make sure you are connected to the Internet, and click the part to get a picture and information about it.
4. **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 kits, so do it right!
5. **Some boards have been pre-loaded with surface mount parts.** Be careful not to flex these boards to avoid having parts snap off.
6. **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. If you're tired, take a break. Enjoy building your kit!
7. **Make sure that you are loading the part that's called for in the right place.** Once loaded, it can be hard to find a misloaded part. Be especially careful to load polarized parts (connectors, ICs, diodes, electrolytic capacitors) in the right direction.
8. **Once you've done a step, put a checkmark inside the parentheses in this manual.** This helps you remember where you left off when you build in stages.
9. **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, 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 Saguaro.

1. **Always have a healthy respect for electricity.** The voltages present inside the Saguaro can be as high as 260VAC, and high currents are available (up to 2 Amps DC). 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. **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 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.

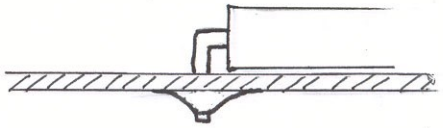
Solder joint problems. Solution: Remove solder with a wick or solder sucker (see below), and reheat the connection, touching the iron to both the component lead and the pad at the same time.

Use a good quality, variable temperature soldering iron with a conical, narrow tip, and set the temperature to 800 degrees F. We provide 10’ of recommended solder in each kit. Keep the sponge damp and wipe the tip on the sponge before 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. After that, they can lift pads off the board.

Good solder connections. 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. Component leads that are properly soldered can not be moved in the hole. The component lies flat on the board.



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 work mats with grounded wrist straps. 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.

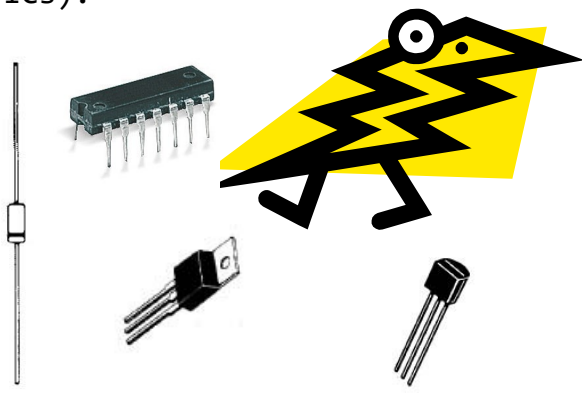
In a dry environment, simply standing up after sitting in a non-grounded chair can also charge you with electricity. If you stand up to stretch, for example, be sure to re-ground yourself before getting back to work. Don't wear insulated sole shoes and avoid nylon, wool or other static-producing material 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 work mat on it. Use a wood or metal table if possible.

Pets 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!

Chassis Parts

Please check each item to make sure it is present in the right quantity. Let us know right away if it's not so that we can ship replacements.

Bag	Item	Description	Vendor	Vendor P/N	Bin	Qty
1	1	Hardware M5 Washer 18-8 SS	McMaster	98689A114	B1	2
1	2	Hardware M5 Wingnut, 18-8 SS	McMaster	94545A225	B2	1
1	3	Hardware M5 KEPS nut 18-8 SS	McMaster	90923A222	B3	3
1	4	Hardware M5 x 16mm PH Phillips M/S SS	McMaster	90116A256	B4	1
1	5	Hardware M2.5 x 20mm PH Phillips M/S Patch SS	McMaster	95911A612	B5	2
1	6	Hardware M2.5 x 6mm PH Philips M/S SS	McMaster	90116A110	B6	2
1	7	Hardware M2.5 Internal tooth lockwasher SS	McMaster	93925A220	B7	2
1	8	Hardware M3 x 6mm FH Philips Black Metric M/S SS	McMaster	91698A302	B8	4
1	9	Hardware M3 x 6mm PH Philips M/S Patch SS	McMaster	95911A211	B9	7
1	10	Hardware M3 x 6mm PH Philips SEMS M/S SS	McMaster	90402A702	B10	12
1	11	Hardware M3 x 10mm PH Philips M/S Patch SS	McMaster	95911A218	B13	4
1	12	Hardware M5 x 12mm FH M/S SS	McMaster	91801A256	B14	2
1	13	Hardware M3 KEPS nut	McMaster	90923A216	B15	4
1	14	Hardware M3 7.5mm plastic spacer	Digikey	145-13ME022-ND	B16	4
1	15	Hardware M2.5 12.45mm Nylon spacer	Digikey	907-490	B17	2
1	16	Hardware 4-40 x 3/8" PH Philips M/S Patch SS	McMaster	96562A108	834	4
1	17	Hardware #10 Solder lug	Mouser	534-913	510	1
1	18	Thermalsil insulator for TO-220	Mouser	532-53-77-4ACG	523	2
1	19	Shoulder washer	Mouser	532-7721-7PPS	303	2
1	20	Unthreaded Bumper, SBR Rubber, 5/8" OD, 9/32" High	McMaster	9540K52	140	4
1	21	Hardware Washer flat rubber for M5 screw	McMaster	99604A143	B32	4

Bag	Item	Description	Vendor	Vendor P/N	Bin	Qty
2	22	Knob .5in dia matte finish indicator line top/side	Allied	70206941	146A	2
2	23	Knob 1.75in dia glossy finish finger dimple no line	Heilind	AMP 3-1437622-8	147	1
3	24	Encoder optical RPG 5V 128ppr 1/4in shaft w/nut	Newark	ENA1J-B28-L00128L	176	1
3	25	Switch on/off rocker	Mouser	DM22J12S205PQ	B26	1
3	26	Resistor variable panel mount 10K Ohm	Mouser	313-1000F-10K	B27	2
3	27	Headphone jack—1/4” stereo, with swiches	Mouser	523-ACJS-MN-5	B35	1
3	28	Connector 2.1mm panel mount	Mouser	502-721A	B36	1
3	29	Fuse - 1/2A 250V 3AG AGC	Mouser	504-BK/AGC-1/2-R	B45	2
4	30	MicroSD card with Raspbian OS and custom software	DZKit	S0074-10102	B38	1
4	31	USB memory stick (manual, ExpressPCB layouts)	DZKit	S0074-10103	B39	1
4	32	Saguaro serial number sticker	BW Ind.	S0074-00501	B40	1
5	33	No-clean .020" Alpha 143090 Lead-free Telecore Solder	Technimark	Alpha 143090	B41	10'
5	34	Heat shrink tubing - 1/8" black	Mouser	602-221V018-4	B42	12"
5	35	Heat shrink tubing - 3/16" gray	Mouser	562-Q2-CB3/1612SS500	740	12"
5	36	Hardware Cable tie - 0.1 x 3.9"	Mouser	571-2-160967-1	526	2
5	37	Tool hex-key .05in	Wiha	35410	96A	1
5	38	Tool hex-key 1/16in	Wiha	35411	96B	1
6	30	Tool Knurled nut fastener 6mm for 3.5mm minijacks	Full Compass	NT500	96D	1

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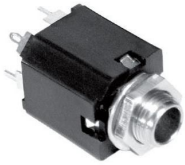
27 

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Item	Loose/Heavy parts	Vendor	Vendor P/N	Bin	Qty
40	Transformer Triad VPS16-1600 16VCT 1.6A	Mouser	553-VPS16-1600	B25	1
41	Power entry module filtered	Mouser	631-FN372-2/22	B28	1
42	Display 7 inch TFT Resistive HDMI	Matrix Orbital	HTT70A-IPS	B30	1
43	Fan with Heatsink for Rpi	GeeekPi	ZP-0110	B33	1
44	Speaker 8 ohm 3W 200Hz-20kHz	Mouser	243-FR10HM-8OHM	B34	1
45	Circuit board kit	DZKit	S0074-40001	B37	1
46	Cable kit	DZKit	S0074-70001	B50	1
47	Chassis	DZKit	S0074-00001	B46	1
48	Top Cover	DZKit	S0074-00002	B47	1
49	Lexan overlay	DZKit	S0074-00003	B31	1
50	Plastic safety shield	DZKit	S0074-00004	B48	1
51	Plastic alignment tooling pins	DZKit	S0074-00005	B49	2

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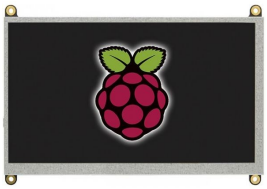

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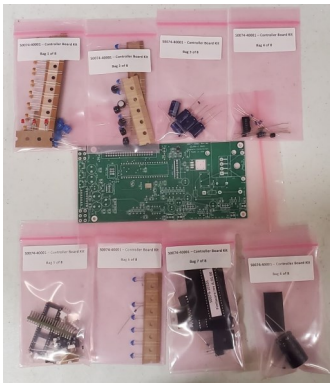

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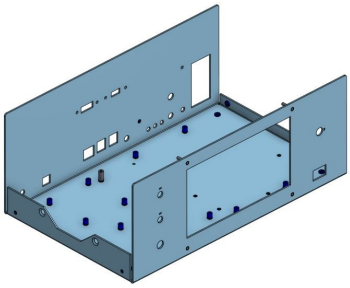

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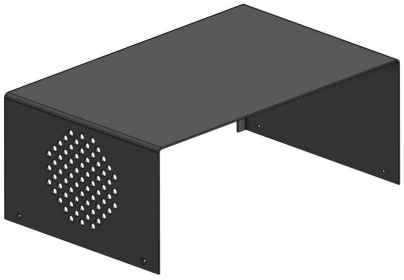

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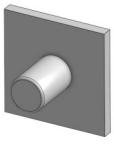
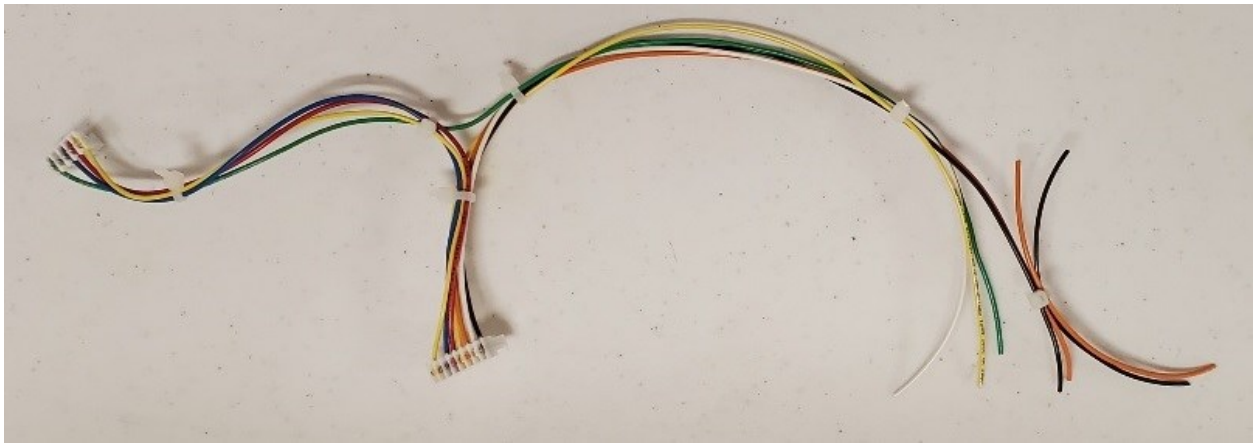


Chassis Cables

S0074-00101: Bag of loose wires. Cut each color wire to the noted length, strip to 3/16” and tin. Extra wire has been provided. If you make a mistake and there isn’t enough remaining of the desired color, it is OK to use a different color, but be sure to keep track of what you used where.

Wire color	Wire length
White	8"
Wht/Gray	8"
Black	8"
Wht/Blk	8"
Blue	2"
Blue	2"
Blue	3.5"
Wht/Blue	3.5"
Red	8"
Red	3"
Wht/Red	3"
Wht/Red	2"
Brown	2"
Brown	2"
Yellow	6"
Yellow	6"
Green	3.5"

S0074-00102: Controller wiring harness



Chassis Cables, continued

S0074-00103: Controller to Display Power

S0074-00104: Controller to Speaker/Headphones kit

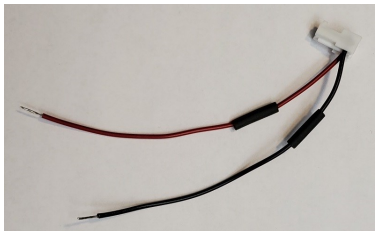
S0074-00106: Pi audio to controller

S0074-00107: Controller to Pi power

S0074-00105: Controller to Pi GPIO

S0074-00108: Pi to HDMI display

S0074-00114: Controller to Pi fan
(shown with heat shrink tubing attached)

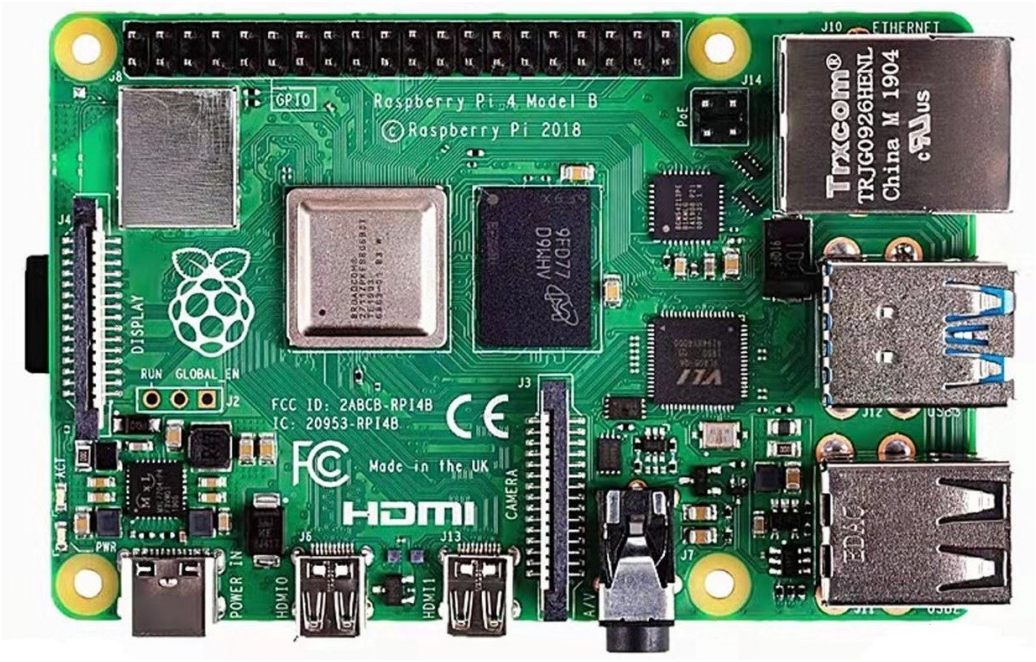


Optional Parts

S0074-00112-1: SDRPlay RSP1A for use inside Saguaro only. Case must be removed and board attached to standoffs inside chassis.

S0074-00112-2: 8” USB-A to USB-B

S0074-00115-1 or –2: Raspberry Pi 4B with either 4G (-1) or 8G (-2) of RAM . Not sold separately. (Required option)



Optional parts

S0074-00110/111 Touch interface

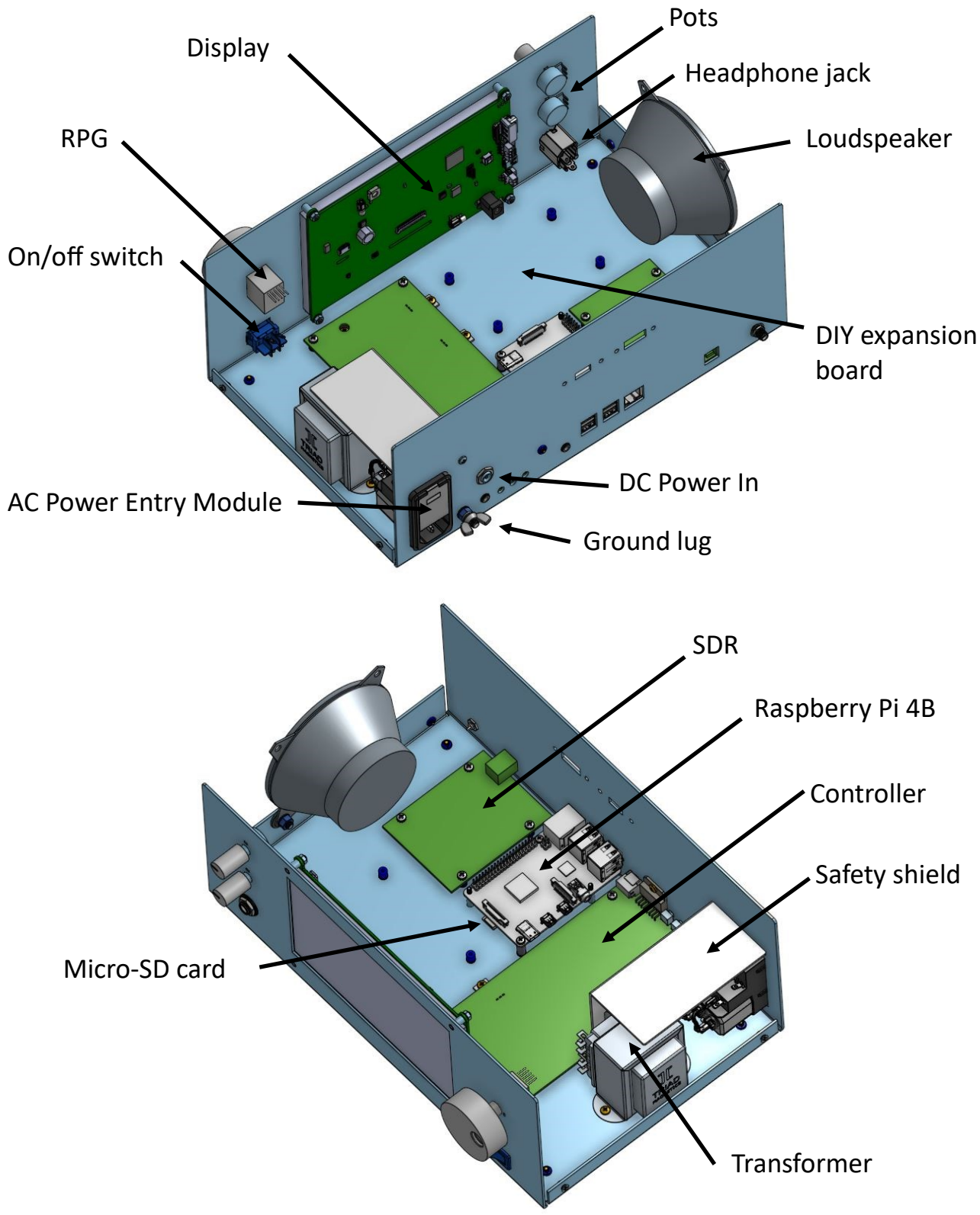
S0074-00109 Ext HDMI interface

S0074-00116 WiFi Keyboard/Mouse

Note: Wireless USB receiver is located inside battery compartment of mouse

S0074-00113-1
AC Power cord and international adapters

S0074-00113-2 18AWG Heavy Duty Power Cord, 3.3ft (1m) 10 Amps 120V Black



General chassis layout

STEP-BY-STEP ASSEMBLY: Chassis

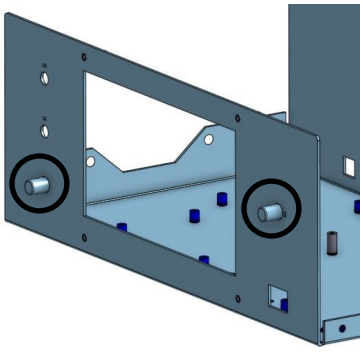
IMPORTANT! Use screws <u>without</u> built-in lock washers to fasten chassis parts to each other. (Some have Nylon patches.) For simplicity, these are referred to as "screws" in the steps.

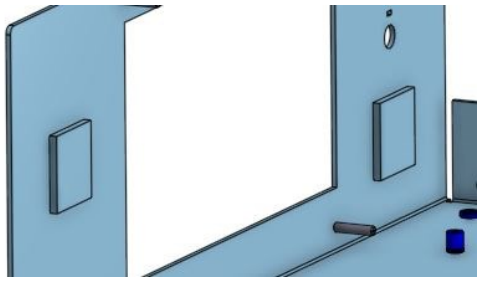
Use SEMS screws (screws <u>with</u> built-in lock washers) <u>ONLY</u> for attaching circuit boards to standoffs and where instructed.

Refer to the "General chassis layout" drawing on page 20.

( ) Using soap and water, clean the front panel of the chassis, then dry it completely. Avoid touching it with your fingers after it is clean.

( ) Insert the plastic front panel alignment pins into the front panel of the chassis from the inside and tape them in place (on the inside of the chassis) using masking or electrical tape.



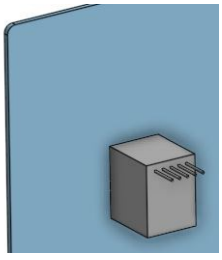


( ) Remove the backing from the polycarbonate overlay (front panel sticker). Place it over the alignment pins and onto the front panel.

( ) Remove the alignment pins.

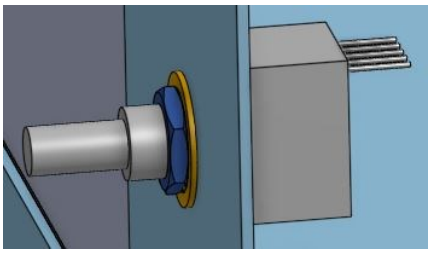
( ) Apply pressure, using your fingers, to attach the sticker securely to the front panel. Push firmly to the sides to remove any air bubbles if present.

( ) Insert the rotary pulse generator (optical encoder) into the large hole to the right of the display opening as shown below. Position it so that the connector pins are located on top. Make sure the tab locks into the small rectangular hole in the sheet metal.

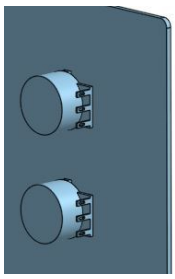


STEP-BY-STEP ASSEMBLY: Chassis

( ) Fasten the RPG to the front panel using the provided lock washer and nut. Tighten securely using a small wrench, but do not overtighten to avoid cracking the overlay. Be careful not to scratch the overlay while tightening the nut.

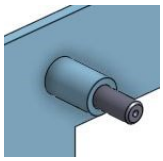


( ) Insert the two potentiometers into the holes on the left side, making sure the small tabs lock into the small rectangular holes. Tighten the pots using the washer and nut provided with the parts. Be careful not to overtighten to avoid damage to the overlay.



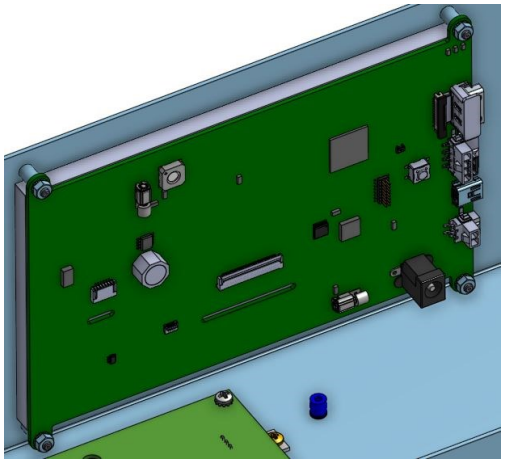
( ) Insert an M3 x 10mm screw (with locking compound) into each rubber foot and attach the feet to the bottom chassis. The screws fasten to captive nuts inside the chassis, so no nuts are needed.

( ) Place four M3 x 7.5mm plastic spacers over the four mounting studs at the corners of the display opening.



( ) Remove the display from its bag. ***Carefully peel the protective cover off the glass.***

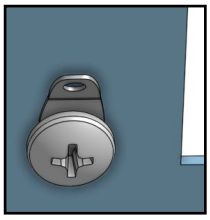
( ) Insert the display onto the studs with the connectors lined up on the left side, nearest the pots. Affix the display to the front panel using four M3 KEPS nuts. Do not overtighten.

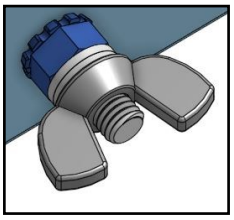


( ) Insert an M5 screw through a #10 solder lug and push the screw from inside the chassis into the hole to the left (viewed from the inside) of the large rectangular opening in the back panel. Make sure

STEP-BY-STEP ASSEMBLY: Chassis

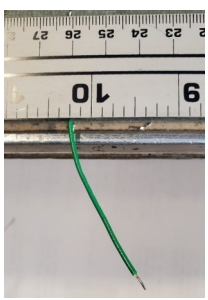
the solder lug faces up. Tighten the assembly to the back panel using an M5 KEPS nut. Place two M5 washers and an M5 Wingnut over the screw, then tighten them finger tight.





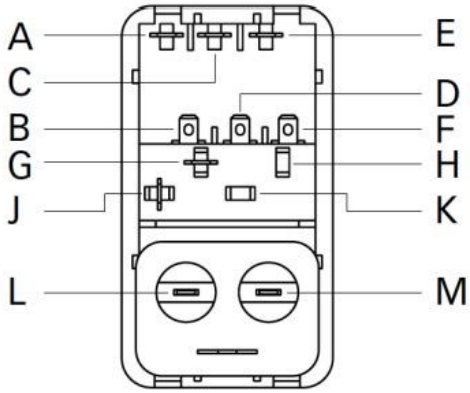
( ) Cut all wires in the "loose wires" bag to the noted length using the table on page 16, then strip each end to 3/16" and "tin" the leads by applying heat from your soldering iron and applying a small amount of solder. Extra wire has been provided for each color.

Hint: Here's a convenient way to tin the leads. You need a ruler anyway, so lay a yardstick or other heavy ruler at the front of your worksurface. You can use it to measure wires and to hold them in place while you tin the leads.



( ) Locate the Power Entry Module (PEM). Remove the two wires that are already attached, being careful not to damage the lugs.

( ) Refer to the drawing below. Solder wires to the Power Entry Module (PEM) as noted below. When attaching wires to lugs, first bend the exposed lead back on itself at a 45 degree angle, then insert it into the hole in the lug, crimping it tightly using needle-nose pliers.



(See photo of finished wiring on page 27)

( ) 8" White to lug M
( ) 8" White/Gray to lug K
( ) 8" Black to lug L
( ) 8" White/Black to lug J
( ) 2" Blue to lug G
( ) 3.5" White/Blue to lug D
( ) 3" Red to lug E
( ) 3.5" Green to filter ground (bottom lug on module)

STEP-BY-STEP ASSEMBLY: Chassis

( ) For each wire soldered in the previous step, place a 1/2” length of 3/16” heat shrink tubing over the loose end of each wire (except green), slide it until it covers the lug, then heat it with either the soldering iron or a heat gun (preferred) until it shrinks, covering the exposed lead as well as the lug on the PEM.

( ) Place a 1/2” length of 3/16” heat shrink tubing over the 2” Blue wire that is attached to lug G. ***Do not heat it.***

( ) Solder the free end of the 2” Blue wire to lug B, being careful not to heat the heat shrink tubing.

( ) Slide the heat shrink tubing along the Blue wire until it covers lug B, then heat it until it shrinks.

( ) Solder a 2” Blue wire and a 3.5” Blue wire to lug F.

( ) Place a 1/2” length of 3/16” heat shrink tubing over the Blue wires that are soldered to pin F, slide it until it covers the lug, then heat it until it shrinks.

( ) Place a 1/2” length of 3/16” heat shrink tubing over the 2” Blue wire on lug F.

( ) Solder the free end of the 2” Blue wire to lug H, being careful not to heat the heat shrink tubing.

( ) Slide the heat shrink tubing along the Blue wire until it covers lug H, then heat it until it shrinks.

( ) Solder a 2” White/Red wire and a 3” White/Red wire to lug C.

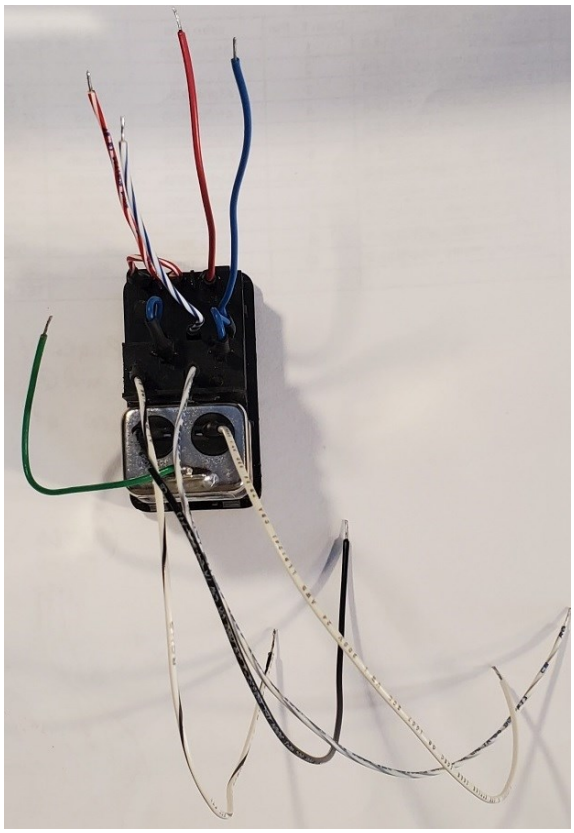
( ) Place a 1/2” length of 3/16” heat shrink tubing over the two wires that are soldered to lug C, slide it until it covers the lug, then heat it until it shrinks.

( ) Place a 1/2” length of 3/16” heat shrink tubing over the 2” White/Red wire.

( ) Solder the free end of the 2” White/Red wire to lug A, being careful not to heat the heat shrink tubing.

( ) Slide the heat shrink tubing along the White/Red wire until it covers lug A, then heat it until it shrinks.

STEP-BY-STEP ASSEMBLY: Chassis



Assembled PEM

( ) Feed the wires from the PEM into the large rectangular opening in the back panel, with the AC power connector on the bottom. Push hard until in snaps into place.

( ) Locate the transformer. Place it on its side, with lugs facing up, immediately next to the PEM.

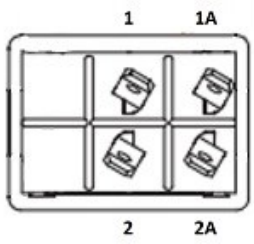
( ) Insert all four 8” wires from the PEM into the on/off switch opening on the front panel.

( ) Place a 1/2” length of 3/16” heat shrink tubing over the 8” White, White/Gray, Black and White/Black wires.

Note: When soldering wires to the switch, do not overheat the pins! The switch is susceptible to damage if too much heat is used. Also be careful not to melt the plastic. But do make sure the wires are soldered well.

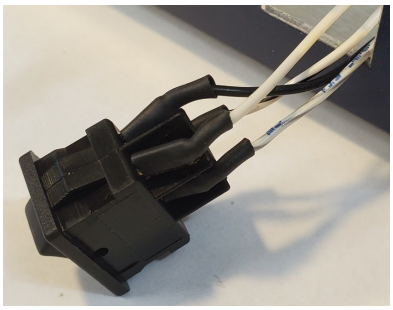
( ) Referring to the drawing of the switch below, solder the wires as follows:

Black – lug 2A
White/Black – lug 2
White – lug 1A
White/Gray – lug 1



STEP-BY-STEP ASSEMBLY: Chassis

( ) Slide the four pieces of heat shrink tubing over the connections on the switch and heat them until they shrink.



( ) Insert the on/off switch through the front panel so that the “1” position is to the right as viewed from the front panel.

( ) Attach the rest of the wires from the PEM to the transformer lugs as follows:

Note: the lug numbers are shown on the opposite side of the transformer from the lugs. The middle lug on both sides is not used. You do not need to use heat shrink tubing. When inserting the wires into the transformer lugs, use lugs that have holes. Route the wires sideways. See picture on page 27.

Red – lug 6 (top)
White/Red – lug 5
Leave the middle lug open
Blue – lug 2
White/Blue – lug 1 (bottom)

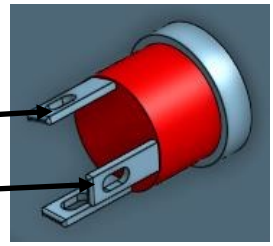
( ) Solder a 1.5” Brown wire and a 6” Yellow wire to lug 7 on the transformer.

( ) Solder the other end of the Brown wire to lug 11.

( ) Solder a 1.5” Brown wire and a 6” Yellow wire to lug 8 on the transformer.

( ) Solder the other end of the Brown wire to lug 12.

( ) Remove the attached nut and washer from the 2.1mm DC power connector, and insert the connector into the hole to the right of the PEM (viewed from the back). Position it so the middle lug is to the right as viewed from the back.



( ) Re-attach the washer and nut from the outside and tighten it.

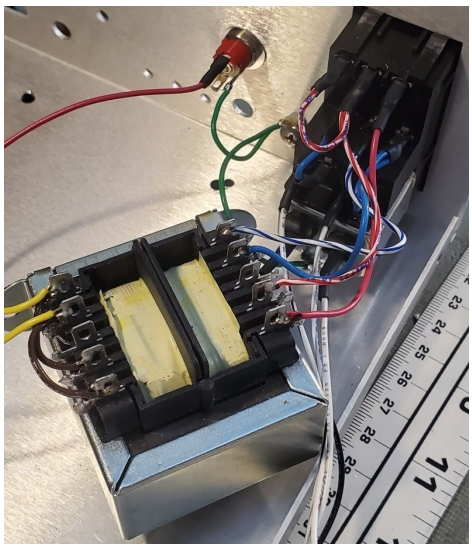
( ) Solder an 8” Red wire to the top lug.

( ) Attach the green wire that is attached to the PEM to the ground lug on the M5 screw that is bolted to the chas-

STEP-BY-STEP ASSEMBLY: Chassis

sis. Do not solder it.

( ) Attach a 2” green wire from the lug marked “Sleeve Terminal”) of the DC power jack to the same ground lug as in the previous step. Solder both wires to the lug.

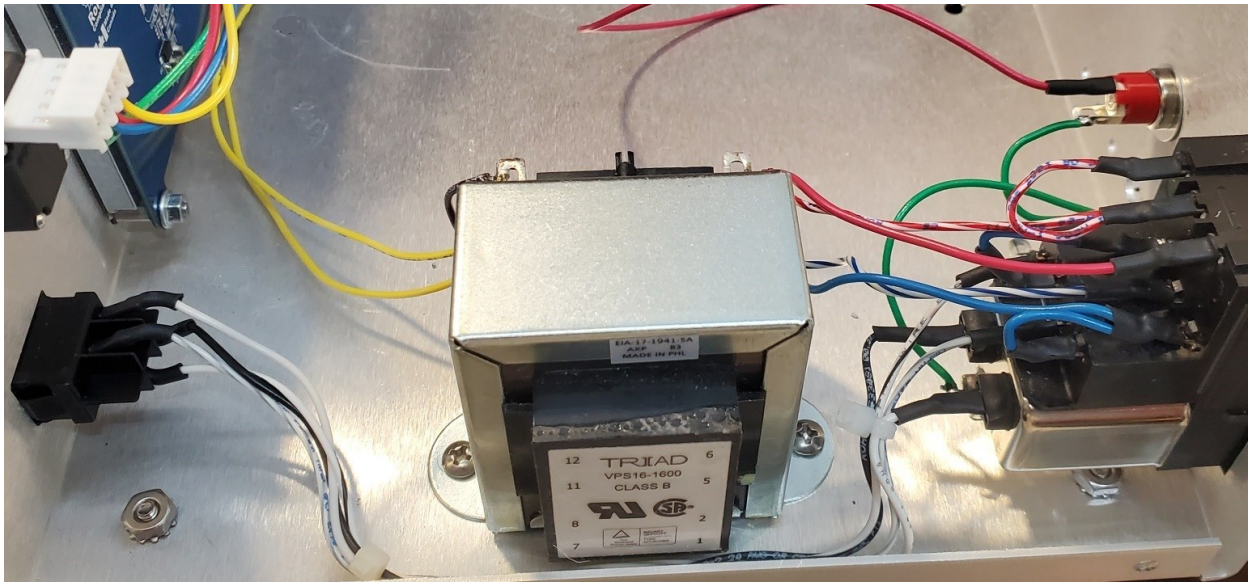


Completed wiring of PEM/Xfmr/DC

( ) Stand the transformer up and mount it to the chassis using two M3 x 6mm screws. Tighten the screws securely.

( ) Route the long switch wires under the transformer. Use two small cable ties to hold the wires neatly on both sides. See photo below.

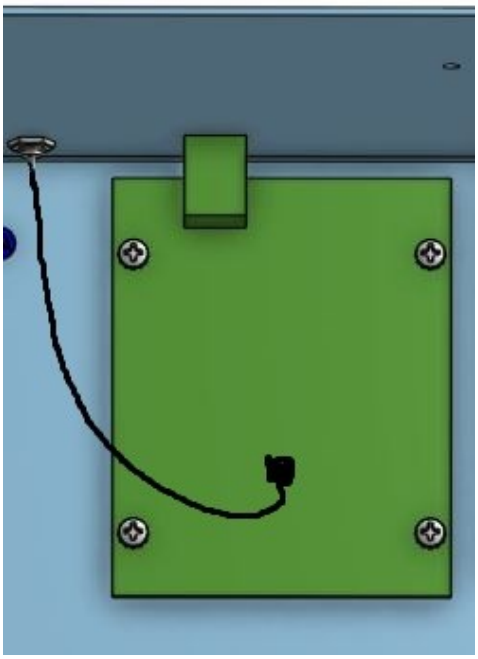
( ) Position the two yellow wires outside the chassis to keep them out of the way while completing the circuit board.



STEP-BY-STEP ASSEMBLY: Chassis

( ) Unpack the RSP1A SDR from the SDRPlay box. Remove the rubber feet and Unscrew the four mounting screws that hold the plastic case together. Remove the board and the antenna cable with connector from the case, holding the board by the edges to avoid static damage.

( ) Attach the SDR to the chassis using four M3 x 6mm SEMS screws.



( ) Remove the nut and lock washer from the SMA antenna connector, then push the antenna connector through the hole labeled “Antenna”. Re-attach the lock washer and nut, and tighten the connector using a small wrench. Note that the connector at the end of the cable, where it attaches to the board, can be rotated. Be careful not to knock the tiny SMT parts loose when doing so.

( ) Locate the 10” gray shielded stereo cable with a white connector on one end. Strip the loose end of the cable to 1.25”. Cut off the foil.

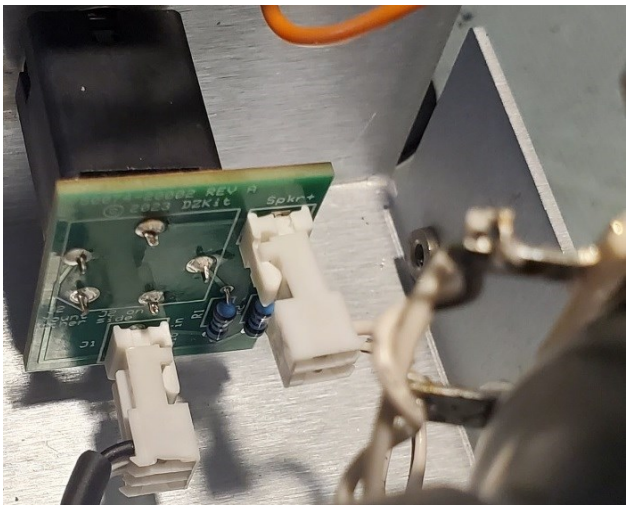
( ) Apply a small amount of solder to the shield to keep the strands from fraying. Place a 3/4” length of heat shrink tubing on the shield and heat it until it shrinks. It will be loose. Fold the end over to keep the tubing from falling off.

( ) Strip the black and clear wires to 3/16” and tin them.

( ) Place a 1/2” length of 1/4” heat shrink tubing on the cable and slide it down to the end with the connector.

( ) Locate the Headphone circuit board kit. Solder the headphone jack (hardware bag 3) to the ***back side (side with no silkscreen)*** of the circuit board. All other parts mount on the top. See picture on next page.

STEP-BY-STEP ASSEMBLY: Chassis



Headphone board installed

( ) Solder resistors R1 and R2 (100 ohm, 1/4W) to the silk-screened side of the board. Clip excess leads.

( ) Mount connectors J1 and J3 to the silkscreened side of the board and solder them on the back. Be sure to position them so that the tab aligns with the thick bar on the silkscreen.

( ) Remove the mounting hardware from the headphone jack, insert the jack into its front panel opening, and re-attach the hardware. Tighten securely. Position the circuit board so that the 2-pin connector faces left (viewed from front).

( ) On the two-pin cable, twist the White and White/Black wires together, two turns per inch.

( ) Locate the loudspeaker. Solder the White wire of the 2-pin cable to the positive (+) terminal on the loudspeaker.

( ) Solder the White/Black wire to the negative (-) terminal on the loudspeaker.

( ) Mount the loudspeaker to the chassis using an M5 x 12mm flathead screw, two rubber washers (between the speaker and the chassis) and an M5 KEPS nut, ***one set for each of the two bottom holes***. Position the audio lugs toward the ***front*** of the radio. Tighten the KEPS nuts very tight.

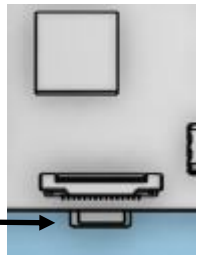
( ) Plug the 2-pin connector coming from the speaker to J3 on the Headphone circuit board.

( ) Plug either end of the shielded cable into J1 on the Headphone circuit board. Leave the other end loose on the chassis bottom. It will be connected to the controller board in a later step.

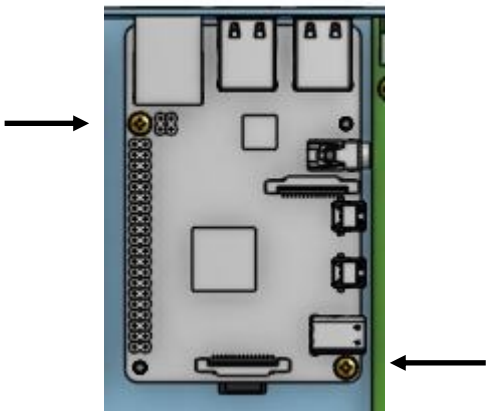
( ) Remove the Raspberry Pi 4B from its box, handling it only by the edges. We will refer to this as the “Pi” from now on.

STEP-BY-STEP ASSEMBLY: Chassis

( ) Locate the small MicroSD card, which has the Linux Operating System and other software pre-loaded. Insert it into the connector on the bottom of the Pi on the end opposite the large connectors. It will only go in one way (connector fingers UP).



( ) Fasten the Raspberry Pi to the two standoffs using two M2.5 x 6mm screws and two M2.5 lock washers.



( ) Locate the fan assembly. Remove the pink thermal insulators from the bag and attach them as shown at the top of the nxt column.

( ) Cut the black connectors off of the three fan wires (red, black, blue). Strip the red and black wires to 1/4”, and tin them. Fold the blue wire back on itself and cover it with 1/2” of 1/8” heat shrink tubing, then apply heat until it shrinks. This wire is not used.

( ) Locate the S0074-00114 cable (2-pin to unterminated red/black wires). Strip the wires to 1/4” and tin them.

( ) Slide 1/2” of 1/8” heat shrink tubing over each of the wires.

( ) Fold the tinned part of the red and black wires back on themselves (loosely) on both the fan and the cable you just prepared. Attach the red to red and black to black. Solder both wires, then slide the heat shrink tubing over the exposed connections and heat them until the tubing shrinks.

STEP-BY-STEP ASSEMBLY: Chassis

( ) Place the fan on the Pi as shown on the previous page.

( ) Turn the chassis on its side. Insert two M2.5 x 20mm screws from the bottom of the chassis into the two Pi mounting holes that do not have chassis-mounted standoffs. Angle them slightly and then place a plastic 12.45mm spacer on each screw (from inside the chassis), then insert the screws into the two mounting holes on the Pi. Tighten the screws. They will pass through the board and into the fan mounting holes. Tighten the screws securely. Since you will be compressing the pink thermal insulators, it will take extra work to tighten them.

( ) Locate the 6” cable that has a 3.5mm stereo minijack on one end. Plug the minijack into the Pi’s 3.5mm minijack receptacle. (It is easier to do this now than after attaching the board to the chassis to avoid clearance issues with the capacitors on the controller board.)

( ) Locate the Controller Wiring Harness, which has one 5-pin and one 8-pin connector, 5 long wires without a connector at one end, and two loose wires.

( ) Remove and discard the cable tie from the end with the loose wires.

Hint: In the next steps, when soldering wires to the pots, tighten the wire(s) in the lug using needle-nose pliers, apply solder, then grab the wire(s) and pull gently while re-heating the solder connection. Let the solder cool before removing your fingers.

( ) Strip the five long wires and both ends of the two loose wires to 3/16”. Tin the wires by applying a small amount of solder.

( ) Attach the long Orange wire and one end of the loose Orange wire to the bottom lug on the bottom pot (Volume Control). Solder both wires.

( ) Solder the other end of the short Orange wire to the bottom lug on the top pot (RFG).

( ) Solder the White wire to the middle lug on the bottom pot.

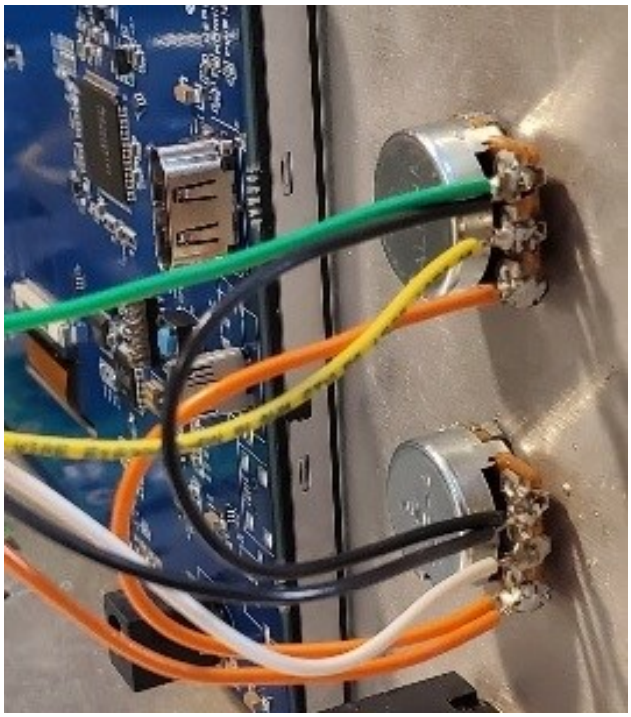
( ) Solder the Yellow wire to the middle lug on the top pot.

( ) Attach the long Black wire and one end of the loose

STEP-BY-STEP ASSEMBLY: Chassis

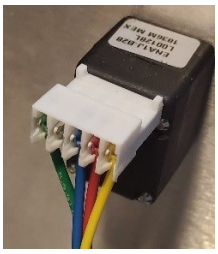
Black wire to the top lug on the bottom pot. Solder both wires.

( ) Solder the other end of the short Black wire and the long Green wire to the top lug on the top pot.



Pot wiring

( ) Push the 5-pin connector onto the RPG (Tuning) as shown below, with the wires facing down. The 8-pin connector will be attached to the controller board in a later step.



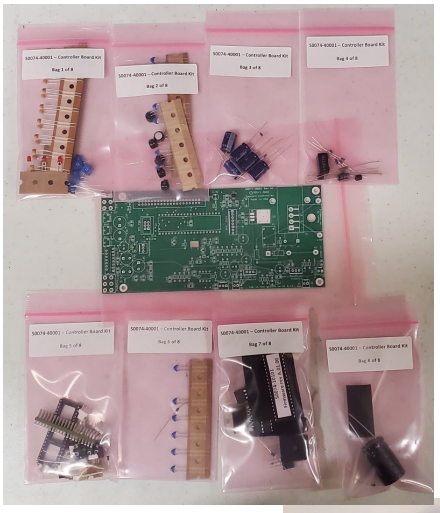
Proceed to the next section to build the Controller board.

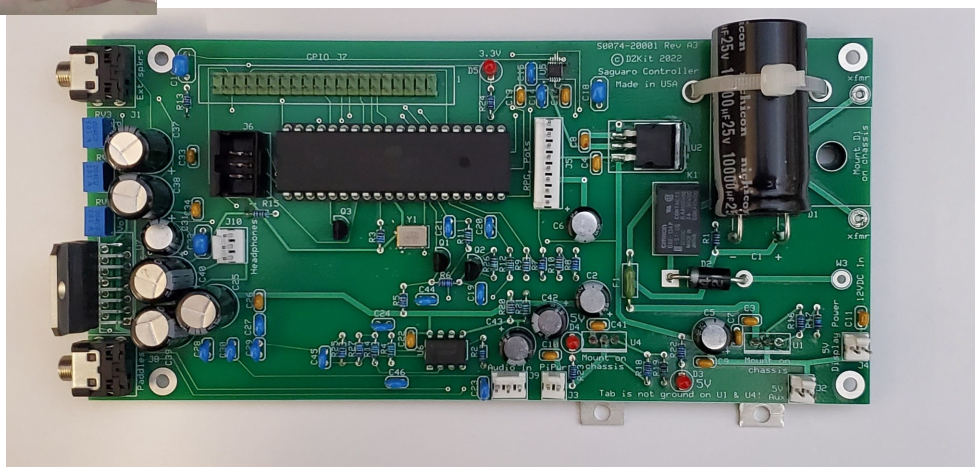
Controller Board Assembly

The Controller board includes an AC power supply that converts the incoming 100-240VAC into 12VDC, and also brings DC power directly into the radio. The microprocessor on this board reads the tuning knob and the two potentiometers and passes their digital values over the gray ribbon cable to the Raspberry Pi computer for processing. It also handles the CW keying–pitch, speed, volume and paddle inputs. Audio from the Raspberry Pi is fed into an audio amplifier that drives the internal speaker, headphones and external speaker jack.

This board is built in two stages. The AC/DC power supply is built first and tested. Once voltages are correct, the rest of the board is completed.

The parts list for the board is included in the board kit bag.





STEP-BY-STEP ASSEMBLY-Controller Board

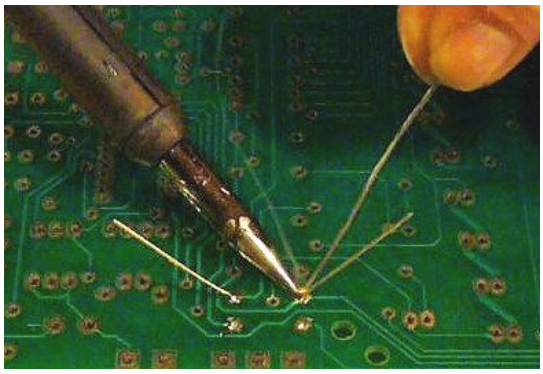
Please read all notes on this page before proceeding:

1. Check off each part on the parts list as you load it.

2. Load the parts from one bag at a time unless specified otherwise in the step. Apply solder to them on the back side of the board, then clip the excess leads using wire cutters.

3. To load resistors, hold a resistor over the holes to see where the leads need to be bent. Bend them sharply using your fingernails. After you do a couple of these, you will understand how far apart to bend the leads.

4. When inserting parts, bend the leads over 90 degrees on the back side of the board to hold them in place. For IC's, if they are loose, just bend one lead in each corner.



5. Make sure all parts lie flat on the board. If they don't, reheat them while pushing down.

6. Resistors have been pre-sorted to make it unnecessary to read color codes or to measure their values with an Ohmmeter. You can measure them if you want to.

7. Small transistors with the black plastic bodies will need to have their leads "sprung" slightly as they are inserted. Make sure the flat side lines up with the silkscreen. See page 7.

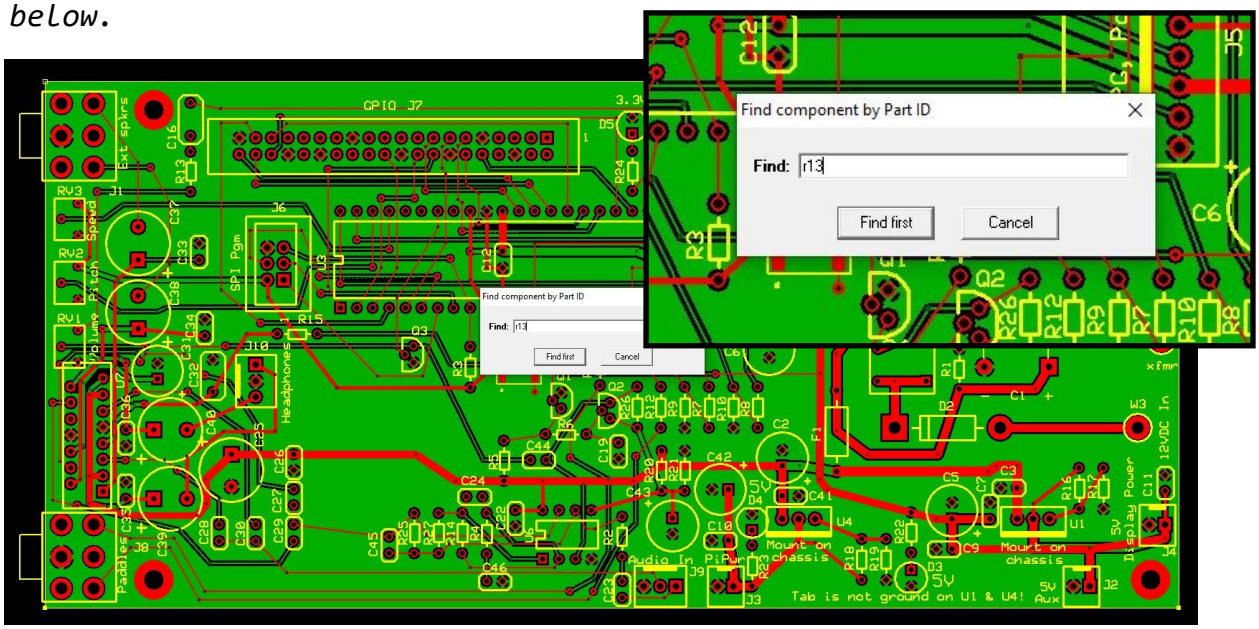
8. When loading integrated circuits, make sure pin 1 is placed in the square pad. The text printed on the body of the part should read correctly left to right when pin 1 is in the square pad. There is also typically a notch or a bar along that end. See page 7.

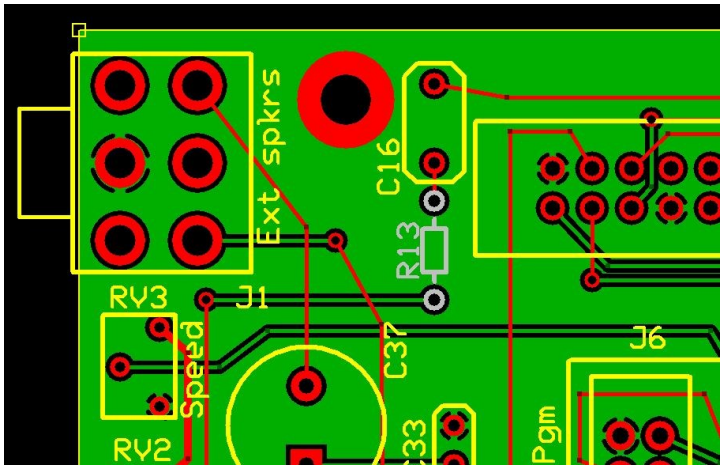
9. Diodes are mounted so that the side with the band goes in the square pad. See page 7.

10. ***DO NOT USE Flux remover or water to clean the circuit board.*** The specially formulated solder that is provided with your kit does not require this, and use of cleaners will actually leave a gummy residue.

( ) I have read all of the above.

Note: *When loading a DZKit circuit board, use the free ExpressPCB software to find the parts, if desired. Download ExpressPCB Classic from www.expresspcb.com, then load the file "pwr_ctl_xx.pcb" (where "xx" is the rev letter/number) from the flash drive included with your kit. Once loaded,* ***press Ctrl-F*** *to pop up the "Find component by Part ID" screen, then enter the designator of the part, such as "R13" (without quotes). The part location will then be shown. See below.*





***Note**: Solder all connections after completing each step, then clip excess leads. Use the parts list in the bag to identify the parts. Check off each part on the parts list as you load it.*

( ) Load and solder all resistors from bags 1 through 8, one bag at a time. For example, from bag 1, load resistors R13, R16, R18, R22, R23 and R24 (all 120 Ohms).

( ) Load and solder all non-electrolytic capacitors (values up to and including 10uF) from bags 1 through 6, one bag at a time. Polarity does not matter.

( ) Load and solder all 100uF (bag 2) and 1000uF (bag 3) electrolytic capacitors. Be very careful to observe correct polarity. The positive lead (longer of the two) goes in the square pad marked "+". The capacitor's negative lead is marked on the body of the part. It goes in the round pad. Push down as you solder the parts to make sure they lie flat against the board.

( ) Load and solder the red LEDs (D3, D4, D5) from bag 1. These are polarized parts. The anode (longer lead) goes in the square pad.

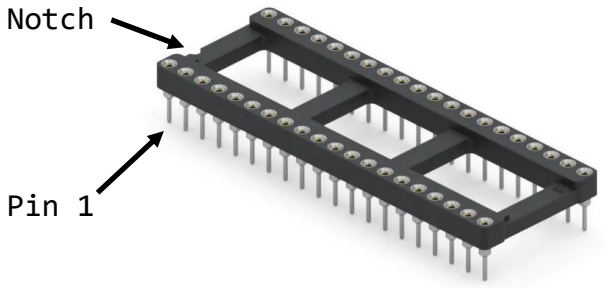
( ) Load and solder fuse F1 from bag 4. Polarity does not matter.

( ) Load and solder the surface mount regulator, U2 (bag 7). Before loading this part, apply solder to the large square pad on the board. Lay the part down so that it lines up with the pads and solder one of the pins. Once it is in place, solder the other two pins. Then apply a liberal amount of solder to the edge of the tab, heating it up until the solder flows under the part. Push the part down and hold it until the solder dries. See below.

( ) ***Do not*** insert the other ICs from bag 7 at this time.

( ) Load and solder all connectors from bag 5. The white "MTA" connectors must be inserted so that the tab on the back of the connector lines up with the tab on the silk-screened outline. Refer to the photo on page 33. (Note: J6 is not provided and does not need to be loaded.)

( ) Load and solder the IC socket U3S. Note that it has a small indent in the plastic. This should be oriented so that it is on the same side as the square pad (pin 1).



( ) Load and solder potentiometers RV1, RV2 and RV3.

( ) Load and solder relay K1 from bag 4. It can only be inserted one way.

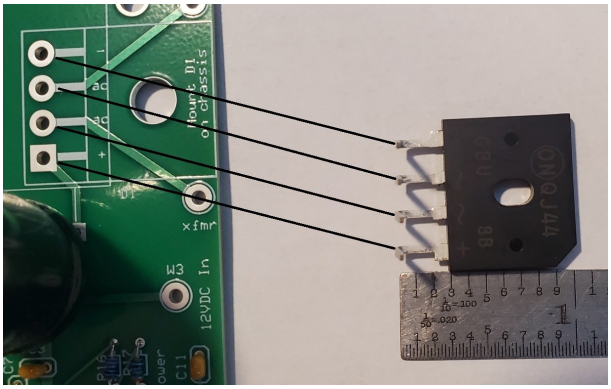
( ) Load and solder diode D2 from bag 4. Make sure the side with the white band goes in the square pad.

( ) Load and solder Q1 and Q3 from bag 4. You will need to spring the pins out slightly to get them to fit. These transistors should be mounted so that the top of the transistor is about 1/4” above the board.

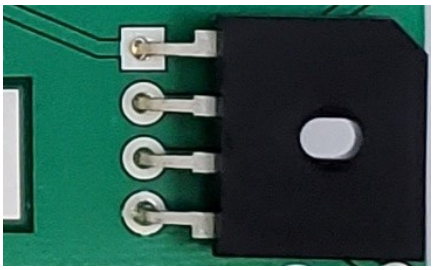
( ) Load and solder transistor Q2 from bag 5.

( ) From bag 8, lay C1 down so that the positive lead (longer of the two) lines up with the marking for C1+ and the body of the part does not extend past the edge of the board. Bend the leads down into the board. Solder them and clip excess leads. Bend C1 back up so that it is upright.

( ) Bend the leads of D1 (bridge rectifier, bag 7) ***up*** 0.3” from the body of the part as shown below. Insert the part from the bottom of the board so that the AC symbols and the + and – line up with the corresponding pads on the silkscreen. Hold the part all the way up against the bottom of the board. Lightly solder the + pin to hold the part in place. Do ***not*** solder the other pins at this time.



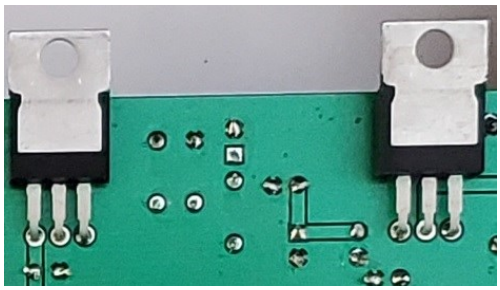
Top view



Bottom view

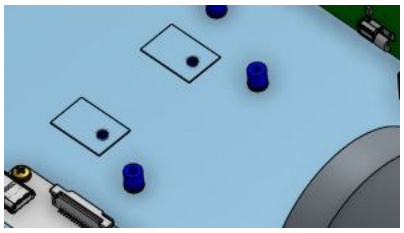
( ) Bend the leads of ICs U1 and U4 (LM350T voltage regulators, bag 7) ***up*** 0.4” from the body of the parts. Insert the parts into the board from the bottom. Hold the part all the way up against the bottom of the board. Lightly solder any one pin on each part to hold the parts in place. Do not solder the other pins.

Top view



Bottom view

( ) Locate the two “Thermalsil” insulators (in the hardware bag). Stick them to the chassis as shown below.



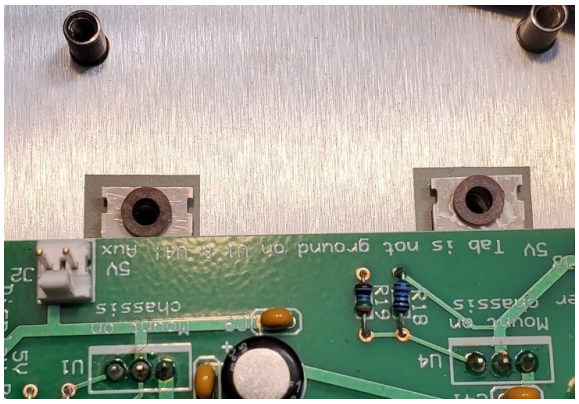
( ) Remove the knurled nuts from the minijacks on the back end of the board. Insert the board into the openings for the two minijacks and reattach the nuts (finger-tight). Do not attach the board to the standoffs at this time.

( ) Using your soldering iron, reheat the + pin you used for D1, and push the part down, allowing it to contact the chassis. Affix it to the chassis using an M3 x 6mm screw. Once it is securely in place, solder all four pins. Clip excess leads as close as possible to the board. Since the large electrolytic capacitor (C1) lies on top of the pins for the D1, it is important that those pins be cut very short.

( ) Fold capacitor C1 down flush with the board. The cable tie and foam insulator will be used to secure this to the board in a later step, after the DC voltage tests have been done.

( ) Using your soldering iron, reheat the one pin you soldered for U1 and U4 and push the IC’s down until they contact the Thermalsil insulators on the chassis. Make sure the mounting hole for each part lines up with the captive nut in the chassis.

( ) Insert a plastic shoulder washer into each mounting hole. Using two M3 x 6mm screws, affix the regulators to the chassis securely. Do not overtighten the screws to avoid damaging the shoulder washers or making the tab cut into the insulator, but make sure they are tight to provide good heat transfer from the tab to chassis. Once they are securely in place, solder all 3 pins on both ICs on top of the board. Clip excess leads.



( ) Using an ohmmeter, measure the continuity between the tab on U1 and chassis ground, and again on U4 to chassis ground. Both should read around 475 ohms. If either are shorted to ground, unscrew the mounting screw and try again to attach the ICs. The Thermalsil insulator along with the shoulder washer are designed to prevent a short from the tab of the regulator to chassis. Inspect carefully for anything that could cause a short.

( ) Measure the following resistances:

( ) Either side of the fuse (F1) to ground.

( ) Across C12 (or pin 10 of U3 – the 40-pin IC socket) to ground

All resistances should be greater than 400 ohms. If they are less than 10 ohms, something on that circuit is shorted. Correct the error before proceeding.

( ) Inspect your work. Look for shorted pads, unsoldered parts, backwards parts, unclipped leads, etc. Compare your board to the picture on page 33. Fix any defects.

( ) Solder the red wire from the DC power jack to the pad marked 12VDC In.

STEP-BY-STEP ASSEMBLY: Voltage tests

( ) Apply 12VDC to the DC input jack. (You do not need to press the on/off switch.) You should hear relay K1 click, switching power from the AC power supply to the DC input.

( ) All three red LEDs should light. If they don't, turn off the power and check your work carefully.

Note: **Voltage measurements are made with the voltmeter ground lead connected to chassis. Use any convenient point.**

( ) Measure the voltage on pin 1 of J2 (5V Aux) and J4 (5V Display Power) on the controller board. Make sure they read between 4.9V and 5.1V.

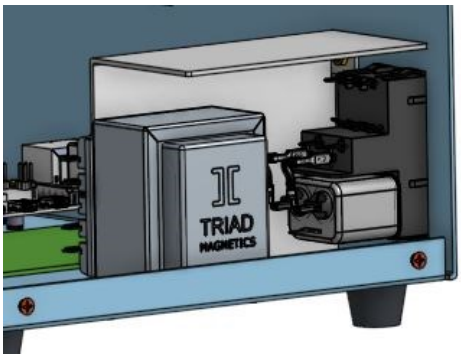
( ) Measure the voltage on pin 1 of J3 (RPi Power) on the controller board. Make sure it reads between 4.9V and 5.1V.

( ) Measure the voltage on pin 6 of 8-pin connector J5. Make sure it reads between 3.2V and 3.4V.

( ) Remove the DC input from the rear panel.

( ) Twist the two yellow wires coming from the transformer together, two turns per inch, then solder the ends to the pads marked "xfmr" on the controller board. It doesn't matter which wire goes to which pad. Be careful not to push the wires in too far. They must not touch the chassis.

( ) Place the safety shield into the chassis as shown below and attach it to the back panel using an M3 x 6mm screw (with Patch compound). Insert the screw from the outside, into the captive nut in the shield. Make sure the green wire passes through the cut-out on the side.



( ) Use a flat-blade screwdriver or similar tool to pop open the PEM using the notch at the top of the PEM, then rotate the voltage selector to the voltage used in your country. It may be somewhat hard to turn.

( ) Insert two 1/2A fuses into the two fuse holders.

( ) Snap the cover shut.

Note: There will be live AC voltage over 100VAC present near the transformer, so be very careful not to touch anything in this area in the next step.

( ) Connect an AC power cord to the Power Entry Module and plug it into your wall outlet. Push the on/off switch to the ON (1) position.

( ) Using an AC voltmeter, measure the AC voltage across the yellow wires coming from the transformer. The voltage should be about 8-9VAC (rms). Note that the peak voltage would therefore be about 13V. After rectification and filtering, it should be about 11V with no load.

( ) Measure the DC voltage across C1 and it should be about 11VDC.

( ) Repeat the voltage measurements that you made earlier (using DC input) on J2 and J5. Make sure they read 4.9-5.1V and 3.2-3.4V, respectively. If the voltages are incorrect, remove power immediately and double check the PEM/transformer wiring.

( ) Switch the power to the off position. Disconnect the AC power cord from the power entry module. Also remove the DC input plug if present.

( ) Insert U7, the audio amplifi-

er, into its place on the controller board. Line up the mounting hole with the hole in the rear panel and attach it with an M3 x 6mm screw. Solder two end pins on the front row to hold it in place, then remove the mounting screw.

( ) Remove the screws on regulators U1 and U4, and bridge rectifier D1.

( ) Unsolder the red and yellow wires.

( ) Remove the knurled nuts holding the controller board to the back panel, and carefully remove the board.

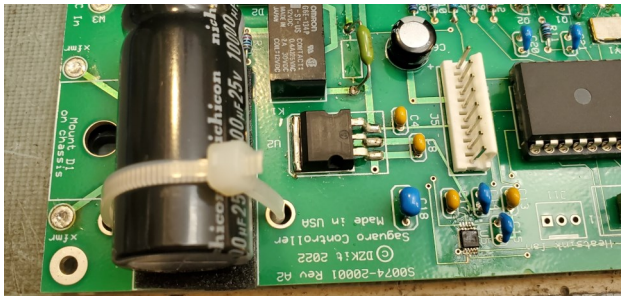
( ) Solder all remaining pins of U7. Clip excess leads.

( ) Insert and solder U6 on the controller board. Make sure pin 1, marked with a small indented circle, lines up with the square pad.

( ) Insert the 40-pin microprocessor in socket U3S. Make sure pin one goes into the socket where the square pad is located (near R15). Also make sure no pins get bent under the connector.

( ) Remove the sticker from the foam insulator and secure it to the board in the outline of C1.

( ) Secure C1 to the board using the large cable tie. Loop it around the capacitor and under the board using the two circuit board holes near the end of C1, and insert the tie into the free end on ***top*** of the capacitor. Clip excess length of the tie.

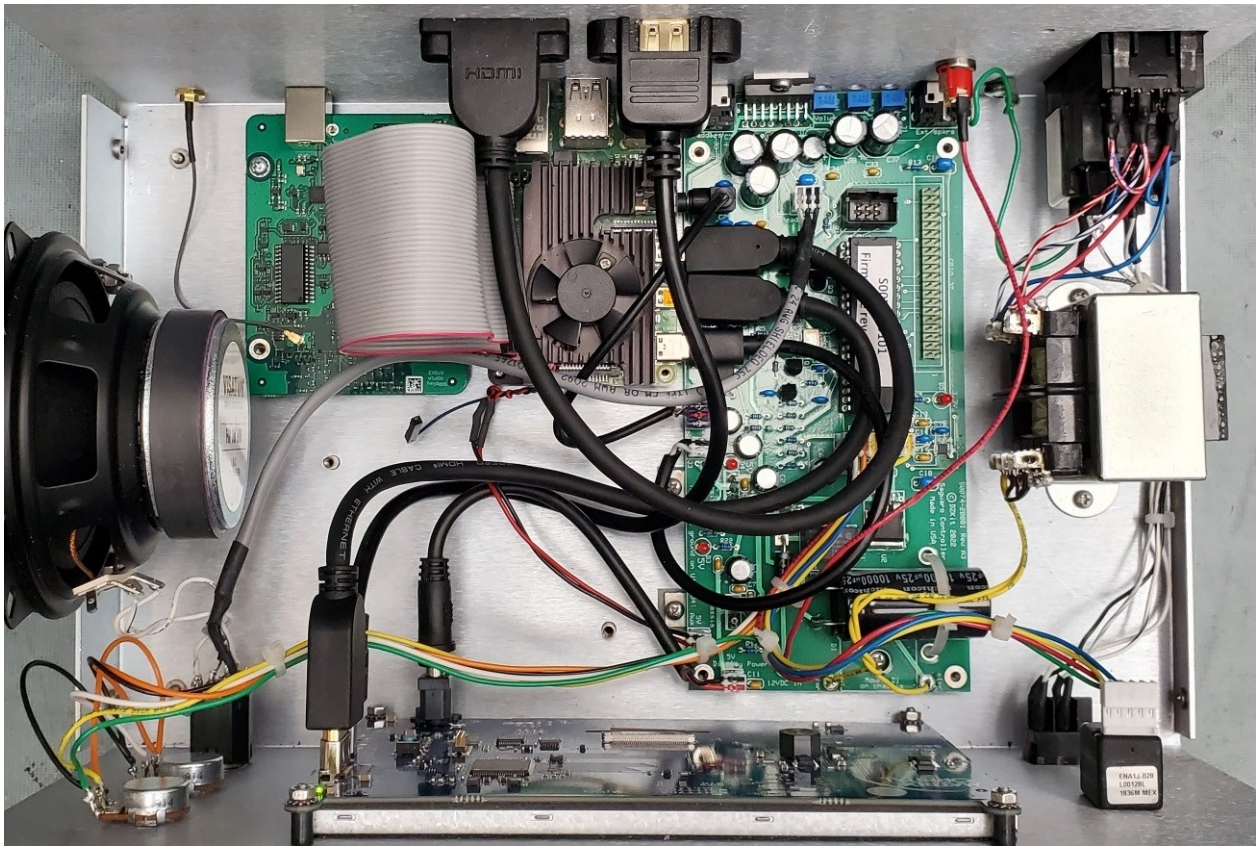


( ) Install the controller board using four M3 x 6mm screws and re-mount D1, U1 and U4. Double check that there is no short to ground on the tabs of U1 and U4.

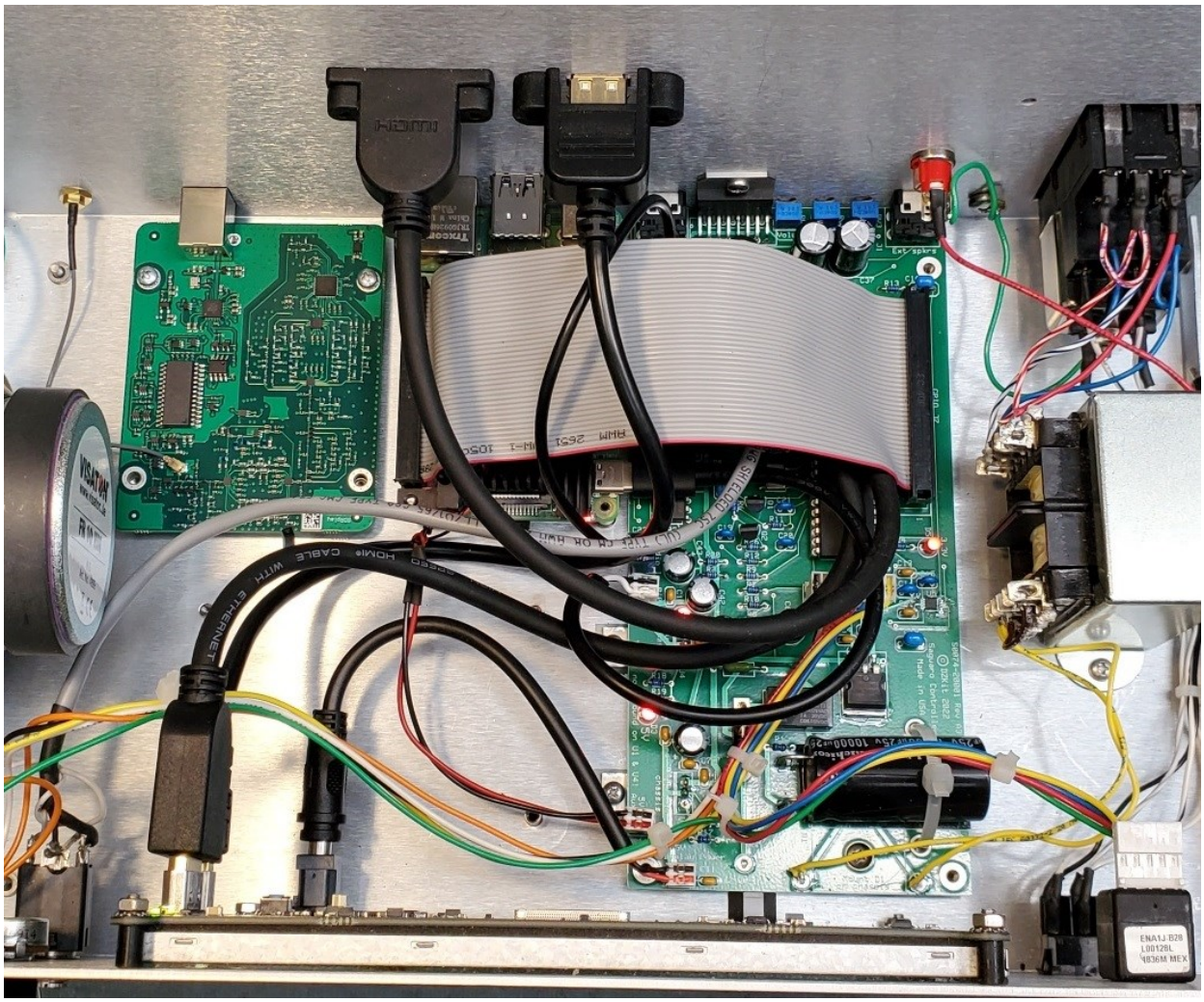
( ) Fasten the knurled nuts to the audio jacks on the back panel.

( ) Re-solder the red and yellow wires.

This completes assembly of the controller board. Proceed to Final Assembly, next, referring to the photos of the assembled unit on pages 43-44 for reference.



Inside view with GPIO cable disconnected from controller board to show cable connections beneath it



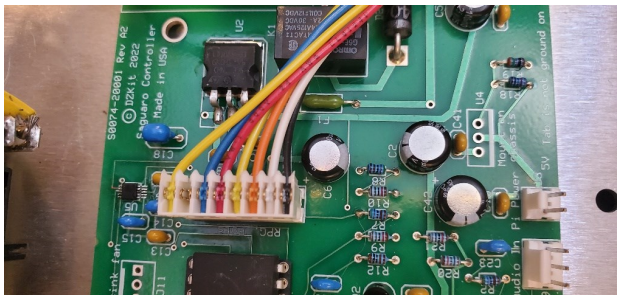
Inside view of assembled unit showing cable connections with GPIO cable in place. Refer to this and the previous page as you complete the wiring on the next few pages.

View of back panel showing USB connections to the Raspberry Pi 4B

STEP-BY-STEP ASSEMBLY - Final Assembly

Note: In the steps below, you will insert the white or blue "AMP MTA" female connectors that are on the cable assemblies into the mating male connectors on the controller board. These must be inserted as shown below, with the locking tabs on the female connector placed in the cutouts in the male connector.

( ) Locate the controller wiring harness (S0074-00102), which was wired earlier to the pots and RPG. Connect the 8-pin connector to the matching 8-pin connector on the controller board.



( ) Locate the 8" cable that has a 2.1mm round connector on one end (S0074-00103). Insert the 2.1mm connector into the 2.1mm power jack on the display. Push the 2-pin MTA connector onto the J4 on the controller board ("Display Power"). (The other cable in the bag is not used.)

( ) Attach the free end of the cable that was attached earlier to the minijack on the Raspberry Pi (S0074-00106) to the controller board at the point labeled "Audio In" (J9).

( ) Locate the 10" cable with a Micro-USB connector on one end and a 2-pin MTA connector on the other end (S0074-00107). Push the USB connector firmly into the mating connector on the Pi. Push the MTA connector onto the connector labeled "Pi Power" (J3) on the controller board.

( ) Locate the 12" cable with a full-size HDMI connector on one end and a Mini-HDMI on the other (S0074-00108). Push the mini-HDMI into the connector labeled HDMI0 (next to the power connector) on the Raspberry Pi. Push the other end into the large HDMI connector on the display.

( ) Locate the 8" USB-A to USB-B cable. Insert the USB-B con-

nector into the SDR control connector on the back panel, and insert the USB-A connector into the bottom of the two USB connectors on the left side of the Pi (viewed from the back panel).

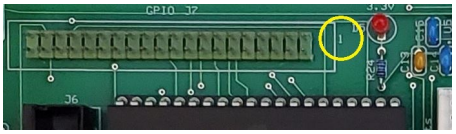
( ) If you purchased the external HDMI option, locate the 12" Micro-HDMI to Panel-mount HDMI cable (S0074-00109). Insert the Micro-HDMI connector into the Raspberry Pi connector marked "HDMI1". Bend components over on the control board if necessary to make this connector go in straight. Push hard to make sure the connector is inserted all the way. Attach the other end to the back panel using two 4-40 x 3/8" screws. (Do not use the screws provided with the cable.) An external HDMI monitor can be connected here. You must supply your own cable and monitor. ***Note: 4-40 x3/8" screws look a lot like M3 x 6mm screws. Do not mix them up!***

( ) If you have purchased the touch option:

( ) Locate the Mini-USB to Panel Mount USB cable (S0074-00110). Insert the Mini-USB connector into the mating connector on the display. Attach the other end to the back panel using two 4-40 x 3/8" screws. ***Note: 4-40 x3/8" screws look a lot like M3 x 6mm screws. Do not mix them up!***

( ) Locate the 6" USB-A to USB-A cable (S0074-00111). Insert one connector into the top left USB connector on the Raspberry Pi (as viewed from the back). Connect the other end to the Touch connector. See picture below.

( ) Locate the GPIO ribbon cable. Push the connector onto the 40-pin connector (J7) on the controller board such that the red stripe is on the side marked pin 1. Connect the other end to the GPIO connector on the Pi. One side of this end of the connector has been ground down slightly to allow it to clear the fan heat sink. Be careful not to bend pins on the male connectors as you insert the cable, and be careful not to insert the cable "off-by-one".



Location of pin 1 of GPIO cable

( ) Attach the free end of the shielded cable that was attached earlier to the headphone circuit board (S0074-00104) to the controller board at the point labeled “Headphones” (J10).

( ) If you wish to experiment with your own circuits using the Saguaro chassis, you can attach a circuit board to the spare standoffs between the display and the Pi/SDR. Use M3 x 6mm SEMS screws (provided) to secure it. You can use the most inexpensive ordering option from Express PCB to get boards made (“Proto Pro”). A sample board layout is included on the flash drive provided with your kit.

( ) Attach the tuning knob to the RPG shaft on the front panel. Tighten the setscrews using the provided 1/16” Allen wrench.

( ) Rotate the front panel Volume and RFG pots to the CCW position (all the way to the left). Using the provided .050” Allen wrench, unscrew the setscrews so that the knobs fit over the Volume and RFG pot shafts. With the indicator line at the 7:00 position, tighten the setscrews. Rotate the RFG knob to the 12:00 position (indicator pointing straight up). Rotate the volume control to the 9:00 position (indicator pointing left).

( ) Affix the serial number sticker to any convenient spot on the back panel.

( ) When you are satisfied that everything is working, attach the cover to the chassis using 4 Black oxide screws.

( ) If you purchased the wireless keyboard and mouse, note that the wireless USB receiver is located inside the battery compartment for the mouse. Plug this into any spare USB port on the back of the Raspberry Pi.

This completes assembly of your Saguaro.

QUICK START GUIDE

Connect an antenna to the SMA connector (marked “Antenna”) on the back panel. If you don’t have an SMA connector or adapter, a wire can be inserted into the connector.

Note: If a thunderstorm is near, we suggest disconnecting the antenna to avoid static build-up or a lightning strike from damaging the radio. Also be sure to discharge any static you may have built up by touching a ground before touching connectors on the back panel.

Note: High power RF can also damage receivers. Be sure that the input power seen by the radio does not exceed +10dBm (10 milliwatts). Do not connect the radio to the same antenna as one that will be used for transmitting.

Apply power, either AC or DC, to the radio. If using AC, make sure the line voltage selector is set for your country, then push the power switch to turn it on. If using DC, make sure it is set to 12V and switch on your DC supply.

The Raspberry Pi 4B will boot, which can take about 45 seconds, and then automatically execute the DZKit Shortwave Receiver program, which will “wake it up” showing the shortwave bands with green-highlighted sections, such as “Standard Broadcast.” The initial frequency is set for 600kHz on the AM Broadcast Band, where there are likely to be many strong signals to tune in. You can then click the mouse on a frequency and/or band, or, if you have the touch feature installed, you can simply touch the screen.

Note: *The touch option will not work correctly with an external monitor connected to the HDMI jack until the DZKit Saguaro program is run. Instructions on how to do this yourself are in the Linux Setup section of this manual.*

The white dial pointer and the yellow digital frequency readout in the center of the display show you the current frequency. Other bands have orange dial pointers showing the frequency that will be chosen when you first select that band.

Once you have selected a frequency, you can tune around by using the Tuning knob. Change the resolution using the “Inc” button at the bottom.

When AGC is on (default), the RFG control is used as a “threshold” and is normally left in the most counterclockwise position. You can increase it to tune in weak signals. When AGC is off, the RFG control functions as a normal RF Gain control, with maximum gain at the clockwise position.

QUICK START GUIDE

Adjust the volume control for comfortable listening.

The Mode, such as AM, FM, NBFM, USB, LSB, CW(USB) and CW(LSB), is selected automatically based on band, but each band can have a mix of different modes, so you can also click the mode button (which defaults to "AM" at initial startup) at the bottom of the screen to change among these modes manually.

Two other buttons allow you to select the next or previous page of shortwave and VHF frequencies.

HEADPHONES

Turn the AFG control to minimum (counter-clockwise) and plug a set of 8 Ohm headphones into the front panel "Phones" jack, then adjust the level back up, slowly. The speaker volume should go down. Adjust the volume up to a comfortable listening level.

***Note**: The speaker is wired in parallel with the right channel and there is a series resistor on both channels to limit the volume when using headphones. When the headphones are plugged in, the speaker is still connected, but very weakly. It is normal to hear low level audio from the speaker when using the headphones.*

If desired, you can plug a set of PC speakers or similar external stereo speakers into the Line Out jack on the back panel.

KEYER OPERATION

Plug a set of keying paddles into the "Paddles" stereo minijack (dit paddle to tip, dah paddle to ring).

Press either the dit or dah paddle and adjust the volume, pitch and speed using the back panel pot adjustments. Use a small Phillips-head screwdriver such as the one that is shipped with the fan.

The keyer can't be connected to a transmitter. It is for code practice only. It defaults to IAMBIC B. You can change the type of keying, using the Shortwave receiver program, to IAMBIC A, IAMBIC B, Ultimatic or Manual.

ENDING A LISTENING SESSION

To end a listening session, click the EXIT button and you will be prompted to either shut down or return to the OS. **(When selecting "shutdown", wait 15 seconds before removing power. This is no different from Windows and will avoid damage to the SD card.**

DETAILED OPERATING GUIDE

Refer to the picture on page 51.

The function of the buttons at the bottom of the screen is as follows:

Muted/Receiving: This button mutes or unmutes audio when clicked. When muted, the button text says “Muted”. Click it again to re-enable the speaker. Text changes to “Receiving.”

AGC On/Off: This button changes the Automatic Gain Control in the SDR. When “On”, use the RFG control as a “Threshold” control, ranging from –60dBm (CCW) to 0dBm (CW). When “Off”, use the RFG control as a normal RF Gain, with minimum gain (CCW) to maximum gain (CW).

Att: This button lets you select attenuators to reduce front end gain, which can help reduce input overload from strong stations. It defaults to 12dB. The available selections vary by frequency, so going from, say FM to AM, you may see the level reset from a higher attenuation to a lower one automatically.

Prev Page: There are several pages of frequencies. This button moves you to the previous page.

Next Page: There are several pages of frequencies. This button moves you to the next page.

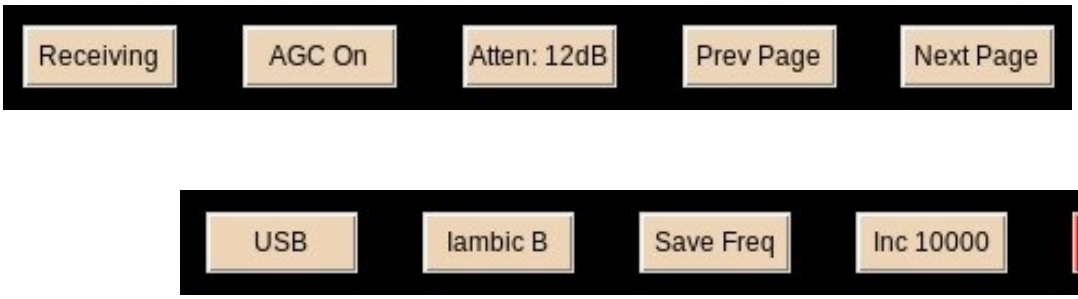
Mode: The current mode is shown in this button. As you click the button, the mode is changed to FM (wideband), NBFM (narrow-band), USB, LSB, CW(USB) or CW(LSB). There are fixed filters that are automatically selected for each mode. FM: 200kHz, AM: 6kHz, USB/LSB: 2.8kHz, CW: 800 Hz. The filters can’t be changed.

Keyer Mode: Choose among Iambic A, B, Ultimatic and Manual modes. See discussion on page 52.

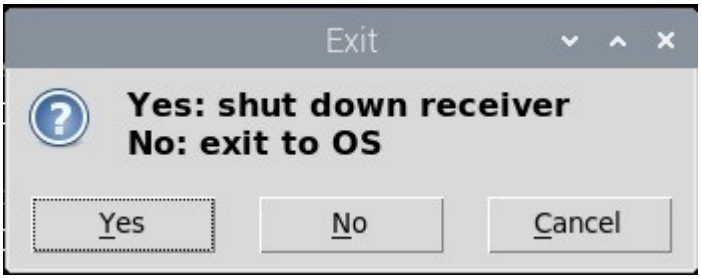
Save Freq: Each band remembers one saved frequency. When you select a band, that frequency is what is first selected. If you move to a different frequency on that band and want to change the saved frequency to the current one, click this button.

Increment: Choose from 1, 10, 100, 1000, 5000 and 10000 Hz as the step size when adjusting the frequency with the tuning knob. Changing the step size also resets the frequency by zeroing the digits for the chosen step. For example, if the frequency is 14222011 on the 1Hz steps, and you select 10Hz, the frequency will change to 14222010.

Exit: Return to the operating system (OS) or prepare for power off. See next page for a detailed description.



Buttons on bottom of screen



Refer to the picture above. When you click the **Exit** button, you are given three choices:

Yes: Exit the program and shut down the computer. ***This must be done prior to turning the radio off to avoid damage to the operating system on the SD card.*** The software outputs a message in the middle of the screen telling you to wait 15 seconds, then turn off power. This gives the OS time to completely shut down. If you forget to do this, it will probably not hurt anything, but better to be safe!

No: Exit the program and return to the Linux Operating System. Choose this option if you want to use any Linux features, such as executing another program.

To run other included programs such as CubicSDR, move the mouse to the top of the screen to expose the menu bar, then click the "Raspberry" button in the top left corner and select your desired program from the drop-down list. It is beyond the scope of this manual to explain operation of these other programs. Please consult the operating manual for that software.

Cancel: This gives you a way out if you hit the button by mistake and just want to keep the program running.

DETAILED OPERATING GUIDE

Refer to the picture below.

RFG. This stands for “Radio Frequency Gain,” and controls the level of RF seen by the input stage. It’s a bit of a misnomer, since it really controls input attenuation, but tradition calls this “gain”. The SDR has several levels of gain, but this control sets the IF gain from –59 to -20 dB (AGC Off) or sets the AGC threshold from –60dBm to 0dBm (AGC On) as the control is rotated clockwise.

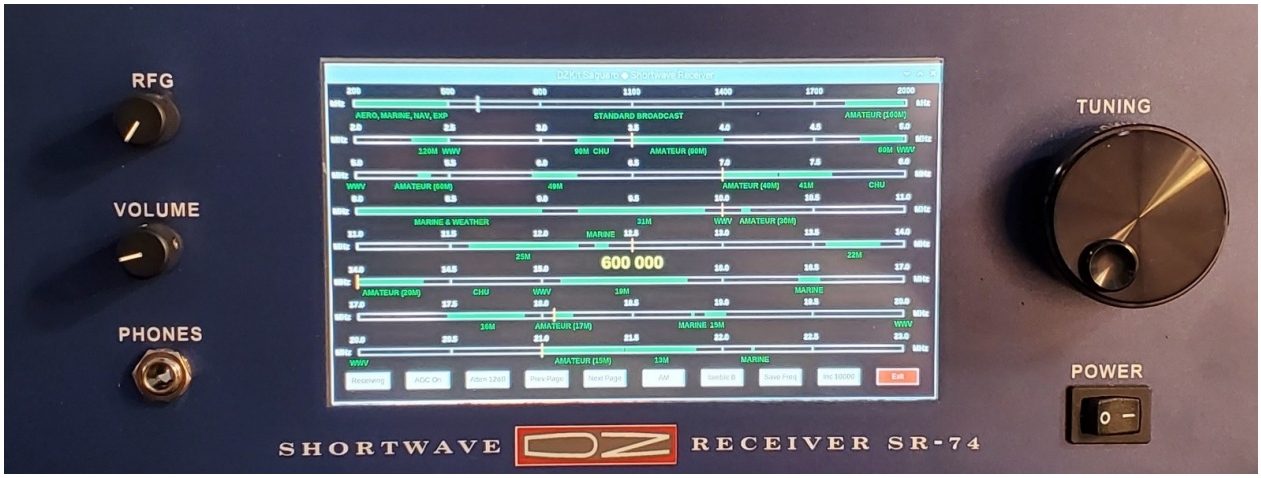
Volume. This controls overall loudness, including that of the speaker, headphones and external line out level.

Phones. Stereo connection to low impedance headphones with a 1/4” stereo phone plug. Tip to Left, Ring to Right, Sleeve to Ground. Plugging in the headphones lowers speaker output greatly, although it is still there.

Tuning. This allows you to change the frequency you are listening to.

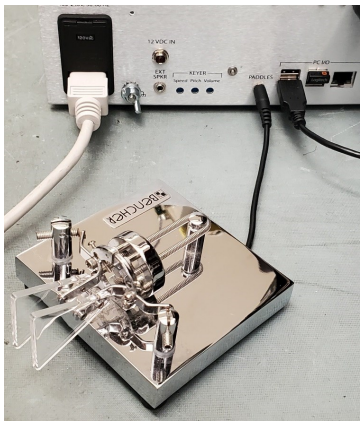
Power. This switch turns the AC supply on (right, “1”) or off (left, “0”). It has no effect on the DC input, which must be turned on and off from the external 12V supply.

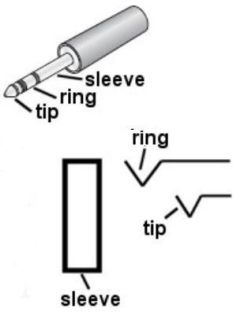
Please note that the RFG and Tuning controls only work when using the provided shortwave receiver program. You can use the volume control with other programs by running the “volume_control.py” program available in the “Other” section of the drop-down list after clicking the raspberry in the upper left corner of the Linux user interface. Do not use this at the same time as the Saguaro receiver program.



KEYER CONNECTIONS:

Plug a set of keying paddles into the “Paddles” stereo minijack (dit paddle to tip, dah paddle to ring, ground to sleeve).





KEYER OPERATION

Note: All keyer modes except manual cause dits (dots) to be generated when you press the dit paddle, and dahs (dashes) to be generated when you press the dah paddle.

- **Iambic A:** Squeezing both paddles causes alternating dits and dahs to be generated. If you release both paddles at the same time, the current element (dit or dah) will finish, and then it will stop.

- **Iambic B:** Squeezing both paddles causes alternating dits and dahs to be generated. If you release both paddles at the same time, the current element (dit or dah) will finish, then another element will be sent and then it will stop.

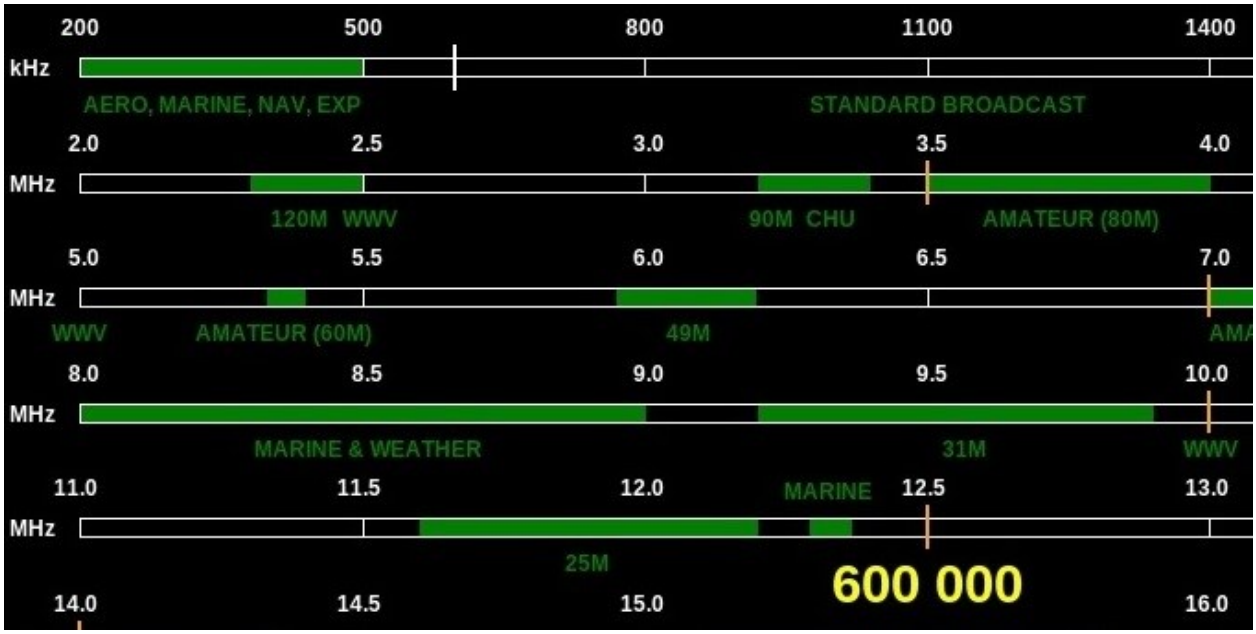
- **Ultimatic:** Whichever paddle was pressed last dominates. So, pressing the dot paddle will generate a stream of dots, and if you continue to hold that paddle down, pressing the dash paddle will generate dashes, and vice versa.

- **Manual:** Pressing either the dit paddle or the dah paddle (or both) will simply turn on a steady tone. When both are released, the tone turns off.

Try sending the letter “C”, which is “_._.” (“Dah-Di-Dah-Dit.”) To start sending, press the dah paddle, so the dah comes out first, and while it is sending, press the dit paddle, which will cause it to alternate dahs and dits forever until you remove your hand from the key. Using Iambic mode A, if you release the paddles during the final dit, the keyer stops after completing the dit. Using Iambic mode B, if you release the paddles during the final dah, the keyer will finish that dah, send a final dit, and then stop.

Note that if you never release both paddles at the same time (thereby not taking advantage of the keyer’s self-completing features), you won’t notice the difference, and you’ll be able to switch between modes more easily.

The selected keyer mode is remembered even after you exit the receiver program.



In this closeup, you can see that the selected frequency is 600 kHz (white line), and that the saved frequencies on the other bands are 3.5 MHz, 7.0 MHz, 10.0 MHz and 12.5MHz (orange lines).

To select a different frequency on the same band, rotate the Tuning knob. At the default 10kHz frequency increment, you can move across the band quickly. You can also simply click somewhere else in the band. The frequency will change to the nearest 10kHz point. When you find a section of the band you want to explore more, change the Increment to 1, 10, 100 or 1000 Hz. That gives you fine-tuning control.

To change the saved frequency on any band, click the **Save Freq** button.

When tuning across the Citizen's Band frequencies (marked "CB", around 27 MHz), the channels are shown when you are on one of those frequencies. Channel 1 is at 26.965000 MHz. Others are generally at 10 kHz spacing, although there are some gaps, and channels 23-25 are not contiguous due to the way channels were assigned when CB expanded from 23 to 40 channels. Operation is primarily AM, but some use SSB.

Marine frequencies are also channelized and those frequencies are also shown when you tune across them.

The Python program that runs the DZKit shortwave emulator is free. You can modify it if you wish. If you come up with interesting ideas for future enhancements, please let us know.

LINUX SETUP

Although we have tried to make Saguaro as easy to use as possible, it does use the Linux Operating System (OS) underneath. This gives you many features that you can tweak depending on your needs. It is beyond the scope of this manual to explain how to use Linux. Rest assured that if something doesn't work right, you can call or email us for help. Some familiarity with a windows-based OS is assume in the comments below.

CONFIG.TXT

One of the most important files in the OS is the config.txt file. This is on the image that is loaded on the SD card that we ship. You can edit it by doing this:

1. Start a command prompt
2. Change folders to /boot
3. Execute a text editor:
   sudo nano config.txt
4. Edit the line you want to change
5. Type Ctrl O to save
6. Type Ctrl X to exit

When making changes to this file, we suggest you make a copy of the working one and save it on a flash drive in case you need to restore it. You can also remove the SD card from the Pi, put it into an adapter, and plug it into a USB port on a Windows PC to edit or replace the file.

MONITORS

The built-in 7" display is made by Matrix Orbital in Canada. The version in your Saguaro is an HDMI 5V unit, 1024x600, with vertical connectors, including a USB connector for the resistive touch interface.

The part number is:

HTT70A-IPS-TPR-BLH-B0-H6-CH-V5

To let Linux know about this display, the following lines have been enabled in the config.txt file:

```
hdmi_group=2
hdmi_mode=87
hdmi_cvt=1024 600 60 6 0 0 0
```

TOUCHSCREEN

The touch option on Saguaro consists of two cables:

1. S0074-0110 Internal Mini-USB to chassis mount USB-A
2. S0074-0111 External USB-A to USB-A

LINUX SETUP

TOUCHSCREEN (CONT'D)

Usually the external monitor is not a touchscreen. This causes Linux to get confused about where to put the cursor as you touch the screen. To fix this, a command must be issued.

1. Start a command prompt

2. Issue the following command:
   xinput

3. The output from this command will tell you the ID of the touch interface. This ID may vary depending on the number of peripherals you have attached and the order of assignment as they are discovered by the OS. Look for the line with the Matrix Orbital Touch description, and take note of the ID.

4. Issue the following command:
   xrandr

5. The output from this command will tell you the names of the two HDMI interfaces. Note that although The Pi has them labeled HDMI0 and HDMI1, they show up in this command as HDMI-1 and HDMI-2. The internal touch display is HDMI-1.

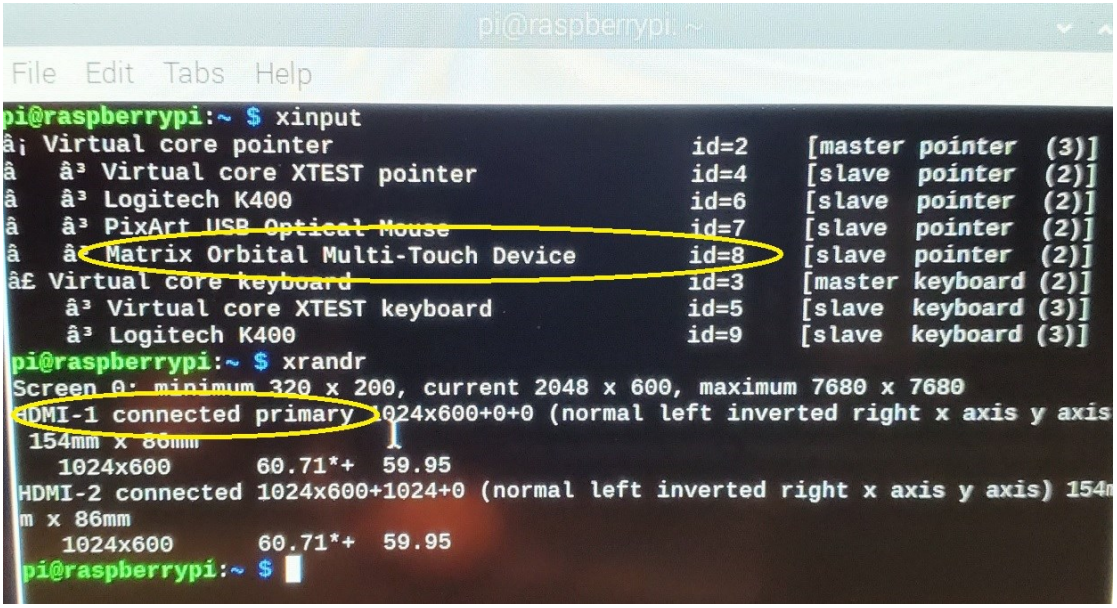
6. Issue the following command:

xinput map-to-output <ID> <HDMI>

From the info shown in the screen shot below, you would enter:

xinput map-to-output 8 HDMI-1

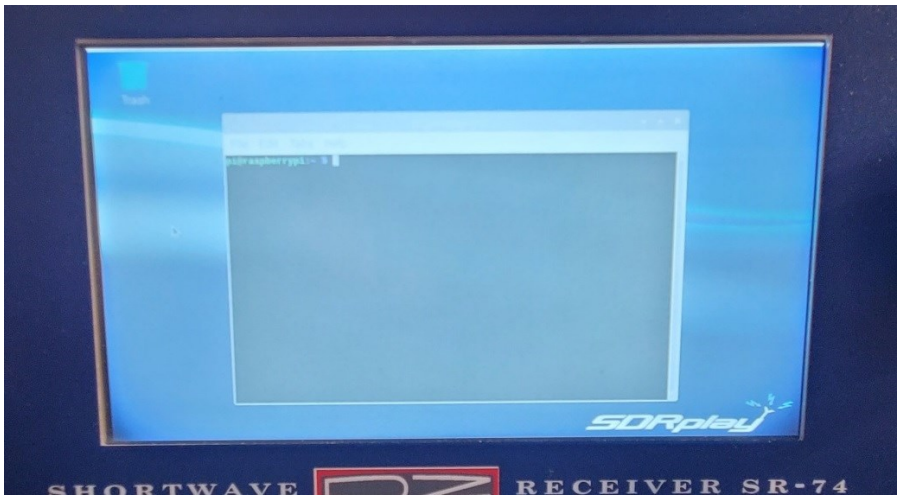
We have included this command in the initialization section of the Saguaro software.

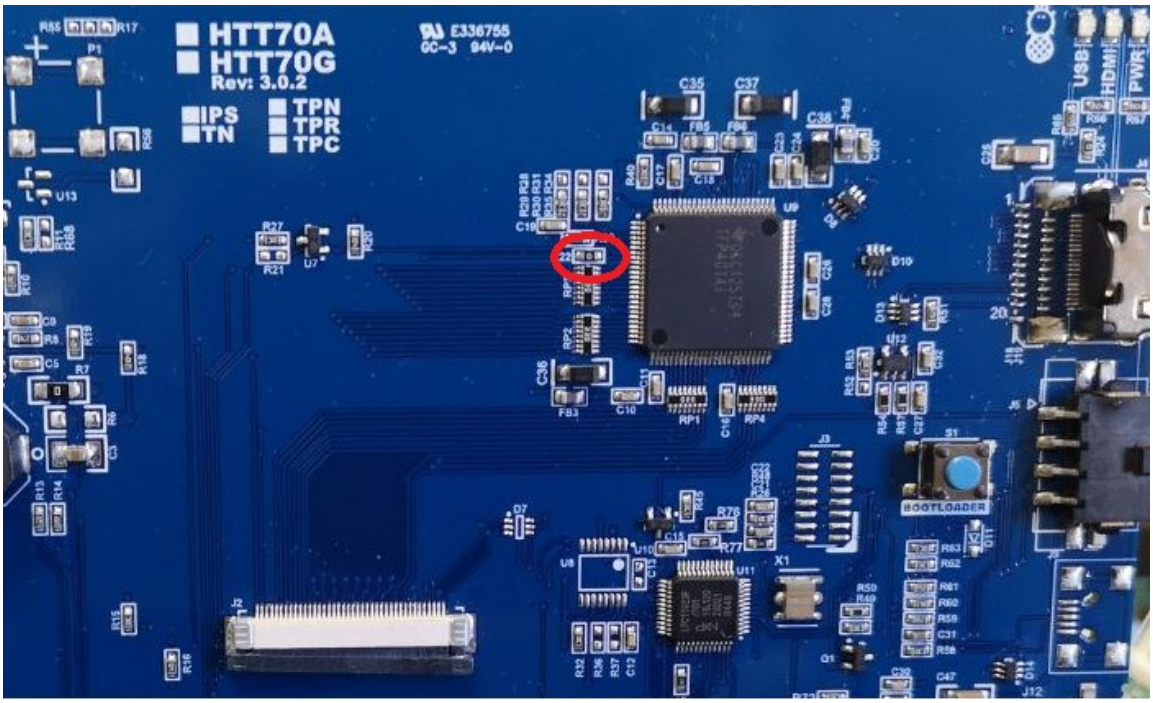


LINUX SETUP

DISPLAY "WASHOUT"

If you leave your Saguaro running unattended, Linux will eventually blank the screen. If left in this state for many hours, a phenomenon called "turbidity" can occur, making the screen appear "washed out." To fix this, remove resistor R22 on the back of the display. An easier solution is to not leave the Saguaro running unattended for many hours, or set the display to never blank the screen.

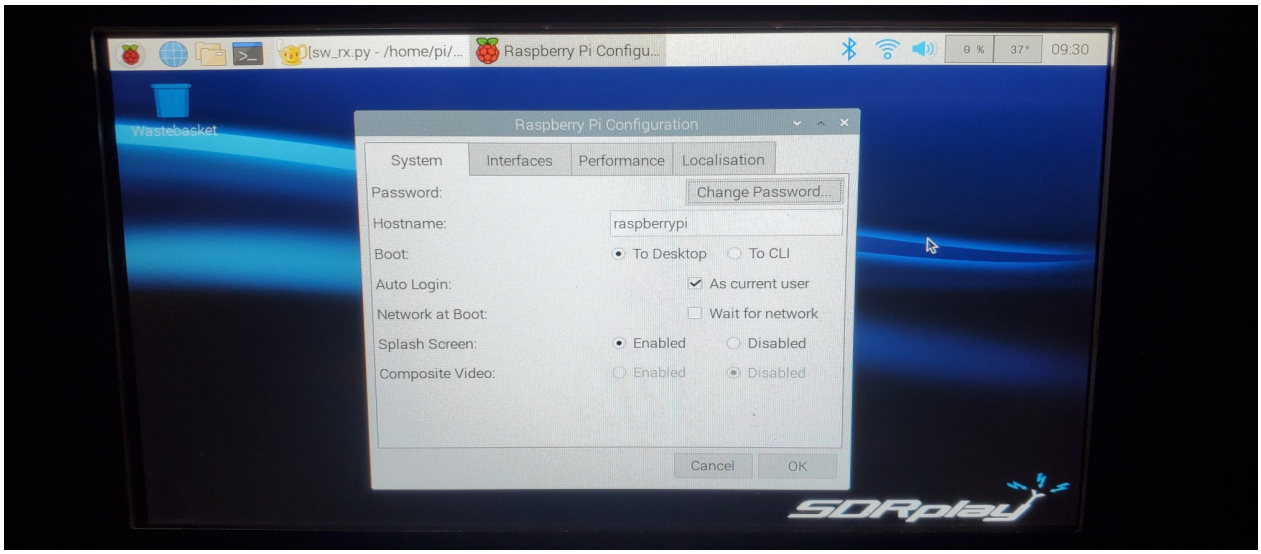


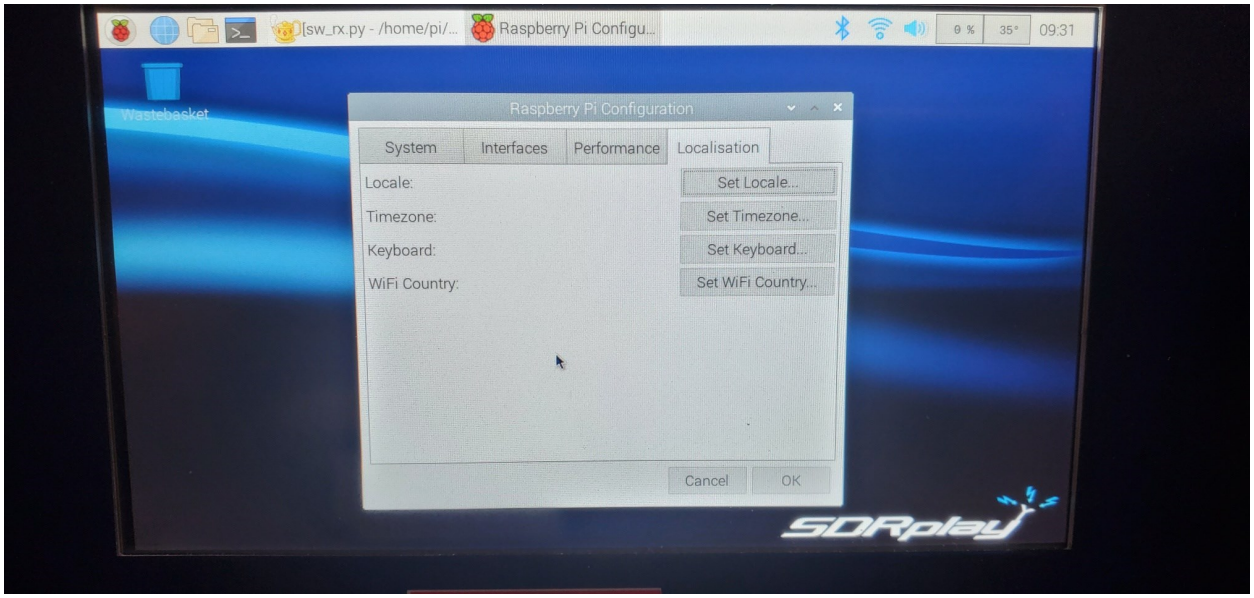


LINUX SETUP

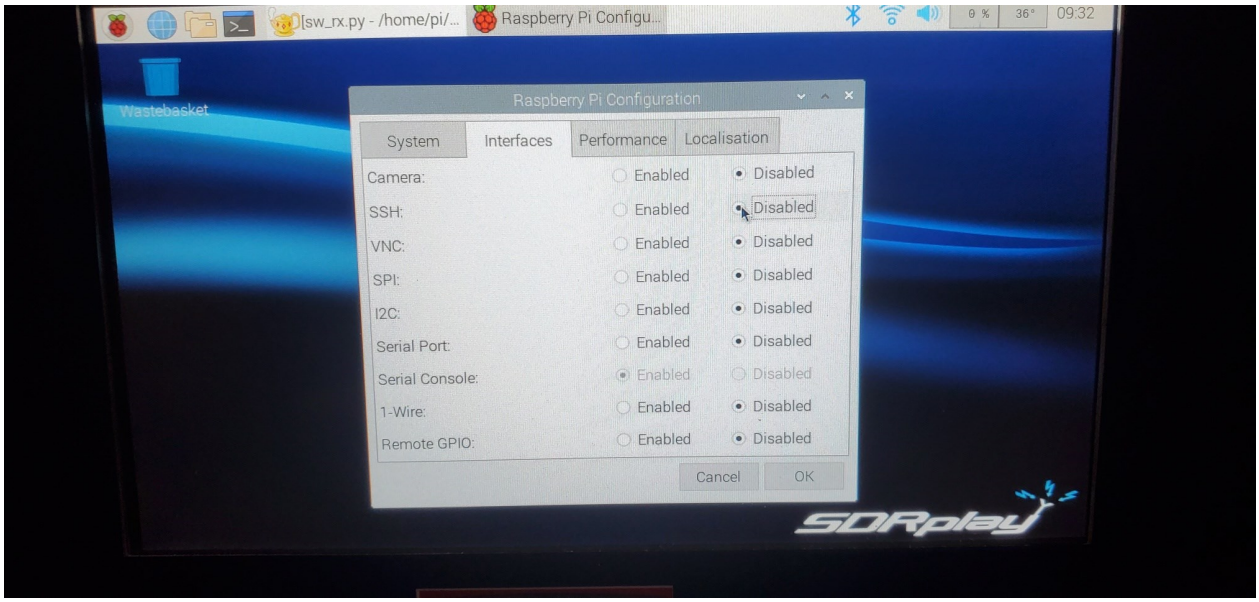
SYSTEM CONFIGURATION

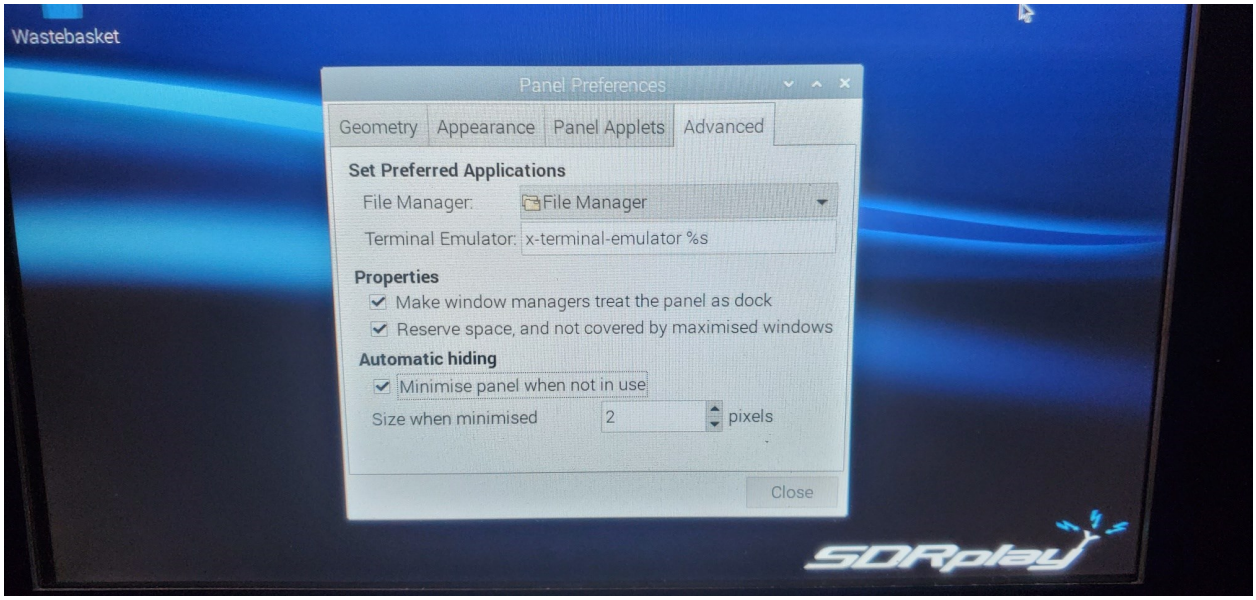
As with all PC OS's, there are many configuration settings you can change based on personal preference, such as timezone, date and time, screen saver, etc. These can be changed by clicking the raspberry icon in the upper left corner, and selecting "Preferences". See below for some of the things you can change. Note too that since the Raspberry Pi organization is located in England, the spelling is British English! The wireless keyboard option has a UK format. You can select this in the "Localisation->Set Keyboard" selection shown below.





LINUX SETUP


[sw_rx.py - /home/pi/...
Raspberry Pi Configu...
09:32
Wastebasket
Raspberry Pi Configuration
System
Interfaces
Performance
Localisation
Camera: Enabled Disabled
SSH: Enabled Disabled
VNC: Enabled Disabled
SPI: Enabled Disabled
I2C: Enabled Disabled
Serial Port: Enabled Disabled
Serial Console: Enabled Disabled
1-Wire: Enabled Disabled
Remote GPIO: Enabled Disabled
Cancel
OK
SDRplay


Wastebasket
Panel Preferences
Geometry
Appearance
Panel Applets
Advanced
Set Preferred Applications
File Manager: File Manager
Terminal Emulator: x-terminal-emulator %s
Properties
Make window managers treat the panel as dock
Reserve space, and not covered by maximised windows
Automatic hiding
Minimise panel when not in use
Size when minimised 2 pixels
Close
SDRplay

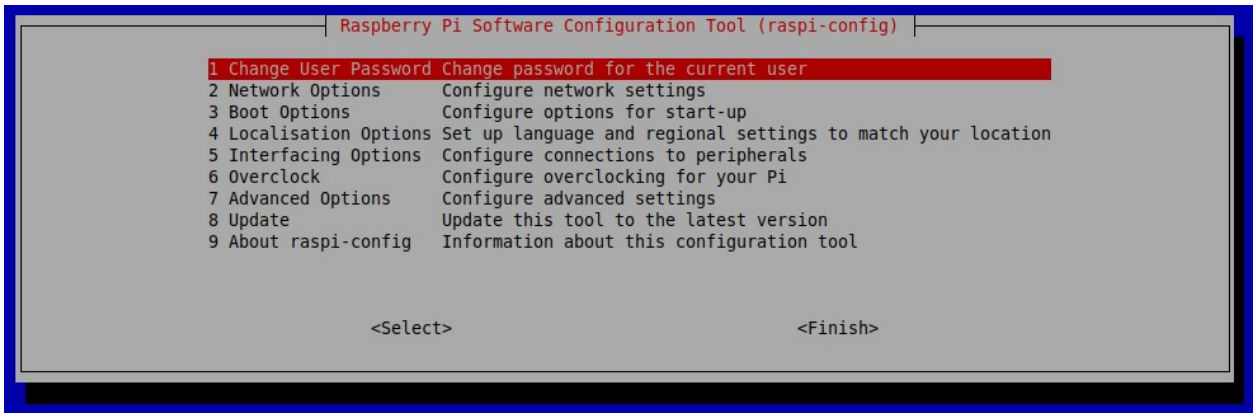
LINUX SETUP

RASPI-CONFIG

Another convenient setup tool is “raspi-config”. To run this, bring up a command prompt and type:

sudo raspi-config

The exact look and feel of this utility changes, so we won’t go into detail here. Please explore what you can do with it, but be careful! It makes important changes to the configuration!



AUDIO OUTPUT

Your Saguaro uses the headphone jack to feed its audio to the Saguaro controller. The audio output can be configured in several places to be either HDMI (0 or 1) or the headphone jack. One way is to right click on the volume control on the upper right side of the Linux taskbar. Another is to use the raspi-config tool above.

You can also change the default volume by sliding the control up and down. This is often how it’s done when ***not*** running the Saguaro control program.

We have also provided a way to use the front panel Saguaro knob to control the volume. To do so, bring up a command window and type:
cd /Home/Pi/DZKit
python3 volume_control.py
You can use this with many other programs that do not change the volume control themselves. Do ***not*** run this while running the DZKit Saguaro Receiver program. This (and Saguaro) are also available from the “Other” menu.

THEORY OF OPERATION/TROUBLESHOOTING

There are five main pieces of hardware in the Saguaro:

1. **Controller board**. This is a DZKit-designed circuit board with an Atmel Mega644P microprocessor that reads the front panel knobs and passes the information to the Raspberry Pi using the GPIO port. It also handles AC-DC conversion, Morse code keying and provides DC regulators for the various circuits.
2. **Raspberry Pi 4B**. This miniature computer runs the Linux Operating System ("Debian" Linux). It is provided with an SD card that has been imaged with the latest Raspberry Pi image and then had DZKit software added to it. It gets its 5V power from the controller board.
3. **SDRPlay RSP1A**. This SDR does all the work of receiving radio signals from 1kHz to 2 GHz. It sends I/Q data to the Pi via USB. It is powered through the USB port by the Raspberry Pi.
4. **Display**. This is a 1024x600 7" HDMI display with resistive touch capability. It gets its 5V power from the controller board.
5. **AC power supply**. The Power Entry Module (PEM), transformer and circuitry on the controller board accepts 100-240VAC and provides 12VDC.

AC Supply.

When properly configured for the input voltage based on country where it is used, the PEM provides AC voltage to the primary of transformer T1. The secondary is floating. An AC voltmeter should read an open-circuit voltage of 9-10 Vrms.

This AC voltage is fed into bridge rectifier D1 on the controller board. The full-wave rectified output voltage is then fed through relay K1, which defaults to the AC power supply. If a DC voltage of 12V is fed into the DC jack, K1 will switch to the DC input.

The selected voltage from K1 is filtered by C1/R1 and should read +11VDC.

The 12VDC output powers the audio amplifier directly, and is also fed into two LM350T 5V regulators (U1 and U4). The resistors in the feedback circuit of each regulator set them for 5VDC. These regulators have the positive output voltage on the tab, so the tab is protected from a short to chassis by a shoulder washer and Thermalsil insulator. Resistance from tab to chassis on each of these regulators should be about 475 Ohms.

Each regulator drives different

THEORY OF OPERATION/TROUBLESHOOTING

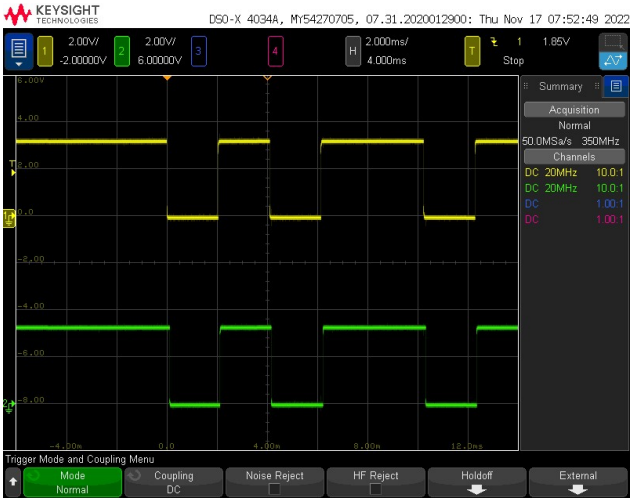
circuits. U4 provides 5V to the Raspberry Pi (and SDR via the USB port), and U1 drives the display, fan and 3.3V regulator.

Handshake
The Raspberry Pi's GPIO port uses 3.3V logic, so the controller's processor and related circuits run at 3.3V, provided by regulator U2.

The Atmel (Microchip) Mega644P microprocessor does two things:

1. **Reads the digital data** from the tuning encoder into PORTD, bits PD2 and 3) and the volume and RFG pots into PORTA (bits PA0 and 1) and passes the data over PORTC and two bits of PORTB, plus handshake lines LDAC (Low-true Data Accepted), LDAV (Low-true Data Valid) and LWR (Low-true Write) to the Pi's GPIO port.
2. **Runs the keyer**. Sidetone pitch and Keyer speed pots are fed into A/D converter inputs on PORTA (bits PA2 and 3). PORTA bit 6 is an enable/disable function to keep the sidetone oscillator quiet between code elements. The oscillator is always running, and a small amount of signal can bleed into the audio stream unless it is shut off.

The encoder requires 5V, so resistors R7-R10 are used to lower



each output bit to 3.3V.
A typical handshake looks like the above on a 2-channel scope: Top trace is LDAV, bottom is LDAC. The controller is master, and brings LDAV (Data Valid) low, after it has put data on the 10 data bus lines. This starts the handshake. When the Pi has read the data, it brings LDAC (Data Accepted) low. This causes the controller to bring LDAV high, which then causes the Pi to bring LDAC high.

The first data exchanged is a command, for which the 10 bit data will be 0, 1, 2 or 16. 0 indicates that the next 10-bit data will be AFG, 1 indicates RFG, and 2 indicates the optical encoder (256 = forward, 768 = backward). 16 indicates that a read will occur next. For a read operation, the data is dummy data and is ignored. Then the bus switches modes where LDAV indicates that

THEORY OF OPERATION/TROUBLESHOOTING

the *controller* is ready to accept data from the Pi, and LDAC indicates that data is ready. The data is simply keyer mode: 0 = Iambic A, 1 = Iambic B, 2 = Ultimatic and 3 = Manual.

Sidetone

The sidetone oscillator is an Analog Devices AD9833 programmable tone generator. It is controlled from serial data lines SDATA, SCLK and FSYNC, which come from PORTD, bits PD5-PD7. It gets its master clock from clock oscillator Y1, a 16MHz oscillator that also provides the clock for the microprocessor.

Keyer paddles are fed into PORTD, bits PD0 and PD1. An RC network on both lines helps prevent static zap from damaging the processor.

The main keying signal is LKEY (Low-true Key), generated from PORTD, bit 4 (PD4). It drives transistor Q1, which drives JFET Q2 through R5, R6 and C19, which provides a wave-shaping function so that there are no clicks in the audio. Q2's output shorts out the audio that normally is amplified by U6, an LM358, pins 1-3. This is a non-inverting op-amp with an AC gain of 2 and DC gain of 1. The positive input of U6 is biased at 6VDC, so that is also the output level. The output of the op-amp drives the other half of U6, which is used as an audio mixer to take the right channel of audio from the Raspberry Pi and mix it with the keyer sidetone.

Left and right channels of audio are then fed into quad power amp U7, a TDA7375 car stereo audio amp with low distortion. One output drives the left and right external speaker output, and the other two outputs drive the headphones. The right channel of the headphone output drives the internal speaker.

Troubleshooting

PORTA bit PA7 on the processor is an "I'm alive" signal. Place a scope on that pin to see if the processor is executing instructions. It simply toggles every 1.024ms.

If LEDs are not on, check the regulators to make sure they are working. If LED D3 is not lit, D5 will also not be lit, since regulator U2 gets its input from U1.

Input power consumption should be less than 2A at 12VDC and under 300mA at 120VAC.

The tuning encoder has a quadrature output, so you should see a square wave on each pin (1 and 3 on J5), and they should be 90 degrees out of phase with each other.

THEORY OF OPERATION/TROUBLESHOOTING

If the sidetone is not working, check to make sure U5 is soldered well and that serial control signals SDATA, SCLK and FSYNC are active.

Signals MOSI, MISO and SCK2 comprise an SPI bus for microprocessor programming and are not used except for factory programming of the microprocessor.

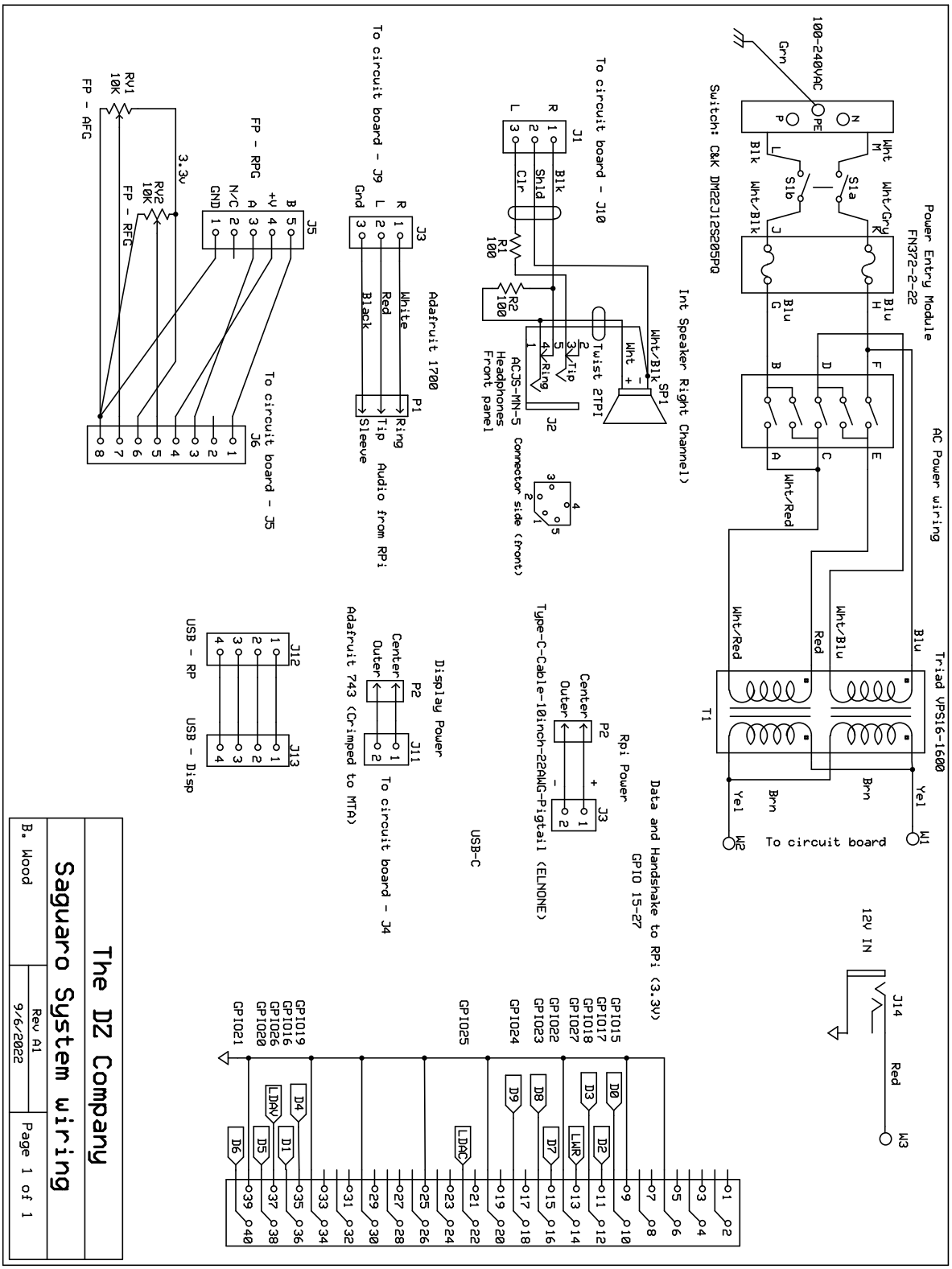
Software

The Python3 program that controls the SDR is broken into several sections:

1. **GUI**. This uses the "tkinter" library to draw all graphics.
2. **Handshake**. The data that is sent back and forth between the Atmel microprocessor and the Pi is handled by an interrupt routine called "LDAV()". When the LDAV hardware line goes high or low, the routine executes and completes the handshake, using the data to set the volume, the RF gain and the frequency.
3. **SDR**. The code to read the data from the SDR is handled in an infinite loop in a thread started by the main program. It reads ~129ms of data from the RSP1A, four "chunks" at a time, each buffer having 4032 I/Q data pairs (complex numbers), for a total buffer of 32256 complex numbers. That buffer is sent to the demodulator code which applies filters of different bandwidths based on operating mode, demodulates the data, converts it to a 16-bit integer (-32768 to +32767) for the sound card, then appends the resulting buffer to the first-in-first-out (FIFO) buffer that is being read by the audio thread.
4. **Audio**. This thread is also started by the main program, and its job is to send data to the sound system whenever requested by the driver.

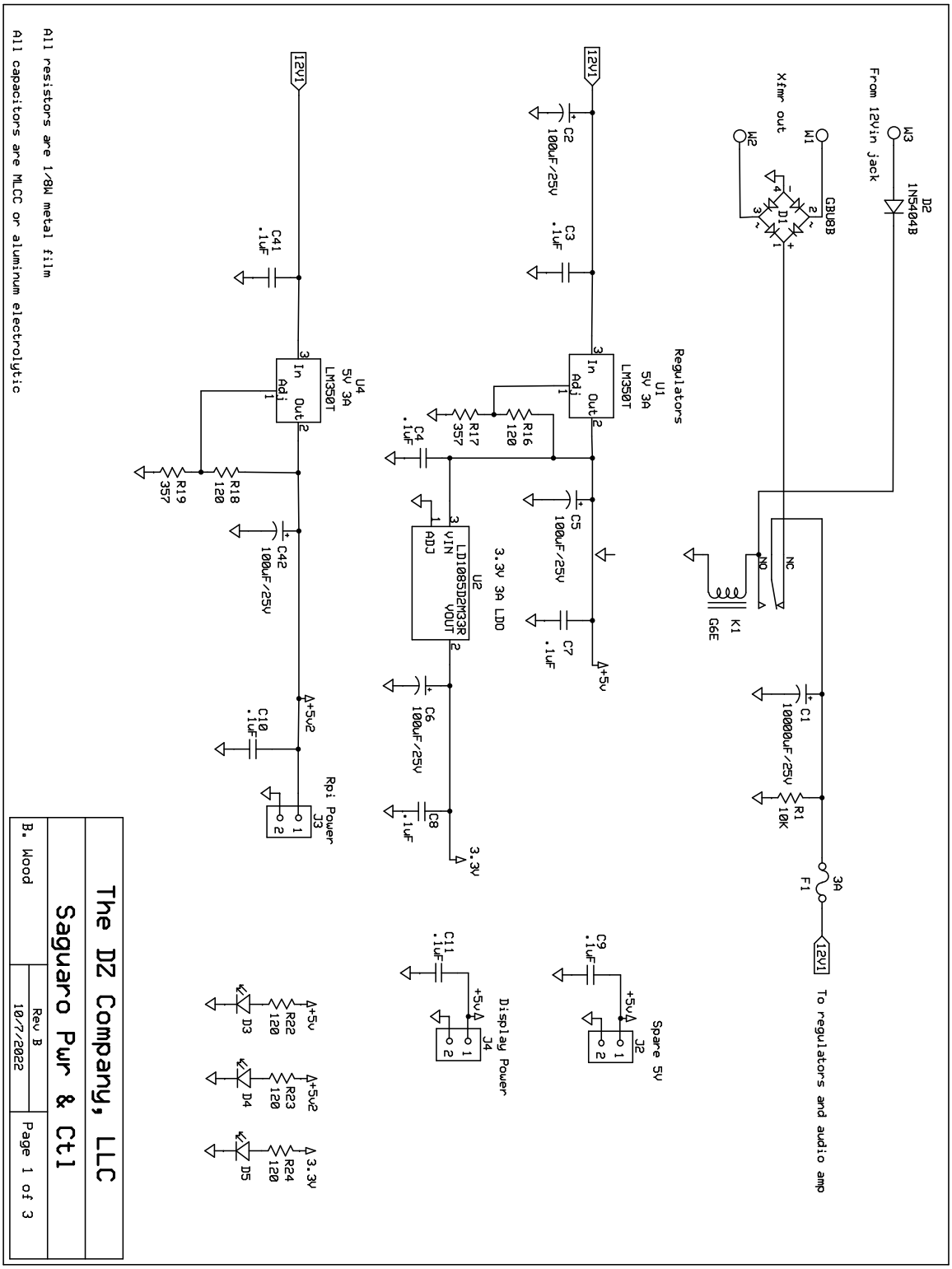
The Python code requires Python version 3.7 or later. It is open source. Feel free to edit it. Naturally we'd like to know if you come up with ideas to make the program better.

SCHEMATICS



The DZ Company		
Saguaro System wiring		
B. Wood	Rev A1 9/6/2022	Page 1 of 1

SCHEMATICS


From 12Vin jack
D2
1N5404B
Xfmr out
W1
W2
W3
GBU8B
D1
K1
G6E
NC
NO
C1
10000uF/25V
R1
10K
3A
F1
12V1
To regulators and audio amp
Regulators
U1
5V 3A
LM350T
In
Adj
Out
C2
100uF/25V
C3
.1uF
R16
120
R17
357
C4
.1uF
C5
100uF/25V
C7
.1uF
+5v
3.3V 3A LDO
U2
LD1085D2M33R
VIN
ADJ
VOUT
C6
100uF/25V
C8
.1uF
3.3v
Spare 5V
J2
C9
.1uF
+5vΔ
Display Power
J4
C11
.1uF
U4
5V 3A
LM350T
C41
.1uF
R18
120
R19
357
C42
100uF/25V
+5v2
C10
.1uF
Rpi Power
J3
D3
D4
D5
R22
120
R23
120
R24
120
All resistors are 1/8W metal film
All capacitors are MLCC or aluminum electrolytic
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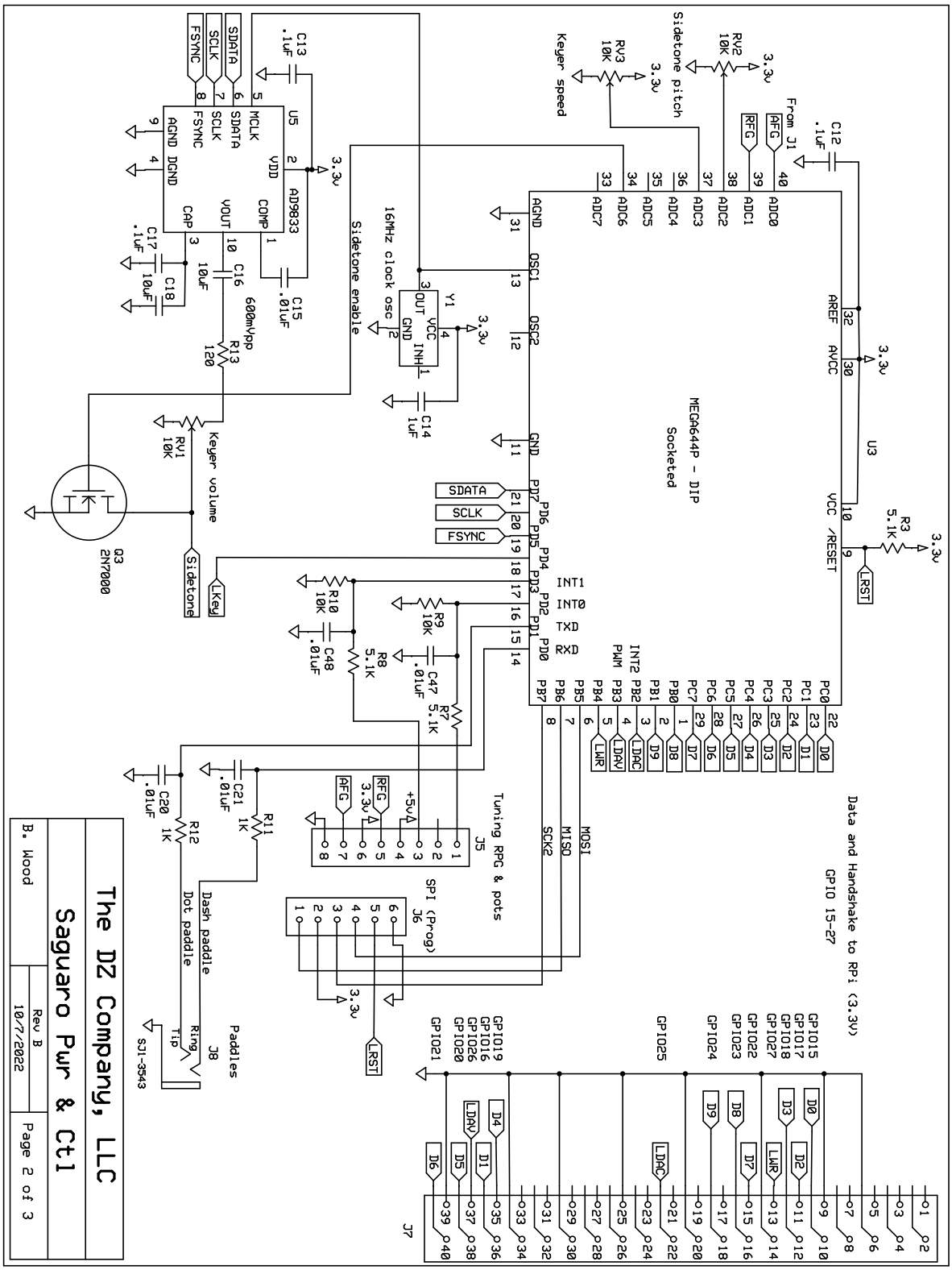
SCHEMATICS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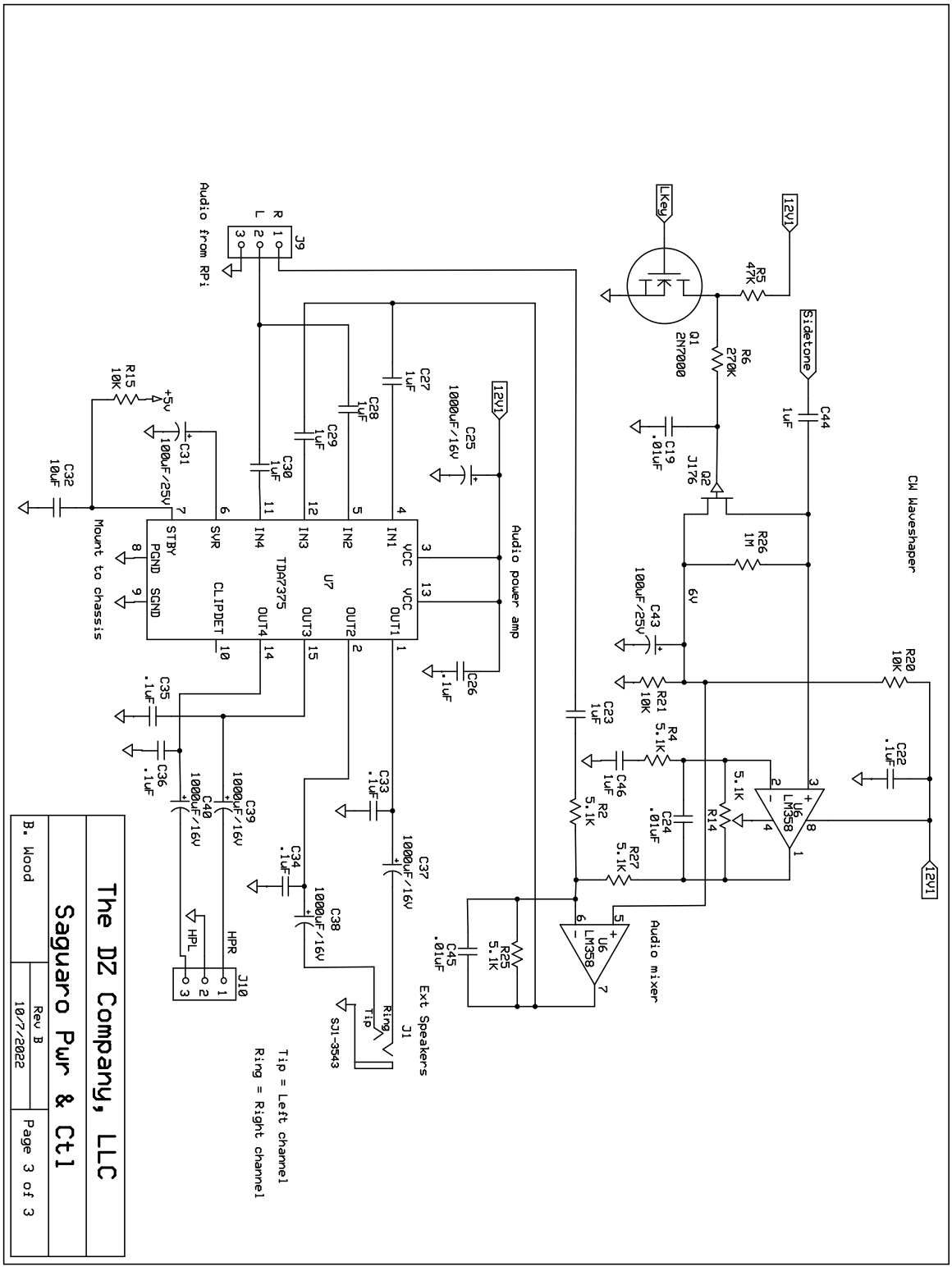
MEGA644P - DIP
Socketed
U3
Data and Handshake to RPi (3.3V)
GPIO 15-27
Tuning RPG & pots
J5
SPI (Prog)
J6
J7
Paddles
J8
Dash paddle
Dot paddle
Tip
Ring
SJ1-3543
Keyer speed
Sidetone pitch
Keyer volume
Sidetone enable
16MHz clock osc
600mVpp
AD9833
Q3
2N7000
From J1
SDATA
SCLK
FSYNC
LRST
LDAC
LDAV
LWR
INT1
INT0
TXD
RXD
INT2
PWM
MOSI
MISO
SCK2

SCHEMATICS


CW Waveshaper
Audio mixer
Audio power amp
Ext Speakers
Audio from RPi
Mount to chassis
Tip = Left channel
Ring = Right channel
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SPECIFICATIONS

RF Specs are identical to those of the SDRPlay RSP1A. See
https://www.sdrplay.com/wp-content/uploads/2018/01/RSP1A-Technical-Information-R1P1.pdf
(also included on the flash drive that accompanies this kit)

Receiver type: Software defined radio, 14-bit ADC, controlled by Linux-based PC

Operating system: Raspberry Pi OS (Debian Linux, rev 11.0, codenamed “Bullseye”)

Frequency Range of SDRPlay RSP1A: 1kHz-2GHz

Frequency coverage of Saguaro software:
- 200kHz-32 MHz (LF, MF and HF in 11 bands)
- 50-56 MHz (Amateur 6M in 2 bands)
- 75-108 MHz (Worldwide FM in 11 bands)
- (Other bands are planned in future software updates. To use other frequencies now, use CubicSDR software, included)

Headphone output impedance: 100 Ohms, suitable for low-Z headphones

External speaker impedance: 4 Ohms min, short-circuit protected, stereo

Connectors and Controls:
- Front panel: On/off, Volume, RF Gain, Tuning, plus mouse/touch control of dial pointer
- Software:
  - Mute, Page up/down, Save Frequency, Frequency resolution (1,10,100,1k,10k Hz), Mode (AM, FM, USB, LSB, CW-U, CW-L), Keyer mode (Man, Iambic A/B, Ultimatic)
- Touch type: Resistive, 3H hardness
- Back panel:
  - AC input (IEC-320)
  - 12VDC Input (2.1mm, center positive)
  - Chassis Ground
  - External speaker (3.5mm stereo minijack)
  - Keyer speed, pitch, volume potentiometers
  - Keyer paddles (pulled up to 3.3V, 1K input, 3.5mm stereo minijack)
  - Touch output: USB-A
  - External display: HDMI
  - Two USB 2.0, Two USB 3.0, One 1GB Ethernet
  - SDR IO: USB-B
  - Antenna: SMA, 50 Ohms, protected to +0dBm input level

Operating temperature: 0-40C

Operating voltage:
- 100-240 VAC, 50/60 Hz, 20W
- 10-14 VDC, 20W

Tube complement: none

IC complement: TDA7375AV quad 28W low THD audio amp, Microchip ATMega644P microprocessor, AD9833 DDS oscillator, LM358P audio mixer, CTS 16MHz clock oscillator, 2xLM350T 5V regulator, LD1085D2M33R 3.3V regulator

Dimensions: 12.5” W x 9.0” D x 5.25” H

Weight: 6.5 lbs

DZ COMPANY

LOVELAND, COLORADO

UNIQUE ELECTRONIC EQUIPMENT IN KIT FORM