DT3000 AM TRANSMITTER
PLANS, ASSEMBLY,
AND
OWNERS MANUAL

Version 001

DT3000
520-1720 kHz Inclusive

FOR REQUIRED PCB and PROGRAMMED CHIP CONTACT:

TransmitterPlans@GMAIL.com

Allow Up To 12-24 hours for a response, closed weekends, and Holidays

All offers may be withdrawn without notice.

WHAT YOU SHOULD AGREE TO BEFORE BUILDING

By building these plans you agree to be within a group of hobbyists, inventors, and other parties that design and build Part 15 transmitters with no intention of ever marketing them as complete units. The reason for this is that if completed kits are sold , the design needs to be tested by a certified laboratory to show the final product is in compliance with FCC regulations. As plans for those individuals described above, this testing requirement is precluded saving considerable expense. Many transmitters are being sold without FCC certification, these are all illegal to use despite meeting the advertised 100 milliwatt power rating. Without FCC certification, only plans and kits such as this are legal to build and use. You also agree to to employ good engineering practices in order to ensure compliance with the Part 15 standards during their construction or if ever modified. The suggested electronics are similar to or based on existing or past Part 15 compliant transmitters and should not be altered, particularly with a different antenna unless the antenna configuration is in accordance with FCC regulations.

For specific information and fines for non compliance may be found at:

https://transition.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet63/oet63rev.pdf

To fully comply with FCC regulations, you must permanently solder the antenna to the PCB board to prevent using other antenna configurations which are not approved. See page 6 of the document below for further details.

https://transition.fcc.gov/oet/ea/presentations/files/may17/32-Part-15-Antennas-Consolidated-KDB-Pub-353028-v2b_r1-TH.pdf

WHY THIS THESE PLANS ARE AVAIABLE

The these instructions provide a basis to start or advance your knowledge in the field of FCC compliant Part 15 Low Power AM (LPAM) transmitters in compliance with FCC regulations. This is accomplished primarily by building the plan per these instructions and taking the time to investigate how the circuits work operate. Learning to program the transmitter with an Arduino Nano will increase your programming skills as well.

WARRANTY

No warranty is written or implied as plans being assembled by individuals of varying skill level results can not be guaranteed. However the information herein is correct and accurate and created in good faith to create a quality transmitter when built with specified parts when created by a reasonably skilled electronic enthusiast. Technical support is not provided.

ABOUT THE DESIGN

Some aspects of this transmitter are based on the no longer available but well performing, popular, and durable SSTRAN AMT3000. At least one of these transmitters has been in constant use for over 20 years. Time progresses as does the electronic industry and associated technologies. Likewise, some parts are no longer available or not readily attainable. This transmitter plan offers several

improvements over the original AMT3000. Notably:

- Digital frequency generation instead of a crystal and PLL circuit
- An isolated audio input suitable for MP3 players and IPODs
- An OLED display indicating the frequency adjusted by a knob instead of the dip switch frequency changing system
- Basic antenna tuning / peaking via a front panel knob. Adjustment results are shown as VDC on the OLED readout on the front of the transmitter. This is an improvement over a capacitor on the board and using a voltmeter for peaking. However, this feature is not needed as the transmitter covers the range allowed by the FCC, 200' in one direction without adjustment subject to local conditions and setup.
- Use an Arduino Nano to reprogram the display and frequencies.

If desired, more extensive antenna tuning / peaking may still be performed via jumpers instead of a dip switch, the same as the original transmitter. Depending on your desired range, changing the inductor jumpers may not be needed and this feature is not typically available on other transmitters. Most other specifications remain the same including similar transmission distance to the AMT3000. It was found by the designer of the AMT 3000, Mr. Phil Bolyn that usable range was well over one mile and could be received over 2 miles by car radio under his local conditions. While the SSTRAN website still operates, plans for a high performance base-loaded vertical antenna may be found at:

http://www.sstran.com/pages/COMMON/sstran_buildant.html

Keep in mind however, the FCC indicates the maximum transmission distance should be no more than about 200 feet from the antenna. https://www.fcc.gov/media/radio/low-power-radio-general-information

The AMT5000, a more expensive transmitter was in some respects similar in design to the AMT3000. Many of the parts are difficult to obtain and while likely it was a fine transmitter, the additional cost of any of the features did not warrant inclusion in the DT3000 transmitter due to the likely marginal performance increase or updated design with the direct digital frequency synthesis.

THERE IS NO ASSOCIATION BETWEEN SSTRAN AND THESE PLANS AND FILES

This manual discusses features available at time of writing, however some features may be removed or not available as time progresses due to several reasons such as popularity, cost, and part availability.

MANUAL ERRORS

Though it is hoped this plan is perfect and has no errors, like most things in life, probably it is not free of errors. Kindly report them to the email on the front cover with a subject for the email “Manual Error”. Improvements and suggestions will be considered as well for the next release.

Manual Overview

Congratulations on deciding to build one of the most advanced LPAM legal transmitters available.

This manual contains sections which will lead you along the journey of ordering the additional parts required and instructions to build your Part 15 compliant LPAM transmitter.

Section 1 provides information on purchasing the parts you need

Section 2 contains information for organizing and identifying your parts

Section 3 contains a list of tools to build the transmitter

Section 4 provides instructions for inserting and soldering components, be sure to read this sections as some parts require specific orientation.

Section 5 contains information about the circuit board and locate where parts belong

Section 6 contains the step by step assembly instructions based on the transmitter components,; power supply, audio, digital display / frequency synthesis, and modulator / RF power output. This is the longest section with many steps containing check boxes to mark. Each section should be tested after assembly using the provided test procedure.

Section 7 contains final assembly checks

Section 8 contains some checks with power applied and some troubleshooting information should you have any problems

Section 9 contains information about mounting the assembled board and connecting the end panels to the connectors

Section 10 contains information on using the adjustments and setting the frequency, gain, modulation, compression, and peak voltage.

Section 11 contains information on manually tuning the conductors using peak voltage to obtain the possibly obtain better output signal

Section 12 contains information on the final installation, a reminder about the FCC rules, antenna considerations, grounding, and closing the case

Section 13 contains information about performance specifications as constructed and other related matters.

To get the most out of this manual, it would be a good idea to read the entire manual before doing anything associated with the transmitter.

Purchasing the Parts

This section contains about purchasing the required parts. There are 4 main sources for the parts:

The plans designer – Specialized parts required for building the transmitter, the PCB and programmed chip or Arduino.

Mouser and Digikey– Electronics part suppliers for the majority of the electronic parts easily ordered using their cart / BOM tools as explained. Be sure to read the section and review the alternative parts list for preferred parts, particularly L1, L2, and L3.

Amazon – Internet market place for non specialized electrical components such as the OLED display, peaking capacitor, and other common parts.

Feel free to use your own excess components or other suppliers should you find better prices and the parts may be interchanged. Be sure to verify your resistors and capacitors with a meter however.

The including these plans, the total cost to build the transmitter is roughly $200 plus relevant taxes and shipping. The price breakdown is as follows:

PCB and programmed chip, approximately $69 + shipping (Ebay and Etsy prices will be higher)

Electronics parts, Mouser / Digikey $100

Amazon Parts, $35

Printed 3D face plate and 5 knobs, $15-35 from https://www.etsy.com/shop/MakerChamber?ref=seller-platform-mcnav

Purchasing Custom Parts From The Plans Designer

To purchase the custom parts from the designer, send an email to:

TransmitterPlans@GMAIL.com

From the plans designer you will purchase:

- Required PCB
- Programmed computer chip

Schematics will be sent email if desired after purchasing the PCB and chip subject to copright laws not allowing transmission and distribution of the files to others. Other parts from the suppliers below on a limited basis may also be available at extra charge.

The designer may use PayPal or similar billing as the payment method. You will receive a link in the email to make the payment via PayPal or similar service, the parts usually ship priority or first class mail in a few days but may take up to a week or more depending on availability. Or purchase through Ebay or Etsy as usually available.

Having The Face Plate and Knobs Made

Contact https://www.etsy.com/shop/MakerChamber?ref=seller-platform-mcnav to order the desired part quality you want for theface plate and other components. Much more information is found below in a few pages.

Purchasing Parts From Mouser and Digikey

It is best to select Mouser or Digikey but not both due to the extra postage if two suppliers are used unless you must use both due to an availability issue. Both have outstanding customer service. Mouser and Digikey have all the parts not ordered from the designer and Amazon. Verify parts availability and price from both before ordering. Always refer to the manufacturer number as DigiKey and Mouser also have different part numbers for the same part but the manufacturer part is always the same. The download spreadsheet has parts from both suppliers with the manufacturer codes, simply delete the files from the supplier you will not use, or, save supplier files separately and compare the prices.

Digikey Parts

Open the combined spreadsheet for Mouser and Digikey and delete any parts for Mouser and save the spreadsheet as Digikey.

The import process is similar to that of Mouser explained below by creating an account, clicking on the shopping cart, click on Upload a File next to Manual Entry in red and following the prompts. Be sure to map the plan part numbers to the customer number during the uplaod or the bags will not be labeled with the parts for you to match the plans.

If you need any help call 800-344-4539, they are helpful and virtually no waiting. Most Digikey parts are the same as Mouser but not all, see the alternate parts list for specific Digikey parts. Mostly the resistors are different and a 47uH inductor must be used in place of a 56uH inductor. Ask them to help substitute parts if needed due to availability.

Mouser Parts

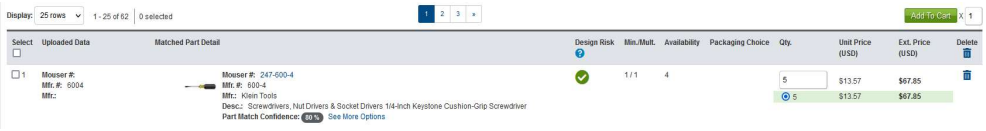
Below is a list of parts to order from Mouser with the manufacturer part number and specifications. Total cost is roughly $100 plus tax and shipping.

Similarly delete any DIGIKEY parts and save the spreadsheet as MOUSER. This may be uploaded as an xls file to Mouser to create a shopping cart using their BOM tool and creating a shopping cart to order from saving having to type in the part numbers. If some parts are not available after creating your shopping cart, see the section on Alternate Suppliers and Parts below. The board is designed to use more than one footprint in some instances for maximum flexibility in ordering parts, particularly for capacitors.

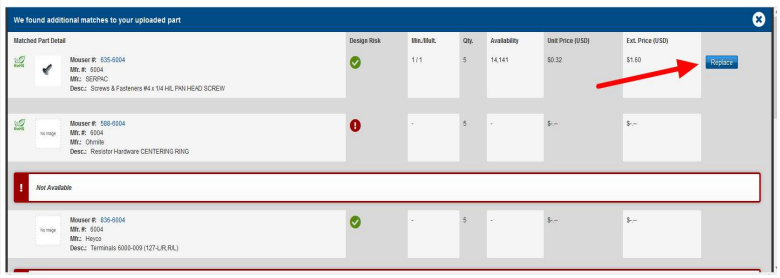
As an overview, to create your Mouser shopping cart and order the parts:

1. Create you Mouser account
2. Select Service and Tools on the webpage
3. Select the Forte BOM tool
4. Select Upload spreadsheet

5. Import the spreadsheet.
6. Select the mapping headers for Customer Number, Quantity1, and Manufacturer Number, should be automatic, but verify the headers.
7. Verify that the mapping tool worked properly and the correct parts are selected. The only known mismatch are the 1/4" PCB screws, rematch to select the screws in place of the Klein screwdriver shown below.



Make the indicated replacement shown.



8. Once the BOM is complete, click on the Add To Cart x 1. Then make the shopping cart and verify the parts are in stock indicated by "Ships Now" in the Availability column. If a part is not available, refer to the Alternate Parts section and search for the part in Mouser and replace the missing part with the part in stock making sure the leads are spaced properly, especially for capacitors. In some instances such as for the bipolar electrolytic capacitors, the alternative parts are less expensive than those in the BOM shopping cart, make changes as needed.

Mouser has excellent customer support, if you have problems creating the cart, or finding substitute parts, call them for assistance. 800-346-6873.

MOUSER PARTS LIST

Be sure to use the attached spreadsheet file and BOM tool when ordering. The customer number will be on the parts bag with the components and identifies the part number for the board and reference in this plan. Make sure you map the fields to Mouser correctly, take your time, it will save confusion when all the parts arrive. See the Mouser parts notes below, in some instances other parts are preferred if available.

Mfr. #	Manufacturer	Customer #	Description

6004	SERPAC	PCB screws	Screws & Fasteners #4 x 1/4 H/L PAN HEAD SCREW
CF1/4C221J	KOA Speer	R28 R29	Carbon Film Resistors - Through Hole 220ohms 5%
CF1/4CT52R473J	KOA Speer	R1 R2 R9	Carbon Film Resistors - Through Hole 47K ohm 5%
CF1/4CT52R105J	KOA Speer	R15 R20	Carbon Film Resistors - Through Hole 1M ohm 5%
CF1/4CT52R102J	KOA Speer	R21, R31	Carbon Film Resistors - Through Hole 1K ohm 5%
CF1/4CT52R472J	KOA Speer	R30	Carbon Film Resistors - Through Hole 4.7K ohm 5%
CF1/4CT52R103J	KOA Speer	R19 R32 R34	Carbon Film Resistors - Through Hole 10K ohm 5%
CF1/4CT52R220J	KOA Speer	R8	Carbon Film Resistors - Through Hole 22 ohm 5%
CF1/4CT52R101J	KOA Speer	R3	Carbon Film Resistors - Through Hole 100 ohm 5%
CF1/4CT52R511J	KOA Speer	R7	Carbon Film Resistors - Through Hole 510 ohm 5%
CFP1/4CT52R821J	KOA Speer	R18	Carbon Film Resistors - Through Hole 820 ohm 5%
CF1/4CT52R152J	KOA Speer	R17	Carbon Film Resistors - Through Hole 1.5K ohm 5%
CF1/4CT52R182J	KOA Speer	R27	Carbon Film Resistors - Through Hole 1.8K ohm 5%
CF1/4CT52R272J	KOA Speer	R4	Carbon Film Resistors - Through Hole 2.7K ohm 5%
CF1/4CT26A682J	KOA Speer	R10	Carbon Film Resistors - Through Hole 6.8K ohm 5%
CF1/4C153J	KOA Speer	R16	Carbon Film Resistors - Through Hole 15Kohms 5%
CF1/4CT52R273J	KOA Speer	R5	Carbon Film Resistors - Through Hole 27K ohm 5%
CF1/4CT52R303J	KOA Speer	R33	Carbon Film Resistors - Through Hole 30K ohm 5%
CF1/4CT52R224J	KOA Speer	R14	Carbon Film Resistors - Through Hole 220K ohm 5%
P160KN2-0EC15B100K	TT Electronics	R34G R36C FRONT	Potentiometers 16mm Rotary Panel Potentiometer
TY-142P	Triad Magnetics	T1	Audio Transformers / Signal Transformers AUDIO XFMR 10Kct:2Kct 4mADC 100mW PCB MOUNT/TY-142P

L7815CV	STMicroelectronics	Q6	Linear Voltage Regulators 15V 1.0A Positive
ECS-160-S-1X	ECS	XTAL	Crystals 16MHz SERIES
151-8003-E	Kobiconn	JUMPER	Headers & Wire Housings MINI JUMPER GF 6.0MM OPEN TYPE RED
24283	Keystone Electronics	STANDOFF	Standoffs & Spacers 4.5 HEX 10.0mm SS
1-2199298-9	TE Connectivity	IC1 BRD SOCKET	IC & Component Sockets 28P DIP SKT 300 CL LADDER
RCJ-034	CUI Devices	CN9 ANT CASE	RCA Phono Connectors RCA Connectors
4832.2300 (See Note 5)	Schurter	CN4 AUDIO CASE	Phone Connectors AUDIO SOCKET 3.5MM 3P SOL
L7805CV	STMicroelectronics	Q7	Linear Voltage Regulators 5.0V 1.0A Positive
P160KN2-0EC15B50K	TT Electronics	R35M FRONT	Potentiometers 16mm Rotary Panel Potentiometer
SSM2166SZ-REEL7 (See Note 4)	Analog Devices Inc.	IC3_AUDIO	Microphone Preamplifiers MICROPHONE PREAMP W/VAR COMPRESS
RCP-024	CUI Devices	ANT MALE	RCA Phono Connectors Plastic-Handled w/Strain Relief, Modular RCA Plug Connector
SSA-115-S-T (See Note 3)	Samtec	NANO HEADER	Headers & Wire Housings .100 Low Cost Socket Strip
SSA-107-S-T	Samtec	AUDIO / DDL HEADER	Headers & Wire Housings .100 Low Cost Socket Strip
PN2222TA	onsemi	Q2 Q3 Q4 Q5	Bipolar Transistors - BJT NPN Transistor General Purpose
2N4403BU	onsemi	Q1	Bipolar Transistors - BJT PNP Transistor General Purpose
K330J15C0GF5TL2	Vishay	C12 C13	Multilayer Ceramic Capacitors MLCC - Leaded 33pF 50V 5% C0G 2.5mm LS
K221J15C0GF5TL2	Vishay	C15 C27	Multilayer Ceramic Capacitors MLCC - Leaded 220pF 50V 5% C0G 2.5mm LS
K561J15C0GF5TL2	Vishay	C23A	Multilayer Ceramic Capacitors MLCC - Leaded 560pF 50volts 5% C0G 2.5mm LS
K102J15C0GF5TL2	Vishay	C17	Multilayer Ceramic Capacitors MLCC - Leaded 1000pF 50V 5% C0G 2.5mm LS

C315C821J1G5TA	KEMET	C23	Multilayer Ceramic Capacitors MLCC - Leaded 100V 820pF C0G 5% LS=2.54mm
2340-6211TG	3M	MALE PIN HEADER	Headers & Wire Housings 40P STRT 1 ROW GOLD
R1-23B	Shin Chin	CN8 PWR CASE BACK	DC Power Connectors DC POWER JACK PANEL MOUNT 2.1MM
1N4002-TP	Micro Commercial Components (MCC)	D1 D2 D3 D4	Rectifiers 1A 200V 140Vrms 200V 30A 1.0Vf 5.0uA 15p
1N914ATR	onsemi	D5 D6	Diodes - General Purpose, Power, Switching Hi Conductance Fast
UES1V471MHM	Nichicon	C4	470uF Aluminum Electrolytic Capacitors - Radial Leaded 35volts 85c 16x25 7.5LS
UES1V101MPM	Nichicon	C32	100uF Aluminum Electrolytic Capacitors - Radial Leaded 35volts 85c 10x20 5LS
UES1V4R7MDM	Nichicon	C18	4.7uF Aluminum Electrolytic Capacitors - Radial Leaded 35volts 4.7uF 85c 5x11 2LS
UES1V100MEM	Nichicon	C24 C25 C26 C29	10uF Aluminum Electrolytic Capacitors - Radial Leaded 2.5mm LS, 35volts 10uF 6.3x11
PC-11478	Bud Industries	CASE	Enclosures, Boxes, & Cases Plasticase Style I Plastic Case (1.6 X 7.9 X 4.8 In)
78F102J-RC	Bourns	L8	Fixed Inductors 1.0mH 5%
78F181J-RC	Bourns	L6	Fixed Inductors RF CHOKE 180uH 5% CONFORMAL COATED
78F471J-RC	Bourns	L7	Fixed Inductors 470uH 5%
78F560J-RC	Bourns	L4	Fixed Inductors RF CHOKE 56uH 5% CONFORMAL COATED
78F820J-RC	Bourns	L5	Fixed Inductors 82uH 5%
29301	Keystone Electronics	PEAK CAP SCREWS	Screws & Fasteners M2.5 6.0mm Screw Zinc Plated Steel
C315C103K5R5TA7303	KEMET	C14 C16	Multilayer Ceramic Capacitors MLCC - Leaded 50V 0.01uF X7R 10% LS=2.54mm
C320C104K5R5TA7301	KEMET	C1-3 C6-11 C22 C28	Multilayer Ceramic Capacitors MLCC - Leaded 50V 0.1uF X7R 10% LS=2.54mm LL=7mm
7447480102 (See Note 1)	Wurth Elektronik	L1 L2 L3	Fixed Inductors WE-TI RadXtnd Ld1014 WW1000uH .8A 1.15Ohm
PEC11R-4215K-S0024	Bourns	ENC1 FRONT	Encoders 15mm SHAFT w/SWITCH

LCQT-SOIC14	Aries Electronics	IC3 AUDIO ADAPTER	Sockets & Adapters SO Prototyp Adaptor 14 contact SOIC
WAU20-500 (See Note 2)	Triad Magnetics	AC ADAPTER	Wall Mount AC Adapters Wall Plug-In Pwr Supply, 20VAC@500mA, cULus, Center POS: 2.1mm diameter.***For Industrial and Commercial Use Only***

NOTE (1): Fastron 77A-102M-01 preferred if available. If you want to save some money and not bother with this additional filtering simply leave them out and use jumpers for S1, S2, and S3 and be sure to use the antenna ground.

NOTE (2): Most any 500 mA or similarly rated, 18-20v VAC or VDC 2.1mm plug diameter will work. Check surplus / thrift stores or your own stock to save money. The lower priced WSU180-0450-R available at both Mouser and Digikey as well.

NOTE (3): Not required if an Arduino NANO will not be used to try programming. On initial boards, Q6 may have to have leads bent to accommodate the mini USB connector.

NOTE (4): A good supplier that seems well stocked with these chips.
https://www.heisener.com/ProductDetail/SSM2166SZ

NOTE(5): In practice the female audio plug is not needed if you decide to use a audio cable with a male plug on the end to plug into the audio device. Simply solder the conductor that matches the part the jack furthest from the tip, the ground to the ground on the PCB as explained in the audio instructions and the positive conductors per the instructions as well. Tie a pigtail inside the case as to prevent stressing the connections if pulled. This way you will never have to search for a double male patch cord.

Amazon Parts

The following parts may be found on Amazon, total cost about $35 excluding tax, shipping should be included.

QUANTITY	DESCRIPTION	MFG	PART NUMBERS
1	223P capacitor	ACXIO	NONE LISTED
1	BNTECHGO 22 Gauge Silicone Wire 10 ft red and 10 ft Black Flexible 22 AWG Stranded Copper Wire	BNTECHGO	SW22G6008F10C2
1	FEMALE TO FEMALE BREADBOARD JUMPER WIRES BOTH ENDS 80 PIECES	GENBASIC	4330127279 B01L5ULRUA
1	0.96 Inch OLED Module 12864 128x64 Yellow Blue SSD1306 Driver I2C Serial Self-Luminous Display Board for Arduino Raspberry Pi Pico 0x3C address	UTRONICS	U602602 B072Q2X2LL
1	AD9833 Sine Square Wave DDS Signal Generator Programmable Microprocessors Serial Interface Module 1Pcs. Be sure to match picture in these plans.	XIMIMARK	8523715509

Case Front (Face Plate) and Knobs Details

The transmitter case uses some 3D printed case components in addition to the BUD box. There are two common methods of 3D printing, FDM and SLA. Essentially FDM uses a spool of plastic material passing through a heated nozzle resulting in a thin string of hot plastic precisely positioned to build up the object. SLA uses a liquid resin in a tank cured by ultraviolet lights to build up a model as the model is drawn up vertically.

SLA is more expensive than FDM and produces a smoother surface. Depending on your budget you may select either SLA or FDM for your face plate. Using FDM is the best price and finish trade off though upon close examination a uniform spaghetti / fingerprint appearance is visible and the resolution level can lose detail for letters. Knobs are usually FDM printed while the face plate, if budget allows is worth using SLA.

You will need 5 knobs and one face plate. Due to 3D printing variation some chamfering or opening of the inside diameter for accepting the knob shafts may be required to fit the knobs. A .240 drill bit seems to make a nice snug fit on the shafts. A drop of silicon glue may be used to secure the knobs as needed. There is also an option to use the white letters for the face plate, but this is often not worth the extra expense as most FDM printers do not use the small nozzle required for the detail and the result is not satisfactory.

There are several face plate and case options in order of expense from low to high:

1) If you wish to forego the expense of the 3D printing for the face plate and have a small rotary tool such as a Dremmel, have the knobs printed and use the rotary tool and a small file to cut a window to mount the OLED using the existing face plate which comes with the BUD case, but the process is time consuming. You will also need to drill .25” holes for the shaft of each control to protrude through the face plate and a total of 3 holes for the peaking capacitor. If this method is selected, be sure to look at the files using the slicer software below to provide an example of machining your face plate.

2) Same as #1 above but also have the printer make the bezel in FDM or SLA.

3) Print the face plate using FDM.

4) Print the face plate using SLA.

5) Do not use the BUD box and have the custom box top, bottom, and back printed FDM and the front printed with SLA .

With all options you will need to drill holes in the rear face plate in the spot toy want to mount the jacks. You will also be required to drill 3 holes in the back plate, for the audio connector .25” diameter, power .430”, and antenna .25” jacks. Of course if you use the RCA audio jacks, those will need to be drilled as well. And, of course you will need the 5 knobs previously discussed.

From an economics and time standpoint, the FDM face plate and knob print combination without the white letters is likely the best combination. Order the SLA face plate if looks are important to you however. All the face plates and knobs may be painted in a color of your choice as well. Flat black or a medium gray are usually a good selection.

The printer may be contacted at: sales@makerchamber.com

The prices offered are as follows and subject to revision:

SLA face plate alone $13.50 + $5.00 shipping (Shipping is $4.00 through Etsy)

FDM face plate alone $8.00 + $5.00 shipping (Shipping is $4.00 through Etsy)

Clam shell case in all FDM $21.00 + $8.00 shipping

Clam shell FDM top, bottom, and back with SLA face plate $31.00+$8.00 shipping

5 knobs $2.00 no additional shipping charged if part of clam shell or face plate order

5 knobs knobs alone $4.00 + $5.00 shipping (Shipping is $3.80 if they order through Etsy)

Bezel price – contact MakerChamber.

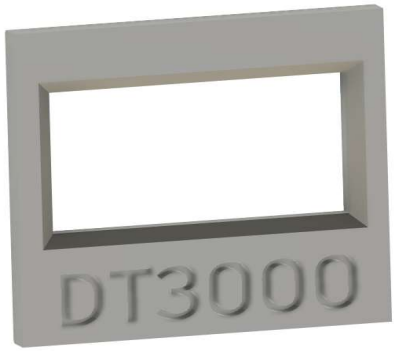
Or, contact through Etsy: https://www.etsy.com/shop/MakerChamber?ref=seller-platform-mcnav

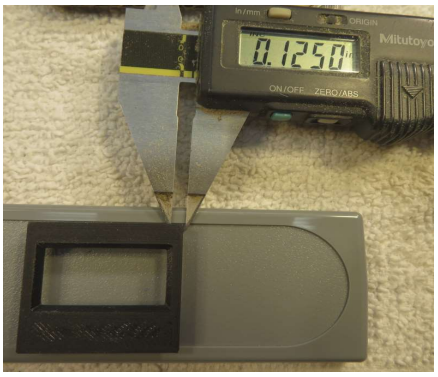
Face Plate and Knobs

The SLA printed front is free of spaghetti / fingerprint effect as would be expected, a fine face plate for the transmitter described in option #4.

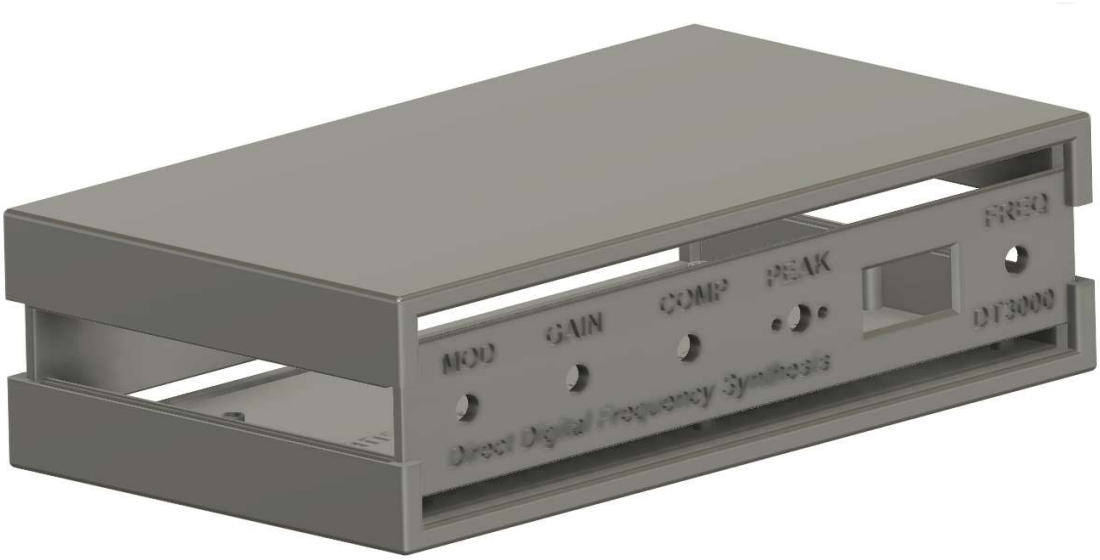
The following image allows a comparison between the FDM and SLA printing results. The FDM is the black face plate while the gray is the SLA face plate.

As discussed in option 2, the bezel for the BUD box face plate is shown below, remember, you will still have to be careful cutting the edges of the OLED window but you have the sides of the bezel to cover the cut. Each side is about 1/8” wide.





Option 5 is the completely printed custom case using FDM for the bottom, top and back while using SLA for the face. This is shown below with the clam shell top and bottom exploded.



Alternate Suppliers and Parts

Make use of any parts you currently have. Other sources include Jameco, Newark, and Arrow to name a few for any out of stock parts at Mouser or to find better pricing. Component prices will vary, but one supplier is best due to the extra shipping costs which usually negate any cost savings between suppliers. Ebay may be a good alternative to Amazon and in some cases to the electronic supply houses, particularly for the SSM2166SZ-REEL7 which is in limited supply at times through the supply houses.

The following table contains some parts and suppliers for some components.

DT3000 Part Number	Comment	Mfg#	Supplier
R28 R29		CF14JT220R	Digikey
R1 R2 R9		CF14JT47K0	Digikey
R15 R20		CF14JT1M00	Digikey
R21, R31		CF14JT1K00	Digikey
R30		CF14JT4K70	Digikey
R19 R32 R34		CF14JT10K0	Digikey
R8		CF14JT22R0	Digikey
R3		CF14JT100R	Digikey
R7		CF14JT510R	Digikey
R18		CF14JT820R	Digikey
R17		CF14JT1K50	Digikey
R27		CF14JT1K80	Digikey
R4		CF14JT2K70	Digikey
R10		CF14JT6K80	Digikey
R16		CF14JT15K0	Digikey
R5		CF14JT27K0	Digikey
R33		CF14JT30K0	Digikey
R14		CF14JT220K	Digikey
C4	470uF Electrolytic Alum, 35v, 20%, Dual Polarity,7.5 mm LEAD spacing, DIA 16mm H=26.6mm height maximum OR: 5mm LEAD spacing	UBT1V471MHD1TO 5mm leads) UBW1V471MHD	Varies

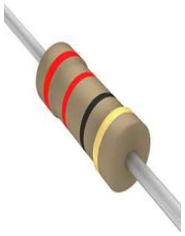
C32	100uF Electrolytic Alum, Radial, 35v, 20%, Dual Polarity, 10mm Diameter H=21.5mm 5mm leads OR: 2.5mm LEAD spacing	UBT1V101MPD8 (10x12.5, 5mm leads) UHV1V101MED1TD 6.3x12mmx2.5 leads	Varies
C18	4.7uF Electrolytic Alum, Radial, 35v, 20%, Dual Polarity, 5mm Diameter H=12.5mm 2mm leads (2mm leads only)	UVR1V4R7MDD 5x12.5 2mm lead	Varies
C24 C25 C26 C29	10uF Electrolytic Alum, Radial, 35v, 20%, Dual Polarity, 6.3mm Diameter H=11mm, 2.5mm lead spacing (2.5mm lead spacing only	UVR1H100MDD1TD 5x11x2.5mm LS ECA-1VM100I	Varies
L1 L2 L3	1000 uF	77A-102M-01 FASTRON (ALT preferred part if available) AIUR-06-102K (ALT2)	Varies
CN8	0.083" (2.10mm ID), 0.217" (5.50mm OD) POWER PLUG	PCL721A	Mouser / Digikey
L4	47uH Inductor substitute for 56uH	78F470J-RC	Digikey

Component Organization and Identification

Components from Mouser or DigiKey will be shipped in bags with the plan numbers (Customer ID).

Some inductors and resistors are similar in appearance, keep all parts on their respective sheets / parts bag until required per the instructions.

If you are unfamiliar with components, below are some enlarged examples similar (shape and color may vary) to the parts.



Resistor

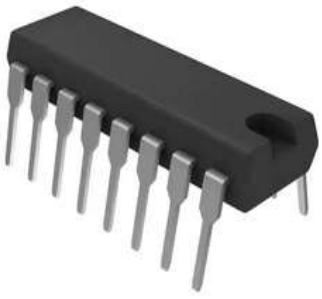
Multilayer capacitor

Ceramic Capacitor

Bipolar Electrolytic Capacitor

Polar Electrolytic Capacitor

Header



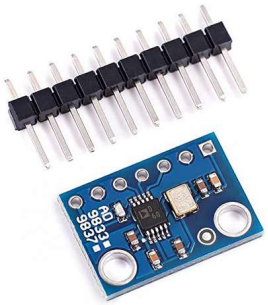
IC Chip

Decoupling Transformer

Voltage Peaking Capacitor

Fixed Inductor

Female Header



AD9833 Module

Tools You Will Need

To assemble the components on the board, verify you have the following tools at your bench. Order them off the internet or purchase them from a local supplier, even Micheal's or Hobby Lobby may have some of them.

- Low wattage (15-25) soldering with a fine pencil style tip
- fine rosin core solder, no acid core solder, or acid flux
- Small long nose pliers, two pair
- Flush cutting dykes or nipping cutters
- Multi stripping tool
- Small flat screwdriver with about a 1/8” flat blade
- Small #1 phillips screwdriver
- Solder suction desoldering tool and perhaps braided copper soldering wick
- Silicon or similar glue for attaching the OLED display to the bezel or case end
- Electric hand drill and some bits about .25”

Some Useful Information and Instructions

This section contains information to help you populate the board with the components in the best way possible assuring success in building your transmitter.

General Considerations

With the exception of transistors, all components should be seated flush with the board, pushed through until the base makes contact with the board. A few components such as diodes and transistors require proper orientation, these requirements are noted in the instructions.

With the exception of the IC chip there are two styles of components, axial where the leads generally pass through the axis of a cylinder and radial where radiate out of one side of the component.

Examples of axial components are typically resistors and chokes, you'll need to carefully bend the leads at right angles to fit through the PCB holes using your small needle nose pliers. For the resistors you will need to bend a 180 degree radius on one end using a small screw driver as a mandrel. This soldering configuration is shown below.

Other components typically include condensers and transistors. These components will only require minor bending of the legs to get through the holes in the PCB.

Soldering

If you are unfamiliar with good soldering technique, search for NASA-STD-8739.3.pdf. This is a good document to review. You'll need to solder similar to page 8-12 figure 8-18 in this document, the straight through termination.

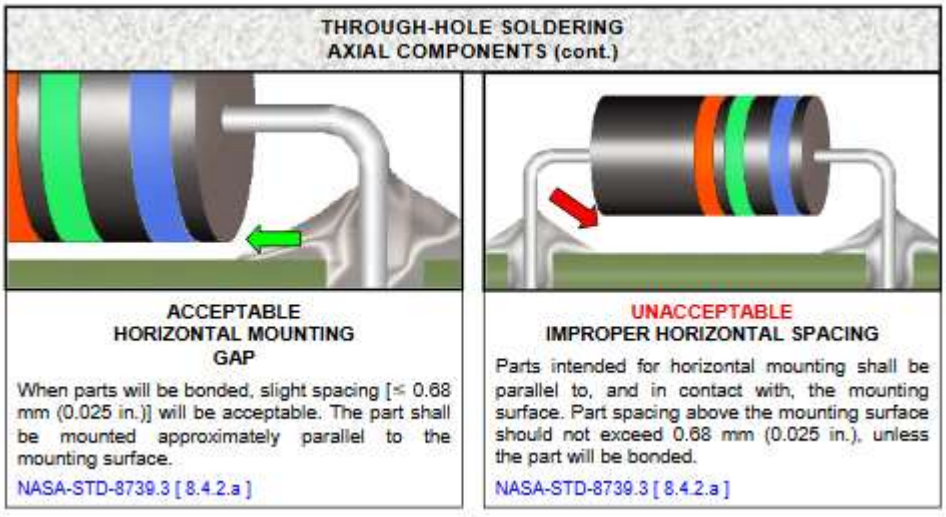
To solder three conditions are required; the parts must be physically clean, chemically clean, and the correct heat. The parts come physically clean of corrosion and dirt. The flux in the solder makes the two parts to be soldered chemically clean removing oxides exposing the bare metals. The proper heat melts the solder and heats the two parts so the solder bonds to the two metals usually the PCB connection and the component.

Be sure to clean the tip of your soldering iron frequently on a sponge soaked in plain water and wrung out and reapply solder to the tip to promote good heat transfer to the components being soldered. To learn more about soldering in addition to the above guide if desired search the internet for "NASA soldering guide."

If you have a problem with the transmitter working, it is likely a component was not soldered, or soldered poorly.

Placing Components Into The PCB

Select the component as instructed to place in the board first by bending the leads to go through the PCB holes using proper orientation if needed. If the component does not easily slide through the holes, rebend the leads as needed ensuring the component, except transistors are flush or very close to the board.

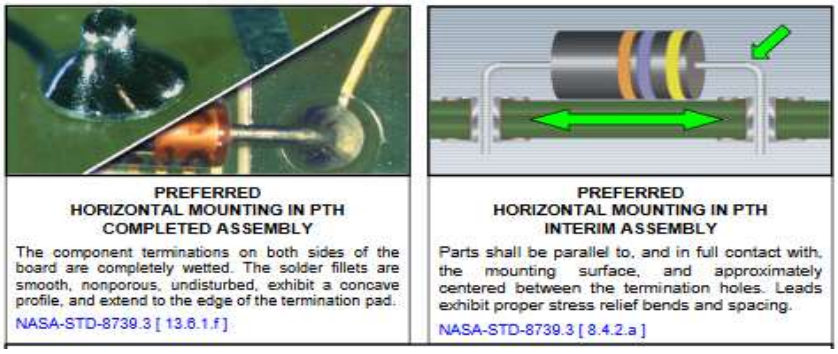


Once inserted through the board gently press the lead about 30 degrees from vertical outward. This will hold the component in place until soldered. It is wise not to place too many components at once as some soldering connections may be missed in the mass soldering. Perhaps 3 or 4 is a good quantity

of components to place counting the number of connections to be sure the count matches the number required. Most board problems may be traced back to missed soldering connections.

Tacking is another method of soldering to hold a component in place while the other connections are soldered. With a small bead of solder on the iron, lightly touch one lead with soldering iron to the PCB with the component in place, essentially forming a weak solder joint. Solder the other connections well, then go back and resolder the tacked connection.

Use the soldering technique s described above to solder the leads to the pass similar to as shown in the NASA pdf on page 8-12 figure 8-18. Once given a few seconds to cool, the flush cutting dykes are used to remove the excess lead material.



The Soldering NASA 609.pdf document has some good graphics of preferred work standards for soldering.

If a solder bridge is accidentally created, use the soldering tools or wick to remove the solder and resolder the connection if necessary.

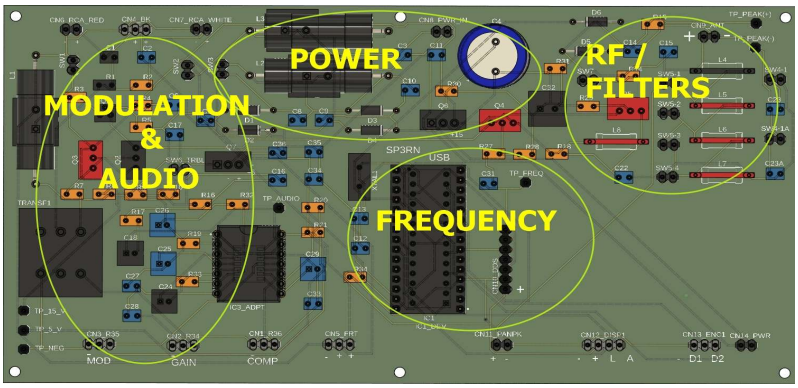
Though none of the transmitter components are particularly sensitive to the heat while soldering, if you ever have such a component on another project you can hold the component above the soldering location with the needle nose pliers to absorb the heat before it enters the component.

Eye Safety

Be sure to wear a pair of glasses particularly when cutting component leads off the back of the PCB after soldering them.

Getting To Know The Circuit Board

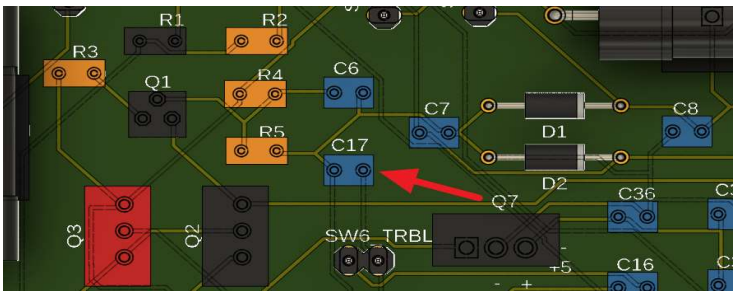
Your circuit board when populated is similar to the one shown below. The silk screening identifies the locations where you will place the components. Generally the components are located by transmitter function in the instructions below. Generally. Audio is the bottom left, frequency and the displays are mid center, RF / filter related components in the top right, and finally the power / filters section is the top center. Connections are on the back and front of the board.



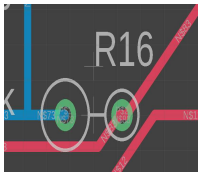
Assembly Related Information

When you start the assembly you'll find that the abbreviations found in the instructions match the board. For example placing capacitor 17, C17 in the instructions corresponds to C17 on the PCB which also corresponds to the labeling on the bag from Mouser. Take the components out of the bags one at a time and place them one at a time soldering each component to prevent confusion. Some components, the diodes are easily installed backwards / reversed. Be sure to read the instructions carefully and look at the component and board to make sure you have the correct orientation. The plan specifies non polar electrolytic capacitors where orientation does not matter, but proper orientation is a good habit to develop for electrolytic capacitors. Due to availability, polarized capacitors may have to be substituted.

In these instructions, resistors are shown in gold color and capacitors as blue.

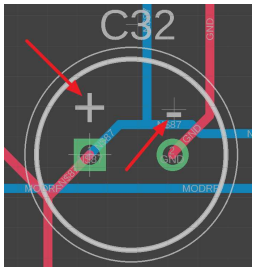


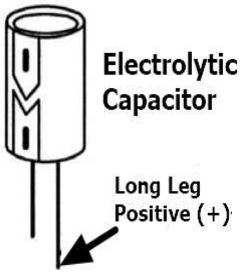
On the PCB resistors are mounted as shown as below, the lead for the body of the resistor is inserted into the wide circle while the formed lead is inserted into the smaller circle. However, the orientation if reversed will not affect operation.



All resistors are ¼ watt, and if by chance they become mixed up, verify them first with an ohm meter or by color bands. If you use your own resistors be sure first to verify the value before using it.

Likewise orientation for the electrolytic capacitors are indicated by the +/- signs on the board. You will notice one lead is longer than the other, the long lead is positive and should be inserted into the + hole and the short leg into the – hole. To minimize problems, use bipolar electrolytic capacitors and the orientation does not matter. None the less, to form good habits, insert the electrolytic capacitors as described to prevent problems using polarized capacitors on another project.

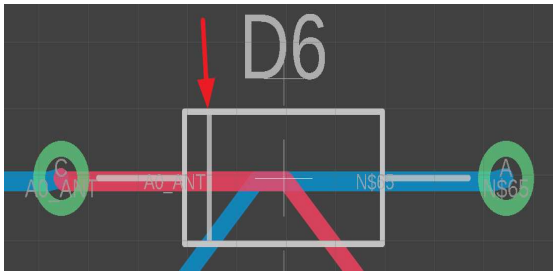




Insert diodes using the orientation for the band to match the circuit board. In the following graphic, the band on the diode would be to the left. Reversing a diode will cause the transmitter not to work.

The transmitter uses female / male bread board wire connectors to connect between the case ends with the controls and connectors to the PCB board headers.

You will need to cut off and discard the male ends, strip the insulation, and solder the wire to the control or connector which will go on a case end. The female end may then be slid over the header pin when assembling the case. Be sure to keep track of the wire colors you use and their connection location on the corresponding PCB header. This method is used as a cost savings over dedicated connectors and to assure easy case assembly and disassembly if needed.



The case uses small ears on the case ends to snap in place on the case body. Before using the case, practice putting it together and taking it apart a few times to become familiar with using it.

The IC chips for the audio and frequency control are static sensitive, be sure to work in static free environments and work with a grounding strap if available. If a ground strap in not available, frequently touch a grounded surface or device which uses a three prong plug which is in the receptacle such as the metal parts of a computer printer or a PC case. Work in a carpet free room if possible.

If the frequency control chip requires minor adjustment because the legs are splayed out, place one side of the legs of a flat surface and bending the entire row of legs at once. Then repeat for the other side. Work slowly and carefully taking care not to over bend the legs. Check the fit into the socket to gage additional bending if required.

After adjusting the legs gently and evenly push the chip into the socket. Once aligned properly, the chip will slide in.

If you need to remove the IC, use a small flat blade screw driver to pry up each end a little at a time as to not bend the pins on either end.

Finally, there is no need to force any components, if a component does not fit after bending, rebend the component leads so it easily fits in the holes on the PCB. Take the time to do your work neatly and professionally.

Other instructions and reminders are include in the step by step instructions which follow, and some are repeated several times.

Step By Step Assembly Instructions

This section contains the step by step instructions you'll following placing the various components on the PCB. Be sure to read the prior sections to ensure you create a well built transmitter.

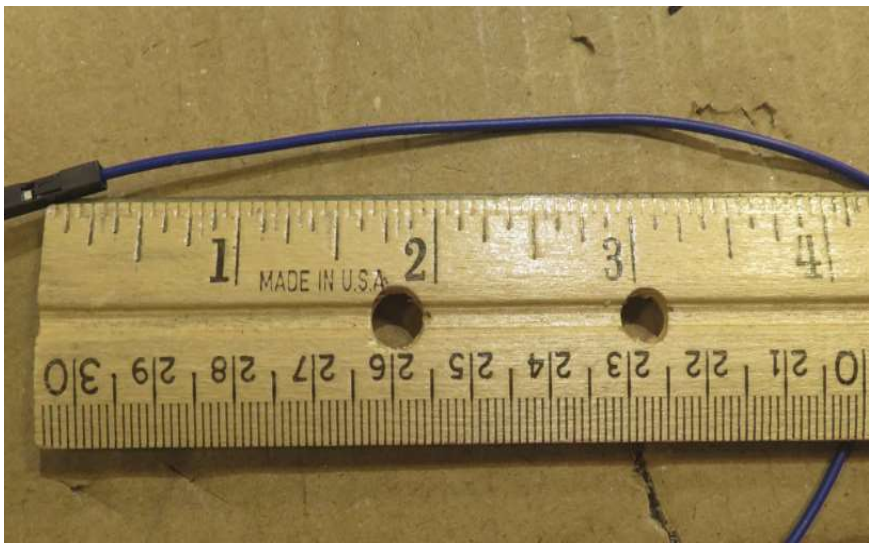
Leave each component taped or in the bag until you place it on the board and solder it in place.

Check off each component as you progress while installing the components. To aide in assembly, graphics are provided with component locations. As PCB revisions take place, some components may not be be located exactly where shown. Component locations in the following graphics you will be using as you progress are identified by light green colors, on the PCB you will see only the component identifier such as C17.

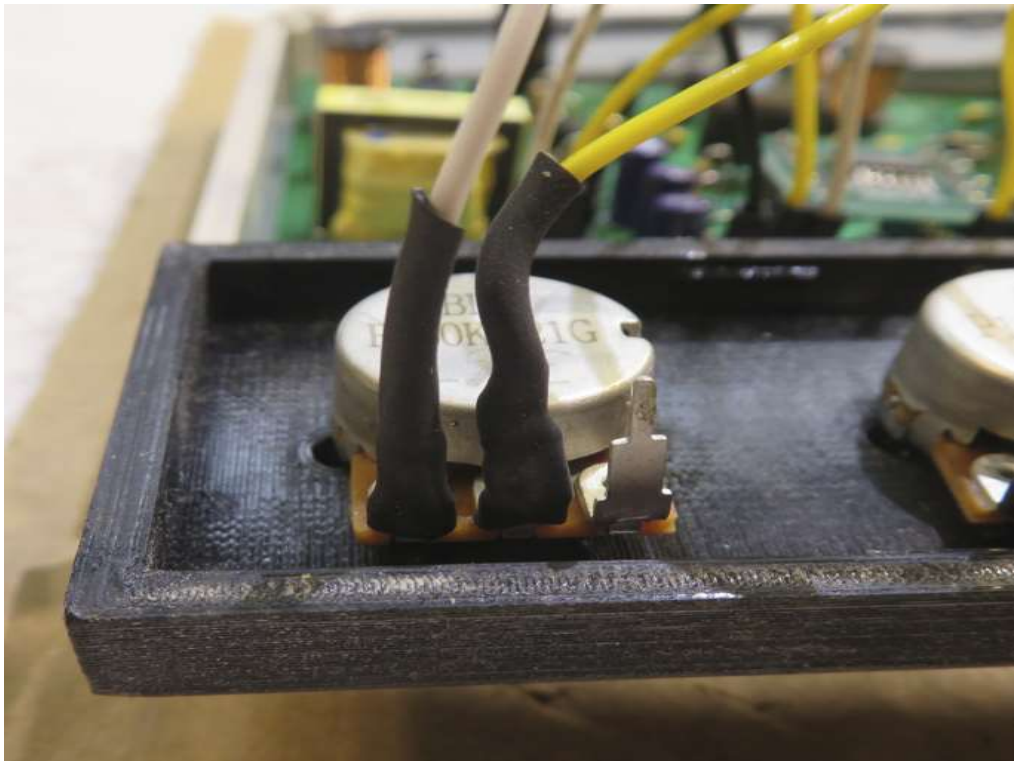
You should now be at your bench or soldering station with the parts organized by component value with your tools at hand. Be sure to have good lighting and take your time. A magnifying glass to inspect soldering is also a good tool to have whether a bench or visor mode.

In some instances you will be requested to use the female breadboard wires to attach a component to the PCB. The female connector is just a convenience. Unless otherwise instructed, make them about 4" long. If you do not have the female bread board wires, simply solder a wire to the pin and the component location as described being sure to use heat shrink as described below using two pieces of heat shrink per wire for each end.

Before soldering a wire, slide a piece of heat shrink about 1/2" long over the wire back about a few inches. Do this for each soldered connection using a bread board wire. When all the wire for a single component has been soldered, slide the heat shrink so it fully covers the soldering lug on the component and use a heat gun to shrink the heat shrink.



Use heat shrink as shown on all the wires attached to the front and back face place components as shown being sure to cover the lug so the heat shrink acts as a stress relief.



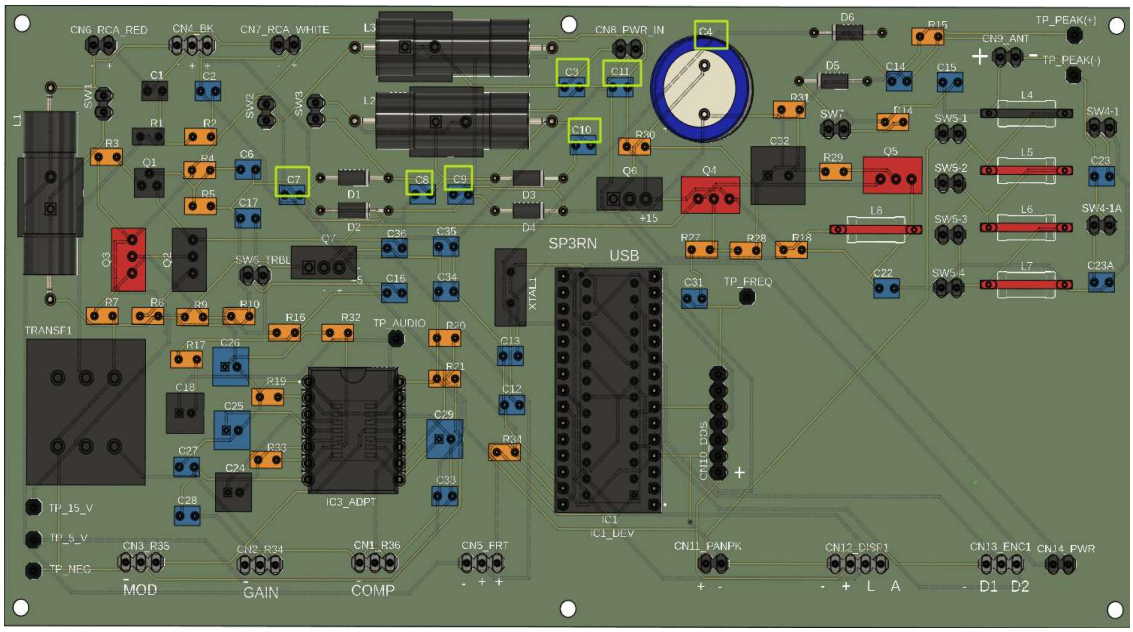
Remember, be sure to wear a pair of glasses particularly when cutting component leads off the back of the PCB after soldering them.

Power Supply Assembly

A wall transformer steps down household current to 18 volts alternating current. Diodes acting as rectifier separate the positive component of the sine wave if you selected an AC source. The DC voltage out is regulated by 5 volt and 15 volt regulators while a capacitor and inductor filter line noise. If the rectifiers (D1-D4) are installed backwards, negative 5 and 15 volts will be produced causing the transmitter not to transmit. Be sure to observe the correct diode orientation placing the diode band in the same direction as shown on the PCB.

Capacitors

Power capacitor locations are shown as follows highlighted in light green. Orientation does not matter for the small yellow ceramic capacitors. For C4, place the long leg in the + hole being sure it is flush to the board due to minimal case clearance.



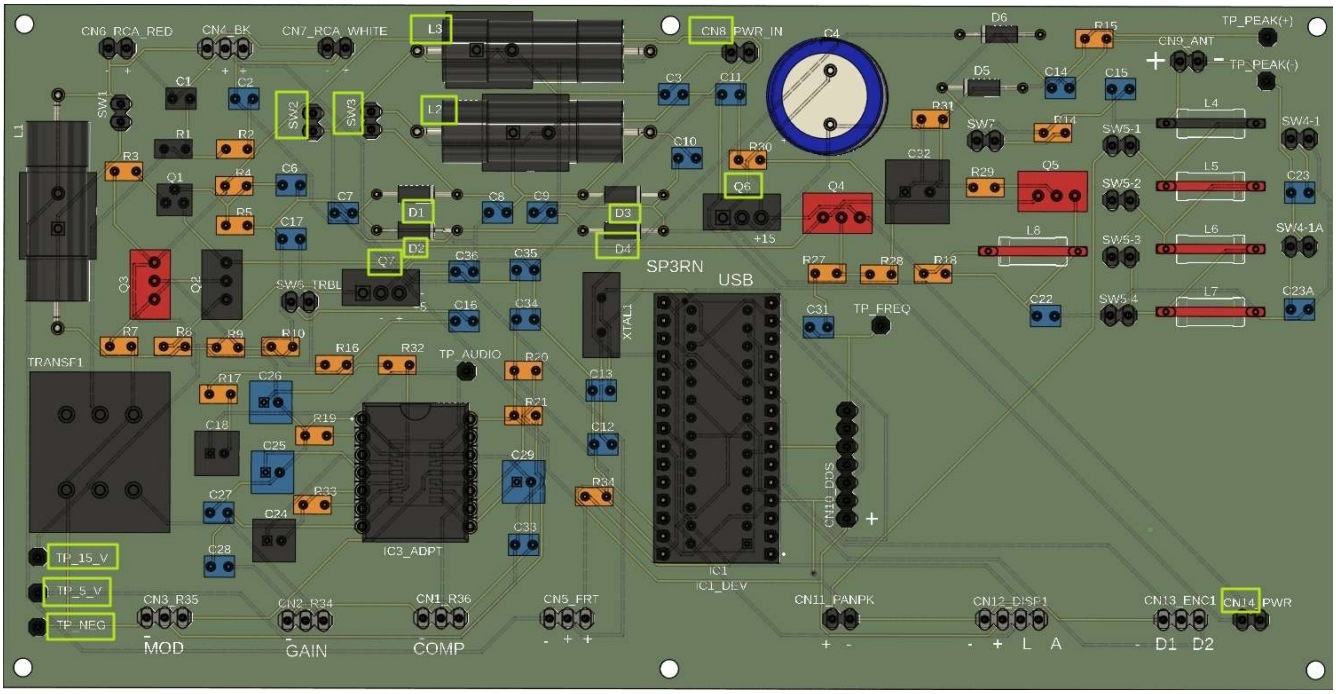
C3 .1 uF **C7 .1 uF** **C8 .1 uF** **C9 .1 uF**

C10 .1 uF **C11 .1 uF**

C4 (7.5mm leads, verify flush to PCB) or C4ALT (5mm leads) 470 uF

C4 may have 5mm (C4ALT) or 7.5mm (C4) leg spacing depending on availability, be sure to insert the long leg into the positively marked hole, particularly if using polarized capacitors.

Diodes / Power Regulators / Headers / Inductors

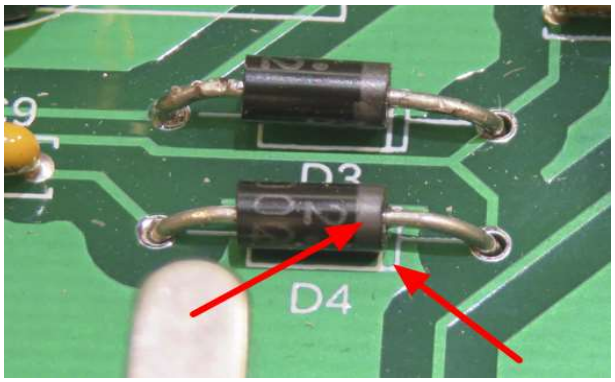


Install Q6 and Q7 the power regulators so the flat side is towards the back and the black is towards the PCB front as shown. On initial boards, Q6 may have to have leads bent to accommodate the mini USB connector.

Q6 l7815 **Q7 L7805**

Be sure to observe the correct diode orientation placing the diode band in the same direction as shown on the PCB.

⁀ **D1** ⁀ **D2** ⁀ **D3** ⁀ **D4**



If supplied as one strip, use a utility knife to create a 2 pin header for each SW2, SW3, CN_18, and CN14 by cutting the strip on the notched segments.

⁀ **SW2** ⁀ **SW3** ⁀ **CN8** ⁀ **CN14**

Place a female jumper over CN14. This connection may be used for a front mount power switch if ever desired.

⁀ **CN14**

Two different types of inductors my be supplied, axial or radial. If you decided not to use these filters, be sure to but jumpers over SW2 and SW3 now.

⁀ **L2 or L2 Alt** ⁀ **L3 or L3 Alt** **(Both are optional)**

If supplied as one strip, use a utility knife to create a 1 pin header for each TP_15_V, TP_5_V, and TP_NEG.

⁀ **TP_15_V** ⁀ **TP_5_V** ⁀ **TP_NEG**

Cut the male ends off two female header wires so the wire is about 4” long and remove the insulation. Solder the wires to the power connector, polarity does not mater as the input is AC.

⁀ **Power Connector**

Power Validation

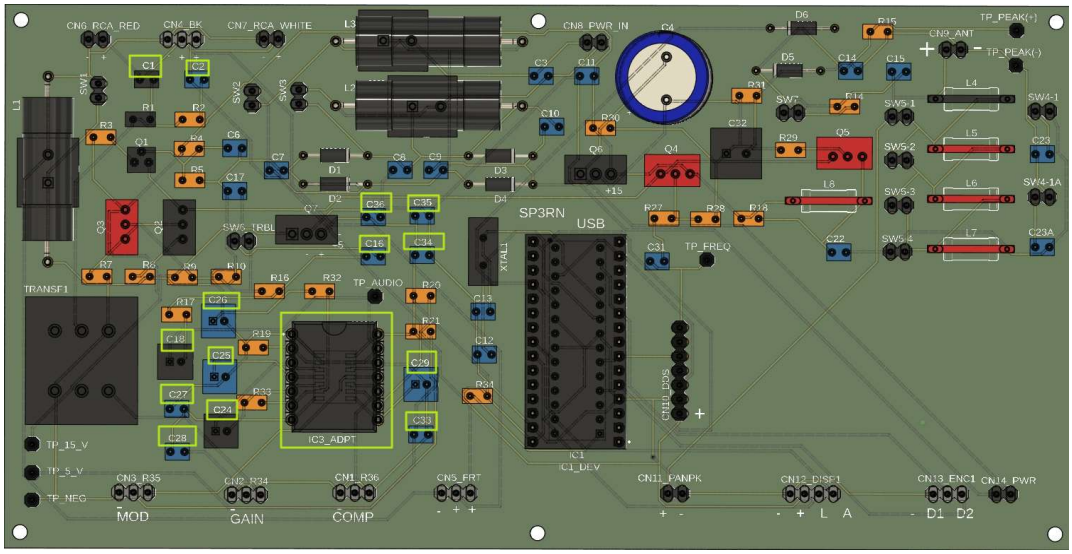
Connect the two female connectors from the case power connector to CN_8 and plug the wall transformer into an electrical 120v household receptacle. As this is alternating current, the connectors may be place on either header pin on CN_8. Using a multimeter, connect the ground to TP_NEG and probe TP_15_V and TP_5_V. The meter should read 15 and 5 VDC respectively. If a negative voltage shows on the meter your leads may be reversed or the diodes are backwards, if no voltage, be sure your receptacle has power, check the components you have in place, and verify they are in place and soldered well by reinspecting each solder connection visually and trying to wiggle the component. Verify the path of the electricity through the circuit. Verify you have the female jumper over CN_14.

When testing is complete, disconnect the power source from the transmitter power connector. Leave the jumpers on SW1 and SW2.

Audio Assembly

The audio section provides adjustments for gain, modulation, and compression. Though a small surface mounted device, the surface mounted audio chip is relatively easy to solder on the 14 pin adapter. Search the internet on an instructional video if needed.

Audio Chip / Adapter and Capacitors

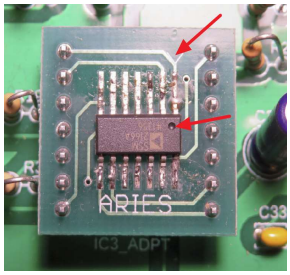


Soldering the Audio Chip On The Adapter

The audio chip is static sensitive. If working on carpet or similar material, wear a grounding wrist band if available.

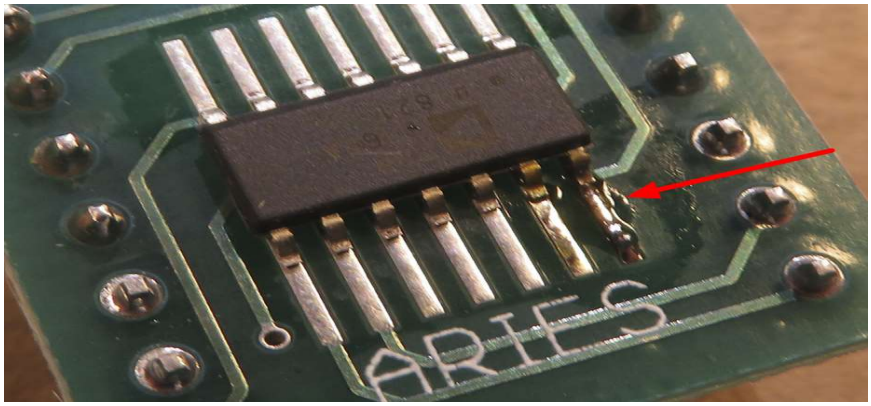
Two other items will help you, CHIPQUICK flux and especially the copper wicking solder removal ribbon.

On both the adapter and chip you will notice there is a dot, these need to be oriented to each other to assure pin 1 is in the proper orientation. This is shown below.



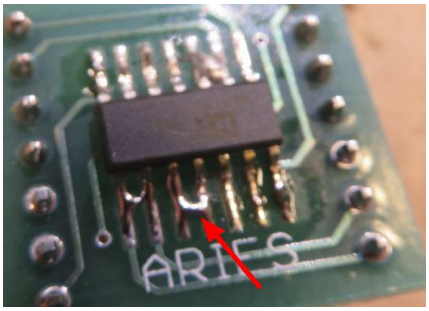
Place the IC on the board aligning the IC leads over the pads on the adapter.

Place a small amount of solder on the iron tip and while holding the chip in place with your finger or a small flat screwdriver and tack one corner of the chip to the pad. No need to worry about bridging pins at this point. There is variability in the dot for pin one. The dot may be printed and more difficult to see as in the case of the chip below.

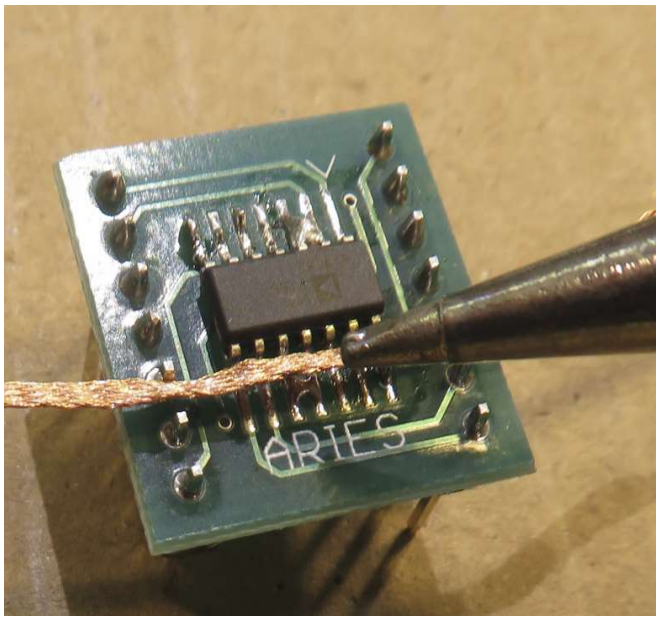


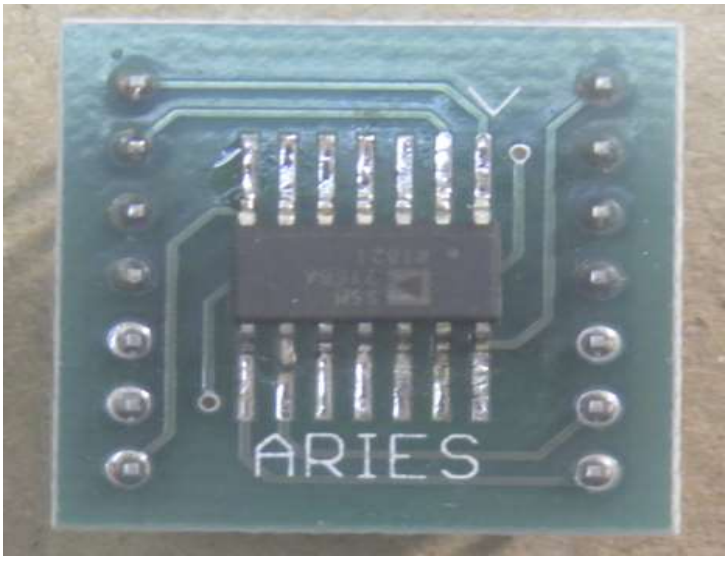
Check the alignment, and if satisfied, tack the diagonal corner of the chip to the pad, then the diagonal corner in the same manner.

Solder one compete side using a small amount of solder on the tip for each pad, don't worry about a bridge between the pads as shown, alignment is all that matters.



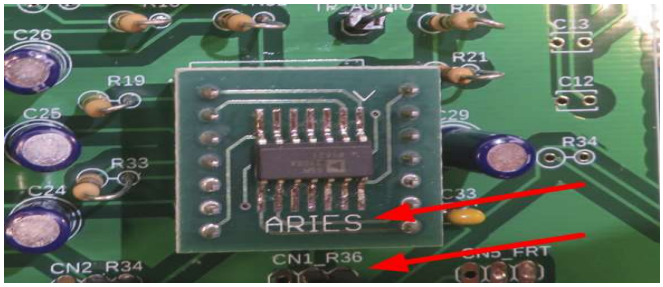
If the solder has bridged, remove any solder from the iron and touch the soldered pad. If you have braided copper soldering wick, lay it over the pads on one side and touch the soldering iron to the wick and any excess solder will be absorbed by the wick removing the bridging.





⁀ **Solder Audio Chip to Adapter**

Place the 7 pin female headers on the adapter audio adapter pins, align the adapter for pin one on the PCB and solder the pins on bottom of the PCB. The adapter pin orientation should be as shown above in the soldering section picture, with the ARIES text oriented right side up closest to you. Use the board marking IC3_ADPT in the picture to assure your orientation is the same.



Place Female Headers, Align, and Solder To Board

Electrolytic Capacitors

Place the long leg into the positive hole indicated on the PCB and mount flush to the board. These are all located near the audio chip, and mostly on the left side. Due to availability, polarized capacitors may have to be used, so positive long leg orientation should be followed.

◯ **C18 4.7 uF** ◯ **C24 10 uF** ◯ **C25 10 uF** ◯ **C26 10 uF**

◯ **C29 10 uF** ◯ **C32 (5mm leads) C32ALT (2.5mm leads) 100 uF**

Ceramic Capacitors

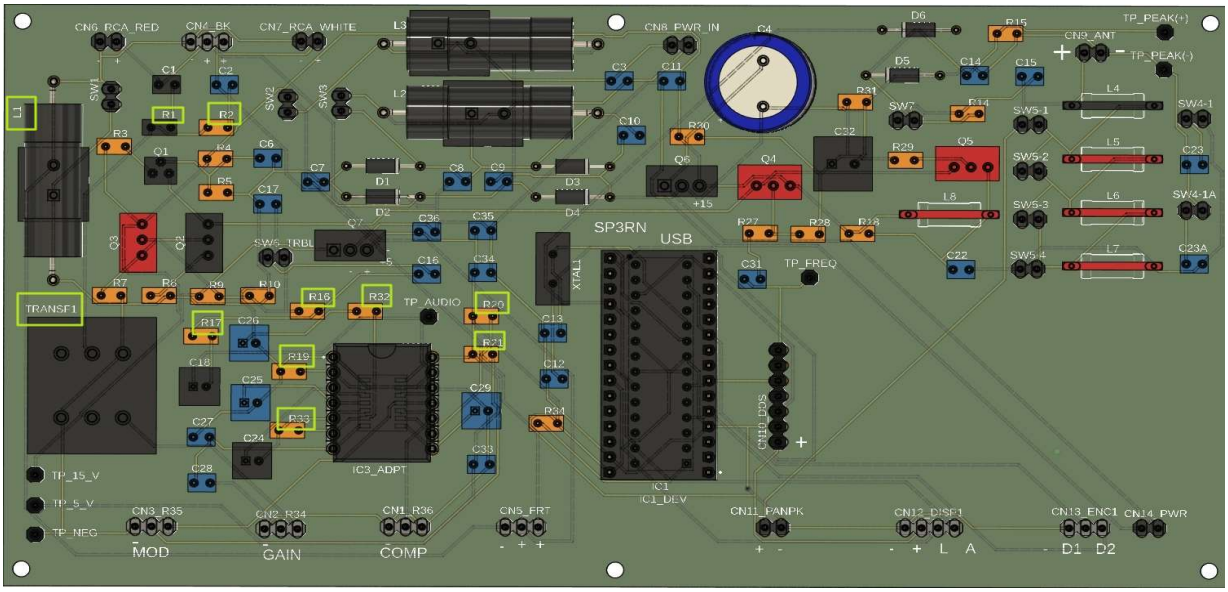
◯ **C27 200 pF** ◯ **C16 .01 uF** ◯ **C28 .1 uF** ◯ **C33 .1 uF**

◯ **C34 .1 uF** ◯ **C35 .1 uF** ◯ **C36 .1 uF**

◯ **C1 .1 uF** ◯ **C2 .1 uF**

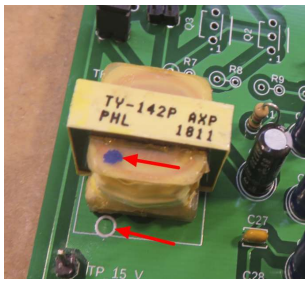
Transformer, Inductors, and Resistors

Remember to prebend the resistors as shown with a small screwdriver shaft as a mandrel creating a radius.



- ⁀ **R1 47k ohms**
- ⁀ **R2 47k ohms**
- ⁀ **R16 15k ohms**
- ⁀ **R17 1.5k ohms**
- ⁀ **R19 10k ohms**
- ⁀ **R20 1 meg ohms**
- ⁀ **R21 1k ohms**
- ⁀ **R32 10k ohms**
- ⁀ **R33 30k ohms**

Mount the transformer so the dot on the board and the dot on the transformer align.



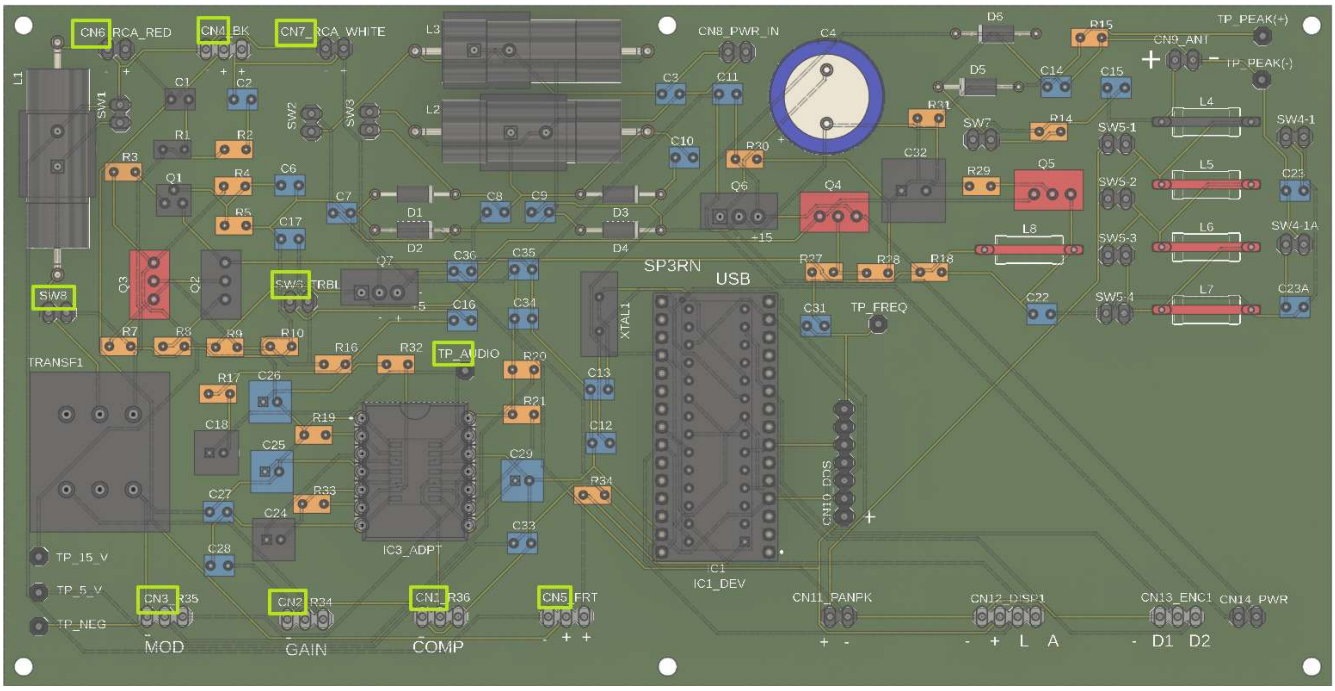
⁀ **Transformer**

Mount the inductor, the orientation may be in either direction.

⁀ **L1 (Optional if you decided not to have audio filtering)**

Audio Headers

The transmitter requires 5 three pin headers, 7 two pin headers, and 1 one pin header in this section. Use a utility to score and cut the headers if needed.



Three Pin Headers

CN1 **CN2** **CN3** **CN4**

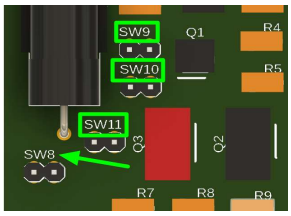
CN5 (Optional if not using front 3.5mm phono jack)

Two Pin Headers

CN6 **CN7** **(Optional if not using RCA Jacks)**

SW6 **SW8** **SW1 (Not shown, just in front of CN6)**

Near SW8 (Not Shown above, see detail below), ⁀ **SW9** ⁀ **SW10** ⁀ **SW11**



One Pin Header

⁀ **TP_Audio**

Audio Variable Resistors and 3.5mm Phono Plug

These components are mounted in the front and rear of the case on the end panels.

As you take the variable resistors out of the packages, label the back of the variable resistor with the component number to prevent confusion as all 3 look the same.

Cut 2 sets, 2 each of the header connection female wires removing the male end so the length and the attached female end remains on each wire so the wire is about 4” long, remove about 1/8” of insulation. Cut a 1/2” piece of heat shrink to slide over each wire before soldering. These are for R35 Modulation, and R36 Compression. If the lugs are vertical when looking at the flat end of the shaft where the knob will eventually slide on, that is, at 90 degrees to the shaft, use the needle nose pliers to bend the lugs 90 degrees or slightly more towards the back of the control so the lugs are parallel to the shaft as shown below.

Solder the wires onto the with the shaft facing you as noted below. The negative (-) header pin, the most left pin is not used on the PCB For R35 and R36. Connect the wires to the PCB using the two right header pins, which is which does not matter.

⁀ **R35 Use the left and middle lugs as shown above on the left**

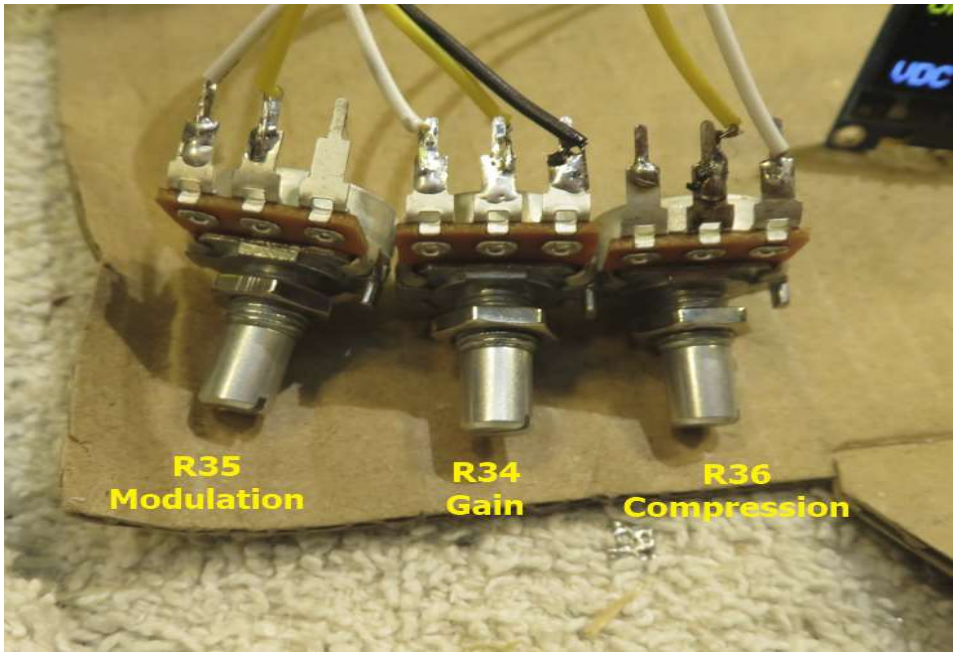
⁀ **R36 Use the right and middle lugs as shown above on the right**

For R34, Gain, cut 1 set, 3 each of the header connection female wires each with different colors removing the male end so the length and the attached female end remains on each wire so the wire is about 4" long. Cut a 1/2" piece of heat shrink to slide over the wire before soldering. Remove about 1/8" of insulation and solder the 3 different wires on the control lugs, same as just done for R35 and R36. See the soldering graphic below, notice the black ground wire is on the left.

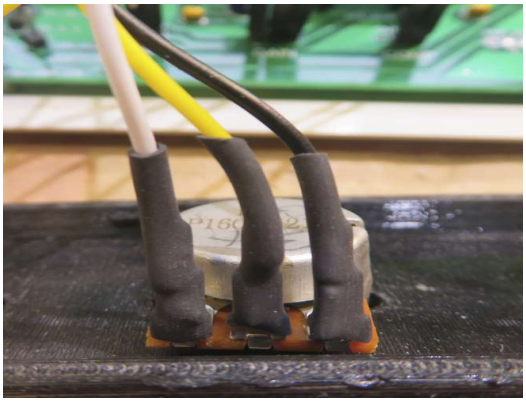
With the shaft facing you, connect the wire on the right side of the control to R35 male header with the negative (-) symbol on to the PCB, the negative symbol may be on either the right or left side depending on PCB version. The middle wire connect to the middle male header, and the last wire to the remaining header. Check to make sure you did it correctly as unlike R34 and R35, this order matters because R35 uses the ground.

⁀ **R34 Per above description verifying negative (–) symbol on PCB for most right lug**

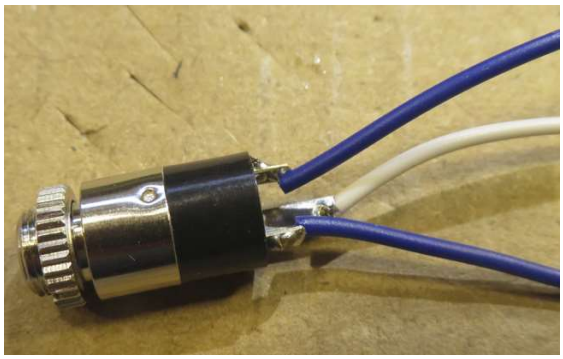
When you have R34, R35, and R36 all soldered they should be similar to the following:



After the heat shrink is slid over the lug and shrunk with a heat gun each potentiometer should be similar to the the following picture, R34 is shown as an example.



If you decide to use the female phono plug in place of a soldered male patch cord, create 1 set of 3 wires, 2 may be the same and one different for the 3.5 mm phono jack and solder the female header wires to the connector placing the one different color wire to the ground pin on the connector, the long pin as shown. Make the wires about 4” long and slide the 1/2” of heat shrink over each wire and shrink after soldering.



CN7

If using the optional front mounted 3.5 mm jack, cut a second set of female header wires a described and drill a hole in the front cover at the desired location to mount the female phono jack. From Mouser or Digikey order Schurter part number 4832.2300 or equivalent. Connect the female connectors to CN5 as described above.

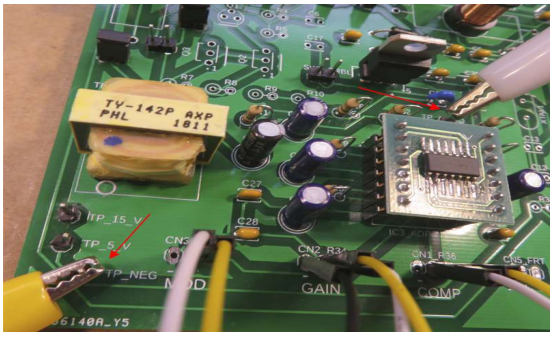
(OPTIONAL RCA JACKS)

If you wish to use the optional RCA jacks, cut 2 sets, 2 wires in a similar fashion to above. Drill two holes in the back of the case end at the desired locations to mount the RCA jacks. On the PCB the polarity for the jacks is marked. The center of the jacks are the positive connection. From Mouser or Digikey order parts CUI RCJ-033 and RCJ-032 or equivalent. You will need to drill two holes in the rear panel in a convenient location to accommodate these jacks. Use the heat shrink in a similar way as with the back connector.

Audio Validation

Place jumpers on SW1, SW8, SW9 and SW10. Remove a jumper if one is on SW11.

Connect an audio device such as an MP3 player to the female phono jack playing music using a double ended male patch cord. Using a pair of ear buds and alligator clip patch cords, connect one alligator clip to the shaft of the earbud male connector closest to the cord side connector (ground) and the other alligator clip to the TP_Neg pin on the PCB. Connect the other patch cord to the TP_AUDIO test pin and the other end of the patch cord to the tip of the male earbud male jack. Connect the power cord to the transmitter. The board connections with alligator clips are shown below, yellow is earphone negative, white is tip



Adjust the modulation and gain knobs all the way clockwise, and the compression knob all the way counter clockwise.

You should hear faint audio on from the earbuds on one side. If you don't, some audio jacks do not make good contact, verify at the female audio jack there is a signal by connecting one lead to the long ground pin and probe the other two pins.

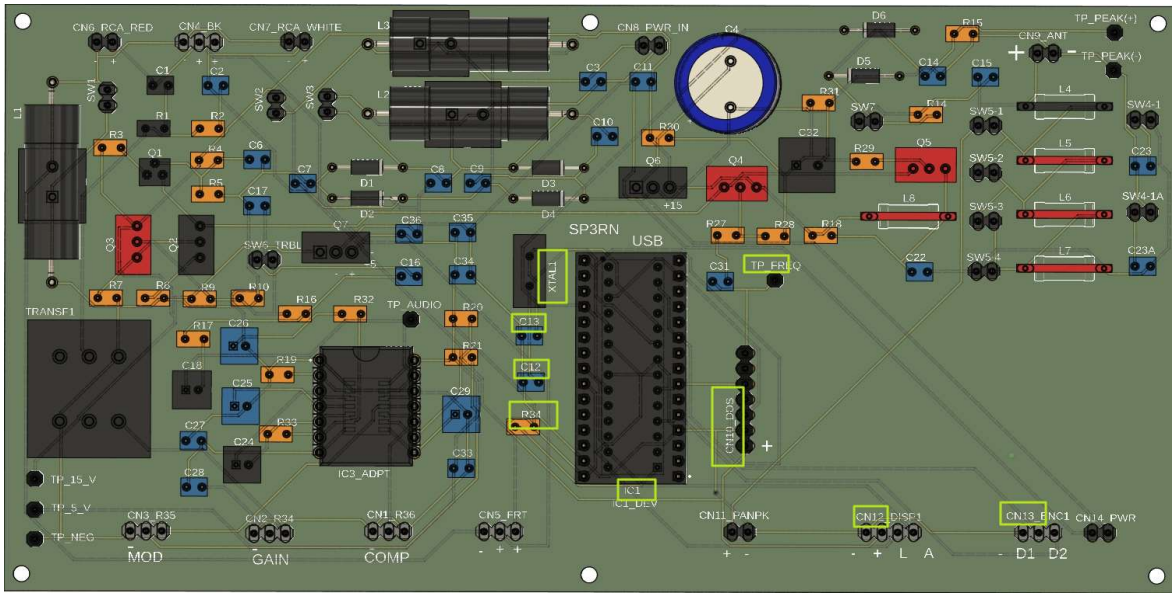
When testing is complete, disconnect the power source from the transmitter power connector.

If you desire complete audio isolation including a common ground which may weaken the final transmitted signal be sure SW8 does not have a jumper in place after initial testing when final assembly is complete. The suggest position for SW8 is in place however. If you decided not to use L1, L2, and L3, the jumper for SW8 should always be in place.

For now, keep jumpers on SW1, SW8, SW9, and SW10.

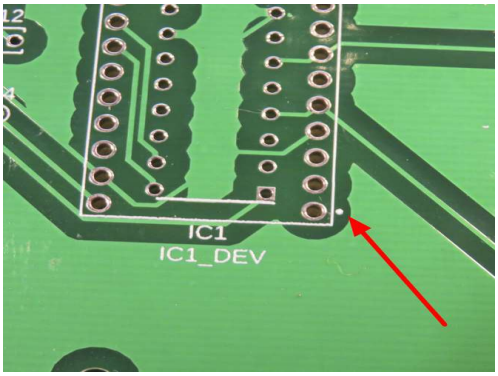
Frequency Assembly

The heart of the digital frequency generation is an AD9833 chip controlled by a microprocessor, an ATMEGA 328P or Arduino.

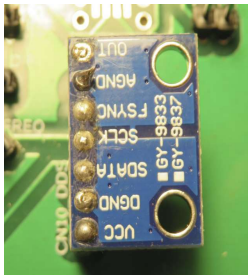


28 Pin Dip Socket IC1 OR two 15 pin headers placed on the NANO

ATMEGA328P Chip, Pin 1 Matching PCB white dot as shown above on the lower right of the socket location OR place NANO on board with USB connections back



If supplied as a strip cut a 7 segment section of the header with a utility knife for the AD9833 module. Place the female header on the AD9833 module. Match the 5V orientation on the module to the board and solder the header so the header is on the left side as shown and solder to the PCB as shown below.



AD9833 Module Header and Module

If supplied as a single header score a 1 piece section for TP_Freq

TP_Freq

XTAL1

C12 22pf

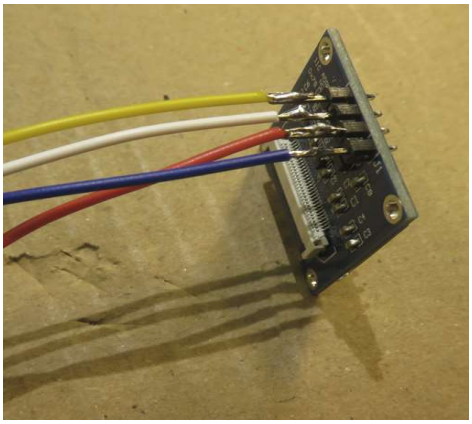
C13 22pf

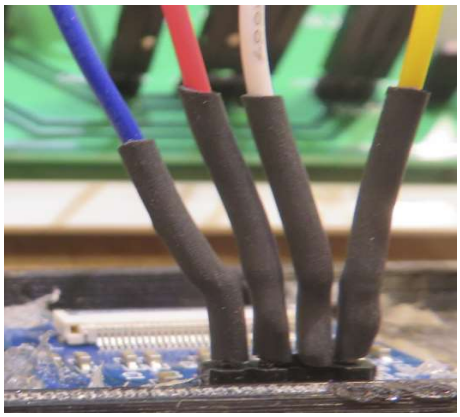
R34 10k ohms

If supplied as a strip cut a 4 segment section of the header with a utility knife for CN12 and solder in place.

CN12

Using wires with all different colors, cut 4 of the header connection female wires removing the male end so the length and the attached female end remains on each wire. These are for connecting the OLED display. Slide the heat shrink over each wire. Solder the wires onto OLED display header first attaching the header if needed orienting the long part of the header opposite the display side. Note which color matches the OLED display header marking of -, +, L, and A and connect the female sections to the previously soldered 4 pin header.



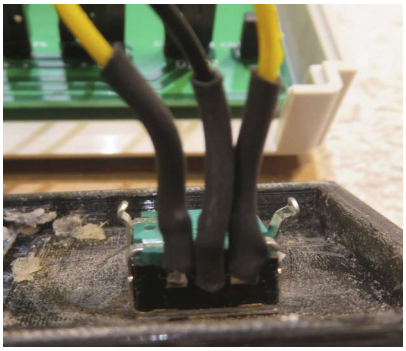


OLED Display

If supplied as a strip cut a 3 segment section of the header with a utility knife for CN13 and solder in place.

CN13

Using two wires with the same color and one different, cut 3 of the header connection female wires removing the male end so the length and the attached female end remains on each wire. Slide on the heat shrink. These are for connecting the encoder control. Solder the wires onto encoder so the two wires with the same are on the side connections and the single color is in the center. Attach the two wires with the same color of the PCB board to CN13 to the D1 and D2 pins. Connect the middle wire to the – pin.



Encoder

The following has not been implemented yet, Nano programming only.

Optionally not needed except for experimentation and not shown in these instructions, located to the right front of the socket for the ATMEGA328 are two pins, CN15_TXD and CN16_RXD.

If supplied as a single header score a 1 piece section for both connections.

⁀ CN15_TXD (Optional) ⁀ CN16_RXD (Optional)

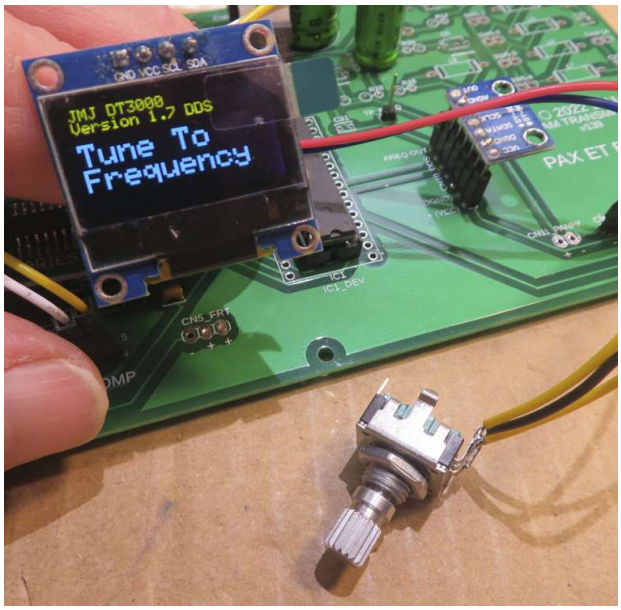
Do not overwrite the supplied ATMEGA328P-PU chip, take the chip out and use another ATMEGA328P-PU if you want to try programming the chip. Better yet, take the chip out and simply use a Arduino Nano. The 15v power regulator and power supply pins on the pin may require minor bending if using a USB cable while the Nano is mounted on the board. Or, simply remove the Nano when programming.

Frequency Validation

Plug in the power source. The display should now light up and have a message "Tune To Frequency."

Turn the encoder shaft slowly and verify frequencies appear as the shaft rotates, the VDC is meaningless as the circuit is not yet built. Connect an oscilloscope to the ground (TP_NEG) and the TP_FREQ pin and check the frequency, it should match the OLED display. If you do not have an oscilloscope, connect a jumper to the TP_FREQ pin and use a small transistor radio tuned to the display frequency and listen for increase volume when the transmitter is powered on and off.

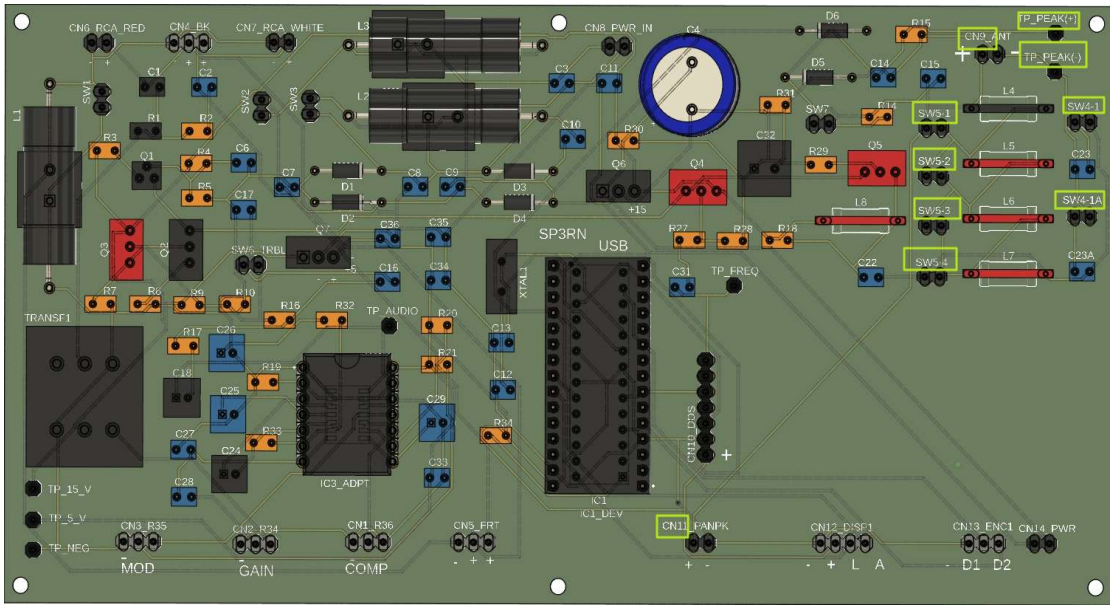
When testing is complete, disconnect the power source from the transmitter power connector.



Your initial power on screen display may not be an exact match or even entirely different to the one shown above.

Modulation / RF Assembly

Connections and Switches



If supplied as one piece, use a utility knife to score and cut the header as follows:

8 two pin pieces

2 one pin pieces

Solder the pins in place

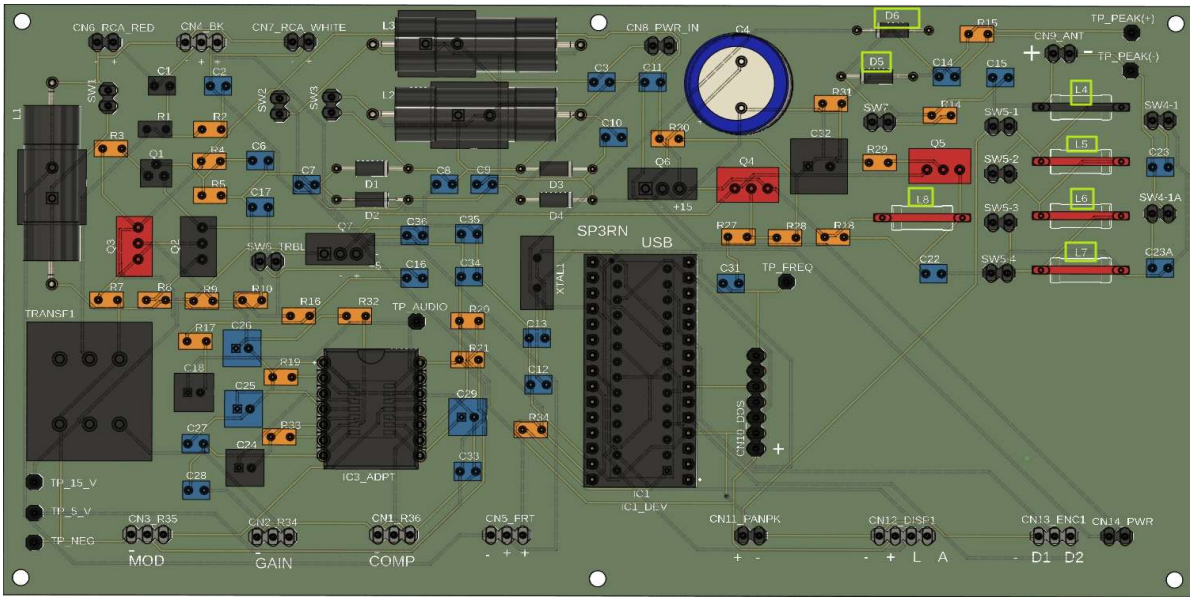
⁀ **SW4-1** ⁀ **SW4-1A**

⁀ **SW5-1** ⁀ **SW5-2** ⁀ **SW5-3** ⁀ **SW5-4**

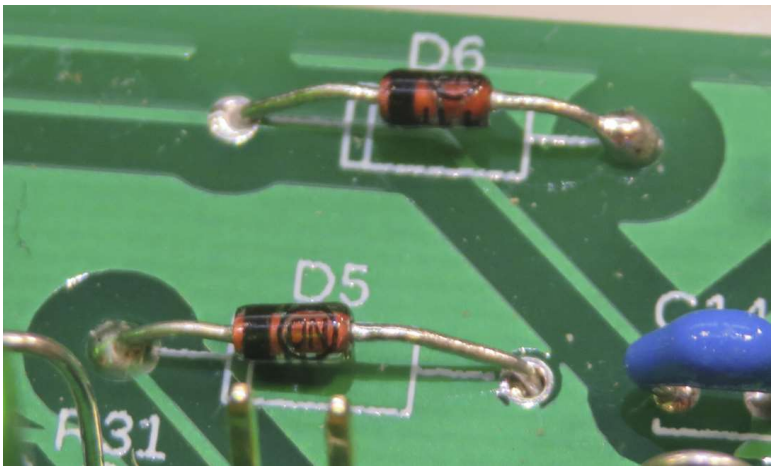
⁀ **CN9** ⁀ **CN11**

⁀ **TP_PEAK(+)** ⁀ **TP_PEAK(-)**

Diodes / Inductors



If D5 and D6 are installed backwards, the peak tuning voltage will always read zero. Be sure to follow the silk screen orientation on the PCB when mounting the diode verifying the band direction.

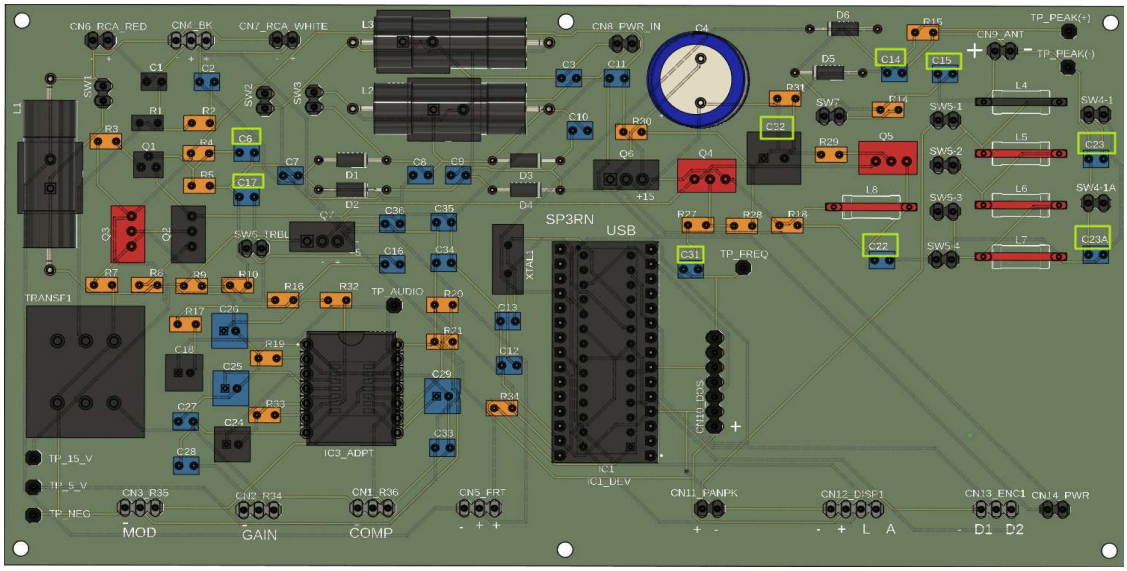


( ) **D5** ( ) **D6**

( ) **L4** ( ) **L5** ( ) **L6** ( ) **L7** ( ) **L8**

Capacitors

For C32 place the long lead into the + position.



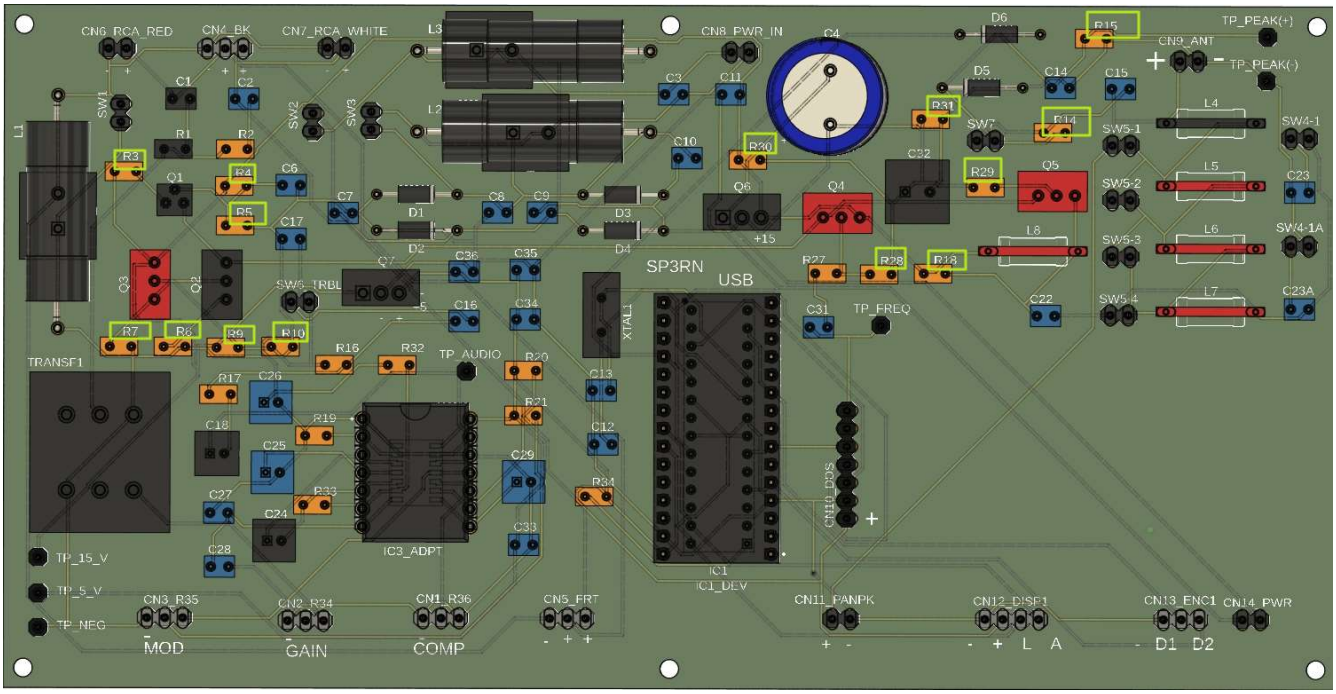
⁀ **C6 .1 uF** ⁀ **C31 .1 uF** ⁀ **C22 .1 uF** ⁀ **C32 100 uF**

⁀ **C14 .01 uF** ⁀ **C15 200 pF** ⁀ **23 820 pF** ⁀ **C23A 560 pF**

⁀ **C17 1000 pF**

Resistors

Use a small screwdriver shaft as mandrel to form the lead as previously discussed.



( ) **R3 100 ohms** ( ) **R4 2.7k ohms** ( ) **R5 27k ohms** ( ) **R7 510 ohms**

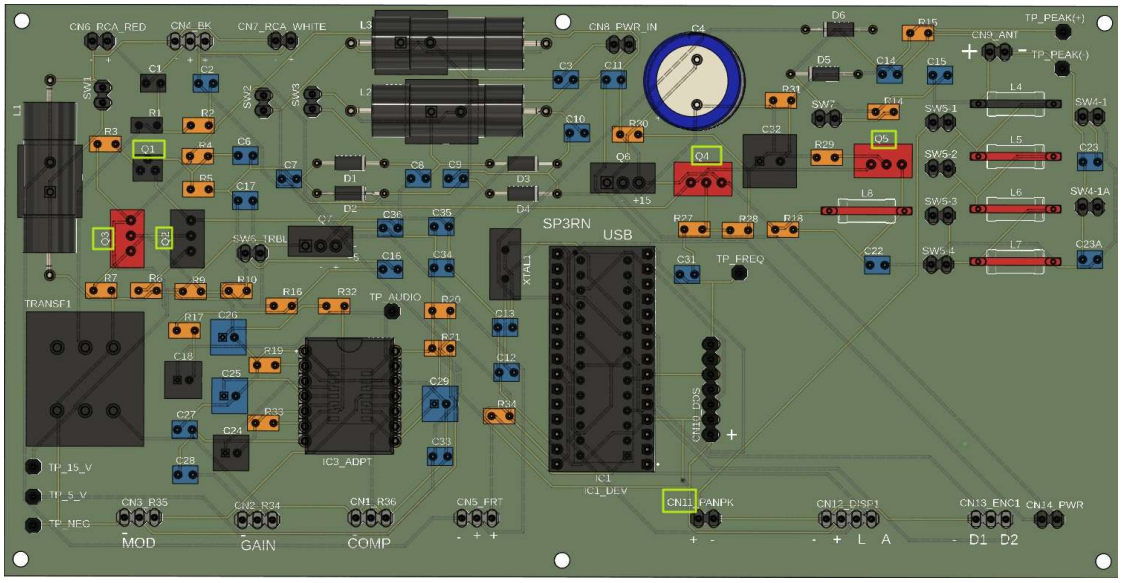
( ) **R8 22 ohms** ( ) **R9 47k ohms** ( ) **R10 6.8k ohms** ( ) **R14 220k ohms**

( ) **R15 1meg ohms** ( ) **R18 820 ohms** ( ) **R27 1.8k ohms** ( ) **R28 220 ohms**

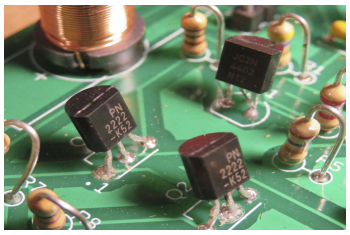
( ) **R29 220 ohms** ( ) **R30 4.7k ohms** ( ) **R31 1k ohms**

R27 is not highlighted and is to the left of R28

Transistors / RF Peaking Capacitor

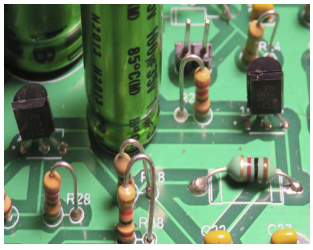


Orientate Q1, Q2, and Q3 as shown, the flat side facing the board front for Q1 and to the right for Q2 and Q3. There is an extra white line on the side the flat side should face.



⁀ **Q1** ⁀ **Q2** ⁀ **Q3**

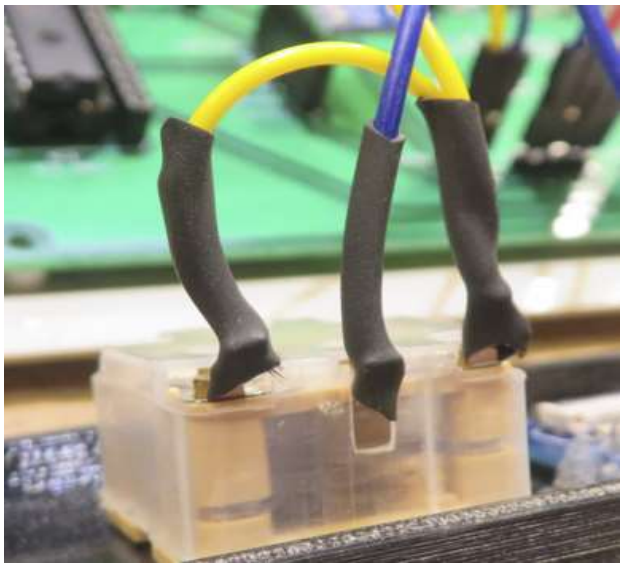
For Q4 and Q5, orientate the flat side to the board front as shown below. There is an extra white line on the side the flat side should face.



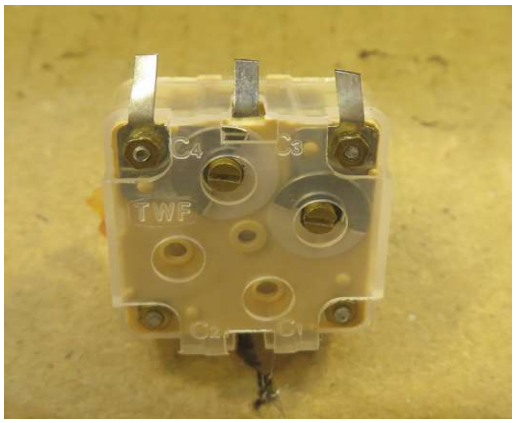
⁀ **Q4** ⁀ **Q5**

The header for the RF peaking capacitor should already be in place.

The completed peaking capacitor is shown below for reference, the instructions follow.



Cut the 3 leads so each is just over about 1/8”.



Cut three pieces of heat shrink and apply them to the wire before soldering. Using two wires with different colors, cut 2 of the header connection female wires removing the male end so the length and the attached female end remains on each wire. Solder one wire to the center lug noting the color of the wire. Solder the other wire to one of the side terminals.

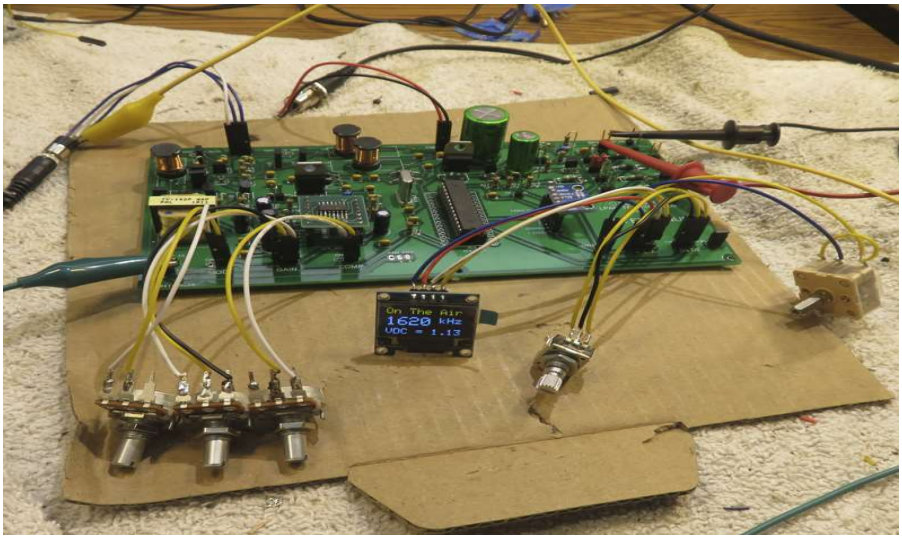
Place the stand off in the threaded center nut used to make adjustments and using two pairs of long nose pliers hold the capacitor shaft and tighten the standoff. Be sure to use two pliers as tightening the standoff against the capacitor end stop will likely damage the capacitor.

Connect the wire which is soldered to the center lug of the capacitor to the CN9 pin marked -. Connect the other wire from the outside lug to the + pin on CN9.

Modulator / RF Validation

Connect a short jumper to the + CN9 pin and apply power to the transmitter. Turn the encoder knob and the frequency should change and a VDC reading should now appear. Attach an MP3 play with a patch cord and tune a portable transistor radio in close proximity to the jumper antenna. You should hear the transmission on the radio. The VDC reading will not perform accurately or consistence without an audio signal and the 3 meter antenna attached.

Your final testing setup should look something like below. The black jumper on the right is to a ground, the red is to the antenna. The yellow and green alligator clips are hooked up to the female phono plug as previously described to verify the audio device is outputting a signal. The transmitter does not transmit until the encoder is turned and does not indicate “Tune To Frequency”



Antenna Connection

The FCC has specific rules on the antenna, now would be a good point to review them as pointed out in the first part of the manual, particularly rule 15.219. To be fully compliant, the antenna must be permanently attached or attached by a unique connector. Soldering is the best way to permanently attached a piece of 20-22 gauge insulated wire no more than 3 meters at the most.

Should you desire otherwise and use the regular yellow coded phono jack, attach 3 meter or less length wire to the center connector and the ground to the outside ring. Again, though convenient, this is a non complaint modification and is not endorsed in this manual. Use the BNTECHGO wire for this purpose if desired. Place the female connector on the back face plate where it will not interfere with the components on the board and drill the location with a .25” bit.

Male Antenna Jack and Solder Connection

Likewise for the phono hole on the back plate, place the female connector on the back face plate where it will not interfere with the components on the board and drill the location with a .2500” bit.

⁀ **Back Plate Phono Jack Hole**

For the power hole on the back plate, place the female connector on the back face plate where it will not interfere with the components on the board and drill the location with a .4500” bit.

⁀ **Back Plate Power Jack Hole**

⁀ **Review these assembly instruction and verify completion**

Board Inspection

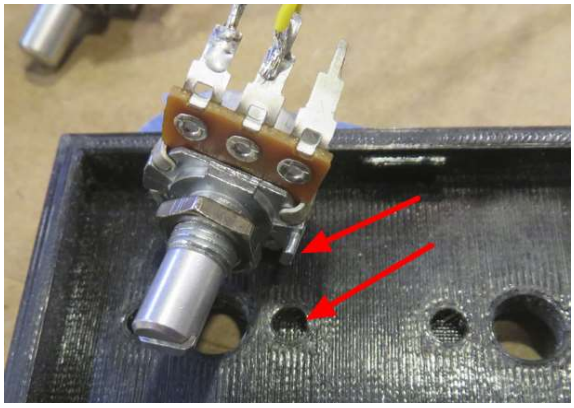
⁀ **Inspect all component soldering against the NASA specification pictures and verify no solder locations are bridged between leads, missed soldering connections. Preferably use a magnifying glass.**

⁀ **Diodes, rectifiers, and IC chips have the correct orientation**

Front Panel Assembly

Assemble the front panel with the potentiometers (R34, R35, AND R36), encoder (ENC1), OLED, and peaking capacitor by removing the nuts and passing them through the case front. Be sure that the holding lug which protrudes from the front of the potentiometers is place in the indentation on the back of the front cover before the nut is tightened. The peaking capacitor requires two small screws to mount to the case. The order from left to right is: modulation, gain, compression, peaking capacitor, OLED, and tuning encoder. Be sure to have the heat shrink in place on the connections to act as a stress relief. See picture below.

Place the lug in the lug holes when mounting the potentiometers.



⁀ **Front Panel Assembly**

Do not mount the OLED yet.

Place knobs controls, if necessary place a small amount of silicon glue on the control shaft to secure the knob to the shaft. Do not forget to place the controls through the front cover and the nuts on the shaft and tightening them before putting on the knobs. If needed open up the holes on the knobs with a . 2300" bit and test for fit, adjust as necessary. If the hole in the knob ended up oversized, try a wrap of black electrical tape around the shaft.

⁀ **Knobs**

Board Placement & Connections

Place the board in the enclosure soldered (components up) side down and secure with the 5 screws in the plastic posts Do not use a screw on the front center location.

⁀ **Board Screws**

⁀ **Connect the connectors in the front panel connections**

In summary,

The modulation (CN3), gain (CN2), and compression (CN1) controls have two wires, connect them to the right two header pins for each control, do not use the – pin.

For the peaking capacitor, connect the center wire to the – pin on CN12 and the outside wire with the jumper on the capacitor to the + pin.

For the OLED connect the wires labeled on the OLED GND to -, VCC to +, SCL to L and SCA to A on

the PCB on CN12

For the encoder connect the center encoder wire to -, the other two wires to the outside pins D1, D2 on the PCB, on CN11.

⁀ **Connect the connectors in the back panel connections (excluding the antenna)**

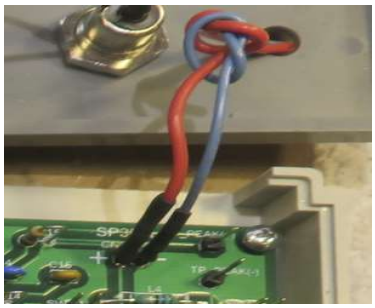
In summary, for the 3.5 mm phono jack,

Connect the wire to the jack long lead to – pin , and the other two wires to the + pins as shown on the PCB for CN4.

For the power supply, CN8, simply connect the wires, orientation does not matter

⁀ **Power supply**

Connect antenna if you decided to modify the recommended soldered antenna, the center connection is + and the outside is -, just the same as a audio source. Make the connection to CN9, the center connection goes to the + pin on the left, the negative connection goes to the – pin. Place the heat shrink on the wires before soldering to the posts.



⁀ **Connect Antenna**

⁀ **Connect the power transformer to the connector**

Do not assemble the case.

⁀ **Power up the transmitter**

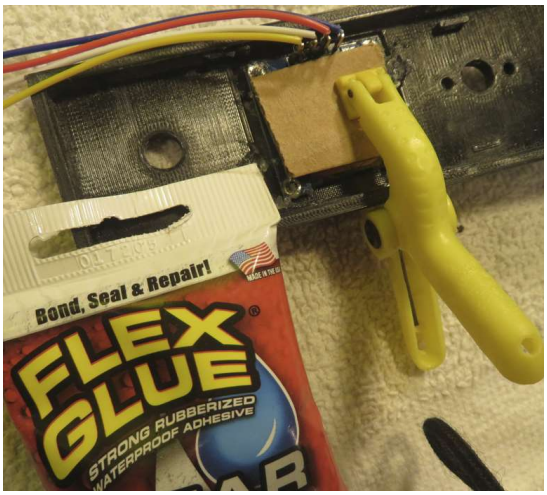
The OLED should have a display on the screen.

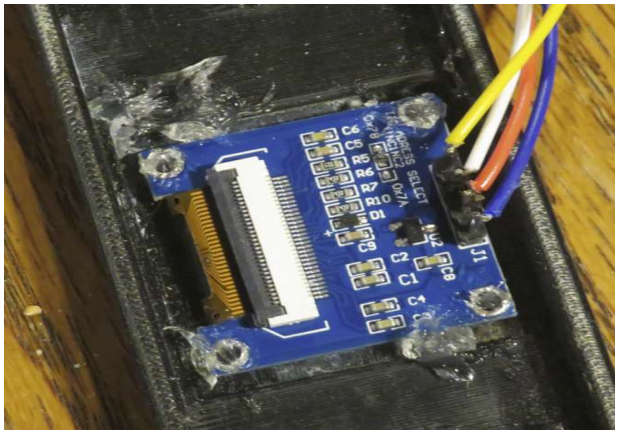
There are variations for mounting the OLED display. Mount the display to the case front, and if using

the bezel, mount the OLED to the bezel, then mount the bezel to the case front. Use silicon glue or similar adhesive (or hot glue gun) to fasten the OLED in place on the four corners so the screen area covered with the protective tape is centered on the opening. Allow to cure before installing the front cover on the transmitter.

Look at the display from the front of the case and be sure the OLED is centered and the full screen and text may be viewed from the window, adjust by sliding to either side or up in down. If needed, cut the small 4 tiny posts in the OLED hole and reposition the OLED as the OLED holes have significant variation in some cases.

Use blue painters tape to hold the OLED in the right place temporarily until the cure takes place if needed. Alternatively use a clamp as shown using two small pieces of cardboard to protect the circuit and display on each side.





OLED Display Mount (Be sure to read above)

The the VDC antenna peak reading will not stabilize until a ground and antenna are provided.

Power On Checks

Once the power is connected the transmitter displays should be illuminated.

⁀ **Attach the antenna ground to a good ground source such as a receptacle face plate screw.**

⁀ **On an AM radio, find a frequency which is not being used by a radio station.**

⁀ **Connect an audio device using the RCA connectors or 3.5mm miniature stereo receptacle in the back first verifying a signal is being produced by the device**

⁀ **Using the frequency knob, the tune the frequency to the AM radio, you should now hear the audio**

The the VDC antenna peak reading will not stabilize until an audio signal, ground, and antenna are provided.

Understanding The Knobs & Display

Your front panel should be similar to the panel shown below.

There are five knobs and one display. Each is explained below along with the adjustments for best audio transmission.

MODULATION – The modulation control increase or decrease the amplitude of the modulation on the carrier wave, more amplitude when the knob is turned to the right.

GAIN – The gain increases or decreases the audio level of the signal fed into the audio IC preamplifier allowing large levels of compensation for many audio devices. The maximum gain position is with the knob turned rotated all the way to the right.

COMPRESSION – Compression decreases the range of the audio to sometime a more soothing range. The compression is increased turning the knob to the right.

Using your test frequency from above, connect the music device and start transmitting the music with the sound initially set at the mid level. To obtain the best combination, of gain, modulation, and compression start with the gain control turned fully clockwise for the maximum and the modulation and compression minimized by turning the controls fully counter clockwise. Lower the volume if it is not clear or is distorted.

Turn the modulation knob slowly clockwise until distortion starts, then turn it back slightly so there is no distortion.

Rotate the gain knob counter clock wise until the volume just starts to become lower. This setting combination limiting occurs only on music volume peaks. Turn the compression knob clockwise until to the point which maintains the loud and quiet sections at a level which suits the way you enjoy the music and does not have all flat volume.

FREQUENCY - The frequency knob adjust the frequency the transmitter operates by 10kHz increments from 520 AM to 1730 AM.

ANTENNA PEAK – This adjusts the transmitter to be resonant with the lowest capacitance. The lower

the capacitance the more power to the antenna, a higher inductance is better than a lower inductance. Though display reads to 1/10 precision, the due to signal variation, just get the highest reading to a few 10ths. The voltage displayed is for peaking purposes only and likely does not represent the true signal voltage to to various components in the circuit allowing the digital display.

The the VDC antenna peak reading will not stabilize until a ground and antenna are provided.

Understanding The Jumpers

There are a total of 12 jumpers indicated by the prefix SW. You can skip this section if you want the default setup as explained in the DEFAULT JUMPER SETUP section below.

SW1, SW2, SW3 provide ground isolation options to reduce possible hum by removing the jumpers. However, the best distance is with the jumpers in place and not isolated. Ground the transmitter via the antenna wire to a face plate screw.

SW1 is the audio isolation switch, to isolate the audio ground from the transmitter ground, do not place the the jumper on the pins. With the jumper in place, the transmitter will partially be grounded through the audio source. The recommended position is closed, the jumper in place unless audio isolation is required. SW8 must use a jumper to ground the audio input. For isolation, jumper 8 must be removed.

SW2 and SW3 provide isolation to the AC power source. If you experience significant hum, try removing these in combination with SW1 in different combinations.

SW4 and SW4-1A are for the antenna matching, SW4-1A is for a base loaded antenna and uses a 560 pF capacitor when the jumper is in place. Typically with the 3 meter wire antenna SW4-1 has the jumper in place. However be sure to test the distance and VDC reading using the jumper both on and off while adjusting the peaking capacitor.

SW5-1, SW5-2, SW5-3, SW5-4 inductors may be adjusted to produce between 56 and 788 uH. The inductance is additive when combined by having the jumpers in place. The jumper values are as follows:

SW5-1 = 56uH (if ordering from Digikey revise the table with the 47 uH inductor value if desired but the small difference in inductors does not significantly change the ranges shown making the changes unnecessary)

SW5-2 = 82 uH

SW5-3 = 180uH

SW5-4 = 470 uH

One way to find out which combination is theoretically best is to pick your desire frequency and look at the following table. Pick an the highest inductance in your frequency range. Then systematically lower the inductance repeaking the VDC each time. The VDC will increase and then decrease once the optimum inductance is passed. When that happens go back to the highest combination. The X indicates having the jumper in place. You will find for a given frequency having the highest inductance will achieve resonance with the lowest peaking capacitance. So be sure to start at the higher end of the inductance and work down until you pass the VDC peak, then go back. This table is for a 3 meter antenna, a shorter antenna will resonate and peak differently. It is interesting to watch how the frequency changes the voltage over the entire frequency range.

In practice try various combinations to see what gives the highest VDC with your antenna of the length you use, but remember the legal maximum length is 3 meters. Interestingly enough, the VDC reading is highly subject to wall circuit wires in houses or in relatively close proximity.

Frequency kHz	SW5-1	SW5-2	SW5-3	SW5-4	uH
1485-1720		X			82
1145-1607	X	X			138
1003-1407			X		180
876-1229	X		X		236
831-1166		X	X		262
754-1059	X	X	X		318
620-871				X	470
586-823	X			X	526
572-803		X		X	522
545-766	X	X			608
528-740			X	X	650
520-710	X		X	X	706

In practice voltage peaking is subject to many factors and is mostly an academic exercise as the transmitter easily covers the area allowed by the FCC.

SW-6 Boosts treble about 8dB with the midpoint of the boost curve at 2kHz. Without this jumper in place, there will be a relatively flat audio response.

SW-7 must be open unless using a base loaded antenna. Instructions may be found be a internet search on SSTRAN Base Loaded Antenna if desired.

SW-8 must be removed for audio isolation, be sure the antenna is grounded if removed.

SW9, SW10, and SW11 allow directly processing your own audio after the transmitter first converts a stereo signal to monaural. The audio isolation transformer is bypassed as well. This is not recommended unless you are skilled in this practice.

SW10 should be removed and SW9 and and SW11 should be in place to use the built in audio part of the transmitter.

Should you wish to process your own audio, remove SW9 and SW11 and place SW10, however processing your own audio is not suggested, but the capability is provided for those who would like to try it or experiment.

Default Jumper Setup

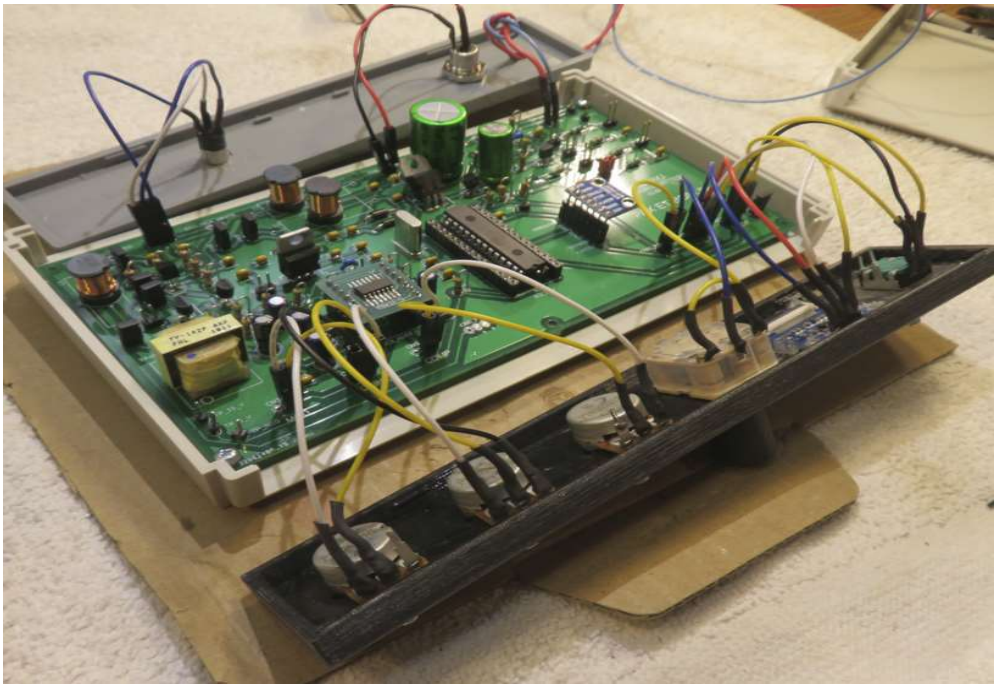
The default setup is jumpers on SW1, SW2, SW3, SW4, SW8, SW9, and SW11 in place.

This combination with the 3 meter antenna has generally been found to produce the best results. The SW5 jumpers should be set to the frequency you will use per the above table. A jumper must be on CN14 to provide power. Most people will find this to be the best combination for general usage.

However, a stronger signal may be produced by trying different SW5 combinations at the next higher or lower frequency than suggested in the table, or possibly all together combinations as every installation is different and affected by local AC power lines as well. Use the VDC meter in the front of the transmitter or a radio to listen to signal strength while you make adjustments to the SW5 jumpers. Peaking is mostly an academic exercise and not needed as the transmitter easily covers the area allowed by the FCC with peaking. Just be sure to use a ground to the transmitter.

Maximize the VDC voltage or the highest volume on the radio for a given SW5 inductor combination.

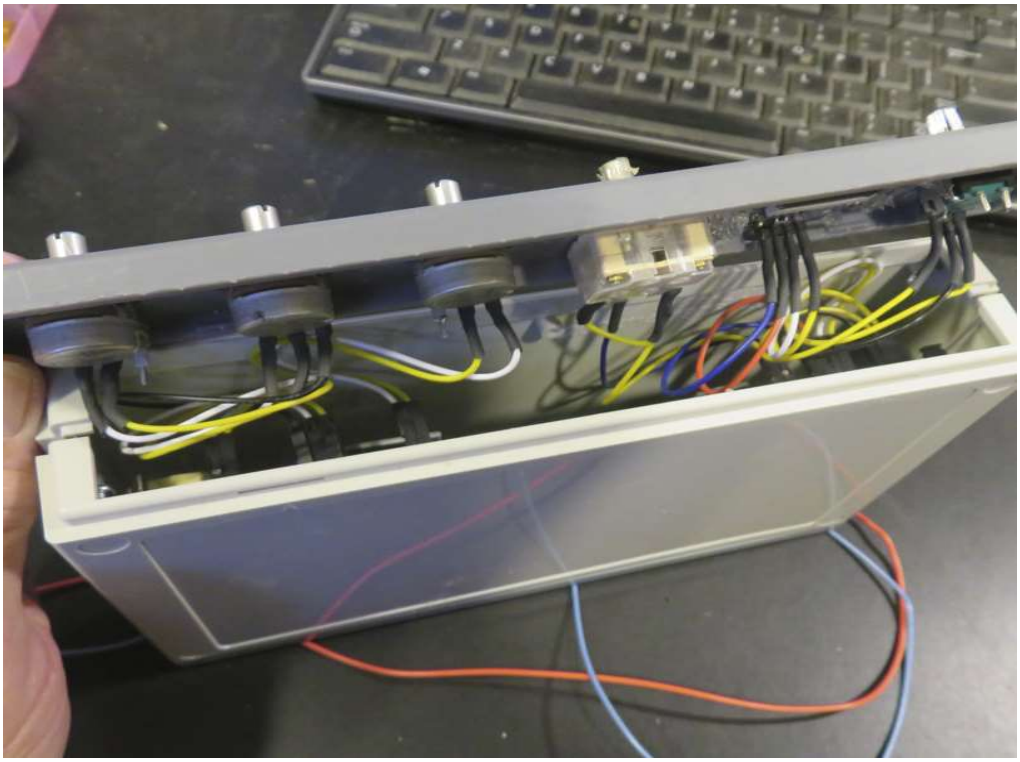
Assemble The Case



Mount the completed PCB in the case if already no done using the 5 sheet metal screws leaving the front center screw out as it would interfere with the peaking capacitor. Your board should be similar to the one shown below. Be sure you have the heat shrink on as it acts as a stress relief for the wires to the components mounted to the face plate and back plate.

Now that you have verified the transmitter is working correctly, take the back of the case setting it in place. You will need to drill three holes, one for the miniature phono plug (.25”), the power jack (.430”) and the antenna and ground wires (.25”) to come through unless using the optional RCA jack for the antenna. Verify the locations you select will not interfere with any mounted components and drill the required holes. Place the components in the holes and secure them adding wire for the antenna and ground being sure to solder them well and tie a knot for pull protection. Recheck the connections are on the proper connection pin from the case components as needed.

Be sure the lugs for the components of the face plate have no vertical bend or even better, bent slightly beyond horizontal downward to assure case clearance as the face plate snaps in place.



Assemble the case, hopefully you practiced in advance as suggested to be familiar with the assembly process. Make sure the lower and up half are fitted together tightly

Be careful with the wires that they are not between the face plate and the case, it is a tight fit but it all will go together.

Antenna Location

Select a location as free as possible of other electrical sources and electrical wiring. The best range will be found with a vertical antenna with the ground connected to a good earth ground such as a face plate screw. Even with a poor installation not following these guidelines, the transmitter will cover an entire house with the signal.

Final Installation Considerations

Noise in form of hums and static are common occurrence due to the many source of electrical interference

created by virtually all electronic and some non electronic machines due to static electricity. Grounding, filtering and shielding are the most effective ways of reducing electrical interference. The transmitter uses inductors which may be used to aide in this process.

Use of this transmitter is for learning purposes and the antenna should never exceed 3 meters, the legal limit and the connection should be soldered to assure compliance to the regulations.

Specifications

Frequency Coverage	520-1720 kHz in 10 kHz steps
Frequency Selection Method	Rotary encoder with digital display
Frequency Resolution	.1 Hz with 25 MHz reference clock
Frequency Generator	Analog devices AD9833 chip
Microprocessor	ATMEGA328P or equivalent
Modulation Type	Amplitude Modulation
Maximum Modulation Level	100.00%
Power Input to Final RF Stage	100 mW
Antenna	118” wire
Antenna Matching	Tunable pi-network matching a high impedance antenna to low impedance RF output
Output Tuning	4 jumpers allowing an inductance range from 82 – 788 uH
RF Output Metering	Measured via a digital display in VDC at maximum resonance
RF Grounding Options	Jumper plug options including / excluding isolation inductors for power supply and audio source ground paths up to isolation transformer
Audio Response	20 Hz to20 kHz +/- 1 dB
Audio Treble Boost	+8 dB, boost midpoint a 2 kHz via jumper
Audio Distortion	Less than 0.5% THD through audio stages
Minimum Audio Input level	200 mV RMS for 100% modulation (input gain a maximum)
Audio Compression	Adjustable from 1:1 to 5:1. Attack time less than 1 ms. Suitable for voice and music
Audio Processor	Analog Devices SSM2166P
Audio Limiting	Adjustable Threshold. 15:1 compression above threshold
Audio Isolation	Common device ground, positive signals isolated
Front Panel Controls	Audio input Gain, Modulation level, and Compression level, antenna peaking, and frequency Selection
Rear Panel Jacks	3.5 mm (1/8”) female phono plug, RCA antenna / ground jack, and 2.1mm power input jack
Display	.96” OLED 128x64
Operating Input Voltage	18V RMS AC in, or 20V DC in
Wall transformer Voltage	120V 60 Hz
Case Dimensions	7.8” x 4.75” x1.5”
Weight	Approximately 16 oz

Learning Resources

AMT 3000 Transmitter History

https://rec.antiques.radio-phono.narkive.com/nVE1woVa/new-amt3000-transmitter-kit

https://rec.antiques.radio-phono.narkive.com/bz96jjpM/transmitter-to-my-old-am-radios

Learning Resources

Most of these may be found at minimal cost or free through thrift stores and internet searches for the pdfs. Of course there are many others as well.

Electronics For Dummies, Doug Lowe

Practical Electronic For Inventors, Scherz / Monk

Basic Radio: Understanding the Key Building Blocks

Publisher ： American Radio Relay League (ARRL); 1 edition (Jan. 2005)

Author: Hallas

ASIN ： B012HU0HU8

The Electronics of Radio

Cambridge University Press; 1st edition (August 13, 1999)

ISBN-10 ： 0521646456