

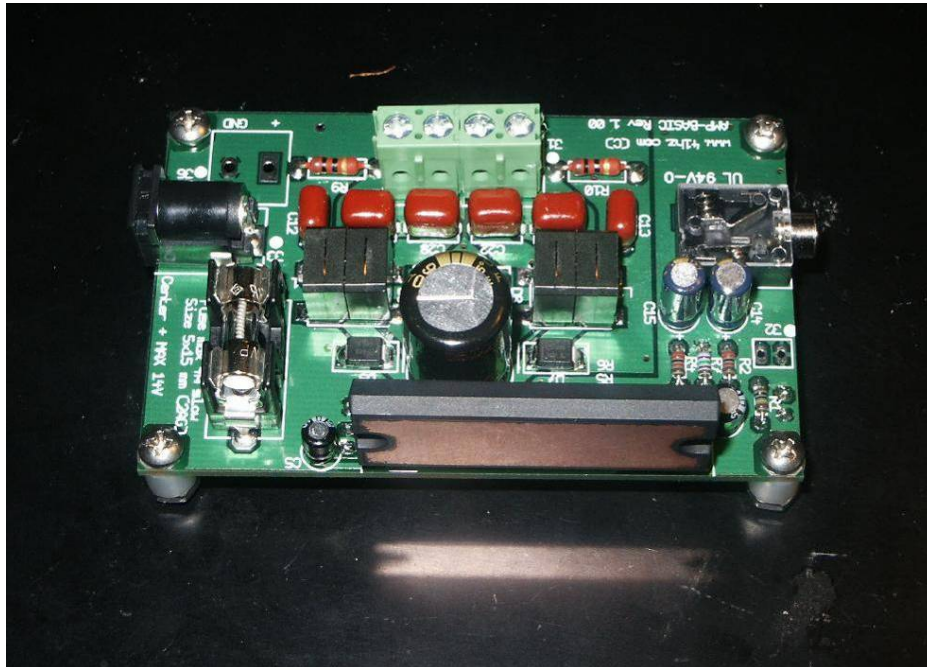
ASSEMBLY INSTRUCTIONS AMP6-BASIC

Assembly instruction

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AMP6-BASIC FEATURES

- Stereo or paralleled mono inputs/outputs
- Audiophile sound quality, < 0,03% TDH+N at 2x10 W RMS, 4 ohm
- Footprint, 50x80 mm
- Line level analogue audio inputs. Sensitivity adjustable with external resistors
- High efficiency 85-90% mean small heat sink and small transformer requirements
- Mute function for click-less on-off
- Over current protection, temperature overload protection
- The module is suitable for amplifiers and active speakers

Tripath TA2020 chip FEATURES

- Class-T architecture
- High Power
- 2x25W @ 4Ω, 10.0% THD+N
- "Audiophile" Sound Quality
- 0.10% IHF-IM @ 25W 4Ω
- High Efficiency
- 88% @ 12W 8Ω
- 81% @ 20W 4Ω
- Dynamic Range = 99 dB
- Mute Input
- Integrated Gate Drive Supply
- Over-current protection
- Bridged outputs
- 32-pin SSIP package

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Introduction

Thank you for choosing an audio kit from 41hz.com!

Check delivery

On delivery, check that all components have been included. We do double-check the component count but mistakes can happen. Please contact us at once if something is not OK with the shipping. A bill of material (BOM) is found as APPENDIX 1 in this document.

Tools needed

Assembly of the kits requires the usual set of electronics working tools

- Wire cutter and screw driver, tweezers or fine pointed pliers.
- Soldering iron. The boards are double sided, double weight copper so a high-power soldering iron is recommended, especially for components connected to the ground plane. Solder irons without temperature control should not be used.
- A magnifying glass/loupe of the type that you wear like a pair of glasses or like a cap is recommended, as it increases the precision and quality of your work
- Solder flux of no-clean type and soldering wick are useful extras.

IMPORTANT

NOTE: components packaged in a shielded, aluminized bag should be considered ESD sensitive and should be handled with ESD care. The Tripath chips use MOSFET outputs which by nature are sensitive to ESD (Electro Static Discharge). Use ESD precautions. Preferably work on a conductive, grounded "ESD mat", and avoid touching the chip leads with your fingers. Discharge yourself before working with the components.

Additional components

The following will at some stage be needed to complete the amplifier, but is not included in the kit:

- Heat sink. Screws and heat conductive paste to mount the heat sink. In most cases, if you mount the Tripath chip to an aluminum amplifier casing, this is sufficient to cool the chip. The Tripath chip does not need to be insulated, as the back of the chip is internally connected to ground.
- Mute/un-mute switch. A jumper on the board can be used to mute / un-mute the amplifier. Preferably wire this to a switch on your casing panel. Muting the amp before power on minimizes the turn on thump and is recommended.
- A power supply. AMP6-BASIC is intended to be used with an external power supply or a 12V battery. The maximum recommended voltage is 14.5V, with 12 to 14V being more comfortable values. The recommended power rating is at least 25W with 8 ohm speakers and at least 50W with 4 ohm speakers. The amplifier works with voltages down to about 9V. You can use power supplies with lower power

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rating, but the amplifier may not perform as well and the power supply may get overloaded.

More information on various considerations and possibilities can be found in the appendixes. It is recommended that you read through these quickly before mounting any components.

Soldering

The boards for AMP6-BASIC are double weight, double sided copper. Even if the PCB and components are small, quite a powerful soldering iron is helpful. Especially components and pads connected to the ground plane require significant heating. A temperature controlled 50W soldering iron is recommended. At the same time, applying excessive heat may damage the board, causing the copper leads to come off. Preheating the board to around 100°C will make work easier and allows using a lower solder iron temperature which decreases the damage risk. Some information on how to solder both SMT and hole-mounted components is available in the forum on <http://www.41hz.com>

AMP6 BASIC basics

AMP6-BASIC is intended to be a very simple amp; all non-vital parts have been omitted. AMP6 BASIC should be simple to build, connect and test. The amp should be suitable for a relative beginner or the experienced builder looking for a minimalist solution.

All connectors are included in the kit, which is usually not the case with our kits.

This assembly instruction is intended to be understandable even for a relative novice to electronics construction. More details and more pictures than usual have been included.

Yet, the final result will be an amp with excellent sound, if built properly.

The most important advice:

- Do not rush. Let the construction take its time. Have patience and do it well. If you rush, you will most likely be disappointed with the result. Accept that building electronic circuits requires craftsmanship, which takes time to learn and years to master.
- Get good tools. It is frustrating to use low quality tools.
- If you do not have a good temperature controlled soldering iron, then borrow one.
- Get some fine solder wire, some solder flux and some solder wick. It saves your nerves and eliminates a lot of frustration.
- Read through this entire manual, at least briefly, before actually building the board.

Mounting the components

The components have been packed in bags; with the bag numbering is also the recommended mounting sequence. These instructions therefore follow the same sequence as the bag numbering.

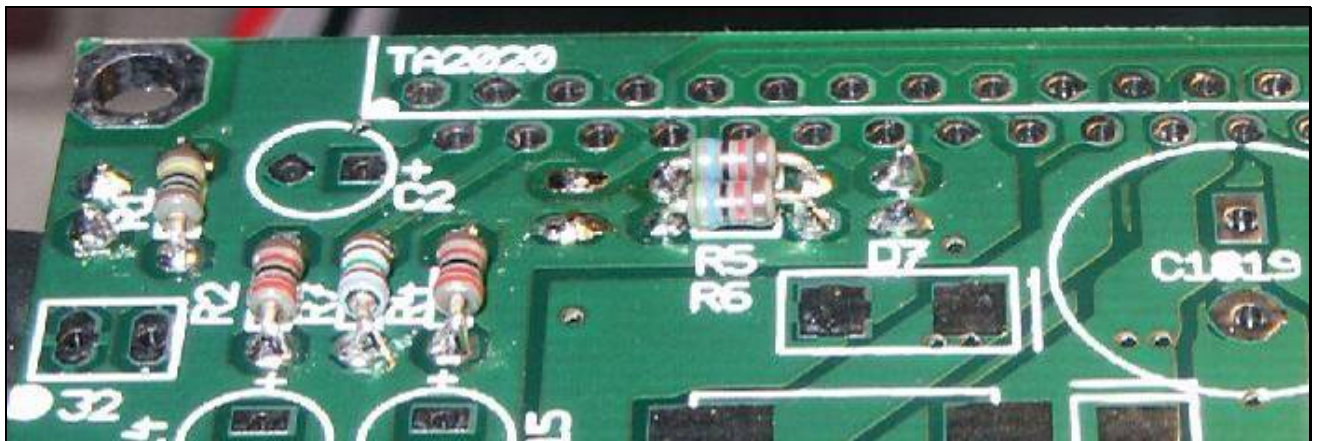
NOTE 1: There are two 0.1 uF capacitors, C6, and C7, in bag 5, which should be mounted and soldered into the holes together with the TA2020 chip. These are critical to the function of the amplifier. The locations of these are printed on the bottom side of the PCB. *Solder these capacitors when you fit the TA2020 chip, which is at the last step of mounting.*

NOTE2: Revision 1.1 has two three components that are not visible on the photos. These are R3 and C21 and a jumper pair more on J2. These are described in the text below.

Suggestion; Read up on soldering and mounting techniques on the forum of the 41Hz web site or elsewhere on the web.

BAG 1

1. So here we go with the first components.
 - a. First mount the four nylon spacers, one in each corner of the board, with the supplied screws. If you are working with a vice, you can leave the standoffs until later.
 - b. Solder the small capacitors C16, C17, C20, C21, C26 and C50 on the bottom side of the board. A picture of how the components are placed is included in the APPENDIX.
 - c. Solder R3 and R7, 8.2Kohm in place
 - d. Solder the two input resistors R2, R4 22Kohm in place



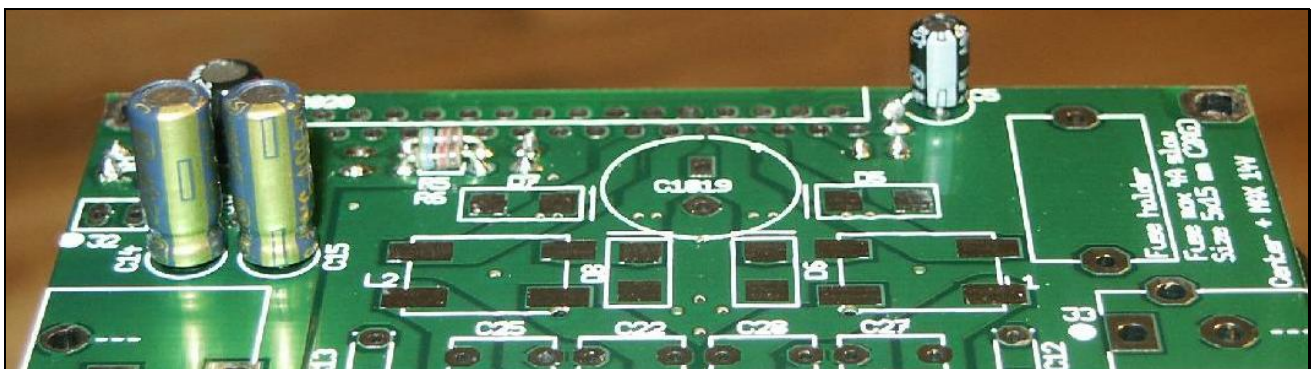
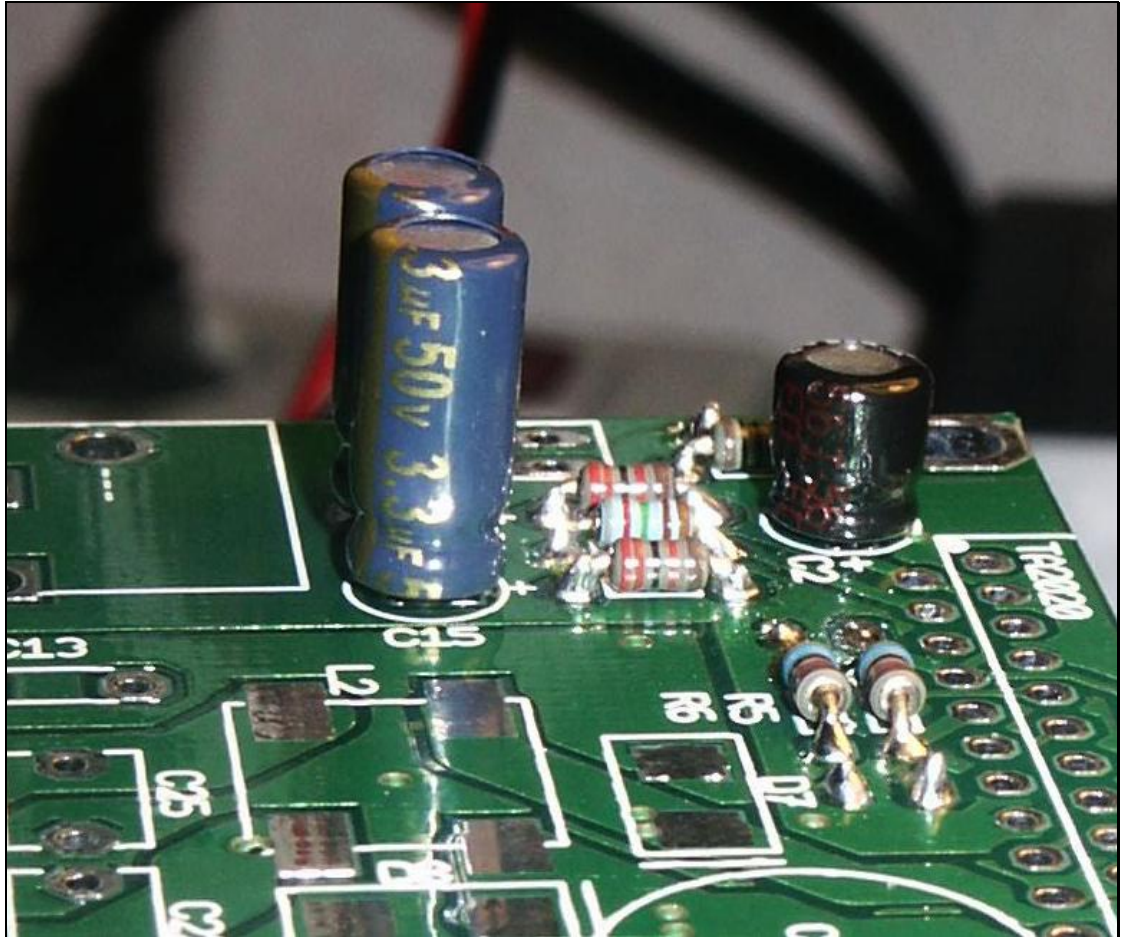
BAG 2

2. More components.
 - a. Solder the sleep pull-up resistor R1, 1Mohm in place
 - b. Solder the feedback resistors R5, R6 in place. These are nominally 56 Kohm, see appendixes on setting the input gain / sensitivity.
 - c. Mount and solder the charge pump capacitor, C5, in place. As with all electrolytic capacitors it is important to mount the leads the right way; the longer lead is positive, the shorter negative. Polarity is marked on the PCB

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with signs and with square pads for positive. C5 has the positive side towards the board edge. It may be safer to look in the component placement drawings.

- d. C14 and C15 are the signal input capacitors. Also these, and the other round cans, are electrolytic and have to be mounted with the right polarity. Mount and solder these.
- e. Mount and solder C2 for decoupling of the internal +5V circuit.



BAG 3

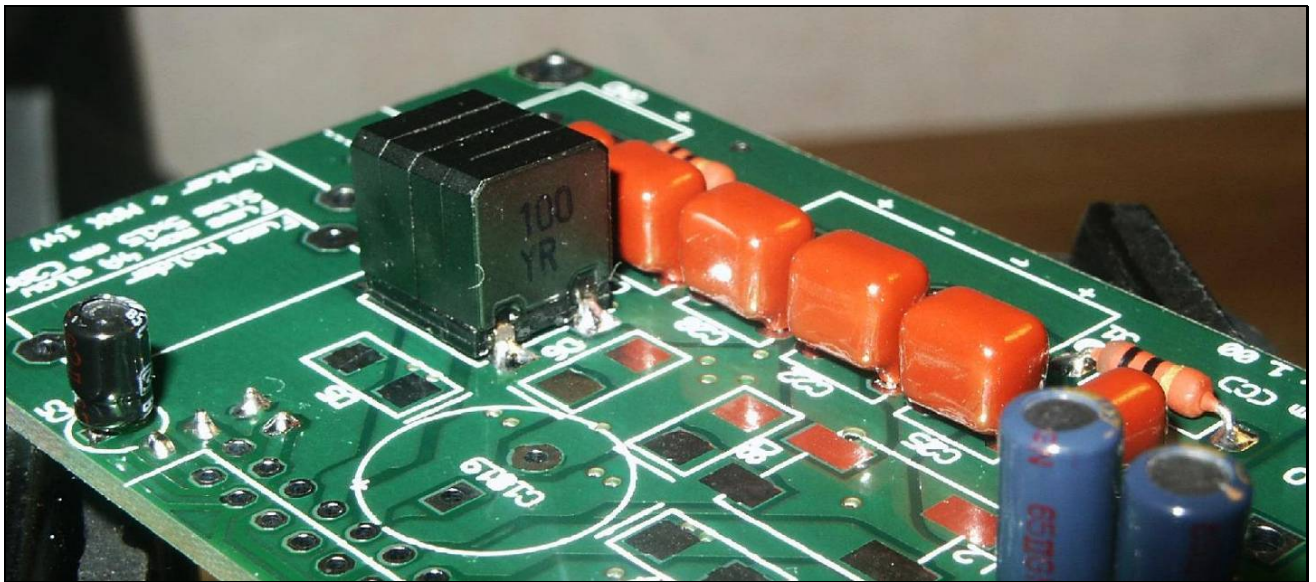
- 3. Bag 3 contains all the output filter components. These remove high frequency noise from the outputs and are all mounted near the speaker connections.
 - a. Solder resistors R9 and R10 in place.

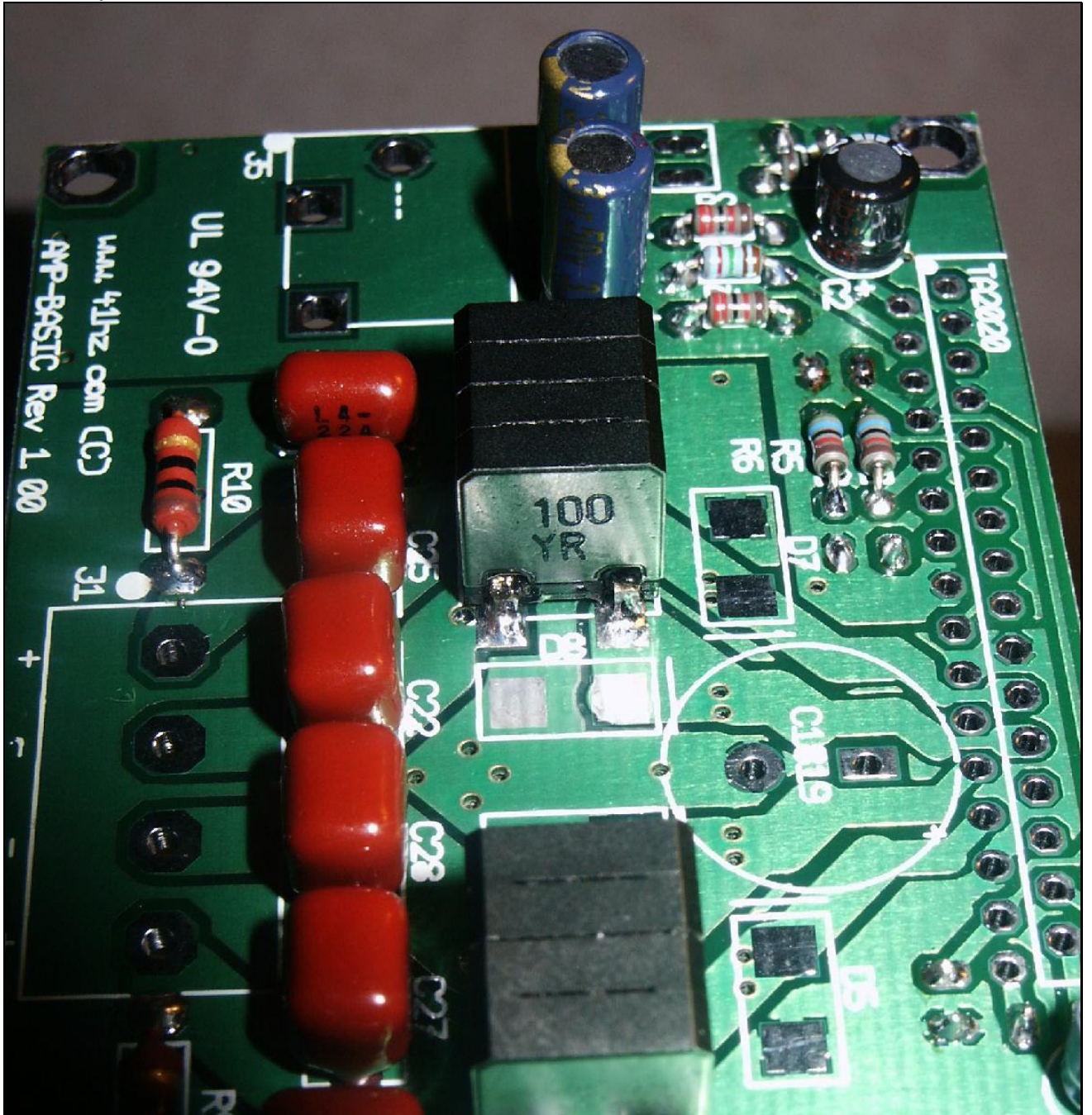
- b. Solder C12 and C13 in place.
- c. Solder C22, C25, C27 and C28 in place.
- d. Mount the inductors L1 and L2. They are the metal cubes. Make sure they are aligned on the solder pads before soldering.

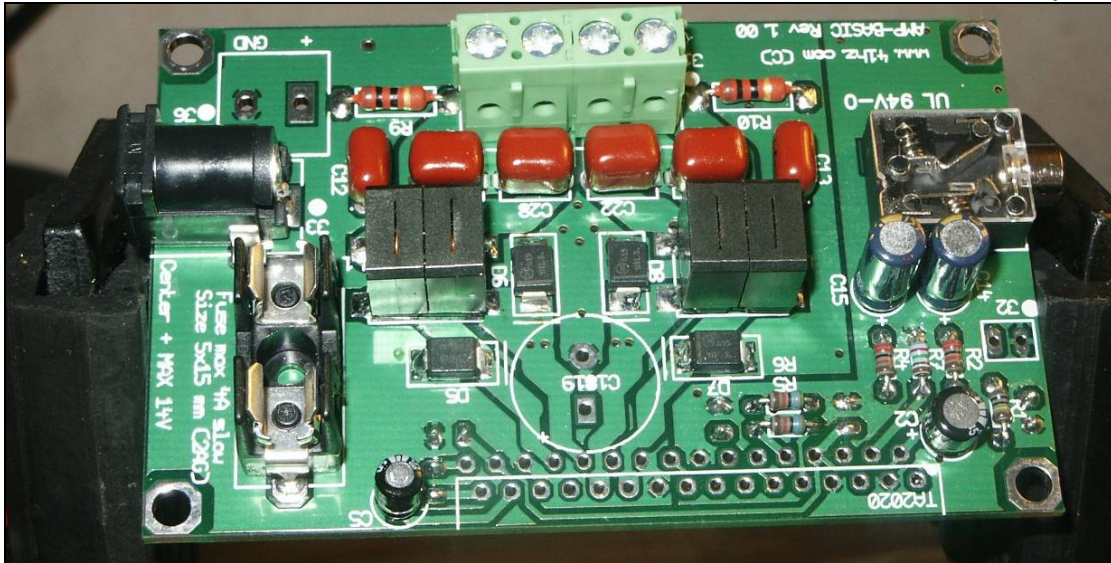
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BAG 4

4. Bag 4 contains connectors and the close-up bulk capacitor.
 - a. Mount the fuse holder F1 in place. It is of USA AG2 size, 15x5 mm in Europe. This is a bit smaller than the more common size 5x20mm. Use a slow blow fuse, 4A. For testing a smaller fuse can be used.
 - b. Solder J1, the speaker connector header, aligned so you can fit the cables!
 - c. Mount and solder J3, the power connector. It is of a size 2.5 mm center pin and 5 or 5.5 mm sleeve. This size connector is common for more powerful external power supplies.
 - d. Mount J5 for signal input. It is a stereo 3.5 mm jack type, of the same size as the headphone connectors for PCs, MP3-players, portable CDs, headphones etc.
 - e. Mount and solder the two pins of J2.
 - f. Save C1819 for later.

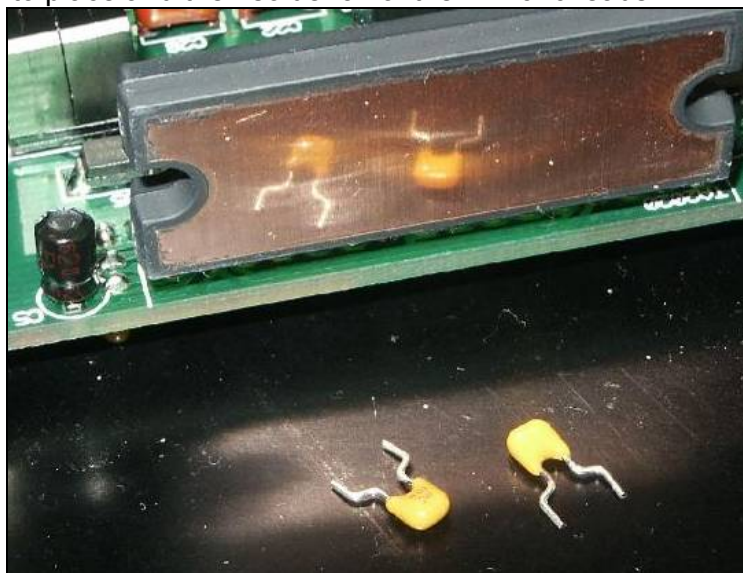


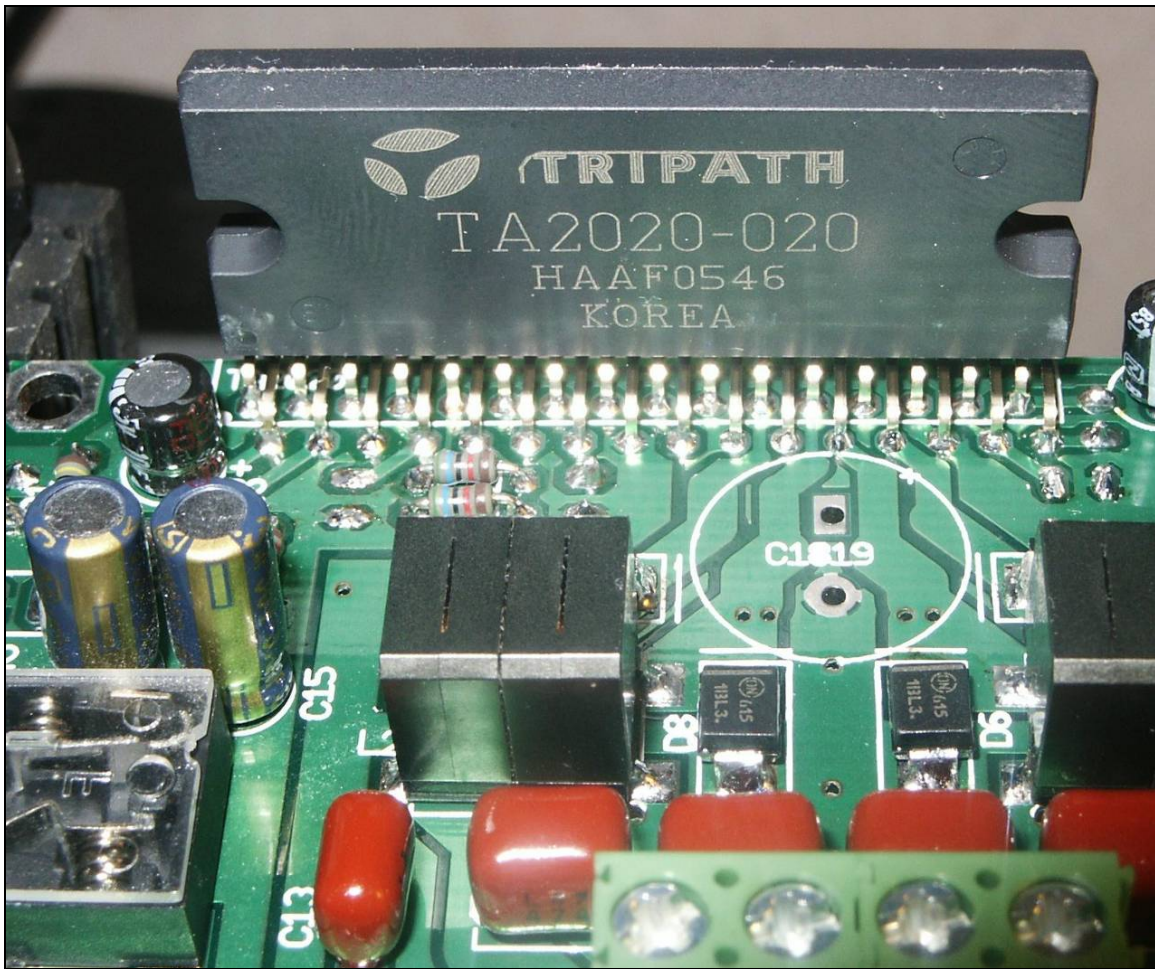
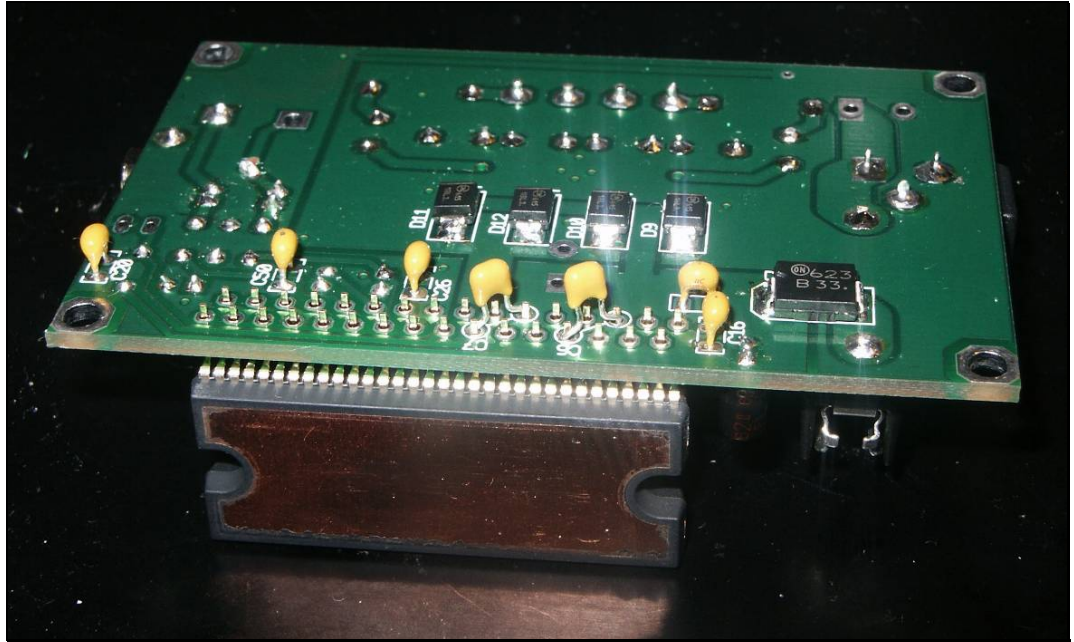




BAG 5

5. This bag contains all the components that should be handled with some ESD care, i.e. discharge yourself before touching any of them. Avoid touching any of the Tripath chip leads with your hands.
 - a. Solder the 8 diodes in place. These have a polarity as marked by a band across them. They MUST be mounted in the right direction or there will be a short circuit.
 - b. Mount and solder the C1819 capacitor from bag 4, making sure it is pushed right to the board so that the leads can not work loose.
 - c. Mount D1 which provides polarity protection for the power supply connection.
 - d. Last, mount the TA2020 chip in place. Take care getting the chip straight and orthogonally to the PCB. Solder a few of the leads lightly and mount C6 and C7 in the holes indicated on the bottom side of the board. You need to cut the leads of these capacitors before mounting them. *It is essential to mount these capacitors as close as possible to the PCB.* You will need to push them gently into place and then solder all of the TA2020 leads.





6. Last connect power connectors and you are ready for testing. For testing at low power no heat sink is required. For low to medium power applications the amplifier housing may be sufficient as a heat sink. For high power use like at full power into 4 ohm speakers, the amplifier can dissipate 20W of heat. Then, a 3 or 4°C/W heat

sink is reasonable. Running at medium or low power the amp will not dissipate a lot of heat. The heat slug of the TA2020 chip is connected to ground and does not require electrically insulated mounting. Silica heat transfer compound or similar should be used to improve cooling.

The mounting holes on the PCB are not connected to the ground plane. Pin 1 of J6 is grounded.

Trimming and testing

Always de-power the amp before doing any work! Never connect or disconnect signal connector or speaker cables with power connected as this can damage the amp. The Sleep/mute jumpers are the ONLY exception.

The Tripath TA2020 chip is rated 16V absolute maximum. About 14.0V is a reasonable maximum in real life, to allow for fluctuations. The center pin of the power supply connector J3 is positive.

Powering up for the first time

- Before connecting the power, inspect the board closely for any solder splutter or other contaminations. Clean off everything that looks suspicious. Re-do any solder joint that does not look perfect.
- Remove the jumpers from J2, if they are there, for *sleep* mode.
- Connect the power supply. When in sleep mode, the amp should draw less than one mA.
- If all seems OK, connect the J2 jumper Awake. If all is OK, connect the MUTE jumper as well (Better is to mount a switch on your amp front panel instead of this jumper, but that can be done later).
- Check the fuse. If it has blown, shut of the power, disconnect the board and check all components and solder connections. Check that the Tripath chip heat slug is not hot.
- If all seems OK, shut of the power.
- Connect the speaker wires to J1. Important: the output is bridged, so each speaker should connect to its own respective plus and minus. The minus is NOT ground and negative is NOT common for the two channels and NOT common to the power supply minus/ground.
- Connect a signal source with its ground leads to J5
- Connect a signal source and set the volume very low
- Turn on the power, awake the amp and check if you get any sound.
- If everything seems OK, you can slowly increase the power. If all is OK, switch off power, replace the power supply fuse for a larger one, rated as your transformer and try again with higher volume. For testing at higher power, the chip should be mounted on a heat sink.
- Enjoy the music!

PROBLEM SOLVING

- Nothing happens when you place the J2 jumpers in place.
 - o Check if the power supply polarity is correct
 - o Check if you have the correct voltage after the D1 diode
 - Check all soldering on the power supply and the D1 diode direction
 - Check if you have 5V over C2 (5V is from a voltage regulator in the Tripath chip)
 - Check if you have about 1.2 V over R7 (internal reference voltage for the chip)
 - Check if you have about 10V over C5 (A voltage generated in the Tripath chip)
 - Check if you have about 2.5 V to ground, after the input capacitors.
 - Redo any suspicious soldering
 - Clean the PCB and solder joints from contaminations and solder splutter
- There is a faint repeated clicking sound from the speakers when J2 are in place
 - o Something on the output section is short circuited and the amp protection mutes and tries to restart about once per second.
 - Check all soldering on the output section, so there is no short circuit
 - Check so the speaker cables are not shorted
- The sound is weak from one channel.
 - o Check if there is a 12V voltage offset on one output. In that case, an output transistor is probably damaged and the chip needs to be replaced.
- The amp plays fine but there is a hizzzzzzing sound from the speakers
 - o Check the soldering of the 0.1 uF capacitors, especially C17, C26 and C50. These caps are important for decoupling of the analogue section.
- Bass response is not so good.
 - o One speaker may be out of phase relative to the other.
 - Check the polarity of the speaker cables. Switch one to see if it gets better or worse. Speakers out of phase give a poor bass response as the sound waves counteract each other.
- The amp shuts down at moderate power, possibly with strange sounds. Starts again after power cycling.
 - o This is due to the over-current protection shutting down the amp to protect it. This can happen if a power carrying connection is bad.
 - Check all soldering on the power section, C1819, the output filter and the speaker connections.
- The amp shuts down after playing some time at high power. Starts again after a minute.
 - o The over-temperature protection shut it down.
 - Make sure the Tripath chip is properly mounted to a large enough heat sink with good thermal connection.
- The amp sounds terrible at high power.
 - o The voltage supply may not be stable at high power.
 - Try a larger power supply with the correct voltage rating.
 - o The signal source is clipping, i.e. output is higher than it can handle
 - Increase the sensitivity of the amplifier inputs by increasing the value of the feedback resistors.
 - o You are simply trying to play louder than the amp can deliver, making it clip badly. If the voltage peaks on the speaker outputs are about as high as the supply voltage, turn down the volume. It can't play louder.

- Get a bigger amp or more sensitive speakers!

If you have any questions, comments or feedback, please write in the forum on the web site <http://www.41hz.com>. You can of course also contact us at jan@41hz.com

APPENDIXES

Considerations

1. On the board there are two signal input capacitors, C14 and C15. These are required, as the amplifier is internally biased to about +2.5V. Two 3.3 uF capacitors are provided with the kit. The board provides space for RM 2.54 (100 mil) and RM5 (200 mil) lead spacing capacitors. The input capacitors form a high pass filter together with the input resistor Rin. The cutoff frequency is $F=1/(2*\pi*Rin*Cin)$ For example, with Rin = 22 Kohm and Cin = 3.3 uF, the cutoff frequency is $F=1/(2*3.14*22*0.0033) \approx 3$ Hz. The cutoff frequency is best kept at least two octaves below the lowest frequency expected. Note that a big input capacitor may contribute to startup thumps. Smaller input capacitors can be used at the expense of low frequency damping. If there is a separate woofer in your system, you could use input capacitors of 1 uF or even smaller.
2. The amplifier input stage, in the Tripath chip, is of the operational amplifier type. The maximum possible voltage the input stage should handle is about 4V peak to peak (1.41 VRMS). You can set the gain of the input stage so that it matches your signal source. The gain is calculated as for a normal inverting operational amplifier: Input Gain = $-1*Rfeedback/Rin$ [V/V]. The minus sign is due to the fact that the input stage is inverting. On the board, R2 and R4 are the Rin and R5 and R6 are the Rfeedback. With the kit, there are four 22 K Ω resistors and two 56 K Ω . With these resistor values, you can choose one of three different input sensitivities as shown in table 1. If you use other input resistors, they should be of a low noise type.

Rin	Rfeedback	Input Gain	Suitable signal source
22 K Ω	56 K Ω	-2.5 V/V	Portable MP3/CD player with built in volume control.
22 K Ω	22 K Ω	-1 V/V	General use
56 K Ω	22 K Ω	-0.4 V/V	Preamplifier with fairly high output signal

Table 1. Gain setting recommendations

R2 and R4 are the Rin and R5 and R6 are the Rfeedback

The total gain of the whole amplifier (voltageout/voltagein) is 12 times the input gain.

3. Will you use a volume control / pot? If you have a preamplifier or sound source with its own volume control, it may be best to leave out the volume pot. If not, a volume pot of 50 kohm pot would be suitable. With a volume pot, there will be some signal damping so you may need to increase the gain a little. Some examples of gain settings are given in table 1. Note that some portable players will clip badly at full volume; that is the signal source output clips, even if the power amp does not clip. In that case increase the power amp input gain.
4. Sleep/mute. The chip has a sleep and a mute function. Both can shut down the amplifier. You can reach both via the jumper J2. In sleep mode the chip draws less than 0.3 mA. If you use a power breaker or a power supply with an on/off switch, you may permanently close the J2 jumper, but there may be turn on thumps. Therefore, using a switch for the mute function is recommended rather than using a

power switch.

5. The chip mute input is also hard wired to the chip error/over-temperature sensing output on the PCB. In case a too high temperature is reached this mutes the amp. It automatically and un-mutes again when the chip has cooled down a bit. In case of over-current the amp is muted in a latched way and must then be power toggled off/on to be restarted.
6. You can use the supplied terminals, screw terminals or solder hookup wire to the PCB. Soldering is generally the best connection from an electrical / signal point of view but may be impractical. Note that you should avoid soldering on/off the cables, especially the power and speaker cables. As these cables are usually quite thick, they will require substantial heating. So repeatedly soldering these may cause the copper tracks to come off, lift, because the FRP below them is beginning to deteriorate. It is then better to unsolder/cut the "other" end of the cable or use a board connector.
7. Power supply. For testing at moderate power any 12V supply rated 200 mA or more should work. For final use, at least 25W and for 4 ohm speakers, at least 50W is recommended for high power use. The transformer / power supply would normally determine the fuse rating, if the power supply does not have built in protection. If the power supply has its own protection, the default 4A slow fuse is suitable. For a power supply without a fuse/protection, the fuse on the PCB should not be higher rated than recommended for the power supply.

Schematic of AMP6-BASIC

The schematics used for AMP6 is almost identical to the schematics in the Tripath data sheet for the TA2020 chip which is in turn more or less identical to the TA2021B chip used in our AMP3. For AMP6, the symbols / component names are the same as for AMP3/TA2021B, rather than the ones used in the TA2020 data sheets.

The schematics can be found on the downloads section of the 1Hz audio web site.

Component placement top side and bottom side

See separate file

BOM (Bill Of Materials) by packaging with comments

Q	Symbol on PCB	Value	Function	NOTE
Bag number 1				
4 Pcs.	---	Screws and nuts	Mounting of PCB	1
4 Pcs.	---	Standoffs	Mounting of PCB	1
6 Pcs.	C16,C17,C20,C21,C26,C50	0.1 uF RM 2.5	Misc. Decoupling capacitors	2
2 Pcs.	R3,R7	8.2K	Reference voltage resistor	3
2 Pcs.	R2,R4	22K	Signal input resistors	4
Bag number 2				
1 Pcs.	R1	1M	Sleep pull-up resistor	5
2 Pcs.	R5,R6	56K	Signal feedback resistors	6
1 Pcs.	C5	1 uF RM2	Charge pump capacitor	7
2 Pcs.	C14,C15	3.3 uF RM2	Signal input capacitors	8
1 Pcs.	C2	10 uF 10V	5V supply decoupling	9
Bag number 3				
2 Pcs.	R9,R10	10 ohm 1W	Output filter resistors	10
2 Pcs.	C12,C13	0.22 uF	Output filter capacitors	10
4 Pcs.	C22,C25,C27,C28	0.47 uF	Output filter capacitors	10
2 Pcs.	L1,L2	Inductor 10 uH dual	Output filter inductors	10
Bag number 4				
1 Pcs.	F1	Fuse holder and fuse	Fuse AG2 / 5x15 mm / 4A slow	11
1 Pcs.	J1	Screw terminal header	Speaker connectors	12
1 Pcs.	J3	Power Jack 2.5 X 5.5mm	Power supply jack	13
		Stereo jack 3.5 mm mini tele		
1 Pcs.	J5		Signal jack	14
2 Pcs.	J2	Header & jumper 2.5mm	Sleep and mute jumpers	15
1 Pcs.	C1819	1500 uF 16V	Main supply decoupling	16
Bag number 5 (ESD)				
8 Pcs.	D5,D6,D7,D8,D9,D10, D11,D12	Diode size SMB Ultra-fast	Output clamping diodes	17
1 Pcs.	D1	Diode size SMC	Power supply polarity protection	18
2 Pcs.	C6,C7	0.1 uF RM 5	Decoupling of power supply	19
1 Pcs.	Q1	Tripath TA2020	Tripath chip amp	20

Notes

- Standoffs lift the PCB from the base or casing to which it is mounted
- Decoupling capacitors remove unwanted high frequency disturbances from power lines
- Voltage divider for the internal reference voltage of the Tripath chip
- Input resistors limit the current of the signal source.
- Current limiting for the sleep pin.
- Feedback resistors. Together with input resistors, they set the gain of the input stage of the amplifier
- The charge pump generates a voltage 10 V higher than the supply voltage, used to drive the gates of the power transistors in the Tripath chip.
- The input capacitors block DC current from flowing between amplifier and sound source
- Decoupling of the Tripath chip 5V supply which must be very noise free
- Output filter removes high frequency noise from the switching outputs
- Fuse for protection from over-current. Use a 4A slow blow fuse of 5x15 mm / AG2 size.
- Connections for speakers. Note the polarity of the connectors
- Power supply jack. The center pin must be positive, the sleeve negative. Maximum 14V. Higher voltage can damage the amplifier.
- Stereo signal source input jack, 3.5 mm mini-tele plug.
- Sleep jumper. Close the jumper to activate the amplifier. Open it to put the amplifier in a low power sleep mode.
- Diodes that protect the Tripath chip outputs from voltage overshoots. D9, D10, D11, D12 can be omitted if the supply voltage is below 13.5V
- Polarity diode which protects the Tripath chip from wrong polarity of the power supply.

Assembly instructions AMP6-BASIC

- 19 Decoupling of main supply. The small 5mm spacing 0.1 uF capacitors must be placed very near the Tripath chip to be efficient and must be mounted and soldered with the Tripath chip as indicated on the PCB.
- 20 The Tripath chip.

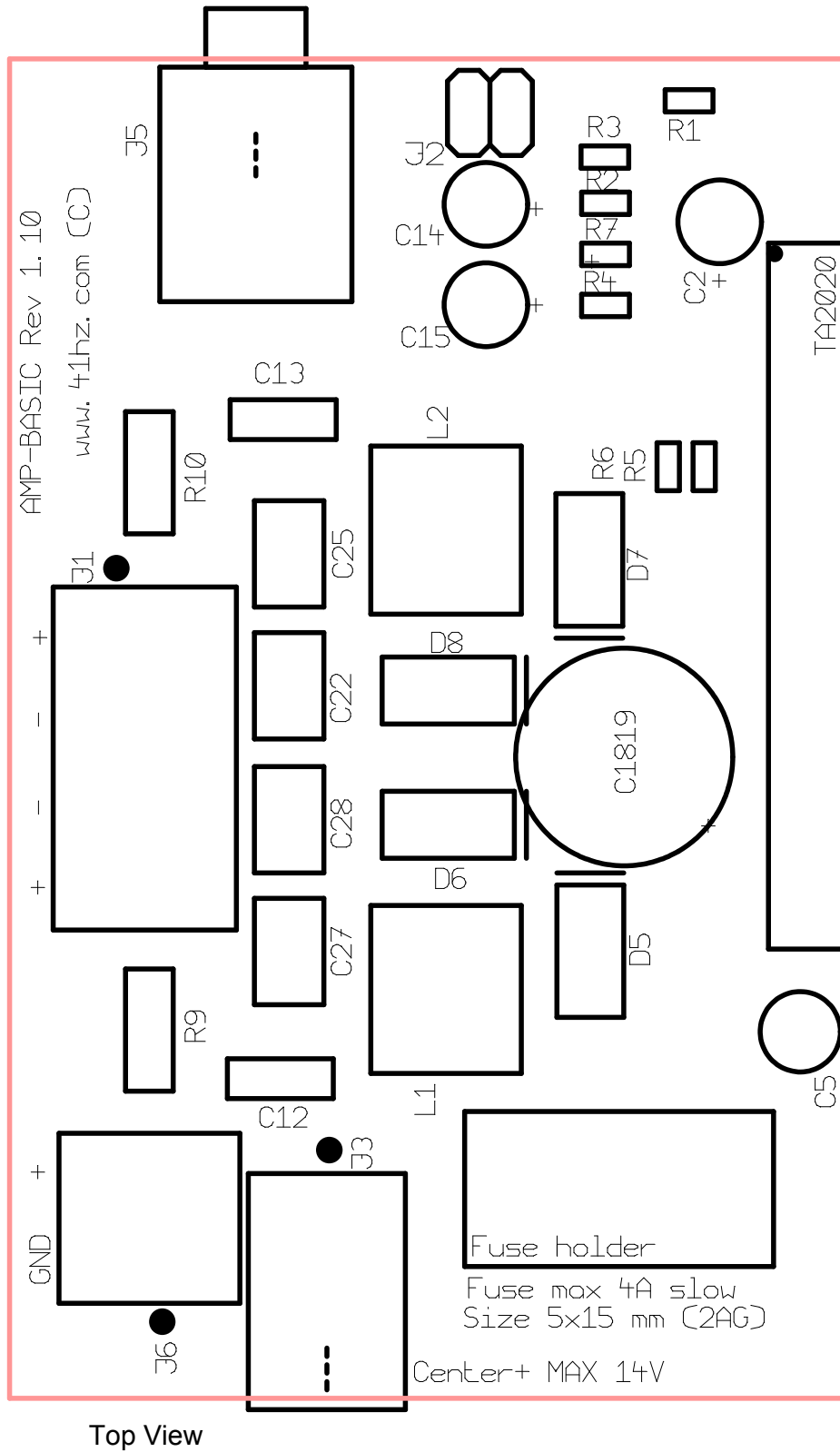
AMP6-BASIC Specifications

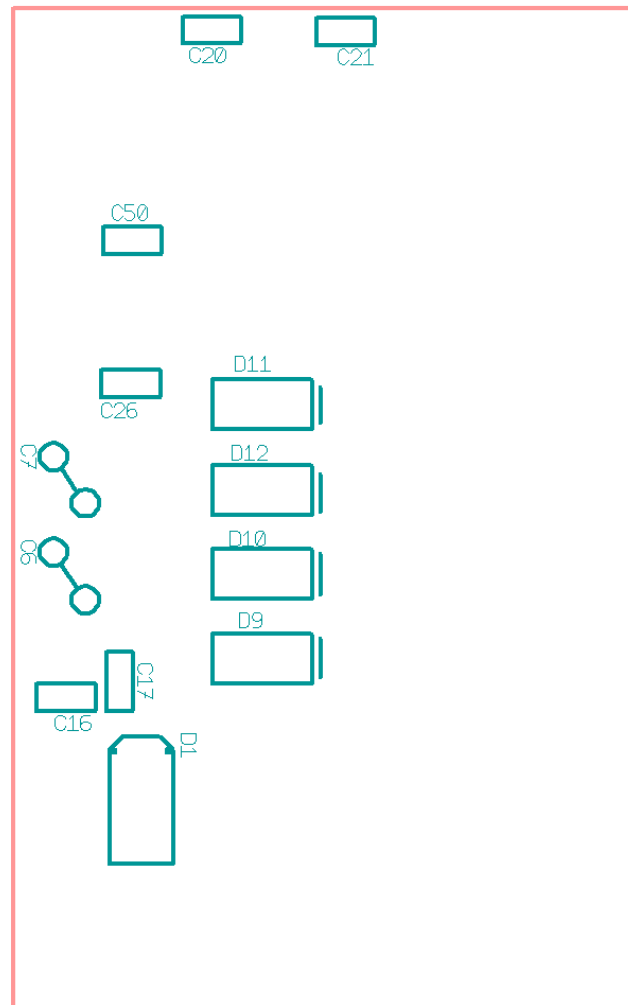
Table with typical data. For full specifications, see the Tripath data sheet for the TK2021B chip

	Min	Typical	Max
Supply voltage	9V	13.5V	14.6V
Output 8 ohm		2 x 9.5W 0.1% THD+N	2 x 14 W 10% THD+N
Output 4 ohm		2 x 15W 0.1% THD+N	2 x 25 W 10% THD+N
Efficiency		88% @ 12W 8 ohm	
Signal/Noise Ratio		100 dB @ 25W 4 ohm	
Power supply rejection	60 dB	80 dB	
Offset voltage		50 mV	150 mV
Output noise		100 μ V	
Power stage gain		12 V/V	

BOM by component name and function

Name	Value	Function
C2	10 uF 10V	+5V bulk cap
C5	1 uF	Charge pump output decoupling
C6	0.1 uF RM 5	Power supply decoupling
C7	0.1 uF RM 5	Power supply decoupling
C12	0.22 uF	Speaker output filter
C13	0.22 uF	Speaker output filter
C14	3.3 uF	Signal input cap / DC blocking
C15	3.3 uF	Signal input cap / DC blocking
C16	0.1 uF RM 2.5	Charge pump switching pin cap
C17	0.1 uF RM 2.5	+5V decoupling
C20	0.1 uF RM 2.5	Sleep jumper de-bounce
C21	0.1 uF RM 2.5	Mute jumper de-bounce
C22	0.47 uF	Speaker output filter
C25	0.47 uF	Speaker output filter
C26	0.1 uF RM 2.5	BIAS decoupling
C27	0.47 uF	Speaker output filter
C28	0.47 uF	Speaker output filter
D1	SMC Schottky diode 4A	Power polarity protection
D5	SMB Ultra-fast diode	Output overshoot protection diode
D6	SMB Ultra-fast diode	Output overshoot protection diode
D7	SMB Ultra-fast diode	Output overshoot protection diode
D8	SMB Ultra-fast diode	Output overshoot protection diode
D9	SMB Ultra-fast diode	Output overshoot protection diode
D10	SMB Ultra-fast diode	Output overshoot protection diode
D11	SMB Ultra-fast diode	Output overshoot protection diode
D12	SMB Ultra-fast diode	Output overshoot protection diode
L6	Dual Inductor 10uH	Speaker output filter inductor
L7	Dual Inductor 10uH	Speaker output filter inductor
Q1	TA2020	Tripath TA2022
R1	1 Mohm	Sleep signal pin pull-up
R2	22 K (alt 56 K)	R_input
R3	8.2 Kohm	Voltage pull-up for Mute
R5	56 K (alt 22 K)	R_feedback
R6	56 K (alt 22 K)	R_feedback
R7	8.2 Kohm	Sets reference voltage (nominally 1.2V)
R9	10 ohm 0.5W	Speaker output filter
R10	10 ohm 0.5W	Speaker output filter





Bottom View