AMP5 from 41Hz Audio

The assembly instructions are constantly under development. When your order was made, the latest available assembly instruction version was sent to you. Later versions may be downloaded from the support web site http://www.support.41hz.com

WARNING: The voltages and currents involved in building this amplifier can be lethal if not handled properly. If you do not have sufficient knowledge, do not proceed in building or using this kit. 41Hz Audio can in no way be held responsible for the consequences of the use of the kit

The kit is not suitable if you have no experience in soldering and electronics.

On delivery, check that all components have been included. If something is missing, let us know immediately, so we can replace then and/or correct the packaging.

Components packaged in an aluminized bag should be considered ESD sensitive and should be handled using normal ESD precautions.

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The layout and schematic of the AMP5 board is similar to the Tripath Reference Board for the TA2022 chip. However, AMP5 has a power supply on the board, both for the bulk supply, and the +5V power supply, and there are other differences. Most components have been upgraded compared to the Tripath Reference board. Datasheets for the TA2022 chip and the demo board are available on the 41hz.com support web site.

Optional components

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

- Transformer, AC supply nominal voltage of +/-18V_{AC} to +/-24V_{AC} is recommended. You can also use a dual DC supply of +/- 20V to +/- 35V. More about this can be found later in this manual.
- Fuse. The fuse should not be higher rated than the transformer maximal nominal load.
- Heat sink. Screws and heat conductive paste to mount the heat sink. These amps run very cool but some heatsink may be needed for high power applications.

- It is recommended that you solder hookup wires to the board. Optionally you can fit screw / solder terminals.
- A mute/un-mute switch is *recommended* for thump-less power-on. You can wire this to a switch on your panel. Optionally use a 2.5 mm jumper (50 mil) on the board.
- You can optionally fit a volume control chip DS1802 on the board. Some additional components will be needed. See the appendix.
- A hi-power kit with additional bulk capacitors and rectifier are available from 41Hz Audio. It may be useful if you plan to use the amp a lot at high power.
- You can add four protection diodes on the input, D21-D24. Use Shottky or switch diodes 1N4148 or similar. They will clamp input voltages between ground and +5V. This way the Tripath chip input is protected from excessive voltages on the inputs. The audio purist may not like this because there will be a small current leakage through the diodes. Also, if the input signal is 0 or 5V the amp will be beyond maximum power output and into a high clipping at outputs so one may think it is not needed. However, for PA and musical instruments, it could be good to add this protection, for example to protect from transients if an input cable is plugged/unplugged under power.

Soldering

The kit is not suitable for complete beginners. If you are not familiar with soldering, it is recommended that you get help from someone who knows how to do, and that you do some test soldering on a separate scrap piece of material.

The boards for AMP5 are double weight, double sided copper. Even if the PCB and components are small, quite a powerful soldering iron is very helpful. Especially components and pads connected to the ground plane require significant heating. A temperature controlled 50W soldering iron is the minimum recommended. At the same time, applying excessive heat may damage the FRP plastic of the board, causing the copper pads to come off. Preheating the board to around 100ºC will make work easier and allows using a lower solder iron temperature which decreases the damage risk. Increasing the solder iron temperature is NOT recommended as it increases the risk of damaging the board. Some information on how to solder components is available in the forum on http://www.41hz.com

Selecting the gain

The amplification, or gain, of the amplifier is set in two stages: Input stage gain and power stage gain. Optimally you should match the input gain to your signal source signal level and the power stage gain to your supply rail voltage. Just remember that music signals are very dynamic by nature, signal levels are approximate and impossible to predict accurately.

Input stage gain

In *table 1* you can see some typical input signal sources and gains you can set with the supplied components. The maximum recommended voltage *out* of the input stage is +/-2V peak to peak (1.41 VRMS), including some margin. At higher output signals, the input stage may clip.

The amplifier input stage in the Tripath chip is of the inverted operational amplifier type. The

gain is calculated as:

Gain = -1 * Rfeedback/Rin

On the board, R51 and R32 are the R_{in} and R43 and R44 are the $R_{feedback}$. With the kit, there are four 22 KΩ resistors and two 47 KΩ. With these resistor values, you can choose one of three different input gains/sensitivities as shown in table 1. If you use other input resistor values, they should be of a low noise type. I recommend metal film resistors.

Table 1. Input stage gain setting recommendations

R_{in}	**$R_{feedback}$**	**Gain [V/V]**	**Suitable signal source**
22 KΩ	47 KΩ	-2.1	Direct connection of portable MP3/CD player with built in volume control or via a passive volume pot.
22 KΩ	22 KΩ	-1	General use
47 KΩ	22 KΩ	-0.47	(Pro) preamplifier with fairly high output signal

Modulator gain

The "modulator gain" is the power stage voltage gain. You can select this to match your power supply voltage, by selecting the value of the modulator feedback resistors R31, R37, R41 and R52. The supplied value fore these is 8.2Kohm. Each of these has a 1Kohm In series (R311, R371, R411, R521). So for the supplied values, the feedback resistors are total 9.2Kohm. *Table 2* gives some values for modulator feedback resistors and the rail voltages they are suitable for. If you use other resistor values than the supplied, you should use 1% tolerance resistors, preferably of the metal film type.

Table 2. Modulator / power stage gain

R_{mfb}	**Gain [V/V]**	**Suitable rail voltage**
6.8+1=7.1 KΩ		+/-20V to +/- 27V
8.2+1=9.2 KΩ		**+/-25V to +/- 32V**
10+1=11 KΩ		+/-28V to +/- 35V

The total gain is the input stage gain multiplied by the modulator gain. If we assume you have selected the input stage gain, as you normally should, for a maximum +/-2V output, then the maximum output voltage to the speakers will be 2x the modulator gain. For example with 10 kOhm feedback resistors, and +/-2V from the input stage, you would have +/- 38.6V out maximum. You can see that the calculated maximum output can be higher than the rail voltage. In reality, the output voltage can only be as high as the rail voltage, or actually a little lower. Therefore there will be some clipping of the highest peaks at the maximum input signal. This is quite OK and assures you can reach maximum output power at near the maximum input volume setting. If you decrease the modulator gain, you will not reach maximum power/clipping even at maximum input signal. If contrary, the modulator gain is too high, you will reach maximum output before the input stage is at full signal. The disadvantage here is that at low volume, the signal voltage will be very low, and the background noise may be higher than it could be.

Summary on selecting the gain

- *Select **input gain** to match the music source signal level*
- *Select the **modulator gain** to match the supply rail voltage*

Table 3. Gain setting; summary

Input stage gain	**Result**
Input Gain to low	Maximum output is to low. Amp may not reach full power.
Input Gain correct	Output from input stage is +/-2V peak to peak at full input volume
Input gain to high	Input stage clips before maximum output power is reached
Power stage gain	
Modulator gain to low	Output never reaches maximum power, even with maximum input signal
Modulator gain correct	Output clips slightly with a main stage input signal of around +/-2V
Modulator gain to high	Input stage is operating at low voltage; possibly increased THD+N at low power levels. Output may clip excessively at full volume.

In the data sheet for the Tripath TA2022 chip there are more details on how to calculate the gain.

Power supply

The TA2022 chip in AMP5 requires a dual rail power supply plus a stabilized +5V 100 mA supply. The rail voltages could be +/-20V to +/-35V. Higher voltage gives a higher possible maximum power output. The limitations are about +/-35V upper limit voltage and the chip has an internal current limiting set at about 7.5A. With 4 ohm speakers or 8 ohm bridged mono, +/-31V is the maximum recommended by Tripath, to avoid tripping the over-current shutdown at high power. With 8 ohm loads, +/- 35V can be used without tripping the over-current limit. Toroid transformers are available with standard values. Nominal voltages of +/-18V_{AC} to +/-24V_{AC} are common. When rectified, this will give about +/-24V_{DC} to +/-33V_{DC}. Note that transformer voltages are given for full rated power. At low power, the voltage will be slightly higher. For maximum power into 4 ohms, a 2x22VAC transformer would be about ideal, while for 8 ohms, 2X24V would be about the maximum.

The VA (power) rating depends on the voltage rating and the load impedance. At the upper end, with a +/-24V_{AC} transformer (which is slightly high as seen above) and 4 ohms speaker load or a 8 ohm bridged load, a VA rating of 300 VA(≈300Watt), or even more, is reasonable, while a with +/-18V_{AC} transformer and 8 ohm loads, as low as 80 VA may be sufficient.

Generally, the higher transformer VA rating, the better, as it is more stable, “stiffer”, and runs cooler. The only drawbacks are price, size and weight. But there may not be mush advantage going to very high VA values.

Bulk capacitors of 10.0000 uF per side are included with the kit. There is space for two 10.000 uF capacitors per side on the PCB, and this is useful for very high power applications. A kit with two more 10.000 uF capacitors and an extra rectifier is available from 41Hz Audio.

The power ground of the PCB is normally grounded into one point with the mains ground (earth) and to the housing ground.

Mains power is lethal! If you are not professionally qualified to work with mains power, get help from someone who is!

The +5V is used for the analogue input amplifier and the in-chip digital parts of the TA2022. It needs to be well stabilized and well bypassed. On the board there is a regulated supply for the +5V. It uses a LM317 voltage regulator and taps from the positive main supply. The +5V should not draw more than about 60 mA. A jumper J10, can break the +5V supply which can be useful when testing.

Hookup and shielding.

Switched mode amplifiers are a bit noisy by nature, in the sense that they emit EMI that is generated by the high power, high frequency output transistors. This can be transmitted via cabling or as radiated in the atmosphere and picked up by other equipment like radios, preamplifiers etc or by the amplifier inputs. It is therefore recommended that some precautions are taken. The most important is that the amp is housed in a metal/shielded casing.

Proper grounding is also important. Note that input ground should be taken to the board J2 connector ground, not to the housing or power supply ground. The speaker returns should lead to J3 ground, not to the casing or power supply ground.

It is strongly recommended that hookup cable for the signal input is shielded and as short as possible so that it does not pick up noise from the outputs. Input cables should lead away from the outputs as far as possible.

Speaker cable and power cables should be twisted to limit EMI radiation. All cables should lead the shortest way out of the casing.

For most users, using shielded cables and a metal housing provides sufficient EMI damping. If this is not the case for you, for example if you get disturbances on radio receivers, damping can be used on the cables. The amplifier inputs can be decoupled with 100pF capacitors on the RCA connectors, between “ground and live”. The two 100 pF can also be placed on the PCB of AMP5. On the speaker outputs, and power rail connections, capacitors of 1000pF can be placed between ground and live. These should be where the cable enters the amp housing. Two 100pF and four 1000 pF capacitors are included with the kit for this. Note; while the speaker returns are “ground” you should connect them to the PCB, and not to the amp housing. The same is true for signal inputs; lead the grounds of the inputs to the input jumper on the PCB rather than to the amp housing.

The TA2022 copper slug on the back of the chip is connected internally to the chip ground. Therefore, it is not required to have electrically insulating mounting of the chip to the heat sink. However, it may be better to use insulation for two reasons; one is to avoid ground loops and the other is top reduce EMI from the heat sink. Some experimentation is recommended and feedback on this would be appreciated.

Wind the toroid inductors.

The toroids used by Tripath are T68-2 size. With the AMP5 kit, slightly larger T80-2 for better linearity / lower load and allowing thicker copper wire for lower resistive loss. The number of turns is related to toroid cross section area and toroid material (which has some tolerance batch to batch) to get the right inductance. With the T80-2 size inductors included in the AMP5 kit you should use about 44 turns of wire to get 11 uH (10-12 uH is acceptable). Wind as tight as you can. Tight winding minimizes HF signal leakage from the inductors. With the supplied 0.7 mm wire, you can wind the 44 turns in a single layer before coming back to the starting point. The first turns where probably not so neat so when you have finished the turns, unwind the first ones and redo them. If you have an inductance meter, measure the value and adjust if required.

The relay

The supplied relay is for nominally 24 Volts. It is fairly tolerant to lower and higher voltages. Voltages from 22V to 28V over the coils should be acceptable. The R60 resistor is in series with the relay, and they are fed from positive rail to ground via MOSFET U4 acting as a switch, controlled by the HMUTE output from the Tripath chip. The relay has a resistance of 1.5K, so with the supplied 220 ohm for the R60, there is 1.72 K in total. With a rail voltage of +30 V, this gives a current of around 17 mA. A 17 mA over 220 ohms is about 0.06W, so a 0.25W resistor is quite enough. There is space for a larger resistor in case you want to use another value for R60.

Rail voltage	R60 value	Voltage over relay	Suitable rail voltage
+24V	22	24V	+20V - +27V
+30V	**220**	**26V**	**+27V - +32V**
+35V	560	25.5V	+28V - +36V

Suitable values for R60

Assembly instructions AMP5 V1.0 © 41Hz Audio / Jan Fredriksson

Mounting the components

1. First mount all the 0.1 uF capacitors *except* the two RM5 / 100 V capacitors C44 and C45. These will be mounted with the Tripath chip later. The small capacitors are best mounted from the back of the board. Also mount the other capacitors that are indicated on the back of the board. Note: all holes are plated through, and the finished soldering should look more or less the same on both sides of the board.

2. Mount all resistors.

3. Mount the diodes. *Important: observe the direction of these*. The line across the diodes goes on the end with the triangle mark on the PCB. Reversing a diode most likely damages the Tripath chip at power-up.

4. Mount the input capacitors. The ones supplied are Panasonic FC type, 3.3 uF. There is space for alternate capacitors here. For a full range system, 2.2uF or 3.3 uF are recommended. For systems with a separate woofer amp, this amp active for middle / high range, you can use 1.0 uF or even less.

5. Mount the other electrolyte capacitors. *Note that these all have a polarity that must be respected.* Reversing a capacitor can damage the Tripath chip at power-up.
    a. Note that C29 may need to be removed for access to the Tripath mounting screw / hole, unless the screw is mounted from the outside.
    b. Also C60 may need to be removed for access to the mounting screw for the rectifier, D98/D99.
    c. If two 10.000 uF caps are used, you can mount these in C61 and C62 while leaving C60 and C63 unpopulated. If using four capacitors, you can leave two out for the first tests.

6. Mount L11, the axial choke that connects the ground plane from the analogue and power sections. Mount the L4 radial inductor. There is space for a toroid inductor here, if you would like to replace the one supplied. It should be rated for 400 kHz and at least 0.25A

7. Mount the two trimmer pots. Set them approximately at center setting.

8. Mount the LED

9. Mount the voltage regulator U5. The flat surface / heat sink side of U5 should face towards the edge of the board / J2.

10. Mount the rectifier. If you use two, you can leave out one for the first testing.

11. Now, you can test the power supply.

IF YOU ARE NOT QUALIFIED TO INSTALL MAINS POWER CONNECTIONS;

GET QUALIFIED HELP: MAINS POWER IS LEATHAL

Leave J10 open. This jumper separates the +5V from the "chip side" of the board, so the +5V can be tested without connecting the rest of the board. Note; do not remove this jumper for testing, once the Tripath chip has been soldered on as this may cause damage. Connect the transformer. Have a *slow blow* fuse of 200-300 mA on the primary side of the transformer. *A larger fuse may be required if you have a large transformer. Large toroid transformers have a very high current peak for a few milliseconds at startup. If you have mounted dual bulk capacitors, can also require larger fuses. However, a larger fuse implies degraded protection.* Check if the +5V is OK. The value should be between 4.9V and 5.1V. The actual value is not critical, but it is critical that it is stable. DO NOT PROCEED FURTHER UNTILL THIS TEST HAS PASSED. If the fuse blows, look for bad soldering and check if the diodes are in the right direction. If you need support, you can always post a question on the support site http://www.support.41hz.com or look in the forum on the web site.

See also the problem solving appendix

DO NOT CONNECT OR DISSCONNECT ANYTHING TO / FROM THE BOARD WHILE UNDER POWER: THIS MAY DAMAGE THE AMP. ALWAYS DE-POWER BEFORE CHANGING ANY CONNECTION, *INCLUDING INPUTS*.

12. If all is OK, discharge the capacitors, for example with a 1K resistor. Mount the relay and the output filter capacitors C37, C38, C39 and C40. Mount the toroids. Pull these snugly to the board before soldering. You can also glue them to the PCB (and to the relay) width a small amount of temperature resistant glue, to prevent them from working loose. Silicone based glues are often suitable.

13. Now mount the Tripath chip. There are two capacitors, C44 and C45, (0.1 uF RM5 /200 mil) which should be mounted from the back of the board into the holes of the rail power supply of the Tripath chip. The two components are marked on the back of the board as a line with circles at the ends. The name of the two capacitors components are not printed on the PCB. It is essential that the leads of these capacitors are kept as short as possible. Check that the Tripath chip is at right angle to the PCB before soldering. Soldering the ground pins of the chip requires quite a lot of heat but take care to work quite fast so the FRP is not damaged.

14. Close the J10 jumper. This connects the +5V to the chip etc.

15. Connect the MUTE switch or jumper to J2. Connecting pin 11-12=MUTE, pin 10-11= unmute. Set the mute switch to MUTE position. Leaving this jumper open leaves the amp in an undefined mute state.

16. Connect the power again. Maintain a small fuse. The led should go on. If not, something is wrong. Search!!!!!

17. If the fuse is OK, and the LED on, set the MUTE switch to awake (or move the jumper on J2 to pin 11 - pin 10). There should be a click from the relay and the LED should go off. If not, try adjusting the offset trimmer pots a bit. If offset is badly off, the amp may not un-mute.

18. If all seems OK, trim the trimmers until the speaker outputs are as close to zero as possible. It should be possible to trim to less than 10 mV from zero.

19. MUTE the amp, de-power. Connect speakers and sound source.

20. Solder wire jumpers on R100 and R101, if not already done. These are possibly replaced by resistors if the onboard volume control chip is used.

21. Solder jumper wire on J8 from pin 2-3 and pin 4-5. This bypasses the volume control chip. If you use a volume control chip, instead join 1-2 and 5-6. See the appendixes for full jumper listings.

22. Power on. Un-mute. Check if all seems OK.

23. If all seems OK, change to a fuse selected as for the power rating of your transformer.

24. Enjoy the music! And please write some feedback in the http://www.41hz.com forum or by email.

APPENDIX 1 Problem solving

First power up, without Tripath chip and J10 open

Problem: Fuses blow. I do not get +5V after the regulator.

If the fuse blows, check that no diode or electrolytic capacitor has been reversed. A large toroid transformer has a very high startup current peak. A slow fuse is a must and a larger fuse may be required. As an alternative, you can use a small “wall wart” power supply with at least 9V, and at least 200 mA and connect this to J3. Connect minus of the power supply to pin 6 (marked GND) and plus to pin 7 (marked AC1).

- Check that you have positive voltage (8 to 35V) on the positive main rail, for example over one of the bulk capacitors.
- Check that you have a DC voltage over C150 which is the input cap to the +5V regulator.
- Check that the regulator has not been reversed. The flat side of the regulator should be on the side marked with a double line on the PCB. Check that R151, R152, R153 are right. Note +5V is available on pin 12 of J2 but not until J10 has been closed.

5V is OK, Tripath chip in place and J10 closed

Problem: LED goes on at power-up, but dos not go off at un-muting. Relay does not close.

- Check that voltages on both rails are within limits. They should be between +/-24 and +/-35V, otherwise the amp will not un-mute.
- Adjust the trimmers and try again (nominally set them in center position). If offset is big, the amp may not un-mute.
- Check if there is about 1.2 V over *REF* which is R42.

Problem: LED goes off at un-muting. Relay does not close.

- Check if there is a voltage over R155. It should be 0 when muted, +5V when un-muted.
- Check if there is a significant voltage change over the relay coil (the two relay pins towards the center of the board), when un-muting. The relay needs about 20V to close. If the voltage is low (i.e. rail voltage is close to 25V), replace R60 with a smaller resistor, 10 to 47 ohms which increases the relay coil voltage

Amp un-mutes, relay closes

Problem; No sound

- Check if there is about 10V over C34, which is the VN10 bulk capacitor. 9 to 12V is OK.
- Check if there is +2.5V on the chip side of the input caps to ground (Input caps are C35 & C36)
    - Note: Touch Ground with your probe just before measuring. An ESD discharge from the probe can cause damage to the chip input)
- Are signal source and speakers connected?

Amp un-mutes, relay closes

Problem: Sound, but with noise

- Proper grounding is essential due to the somewhat noisy nature of the switching section.
- Signal sources should be connected with its ground to J2. Use shielded cables. Microphone type cable is usually usable. Ethernet type cable can be an alternative. Make sure no signal leads are near the power section.
- Make sure speakers are grounded to J3, RET1 and RET2, not to chassis.
- Connect transformer ground and chassis ground/earth to J3 PGND with heavy duty wire.
- Go over the soldering of the 0.1 uF capacitors. Especially C48.
- Check that toroids and output filters are properly soldered.
- Put some distance between amp and transformer.
- If there is a ringing of around 2 kHz; check L4, if the tone changes when placing for example a screw diver near L4. This is an inductor for the built in VN10 generator. This is a small SMPS, running at 400 kHz. The L4 is the exact part number recommended by

Tripath. However, it is an axial choke that seems to emit some disturbances, for some users, with some signal sources.
    - Arranging cables properly and using shielded hookup cable seems to help.
    - Grounding the Tripath chip slug may help.
    - Using a larger C34 may help

  If none of this helps, we are investigating alternate shielded type inductors. Contact 41Hz Audio for a replacement.
- Put the amp in a shielded enclosure.

The amp will be very quiet when everything is OK.

APPENDIX 2 Connectors / jumpers

J2

Pin	Mark	Description
1	In1	Analogue signal input channel 1
2	G1	Analogue ground (for input 1)
3	G2	Analogue ground (for input 2)
4	In2	Analogue signal input channel 2
5	Up	Volume up (with volume control chip installed)
6	Dn	Volume down (with volume control chip installed)
7	B1	Balance > (with volume control chip installed)
8	B2	Balance < (with volume control chip installed)
9	HMUTE	Hmute output. Can drive LED, with 2.2K in series, if onboard LED is removed.
10	Awake	AGND (for unmute)
11		MUTE input. Unmute when tied to pin 10, mute when tied to pin 12
12	Mute	+5V (for mute)

J3

Pin	Mark	Description
1	Ret2	Speaker return / ground 2
2	Out2	Speaker output 2
3	Ret1	Speaker return / ground 1
4	Out1	Speaker output 1
5	PGND	Power Ground (to transformer / chassis)
6	PGND	Power Ground (to transformer / chassis)
7	AC2	AC / Secondary winding of transformer 2
8	AC1	AC / Secondary winding of transformer 1

J5

Pin	Mark	Description
1		Analog ground (for pin 2)
2		Mode selector for DS1802 volume chip (see DS1802 data sheet)

J7

Pin	Mark	Description
1		RST for DS1802 volume chip (see DS1802 data sheet)
2		D for DS1802 volume chip (see DS1802 data sheet)
3		CLK for DS1802 volume chip (see DS1802 data sheet)

J8

Pin	Mark	Description
1		W1 from DS1802 volume chip (see DS1802 data sheet)
2		INV1 to Tripath TA2022
3		From input 2 (C35)
4		From input 1 (C36)
5		INV2 to Tripath TA2022
6		W2 from DS1802 volume chip (see DS1802 data sheet)

J10

Pin	Mark	Description
1		+5V from regulator U5
2		+5V to Tripath chip etc

APPENDIX 3 Bill of Materials (BOM)

The component names for AMP5 are as far as possible identical to the ones used in the Tripath data sheets for the TA2022 chip and the reference board for the TA2022

AMP5 Bill Of Materials

Name	Value	PACKAGE/FOOTPRINT	Short explanation	Note
C150	220 uF 50V	CAP10MM_RAD	Bulk supply input decoupling to +5V	
C151	0.1 uF 50V	CAP_RM2.5	Decoupling of +5V regulator	
C152	0.1 uF 50V	CAP_RM2.5	Decoupling of +5V regulator	
C153	10 uF 10V	CAP6MM_RAD_RM2.5	Stabilizing of +5V regulator	
C154	1000 uF 10V	CAP8MM_RAD_RM3.5	Bulk capacitor of +5V	
C155	10 uF 10V	CAP6MM_RAD_RM2.5	Decoupling of +5V volume control	2
C27	47 uF 25V	CAP6MM_RAD_RM2.5	Bulk bootstrap capacitor	
C28	47 uF 25V	CAP6MM_RAD_RM2.5	Bulk bootstrap capacitor	
C29	470 uF 50V	CAP12MM_RAD	Supply decoupling for the power supply pins.	
C30	100 pF	CAP_RM2.5	Input EMI suppression cap	
C32	470 uF 50V	CAP12MM_RAD	Supply decoupling for the power supply pins.	
C33	0.1 uF	CAP_RM2.5	Decoupling of VN10	
C34	100 uF 35V	CAP8MM_RAD_RM3.5	Filter of VN10	
C35	3.3 uF	CAP6MM_RAD_RM2.5	Input capacitor	
C36	3.3 uF	CAP6MM_RAD_RM2.5	Input capacitor	
C37	0.22 uF 50V	CAP_RM5	Output filter capacitor	
C38	0.22 uF 50V	CAP_RM5	Output filter capacitor	
C39	0.22 uF 50V	CAP_RM5	Output filter capacitor	
C40	0.22 uF 50V	CAP_RM5	Output filter capacitor	
C41	0.1 uF	CAP_RM2.5	Bootstrap capacitor	
C42	0.1 uF	CAP_RM2.5	Bootstrap capacitor	

C43	0.1 uF	CAP_RM2.5	VN10 generator feedback capacitor.	
C44	0.1 uF 100V	CAP RM5	Rail to rail supply capacitor	3
C45	0.1 uF 100V	CAP RM5	Rail to rail supply capacitor	3
C441	0.1 uF	CAP_RM2.5	Decoupling of VNN	
C442	0.1 uF	CAP_RM2.5	Decoupling of VPP	
C452	0.1 uF	CAP_RM2.5	Decoupling of VPP	
C46	330 pF	CAP_RM2.5	Feedback delay capacitor (C46 and C47 have different values)	
C47	390 pF	CAP_RM2.5	Feedback delay capacitor (C46 and C47 have different values)	
C48	0.1 uF	CAP_RM2.5	Bisacap, bias voltage filter / decoupling	
C49	0.1 uF	CAP_RM2.5	Decoupling of +5V	
C491	0.1 uF	CAP_RM2.5	Decoupling of +5V	
C60	10.000 uF 50V	CAP30MM_RAD	Bulk capacitor	
C61	10.000 uF 50V	CAP30MM_RAD	Bulk capacitor	
C62	10.000 uF 50V	CAP30MM_RAD	Bulk capacitor	1
C63	10.000 uF 50V	CAP30MM_RAD	Bulk capacitor	1
C76	100 pF	CAP_RM2.5	Input EMI suppression cap	
D1	MUR120	DIODE_4001	Output diode	
D11	MUR120	DIODE_4001	Output diode	
D12	MUR120	DIODE_4001	Output diode	
D13	MUR120	DIODE_4001	Output diode	
D150	N4001	DIODE_4001	Supply to +5V	
D21	1N4148	DIODE_RM5	Protection of volume control chip	2
D22	1N4148	DIODE_RM5	Protection of volume control chip	2
D23	1N4148	DIODE_RM5	Protection of volume control chip	2
D24	1N4148	DIODE_RM5	Protection of volume control chip	2
D5	MUR120	DIODE_4001	Protection of +5	
D8	MUR120	DIODE_4001	Bootstrap diode	
D9	MUR120	DIODE_4001	Bootstrap diode	
D98	RECT_GBU	RECTIFIER_LINEAR_PKG	Main rectifier bridge	
D99	RECT_GBU	RECTIFIER_LINEAR_PKG	Main rectifier bridge	1
J10	Jumper	Jumper	+5V test jumper	
J2	CONNECTOR 2.54X8	PINCONNECTOR2_54_X8	Low level signal connector	4
J3	CONNECTOR 5.08X8	PINCONNECTOR508_X8	Power input / speaker output connector	4
J5	CONNECTOR 2.54X2	PINCONNECTOR2_54_X2	Mode selector for volume chip	2, 4
J7	CONNECTOR 2.54X3	PINCONNECTOR2_54_X3	Digital input for volume control	2, 4
J8	CONNECTOR 2.54X6	PINCONNECTOR2_54_6	Mode selector with/without volume control chip	2, 4
L11	Axial choke	DIOD_4001_RM7.5	Ground plane separator choke	
L4	100 uH 2A	CAP10MM_RAD	VN10 generator filter inductor.	
L5	TOROID_T80	TOROID_T80	Speaker output filter inductor	
L6	TOROID_T80	TOROID_T80	Speaker output filter inductor	
LED1	LED	LED1ST	LED	
R100	0 ohm jumper	R04W_RM5	Jumper or attenuation resistor for input signal. Close with wire for normal use	2
R101	0 ohm jumper	R04W_RM5	Jumper or attenuation resistor for input signal. Close with wire for normal use	2
R150	47 ohm 1W	R1W_RM10	Voltage drop and LP filter for +5V regulator	
R151	560 ohm	R04W_RM5	Set point resistors for +5V regulator	
R152	220 ohm	R04W_RM5	Set point resistors for +5V regulator	
R153	100 ohm	R04W_RM5	Set point resistors for +5V regulator. R151 and R153 are in series	
R155	220 Kohm	R04W_RM5	Pull up for U1 (Relay)	
R201	1 K	R04W_RM5	Voltage divider for volume control	2
R202	1 K	R04W_RM5	Voltage divider for volume control	2
R203	1 K	R04W_RM5	Voltage divider for volume control	2
R204	1 K	R04W_RM5	Voltage divider for volume control	2
R30	1 K	R04W_RM5	Feedback divider resistor connected to V5.	
R31	8.2 K	R04W_RM5	REF, sets internal reference voltage	
R311	1 K	R04W_RM5	Feedback second resistor	
R32	22 K	R04W_RM5	Rin	
R33	1 K	R04W_RM5	Feedback divider resistor connected to V5.	

R34	1 K	R04W_RM5	Feedback divider resistor connected to V5.	
R35	1 K	R04W_RM5	Feedback divider resistor connected to V5.	
R36	1.2 K	R04W_RM5	Feedback divider resistor connected to AGND.	
R37	8.2 K	R04W_RM5	Feedback, in series with R371	
R371	1 K	R04W_RM5	Feedback second resistor	
R38	1.2 K	R04W_RM5	Feedback divider resistor connected to AGND.	
R39	1.2 K	R04W_RM5	Feedback divider resistor connected to AGND.	
R40	1.2 K	R04W_RM5	Feedback divider resistor connected to AGND.	
R41	8.2 K	R04W_RM5	Feedback, in series with R411	
R411	1 K	R04W_RM5	Feedback second resistor	
R42	8.2 K	R04W_RM5	REF, sets internal reference voltage	
R43	39 K	R04W_RM5	Rfeedback	
R44	39 K	R04W_RM5	Rfeedback	
R45	220 K	R04W_RM5	Voltage sense, in series with R451	
R451	27 K	R04W_RM5	Voltage sense second resistor	
R46	220 K	R04W_RM5	Voltage sense, in series with R461	
R461	27 K	R04W_RM5	Voltage sense second resistor	
R47	270 ohm	R04W_RM5	Bootstrap resistor	
R48	270 ohm	R04W_RM5	Bootstrap resistor	
R49	5.6 K	R04W_RM5	Resistor that limits the manual DC offset trim range	
R50	1 K	R04W_RM5	VN10 generator feedback resistor.	
R51	22 K	R04W_RM5	Rin	
R52	8.2 K	R04W_RM5	Feedback, in series with R521	
R521	1 K	R04W_RM5	Feedback second resistor	
R53	5.6 K	R04W_RM5	Resistor that limits the manual DC offset trim range	
R54	50 K trimmer	TRIM_3_RM5_D8	Offset trimmer resistor	
R55	50 K trimmer	TRIM_3_RM5_D8	Offset trimmer resistor	
R56	5.6 ohm 2W	R1W_RM10	Output filter resistor	
R57	5.6 ohm 2W	R1W_RM10	Output filter resistor	
R60	220 ohm	R1W_RM10	Voltage drop for relay (0.4W resistor on 1.0 W footprint)	
R70	2.2 K	R04W_RM5	Current / voltage limiter for LED	
R80	10K	R04W_RM5	Discharge of VNN	
R81	10K	R04W_RM5	Discharge of VPP	
Relay1	RELAY 2x8A	RELAY	Output relay	
U1	2N7000	TO-92	Relay driver	
U2	Tripath TA2022	SSIP 32	Main Tripath chip	
U3	DS1802	DIL20	Volume control chip	2
U4	2N7000	TO-92	Relay driver signal inverter	
U5	LM317	TO220	Voltage regulator for +5V	
	1000 pF capacitors 4 pcs		These are for damping EMI from being lead out with the speaker and power cables. These capacitors can be mounted where the cables leave the amp housing, from each lead, to ground (housing). One for each speaker lead, one for each side of the power supply.	

NOTES

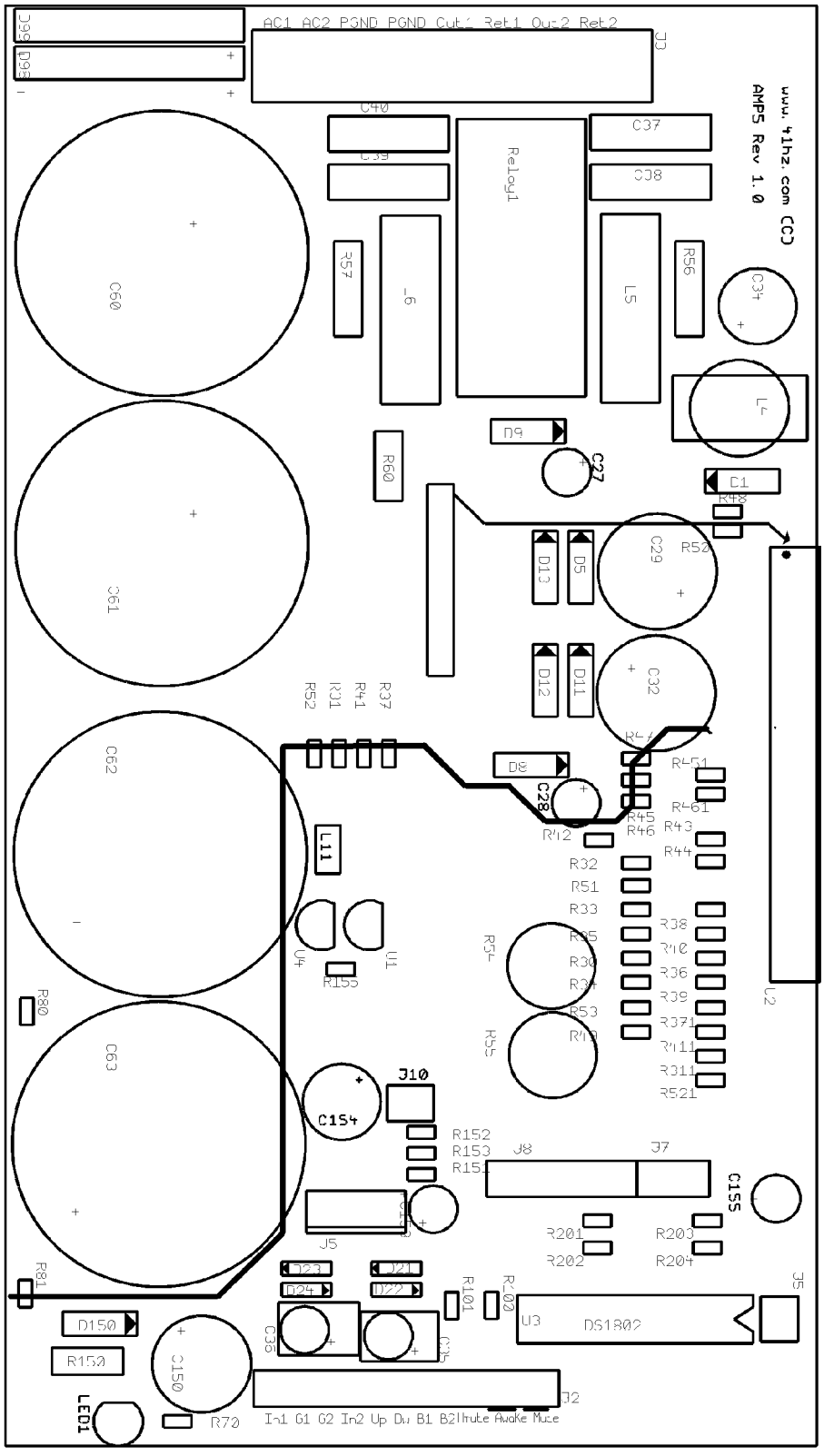
Note = 1, Component in Hi-power kit only

Note= 2, Component in / for volume control kit only

Note= 3; Component name is not on the PCB. These capacitors are placed in the holes of the TA2022 chip as indicated on the back of the PCB. The leads should be as short as possible.

Note = 4, Component not in kit. Solder with wire or as appropriate in the application.

APPENDIX 4 Component placement top side



Component placement bottom side