

# **Truepath Assembly Instructions**

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The Truepath is an advanced high power amplifier. Building this amplifier is not for “beginners”. It is assumed that you have thorough knowledge about electronics and building electrical and electronic devices.

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

## Assembly instructions for Truepath

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

On delivery, check that all components have been included. If something is missing, let us know immediately. A bill of material (BOM) should have been included with your delivery and is downloadable from the web site.

Download the data sheet for the Tripath TA3020 reference board, as the schematic and layout of Truepath is similar. However, component specifications and values may differ. Generally, better components are delivered with the Truepath kit than specified for the reference board. The data sheet for the TA3020 is another useful source of information.

### ***Considerations before you start***

The Truepath kit is designed for certain operating conditions. Depending on the way you will use it, there will some considerations are left to you. The Truepath kit is intended for supply voltages of about +/- 40V to +/- 50V and four ohm or eight ohm speaker loads. With eight ohm loads, +/- 60V supplies can be used, with only minor changes. Power supply voltages or impedances outside this range may require changing of some components. If you want to use the Truepath board with 4 ohm loads and voltages higher than +/-50 and thereby very high power outputs, you may also need to update some components. Also for lower voltages, you should change a few component values. With the supplied components you will have the following:

- Current limiting is set to 10A. You may want to increase or decrease this depending on your application.
- Voltage limiting is set to about +/-33 to +/-70 V. You may want to change this. Note that supply voltages between +/-40 to +/- 60V are still recommended with the components in the Truepath kit.
- Input sensitivity. With the supplied components the amplifier is optimized for a nominal average signal of 1.23V RMS at full power. This is the standard signal level for most pro audio equipment and some HiFi preamplifiers. Domestic audio devices and portable players without a preamplifier typically have a lower signal level and for those, a higher input sensitivity setting in Truepath may be required.
- Modulator gain (power stage gain) is selected so that the amplifier will start clipping at 2V RMS signal input with a +/-45V supply and the suggested input sensitivity. You may want to fine tune this.

Please read more about how to fine tune the Truepath kit in APPENDIX 2.

The TA3020 chip will dissipate some heat and must be kept cool, but does normally not require a heat sink.

If you are not familiar with soldering surface mount components, it is recommended that you do some test soldering on a separate scrap piece of material. Preferably buy some simpler kit or components and practice on these.

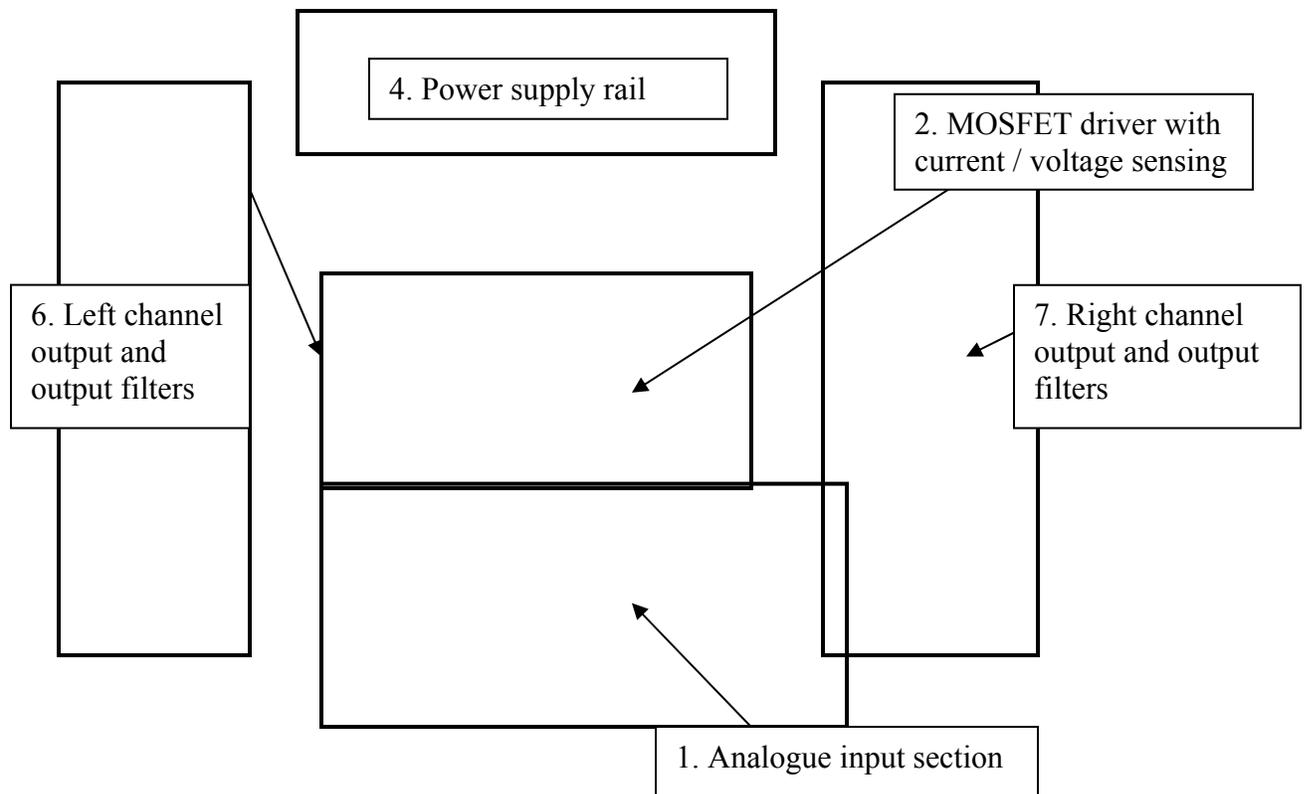
### ***Tools needed***

Assembly of the kits requires the usual set of electronics working tools; soldering iron, wire cutter etc.

The boards for Truepath are *double* weight, four layer copper. This requires quite a powerful soldering iron to heat. Especially the components and pads that are connected to the ground plane require substantial heating. A 50W soldering iron is the very minimum recommended. Preheating the board to about 100°C will help a lot.

Some information on how to solder SMT components is available on the web site.

### ***The PCB, a summary (this section is not updated!)***



**Figure 1: Top view of the PCB**

The numbers refer to the sections shown in

Figure 1: Top view of the PCB.

1. The main component of the input section of the TA3020; the TC2001 signal modulator. This section of the chip sees only low voltages 0 and +5V. It translates analogue inputs to a digital signal train. Input capacitors block DC signal to and from the chip. There are also offset trimmers and timing jumpers here. There are connectors for low level signals to and from the board. The chip modulator generates binary logic level outputs that control the TP2350 MOSFET driver section. The driver frequency is 600 kHz at idle and is a spread spectrum type signal varying from about 200 kHz to 1.2 MHz.
2. The TA3020 driver translates the logic signals from the modulator chip into level shifted 10 volt high current pulses required to switch the power MOSFETs gates on and off. The TA3020 chip also has voltage and current sensing inputs that can shut off the gate drivers if the correct conditions are not met. The chip controls external power MOSFETs. These are basically voltage controlled devices. But in reality, the gates of the MOSFETs have a capacitance and a significant current pulse is required to switch the MOSFETs on and off at high frequency. The chip may get hot and but does not normally need a heat sink
3. Gate drive resistors and discharge diodes. These are between the driver chip and the FETs and control the switching speed and indirectly also the heat dissipated by the driver chip. Also, the current sense resistors are here.
4. This is the main power supply rail with positive, ground and negative supplies. The rail has high ripple, low ESR, bulk capacitors that the MOSFETs draw current from. There are also decoupling capacitors and protection diodes.

5. This is where the power switching MOSFETs are. There are normally two MOSFETs for each side; one for the negative side and one for the positive side. Most users will probably use only the standard MOSFETs. Each of the four FETs has a gate drive resistor and protection diode. Between the power rail and the MOSFETs there are current sense resistors for over current detection / protection. These shut down the output in case the current is too high, such as if the speaker cables are shorted (don't try it...) For the low side FETs, the gate drive voltage must be 10V above the negative power rail. The TA3020 does not have a built regulator for: a 200 mA at 10V positive voltage regulator referenced to the negative rail, is required for this.
6. Left channel output section. The output part for each side has filters that remove high frequency patterns from the power switches that could otherwise recombine into audible noise. A second order, two pole filter is used. It consists of a toroid inductor, some high ripple filter capacitors and a zobel / CR high pass filter. The corner frequency is in the order of 100 kHz. This section also holds the connection points for the loudspeaker leads.
7. The same as section 6 but for the right hand channel.

### ***Components not included in the kit***

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

- Heat sink with screws and heat conductive paste to mount the heat sink. One of the great advantages with PWM mode amplifiers is that the heat losses are small. However, this is a high power amplifier and even if only a small percentage of the power is dissipated as heat, the heat can be considerable for a high power / low impedance application.
- Copper wire for the inductors. About 2.5 meters (8 ft) of 1.2 or 1.3 mm (AWG 16) enamel insulation copper wire is needed. "Litz" type multi-strand wire of the same equivalent area can also be used and is recommended as it is much easier to wind and has good high frequency characteristics. However, Litz wire is expensive and a bit hard to source (**currently kits are supplied with Litz wire!**)
- Connection / hookup wire. Screw headers are included with the delivery. But you can solder wires to the board unless you plan to connect and disconnect them a lot. Soldering them requires substantial heat and with repeated soldering you risk damaging the PCB. There is much debate in the audio world about connectors and IMO the best connector is none at all; a well made solder connection is better than the best connector. Unless you need to disconnect them frequently.
- Wire jumpers. Depending on how you configure the board you will need some wire jumpers.

### ***Mounting the components***

This is a reasonable mounting sequence:

1. First, solder the TA3020 chip. If you are using a socket (not provided), solder it instead.
2. Solder all surface mount components on the bottom side. A picture of how the components are placed is included below in *Error! Reference source not found.*
3. Turn the board over and solder all surface mount components on the top side. A picture of the component placement can be found in *Error! Reference source not found.*
  - a. J1 is a jumper wires that set the BBM (Break Before Make) timing. Normally set the BBM to 80 nS by placing the jumpers as shown in *Error! Reference source not found.* Shorter BBM timing may cause current shoot-through and is not recommended. 120 nS BBM timing can be used for heavy duty (woofer amps) for increased shoot through margin but may increase distortion in the > 2 kHz range.
  - b. Leave R33 open. It's connected to an undocumented test pin. Tripath just state it should be left open.
4. Solder the inductor chip bead. This component connects the analogue signal ground plane around the TC2001 chip to the rail power ground plane and dampens HF power ground plane fluctuations from disturbing the analogue section.
5. Solder the axial resistors and diodes.
  - a. The leads of the current sense resistors R1, R2, R15, and R18. These should preferably be mounted with some standoff that helps keeping them cool. The whole supply rail current will pass through these resistors.
  - b. Mount the gate diodes and resistors D1, D2, D3, D4, R3, R4, R11 and R12.
  - c. Mount the other axial resistors.
6. Solder the offset trim potentiometers.
7. Before connecting the final components, now is the time do a first test of the board. Do not proceed further until the test described below, has completed successfully. Please look at APPENDIX 4 for the connector pin assignments. Testing:
  - a. Check the resistance on the power supply connector J1. It should be about 1 Mohm between positive and ground, about 1.3 Mohm between negative and ground and about 2 Mohm between positive and negative rail.
  - b. The +5V input should measure something like 0.5 kohm to ground.
  - c. The +5V supply should be well stabilized and fused, (before the voltage regulator), at 200mA. Use a shielded cable for connecting the +5V. **The +5 supply should never go above +6V, or be connected with wrong polarity, as this will damage the Tripath chipset. Do not turn on the power yet.**
    - i. Note, the +5V is used for both the analogue preamp section of the Tripath chip and also for the logic level signals in the chipset. It is essential that the +5V supply is quiet / well stabilized. Using shielded cable for hooking up the +5V prevents feedback of high frequency EMI from the power amp into the analogue section.
  - d. Connect a 10V supply for VN10. It MUST be referenced to the negative rail. Read more in the appendixes on how this should be done.

- e. Connect the rail positive, ground and negative power. **Double check the polarity! Connecting the wrong polarity will damage components.** The amp may draw around 100 mA on the positive rail and around 200-250 mA on the negative rail at “transistor radio volume”. *Do not turn on the power yet.*
  - i. As a protection you should use current limiting resistors in series with the power supply lines. If the amp draws unexpectedly high current, the voltage will drop below the level where under-voltage limit shuts off the amp. Suitable resistor values can be 68 to 100 ohms, 3W for the positive rail and 33 ohms to 47 ohm 3W for the negative rail. With the default components, the amp will mute if the supply voltage drops below about +/- 34V. *Do not turn on the power yet.*
  - ii. Alternatively, the amp could be protected with a 100mA fuse, placed on the AC side of the supply. This way, both rails de-power in the case of failure. The down side is that the energy in the supply capacitors may discharge through the amp, even if the fuse has blown. Other fuse values may be required, depending on your transformer and capacitors. *Do not turn on the power yet.*
- f. The onboard LED is connected via R90 (2.2K). Optionally, instead connect an external LED from, for example on the front panel of your amp. An external LED needs its own 2.2 kΩ resistor to ground. A LED helps a lot when testing.
  - i. Do not connect two LEDs at the same time, as this may draw too much current from output
  - ii. The HMUTE output can be used to control speaker output relay, via a driver circuit. The HMUTE will go high (+5V) in case the amp is muted or in case of over current, over/under voltage and other errors. Shorted outputs or shorted output transistors would also trig the over current sensing. If no errors are detected and the amp is unmuted HMUTE will be low (0V).
- g. Connect the MUTE jumper.
- h. Switch on the +5V supply, *but not the main rail voltage yet.* The +5V should draw about 25 mA. If a LED is connected to J2 pin 9, it should light up. If a LED is not connected, check if there is +5V on the J2 pin 9.
- i. Now, switch on the rail (main) power supply. It should draw a current of about 1mA.
- j. Removing the MUTE jumper +5V to ground will toggle the amplifier from mute to active. Now the amps should go active, and the +5V should draw about 50mA and the LED should go low/off. If it does not, this indicates the amplifier is still muted, for example because the voltage is too low or high or current is over limits (shorted outputs...) If this happens, shut off the power, discharge the rail capacitors with a suitable resistor. Check all soldering and everything else in the previous paragraphs. *Do not proceed further until this testing stage has passed successfully.*
  - i. Note that under-voltage protection has a 200 mS delay and is non-latching and the amp may “instantly” turn on again when the voltage recovers, and then go on-off-on-off several times per second. In that case, turn the power off!
  - ii. Note with the supplied voltage sense resistors, R112, R113, R114 and R115, the lowest voltage the amplifier can be operated at is about +/-34V. At lower voltages, the amp will *not* leave the mute state.

- iii. Note also that the current sense (0.01 ohm) resistors must be in place for this test to work.
  - k. When the amplifier is un-muted (LED is turned off), the positive rail should draw a maximum of 40-80mA. The negative rail current may be 150-200 mA.
  - l. If everything looks OK, then power down, remove the current limiting resistors, and proceed as described below.
8. Mount and solder radial lead capacitors.
9. Mount and electrolytic capacitors. Respect the polarity as marked on the PCBs.
10. Wind the toroid inductors. You should use 29 turns of 1.2 or 1.3 mm enamel insulated wire for the T108-2 toroids included in the kit. The inductance should be 11 uH. Wind as tight as you can. Tight winding minimizes any stray signals. This thick wire is a challenge to wind. Leave a bit of wire so you can pull the toroids snugly to the board.
  - i. For high frequency, high current windings like the main inductors, a good alternative is to use several thinner wires, with the same cross section area, in parallel. A bundle of thin wires is easy to wind and the insulation between strands reduces the “skin effect” and thereby reduces losses. You can buy “Litz” wire which is simply a pre-made multi-strand wire, where each strand is separately insulated with enamel insulation.
11. Scrape the enamel off the wires or torch them with a gas flame where they will be soldered and solder the wires to the PCB
12. Optionally solder board connectors for power and for speakers. Connectors should have a current rating exceeding the currents you expect to have and also exceed the current limit setting you use. The default for the Truepath kit is 10A. If you do not use connectors, solder the power cabling and speaker output cabling in place.
13. Connect signal connectors. Again consult the APPENDIX 4 and decide what connections you would like to make.
  - a. Bridging or no bridging? Permanent bridging or an external switch?
  - b. Mute switch? Strongly recommended!
  - c. Hmute indicator? The Hmute can drive an external LED via a 2 kΩ resistor. The LED will be *on* if the amplifier is muted or due to over voltage or over current limit has been exceeded.
14. Mount the four MOSFETs in positions M1, M2, M3 and M4. IMPORTANT. Take care that the leads of the MOSFETs do not touch adjoining tracks before soldering them. The legs of the provided MOSFETs have a fairly wide shoulder that may short circuit to adjoining tracks. Therefore the MOSFETs could be lifted by about a millimeter before they are soldered. Make sure they are in line, at the same height and flatly on the same surface. They need to adhere well to the heat sink.
15. You are now ready to test the amplifier as described below. A heat sink is not required for low power testing but will surely be required for higher power levels.

### ***Trimming and testing***

- Put the amplifier to Mute
- Ground the signal inputs to signal ground (connect IN1 and IN2 to AGND on connector J2). Do NOT connect the speakers yet.
- Connect the +5V and VN10 supplies.
- Connect the power supply. **Double check the polarity of the power supply.** Wrong polarity will permanently destroy some components, including the Tripath chipset. For the first testing, use current limiting resistors as described above.
- Turn on the power.
- When muted and with no speakers connected, the +5V should draw about 20 mA and each main rail should draw about 1mA.
- Switch the MUTE setting from Mute to Awake
- Check the fuses. If they have blown, disconnect the board and check all components and solders.
- With the amp unmated (awake) the +5V should draw about 50mA and the main rails should draw about 100 mA each.
- If the fuses are OK then, adjust the trimmer pots until the speaker output signal is as close to 0V as you can get it. This minimizes turn on/off pops and minimizes DC through the speakers. You should be able to trim the offset to below 10 mV. Do not run the amp for extended periods without speakers or a dummy resistor connected.
- Shut of the power.
- Connect the speaker wires
- Connect a signal source with music.
- Set the volume on the signal source very low
- Turn on the power and check if you get any sound.
- If everything seems OK, switch off power, replace the power supply fuses for larger fuses like 1A and try again at slightly higher volume. (The 5V fuse should remain about 100-200mA).
- 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 outputs, you should have an efficiency of 90-95% with 8 ohm loads and 85-90% with 4 ohm loads. The rest of the power, 5-15%, can be assumed that is dissipated from the MOSFETs. I.e. if you drive the amplifier to 2x150W into 8 ohms you will have 15-30W of heat dissipated. If you drive the amp to 2x300W into 4 ohms you will have 60-90W of heat. Select a heat sink / cooling method that can handle this. Keeping the FET temperature down is important for reliability and lifetime. The MOSFETs **must** be electrically insulated form the heat sink. Using thick pads between the FETs and heat sink is a good idea s this decreases capacitive coupling between FETs and heat sink, and thereby minimizes the EMI that may otherwise be emitted by the heat sink.
- Connect the amplifier to your power supply and change the power supply fuses to the proper value.
- Enjoy!
- Please note:
  - Speaker leads must be grounded to the PCB connectors, not to the power supply. The modulator feedback has separate returns from these connections. The speaker returns are grounded in a star point on the PCB.
  - Audio signal sources and the 5V supply must be grounded to its respective connector. These connectors are in turn grounded via an inductor bead to the star grounding point where the power supply is connected.

If you have any questions, write any questions on the forum on our web site <http://www.support.41hz.com> , as the questions may be of general interest. For any questions please do not hesitate to contact us at [jan@41hz.com](mailto:jan@41hz.com)

**Feedback is very much appreciated!**

### ***Other useful documents and information***

- Truepath Schematic
- Truepath BOM
- Component placement printouts
- TA3020 datasheet
- TA3020 reference board
- The 41Hz audio Forum

The 41Hz Audio Support web site

## ***APPENDIX APPENDIX 2: Fine tuning the Truepath***

The components included in the Truepath kit work well for many users. For optimal performance the Truepath board may be fine tuned to each application. Here is a summary of what to think of.

### ***Input impedance, input gain***

The Truepath can be described as a two stage amplifier. The first is an operational amplifier while the second is the power stage / modulator.

So first we have to select input and gain resistors for the input operational amplifier. The input impedance has an effect on any equipment upstream of the amplifier, such as pre amplifiers. Modern pre-amplifiers are usually capable of driving fairly high currents / low impedance loads. But usually, the THD+N is better if the impedance is not too low. On the other hand very high impedance in the power amplifier will introduce current noise so a compromise has to be found. Values of between 10k  $\Omega$  and 100K $\Omega$  are typical while 20 K $\Omega$  to 50 K $\Omega$  are most common. Some people prefer carbon thick film resistors for the input and feedback resistors while others prefer thin film or metal film resistors which usually have lower noise. With thick film carbon resistors we could use lower values, say 20 K $\Omega$  for low noise while higher values can be used with thin film or metal film, often 50 K $\Omega$ .

Most consumer audio equipment like CD players etc have a signal level output of -10dBV which corresponds to 0.316 V RMS. Portable devices like MP3 players, MD and CD players often have lower output to extend battery life. A preamplifier would usually have a gain of about +10 dB giving an output of 0dBV or 0.775 V RMS maximum. Similar levels could be expected from computer soundcards. Professional equipment usually has a nominal +4 dBU maximum output signal which corresponds to 1.23 V RMS.

The TK2350 amplifier chip modulator stage has a maximum input level of about 4V peak to peak, equivalent to 1.41 V RMS. For best performance we should select the gain for the input stage so that at maximum volume (from the preamp) the voltage in the input stage is close to the maximum 4V<sub>ptp</sub>. Some headroom margin for transient peaks is however required.

The following table gives some examples. For a consumer audio level signal of 0.316 V and select a gain of one (1) for the power amplifier input stage, we would have headroom of 15dB which is a bit much and means the amplifier can not reach its maximum power. If we add a +10dB gain preamplifier we would have headroom of 5 dB which is reasonable. With a pro audio input of 1.23 V and an amplifier gain setting of -0.4 we would have 10dB headroom, which again is reasonable.

	Consumer audio	With +10 dB pre-amp	Pro audio +4dBu	Value in Truepath kit
Nominal $V_{inRMS}$	0.316	0.775	1.23	1.25
Truepath Gain	1	1	0.4	0.45
$R_{in}$	50 K $\Omega$	50 K $\Omega$	50 K $\Omega$	47 K $\Omega$
$R_{feedback}$	50 K $\Omega$	50 K $\Omega$	20 K $\Omega$	22 K $\Omega$
Headroom/margin	15 dB	5 dB	10 dB	

The gain, G is calculated:  $G = -R_{feedback}/R_{in}$

The Truepath kit is shipped with 47 K $\Omega$  input resistors and 22 K $\Omega$  feedback resistors for a 0.45 gain. These are 0805 size low noise thin film type. You may want to adjust these values for your own application. A number of alternative resistors are supplied with the kit in component bag number 9.

#### SUMMARY

- The input sensitivity with the Truepath kit components are suitable for a pro audio signal level of 1.23VRMS (+4 dBu)
- For home audio equipment you should probably increase the input stage gain by replacing the 22 K feedback resistors with other, higher values.

### ***Input capacitors***

Some people have an almost religious in the belief of the influence on the sound quality from the input capacitors. The Truepath PCBs have space for RM10 lead spacing for the input capacitors so you can practice your belief. You can use many different types of capacitors. Input capacitors are recommended as they block any DC from flowing between equipment components. The inputs of the Tripath chips are biased by about 2.5V, so a capacitor is usually required. However, if you hardwire the power amp to a preamplifier that has a capacitor on the output, then the input capacitor to the power amplifier can be omitted and replaced by a jumper. The input impedance resistor and the input capacitor form a high pass filter. The corner frequency is

$$f_c = 1/(2*\pi*R_{in}*C_{in}).$$

The value should be chosen so that the corner frequency is well below the used lowest frequency. There will be a phase shift close to the corner frequency so a margin of at least one octave is desirable. A  $f_c$  of lower than 10 Hz should usually be used for full range and woofer amplifiers. Higher values can be used for mid range / tweeter amplifiers. Sometimes it is claimed that input capacitor values should be about 5 uF or more. This may be true with older carbon film input resistors where impedance had to be low to minimize noise. But with low noise thin film resistors, fairly high impedance can be used and a corresponding low value for the capacitor. The Truepath kit is shipped with 47 K $\Omega$  input resistors and 2.2 uF capacitors, giving a corner frequency of around 2 Hz.

It should be noted that two capacitors in series (in the pre amp output and power amp input) will combine into half the equivalent value, increasing the corner frequency. It can also be noted that

the Tripath boards and measurement results given in the Tripath data sheets are usually done with standard electrolyte capacitors as input caps.

## **Modulator gain**

The Truepath and TK2350 is a feedback topology. The voltage gain of the power section of the amplifier is set by resistors that feed back the loudspeaker output voltage to the chipset. The ground for each side has separate lead backs, for accurate sensing. This means there are four feedback paths and four feedback resistors. For optimal amplifier use, the gain resistor values could be changed, depending on the used rail voltage and the application. Some "over gain" could be used so that the power stage will start clipping, i.e. output voltage is as high as the rail voltage, when the input signal is a bit over the nominal maximum. If the gain is set to low then the power stage will run below full power even when the input stage signal is high enough to saturate the input stage. If the gain is too high, the power stage will start clipping at a low input signal and this implies the preamp level has to be turned down, which may be unfavorable from a THD+N point of view, especially at low volume. A reasonable balance has to be found.

### *Calculating the modulator gain / feedback resistor values*

	Description	Typical value	
Vpp	Rail voltage (+/-)	40-50V	50-60V
Rfba	Typical value	1 K $\Omega$	1 K $\Omega$
Rfbb	= Rfba * Vpp/(Vpp-4)	1.1 K $\Omega$	1.07 K $\Omega$
Rfbc	= Rfba * Vpp/4	12 K $\Omega$	15 K

## **Current limiting**

The TK2350 chipset has built in over current setting. Actually, it senses the voltage over a current sense resistor via set point resistors. The set point resistors are of the 0805 size. At an over current situation the amplifier will go into mute and has to be power cycled off/on to reset. The resistors supplied in the Truepath component kit are 20 K $\Omega$  and will trip the amplifier at 10A. You may want to select other values for your application. The on-board power supply capacitors are placed after the current sense resistors. Therefore the MOSFETs may draw current from the caps and the current sense resistors will see a slightly smoothed current signal. The over current sensing is still fast and will mute the amplifier even on short over current peaks. *Please note that the over current shut-off sets the chipset into mute state but if the MOSFETs are damaged, the rail voltage can still be on the speaker outputs.* The over current protection should therefore be regarded as "soft" protection. *Proper fuses are still required.* But fuses may not blow before the loudspeakers are damaged. For "hard" shutdown you can use a relay on the speaker outputs, controlled by the HMUTE signal output. This will shut of the speaker outputs even if the output FETs are damaged.

*Calculating the over current sense resistor values*

	Description	Current limit trip point					
		6A	10A	12A	16A	22A	
$I_{sc}$	Over-current trip point	6A	10A	12A	16A	22A	
$R_{sense}$	Current sense resistor	0.01 $\Omega$	0.01 $\Omega$	0.01 $\Omega$	0.01 $\Omega$	0.01 $\Omega$	
$R_{orc}$	$=3473/(R_{sense} * I_{sc}+0.0716)$	27K	20K	18K	15K	12K	

**Voltage limiting**

The TA3020 chipset also has over / under voltage sensing. The voltage values are set with four resistors in the 0805 size. If the voltage is outside the specified values, the amplifier will mute. Unlike the over current sensing the voltage sensing is non latching i.e if the amplifier is unmuted it will mute when outside the specified range and go back to the unmuted state as soon as the voltage is within specified values again. Please again note that that the over voltage sensing sets the chipset in mute and can prevent damage by stopping instable conditions like power supply transients. However *it can not protect the chipset from severe over voltage damage; the maximum chipset voltage is +/- 70V also when muted.*

*The voltage limiting trip point resistor values*

	Description	Value in the Truepath kit	
Vpp	Rail voltage (positive)	(+40 to +60V)	
Vnn	Rail voltage (negative)	(-40 to -60V)	
$I_{vppsense}$	Positive sense current from data sheet	(0.162mA)	
$I_{vnnsense}$	Negative sense current from data sheet	(0.174mA)	
$R_{vpp1}$	$= V_{pp} / I_{vppsense}$	422 K $\Omega$	
$R_{vpp2}$	$= V_{pp} / I_{vppsense}$	422 K $\Omega$	
$R_{vnn1}$	$= V_{nn} / I_{vnnsense}$	392 K $\Omega$	
$R_{vnn2}$	$= 3xR_{vnn1}$	1.18 M $\Omega$	

The tolerances of the voltage sensing and limiting are not very tight so there may be variations in the actual trip points. Please see the TK3020 chipset datasheet for details.

The resistors supplied with the Truepath component kits will set the lower voltage limit to about +/- 33 volts and the upper limit to about +/- 65 volts.

*Note you should have a margin of about 5V from the nominal power supply voltage, or the voltage protection may mute the amp due to voltage transients and component tolerances.*

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