Grown/UP

technical manual for the bmh3d amplifier module
as used in the ServoLabs Grown/Up motional feedback enclosure

Contents

Module Description

The BMH3D (Bass Midrange High 3D class power stages) module was designed to offer a modern compact power solution for 3 way active loudspeaker systems like the ServoLabs Grown/Up enclosure, a cash & carry 3way servoloop system available through http://servolabs.nl

Design goals

Overall goal was to build an integrated, cost effective all in one solution for powering a 3 way motional feedback loudspeaker system by

- minimizing module size by using modern surface mount technology.
- minimizing heat production by using high efficiency Class D amplification.
- avoiding dsp incurred system latency by using analog filter and feedback technology only.
- using a single 24V fed circuitry enabling the usage of modern off the shelf industrial power supplies.
- obtaining a high price-performance ratio using modern pick & place fabrication techniques.
- Support studio usage by offering balanced signal inputs.

Specifications

The woofer channel is high passed at 30hz with a second order 12dB/Octave Q=0.5 LR filter slope and low passed at 400hz with a second order 12dB/Octave Q=0.7 LR filter slope and amplified by dual tpa3116 amplifier channels set to operate in power BTL mode offering a maximum voltage swing of 24V or 70 watts RMS @ 4ohms.

The midrange channel is high passed at 400hz with a second order 12dB/Octave Q=0.7 LR filter slope and low passed at 4000hz with a fourth order 24dB/Octave Q=0.7 LR filter slope and amplified by single tpa3116 amplifier channel set to operate in BTL mode offering a maximum voltage swing of 24V or 35 watts RMS @ 8ohms.

The tweeter channel is high passed at 4000hz with a fourth order 24dB/Octave Q=0.7 LR filter slope and amplified by single tpa3116 amplifier channel set to operate in BTL mode.offering a maximum voltage swing of 24V or 35 watts RMS @ 8ohms.

MiniXLR balanced input impedance : 10Kohm, idle switching residue 270mVtt @ 400khz. At maximum power output the average current consumption is 8A (12A peak)., system sensitivity is -10dBu @ 50Kohm (240mV). The module is activated by it's build in ekomatic for input signal levels >3 mV.

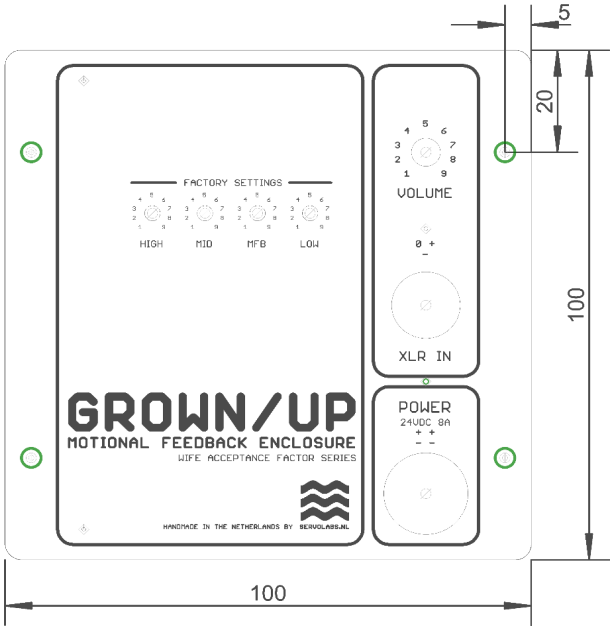
Availability

An OEM version of the BMH3D module with tailored faceplate is available upon request via the contact page at piratelogic.nl

Technical Overview

Module construction

The BMH3D module consists of two parts, a logic board containing the actual electronics and a faceplate used to mount the module into the enclosure. Please note the module is not airtight and should be placed into a separate compartment within the loudspeaker enclosure, also see **Compartment cutout**.



Face plate

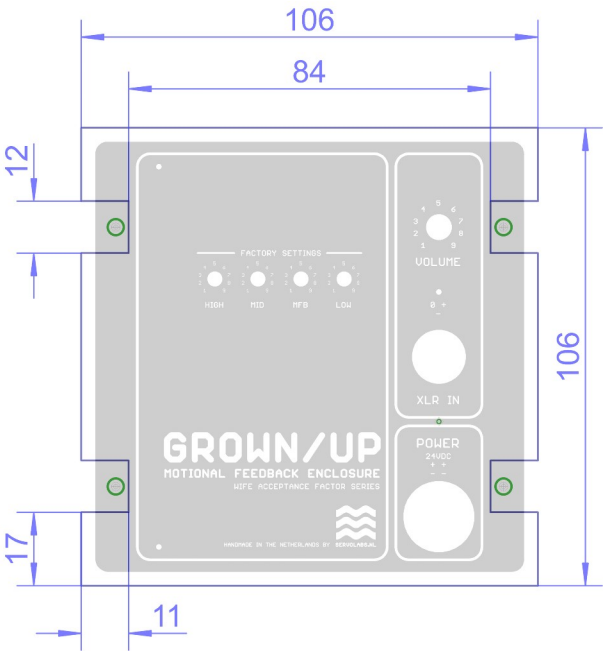
The BMH3D module is mounted via its faceplate allowing access to the logic board factory setting potentiometers high, mid, mfb and low. Refer to adjustments chapter for details.

The volume potentiometer adjusts the BMH3D incoming signal level at the miniXLR equipped XLR IN signal input. The XLR input follows the standard XLR balanced signal pin out, 1 for ground, 2 positive and 3 negative. To use the BMH3D with single ended asymmetric input connect pin 3 and 1 together.

The BMH3D module receives it's power from an external power source connected to the GX12 aviation connector POWER input, refer to the POWER requirements chapter for further details.

Compartment cutout

To safeguard sufficient free air convection allow for a 3mm gap between the enclosure and faceplate edges. The module compartment minimal depth is 30mm.



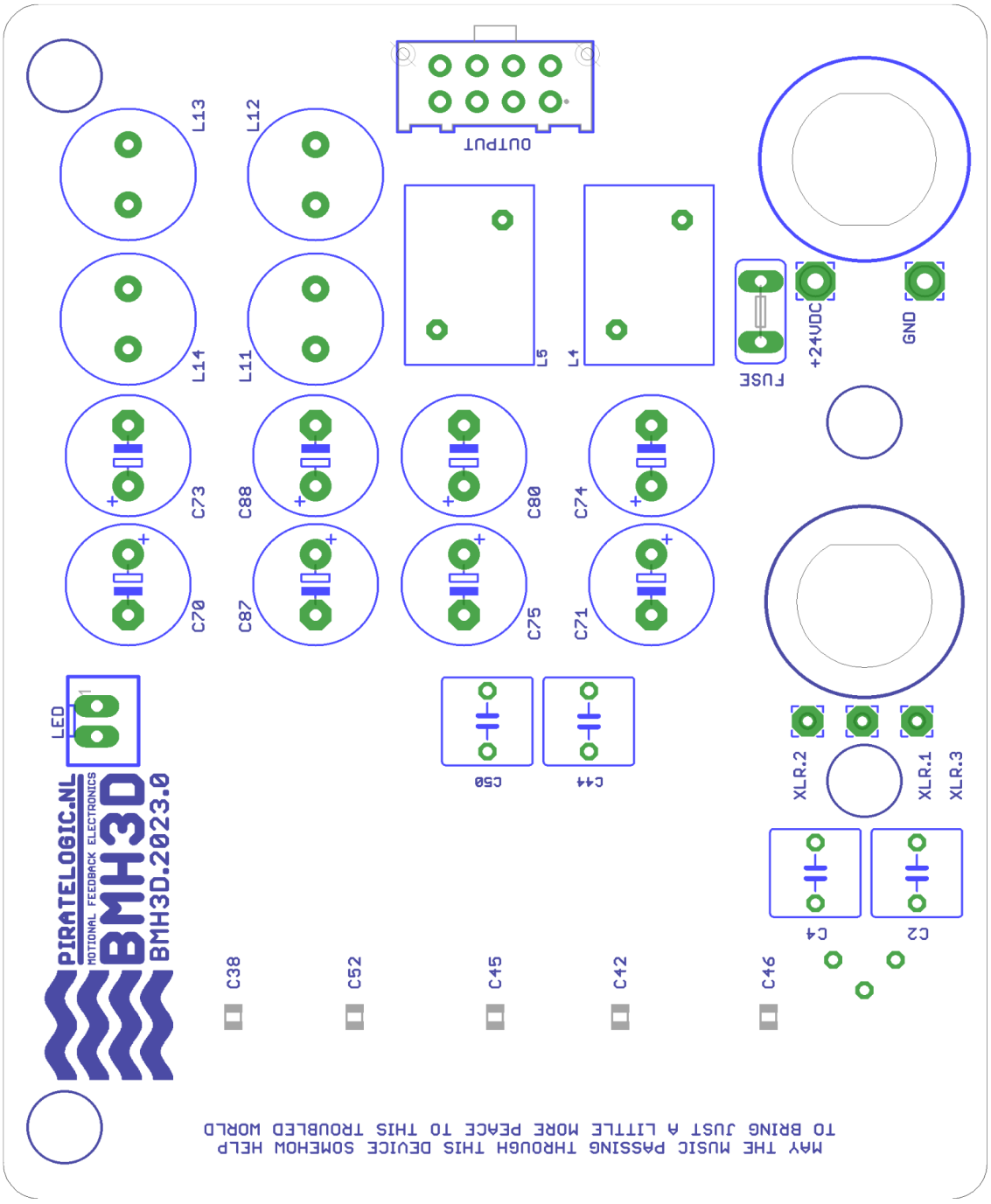
Module disassembly

The face plate and logic board are joined together using 4 M3 screws located on the logic board top side. When disassembling the module take care to reposition the thermal filler correctly upon re-assembly.

Logic board

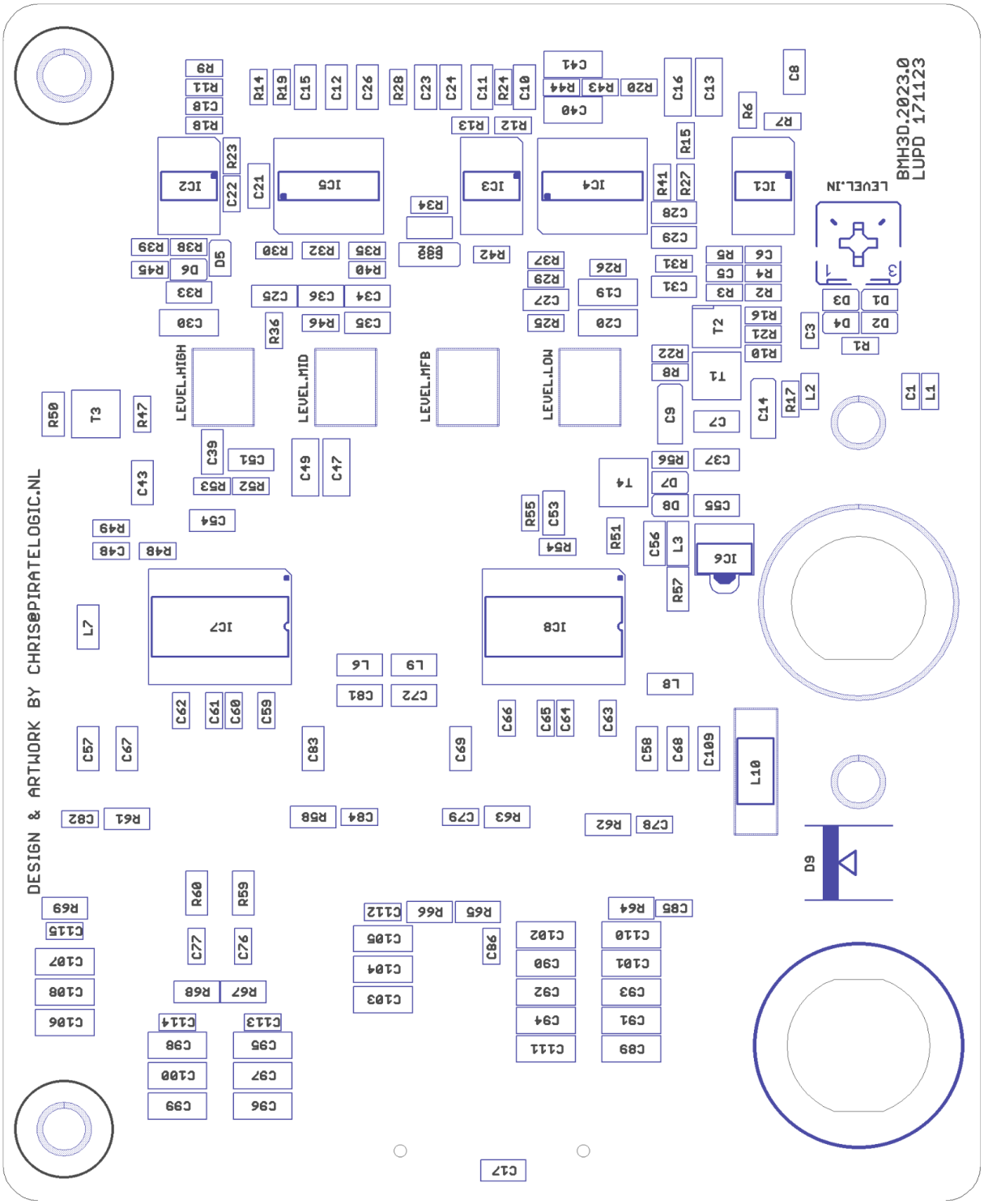
Top view

The logic board top side contains the connectors for the drivers, accelerometer and states LED, refer to the Module Connections chapter for connection details.

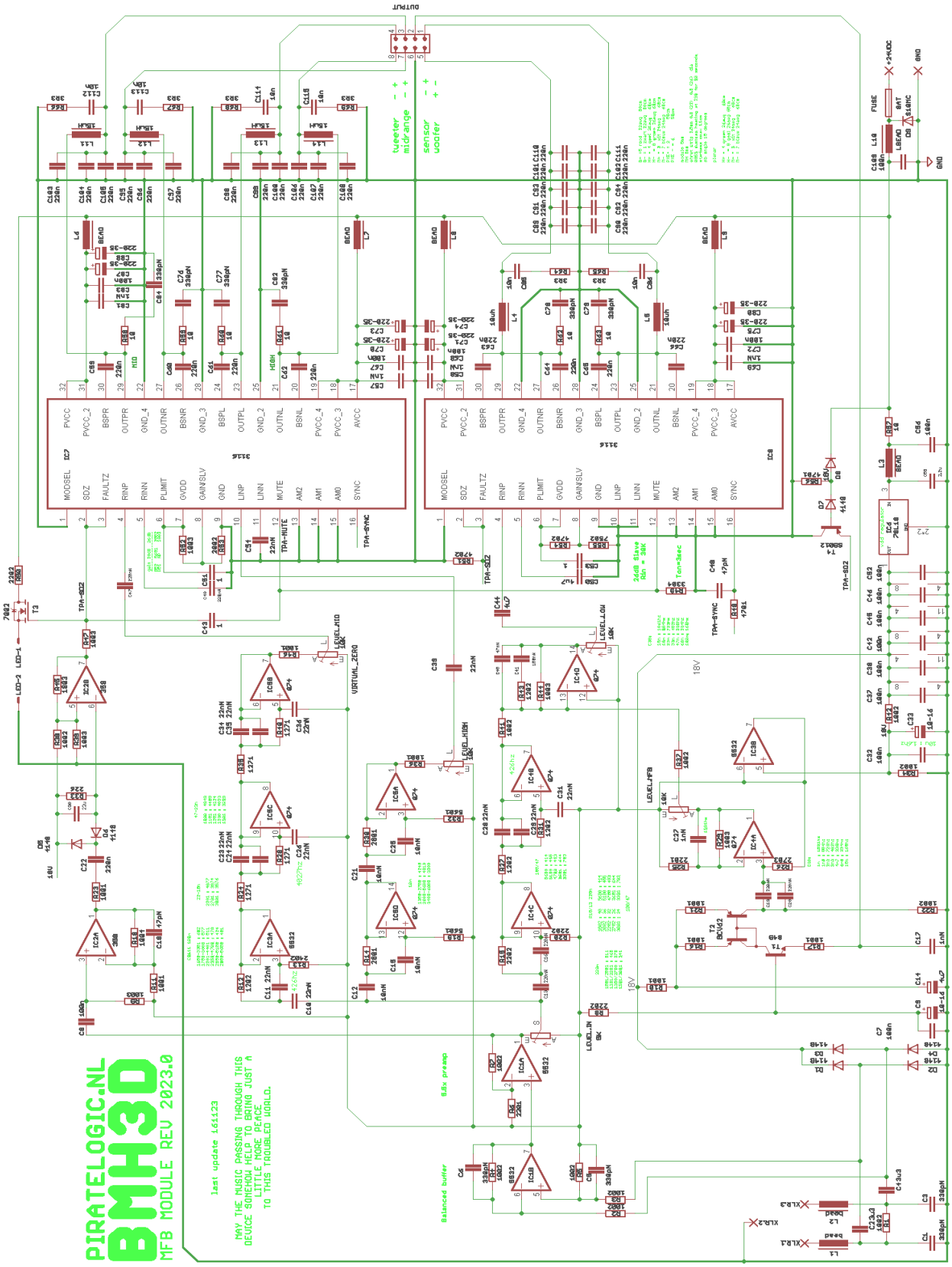


Bottom view

The logic board bottom side contains the surface mount electronics :IC7 and 8 which are the class D poweramps which together with the power regulator IC6 are thermally connected to the faceplate bottom copper layer via a thermal filler. **When disassembling the module ensure correct re seating of the thermal filler to avoid thermal defects.** The volume and factory settings are directly mounted to the bottom side of the logic board and accessible from the outside by the corresponding holes in the module face plate.



Circuit diagram



Circuit description

Balanced Signal Input

The audio signal enters the bmd3d module via the miniXLR socket XLR1 – ground, XLR-2 – negative and XLR-3 – positive followed by rfi snubbers L1 C5 and L2 C6 to avoid EMI from entering the system. The signal then reaches balanced input buffer IC1b via DC blocking caps C1 and C2 and is limited to 15Vtt via D1..4 to safeguard the input from voltage spikes. The signal from IC1b arrives at 15dB gainstage IC1a enabling usage of direct connected mobile devices and is routed to the system volume potentiometer level.in.

Crossover logic

The signal from LEVEL.IN is divided over three separate low, mid and hign sallen-key filters. The low note signal is high passed at 35hz by IC5c via C10,C13,R13 and R16 to safeguard the servoloop from trying to process subsonic content. The midnote signal gets 2nd order high passed at 401hz by IC3a via C8,C11,R11 and R14 and then 4th order lowpassed at 3974hz by IC4c, IC4b, R22,27,35,38 and C22,23,26,31,32,35. The highnote is 4th order highpassed at 4019hz by IC4d, IC4a and C9,12,17,19 and R12,15,25, 29.

Servo loop

The low note servoloop receives the StarBass accelerometer current signal via pin 2 of the MicroFit system connector where it passes R24 and C18 EMI filter, T1 acts as I/V convertor to the accelerometer current signal while providing a stable 7V bias voltage for the StarBass jFET and is further buffered by T2. The StarBass correction signal is amplified and 1st order lowpassed at 1591hz by IC5a to avoid cone breakup info from entering the servoloop. The processed StarBass signal is added to the filtered low note signal from IC5b by IC5d which is tuned to the openloop Grown/Up enclosure/driver frequency response by the correction network R42,43,C38,39.

Powerstages

The processed low, mid and high note signals reach the power stages IC7,8 via the LEVEL.HIGH, LEVEL.MID and LEVEL.LOW potentiometers. IC7 processes the mid and high signals and IC8 the low note signal. Both amplifiers operate in class D with their pwm outputs fed to the LC reconstruction filters L13,14 (highnote) L11,12 (midnote) and L4,5 (low note). Both IC7 and 8 are operating in class BD modulation to minimize idle dissipation and EMI emissions, have their voltage gain set to 26dB with IC7 set as pwm masterclock with slave IC8 pwm clock synchronized via R48 to avoid generation of pwm carrier wave intermodulation products. IC7 is set to dual channel BTL mode driving both mid and tweeter, IC8 to single channel PBTL mode driving the woofer.

EKOMATIC automatic on/off logic

Both powerstages IC7 and 8 are normally disabled and activated upon receiving an input signal >1 mV by IC2a and IC2b where the former looks for input signals > 1mV and the latter performs a schmitt trigger function with a no-signal turn off timer C28 and R31 of 3 minutes. The IC2b output signal is used to wakeup the power stages via their SDZ pins, C43 together with R49 provides for a 3 sec power on delay to avoid system startup artifacts from reaching the drivers during initial startup.

Powersupply

The 24V power enters the system via the polarity protection FUSE and D9, then enters snubber L10 and the power stages via L6,7,8,9 and the filter and loop logic via stabilizer IC6. To provide the opamps with a virtual zero a rail splitter is added by IC3b, R32,36 and C29. The circuit around T3 and D8 provide an UVP at 20V.

Power & supply

Power consumption

The BMH3D module has been designed to deliver 70watts rms into a 4ohm woofer, 35 watts rms into a 6ohm midrange and 15 watts rms into an 6 ohm tweeter totaling 110 watts of rms output power at a stabilized 24Vdc. The maximal current draw depends on the driver load impedance and is subject to thermal limitations as described in the TPA3116 datasheet. The current consumption for the Servolabs Grown/Up enclosure is 5A max, maximum currentdraw is physically limited by an onboard 8A fuse.In order to protect the BMH3D module against a faulty power connection a non user replaceable fuse 8A is placed near the GX12 power connector. If this fuse appears blown the module should be returned to servolabs for inspection.

Module cooling

Class D amplification known high efficiency often leads to a gross underestimation of the cooling required which severely effect the module buffer capacitors lifespan in particular and it's overall lifespan in general. The BMH3D module has been designed and tested with the enclosure design shown in the **Compartment cutout paragraph** which provides adequate module cooling assuring operation within specification. Defects caused by overheating due to poor thermal management are not covered by warranty.

ON/OFF statusled

Upon arrival of an input signal the EKOmatic logic will take the BMH3D out of standby and into idle mode while performing an system check, if no errors are found the power stages are activated and the bmh3d become operational. Upon removal of the input signal a 3 minute timer is started which will set the bmh3d into standby mode again. When the system enters idle mode the **LED** connected to the logic board JSTxh led connector will lit up. If no status-light function is desired disable it by disconnecting the led connector.

Power solutions

The BMH3D module has been tested with several power sources ranging from mains fed AC/DC adapters to lithium-ion and lead cell battery powered solutions for mobile use. It is up to the end user to decide on what power solution is used, main considerations when buying/building a power supply are system safety and noise.

System Safety

As with the main part of todays electronics the BMH3D itself operates with a low voltage which is obtained from an externally connected powersource. To choice for this power source is regulated by local authorities, for EU based ruling refer to https://commission.europa.eu/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/energy-label-and-ecodesign/energy-efficient-products/power-transformers_en

It is the endusers responsibility to adhere to local regulations for powering the BMH3D module, the manufacturer does hereby wafer any responsibility for any damage resulting from non compliance with these regulations.

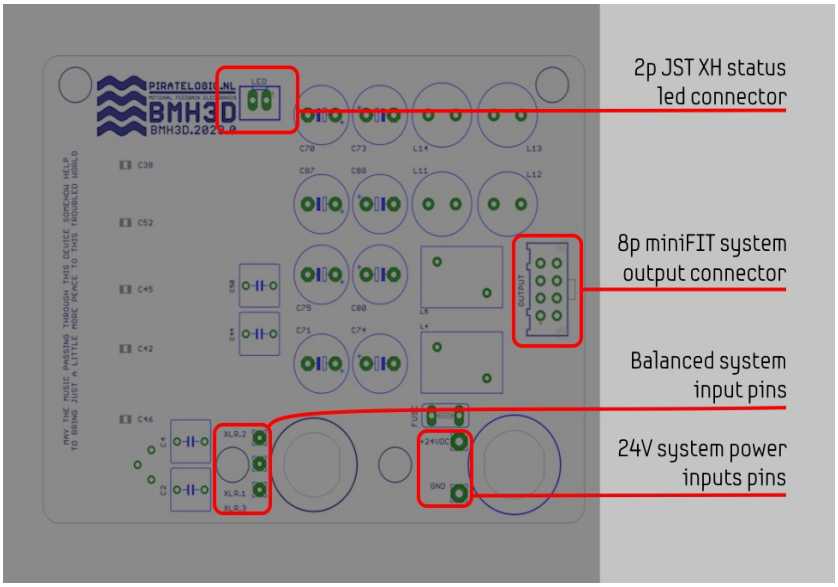
System Noise

The BMH3D onboard filtering and buffering allows the module to be used with standard industrial switchmode power supplies as long as it's output noise does not exceed 200mV p-p. The module standby (off, no signal) current draw is 30mA or 0.72 Watt, Idle consumption (on, no signal) is 120mA or 2.9 Watt. When choosing an SMPS avoid using models that enter hick-up mode below 120mA current draw to minimize smps induced system noise.

Module connections

Logic board

The logicboard connections are made *during* construction of the enclosure and are not user accesible afterwards.



LED connector

If desired the loudspeaker enclosure can be fitted with a status LED of your choice which can be connected to the BMH3D module via 2pole female JST XH **LED** connector.

OUTPUT connector

The 8 pin microFIT connector connects the drivers and accelerometer signal to the BMH3D module using a color coded connection cable. Please note the accelerometer signal – pin 2 & 6 – enters the module via a shielded cable.

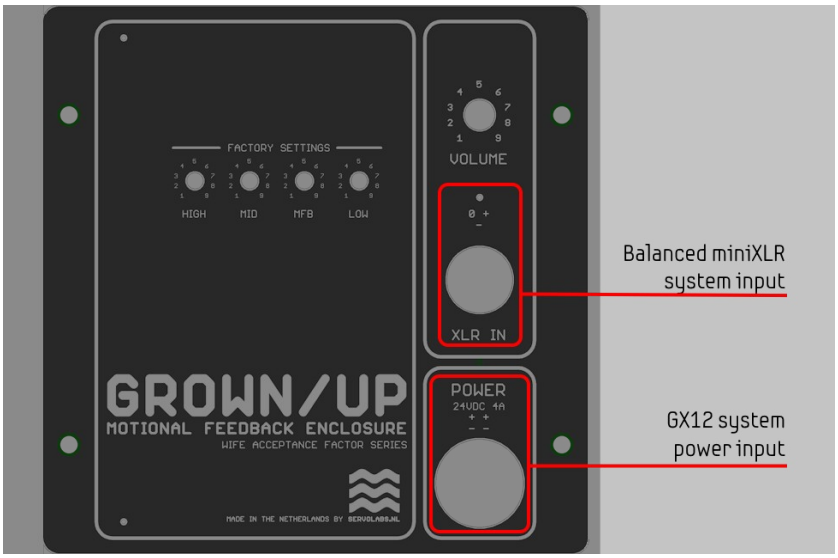
BMH3D connector color codes

PIN	CONNECTS TO	COLOR	
5	WOOFER +	RED	
1	WOOFER -	BLACK	
6	STARBASS SENSOR -	SHIELD	
2	STARBASS SENSOR +	CORE	
7	MIDRANGE -	BLUE	
3	MIDRANGE +	WHITE	
8	TWEETER -	GREEN	
4	TWEETER +	YELLOW	

Input pins

The faceplate inputs are internally wired to their respective logic board input pins.

Face plate



MiniXLR input

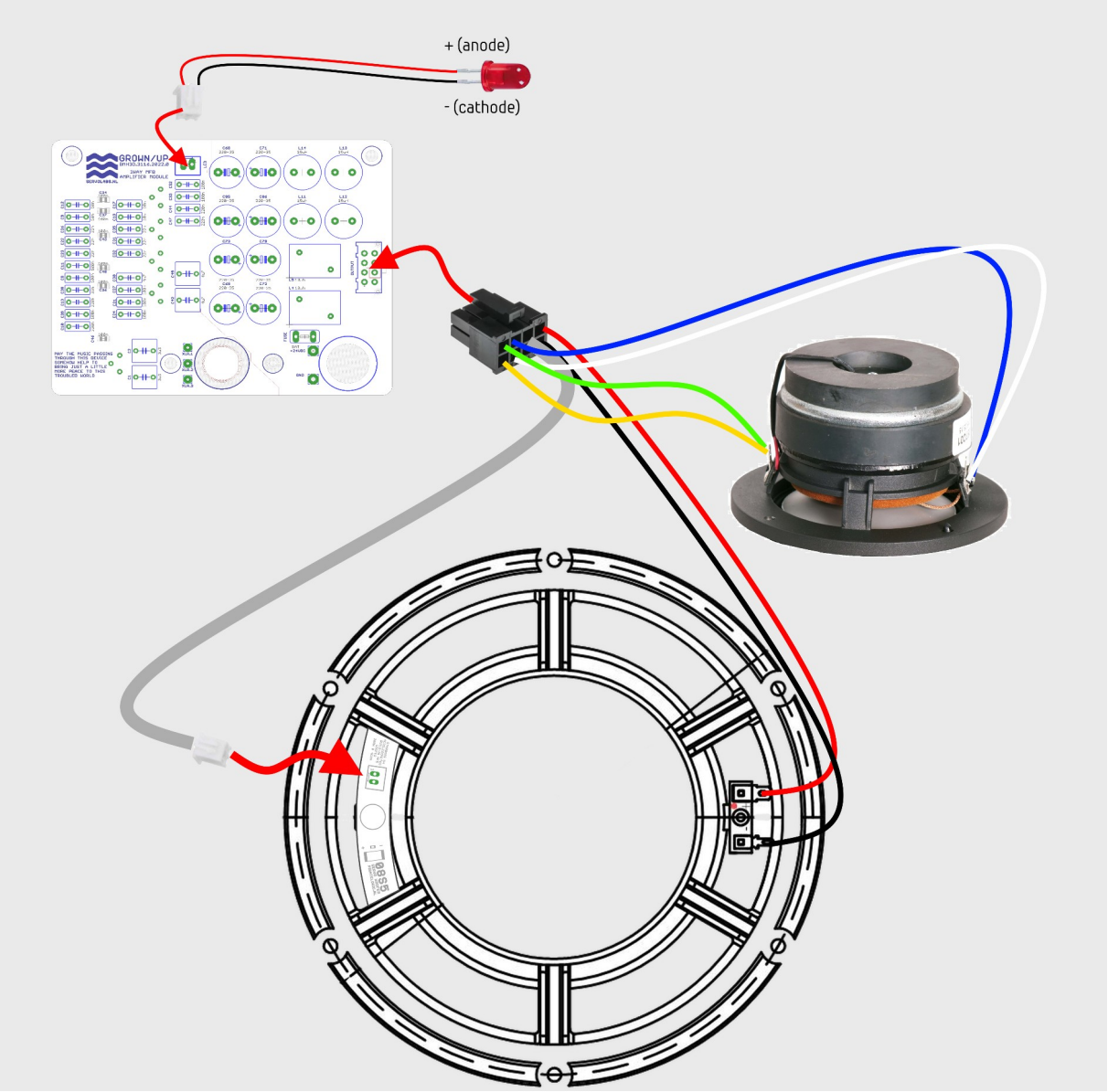
The BMH3D module receives its audio input signal via a standard miniXLR male connector. Note the pin layout above the connector.

24V Power

The 24V power is provided through a GX12 male connector, When connecting 24Vdc via the GX12 connector ensure the following polarity is used. Failure to comply will blow the internal – non user replaceable – fuse. + 24V : pin1,4 - 24V : pin 2,3

Wiring diagram

When the BMH3D is used in the Servolabs Grown/Up enclosure the following wiring diagram is used.



Grown/Up drivers

Piratelogic 08S5 woofer

The BMH3D module has been tuned for use with the Piratelogic 08S5 woofer equipped with a Piratelogic StarBass 5 accelerometer, visit https://piratelogic.nl/?p=en.drivers.08s5 for further details. The accelerometer connection to the BMH3D module is made using a JST XH 2.5 mm pitch 2 pole connector via a shielded cable, see the **MicroFIT Connector** chapter for color codes and connection details.

4 inch coaxial mid/high

The BMH3D module has been tuned for use with below coaxial mid/high driver. See the **MicroFIT Connector** chapter for color codes and connection details.

System calibration

Grown/Up

BMH3D development started in 2018 with early versions being developed as a generic 3 way system allowing it to be matched with a wide variety of drivers. Upon the introduction of the Servolabs Grown/Up system in 2020 the design focus shifted towards tuning it to this system.

As with any active loudspeaker system it's final adjustment procedure depends on the drivers / enclosure used and as such can only be given for fixed configurations like the Servolabs Grown/Up which is used in the example below. For other configurations the described procedure can act as a starting point but will need adjusting to match specific driver and enclosure parameters.

Measurement setup

Adjusting the BMH3D requires the following setup:

- A MiniDSP UMIK-1 measurement microphone, see https://www.minidsp.nl/umik-1.html
- A laptop running ARTA, see https://www.artalabs.hr/
- Stands for both the Grown/Up enclosure as the measurement microphone to be elevated so the Coaxial driver is on the same vertical level as your ears when you are sitting in your favorite listening position.
- Connection cable between the laptop audio output and the Grown/Up miniXLR connector.
- Turn the BMH3D LEVEL, LOW and MFB potentiometers clockwise to their maximal value, turn both MID and HIGH potentiometer counter clockwise to their minimal value. Set your laptop audio output to minimal

Adjusting the Woofer channel

Woofer adjustment is done using two potentiometers, LOW and MFB.

- Place the UMIK-1 in front of the woofer so it points to the center of the cone with a 10cm distance between the two.
- Start ARTA and select the FR1 measurement option, adjust the frequency band with the FrLow toggle to 20hz and the FrHigh toggle to 1Khz.
- Start the noise generator by pressing the red arrow button and adjust the laptop volume to measure a maximum SPL of 100dB.
- Turn the MFB potentiometer counter clockwise until the frequency response between 50 and 400hz does not exceed 80dB.

Adjusting the mid and high channel

- Place the UMIK-1 in front of the coaxial so it points to the tweeter with a 10cm distance between the two.
- Adjust the ARTA frequency band with the FrLow toggle to 200hz and the FrHigh toggle to 20Khz.

- Turn the MID potentiometer clockwise until the average frequency response between 200 and 4Khz does not exceed 80dB.
- Turn the HIGH potentiometer clockwise until the average frequency response between 4Khz and 20Khz does not exceed 80dB.

Woofer powerstage

The below graphs were taken from the Texas Instruments documentation, for further details refer to: https://www.ti.com/product/TPA3116D2.

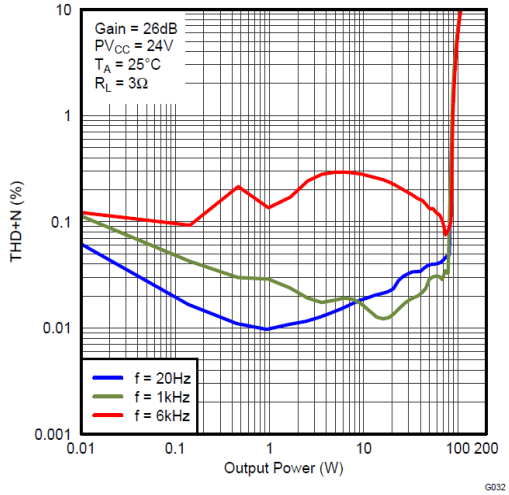


Figure 25. Total Harmonic Distortion + Noise (PBTL) vs Output Power

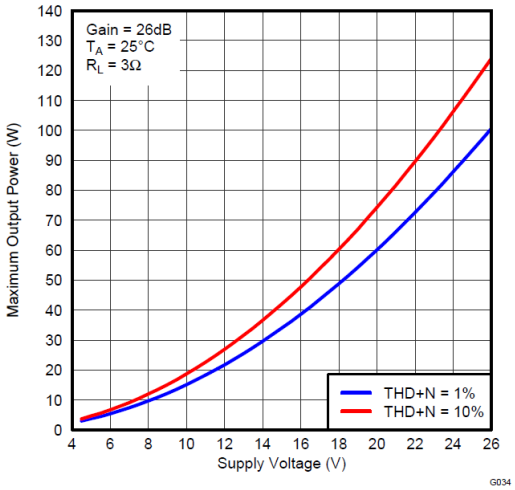


Figure 26. Maximum Output Power (PBTL) vs Supply Voltage

The BMH3D woofer channel is driven by a IC8, module heatsinking has been designed for use with for 4 ohm loads only, usage of lower impedance drivers may require additional – forced - module cooling. THD figures are shown for a 3ohm driver and remain well under 0.1% for a RMS output upto 80 watts into 3 ohms or 70 watts into 4 ohms. The maximum allowable supply voltage for the BMH3D module is 26Vdc, the recommended supply voltage is 24Vdc.

Midrange & tweeter powerstages

The mid and high channels are driven by a IC7, module heatsinking has been designed and tested with 6 ohm loads, usage of lower impedance drivers may require additional forced module cooling.

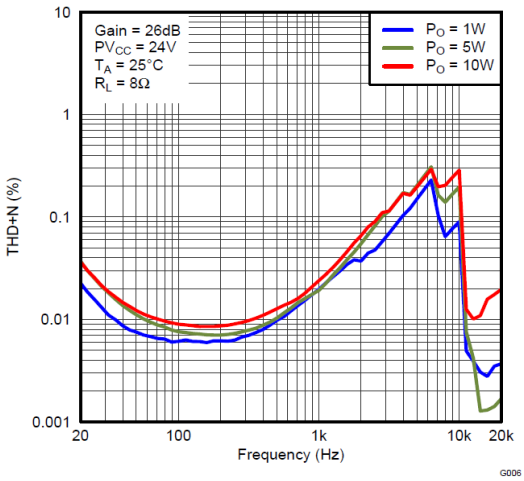


Figure 5. Total Harmonic Distortion + Noise (BTL) vs Frequency

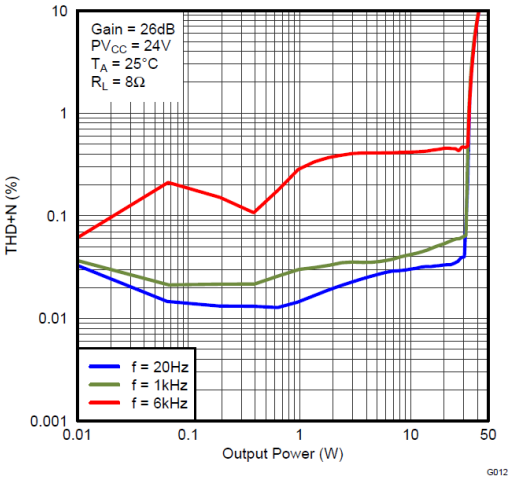


Figure 10. Total Harmonic Distortion + Noise (BTL) vs Output Power

Enclosure

The Grown/Up enclosure is finished in an either a black or white Warnex protective coating. To obtain an optimal audiophile dispersion characteristic the Grown/UP's are best enjoyed to without covers.

Optional cover

A magnetically mounted protective front cover to shield the drivers from investigative fingers is available upon request.

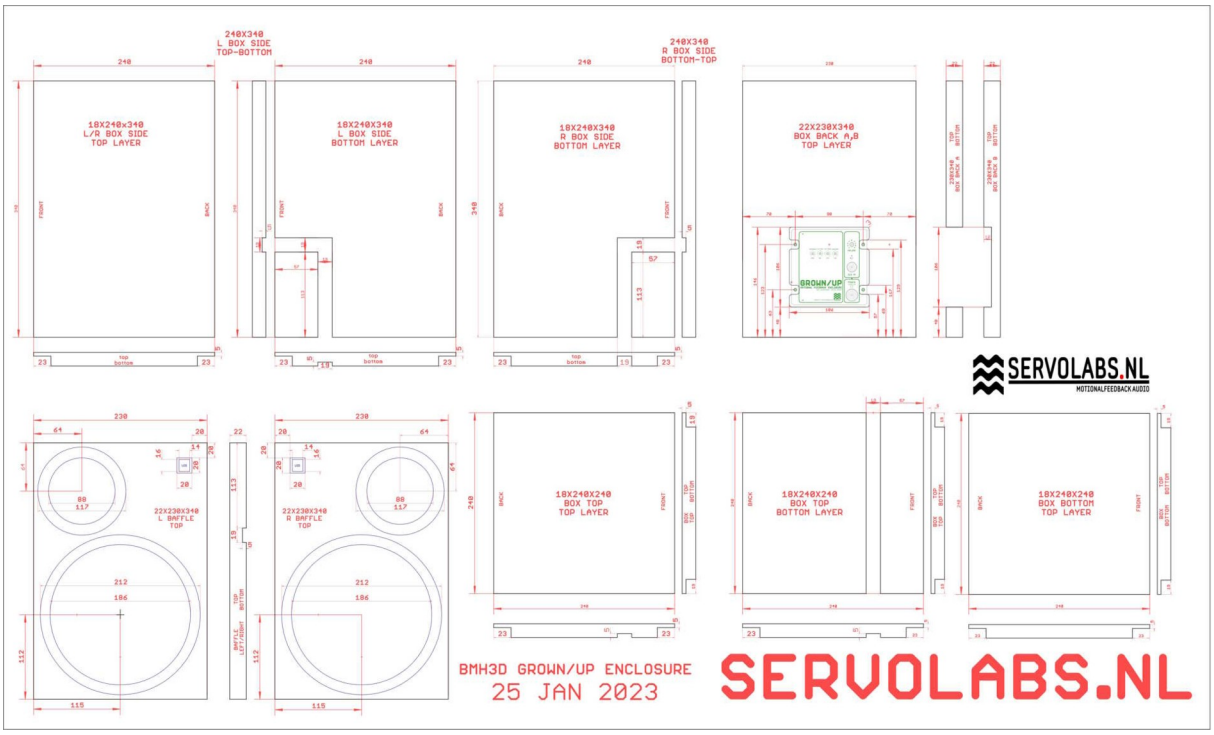
Warnex coating

All Servolabs enclosures receive a Warnex coating which is a water based high impact scratch resistant paint used in professional road capable audio. Other coatings and/or enclosure materials are optional and available upon request.

Enclosure buildup

The enclosure is made from 18 and 22mm cnc machined medium density fiberboard, upon request the enclosure can be pre fitted with mounting points for commercially available stands and fly gear. **Any retrofitting not performed by Servolabs will void your warranty.**

The cutting plan below is provided for reference only and subject to change.



General Information

Servolabs

Servolabs sells completed modules and system based upon Piratelogic electronics. Checkout http://servolabs.nl for further details.

Piratelogic

This manual, the bmh3d module, it's accompanying accelerometer equipped low note driver are developed by chris@piratelogic.nl from Diemen, the Netherlands. Checkout http://piratelogic.nl for further details.

Availability

This module is available through http://servolabs.nl

Warranty

ServoLabs warrants this product to be free of defects in material and workmanship for a period of five (5) years for parts and for a period of five (5) years for labor from the date of original purchase. During the warranty period ServoLabs shall, at its sole and absolute option, either repair or replace free of charge any product that proves to be defective on inspection by ServoLabs.

In all cases disputes concerning this warranty shall be resolved as prescribed by law. To obtain warranty service, the purchaser must contact ServoLabs via

https://servolabs.nl/?p=nl.home#contact

prior sending the unit in for service. All inquiries must be accompanied by a description of the problem. All authorized returns must be sent to ServoLabs with postage prepaid, insured and properly packaged. Proof of purchase must be presented in the form of a bill of sale or some other positive proof that the product is within the warranty period. ServoLabs reserves the right to update any unit returned for repair. ServoLabs reserves the right to change or improve design of the product at any time without prior notice.

This warranty does not cover claims for damage due to abuse, neglect, alteration or attempted repair by unauthorized personnel, and is limited to failures arising during normal use that are due to defects in material or workmanship in the product. In no event will ServoLabs be liable for incidental, consequential, indirect or other damages resulting from the breach of any express or implied warranty, including, among other things, damage to property, damage based on inconvenience or on loss of use of the product, and, to the extent permitted by law, damages for personal injury

Forum, sites & socials

https://www.facebook.com/servolabs

https://www.facebook.com/piratelogic

https://zelfbouwaudio.nl/forum/

https://servolabs.nl

https://piratelogic.nl/

Document Revisions

19-11-23	DRAFT version by CC
13-11-24	Added tpa3116 info
18-10-24	Updates on module connections
03-12-24	Minor textual updates