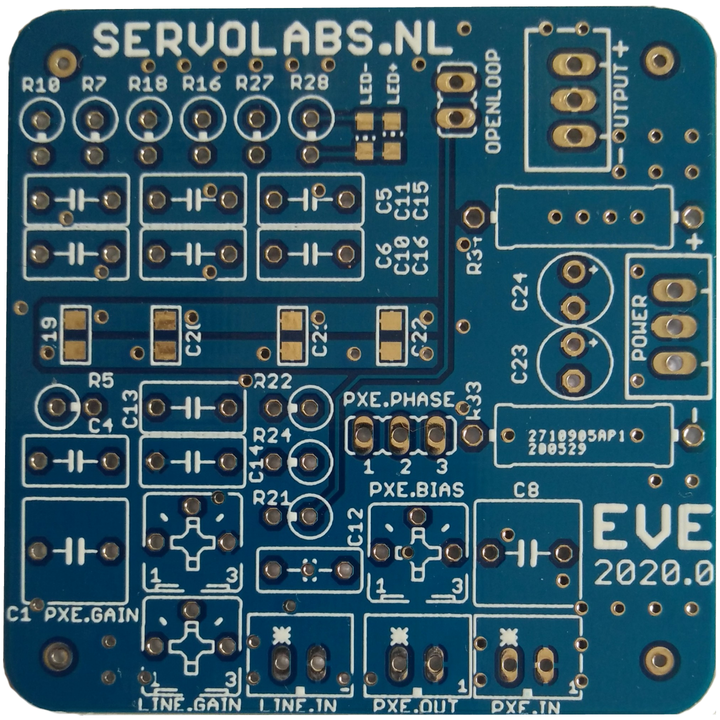
EVE

servo evaluation pcb

VERSION 2020.0



SUBJECT TO PERMANENT DEVELOPMENT

Contents

Before you start ....

Thank you for purchasing the EVE pcb, please note this manual is subject to permanent development so expect grammar & spell checks, corrections and improvements, **read the ERRATA section before building EVE !!**

Prerequisites

In order to successfully assemble the pcb the following prerequisites are needed.

- ESD safe working environment : EVE contains ESD sensitive jFet devices, please adhere to guidelines for safe handling of ESD sensitive components during assembly of the sensors.
- SMD soldering station : the EVE design uses surface mount technology and requires handling and use of an appropriate soldering station to avoid thermal damage to the used parts when soldered onto the PCB.

Warranty / Disclaimer

Although this pcb has been developed with lots of love, tenderness and devotion and has been tested with numerous MFB enclosures it is subject to constant research and development and as such no guarantees and/or warranties can be given for the correct / optimal / failure free working of the module. No responsibility is taken for any damage resulting from the use of this module.

Designing & building servo drive systems like described in this manual requires a thorough understanding of and working experience with the underlying electronics. An engineering degree and experience with component level board repair is strongly advised. This is NO starter project !!!!

Availability

Bare EVE printed circuit boards without components are available for 15 euro a piece by sending an email to chris*nospam*piratelogic.nl – replace *nospam* with the standard @. At the time of writing pricing for a smd prepopulated pcb are being negotiated and will appear here in future manual updates. Pricing excludes VAT and shipment.

Copyright

The EVE circuit design is free for use both for hobby as well commercially.

Design scope

Back in 2017 EVE got originally developed as a quick and dirty solution to add servo bass functionality to an ADAM A7 monitor in conjunction with a StarBass IV accelerometer equipped woofer. EVE 2020.0 basically follows an identical setup with the quick and dirty parts removed and has been optimized using user input to improve both its performance as well as its ease of implementation.

MAY THE MUSIC PASSING THROUGH THIS DEVICE
SOMEHOW HELP TO BRING JUST A LITTLE MORE PEACE
TO THIS TROUBLED WORLD

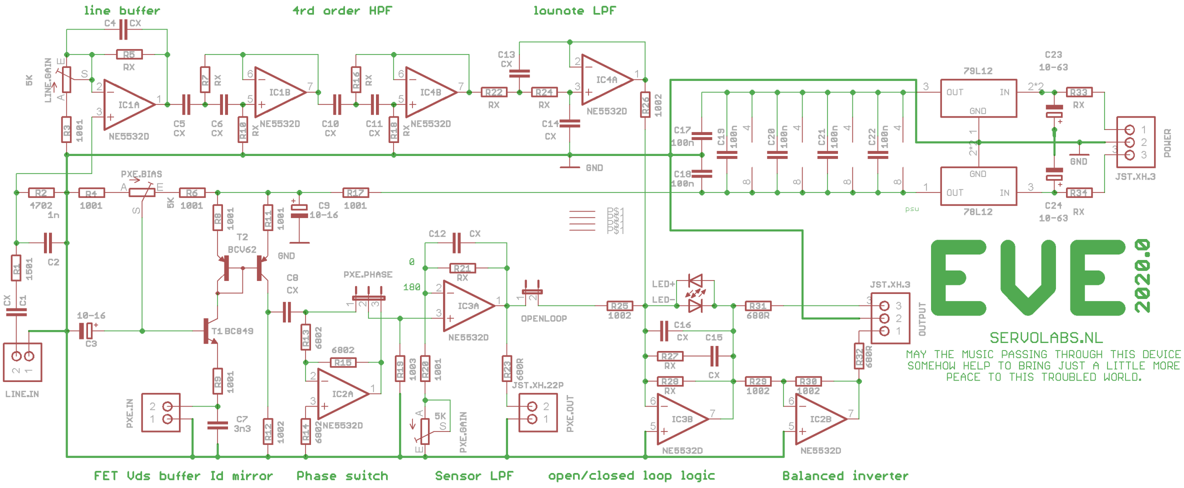
Bill of materials

The parts listed below are surface mount devices, the schematic parts listed Cx and Rx are through-hole components which values are setup dependend. The LCSC identifiers can be used with https://jlcpcb.com/parts .

Part	Value	Package	Description	LCSC	MOUSER	MPN
78XX	7812	SOT89-3	Voltage stabilizer	C8615		CJ78L12
79XX	7912	SOT89-3	Voltage stabilizer	C8626		CJ79L12
C17	100n	C0805	SMD capacitor	C49678		CC0805KRX7R9BB104
C18	100n	C0805	SMD capacitor	C49678		CC0805KRX7R9BB104
C19	100n	C0805	SMD capacitor	C49678		CC0805KRX7R9BB104
C2	10n	C0805	SMD capacitor	C1710		CL21B103KBANNNC
C20	100n	C0805	SMD capacitor	C49678		CC0805KRX7R9BB104
C21	100n	C0805	SMD capacitor	C49678		CC0805KRX7R9BB104
C22	100n	C0805	SMD capacitor	C49678		CC0805KRX7R9BB104
C3	10-16	SMC_A	SMD capacitor	C7171		TAJA106K016RNJ
C7	10n	C0805	SMD capacitor	C1710		CL21B103KBANNNC
C9	10-16	SMC_A	SMD capacitor	C7171		TAJA106K016RNJ
IC1	5532	SO08	AUDIO AMPLIFIER	C7426		NE5532DR
IC2	5532	SO08	AUDIO AMPLIFIER	C7426		NE5532DR
IC3	5532	SO08	AUDIO AMPLIFIER	C7426		NE5532DR
IC4	5532	SO08	AUDIO AMPLIFIER	C7426		NE5532DR
LED-		CHIP-LED0805	LED	C84256	FC-2012HRK-620D	
LED+		CHIP-LED0805	LED	C84256	FC-2012HRK-620D	
LINE.GAIN	5K	B25P	POTENTIOMETER		652-3362P-1-502LF	
PXE.BIAS	5K	B25P	POTENTIOMETER		652-3362P-1-502LF	
PXE.GAIN	5K	B25P	POTENTIOMETER		652-3362P-1-502LF	
R1	1501	R0805D	SMD resistor	C4310		0805W8F1501T5E
R11	1001	R0805D	SMD resistor	C17513		0805W8F1001T5E
R12	1002	R0805D	SMD resistor	C17414		0805W8F1002T5E
R13	1003	R0805D	SMD resistor	C17407		0805W8F1003T5E
R14	4702	R0805D	SMD resistor	C17713		0805W8F4702T5E
R15	1003	R0805D	SMD resistor	C17407		0805W8F1003T5E
R17	1001	R0805D	SMD resistor	C17513		0805W8F1001T5E
R19	1003	R0805D	SMD resistor	C17407		0805W8F1003T5E
R2	4702	R0805D	SMD resistor	C17713		0805W8F4702T5E
R20	1001	R0805D	SMD resistor	C17513		0805W8F1001T5E
R23	680R	R0805D	SMD resistor	C17798		0805W8F6800T5E
R25	1002	R0805D	SMD resistor	C17414		0805W8F1002T5E
R26	1002	R0805D	SMD resistor	C17414		0805W8F1002T5E
R29	1002	R0805D	SMD resistor	C17414		0805W8F1002T5E
R3	1001	R0805D	SMD resistor	C17513		0805W8F1001T5E
R30	1002	R0805D	SMD resistor	C17414		0805W8F1002T5E
R31	680R	R0805D	SMD resistor	C17798		0805W8F6800T5E
R32	680R	R0805D	SMD resistor	C17798		0805W8F6800T5E
R4	4701	R0805D	SMD resistor	C17673		0805W8F4701T5E
R6	4701	R0805D	SMD resistor	C17673		0805W8F4701T5E
R8	1001	R0805D	SMD resistor	C17513		0805W8F1001T5E
R9	1001	R0805D	SMD resistor	C17513		0805W8F1001T5E
T1	BC849	SOT23	NPN TRANSISTOR		863-BC849CLT1G	
T2	BCV62	SOT143B	PNP current mirror		726-BCV62CE6327	

Schematic description

See page #18 for a larger version



Line buffer

The line buffer circuitry performs the following functions:

- The incoming audio signal arrives at LINE.IN where passes DC blocking capacitor C1 which together with R2 in paralel with input resistance of the 5532 - typically 300K – 300K // 47K = 40K forms a 1st order high pass set at 3.9hz using a 1 uF capacitor for C1.
- To minimize EVE's rf input susceptibility the lowpass filter R1,C2 is used, with C2=10n the LPF is set at 10Khz. **To avoid microphonics make sure to use a NPO for C2 !**
- Depending on your setup and power amplifier gain setting the EVE gain can be set between 2.6 and 11x with LINE.GAIN to adapt for use with low gain final stages.

4th order high pass

The bandwith for the incoming line buffer signal is set by the 4th order HPF build around IC1b and IC4b and the 2nd order LPF around IC4a.

PXE input buffer

The pxe input buffer processes the incoming accelerometer current signal and performs the following functions:

- The accelerometer current souce signal enters EVE at PXE.IN where it passes rf filter R9,C7 which corner freqency is set to 16 Khz. **To avoid microphonics make sure to use a NPO for C7 !**
- To adapt for jFet Vgs variations EVE allows the accelerometer bias voltage set for optimal linear operation by setting PXE.BIAS voltage for T1, the standard StarBass bias voltage is 6V.
- The output of the current mirror T2 arrives at IC2a which allows phase invertion of the accelerometer signal. Sensor signal gain and low pass is provided by IC3a, for measurement purposes the accelerometer signal is made available via PXE.OUT. Use the **OPENLOOP** jumper to perform open/closed loop measurements.

Loop Mixer

The buffered, amplified and lowpassed StarBass signal arrives at IC3b where it is summed with the incoming audio signal via R26. C15, C16, R27 and R28 are used for setting loop gain and shaping.

Limiter

LED+ and – are used to limit the output of IC3b. Take care not to illuminate these externally to avoid the introduction of DC components into the feedback loop - thanks es163@diyaudio for bringing this to my attention . The phase inverter IC2B is used to build the symmetric OUTPUT 3+ and 1-.

Power

7812 and 7912 are standard voltage regulators to allow EVE from being operated from the power amp rails, Eve's current draw is 40mA max, use R33 and R34 to bleed of excessive rails (regulator inputs are max +/- 35V).

Improvements over EVE version 2018:

- Input buffer
- Low noise pxe buffer with adjustable accelerometer bias voltage
- Through-hole loop shaping / filter parts & rails bleeders
- Max rails +/- 60V
- Open/closed loop mode switch
- led loop limiter
- Symmetric line out
- ne5532 opamps
- 50x50 mm pcb size.
- JST headers

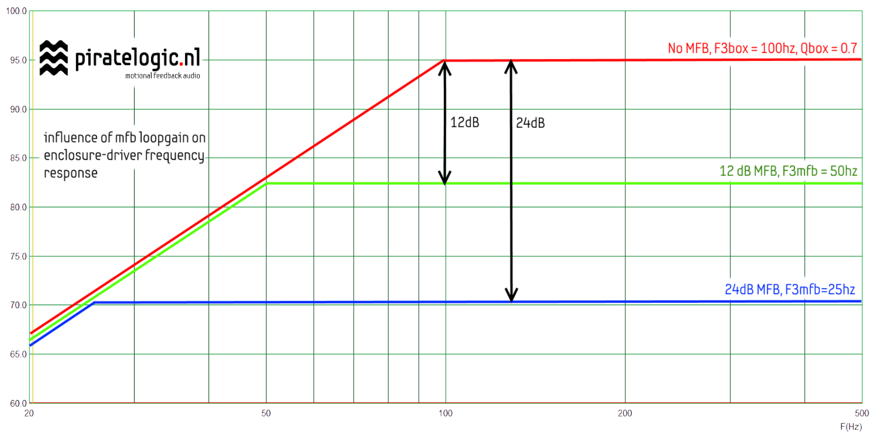
Main design considerations

Being designed as a generic mfb correction module EVE supports a wide variety of driver, enclosure and loopgain choices. Because of this generic setup it is not possible to provide a common set of component values, to assist the user with making educated choices the following information is given. **Servo / Motional feedback does not work with Helmholtz resonator based enclosures such as bass reflex boxes.**

Servo loop gain

EVE has been designed to offer a theoretical maximum servo loopgain of 20dB, refer to below graph for the relation between servo loopgain and a Q0.7 enclosure frequency response. Servo loopgain determines:

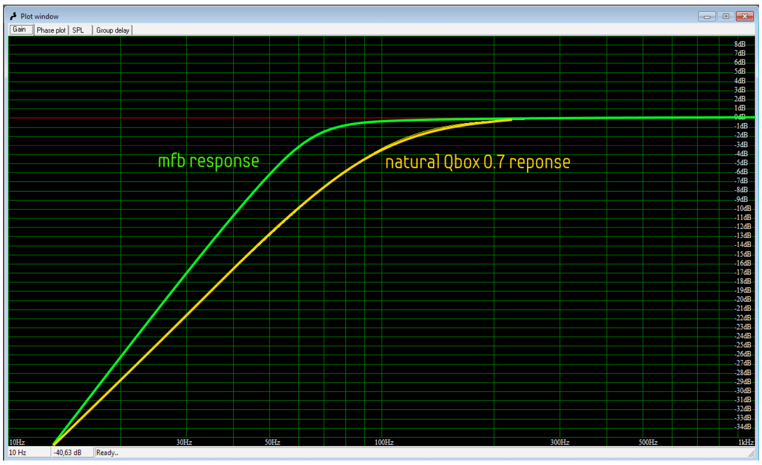
- The **F3mfb**, the higher the amount of gain the lower the resulting **F3mfb** will be.
- Maximum SPL, the 'extra' energy is rerouted to low extension.
- The amount of second and third harmonics supression available .



Enclosure parameters

The first step is to set the low frequency pole for your mfb box F3**mfb** equal to the driver physical resonance frequency F3driver or higher, choosing values below F3driver will severely limit driver efficiency due to usage outside it's physical limits.

The second step is to choose an enclosure volume using the standard closed box design formulas combined with the driver T&S parameters – to ease down on the involved math use a program like WinISD. Start with an enclosure Q of 0.7. As displayed above 12dB MFB loopgain allows you to split F3**box** in half so if the desired lower frequency pole of your finished box F3**mfb** is 60hz the chosen F3**box** should be 120hz or lower.

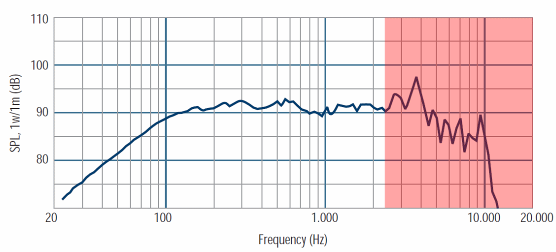


Example WINISD *response plot for a driver with a F***c** *of 60hz mounted in a sealed Q=0.7 enclosure with a natural F***box** *of 120hz which is moved down to F***mfb** *of 60hz.*

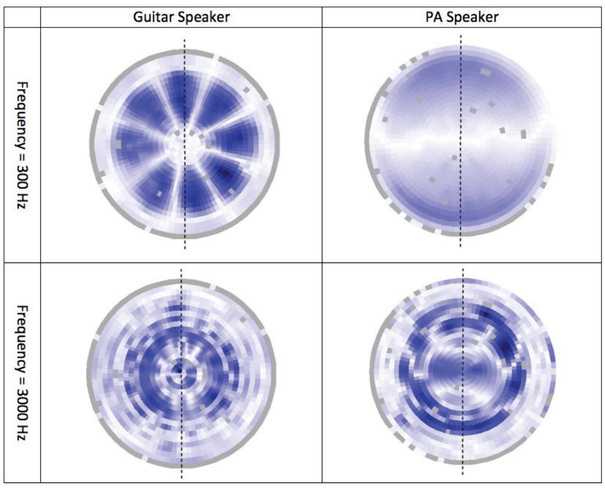
Keep in mind that the higher Q**box** is chosen (= smaller box) the harder the driver will need to work to reach the required excursion, as such one is discouraged from using Q**box** values above 1 as it will limit system efficiency and SPL.

Low Pass Filter

The 3rd step is to decide on a low pass filter frequency - **Flpf** - using the drivers datasheet as reference. EVE's onboard lowpass filter follows a 2nd order Sallen Key setup, as such it is advised to choose **Flpf** at least 1 octave away from the first occurrence of cone breakup. In the example on the right cone breakup occurs in the red region onwards 2500hz making 1250hz or lower a valid choice for **Flpf**



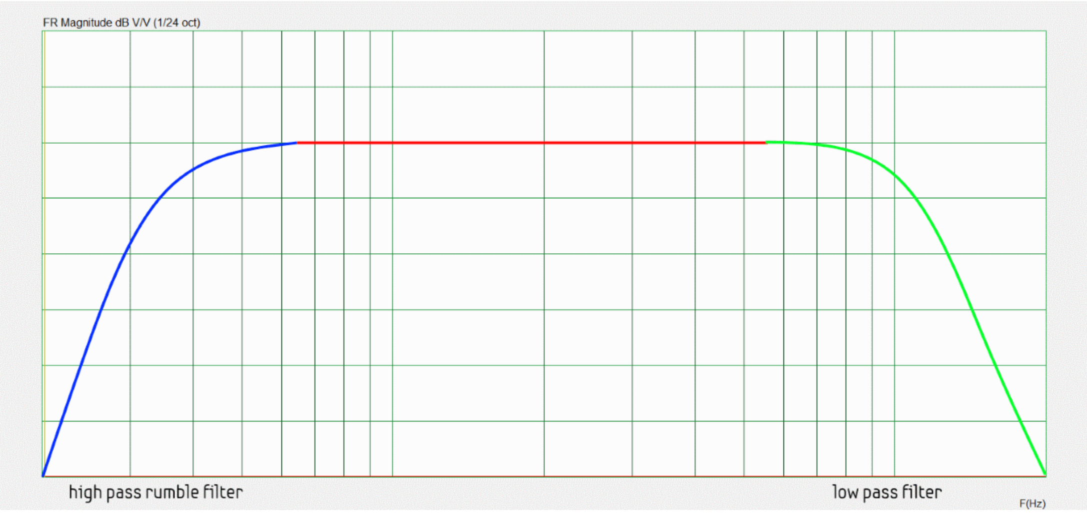
For mfb to work best the driver cone movement needs to be *pistonic* in the area your loop is active in – voicecoil movement must mimic the cone without any partial vibrations like shown for the guitar speaker image (courtesy https://www.premierguitar.com) on the right.



Without pistonic movement the correction signal will contain distortions that will mess up your control loop. None pistonic movement, also called cone breakup, introduces partial distortions which are not 'heard' by the accelerometer and thus not covered by the feedbackloop.

Crossover points

Using F3mfb and F1pf and F3box the component values for the desired crossover points can be calculated. The blue curve represents F3mfb and the green curve F1pf. These values were calculated using http://sim.okawa-denshi.jp/en/OPstool.php for the lowpass and http://sim.okawa-denshi.jp/en/OPseikiHikeisan.htm for the highpass filters.



4th order Rumble filter IC1B, IC4B Q=0.5

C5,C6,C10,C11 (nF)	R7,R10,R16,R18 (K)	Frequency (hz)
100	15	106
100	18	88
220	10	72
220	12	60
220	15	48
220	18	40
220	22	32
220	27	27
220	33	21

2nd order Lowpass filter IC1C Q=0.74

R22,R24 (K)	C14 (nF)	C13(nF)	Frequency (hz)	C16 (nF)
2.2	47	100	1055	1n5
3.3	47	100	703	2n2
3.9	47	100	595	2n7
4.7	47	100	493	3n3
2.7	100	220	397	3n9
3.3	100	220	325	4n7
3.9	100	220	275	5n6
4.7	100	220	228	6n8
5.6	100	220	191	8n2

Rumble High Pass Filter

When choosing values for the rumble hpf be aware of the fact that the servoloop will attempt to correct cone motion right down to the lower pole of the EVE circuit. So if the system is offered a 5hz signal from a wobbly recordplayer it will make the connected driver follow this signal no matter it's amplitude. In the oldskool days this was the reason why commercial amplifiers were often equipped with a so called "SubSonics" filter. Be careful not to set the rumble frequency too low, -3dB @ 10hz may look nice on your spec list but will severly stress your driver when connected to a 500 watt Class D amp. *Perform a LF sweep before deciding on how low you want things to go and keep in mind that average electronic music starts at 20hz.*

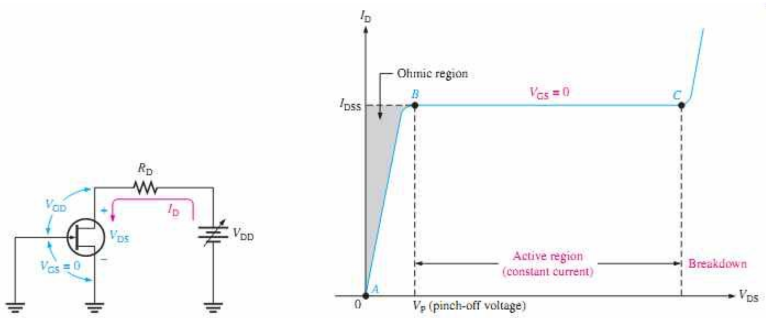
In case EVE is to be used with existing active enclosures it's build-in rumble and lowpass filters may need disabling:

- **Disabling the rumble filter** : omit **R7, R10, R16, R18** and replace **C5, C6, C10, C11** with wire bridges.
- **Disabling the lowpass filter** : omit **C13, C14** and replace **R22, R24** with 0 ohm resistors.

Accelerometer settings

Bias

All StarBass accelerometers use a jFet transistor as impedance transformer with the pxe sensor element connected between it's gate and source. To obtain linear operation the jFet is biased into its ohmic region by setting Vgs to 0Vdc and placing a resistor over the pxe element which itself behaves like a capacitor :



(a) JFET with $V_{GS} = 0$ V and a variable V_{DS} (V_{DD}) (b) Drain characteristic

image courtesy of https://www.industrial-electronics.com/electrnc-dvcs-9e_8.html

To minimize StarBass distortion while maximizing it's output EVE2020 allows you to bias the pxe voltage between 4 and 8V using the PXE.BIAS potentiometer to accommodate for different Vgs voltages. For further information regarding jFet gate-source pinch off voltages see https://en.wikipedia.org/wiki/JFET

Gain

Acceleration sensor output is determined both by its sensitivity in mV/G as well as the drivers linear cone excursion - to reproduce a certain SPL a small diameter driver will need to perform larger excursions then a large diameter driver, as such the accelerometer output is depended on the driver cone diameter. Longstroke drivers with a high Xmax will typically exhibit a relative high signal output when compared to standard drivers. To accommodate for this ajust **PXE.GAIN** which sets the gain for the incoming accelerometer signal.

Highpass filter

To avoid problems caused by the difference between the mirror output and opamp input DC levels a capacitor C8 was added to the circuit. The lower pole for the accelerometer signal Fpxe.low determines the low end loop stability and should be chosen at least at one tenth of F3mfb, too high values in respect to F3mfb will cause phase shift induced LF oscillations. Starting values for C8 and R19 are 680n and 120K setting Fpxe.low at 2hz. See also the topic *Amplifier bandwidth* in the chapter *Configuring the Servo Feedback Loop*.

Lowpass filter

The high pole for the accelerometer signal – Fpxe.high – avoids driver breakup from entering the summation signal at IC3b. As a starting value half the low pass filter frequency Flpf should be used when calculating C12.

C12	Sensor cut-off frequency	C12	Sensor cut-off frequency
2n2	7200 hz	8n2	1940 hz
3n3	4822 hz	10n	1591 hz
3n9	4080 hz	15n	1061 hz
4n7	3386 hz	22n	723 hz
5n6	2842 hz	33n	482 hz
6n8	2340 hz	47n	338 hz

Configuring the Servo Feedback Loop

With the main design parameters being set the next step is to tune the servo loop to match a chosen enclosure and driver combination. Like any other feedback system it's feedback loop needs to perform within certain parameters to ensure stable operation while maximizing sonic performance. The EVE loop mixer design incorporates all parts needed to build a well tuned feedback loop.

DIYaudio test case

It is outside the scope of this document to fully cover the physical and electronical ins & outs of the tuning process but I have attempted to collect the most important parts, for use-case information please refer to the excellent thread by Rob Campbell **MFB for ACI SV12 Drivers using Piratelogic Electronics** on DIYAUDIO available here:

https://www.diyaudio.com/forums/subwoofers/336070-mfb-aci-sv12-drivers-using-piratelogic-electronics.html

Basics

From a physics perspective a closed loudspeaker enclosure behaves like a spring-mass system, with its response transitioning from compliance dependant – controlled by the spider & surround - to purely mass controlled with F3box as the turning point inbetween. From an electronical perspective it behaves similar to a standard second order high pass filter with the corresponding 12 dB/Oct slope and 180° phase shift at F3box.

In order to do it's magic a well tuned MFB system will not only compensate for the -12dB slope below F3box but also introduce a phase shift to compensate for the natural 180° phase shift at F3box and thereby maintain phase neutral operation. Without the latter loop stability is in danger resulting in positive feedback making the loop oscillate at a frequency below F3box. Depending on available power and F3box this may result in very low – un hearable ! - freqency instabilities which ultimately will overheat and damage the driver motor system.

A well designed servo system will not only maintain shape between it's in en output but also keep them in phase.

Example ScanSpeak

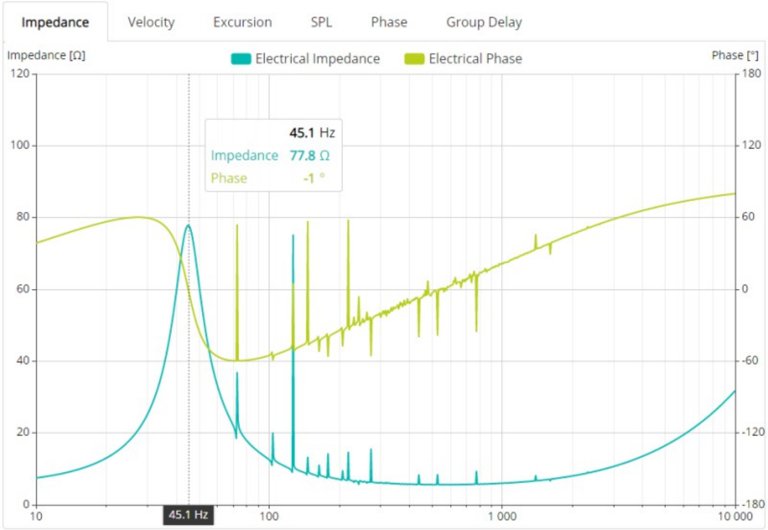
Free air response

With help of the excellent online loudspeaker database available at

http://www.loudspeakerdatabase.com/

the following simulation was made for a Scan-Speak 15W/8424G00.

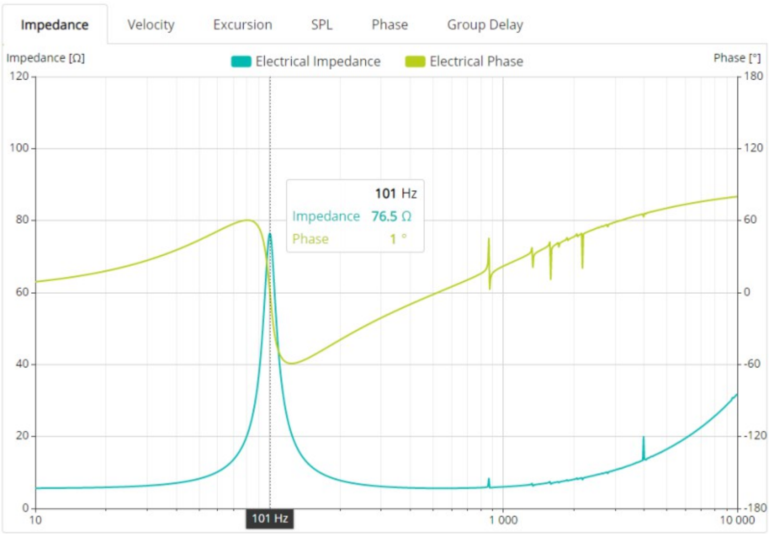
Shown on the right is the drivers free air impedance/phase curve. Note the 120 degree phase shift at 45hz, the drivers free air resonance frequency F3driver. Using this driver TS parameters as a reference the choosen F3mfb frequency would equal 45hz or higher.



Closed box response

The graph on the right shows the impedance/phase plot for the driver mounted into a 3.7 Little/One closed box, both F3box and it's accompaning phase shift have shifted towards 101 hz .

To assure stable operation the F3box phase shift should be compensated by the stepfilter R27 and C15.



Loop phase

Please note EVE introduces a 180 degree phase shift between it's LINE.IN and OUTPUT.3 signal due to the inverting nature of the summation opamp IC3b. EVE2020 is fitted with an extra phase invertor to allow the module to be directly connected to power amplifiers with a symmetric input. To invert the phase operation simply swap the 1 and 3 output pins to your amplifier. When your amp is equipped with a single async input connect it to either pin 1 or 3 of the OUTPUT. In either case use the PXE.PHASE jumper to maintain the negative feedback loop.

Loop bandwidth

C16 limits the upper bandwidth of the mfb loop and it's value should be set to match the lowpass filter setting for IC4a. Please refer to *2nd order Lowpass filter IC1C* table on page 8 for C16 values.

Amplifier bandwidth

When using EVE with third party power amplifiers make sure their lower bandwidth pole starts sufficiently low, a too high value may negatively effect loop stability due to the introduction of LF phaseshifts. As a rule of thumb make sure your amplifier lower F3 pole is at least 1 tenth of your desired F3mfb.

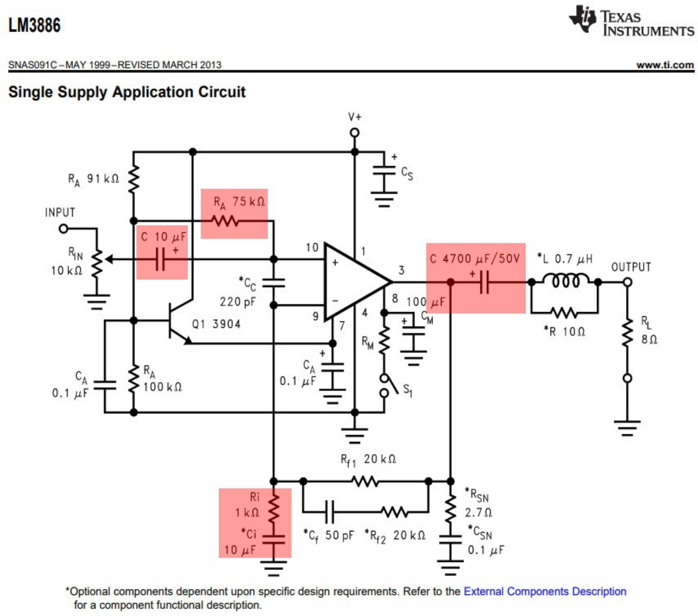


Figure 3. Typical Single Supply Audio Amplifier Application Circuit

As an example please find the following points of attention in the LM3886 based setup on the right:

- The amp input RC 10uF/75K, F corner for this combination is 0,21 hz allowing for a F3mfb of 2,1 hz and above.
- The amp feedback loop RC 10uF/1K , F corner for this combination is 16 hz allowing for a F3mfb of 160 hz and above. For a F3mfb of 20hz up the capacitor to at least 100uF.
- Some older designs use an dc blocking output capacitor in series with the driver, for a F3mfb of 20hz in combination with a 4 ohm driver use an output capacitor of at least 20.000uF.

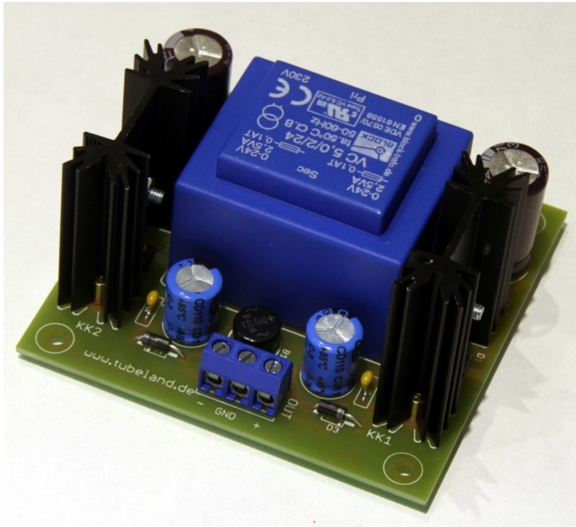
Building EVE

Power requirements

The EVE current draw at +/- 12V is 40mA max.. The onboard 78L12 and 79L12 regulators allow EVE to be powered directly from a maximum rail voltage of +/- 35V without the use of the rails bleeders R33 and R34 which can be ommitted using wire bridges. When powering EVE from higher voltage rails use R33 and R34 to bleed of the extra voltage. The shapes for R33 and 34 allow usage of 1 Watt resistors which with a currentdraw of 40mA and a value of 680 ohms allow for a maximum voltage drop of 25V resulting in a maximum admissable rail voltage of +/- 60V.

Incase EVE is to be used as a standalone module please provide for a symmetrical psu capable of delivering +/- 15V @ 80mA minimum such as done by this kit:

https://www.tubeland.de/product_info.php?products_id=13:

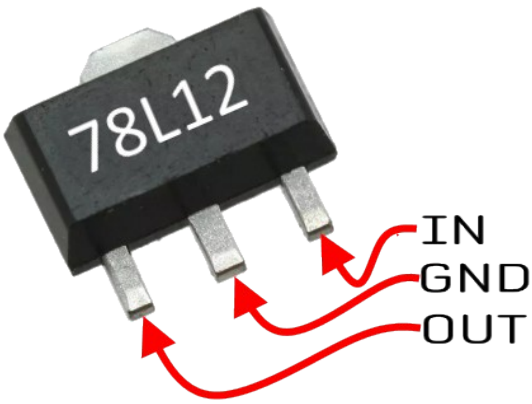


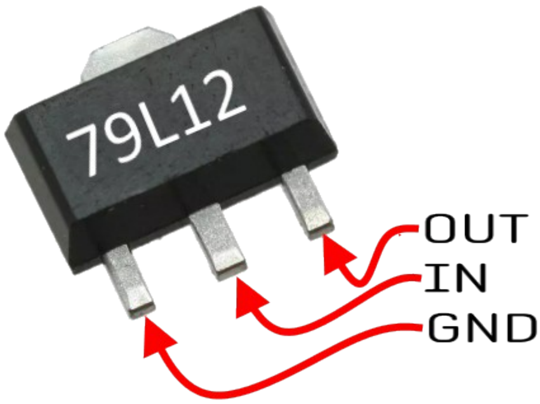
Choosing Components

EVE's primary goal is to offer a bare bone *proof of concept* servo loop solution and has been designed with cost effective readily available non-exotic parts in mind. The used 5532 opamps dates back to 1978 and by no means represents the state of the art in opamp design. However since servo loops typically operate in the lf domain it's specs are more then sufficient for the task at hand, refer to the 5532 datasheet for further information.

Onboard Regulators

Contrary to EVE2018 the 2020 version uses the standard 78L12 and 79L12 regulators in a SOT89 package, before ordering please verify the below indicated pin layouts are used.

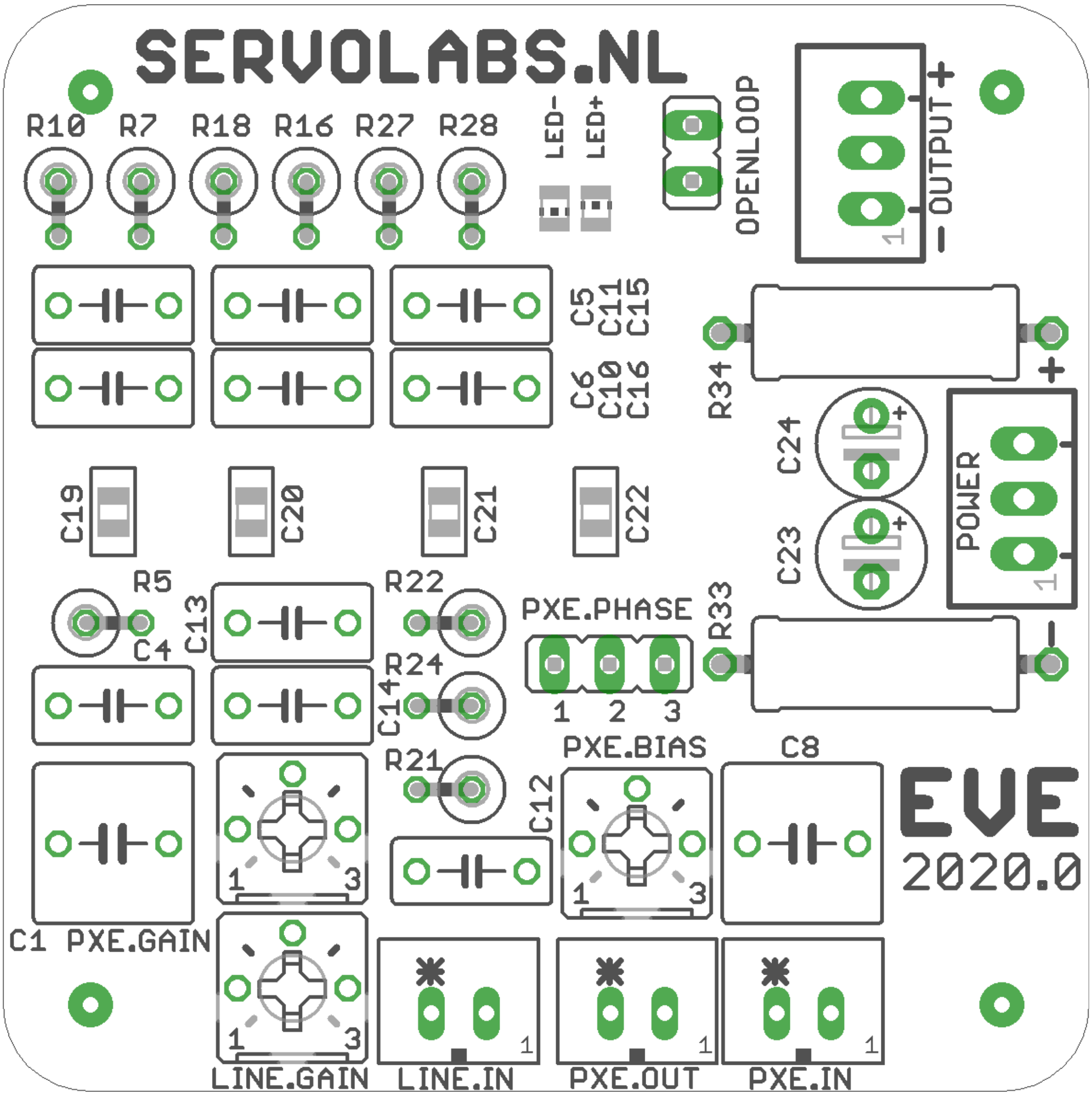




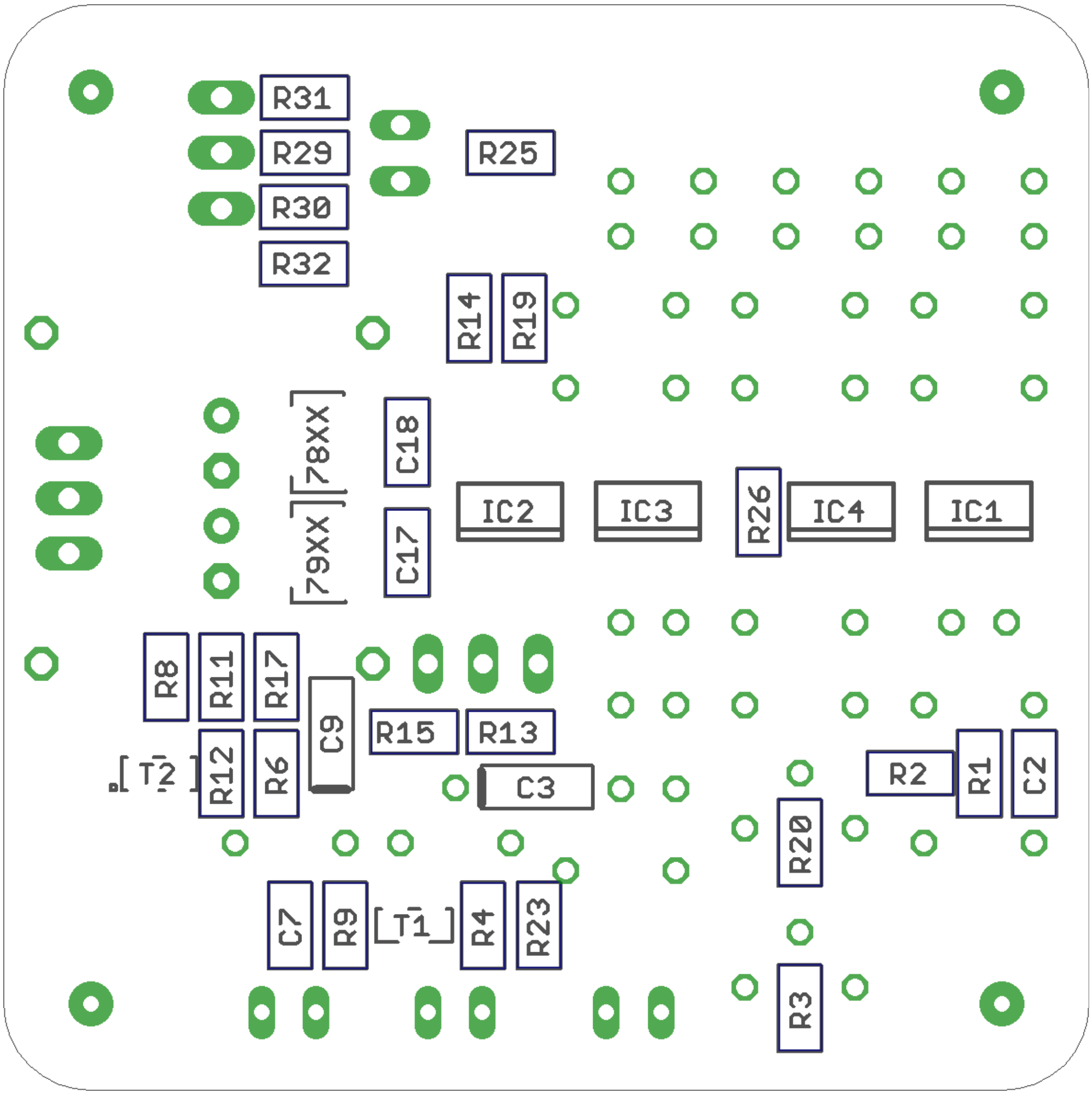
PCB Layout

Top layer names

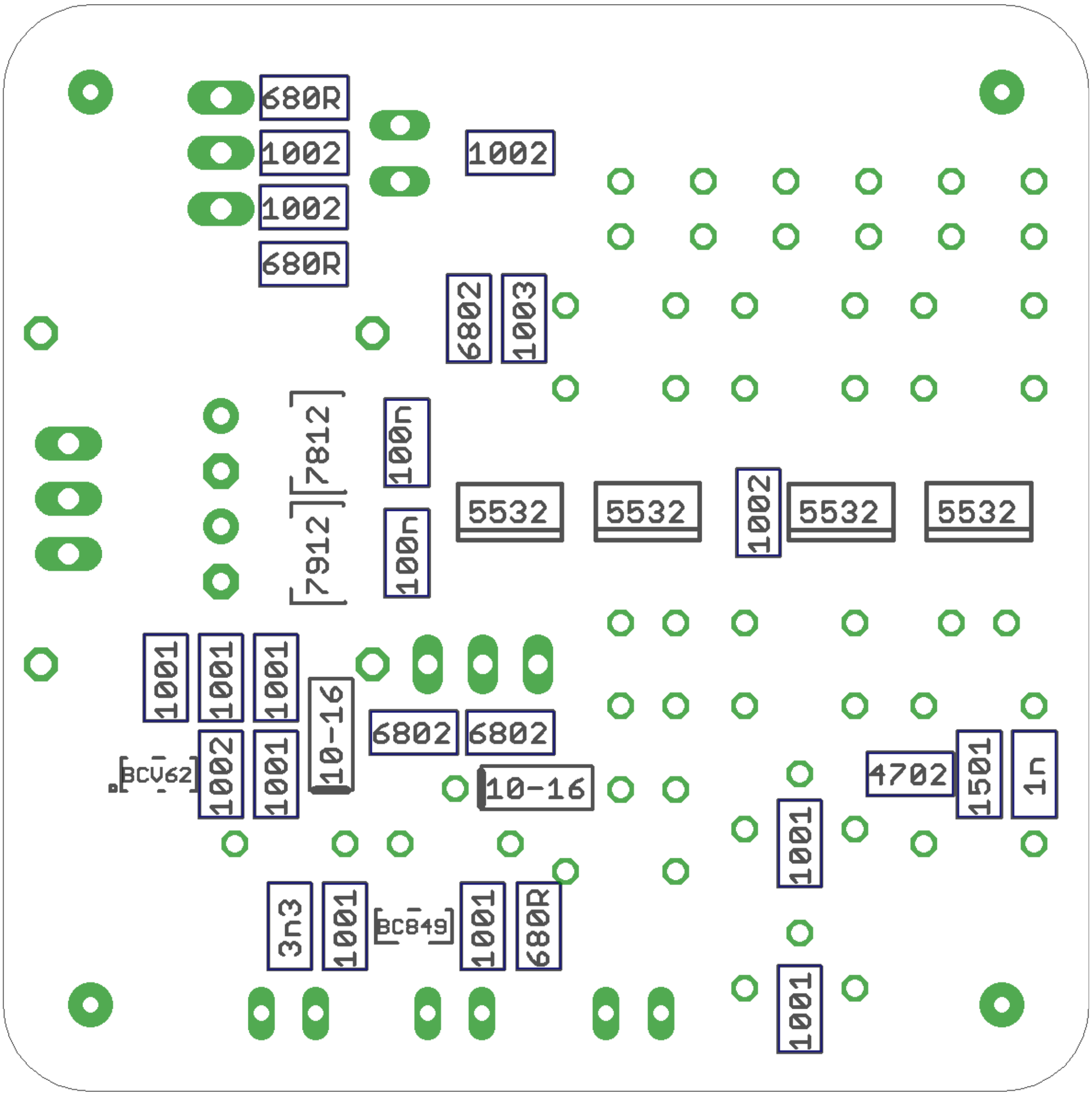
Please note **EVE is currently sold as bare PCB only and as such does not contain any components** .



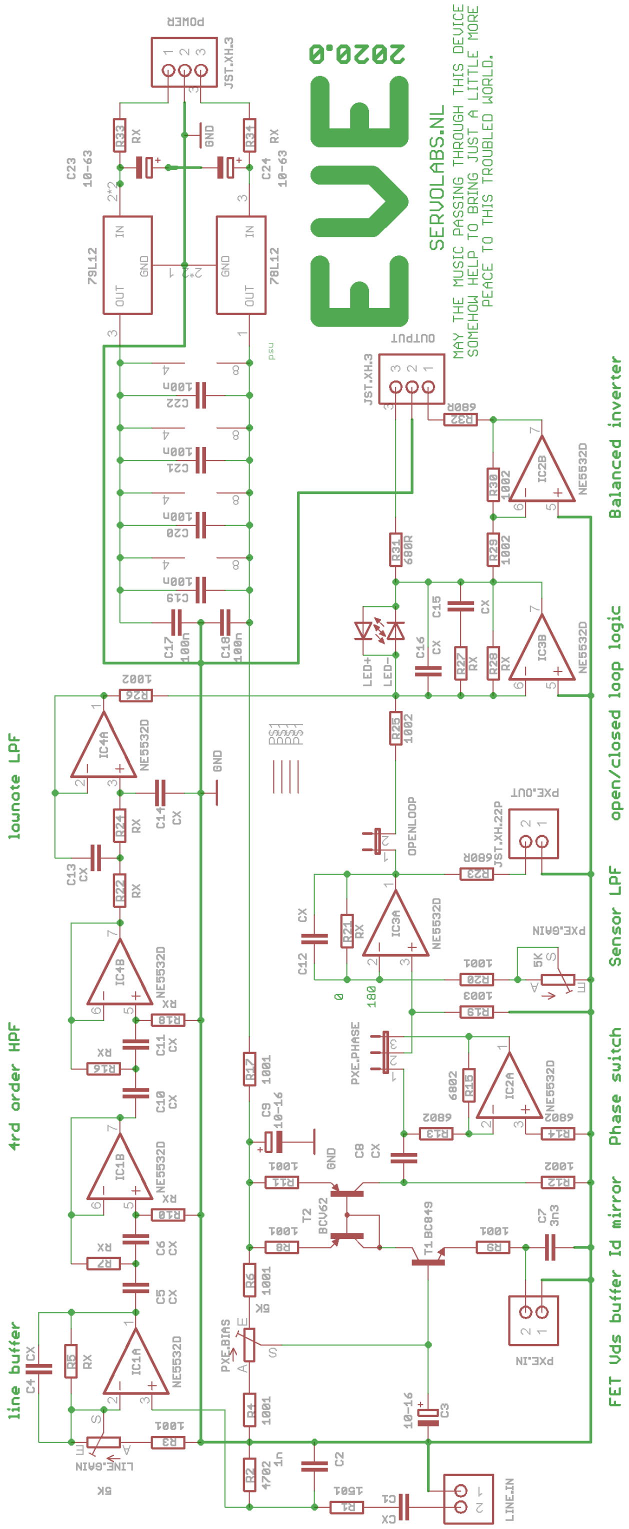
Bottom layer - names



Bottom layer - values



PCB circuit


EVE 2020.0
SERVOLABS.NL
MAY THE MUSIC PASSING THROUGH THIS DEVICE SOMEHOW HELP TO BRING JUST A LITTLE MORE PEACE TO THIS TROUBLED WORLD.
line buffer
4rd order HPF
lounote LPF
FET Uds buffer
Id mirror
Phase switch
Sensor LPF
open/closed loop logic
Balanced inverter
POWER
OUTPUT
LINE.IN
PXE.IN
PXE.OUT
PXE.GAIN
PXE.PHASE
PXE.BIAS
LINE.GAIN
OPENLOOP

Driver Selection

Overall design considerations

Designing a low note system starts with choosing main design parameters like sound presure level, dispersion pattern, power bandwidth etc, for the most of it designing a MFB system follows identical rules and logic with the exception of some important design considerations unique to MFB that need highlighting:

- As the feedback loop will attempt to mimic physical cone movement to amplifier input ported designs exhibiting a helmholtz resonance will not work without extensive loop tuning.
- MFB exchanges acoustical power output for lownote extension, if it's purely SPL your after MFB might not be your weapon of choice as the extra fundament comes at a price.
- Operating a driver / enclosure below F3box requires extra power to force cone movement to mimic the incoming electrical waveform . The extra amplifier power has thermal consequences for the driver motor system and requires extra care not to exceed thermal power handling and safe operating areas, specially since closed cabinets lack motor cooling by natural convection.

Main selection criteria

Selecting a driver for use with motional feedback systems requires attention to the following specific design details:

Cone size / material : make sure the driver cone maintains pistonic motion in the area mfb will be active in. The larger the driver the harder it will be for it to maintain pistonic operation. For high SPL designs daisy chaining multiple smaller diameter drivers might yield better results then a single large one, small lightweight & sturdy cones are favourable over large and heavy ones.

High BL: to maximise mfb control over the driver cone movement a strong motor system is required.

High Xmax : depending on the desired power bandwidth and used cabinet Q the driver needs to linearly move as much air as possible.

Low CMS : a too high value in combination with MFB will severely affect distortion figures due to the deformation of the surround caused by the cones pumping action . This is especially comes into play with Qbox designs above 0.7.

Ventilated polepiece : to allow convection of heat away from the voice coil as quickly as possible. Note that since MFB required a closed cabinet the temperature inside the enclosure will be considerably higher compared to vented enclosures. Aluminium cones exhibit better heat transfer characteristics then carbon / non metalic models.

High temp voicecoil former : usage of vintage – paper – voicecoil formers severely restrict the powerhandling.

Driver on display : http://www.loudspeakerdatabase.com/VOLT/RV3143

Accelerometer Selection

Altough EVE can be tailored to work with a wide variety of accelerometers the best results are obtained in conjunction with the Piratelogic StarBass sensors. Third party sensors might also work but have not been tested extensively and might need additional tuning in order to perform well.

The original Philips MFB sensor

When planning on using a Philips MFB woofer equiped with the original BFW11 sensor like displayed – the picture shows the sensor mounted in a AD12100/MFB as used with their famous 545 enclosure – note you will have to compensate for the combination of their low capacitance of the used pxe element (1n5) and 10M *brown – black – blue* gate resistor resulting in a lower pole of 10.61hz. See the sensor circuit below for more info. Without loop compensation the resulting phase shift might introduce subsonic instabilities below 100hz. For more information google the 545 service manual and lookup the circuitry around TS549 for further details. All StarBass sensors have their lower pole sit at 2.7hz making them suitable for use from 27hz and upwards .

Measurement specialities ACH-01

When planning on using the ACH-01 accelerometer please note the following:

- Although shielded from above the sensors ceramic baseplate is not shielded and will pickup noise if left un treated.
- When mounted on a carrier construct make sure to take precautions against the pickup of base strain induced non axial information.

Accelerometer ACH-01

measurement SPECIALTIES

Piezoelectric Accelerometer
Wide Bandwidth; AC Coupled
Ultra Low Power
High G Ranges

The ACH-01 is an inexpensive, general purpose accelerometer with outstanding performance characteristics. The use of piezoelectric polymer film in the ACH-01 provides many cost/performance advantages that allow it to be used in a wide range of applications where the use of traditional accelerometer technology is impractical. It is specifically designed for high volume applications which require the permanent installation of an accelerometer.

FEATURES

- Wide Frequency Response
- Excellent Phase Response
- Small Temperature Dependence
- Wide Supply Voltage Range
- Excellent Linearity
- Very High Resonant Frequency
- Wide Dynamic Range
- Low Transverse Sensitivity
- Wide Temperature Range
- Low Impedance Output
- Ultra Low Power

APPLICATIONS

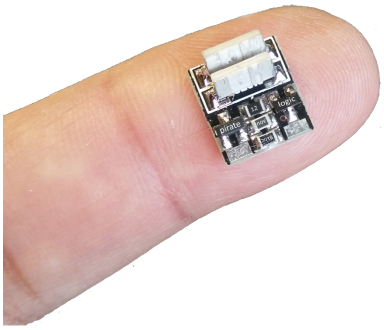
- Machine Health Monitoring
- Model Analysis
- Automotive Sensors
- Appliances
- Feedback Control Systems

dimensions

ACH 01 Rev 1 www.meas-spec.com 1 of 4 10/07/2008

Piratelogic Sensors

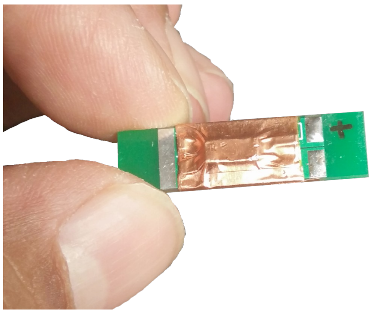
All StarBass accelerometers feature a low distortion design with a current output, shielded against EMI, RF and static electricity. **For pricing and availability visit piratelogic.nl .** Piratelogic offers accelerometer products for a wide variety of low note drivers ranging from small 0.8inch VC home use to large 4 inch pro models, drivers using an extended polepiece for BL over Xmax linearisation and low profile drivers. To assist the user in the selection process the following information is given.



Starbass ClingOn

Low MMS 2P motional feedback accelerometer for use with polepiece extended motors, designed to be vertically mounted against the outer voicecoil former. Available with 3 primary axis, see **Motor assembly variants** for more info. The ClingOn is 11mm wide, 12mm high and 6mm thick., the standard coax connection cable length is 10cm.

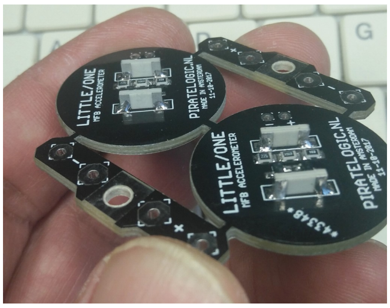
Current status : beta 2, samples available.



Starbass Stripper

Low MMS 2P motional feedback accelerometer for use with voicecoil diameters between 20 and 25 mm, designed to be mounted horizontally inside the voicecoil former.

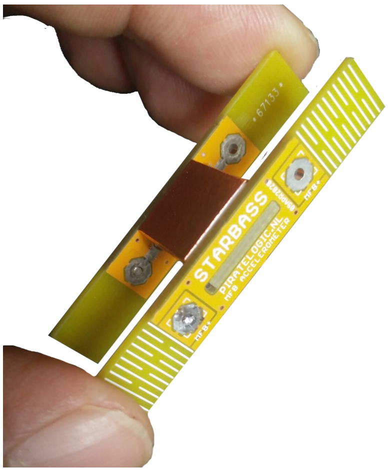
Current status : beta 1, samples available.



StarBass 26

Low MMS 2P motional feedback accelerometer for use with voicecoil diameters between 25 and 26 mm, designed to be mounted horizontally inside the voicecoil former. Sold in pairs of two with accompaning connector strips in a single breakout pcb.

Current status: backorder.

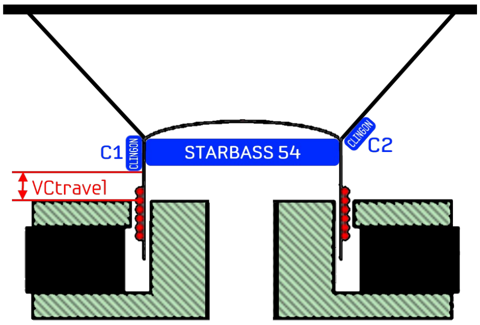


StarBass 54

Low MMS 2P motional feedback accelerometer for use with voicecoil diameters between 30 and 54 mm or 1.25" - 2", designed to be mounted inside the voicecoil former.

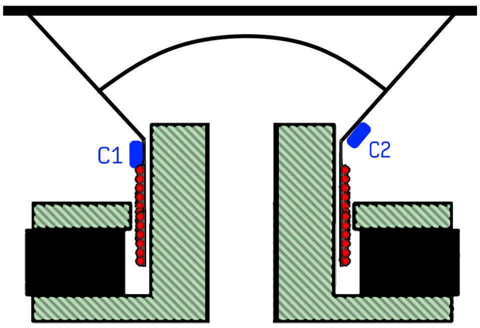
Current status: production version 5, in stock.

ClingOn variants C1, C2, C3



Accelerometer and placement choices for the most used driver motor structure:

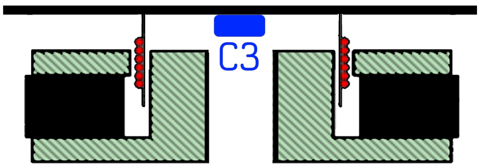
1. StarBass 54 requires disassembly of the dustcap, best quality feedback signal for VC diameters between 1.5 and 2 inch. Balanced loading, between 3 and 4 gramms addition to MMS.
2. ClingOn C1 with 90° primary axis, no dustcap disassembly required, usability depends on Vctravel, risk of unbalanced loading with low MMS cones.
3. ClingOn C2 with 45° primary axis, no dustcap disassembly required, Risk of unbalanced loading with low MMS cones, risk of cone breakup information pickup.



Accelerometer and placement choices for extended polepiece motor structures:

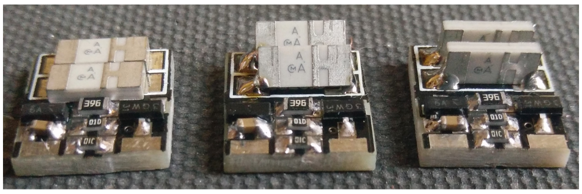
Due to the used of an extended polepiece the use of a StarBass 54 is ruled out. This setup has succesfully been tested with Peerless XLS10 and WaveCor SW023 chassis.

1. ClingOn C1 with 90° primary axis, no dustcap disassembly required, usability depends on Vctravel, risk of unbalanced loading with low MMS cones.
2. ClingOn C2 with 45° primary axis, no dustcap disassembly required, Risk of unbalanced loading with low MMS cones, risk of cone breakup information pickup.



Accelerometer and placement choices for flat panel motor structures:

ClingOn C3 with 0° primary axis, usage of ClingON accelerometers with this type of motor structure has not been tested but is given in response to a DIYaudio post by Lejonkungen investigating it's use with a TangBand w3-1876 .



C1:90° C2:45° C3:0°

When ordering ClingOn accelerometers please indicated the desired primary axis,

- ClingOn C1 : 90°
- ClingOn C2: 45°
- ClingOn C3: 0°

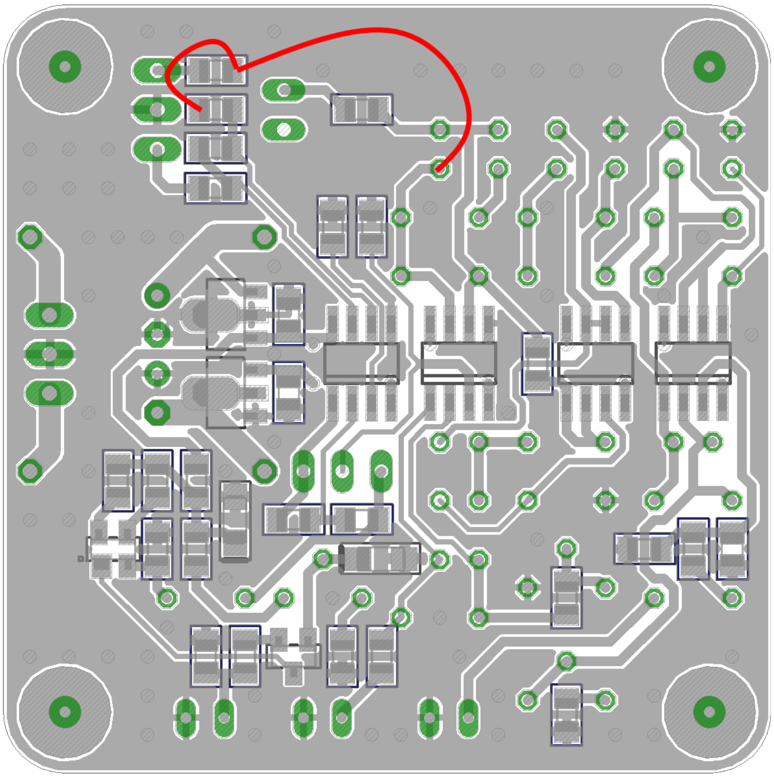
Please note that all StarBass models register axial acceleration info only with complete absence of non axial information caused by VC deformation, while at the same time don't suffer from transformation effects such as the case with pickup-coil based systems.

Addendum

Errata

Errata #1, missing trace

Please note the EVE2020.0 pcb is **missing a bottom trace** resulting in the + output not being connected, please add a small wire between the solder points as shown in the image on the right to fix this.

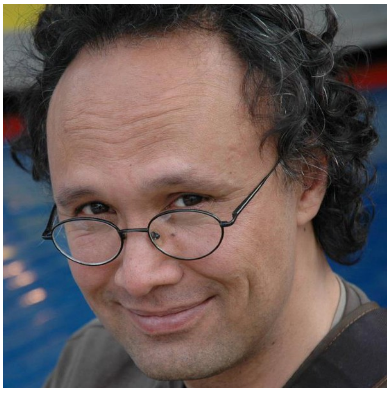


Document history

Prior to starting work please check if the date & time stamp at the footer of this page corresponds with the one in the online version by clicking the Piratelogic EVE 2020.0 Manual link in the footer of this document.

14/06/2020	Initial version by CC	19/03/2021	Added warning for photovoltaic effect of limiter leds (thx esl63)
15/06/2020	Updated schematic captions by CC	16/12/2021	Added warning on microphonics for C2,9
28/06/2020	Added Accelerometer Selection information	05/02/22	Added functional info on C8.
08/07/2020	Updated BOM & schematics	21/02/22	Added external psu info (thx Thoren)
05/08/2020	Added engineering degree requirment	05/03/22	Fuck Putin & added 3rd party sensor info
20/09/2020	Added Erata #1, PCB price drop to 15 euro.	09/04/22	Recovering from Covid, added C1 info and corrected PXE lpf typo, thanks ESL63 !
23/09/2020	Added ClingOn C1/C2/C3 primary axis info.	17/06/22	Added ClingOn dimensions
21/01/2021	Updated Erata #1 PCB image		
08/02/2021	Spelling / Wording		

About the author



Ever since I first was subjected to the Motional Feedback bass reproduction at age eleven I'm amongst the evangelists for this truly groundbreaking loudspeaker technology. It's sheer impact on low note sonics, it's power and control will remain with anyone fortunate enough to have witnessed it.

During research into electro & mechatronics, the science behind motional feedback, it quickly became obvious that all starts with obtaining a high resolution and error free control signal, as such focus was shifted towards development of the Piratelogic StarBass accelerometers. A turning point was the discovery of an industrial shock sensor paving the way for a new breed of high quality servo designs. Being a hands-on guy I prefer building things using an educated trial and error approach , simulations and formula's are great but witnessing things react the way they do is gold. Building well performing MFB systems isn't an easy thing to do but using EVE with an StarBass equipped driver allows you to skip the hardest parts.

Created from an affordable budget the Little/One 2 way system is my proof of concept that MFB is still very much alive and kicking and it's successor, the Grown/Up 3 way is on its way to create even more fuzz. The EVE 2020 design incorporates lessons learned sofar, its opensource design is my gift to you, ready to be pirated world wide. Hence the *logic* in Piratelogic .... now **GO!** use EVE to learn about MFB, use it to create your own servo drive low note system and put motional feedback back where it belongs : into the spotlights among the top low frequency enclosures out there.

Stay safe & keep away from audiophile cabling & fuses discussions

Greetings from Amsterdam,

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MFBlabs.nl	/motoindo
facebook	/sonny soerabaja
	/piratelogic

Youtube channel : https://www.youtube.com/user/motorindo

Chris Camphuisen