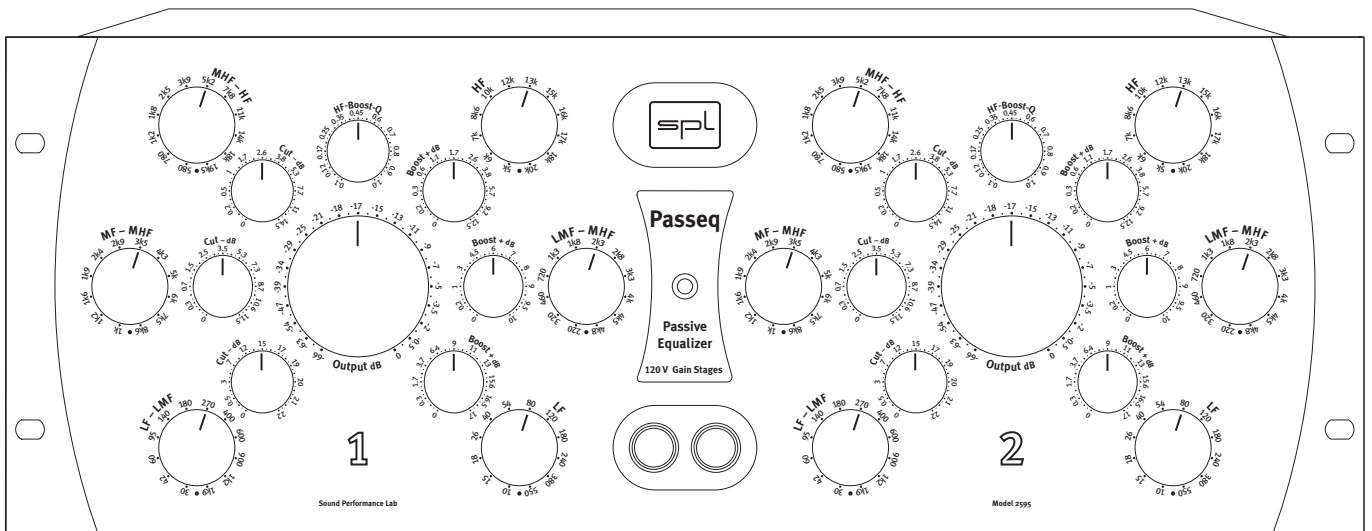




Manual



Passeq

Model 2595

Manual Passeq, Model 2595

Version 1.0 – 7/2006

Designer: Wolfgang Neumann

This user's guide contains a description of the product. It in no way represents a guarantee of particular characteristics or results of use. The information in this document has been carefully compiled and verified and, unless otherwise stated or agreed upon, correctly describes the product at the time of packaging with this document.

Sound Performance Lab (SPL) continuously strives to improve its products and reserves the right to modify the product described in this manual at any time without prior notice. This document is the property of SPL and may not be copied or reproduced in any manner, in part or fully, without prior authorization by SPL.

SPL electronics GmbH
Sohlweg 80
41372 Niederkruechten
Germany

Tel. +49 (0)2163 983 40
Fax +49 (0)2163 983 420

Email: info@soundperformancelab.com
Web: www.soundperformancelab.com

CE Declaration of Conformity

Manufacturer: SPL electronics GmbH

Type of Equipment: Audio Signal Processor

Product: Passeq, Model 2595

Compliance Engineer: Wolfgang Neumann

Test Basis: EN50081-1:1992, EN50082-1:1992, EN60065:1993, EN61000-3-3:1995, EN60065:2002, EN55013:2001, EN55020:2002, EN61000-3-2:2000, 73/23 EWG; 93/68 EWG.

We herewith declare, that the construction of the Passeq, Model 2595, is in compliance with the standards and regulations mentioned above.



Notes on environmental protection

At the end of its operating life, this product must not be disposed of with regular household waste but must be returned to a collection point for the recycling of electrical and electronic equipment. The “wheelie bin” symbol on the product, user’s manual and packaging indicates that. The materials can be re-used in accordance with their markings. Through re-use, recycling of raw materials, or other forms of recycling of old products, you are making an important contribution to the protection of our environment. Your local administrative office can advise you of the responsible waste disposal point.

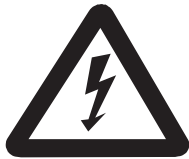


WEEE Registration: 97334988

© 2008 SPL electronics GmbH. All rights reserved. Names of other companies and their products are trademarks of their respective owners.

Important Safety Information	4
Hook Up	5
Introduction	6
Unique Features, Special Features	6
Advantages of Passive Filtering, 72 passive Filters with 120V Makeup Amplifiers, Filter Types, Single Core Coils, Peak and Shelving Filters	7
120V Makeup Amplifiers, SPL SUPRA Op-Amps	8
Lundahl Transformers, Other Features, Conclusion	9
Rear Panel	10
Rear Panel, XLR Pin Wiring	10
Connections	11
Power and Signal Connections	11
Operation	11
Power, Channel Switches, Layout of Operational Elements, The most powerful passive EQ system ever made	11
One Coil per Filter, one Core per Coil, Allocation of Frequencies, Frequency Table/per Band	12
Table: Allocation of Frequencies	13
LF-LMF Cut and LF Boost, MF-MHF Cut and LMF-MHF Boost	14
MHF-HF Cut and HF Boost, HF Boost Q Settings with the Proportional Q Principle, MHF-HF Cut, Output Control	15
Recommendations on using Equalizers	16
Basic Approaches and Working Techniques, EQ Yin & Yang	16
First control levels, then apply EQ, First cut, then boost, Reducing bleed from other instruments or noise outside an instrument's frequency range, Reducing bleed within an Instrument's frequency range, Boosting harmonic frequency levels, Boosting fundamental levels	17
Cutting fundamental levels, Emphasis of an instrument's main frequencies, In the mix—or not?, Splitting frequency bands to reduce masking effects, Complementary filtering	18
An overview of frequencies and examples for possible processing	19
Classical instruments and their frequencies	20
The Basics of Frequency Filtering	21
Frequency and Energy, Tone and Sound, Sound Correction and Sound Design	21
Frequency Filters, Filter Types, Shelf Filters, Peak Filters	22
Bandwidth, Equalizer, Passive EQs, Schematic and block diagrams on passive filters	23
Active EQs, Parametric EQs, Graphic EQs	24
Power Supply	25
Specifications	25
Guarantee & Product Registration	26
Copy Master: Recall Settings	27

Important Safety Information



Please note and retain this information. Carefully read and follow all of the safety and operating instructions before you use the machine. Be doubly careful to note and follow the warnings and special safety notices.

Connections: Only use the connections as described. Other connections can lead to health risks and equipment damage.

Water and Humidity: Do NOT use this machine anywhere near water (for example near a wash basin or bath, in a damp cellar, near swimming pools, or the like). In such cases there is an extremely high risk of fatal electrical shocks!

Insertion of Foreign Objects or Fluids: NEVER allow a foreign object through any of the machine's chassis openings. You can easily come into contact with dangerous voltage or cause a damaging short circuit. NEVER allow any fluids to be spilled or sprayed on the machine. Such actions can lead to dangerous electrical shocks or fire!

Opening the Machine: Do NOT open the machine housing, as there is great risk you will damage the machine, or – even after being disconnected – you may receive a dangerous electrical shock!

Electrical Power: Run this machine ONLY from sources which can provide proper power at the prescribed rating. When in doubt about a source, contact your dealer or a professional electrician. To be sure you have isolated the machine, do so by disconnecting the power cord from your wall connection. Be sure that the power cord plug is always accessible. When not using the machine for a longer period, make sure to unplug it from your wall power socket.

Power Cord Protection: Make sure that your power cord is arranged to avoid being stepped on or any kind of crimping and damage related to such event. Do not allow any equipment or furniture to crimp this power cord.

Power Connection Overloads: Avoid any kind of overload in connections to wall sockets, extension or splitter power cords. Always keep manufacturer warnings and instructions in mind. Overloads create fire hazards and risk of dangerous shocks!

Lightning: Before thunderstorms or other severe weather, disconnect the machine from wall power (but to avoid life threatening lightning strikes, not during a storm). Similarly, before any severe weather, disconnect ALL the power connections of other machines and antenna and phone/internet cables which may be interconnected so that no lightning damage or overload results from such secondary connections.

Air Circulation: Chassis openings offer ventilation and serve to protect the machine from overheating. NEVER cover or otherwise close off these openings. NEVER place the machine on a soft surface (carpet, sofa, etc.). Make sure to provide for a mounting space of 4-5 cm/2 inches when mounting the machine in racks or cabinets.

Repairs: Unplug the machine and immediately contact a qualified technician when you think repairs are needed – or when moisture or foreign objects may accidentally have gotten in to the housing, or in cases when the machine may have fallen and shows any sign of having been damaged. This also applies to any situation in which the machine has not been subjected to any of these unusual circumstances but still is not functioning normally or its performance is substantially altered.

In cases of damage to the power cord or its plug, first consider turning off the main circuit breaker before unplugging the power cord.

Operate the controls and switches only as described in the manual. Incorrect adjustments outside safe parameters can lead to damage and unnecessary repair costs. Never use the switches or level controls to effect excessive or extreme changes.

Replacement/Substitute Parts: Be sure that any service technician uses original replacement parts or those with identical specifications as the originals. Incorrectly substituted parts can lead to fire, electrical shock, or other dangers, including further equipment damage.

Safety inspection: Be sure always to ask a service technician to conduct a thorough safety check and ensure that the state of the repaired machine is in all respects up to factory standards.

Cleaning: In cleaning, do NOT use any solvents, as these can damage the chassis finish. Use a clean, dry cloth (if necessary, with an acid-free cleaning oil). Disconnect the machine from your power source before cleaning.

Be very careful to check that the rear chassis power selection switch is set to the correct local line voltage position before using the unit (230V position: 220-240V, 115V position: 110-120V)! When in doubt about a source, contact your dealer or a professional electrician.

Before connecting any equipment make sure that any machine to be connected is turned off (rear panel power switch). Follow all safety instructions on page 4.

Place the unit on a level and stable surface. The unit's enclosure is EMC-safe and effectively shielded against HF interference. Nonetheless, you should carefully consider where you place the unit to avoid electrical disturbances. It should be positioned so that you can easily reach it, but there are other considerations. Try not to place it near heat sources or in direct sunlight, and avoid exposure to vibrations, dust, heat, cold or moisture. It should also be kept away from transformers, motors, power amplifiers and digital processors. Always ensure sufficient air circulation by keeping a distance of 4-5 cm/2 inches to other units and to the sides of the unit.

Rack Mounting

Be sure that both above and below the machine you maintain a distance of 1U (44mm/ 1.5-2 inches) in order to eliminate electromagnetic or high frequency interference from other equipment. Moreover, this will ensure adequate air circulation to prevent overheating. Do NOT locate other machines that produce excessive heat below the Transducer. The rear side of the machine should be properly supported – especially when transport is involved.

Warnings

DO NOT PLACE THE MACHINE IN SUCH A WAY THAT IT MIGHT COME INTO CONTACT WITH OR SIT ON ANY FLUIDS. AVOIDING SUCH CONTACT WILL AVOID HAZARDS FROM FIRE, DANGEROUS ELECTRICAL SHOCK OR MACHINE DAMAGE. DO NOT OPEN THE MACHINE. THE LIGHTNING SYMBOL WITHIN A TRIANGLE WARNS YOU ABOUT UNINSULATED HIGH VOLTAGE INSIDE THE TRANSDUCER AND THE POTENTIAL FOR DANGEROUS ELECTRICAL SHOCKS – WHICH CAN ALSO OCCUR EVEN AFTER THE MACHINE HAS BEEN DISCONNECTED FROM A POWER SOURCE.

Symbols and Notes

ALSO IN THIS MANUAL A LIGHTNING SYMBOL WITHIN A TRIANGLE WARNS YOU ABOUT THE POTENTIAL FOR DANGEROUS ELECTRICAL SHOCKS – WHICH CAN ALSO OCCUR EVEN AFTER THE MACHINE HAS BEEN DISCONNECTED FROM A POWER SOURCE.

AN EXCLAMATION MARK (!) WITHIN A TRIANGLE IS INTENDED TO MAKE YOU AWARE OF IMPORTANT OPERATIONAL ADVICE AND/OR WARNINGS THAT MUST BE FOLLOWED. BE ESPECIALLY ATTENTIVE TO THESE AND ALWAYS FOLLOW THE ADVICE THEY GIVE.

The symbol of a lamp directs your attention to explanations of important functions or applications.

Attention

Do not attempt any alterations to this machine without the approval or supervision of SPL electronics GmbH. Doing so could nullify completely any and all of your warranty/guarantee rights and claims to user support.



SPL Passeq—the most powerful passive Equalizer ever made

Unique Features

- The most powerful passive EQ ever made—72 (!) passive filters per channel in one EQ.
- 120V makeup amplifiers based upon SPL SUPRA-OPs with 150dB dynamic range and 200V/ms slew rate.
- Individual coils per filter.
- Single core coils, which means that every one is wound individually on its own dedicated core. This excludes sonic degradation from mutual influences while at the same time improving THD values.

Special Features

- Individual design and component specificity for each filter.
- Custom made coils for critical mid-frequency ranges.
- Boost and cut crossovers mesh perfectly so that with the high number of frequencies one can dependably command the most elaborate set of response curves that to date any passive EQ has offered.
- Transformers from Lundahl with perfectly matched sonic characteristics provide for balanced I/O stages.

Advantages of Passive Filtering

- Typically coil inductance in virtually all active filters is achieved through simulation. True passive coil filters, on the contrary, can only deliver the genuine, characteristic sound associated with inductive components.
- Inherent distortion elements of active filters are ruled out by passive filter design.
- For any number of reasons stemming from design and component advantages over active filters, passive filters achieve a very natural aural quality and through their harmonic treatment (THD, distortion, phase response, etc.), offering at the very least, a clear sonic alternative, which our ears often perceive as an extremely attractive one.
- All passive filter components (variable resistor, capacitor and coil) work in concert to produce this beautiful sonic result. An important part of this process is played by coil and condenser loading and saturation characteristics. The resulting difference in latency from characteristically extremely fast reaction of active filters provides for more pleasant, musical sonic qualities. We tend to perceive these attributes in terms of an increased suppleness and transparency, with perceptibly improved, silky highs and robust basses.

72 passive Filters with 120 Volt Makeup Amplifiers

With 72 passive filters (36 x boost, 36 x cut per channel), the Passeq surpasses all previous designs of this type by a wide margin. Each channel is divided into three cut and three boost bands, each offering 12 switchable frequency ranges. The cut and boost ranges are not identical; crossovers are designed to work with like a precise mechanic cogwheel so as to allow the engineer access to the largest possible number of optimal, wide-band S-curves with variable slopes. A further noteworthy Passeq feature is its individual sonic adaptation of each inductive filter through separate coil/condenser/resistor combinations: In stark contrast to earlier filter design and construction, each Passeq filter is optimized for the frequency assigned. To insure the best possible signal warmth, richness and musicality in processing, coils for critical voice frequencies are custom-made for the Passeq. This achieves the widest possible range and tonally appealing sound color palette from any passive EQ.

Filter Types

The Passeq employs two distinct filter types: One of these functions much like traditional shelving filters, while the other, as a peak filter, and together, they provide the combined characteristics of wide-band control in low and high ranges with more specific frequency range control in mids. This selection minimizes mutual influences between low, mid and high bands while providing a more selective control in the mids is often useful.

Single Core Coils

Until now design approaches have involved individually wound coils, but multiple coils have nonetheless been placed on a single core. The Passeq design places each coil on separate cores. This eliminates any possible unwanted mutual influence transmitted through common-core windings and thus, among other improvements, results in better THD values.

Peak and Shelving Filters

Mid boost and cut, as well as HF boost filters have been set up in a peak (bell) configuration, while the hi cut, low cut and low boost filters function in a shelving configuration. The HF boost band offers variable values from $Q=1$ to 0.1 .

120 Volt Makeup Amplifiers

With passive filtering comes an unavoidable drop in signal level that requires makeup amplification, and with the Passeq, here SPL's extraordinary Supra-OPs, with their unique analog 120-volt technology, come into play. With a 116 dB signal-to-noise ratio and +34 dB of headroom, the SUPRA-OPs offer a stunning 150 dB dynamic range, placing them in an unsurpassed leadership position in either analog or digital signal processing.

The tremendously fast SUPRA slew rate of 200V/ms allows for a highest possible precision in filter output signals, particularly in the all-important arena of transient response. These amplifiers effortlessly and without coloration or degradation, transmit all the desired filter characteristics and sonic results an engineer has sought out and in the process, pushing beyond the limits of what has been technically possible to now.

SPL SUPRA Op-Amps

The specially designed and for-audio optimized SUPRA-OPs are constructed in three stages with high performance, extremely low noise transistors from the HF technology sector.

Input Stages of the SUPRA Components

The development of the SUPRA components focused on high loop amplification, extremely low phase shifting and THD, combined with maximum amplification and a frequency response up to 100 kHz.

A main and obvious advantage of the discrete SUPRA components is the exclusion of parts often found in industrially manufactured standard components that are not necessary for audio processing.

The SUPRA input stages are designed as balanced differential stages and comprise six matched high voltage transistors switched in parallel. The concept of the input stage is based on the established principle that currents of not correlated noise sources in shunt circuits add up—which decreases the overall noise of the input circuitry. The input stages are free of coupling capacitors to exclude additional capacitor noise. The balanced operational voltage of +/-60V is delivered from a linear -80 dB high voltage power supply.

Intermediate Stages of the SUPRA Components

The audio signal is further routed to a differential stage and from there through further processing stages to the Class-A output stage. All passive components have been tested to yield the highest possible fidelity.

Output Stages of the SUPRA Components

Extremely low noise, high voltage output transistors are set up with a high quiescent current and excess heat is dissipated via special cooling plates.

Lundahl Transformers

The Swedish firm of Lundahl is recognized world wide for the superior sonic qualities of its hand made transformers. SPL has used Lundahl transformers for many years, typically for optional in- and output stages of various products. In the case of the Passeq, there is no question of whether solid state or transformer-based input and output stages are the better choice: Because of their excellent and similar sonic qualities, Lundahl transformers are a clear choice to complement to the Passeq's EQ circuitry.

I/O transformers are classical analog components in many "vintage" machines. In addition to increased operational safety due to the isolation from incidental I/O electrical interference they offer, transformers also introduce their own element of sonic "warmth" that is today too often inadequately attributed solely to tube circuitry.

The sonic quality from Passeq's Lundahl transformers may be described in comparison to straight electronic I/O circuitry as: Bass and fundamentals are rounder, fuller, and exhibit more "punch", while higher frequencies and harmonics sound silkier and more present, yet without leaving the impression of being overly emphasized or singled out. Moreover, they add the subtle impression that mix elements are better localized.

The reasons for this are the tendency of transformers to reduce uneven harmonics (which often give the impression of harshness in a sonic canvas) and to act with some latency compared to electronically balanced stages. In particular, fundamentals and low frequencies benefit from this.

Other Features

XLR contacts from Switchcraft serve as In and Output connections, while controls and switches are from the manufacturers Elma and ALPS (including ALPS' "Big Blue" with 41 steps). The internal, fully analog power supply features a generously proportioned toroidal transformer that offers switchable, 110-120 Volt/60 Hz or 220-240Volt/50 Hz functions.

Conclusion

The Passeq represents the most powerful passive EQ system to date and fulfills the highest expectations in all areas of audio processing, from recording through mixing to mastering.



Serial Number

SPL

Sound Performance Lab
Niederkrüchten, Germany
www.soundperformancelab.com
MADE IN GERMANY

XLR Pin-Wiring: Pin 1 = GND, Pin 2 = (+) Hot, Pin 3 = (-) Cold

Right Channel

Left Channel

CAUTION
RISK OF ELECTRIC SHOCK
DO NOT OPEN
AVIS: RISQUE DE CHOC ELECTRIQUE - NE PAS OUVRIE

AC Mains Input

AC Mains Input

Fuse Rating
220 V - 240 V / 50 Hz: 500mA slow
110 V - 120 V / 60 Hz: 1A slow

Fuse Rating

WARNING
TO REDUCE RISK OF FIRE OR ELECTRIC SHOCK DO NOT EXPOSE THIS UNIT TO RAIN OR MOISTURE. DISCONNECT MAINS BEFORE REMOVING COVER. THIS EQUIPMENT MUST BE EARTHED.

CE

Voltage Selector

ZH 05 / A02 - 240V - 110V
ZH 05 / A02 - 240V - 110V

Voltage Selector

220 V - 240 V / 50 Hz
110 V - 120 V / 60 Hz

The GND Lift switch separates internal ground from chassis ground to eliminate ground loop humming. Usually the GND lift should be deactivated (switch down).

Power switch and voltage selector: Please refer to the notes on the next page.

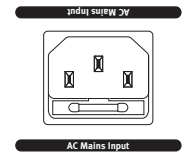
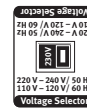
Pin Wiring XLR Sockets
1=GND, 2=hot (+), 3=cold (-)

Power and Signal Connections

Be very careful to check that the rear chassis power selection switch is set to the correct local line voltage position (either 230 or 115 volts) before using the unit!

Before connecting any equipment make sure that any machine to be connected is turned off (on the Passeq rear panel the power switch must be pushed down).

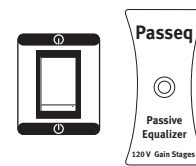
An AC power cord is included for connection to the standard 3-prong IEC connector. The transformer, power cord and IEC connector are VDE, UL and CSA approved. The AC fuse is rated at 500 mA for 220/240 V and 1A for 110/120 V.



Operation

Power

The Passeq is turned on and off with the rear Power switch. The blue LED in the center of the front indicates operating status.



Channel Switches

Two illuminated switches in the center of the front activate or bypass the left or right channel.



Layout of Operational Elements

Initially one might be struck by the circular arrangement of the Passeq's control elements. As unusual as this first appears, the more understandable and clearer this layout becomes when one looks closer.

Along with the fact that we simply like this design from an aesthetical view, this layout makes even more sense with respect to the idea of the passive EQ concept itself: In a passive design, filters for boosting and cutting a frequency range are physically separated from each other. Reflecting this fact, the elements left of the central output control perform level cuts, while controls to the right of this central regulator serve as signal boost controls. Cut and boost switches are positioned next to the appropriate frequency band selector and frequency bands are arranged from low to high from the standpoint of both physical and frequency range layout—all in all a clear overall functional picture though without much in the way of boring routine.



The most powerful passive EQ system ever made

The Passeq is the first passive EQ which provides three separate frequency ranges for both boost and cut stages. One famous, if not the most famous, passive design was the Pulteq EQ from the decades of the 1950's and 60's. This EQ sported two frequency bands (low and high frequencies, or LF and HF), and had only a few switchable frequencies to offer. In contrast, the Passeq has 12 switchable frequencies per band, totaling 36 boost and 36 cut frequencies. Boost and cut frequencies are NOT identical, thus the resultant 72 frequencies per channel offer an enormous choice for the most elaborate EQ curves (please refer to the next chapter, "Frequency Layout").

The Passeq offers for the first time passive filter control possibilities extending throughout the relevant audio frequency range—and that with an unheard of abundance of filter choices.

One Coil per Filter, one Core per Coil

Each Passeq filter is individually constructed for its intended frequency, that is, each coil, condenser and variable resistor (var. resistor=boost or cut control) ensemble is sonically tuned to its intended frequency range. Thus each filter has its own musically sensible audio color appropriate to its own frequency.

In turn, each coil is also wound on its own separate core to avoid mutual and degrading influences which stem from past designs where multiple coils were wound on a single core. Not the least, the construction of each filter on its own particularly core also provides for excellent THD values.

Allocation of Frequencies

One of the greatest Passeq design challenges was in determining the choice of frequencies, which in contrast to parametric EQ designs, are fixed or nonadjustable. One could accept standardized values from such as the so-called ISO frequencies, but such measurements stem too much either from conventional measurement standards or those from room corrections rather than choices of what may be musically more sensible. In assigning the Passeq's frequencies it was inevitable that we would rely on the nearly 30 years of experience of SPL's chief developer, audio engineer and musician, Wolfgang Neumann.

To enhance further our achieving this musical objective many audio experts and musicians were consulted regarding their favored frequencies. Among the many, David Reitzas, Michael Wagener, Bob Ludwig, Ronald Prent and Peter Schmidt offered valuable advice. From this point of departure we managed to determine that there is definite agreement among professionals about their preferred musical frequencies, and these differ clearly from the standard ISO choices.



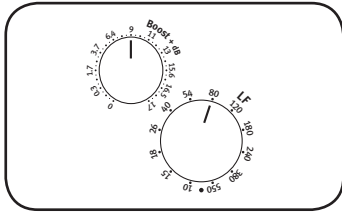
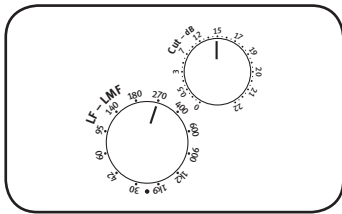
The results also showed that the closely meshed boost and cut frequencies are important and sensible. Through them one can on the one hand focus more precisely on a certain frequency, and on the other, offer the option of influencing the Q factor (which is typically rather small in passive designs) by creating so-called S curves. An Example: Assume you wish to boost in the mids around 320Hz, an instrument or voice level while at the same time avoiding a boost to the frequency range below it due to the small Q factor (high bandwidth) of the filter, and perhaps even lower it. In this case, let's say you choose the LMF-MHF boost band and increase the chosen (320Hz) frequency range by about 3 dB. At the same time, you chose a 4 dB reduction in the LF-LMF cut band. The close proximity of the chosen frequencies allows you achieve an increase in the slope between the two. This is "S slope EQ-ing" at its best, and in this discipline, the Passeq is a world champion in both options and results.

Frequency Table/per Band

LF Boost	LF-LMF Cut	LMF-MHF Boost	MF-MHF Cut	MHF-HF Boost	HF Boost
Frequenz	Frequenz	Frequenz	Frequenz	Frequenz	Frequenz
10	30	220	1k	580	5k
15	42	320	1k2	780	6k
18	60	460	1k6	1k2	7k
26	95	720	1k9	1k8	8k6
40	140	1k3	2k4	2k5	10k
54	180	1k8	2k9	3k9	12k
80	270	2k3	3k5	5k2	13k
120	400	2k8	4k3	7k8	15k
180	600	3k3	5k	11k	16k
240	900	4k	6k	14k	17k
380	1k2	4k5	7k5	18k	18k
550	1k9	4k8	8k6	19k5	20k

Cut LF-LMF	Cut MF-MHF	Cut MHF-HF	Boost LF	B. LMF-MHF	Boost HF
					20k
		19k5			
		18k			18k
					17k
					16k
					15k
		14k			
					13k
					12k
		11k			
					10k
	8k6				8k6
		7k8			
	7k5				
					7k
	6k				6k
		5k2			
	5k				5k
				4k8	
				4k5	
	4k3				
				4k	
		3k9			
	3k5				
				3k3	
	2k9				
				2k8	
		2k5			
	2k4				
				2k3	
1k9	1k9				
		1k8		1k8	
	1k6				
				1k3	
1k2	1k2	1k2			
	1k				
900					
		780			
				720	
600					
		580			
			550		
				460	
400					
			380		
				320	
270					
			240		
				220	
180			180		
140					
			120		
95					
			80		
60					
			54		
42					
			40		
30					
			26		
			18		
			15		
			10		

Operational Elements

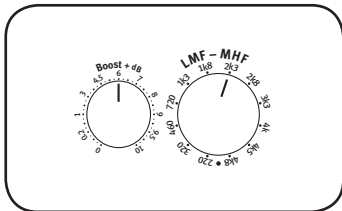
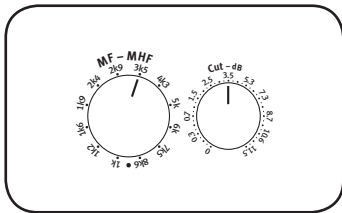


LF-LMF Cut and LF Boost

The low cut frequency range extends from 30 Hz to 1.9 kHz and will be referred to in this text as LF-LMF (Low to Low-Mid frequencies). In contrast, the low boost (LF Boost) band encompasses a range of 10 Hz to 550 Hz. The maximum available increase in this LF boost band is (+)17 dB, while the maximum reduction of the LF-LMF cut band is (-)22 dB.

Optically these filter bands may be represented as having a shelving characteristic with an 6 dB slope. Passive filters do not allow for direct alteration of the slope gradient because this quality is pre-determined by component selection and not, as with active filters, by a variable value.

The lowest frequencies begin here with 10 Hz, then follow with 15, 18, 26, 40 Hz, and so on. At this point one might think that such a lavish set of frequency choice in this range might be a bit overdone, as there is acoustically a rather limited amount of audio material of any real significance below 26 Hz. However, these choices are anything but arbitrary. These frequencies represent a consistent -3 dB point of a sloping down response curve. That is, the gentle 6 dB slope also allows frequencies above 10 Hz to be processed. As mentioned in other parts of this text, special condenser/coil/resistor filter networks have been designed for each frequency range. The choice of one or the other inductances produces differences in sonic coloration even when limited differences between frequencies such as 10 Hz or 15 Hz play a subordinate role. Along with this differing phase relationships may come into play and affect tonal color. Because modern productions often demand a definite number of choices in an engineer's options for achieving an optimal result in bass emphasis, the Passeq has been designed with a very complete set of low frequency options to insure realizing these goals.



MF-MHF Cut and LMF-MHF Boost

The midrange bands elevate the Passeq to a complete combination of filter options that classic passive designs do not offer. Both midrange bands exhibit peak filter characteristics, that is, when viewed from the boost band, the frequency curve appears as bell-shaped slopes above and below the chosen frequency range. The slope or Q-value is, again, not variable, but attuned through the choice and configuration of the passive filter's components for a maximum in musical efficiency, relying in the Passeq on its developer, Wolfgang Neumann's years of musical experience. The middle bands' peak structure is chosen for a clean separation of LF and HF bands. Were the choice here to be for a shelving filter design, too many neighboring frequencies would be processed, with resulting undesirable influences extending into LF and HF bands. Along with this is the simple fact that a midrange peak filter characteristic is accompanied by a more easily focused center point processing of critical voice and instrument fundamental frequencies.

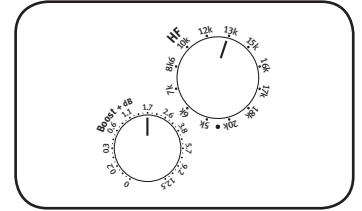
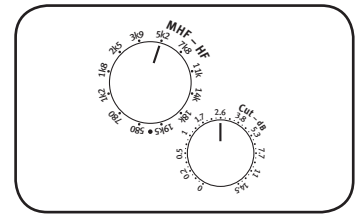
The MF-MHF cut band overlaps the LF-LMF cut band by approximately an octave, with its lowest frequency extending from 1 kHz. The LF boost and LMF-MHF boost bands are set up in a similar fashion, with the lowest LMF-MHF boost band frequency set at 220 Hz and thereby 1-1/2 octaves under the highest LF boost band frequency. The maximum values of the MF-MHF cut and LMF-MHF boost band extend from -11.5 dB to +10 dB.

The overlapping band characteristics give a good idea of the available degree of precision in frequency adjustment: For example, one can boost in the LMF-MHF boost band at 220 Hz while in the LF boost band, 240 Hz can be followed by 320 Hz in the LMF-MHF boost band: The next step could be at 380 Hz in the LF boost band, followed by 460 Hz in the LMF-MHF boost band and 550 Hz in the LF boost band ...

MHF-HF Cut and HF Boost

Passeq’s high frequency bands have a different layout for the cut and boost ranges: The MHF-HF cut band exhibits a (wide-band) shelving characteristic, while the HF boost band exhibits a variable Q, peak filter characteristic.

As seen above, one can also note and intensification in choice of frequencies in the high range. Here the same reasons apply as in prior cases: Individually designed and constructed coil-condenser-resistor configurations result in slightly differing sonic characteristics. Thus beginning at 10kHz there are seven additional switchable frequencies. The available variable Q (ranging from $Q=0.1$ to $Q=1.0$) allows the engineer access to an enormously flexible range in high frequency boost options.



HF Boost Q Settings with the Proportional Q Principle

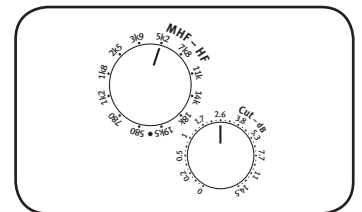
With the proportional or variable Q principle, boost control settings would apply only if the HF boost Q were to be set at $Q=1.0$ (control set fully clockwise). Were the value to be reduced (thus increasing the bandwidth), the boost would also be reduced. This can lead to a situation wherein, for example, a HF boost Q setting of 0.1 and a boost of 3 dB would result in effectively no audible boost in the chosen frequency—at this value the Q value resides at about 0.3 dB. With this Q value, don’t hesitate to turn turn up the HF band boost control to its full 12.5 dB setting—this results in an actual overall increase of around 3.5 dB. Narrower Q settings, for example, to 0.6, result in further level boosts again.

The advantage of proportional Q as compared to constant Q designs rests with the musically superior way it functions. The wave energy which resides below the bell curve remains essentially the same and in the process, retains the balance of high frequencies in relation to the entire frequency spectrum as one experiments with varying Q values. While it is true that one must think independently of the scaled HF boost dB values in such cases (because these only apply to a value of 1), the result is a simpler, more musically sensible and worthwhile way to work that does not require continual additional corrections.

MHF-HF Cut

The MHF-HF cut band is similar to a shelving filter that can reduce higher frequencies in a wide bandwidth. It is appropriately wide, beginning with 580 Hz and extending to 19.5 kHz, a range of over 5 octaves and overlapping the lowest, LF-LMF cut band by just about two octaves. With it one can lower a very wide bandwidth and with the peak mid range filters further reduce—or raise—specific ranges. The process can result in the creation of very interesting curves. Here the maximum cut is -14.5 dB, while the maximum boost reaches +12.5 dB.

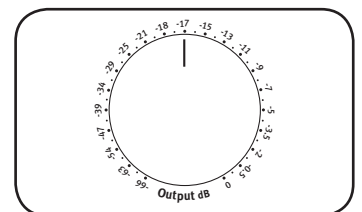
The Passeq is not limited to any one particular kind of application, and, for example, is also especially well suited to processing individual instruments in recording sessions. In such cases the wide downward reaching MHF-HF cut band may be play an exceptional role. Individual instruments can easily be cut upwards, either to give them a more compact sound or when higher frequencies might be supplied from different microphone—or because the mix simply suggests it.



Output Control

The Output control serves as output level regulator. If boosts increase levels at the output, they can be reduced again to the input level’s value. (compare the block diagram “passive filter at +18 dB boost” on page 21).

The proven “Big Blue” potentiometer from ALPS with 41 steps is employed here to ensure precise control and minimum tolerances over both channels.



Recommendations on using Equalizers

In the arenas of recording and mixing one can generally distinguish between two main goals in applying EQ: The first is sound correction, or sound design through processing of individual channels while the second may be improving their separation or presence in the mix.

In the overall recording process there may be deficiencies due to technical problems, for example, noise or bleeding of neighboring instrument sounds that detract from the natural quality of the desired instrument.

Through frequency response characteristics of a microphone or phase shifts due to reflections, energy at certain frequencies can be reduced or get lost, denigrating the original sound quality of an instrument. EQ is probably the most important tool to combat these problem areas. Moreover, an instrument's sound can also be accentuated or emphasized—to the point that this becomes in its own right a creative sonic activity with a production made only possible by the employment of EQs and their special characteristics.

Basic Approaches and Working Techniques

While we would never assume that in creative and artistic work there should be absolute rules, and this also applies to work with EQ: There is no such thing as “The Voice” or “The Kick Drum” or “The Piano”.

The following is thus offered strictly as a basic orientation or starting point for such work, and should not be misconstrued as dogma or any other kind of absolute. Nonetheless, in order to achieve sometimes hard-to-define goals when applying EQ, it really is important to be aware of and be able to use a few accepted basic musical and technical guidelines.

EQ Yin & Yang

This section, on “EQ Yin & Yang” reproduces thoughts and verbalizations by Bob Katz, whose superb Focal Press book based on a series of lectures entitled, “Mastering audio, the art and the science”, we highly recommend.

In Chinese philosophy, Yin and Yang describe unconditionally bound opposites within some kind of unity, which in turn, both complement and conflict with one other. This idea also provides an insightful analogy to the understanding of the connection between music, harmony, fundamentals and harmonics (please see also, “Basics of frequency filtering, Tone and Sound”, beginning on page 19). This mutual bond and interaction between such opposites creates inevitable and mutual reactions and repercussions in the other whenever something occurs to one.

Here are a few examples:

- A small reduction in the lower middle range around 250 Hz can have a similar effect as an increase in the presence region of 5 kHz.
- Added energy in the very high region of 15-20 kHz can create the impression of having made the bass and lower mids thinner.
- Adding warmth to a voice will reduce its mix presence.

Working with EQ and this Yin and Yang principal means ideally to consider always such implied repercussions of work in one frequency—for example, that in working to enhance warmth, that one might want to avoid losing presence.

Harshness in the upper middle to lower high range can be countered with more than one approach: A harsh trumpet section may be improved through a reduction around 6-8 kHz, or with an increase at around 250 Hz. Both of these measures result in a warmer sound, but the decision of which to use should depend on which of the two also works best in the entire mix.

Moreover, one should never forget how easy it is, while working intensely with isolated elements of a mix, to fall into the trap of forgetting how such elements can influence, for better or worse, the rest of the mix.

First control levels, then apply EQ

Badly adjusted levels often induce us to misuse EQ in misguided efforts to correct them. As soon as one has the feeling that he or she needs more than 6 dB in EQ (boost), one should investigate thoroughly whether or not initial levels have been set properly.

First cut, then boost

“The ear” is more used to energy reductions in a frequency range, thus boosts attract more attention. That is, a 6 dB boost is perceived to be similar in amount to a 9 dB cut. Therefore when wishing to emphasize one frequency, it is typically better first to consider a reduction in others. The result will bring more transparency and clarity as well as reduce possible unwanted coloration of the signal.

Reducing bleed from other instruments or noise outside an instrument's frequency range

Wide band filters setups should be chosen with threshold frequencies in ranges from one-to-two octaves above or below the highest or deepest instrument's frequency. Example: To eliminate cymbal bleeding in a kick drum recording, one should try a setting from about 10 kHz with a 10-15 dB cut.

Reducing bleed within an instrument's frequency range

The main frequencies of the bleeding instrument should be reduced as far as possible while avoiding to alter the natural sound of the main instrument in an unnatural way.

Boosting harmonic frequency levels

Harmonic enhancement is one of the foremost techniques for increasing the clarity and definition of an instrument. The following is an overview for three typical instruments:

- Bass – 400 Hz: Bass lines will be accented
- Bass – 1500 Hz: More clarity and attack sounds
- Guitar – 3 kHz: Clearer attacks
- Guitar – 5 kHz: Brighter, more brilliance
- Vocals – 5 kHz: More presence
- Vocals – 10 kHz: Brighten up

Note that each instrument will have at least two frequencies where EQ can achieve a greater clarity or brilliance.

Boosting fundamental levels

Inexperienced audio engineers will often first try to make corrections by boosting fundamentals, something which in fact should be the last thing one considers. Boosting fundamentals typically lowers clarity and produces a muddy sound. If two instruments are playing the same part and thereby produce the same fundamental, raising these levels will lead to a decrease in the sonic difference between them, (i.e., will make the two instruments sound more alike and lower their intelligibility in the mix). This is also true when two instruments play similar parts in the same key.

Exception: When an instrument sounds thin or small, boosting the fundamental can help. Or perhaps a microphone was poorly placed or the harmonics had been raised excessively through EQ. Finally, increasing fundamental levels can also play a constructive role when instruments play alone or as soloists with others in the background.

Recommendations on using Equalizers

Cutting fundamental levels

Cutting fundamental frequencies provides for a perceived increase in harmonics and is therefore an effective alternative to boosting harmonic levels. This is a common practice in Rock/Pop productions that can be effective in all musical recording genre. An example:

Bass, Reduction at 40 Hz: may limit boominess and increase presence.

Guitar, Reduction at 100 Hz: may limit boominess and increase clarity.

Voice, Reduction at 200 Hz: limits muddiness in the sound.

Emphasis of an instrument's main frequencies

For this purpose a bandwidth of 1 and 1/3 octaves is generally a very good starting point—in other words, this range best encompasses that of most instruments' frequency spectrum. This can be somewhat narrower with percussion instruments, while it is recommendable to consider a wider bandwidth for melody instruments such as voice or bowed strings. The boost value should remain between 3 and 6 dB.

In the mix—or not?

The more an instrument is placed “outside” a mix (resp. above or in front of a mix), the more natural its sound should remain. When already embedded in a mix, main frequencies should on the other hand be processed with a higher dB value but lower bandwidth. An example: A boost of 3 dB at 5 kHz may serve to make a voice track clearer and much more present in front of a mix, while when embedded in the mix, a 6 dB boost with less bandwidth may be more useful.

Splitting frequency bands to reduce masking effects

In order to separate two instruments whose sound lies in the same range, one may choose to process frequencies that are a half an octave from each other. With a bandwidth of a half octave and 3 dB boost, one can achieve clarity and instrument differentiation. The higher frequency should be applied to the instrument which sounds brighter or more brilliant.

Complementary filtering

One of the most difficult problems in mixing instruments is the masking effect. Loud instruments cover others when their frequencies lie in the same range. It can be very frustrating to discover that a terrific sounding instrument track suddenly sounds boring when added to a mix.

Of great help here can be an application of the above-described frequency range separation and processing through complementary signal filtering. In the process specific frequencies of one instrument should be reduced with narrow bandwidths while increasing the same frequencies of other instruments. This involves boost and cut values between ca. 3-6 dB.

Classic conflicts of this type happen, for example, between kick drum and bass or between lead and background vocals, and these are perfect circumstances for applying complementary filtering to avoid masking problems:

- Kick Drum/Bass: A reduction of the kick drum between 350 and 400 Hz and an increase in the same bass frequencies will reduce the cardboard sound of the kick drum while lending the bass more presence.
- Lead/Background Vocals: A cut between 3 and 4 kHz in the background voices gives them a needed airy quality, while boosting the same lead vocal range allows it to come through with more clarity.

Recommendations on using Equalizers

An overview of frequencies and examples for possible processing

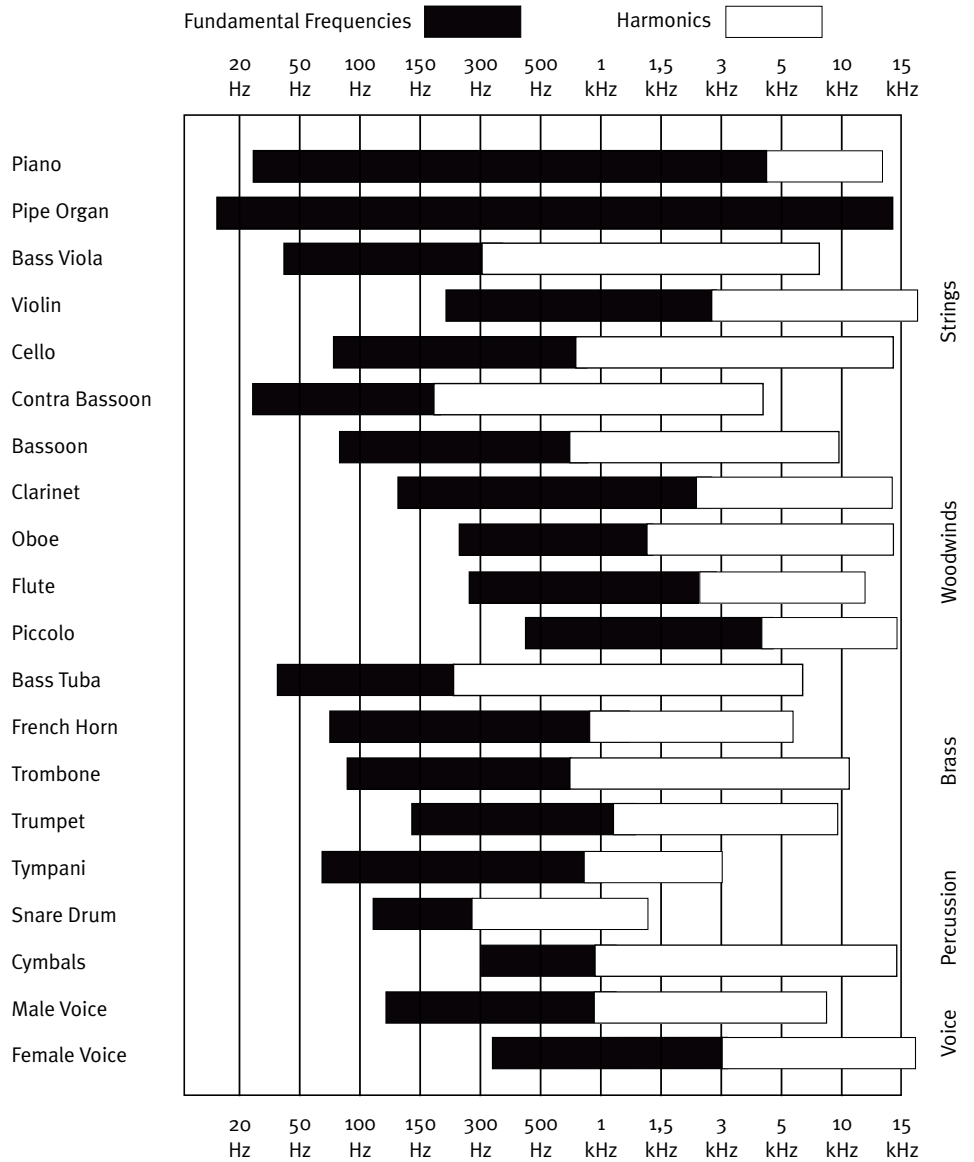
(Here we provide approximate values which may expand to adjacent areas)

50 Hz – cut:	Reduces boominess in all lower instruments (basses, kick drums, toms) whose function also implicitly increases the relative level of harmonics and improves the presence of bass lines.
50 Hz – boost:	Fuller sonic qualities for all lower frequency instruments.
100 Hz - cut:	Limits boominess, greatly increased guitar clarity and limits sustain with Toms.
100 Hz – boost:	Firmer bass sound for all low frequency instruments, adds more warmth to piano and horns.
200 Hz – cut:	Less muddiness with voices and middle instruments, while helping to eliminate the “gong” resonance with cymbals.
200 Hz – boost:	Fuller sound for voices, snare drums and guitars.
400 Hz – cut:	Limits hollower sound qualities in lower drums.
400 Hz – boost:	Clearer bass lines.
800 Hz – cut:	Diminishes the “cheap” sound of some guitars.
800 Hz – boost:	Noticeably clearer, punchier bass lines.
1.5 kHz – cut:	Reduces an uninteresting sound in guitar tracks.
1.5 kHz – boost:	Clearer, cleaner basses.
3 kHz – cut:	Hides badly tuned guitars or other problems with poor intonation.
3 kHz – boost:	Better bass guitar attacks, more attack with electric and acoustic guitars, snares and other percussion as well as lower piano parts, more voice clarity.
5 kHz – cut:	Softens thinner or tiny sounding guitars.
5 kHz – boost:	Improves voice presence and brightens guitars, gives more attack to low frequency drums, piano, and acoustic guitars.
7 kHz – cut:	Reduces sibilants.
7 kHz – boost:	Provides more attack with percussive instruments.
10 kHz – cut:	Also reduces sibilants.
10 kHz – boost:	Brightens voices, similarly brightens guitar, piano and harder cymbals.
15 kHz:	Boosts in this range brighten most sounds, but be careful with hidden dangers such as emphasizing noise, hiss and/or creating excessive sibilance. The rule always applies: Before reaching for the knob to boost levels, first try cutting frequencies elsewhere for accentuations.

Recommendations on using Equalizers

Classical instruments and their frequencies

A symphony orchestra presents a kind of ideal paradigm of a balanced, wide-spectrum instrumental sound canvas. It is therefore only sensible to consider its sound as an orientation point also for other musical genres—it will definitely not harm a Rock or Pop production to employ such an orientation to achieve a comparable balance and proper distribution of mix elements in the latter.



Frequency and Energy

In general, a frequency prescribes a number of events in a time interval. The per-second cycle of a wave form is given in Hertz (Hz). Lower tones produce longer waves and higher, waves of shorter length, and the higher the frequency, the higher the tone. The higher the amplitude of a wave, the higher its energy level and in turn, the louder it is perceived.

Tone and Sound

In the area of music, a sound event is referred to as a tone. Such a tone is complex: it is comprised of different frequencies, each at a different energy level.

In analyzing the components of a naturally produced tone (such as those created by a real instrument or voice), we see the following ingredients: A natural tone is comprised of a lowest pitch or fundamental along with many additional higher components called harmonics. The arrangement of these pitches is called the harmonic series, which includes the entire group of frequencies from fundamental to higher harmonics and is called the frequency spectrum of a tone.

As the lowest pitch, a fundamental determines the basic frequency and its perceived pitch. The frequencies of the harmonics are multiples of the fundamental frequency and determine the specific sound of a tone (that is, whether it sounds like an instrument, voice, etc.).

Should one wish by electronic means to record, process and play back a given tone, it is crucial to maintain the accuracy of the frequency spectrum if one wishes to be able to recognize it later as the original. Just as important is the aspect of maintaining the original energy levels of all frequencies it is composed of.

In producing a tone, the distribution of energy within the frequency spectrum is further and decisively influenced by the acoustic environment through the mixing of direct and reflected sound. The energy relationship between fundamentals and harmonics is different between direct sound and that which is reflected (for example, harmonics of a reflected frequency spectrum may have measurable more energy), and this can change a tone's perceived sound. Later, when a musician has the impression that a recording is not true to the original, that he or she has either played or sung, an important consideration to make is to examine the resultant frequency spectrum.

Sound Correction and Sound Design

Along with acoustic influences of a recording ambience, it should also be understood and accepted that, to say the least, there are definite technical limits to recording and playback that may strongly influence an end result. In the first decades of electronic recording, the principle influence on the quality of such recordings centered on the choice and placement of microphones. The first Equalizers were used to combat technical and acoustical problems such as insufficient frequency response from microphones and loudspeakers or even inadequate relationships in room acoustics that needed to be corrected or brought into balance. The goal was always to bring into balance as much as possible—and maintain—the correct frequency spectrum of an originating tone source.

The introduction of multi-track recording in the 1960's brought a fundamental change in the way recording was done. Instruments intended for one production could be recorded in separate sessions and at different times. The mix from many individual recordings—at first in only four tracks—nonetheless added a new problem of offering ways to add further sonic quality through further processing of individual tracks, because with each copy a track's quality was reduced.

This introduced an entirely new function for EQ, for example, the emphasizing of particular instruments in their tracks to prevent them from being lost in a mix by altering certain parts of their frequency ranges. Along with this ability to emphasize specific tonal qualities appeared the added capacity to indulge in even more creative work through much stronger or even exaggerated processing of a sound and thereby lend it even more presence in mixes. Without a doubt, the increasing popularity of electronic tone production has played a large part in the further development of EQ filtering as a creative element in audio production.

The Basics of Frequency Filtering

Frequency Filters

As a rule almost everyone of us has first made an acquaintance with frequency filtering through our listening to home stereos. Such elementary kinds of filters are simple amplitude-based filters: When one turns a bass control clockwise, one hears a general or overall increase in bass frequency energy.

But with the explanation above on the composition of a complex, natural tone, it is clear that such a low frequency control does not only influence the energy of the fundamental frequency, but also always the sound of a tone—the relationship between energy of the fundamental and harmonics frequencies is changed.

Typically amplitude-based frequency filtering boosts or cuts the energy of a specific audio frequency band. In such processes it is possible to employ filters with design and function that are very different from each other: Depending upon the technical construction, such filters may, for example, process only high or low frequencies in certain way.

Filter Types

There are two types of filters used in the Passeq: wide-band filters which are comparable to shelf-filter characteristics and bell-formed peak-filters with narrower bandwidths.

Shelf Filters

A shelf filter increases or decreases the energy of all frequencies above or below a chosen frequency. Depending upon the direction of processing one refers to high frequency (HF) or low frequency (LF) shelf filters. Beginning with the threshold frequency, the frequency band is boosted or cut much like a shelf. The maximum boost or cut achieved at the point furthest from the threshold frequency. The threshold frequency is usually about 3 dB less (with the overall increase set to maximum). This gives the typical rising form of the shelf filter's response curve.

Peak Filters

A peak filter boosts or cuts a chosen frequency's energy with a maximum amplitude and a definable frequency range around this frequency with a fall off of up to 3 dB to both sides. The chosen frequency with the maximum amplitude is called center frequency—it takes place in the middle at the peak of the response curve. The response curve forms a bell, thus peak filters are also often referred to as bell filters.

Bandwidth

The width of a frequency range or band is musically defined in octaves. The technical counterpart to this is the "Quality" of a filter, and the abbreviated "Q" is the most common value for the bandwidth of a filter.

A high Q value means a narrow bandwidth while a smaller Q factor corresponds to a wider one:

Bandwidth 2 Octaven: 0.7 Q

Bandwidth 1 1/3 Octaven: 1 Q

Bandwidth 1 Octave: 1.4 Q

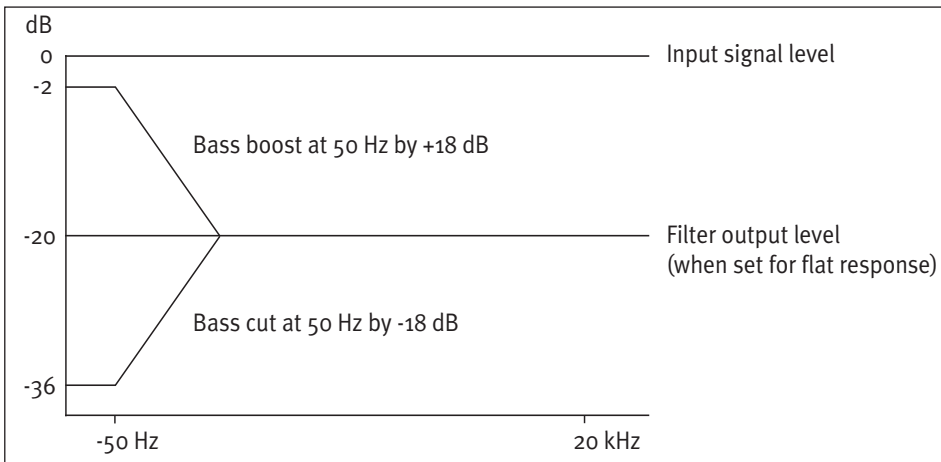
Bandwidth 1/2 Octave: 2.8 Q

Equalizer

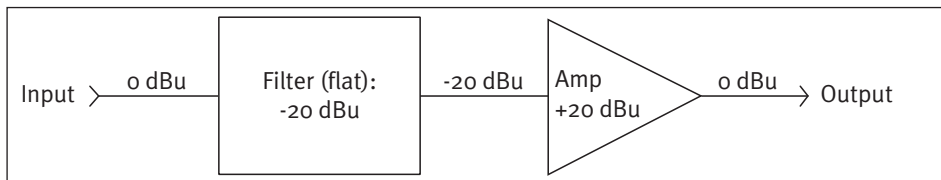
In our context here, an EQ is in effect a network of frequency filters which changes its output characteristics depending on frequencies. The common recording studio concept for sound shaping or correction is the amplitude-based EQ. But owing to the large number of filter combinations, there are practically too many existing formulations of this design concept to count. Nonetheless it is sensible to make some general observations that categorize the most important technical differences among these design concepts.

Passive EQs

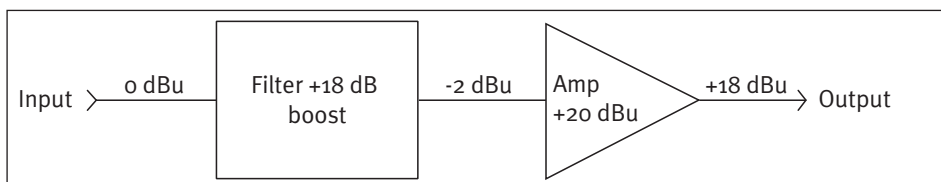
The filters in a passive network employ no intrinsic amplification elements and therefore need no external power, which means in effect that they can really only cut the energy of a chosen frequency. In order to expand this capability to include boosting the energy of a bandwidth (that is, to be able to boost and cut frequencies), the overall filter input signal level is reduced. Based on this overall reduction and relative to the original input signal, one can achieve a further cut or boost in the form of a return to that original signal level. Thus a passive filter is always followed by an amplifier which is responsible to regain the initial energy reduction and restore level balance between the input and output signal levels.



Schematic of a passive frequency filter



Block diagram of passive filter set flat



Block diagram of a passive filter at +18 dB boost

Passive filters react differently than active filters, mostly due to the saturation and loading characteristics of its coils and condensers. The characteristics of passive filters often are very advantageous in their ability to create a musically pleasing sonic result: they sound comparably very smooth and harmonious (please see “Introduction—Advantages of Passive Filter s” on page 5).

The Basics of Frequency Filtering

Active EQs

The filters of an active network require external power which allows for an integration of amplifying elements that allow for both boost and cut functions.

Active EQs dominate the market, and perhaps a good part of this is due to their user friendly capacity to combine both boost and cut features into single controls. A very good active filter designs can often offer very responsive characteristics with relatively little signal coloration or alteration. But the operative word here is “can”—the sonic result of filtering comes under the influences of so many parameters that it is almost impossible to fulfill any such claims made categorically.

Parametric EQs

With a fully parametric EQ, all filter parameters are adjustable: The frequency, amplitude and bandwidth of each filter can be adjusted by a user. The fully parametric EQ is therefore ideally suited to working very specific or in very narrow limits at any desired frequency. There is also the case of semi- or half-parametric filters, whose bandwidth is fixed, usually at around two octaves.

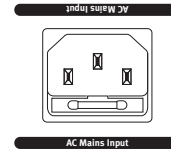
Graphic EQs

For working with the entire audible frequency range, there are available certain fixed frequency and bandwidth active filters. One can only alter the amplitude of each filter. Because the designs of such machines originally employed fader controls (and often continue to do so), these adjusted faders represent in a graphic curve the frequencies and amount of alteration, and thus earned the name, graphic EQ.

The power supply was carefully engineered to provide clean and consistent current, an important prerequisite for excellent audio. Built around a toroidal transformer, the power supply generates a minimal electromagnetic field with no hum or mechanical noise. The output side is filtered by an RC circuit to extract noise and hums inherent in commercial AC power.

All audio-related components are fed by two separate voltage regulators to minimize disturbance from other components.

An AC power cord is included for connection to the standard 3-prong IEC connector. The transformer, power cord and IEC connector are VDE, UL and CSA approved. The AC fuse is rated at 500 mA (230 V version) or 1 A (115 V version).



Specifications

Inputs and Outputs

Instrumentational amplifier, transformer balanced

Nominal Input Level	+4 dBu
Input Impedance	=22 kOhm
Output Impedance	< 600 Ohm
Max. Input Level	+28 dBu
Max. Output Level	+32 dBu

Measurements

Frequency Range	20 Hz-50 kHz linear, 50 kHz-100 kHz: -3 dB
CMRR	> 70 dBu (@ 1 kHz)
THD & N (@ 0 dBu Input Level)	> -110 dBu
S/N A-weighted	-115 dBu
Crosstalk L/R (@ 1 kHz)	> -85 dBu
Dynamic Range	143 dB

Power Supply

Toroidal Transformer	48 VA
Fuses	500 mA/230 V, 1 A/115 V
Voltage Selector	230/50 Hz ↔ 115 V/60 Hz
Power Consumption	40 W

Dimensions

Standard EIA 19 Inch Housing/4U	482 x 176 x 390 mm / ca. 19 x 7 x 15.6 inches
Weight	11,8 kg / 25.96 lb

Notes:

0 dBu = 0,775 V

Subject to change without notice.

Guarantee & Product Registration

All SPL products come with a two-year manufacturer's guarantee against defects in material or assembly from the date of purchase. Tubes have a guarantee of three months.

End users are supported in the two-year guarantee through their distributor. In such cases, please contact your dealer for full guarantee conditions and service.

Direct SPL product support requires product registration. Please fill out the guarantee card enclosed in the package legibly in printed letters and send it directly to SPL. Or use the online registration form that may be reached at www.soundperformancelab.com (international clients) or www.spl-usa.com (US clients).

Copy Master: Recall Settings



Artist:

Engineer:

Album:

Track(s)/Groups:

Title:

Date:

