
# DU EQ 2022 USER GUIDE
# STEREO

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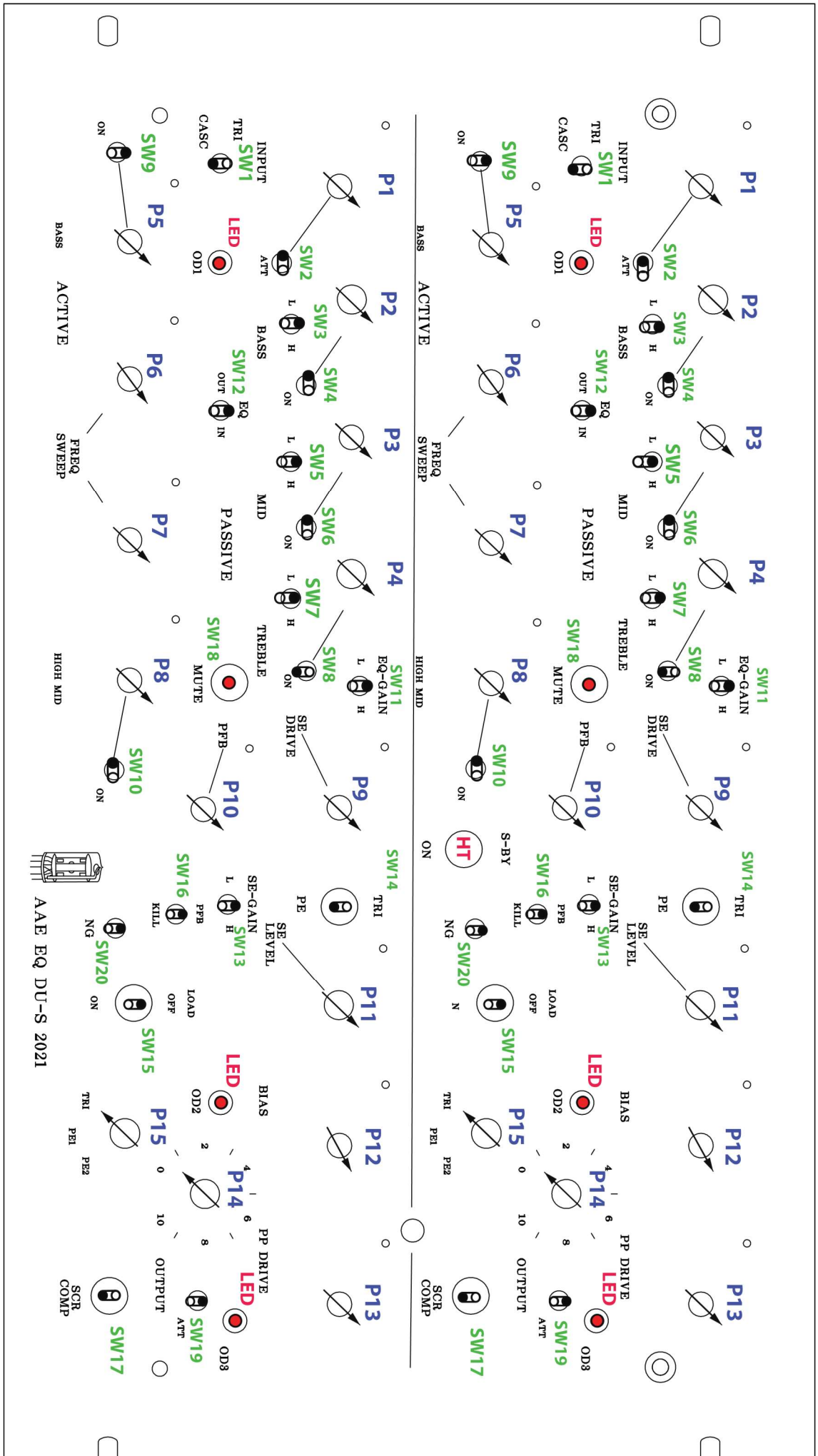
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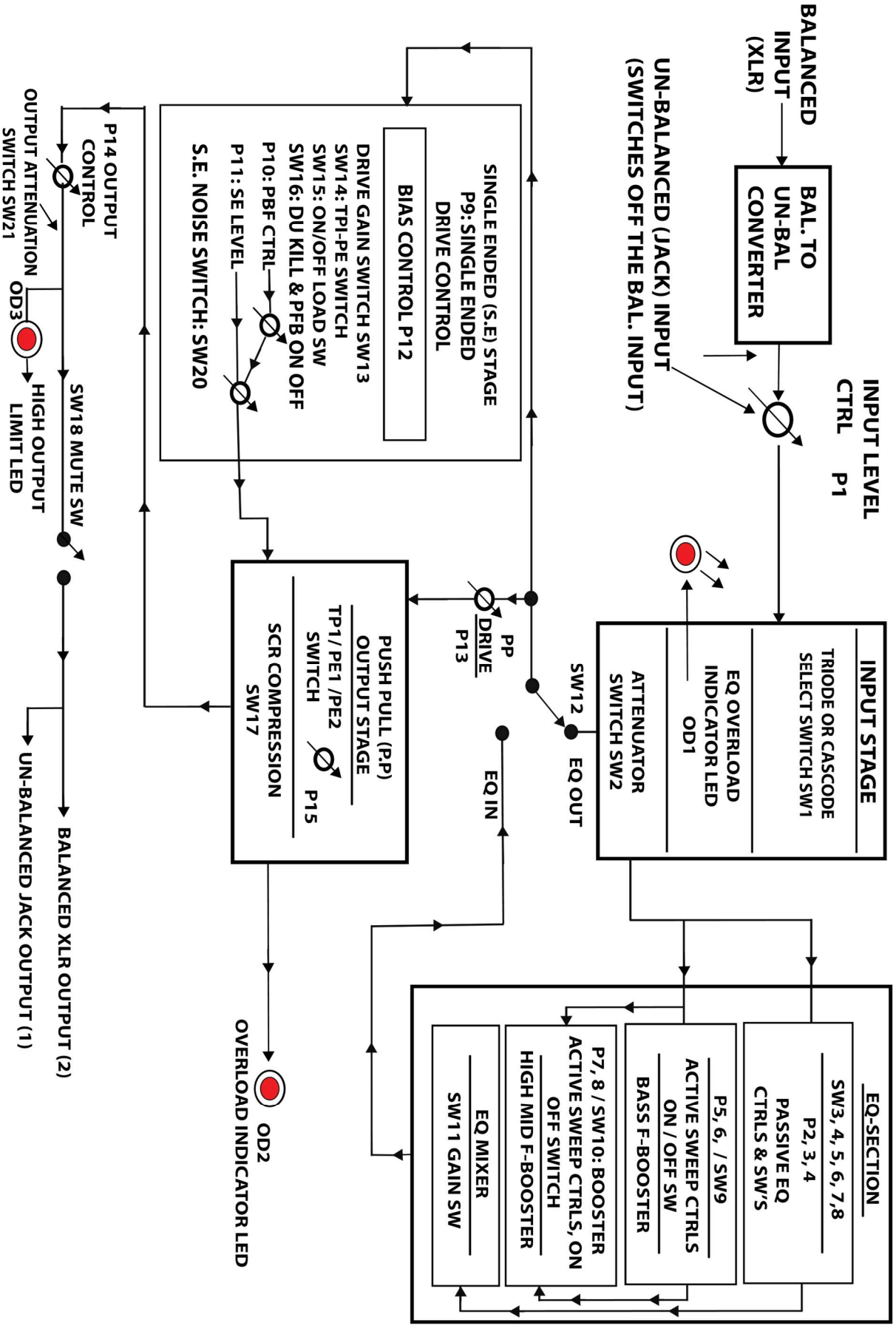
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# PLACEMENT

## THE MAIN UNIT

The location of the distortion unit **(DU)** is important.
Its location/mounting must allow **adequate air circulation** from below, the sides and above it to disperse the heat that the tubes/semiconductors generate.

**Avoid hot locations** such as near **radiators** or other heating units.

IF THE UNIT IS MOUNTED ON A RACK:

**(a)** If mounted on a rack ensure that the unit below it does not get hot.

**(b)** Even if the unit below the DU runs cool, there must still be a distance of at least a 2U (3(1/2) inches, 90mm) of empty air space between the DU and the unit below. If the unit below gets warm this gap must be increased by least 4U (7 inches,180mm).

**(c)** Leave a **4U** distance of empty air space between the DU and the unit that is on **top** of it.

**(d) both sides of the whole rack must be open to allow air passage.**

**(e)** Also, if the unit is mounted on a **rack** it may need **extra support** from below due to its **weight.** A sturdy **rack shelf is** suitable the 1" feet will allow air to enter from below.

Keep the top **clear** of items such as papers or anything that could **block air passage** and cause **overheating.**

PLACE THE UNIT AWAY FROM SOURCES OF INTERFERENCE

**(a)** AC power lines, fluorescent lights, fans etc.

**(b)** The power supply cords that are plugged to the power supply must always run from behind the unit never along its sides to the power supply.

**(c)** If the room where the unit is operated is electrically and/or magnetically noisy, you may have to slightly move it around and find the most suitable location in order to completely eliminate any noise.

## THE POWER SUPPLY UNIT

**(a) Before you connect the power supply to the mains**, connect the two power supply cords to the power supply sockets. These are the two cables, one grey and one black, that come out from the back of the main unit. Please treat both cords with care.

**Both** of the plug **connectors** at the end of these cables and their respective **sockets on the power supply front** panel are **mated** in only **one possible orientation.** The smaller round **high voltage plug** at the end of the **black cord** features **keyway polarisation:** it has a notch to make possible to **fit in one way only.** The bigger **plug** on the **grey cord** and its **socket** (on the power supply) are also **non-reversible,** they have a flat side in the middle to make them **mate one way only.**

Please **examine both sockets and plugs before connecting to recognise their mating features and do not use any force when inserting** the plugs into their sockets.

**(b**) The power supply is also a source of electrostatic and magnetic interference and it must be placed as far away from the main unit as possible, preferably on the floor.

**(c)** Please allow plenty of ventilation for the power supply unit too. Avoid hot locations such as near radiators, heating units, hot central heating pipes etc.

## GROUND LIFT SWITCH

If this switch is used **incorrectly** the unit will become susceptible to **interference, noise and hum.** Ensure that this switch which is situated in the rear panel is in the on position which is with the **(I) pressed down.** This is to ensure that the metal case is connected to the negative signal ground of the unit's electronic circuits so that it (the metal case) works as a **shield against external interference** but also prevents **internal instability and oscillation.**

In most studios and especially if the balanced (XLR) inputs and outputs are used it may never be necessary to operate this ground switch, so there is a piece **of tape to keep it in the ON position at all times.**

If you need to operate this switch (see **notes on ground lifting & loops**) just pull the tape off.

**It is important to remember that unless the case is shielded (connected to the signal ground) by other means if the GROUND LIFT SWITCH in is the off position the unit will be noisy.**

# PRECAUTIONS

- Please do not leave the unit switched on when not in use

Each time:

**(a)** you increase any gain settings

**(b)** change from triode to pentode,

**(c)** operate in **OFF LOAD** mode

**(d)** operate in positive feedback (PFB) mode

- Ensure that you decrease the **OUTPUT P14** control and/or use the attenuator **(OUTPUT ATT)** switch **(SW21,** in the right position) so that the output level of the unit remains as constant as possible.

- Until you get to know the unit, always turn the **OUTPUT** control (**P14)** down to zero whenever you change anything and then gradually turn it up again.

- Ensure that output overload **LED OD3** is always off.

- Always set the **S-BY/ON** switch on **S-BY** (up) before you use the **TRI/PE1/PE2 (P15)** rotary selector switch and then press **S-BY/ON** down again (ON). This procedure is explained in the 'THE OPERATING GUIDELINES' section.

# OPERATING GUIDELINES CONTROLS & SWITCHES

## DUAL MONO

**(a)** The Tube amplifiers in this unit do not employ any form of negative feedback (NFB) in order to retain the harmonic sonic character of each tube and to be able to overdrive it to its full extent softly or harshly depending on how the controls/switches are set.

NFB not only reduces distortion but it also offers accurate amplification by controlling parameter tolerances of each tube. The gain (and other parameters) can vary from tube to tube (of the same type).

Components like the potentiometer controls, signal capacitors, etc have small tolerances too.

For these reasons individual minor fine adjustments of each channel may be necessary in order to make them produce exactly the same output in some operating modes. For instance, sometimes, a drive/level/output control in one channel may need to be set at 5(1/3) (= a third of the distance between 5 and 6 on the knob dial) while the same control is set at 5 in the other channel.

**(b)** Due to the complexity of the unit I personally found it easier (when operating for the first time) to fully test one channel first, then the other and finally align them both in stereo mode.

**(c)** When I switch on each unit for the first time, I also prefer testing each section separately (in each channel) and then mix them altogether. For instance, test the whole channel without the SE (single ended) and active EQ sections then bring in the SE section, then the active EQs and so on. It is possible to test each section separately.

## (1) INPUT SECTION

**P1: INPUT LEVEL CONTROL**, it adjusts the amount of signal level that enters the unit from the unbalanced (jack) input

**SW1: INPUT STAGE SELECT SWITCH**

This switch selects the operating mode of this stage. In the **up** position is **triode (TRI)** in the **down** position **cascode** (**CASC)** mode

*In **triode** mode, at low P1 settings, the input stage will produce a clean sound, but with 'musical' low order even (mainly second) harmonic distortion, the amount being directly proportional to the signal level set by P1. The more you turn up P1, the more harmonic and intermodulation distortion is generated, resulting in noticeable sound colouration.*

***Cascode** mode, is to be used for harsher and dirtier sound. Cascode is a low noise pentode made out of two triodes (= CasCaded triode), that produces more distortion even at lower P1 settings. The distorted*

*signal contains both even and odd products. Bass, drum-loops and keyboards/synths sound interesting in this mode. However, it also **amplifies more.***

The **SW1 (TRI/CASC**) converts the input stage (as already explained) from a **Triode** to a **cascode** circuit with more distortion and gain.

During the change the operating conditions of the two input tubes change **rapidly** and the signal may **disappear** for a **very short** period of **time.**

**(a)** in order to avoid premature failure of either or both of these tubes please **disconnect the high voltage (B, HT)** through setting the **S-BY** switch in the up position before operating SW1 and re-connect the high voltage afterwards by pressing the S-By down again.

(**b)** The changeover is a noisy procedure so the **MUTE (SW18)** switch can be pressed while operating SW1 (and the HT switch) to silence the output of the unit.

Procedure **(a)&(b)** above is the same as the one used for changing from **Pentode to triode (and vice versa) in PP** output section. This **procedure is discussed in detail** further in the text. (see **PRECAUTIONS, OPERATING GUIDELINES,** and **SWITCHING ON/TESTING**.

**SW2: ATT**, an attenuation switch that reduces the signal level coming out of the input stage by 12dB's. This is to avoid overloading of the following stages, when the input stage (especially in cascode mode), produces a high-level signal, when (and if) this type of overloading is not wanted.

## (2) PASSIVE EQ SECTION

This is a passive EQ, with an inductor in the midrange section, that can emphasize certain harmonics, eliminate others and add a certain character to the sound.

**P2: BASS**, a shelving type control for the low frequencies.

**SW3: L /H**, bass frequencies select switch, when P2 starts having a noticeable effect
L = 70Hz, H=100Hz

**SW4: ON**, bass on /off switch, it is not a 'kill' switch, but it cuts off the low frequencies.

**P3: MID**, midrange frequency control.

**SW5: L/H,** midrange frequencies select switch, see text below

**SW6: ON**, mid control (P3) on /off switch

**P4: TREBLE**, a shelving type control for the high frequencies.

**SW7: L/CENTRE/H**, treble frequencies select switch when P4 starts having a noticeable effect
L= 4.5kHz, centre =9kHz, H = 7kHz

**SW8: ON**, treble on/off switch it is not a 'kill' switch, but it cuts off the high frequencies.

*This EQ interacts both with the stages before it and the stages after it. For instance, you can:*

***a)*** *overdrive the input stage, before the EQ and use its controls to either boost or filter out harmonics that have been generated by the input stage, especially in cascode mode.*

*Another option may be to:*

***b)*** *keep the input stage clean, (Triode Low distortion mode) and cut or boost certain frequencies of the signal that enters the following stages (SE & PP DU's) and overdrive these stages.*

***c)*** *Most commonly used option is a combination of a) and b).*

*The Bass and Treble is a Baxandall tone control, switch SW3 selects the low frequencies below which maximum variation occurs, switch SW7 selects the high frequencies above which maximum variation occurs. When SW7 is in the centre position the frequencies controlled by P5 are too high (often called "air" frequencies) and the variation is not very audible.*

*When SW3 is set in H and SW7 in L, P2 and P4 become more responsive and interactive.*

*When SW5 is set in L control P3 affects a wide range of low mid- frequencies centred at 500Hz and the sound becomes fuller on high P3 settings. When SW5 is set in H, P3 affects a narrower range of higher midrange frequencies centred around 1kHz.*

*By turning P3 fully anticlockwise, or by switching off the mid switch SW6 most of the midrange frequencies disappear and the Bass & Treble (P2, P4) controls become more effective.*

## (3) ACTIVE EQ SECTION

**(a)** BASS Variable Frequency Booster (VFB)

This is an active Variable Frequency Booster (VFB), a high Q ( + 27dB) band -pass filter at a frequency set by SWEEP control P6. It uses both Negative and Positive Feedback mechanisms to function and swings between the two. This circuit works in a way as if it is "trying" to oscillate at the chosen frequency but never actually gets there. P6 selects this frequency from 30Hz to 350Hz, and the BOOST control P5 sets the output level entering the EQ mixing stage.

This is a hybrid circuit, made out of a 12AX7 tube voltage amplifier and a high voltage transistor buffer. The 12AX7 is producing a small amount of harmonic distortion and its unique grid current behaviour set by the operating conditions of the circuit plays a role in the sound.

**P5: BASS BOOST** control

**P6: FREQ**, bass frequency **SWEEP** control

**SW9: ON** bass frequency booster on/off switch, when pressed down the boosted signal enters the EQ mixing stage; it can also be used as a KILL switch.

**(b) HIGH MID Variable Frequency Booster (VFB)**

*Same as the previous circuit but its frequency range (900Hz ... 4.2kHz) covers the high midrange and presence frequencies.*

**P7: FREQ,** high mid frequency **SWEEP** control.

**P8: HIGH MID BOOST** control

**SW10: ON high** mid frequency booster on/off or "KILL" switch

There is a **limiter** before the input of both bass and high mid VFB's to **avoid overloading** them. *Such type of overload must be avoided because it will result into instability and hard clipping.*

On high level signals, after a certain amplitude has been reached, this limiting action creates a form of compression and adds some sustain in the narrow range of the chosen frequencies. It also generates distortion in the frequencies that the booster circuits reject but are near their narrow bandwidth.

**OD1:** this **LED** is lit when the signal that enters the VFBs has reached a level high enough to **activate the limiter.**

**NOTES ON EQ SECTION (ACTIVE & PASSIVE)**

**(a**) The output of the **ACTIVE EQ** section can produce a **much higher signal level** output with far **more** distortion than the **PASSIVE** section which only slightly colours the sound.

The high-level signals from the active section are in the low and high mid frequencies and **BASS BOOST & HIGH MID BOOST** controls **(P5&P8)** are **logarithmic** to enable **fine** adjustment at settings **below 5.** These controls can be set **low** (at first at least until you get used to the unit) especially if the **EQ gain** switch **(SW11)** is set in the high **(H)** position. You can set this switch for higher EQ gain if you need more signal coming out of the Passive EQ section.

**(b)** The ACTIVE section also produces more distortion in the frequencies that the two Variable Frequency Boosters (VFBs, or resonators) **do not affect** as already mentioned in the text.

**(c)** Because of the nature of the VFB circuits (positive& negative feedback, oscillating effect, distortion etc) and tube tolerances the signal boost is not 100% equal at all sweep frequencies and amplitudes vary slightly from channel to channel so some fine re-adjustment may be necessary through the **P5, P8 boost** controls every time the sweep **P6/P7** controls are used.

**(4)** The signals from the passive and active EQ stages enter the EQ MIXING stage where:

**SW11: L/H** a gain switch; the EQ MIXING stage provides a +9.5dB of gain when this switch set on H.

**SW12: EQ IN/ OUT** switch, it bypasses the whole EQ system when set in OUT.

**(5)** After SW12 the signal splits in two parts:

**(a)** it enters (PP) Push Pull output stage through the **P13: PP DRIVE** control, that adjusts the amount of signal level entering the Push Pull output amplifier.

and

**(b)** it also enters the Single Ended (SE) distortion stage.

There is a mixing stage inside the PP stage that mixes the output of the EQ MIXER and the output of the SE DU stage.

## (6) MAIN DIFFERENCES BETWEEN SE & PP STAGES

Both SE and PP stages can function as clean audio amps with very little distortion only high enough to add colouration and “warmth”, if they are driven softly by adjusting their corresponding level controls and mode switches. They are both working in 'open loop' mode i.e. there is no Negative Feed Back (NFB) applied to them.

But there are two fundamental differences between them:

**(a)** The **SE** stage, in **Triode (TRI)** mode, is producing mainly even harmonic distortion, and in **Pentode (PE)** mode a combination of **even** and **odd**.

The **PP** stage in itself does **not produce even harmonic distortion, just odd.**

The order and the amount of the distortion in both stages increase the harder they are driven.

**(b)** The SE creates a lot more “crunchy” type of distortion in the low frequencies especially in Pentode mode when it is driven a bit harder. This is due to the fact that the choke that forms part of the output load is gapped to avoid core saturation, so its inductive reactance is lower and thus loads the output tube in the low frequencies.

The PP on the other hand has a full smooth bass sound with more headroom and it does not distort the bass as quickly as the SE does, but it produces a different, type of bass distortion heavier and “warmer”.

**(c)** The SE can sound bright and sharp on the treble especially in PE mode, even more in PE and NO LOAD mode.

There is a big difference in **low frequency** sound signals **between the SE and PP stages** especially when they are **overdriven.**
**(d)** In some settings the signals level dynamic range can be higher in the SE than in the PP stage so it would sometimes appear that the SE stage produces far too much gain. This is for two reasons:

- The SE stage must be able to produce anything from a clean smooth sound to very extreme and much higher distortion levels than the PP stage does. For this reason, it must be capable to generate ample amounts of gain if set so; for instance, it has an extra gain SE**-GAIN (SW13**) plus **OFF LOAD** and **PFB (Positive Feed Back)** modes.

- The SE stage drives the PP stage, so any SE gain increase will also appear in the PP stage which is also the output stage.

**SE LEVEL P11** control is a **logarithmic** type to enable **fine adjustment** at levels below 5 (on the P11 dial)

**(e)** The latest version of the PP stage has been designed so that **(only when over-driven)** one half of the (signal) cycle grid-clips softly earlier (than the other half) so that results in a relatively small amount of **even** as well as the odd harmonic distortion.

**This slight half cycle soft grid clipping** occurs in Triode mode **(TRI)** and to a lesser degree in Pentode **(PE2**) mode.

## BIAS CONTROL AND HOW IT AFFECTS DISTORTION AND CLIPPING IN THE SE DISTORTION SECTION

The output stage of the SE section has a bias control that sets the amount of DC current that flows through the output tube and output inductor under idle (no signal) conditions.

The lower this bias control is set the higher the even harmonic distortion generated by the SE output stage will be.

When the power (output) stage is driven hard:

**(1)** One part (say for instance the top half) of the waveform clips because the output signal in the power tube is entering its cut off region and this is called cut off clipping.

* Cut off clipping is soft and builds up gradually.

**(2)** The other part (say for instance the bottom half) of the waveform clips because of:

**(a)** In **triode** mode

An electrode at the input of this tube called the grid starts drawing current and this is called grid clipping.

*Grid clipping in most control settings starts abruptly and is hard and makes bass sound “crunchy".

The higher the bias control is set the higher the grid current effect is.

**(b)** In **pentode** mode

(i) the same grid current effect takes place that occurs in triode mode

(ii) the output signal in the power tube is entering its saturation region

*In most control settings in pentode mode saturation clipping is gradual and it coincides with grid clipping. As a result, this creates a softer clipping in this part of the cycle despite the harshness of the grid current effect unless the tube operates in high bias currents where grid clipping takes place before saturation.

*At certain settings in both triode and pentode mode you can create a symmetrical output waveform where both parts of the signal 's cycle clip softly

## (7) SINGLE ENDED DISTORTION SECTION

**P9: SE DRIVE** control, it adjusts the signal level that enters the output tube of this stage. On low settings, and in triode mode, the sound will be clean, with a small amount of second harmonic distortion, introducing mild colouration. On higher P9 settings, the distortion increases especially in Pentode mode at a rate proportional to the signal strength. At the same time the SE output signal will increase too.

**P11: SE LEVEL** control, it adjusts the level of the SE output signal. **P11 may have to be turned down** if it is necessary to **keep the same signal level coming out of the output of the SE DU as P9 is turned higher,** in order to achieve more distortion.

**P12: BIAS** control it sets the amount of current that the SE output tube is operating on.

**SW13: SE-GAIN, L/H** when this switch is set in **H** the gain inside the single ended stage is **increased by 11.6 dBs.**

**SW14: TRI /PE** switch, it selects Triode or Pentode mode of operation for the SE DU output tube.

## DIFFERENCES BETWEEN TRIODE & PENTODE

*At low input signals triodes produce predominantly second harmonic distortion which is more musical. SE DRIVE control P9 can be set low to drive the DU softly if this kind of sound colouration is desired and to avoid clipping .The amount of distortion is directly proportional to the signal amplitude set by P9 and that means as this control is turned up, more distortion will be generated (especially if the SW13 switch is set in H), first low even, then low odd (like third ) and a smaller amount of higher orders both even and odd, until eventually soft clipping occurs.*

*In PENTODE mode the distortion starts earlier as far as P9 is concerned. Pentode output will produce more third and higher order odd distortion products in addition to second and higher even products by overdriving it when increasing the signal drive through P9 (and/or setting SW13 in H), resulting in a harsh and edgy sound and a boost in high mid and treble.*

**SW15: ON/OFF LOAD** switch, it disconnects the internal load that the SE DU is connected to. It is more of an effect when SW14 is set in PE mode, and under these conditions extreme distortion, echo-y sound (in some frequencies) and shrill treble is the result.

**It is highly recommended to turn the output level control P14 all the way down** to a very low setting, until you get used to the high-volume level of this particular effect. This is because the output signal can reach very high levels when the SE output tube operates in the Pentode OFF LOAD mode. SE DRIVE control P9 must also be set low when you experiment in OFF LOAD for the first time.

**SW16: KILL & PFB** this is a switch, that serves three purposes:

**(a)** When pressed **down** it **kills** the output of the **SE DU**

**(b)** In the **centre** position the **SE DU is on, and** it **enters** the **PP output stage.**

**(c)** In the **up** position (labelled **PFB**) it enables the output signal to re-enter the input of the SE DU in such a manner as to increase its strength and generate the **P**ositive **F**eed **B**ack **(PFB)** effect.

**P10: PFB** control, it adjusts the amount of the signal re-entering the SE amp. It must be used carefully, if it is turned high enough the SE DU will start oscillating. The trick is to turn it up until oscillation starts, then back off a bit until it stops. Again, when you operate in Pentode , and especially in PE /OFF LOAD mode the PFB effect becomes more extreme.

**SW20: noise gate switch, it only affects the single ended section (SE DU).**

If you operate the **SE DU** on a high gain mode for **high distortion**, like **OFF LOAD**, **PENTODE,** with the **EQ-GAIN&SE-GAIN SW11&SW13** switches set in **high gain (H)** and especially with the **HIGH MID BOOST P8 control set high** you can press this switch down to **remove hiss and noise.**

For low **SE DU** distortion (just **mild colouration**) and **low P8** settings, you can keep this switch in the up position because it introduces **crossover distortion,** unless of course you want to add this type of distortion to the mix.

## (8) THE PUSH PULL (PP) OUTPUT STAGE

**P13: PP DRIVE** control it adjusts the signal coming out of the **EQ mixing stage** and entering the PP stage if the **EQ IN/OUT SW12** switch is set in **'IN'.**

If **SW12** is set in **'OUT**' the PP drive control **P13** picks up the signal directly from the **output** of the **INPUT STAGE.**

The **SE DU** stage also feeds the **PP** stage, and **SE LEVEL** control **P11** adjusts the SE signal **entering the PP stage.**

The **output of the Equalizer (EQ) also drives the SE stage if SW12 is set in "IN"** *and there is a summing network at the input of the PP stage that mixes these two signals.*

The **PP stage** is the **output** stage of the **whole unit** and it free of global NFB.

*Global **N**egative **F**eed-**B**ack is a distortion correction network. It samples the output signal of a circuit and feeds an out of phase portion of it to its input and by doing so it removes distortion.*

This output stage can operate as a **linear amplifier** by

**(a)** Setting **P11** and **P13 low**

and

**(b)** Operating in **Triode** mode. Just like in the SE stage , distortion in the PP stage is also proportional to its input signal amplitude and it will first occur in the low frequencies (Bass) due to saturation in the output transformer. The PP output transformer primary inductance is quite high, so in triode mode it has little effect on the distortion.

**OD2:** PP stage overload **LED.**

This will light up when this stage starts **distorting on the Bass**. Controls **P11** and **P13** can be **turned down** as soon as **OD2** lights up, if it is desired to keep the PP stage in clean mode. The PP stage is designed to clip very softly.

**P14: OUTPUT** level control, it sets the output signal level of the whole system. As in the case with the single ended DU, if the output becomes low because P11 and P13 are set low to achieve a clean output, P14 must be turned up to get the right volume. With P14 all the way up, the maximum undistorted output in PP triode mode at 30...40Hz is 5.3V RMS (= + 16.7 dBu) approx.

Obviously, if the PP stage is set for distortion by **turning P11 and P13 up, P14 must be turned down in order to maintain the same amount of volume. P15:TRI/PE1/PE2 rotary switch, it selects between TRIODE and two different modes of PENTODE operation. Always set the S-BY/ON switch on S-BY (up) before you use the P15 rotary switch and then press S-BY/ON down again (ON). This procedure is explained in the 'THE OPERATING GUIDELINES' section.**

Triode operation is preferred for clean sound like in the SE DU , whilst Pentone (PE 1) gives more distortion *by operating the Screens of the output tubes at a lower voltage.* Pentode operation in PE 2 is cleaner, with more headroom *due to the higher Screen voltage.*

**SW17: SCREEN COMPRESSION** switch, this effect introduces a mild compression by limiting the screen current and it is more **noticeable in PE 2.**

**OD3: output limit LED** indicator, it will light up when the output signal reaches **8.2V RMS (= +20.5 dBu)** sine wave approximately.

The OD3 led will light up at a lower output level around +19dBs similar to the older units. After the OD3 is lit the output can still reach a maximum **25V peak to peak square wave.**

When that occurs, the in-built limiter will ensure that the output signal never exceeds that signal level by making it clip very hard. To avoid this happening the output level control **P14 must be turned down as soon as OD3 starts lighting up, in order to avoid hard clipping and overloading the equipment that the unit is driving.** Therefore, to keep the output signal at reasonable levels OD3 must never light up.

The OD3 indicator must not be confused with the OD2 which indicates (as already mentioned) the PP output stage overload condition on the bass. The **output control P14 has does not affect the OD2** led because P14 is placed after OD2. It is safe to overload the PP DU and let OD2 light up, but you must **make sure the output is kept low through P14 and OD3 must never lights up.**
The restriction in the amplitude of the output signal is achieved by a clipping circuit and this clipping is **hard and sounds very harsh.**

**HT SWITCH or STAND- BY SWITCH (S-BY**), it applies the high voltage (**SW19**) on the tubes when pressed down.

**SW21** This is the output attenuation switch which when pressed to the right, it introduces a **-6bB** attenuation in the output signal.

# PREPARATION BEFORE SWITCHING ON/TESTING

Connect the main unit to the power supply unit.

**(1)** Ensure that the **stand-by switch** on the front panel of the of the main unit is **OFF**, i.e. the up position. This is because the high voltage (HT) must not be applied to the tubes until they **warm up.**

**FOR THE FIRST TEST**

**(2)** Turn these level controls fully anticlockwise: INPUT P1, BASS BOOST P5 , HIGH MID BOOST P8 , SE DRIVE P9, SE PFB P10, SE LEVEL P11 , PP DRIVE P13 and OUTPUT P14

Once you are familiar with the unit you may only have to turn P14 down to zero before switching on.

**IMPORTANT NOTE**

**This unit can produce a large amount of gain and high output levels, but its output is internally limited by restricting the amplitude of the output signal (through hard clipping) as soon as it reaches 8.2V RMS (20.5dBu). However, even with this protection, if you accidentally send a high signal through it (for instance a loud buzzing noise caused by a faulty input lead ) it may generate enough of an output to damage your monitor amp or speakers on certain settings if the OUTPUT control P14 is set unreasonably high.**

**Also, P14 must always be turned down when you operate in Pentode OFF LOAD and/or the positive feedback mode (PFB, P10), because the output may become too high.**

The **Bass** sections (Bass control P2, Bass sweep boost P5) and the **high mid sweep** (boost P8) section can produce **high outputs too.**

**It is therefore advisable to start quietly and then gradually turn the levels up so that you can keep control of the units overall output level.**

Due to the complexity of the system for the first test, start with the Input Stage, passive EQ and output PP amplifier only, and then try one of the other sections at a time.

**(3)** Ensure that the input stage **ATT**ENUATION switch **SW2** is **OFF**, i.e. in the **up** position.

**(4)** Set **EQ** gain switch **SW11** on low gain i.e., in the **left** position.

**(5)** "Kill" **Bass** and **High Mid F-Boosters,** by turning **SW9** and **SW10 up**

**(6)** "Kill" the **SE DU** stage by pressing **PFB/KILL SW16** switch **down.**

**(7)** Set passive Bass/Mid/Treble EQ frequency select switches **SW3** on **H**, **SW5** on **L** and **SW7** on **L.**

**(8)** Set **EQ OUT /IN** switch **SW12** on **IN.**

**(9)** For a **flat response** set Bass control **P2** on half, Mid **P3** just over half and Treble control **P4** just below half.

**(10)** Press tone control switches **SW4/SW6/SW8** down i.e. **ON.**

**(11)** Set **TRI/CASC** (triode/cascode) select switch **SW1** on **TRI** (Triode).

**(12)** Set **PP** output stage mode rotary select switch **P15** on **TRI** (Triode) mode.

**(13)** Until you get used to the output levels of the unit set the **OUTPUT ATT** switch **SW21** in the down position, to introduce output attenuation.

**(14)** Connect the output of the unit to a sound monitor, with an INPUT IMPEDANCE of at least **10K.**

**When the output is taken out of the un-balanced JACK, one side of the balanced output XLR is grounded, if the jack plug used is a mono type, they are the ones with no ring, just sleeve and tip. These are the only jack plugs to be used for both inputs and outputs of this unit.** P**lease do not use both balanced and unbalanced outputs simultaneously.**

**(15)** Connect a sound source of an average **level of 0dBu (0.775V rms)** into the input of the unit (*) This figure refers to the **jack unbalanced inputs** and it is an approximate value. For the **XLR balanced input** I would increase that to **0.753dBu (0.845Vrms**), **a very small increase** since the input balanced to unbalanced transformer introduces a 0.753dB attenuation.

All my units use this input signal level for the various control knob number references I mention throughout the manual. Under these conditions (*) you will have to set **P1** in **approx. 5** for led **OD1 to light up.**

For higher input level sources like **+4dBu** or more you will have to set the **INPUT CONTROL P1** to a lower setting.

The input level control P1 works well for even higher inputs; for instance, at a **+10dBu** input signal you may have to set **P1** to **around 2** for OD1 to just about light up. This is because P1 is a **logarithmic** control. However, in settings **below 1** it may be difficult to fine tune the two channels.

Another important thing to emphasize here is that you can **overdrive the input anyway** in which case those settings I mention above can be ignored. The settings and the recommended input levels are only given for the specific case of generating **a clean, very slightly coloured output signal in the low frequencies (around 30Hz)** when the **input** stage is operating in **triode** mode and the **output** stages (**SE and/or PP**) are also in **triode** mode. This is a good way to start and then move into more distortion gradually.

In tube circuits with no distortion control networks like overall **NFB** (negative feedback), input levels are integral to the way in which these circuits create a 'tone'. The design of the input section must also provide a lot of gain and distortion if a 'dirty' sound is required. It is part of a distortion unit after all and that is what it does at high P1 settings especially in cascode mode, hence the restrictions in input levels.

If you use the unbalanced (JACK) input the balanced (XLR) input is **automatically disconnected.**

**(16) Controls and switches** (possible errors)

Due to the large number of controls and switches it is easy to get confused and not get identical signals in both channels if for instance one control/switch in one channel is in a slightly different setting in the other channel.

Another problem is a missing signal in either channel because a switch is in the off/kill position, or a control is turned down to zero by mistake.

**(17)** EQ on/off**:** I usually start with the EQ IN (SW12), but for simplicity you can start with the EQ OUT first. There will be signal strength differences between EQ IN/OUT depending on the settings. There is also a phase reversal between EQ IN and EQ out.

# SWITCHING ON/TESTING

Switch on the power supply unit PSU then **the first three LEDs** from left to right will light up. Each one of these LEDs indicates the state of a power supply line; if one is not lit that means a fuse (internal or external or both) in this line is blown.

**All fuses are in the power supply:**

**a)** the **mains** which is **external** next (on the right) of the power supply rocker switch

**b)** Two low voltage line fuses (first and second LED from the left), one **internal** and one **external** for each voltage line

**c)** Two high voltage line fuses (third and fourth LED from the left), one **internal** and one **external** for each voltage line.

**There are no fuses inside the main unit**

So, by switching on **only** the power supply (whilst the S-BY switch in the main unit is off i.e., up position) **only two low** voltage lines and **one high** voltage line are activated.

In this **main** unit there is only **one** (two colour) pilot LED. When you switch on the power supply (S-BY switch still off) the pilot led will light up **red on the front panel.**

In the **main** unit, after approx. one-minute press the **HT switch ON** (i.e., down) to operate.

Two things will happen next:

**d)** The fourth led in the **power supply** will light up **red.**

**e)** The pilot led in the **front panel (main unit)** will turn **amber.**

Now all the power supply lines are entering the main unit and you are **ready to operate.**

**(1)** Turn up **P1** until Led OD1 lights up.

**(2)** Turn the OUTPUT control **P14 about half way** and by turning up the **PP Drive P13** you should be able to hear the audio signal. By pressing the EQ gain **SW11** switch to the right **(H)**, the signal increases by **8.6dB's.**

If you want to create a more **transparent/clean** sound turn the **INPUT** control **P1 down to a lower setting,** perhaps 5 (or lower).

If you then want to increase the volume:

**(a)** First turn the output control **P14 fully anticlockwise**.

(b**) Remove** the **output attenuation** by setting the **OUTPUT ATT** switch **SW19** (situated at the far right of the front panel) in the **'up'** position (=no output attenuation).

And then

**(c)** Readjust the **OUTPUT LEVEL** control P14 for the **same output level as before**

**(3)** Now you can experiment with the P2/P3/P4 controls, the SW4/SW6/SW8 ON/OFF switches and the frequency select SW3/SW5/SW7 switches on the passive EQ section.

As already mentioned:

**(a)** SW4 and SW8 ON/OFF switches are not "kill" switches, they only attenuates the low (SW4) and the high (SW8) frequencies respectively.

**(b)** As soon as the MID is off by either setting P3 to zero or switching SW6 off (i.e. up) BASS and TREBLE controls P2 & P4 become more responsive
.
**(c)** All controls and switches of the passive EQ are interactive.

***Interesting settings:***

*Set Bass & Treble P2/P4 all the way up and switch (SW6) MID switch off.*
*Do the opposite, i.e. turn SW4/SW8 off and turn the Midrange switch SW6 ON and P3 control all the way up, experiment with (L/H) MID switch SW5.*
*Do the same with P2/P4 controls fully anticlockwise.*
*Then repeat with SW4/SW8 in the ON position.*

**(4)** Try the triode & cascode modes (TRI/CASC SW1 switch) with different P1 settings, various EQ settings, EQ gain switch SW11 in the H position and PP DRIVE P13 settings.

**make sure that:**

**(a)** use **MUTE** switch SW18 when you operate **TRI/CASC SW1 and** always **turn down OUTPUT P14** before you do anything that may increase the gain/signal level of any section.

and then

**(b) re-adjust P14** to get the right level

*You can **(i)** overdrive the input in cascode mode by turning up P1, and keep the output clean by keeping P14 low, or **(ii)** set the input in triode mode, set P1 not too high and overdrive the output by turning up P14 and SW11 in H or **(iii)** try any combination of **(i)** and **(ii).***

**(5)** Combine **(3)** and **(4)** tests, remember switch **SW12 by-passes the whole of the EQ when is set on OUT.**

**(6) Pentode mode operation of the Push Pull (PP) OUTPUT stage**

**Before you switch from Triode to Pentode and vice versa you must first remove the high voltage HT (B+, US) from the unit.**

**PROCEDURE:**

**(a) press the momentary MUTE switch SW18 to silence the output and avoid any loud clicking noises**

**(b) switch off the high voltage by turning the HT switch up, while still pressing SW18**

**(c) choose Pentode (or Triode) using rotary switch P15 for the Push-Pull stage, while still pressing SW18.**
**(d) switch the HT back on again while still pressing SW18**
**(e) release SW18**

**(7)** The gain in **pentode** mode is **higher** so you may have to **turn down** PP drive **P13** to **reduce the overload distortion/ signal level** or OUTPUT **P14** to maintain the same overall output level.

For a transparent sound try PE2 first because the distortion in PE mode is lower. The compression effect (when SW17 is pressed down) works much better in PE2.

For the first test ensure that Screen Compression is off, by keeping the SCR COMP switch SW17 UP.

Using a Bass loop as a source at the input, gradually increase the bass control P2 (and perhaps P13 Drive to a lesser degree) until **OD2 LED** lights up to understand the type of **low frequency distortion** this stage produces.

**(8)** Whilst still in PE2 mode press now **SCR COMP switch SW17 down** and drive the stage a **bit harder.** *The nature of distortion will change, the signal will clip softly earlier, and the sound will appear more compressed and softer on the bass.*

**(9)** Repeat **(7)** and **(8)** but using **P15** switch on to **PE1** now. Remember to **use** procedure **(6) (a,b,c,d,e)** above to remove the HT before operating rotary switch P14. The sound will appear more compressed, even with SW17 in the off position (i.e. up), and again the signal will clip earlier. The difference in compression that SW17 brings when it is pressed down is a lot more subtle on PE1 mode. The effect is more distortion rather than compression.

**(10)** Combine tests **(7), (8)** and **(9)** with test **(4)**.

**(11)** *Repeat tests **(4), (7), (8), (9)** but various different sound sources not just bass.*

**(12)** Testing the **BASS BOOST and HIGH MID VFB's**

In order to get a better feel how the whole EQUALIZER system works, it is better to test the VFB's with the PP OUTPUT stage only, before inserting the SE DU in the mix.

Also, for the first test set:

**(a)P15 on TRI, SW1 on TRI, and set P1 and P13** on relatively **low** settings to get a transparent sound, how low it depends on the signal strength of your sound source. By doing so and if the **ATT** switch points to the right (i.e., output attenuation), the signal volume in **TRI mode** will be **low** but as soon as you switch to PE1 or PE2 the volume will become **x3 or x4 higher**. It may be better to start with a low output first (output ATT to the right) and later when you get used to the output signal levels you can turn up (output ATT to the left).

In pentode modes PE2 and especially PE1 as the power tubes are driven harder on there may be differences between the two channels (top and bottom) due to tube parameter tolerances.
These tolerances are still there in triode mode (TRI) but they are minor. In order to create the 'tone' of the unit there is no overall negative feedback applied to the various circuits to compensate for small parameter variations between tubes.

Therefore, often you may have to adjust each channel slightly different in some settings.

**(b)** Turn the **PASSIVE EQ** controls **P2/P3/P4** fully **anticlockwise**, and press **SW4/SW6/SW8 up (ie OFF)** to temporarily remove the PASSIVE EQ and only **concentrate on the VFB's.**

*A drum loop with some bass and keyboards is a good sound source for these tests*

**(c)** Turn BASS BOOST P5 to about 2/3 of its maximum, switch on the BASS VFB by pressing SW9 down (ON) and sweep the frequency range using the FREQ SWEEP control P6.

**(d)** Next switch on the PASSIVE BASS CONTROL P2 through SW4, turn up P2, and try to mix the two signals, PASSIVE through P2, an ACTIVE through P5, whilst also sweeping the frequency through P6

**(e)** Now, do a mix with the other PASSIVE EQ controls too.

**(f)** Use the same method to familiarize yourself with the **HIGH MID VFB,** using the **P7** FREQ SWEEP and **P8** BOOST, remember to switch on the HIGH MID VFB by pressing **SW10** down **(ON)**. Also, mix **P8** with the **P3** PASSIVE MID control, experiment with the PASSIVE MID SHIFT SWITCH **SW5** plus the TREBLE control **P4.**

Combine ***(c), (d), (e), and (f)*** tests.
**(13)** Combine all tests done **(3), (4), (5) ....** up to now with the **BASS and HIGH MID VFB's** included

## (14) The Single Ended Distortion Stage (SE)

In the SE section **(only)** you do not need to switch off the high voltage (HT) from the unit when you change from triode to pentode **(TRI, PE)** and vice versa because the **TRI/PE** switch SW14 has an **off centre** position that automatically disconnects the SE channel (only) from the high voltage supply.

The channel that is disconnected is **only** the channel (top or bottom) where **SW14 is located**. This switch has **no effect on the other SE channel or the other sections of the unit.**

When operating the TRI/PE1/PE2 **P15** rotary switch you will still have to follow **PROCEDURE (a,b,c,d,e)**

**(a)** Set the PP output stage so that it produces a **neutral sound**: **P15 on TRI, set the SE LEVEL P11 control to maximum (10) in triode mode, but if you change into pentode modes in either SE, PP or both you may have to turn P11 down to keep the output level low OUTPUT P14 around half** (you may have to turn down P14 for more loud SE DU settings later). Please read IMPORTANT NOTE on PREPERATION BEFORE TURNING ON under paragraph (2).

Remember that the **PP DRIVE control P13 does not control the SE DU output, i**t only controls the signal coming out of the EQ MIXER so **initially** set P13 to zero. You can turn up P13 control later if you want to blend (mix) the SE and PP sections.

Therefore, to **isolate the SE STAGE** you can turn the **PP DRIVE** all the way down to zero.

ALSO: **set the BIAS control P12 to 5 for transparent low frequency response, later you can try other settings.**

**(b)** For the first test **remove the BASS and HIGH MID VFB's** from the system by turning switches **SW9 and SW10** up, (i.e., **up**) and set the passive EQ for a flat response:

Bass control **P2** on half, Mid **P3** just over half and Treble control **P4** just below half.
or
**by-pass** the **EQ** by setting **SW12** switch in **OUT.**

**(c)** In the input stage set **SW1** in triode **(TRI)** and P**1** on a **high** setting 7...9, ensure that the ATT switch SW2 is **up** (no Attenuation).

**(d)** In the output stage set **P15** in triode **(TRI)**, **use** procedure **(6) (a,b,c,d,e)**

**(e)** Start with **SW14** in **TRI** mode (if in PE **use** procedure **(6) (a,b,c,d,e))** and **SW15** in **ON LOAD** position

**(f)** Set the **SW16 SE DU (ON OFF/ PFB) SWITCH** in the centre position, to allow the **SE** signal to **enter the mixing stage** in the PP OUTPUT stage, but **without the PFB for now.**

**(g)** Use the SE LEVEL **P11** to adjust the amount of this signal.

Initially keep the SE drive stage low by keeping the **SW13 SE-GAIN** in the low (**L**, on the left) position

*You can use synths, keyboards or drum-loops to sound test the SE DU.*

Gradually turn up the **SE DRIVE** control **P9 and** be ready to reduce the SE signal level entering the PP stage through **P11**. Also, **SE gain switch SW13 in conjunction with P9 enables a finer SE drive adjustment.**

**(h)** You can use **SW14** to try **PENTODE** operation.

**(i)** Use the **LOAD OFF SWITCH SW15**, on Pentode the output level will increase too, so you will have to reduce the SE output through P11. This is an interesting effect in **low SE DRIVE (P9)** settings, when the SE DU is not overdriven but has a high dynamic range combined with a treble boost.

**(j)** At this stage you can experiment with using the SE section to overdrive the PP section in the various different modes (TRI, PE, etc) on both sections. When operating in **OFF LOAD** try to keep the **BIAS** control between **0 and 5**, in most settings there is not much of a change between **5 and 10** in **Off LOAD** mode. The signal can change **substantially in amplitude and shape** between 0 and 5, the amplitude **(strength)** increases a lot when bias P12 is in 0.

In SE **triode** mode you may have to introduce **more gain**, so set the SE gain switch SW 13 in H. In SE **pentode** mode, the signal will be high, **no extra gain is needed.**

**(k)** Repeat the tests above at **different BIAS P12 control settings,** see also **(16)** below.

**(l)** You can try mixing the three P9/P11/12/13 controls especially to experiment with bass sound.

**Always be ready to reduce the output through P14, because the effect of the combined overdrive will be to produce a very high output signal**

**(15)** Now you can investigate how various PASSIVE &ACTIVE EQ settings combine with the different modes of operation of each stage plus the soft, medium, hard drive and gain choices of each stage, including Cascode in the input stage. That means combining all the tests up to now and working out how the INPUT STAGE, EQ's and the DU's, interact with one another. Again, remember to **keep the output level low, and switch off the HT whenever you operate the TRI/PE switches.**

**(16)** *An interesting effect occurs when the signal coming out of the SE DU is varied through the SE LEVEL control P11 while simultaneously varying the SE bias (P12) and the signal coming out of the EQ MIXER using the PP DRIVE control P13, especially on keyboards, synths and bass.*

**(17) The Positive Feedback in the SE DU section:**

Please read **IMPORTANT NOTE** in (2), at the beginning of the previous section

As already explained:

The **PFB** control adjusts the amount of the signal re-entering the SE amp and it must be used carefully. If it is turned **high** enough the SE DU will start **oscillating.**

***The trick is to turn it up until oscillation starts, then back off a bit until it stops.***

When you operate in Pentode, and especially in **PE /OFF LOAD** mode the **PFB** effect becomes more **extreme.**

Also, when you use the Positive Feedback facility in **pentode mode (especially in OFF LOAD)**, the SE stage may **oscillate** at much **lower SE DRIVE P9 and PFB P10** settings than when it is operating in triode mode. Output control P14 must thus be turned down when SW16 is set on PFB for the first time.

**This feature can be very unpredictable, so:**

**(a)** Set SE DRIVE **P9** to 3...4, PFB control **P10** to zero, **SW14** in TRI, LOAD switch **SW15** in ON, **P11** in 5 and keep OUTPUT control **P14** low.

**(b)** Set the BIAS control **P12** in 8.

**(c)** Press the **SE/PFB SW16** switch **down (from the centre position) to enable the PFB to enter the mix.**

(**d**) Turn up the PFB control **P10** gradually and if oscillation starts turn it down until it stops. Remember that **P10 and SE DRIVE control P9 are very interactive**, and you may end up using them together. Make sure that you keep the output **low** through P11 and/or P14

**(e)** Repeat **(d**) in PENTODE mode, note that the output will increase, use P11 and/or P14 to reduce the output and you will have to re-adjust P9 and P10 too.

**(f)** Bring the **VFB's back into the mix by pressing SW9&SW10** switches down, and hear how the whole EQ system interacts with the PFB feature on the SE DU.

**(g)** Repeat **(d), (e) and (f)** but in the OFF LOAD mode but remember the output will increase substantially now, especially in Pentode mode, use **P14 to reduce the output level.**

**(h)** Try **different BIAS P12** control settings especially when you operate in **Pentode OFF LOAD** mode.

**(i) Repeat all of the above by bringing into the mix signal that does not go through the SE DU section by using the PP DRIVE control.**

## ABBREVIATIONS

SW= switch

OD= overdrive, referred to a LED indicator showing when a stage is overdriven

EQ= equalizer or a section of an equalizer

VFB= variable frequency booster

F-BOOSTER = frequency booster

FREQ = frequency

PE= pentode

TRI= triode

LIM= limiter

CASC= cascode, cascaded triode

SCR = screen (terminal of a pentode tube)

COMP = compression

MID= midrange frequencies.

PFB= positive feedback

NFB= negative feedback

HT = High Tension, high voltage power supply line(s) (UK)

B+ = abbreviation for HT in US

ATT= attenuation