Hammond® X-66

Bass Enhancer Unit

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BASS ENHANCER for Hammond X-66.

Forewords – Purpose of this Bass Enhancer unit

The Bass Enhancer unit described hereafter is simply based on a personal taste.
Like most B3 players, I like to get a reinforced bass response either on my left foot from the pedal keyboard as well as on my left hand from the lower manual.

When playing with the combination X-66 Console + TC-1277 cabinet(s), the bass response seems to me somewhat reasonable while not being enthusiastic with TC-1277 overall sound reproduction. It's a matter of personal feeling.
This point was extensively detailled in a previous chapter ' X-66 Restoring '.

The other alternative is to disconnect the TC-1277 and take benefit of the 7-pins socket to drive an external audio mixer followed by a power amplifier and speakers.
That's the recommended configuration providing the best flexibility of sound, again to my opinion.

However, with this configuration, it seems that the bass response was still not adequate to me even after having tried all possible settings offered by today's audio mixers.

I mean that the 'grooving sound' well known on B3's is not present, not only from the pedal keyboard but also on the left hand side of the upper and lower keyboards.
A bit too dry, not enough 'warmth' or let's call it 'velvet' sound.
Again a pure personal opinion found on my X-66, some other players may like it so.

Several experiments were conducted in different areas of the X-66 Console but I have to recognize it unsuccessfully and I came to the conclusion that one extra Bass Channel has to be added to fully control this low-end part of the audio spectrum.

That's exactly the purpose of this additional unit ' X-66 Bass Enhancer '.

General Description.

Bass Enhancer concept.

All X-66 owners know that four channels are available out of the X-66 Console:

- Drawbar ‘ A’ also called Tibia ‘A’
- Drawbar ‘ B ‘ also called Tibia ‘B’
- Tabs also called ‘ Brights ‘
- Reverb

When analyzing Fig. 5-7 of the X-66 Service Manual, it appears that low frequencies signals (bass) are available at several points of the output section and to a certain degree at the 7-pins outlet.

Listening tests and measurements have revealed that only Drawbar ‘A‘ and ‘Tabs‘ are needed since they contain the adequate low frequencies (LF) ingredients.

Reverb channel has been discarded automatically since injecting bass signals on ‘Reverb’ is, again to my personal opinion, a total non-sense specially when spring reverberation devices are used as it is the case with the X-66 Console.

How to proceed ?

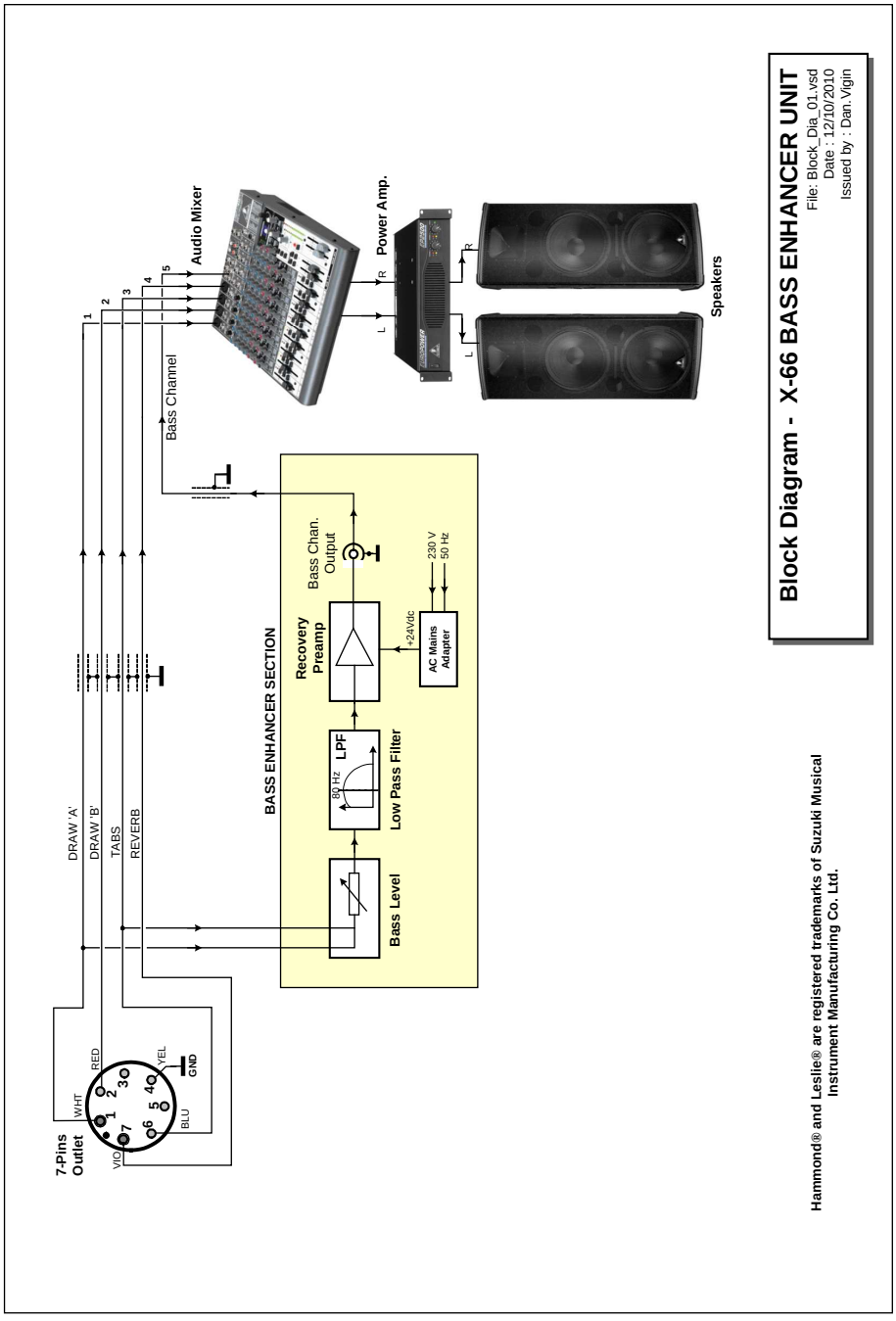
It is evident that the four basic channels ‘A’, ‘B’, ‘Tabs’ and ‘Reverb’ must remain unaltered and be routed to the audio mixer in order to preserve the original X-66 sound. No question about that. It has been always my principle that any addons implemented not only on X-66 Console but also on other Hammond instruments should never affect the original sound reproduction.

Let’s have a look to the Block Diagram on next page.

The four original channels are physically coupled to the audio mixer. No change.
The only trick used is to route the Draw ‘A’ and ‘Tabs’ signals in parallel to drive the Bass Enhancer unit.
This is done via two high value resistors avoiding so any signal drop.

Both Draw ‘A’ and ‘Tabs’ signals are adjusted via a potentiometer to the desired listening level.

To be noted that even after level adjustment, both channels Draw ‘A’ and ‘Tabs’ do still contain the full audio spectrum i.e. low-ends, midranges and high-ends.
In this application, only the low-ends have to be ‘enhanced’ that’s the reason why mid’s and high’s have to be eliminated with the help of a Low Pass Filter.



To achieve this, a second stage, called ‘Low-Pass Filter’ (or LPF for short) is inserted just after the potentiometer. The role of this LPF is to emphasize the low frequencies and to cut down gradually the mid’s and high’s.

In electronic, it exists many types of filters.

For this application a basic two-pole passive RC filter is used for several reasons:

- easy to build, only standard components used
- inexpensive
- provide the adequate expectations in terms of frequencies
- provide a smooth attenuation slope avoiding so undesirable phase shifts, audible beats and the like
- easy to modify to user's discretion if any

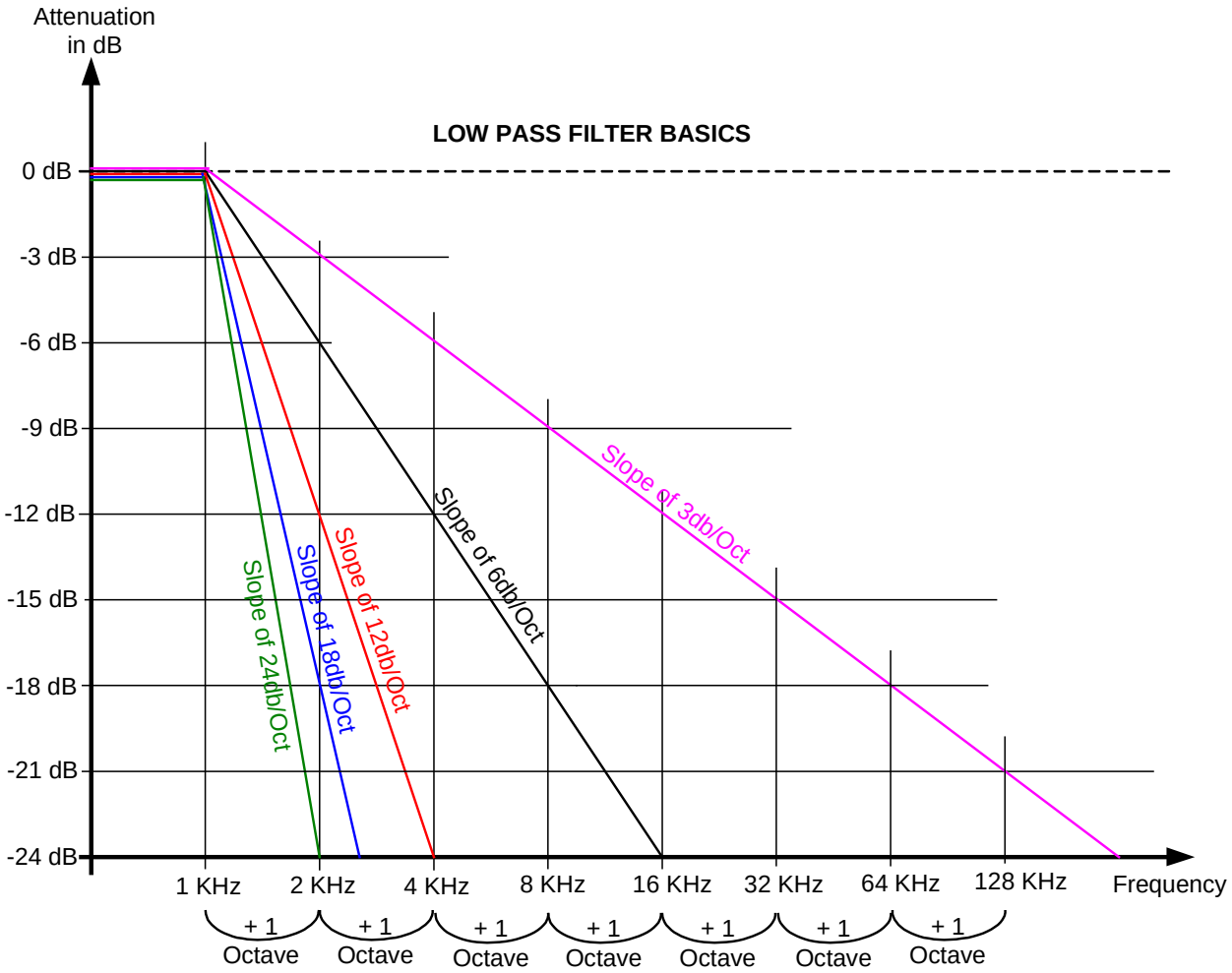
The negative aspect of such passive filters is the signal attenuation at the output.

Inevitably, a so-called recovery preamplifier has to be added after LPF filtering to restore exploitable enough signals to drive the Bass Channel of the audio mixer.

This stage is the only part using an active device i.e. one NPN transistor. That's all.

Basic theory on Low Pass Filter (LPF).

LPF is the heart of the Bass Enhancer unit. It is quite possible to design a filter with a very sharp slope that really cuts undesired frequencies from a defined frequency point. Generally, those slopes are expressed in dB/octave.
In other terms, f.i. if an LPF is calculated with a 6db/oct slope from 1 KHz onwards, this means that upper octave 2 KHz will be attenuated by 6db, the 4KHz by 12 dB, etc… refer to graph hereunder for easier understanding.



As a conclusion a 24dB/Oct filter will cut off very sharply the undesired frequencies while a 3db/Oct filter will attenuate the undesired frequencies in a much smoother way.

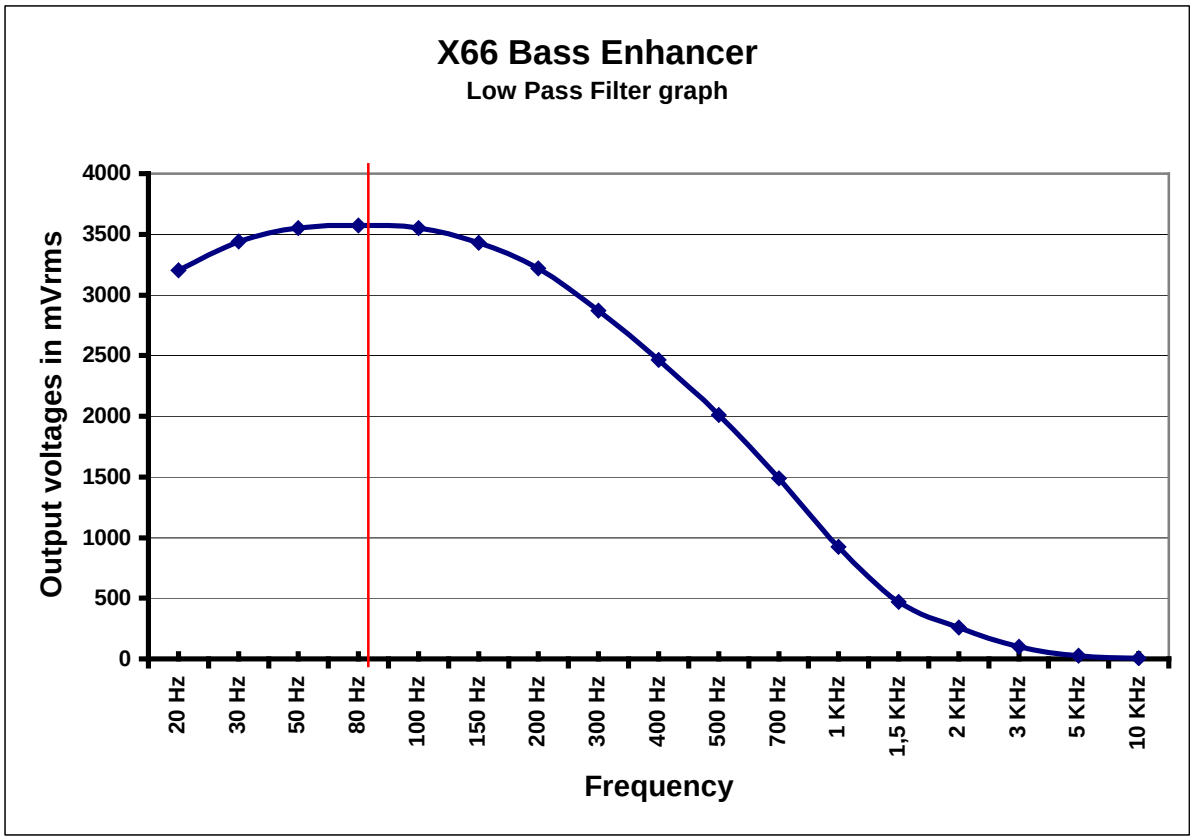
Then, " what does it mean on the keyboard ? " Quite easy to answer, if a 24db/Oct filter would be used, the player would hear the 'E' in the middle of the keyboard, the next 'F' will be still audible and the 'G' and 'A' will simply disappear.

In this application, we are expecting a very smooth increase of amplitude starting somewhere in the middle of the keyboards up to the left end side of the keyboard. Whether it's the pedal keyboard or Upper or Lower manuals. To achieve this and in order to provide the adequate feeling to the player, a slow slope filter in the range of 3db/Oct has been selected.

Low Pass Filter (LPF) used in Bass Enhancer.

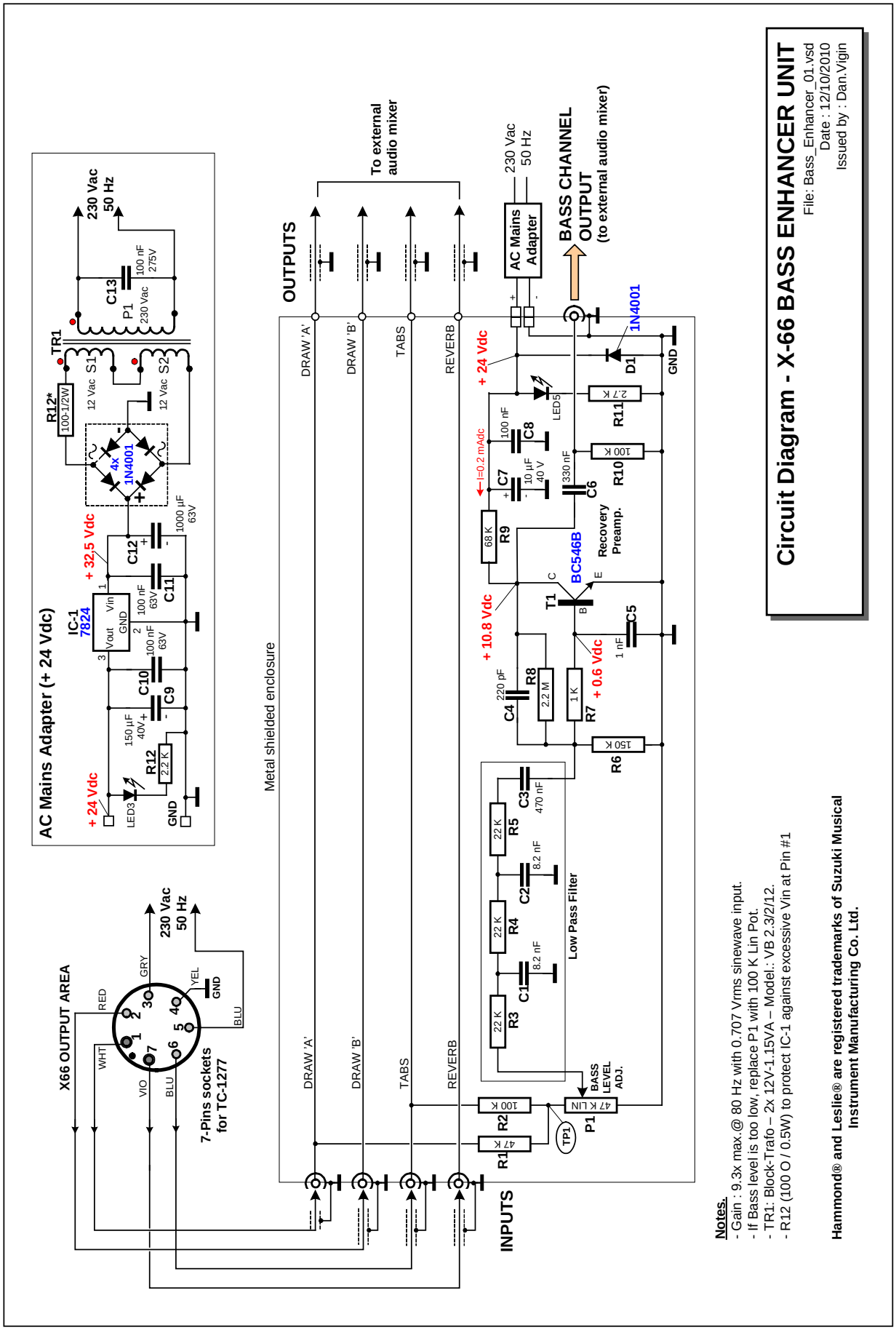
In practice, a cascaded LPF RC filter is used. This special LPF has been initially designed by computer via a software simulator (CAD) avoiding so extensive calculations. Results issued by software simulator were realized later on a prototype sample and beside some minor modifications (mostly values of components), listening tests were quite encouraging on the X66 Console and left as such.

Hereunder is the LPF curve measured on the Bass Enhancer unit. The center frequency (Fc) has been centered on purpose around 80 Hz (Ref. 0dB - red line).
Frequencies below 80 Hz are slightly decreasing , not perceptible by ear.
Frequencies above 80 Hz are also smoothly decreasing with the frequencies avoiding so major variations of amplitude during play as already explained.



In the graph, output values are expressed in mVrms but they can be easily translate into ‘dB’ if needed.

For those who really like to inject REVERB through this bass filter, connect one 100K resistor (1/4 W) between the Reverb line and TP1.
Refer to schematic diagram on next page.


Circuit Diagram - X-66 BASS ENHANCER UNIT
File: Bass_Enhancer_01.vsd
Date : 12/10/2010
Issued by : Dan.Vigin
AC Mains Adapter (+ 24 Vdc)
230 Vac 50 Hz
TR1
P1
C13 100 nF 275V
R12* 100-1/2W
12 Vac S1
12 Vac S2
4x 1N4001
+ 32,5 Vdc
C12 1000 µF 63V
C11 100 nF 63V
IC-1 7824
Vin Vout GND
C10 100 nF 63V
C9
150 µF 40V
R12 2.2 K
LED3
+ 24 Vdc
GND
OUTPUTS
To external audio mixer
DRAW 'A'
DRAW 'B'
TABS
REVERB
Metal shielded enclosure
AC Mains Adapter
230 Vac 50 Hz
BASS CHANNEL OUTPUT (to external audio mixer)
+ 24 Vdc
LED5
R11 2.7 K
D1 1N4001
GND
C8 100 nF
C7 10 µF 40 V
I=0.2 mAdc
C6 330 nF
R10 100 K
R9 68 K
+ 10.8 Vdc
T1 BC546B
Recovery Preamp.
C4 220 pF
R8 2.2 M
R7 1 K
+ 0.6 Vdc
C5 1 nF
R6 150 K
C3 470 nF
R5 22 K
C2 8.2 nF
R4 22 K
C1 8.2 nF
R3 22 K
Low Pass Filter
R2 100 K
R1 47 K
TP1
P1 47 K LIN
BASS LEVEL ADJ.
INPUTS
X66 OUTPUT AREA
RED
WHT
VIO
BLU
GRY
YEL
GND
BLU
7-Pins sockets for TC-1277
230 Vac 50 Hz
Notes.
- Gain : 9.3x max.@ 80 Hz with 0.707 Vrms sinewave input.
- If Bass level is too low, replace P1 with 100 K Lin Pot.
- TR1: Block-Trafo – 2x 12V-1.15VA – Model.: VB 2.3/2/12.
- R12 (100 O / 0.5W) to protect IC-1 against excessive Vin at Pin #1
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Recovery Preamp.

Like all passive RC-Filters, the incoming signals are somewhat attenuated during filtering and need to be levelled up in order to be connected later on to the audio mixer.

This is called ‘Recovery Preamp’ in electronic jargon. To achieve this, only one amplification stage composed of one single transistor is needed.
The max. gain of this preamp stands around 9x.

There is no so much to tell about this preamp stage except that it is built with discrete standard components and provides quite good performances as such.

Powering the Bass Enhancer – External Power Supply Unit (PSU).

Since the function of this Bass Enhancer is to emphasize ‘by definition’ the bass response, it is not recommended to include the power supply in the same enclosure.

As a matter of act, conventional power transfromer, rectifier bridge, wiring carrying AC Mains, filter caps are generating undesirable magnetic leaks, spikes of diodes, ground currents and the like that may be easliy picked up by the LPF and recovery preamp and produce noisy 50 Hz hum with its harmonics, 100 Hz, 150 Hz, etc…

Surely, unless you have a well-shielded switching power supply available on hand, the integration of a conventional PSU in the same enclosure is not a good idea.

Due to extreme low current consumption of this Bass Enhancer circuit, it was easy to rebuild a conventional PSU inside an AC Mains adapter. This PSU has to supply + 24 Vdc to the circuit. Refer to the schematic diagram for details.

Based on past experience, no fuse protection were foreseen because the DC resistance of the windings of those small power transformers will limit damages by itself.
As a protection against misuse, only one diode D1 is installed in inverse polarity on the Bass Enhancer PCB.
LED3 and LED5 will indicate the presence of + 24 Vdc at both ends.

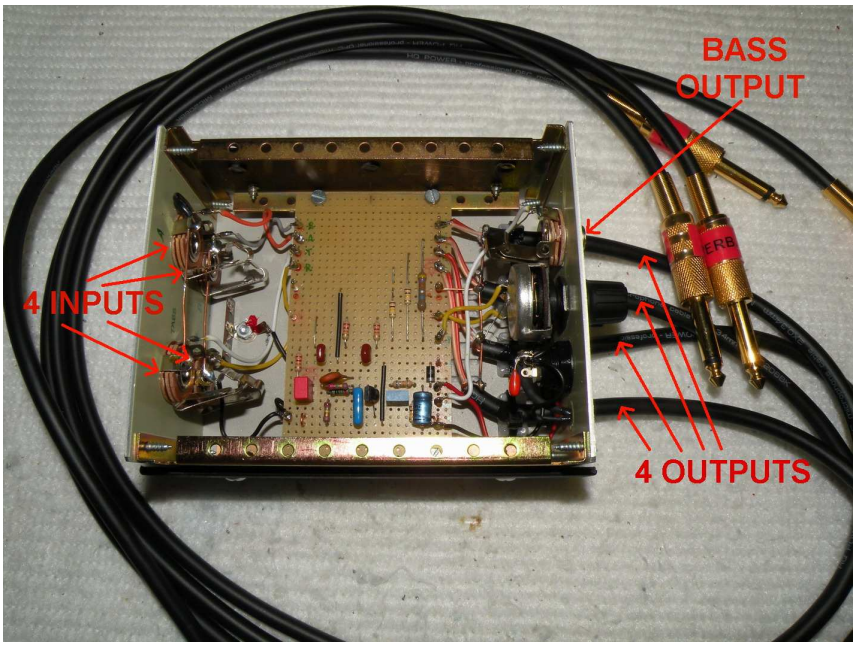
To be noted that one 100Ω / 0.5W resitor is inserted in series with the secondary winding of TR1 in order to maintain Vin at Pin#1 of IC-1 below 37 Vdc to comply with 7824 specs.

Realization

1. Bass Enhancer unit.

Quite simple. A standard metal shielded enclosure of 130 mm X 100 mm X 60 mm is used to accommodate all components. See picture herebelow.

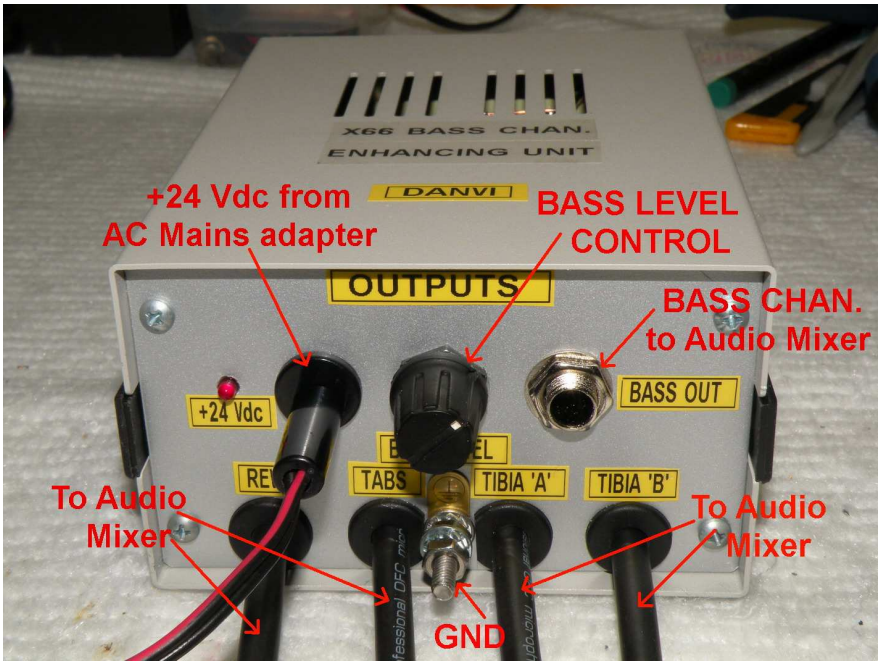
Top view:



Left: - four 6.3 mm sockets will accommodate the four channels from the 7-Pins outlet of the X-66 Console.

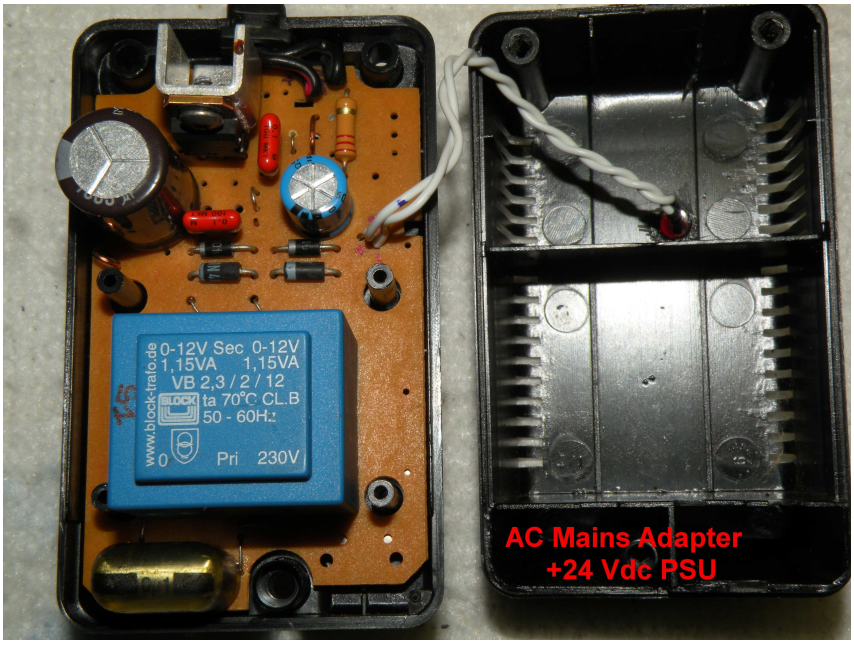
Center: - one stripboard (with continuous copper strips) has been used to install the electronic components.

Right: - four captive output cables to the audio mixer, one output 6.3 mm socket for the Bass Channel cable, one 47 K Lin potentiometer for Bass Level adjustment, one socket to accommodate +24Vdc from AC Mains adapter. Chassis ground is also foreseen while not used.



2. AC Mains adapter (+24 Vdc PSU).

The PSU was modified and rewired from an existing AC Mains adapter. The previous components were removed and PCB has been rewired accordingly.



As ‘ON’ indicator, one LED is installed on the cover. See Schematic diagram for details.

Conclusions.

After having conducted listening tests with and without this Bass Enhancer unit, I have to recognize that it emphasizes and highlights positively the bass response of the Hammond X-66.

This Bass Enhancer unit adds more presence to the whole system, more ‘warmth and velvet’ in the low-end part of the audio spectrum which was, to my opinion, rather weak and dry as such (unless the ‘booming’ TC-1277 is connected).
At least, it’s my personal feeling noticed on my X-66 Console.

It is also supposed that a professional grade audio mixing table followed by adequate power amplifier and speakers are available behind this Bass Enhancer.

Needless to say that ‘left-hand bass players’ will appreciate the additional performances procured by this Bass Enhancer unit.
Evidently, I’m mostly referring to Hammond B3’s jazz players who like ‘groovy sound’.

The settings of this fifth bass channel connected to the audio mixer is not so easy and require extensive trials and careful attention if one wants to achieve the correct balance.

As already mentioned, the addition of this Bass Enhancer does not affect at all the original Hammond X-66 sound which can be restored back at any time even during play by simply depressing the MUTE button of the mixing table but, frankly spoken, once you get accustomed with it you will leave probably always ON.

All the best,

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