# SM2010 “Marco” *

# Line preamplifier

## with tone controls

* A friend of mine

A. E. Rinaldo 2011

Line preamplifier SM 2010

**PRE MARCO 2010 Controlli di tono ??? decisamente si!!**

**Preamplificatore linea descrizione del circuito**

Il mio progetto è ispirato dal famoso PST 200 di Bartolomeo Aloia degli anni ’80. Un circuito ancora attuale e all’avanguardia dal punto di vista delle prestazioni.
Il circuito impiega, in cascata, due stadi di amplificazione in configurazione “Totem Pole” . Tale configurazione è stata descritta in molteplici riviste e articoli tecnici nel passato per cui non ne riproporrò la spiegazione. Comunque, chi non fosse familiare con detta circuitazione potrà trovare una ampia illustrazione in un mio libro “**Valvole e Dintorni HI-FI**” *–L’alta fedeltà tra le mura domestiche*- edito da **Sanditlibri.**

Ogni stadio guadagna circa 20 db (10 volte in tensione) mentre il circuito del controllo del tono posto tra i due, attenua il segnale di altrettanti db alla frequenza di 1000 Hz che vengono ripristinati dallo stadio che segue. Il guadagno complessivo è quindi di 20 decibel che è un valore più che sufficiente per un amplificatore linea. Il circuito completo è riportato nella **fig. 1**.
Il segnale, allo stadio di ingresso (V1), è fornito attraverso un selettore di ingressi commerciale a 5 relays. Relays che possono essere attuati manualmente o tramite un telecomando. L’insieme, del tipo GA5 è fornito, completo, da “Audioselection” e include il dispositivo per il telecomando e un potenziometro motorizzato per il volume. (**foto 1**).
Dall’ingresso, attraverso i connettori di tipo RCA, ogni segnale viene applicato ai potenziometri semifissi con lo scopo di calibrare il loro livello per garantire una uscita dal pre, equilibrata quando si passa da una sorgente all’altra. Questa opzione può essere omessa se l’hobbista non ha interesse a questa soluzione.
L’uscita dal primo stadio alimenta il circuito di controllo dei toni quando il relay RY1 è attivato tramite l’interruttore SW1 posto sul pannello frontale. Viceversa il segnale prelevato dal cursore di P6 “bypassa” i toni ed entra direttamente nello stadio di uscita. V3/V4. L’accorgimento del partitore e la regolazione di P6 assicura che, durante la commutazione di SW1, non ci siano salti di livello in uscita con i controlli di tono in posizione “*flat*” –nessuna esaltazione ne attenuazione-

**L’alimentazione**
I circuiti ad alta fedeltà necessitano di una alimentazione anodica e dei filamenti “curata” Io ho scelto di stabilizzare l’anodica con un semplice regolatore a Mos-Fet , di tenere l’alimentazione dei due canali separata e di alimentare i filamenti con una tensione stabilizzata continua di 12 volts.
I filamenti sono collegati in serie e la tensione è fornita tramite gli alimentatori costituiti dai 2 integrati del tipo L7812.
La scelta di separare l’alimentazione dei filamenti è dettata dal fatto che le valvole “alte” (V2 e V4) hanno il catodo ad un potenziale continuo di circa 130 volts di gran lunga oltre il limite Vkf consentito dalle specifiche delle valvole E88CC. (tensione massima permessa tra filamento e catodo).
Questa soluzione permette di polarizzare i filamenti delle valvole superiori con una tensione di 130 volt prelevandola da un partitore di tensione sull’alimentatore principale e quindi di riportare la differenza di potenziale, altrimenti esistente, entro i limiti di specifica.
Altre soluzioni, quali quelle di lasciare i filamenti “floating” -sospesi- ha delle controindicazioni per il rischio di effetti imprevedibili e non quantificabili.
Lo schema completato da un alimentatore di servizio, atto a fornire le tensioni per i led’s, i relays etc, e visibile nella **fig. 2** ed è semplice da comprendere.

**Il cablaggio e l’assiematura finale**
La **foto 2** mostra la vista superiore del preamplificatore. Sulla sinistra è visibile la sezione alimentazione e la posizione del trasformatore di alimentazione piuttosto lontana dagli ingressi dei segnali. Questo accorgimento garantisce l’assenza (o minimizza il rischio) di rumori captati accidentalmente dal campo magnetico spurio del trasformatore stesso.
Le uscite dai vari alimentatori fanno capo ad un connettore che all’occorrenza può essere scollegato per manutenzione o altro e facilitare la rimozione di componenti o assiemi.
Gli alimentatori sono stati realizzati su circuiti stampati eseguiti manualmente e visibili in **fig. 3** e **fig. 4**

Alla prova di ascolto il preamplificatore non esibisce alcuna peculiarità, è pulito, fedele, limpido, senza colorazioni …. e in più per chi lo desidera dispone di buoni controlli di tono

**PRE MARCO SM 2010** **Tone controls? Definitely yes!**

**Circuit description**

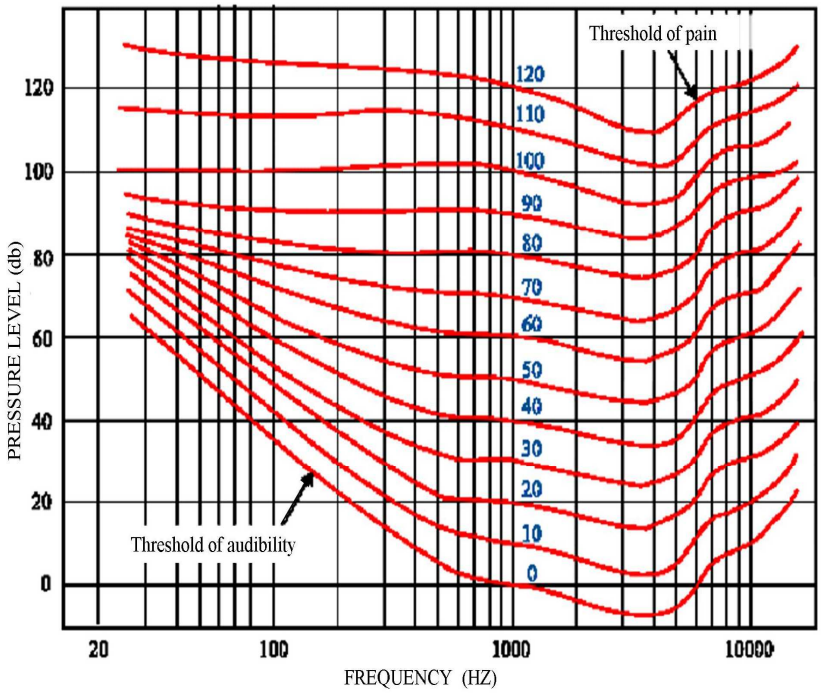
High end class preamplifiers neglect the use of tones control. Reason: they introduce distortion to the system end therefore they must be eliminated. True! Tone includes some sort of distortion but ... what happen when you lower the volume? What happen when your room response is far from ideal? What amount of distortion do they introduce? Can it be really heard?

It is widely known how our hears respond to sound level at different frequencies. Fletcher and Munson, back in the thirties (and more recently Robertson & Dadson in the fifties) have established how variations in the perceived loudness of sounds changes with sound frequency. They depicted the curves shown in fig 1 below.

If you hear an orchestra live, its sound amplitude may easily reach 80 – 90db, or even more. If, with your reproduction set, you desire to have same sensation of the original sound you should therefore push the volume to reproduce that particular level. However your lovely wife, your neighbor or even the acoustics limit of your room may force you to lower the volume to, say 60- 70 db.

As you do that, the perception of lower frequencies, with reference to 1kHz, changes significantly.

For example, with reference to a frequency of 1kHz, at 80/90 db of sound pressure level, the sensation is about the same for all frequencies. As you lower the volume, (say at 60 db), in order to maintain same dynamic, a frequency of 100 Hz must be compensated by at least 15 db




The perception of the lower frequency spectrum in fact, has completely changed. This is where tone controls come into the picture by providing a means of compensation.

An additional example could be that your room carpeting, curtains, or library may absorb excessively the highest frequencies and therefore you need to boost that particular range of the audio spectrum to rebalance your perception. Vice versa, an empty room may produces excessive bass or high frequencies and therefore a means of cutting them must be provided.

It must be clear that the amount of boost or cut of both high or low frequency span is absolutely arbitrary and it must be applied to fulfill your hearing pleasure and nothing else.

It is said : tone controls introduce distortion.

The level of this distortion is hardly heard; certainly it is by far less than the distortion caused by your room acoustics, by the change in the frequencies perception as you lower the volume and by other factors.

The circuit to include them may be design in such a way that tones control can be completely bypassed; in this way it is your choice to include them.

**The line amplifier schematic**

My design resembles the line stage of famous (almost 30 years old now) PST 200 of B. Aloia, an Italian HI-FI authority in this field; the circuit makes use of two totem pole in a cascade configuration. The complete circuit is shown in **fig.1.**

Totem pole has been thoroughly described in this magazine several time and therefore I'm not going to address it again. Each stage gains about 20 db while the tone controls, inserted between the two stages, introduces a loss of the same amount when positioned to zero boost/cut. The end results is a total gain of 20

db which is quite good for a line preamplifier.

The input stage is fed from a commercially available inputs selector assembly actuated by means of 5 relays. The switching operation can be performed manually or it can be remotely controlled. This assembly, is an OEM part - model GA5- supplied and fully tested by *Audioselection* and includes also a motorized volume control feature. (**photo 1**)
The signal level of each input can be adjusted with the 5 dual ganged potentiometers (P1 through P5 of fig. 3) in order to level out various input signals and balance the preamplifier output level.
This option can be omitted if DIYer's elect to allow the output levels to track each input source level. (the higher the input the higher the output and viceversa).

The output of the first stage (V1 and V2) feeds the tone control circuit and, in turn, the second totem pole output stage, when relay RY1 is energized by SW1 (tone controls on). The output stage (V3 and V4) restores the loss of tone controls circuit and provide a low impedance output through volume control P7.
When tone controls SW1 is off (RY1 not energized) they are totally bypassed and the audio signal is taken

from cursor of P6.
P6 needs to be adjusted once, to equal the level of tone controls when in a *flat* position.
V3/V4 act as buffer with its 20 db gain and assure a low output impedance connection to volume control and, from there, to the power amplifier.

**Power supply**
High End/high quality circuits requires a lot of attention on how voltages are supplied. My choice was to keep right and left channels plate voltage separated and to provide a certain level of regulation.
Totem pole is fed with 260 Vcc (130Vcc drop on each valve). Regulation is achieved by a series of zeners diodes and a suitable MOS-FET transistor.
The circuit is shown in **fig. 2** and fairly simple to comprehend.

Totem pole has the cathode of upper valve tied to a potential of about 130 Vcc. This exceeds the Vkf limit (voltage between cathode and filament) specified for the E88CC/6DJ6 when one side of the filament is connected to ground. To overcome this problem, upper filament must be properly biased to off set this potential difference. To prevent this I've seen circuits, using a solution with a floating filaments; this is not a good practice and I'm not recommending it; if done, there may be unpredictable and unexpected negative side effects.
In addition, filaments, when heated by an a.c. current, may introduce some level of hum that is absolutely unacceptable on an High End class preamplifier.

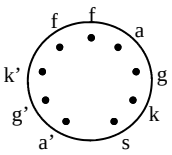
To resolve both problems I've elected to feed heaters in series with 12,6 Vcc using a simple three lead regulators, IC1 – IC2, type L7812 and, in addition, to provide a 130 Vcc bias to the upper filament by taking it from a power supply voltage partition.
Lastly, a small service circuit, supplies 12 Vac required by the input selector switch circuit and 12 Vcc for RY1 on the tone controls and all LED diodes.

**Assembly operation**
**Photo 2** shows a top view of the preamplifier. To the left, the power supplies section with the transformer positioned far away from all inputs to minimize adverse effect of stray field. All output voltages are terminated on a pluggable terminal board to facilitate assembly or removal of any parts.
Power supplies are assembled on a hand made printed circuit as shown on **photo 3 and 4**.

**How does it sound**
Clean, neutral, no coloration at all, extreme bandwidth…… and in addition it has, for those who want them, the tone controls.

Note: Right channel uses other half of tube's pins (6, 7, 8)
Screen (pin 9) must be connected to signal gnd

# Line preamplifier SM2010 Left channel




E88CC
pin side

**fig 1**

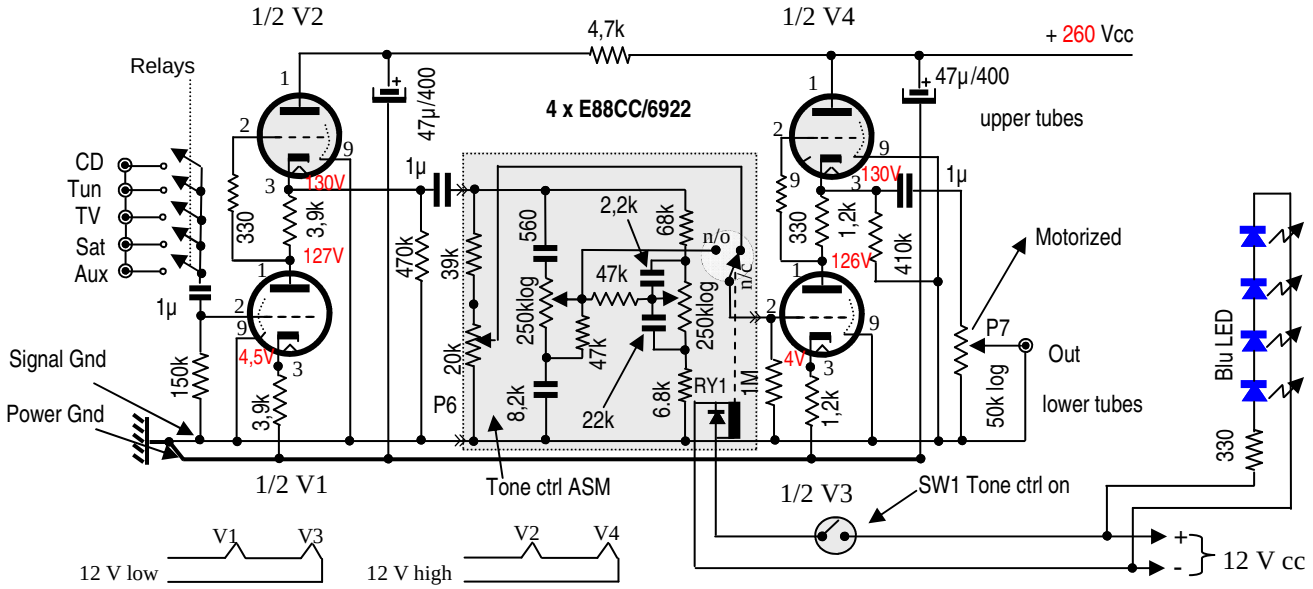
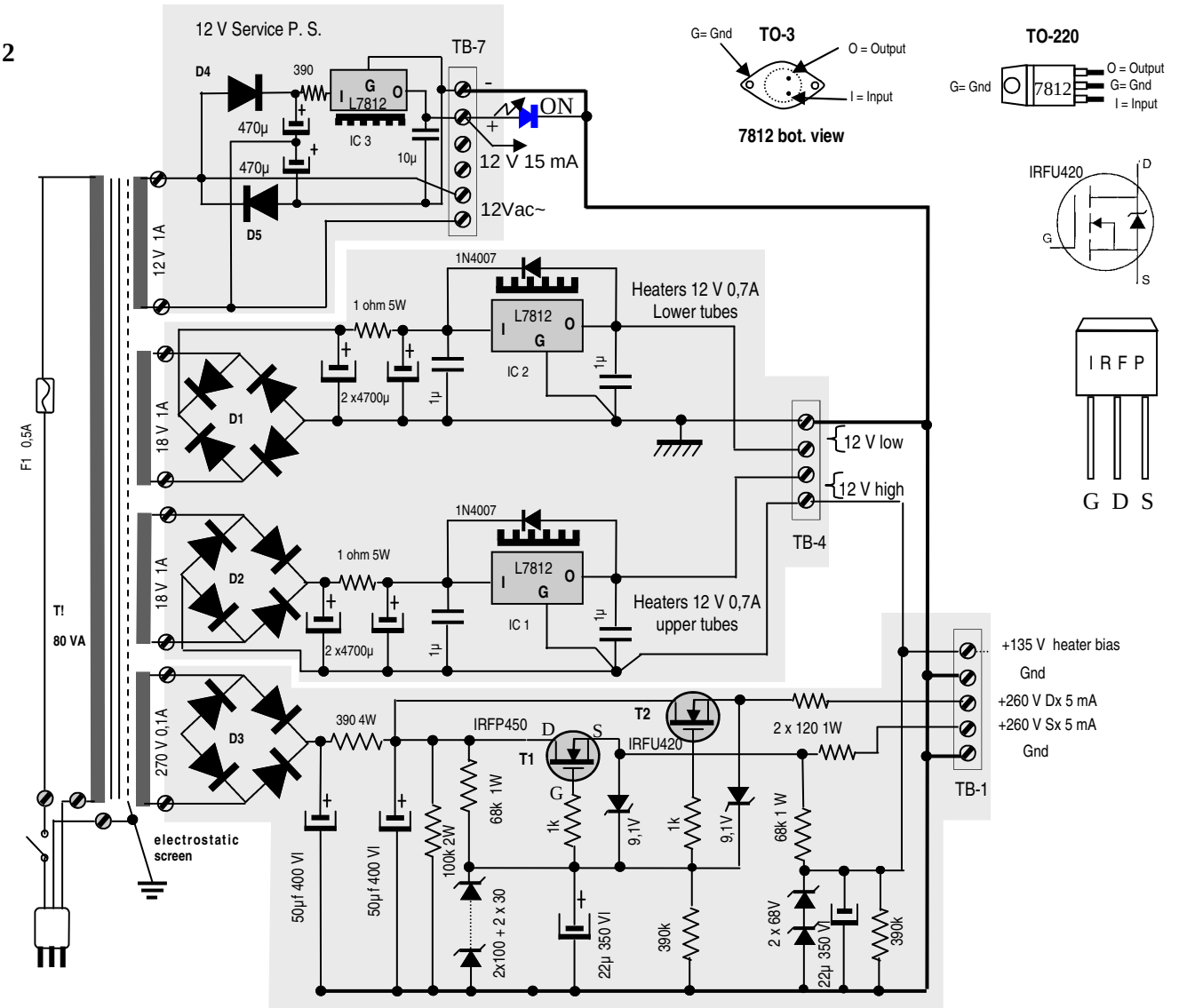



**fig 2**




TB position

Regulated Power supplies

**Bill of Material**

Preamp section

| | | | |
|---|---|---|---|
| Resistors | 150K | 2 | 1/2 W |
| | 330 Ω | 4 | 1/2 W |
| | 3,9K | 4 | 1/2 W |
| | 470K | 2 | 1/2 W |
| | 39K | 2 | |
| | 3,3K | 2 | |
| | 47K | 4 | Tones 1/4W |
| | 68K | 2 | |
| | 6,8K | 2 | |
| Poti Tones | 250+250K | 2 | Log |
| Resistors | 1M | 2 | 1/2 W |
| | 1,2K | 4 | 1/2 W |
| | 4,7K | 2 | 1/2 W |
| | 390K | 2 | 1/2 W |
| Poti Vol. | 100+100K | 1 | Log (see text) |
| Tubes | E88CC | 4 | (6DJ8) |
| Capacitors | 400 V | | Axial |
| Elettrol. | 47µf | 4 | |
| Poliprop. | 1µ | 4 | |
| Poliprop. | 560 p | 2 | |
| Poliprop. | 8,2kpf | 2 | Toni |
| Poliprop. | 2,2kpf | 2 | |
| Poliprop. | 22kpf | 2 | |

Miscellanea

| | | | |
|---|---|---|---|
| RCA in/out plug | | 14 | golden choice |
| socket | Noval | 4 | ceramic |
| Trimmer | 100+100K | 5 | Log |
| Remote ctrl | Asm | 1 | see text |
| Relay | 2ways | 1 | 12V |

**Bill of Material**

Power regulators section

| | | | |
|---|---|---|---|
| Trasformer T1 | 80VA toroidal | | 1 |
| diode bridge | 1000V 1,5A | W10M | 1 |
| " | 100V 5A | SABV10A | 2 |
| Diode | 1N4007 1000V 1A | | 2 |
| Regulators IC | L7812 -TO3- | | 2 |
| Transistor Mosfet | IRFP 450/IRF830 | | 2 |
| Zener diodes | 68V1W 1N5369 | | 6 |
| | 9,1V BZV85C | | 2 |

Resistors

| | | | |
|---|---|---|---|
| | 1Ω | 5 W | 2 |
| | 1,2k | 4 W | 1 |
| | 100k | 1/2 W | 1 |
| | 47K | 2 W | 1 |
| | 68k | 2 W | 1 |
| | 1k | 1/2 W | 2 |
| | 120 | 1 W | 2 |

| | | | |
|---|---|---|---|
| Capacitors | Radial | | |
| Electrolitic | 4700µf | 350V | 2 |
| Polipropilene | 1µf | 100V | 4 |
| Paper oil* | 50µf | 350VL ac | 2 |

* Alternative electrolitic 450 V

**Transformer specifications**

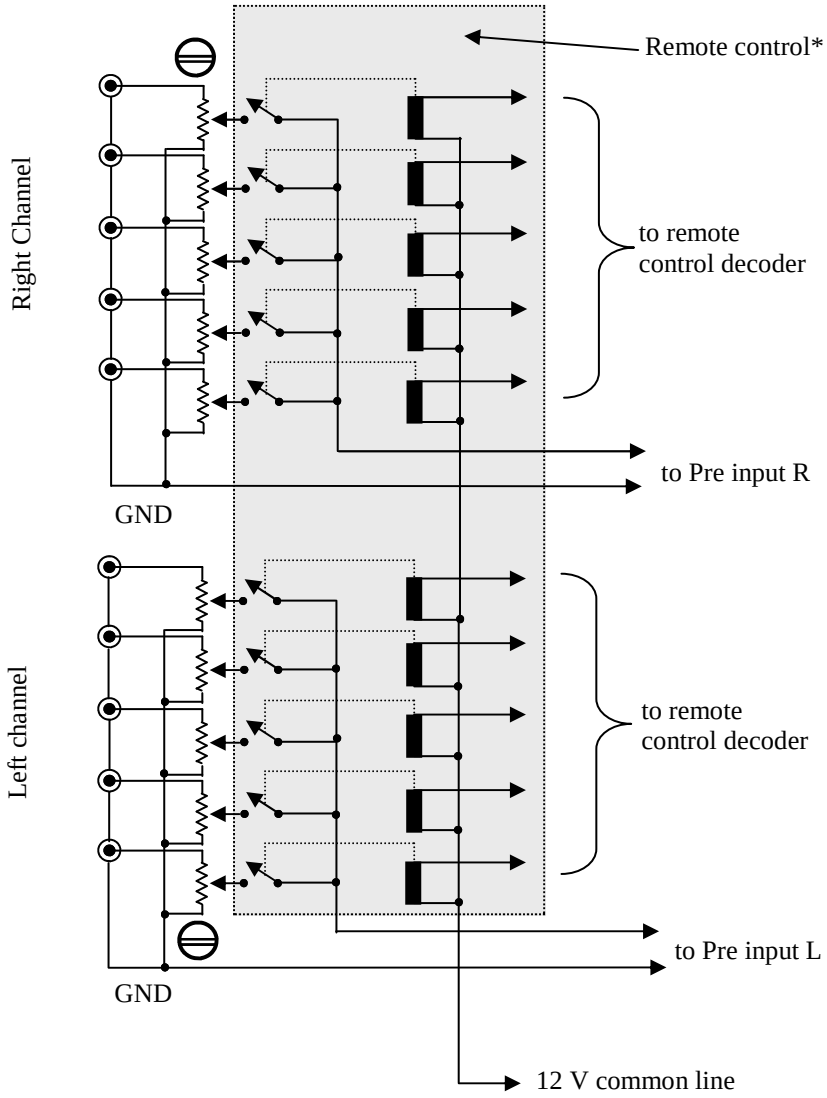
| | | |
|---|---|---|
| Power | 80 V | audio grade |
| Primary | 120/230 | Vac |
| Secondary: | 18V | 1 Amp. |
| | 18V | 1 Amp. |
| | 270V | 0,1 Amp. |

- Heaters winding insulation < 500V
- Electrostatic screen between primary and secondary windings
- Minimum output wires length 15 cm.

**Symbol Parameter Value Uni t of IFRP450**

VDS Drain-source Voltage (VGS = 0) 500 V
VDGR Drain- gate Voltage (RGS = 20 kW) 500 V
VGS Gate-source Voltage ± 20 V
ID Drain Current (continuous) at Tc = 25 oC 14 A
ID Drain Current (continuous) at Tc = 100 oC 8.7 A
IDM(•) Drain Current (pulsed) 56 A
Ptot Total Dissipation at Tc = 25 oC 190 W
Derating Factor 1.5 W/oC
dv/dt(1) Peak Diode Recovery voltage slope 3.5 V/ns
Tstg Storage Temperature -65 to 150 oC
Tj Max. Operating Junction Temperature 150 oC
(•) Pulse width limited by safe operating area (1) ISD 314 A, di/dt 3 130 A/ms, VDD 3 V(BR)DSS, Tj 3 TJMAX

Inputs selector and level control




NOTE:

All trimmers are 100 kOhm HQ logaritmic type, dual gang, 100+ 100 KΩ (they may be omitted if inputs level regulation is not required)

Adjustements are made to get equal output level from all the sources.
Start with lower input signal first.

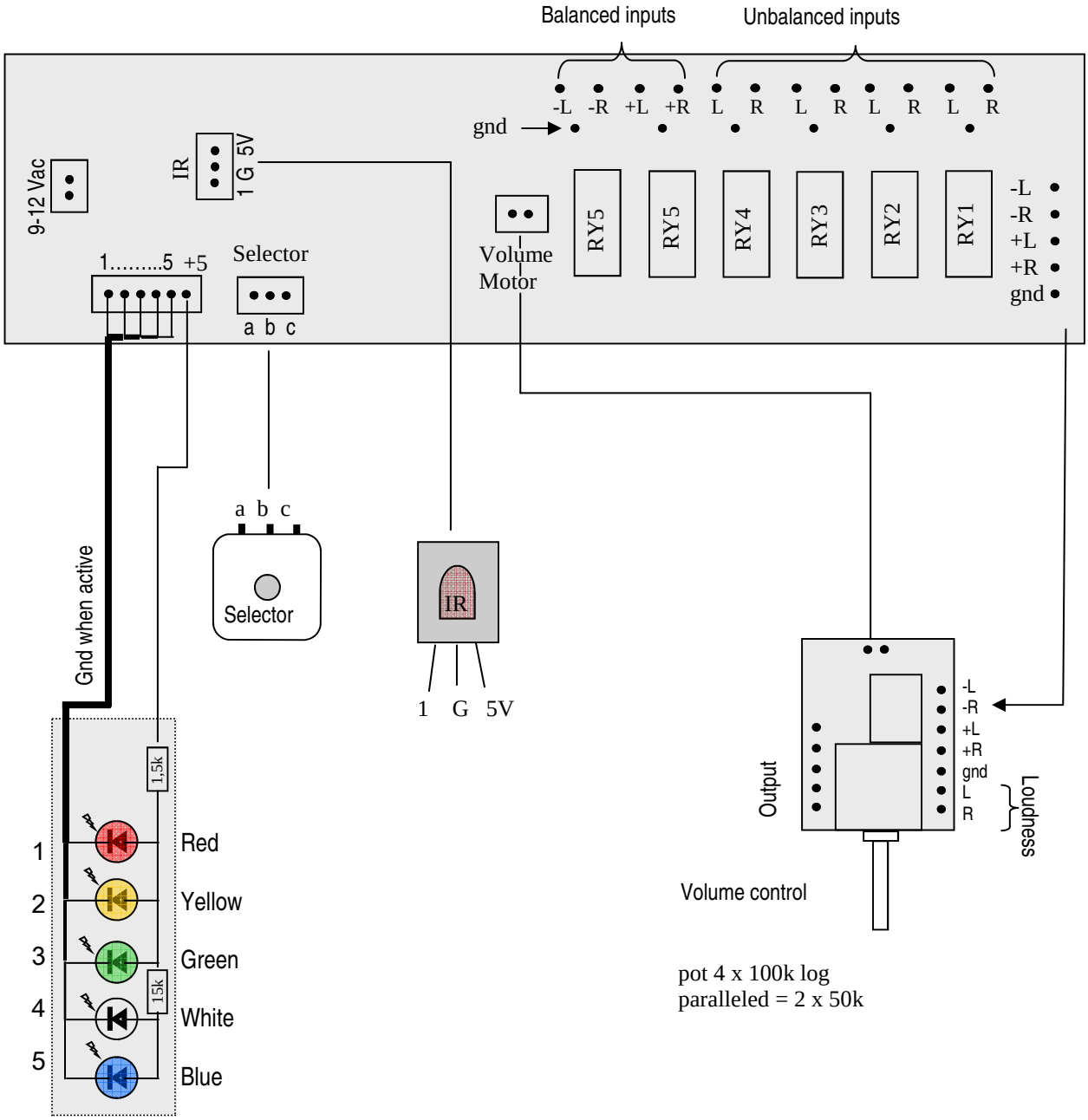
* Selectors shown are remotely controlled and actuated though a series of relays
Doyer's may elect to switch inputs manually by means of a 5 positions, 2 way rotare sw.

Note:
Balanced inputs not used.
Unbalanced inputs exits on +L or +R

Ingressi bilanciati non usati
Ingressi sbilanciati su pins +L, *R

Audioselection.it

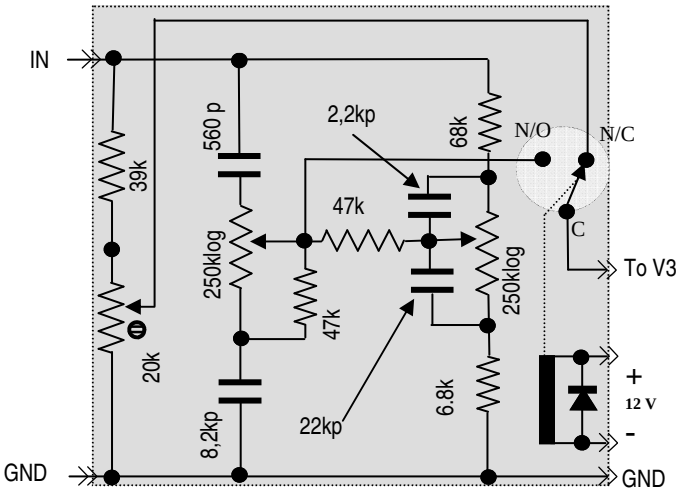
Input selector type GA5




pot 4 x 100k log
paralleled = 2 x 50k

Remote control connections

Fig Tone control schematic



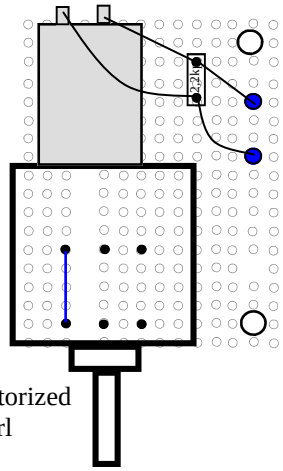
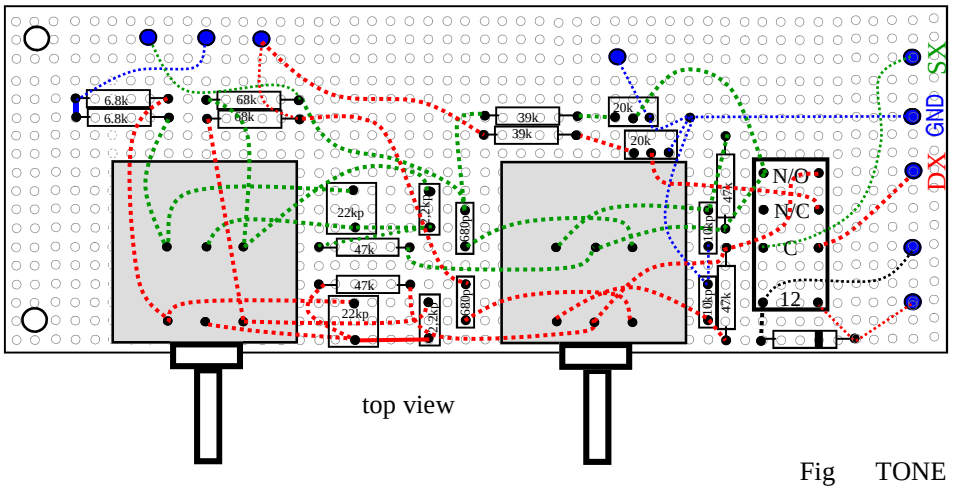




Fig Motorized Volume ctrl

IN

SX GND DX



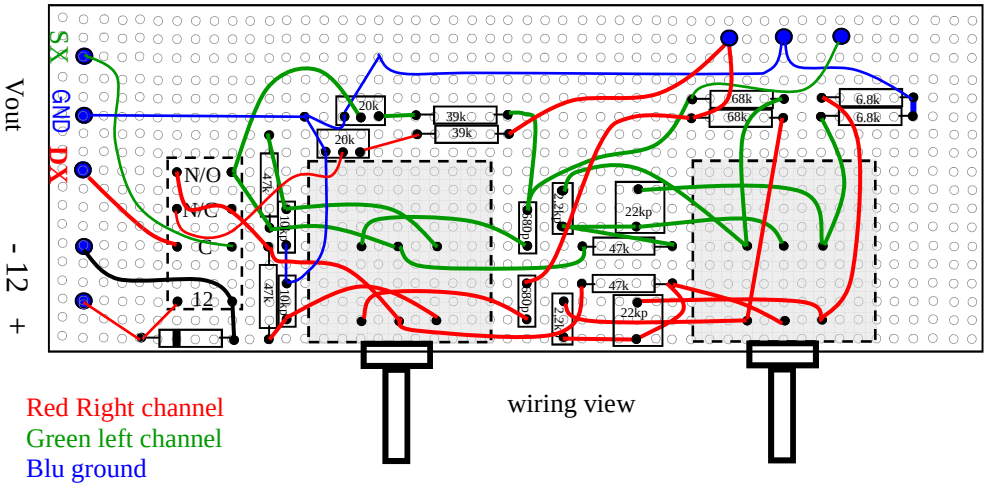

top view

BASS TREBLE

Fig TONE BOARD

IN

DX GND SX

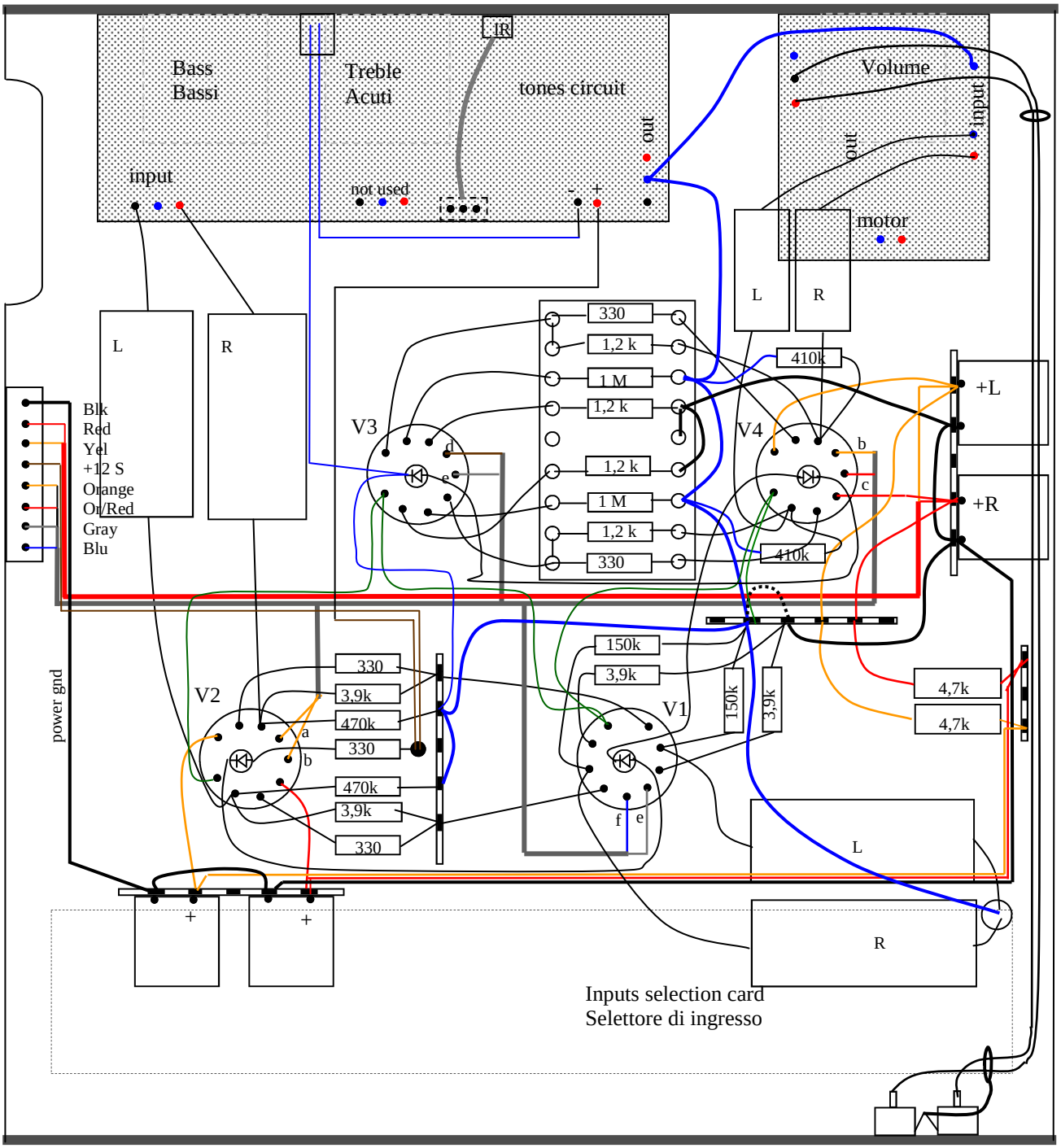



wiring view

Red Right channel
Green left channel
Blu ground

TREBLE BASS

Wiring scheme
Schema collegamenti




BOTTOM VIEW
Visto lato filatura

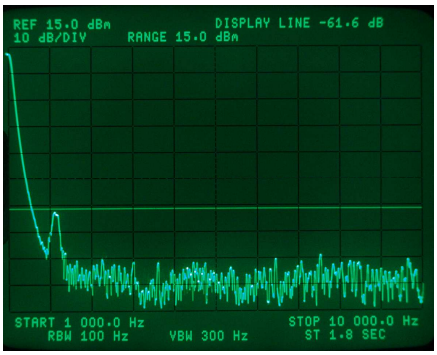
Pre -SM 2010

Cablatura/Cabling

# Performance measurements

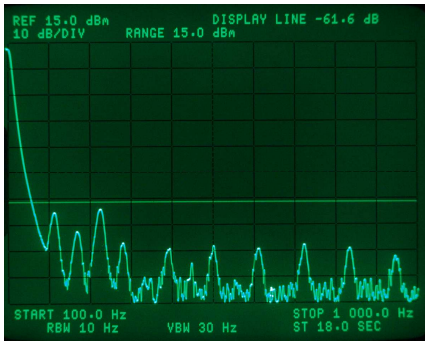
| | |
|---|---|
| Gain | 21 db |
| N. of inputs | 5 (Remotely controlled) |
| inputs voltage | 100 mV(1,1 V output) |
| Overload | 5 V |
| Bass boost | + 16 db @ 100 Hz |
| Bass cut | - 15 db @ 100 Hz |
| Treble boost | + 20 db @ 10 kHz |
| Treble cut | - 20 db @ 10 kHz |

| | |
|---|---|
| Freq. response | 10 - 40kHz ±1 db (- 3db 80kHz) |
| Distortion -TDH- | below 0.02% 20 - 40kHz (@ 1V output) |
| Anode voltage | 260 Vcc 5 mA max per channel |
| filament voltage | 12 Vcc0,7 A (two E88CC in serie) x 2 |
| Service voltage | 12 Vcc15 mA |
| Input power | 220 Vac 70VA |
| Inputs selection | via rotary sw and/or remote control |

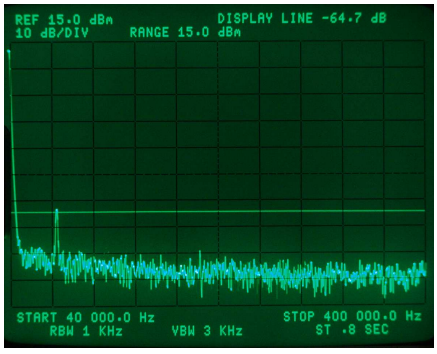



top/sopra
1 k Hz - 61 db 2° harmonic
- 80 db 5° harmonic

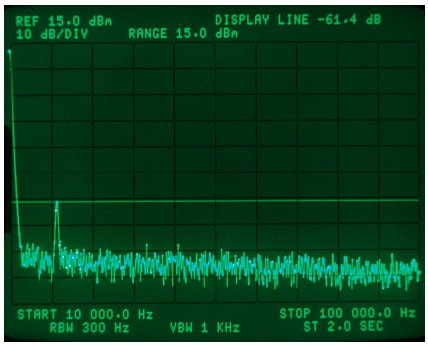
Distortion measurements
HP 3585A Spectrum analyser



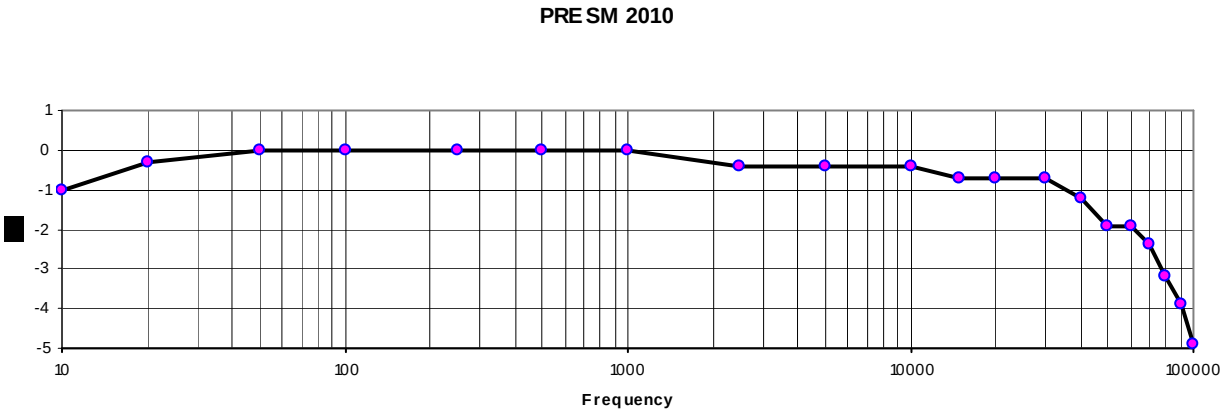

Top/sopra
100 Hz - 61 db
- 80 db 5° harmonic




Top/sopra:
40 kHz - 64 db 2° harmonic
- 85 db noise

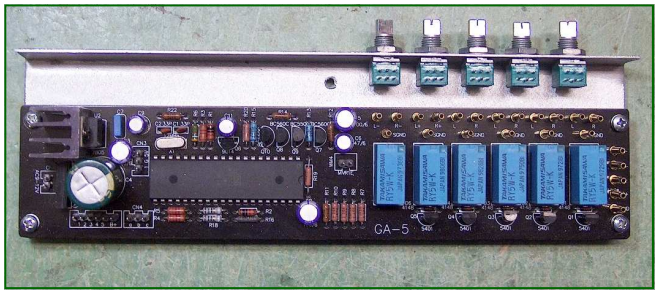



Top/sopra:
10 k Hz - 61 db 2° harmonic
- 85 db noise

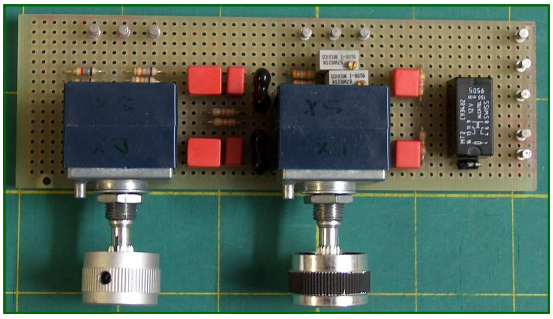



Frequency response plot.

Flat from 10 Hz to 40kHz -1db



Selettore di ingressi e telecomando
Inputs selector and remote control asm



Controlli di tono
Tone control asm (top view)

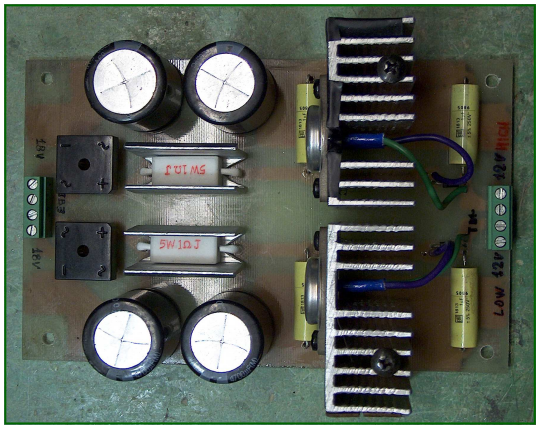


**FIG: 3** Alimentatore per filamenti in cc
Heaters power supply asm.

**FIG. 4** Alimentatore alta tensione (260V)
High voltage power supply asm.(260 V)

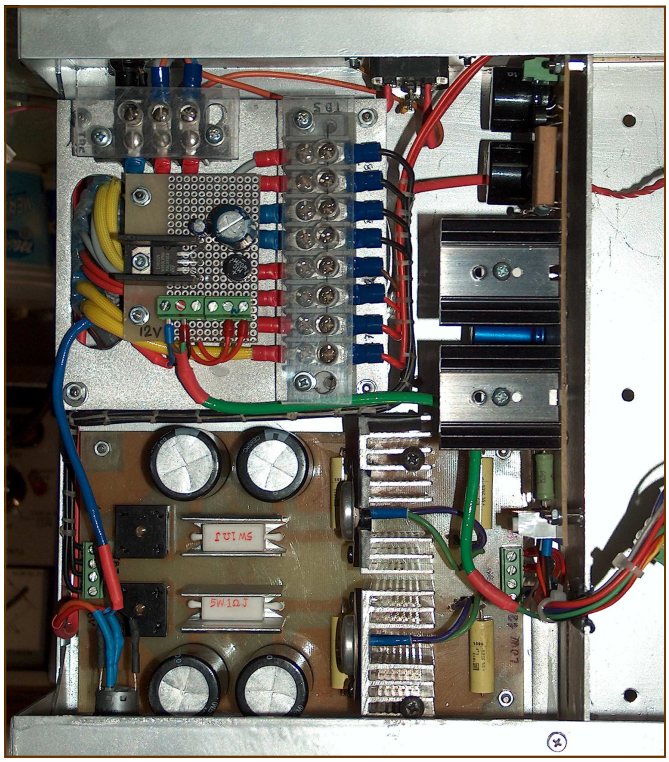
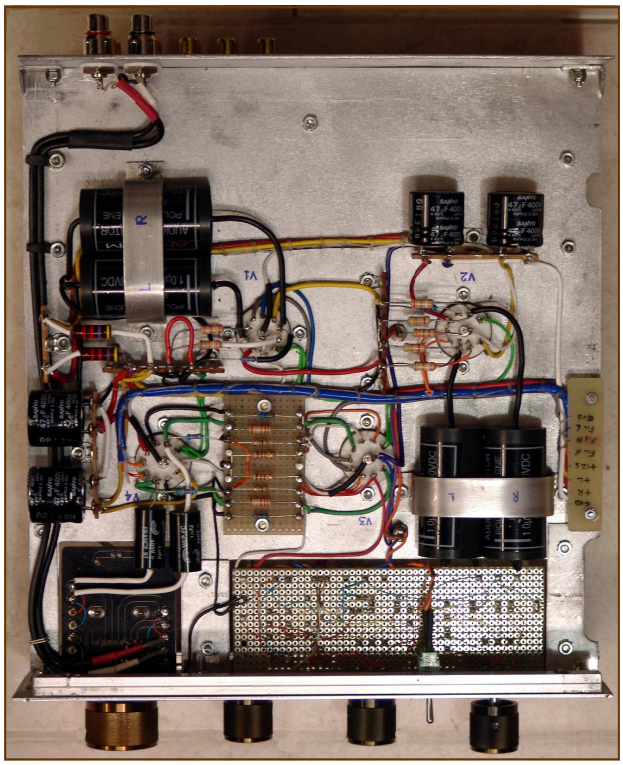
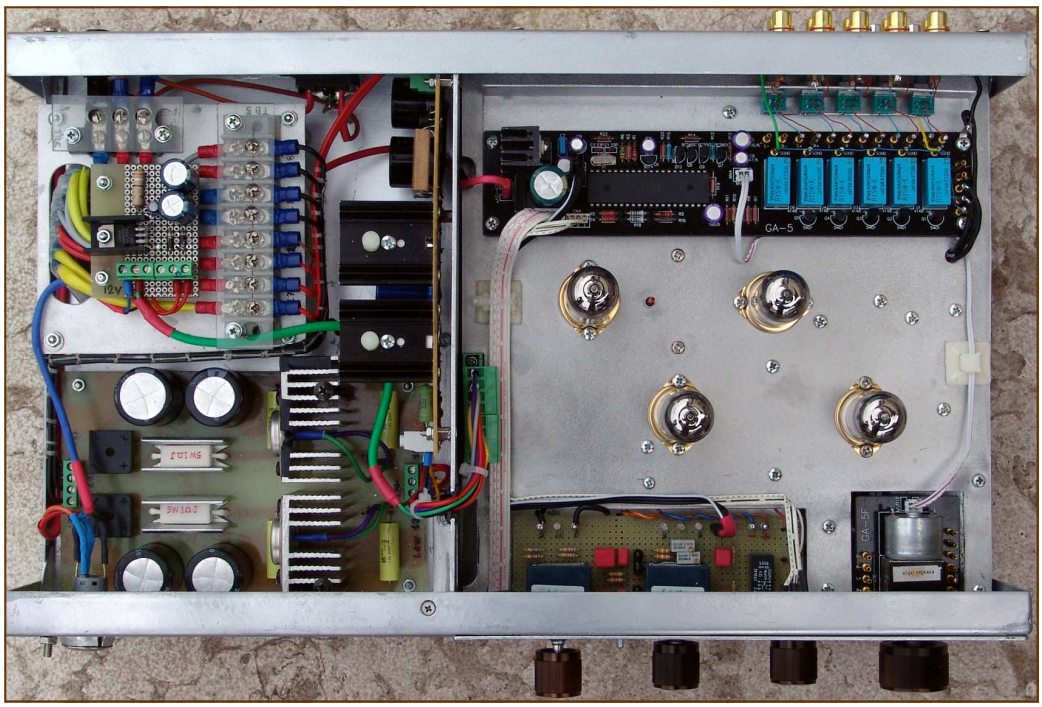


**Photo 2** Alimentatore completo
Complete power supplies section and cabling



Cablaggio del circuito
Preamplifier section, components layout and cables routing



Vista superiore. A sinistra l'alimentazione e a destra i tubi elettronici e il circuito selettore degli ingressi.

Top Asm view.
On the left thta power supplies sectin and, on the right, the line amplifier with its tone control circuit and the input selector

Visione dell'amplificatore completo .

Final asm view.
Through the front panel a small windows allows to see all the vacuum tubes illuminated by four blu LEd'S inserted into the sokets.

Vista posteriore con gli ingressi e, sotto i fori di accesso ai potenziometri di livello.

Back view. On the left five inputs RCA connectors and, at the bottom, the output.
On the right, mains receptacle and a 1A protection fuse.