SYNERGY - P.P.S.

SINGLE CHASSIS
PRE POWER SYSTEM
BY TUBE TECHNOLOGY

~ USER'S MANUAL ~

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(defn) Syn'er·gy (-jè) ***n.*** **[** the simultaneous action of separate instances which, together have a greater total effect than the sum of their individual effects.**]**

Designed to be the ultimate Single Chassis Pre-Power System.

Introduction

Thank you for selecting the Synergy Amplifier from Tube Technology. You have purchased the worlds first remote controlled vacuum tube integrated amplifier, a small feat by 20th century standards, but one that hasn't happened until now;

Our intentions were simple; A tube amplifier built to audiophile standards with adeaquate remote features which do not add or subtract from what is of course most important, *the music.* The Synergy encompasses this, and more, we hope it will bring you many years of pleasure as an important part of your hi-fi system.

Please read through this manual so you will know how to operate your Synergy amplifier properly. After you have finished reading this manual, please put it away in a safe place for future reference.

Please do not forget to complete and return the enclosed registration card.

We wish you many hours of musical enjoyment !

Contents

Conventions

This manual uses the following conventions;

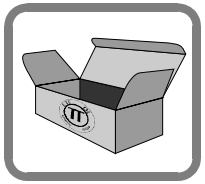
Bold indicates emphasis or a minor heading.

Italic Bold refers to a sub heading of a chapter.

This symbol refers to Notes containing important information set off from the text.

THIS SYMBOL REFERS TO CAUTION MESSAGES AND PROCEDURES WHICH IF NOT OBSERVED CAN LEAD TO DAMAGE OR INJURY

Getting Started



This chapter contains information on;

- ***Unpacking your Synergy Amplifier***
- ***Checking & Installing the Vacuum Tubes***

Unpacking

Your amplifier is packed in "jiffy-cell" support foam. Grip the top of this foam and simply pull it out of the box. The Synergy is then left sitting on its bottom support. Lift out carefully, remembering that the centre of gravity is biased towards the rear of the unit due to the heavy transformers.(It may be neccessary for another person to help manouvre the unit as it is very heavy)

All packing should be retained. Amplifiers returned under guarantee are only accepted in their original packaging.

The following items are included in the packaging of a Synergy No.1;

1 x Synergy No.1 Integrated Amplifier
12 x EL34 Output Vacuum Tubes
1 x Remote Control Handset
1 x Bias Adjust trimmer
1 x Reference Manual & Registration Card
1 x IEC Mains Lead
1 x Spare mains fuse (6.3A T)

Installing the Tubes

The Synergy is usually shipped with its output tubes packed separately, this helps protect them during transit.

If you have ordered a protection grille with your amplifier the output tubes have already been installed and there is no need to read this section.

The input and driver tubes are already in place inside the amplifier, please do not remove these, as they have been calibrated.

The vacant tube sockets on the amplifier are numbered 1 to 6, for the left hand channel of the amplifier and 7 to 12 for the right hand side.
(See diagram 1)

The output tubes which are packed separately locate in these sockets. The relevant tube number is printed on the inside flap of each box, and is also marked on the tube base. Remove the tube carefully from its packing and install it in its matching socket, as labeled in
Diagram 1.

Ensure that the keyway on the base of the tube lines up with the keyway on the tube socket. Each tube must be inserted carefully. Align the tube pins in the centre of the receptacles on the tube base, then apply gentle downwards pressure, firmly pushing the tube home into its base. Do not rock the tube from side to side as the keyway on the tube base will fracture.

Diagram 1

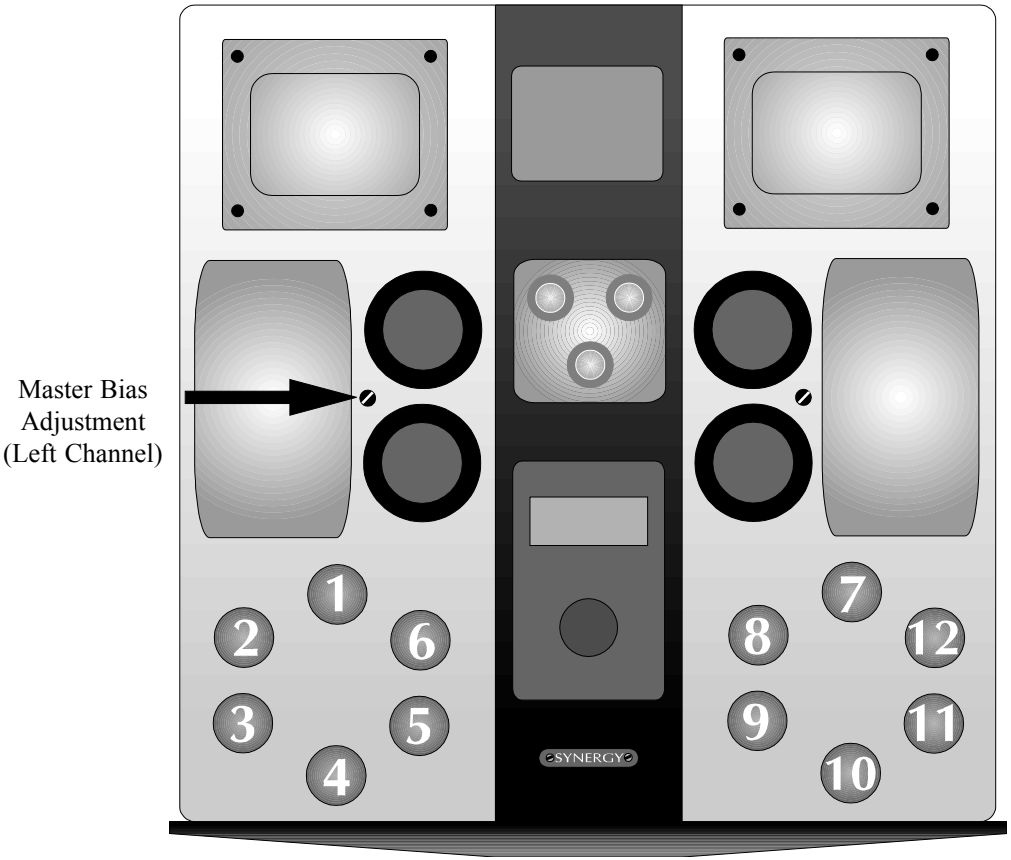

Master Bias
Adjustment
(Left Channel)
1
2
3
4
5
6
7
8
9
10
11
12
SYNERGY

Diagram 2 shows the arrow pointing to the positions of the keyways on the EL34 and the keyways on the amplifiers tube sockets.

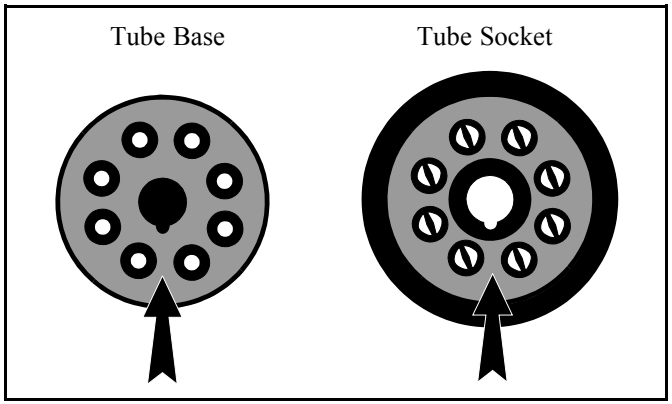


Diagram 2

If the glass on any of the tubes is cracked or broken do not use, consult your dealer for a replacement and refer to the **Maintenance** chapter for instructions on how to replace a faulty tube.

Remove the tubes from their cartons and fit - one at a time. This will ensure that each tube is in its correct socket as calibrated when leaving the factory. If you should mix up the order refer to *replacing a tube* in the maintenance chapter.

Mains Connection

This chapter contains information on;

- ***Connecting the Synergy to the household mains supply.***
- ***Wiring a mains plug (UK)***

Mains Connection

Your Synergy amplifier plugs into the mains supply via the IEC socket located on the back panel (see diagram 3). The amplifier has been factory set to the correct mains voltage for your country. The voltage setting is marked on the serial badge, located on the rear panel. (See diagram 3). Check that this voltage complies with your local supply. Also make sure that your mains outlet is able to deliver the required current for the equipment plugged into it. The wattage rating is also marked on the serial badge.

DO NOT CONNECT/SWITCH-ON THE MAINS SUPPLY TO THE AMPLIFIER BEFORE COMPLETING ALL OTHER CONNECTIONS. IF YOU ARE IN ANY DOUBT REGARDING MAINS CONNECTIONS PLEASE DO NOT PROCEED ANY FURTHER WITHOUT CONSULTING YOUR DEALER.

Wiring a Mains Plug

Export units for certain markets have a moulded mains plug fitted to comply with local standards. If your mains supply lead does not have a plug fitted, the coloured wires should be connected to the appropriate plug terminals in accordance with the following code.

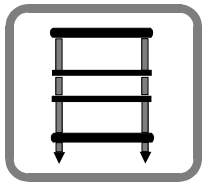
Wire Colour	Label on Plug
GREEN/YELLOW	**E** or EARTH or ⏚
BLUE	**N** or NEUTRAL or BLACK
BROWN	**L** or LIVE or RED

If your mains plug has a fuse, please fit a fuse with **13A** rating.

If your amplifier is not set correctly for the local supply or if you intend to move the amplifier to a location where the supply is at a different voltage, it will be necessary to change the voltage taps on the mains transformer. We recommend that this is done by an experienced technician. Refer to *changing voltage* in the maintenance chapter.

DO NOT SWITCH ON THE AMPLIFIERS BEFORE COMPLETING THE AUDIO CONNECTIONS.

Installation



Installing & Vetilation

This chapter contains information on;

- ***Installing and Ventilating your amplifiers***

Ensure that the amplifier is placed in a stable location that is able to accept its weight each unit weighs 46 kilograms.

It is not recommended that amplifiers are installed in cupboards or in any enclosed area if there is not sufficient air space and ventilation to keep them cool. A minimum distance of six inches above the amplifier should be allowed as this is where most of the heat is generated.
Dedicated racks are available for housing your tube equipment, contact your dealer or Tube Technology. Do not locate the amplifier close to radiators or any other heat source, this could increase the operating temperature.

Do not locate the amplifier too close to a turntable, as the cartridge could pick up hum from the power transformers.

THE OUTPUT TUBES REACH VERY HIGH TEMPRATURES!! DO NOT TOUCH UNDER ANY CIRCUMSTANCES. FOR EXTRA PRECAUTIONS A TUBE PROTECTION GRILLE IS AVAILABLE.

Audio Connection

This chapter contains information on;

- ***Connecting the Synergy's Inputs & Output***
- ***Connecting your Synergy to the loudspeakers.***
- ***Rear Panel Information***

Connecting the Inputs & Output

Your amplifier uses high quality connectors to ensure that maximum signal transfer is possible, therefore ensure that all cables used for connection to the amplifier are terminated with connectors of similar quality.

REC OUT

These outputs provide an audio output suitable for connection to the RECORD input of a tape deck. The source to be recorded is selected by means of the input selector switch on the control panel. See Diagram 5.

CD

These inputs are used to connect the audio output of a digital compact disc player or any other audio hi-fi component that produces output voltage within the range 150mV-3 V.

AUX 1
AUX 2
TAPE

These inputs are used to connect the audio output of a tape deck or audio section of a video recorder or any other audio hi-fi component that produces output voltage within the range 150mV - 1V.

TUNER

These inputs are used to connect the audio output of a Tuner or any other audio hi-fi component that produces output voltage within the range 150mV-1 V.

TUBE PROTECTION

The Synergy incorporates a special resettable fuse for each of the twelve output tubes. This protects the amplifier from the potential damage that may be caused to the amplifier electronics if an output tube should go faulty. When activated the fuse stops the tube from drawing current, the bias meter will display -1. Please note the filament will still be glowing.

IEC INLET

The IEC connector on the rear panel, connects to the mains supply via the mains cable supplied.

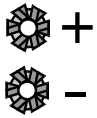
MAINS FUSE

This fuse is rated at 6.3 A, and protects both the large dome shaped transformers.

MAINS SWITCH

This switches the amplifier On & Off, it has a red indicator when in the On position.

Connection to Loudspeakers



The loudspeaker outputs are suitable for driving loudspeakers with impedances in the range of 6-8 ohms. The output terminals are 4mm terminal posts and each will except two 4mm (banana) plugs or bare wire. For bi-wiring use the side entry holes together with the front entry holes. Connect the positive or (+) of the speaker cable to the red terminal on the amplifier, and the negative or (-) to the black terminal on the amplifier.

DO NOT SWITCH-ON THE SYSTEM UNTIL YOU HAVE READ CHAPTER 5 **Operating Your System.**

Rear Panel

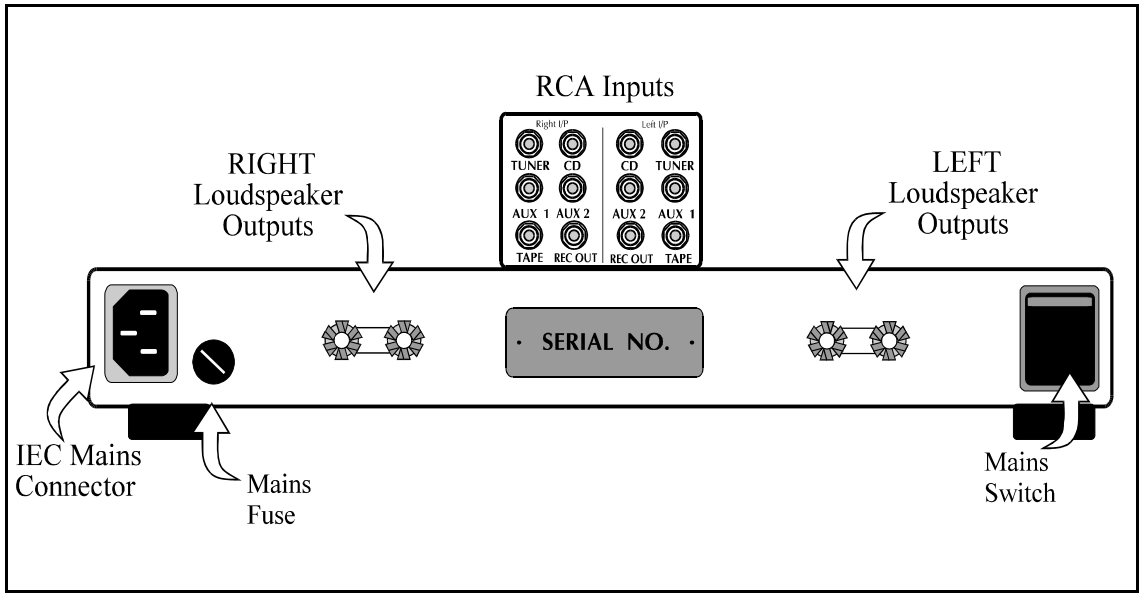


Diagram 3

Operating your System

This chapter contains information on;

- ***Switching your amplifier ON and OFF.***
- ***Control & Front Panel Functions***
- ***IR Remote Control Functions***
- ***Operational Notes***

Switching On & Off

After switch on there is a delay of approx. 15 seconds before the main HT is switched, each channel is switched On separately, an audible thump is heard from the mains transformer on each channel as they power up, this is due to pole reversal which is quite normal for large power transformers. The unit can also be switched On and Off via the remote handset, please read the **IR Remote Control Functions** section.

Front Panel

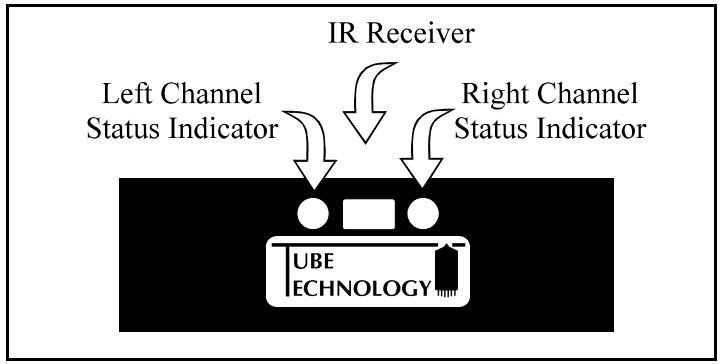


Diagram 4

Front Panel Functions

Left & Right Status Indicators

These LED's are tri-colour and are illuminated in either three colours. GREEN indicates that the unit is switched on and functional, YELLOW indicates that the unit is switched on and is in mute (activated via the remote handset) and RED indicates that the unit is in Stand-by mode.

IR Receiver

This is the 'magic eye' that receives infra-red transmissions from the remote handset, a red indicator is displayed when in range, and when just out of range this indicator flashes red.

Control Panel Functions

Left & Right Source Selector

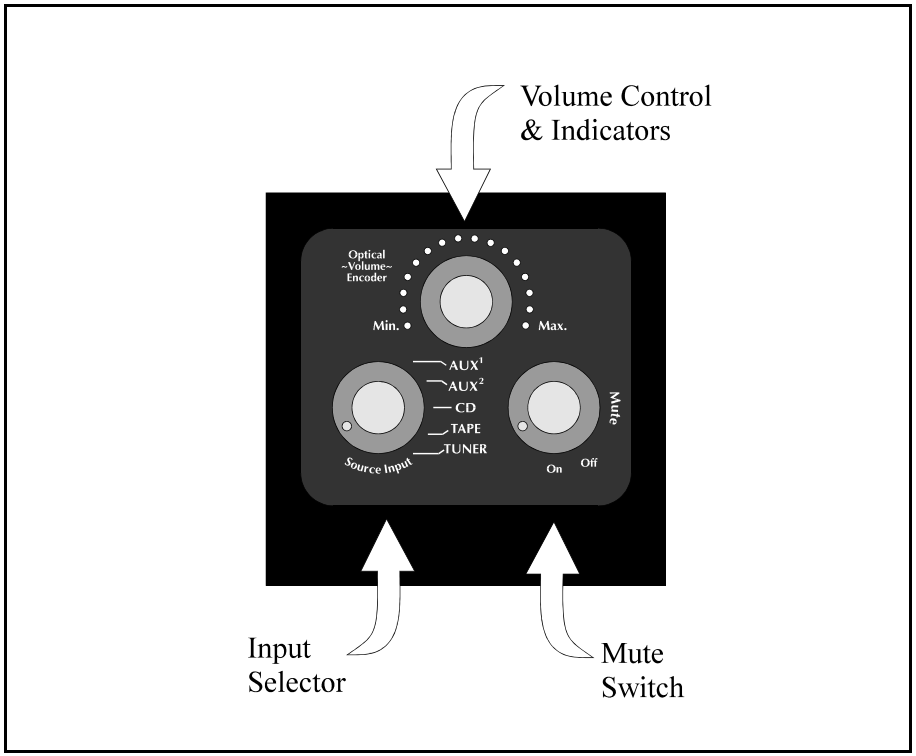
Selects the source of the input signal by turning clockwise or anti-clockwise. (See Diagram 5) A switch is provided for each channel for maximum stereo separation.

CD	- Selection for listening to a Compact Disc
AUX 1	- Selection for listening to an Auxiliary Input such as TV or Video
AUX 2	- Selection for listening to an Auxiliary Input such as TV or Video
TAPE	- Selection for listening to a cassette tape
TUNER	- Selection for listening to a radio broadcast

Volume Control

Indicates the amount of volume. This control utilizes an optical encoder which means it does not have an end-stop. Turning the control knob clockwise increases volume and anti-clockwise decreases volume. Green led's around the circumference of the knob indicate volume level.

Diagram 5
Control Panel



IR Remote Control Functions

ON & ST/BY

By pressing the **(ST/BY)** button the unit is switched to Stand-By. The unit is completely switched off apart from use of the volume control settings. The front panel indicators turn red. Pressing ON returns the amplifier to operation.

VOLUME + & -

By pressing the **VOLUME (+)** button the volume is increased, and pressing the **(-)** button decreases the voulme. The electronics which control the volume has two operating speeds. Pressing the **(+)** or **(-)** buttons for less than 1 second allows the controller to make small movements on speed 1, and holding either button down for longer than 1 second allows the volume to travel at full speed.

MUTE

By pressing the **MUTE** button, both channels simultaneously are muted, the front panel indicators turn amber, by pressing the same button again allows the amplifier to produce sound once again. A small click is sometimes heard through the loudspeakers on operation of the mute button, this depends on your volume setting and is quite normal.

The handset is fitted with one PP3 battery, accesed via the sliding door on the rear of the handset

Operational Notes

Some users of tube amplifiers believe that because tube amplifiers take some time to warm up that they should be left on all the time. The Synergy amplifier reaches peak performance levels 15-20 minutes after switch on. Unless absolutely necessary it is not recommended that you leave your amplifier permanently switched on, this only wastes electricity and tube life, but if necessary the Synergy is quite capable of being left switched on for very long periods of time.

THE OUTPUT TUBES REACH VERY HIGH TEMPERATURES!! DO NOT TOUCH UNDER ANY CIRCUMSTANCES. FOR EXTRA PRECAUTIONS A TUBE PROTECTION GRILLE IS AVAILABLE.

The glass envelope surrounding the tube can reach temperatures of up to 300 degrees centigrade. A tube is a perfectly safe device if not touched when it is operating, rather like a hot light bulb. For owners of pets and young children we recommend a Tube Technology tube protection grille.

It is quite normal for the amplifiers to produce a very small amount of mechanical hum when they are in operation.. This is due to the large power transformers.

DO NOT REPEATEDLY SWITCH THE AMPLIFIER ON AND OFF. ONCE YOU HAVE SWITCHED THE AMPLIFIER OFF, WAIT APPROX. 15 SECONDS BEFORE SWITCHING IT ON AGAIN.

Running-In

This chapter contains information on;

- ***Burning-In your Amplifier***
- ***Tube Information***

Burning-In Amplifiers

"Burning-In" is a generic term given to the basic 'running-in' of the amplifier. You may notice a slight 'electronic-smell' from your amplifier during the first few days of operation. This smell is usually caused by various prints and dyes used on the components which takes some time to evaporate This is quite normal and there is no need for concern as your amplifier has been extensively soak tested before leaving the factory. This burning-in process continues with your use of the amplifier.

This process simply allows for new components like tubes, capacitors and resistors to settle and 'sweeten' enhancing the amplifiers sonic performance. An estimated 80 hours of operation allows your Synergy amplifier this running-in period.

Tube Information

Unlike most other amplifiers, we run our tubes with very little standing current, this conservative use of the tube provides an extended reliable tube life. As with all tubes, their qualities degrade with age due to cathode emission (a natural process common to all tubes) A typical life span of an EL34 output tube in a Synergy would be approx. 4000 hours, after which time they should be replaced, thus keeping your amplifier at it's maximum sonic performance; Refer to the **Maintenance** chapter.

Maintenance

This chapter contains information on;

- ***Care and Cleaning of your amplifier***
- ***Bias Measurements of the Output Tubes***
- ***Troubleshooting***
- ***Changing Mains Voltage***

Care & Cleaning

All polished metal parts on your amplifier are unlacquered. These metal parts will in time lack lustre due to oxidisation. They can easily be restored to original condition by using a mild metal polish (such as duraglit) and a soft polishing cloth. Do not clean the units with water as this smears the surface and can leave water marks. When dusting the amplifiers be sure not to catch the tubes as this may crack the glass. Alternatively you can remove the tubes (remembering the order they were removed in) and clean the amplifier. Anodised parts such as the front panel and control panel & painted parts such as the bottom cover are best cleaned with a damp cloth then buffed with a dry cloth.

OBBC Bias Measurement

The Synergy amplifier uses a fixed bias system that requires very little attention. It is necessary to re-adjust the bias if you fit a **new** tube to the amplifier, or if the order of the tubes shipped with the amplifier has been mixed up. The Synergy uses an On Board Bias Control (OBBC) to adjust the amount of bias on each tube. This metering system is located behind the removable door in the middle of the control panel. On lifting this door the amplifier automatically switches into mute, this is neccessary to adjust the bias. Follow the procedure in table 1 to adjust the bias.

Table 1

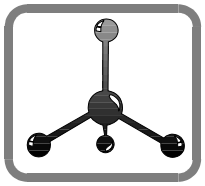
Step	Action	Remark
1.	Remove the door in the centre of the control panel, to reveal the meter.	Identify the 12 bias potentiometers, located in the lower section of the cutout. Gold screw heads are visible, through round holes. 1-6 are for the left hand channel and 7-12 for the right hand channel.
2.	Rotate the black knob in the centre of the meter to the relevant tube number. (see diagram 1 for tube numbers)	The Liquid Crystal Display will now give a reading of this particular tube.
3.	With the trimming tool provided adjust the bias potentiometer gold screw head until the meter gives a readout of 35.0.	This action should be carried out after the amplifier has warmed up for at least 5 minutes.
4.	If you are unable to bias a tube to 35 it is possible to adjust the master bias for extra voltage range. (see diagram 1) This adjustment is very critical and only needs a small turn for a large change in reading.	

UNDER NO CIRCUMSTANCES SHOULD AN UNQUALIFIED PERSON REMOVE THE COVERS OF AN AMPLIFIER.

Troubleshooting

SYMPTOM	REMEDY
Amplifier switches on but there is no sound from the system.	**1.** Check you have connected the source you are trying to play ie. cd player to the relavant RCA input connector on amplifier **2.** Check that the loudspeaker connections have been made. **3**.Ensure the amplifier has its OBBC lid on, and it is not in mute.
Amplifier does not switch on	**1**. Ensure IEC plug on mains lead is a snug fit. **2.** Check the mains fuse located on the rear panel see diagram 3.
Tubes Pulsate and glow blue	**2.** Ensure you have not switched the amplifier On & Off without waiting at least 30 secs.
A tube or tubes glow very bright cherry red, shortly after switch on. *(Do not confuse with normal filament glow)*	**1.** Turn amplifier off imediately**.** **2.** Tube is faulty, check this tube with the OBBC
	1. The tube you have replaced is ' microphonic '. This is particularly noticeable if the tube has been **2.** Change the tube for another.

Specifications



Figures given below are for a typical Synergy Integrated Amplifier

Vacuum Tubes	EL34/6CA7 x 12 ECC82/12AU7 x 2 (Line Stage) ECC81/12AT7 x 4 (Driver Stage)
Output Power	150 watts + 150 watts (8 ohms)
Frequency Response	LINE - 5Hz - 120 KHz @ 1W +/- 1dB 10Hz - 50KHz @ 150W +/- 1dB
Input Sensitivity	LINE - 200 mV (output 1V into driver)
Input Impedance	LINE - 200 Ohms
Output Load Impedance	6 - 8 Ohms (2 ohms switchable optional)
Power Consumption	Quiescent = 375W, Full power = 750W
Voltage	110V, 120V, 220V, 230V, 240VAC
Dimensions	470 (W) x 470 (D) x 150 (H) mm
Weight	48 Kilograms

Guarantee

Guarantee

This chapter contains information on;

- ***The Guarantee of your Synergy amplifier***
- ***Tube Guarantee***
- ***Registration***
- ***Claims under this Guarantee***

This equipment has been fully tested and a full record of these tests made before despatch from the factory. Both the workmanship and the performance of this equipment are guaranteed against defects for a period of TEN YEARS from the date of purchase, provided that it was originally purchased from an authorised dealer under a consumer sale agreement, at or near the recommended retail price. (The words "consumer sale" shall be construed in accordance with section 15 of the Supply of Goods (Implied Terms) act 1973).

This guarantee covers both labour and parts and is transferable to subsequent purchasers but the liability of the manufacturers is limited to the cost of repair or replacement (at the discretion of the manufacturers) of the defective parts and under no circumstances extends to consequential loss, damage or shipping charges.

The manufacturers can accept no responsibility for defects arising from accident, misuse, wear and tear, neglect or through unauthorised adjustments and or repair, neither can they accept responsibility for damage or loss occurring during transit to or from the person claiming under this guarantee.

Tube Guarantee

This equipment has a SIX MONTH guarantee on the tubes allowing for any manufacturing defects to arise. If a tube is found to be defective it should be returned to the dealer or failing this, directly to Tube Technology packed in its original packaging.

Registration

Please complete the registration card and return it to Tube Technology. **Your guarantee is invalid without registration.** To transfer this guarantee to subsequent purchasers, the new owner must notify Tube Technology of their name, address and serial numbers of the equipment.

Claims under this Guarantee

This equipment should be packaged in the original packaging and returned to the dealer from whom it was purchased or, failing this, any other authorised Tube Technology dealer. If it is not possible to return the equipment by hand then it should be sent carriage prepaid by a reputable carrier. Should the original packaging not be available replacement packaging can be purchased from the manufacturers. The equipment should not be sent by post.

DO NOT CONSIGN THE EQUIPMENT TO TUBE TECHNOLOGY UNLESS YOU HAVE FIRST BEEN SPECIFICALLY REQUESTED TO DO SO BY THE MANUFACTURERS TECHNICAL SERVICE DEPARTMENT. DO NOT UNDER ANY CIRCUMSTANCES ATTEMPT TO DISASSEMBLE THE EQUIPMENT BEFORE DESPATCH.

If you have any difficulty complying with these requirements, please contact the manufacturers at the following address:

TUBE TECHNOLOGY
IMAGE HOUSE
326 MOLESEY ROAD
WALTON-ON-THAMES
SURREY
KT12 3PD

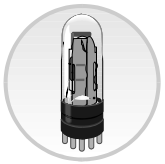
TEL: 01932 242420
FAX: 01932 244455

In either case you should state clearly your name and address, the date and place of purchase together with a brief description of the fault experienced. In the event of equipment being returned which on test is found to comply with the published specifications the manufacturers reserve the right to charge a reasonable fee for testing the equipment and for return carriage.

The manufacturers are happy to answer any queries you may have regarding the use of this equipment on the condition that this enquiry is by letter. You should state clearly the serial number of the unit, the dealer from whom it was purchased and the date of purchase.

THIS GUARANTEE IN NO WAY VARIES OR REMOVES A PURCHASERS STATUTORY RIGHTS.

Tube Renaissance



Tube Renaissance

A possible expalnation of why tubes may sound better than transistors.

From the late 1960's, tubes were largely, though not entirely, superceded by semiconductors in audio frequency amplifier designs. This was an inevitable consequence of a continuing quest for new techniques. Semiconductors (Transistors and Integrated Circuits) have certain and obvious advantages: their small size, absence of heaters, low voltage operation and consequent opportunity to dispense with output transformers may appear to make tubes obsolete. However, from about 1975 onward, there has been a resurgence of interest in tubes; and it seems worthwhile to consider why.

It is said by 'hi-fi' enthusiasts that tube amplifiers sound better, that their distortion is either lower or less noticable. Carefully conducted listening tests seem to bear this out, although their results are difficult to interpret. If there really are subjective differences to a listener between tubes and semiconductor amplifiers, can they be explained technically?

One thing should be clearly understood: it is possible to design either a tube or a semiconductor amplifier so that over a certain range of output power its distortion will be so small as to be imperceptable to the ear. Therefore, if two similarly rated well-designed high fidelity amplifiers, one using tubes and the other using semiconductors, are compared in the same listening conditions, correctly operated, their performance should be indistinguishable - and subjectively perfect.

Now, on the basis of measured performance, many modern high fidelity semiconductor amplifiers are actually superior to the older tube amplifiers, which were already good enough for their distortion tobe imperceptable; so how can here be subjective differences? It seems that there cannot be any, while the amplifiers are correctly operated: and this may be the key to the mystery, for there are two major problems: one is that it is extremely difficult to avoid occasional over driving of an amplifer, because of the very

large dynamic range of the audio signal; and the other is that the loading is not always resistive. It is under these (usually unintentional) wrong conditions that differences may show up.

Let us consider the over driving first. Owing to continual improvements in recording and playback technique, the possible dynamic range of music signals- from either disc or tape - is greater now than it used to be. As a tentative estimate, it appears that the loadest passage of a modern disc recording maybe 40dB above the average sound level. Now it may be said that amplifiers in a high fidelity system ought theoretically to be able to reproduce the loudest of loud bursts without distortion. However, to allow for 40dB above 50mW - not a very high listening level - a power capability of 500W would be required; and further developments may make the figure even greater. One seems to hear a cry of “where is it all going to end?” Anyway, when setting up an amplifier system one adjusts the gain to give the prefered average sound level. One has no way in advance of knowing in advance whether there is an exceptionally loud passage coming that will over drive the amplifier. Bursts in excess of 30dB above the average are quite rare.

If we accept, then, that occasional over driving is virtually inevitable, how will the amplifier behave? We now come to the first possible reasons why tubes and semiconductors may “sound different”.

Presented with an over large signal, tubes merely clip the peaks, delivering a flat-topped waveform while the over driving is taking place. The limiting may occur at the grid as the circuit resistances are commonly such as to prevent it from being driven more than slightly positive, or it may be the results of coalescence of characteristic curves at lower voltages. The ear is surprisingly tolerant of such clipping when it occurs only on these occasional load bursts.

The semiconductors used in audio amplifiers are virtually always bipolar transistors, either discrete or integrated. They require base

current to be applied in order to make collector current flow. Now transistor amplifiers normally incorporate a large amount of negative feedback, and, when such an amplifier limits, some of its stages are driven very hard, so that extra large base currents are drawn. If any capacitors are affected by such current pulses, the result may well be that a brief over driving is followed by a comparatively long recovery signal, which would be much more noticeable than mere clipping of peaks. Even with dc coupling, there may still be capacitors that can cause such extra signals.

There is a further effect that takes place in the transistor itself, because of the phenomenon of charge storage. A transistor that has been conducting does not switch off immediately when the forward base bias is removed, but continues to take collector current until all the relevant charge carriers that are in transit have been swept out. The effect is most pronounced in a transistor that has been turned on hard: in fact the larger the base current the longer will be the turn-off time. In audio transistors that have been over driven this time may be of the order of hundreds of microseconds, so this effect can also give rise to spurious signals.

When it is realised that even the most critical listener cannot detect peak clipping of occasional short loud bursts by as much as 6dB, we can understand why it is sometimes said that a 50W tube amplifier can sound equal to some 200W transistor amplifiers. A tube amplifier can be quite grossly over driven with little or no subjective effect on sound quality, whereas most transistor amplifiers probably cannot.

The other kind of unintentional wrong operation we have to consider is incorrect oading. The impedance of a loudspeaker system is by no means constant: a so-called 8 ohm system may well present anything from 4 to 16 ohms over the audio frequency range, and be highly reactive at some frequencies. It is under reactive load conditions with large signals that another major difference appears between tubes and transistors. The combina-

tion of simultaneous high voltage drop and high current occurring for brief periods at certain parts of the elliptical load line does not normally affect tubes, may cause a catastrophic second breakdown effect, in which a permanent short circuit develops - not to be confused with ordinary avalanche break down, which is a reversible phenomenon.

The risk of second break down may be avoided by using transistors with sufficiently high ratings to be well clear of the effect, if available; but the alternative commonly employed is to incorporate protective circuitry that cuts the signal whenever the output transistors are subject to a dangerous combination of voltage and current, and this obviously has a very unpleasant effect on the sound. The purpose of these remarks is not to denigrate transistor amplifiers, but to present a case for tubes, and to show that there may be technical reasons for the supposedly subjective effects that have been attributed to transistors. Ways may be found of eliminating or obviating these effects in a transistor amplifier design; but there is a simplicity about tube circuitry which may appeal to many audio engineers, both professional and amateur.

A further point can be made in favour of tubes, concerning cooling. Output transistors have to be conduction cooled, preferably by some method that does not heat up other semiconductors in the circuit. This requires some rather bulky metalwork thermally isolated from the rest of the chassis. Glass envelope tubes, on the other hand, looses most of their heat by a mixture of convection and radiation.

A brief reference may be in order here about what is usually considered to be main disadvantage of a tube amplifier, the output transformer. It is indeed a heavy and costly item, to be set against the relative simplicity of circuit and various other advantages that have here been attributed to the tube equipment. However it can enable the amplifier to work into more than one load impedance, whilst a transformerless

semiconductor amplifier designed to drive an 8 ohm load would usually deliver only half its normal power into a 16 ohms, and might be damaged if operated with 4 ohms. Also, with an output transformer provided that it is correctly loaded, the amplifier input sensitivity without feedback is the same whatever the value of load impedance; and by taking the negative feedback connection from a fixed point on the secondary winding the sensitivity with feedback can be made similarly independent of load impedance: in other words, the number of decibels of feedback and therefore the reduction of distortion, damping factor and so on, are the same whatever the load. So there is something to be said for having an output transformer.

Perhaps enough has been said to suggest at least that the advantages are not entirely on the side of semiconductors, and that points can be made in favour of tubes, concerning both performance and convenience in use. Semiconductors may produce un-welcome effects on over driving, so difficult to avoid in practise; and not only the output stage, but also low level stages are involved in these. Tubes have a distict advantage in operation with reactive loads, and are easier to cool. Even the need for an output transformer is not quite such an unmitigated drawback as it may sometimes seem.

These may be some of the reasons why a substantial part of the audio amplifier market has stayed with tubes during the “transistor era”, and why there has recently been such a remarkable “Tube Renaissance”.