POWER AMPLIFICATION SYSTEMS
by
Valve Amplification Company

Model PA90C1 Power Amplifier

& Model PS90C1 Power Supply

Operation & Maintenance

CAUTION

DO NOT OPERATE THESE UNITS WITHOUT THE GROUND STRAP ATTACHED BETWEEN EACH AMPLIFIER AND ITS ASSOCIATED POWER SUPPLY. OPERATION WITHOUT THE GROUND STRAP POSES A POTENTIALLY LETHAL SITUATION.

THESE UNITS CONTAIN NO USER SERVICEABLE PARTS. DO NOT REMOVE THE BOTTOM PLATES OR TOP COVERS. LETHAL VOLTAGES ARE PRESENT WITHIN THE CHASSIS. DO NOT OPERATE THE UNITS IF THEY ARE WET.

VACUUM TUBES BECOME HOT ENOUGH TO CAUSE SERIOUS BURNS. NEVER TOUCH A TUBE WHEN THE UNIT IS ON. IT MAY TAKE SEVERAL MINUTES FOR THE TUBES TO COOL DOWN AFTER THE UNIT IS SWITCHED OFF.

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INTRODUCTION

Your VAC Power Amplifier is designed not to the latest fad but to substance, providing the highest quality of sound. Time spent familiarizing yourself with this manual will be well rewarded.

Figure 1 demonstrates the way to connect the VAC amplifiers and power supplies. A single PA90 is connected to a PS90 to form a 120 watt monophonic amplifier.

Some of the features of your power amplifiers include:

The maximally balanced push-pull circuitry, with push-pull conversion (phase inversion) occurring in the first stage, better exploits the inherent advantages of push-pull operation and allows improved performance of the driver stage.

Modest loop negative feedback (8 dB) ensures better dynamics, gentle clipping, and superior overload recovery. Simple feedback arrangement avoids unnecessary multiplication of the order of distortion products.

Completely hand wired in three dimensional space for the shortest possible lead lengths, allowing passive components to perform much nearer to the theoretical ideal.

All chassis are machined 1/8 inch thick aluminum, creating an extraordinarily rigid non-magnetic platform that is unusually resistant to vibrations that could mar the sound. Mechanical vibration from the power supply is completely isolated from the amplification circuitry due to the multiple chassis design.

Energy storage is distributed among the chassis to place it nearer to the point of demand and dedicated to particular uses, ensuring superior isolation of the various stages.

Output stage is based on the KT77 Beam Power tube or the EL34/6CA7 Power Pentode operated in Class A at 54 milliamperes idle current per tube.

Output stage may be operated in partial-triode (ultra-linear) or full triode mode, selected via a single switch.

Impedance matching taps are provided for 2, 4, and 8 ohms.

UNPACKING

Each amplifier and power supply chassis is packed in double box cartons for the greatest possible protection during shipping. Included in the power amplifier carton are vacuum tubes, a power cable for attachment to the PS90 Power Supply, and a separate grounding strap which must be attached to the PS90 for safety. Tubes are packed individually to prevent damage, and must be fitted to the PA90 Power Amplifier before installation can proceed.

Each tube socket is covered by a small round sticker. On this sticker is a number that corresponds to a numbered sticker on each tube. Fit each tube into the matching socket, first *removing* the sticker from the PA90 and the tube. The bias levels for the output tubes have been factory set, but should be checked during the installation procedure.

DO NOT CONNECT TWO PA90 POWER AMPLIFIERS TO A SINGLE PS90 POWER SUPPLY.

INSTALLATION

Physical requirements:

1) Provide adequate ventilation - allow at least 3 inches above and 1/4 inch between VAC chassis.
2) Do not place in a completely enclosed cabinet.
3) Do not stack other equipment on top of the VAC units.
4) Do not operate on carpet or any other surface that might block air flow.
5) The chassis of the PS90 will become hot in normal use.
6) Do not allow the chassis of the VAC components to touch any metal parts, such as the frame of an equipment rack. This might create a parallel ground path that will degrade the sound of your system.

Electrical connections (refer to Figure 2 to identify the connectors and leads referred to in these directions.):

1) FOLLOW THESE DIRECTIONS CAREFULLY. FAILURE TO CONNECT THESE UNITS AS DESCRIBED MAY RESULT IN INCORRECT OPERATION AND MAY POSE A DANGER OF LETHAL SHOCK.
2) The PS90 Power Supply must be unplugged and turned completely off.
3) Connect the heavy gauge grounding cables between the ground terminal of the PS90 and the ground terminal of the PA90 Power Amplifier. The binding posts provided for this purpose have a nut that can be completely removed, and so accommodates the circular lug (ring tongue terminal) used on the ground cables. Remove the nut, place the lug over the binding post shaft, replace the nut and tighten firmly (an 11 millimeter open end wrench may be used). The ground cable ensures a ground return for the power supply in the unlikely event that the two redundant ground paths in the power cable between chassis should fail.
4) Connect the power cable provided into either socket marked "To Power Amplifier" on the back of the PS90 Power Supply. Connect the other end of the power cable into the socket marked "Power Supply In" on the PA90. NOTE THAT THE POWER CONNECTORS ARE DIFFERENT ON EACH END OF THE CABLE, ARE KEYED, AND HAVE A KEYED LOCKING COLLAR. You should feel a slight "snap" when the locking collar has been fully turned. Never attach two PA90s to a single PS90.
5) Connect signal inputs to the power amplifiers. BALANCED (XLR INPUT) AMPLIFIERS CAN ONLY WORK CORRECTLY WITH FULLY BALANCED INPUT SIGNALS - OTHERWISE DAMAGE WILL OCCUR.
6) Connect loudspeakers between the appropriate pair of binding posts on the back of the power amplifiers. The binding post nut accepts an 11 millimeter open end wrench. Be careful not to over tighten. Note that the positive terminal is the same for all impedance connections. For further information see Tips & Advice: A Word About Impedance Matching.
7) Connect the PS90 to the power source indicated on the rear panel, either 120 volts AC or 220 volts AC, 50 or 60 Hertz.
8) Follow the BIAS procedure described in this manual to set the idle current at 54 milliamperes per tube, checking the idle current at 1 minute, 30 minutes, 1 hour, and 2 hours. Also, read the section entitled INSTALLING NEW OUTPUT TUBES.

CAUTION FOR GROUNDED SPEAKER SYSTEMS OR COMMON GROUND SWITCHING SYSTEMS. The PA90 chassis and "-2 ohm" output connector are at ground potential with respect to the 120 volt AC source and the signal input shield. NEVER CONNECT ANY OUTPUT TAP EXCEPT "-2" TO THE GROUNDED SIDE OF A GROUNDED LOAD, such as may be encountered with some switch boxes and certain speakers. In such a system, the only output impedance available from the PA90 is 2 ohms. Special modifications for grounded and common loads are available. Contact VAC for details.

OPERATION

Set the STANDBY switch on the PS90 to on. This provides power to the filaments (heaters) of the PA90 tubes and charges the bias supply. After a delay of 2 minutes the OPERATE switch may be set on, providing full voltage (approximately 480 volts) to the plates of the tubes. The amplifier is now on and ready for listening.

Following the turn on procedure described above will help ensure long tube life. Having two power switches provides additional control over the amplifier.

To turn the unit off, first turn the OPERATE switch to off, followed by the STANDBY switch. (Actually, they may be thrown simultaneously. In addition, switching off STANDBY alone will cut both supplies, but OPERATE must be switched off before the next turn-on.) Sound (distorted) will continue for several seconds after the power is switched off. The slow sound decay is caused by the slow discharge of the large energy storage capacitors in the power supply and power amplifier. (The sound would continue for much longer except for the bleeder resistors in the PS90.)

To mute the unit for a short time (15 minutes maximum advisable), turn the OPERATE switch to off but leave the STANDBY switch on. The unit will play immediately when OPERATE is again switched on. *Do not use the STANDBY mode for periods exceeding 15 minutes.*

Before disconnecting your amplifiers from their power supplies allow them to sit with power off for five minutes. This allows energy stored in the amplifier chassis to drain back in to the power supplies. Failure to do so may result in damage to the regulators when the units are reconnected.

As with all high fidelity products, the sound characteristics of the VAC amplifiers change somewhat as they warm up. Best sound will be achieved after one hour of operation, with subtle changes occurring for up to two hours. However, we advise against leaving the equipment on at all times because of the attendant acceleration of output tube wear. Life of the output tubes averages between 3,000 and 10,000 hours depending upon brand fitted and random variations within the tubes themselves.

Any time that the VAC Power Amplifier has not been used for a few weeks the sound may be different. This is also normal for high resolution audio equipment. Optimum sound should return after a few hours of operation, preferably with an audio signal. Refer to the discussion of break in contained in the INTRODUCTION section of this manual for further information.

Please note that although your VAC System has been run for 48 hours at the factory, they will continue to "break in" for approximately 150 hours. The break in is most pronounced on the 90 Watt Amplifiers, particularly in the ultralinear mode. Note that the triode and ultra-linear modes do not require separate break in periods, and that the ultra-linear mode will improve even if you only operate the amplifiers in the triode mode (this is in most cases the most listenable way to break in the PA90).

Also be aware that many components display the need for a new break in period after being transported in unheated cargo aircraft.

BIASING

Your VAC Power Amplifier has been shipped with output tube bias set for an idle current of 54 milliamperes (mA) per tube. This should be checked when you install your amplifier, and approximately every month thereafter. It must also be set whenever an output tube is changed.

Refer to Figure 3. Bias levels must be set with accessory PM1 milliammeter. Insert the phone plug of the PM1 into the socket labelled "METER" on the top front of the PA90. Depress each black button in turn to read the idle current for each output tube. Follow a pattern of checking a tube on the left side, then a tube on the right, then the other left, then the other right, etc. Adjust the corresponding bias potentiometer until a reading of 54 mA is obtained. (Turning the control counter clockwise increases the current.) Now, recheck each tube and adjust as necessary. (A change in the setting of one tube may affect the others). Repeat until all tubes are at the desired idle current. Recheck the settings after 30 minutes and one hour. A change of several milliamperes during warm up is normal and no cause for concern.

Bias levels should be checked monthly to ensure optimum sound quality. Allow the PA90 to warm up for at least one hour before checking. It is not unusual for bias current to change with time, particularly when tubes are new. In fact, the greatest amount of drift occurs during the first 200 hours of a tube's life. The drift may change direction periodically, such that the bias control must be increased and then later decreased, or vice versa.

If a PM1 current meter is not available, you may use a high quality VTVM or FET-VM to make the measurements. Wire a 1/4 inch phone plug to the meter with the tip of the plug connected to the positive input of the meter. Set the meter to measure direct current on a scale that reads to approximately 100 milliamperes. If you hear a hum when you try to make the measurement, STOP - the meter is not suitable for this purpose.

Note that in order to make an accurate bias measurement you must have a meter with a very low series resistance. This is due to the fact that the meter's resistance appears in the cathode circuit of the tube being measured, and will induce some cathode (self) bias during the measurement. The result of this is that the actual idle current will be greater than that which was measured, possibly by enough to damage the output tubes.

For further information, refer to Tips & Advice: A Word About Bias Levels.

AC BALANCE ADJUSTMENT

The AC balance adjustment, located on the top of the PA90 between the low level tubes, allows the amplifier to be adjusted for maximum symmetry of the push-pull signal. It has been set at the factory for lowest distortion performance with the supplied tubes.

Ordinarily, you need not change the setting of this control, even when the low signal tubes are changed, for two reasons. Firstly, most low level tubes will call for approximately the same setting, such that very little imbalance is to be expected from a tube change. Secondly, although a change in the AC Balance setting can have an impact upon measured distortion, it can be very difficult to hear.

Proper adjustment of the AC Balance control requires access to a low distortion signal generator and a harmonic distortion meter. Connect the signal generator to the amplifier input, and the output to an appropriate load resistor. (NOTE: Do not connect a grounded test lead to ANY output tap except "-2 ohms".) Adjust the signal generator to 1000 Hertz. Set the level such that the amplifier is producing approximately 10 watts. Adjust the AC Balance control to minimize distortion measured across the load resistor.

The precise setting for minimum measured distortion is slightly different for the triode and ultra-linear output modes. Given that the AC balance is adjusted for one mode, the measured full power distortion in the other mode will be approximately .2% THD higher than when that other mode is optimized. The PA90 is supplied optimized for triode operation.

If for some reason you *need* to make an adjustment without access to test equipment, the following rule of thumb will result in a good setting. Turn the AC balance control full counter-clockwise. Think of the screwdriver slot as if it is pointing to the numbers on a clock's face. For ultra-linear operation, turn the control less than 1/4 turn, until the screwdriver slot is approximately sideways (as in 9 and 3 on a clock's face). For triode operation, turn the control slightly farther to approximately 9:30 and 3:30.

SELECTION OF OUTPUT STAGE OPERATING MODE

All VAC amplifier output stages may be operated in partial-triode (ultralinear) or full triode modes, at your discretion via a single switch. Although the mode may be changed with the amplifier in operation, we strongly suggest that you turn the OPERATE switch to off before operating the mode switch. To change the mode, insert a flat blade screwdriver into the switch opening between the output tubes (be careful not to burn yourself on the output tubes). Turn the switch to the position indicated on the brass plate. Then power the unit up and listen.

Less power is available in the full triode mode. Experience reveals that the triode mode will sound somewhat lean on some systems and better defined on others. In many ways this is an issue of system matching, and universal recommendations do not exist.

Note that the bias current will typically read 2 milliamperes lower in the triode mode than in the ultralinear mode. Simply follow the BIAS procedure to restore the idle current to 54 milliamperes per tube.

For further information, refer to Tips & Advice: A Word About Output Stage Operating Mode.

INSTALLING NEW OUTPUT TUBES

Replacement tubes are available from VAC and other sources. Output tubes may be KT77 beam power tubes or EL34/6CA7 power pentodes. It is not necessary that they be matched pairs, although an improvement in measured performance may be achieved in this way. Make certain that each tube fits firmly in its socket. A tube that fits loosely may not make correct contact on all pins and might "run away" (read on). DO NOT MIX TYPE KT77 AND TYPE EL34 TUBES.

Refer to Figure 4 for the location and types of tubes.

ALL POWER MUST BE OFF. Remove the old tubes after they have cooled down (TUBES BECOME HOT ENOUGH TO CAUSE SERIOUS BURNS WHEN IN OPERATION AND MAY TAKE SEVERAL MINUTES TO COOL DOWN). Install the new tubes firmly and fully in the sockets, taking care to observe the direction of the locating ridge on the plastic center pin of each tube.

Turn the BIAS controls to the midpoint of their rotation, with the screwdriver slot approximately straight up and down (12 o'clock position).

Follow the normal turn on procedure and begin the BIAS procedure. While doing this, keep an eye on the plate (the outermost metal structure) of the output tubes. SWITCH OFF IMMEDIATELY IF THEY BEGIN TO GLOW RED. This indicates that the tube is "running away", being destroyed in a matter of seconds by conducting excessive current. (Note: with some KT77s a slight dull orange glow may occur over a very small section of the plate, usually at an edge. This is acceptable and not the same as running away, in which most of the plate will become bright orange or red.)

Tubes may run away for several reasons:

1) The tube is not fully inserted in the socket.

2) The tube fits loosely in the socket and thus can not make correct contact. Such a tube is unusable and should be returned to its seller.

3) The tube is defective.

4) The bias pot has been turned too far COUNTER-CLOCKWISE.

5) The power connectors between the amplifier and the power supply connector may not be fully inserted and locked.

6) There is a problem with either the amplifier or the power supply. Contact VAC or your dealer to arrange service.

In the event that trouble is encountered check connections and/or try another tube. Stop if the problem persists and consult with your dealer or VAC.

Follow the BIAS procedure described previously in this manual to set the idle current at 54 milliamperes per tube, checking the idle current at 1 minute, 30 minutes, 1 hour, and 2 hours.

For further information, refer to Tips & Advice: A Word About Tubes in General and Tips & Advice: A Word About Output Tubes.

REPLACEMENT OF LOW LEVEL TUBES

Refer to Figure 4 for the location and types of tubes. All power must be switched off. Allow tubes to cool down. Remove and replace with new tubes of the appropriate types, noting the location of holes in the socket and pins of the tubes.

AC BALANCE may be readjusted for minimum measured distortion if desired, but most tubes will perform correctly without adjustment.

Replacement tubes are available from VAC and other sources.

For further information, refer to Tips & Advice: A Word About Tubes in General and Tips & Advice: A Word About Low Level Tubes.

CARE OF CHASSIS

VAC chassis are machined aluminum for superior electromagnetic performance, and finished in highly polished black lacquer or textured black. This finish is durable but can be scratched or chipped, just as that of a fine automobile may be damaged. Cleaning with a damp cloth WHILE THE AMP IS SWITCHED OFF AND UNPLUGGED should suffice.

When shipping your VAC amplifier, be certain to wrap the amplifier in the cloth or tissue originally shipped from the factory. With the lacquer finish, take care to ensure that there are no ridges in the cloth. Use of a harsher cloth or the presence of deep wrinkles in the cloth may result in abrasion of the finish.

TIPS & ADVICE

A Word About Tubes in General

It is a truth that each brand of tube sounds different in a particular high resolution circuit. This is because no two manufacturers make a tube type in quite the same way, and the central tendencies of the performance parameters will differ slightly with each maker. To emphasize the point, examine the plate structure of any two 12AX7 from different manufacturers will probably find that they may not even the same shape and size. (Be careful here, as often a tube is made by a firm other than indicated on its label. In the heyday of tubes it was common to crossbrand between major labels, such as GE and RCA. Today many labels do not manufacture their tubes at all, including Gold Aero and RAM.)

This sonic variability may at first seem a liability, but further thought will reveal that it is an advantage, just like the ability to adjust VTA on a tone arm. The owner of a tube amplifier can select those tubes which sound like the real thing in his/her specific system. Of course, if the manufacturer you prefer is rare you may want to purchase a few spare tubes for the future.

How long should tubes last? It has long been known in professional circles (and probably now forgotten) that a tube such as the 12AX7 will display better performance characteristics after two years of continual operation than when it was new. In normal use it is not unusual for a low level tube to last 10 years or longer. Output tubes are another story, as they are continually providing significant amounts of current. Here the sound is your best guide. Certainly tubes should be replaced when the amplifiers can no longer meet specifications or when (if you have access to a tube tester) the tube's emission is significantly down or its transconductance is substantially out of specification. In normal use, output tubes will last at least 2 years and perhaps more than 10 years.

VAC will be happy to test tubes for concerned customers.

TIPS & ADVICE

A Word About Output Tubes

Your VAC Amplifier can use 2 different output tube types: the KT77 Beam Power Tetrode and the EL34/6CA7 Power Pentode. From the engineering perspective, beam power tubes have sharper "knees" to their plate characteristics, more second harmonic distortion, less third harmonic distortion, and are somewhat less tolerant of load impedance mismatches.

As with interconnects and speaker cables, each tube manufacturer's EL34 tends to have a distinct sound when used in VAC amplifiers, and of course the KT77 sounds different as well.

Feel free to experiment with different brands and types to customize the sound to your tastes.

A Word About Low Level Tubes

The Voltage Amplifier/Phase Splitter tube in the VAC Amplifiers is a type 12AX7. This tube is essentially the same as types 12AX7A, 12AX7WA, 7025, CV4004, ECC83, and E83CC. The driver tube type 12AU7 is also known as types 12AU7A, 6189, CV4003, E82CC, and ECC82. The quality of the tube used is by far more important than which of these (equivalent) types is used.

The preferred 12AX7A is the British/Chinese Golden Dragon. Acceptable alternate versions of the 12AX7 include the Chinese 12AX7, the old USA Sylvania 12AX7 stock sometimes available under the ECG/Phillips label, the Brimar CV4004, the Hungarian 7025, and the GE 12AX7. The Yugoslavian 12AX7 yields a somewhat coarse and forward sound.

The best tubes for the 12AU7 spot are the Golden Dragon 12AU7 and the Brimar CV4003 (ribbed plate style, *not* the smooth plate version). A darker sound is obtained with the Sylvania 6189, and the Mullard CV4003 is a more lean and hollow sounding cousin. The Yugoslavian made 12AU7 is adequate but not preferred.

Many classic tubes worth trying if you have access to them, such as those from Telefunken and Amperex, although a caution is in order, as we have recently seen East German EL34 relabelled "Telefunken West Germany." Tubes actually manufactured by RCA, Westinghouse, and Sylvania can be quite good, but the name on the tube doesn't always indicate who actually made it. Other names to watch for are Valvo, Mazda, Tung-Sol, Bendix, Mullard, Brimar, and Raytheon.

A Word About Bias Levels

The PA90 is designed to operate in Class A at an idle current of 54 (mA) per tube, at approximately 480 VDC. This represents Class A_1 operation with no output tube reaching cut-off or drawing grid current (see VAC Technical Monograph 90-8).

You may have noticed that many competing amplifiers consider a much less demanding 26 mA as "enriched" Class AB_1, representing operation without output tube cut-off ("Class A") only up to approximately 16 watts. Some even erroneously refer to this as Class A_1. Be assured that the PA90 is strong enough to handle the more demanding 54 mA level. However, if you prefer the slightly greater tube life predicted by a lower idle current, you may adjust the bias level down to as little as 40 mA. This will change the amplifier's class of operation to AB_1. If you do, experiment with the output impedance connections for best sonic results.

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A Word About Impedance Matching

We strongly suggest that you experiment with the three available impedance connections for the best sonic match with your system. Since no loudspeaker represents an unchanging impedance at all frequencies, it is impossible to assert with certainty which output tap is appropriate to use. In many systems an amazing difference in sound will exist between the various impedance taps.

You should consider the output impedance markings on your VAC Power Amplifier as follows:

"8 ohms" matches loads between 4 ohms and 8 ohms
"4 ohms" matches loads between 2 ohms and 4 ohms
"2 ohms" matches loads between 1 ohm and 2 ohms

Most loudspeakers vary outside of any one of these ranges, which is why experimentation is essential. We often find that matching a speaker's minimum impedance is more important than matching its nominal (average) impedance.

If you bi-wire your system (run separate speaker leads from the amplifier to the high and low frequency transducers) you may discover that two different impedance taps work best. For example, with early production Martin Logan Sequel II we find that the bass speaker is best matched with the 4 ohm tap, while the electrostatic panel is best controlled by the 2 ohm tap. To achieve this connection, the positive leads of both speaker cables connect to "+8/+4/+2" on the back of the VAC Power Amplifier. The negative speaker lead for the electrostatic panel connects to "-2 ohms", while the negative speaker lead from the woofer connects to "-4 ohms". On later production Sequels we use the 4 ohm connection to both drivers.

Contrary to popular misconception, no power is lost due to unused output taps. Also, the amount of negative loop feedback in the amplifier does not change, being fixed at approximately 8 decibels for all output taps. For more information consult VAC Technical Monograph 90-9.

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A Word About Output Stage Operating Mode

Triode amplification is the oldest form of amplification known, while partial triode ("ultra-linear") operation of pentodes and beam power tubes dates back to 1937. Both modes of operation are available with your VAC Power Amplifier.

From the engineering perspective, the triode mode differs from the ultra-linear mode in the following ways:

1) Somewhat more distortion at low power levels
2) Somewhat less distortion at moderate power levels
3) Reduced maximum power output
4) Output impedance matching is somewhat less critical
5) Increased damping factor.

The ultra-linear mode applies negative voltage feedback from the primary of the output transformer to the screens of the output tubes. The ultra-linear circuit displays different characteristics (efficiency, distortion components and levels, etc.) depending upon how much of the primary winding is common to both the screen and plate of the output tubes. One commonly sees 20% to 45% winding in common. The VAC implementation of the ultra-linear circuit has been selected to achieve performance quality as close to pure triode as possible while still increasing power output and efficiency.

Subjectively, the triode mode often produces a more natural sound provided that sufficient power is available for your application. Listen to both, and select the mode most pleasing in your system.

SPECIFICATIONS

The VAC System has been developed with the critical ear as the major arbiter of quality, with both conventional and unique measurements providing insight and guidance as necessary. The lack of emphasis on measurements is due to the fact that engineering's arsenal of equipment and techniques do not operate on the pattern recognition principals that control human perception of sound.

In the immortal words of Daniel von Recklinghausen, if it measures good and sounds bad, it is bad. If it measures bad and sounds good, you've measured the wrong things.

For those concerned with test bench performance, the following describes typical measured performance of a PA90C1/PS90C 90 Watt combination operated at 120 VAC, 60 Hz.

Power Output: 96 watts continuous average power at 1 kHz with less than .35% THD into 8 ohms connected to the 8 ohm tap. 120 watts continuous average power at 1 kHz with less than .45% THD into 5.33 ohms connected to the 8 ohm tap. Triode mode reduces power to 60 watts.

Frequency Response: down 0.5 dB at 6 Hz and 90 kHz, ref 0 dB = 1 watt @ 1 kHz.
down 3.0 dB at 2 Hz and 103 kHz, ref 0 dB = 1 watt @ 1 kHz.

(Note: response peaks will be observed at approximately 68 kHz and 190 kHz. Such peaks are present in all tube type transformer coupled power amplifiers, and are normally suppressed by the use of a phase compensation network in the negative feedback loop. VAC has deliberately avoided this technique, finding that it is sonically inferior to the slight ultrasonic peaks encountered with an excellent output transformer. The compensation technique looks good into a resistive load, but falters in the real world. Interested audiophiles should see Some Defects in Amplifier Performance Not Covered by Standard Specifications by Norman H. Crowhurst, published in the October 1957 **Journal of the Audio Engineering Society**.)

Power Bandwidth: down 0.5 dB at 12 Hz and 58 kHz, ref 0 dB = 90 watts @ 1 kHz.
down 3.0 dB at 7 Hz and 72 kHz, ref 0 dB = 90 watts @ 1 kHz.

Slew Rate: Approximately 10 volts per microsecond.

Energy Storage: Approximately 217 Joules per pair.

(Note: This figure is difficult to compare with other designs, as the majority of the energy storage is not shared among stages but dedicated to individual stages or tube sections. Thus interactions within the amplifier are less than with conventional amplifiers with more Joules.)

Negative Feedback: Loop feedback is fixed at approximately 8.3 dB regardless of output tap selected.

Absolute Polarity: The PA90 does not invert signal polarity.

Input Impedance: 100k ohms

Sensitivity: .7 volts RMS input produces 90 watts output

S/N ratio: > 94 dB

WARRANTY

Your equipment is warranted for a period of thirty (30) days from the date of purchase.

In addition, if the registration card(s) is received by VAC along with a copy of your sales receipt from an authorized VAC dealer within this thirty days, a service contract will be extended to cover your equipment for three (3) years (tubes excepted). Receipt of your registration card will be confirmed in writing by VAC: it is important that you call VAC if you do not receive this confirmation.

This warranty applies only to units sold in the United States of America through authorized VAC dealers and operated within the United States. For warranty information outside of the U.S. contact the importer of VAC equipment for your country. Units sold outside of the U.S. should still be registered with VAC. It is the responsibility of the customer to ensure suitability of this product for any specific application.

Your questions and comments are always welcome. Contact:

Valve Amplification Company, Inc.
info@vac-amps.com

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^ Detach and mail to the address above as soon as possible.

REGISTRATION FORM

Name _____

Address _____

_____

Telephone _____/_____-_____

E-mail address _____

Dealer name _____

" address _____

Purchase date _____ Serial Number(s) to be registered _____

Salesperson _____

How did you first learn of VAC products? _____

Please provide any comments on VAC products or your dealer _____

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