

**Pass Laboratories**

**X-2 Owner's Manual**

**Serial Number:**

## Introduction

The X-2 is a balanced single ended Class A audio preamplifier combining new design thought applied to a traditional topology and the experience of over twenty five years of amplifier design. The circuitry is based loosely on that of the Pass Aleph P, but has been revised for manual operation without remote control.

This product design flows from a commitment to create the best sounding product: a simple circuit with the most natural characteristic. The X-2 integrates power Mosfet devices and balanced single ended Class A operation in a simple topology in order to deliver the most natural sound possible.

The design of the X-2 has been kept simple and functional. An input selector switch selects between the four available inputs. The first input can be either balanced or single ended, and the other three inputs are single-ended. The fourth input can be utilized as a standard input or as a tape monitor input. The input selector along with a separate tape selector allows monitoring recordings or recording from a source different from the one you are listening to.

The X-2 minimizes the number of components in the signal path, and yet retains superior objective and subjective performance. It exemplifies the state of the art in exploring how much quality is obtainable with very elementary gain stages. Each gain stage consists of a single Mosfet power transistor operated in common source mode. One such circuit amplifies each signal polarity of a balanced input signal, and their operation is inter-coupled to allow optimal operation with both balanced and unbalanced input signals while providing balanced and unbalanced outputs.

The gain stage uses an ultra-matched pair of power Mosfets biased by a single constant current source. The signal path of the X2 is as simple as you can get and operates entirely without negative feedback. In spite of this extreme simplicity the circuit delivers as high as 70 volt balanced peaks. At levels which merely clip amplifiers the distortion level is about .007% across the audio band, with a frequency response which is flat to 200 KHz.

The volume control has 24 matched sets of precision metal film resistors on a Swiss-made stepped switch which offers a 60 dB range and .1 dB tracking.

Two separate toroidal power transformers provide an unregulated 160 volts which is then actively and passively regulated down to 130 volts using separate regulator systems for each channel. The noise of these power supplies is on the order of 20 microvolts. The preamplifier has a muting relay with a control circuit which delays output connection on turn-on and which mutes the preamp in case of insufficient line voltage for proper regulation.

Thank you for purchasing this product. We at Pass Labs hope that it provides you with the sonic experience that you are seeking, and that your enjoyment of it is equal to the effort we put into its design and construction.

## Setup

The preamplifier has four sets of input connections, two sets of output connections, an input selector, tape selector, and one level control.

It also has an AC line power connection. The preamplifier's voltage rating is indicated on the rear. It will be either 240 volts, 120 volts, or 100 volts. A .5 amp 3AG slow blow fuse is provided with 100-120 volt units, and a .25 amp slow blow fuse is provided with 220-240 volt units. The frequency rating of the power supply is 50 to 60 Hz. The preamplifier draws 30 watts and is designed to run continuously.

We have provided a standard AC power cord which fits into the line receptacle at the rear. The preamplifier is equipped for operation with an earth ground provided by the AC outlet. Do not defeat this ground. The chassis and circuit ground of the preamplifier is connected to earth through a power thermistor, which gives a ground connection for safety but helps avoid ground loops.

The input connections on the rear are one pair of XLR and four pairs of RCA connectors with right and left channels indicated. If your signal source is balanced, you will want to use the XLR input connectors. On these connectors, pin 1 is grounded, pin 2 is the positive signal input, and pin 3 is the negative signal input. The RCA input on the first input connects to pin 2 of the XLR connector.

For unbalanced operation on the first input, a shorting plug is provided between pins 1 and 3, shorting the negative input to ground, and providing the lowest possible noise. Except for a small difference in noise, there is no significant difference in performance between using the shorting plug or not.

The unbalanced input impedance of the preamplifier is a nominal 10 kOhms. In balanced mode, the input impedance is higher, with a differential impedance of 20 kOhms.

Next to the inputs on the rear panel, the preamplifier offers tape outputs through RCA connectors. Input 4 is deliberately not available through the tape output connection. Input 4 is designated for use with a tape recorder if you have one, and we have arranged that it will not place its output on the tape out, which will prevent you from accidentally creating a feedback connection with your tape machine.

At the left hand side (viewed from the rear) of the rear panel, two male XLR connectors and two RCA connectors are used for the main output. On the XLR, pin 1 is ground, pin 2 is positive, and pin 3 is negative. The RCA connector's ground is in parallel with pin 1 and the RCA hot is attached to pin 2. You may use either or both of these connectors for balanced or unbalanced operation.

The circuitry of the preamplifier is such that it will drive any impedance without distortion, however as the load impedance goes down, you will experience a reduction in gain. The preamplifier will act as a maximum plus and minus 30 ma current source into a dead short.

We recommend the use of the balanced output mode whenever possible. It offers less distortion, less noise, more gain, and more voltage swing, all without compromising the sound.

Additional gain and voltage swing are available beyond the settings with which the preamp is shipped. In "high gain" mode, the preamp can give an additional 6 dB of voltage gain and nearly twice as much maximum output swing, with a penalty of proportionately higher noise and distortion.

If you find that you must have more gain and/or voltage swing, high gain mode can be enabled by removing the four "gain" jumpers on the interior main board of the preamp. These are located near the output connectors.

Please avoid electrical shock by adhering to the following advice:

As removing these jumpers requires opening the preamp, it is very important that this task be performed by someone with some skill. AC power to the preamp must be removed and insured by removing the power cord from the preamp. Allow at least one minute from removal of AC power before opening the top, so that the high voltages inside have a chance to bleed down to safe levels. When you remove the gain jumpers, we advise that you "park" them on one of the two pins so as to not lose them.

The X-2 uses power Mosfets exclusively for its gain stage. These Mosfets were chosen because they have an excellent transfer curve for an asymmetric Class A design. The gain Mosfets are rated at 32 watts each and peak currents in excess of 5 amps. Needless to say, they do not work very hard when sourcing 30 milliamps into a load. The use of such devices does provide very high transconductance and charge surface area over small gain devices, and this shows in the excellent linearity obtained with only one device operated without feedback.

Mosfets provide the widest bandwidth of solid state power devices, however they were not chosen for this reason. The design of the X-2 does not seek to maximize the preamplifier bandwidth as such. The capacitances of the Mosfets provide a natural rolloff in conjunction with the resistive impedances found in the circuit, and the simplicity of the circuit allows for what is largely a single pole rolloff characteristic. Nevertheless, the bandwidth of the circuit will typically extend to about 200 kHz (-3dB).

There is no such thing as a slew rate for this circuit, as it will retain the linear RC characteristic for any input signal.

The common mode rejection of the preamp reflects the constant current source biasing, the matching of the gain devices, and the matching of the output loading. In this case we have been able to deliver a total match of about .1%, for a common mode rejection of approximately -60 dB.

The input system of the preamplifier will exhibit full common mode noise rejection with passive balanced sources, where the negative input is connected to ground at

the source through the appropriate source impedance. This allows adaptation of unbalanced sources to balanced operation with passive cable connections in a manner that achieves the noise rejection of active balanced sources.

Load impedances do not make much difference to the character of the output. The intrinsic output of the impedance of the preamp is passive in nature, and no load will create nonlinearity, only level attenuation.

The output of the preamplifier is guarded by muting relays which delay connection during turn-on and shut off the output when insufficient power supply is available to maintain regulation. The preamplifier is designed to run constantly, and will exhibit optimum performance within an hour of turn-on.

As mentioned previously, the volume control has 24 matched sets of precision metal film resistors on a Swiss-made stepped switch with gold contacts. This switch offers a 60 dB range of level with about .1 dB tracking. Most of the steps are in about 2 dB increments, with greater increments near the counter-clockwise position.

The internal power supply for the X-2 consists of a two toroidal power transformers delivering an unregulated 160 volts which is actively regulated for each channel before feeding passive filtering. By the time the voltage reaches the circuit, it has become +100 volts and -30 volts with noise figures on the order of 20 microvolts. This noise is then differentially rejected by the balanced topology of the circuitry. The +100 volts is available for output voltage swing, and the -30 volts is used to power the constant current sources. This bi-polar supply arrangement allows us to use direct coupled inputs on the Mosfets. The output must still be capacitively coupled, as it sits at about +50 volts (halfway to the positive supply), but we use high quality film capacitors to insure minimal degradation.

The chassis of the X-2 is made entirely of machined aluminum. We mill and engrave the chassis components from solid aluminum material on computer controlled vertical milling machines. No sheet metal is employed.

The X-2 is warranted by Pass Laboratories to meet performance specifications for 3 years from date of manufacture. During that time, Pass Laboratories will provide free labor and parts at the manufacturing site. The warranty does not include damage due to misuse or abuse or modified products and also does not include consequential damage.

## SPECIFICATIONS

Gain	10 dB (normal)	16 dB (high gain)
Freq. Response	-3 dB @ 5 Hz	-3 dB at > 100 kHz
Distortion	< .01 % THD @ 2 volts rms balanced	
	< 1% @ 18 volts rms balanced (normal)	
	< 1% @ 40 volts rms balanced (high gain)	
Maximum Output	18 volts rms. balanced out (normal)	
	40 volts rms. Balanced out (high gain)	
Output Impedance	1000 ohms each output polarity	
Input Impedance	10 kOhm unbalanced	20 kOhm balanced
CMRR	less than -50 dB, 20-20 KHz	
	typically less than -67 dB @ 1 KHz	
Crosstalk	less than -60 dB, 20-20 KHz	
	Typically less than -80 dB @ 1 KHz	
Output Noise	80 microvolts rms 20-20 KHz band unweighted	
Power Consumption	30 watts	
Dimensions	17 " W x 11.5 " D x 3.5" H	
Shipping Weight	35 lb.	

# PASS

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