

## **WHY TUBES**

### **A COMMENT ON TUBES VERSUS TRANSISTORS FOR REPRODUCTION OF RECORDED MUSIC**

I first became interested in Audio in the early fifties, well before transistors and other high tech materials became available to the Audio Industry. We were constantly looking for ways to improve in the quality of sound production, even before the development of stereo vinyl. Stereo tapes were available, but the program material was so limited that few people had invested in two channel systems.

Instead some of us went to great extremes to try to improve the realism of our playback systems. I remember well my first three channel, monaural system which used passive high level crossovers to divide the music spectrum into three audio bands. The crossovers were at 500 hertz and 5000 hertz and separate amplifiers were used for each of the three frequency ranges. The results were not particularly good, but we thought it was great, being driven more by the quantity of hardware in the system than by sonic splendor.

Then came the first stereo vinyl recordings which were really very good even today, when played with state of the art turntable cartridge systems. The problem was the transducers, both at the beginning and the end of the playback system. Compliance without excessive resonance was an elusive goal for the cartridge designers at the time. The first cartridge I bought, a Grado was probably the first they ever designed. It weighed several ounces and really made a great sinker for fishing line. As a retriever of the nuances of audio from fragile vinyl it was a disaster.

The tube technology used for amplification was very mature by this time and probably much better than we realized. It was the transducers that were limiting the quality of reproduced sound. A good phono cartridge was extremely difficult to make and when the

design was good it was very difficult to make them in quantity with the same level of performance. Later in the fifties and early sixties transistor equipment became available and everyone was entranced by the absence of noise and ease with which good specifications could be achieved for a modest cost.

In fact it was the transistor that prompted me to quit designing and building tube based equipment. Even very simple solid state circuits performed better on the **workbench** than my most sophisticated tube designs. At the time I decided that it was the answer to the quest for the **grail** in amplification and I began to look for the pot of gold at the rainbow's end. Oddly enough it was not to be found and sound reproduction seemed to have reached a plateau that we thought was good, but not great. By the mid seventies virtually all high-fi and most hi-end gear was transistor based. In the meantime space age technology had seeped into the audio world and transducers were steadily improving.

By the early eighties the advent of the CD player (unfortunately transistor based) was revolutionizing the beginning of the audio reproduction chain and the new materials available were allowing designers to develop phono cartridges and speakers with dramatically improved characteristics. But there was still something missing in most music reproduction. No one really understood why, even with hardware that measured magnitudes better than that available in the fifties and sixties, recorded music still did not sound very good let alone create an illusion of the real thing.

I should have been able to make the discovery that turned this thing around, but being an engineer, I was convinced that what measured the best, sounded the best! For fifteen agonizing years the audio community struggled with the realization that tube hardware used judiciously in a playback system almost always produced a more enjoyable sound and a better illusion of live music.

The engineers laughed at this and continued to bash anything that did not measure perfectly. In fact they were so sure that ordinary



copper wire measured so perfect, the developing high end cable industry was thought to be a bad joke. In fact you still hear some engineers say that the best amplifier is a straight wire with gain. Wow, how wrong can you be!

To put it simply, tubes have a sonic signature that mimics acoustic music and transistors do not. Now I'm going to lay low while the cannon shots pass over my head. It is certainly true that good, let's say average, performance is easier to obtain with solid state hardware than with tube designs. However, well designed tube equipment coupled with a good output transformer will sound more musical and is more satisfying to listen to than solid state at any price. It does take a little maintenance, but it will warm your feet on a cold winter night. The next level of sonic achievement can be obtained by use of an all tube OTL - but that's another story.

The real improvement in audio reproduction in the last forty years has taken place at the ends of the chain - namely good transducers. These are the devices that change acoustic energy to electrical energy and back again. Even the CD player, which begins its life with solid state technology, is a major advancement in transducer technology. Better analogue circuitry has resulted in very good sounding digital information recovery, but it still lies in the realm of the vacuum tube to produce the recorded sound musically and with realism.

You will notice that I don't use the term accuracy. This throws us back into the engineers argument with the artisans that the most accurate is the best. The answer to that is a flat **no**.

# THE JOULE ELECTRA OPS/MII PHONO SYSTEM

## INTRODUCTION

By reading the attached comments on the evolution of audio reproduction over the last fifty years you will realize why Joule Electra has spent so much time developing a tube phono stage for use in high end music systems. Without question the engineer's choice for phono playback is the low impedance, low noise capability of a well designed solid state front end. The Gold Aero DB 45 is an example of how a very simple solid state circuit can produce excellent results in the recovery of information from vinyl. We have used this device in our line amps for three years and will continue to offer it as an onboard option for our LA-100 line amplifier.

Joule Electra has now developed a medium/high gain phono stage that captures the sonic superiority of tubes in the reproduction of vinyl. Two dedicated triode pairs driving a modified Mu Follower gain stage using modest feedback results in a circuit that recovers the magic of recorded information available on vinyl - magic that has been there for decades.

There are compromises in using an all tube design for this **QUEST**. Transistor circuits are, or can be, inherently quieter, and allow the designer a much easier task in controlling noise in both the form of hum and hiss.<sup>1</sup> Our tube design will not provide the degree of quietness available from the best solid state designs. It does, however, match the nature of analogue acoustic information found in the vinyl medium, and with a good reproduction system can produce sonics that will satisfy even the most jaded listener.

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<sup>1</sup> David Manley says best in his book, "...one and a half volts rms from point two of a millivolt or three-quarters of a volt from point one of a millivolt. Truthfully, this is stretching tube amplification technology to the absolute limit in noise terms, both from microphonoy and the Miller/rush effect".



## **CARTRIDGE OUTPUT REQUIREMENTS**

We recommend the high gain version of our phono stage be used with cartridges having at least 0.3 millivolts. In some cases this will not produce a noise floor low enough for some audiophiles. A cartridge with an output of 0.4 or above is the best choice. Our standard tube circuit comes with a switch between the head amp, a paralalled pair of 6DJ8's, and the RIAA circuit. This allows the user to select the best sounding compromise between amplification and noise level for the higher output cartridges.

The OPS/MII phono stage produces a phase inversion at the output when used in the high gain setting. This requires that the - and + connections to each half of the cartridge be reversed for normal system compatibility. Conversely the low gain setting does not invert phase and the cartridge is connected in the normal manner. Figure 1 shows how to properly connect the phono stage for different system parameters. We will be happy to answer this and other questions the user may have about the OPS/MII.

An extra RCA jack is provided for each channel to allow cartridge loading if other than the standard 47,000 ohms is required. Higher values of loading will necessitate that the internal loading resistors be cut loose from the input jacks. This is very simple to do, or the phono stage may be returned to Joule Electra for custom arrangements.

## **CIRCUIT DESIGN**

The circuitry for the OPS uses the same Mu follower topology found in the very successful Joule Electra LA-100 line amplifier. In the RIAA section an extra gain stage has been added to allow the proper equalization to be implemented using feedback. We found by comparing different circuit designs that feedback equalization gives the most satisfying sonic signature. You will note that again we do not refer to accuracy. This is for the engineer to decide, but we put our text books away when we listen to music.

Six tubes are required to do the job in an adequate manner and we will probably offer a more exotic version with more tubes later this year. The basic circuit will be essentially the same but incorporate two more paralleled triodes in the execution of the RIAA stage. It will be a state of the art execution of our basic circuit and will be about double the price of the OPS/MKII.

The OPS/MII can be added to any Joule Electra LA-100 for the power source. There is no charge for this when done at the time of purchase of the preamplifier/phono stage combination. A small charge is made when the preamp is returned for this modification. The separate power supply available for the OPS/MII is identical the power supply in the LA-100 but the Phono/Power Supply combination has the mute circuit duplicated for stand alone use.

The power supply has two dual triodes that perform the voltage regulation function coupled with two OA2 voltage reference tubes. This results in a "modest ten tubes" for our phono system. We are planning to offer a minimalist version of the phono stage/line stage later this year. This product will provide a line stage identical to the LA-100 which will be switched to operate as a phono stage, either high gain or medium gain. It should provide adequate gain for 0.4 millivolt cartridge and above in most systems. It will accommodate only one or maybe two inputs, with direct coupling.

## **SPECIFICATIONS FOR THE OPS/MII**

GAIN, SELECTIBLE	HI 62 db	LOW 36 db
INPUT IMPEDANCE	HI/LOW 47,000 OHMS ALTERNATE LOADING AVAILABLE	
OUTPUT IMPEDANCE	1000 OHMS	
OUTPUT VOLTAGE	2 VOLTS INTO 10,000 OHMS	
TUBE COMPLEMENT	HEAD AMP	2-6DJ8's
	RIAA STAGE	4-5751's
EQUALIZATION	RIAA +- 0.5 db	
NOISE	- 60 db @ 2 VOLTS OUT	
WEIGHT	PHONO STAGE	10 LBS
	POWER SUPPLY	15 LBS
DIMENSIONS	WIDTH	17 INCHES
	HEIGHT	4 INCHES
	DEPTH	9 INCHES