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## How to Select a Preamp with the Correct Gain

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Preamplifiers or preamps are very key pieces of equipment in any audio path. Although not always required, they play an important role by boosting very tiny signals produced by phonograph turntables, CD players, Digital to Analog Converters (DACs), and other audio source components. In fact, most components that don't require a standalone preamp will have one built in to boost the signals available at the output of the device.

### 1. Purpose of a Preamp

A preamp is used to increase the amplitude or signal level from a source component so that the signal available at the output can effectively drive an amplifier. That is, with a given input signal to an amplifier, you achieve the maximum output power to your speakers.

"Can't I just turn up the volume on my amplifier?"

You sure can, but this will only work up to a point. If the input signal is too small even with maximum amplifier volume, the listening volume will still be very quiet. This is caused by the amplifier having a fixed gain from input to output. Even with the volume control at the maximum level, the amplifier does not have enough gain to reach full output with such tiny signals.

One of the most common applications for a standalone preamplifier is for running a turntable used to play vinyl records. These preamps are often called phono preamps. A phono preamp serves two purposes: First to provide the proper equalization for flat frequency response during playback (known as the RIAA curve) and second to boost the miniscule output voltages from the phono needle and cartridge. The output voltage signal level depends on the phono cartridge mounted onto the end of the tonearm. For moving magnet (MM) type cartridges, the voltage specified at 1KHz is usually in the 3-7mV range. Moving Coil (MC) types are generally much lower can be as low as 0.3mV or 0.0003V.

### 2. Gain

Gain is an electrical specification that sets the factor of signal multiplication for an amplifier or preamp. The output signal level will be equal to the input signal level multiplied by the gain, hence it amplifies the input signal. Here the signal levels are measured in Volts as seen in Equation 1.

$$V_{out} = Gain \times V_{in} \quad \text{Equation 1}$$

The numerical value of gain has no units; however, it can be expressed as either a raw scalar number or in decibels (dB). dB is simply a logarithmic transformation of gain often used in engineering.

$$dB = 20 \times \text{LOG}_{10}(\text{Gain}) \quad \text{Equation 2}$$

$$\text{Gain} = 10^{\frac{dB}{20}} \quad \text{Equation 3}$$

Equations 2 and 3 can be used to transform gain into dB and back into scalar form. This is important since many amplifier and preamplifiers specify gain in dB.

### 3. Preamp Selection

Finding the necessary gain for a preamp is a relatively simple exercise. First we need to know the required signal level to drive our amplifier to full output power. For our 288 amplifier, the specification is 1.7V RMS. With a 1.7V RMS input signal the amplifier can be driven to its full 60W spec.

Now if we have selected a phono cartridge for our turntable that produces 3mV the required gain is simply:

$$\frac{1.7V}{0.003} = 2366.6$$

For this result, equation 1 was simply rearranged. However, since most audio equipment is specified in db, we should use equation 2 to convert:

$$20 \times \text{LOG}_{10}(2366.6) = 67.5dB$$

Therefore, we need a gain of 67.5dB between our turntable and our amplifier. Ideally we would probably want a little more than this to give ourselves some headroom, but around this number is a good target.

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Since most phono preamps come with 40dB or 60dB, we could choose a 60dB phono preamp and then have one more intermediary preamp with a gain of around 10dB more. This would give a total signal path gain of 70dB, which would be more than ample.

Another benefit of having a secondary preamp is that you could find one with multiple inputs to switch between audio sources. Since this secondary preamp does not need to have the RIAA Eq (which is taken care of in the phono preamp), we can connect a TV, CD player, DAC or other audio sources into this secondary preamp to help boost their signals and control volume. Multiple input lower gain preamps can be found readily and serve very well for this purpose. The same method used previously should be used on all of the sources in such a system. This way we can ensure that no matter which source component is being used, the signal path will always have enough gain.

### 4. A Few Final Thoughts

First, in the above example we calculated that a gain of around 70dB would be a good target to drive our system to full power. However, in most circumstances home listening is done with only a few watts of power. Therefore, the full 70dB may not be required which would open up the option for a potentially less expensive preamp or a signal chain with single preamp with less gain.

Second, it is important to keep in mind that the maximum output signal swing and gain are very independent. For example, as stated earlier a gain of 67.5dB is equal to 2366. Does this mean that 1V into this system will produce 2366V or 2.3KV of signal voltage? Hopefully not, as this would be very

dangerous! Most manufacturers will specify the maximum output voltage available from a preamp. This is regardless of the gain of the system. It is important to keep this in specification mind so that not too much voltage swing is demanded from the preamp for the desired input signal level. Even if the gain is selected correctly, running out of signal swing will end up limiting the output.