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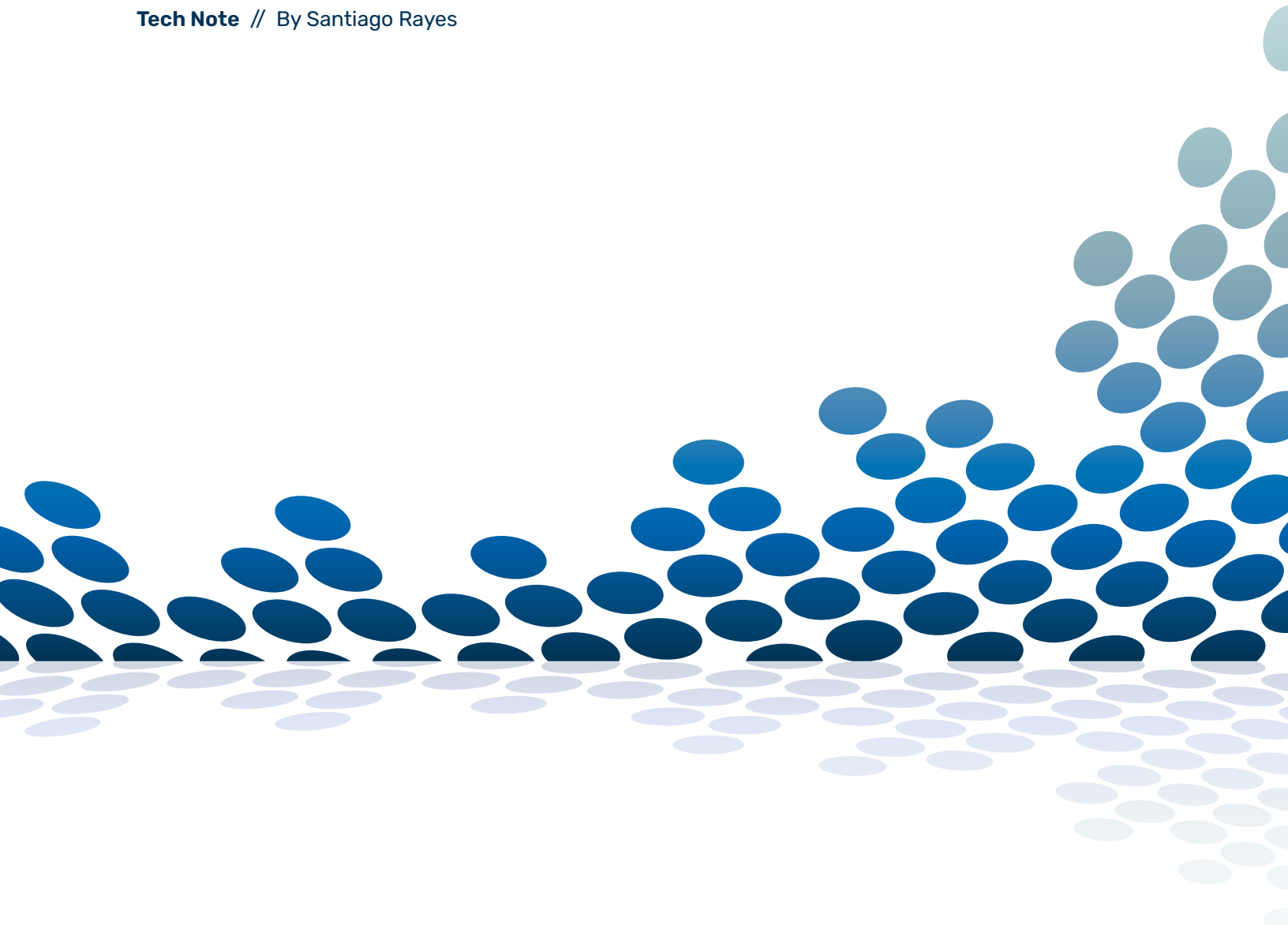
Can I Power a GRAS Microphone Using Phantom Power?

GRAS Sound & Vibration
Tech Note // By Santiago Rayes



TECH NOTE

Can I Power a GRAS Microphone Using Phantom Power?

Phantom Power is DC electric power that is typically used in the audio industry as a power supply for audio equipment such as microphones with active electronic circuits (like studio condenser microphones) and some other audio devices. The Phantom Power is usually transmitted through balanced cables with XLR type connectors and can be found in equipment like modern mixing consoles and audio interfaces (see Figure 1). State of the art testing equipment like the Audio Precision´s APx517 audio analyzer and APx1701 transducer interface also has built-in Phantom Power supply (see Figure 2).

FIGURE 1.
Top RME audio interface with built-in +48 V Phantom Power. Bottom: SSL mixing console with built-in +48 V Phantom Power.

Phantom power is mentioned on the IEC 61938 standard (Multimedia systems – Guide to the recommended characteristics of analogue interfaces to achieve interoperability) where basic specifications for the system are stablished. Even though there are multiple types of phantom power implementations, with +12, +24 and +48VDC supply, +48VDC (typically +/- 4V) tends to be the most common type of phantom supply found in most modern audio interfaces and consoles. The standardization of the +48V Phantom Power format is called “P48” where the supply can provide up to max 10mA (7mA nominal) through 6.8kΩ resistors.

There are other formats, such as “P12” and “SP48”, that provide different specifications.

FIGURE 2.
Top: APx1701 transducer interface with +48V with phantom power. Bottom: APx517 audio analyzer with +48V phantom power.

Measurement microphone technologies

Measurement microphone sets are made from two main parts: the microphone capsule and the preamplifier with a connector (see Figure 3). The microphone capsule contains the diaphragm, which is designed to move when exposed to acoustic pressure fluctuations. On the other hand, the preamplifier is a device designed to transform the high impedance signal coming from the microphone capsule and change it to a low impedance signal that can be fed to a cable that will send the signal to an Analyzer or Data Acquisition System (DAQ).

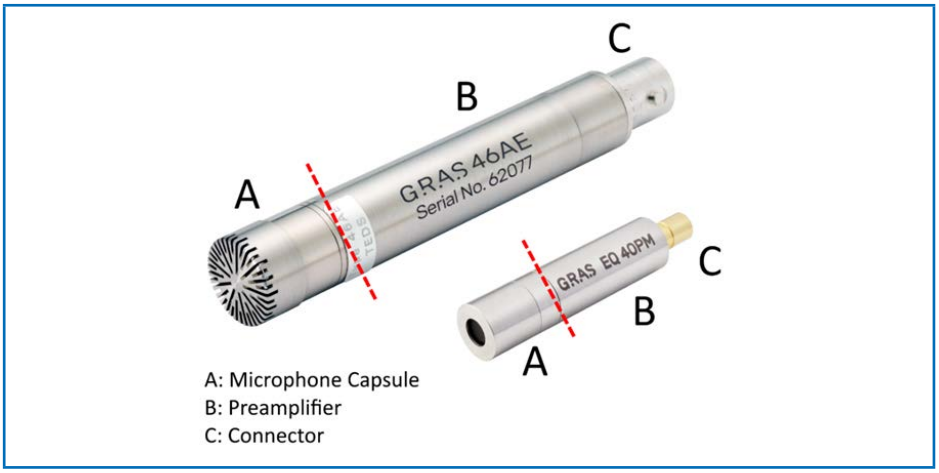


FIGURE 3.
GRAS 46AE (left) and 40PM (Right) microphone sets comprised of a microphone capsule and a preamplifier with connector.

Depending on the method used to polarize the microphone capsule, the measurement microphone capsules are divided into two categories: **Externally Polarized**, that require an external source to provide a polarization voltage for the capsule (typically +200V), and **Pre-Polarized**, that have a thin layer of electrically charged material on its backplate that will provide the polarization voltage needed for the plate capacitor to work.

On the other hand, we also have two different preamplifier technologies: **Traditional LEMO**, that use multi-pin LEMO connectors and are voltage driven, using both single sided and dual sided power supplies (some preamplifiers will support both types of supplies like +/-15V, +/-60V, +28V and +120V). Then there is **CCP (Constant Current Power)** preamplifiers, that are also known as IEPE, ICP or CCLD. These are different names for compatible technologies. CCP preamplifiers use a two-wire coaxial cable, where one wire is used for both the constant current supply for the preamp circuit and the signal output. The other wire is used for ground connection. The output signal from the microphone superimposes fluctuation around the DC level. Typical CCP supply will output 2-20 mA @24-30 VDC.

You can read more about measurement microphone technologies in the "Measurement Microphone Capsule and Preamplifier Technologies" technical note available on the GRAS website.

Measurement microphones and Phantom Power

As seen in the previous section, Phantom Power is not a common way of driving a measurement microphone, however that doesn´t mean that is not possible. Measurement microphones using CCP preamplifiers from GRAS have the possibility to be powered with a Phantom Power supply.

Phantom supply uses a circuit that applies direct current with a 48VDC supply via the two signal connectors of a balanced audio connector. Typically, XLR connector are used here, where pins 2 and 3 correspond to the signal wires and pin 1 is the ground. However, as mentioned above, CCP preamplifiers of measurement microphones use a two-wire system (signal and ground) which is an unbalanced connection. That means that it is necessary to use an adapter to go from the XLR balanced connector to the unbalanced connection of the CCP preamplifier. Most DAQs working with CCP powered sensors use BNC connectors, which is used for unbalanced signals. Therefore, it is very common to use coaxial cables with BNC connectors when working with CCP preamplifiers.

An XLR-BNC adapter can be used to connect a GRAS microphone set with CCP preamplifier, into a DAQ/Analyzer/Audio interface using XLR input connectors with a Phantom supply (see Figure 4). GRAS offers the AG0003 BNC to XLR adapter shown in Figure 5. This adapter is wired in the same way as shown in Figure 4. It is important to consider that an adapter like AG0003 will work with GRAS CCP preamps, but it might not work properly with preamplifiers from other vendors. So, it´s always a good idea to double-check with the preamplifier manufacturer before attempting such connection.

It is important to mention that GRAS test fixtures using a combination of ear simulators or microphones with CCP preamplifiers can also be driven with a phantom power supply using an adapter like the GRAS AG0003. These include the CCP versions of test fixtures such as the ones shown above: GRAS KEMAR, GRAS 45CC and GRAS 45CA, or CCP versions of small desktop fixtures like GRAS 43AG, GRAS 43AA and GRAS 43AC among others.

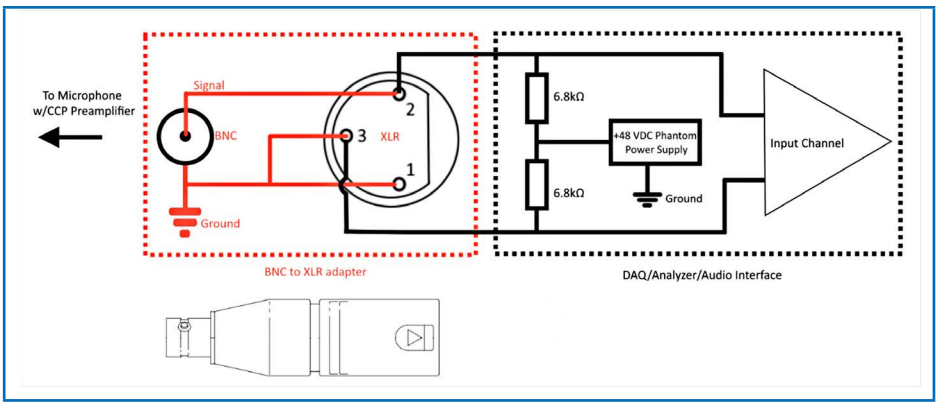


FIGURE 4.
Phantom supply and BNC to XLR adapter wiring diagram.

FIGURE 5.
GRAS AG0003 adapter CCP preamplifier to XLR input with Phantom Power.

The GRAS AG0003 provides an easy way to connect a CCP preamplifier into a card with XLR inputs and Phantom power supply. Since the adapter is offering a direct connection from the XLR connector to BNC, the signal channel will carry an unbalanced signal. AG0003 is wired according to IEC 60268-12 (“Sound system equipment. Part 12: Application of connectors for broadcast and similar use”) and, as seen in Figure 4, Pins 1 and 3 are grounded, so it´s only Pin 2 that is used for the signal coming out of the microphone and providing a constant current supply through the phantom power circuit.

Most CCP preamplifiers work with 2 to 20mA of constant current, but there are some cases that a minimum of 4mA might be needed. Most CCP measurement

microphone sets and preamplifiers manufacturer will provide this information in the product´s technical specifications. Therefore, it is important to know if the Phantom supply used can provide the necessary current to drive the microphone set. “P48” format Phantom supplies, the most common Phantom supply available in audio interfaces today, are typically able to provide up to 7 to 10mA of current. If there are any doubts about the performance of the audio interface, contact the manufacturer for more details. A Phantom power tester or a voltmeter can also be used to test the unloaded performance of the Phantom power supply. If a voltmeter is connected between pin 1 and pins 2/3, it should read +48VDC (+/- 4V) and 0VAC.

Microphone set´s Dynamic Range using CCP vs Phantom Supplies

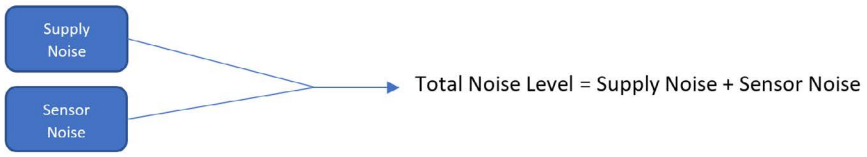
The Dynamic Range of a system is defined as the range between the noise floor of the system and the highest level that the system can handle, and it is typically expressed in dB:

Dyncamic Range [dB]=Dyn Range Upper Limit-Dyn Range Lower Limit (Noise Floor)

For a measurement microphone set, the dynamic range will be linked to the sensitivity of the microphone capsule, the total noise floor of the system, and the power supply used to drive the preamplifier.

Phantom Supplies, particularly the ones that are built-into cost effective audio interfaces tend to have a higher noise floor compared to modern CCP/ICP/IEPE/CCLD supplies included in test & measurement data acquisition systems. Since the dynamic range of GRAS microphone sets is measured with high-quality low noise equipment with CCP supplies, it is important to know that this dynamic range could be affected whenever a different type of microphone supply (like Phantom power) is used.

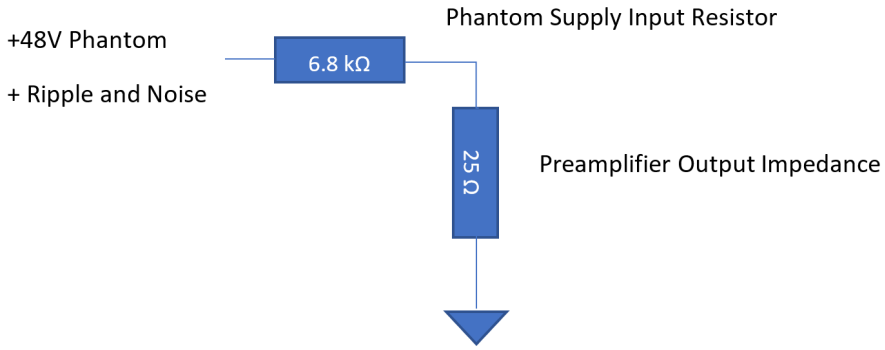
The higher noise in the Phantom power supply can be caused by ripple and noise. The ripple is dampened by the preamplifier, and you can consider the ripple and noise coming from Phantom Supply as a secondary noise source that is added to the inherent noise of the microphone set, as illustrated below:



The mentioned dampening of the ripple and noise in the preamplifier can be calculated in the following way:

$$Preamplifier\ Damping\ [dB] = 20\ \times \log_{10}\left(\frac{Preamplifier\ Output\ Impedance\ [\Omega]}{Phantom\ Power\ Resistor[\Omega]}\right)$$

The Phantom Power resistor is typically 6.8k kΩ with 1% tolerance (for P48 format Phantom) and the Preamp output impedance is around 25Ω, as shown below:



With these values the Damping will be around -48.7 dB.

This means that if a Phantom supply has a relative high noise level, it will have an influence on the dynamic range lower limit for your measurement system. The new dynamic range lower limit, considering the power supply noise, can be calculated in the following way:

$$System\ Lower\ Dynamic\ Range\ [dB] = 94 - (20\ \times \log_{10}\left(\frac{Microphone\ Sensitivity\ [mV/Pa]}{\left(\frac{Loaded\ Phantom\ Supply\ Noise\ [mV]}{Preamplifier\ Damping\ Factor}\right)}\right)$$

$$Preamplifier\ Damping\ Factor = \frac{Preamplifier\ Output\ Impedance\ [\Omega]}{Phantom\ Power\ Resistor\ [\Omega]}$$

Typically, the Phantom power Supply noise is low, below 1 mV, which means the extra contribution to the noise floor is about 2 – 4 µV. This means that for a microphone set with a sensitivity of 50 mV/Pa, the dynamic range lower limit will increase from around 0.5 dB to 1.5 dB.

The chart below shows the difference in 1/3 octave noise floor of the same GRAS 46AE measured in the same setup using first a high quality CCP supply, and a high quality +48V Phantom Power supply (P48 format) after:

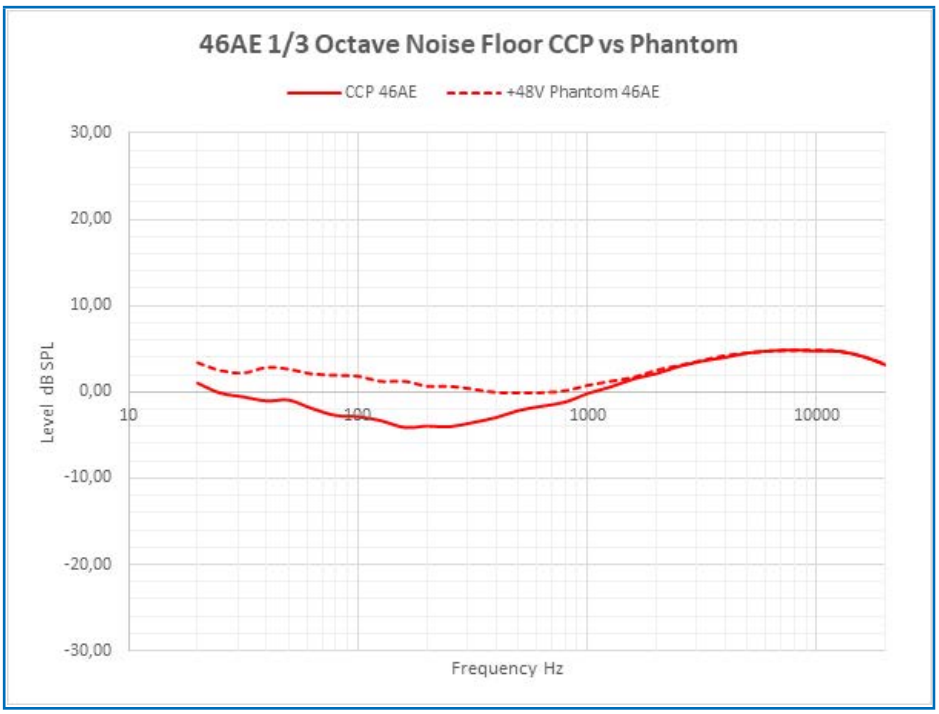


FIGURE 6.
GRAS 46AE microphone set´s 1/3 octave noise floor with CCP and +48V Phantom Power supplies.

As it is possible to see, the noise floor of the system with the +48V Phantom Supply has a higher noise floor in frequencies below 1kHz. This will increase the noise floor of the system from 16.26 dBSPL using the CCP supply, to 17.56 dBSPL using the +48V Phantom Supply. A Total Noise increase of 1.3 dB only related to the use of a different power supply. This is within the expected values from 0.5 to 1.5 dB mentioned above.

When it comes to the Upper Dynamic Range Limit, the use of a +48V Phantom Power (P48) supply won´t have any influence on the specified value for the microphone set. This is valid only if the supply can provide the necessary current needed by the microphone set. But as mentioned before, most modern Phantom supplies will be able to provide up to 7 to 10mA of current, which is more than enough for most measurement microphone sets available in the market. Even if a +24V phantom supply is used, the effect of the Phantom supply on the upper dynamic range limit will be negligible. A lower voltage than +24V will limit the maximum voltage swing of the preamplifier and will therefore limit the upper dynamic range limit.

Extra considerations

It is possible to find audio interfaces with analog inputs and built-in Phantom power supplies in a wide variety of quality ranges. A high-quality device will guarantee a low noise supply with a stable output but it typically comes at a expense of a higher price. Lower quality devices might have a higher noise floor that will limit the dynamic range of the measurement system and might expose the microphone set to unstable supply that will affect its performance. Another thing to consider is that the preamplifier might be exposed to voltage spikes when turning ON and OFF the unit or when turning ON and OFF the power supply. GRAS preamplifiers have protection against overvoltage, but other preamplifiers might not be able to withstand such situations. If that is the case, refrain from having the preamplifier connected to the XLR analog input while powering ON and OFF the audio interface and Phantom supply.

Having a +48V Phantom Power can be seen as an advantage when asymmetrical signals (like impulses) are measured. With a standard CCP supply, a CCP preamplifier will have an output voltage swing of +/- 8Vpk. With a +48V Phantom Supply the positive side of the voltage swing will be extended and therefore higher positive acoustical pressure (that generate a positive voltage output on the microphone) can be measured (See Figure 7). Nevertheless, even when the positive voltage swing of the preamplifier can be extended so much, there is still a limitation on the possible mechanical movement of the microphone´s diaphragm. Therefore, the gains in the upper dynamic range limit for positive acoustical pressure will be limited to only around 10 dB.

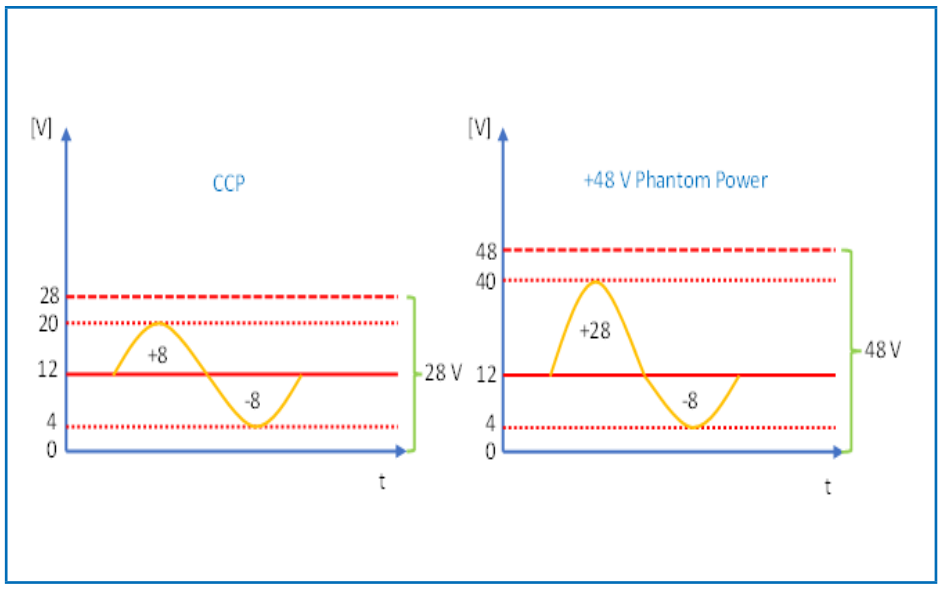


FIGURE 7.
Preamplifier output voltage swing for CCP supply vs +48V Phantom supply. This considers only the preamplifier. In practice, the microphone capsule will limit the maximum sound pressure level that can be measured due to the mechanical limitation of the microphone´s diaphragm movement. Nevertheless, +48V phantom supply will extend the upper dynamic range limit for positive acoustical pressure by a few dB compared to a CCP supply.

Conclusion

GRAS measurement microphones are used in a wide variety of applications, going from research and development labs, field testing and production lines. Sometimes, due to technical or cost reasons, it is necessary to use an audio interface with XLR analog inputs as data acquisition system. Most modern audio interfaces have built-in +48V Phantom supply (P48 format) in their analog inputs. Even though measurement microphones were not originally meant to be driven with a Phantom power supply, thanks to adapters like the GRAS AG0003, it is possible to connect a GRAS microphone to a +48 Phantom supply, or even to Phantom supplies with lower voltages like +24V with small to negligible impact on the performance of the microphone.

Below there is an example test setup where an audio interface was required for a near-field acoustic test of a portable loudspeaker in a production line environment. The audio interface has XLR analog inputs with a built-in +48V Phantom supply. Due to this, it is possible to use the GRAS AG0003 adapter in combination with a GRAS CCP microphone set. A great setup for this application can be completed with the GRAS 40PM microphone set with EQset technology (find more information about GRAS 40PM and EQset technology on the GRAS website), and the Audio Precision APx500 software by using the APxFlex key (that allows the use of the powerful APx500 software with ASIO compatible audio interfaces).

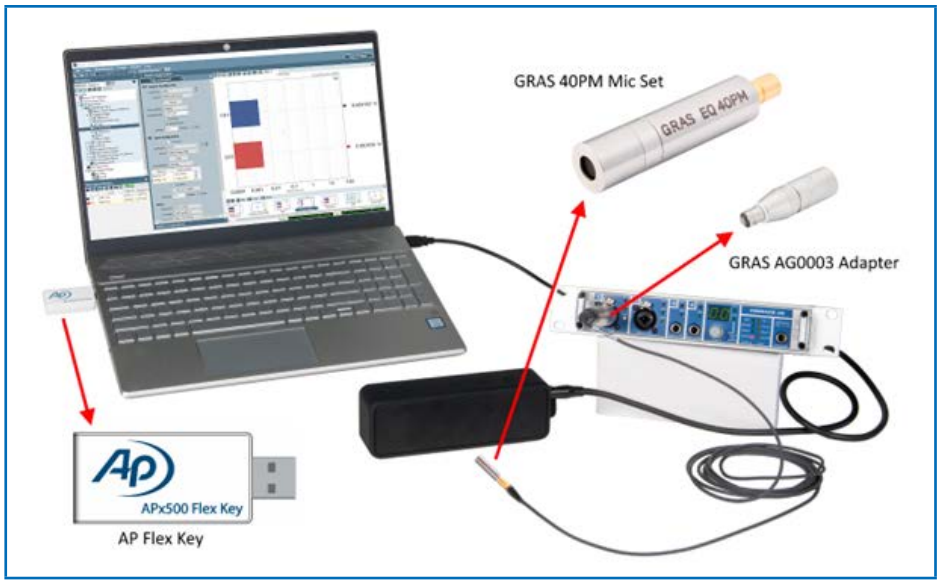


FIGURE 8.
Audio Precision and GRAS setup for production line testing of a small loudspeaker using APxFlex key with a GRAS 40PM microphone set connected to an audio interface with +48V phantom power via the GRAS AG0003 adapter.