Some Remarks on Phantom Powering

as sent to AES Standards Working Group SC-04-04, June 12, 2006

As someone who has witnessed and participated in over thirty years' development of the standard for phantom powering, I would like to list some relevant facts for the sake of better understanding.

1. Phantom powering arose in the mid-1960s as the first transistorized condenser microphones were being developed. Neumann began with several models for parallel ("AB" or "T") powering, a system which is seldom used any more. Soon they also introduced 48-Volt phantom powering. Schoeps had already begun in the meantime to use 9-Volt phantom powering (with its positive pole grounded, since the first low-noise silicon transistors were npn types); this was followed by 12-Volt phantom powering in the now-usual direction, and microphones for parallel and 48-Volt phantom powering as well. AKG developed microphones which could be driven by any phantom powering from 9 to 52 Volts if appropriate feed resistors were used. Sennheiser's transistorized microphones were designed for parallel powering at first; they introduced phantom-powered microphones only later.
2. The term "phantom powering" expresses the fact that operating current reaches the microphone in a "non-corporeal" manner—in theory, without any voltage difference between the two leads of the requisite balanced circuit. Half of the current flows in each lead, causing an identical voltage drop across each of the two feed resistors; the two voltages cancel each other out and become "invisible" to the balanced audio signal.
3. Since both signal leads are at the same potential, other types of microphone can be connected to a balanced phantom-powered microphone input without any need to turn off the powering, provided that the implementation is symmetrical and "floating" (*i.e.* with no DC connection from either modulation lead to ground).
4. The term "phantom powering" was already in use in telephone systems, where it referred to a method of connecting three telephones with only two cables. However, in 1969 Gotham Audio Corp. (the U.S. representative of Neumann) applied to register the word "phantom" as a trademark in the U.S., and in 1970 filed a similar application for "phantom powering." The two trademarks were officially registered in 1971, but have since been allowed to expire. To avoid possible difficulties, terms such as "simplex" or "X/Y" powering were occasionally used as alternatives during that period.
5. Phantom powering was established as a standard in 1973 (DIN 45596). That definition covered only the powering for a single microphone, and did not describe the circuit configuration of the microphone, which has remained the exclusive responsibility of the microphone manufacturer.
6. The two most important parameters of phantom powering are the voltage and the corresponding value of the feed resistor[s]. The most important voltage is 48 Volts. It is only for historical reasons that this voltage is so high; today one can consider that a disadvantage. 12-Volt phantom powering is less common but is still in use. The proposal for 24-Volt phantom powering arose too long after 48-Volt phantom powering was already generally established, and is no longer being advocated.
7. The value given for "maximum current" indicates the current which a supply must be able to deliver per microphone if that supply is to comply with the standard. The current which is actually drawn depends on the microphone design, however; it is generally smaller. Since the voltage drop across the feed resistors is proportional to the current flowing through them, different microphones run with different DC voltages between their two modulation leads and ground. As a result that voltage is not established directly in the standard, though it can easily be calculated with Ohm's Law.
8. The voltage source for a phantom power supply is supposed to be stable, which includes a negligible internal resistance. However, many phantom power supplies now on the market—including some which are from well-known manufacturers—have additional "current limiting" resistors of several thousand Ohms, either due to error or ignorance of the standard. This extra series resistance causes the supply voltage to sag unacceptably as microphones are connected and draw current.
9. Until 1979, the maximum current was set by the standard at only 2 mA for historical reasons. That was enough for the earliest circuits, since they mostly contained only a single field effect transistor.

10. The maximum allowable current as set in the standard has been 10 mA per microphone since 1979. Now that it is over a quarter-century later, phantom power supplies should really be able to deliver this amount! A value of 7 mA might perhaps have made more sense, since that is the point at which the maximum power is delivered to the microphone amplifier, but some reserve was desired—and some microphones today really do draw 10 mA apiece. (A list of the specifications for almost every microphone on the world market can be found in the *Microphone Data Book* by Chris Woolf.)
11. It seems as if some manufacturers are rather half-hearted about building phantom powering into their mixers and microphone preamplifiers, since so many of their implementations of phantom powering don't comply with the standard. The primary weak points are voltages that are too low and/or an insufficient reserve of current.

Not all provisions of DIN 45596 have been noted here. Unfortunately, the features of the standard weren't published in English until 1981, in IEC standard 268-15A. Even today they are not known widely enough.

Occasionally, people who are new to the process of standardization seem to feel the urge to reinvent everything before they even learn what has already been done. There might indeed be useful ways to approach phantom power differently. But given the state of things today, it would be real progress if manufacturers would finally implement even the simplest form of phantom powering correctly (a stable voltage source plus two resistors). Further details are given in my paper "The Feeble Phantom," which can be downloaded from **`http://www.reddingaudio.com/schoeps/the_feeble_phantom.pdf`** .

In any future discussion, I would ask that people consider the following:

- A major reason for the existence of standards is to avoid incompatibilities and operational difficulties. Given the large number of existing microphones that have been designed for 48-Volt and 12-Volt phantom powering, the leeway for making significant changes to the standard is very limited.

- Given the current state of complex studio and stage technology, people sometimes seem to wish for capabilities which classical phantom powering cannot offer. For example, phantom powering was designed for the powering of individual microphones. When multiple condenser microphones are to be operated, each one will require separate powering. Conversely, phantom powering was designed for the connection of a microphone to only one input. When a microphone is connected to multiple inputs in parallel, the permissible load conditions must be considered in order to avoid non-linearities, and the phantom powering should come from only one input or supply.

- There is persistent confusion about impedances. The clearest way to express the situation is in terms of a microphone's *source impedance*, which should be as low as possible, and the *load impedance* of the input to which the microphone is connected, which should be as high as possible—an open circuit being the ideal. The input impedance of microphone preamplifiers has been standardized for decades, but this fact seems to have eluded some manufacturers who now offer selectable input impedance as if it were a kind of tone control. The entire concept of impedance matching simply doesn't belong in this context. Studio microphones aren't designed for matched-impedance loading, and they don't work well when forced to push current into loads which are less than five to ten times their own source impedance.

- The standard has never said anything up to now about the effect which a microphone connected to one input might have on adjacent input channels. In theory there should be no such effect at all since a voltage source has zero source impedance. But evidence could be brought to show that such problems sometimes do occur in practice.

—Jörg Wuttke
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Please note: This text is intended only as a basis for informal discussion at the AES Convention. For any serious historical purposes, the facts and dates given here should be rechecked.

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