Phantom Power Testing

with the MR-PRO

Minirator MR-PRO measures phantom power

Phantom powering is ubiquitous in professional audio. The MR-PRO includes special features to continuously monitor and display DC voltages present at its output. The MR-PRO may be connected to the microphone input of the mixing desk and continuously measures the actual effective phantom power with or without load. This application note describes how to test conformity of the phantom power source in use according to the relevant IEC 1938 standard.

General

Phantom powered devices are commonly used in the audio industry. As no additional conductor for power supply is required both the signal- and power-path share the same connections, thus only one cable is required, applicable at e.g. microphones and preamplifiers.

Standard IEC1938, covering specifications of audio and video interconnections, also comprises the definition of phantom power for balanced audio. These specifications, listed in Table 1, determine power and DC-voltage available to the device based on DC-load impedance. The phantom power voltage is listed as e.g. P24 (= phantom 24 Volt).

PhantomPower	P12	P24	P48
no load voltage Pph0	12V+/-1V	24V+/-4V	48V+/-4V
supplied current up to Imax	15mA	10mA	10mA
R_phantom	680 || 680	1.2k || 1.2k	6.8k || 6.8k

Table 1, Balanced phantom power supply specifications acc. to IEC1938

Surprisingly often audio phantom power sources can be found not conforming to the standard. This can severely affect performance of connected devices. Giving some examples:

- maximum sound pressure level available in the operating range of analog microphones may be lowered, if available output voltage is lower then to be expected from the standard
- sensitivity of analog microphones may be changed, if phantom power impedance is incorrect
- frequency response of analog microphones may break down at low frequencies if the microphones includes capacitive output coupling and phantom power impedance is lower then given in the standard
- power hungry devices (as some digital microphones) might not even start to work
- connecting of a P12 or P24 device to a non-standard impedance P48 may damage the device

PhantomPower	P12	P24	P48
Umin @ Imax	5.9V	14V	10V
p_load @ Imax	88mW	140mW	100mW
p_max @ Uph0 nominal	106mW	240mW	169mW
I @ p_max	17.6mA	20mA	7mA

Table 2, Characteristic phantom power supply parameters for R&D

Besides others Table 2 lists the minimum voltage Umin @ Imax, which is available to the remote powered device. It can be measured at pin2 (or pin3) relative to pin1 if the maximum allowed current Imax is drawn and if voltage Uph0 (no load phantom voltage) is at its minimum specified value. In case the DC-impedances are matched between phantom power source and connected device, the maximum power will be available, thus DC-voltage at pin2 and pin3 will be just half the no load voltage Uph0.

The available power is maximized for P24 and so recommended by the IEC for new designs. But still P48 is the most widespread phantom power voltage. This is due to the fact that using P48 with analog microphones circuits allows for maximum available sound pressure level by less expensive circuits.

Phantom power measurement with Minirator MR-PRO

Phantom power screen
Minirator MR-PRO

The MR-PRO displays the "DC" field continuously including the average voltage value of Pin 2 and Pin 3 of the connection. By moving the main cursor over the "DC" field, a popup panel appears showing the two individual phantom power voltages on pin 2 and pin 3.

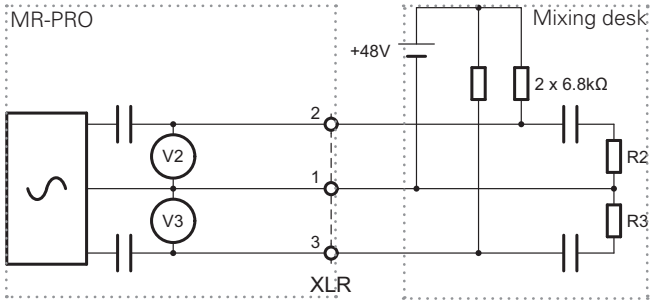


Figure1, Schematics of a typical 48VDC phantom power supply

How to qualify the phantom power source?

Testing the phantom power source consists of two steps:

- Measure phantom power voltage at "no load" condition
- Measure phantom power voltage at Imax

1. Measure phantom power voltage at "no load" condition

Connect the MR-PRO to the audio input with a balanced XLR cable and switch the phantom power on.

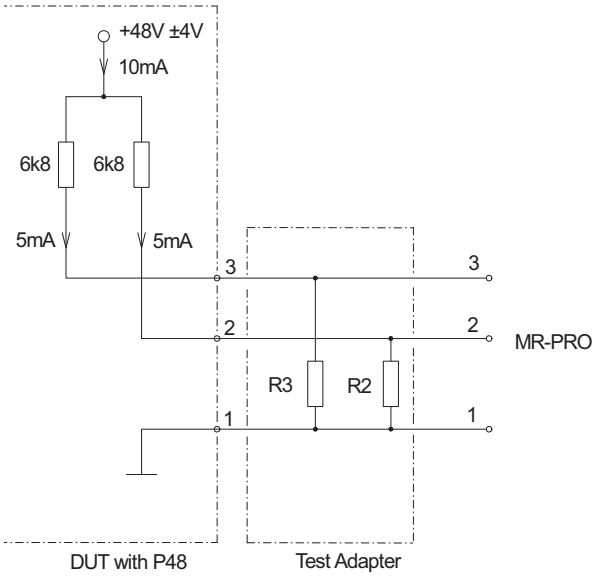
The displayed DC value will slightly differ from the no load voltage. This is due to the impedance of the MR-PRO which is necessary to discharge the output AC-coupling capacitor. Table 3 shows the range of displayed DC values (including measurement tolerances) for which Uph0 conforms to the standard.

PhantomPower	P12	P24	P48
max. Uph0	13.4V	28.6V	51.4V
min. Uph0	10.4V	19.2V	40.9V

Table 3, Phantom power voltage range meeting specifications at no load conditions measured by MR-PRO

2. Measure phantom power at Imax

A defined load has to be connected to the phantom power source, thus drawing the maximum current Imax. For this purpose a test adapter may be applied. The test adapter shall be connected between the MR-PRO output and the phantom power output, as shown in the drawing below. With an additional Y-cable the MR-PRO monitors the phantom power supply during an actual microphone connected.



Test Adapter simulating maximum load conditions

The resistor values R2 and R3 for the defined load are listed in Table 4. With these resistance values the DC-current will be Imax if Uph0 is at specified minimum.

PhantomPower	P12	P24	P48
R2 || R3	787 || 787	2.8k || 2.8k	2k || 2k

Table 4, Test resistor values (R2, R3 see schematics)

The following Table 5 shows the range of displayed DC values at loads according to Table 4 for which the phantom power source conforms to the standard. The table includes DC-measurement tolerances.

PhantomPower	P12	P24	P48
max. Uph0	7.2V	20.2V	12.2V
min. Uph0	5.4V	13.5V	9.5V

Table 5, Phantom power voltage range meeting specifications at max load conditions measured by MR-PRO

Measurement at mixing desks with multiple phantom power supplies

Conformity to the standard should be assured at maximum load at each phantom power input at e.g. mixing desks. The phantom power measurement shall be carried out as follows:

- Enable all phantom powered outputs and load them with devices for simulation of the worst case conditions or alternatively insert the described test adapters at each output.
- Measure the phantom power at each channel with the Minirator MR-PRO
- Compare the test results with the values listed above

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