A Handy Tool for Measuring "Constant Voltage" Sound System Impedance and Calculated Power

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I recently had the opportunity to evaluate GOLD LINE'S new hand-held ac impedance and calculated watts meter.

Many sound reinforcement systems use "constant voltage" distributed loudspeakers i.e. the rated output of the amplifier is designated as 25V(volt), 50V, 70.7V or 100V. While there is no magic to installing a distributed sound system, it's worth a short review of distributed systems and the problems that can arise from them. In "constant voltage" systems, the loudspeakers are connected to the amplifier with "constant voltage" transformers and most often more than one loudspeaker/transformer is connected to the amplifier. Under this system, full amplifier power output is realized when the RMS voltage as read by an RMS voltmeter reads the designated voltage and the amplifier sees the proper impedance. For example, a 100 watt 70.7 volt system will deliver 100 watts to the load when the amplifier output voltage is 70.7 volts and the load impedance is 50 ohms. The equation to determine this is $P= V^2/Z$ where P is the power taken from the amplifier, V is the amplifier output voltage and Z is the impedance of the load. Constant voltage systems are used for two main reasons:

1. The impedance of the loudspeaker/transformer load is high therefore small wire size (often #l8 AWG or #20 AWG) can be used without heavy line loss.
2. The power delivered to each individual loudspeaker can be set at the loudspeaker by changing the transformer primary taps without effecting the output of the remaining loudspeakers.

The constant voltage transformer method was developed to permit easy calculation and installation of distributed sound systems. If the sound system designer knows the desired sound pressure level (SPL) and the sensitivity of the loudspeaker (SPL/WATT), he may calculate the wattage required at the loudspeaker for a given SPL. The transformer's "turns ratio" converts the high impedance of the amplifier's output to the lower impedance of the loudspeaker, providing efficient power transfer from the amplifier to the loudspeaker. By changing the turns ratio of the transformer, the power delivered to the loudspeaker can be varied. This allows different loudspeaker/ transformer combinations to take different levels of power from the amplifier in a low loss manner. The total power taken from the amplifier is the sum of the wattage for each of the loudspeaker/transformer assemblies.

Constant voltage transformers can be specified two ways; the first way is by specifying the power delivered to the load (the secondary of the transformer) and second way is by specifying the power taken from the amplifier (the power delivered to the transformer.) These will be different due to the insertion losses in the transformer. The installer should know which specification is being used as one can mean not enough SPL in the room at full power and the second can mean too much power is being taken from the amplifier, resulting in amplifier failure.

Since most systems are characterized using watts and not impedance, a instrument that can calculate watts can speed up installation and be more understandable by non-technical employees. I found that the new Gold Line ZMl meter made it easy for an installer with little technical background to measure the ac impedance and the watts required at the loudspeaker for a given SPL. The ZM1 reads impedance as many other impedance meters do plus it measures "calculated watts" or the power which appears at the loudspeaker when the system voltage, such as 70.7V or 100V is applied. The ZM1 is very versatile and rapidly provides an accurate measurement of the individual loudspeaker/transformer ac impedance and calculated power delivered to it by the amplifier when that individual loudspeaker/transformer is measured. The total load ac impedance and calculated power as seen by the amplifier is measured when the ZM1 is connected to the entire load.

The ZM1 provides a 100Hz, 330Hz, 1kHz and 10kHz sine wave and calculates watts on 25V, 50V, 70V and 100V systems at each frequency. By simply connecting the probes of the ZM1 to the device under test (DUT), the ZM1 will display ac impedance and calculated power for "constant voltage" transformer-coupled loudspeaker systems. The ZM1 eliminates the requirement of the installer to calculate wattage, as it does it for you. It is also more accurate since it makes real system measurements, taking into consideration system losses and variations from actual specifications which are incorporated into the calculated watts equation. To understand how important this is, consider that transformer insertion loss can vary from 0.5dBm for high quality transformers to 3dBm for less expensive transformers. For example, a transformer with a rated 10W tap, which has a 1.5dB insertion loss, would actually draw 14.13 W from the amplifier. If 10 ten watt loudspeaker/transformers were connected to a 100 watt amplifier, the load would have tried to draw 141 watts from the amplifier... not a good scene if reliability is a concern.

The ZM1 is a small, battery operated impedance/power meter which saves time and provides accurate measurements for installers, and at a reasonable cost.

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