Know-how 100 V PA technology

Introduction
Often extensive speaker systems are installed in hotels, department stores, office and storage buildings to play background music or to amplify announcements. However, the installation of such systems can be problematic. For regular, low-impedance cabling requires bulky and expensive cables which are hard to lay over long distances. Additionally, the loss is substantial and there is a danger that the amplifier becomes overloaded. To avoid this danger, there is no way around complex parallel-series connections which makes the installation even more difficult. And you would have to put in a lot of effort to control the speakers individually. A simple and elegant solution for such problems is 100 V technique, also referred to as public address system (or PA system), which is an electronic amplification system.

In standard hi-fi or PA loudspeaker systems, speakers are connected directly to an amplifier. A relatively large current, several ampere, flows in the cable which is the reason why large cable cross sections and short cables are required. On 100 V PA lines, which are particularly suitable for large cable distances, a transformer is installed after the amplifier. The transformer transforms the amplifier's voltage to 100 V at full condition. (Most of the times, the transformer is integrated in the amplifier). Before each speaker there is another transformer installed which converts the 100 V back to a voltage suitable for speakers. (Normally, the transformer is installed in or at the speaker.) Both transformers may have a different wattage: There may be a 100 W transformer at the amplifier and a 10 W transformer at the speakers. So the whole thing works similar to a high-voltage line. The high voltage minimizes the current and results in minimal signal loss even over long distances. The main advantage of 100 V PA systems is that all further speakers may be connected in parallel to the main cable which makes cabling speakers real easy. Due to the high voltage, only little current circulates which allows for long cable distances and small cable cross sections.

Calculation example:
A PA system consisting of 32 speakers 8 ohms with 10 watts maximum power is to be established in a multi-purpose hall. The last speaker is 100 meters away from the amplifier. The minimum cable cross section for a low-impedance PA system is calculated as follows: Due to a parallel-series connection of the 32 speakers (four pieces in series at a time, eight of these series connections in parallel) we achieve an optimum impedance of 4 ohms and the total power is 320 watts. Subsequently a maximum current of almost 9 ampere (according to $P = I^2 \times R$) flows in the system. In order to avoid exceeding the permitted 3 % voltage drop, in our case only around 1 volt (according to $U = P / I$), a cable cross section of 32 mm^2 is necessary for the PA system (according to $A = (I \cdot \rho \cdot 2 \cdot L) / Uv$). However, if we transform the maximum voltage up to 100 V, the current is reduced to 3.2 ampere ($I = P/U$) and the required cable cross section to only 4 mm^2. The 33 small transformers needed in total for our PA system cost only a fraction compared to the cable from the calculation for a low-voltage PA system.

Moreover, with a 100 V PA system the installer does not have to take the impedance into consideration nor make a complicated parallel-series connection as in the example above but match the total power of the connected speakers to the power amplifier used.

Another advantage is that each speaker can be adjusted in volume by different transformer wirings - either on the speaker itself or by a preceding volume controller allowing to optimally match the level to surroundings. This makes 100 V PA technology the top choice for use in office buildings, workshops and warehouses, on sport fields, in churches and public buildings as well as in large restaurants and hotels.

Previously, 100 V PA technique was said to be of poor quality. Today, this criticism is no longer tenable as there were major improvements in the audio transformer technique. Meanwhile, it is possible to reproduce the often demanded frequency range of 20 Hz to 20 kHz at ratings of more than 100 watts by means of transformers. Listeners cannot hear a difference in sound anymore. The mono signal reproduction, which is used for most systems, does not result in a loss of quality for standard applications (speech amplification, background music). On the contrary: If listeners move freely in a room with a PA system their stereo perception would change constantly and unwanted interference would be the result. However, the condition for good sound quality is the use of suitable and powerful amplifiers and speakers. Normally, 100 V PA technology is not used for sophisticated PA systems, but by no means impossible.

Integrating a microphone into the system
If a PA system is to be complemented by temporary automated or manual announcements, it is easily possible with most PA amplifiers due to standard microphone inputs and integrated pre-amplifiers. The amplifiers of the OMNITRONIC MP/MPZ/MPVZ series additionally have an adjustable talkover function which automatically attenuates the volume of the music when a signal is present at the microphone input. Furthermore, a signal tone can be activated at the power amplifier prior to making a manual announcement. In low-impedance systems this would only be possible by implementing an additional special mixing console.

Fewer problems with room acoustics by using many small speakers
While multi-purpose buildings and churches are often prone to complicated room acoustics and for optical reasons pose a problem when using mechanical tools such as specially positioned absorbers on the room's sides or ceiling, or reflectors above the lectern to reduce notch filter effects or other acoustic problems, a 100 V PA system allows lower individual levels with far less room reflection and a more favorable reverberation time (headword speech intelligibility). Usually the much smaller speakers can be integrated more easily into the surroundings. Moreover, most 100 V PA speakers are available in different colors.

More operating reliability via ring lines

A problem of many 100 V PA installations are the long cable lines and the associated risk of failure. In case the line is interrupted at some point all speakers situated behind that point will no longer operate. One possibility to avoid this problem without integrating an expensive and complicated line monitoring unit is the installation of a ring line. Here, the signal is simply fed from the last speaker back to the amplifier. Make sure the line has the correct polarity when using this type of cabling. When using this technique only an interruption at two different points would result in a failure. Do not try this on a low-impedance system by any means!

Combining a 100 V line with low-impedance speakers and active speakers

Depending on the place of installation it may be necessary to integrate low-impedance speakers or active speakers into a 100 V PA system. For this purpose, the 100 V signal can by changed into the desired signal with special transformers such as the ELA-T10 to T20 and converters such as the ELA-100V-2-L by OMNITRONIC. In any case, avoid connecting low-impedance or active speakers directly to a 100 V signal! In case 100 V PA components are to be connected to a low-impedance system 100 V adapters such as the OMNITRONIC MCX-4250 are available.

Safety instructions

A 100 V PA system is an electronic system that operates with high voltages dangerous for human safety. Therefore, leave installation and maintenance of 100 V PA systems to qualified personnel only and consider all relevant safety regulations.