Advantages Of Direct Constant-Voltage Operation In Crown Power Amps

Electric-power companies have a good idea which has been applied to audio engineering. When they run power through miles of cable, they minimize resistive power loss by running the power as high voltage and low current. To do this, they use a step-up transformer at the power station and a step-down transformer at each customer's location. This reduces power loss due to the I^2R heating of the power cables.

The same solution can be applied to audio communications in the form of a constant-voltage system (typically 70 volts). Such a system is often used when a single power amplifier drives many loudspeakers through long cable runs (over 50 feet). Some examples of this condition are distributed speaker systems for P.A., paging, or low-SPL background music.

What is constant voltage? The label "constant voltage" has been confusing because the voltage is really not constant in an audio program. A better term might be "high voltage."

Figure 1 shows a typical high-voltage system. A transformer at the power-amplifier output steps up the voltage to approximately 70 volts at full power. Each speaker has a step-down transformer that matches the 70V line to each speaker's impedance. The primaries of all the speaker transformers are paralleled across the transformer secondary on the power amplifier.

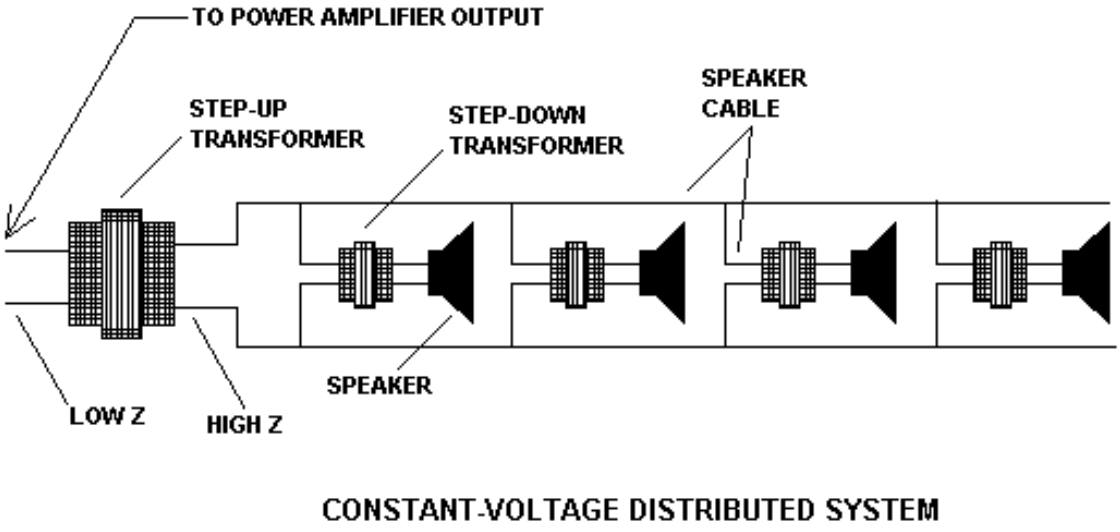

Figure 1. A constant-voltage (high-voltage) audio system.

The signal line to the loudspeakers is high voltage, low current, and usually high impedance. Typical line values for a 100-watt amplifier are 70V, 1.41 amperes, and 50 ohms.

How did the 70V line get its name? The intention was to have 100V peak on the line, which is 70.7V rms. The technically correct value is 70.7V rms, but "70V" is the common term. There are 70 volts on the line at maximum amplifier output with a sine wave signal. The actual voltage depnds on the power-amplifier wattage rating and the step-up ratio of the transformer. The audio program voltage in a 70V system might not even reach 70V. Conversely, peaks in the audio program might exceed 70V.

Various voltages have been tried such as 25, 35, 50, 70, 100, 140, and 200 volts, but the 70V system has become the most widespread. Although rare, the 200V system has been used for cable length exceeding one mile.

Advantages of high-voltage operation

As stated before, a high-voltage line reduces power loss due to cable heating. That's because the speaker cable carries the audio signal as a low current. Consequently you can use smaller-gauge speaker cable, or very long cable runs, without losing excessive power.

Another advantage of high-voltage operation is that you can more easily provide the amplifier with a matching load. Suppose you're connecting dozens of speakers to a single 8-ohm amplifier output. It can be difficult to wire the speakers in a series-parallel combination having a total impedance of 8 ohms. Also it's bad practice to run speakers in series because if one speaker fails, all the speakers in series are lost. This changes the load impedance seen by the power amplifier.

With a high-voltage system you can hang hundreds of speakers in parallel on a single amplifier output, if you provide a matching load. In addition, a high-voltage distributed system is relatively easy to design, and allows flexibility in power settings due to multiple taps on the speaker transformers.

An external step-up transformer is not the only way to get high voltage from the amplifier. Some amplifiers have built-in step-up transformers, while others provide a high-voltage, transformerless (direct) output.

Overcoming the flaws of step-up transformers

One disadvantage of transformers is that they add expense. Particulary if you use large transformers for extended low-frequency response, the cost per transformer may run $70 to $200. Another disadvantage is that transformers can degrade the frequency response and add distortion - both at the amplifier end and the loudspeaker end.

Half of this problem was solved in 1967 When Crown International introduced the DC-300. It was most likely the first high-powered, low-distortion, solid-state power amplifier capable of directly driving a 70V line without a step-up transformer. And in June 1987, the Macro-Tech 2400 was introduced with the capability of directly driving a 100V line. Com-Tech and CTs power amps also have this ability. Thus, today only the loudspeakers need transformers to step down the voltage.

The direct high-voltage advantage

As stated earlier, there are three power-amplifier options that provide a high-voltage output. The amplifier might have

- an external step-up transformer
- a built-in step-up transformer
- a high-voltage, transformerless output

Many high-power amplifiers can drive 70V lines directly without an output transformer, simply because they provide a high output voltage. For example, a Crown DC-300 provides 35 volts per channel loaded, or 70 volts in bridge-mono mode. A 1000-watt amplifier driving a total load of 4 ohms provides 63 volts.

The direct high-voltage approach eliminates the drawbacks of transformers:

- cost
- weight
- limited bandwidth
- distortion
- core saturation at low frequencies

Let's look at the core-saturation problem in more detail. Sound systems can generate unwanted low frequencies, due to, say, a dropped microphone or a phantom-powered mic pulled out of its connector. Low frequencies at high power tend to saturate the core of a transformer. The less the amount of iron in the transformer, the more likely it is to saturate.

Saturation reduces the impedance of the transformer, which in turn may cause the amplifier to go into current limiting. When this occurs, negative voltage spikes are generated in the transformer that travel back to the amplifier -- a phenomenon called flyback. The spikes cause a raspy, distorted sound. In addition, the extreme low-impedance load might cause the power amplifier to fail.

Crown amplifiers are designed with high-current capability to tolerate these low-frequency stresses. Production amplifiers are given a "torture test". Each amplifier must deliver a 15-Hz signal at full power into a saturated DCA Power transformer for 1 second without developing a hernia!

Many transformers are reactive, so their impedance varies with frequency. Some 8-ohm transformers measure as low as 1 ohm at low frequencies. That's another reason for specifying an amplifier with high current capability.

Recent models with direct constant-voltage ability

The Crown Com-Tech Series was the first to offer independent selection of high- and low-impedance operation for a specific channel, and CDi and CTs Series amplifiers continue that tradition, with power levels and features carefully chosen to integrate into fixed-install designs.

The Crown CDi Series provides 70V (dual mode) and 140V (bridge mode) as well as low-impedance (2/4/8 ohm) operation. CTs Series amplifiers provide direct constant-voltage (70V/100V/140V/200V) or low-impedance (2/4/8 ohm) operation. In Dual Mode, the CTs 600/1200 can power 25/50/70V lines; the CTs 2000/3000 can power 25/50/70/100V lines. In Bridge-Mono mode, the CTs 600/1200 can power 140V lines; the CTs 2000/3000 can power 140V and 200V lines.

With CDi Series and CTs Series amplifiers, one channel can drive low-impedance loudspeakers, while another channel drives loudspeakers with 70V transformers. This makes it easy to set up a system with large, low-Z speakers for local coverage and distributed 70V speakers for distant rooms -- all with a single amplifier.

Accessories

If you have a conventional amplifier with low-Z outputs only, and you want 70V or 100V operation, Crown has the needed accessories. The TP-170V is a panel with four built-in autoformers that convert four low-Z outputs to high-Z. The T-170V is a single autoformer for the same purpose.

For additional assistance with constant-voltage system design, please visit Crown's Design Tools at www.crownaudio.com. When there, click on Applications > System Design Tools > Constant Voltage Transformer Power. Or just go to the following URL:http://www.crownaudio.com/index.php/cv-xform-pwr.htm There youll find a calculator that can help you either test what you have learned in this article, or set up your next constant voltage system.

Considering the many advantages of direct constant-voltage operation, we suggest that you specify Crown power amps in your next distributed-speaker installation.