Introduction

Distributed audio, particularly for speech applications, will often require many speakers to be positioned around a venue, to provide even coverage at acceptable levels in all locations. These speakers may be spread over a considerable area and involve long cable runs to achieve this. Using low impedance "traditional" methods would introduce unacceptable losses due to the actual resistance vs. the speaker impedance – it is easy to envisage a situation where the length of the cable could cause 50% loss in available power.

Using heavier gauge cabling can go some way to reducing the losses, but this often is costly and entirely impractical where many speakers are involved. Borrowing the method used to distribute mains electricity across long distances, where mains supplies are stepped up (using transformers) to higher voltages and stepped down for local consumption also works for distributed audio.

This method helps because, as the voltage is increased, to achieve the same power delivery there is a corresponding decrease in the current that must travel along the conductors. Lower current requirements mean thinner gauge cabling and lower losses due to the square law of power delivery. Thinner gauge cabling therefore also means reduced costs, and lower amplifier power requirements than if each speaker (or at best a few speakers) required an individual amplifier channel.

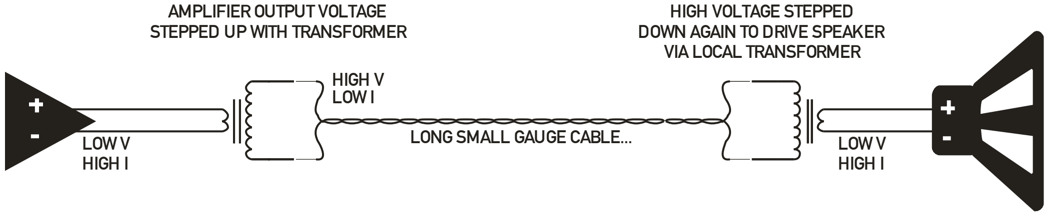
How It Works

Firstly, a few misconceptions around the name of this method should be clarified. It is true that the low voltage/higher current output of a standard audio amplifier is fed into a step-up transformer to produce a higher voltage/lower current output that can travel longer distances using thinner cables. This incurs fewer losses than a direct connection of a low impedance speaker directly over the same distance.

However, the concept of this system operating at either a "constant voltage", or "100V", or "70V" is slightly wrong. The system does NOT have a constant voltage output of any sort, unless a constant level of audio is being fed into the amplifier (such as a sine wave), at which point the output will be at a constant level. This would hold true in the low impedance (standard) case too. There is no extra method of modulating a fixed voltage, or there being a permanent high voltage output on the speaker lines.

The use of the terms "100V line" or "70V line" comes from the description of the system running at full power output only. The transformer used to step up the voltage should be chosen so that, when the amplifier is running at full power, the voltage across the lines will then be 100V (or 70V or whatever has been deemed appropriate for the given application). The only thing that is "constant" with this type of system is rated voltage at the amplifier's rated power. So, whether it's a 30W amplifier for distributing speech to some horns by a racetrack, or a 300W amplifier distributing music and announcements throughout a warehouse, both the systems will produce 100V (or whatever) when the amplifier is running at maximum power.

The majority of the time, the voltages present on the lines will be an order of magnitude less than 100V, as the audio being delivered will be at a much lower level than full output (assuming the amplifier chosen is up to the job!).



MC² AUDIO

www.mc2-audio.co.uk
Tel. +44 (0)1404 44633 Fax. +44(0)1404 44660
MC² AUDIO Ltd. |Units 6-8 Kingsgate | Heathpark Industrial Estate
Honiton | Devon | England | EX14 1YG

Once the voltage has been "stepped up" to the higher level for long distance transmission, when it reaches the speaker, in common with mains power reaching its destination, there must be some form of "stepping down" again to restore it to a voltage/current suitable for driving the speaker. This is achieved by using a localised "step-down" transformer, normally attached directly to the speaker chassis itself, or in the enclosure with the driver.

From this point on, the process for working out how many speakers can be connected to an amplifier channel becomes relatively simple, but remember one thing – this doesn't change the laws of physics – just as there is a limit to how many speakers can be connected in parallel on a "normal" channel of an amplifier, there is still a limit for 100V or 70V systems too!

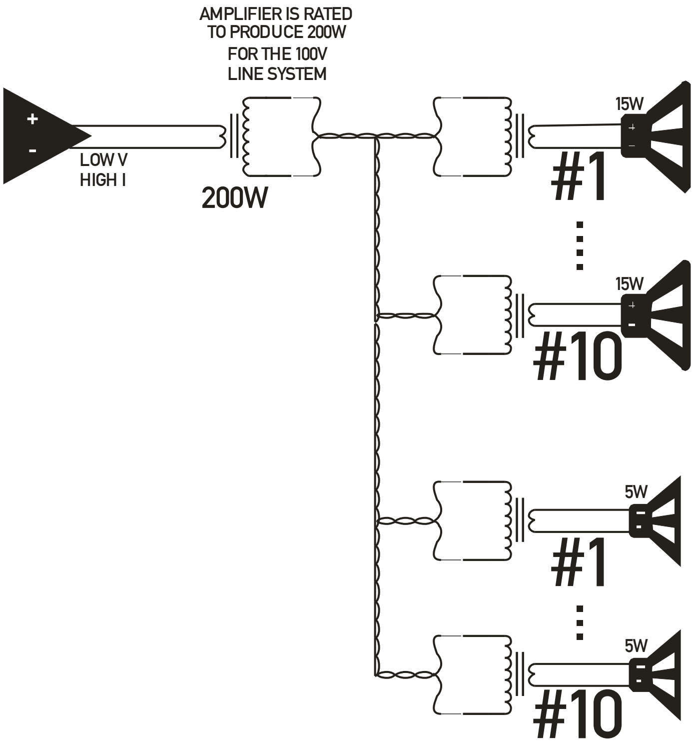
Example: How many speakers can I connect to an amp channel?

We'll start with an amplifier capable of supplying 200W to a 100V line system. This total "pool" of 200W can be split up any way we want to as many speakers as we want, providing their requirements don't exceed 200W in total.

The requirement of any particular 100V line configured speaker is quoted as a power rating for a given SPL output. Let's say we have decided upon two sizes of ceiling speaker for a given installation – one rated at 15W and one rated at 5W. Ignoring the SPL ratings for now, it's a reasonable assumption to make that the "15W" speaker will be generating a higher output level than the "5W" speaker (for any given voltage on the line).

Remember – this wattage value isn't the power rating of the driver – this is the power it will consume from the amplifier – the speaker's rating itself is not relevant (and is unlikely to be quoted as part of the speaker's spec. sheet).

So, to work out how many speakers the amplifier can handle, it's as simple as adding up the number of 15W speakers we want to use and the number of 5W speakers, and making sure this total is no more than the 200W we have available.



www.mc2-audio.co.uk
Tel. +44 (0)1404 44633 Fax. +44(0)1404 44660
MC² AUDIO Ltd. |Units 6-8 Kingsgate | Heathpark Industrial Estate
Honiton | Devon | England | EX14 1YG

Let's say we have worked out that we need 10 of the 15W speakers, for starters – that comes to 10 x 15W = 150W, leaving us with 50W "spare", which means we could connect another 10 of the 5W speakers. That's 20 areas in total – not bad for just 200W!

This is in an ideal world of course…now for how it really works!

Calculating Real World Requirements

The choice of amplifier power, in an ideal world, would allow us to do this simple calculation and everything to operate perfectly with the power available exactly matching the power delivered to the speakers. However, this isn't an ideal world, and there are two main factors that impede (!) this from being true – losses in the cables themselves, and insertion losses in the step-up and step-down transformers.

Whilst it is theoretically possible to calculate these losses, there is a "Catch 22" situation in play here, which means that even measuring the real-world losses through cables in a system becomes impossible. Getting hold of insertion loss information for transformers is difficult, and in order to measure the losses, you need to build the system, which you can't do until you specify your amp power, which you can't do until you measure the losses!

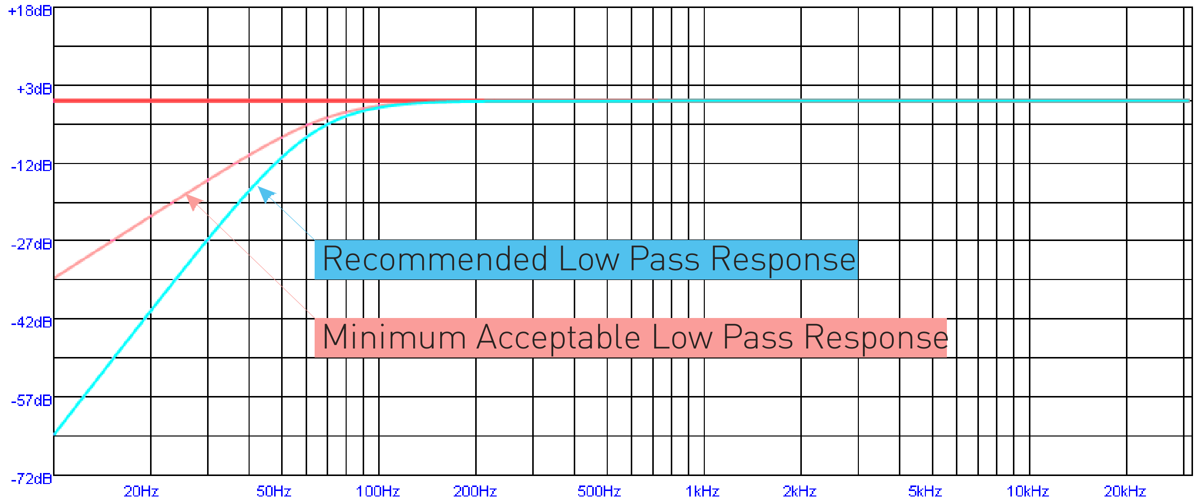
Thus, there is a reliable "rule of thumb" that states that amplifier power should be approximately 50% bigger than your speaker power requirements would suggest. So, if your speakers total power comes to 100W per channel, go for an amplifier nearer 150W per channel to account for all the losses and ensure you deliver the power and so SPL you require.

Getting The Best Performance

As 100V line systems are primarily intended for background music applications and foreground delivery of speech program only, the necessity for the highest fidelity audio has never been paramount. This does not mean that a carefully designed system can't perform to a high audio standard – it can, but there are certain constraints that need to be considered when evaluating performance.

Due to the fact that transformers are in use throughout a 100V line systems, being careful not to saturate the cores of these transformers with excessive energy is paramount to the system not just working well, but not damaging the amplifier. Low frequency power tends to be the main culprit for this condition, and a saturated transformer core appears as a very low impedance across the amplifier's output terminals, close to a direct short, resulting in early amplifier overheating, protection circuits muting the audio unnecessarily and generally bad behaviour! It manifests itself, in audio terms, as a distorted rasping sound - similar to a misaligned voice coil might sound.

This can be easily avoided by ensuring that high pass filters are fitted to all channels to limit the low frequency content of the system. We recommend fitting crossover cards to our amplifiers, or inserting suitable filtering using an external speaker management system, such as the XTA DP4 and 5 Series. Our recommendation is a 63Hz HPF with a roll-off of 24dB/Octave. The minimum response requirement is -3dB @ 70Hz and 12dB/Octave roll off below this.



All ranges of MC² amplifiers can be fitted with these cards – please contact us for more information.

Working Without Step-Up Transformers

In most circumstances, the power output of amplifiers used in 100V line systems is only in the order of a few hundred watts, due to the total power requirements of the multiple small speakers being installed only reaching this sort of figure.

However, higher powered amplifiers are capable of generating a voltage swing sufficient to drive a 100V system without the need of a set-up transformer. There may be circumstances when using a larger amplifier is required – for instance when the amplifier's usage is being split to provide distributed audio on one channel and local higher power on another (perhaps for a sub-bass system) or if there is an unusually large number of higher power 100V line speakers on the system.

The MC² amplifiers listed overleaf may be used without a step-up transformer – as mentioned earlier, whilst their maximum output voltage may not reach 100V, they are capable of being running transformerless 70V if required.

Where peak voltages may exceed the 70V or 100V system requirements, a limiter will be required

That is refers only to the step-up transformer at the amplifier – the speakers will still require their individual step-down transformers. MC² also still advise using a high pass filter on channels driving a 100V line system.

Note that the Delta 20 powers quoted are for using a bridge pair with no step-up transformers fitted – this amplifier is the exception insofar as it can be fitted with internal individual 100V or 70V transformers, meaning channels do not have to be bridged to achieve the required voltage swing and power output. This is our recommended method of using this model.

MODEL	Peak Volts	100V Power	70V Power	Notes
T/Ti 3500	90V++	-	1000W	T3500 discontinued (Ti3500 still current model)
T/Ti 2000	70V++	-	1000W	
T/Ti 1500	130V* ++	2100W	2100W	*bridged only
T/Ti 1000	115V* ++	1600W	1600W	*bridged only
E90	140V	4900W	4900W	E90 discontinued model [Delta 120 is replacement]
E100	105V	2700W	2700W	E100 discontinued model [Delta 100 is replacement]
E45	100V	2500W	2500W	
E60	80V	-	1500W	E60 discontinued model [Delta 80 is replacement]
E25	75V	-	2700W	
E15	120V*	1700W	1700W	*bridged only
E475	80V	-	1800W	
D20	74V*	-	700W	*bridged but 100/70V TXs available [200/350W x 4]
D40/40DSP	126V*	1000W	1000W	*bridged only
D80/80DSP	88V	-	2000W	
D100/100DSP	105V	2700W	2700W	
D120	142V	5000W	5000W	

In Conclusion…

Working with distributed audio using the 100V line system need not be a complex undertaking – just remember these key points:

- If in doubt about how much power you need, go for your upper estimate – an underpowered system will perform worse in all circumstances, not just when the system is being driven hard!

- Always fit high pass filtering on each amplifier channel to prevent premature amplifier failure and circumvent poor audio performance

++MC² manufacture a special external 100V line transformer system for use with certain T and Ti Series models – this product is called "T-Line" and can be loaded with a variety of transformers according to system requirements. More information on this is on our website here:

https://www.mc2-audio.co.uk/wp-content/uploads/tline_datasheet.pdf

Doc revision1.1 11/19

www.mc2-audio.co.uk
Tel. +44 (0)1404 44633 Fax. +44(0)1404 44660
MC² AUDIO Ltd. |Units 6-8 Kingsgate | Heathpark Industrial Estate
Honiton | Devon | England | EX14 1YG