Loops In Theatres Are Causing A Buzz

And so they should.

Theatre Managers- Create the right buzz:

1. **Imagine what it's like to be a hard of hearing person**
- Do you want to declare your disability, not enjoy your experience because you couldn't hear, have a theatre pay lip service to you? No.
- 1 in 6 people in the UK have hearing problems. By creating a truly inclusive environment, more will visit with family and friends. And that's good for business

2. **Use only professional audio experts to install your loop**
- An induction loop is like any other audio system. It needs designing and installing by experienced professional audio specialists.
- By working with experts you will be assured of a job well done, no compromise for users and no poor installations to rectify.

3. **Be fully aware of all the costs of using a loop alternative**
- FM and Infrared systems may appear to be an easy low cost alternative to an induction loop, but aside from poor performance and no anonymity for users, they do not offer long term value for money.
- Ongoing costs include managing, cleaning, charging, repairing, and replacing receivers.

Installers - Eliminate the Buzz with 5 simple steps

1. **Prevent Ground Loops**
- Only install equipment with balanced input/output connections
- Connect input signals to the loop amplifier using twisted pair screened cables.
- Connect the chassis of each piece of equipment to the same outlet supply ground point, keeping the conductors as short as possible using a star ground configuration.

2. **If A Ground Loop Exists, Rectify It By:-**
- Lifting the 'ground lift' switch on either the loop amplifier or the audio source equipment if fitted.
- Disconnecting the ground connection in the interconnecting signal lead at the input end to the induction loop amplifier.
- Using an isolation transformer on all inputs to the induction loop amplifier.

3. **Avoid Cross Talk**
- Do not run any signal cables parallel and in close proximity to the output (loop) cables.
- Use an SLS system; this has an average field strength of almost zero and is much more efficient than a standard perimeter loop reducing the magnetic field and risk of cross talk by 40 to 60dB within the looped area.

4. **Prevent Acoustic/Inductive Feedback**
- Do not use dynamic microphones or electric guitars within the looped area.
- Install a SuperLoop™ system with spill control to the stage and to the mixing console.

5. **Set The Input Level Correctly**
- Adjust the input sensitivity of the loop amplifier using actual signals in accordance with the manufacturer's instructions. *The higher the gain, the less stable the system may become.*

Not only are induction loop systems the preferred assistive listening technology of hard of hearing people, they also offer the best value for money, hassle free, no compromise solution for theatre managers and installers.

But sadly, it's not the buzz of enjoyment that the hard of hearing person gets from using the system, the buzz of delight from simply switching their hearing aid to T and sensing the sounds so clearly they think they are in their head. The buzz of gratitude they have when they arrive at the theatre knowing they will not need to hunt down a receiver to hear, or the buzz they get out of using the assistive listening system without anyone else knowing. It's not even the buzz the theatre manager gets, delighted with the money and time saved from not having receivers to manage, clean, charge, repair and replace. And there's certainly no buzz for the Installer, confident in the knowledge that he is getting it right, avoiding frustration from post installation problems, and delighting his customers.

No. It's the buzz, the hum and the screech that the installed loop system will, according to the theatre manager, inevitably cause. In fact, touring companies are so paranoid about the buzz from loop systems that they will insist they are turned off during performances, making them redundant and forcing the theatre to use a more discriminatory technology. Ordinarily, this would provoke a louder buzz of dissatisfied, excluded customers but, hard of hearing people are so used to a second rate service, they will rarely complain.

But it does not have to be like this. There are thousands of induction loop installations in theatres throughout the world working tirelessly to assist hard of hearing people without causing the slightest perturbation in the audio system. And it's easy to achieve. Copenhagen Opera House, the Stockholm Concert Hall and the Danish broadcasting City are just a few examples.

Induction loops are no different to any other audio system. A well designed system, correctly installed will provide years of buzz free, hum free, screech-less service. The same techniques used by professional audio technicians and equipment manufacturers to mitigate feedback, eliminate buzz and squash hum in an audio system apply to induction loop systems. Ground loops, feedback paths and cross signal coupling are well understood by sound technicians. By using a common star ground, isolation transformers, balanced line feeds and a few other simple techniques they can cope with them all. So why does it sometimes go wrong with induction loop installations?

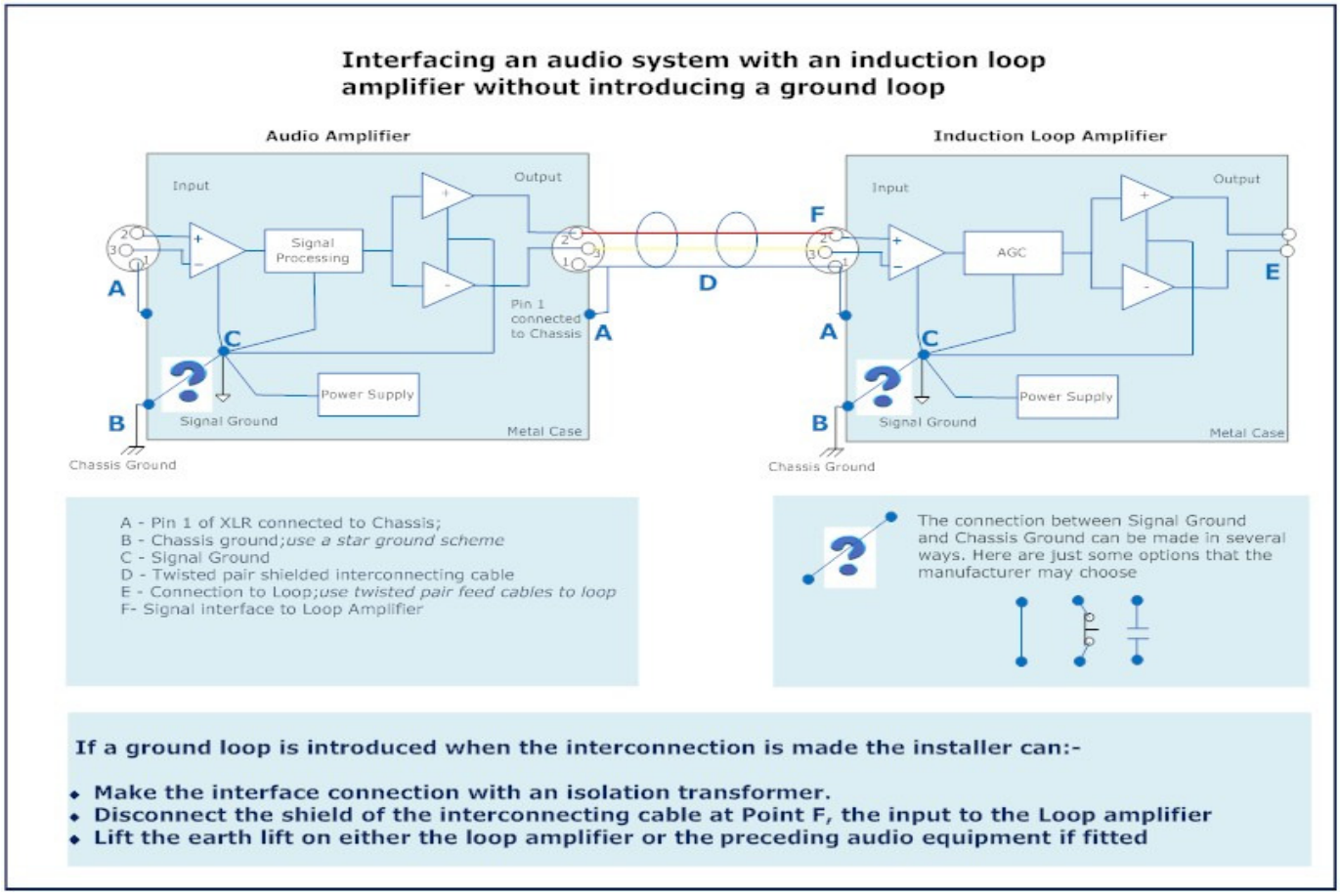
Either professional audio technicians forget all they have learnt when installing loop systems or more likely, induction loop systems are being installed by well-meaning electricians and other contractors who do not understand the issues.

Ground Loops

Ground loops are probably the most common cause of hum in an audio system. They can be difficult to trace and rectify after installation, but through the correct choice of equipment and careful planning, they need never be present.

Each piece of audio equipment will have its own internal signal ground; connecting the units together via the signal cables, the output from one unit to the input of the other, may tie the 2 signal grounds together. This in itself is considered good practice as it shields against electromagnetic interference and is why cable assemblies are supplied with cable shields terminated at both ends. However, if the signal grounds of the 2 units are also tied together by another cable eg; the earth leads of the supply cables, or their metal cases through the rack in which they are housed, a circuit may be created. The current will flow through this closed loop from one unit's ground out to the second unit and then back to the first, modulating the signal ground potential and thus causing hum.

This phenomenon is well understood by manufacturers and professional audio installers, and both will use a range of techniques to mitigate ground loops as described below.



Some equipment design practices that reduce or eliminate the possibility of creating a ground loop:-

- Galvanic isolation between the signal earth and the chassis earth. *This can be achieved by using a capacitor to make the signal ground to chassis ground connection. Some manufacturers incorporate an 'earth lift' switch, which in theory, allows the user to disconnect the signal ground from the chassis. However, electrostatic coupling between the 2 grounds in this latter approach can cause high frequency noise in the audio path and is now less common.*
- Star grounding scheme within the equipment; *the signal ground for all the interconnecting circuits, the power supply ground and the chassis ground are all connected to a single ground point via separate conductors.*
- Balanced input and output connectors with pin 1 connected to chassis ground; *gives good common mode noise reduction and minimises noise on signal ground.*

Some installation practices that reduce or eliminate the possibility of creating a ground loop:-

- The use of twisted pair, shielded interconnecting cables with the shield terminated at both ends. *This is how it should be done, but it assumes that the equipment has been designed and constructed to support this approach with pin 1 connected to chassis ground and not signal ground.*
- Star grounding scheme for all interconnected audio equipment. *The chassis of each piece of audio equipment within the system has a direct connection to a single common ground point. With audio equipment mounted in the same rack, this is relatively easy to achieve, but easily overlooked when the induction loop is retrofitted later.*
- The use of isolation transformers on all inputs. *This is particularly important when interfacing with an unbalanced system.*

Some installation techniques to rectify an earth loop problem with an induction loop system:-

If an earth loop is created when an induction loop system is interfaced with the audio system, there are several possible remedies, none of which include turning off the loop system during performances.

- If either the loop amplifier or the interconnecting audio equipment is fitted with an earth lift switch, try lifting the switch. *Note : Earth lift switches are not generally found on modern equipment, but where they are fitted, it may provide a quick fix.*
- Disconnect the shield from the input end of the interconnecting signal cables. *In a theatre application, this is quite simple as there should only be one connection, which is a line level feed from the mixing console.*
- Make the audio input connection to the induction loop amplifier via an isolation transformer.

A touring theatre company can avoid ground loop hum by simply interfacing to the loop amplifier via an isolation transformer

Never remove the safety earth

Cross Talk or Inductive Coupling

Where cables are run in parallel and in close proximity to each other, there is a possibility that the signal current in one cable will be induced and appear on the other. This is cross talk or inductive coupling. The magnitude of the cross talk will depend on how close the cables are, over what length they run in parallel and the magnitude of the signal currents. By using balanced lines, the system has some immunity to cross talk since any induced currents will be common mode and are automatically rejected.

In an induction loop system, it is necessary to separate the low level input signal cables from the high level, high current on the loop conductors to avoid inductive feedback. Running a microphone cable close and in parallel to a loop cable must be avoided. The greater the disparity in signal level, the greater the risk of feedback. Dynamic microphones have outputs typically 10 times lower (20dB) than many cheap condenser microphones increasing the feedback risk by a factor of 10.

Whilst loop and signal cables must not run in close proximity and in parallel, they may cross each other. This means alternative routes for signal cables and loop cables can generally be found.

In a theatre application there are two areas where it may be difficult to manage the signal cabling, on the stage and at the mixing desk. At a temporary event in the Kennedy Centre, in Washington, the touring company were linking two mixing desks through an unbalanced connection. By moving the loop cable running parallel to the mixing desks to a distance of approximately 2m away, the cross talk was supressed to below a detectable level.

In this application the loop was temporary, installed with gaffer tape onto the carpet, so it was easy to move. In a fixed installation this would not be possible, however, by using SuperLoop™ technology cross talk or inductive coupling can be easily designed out. A SuperLoop™ has many advantages over the conventional perimeter loop, not least is its ultra-low spill control.

By designing a SuperLoop™ system with spill control to the stage and spill control to a designated area at the back of the theatre for the touring company's mixing desk, the risk of inductive coupling is eliminated.

Furthermore, with the more efficient SuperLoop™, a balanced 2-layer system, the total sum of the magnetic field is almost zero, such that the induced current on multiple cables running from the stage area across the stalls to the back-centre placed mixer, a common place for a mixing desk, will be down by 40 to 60dB compared to a standard perimeter loop.

Acoustic Feedback

Acoustic feedback occurs when the acoustic output from the speaker is picked up by the microphone, amplified and fed back to the speaker causing a higher acoustic output which in turn is picked up by the microphone and so on until the system becomes unstable and howls in complaint.

A standalone induction loop system has no acoustic output and is therefore not subject to acoustic feedback. This gives the apparent advantage of setting the sensitivity of the microphone high so that it can be used at long distance from the person speaking. An installer with little acoustic knowledge and understanding of assistive listening may be tempted to take advantage of this increased sensitivity and use a single omnidirectional boundary microphone in the middle of a room to feed the induction loop system. However, this system will inevitably deliver poor intelligibility as it will pick up reflected sounds and background noise which will blur the speech.

Unless the microphone used is highly directional, the microphone must be placed as close as possible to the person speaking; tie clip and head set microphones are ideal.

A combined induction loop and audio system is of course susceptible to acoustic feedback. The acoustic path of speaker to microphone back to speaker is still present but now there is the possibility of creating an additional feedback mechanism. A dynamic microphone or the pickup coil of an electric guitar may also sense and amplify the magnetic field. In this case, the amplified signal will be driving both an acoustic speaker and an induction loop harder which in turn will be fed back to the input acoustically and magnetically. The resulting sound as the system oscillates is different from traditional acoustic feedback as there are now two feedback mechanisms involved.

The solution is quite simple. The magnetic field must be reduced or removed at the input which in a theatre means it must not be present on the stage. A cancellation loop on the first row or a SuperLoop™ System with its Ultra-low spill control will achieve this.

Too Much Gain

Setting the input sensitivity too high on any system will increase the risk of interference and feedback. This holds true for induction loop systems. Good induction loop amplifiers will have automatic gain control (AGC) to achieve a constant field strength output compliant with the IEC standard and an input level indicator to help set the correct input sensitivity (gain). With the input sensitivity set too high, the AGC will over compensate, amplifying and transmitting the acoustic background noise on the loop. To avoid this, the input sensitivity must be set in accordance with the manufacturer's instructions.

Conclusion

An induction loop system will not cause interference in an audio system when it is planned, designed and installed correctly. However, until theatre managers and others responsible for procuring induction loop systems appreciate that they are buying an audio system, which like any other professional audio system, should be installed by a specialist, loops in theatres will continue to buzz for all the wrong reasons.