

so your church is considering IN-EAR MONITORING...

your IEM questions answered, part one

by Thom Fiegle

With the growing popularity of contemporary praise bands, many houses of worship have experienced a significant increase in volume levels, to the point where there are complaints from the congregation. In-ear monitors, also known as personal monitors or IEMs, can get this situation under control, while at the same time offering the possibility of better sound quality and improved performances from the praise band.

As with any new technology incorporated into a house of worship, it's critically important to have a firm grasp on the facts before making a big investment. This article hopes to answer some basic questions and dispel a few myths on this important topic.

Why should my worship team switch to in-ear monitors?

Personal monitors are a very practical solution to a common set of problems in live musical performance. Typically, each musician is provided with a monitor mix, allowing them to hear themselves (and the rest of the band) while performing.

The problem with this approach is that the monitor speakers (also called floor wedges) and acoustic sounds from nearby instruments interfere with each other, resulting in "volume wars" between musicians. As a result, on-stage volumes can become dangerously loud, and the threat of feedback is significantly increased. In an acoustically resonant environment like a house of worship, the stage monitors also force the main PA system to be operated at a higher level, while at the same time interfering with the fidelity of the mix.

Basically, IEM systems eliminate floor wedges by putting the monitor mix directly in the musicians' ear canals, creating a much more controlled listening environment for both the praise band and the congregation. In short, any praise band that includes a drummer and/or amplified instruments can benefit greatly by switching to personal monitors.

What are the benefits of IEM (in-ear monitoring) systems over loudspeakers?

Improved Sound Quality—Both the praise band and the congregation benefit from IEM systems. For musicians, isolating earphones provide a rich, full mix at their preferred level while effectively eliminating competing sound from other musicians. By the same token, the main house mix is no longer muddied by monitor leakage, resulting in higher fidelity for the congregation.

Feedback Elimination—With no monitor speakers on stage, the risk of acoustic feedback is significantly reduced. This also reduces the time it takes for the engineer to equalize the sound for best gain-before-feedback.

Improved Performances—The use of in-ear systems helps in two specific ways. First, singers gain significantly better control of pitch since they no longer have to strain to hear themselves over their monitor speaker. In addition, musical timing improves since propagation delay due to the physical distance among ears and sound sources is virtually eliminated when using IEMs.

Freedom of Movement—No matter where performers go, they are always in the sonic "sweet spot." This allows for more creative stage presentations.

Tech Crew Advantages—Monitor engineers spend less time equalizing the wedges for best gain-before-feedback and can expect consistent results from week to week. In addition, the task of dragging bulky wedges and cabling on and off the stage is eliminated, as are the associated amplifiers and processors, resulting in a clean stage and faster setup.

Reduced Risk of Hearing Loss (if Used Properly)—By isolating the musician's ear, the signal-to-noise ratio is significantly improved, which allows for clear listening at significantly lower volume than when using floor wedges. However, this is a learned behavior. Musicians must be actively encouraged to turn down the levels of their IEM systems to take advantage of this fact. Some ear monitor

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systems can still produce dangerously high sound pressure levels—in excess of 120 dB!

Sounds like a big commitment. Does the whole band have to use in-ear systems?

In a word, no. While the benefits of personal monitors are maximized on a quiet stage, it is an industry myth that the entire band needs to convert. The fact is, not every performer on a given stage needs or wants personal monitors, and those that do still gain the performance and listening benefits.

Successful IEM implementation into a praise band starts by identifying who can benefit and making their transition a pleasant, stress-free experience. Soon, other members of the group will notice that the first performer is no longer having trouble hearing himself/herself and become interested. Before long, they will follow the path of the early adopter in order to reap all the same benefits. In addition, a gradual transition process minimizes the stress of making a major change all at once—a definite concern with volunteer musicians and sound engineers.

Which members of the praise team can benefit the most?

In any praise band that includes a drum kit, an IEM system can help anyone, including the drummer, to hear themselves better by isolating them from the din emanating from the drum set. Here are some examples.

Worship Leader—This is a delicate question. Many worship leaders have many years experience invested in their accustomed routine at the pulpit, whether with or without monitor wedge speakers. However, if the worship leader is an active participant with the praise band, an in-ear system can really take his performance to the next level. Ultimately, this is an individual choice.

Vocalists—Virtually any singer is a likely candidate for personal monitors. The wedge loudspeaker was originally invented to reinforce vocalists singing into microphones, in an attempt to help them hear themselves over a drum set and the delayed (and therefore confusing) sound bouncing back from the main PA speakers. In contrast, the choir might not benefit from IEM because their need to hear the acoustic “blend” of their voices outweighs the need to hear any individual.

Drummer—Drummers can’t help it, so they won’t

apologize, but their instrument is loud. The harder one hits a drum, the better it sounds, so they can’t really be faulted for doing the right thing. A snare drum measures 90 to 100 dBA in even the tamest of bands; anything else the drummer needs to hear must be at least 3 to 6 dB louder at the drummer’s ear.

It should be obvious that drummers are excellent candidates for personal monitors. In addition, because the drum wedge is the loudest sound source on stage, eliminating it is the biggest single improvement that can be made toward controlling a group’s volume. The good news is that most drummers will go willingly.

Keyboards—These days, most keyboardists use electronic instruments. Like electric guitar, they need some type of amplification system to be heard at all. Most keyboardists use their own onstage mixer to control their myriad of sound modules. Electronic keyboardists (and DJs) are prime candidates for IEMs simply because their instruments do not make a sound acoustically, and many of these performers use headphones anyway.

Acoustic pianists in a contemporary praise band setting, on the other hand, have an entirely different set of problems. The competition from drums, amplifiers and neighboring floor monitors makes it difficult to hear the instrument acoustically, forcing them to listen through monitors. The competing, louder sound sources are picked up by the piano mics, compromising the sound quality of the acoustic piano and greatly increasing the risk of acoustic feedback on stage. In this situation, personal monitors for the pianist are a big help.

Guitarists—An acoustic guitar makes a sound loud enough to fill a small room without any reinforcement at all. But once a drummer starts playing along, no one can hear the guitar very well. Like the piano outlined above, the acoustic guitar can be a severe feedback risk on a stage with wedge monitor loudspeakers. The result is a sonic compromise and not a good reference for the guitarist to judge how well his performance is going. IEMs allow acoustic guitarists these players to hear their instrument completely unprocessed, with all of its richness intact. Like vocalists, acoustic guitarists (and other stringed instrument players) tend to gravitate to IEM willingly and with excellent results.

Electric guitarists, on the other hand, have a low acceptance quotient for personal monitors, and for good reason. An electric guitar is part of a two-part sound system: the guitar and its amplifier (often located up to 20 feet away). The



The Aviom Pro16 system provides on-stage mix stations for each performer.

player can literally walk in and out of his sound to hear himself when required (e.g., guitar solo), and then move away to hear other sounds. The same is true of other remotely amplified instruments.

As a long-time mixer and champion of personal monitors, I have a theory explaining this resistance to IEMs. Basically, an electric guitarist's technique is developed subject to a small propagation delay between what the hands perform and what the ear hears. The sound reaches his ear milliseconds after the sound is initiated due to the amp's physical distance from the ear. A standard way to mic a guitar amp is by placing a microphone very close to the speaker producing the sound. This is ideal for the sound engineer to mix into the audience PA, but not so good for the guitarist wearing isolating earphones. The close proximity of the microphone to the sound source eliminates the guitarist's accustomed delay time, creating a subtle sense that the sound is happening (ironically) "too soon" for his liking.

That is not to say that electric guitarists can't or won't use IEMs. It's simply a bigger adjustment to be isolated acoustically from their amplifier. However, personal monitors have been around for well over a decade now, and many players are already accustomed to them, and can certainly benefit from their accuracy and immediacy.

How should we decide between wireless and wired IEM systems?

The easy answer to this question is to treat it the same as deciding on wired vs. wireless microphones. Stationary performers, most notably drummers and keyboardists, can use wired systems. Musicians who move around on stage, particularly worship leaders, vocalists and guitarists, are excellent candidates for wireless monitoring. Obviously, wireless systems are more expensive. It should be pointed out, however, that wired systems are easier to troubleshoot and less expensive to repair or replace. In many ways, this decision is tied to the desired style of the stage presentation, and the technical abilities of the staff.

Many houses of worship have incorporated a distributed monitoring system like those by Aviom or Hear



A popular choice for wireless personal monitors is the evolution G2 by Sennheiser.

Technologies. These systems provide each performer with a small mixing station on the stage, into which they plug their earphones. This relieves the sound engineer of the need to actively mix monitors, since individual instrument outputs are sent to all mix stations. These systems are inherently wired.

Which earphones are right for me?

There is a common misconception that personal monitor earphones are the equivalent of the earbuds sold with portable music players. Such earbuds do deliver sound, but don't always fit securely and provide little isolation from ambient sound. In short, they are simply not adequate for use on stage.

An isolating earphone starts as an ear plug, completely sealing the wearer's ear from other sound sources. Tiny speakers inside the housing provide the monitor mix directly to the ears. This allows musicians to hear their mix at any volume level without affecting the musician near them, a feat of engineering with which loudspeakers cannot compete. Isolating earphones come in a variety of forms ranging from simple dynamic earbuds to multi-speaker devices with crossover networks, enabling amazing sound reproduction from the lowest lows to the highest highs.

Should we invest in custom-fit earphones?

Many manufacturers make generic-fit or universal-fit earphones. These devices have replaceable or reusable ear tips made of foam, rubber and/or plastic, designed to fit in most anyone's ear canals. While these "fit kit" systems work well for some, the natural variation of ear canal size and shape results in varying degrees of success in terms of secure fit, comfort and isolation. A secure fit is a necessity, as a tight seal between the ear canal and earphone yields much better bass frequency response and a higher signal-to-noise ratio. When a musician complains of bad sound quality, it is often a fit issue.

Custom-fit earphones are molded specifically to an individual's ears, inserting deep into the ear canal to yield a personalized fit and superior isolation. They also look better



The Shure E3 is a popular balanced-armature earphone, shown here with custom-fit sleeve by Sensaphonics (left) and universal-fit ear tip.

in the wearer's ear, with a sleeker, low profile design. If made from a soft, flexible material like gel silicone, they will also be very comfortable, resulting in the wearer's ability to use them for extended periods of time without "itchy ears" or other issues inherent in universal-fit earphones. In short, custom-fit earphones take greater advantage of the benefits of in-ear monitoring. For many churches, it makes sense to invest in custom earphones for featured performers, notably the worship leader, music director, and lead vocalists.

There is also a middle ground. Many generic earphones can be converted to custom-fit by adding a molded sleeve to replace the universal ear tips. These custom sleeves add greater comfort, a more secure fit and better isolation without defeating the earphone's ability to fit someone else when the custom tip is removed.

How can you tell when your earphones are fitted correctly?

Many people are understandably a bit skittish about inserting earphones deep into the ear canal. As a result, users of generic-fit earphones often fail to achieve the full, tight seal necessary for full-range sound reproduction. It's common and natural to blame the equipment for this problem.

Custom-fit earphones are dispensed by an audiologist or other hearing health care provider. These professionals can provide a fitting session for the purchaser, teaching the proper technique for full insertion while checking that the earphones do, in fact, fit correctly.

A poor seal of balanced-armature earphones results specifically in a dramatic loss of bass response. This is easy to check. Sensaphonics Hearing Conservation offers a free online Seal Test (www.sensaphonics.com/test) that quickly and easily determines whether this is a problem.

What types of earphone speakers should I look for?

Some manufacturers still use earbud-style moving coil speakers (called "dynamic drivers") in their earphones. While this style of earphones is economical to purchase, they have difficulty achieving high fidelity sound in a sealed ear canal. Typically, these products use a venting system to help improve the sound quality, with the unfortunate side effect of preventing a complete seal. These devices can provide plenty of low frequency response, but have difficulty generating crisp and detailed high frequencies.

Balanced armature speakers are significantly smaller than their dynamic counterparts. This enables very small earphone designs as well as the ability to place more than one of them within the earphone housing. Balanced armature speakers are more sensitive and can exhibit much wider frequency response, especially in multi-driver designs. Balanced armature earphones typically cost more than their dynamic counterparts.



One advantage of custom-fit earphones is a low-profile look. Shown here: Sensaphonics 2X-S earphone.

Are there benefits to multiple-driver earphone designs?

Single-driver balanced armature earphones have the benefit of being the lowest profile and lightest earphones on the market. They can reproduce the vocal range with astonishing clarity and definition. They are, however, difficult to design for low frequency reproduction like a bass guitar's strings, a drummer's kick drum or the low keys of the piano or organ.

Enter the dual driver earphone. Similar to the concept of two-way loudspeakers, these earphones use separate drivers for low and high frequencies. Just like loudspeakers, multi-driver earphones offer efficiencies that a single speaker cannot. With each driver doing less work, the tweeter can reproduce mids and highs without undue stress, while the woofer delivers thunderous bass. Some manufacturers offer designs with three or four speakers. It's probably fair to say that there is a diminishing benefit to adding more and more speakers, just as is true with conventional loudspeakers. However, it's clear that multi-driver designs produce the most accurate frequency response. Performers who are seeking realistic bass response will not be disappointed.

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“Custom-fit earphones are dispensed by an audiologist or other hearing health care provider. These professionals can provide a fitting session for the purchaser, teaching the proper technique for full insertion while checking that the earphones do, in fact, fit correctly.”



The state of the art in IEMs is the 3D Active Ambient, offering full isolation while capturing ambient sound with microphones embedded in the earpieces.

Does isolation create problems on stage?

While many performers absolutely love the fact that their monitor mix is placed so squarely in their heads without interference from sounds around them, some musicians cannot get over the fact that their ears are plugged. Verbal communication with other band members is difficult, and the audience cannot be heard.

There are several ways to deal with this issue. One is to set up microphones to pick up the audience, adding it to the in-ear mix as needed. Some musicians are tempted to simply remove one earphone. This is a dangerous practice in terms of hearing health, as it requires turning up the sound in the earphone, while the open is unprotected. A recent development by Sensaphonics is the “active ambient” earphone system, which embeds tiny microphones in the earphones, giving the user fully adjustable ambience without losing the benefits of full isolation.

What about hearing conservation?

From the performer’s perspective, hearing protection is usually a secondary concern. Their first priority is performing the best they possibly can. But the fact is, prolonged exposure to overly loud sound can result in permanent hearing damage. The good news is that high isolation in-ear monitoring allows exceptional fidelity that can still be heard at significantly lower volumes.

Virtually every manufacturer of personal monitoring products claims that “when used properly” their products can provide hearing protection to the user. However, few manufacturers provide specific advice on how to use the products “properly” from a hearing safety perspective. When asked, most manufacturers will explain simply, “don’t turn them up too loud.” Obviously, that’s not very specific.

How can I encourage the praise band to use their IEMs safely?

Left to their own devices, musicians will naturally turn up their IEM system to the same volume level they are used to. Because a well-fitted isolating earphone can provide up to 26 dB of isolation, the user can actually hear the monitor mix just as clearly at significantly lower levels. But because each ear, earphone and IEM system is different, there is no clear-cut method for determining a volume setting that is guaranteed to be safe. It is critical to impress the band with the importance of changing their behavior, learning to monitor at the lowest level they can, rather than the highest level they can stand.

To date, there is no readily-available device to determine what a given volume setting on an earphone amplifier equates to in terms of decibel levels at the user’s eardrum. Some audiologists do have special equipment to measure the earphone output within the ear canal. However, the best way to determine if there are hearing health issues is to encourage all members of the praise team to get annual hearing checks.

It’s clear that the adoption of in-ear monitoring can help control volume levels while enabling a more high-fidelity mix for both the praise band and the congregation. Whether incorporating IEMs slowly or all at once, the key to successfully adopting this technology lies in understanding and taking advantage of its benefits over conventional floor wedge monitoring. If you’ve read this article all the way through, you’ve taken a positive first step.❖

Thom Fiegle of Sensaphonics has spent his entire career in the pro audio industry. Since 1984, he has been owner/operator of Figleaf Productions, a Chicago-area sound company. He is also partner and chief technician at Reelsounds Recording Studios, and constantly mixes sound at local nightclubs.

By day, Thom is the sound engineering consultant for Sensaphonics, a manufacturer of custom earphones for musicians, where he is affectionately known as The Sound Guy, offering advice to customers and helping design new products. Previously, Thom worked for Shure, including a lengthy stint as product specialist for personal monitors. He was also technology liaison for the Advanced Development Engineering group, helping recommend and develop new technologies for future products.

With his extensive experience and expertise in both product development and hands-on live sound, Thom Fiegle offers a unique combination of skills that help Sensaphonics customers get the most from their investment in personal monitors. For more information, visit the Sensaphonics Web Site at www.sensaphonics.com.

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