

CHAPTER TWO

WHY USE PERSONAL MONITORS?

When was the last time you had a great experience with a wedge monitor system? You could hear everything, no feedback, plenty of volume (without being dangerous), and the monitor engineer instantly responded to your every request? If you can't remember, you're not alone. Anyone who has performed live has probably dealt with a poor monitor system, but even a great system has many limitations due to the laws of physics, and those laws bend for no one. The concept of personal monitoring rose from the desire to create an on-stage listening experience that could overcome the limitations imposed by a traditional floor monitor system.

Let's define a personal monitor system. Many parallels exist between personal monitors and a traditional floor wedge setup. The purpose of any monitor system is to allow performers to hear themselves. The sounds to be monitored need to be converted to electronic signals for input to the monitor system. This is usually accomplished via microphones, although in the case of electronic instruments such as keyboards and electronic drums, the signals can be input directly to a mixing console. The various signals are then combined at a mixer, and output to either power amplifiers and loudspeakers or to the inputs of personal monitor systems. Any amount of signal processing, such as equalizers or dynamics processing (compressors, limiters, etc.), can be added in-between. A hardwired personal monitor system is similar (in signal flow terms) to a traditional wedge system, since the belt pack is basically a power amplifier, and the earphones are tiny loudspeakers. A wireless personal monitor system, however, adds a few more components, specifically a transmitter and receiver. From the output of the mixer, the audio signal goes to a transmitter, which converts it to a radio frequency (RF) signal. A belt-pack receiver, worn by the performer, picks up the RF signal and converts it back to an audio signal. At this stage the audio is then amplified and output to the earphones. See Chapter 4 for a complete discussion of the various earphone types available.

So just what is the "experience" of personal monitors? The four most prominent benefits when using them are listed below:

- *Superior sound quality*
- *Portability*
- *Mobility*
- *Personal Control*



Hardwired System

Wireless System

The term "personal monitors" is derived from several factors, but basically revolves around the concept of taking a monitor mix and tailoring it to each performer's specific needs, without affecting the performance or listening conditions of the others. The concept is broader than that of "in-ear monitoring", which states where the monitors are positioned, but gives no further information on the experience.

Superior Sound Quality

There are several factors that, when taken as a whole, result in the superior sound quality of personal monitor systems. These factors include adequate volume for the performers, gain-before-feedback, hearing conservation, reduced vocal strain, and less interference with the audience mix.

Adequate Volume

The most common request given to monitor engineers is "Can you turn me up?" (Sometimes not phrased quite so politely.) Unfortunately, it is not always quite that simple. Many factors can limit how loud a signal can be brought up when using traditional floor monitors: size of the power amplifiers, power handling of the speakers, and most importantly, potential acoustic gain (see Gain-Before-Feedback below). Another factor that makes hearing oneself difficult is the noise level onstage. Many times, vocalists rely solely on stage monitors, unlike guitarists, bassists, and keyboardists whose instruments are generally amplified to begin with. Drummers, of course, are acoustically loud without amplification. Volume wars are not uncommon as musicians struggle to hear themselves over the ever-increasing din. The clarity of the vocals is often obscured as other instruments are added to the monitor mix, which becomes increasingly necessary if fewer mixes are available. Keyboards, acoustic guitars, and other instruments that rely on the monitors often compete with the vocals for sonic space. A personal monitor system, which isolates the user from crushing stage volumes and poor room acoustics, allows the musician to achieve a "studio-like" quality in the onstage listening experience. Professional, isolating earphones, when used properly, provide between 10 and 20 dB of reduction in background noise level

(see Chapter 4 for more information on earphones). The monitor mix can then be tailored to individual taste without fighting against otherwise uncontrollable factors.

Gain-Before-Feedback

When it comes to achieving higher monitoring levels with traditional stage wedges, you can always add more amplifiers and more loudspeakers, but you cannot defy the laws of physics. The concept of gain-before-feedback relates to how loud a microphone can be turned up before feedback occurs.

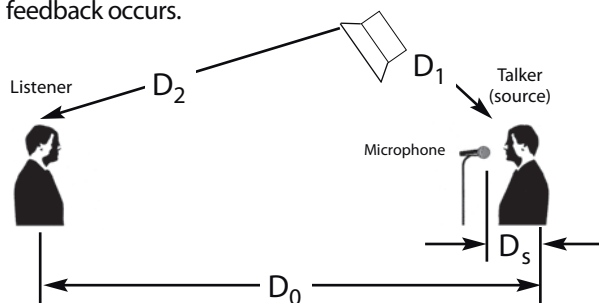


Figure 1 Potential Acoustic Gain

$$\text{PAG} = 20 (\log D_1 \log D_2 + \log D_0 - \log D_s) - 10 \log \text{NOM} - 6$$

Closely related is PAG, or Potential Acoustic Gain. The PAG equation is a mathematical formula that allows you to predict how much gain is available in your sound system before reaching the feedback threshold, by plugging in known factors such as source-to-microphone distance and microphone-to-loudspeaker distance (see figure 1). Simply stated, the further away you get from the microphone, or the closer the microphone is to the loudspeaker, or the further away the loudspeaker is from the listener, then the less available gain-before-feedback. Now picture a typical stage. The microphone is close to your mouth; that's good. The microphone is close (relatively) to the monitor loudspeaker; that's bad. The monitor loudspeaker is far (relatively) from your ears; that's also bad. Feedback occurs whenever the sound entering a microphone is reproduced by a loudspeaker and "heard" by the same microphone again. To achieve a decent monitoring level, you need quite a bit of available gain. But given the above situation, you have two major factors working against you. Compounding the problem is the issue of NOM, or Number of Open Microphones. Every time you double the number of open microphones, the available gain-before-feedback drops by 3 dB. With four open microphones on stage instead of one, the available gain has dropped by 6 dB. What can you do? The PAG equation assumes omnidirectional microphones, so using cardioid or even supercardioid pattern microphones will help; just don't point them at the speakers. Also, the equation assumes that the sound system

has a perfectly flat frequency response. The most commonly employed tool for reducing feedback due to response problems is the graphic equalizer. Since some frequencies will feedback before others, an equalizer allows a skilled user to reduce the monitor system's output of those troublesome frequencies. This technique results in approximately 3-9 dB of additional gain, assuming the microphone position doesn't change. It is common practice for some monitor engineers to attempt to equalize the monitor system to the point where there is no feedback, even with a microphone pointed right into the speaker cone. Unfortunately, the fidelity of the monitor is often completely destroyed in an effort to eliminate feedback using equalizers. Even after equalization has "flattened" the response of the monitor system, PAG again becomes the limiting factor. At this point, you can't get any closer to the microphone, and moving the loudspeaker closer to your ears also makes it closer to the microphone, negating any useful effect on PAG.

Personal monitoring completely removes PAG and gain-before-feedback issues. The "loudspeakers" are now sealed inside your ear canal, isolated from the microphone. With the feedback loop broken, it is possible to achieve as much volume as necessary – which leads to the next topic...

Hearing Conservation

The main purpose of personal monitors is to hear yourself better. But it doesn't do any good if you can't hear at all. As mentioned earlier, volume wars on stage are a universal problem. Prolonged exposure to extremely high sound pressure levels can quickly cause hearing to deteriorate. Some performers have taken to wearing ear plugs to protect their hearing, but even the best ear plugs cause some alteration of frequency response. Personal monitors offer a level of hearing protection equal to that of ear plugs, but with the additional benefit of tiny loudspeakers in the plugs. The monitoring level is now in the hands of the performer. If it seems to be too loud, there is no excuse for not turning the monitors down to a comfortable level. The use of an onboard limiter is strongly recommended to prevent high level transients from causing permanent damage. In larger, complex monitor rigs, outboard compressors and limiters are often employed to offer a greater degree of control and protection.

NOTE: Using a personal monitor system does not guarantee that you will not or can not suffer hearing damage. These systems are capable of producing levels in excess of 130 dB SPL. Prolonged exposure to these kinds of levels can cause hearing damage. It is up to the individual user to be responsible for protecting his or her own hearing. Please see Chapter 8 for more information on safely using personal monitors.

Reduced Vocal Strain

Closely related to the volume issue, the ability to hear more clearly reduces vocal strain for singers. In order to compensate for a monitor system that does not provide adequate vocal reinforcement, many singers will force themselves to sing with more power than is normal or healthy. Anyone who makes a living with their voice knows that once you lose it, you lose your livelihood. Every precaution should be taken to protect your “instrument,” and personal monitors are a key ingredient in helping vocalists continue to sing for years to come (See Adequate Volume, previously discussed.)

Stereo

A distinct advantage of using a personal monitor system is the ability to listen in stereo. While it may not be applicable to all situations, especially with a limited number of mixes available, a monitor mix created in stereo can more accurately recreate a realistic listening environment. We spend our entire lives listening in stereo; logically, a stereo monitor mix increases the perception of a natural sound stage. Monitoring in stereo can also allow for lower overall listening levels. Imagine a group with two guitar players sharing the same mix. Both instruments are occupying the same frequency spectrum, and in order for each guitarist to hear, they are constantly requesting their own level be turned up. When monitoring in mono, the brain interprets sounds based only on amplitude and timbre. Therefore, when two sounds have roughly the same timbre, the only clue the brain has for perception is amplitude, or level. Stereo monitoring adds another dimension, localization. If the guitars are panned, even slightly, from center, each sound occupies its own “space.” The brain uses these localization cues as part of its perception of the sound. Research has shown that if the signals are spread across the stereo spectrum, the overall level of each signal can be lower, due to the brain’s ability to identify sounds based on their location.

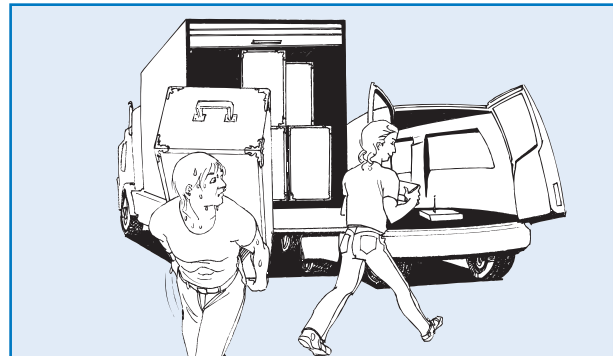
Interference with the Audience Mix

The benefits of personal monitors extend beyond those available to the performer. An unfortunate side-effect of wedge monitors is spill from the stage into the audience area. Although directional at high frequencies, speaker cabinets radiate low frequency information in a more or less omnidirectional manner. This situation aggravates the

already complex task facing the FOH (front-of-house) engineer, who must fight against loud stage volumes when creating the audience mix. The excessive low frequencies coming off the backs of the monitors make the house mix sound “muddy” and can severely restrict the intelligibility of the vocals, especially in smaller venues. But eliminate the wedges, and the sound clears up considerably.

Portability

Portability is an important consideration for performing groups that travel, and for installations where the sound system or the band performance area is struck after every event. Consider the average monitor system that includes 3 or 4 monitor wedges at roughly 40 pounds each, and one or more power amplifiers at 50 pounds – this would be a relatively small monitor rig. A complete personal monitor system, on the other hand, fits in a briefcase. Purely an aesthetic consideration, removing wedges and bulky speaker cables from the stage improves the overall appearance. This is of particular importance to corporate/wedding bands and church groups, where a professional, unobtrusive presentation is as important as sound quality. Personal monitors result in a clean, professional-looking stage environment.



Personal Monitors Won't Break Your Back.

Mobility

Monitor wedges produce a “sweet spot” on stage; a place where everything sounds pretty good. If you move a foot to the left or right, suddenly things do not sound as good anymore (see figure 2). The relatively directional nature of loudspeakers, especially at high frequencies, is responsible for this effect. Using personal monitors, though, is like using headphones – the sound goes where you go. The consistent nature of personal monitors also translates from venue to venue. When using wedges, room acoustics play a large part in the overall quality of the sound. Since professional earphones form a seal against ambient

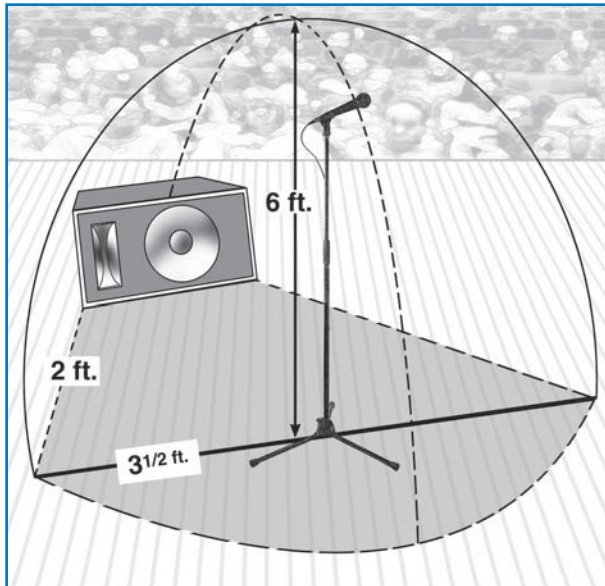


Figure 2 Sweet Spot Created by a Monitor Wedge

noise, acoustics are removed from the equation. In theory, given the same band with the same members, the monitor settings could remain virtually unchanged, and the mix will sound the same every night.

Personal Control

Perhaps the most practical benefit to personal monitors is the ability to have direct control over what you are hearing. While still relying on the sound engineer to make fine adjustments, personal monitor systems give the performer some ability to make broad adjustments, such as overall volume, pan, or the ability to choose different mixes. If everything in the mix needs to be louder, instead of giving a series of complex hand gestures to the monitor engineer, the performer can raise the overall volume directly from the belt-pack. Further personal control is provided by systems that feature a “dual-mono” mode, where the belt-pack combines the left and right audio channels of a stereo system and sends the combined signal to both sides of the earphones (see figure 3). The inputs to the system should now be treated as “Mix 1” and “Mix 2” instead of left and right. The balance control on the receiver acts as a mix control, allowing the performer to choose between two mixes, or listen to a combination of both mixes with control over the level of each. Panning to the left gradually increases the level of “Mix 1” in both ears, while reducing the level of “Mix 2,” and vice versa. Chapter 5 includes some practical applications for dual-mono monitoring. Putting a small, outboard mixer near the performer increases the amount of

control. By giving control of the monitor mix to the performer, the sound engineer can spend more time concentrating on making the band sound good for the audience instead of worrying about making the band happy.

Lesser expensive, mono-only systems can offer a similar type of control by providing multiple inputs at the transmitter, with a separate volume control for each. Consequently, the transmitter should be located near the performer for quick mix adjustments.

The cost of transitioning to personal monitors has recently dropped dramatically. A basic system costs as much, if not less than, a typical monitor wedge, power amplifier, and graphic equalizer combination. Expanding a system is also more cost effective. When providing additional wedges for reproducing the same mix, a limited number can be added before the load on the amplifier is too great, and another amp is required. With a wireless personal monitor system, however, the number of receivers monitoring that same mix is unlimited. Additional receivers do not “load” the transmitter, so feel free to add as many receivers as necessary without adding more transmitters. For bands that haul their own PA, transportation costs may be reduced as well. Less gear means a smaller truck, and possibly one less roadie.

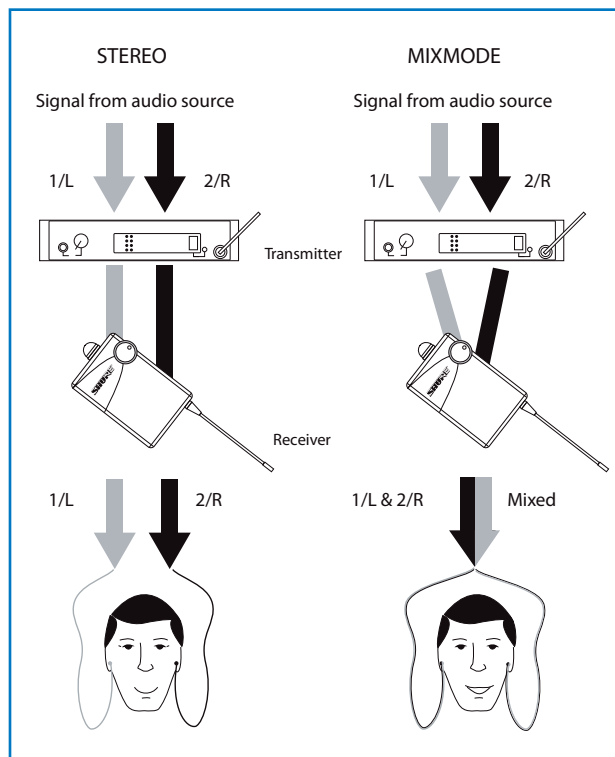


Figure 3 Graphic Representation of Stereo vs. Dual Mono