Stick It In Your Ear

Enrolling in "IEM 101"

By Mark Herman

Enrique Iglesias taking advantage of IEM.

Performers and sound professionals alike are now using in-ear personal monitoring systems (IEM) instead of – or in conjunction with – standard monitor wedges. And with prices dropping, IEM is now available to a much broader range of users.

One chief advantage is improved gain-before-feedback. Isolating the stage loudspeakers at the ear helps break the feedback "loop" – there's dramatically less noise on stage to spill into open microphones. Therefore, it's easier than ever to attain much higher sound pressure levels (SPL) for monitoring, which in turn can be beneficial to artists as well as both front-of-house (FOH) and monitor engineers.

If working with the same artist(s), optimized monitor system settings can be saved and therefore remain virtually unchanged from show to show. The need to "fight" a given room's acoustics to get the monitor mix right is also rendered moot.

Further, less overall stage noise can directly lead to a cleaner FOH mix, and again, more headroom in this regard is feasible. In addition, the IEM approach has opened up a whole new world in terms of mic selection. A downside is that artists tend to want the enhanced SPL to such a high degree that it can lead to temporary and permanent hearing damage. (This is an entire topic all its own!)

For the artist, IEM (particularly when wireless) provides increased mobility, as well as easily achieved stereo mixes, no more "sweet spots", and a more consistent overall mix. IEM earpieces can also reduce ambient sound and provide less exposure to potentially damaging stage levels - if, if, if - the IEM mix is kept at a safe, reasonable level.

Sound companies benefit with faster load-ins and load-outs, easier soundchecks and reduced truck packs. Eliminating wedges and speaker cables can improve stage layout and appearance as well. A complete IEM rig can often fit in a briefcase. Still, some artists still prefer using both wedges and IEM, while others continue to shy away from IEM altogether.

DELIVERY & DESTINATION

Simply put, the monitor signal is sent from the mixing console, and via IEM hardwire or wireless hardware, is routed to the end-user's earpiece(s). In between, various signal processing devices may be inserted to create whatever effects are desired. When working with any IEM rig, it's usually recommended that equalization (EQ) be employed to shape the sound, along with a compressor to help "smooth" transient peaks that are common with vocals, guitars and drums.

IEM systems can be broken down into distinct and separate parts. The delivery system is either hardwired or wireless, consisting of transmitters and belt packs. Wireless systems are more costly than hardwired (drum and keyboard use primarily). With wireless, the transmitter receives a signal from the monitor output or auxiliary output of the console and then transmits the signal to the receiver linked via a cable to the earpiece(s).

One primary focus here is the final hardware destination: the earpiece. One might think that this is a high science, measurements galore and etc., but we've actually found just the opposite. Earpiece design and performance is one of the most subjective and least understood parts of the equation.

Obviously there are some "checked out" people that understand earpieces, but my guess is that over 95 percent of the target audience can't name the leading manufacturers and models or explain the differences between armature and dynamic earpieces.

Earpieces are either universal (generic) or custom molded. The quality and choice of the earpiece is extremely important. All of the components in the IEM signal path will be rendered ineffective by a low-quality earpiece. Deciding which earpiece to use is perhaps the hardest and most subjective part of the equation.

WHO MAKES THIS STUFF?

Essentially there are five companies producing and marketing pro-caliber earpieces. Currently the major players are Shure, Future Sonics, Ultimate Ears, Sensaphonics and Westone. Other IEM system manufacturers, such as Sennheiser, include earpieces made by one of these manufacturers.)

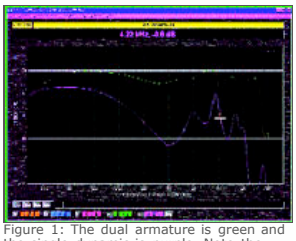

Figure 1: The dual armature is green and the single dynamic is purple. Note the dramatic rolloff on the high-end frequencies.

Each of these five players has a unique history, culture and flavor. Further, there are generic, custom, ambient, isolated, louder, cheaper, artier, and safer models to choose from; but "better" is in the ears of the individual wearer. It usually comes down to what each likes (and can afford).

With the exception of Shure, these companies have small staffs and even smaller research and development departments, more "garage-like" operations, which, in my opinion, make it very exciting. Who knows what's coming next? Glad you asked. For one thing, earpieces for your IPOD. MacWorld magazine's December 2003 issue is already touting the benefits of Ultimate Ear products for audiophile consumer use. And Shure now offers consumers the E5c, much the same product as the pro E5.

Just to make it all more confusing, musicians wanting or using IEM are usually even more clueless than we are. The best remedy is to bone up on earpiece jargon, manufacturers' names and philosophies, models, and the latest products. After that, the best path is learning how to successfully mix and care for IEM. In future issues, we'll address setting up IEM mixes as well as interacting with artists on this topic.

DRIVER MEASUREMENT

As a matter of conscience, Live Sound tries not to list any measurement in the model specifications that has no reference point. (See the model listings beginning on page 48 of this issue.) Frequency response means absolutely nothing unless it has a +/- dB point, and for a variety of reasons, I've settled on +/- 6 dB as the reference point for IEM. The only manufacturer to present this information correctly to us was Ultimate Ears; they stress the measurement presentation.

Who cares if there is some limited frequency response at 20 dB down? When manufacturers present 20 Hz to 20 kHz with no reference point, I've got to believe that marketing is winning over reality. As will notice in the model listings, four of the five manufacturers are guilty as charged.

If you could look at performance charts of all the IEM earpieces (and good luck in trying to do this!), you'd likely be completely discouraged from using or buying ANY of them. The performance specs look dreadful, but the reality is that there is far more to it than first meets the eye. Most of the armature drivers look wimpy on the lows and drop like a rock somewhere after 8 kHz on the highs.

Except for the low-end, the dynamic drivers look even worse. There is a sharp drop after 4 kHz, a rise around 6 kHz, and then response falls into oblivion. How does that grab you? I mean who would ever buy a monitor wedge with specs like these? But the reality is that both armature and dynamic earpieces do work quite well in the real world for many users. How can this be? (**Figure 1** above)

Measurement doesn't paint the picture as well as it does in other audio applications. The most subjective parts of the human being are the brain and hearing. We all smell, see and touch things in a reasonably similar objective way, but we hear and emotionally feel sound much differently.

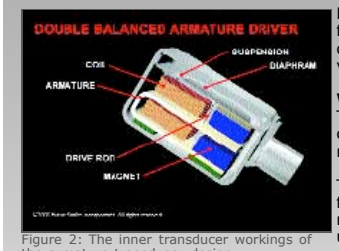

Figure 2: The inner transducer workings of the armature transducer design

Earpieces are a very personal connection to the human body and all the scientific research so far has provided us with only a vague roadmap. Each human ear canal "plumbing" has a different length and diameter; the way it couples with an earpiece creates a situation with variations upon variations for frequency response and fit.

WHAT'S AN ARMATURE?
The balanced armature transducer design (**Figure 2**) came from the hearing aid industry. It combines a small footprint with high sensitivity and obtains a reasonable high-frequency response if a good seal can be maintained between the earpiece and the human ear canal.

The earpiece market has developed two-way, and recently, three-way models with the frequency spectrum – low, mid, high – divided by a passive crossover network. Each driver reproduces the frequency range for which it has been optimized. The concept is the same as used in regular loudspeakers.

The end result of two- and the new three-way designs (no field responses on the latter yet) is usually increased low end as well as extended high frequency response. There are also models with dual-low-frequency armature drivers and a single-high armature driver, a design that theoretically improves low-end response.

Some musicians prefer one armature model over another based on the instrument they play. Vocalists and horn players often like the single driver designs, while bass players and drummers seem to go with dual drivers.

TRULY DYNAMIC?
Dynamic drivers (Figure 3) work on much of the same principles as most loudspeakers. A diaphragm is attached to a coil of wire suspended in a magnetic field. The coil vibrates along with the variations in voltage that then forces the diaphragm to move and create variations in air pressure, which we translate into sound.

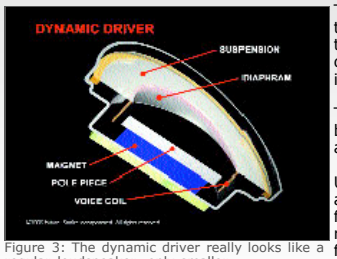

Figure 3: The dynamic driver really looks like a regular loudspeaker, only smaller.

The size of the coil assembly has a direct bearing on the size of the earpiece. This is why the dynamics are larger than the armature drivers. We see very inexpensive dynamic transducers commonly used in consumer "earbuds" for Sony Walkman and other playback devices. The consumer earbuds do not hold up in the pro environment and have substandard isolation. Professional use can be found in either generic "universal" or custom earpieces.

To achieve proper low frequency response, an earpiece with a dynamic driver must usually be "ported", which means there are openings in the earpiece. This allows a fair amount of ambience into the ear and limits any safety aspects of IEM use.

Universal earpieces – dynamic and armature – use interchangeable sleeves that are used to adapt the earpiece to the ear canal. These sleeves can be foam, flexible rubber, rubber flange tips, and custom molded. (Figure 4) Each type has advantages and disadvantages. I recently tried a universal with foam sleeves and found the fat ones best for me, while a friend preferred the small ones. Same earpiece, different-size foam, completely different reaction.

THE CUSTOM ROUTE
If you're a pro and have the cash, you should seriously think about getting an ear impression and going the custom route. There is a high element of suspense (risk) in choosing the type of driver, manufacturer and specific model because you can't return it!

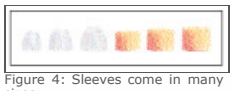
Figure 4: Sleeves come in many sizes.

It's wise to try to figure out the type and configuration of driver(s) you like. Always remember that each individual has a unique set of ears, and subliminal desires that greatly influence audio quality perception. There is no one best model that wins every time.

Even though this method is crude, it helps establish what style an individual leans toward. Go to a Shure dealer (the only ones that offer all major types in one location) and demo the E1 single armature driver, the E5 dual armature driver and the E2 dynamic driver. This can get you close, just be aware that the performance of a custom fit will blow away the universal just about every time and it also won't exactly replicate the differences found in the universals.

Other considerations are how an earpiece looks and feels. Some now have soft silicone or acrylic exteriors for added comfort. Of course every manufacturer says it has the softest; there are significant degrees of soft being floated.

And, many models are available in a multitude of colors and patterns if you want to make a fashion statement. Westone even has a custom art shop that will imprint images and patterns on earpieces.

General Observations – Selecting Earpieces
And add a healthy dose of salt!
1. Universal earpieces are relatively inexpensive, while custom units cost way more but work much better.
2. Armatures tend to work very well cutting through loud stage volumes when wedges are still being used.
3. The acoustic isolation of an armature driver in a custom mold can be really weird at first but it can save your hearing if SPL is kept at a reasonable level.
4. Dual and triple drivers allow for very high SPL and increased frequency response in the earpieces. This is bad (hearing loss potential goes up) or good (For those who get off on loudness, more headroom, more response), depending on what an individual wants.
5. Dynamics appear to be much smoother on the low-end but the high-frequency response is limited. Those who desire clean low tones (take notes you bass players) will probably gravitate towards a dynamic. If you want to hear that "breathy air" – forget it!
6. Dynamics aren't as well suited for competition with wedges and also allow much more ambient noise in through the ports. Future Sonics President Marty Garcia even says that he avoids working with heavy metal bands because of this. Many artists who want to have a personal "feel" for the stage and audience desire ambient noise.
7. Keep an eye out for new models that increase performance.
8. Every person's ear is totally different, so keep your options open.
9. Contact earpiece manufacturers directly if you really want to learn about their products.
10. Remember that this is a SUBJECTIVE choice that can lead to all sorts of objective results.
11. If you spring for the custom earpiece remember that you can use them for private pleasure as well as work. They are good for airline, bus and car travel, backpacking, extreme sports, yard work, watching TV in bed, working out and for pretending you're deaf. Go ahead - treat yourself to a better audio life!

Moving Forward with a Hybrid Approach
Real World Gear: In Ear Monitors
An expert view on IEM and hearing

Mark Herman is publisher of Live Sound magazine and finds that he just can't get enough of IEM earpieces these days. Reach him at ***mherman@livesoundint.com****.*

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