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THE AUX-FED SUBWOOFER TECHNIQUE

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THE AUX-FED SUBWOOFER TECHNIQUE

Clearing up the confusion as to what this approach actually encompasses and what it accomplishes. *by Tom Young*

Several years ago, a technique most commonly called "aux fed subs" has been developed for reducing low-frequency "muddiness" from front-of-house loudspeaker systems. This technique has resulted in considerable benefits over a wide variety of sound reinforcement applications, but there is confusion as to what it encompasses and what it accomplishes.

Let's clarify the details and describe the set up of an aux fed subwoofer system. We'll also address some frequently asked questions on the topic.

In a traditional loudspeaker system where subwoofers are used, the primary mix bus from the house mixing console feeds the loudspeaker system processor. This provides the separate output that in turn feeds the subwoofer amplifier and loudspeakers.

The crossover parameters for the subs are derived from measurement of both the subs and the midrange drivers next up in the frequency scale of the

loudspeaker system. Most often the crossover point between the subs and midrange is chosen for the best (most equal) phase response to ensure coherence through the crossover region.

Electrical delay is likely to be required to achieve this alignment due to the position of the subwoofers versus the position of the full-range loudspeakers. Once crossover points have been set, the relative gain levels (and etc.) must not be altered, because this will change both the crossover point and phase alignment of the system.

In an aux fed sub system, each input to be fed into the subwoofer system is sent through the house console's "post-fader/post-EQ" aux send, from each selected channel. By routing through this aux send, any changes in channel fader position will result in a comparable change in the subwoofer level (just as would be the case in a traditional subwoofer system). A properly configured and operated aux-fed subwoofer system will maintain the gain structure and the crossover relationships that have been derived from the system optimization process.

What's It Mean?

The significance of assigning specific inputs to subwoofers lies in removing all other channels from the subwoofer mix. These channels are not just attenuated so many dB at whatever high-pass frequency you have available, they are completely removed from the subwoofers and are also attenuated (by as much as 24 dB-per-octave) below the high-pass frequency feeding the full-range loudspeakers.

This is most effective with those microphones that are not closely positioned to the source and which therefore are very likely to be picking up ambient sound — mostly LF rumble and/or leakage. Mics used for pickup of choir, horn sections and string sections are the most frequently encountered that fall into this category.

Other common microphone applications are also very good candidates for removal from the subwoofer mix, such as acoustic piano, where external low-frequency leakage is prone to be focused (by the piano body) into the microphones. Ditto male vocals using cardioid handheld microphones (with proximity effect).

For spoken-word applications and especially with cardioid lavalier microphones, the normally huge LF explosions that occur through subwoofers when the person talking uses plosive consonants (B, F, P, T, etc) are reduced dramatically.

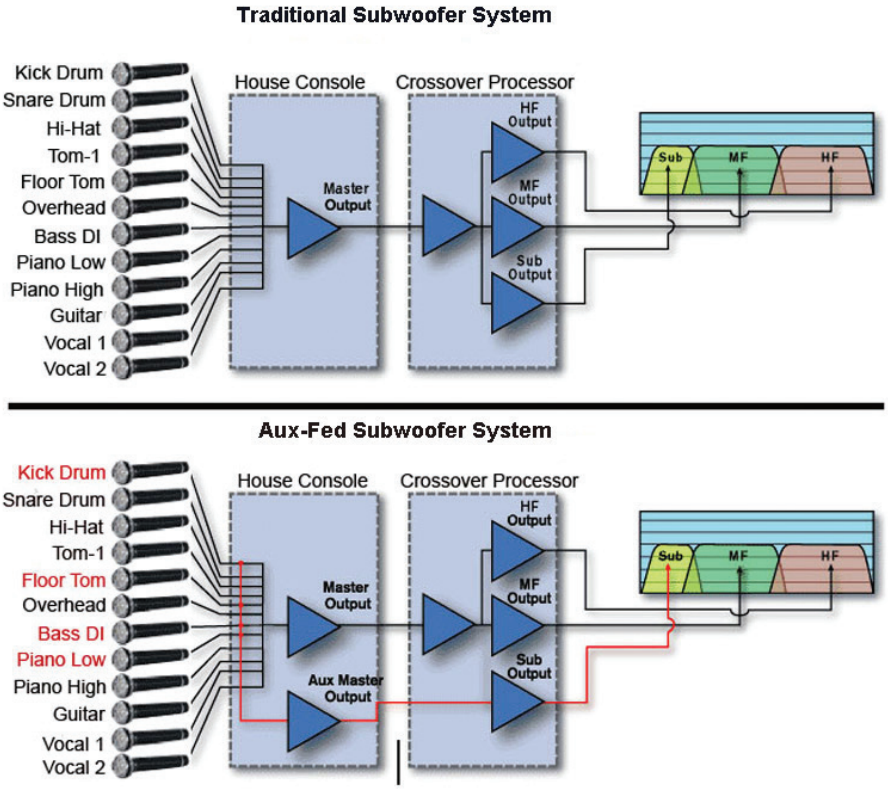
In fact, when mixing pop music on virtually any reinforcement system, there will very likely be numerous microphone channels that have no useful infor-

mation that could be enhanced by the subwoofers. For these instruments/sources it is also likely that efforts will be made to reduce the pick up of energy below (approximately) 100 Hz.

Getting It Done

Normally, the most effective and readily available tool is the high-pass filter provided on the console's input channels, in the form of fixed or sweepable corner frequency with (typically) a 12 dB-per-octave filter. But high-pass filters have restricted effectiveness near their corner frequency and there will remain at least some low-frequency (LF) energy that is still fed into the subwoofers.

And note that even with high-pass filters engaged, groups of microphones positioned in the same area have an accumulative and substantial amount of LF energy that is passed into the subwoofers. The result is an almost omnipresent and collective mish-mash of LF energy that serves no useful function but has a negative impact on the clarity of those instruments that we intentionally will attempt to reinforce, or enhance, in the subwoofer frequency range.



The best example I've seen to illustrate this point: choir microphones. In almost any church featuring either contemporary praise music or gospel music, several (or more) suspended choir mics are (most) likely used.

For purposes of this discussion, let's say we've got eight condenser cardioid

choir mics arrayed above, and forward, of the target choir members (or sections). For the majority of experienced sound mixers it is a "no-brainer" to apply channel high-pass filters on each of these microphones to reduce the LF "rumble" that can be heard when soloing (or otherwise monitoring) these mics.

Again, the most common slope for these high-pass filters is 12 dB-per-octave, and if a corner frequency of 100 Hz is chosen, this equates to the response for each mic being -3 dB at 100 Hz and -15 dB at 50 Hz (one octave lower). This looks (on paper) and sounds (when soloing) like a significant reduction in LF junk.

But think about this: these choir mics are employed in "area mic'ing" (not close) positions, suspended at least several feet from their target sources. Further, they are combined into the mix bus(s) and will combine acoustically, and to some degree even if panned through a stereo loudspeaker system.

Two choir mics, when combined in the mixer, provide +3 dB more energy than they do individually, primarily at low frequencies. (Note: two or more mics pick up more mid- and high-frequency energy as well, but at these higher frequencies there is both addition and cancellation at various frequencies and the resulting increase is likely to be less than 3 dB per doubling of microphones).

So the high-passed response of two microphones is now flat at 100 Hz and -12 dB at 50 Hz. Double this for four mics and you then have +3 dB at 100 Hz and -9 dB at 50 Hz. Now double it again for eight mics and the combined response is +6 dB at 100 Hz and -6 dB at 50 Hz.

The Bottom Line

To summarize: despite the use of the high-pass filters, there's still significant bass energy that is unintentionally sent into the subwoofers. This LF energy is not only unnecessary from a musical standpoint, but it also robs power from the subwoofer system, it competes with the instruments that we are attempting to enhance with the subwoofers, and it also adds to the quagmire of destructive LF energy that is projected out into the house.

In our example, we are describing what one encounters when doing most larger-scale productions. There are many other commonly encountered scenarios that represent similar opportunities for an aux-fed subwoofer system.

Classical symphonic music reinforcement, ethnic music, jazz big band, musical theatre, outdoor shows with wind noise and others present their own unique mic applications that will benefit from this technique. Even smaller events (such as basic R&B/folk/blues) can be audibly improved by getting the vocal mics, drum overheads and horn mics completely out of the subwoofers.

As is always the case in professional sound reinforcement, one must not misapply this technique. There are events that should not be treated in this

manner, such as acoustic jazz ensembles, where piano and drums mics are used "full bandwidth" because the overall LF energy is less dense and the sub-bass content from these instruments can be put to good use when enhanced through the subwoofers.

For such events, all that is required is to set the aux controls on each input at the "unity gain" position and this results in exactly the same signal content as in a traditional system.

FAQS ABOUT AUX-FED SUBWOOFERS

Doesn't an aux-fed subwoofer system alter the gain structure in the crossover/processor, and therefore, corrupt the crossover points for the FOH loudspeaker system?

No. An aux-fed subwoofer system as described in this article is set up exactly like a traditional system and those channels that are assigned to the subwoofers are operated at a set ("calibrated") level, resulting in no change to the relative level that the subwoofers are fed. Aux-fed subwoofers should not be used by novice operators who may change the aux send settings without realization of the consequences.

Some describe an aux-fed system as an "effects" system. Is this correct?

Although there are a few who employ aux-fed subwoofers as an "effect" — by altering the aux send level for specific channels here and there during the performance — the intent for the majority of aux-fed subwoofer systems is to exactly mimic that of a traditional subwoofer system and to not vary the gain of each channel's aux send. Any variation in the aux send levels for those channels assigned to the subwoofers will result in degradation of the balance between the subwoofers and the rest of the loudspeaker system. This will negatively impact the crossover and phase response of the system.

What happens when I do a fade-out from the master faders? Doesn't this leave the subwoofers on?

If you do fade out the masters on the console, you must also fade out the master aux send for the subs. Consoles with VCAs obviously provide a much better means for this.

Will I need an additional crossover processor for an aux-fed subwoofer system?

Perhaps. In an aux-fed subwoofer system you will need a separate crossover input and output (plus filters). Many modern digital "loudspeaker manage-

ment" systems have additional inputs and outputs beyond those used for stereo bi- or tri-amping. If you don't have this input/output available you will need an additional stand-alone crossover.

What are the restrictions as far as crossover frequency between subwoofers and full-range loudspeakers?

Full-range loudspeaker systems with aux-fed subwoofers must be able to function well down to the 100 Hz range. One can go as high as 12 0Hz before there is clearly an absence of reinforcement in the fundamental frequency range of most inputs. But this is not that different than in traditional subwoofer systems.

What are the channels that usually get assigned to an aux-fed subwoofer system?

Bass guitar, upright acoustic bass, kick drum, floor tom(s), low mic on a grand piano, low mic on a Leslie speaker, electronic keyboards and tape/CD playback.

Doesn't this technique remove part of the natural frequency response of quite a few of the sources that are not assigned to the aux-fed subwoofers?

In theory this may be the case with some sources. But sound reinforcement has always been — and remains — a skill based on compromise. In the example case given in this article, the below 100 Hz response of the choir microphones provides no useful musical information and typically has a destructive effect if sent to the subwoofers. One of the cool things about an aux-fed subwoofer system is that any input channel can be assigned to the subwoofers at the whim of the sound mixers. So experimentation can be conducted for those sources you may have reservations about. Again, as long as the calibrated level on the aux send is maintained, there will be no adverse effects on the crossover alignment of the system.

The late **TOM YOUNG** served as a top AV consultant, system designer, and mix engineer over a long, diverse career in professional audio.