

How to Combine Personal FM and Classroom Sound Systems: A Total Auditory Integration Method for Student's Benefit.



child
friendly
hearing
care

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Abstract

Combining personal FM (PFM) systems and classroom amplification (sound field) technologies in the classroom can have huge educational and social benefits for students with hearing loss or auditory deficits - or it can contribute to their isolation. The key is how they are combined. When connected the right way, students can:

- hear the voices of their peers by way of a pass-around microphone.
- hear multimedia - including movies, sound from educational software, music, and more.

In addition to the well-documented social and academic advantages to hearing the teacher's voice consistently and clearly, these features offer a huge advantage for classroom engagement and participation.

In this paper, you'll learn how to *easily* connect PFM systems and classroom amplification systems in the proper way to fully enrich your students' learning experience.

Introduction

For children with hearing loss or auditory processing disorders, listening and learning in a noisy classroom environment is extremely challenging. A personal FM (PFM) system can solve the bulk of the problem by transmitting the teacher's voice directly to the students, but what about sound from videos or other multimedia played in class? And how well does the student with hearing loss hear his/her peers during classroom discussions?

The best way to ensure all your students' needs are met auditorily, educationally, and socially is to support them with both PFM systems and properly designed classroom amplification.

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Only then can your students have equal access to all educational content and truly feel on the same level as their peers.

Why Do It?

It is well documented that classroom amplification systems are beneficial for all students - even those with no hearing or auditory deficits. For example, Chelius (2004) reported that students in grades 1, 3, 4, and 5 in amplified classes achieved better standardized test scores in early literacy and in reading fluency than students in unamplified classrooms did.*

Students with hearing loss can have access to these benefits when hearing-health professionals integrate their PFM systems with classroom amplification. For example, interfacing the two technologies can:

Keep your students with hearing loss connected to the rest of the class.

One-to-one PFM systems are almost universally available to students with hearing loss, so the biggest challenge isn't hearing their teacher - it's hearing their classmates. That's because PFM systems excel at clarifying the teacher's voice, but do a poor job of transmitting what's happening throughout the rest of the classroom - if they do so at all. For example, if Billy is telling the class about his summer,

*This and many other research references are available at www.gofrontrow.com/classroom/case-studies.

Becky – who has a hearing loss and sits on the other side of the room – may miss a significant portion of Billy’s story and the class discussion. She may feel alienated and hesitant to participate in a conversation she cannot follow.



By adding classroom amplification to the PFM systems, however, Becky’s hearing health-care professional makes it possible for Billy to talk into a second pass-around microphone that also transmits sound directly to Becky’s personal receiver. As this microphone gets passed around to various students, Becky isn’t just hearing her teacher; now she’s hearing all her classmates too.

Because classroom audio systems aren’t limited to allowing one talker at a time like some PFM systems are, Becky can participate in natural peer-to-peer discussions in a way that she wasn’t able to do with her PFM system alone. This can have a profound effect on her confidence, enjoyment of class, and academic performance.

The benefit doesn’t stop at Becky either, for as research indicates, all students will benefit from an enhanced audio signal when it comes to language understanding and acquisition. Psychosocial benefits have also been recognized since most students immediately feel a sense of pride when speaking in a microphone - what they have to say is really important. Public speaking confidence soars!

Ensure your students have access to all classroom multimedia.

While a large part of the school day centers around verbal instruction from the teacher, students also spend a significant amount of time learning through technology. The teacher may use interactive whiteboards, laptops, DVD players, iPods, and other multimedia to bring learning to life.

While a large part of the school day centers around verbal instruction from the teacher, students also spend a significant amount of time learning through technology.

The only way to ensure everyone has equal access to the audio coming from these devices is to incorporate classroom amplification. Without it, only the kids with healthy hearing will be able to hear what’s going on. Even for them, the sound will be sacrificed since speakers (if there are any at all) attached to interactive whiteboards, laptops, etc. can’t properly and evenly project sound throughout an entire classroom.

For students with hearing loss, properly integrating classroom amplification is even more critical because it is the only practical method for allowing them to hear all the educational content that’s being delivered - whether it’s through movies, music, or educational software. Without classroom amplification integration, they’ll be

restricted to whatever audio the microphones make available.

“Level the playing field” for students with hearing loss.

Students with hearing loss or auditory processing disorders often have to work that much harder to hear and understand the lesson. Students like Becky may also feel the social stigma of being “different” from other kids – especially when the teacher is wearing a microphone to accommodate her alone.

With classroom amplification, you are giving Becky the extra boost she needs to keep up with the rest of the class and you are also promoting a universally-designed environment where kids with special needs are brought into the mainstream and receive the same opportunities as everyone else. When classroom amplification is used, students recognize that using microphones is normal and helpful. The classroom becomes less restrictive - both educationally and socially - now that every student participates both in hearing and in being heard.

Research shows that there are fewer special education referrals when classroom amplification is used. In a study conducted in the Oconto Falls School District in Wisconsin, special education referral rates fell from an average of 7.72% between 1989 and 1998, to 4.6% from 1998 to 2000 where classroom amplification systems were installed in every classroom district-wide, from Kindergarten to grade five (Flexer and Long, 2004).

For teachers, the benefits of integrating PFM systems and classroom amplification systems are just as significant. For example:

Teachers can maximize their whole-class instruction time.

Studies have shown that when classroom amplification is used, there is less need for teachers to repeat instructions to individual students. That's because when students can hear the lesson better, they become more engaged in it.

In a 2007 study of nearly 1,200 K-3 students in New Brunswick, Canada (entitled "Evaluating Sound Field Amplification Technology in New Brunswick Schools"), results confirmed that in classes with classroom amplification, students were more attentive and more focused because they could hear better. While the teacher was talking, they spent less time talking to their peers and more time listening. When the hand-held microphone was given to them to pass around, it increased the participation of shy and quiet children and built their confidence. In contrast, over the course of the study in unamplified classrooms, there was a significant drop in student response rate to statements directed to them.

The technology supports a team-teaching environment, rather than a teacher-focused set-up.

In the interest of building student engagement and participation, the archaic pedagogical model of a teacher standing at the front of the class and talking to students is being replaced with teachers talking *with* students. Using their wireless microphone, teachers can move freely within the room and interact with students as they collaborate on and discuss various projects.



The teacher only has to wear one microphone.

Combining PFM and classroom amplification technologies does not mean that teachers have to wear two microphones. The teacher simply wears one microphone (the classroom amplification microphone) that directly or indirectly broadcasts to both the classroom speakers as well as the PFM receiver simultaneously. With just a press of a button, the teacher can reach all students - those with hearing loss and those without.

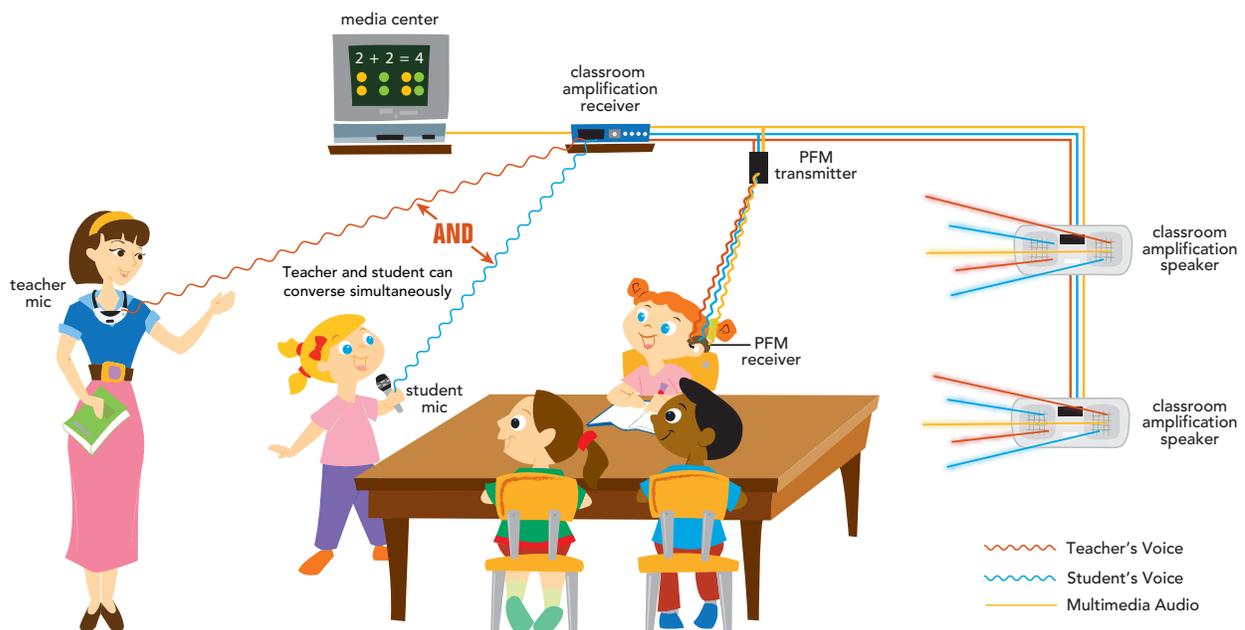
How It's Done:

There are two standard methods for integrating sound with a PFM, however they are not equally effective so it's important to select the solutions that are easiest to integrate and provide the broadest range of clarity and multimedia audio integration capability. The first method - Microphone Restricted Integration (or "Matching") - allows for the teacher's voice and one other audio source to be transmitted to the student's PFM system. However, since matching is only used with FM systems, channel management issues may arise and, dependent upon the manufacturer's system you are using, multimedia integration may also be lost.

The second and more effective method is Total Auditory Integration (or "Patching"). With this method, multiple audio sources can be connected at one time, so the student with hearing loss can hear the teacher's voice, audio from a DVD, a computer, an iPod and another student. Since patching can be done with infrared (IR) systems, channel management is not an issue - a school can be outfitted with an unlimited number of systems. Patching may also be done with FM-based sound field systems but attention must be paid to selected channels for potential interference.

Total Auditory Integration:

- This preferred method sums all audio from the teacher, the students, and multimedia sources **before** sending it to the student's receiver.
 - o The classroom amplification receiver's Audio Output is connected via a cord to the PFM transmitter's Audio Input jack.
 - o The PFM transmitter then sends all audio directly to the PFM receiver.
 - o Advantage: Ensures your special needs students are connected on *all* levels.
 - o Disadvantage: Connecting a PFM transmitter is required.



*Total Auditory Integration is the preferred method of integrating sound field and PFM systems as it keeps students connected to **everything** - including the teacher's voice, multimedia, and peer-to-peer discussions.*

(Please use as a tear-away piece for easy reference.)

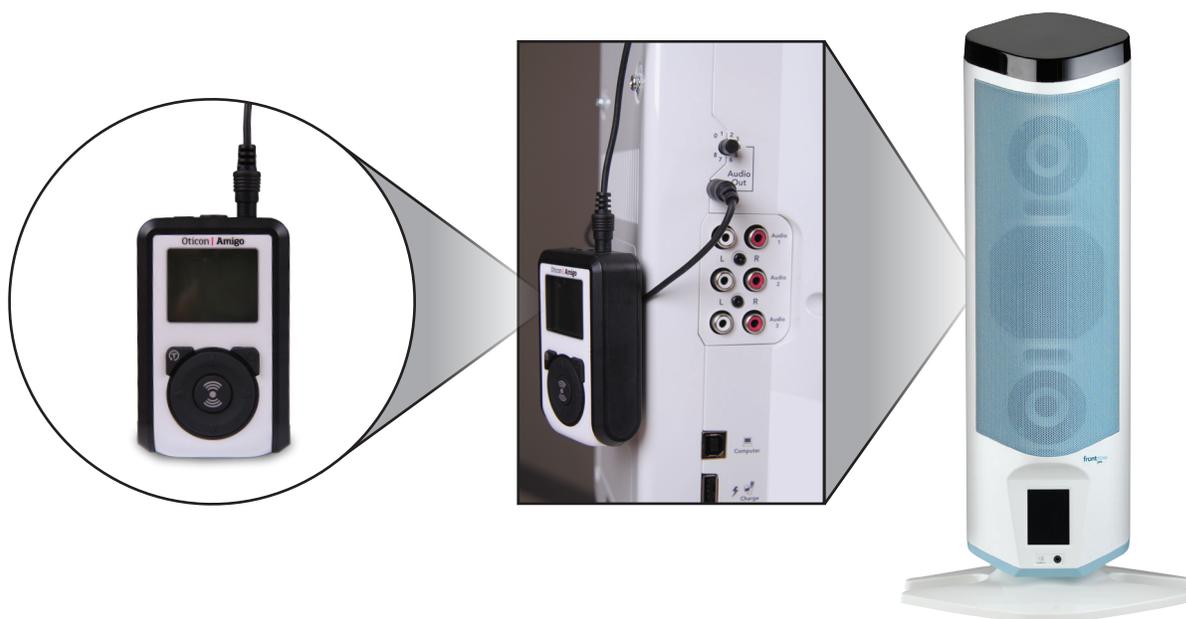
How to Easily Connect a Personal FM System to a Classroom Amplification System

Step 1: Turn on the student's personal FM transmitter.

Step 2: If using Oticon Amigo T30 or T31-connect a 2.5mm audio cable to the transmitter's microphone jack.
If using the Phonak Inspiro-connect an audio cable to the transmitter's audio input jack, attach and extend the microphone.

Step 3: Connect the 3.5 mm cable to the classroom receiver's audio output jack.

Step 4: Adjust the Audio Out gain if desired by the student.



Tips for Specific PFM Transmitters and Classroom Amplification Receivers:

Oticon Amigo T5:

- Mute the transmitter
- Suggested classroom receiver gain setting:
 - half (FrontRow ToGo and Pro Digital)
 - 5 (FrontRow Lasso)

Oticon Amigo T10:

- Set the LO/HI switch to LO
- Turn the transmitter OFF (don't worry; it will detect the audio signal and transmit)
- Suggested classroom receiver gain setting:
 - full (FrontRow ToGo)
 - half (FrontRow Pro Digital)
 - 3 (FrontRow Lasso)

Oticon Amigo T30

- Do *not* mute the transmitter
- Connect to mic jack using 2.5mm to 3.5mm cable or if using a 3.5mm to 3.5mm cable add a 2.5mm adaptor.
- Suggested classroom receiver gain setting: minimal

Phonak Inspiro:

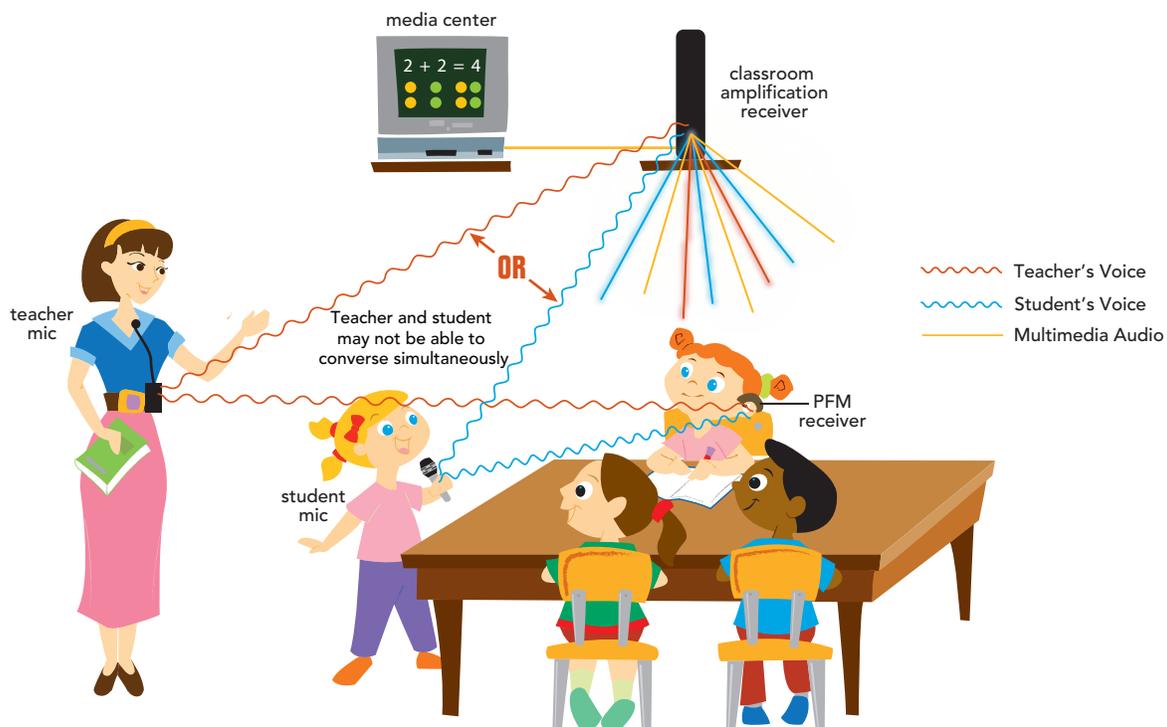
- Mute the transmitter
- Special features (e.g., "Dynamic FM") will not work when connected to a classroom amplification system
- Suggested classroom receiver gain setting:
 - full (FrontRow ToGo)
 - half (FrontRow Pro Digital)
 - 7 (FrontRow Lasso)

Phonak EasyLink (SmartLink+, ZoomLink+, EasyLink+):

- Link+ transmitters require a separate adapter to connect the audio cord (see User Manual)
- Turn the transmitter on first, then connect for best results
- Suggested classroom receiver gain setting:
 - full (FrontRow ToGo)
 - half (FrontRow Pro Digital)
 - 7 (FrontRow Lasso)

Microphone-Restricted Integration:

- Uses the teacher transmitter to transmit directly to the classroom amplification receiver and the student's PFM device simultaneously.
 - o This method only works with FM-based classroom amplification systems with compatible PFM frequencies.
 - o The teacher transmitter must be on the same channel as both the PFM receiver and the classroom amplification receiver. In the case of the Phonak Digimaster, an additional synchronization step is required to pair the teacher transmitter with the classroom amplification receiver on a different band/channel.
 - o Advantage: No connection of a PFM transmitter is required.
 - o Disadvantage: The student will only hear the teacher's voice – not multimedia audio. Those models (in particular, the Phonak Digimaster) that do allow the student with hearing loss to hear other students permit only one active mic at a time: this can limit natural discussions in a classroom setting. In addition, FM channel pairing and management must be considered to avoid potential channel overlap and interference.



*Microphone-Restricted Integration allows the teacher to transmit his/her voice directly to the student with hearing loss **and** the classroom amplification receiver. However, it does not allow the student to hear multimedia audio.*

If you must use the Microphone-Restricted Integration method, here is how to do it:

1. Ensure your teacher mic, PFM receiver and sound field receiver are all tuned to the same frequency (only available on FM-based systems). Please see the channel matching chart in Appendix 1. If using a Phonak Digimaster system, a separate pairing step is required. (See User Manual).
2. Once reconfigured, turn your classroom amplification receiver on and off to re-set.
3. The teacher may now use the transmitter. The teacher will be heard by the entire class as well as by the student with hearing loss directly through their personal system. (Student voices and multimedia audio may not be heard by the student with hearing loss).

Types of Classroom Amplification

There are two main types of classroom amplification systems: Infrared (IR) and FM. The features/benefits for each are noted below:

	FM (Radio)	Infrared
Main advantage	Simpler installation, no drop out, indoor/outdoor	No channel management, generally better audio bandwidth
Main disadvantage	Each classroom needs at least one unique channel; potential for outside radio interference	More involved installation
Number of useable soundfield systems per school	Depends on available channels and external interference sources (cordless phones, WiFi, Bluetooth, car alarms in the case of 2.4GHz; television or wireless PA systems in the case of 216MHz)	Unlimited
Choose when	Tech integration is important	More than 6 systems/school or plan to outfit entire school
Avoid if	Many systems will be used nearby, channel management resources are limited	Gym or other very large space; walls don't exist between classrooms

In addition to transmission type, schools can choose from a number of different speaker configurations, depending on their needs:

	Ceiling + Wall	Line Array	Flat-Panel
Features	Speakers are placed strategically throughout the classroom to ensure maximum sound coverage	A group of speaker elements arrayed in a straight line, closely spaced and operating with equal amplitude and in phase	A single-speaker unit consisting of one or more small drivers mounted to a single plastic panel
Advantages	Clear, distortion-free sound is spread uniformly around a classroom, resulting in less feedback and no hot spots	No installation required, can be moved from class to class with the identified student, more uniform speech range coverage than a flat-panel device	No installation required, can be moved from class to class with the identified student
Disadvantages	Installation is required	May be too heavy or awkward for students to carry from class to class	Poor sound quality; doesn't adequately cover a classroom; distortion hot spots and feedback are common

What to Look for in a Classroom Amplification System

Aside from compatibility with PFM systems, some factors that you'll want to consider in selecting the right classroom amplification system are:

Equal Classroom Sound Distribution

In today's classrooms it is very rare for any student to be sitting in the same chair all day long. For this reason, it is imperative that your entire classroom have equal sound distribution. Unless you are using a line array (which has proven and measurable equal sound distribution and not just marketing statements), you should be using a four-speaker distributed system to ensure equal coverage throughout the room. Four speakers allow for even and total coverage. Line arrays (like the FrontRow ToGo and Phonak DigiMaster) have measurable sound coverage patterns that minimize signal drop off. If you think about it, when was the last time you saw a flat-panel speaker in an auditorium, arena or conference centre? Single speaker units (with the exception of line arrays) tend to produce "hot spots," which deliver higher sound outputs near the speaker and lesser outputs as you move away.

Performance

- Obviously, a clear, distortion-free signal is important for all of your students. Be aware that looking at specification sheets is usually not a good enough indicator of the actual sound quality of the product. **Most good manufacturers offer some type of free evaluation period.** Ask for a side-by-side demonstration and listen to the products yourself and with the teachers who will be using the equipment.
- Some manufacturers offer **features that can improve speech comprehension.** For example, the FrontRow OptiVoice feature emphasizes consonant sounds to help improve intelligibility.
- You may want to consider choosing a system with **automatic feedback suppression** – especially in single-speaker models where higher output levels and limited speaker locations may create problems – to help eliminate harsh interruptions.
- **Multiple speakers or line arrays** provide the most even sound coverage, even in large rooms. Single-speaker solutions (e.g., flat panels, small portable units) are convenient to move and often less expensive, but don't provide the most even sound coverage.
- Because these products are used with children, **durability is a factor for consideration.** In recent years, a number of brands have emerged that are simply sourcing inexpensive karaoke products in Asia. The build quality of really inferior products will be apparent to the naked eye, but the manufacturers you are considering should be able to demonstrate that they have high-quality (and socially responsible) design and manufacturing processes in place. Look for things like evidence of ISO qualification, reliability testing, a strong warranty, and other signs that the company is focused on quality.

Accessories to Encourage Participation

A student pass-around microphone is a must to ensure students with hearing loss can hear their peers and join in on the conversation. Manufacturers are getting better at designing microphones specifically for children rather than just re-purposing adult karaoke microphones. Look for ones that are durable and manageable for kids.



Simplicity and Comfort

- Teachers will be wearing their microphones all day, so choose one that is **light and comfortable**.
- **Teachers have been observed using the transmitter mute button up to 30 times per day**, so select teacher microphones that make this easy to find and use by touch alone.
- Even though boom microphones provide the best sound quality, **most teachers find even sleek boom microphones uncomfortable and unattractive**. Keep this in mind when considering long-term usability of a particular solution. Some manufacturers offer transmitters that can be either worn around the neck (i.e., without a boom mic) or can also accept a boom microphone. If you want to push for boom mic usage you may want to choose a mic that gives you this flexibility and go with 'Plan B' if you meet resistance.
- You probably know from PFM experience that most teachers have very little time or patience for overly-complex gadgets. In general, **the number of knobs and switches on the transmitter and receiver is in direct proportion to the amount of time you'll have to spend in training, retraining, and troubleshooting**. You'll be better off choosing a classroom amplification system that minimizes the buttons. The good news is, there are a number of simple, yet good options available – some even let the teacher use just one button.

Minimal Installation

Only a few years ago, the responsibility for installing and maintaining classroom amplification systems almost always fell on the audiologist or speech-language pathologist. These days, it's increasingly common to have these fall under the purview of the district technology director. If you are concerned about having to install or move a classroom amplification system, there are a number of no- or low-installation options that don't necessarily compromise sound quality. **Your first choice for balancing the conflicting demands of no-toolbelt-required setup with good sound coverage should be line arrays**. These do a generally excellent job of maintaining good and even speech intelligibility, and they set up in minutes. You should probably avoid flat-panel speakers if you are concerned with coverage, however: when it comes to measured intelligibility indices, they don't compare well with multi-speaker or line array configurations (see [http://gofrontrow.com/files/documents/research/Whitepaper-\(LightSpeed-flatpanel-speakers\).pdf](http://gofrontrow.com/files/documents/research/Whitepaper-(LightSpeed-flatpanel-speakers).pdf)).

You should probably avoid flat-panel speakers if you are concerned with coverage.

Full Multimedia Integration

The ability to run *all* classroom media through your classroom amplification system to deliver better audio to the whole class - and straight to your students with hearing loss - is a crucial benefit of combining these technologies. That's why it's important to select a classroom receiver that not only accepts multiple secondary inputs (e.g., DVD player, computer) but also offers **a mixed output for connection to the PFM transmitter**. Most do, but there are still a few models that do not offer this important feature, so don't leave this off your checklist!

Integrating Classroom Amplification and PFM Systems with Other Classroom Technology

Many materials viewed by students – streaming videos, news clips, etc. – have an audio component as well as a visual one. Unfortunately, projectors and computer speakers just aren't up to the task of amplifying to the whole classroom. More importantly, the sound doesn't properly get to your students with hearing loss – there is still the distance/speaker proximity problem.

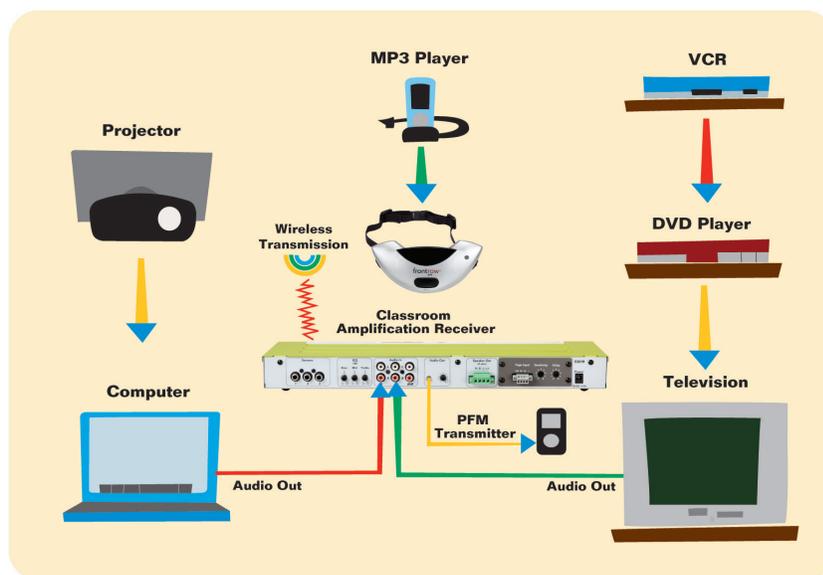
By running everything through your classroom amplification system, the system becomes the “hub” for all classroom media devices and ensures that everyone has equal access to the enhanced audio experience.

Through this technology integration, your students with hearing loss will be able to hear and do things that they weren't able to before, such as:

- Properly view movies.
- Listen to music and other audio.
- Participate and engage in interactive whiteboard lessons.
- Help record, listen, and post podcasts.
- Engage in global learning activities, such as placing video conference calls with Skype, Adobe Connect, or Elluminate.

Many classroom amplification systems have a minimal level of multimedia integration, so it's important to choose one that will work with various classroom technologies. Only then can your students with hearing loss access all educational content. Without this level of integration, your students will miss vital components of their education and not have the access that other students do to the required content.

Classroom Amplification/Technology Integration



Most classroom technologies can easily be plugged into your classroom amplification system to enhance and amplify the learning environment.

What to Look for in a PFM System

PFM systems help to improve signal-to-noise ratio and overcome background noise, distance to sound source, and/or reverberation that can interfere with clear speech understanding. For younger students, speech understanding is critical to language development, learning, and socializing.

Just as with classroom amplification, quality and performance are key. Look for:

Speech Intelligibility Features

Advanced digital sound processing in order to provide clearer access to vital speech.

Maximum Speech Bandwidth

Research has shown that children with hearing loss can benefit from additional high-frequency information available with broader bandwidth (Kortekaas & Stelmachowicz, 2000). With a broader bandwidth, transmitters can make the soft consonants stand out more clearly. Look for models that have an audio bandwidth in the range of 7000 Hz and higher.

Simplicity and Ease of Use

Just as with classroom amplification systems, you'll want to keep in mind the limits of your teachers when choosing PFM systems. Keep it simple and comfortable.

Easy Channel Management

A number of options are available today that offer full programming and fitting capabilities in the palm of your hand - such as pre-programmed channels to take the work out of channel management by creating a prioritized channel list.

Upgrade Capability

The software offered by leading PFM manufacturers changes regularly, so you should look for devices with a USB port for easy upgrading of software, and access to new features that will keep your PFM system efficient and cost-effective.

Versatile, Compatible Equipment

Unless you're in tight control of your students' hearing aid choice, you should look for PFM solutions that work with a broad range of behind-the-ear (BTE) instruments, cochlear implant (CI) processors, and other brands of receivers and transmitters, without compromising signal durability or sound quality. Most major brands offer solutions that can handle the typically unpredictable variety of devices that will appear on your students' ears.



Reliability & Service

- Accident-proof, moisture-repellent transmitters.
- Batteries should last approximately 10 hours and come with fail-safe charging.
- Quick turnaround time if units need factory repair.

Conclusion

For a rich and engaging learning experience, your students with hearing loss can benefit most from a PFM system properly *integrated* with classroom amplification. The Total Auditory Integration method effectively ensures your special needs kids are connected on all levels - enabling them to hear their teacher better, engage in every lesson, catch all the conversation, and feel included with their peers.

Appendix 1 - 216 Frequency Compatibility

(significant only if using the Microphone-Restricted Integration method)

216 MHZ FREQUENCY	Oticon T5	Oticon T10	PHONAK	OTICON AMIGO T20/T21/T30/T31	PHONIC EAR RADIUM SF	FRONTROW TO GO SF
215.9875			N31			
216.0125		1	N01	01		
216.0375		2	N02	02		
216.0750	42	42		42	42	42
216.0875			N04	04		
216.1125			N05	05		
216.1875			N08	08		
216.2125			N09	09		
216.2250	45	45		45	45	45
216.2750	46					46
216.2875		12	N12	12		
216.2750					46	
216.3125			N13	13		
216.3250					47	47
216.3750	48	48		48	48	48
216.3875			N16	16		
216.4125			N17	17		
216.4375			N18	18		
216.5125			N61	21		
216.5250	51	51		51	51	51
216.5375			N62	22		
216.5750	52		N52	52		52
216.5875		24	N64	24		
216.6125			N65	25		
216.6250	53					53
216.6750	54			54		54
216.6875			N68	28		
216.7125			N69	29		
216.7250	55		N55	55		55
216.7750	56					56
216.7875		32	N72	32		
216.8125			N73	33		
216.8250	57	57	N57	57		57
216.8750	58				58	58
216.8875			N76	36		
216.9125		37	N77	37		
216.9625			N79	39		
216.9750	60	60	N60	60		
216.9875		40	N80	40		
217.0125			N32			
217.1875			N33			
217.2875			N34			
217.4375			N35			
217.5875			N36			
217.7875			N37			
217.9875			N38			
218.0125			N39			
218.1875			N40			
218.2875			N41			
218.4375			N42			
218.5875			N43			
218.7875			N44			

People First

People First is our promise to empower people to communicate freely, interact naturally and participate actively

child
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It takes a truly dedicated approach to help children with hearing problems achieve their full potential. That's why we deliver the solutions and services that professionals and caregivers need to provide children the opportunities they deserve. This is what child-friendly hearing care is all about.



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