

White Paper

FC101 Feedback Canceller™



WideBand Solutions, Inc.

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1. Overview

The term “Public Address” or P.A. system was coined in the 1930s describing microphone(s) amplified through loudspeakers. In the 1960s the term Sound Reinforcement was introduced to imply high quality microphone to speaker amplification absent of distortion when compared with older PA systems.

PA is still a common term that refers to a simple system with high gain. Sound reinforcement describes a more complex system designed to improve intelligibility of speech or music. Both types of systems are subject to acoustic feedback as the sound from the speakers is re-amplified by the microphones.

Acceptable Vs Required Gain

Establishing the proper microphone gain can very subjective. Proper system design calculates N.A.G. (Needed Audio Gain) in an environment. This formula calculates the gain required by the sound system to replace lost speech energy in a space. Listeners experience a mix of the talker’s natural voice and amplified voice through the speakers. Time delay is used to synchronize the two sources for a more natural sound. N.A.G. is compared to P.A.G. or Potential Audio Gain. This formula calculates the gain that can be expected in the room by the sound system. P.A.G. should exceed N.A.G. or the system will feedback before the required gain improvement for the room is achieved. Good system engineering and careful calibration should result in simulating a conversation of two individuals from 8-10 feet.

Sound engineering makes it possible to achieve the *required gain* of a sound system. *Acceptable gain* is very different from required gain. While N.A.G. may be calculated, there is often an unknown variable not considered in the formula, the user.

“The system is not loud enough!”

Unmet user expectations can be very time consuming, expensive and ultimately damaging to a relationship. Since N.A.G. / P.A.G. formulas calculate a static environment, there are several other variables that result in an unstable system:

- Microphone mobility
- User adjustments
- Temperature and humidity changes
- High speech levels
- Unplanned component additions

With so many variables complicating the ultimate task of pleasing the customer, many sound engineers have turned to various methods of providing “**feedback insurance**”. Methods include notch filters, equalization and phase shifting.

How reliable is your feedback insurance?!

Ideally an anti-feedback product should maximize gain as the system starts to screech and howl from feedback. Feedback Cancellation technology developed by Jun Yang Ph.D., of WideBand Solutions, Inc. provides consistent system gain improvement of 10dB at the start of feedback. The technology self adapts to system and climate changes without compromising sound quality.

2. Product Description

The Model FC101 Feedback Canceller™ is a single rack space unit (1RU) designed to be inserted at the end of an audio chain.

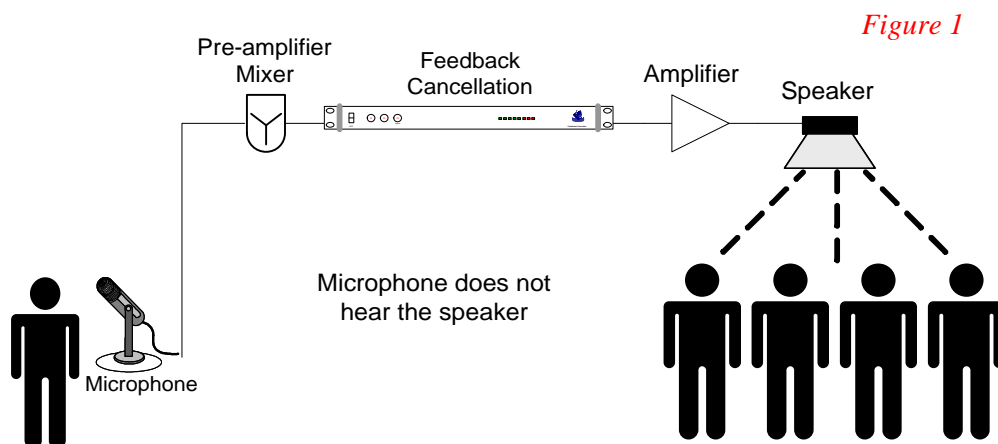


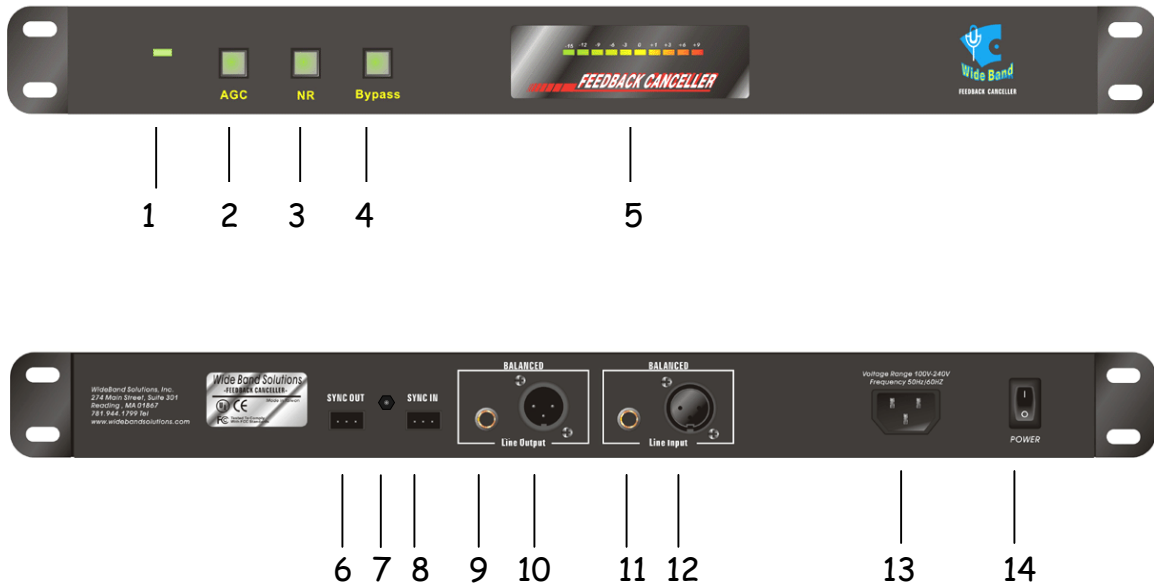
Figure 1 illustrates a simple system where the FC101 Feedback Canceller™ is placed between the mixer and amplifier. The applications section will describe two primary applications with a list of vertical markets.

The FC101 offers several unique features due to advancements in digital signal processing and the algorithms created by Dr. Yang.

Improving gain with legacy methods like notch filter, equalization or phase shifting requires a tedious calibration process. The FC101 is unique because the setup is **completely automatic** and occurs in **less than 1 second**. The FC-101 will continue to monitor the system to assure stability. Return visits to “tweak “ or adjust the system are not required.

3. Front & Rear Panels

Figure 2



1. **Power LED**
2. **AGC:** The Automatic Gain Control is a selectable signal enhancement designed to automatically raise the output level for soft talkers or lower the output level for loud talkers.
3. **NR:** The Noise Reduction filter is a selectable signal enhancement designed to reduce steady-state noise cause by HVAC systems and projectors.
4. **Bypass:** This switch bypasses all signal processing including Feedback Cancellation and signal enhancements.
5. **LED Meter:** The meter displays the input level of either the XLR or ¼ inch jack. The FC-101 is designed for a nominal signal level of 0dB.
6. **Sync Out:** The terminal block is used to connect an additional FC101 used in the same system. Sync is only required when multiple speaker zones couple with microphone zones.
7. **Sync Switch:** The "Sync On/Off" switch is designed for switching between a single or multiple zone application.

When Sync is OFF (Switch Down) *for single zone application*, FC101 works as a two-input / one-output to the amplifier. The "Line-In" is one input with enhancement functions for speech, and the "Sync In" is another input without enhancement for program audio (music).

When Sync is ON (switch up) *for a multi-zone application*, "Sync In" is the input for reference that monitors the signal sent to loudspeaker.

8. **Sync In:** Dual Function Input

- The terminal accepts the "Sync Out" signal of a FC101. Sync is only required when multiple speaker zones couple with microphone zones.
- The terminal accepts program audio sources for a single zone / amplifier system.

9. **¼ Inch Output Jack:** The jack provides a balanced line level output from the unit. The XLR output may not be used when connecting to this jack.

10. **XLR Output Jack:** The jack provides a balanced line level connection from the unit. The ¼ inch output may not be used when connecting to this jack.

11. **¼ Inch Input Jack:** The jack provides a balanced line level input to the unit. The XLR input may not be used when connecting to this jack.

12. **XLR Input Jack:** The jack provides a balanced line level connection to the unit. The ¼ inch input may not be used when connecting to this jack.

13. **Power Supply:** The internal power supply operates at all worldwide power and frequency standards.

14. **Power Switch:** The system is designed to be powered ON 100% of the time. When the switch is set to OFF signal will not pass through the unit even in Bypass Mode.

4. Feedback Cancellation

The FC-101 is designed to eliminate compromises associated with achieving system gain beyond the start of feedback. *Figure 4* compares Feedback Cancellation with older methods like notch filters and EQ which attenuate feedback frequencies to improve gain.

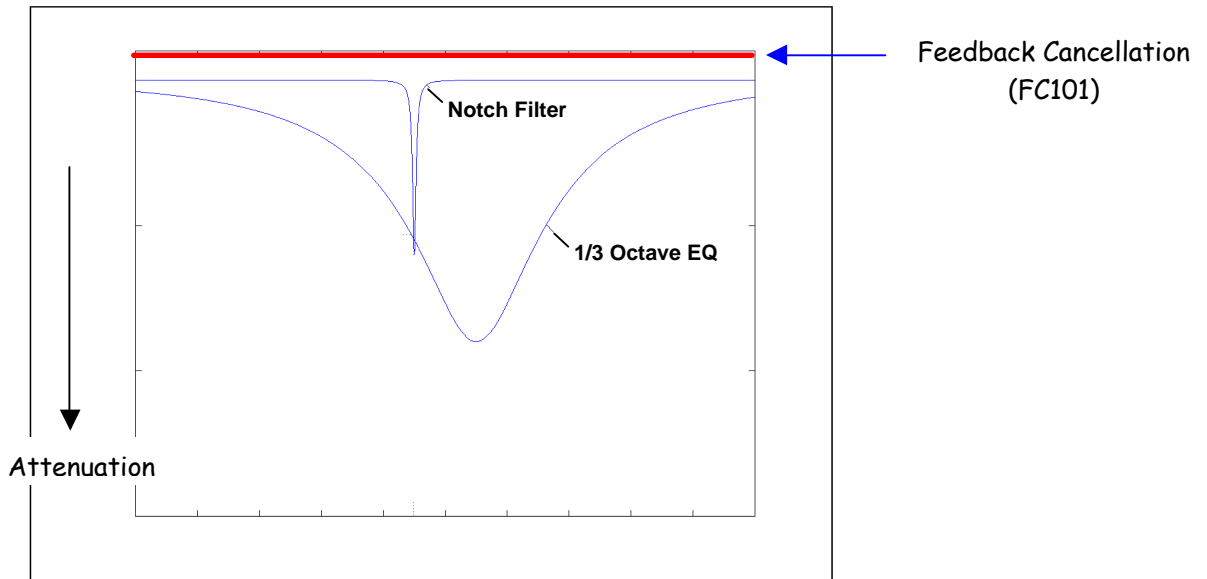


Figure 4

Notch filters are very narrow attenuation points but still compromise sound. The red line at the top of the illustration represents Feedback Cancellation. The FC-101 outperforms notch filters and EQ by providing a minimum gain improvement of 10dB without compromising the sound.

Equalization is a great tool for improving intelligibility and shaping the sound for speech or program sources. Since it is not required for system stability with Feedback Cancellation technology, an EQ may be inserted earlier in the audio chain before the FC101.

Feedback Cancellation

This method utilizes several algorithms specifically designed to prevent the audio from loud speakers from being re-amplified by the microphones. There are several key points that separate this new technology from digital notch filter product solutions:

1. The FC101 does not require any setup or calibration. It simply self-adapts as soon as sound is detected in less than 1 second.

2. The FC101 does not attenuate or notch feedback frequencies so the sound stays in tact.
3. The FC101 self-adapts to temperature and humidity changes.
4. The FC101 is ideal for microphone mobility, microphone additions and other dynamic conditions or changes to the system.
5. The FC101 may be used with auto-mixers, equalization and other methods of improving intelligibility.
6. The FC101 has a 20 Hz to 20 KHz frequency response.
7. The FC101 offers signal enhancements to further improve speech intelligibility.
8. Since the unit constantly adapts, power losses are not an issue with the FC101.

Feedback Cancellation Vs Acoustic Echo Cancellation

Feedback Cancellation solves a different problem than Acoustic Echo Cancellation:

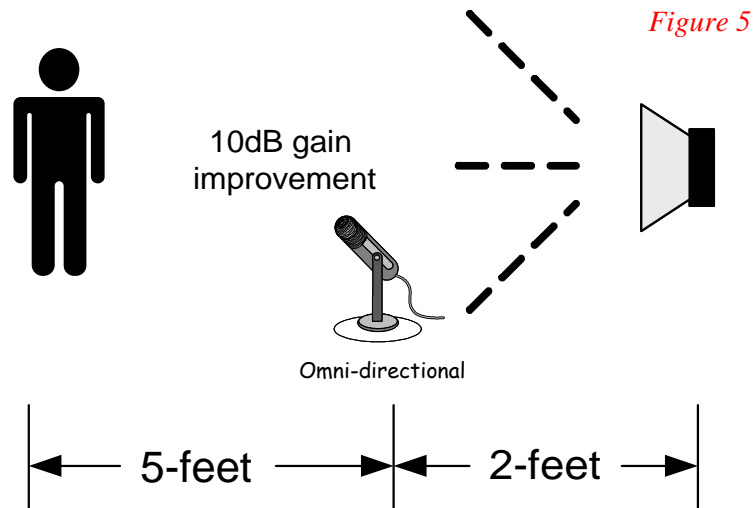
Problem - Sound Reinforcement. The sound from the loud speakers is re-amplified by the microphones and creates a feedback loop.

Solution – Digitally break the feedback loop with feedback cancellation.

AEC is designed to eliminate transmission echo from a remote location in a full duplex system. FC is designed to break a feedback loop between a microphone and speaker in the *same system* in the same room. Since AEC was designed for teleconferencing applications it results in compromises when used for sound reinforcement applications.

5. 10dB Gain

Some manufacturers of digital notch filter products specify a gain improvement of “6dB to 9dB typical”. Typical implies that there are conditions where 6dB to 9dB is not possible. Since room acoustics, microphone / speaker position and several other variables impact performance, WideBand tested the same configuration in a variety of rooms to establish our specification.



Sample of tests:

| Room | RT ₆₀ @ 1K | D _c | Notch Filter | Feedback Canceller™ |
|-----------|-----------------------|----------------|--------------|---------------------|
| 45' x 35' | .36 | 8.24' | <6dB | >10dB |
| 43' x 25' | .58 | 5.69' | <3dB | >10dB |
| 16'x14' | .25 | 3.98' | <3dB | >10dB |

The gain improvement (XdB) is measured at the start of feedback as the gain is increased. Since our specification is based on extreme conditions we expect improved performance as microphone and speaker coupling is reduced.

6. Signal Enhancements

The FC101 offers two signal enhancements to improve speech intelligibility for different room conditions and speech levels:

Noise Reduction

This filter is designed to reduce noise generated by a HVAC system and projector fans. When enabled the filter automatically removes up to **15dB** of steady-state noise. A talker should achieve a 12dB increase over room noise to be heard clearly. The filter is very effective in identifying steady-state noise and only passing speech. The filter is disabled during Bypass Mode.

Automatic Gain Control

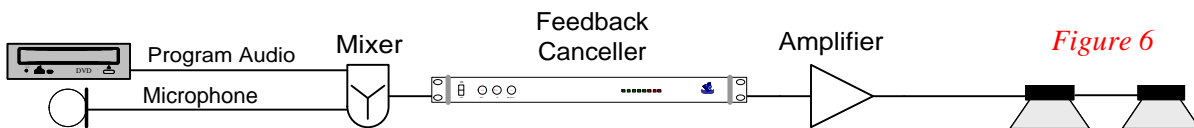
AGC is designed to increase the level for soft speech and decrease the level for loud speech to a nominal level. The enhancement is very effective in resolving the following situations:

- Talker “eating” the microphone
- Hand held microphone constantly changing positions by the presenter
- Lapel microphones
- Shouters
- Soft spoken individuals

The filter is disabled during Bypass Mode.

7. Applications

Basic System – The signal flow represents a basic sound reinforcement system. Since the FC-101 has a 20 Hz to 20 KHz frequency response the fidelity of the program sources is not compromised. An EQ may be inserted before the FC-101 Feedback Canceller to improve microphone intelligibility or to shape the sound of the program audio.



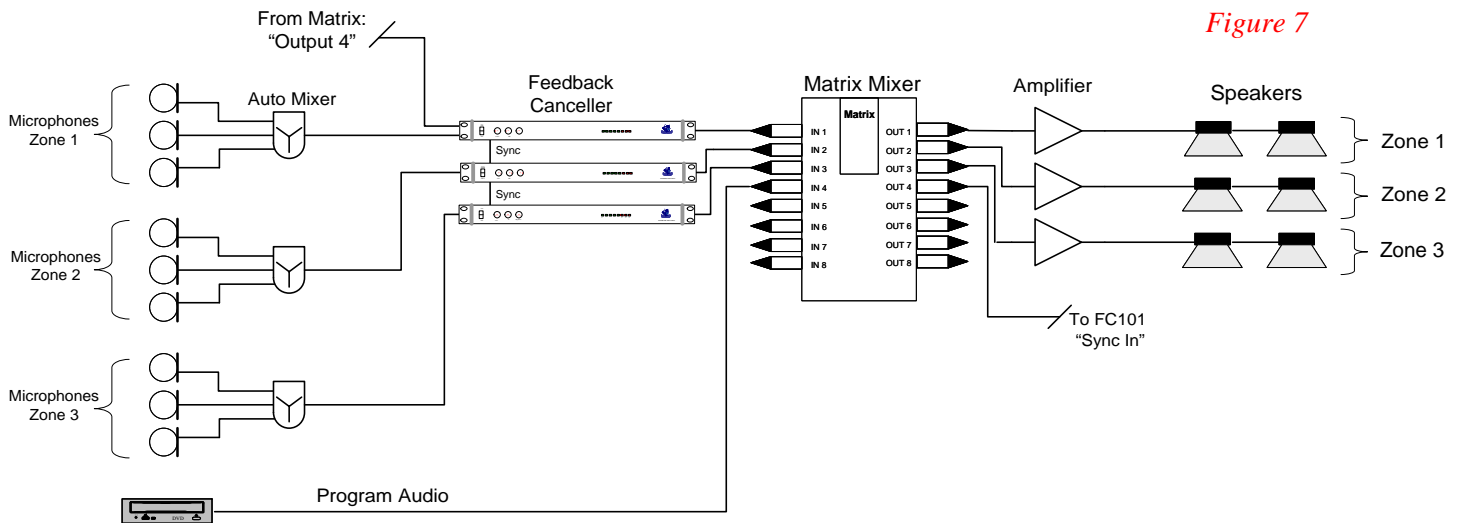
- Conference Rooms
- Training Rooms
- Hotels
- Corporate Cafeterias
- Classrooms
- Lecture Halls
- Houses of Worship

Multi-Zone Voice Reinforcement – Multi-zone systems are typically deployed in large rooms to allow an interactive environment. In a conference room environment, each microphone zones feeds opposing speaker zones. In this example:

Zone 1 feeds 2 & 3
Zone 2 feeds 1 & 3
Zone 3 feeds 1 & 2

“Output 4” of the matrix feeds zones 1, 2, & 3 to “Sync In” of the FC101

Auto-mixing and mix-minus zoning increases the gain potential before feedback and provides a natural voice reinforcement environment. Adding the FC 101 Feedback Canceller dramatically increases the gain potential. An EQ may be inserted before a FC-101 to improve microphone intelligibility or after the program audio sources.



- Conference Rooms
- Training Rooms
- Boardrooms
- Hotels
- Courtrooms
- Distant Learning Classrooms
- Auditoriums
- Houses of Worship

8. Specifications

| | |
|---|-------------------|
| Frequency Response..... | 20 Hz to 20 KHz |
| Feedback Cancellation (gain improvement)..... | ≥ 10dB |
| Background noise reduction..... | 15dB |
| AGC range..... | 12dB, +/- 6db |
| Input: Balanced Line Input..... | 0dB Nominal Level |
| Input Impedance..... | ≥ 10Kohm |
| Output: Balanced Line Output..... | 0dB Nominal Level |
| Output Impedance..... | 50 ohms |
| Power Supply..... | AC 100V – 240V |
| Line Input Level Indicator..... | -18dB to +9 dB |
| Power Switch | |
| Bypass ON/OFF Switch and LED | |
| AGC ON/OFF Switch and LED | |
| Noise Cancellation ON/OFF Switch and LED | |

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