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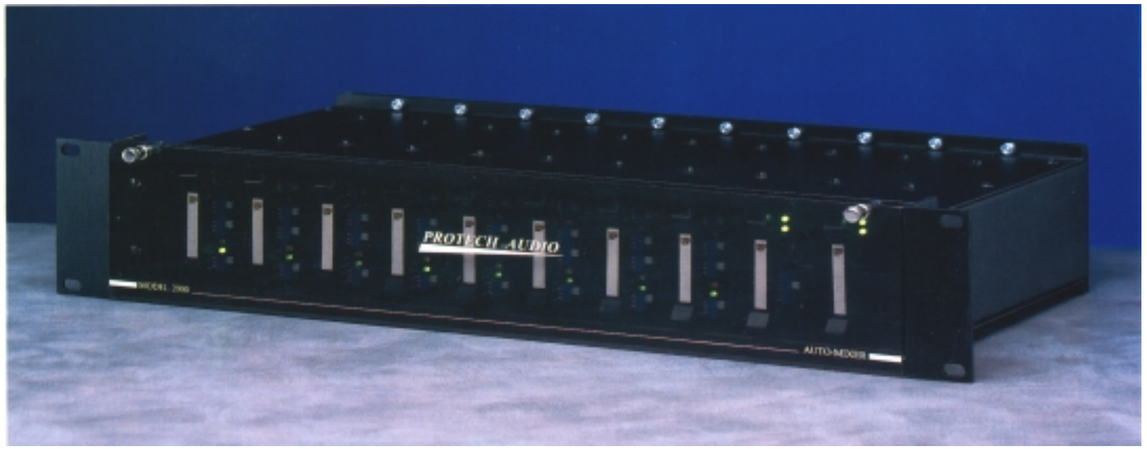
The Path Less Taken -



- Dugan Automixing

The question is “Does the Dugan Speech System™ algorithm, when properly implemented, provide superior audio performance?” The answer is “Yes, for two reasons”.

First, the algorithm provides more useable gain to active inputs. Unlike gating automixers, the Dugan Speech System subtracts gain from unused inputs, and makes that gain available to active inputs. Gating automixers leave that gain in the unused inputs, and therefore cannot achieve the same output level, before feedback. Trying to process coherent signals also creates problems for the gated automixers. These artifacts are most noticeable in recorded proceedings, or teleconferencing applications.

Second, by subtracting gain from unused inputs, and moving it to active inputs, the amount of room echo is greatly reduced. A gated mixer would leave unused inputs at higher gain levels, and pick up more room noise. This has resulted in some gated automixers incorporating echo cancellers, in an attempt to reduce the problem created by the gating architecture. It also greatly increases the price of these gated units.

Perhaps the best way to describe the actual effect of the Dugan Speech System, would be to compare it to an audio professional sitting at a mix position. As an actor or entertainer walked across the stage, the person doing the mixing would adjust gains on different inputs, to “follow” the action. At some point the actor would be standing directly in front of a single microphone, and the gain of that channel would be adjusted to maximum, while all other channel gains would be minimized. As the actor walked across the stage, leaving one microphone position, and approaching another, the mixer would reduce gain on the one position, as he or she raised gain on the new position. No abrupt gain changes, just a smooth transition from position one, to position two.

Over the years, several attempts have been made to implement the Dugan Speech System, or variations of the original algorithm. Some systems start with a quasi-Dugan algorithm, and then skew the gain. Others have tried to create the algorithm with circuitry that drifts over time, which can cause false triggering of the patented gain shifting.

The original algorithm works on an elegantly simple principle. *Each individual input channel is attenuated by an amount, in dB, equal to the difference, in dB, between that channel’s level and the sum of all channel levels.*

To date, the most stable control mechanism for implementing the original algorithm, is the circuit designed by Dan Dugan, the inventor of automixers. The exact same circuit used in the world famous Dugan Model D Automatic Mixing Controller, is used in all three automixers manufactured by Protech Audio. This circuit provides completely transparent automixing.

THE DUGAN ALGORITHM

The Dugan Speech System algorithm can be expressed mathematically as:

$L_n' = L_n - [Sum(L_n) - L_n]$

L_n is the level in channel n before attenuation.

L_n' is the level in channel n after attenuation.

$Sum(L_n)$ is the sum of the levels in all channels (the sum is taken before individual channels are attenuated).

All Levels are in dB

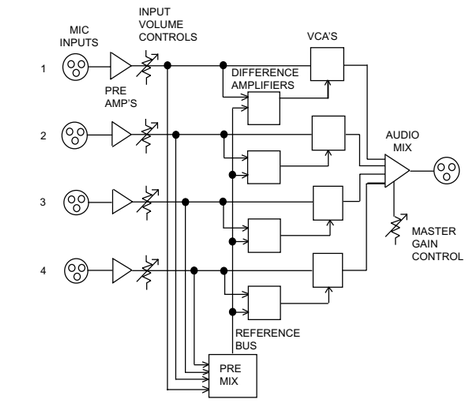


Figure 1. Simplified Block Diagram of a Four-Input Dugan Automatic Mixer

In the block diagram, L_n is the level in any channel immediately following that channel's volume control. The volume control allows the gain to be adjusted before any automatic mixing takes place.
The square labeled "Pre Mix" sums the levels from all channels (after the volume controls) and produces the term $Sum(L_n)$ in the equation.
The output of the pre-mix circuit feeds the square labeled "Difference Amplifier" in each channel. The Difference Amplifier circuit in each channel performs a linear subtraction function producing the term $[Sum(L_n) - L_n]$ in the equation.
The "VCA" circuit now performs the final automatic operation by subtracting this bracketed term from the original signal. The output of the VCA is the final input channel level, L_n'.
The L_n' levels from all channels are finally mixed and pass through to the master output.

COHERENT AND NON-COHERENT SIGNALS

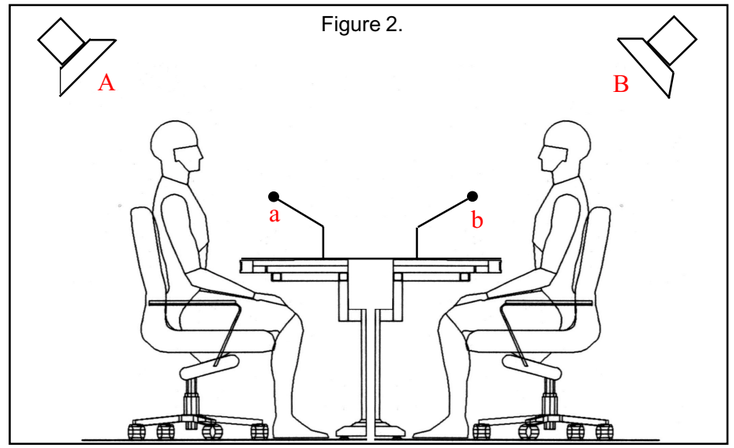
In a standard boardroom, different talkers use different microphones, and the signals entering these two microphones are totally unrelated to each other. These signals, which bear no relation to each other are called "non-coherent" signals.
A single talker, positioned an equal distance from two microphones, would produce an equal signal in both microphones. Signals of this type are called "coherent" signals. Coherent signals do not have to be equal in level, but do have to be very similar. Another example of coherent signals reaching two or more microphones results when a door is slammed or a book is dropped at an approximately equal distance from two or more microphones.

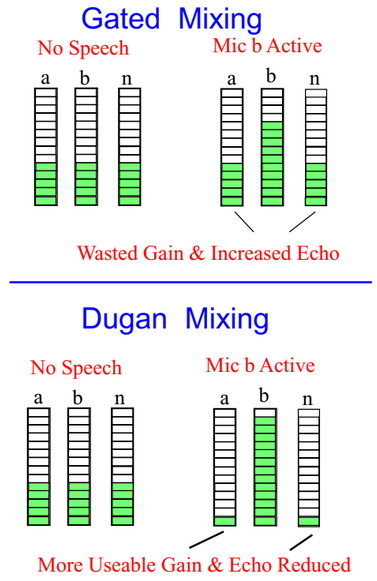
The significance of coherent and non-coherent signals is this: When two non-coherent signals of equal level are mixed together, the resultant signal is 3dB higher than either of the two original signals. When two coherent signals of equal level are mixed together, the resultant signal is 6dB higher than either of the two original signals.

If the design of an automatic mixer were to fail to recognize that coherent signals add differently than non-coherent signals, the automatic mixer could potentially make serious mixing errors. In the case of the slammed door or dropped book, for example, it would even be possible for the poorly designed automatic mixer to cause the sound system to go into feedback.

All three Dugan Automixers (Models 2000, Model 2000-C, 2008) manufactured by Protech Audio are designed to accurately compensate for the differences between coherent and non-coherent signals, thus avoiding these potential mixing errors.

Dugan Vs. Gated Mixing





Example 1- Gated Mixers.

The gain of unused microphone channels would remain at a fixed level, even though another microphone channel is in use. This results in more background noise pickup, or room echo effect from speakers A & B. It also limits the maximum gain available for the active channel, and a lower signal-to-noise ratio.

Example 2 - Dugan Mixing

In Figure 2, microphone "a" would be attenuated, while microphone "b" is in use. This will reduce the level of unwanted signals entering microphone "a". This feature would be effective for all other microphones in the system. The effect is to greatly reduce room echo. Another benefit of the Dugan mixing is the gain reduction in the unused channels makes more gain available in the active channel, resulting in a higher SPL for that signal, and a better signal-to-noise ratio.

Model 2000 Dugan Automixer

The Model 2000 is designed to provide Dugan automixing to boardroom, legislative chambers, lecture halls, and council chamber applications. The Model 2000 is modular in construction, with each module individually fused, to prevent system wide failure. In the event a module should fail, that module will remove itself from the power supply bus, allowing the balance of the system to continue operating. Module replacement can be done in minutes, as all level adjustments are made on the frame. The Model 2000 can be configured, via backpanel jumpers, to provide mix-minus outputs, as well as direct outputs, post autogain direct outputs, and dual master outputs.
Each Model 2000 frame can hold up to 8 input modules. Frames are linkable for larger systems.

Model 2000-C Dugan Automixer

The Model 2000 is designed to provide Dugan automixing to courtroom applications. The Model 2000-C is modular in construction, with each module individually fused, to prevent system wide failure. In the event a module should fail, that module will remove itself from the power supply bus, allowing the balance of the system to continue operating. Module replacement can be done in minutes, as all level adjustments are made on the frame. The Model 2000-C incorporates logging recorder outputs, and can be configured, via backpanel jumpers, to provide mix-minus outputs, as well as direct outputs, post autogain direct outputs, and dual master outputs.
Each Model 2000-C frame can hold up to 8 input modules. Frames are linkable for larger systems.

See Also Models 2004 & 2008 Dugan Automixers