PA System in a Box

Edwin Africano, Nathan Gutierrez, Tuan Phan
Overview

A public address system (PA System) is an electronic sound distribution system that allows music and speech to reach a large amount of people.

Goal: Create a portable and easy to setup system with the features of larger, more expensive systems.
Motivation

● Sound translates naturally to the analog domain
  ○ Unnecessary to convert to digital for majority of applications
● Most PA systems are large and expensive
  ○ How can we package modules together
  ○ Relatively affordable
● Practical
  ○ Personal playback / recording
  ○ On-campus group events
  ○ Parties
● We love sound
Block Diagram

- Signals between all modules are single ended and at an average of +4 dBu (1.23 Vrms) (professional line level)
- Signals on right side of diagram are all stereo
Microphone / Line Input Channel

Receives balanced (differential) or unbalanced signals ranging in amplitude (microphone level to line level) and outputs a single +4 dBu signal.

- **Preamplifier**
  - Up to 60 dB of adjustable gain
  - 15dB pad switch

- **Filter (Sallen Key)**
  - Switchable lowpass and highpass
  - LP 900 Hz -> 8 kHz
  - HP 33 Hz -> 185 Hz

- **EQ (Wien Bridge)**
  - Single-band parametric
  - ±12 dB of boost or cut
  - 120 Hz -> 1300 Hz sweepable frequency

- **Peak Detection**
  - Provides visual indication for setting average input levels (should light up only on peaks)
Mixer

Allows multiple signal sources to be mixed together in stereo while providing sends and returns.

- **Volume Faders**
  - Signal attenuated with logarithmic relation

- **Panning**
  - Moves sound between left and right speakers
  - Follows 3 dB pan-law

- **LR Bus**
  - The summation of the various input channels

- **Send / Returns**
  - Buffered and switchable
  - Allows the audio signal to be sent to another module for processing

- **Balanced Output**
  - Allows for connection to recording devices
  - Outputs a balanced differential signal
Compressor

Purpose: To maintain a more consistent dynamic level. Lowers the signal level for loud transients. With gain allows for boosting the level when the signal is too quiet.

- **Gain Control Element:**
  - Attenuates or boost the signal based on control voltages created by the.
- **Make-up Gain:**
  - Provides gain to output signal to “make-up” for loss of level after compression
- **Feedback Element:**
  - Allows user to set response of the compressor (Attack, Decay, Threshold)
  - Converts audio signal into control voltage for gain control element
Power Amplifier

**Purposes:** To amplify the input signal for the speakers.

**Class G Amplifier:**

- **Input Stages:**
  - Uses a differential pair of transistors
  - Minimal noises and bandwidth from 20 Hz - 20 kHz

- **Voltage Amplification Stage:**
  - Boost incoming line level feeding into the output stage full voltage swing.

- **Class G output:**
  - Enhance version of class AB
  - Allows use of multiple power rails
  - Inner drive - class B; Outer class - class C
Power Supply

Motivation:
● Provide power for our system
● Make the system portable
● Minimize footprint

Design:
● Transformer and linear rectifier for AC-DC
● Filtering to reduce noise and minimize ripple
● Take ± 35 V rails from this output
● Buck converter circuit: -15 V
● Boost converter circuit: 15 V

http://sound.westhost.com/articles/smps-primer.html#s3
Physical Build

Motivation: Ensure that the system is portable and user friendly

Design:

- Plexiglass/Acrylic enclosure
- Design using Coreldraw
- Manufacture using EDS
- Must consider cooling
- User panel ease of access and use
- Integrate LED Metering / Visualization
- Consideration of internal components layout
Challenges / Stretch Goals

- Making sure relations between controls and audio make sense
  - I.E. Volume controls should be logarithmic, pan controls sin-cos like
- Maintain low noise and full frequency response
- Ensure enclosure meets cooling requirements and is also as small as possible
- Minimize power supply noise/ripple while meeting power requirement

- **Headphone Amplifier**
  - Class AB, fed from mixer output
  - Allows use of equipment without speakers

- **Graphic EQ**
  - Placed as an insert on mixer
  - Allows frequencies to be boost or cut
  - “Graphic” refers to visual representation of interface (sliders correspond to frequencies)

- **PCBs**
  - If time allows, create PCBs for modules
Timeline

Week of April 11th
- Have initial designs completed
- Breadboard prototypes of core modules

Week of April 18th
- Have core modules functional and meeting specs
- Begin integration of core modules
- Complete construction of power supply and finish testing

Week of April 25th
- Continue testing and debugging
- Work on stretch goals
- Design enclosure

Week of May 2
- Testing and debugging
- Package modules into a single enclosure
- Demonstration of project