PhaseAlign Pro is a professional audio plugin written in JSFX (JavaScript Effects) for phase alignment between stereo channels. This is an important tool in audio mixing and mastering.

Plugin Overview

PhaseAlign Pro v1.0 is an advanced phase alignment tool with multiple features including sample delay, phase rotation, frequency band processing, and automatic learning mode to find optimal settings.

Code Structure and Functions

Initialization (@init)

The initialization code sets up necessary buffers and variables:

- **Buffer management**: Creates delay buffers for left and right channels with maximum size of 2048 samples
- **FFT buffer**: For frequency spectrum analysis (1024 samples)
- **Frequency filters**: Initializes biquad filters for bass (<200Hz), mid (200Hz-2kHz), and high (>2kHz)
- **Auto Learn**: Sets up automatic learning system with 2-second duration

Slider Processing (@slider)

This section handles presets and parameter conversion:

- **Preset system**: 8 presets optimized for different scenarios (Drum OH, Snare, Kick, Bass, Guitar, Vocal, Piano)
- **Delay conversion**: Converts from samples and milliseconds to actual delay
- **Phase rotation**: Converts from degrees to radians for processing

Audio Processing (@sample)

This is the main audio processing section:

```
//     Delay     processing     with     interpolation
delay_samples          >          0          ?          (
  //           Delay           right           channel
  delayed_r   =   delay_buffer_r[read_pos]   *   (1   -
delay_frac)                                          +
             delay_buffer_r[read_pos_next]           *
delay_frac;
)                          :                         (
  //           Delay           left            channel
  delayed_l   =   delay_buffer_l[read_pos]   *   (1   -
delay_frac)                                          +
             delay_buffer_l[read_pos_next]           *
delay_frac;
);
```

Processing steps:

1. **Delay processing**: Applies delay with interpolation for high accuracy
2. **Polarity flip**: Inverts polarity if needed
3. **Frequency band processing**: Processes each frequency band separately
4. **Phase rotation**: Rotates phase for each band or entire signal
5. **Bass lock**: Keeps bass in mono mode
6. **Monitor modes**: Different listening modes

Interface (@gfx)

Creates visual interface with:

- **Phase correlation meter**: Correlation meter with color coding
- **Spectral display**: Shows spectrum analysis (when Advanced Mode is enabled)
- **Status indicators**: Shows feature status
- **Real-time feedback**: Warnings about phase issues

Detailed Usage Guide

Step 1: Initial Setup

1. **Select appropriate Preset:**
    - **Drum OH**: For overhead drums
    - **Snare**: For snare top/bottom with automatic phase inversion
    - **Kick**: For kick in/out with bass lock
    - **Bass DI+Amp**: For bass DI and amp
    - **Guitar Multi**: For guitar multi-mic
    - **Vocal**: For vocal harmony with mono check
    - **Piano**: For stereo piano
2. **Enable Auto Learn:**
    - Turn on "Auto Learn" slider
    - Plugin will automatically analyze for 2 seconds
    - Finds optimal delay based on highest correlation
    - Automatically turns off when complete

Step 2: Manual Adjustment

Sample Delay (-1000 to 1000):

- Adjusts delay by samples
- Positive values: delay right channel
- Negative values: delay left channel

MS Delay (-50ms to 50ms):

- Adjusts delay by milliseconds
- Higher precision for small timing adjustments

Phase Rotation (0-360°):

- Rotates phase of entire signal
- 180° = complete phase inversion

Step 3: Advanced Frequency Processing

When **Advanced Mode** is enabled, you can adjust each frequency band:

Bass Phase (0-360°):

- Adjusts phase for frequencies <200Hz
- Important for bass and kick

Mid Phase (0-360°):

- Adjusts phase for 200Hz-2kHz
- Affects vocals and snare

High Phase (0-360°):

- Adjusts phase for >2kHz
- Affects cymbals and detail

Step 4: Using Special Features

Bass Lock:

- Keeps bass in mono mode
- Prevents phase cancellation at low frequencies
- Important for live sound systems

Mono Check:

- Tests mono compatibility
- Detects phase cancellation issues

Monitor Modes:

- **Stereo**: Normal listening
- **Mono**: Tests mono compatibility
- **L Only/R Only**: Listen to individual channels
- **Difference**: Listen to difference signal (detects phase issues)

Step 5: Reading Phase Correlation Meter

Colors and meanings:

- **Green (>0.7)**: Excellent - perfect phase alignment
- **Yellow-green (0.3-0.7)**: Good - acceptable phase
- **Yellow (0-0.3)**: Medium - needs adjustment
- **Orange (-0.3-0)**: Poor - phase issues present
- **Red (<-0.3)**: Severe - phase cancellation

Recommended Workflow

For Recording Studio:

1. **Drum Kit:**
    - Use "Drum OH" preset for overheads
    - "Snare" preset for snare top/bottom
    - "Kick" preset for kick in/out
2. **Bass Recording:**
    - "Bass DI+Amp" preset for DI and amp
    - Enable Bass Lock
    - Check in Mono mode
3. **Guitar:**
    - "Guitar Multi" preset for multi-mic
    - Adjust Mid Phase if needed

For Live Sound:

1. **Enable Bass Lock** for all bass sources
2. **Use Mono Check** regularly
3. **Monitor in Difference mode** to detect issues

For Mixing:

1. **Check correlation** before mixing
2. **Use Auto Learn** as starting point
3. **Fine-tune manually** according to music
4. **Final check** in Mono mode

Important Notes

- **CPU Load**: Advanced Mode and Spectral Display consume more CPU
- **Auto Learn**: Automatically turns off after completion
- **Real-time monitoring**: Always monitor correlation meter
- **Backup settings**: Save custom presets for common situations

This plugin is a powerful tool for professional phase alignment, significantly improving audio quality in both recording and live sound applications.