APPENDIX C: PSYCHOACOUSTIC FILTER

The psychoacoustic filter in the CS5396 is based on the paper: "Robert A. Wannamaker, Psychoacoustically Optimal Noise Shaping, Journal of the Audio Engineering Society, Vol 40, No 7/8, 1992 July/August." The default coefficients in the CS5396 are the FIR 9-tap filter coefficients described in Table 3 of the paper. Since the effective noise shaping function is (1-H), the CS5396 registers save the (1-H) function coefficients. Therefore, the negative of each filter coefficient is stored in the registers. Each coefficient is represented as a binary 2’s complement number where the 4 MSB’s represent the whole number of the coefficient and the 4 LSB’s represent the fractional portion truncated to 4 binary bits.

Default Coefficients as listed in "Robert A. Wannamaker, Psychoacoustically Optimal Noise Shaping"

\[
\begin{align*}
a1 &= 2.412 \\
a2 &= -3.370 \\
a3 &= 3.937 \\
a4 &= -4.174 \\
a5 &= 3.353 \\
a6 &= -2.205 \\
a7 &= 1.281 \\
a8 &= -0.569 \\
a9 &= 0.0847
\end{align*}
\]

Coefficient conversion example 1:

\[
a1 = 2.412
\]

\[
a1 = (0010.0110) \text{ binary representation with the fractional portion truncated to 4 bits.}
\]

\[
-a1 = -(0010.0110) \text{ binary representation}
\]

\[
-a1 = 1101.1010 \text{ in two's complement}
\]

this value is stored in register 10h.

Coefficient conversion example 2:

\[
a2 = -3.370
\]

\[
-a2 = 3.370
\]

\[
-a2 = 0011.0101 \text{ binary representation with the fractional portion truncated to 4 bits.}
\]

\[
-a2 = 0011.0101 \text{ in 2's complement}
\]

this value is stored in register 11h.
PSYCHO-AcouStIC FILTER COEFFICIENTS

<table>
<thead>
<tr>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSB</td>
<td>BIT 6</td>
<td>BIT 5</td>
<td>BIT 4</td>
<td>BIT 3</td>
<td>BIT 2</td>
<td>BIT 1</td>
<td>LSB</td>
</tr>
</tbody>
</table>

Access:
R/W in I2C and write only in SPI

Filter coefficient a1 (address 10h)
Filter coefficient a2 (address 11h)
Filter coefficient a3 (address 12h)
Filter coefficient a4 (address 13h)
Filter coefficient a5 (address 14h)
Filter coefficient a6 (address 15h)
Filter coefficient a7 (address 16h)
Filter coefficient a8 (address 17h)
Filter coefficient a9 (address 18h)

Default:
- a1 - 1101 1010
- a2 - 0011 0101
- a3 - 1100 0010
- a4 - 0100 0011
- a5 - 1100 1011
- a6 - 0010 0011
- a7 - 1110 1100
- a8 - 0000 1001
- a9 - 1111 1111