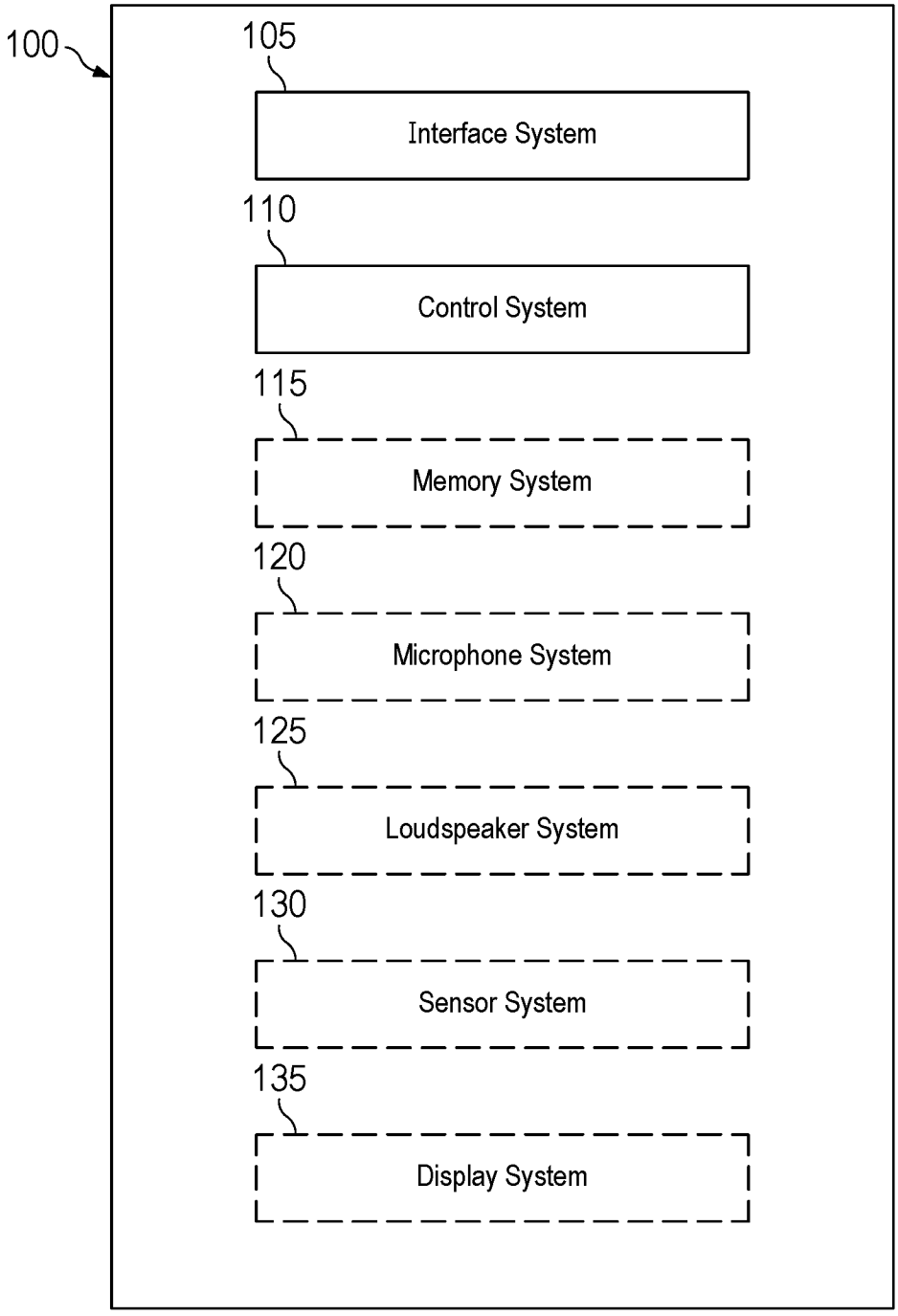

100
105
Interface System
110
Control System
115
Memory System
120
Microphone System
125
Loudspeaker System
130
Sensor System
135
Display System

Figure 1

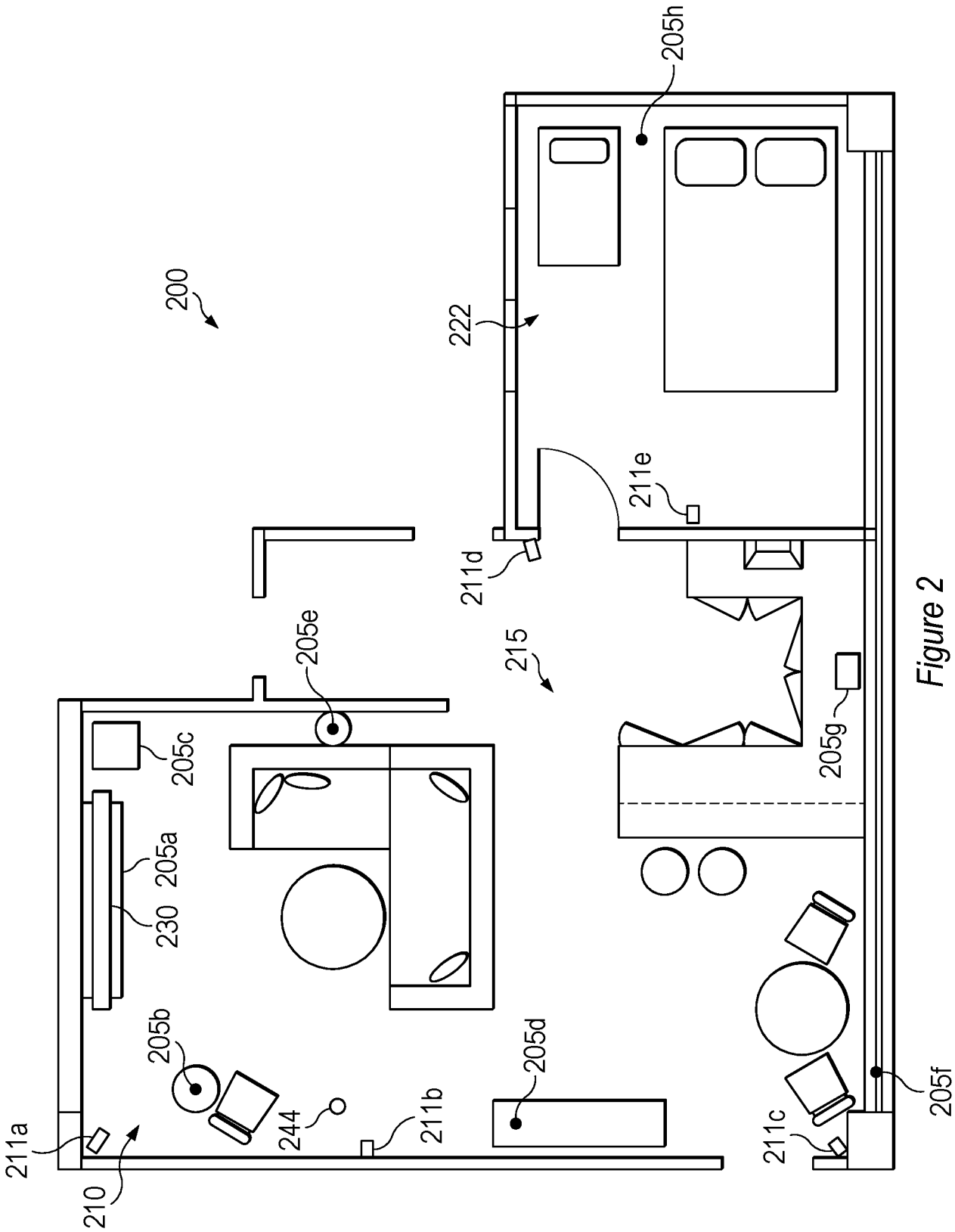

200
205h
222
211e
211d
215
205e
205c
205a
230
205g
205b
205d
205f
211a
210
244
211b
211c

Figure 2

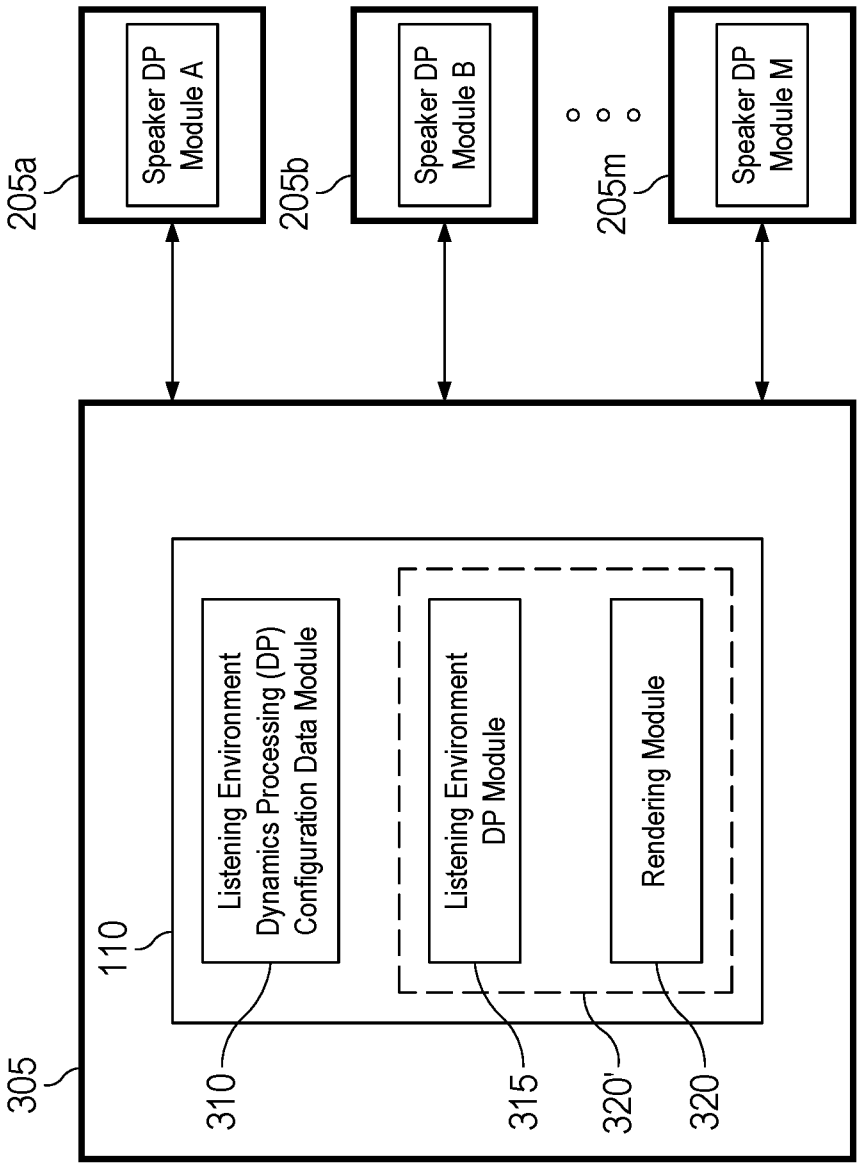

205a
Speaker DP Module A
205b
Speaker DP Module B
205m
Speaker DP Module M
305
110
Listening Environment Dynamics Processing (DP) Configuration Data Module
Listening Environment DP Module
Rendering Module
310
315
320'
320
300

Figure 3

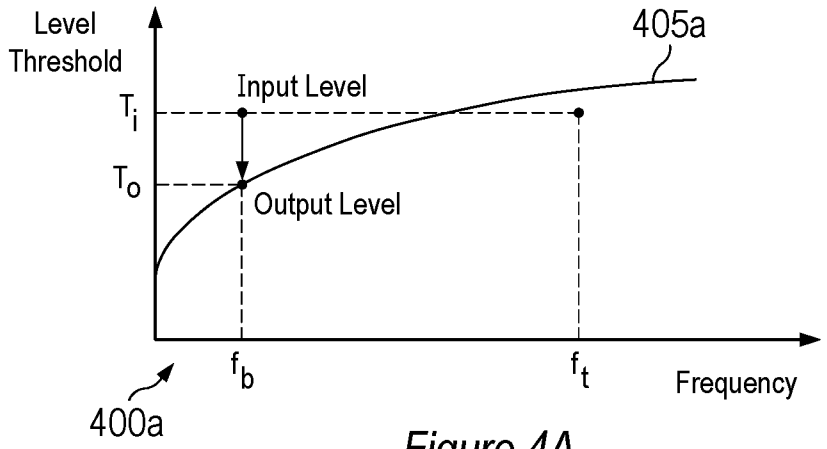


Figure 4A

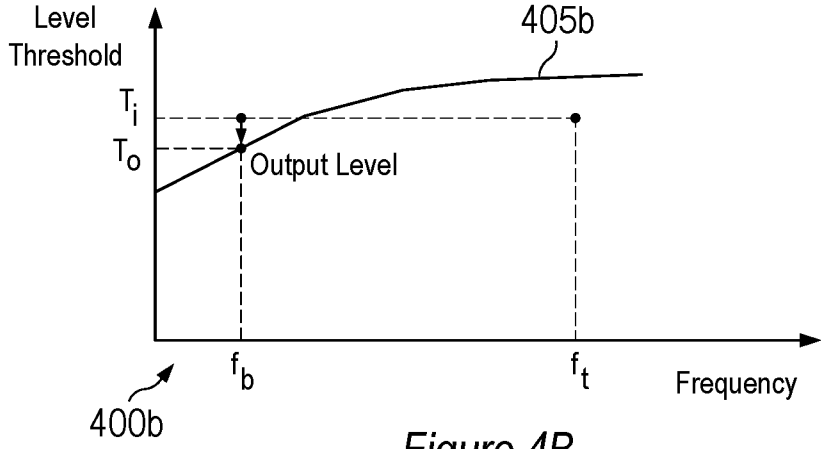


Figure 4B

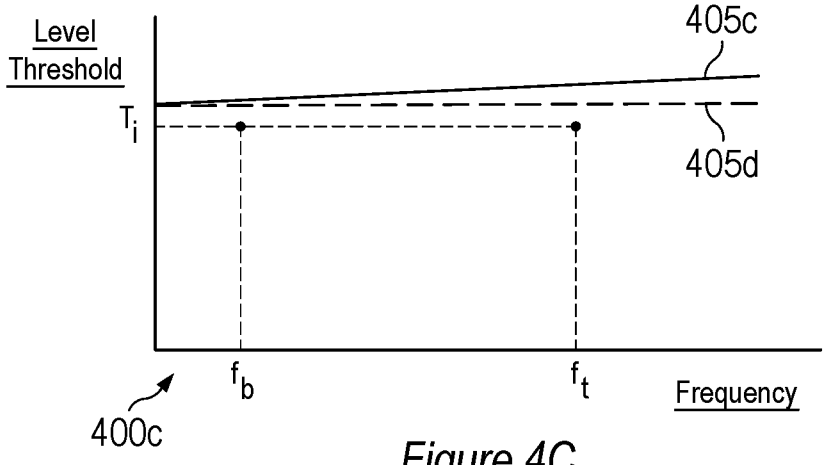


Figure 4C

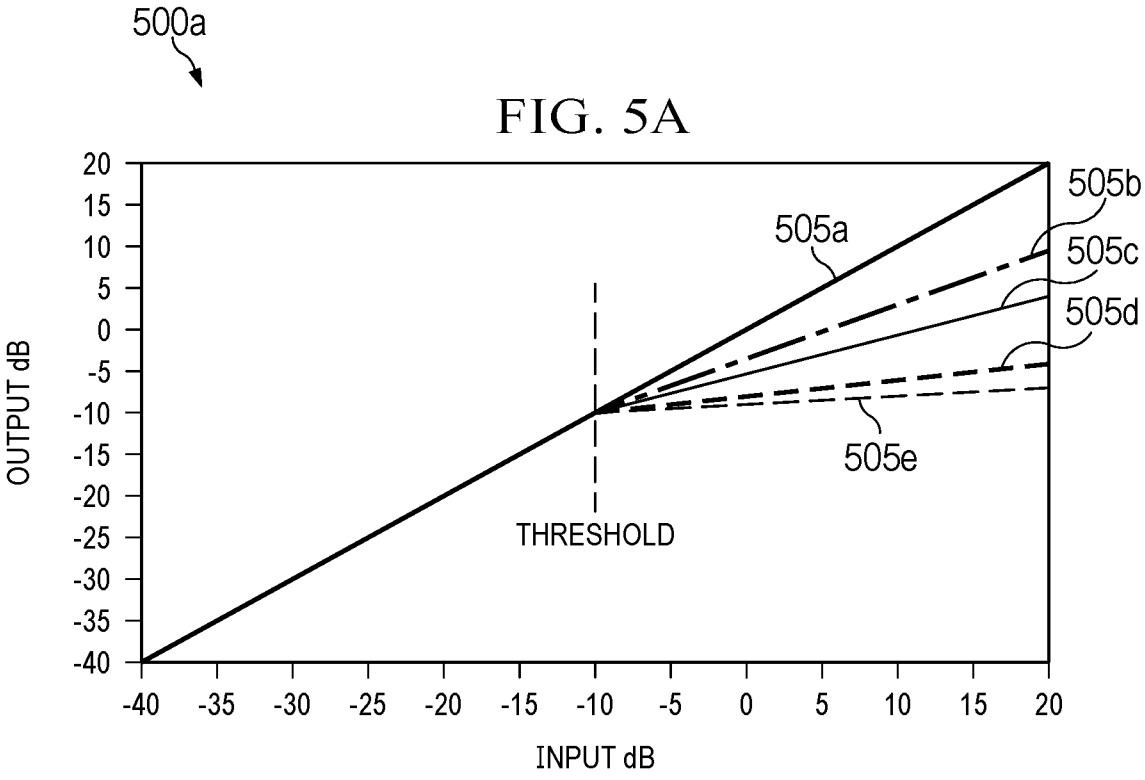

500a
OUTPUT dB
INPUT dB
THRESHOLD
505a
505b
505c
505d
505e
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40

FIG. 5A

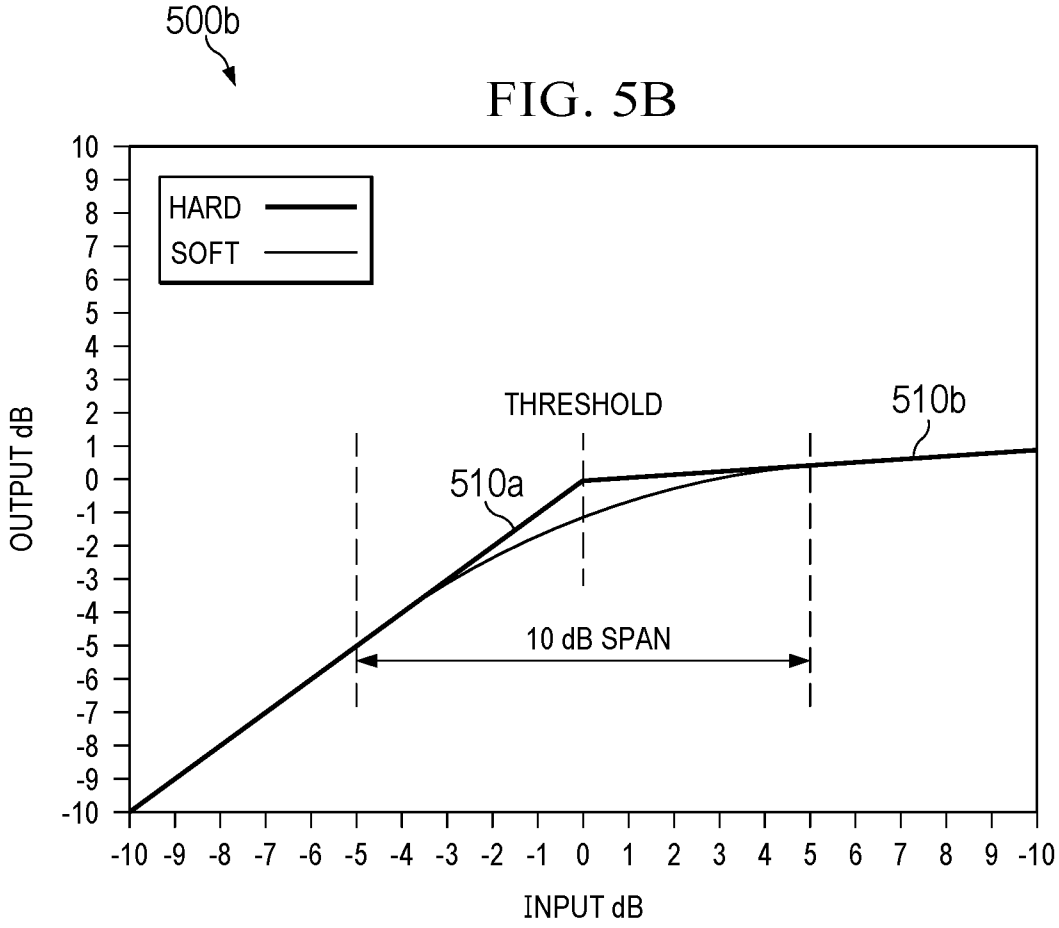

500b
HARD
SOFT
OUTPUT dB
INPUT dB
THRESHOLD
510a
510b
10 dB SPAN

FIG. 5B

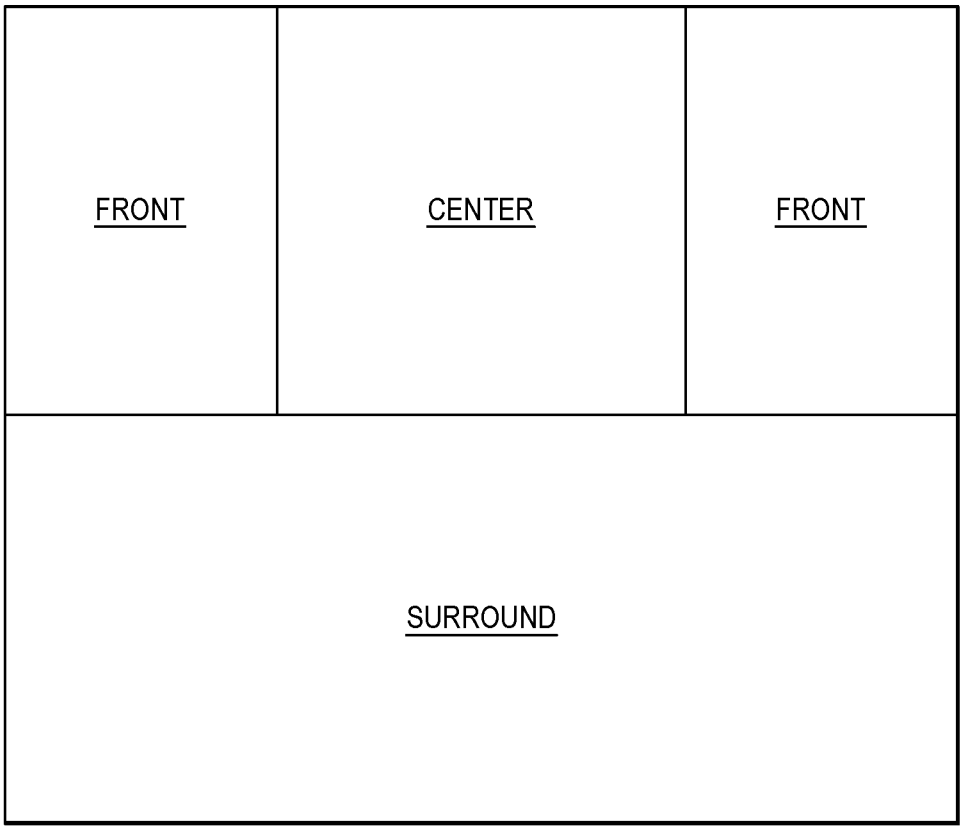


Figure 6

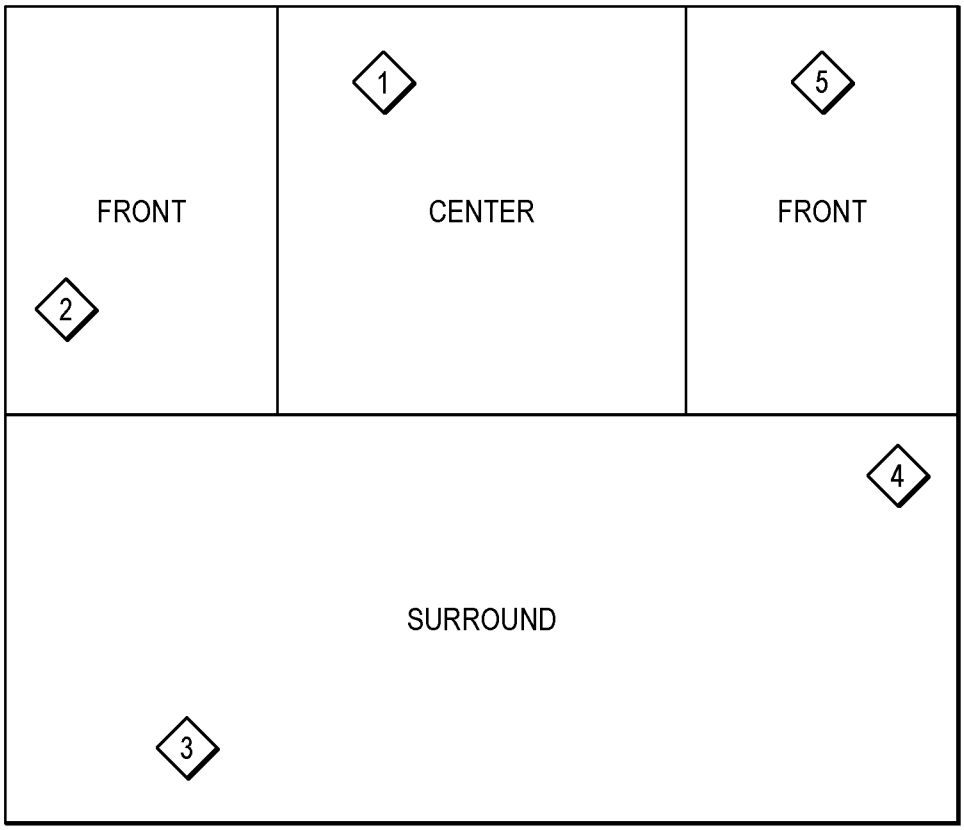


Figure 7

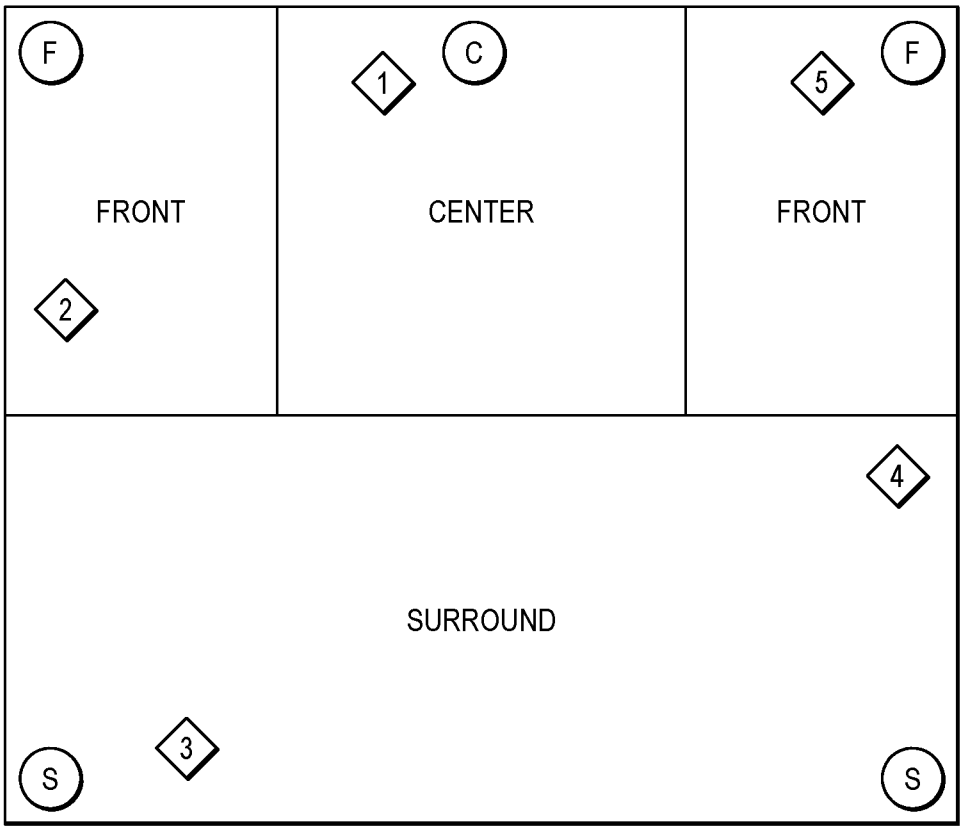


Figure 8

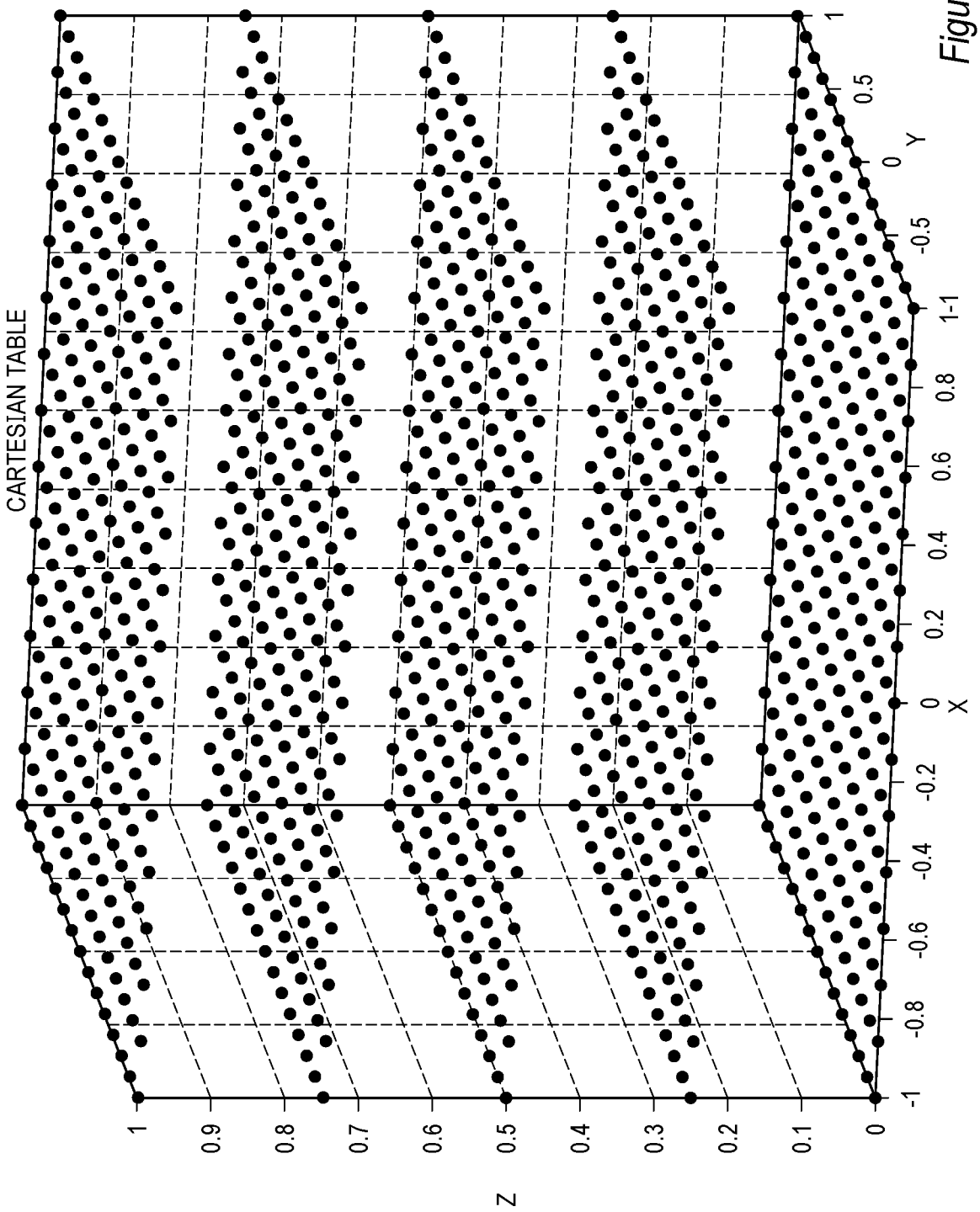

CARTESIAN TABLE
Z
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
X
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1-1
Y
-0.5
0
0.5
1

Figure 9

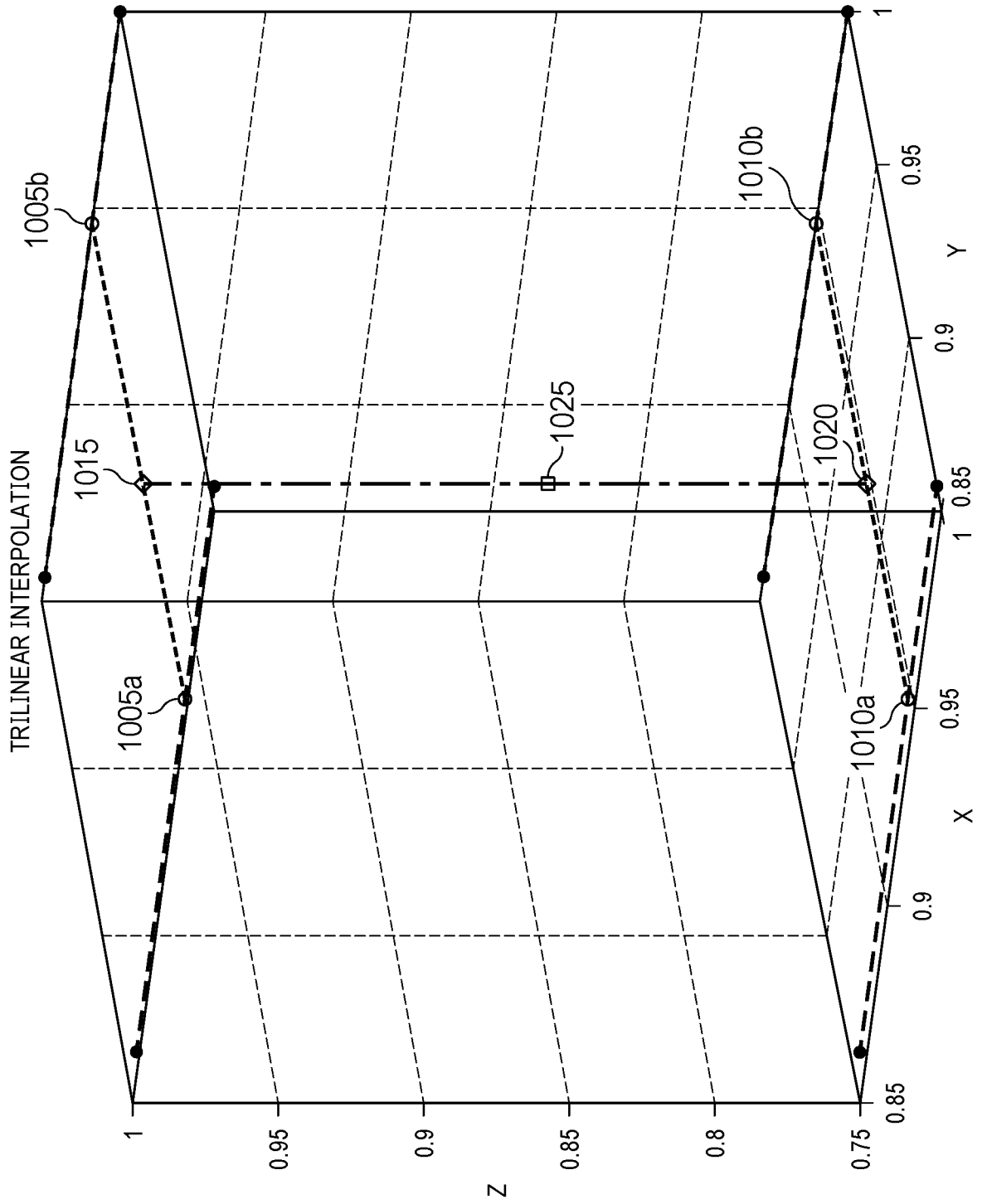
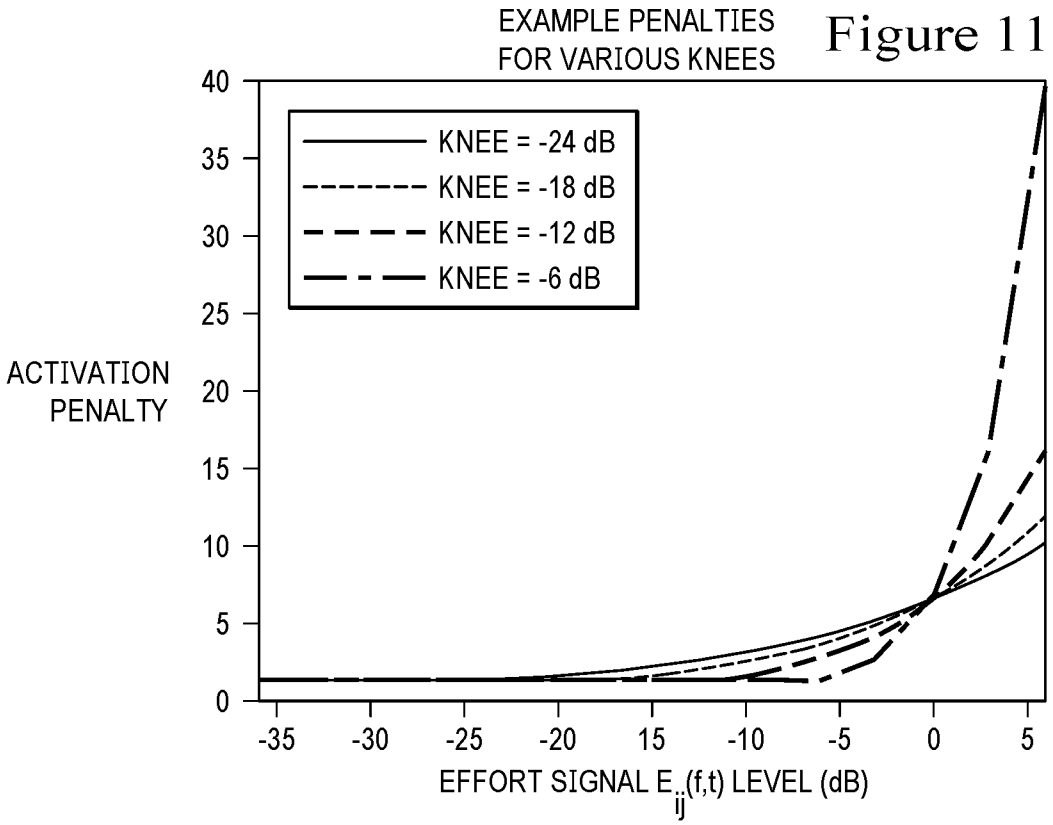

TRILINEAR INTERPOLATION
1005b
1010b
1015
1025
1020
1005a
1010a
Z
1
0.95
0.9
0.85
0.8
0.75
X
1
0.95
0.9
0.85
Y
1
0.95
0.9
0.85

Figure 10

Figure 11


EXAMPLE PENALTIES
FOR VARIOUS KNEES
KNEE = -24 dB
KNEE = -18 dB
KNEE = -12 dB
KNEE = -6 dB
ACTIVATION
PENALTY
40
35
30
25
20
15
10
5
0
-35
-30
-25
-20
15
-10
-5
0
5
EFFORT SIGNAL E_ij(f,t) LEVEL (dB)

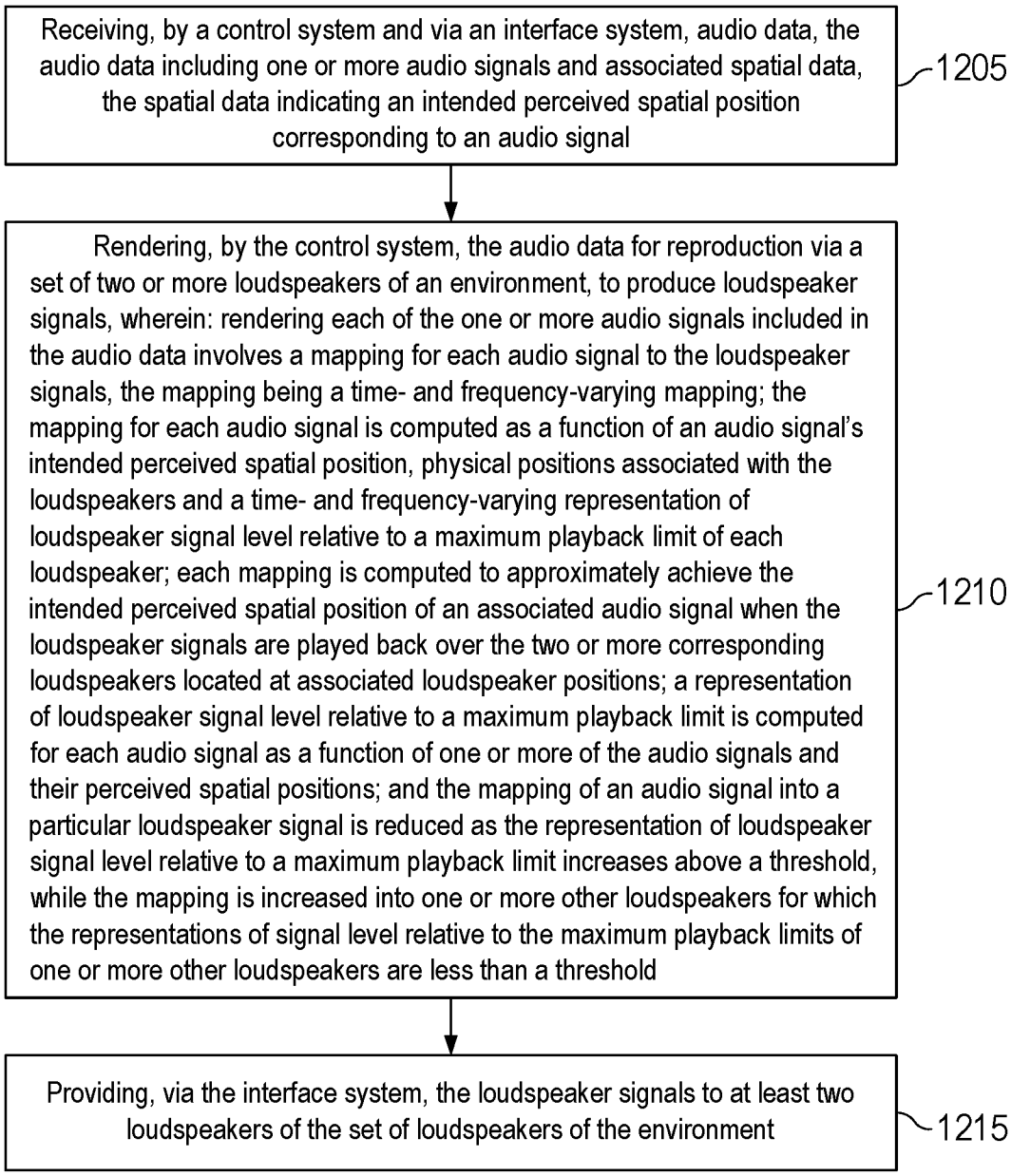

Receiving, by a control system and via an interface system, audio data, the audio data including one or more audio signals and associated spatial data, the spatial data indicating an intended perceived spatial position corresponding to an audio signal
1205
Rendering, by the control system, the audio data for reproduction via a set of two or more loudspeakers of an environment, to produce loudspeaker signals, wherein: rendering each of the one or more audio signals included in the audio data involves a mapping for each audio signal to the loudspeaker signals, the mapping being a time- and frequency-varying mapping; the mapping for each audio signal is computed as a function of an audio signal's intended perceived spatial position, physical positions associated with the loudspeakers and a time- and frequency-varying representation of loudspeaker signal level relative to a maximum playback limit of each loudspeaker; each mapping is computed to approximately achieve the intended perceived spatial position of an associated audio signal when the loudspeaker signals are played back over the two or more corresponding loudspeakers located at associated loudspeaker positions; a representation of loudspeaker signal level relative to a maximum playback limit is computed for each audio signal as a function of one or more of the audio signals and their perceived spatial positions; and the mapping of an audio signal into a particular loudspeaker signal is reduced as the representation of loudspeaker signal level relative to a maximum playback limit increases above a threshold, while the mapping is increased into one or more other loudspeakers for which the representations of signal level relative to the maximum playback limits of one or more other loudspeakers are less than a threshold
1210
Providing, via the interface system, the loudspeaker signals to at least two loudspeakers of the set of loudspeakers of the environment
1215
1200

Figure 12