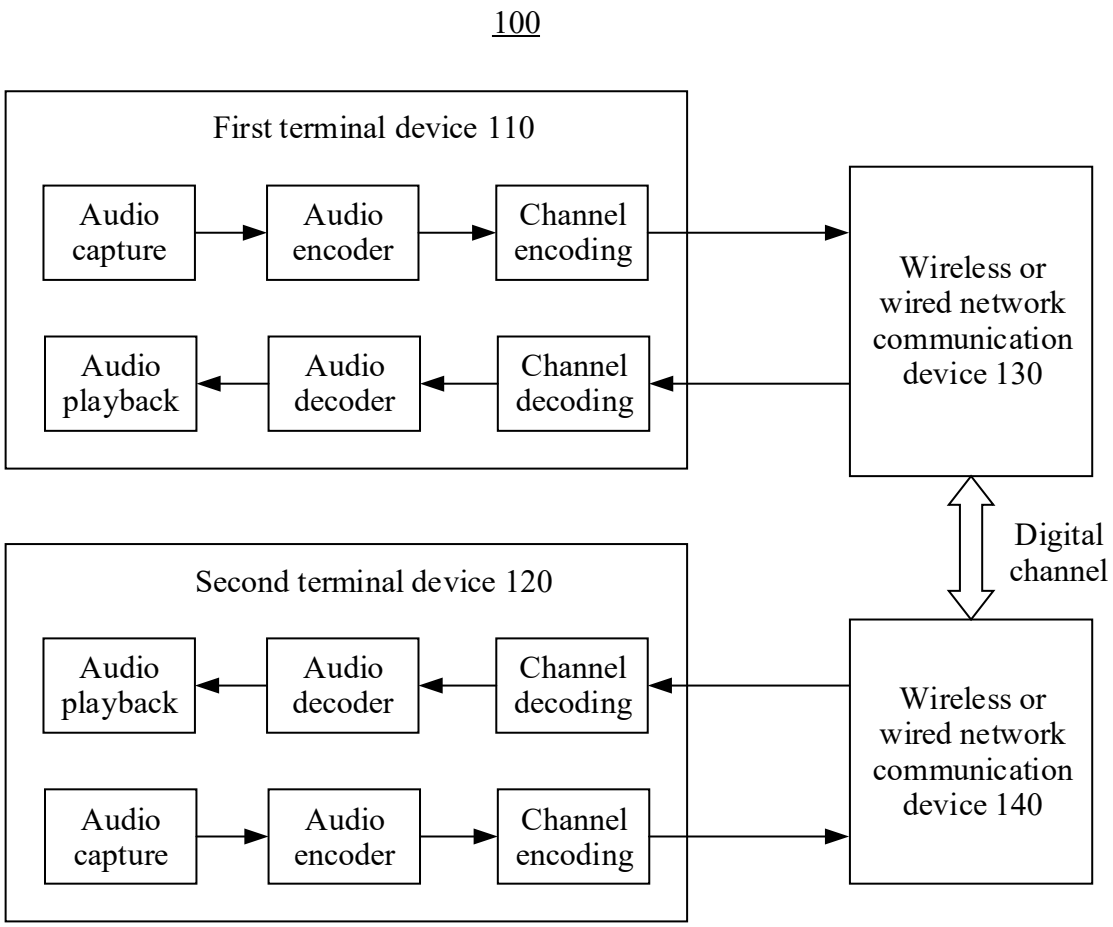
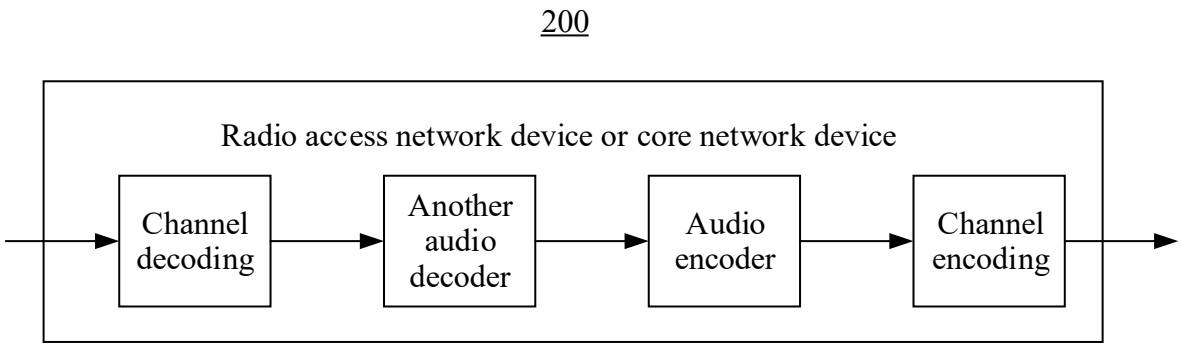
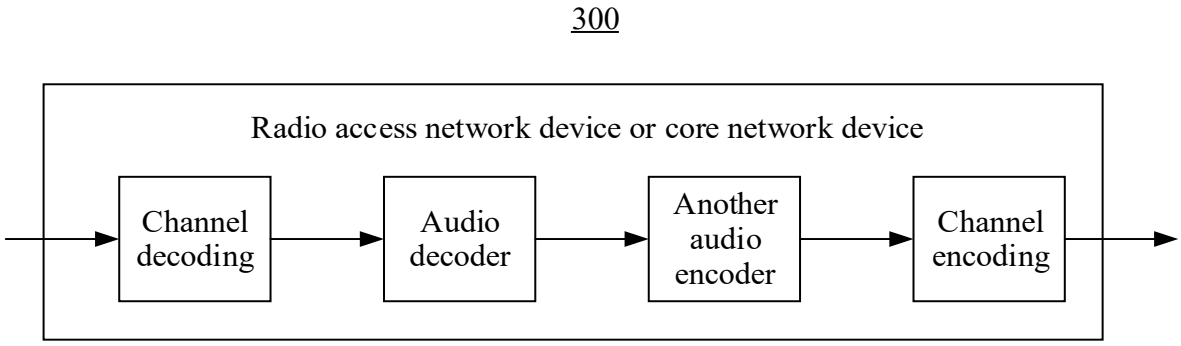
[FIG. 1]


100
First terminal device 110
Audio capture
Audio encoder
Channel encoding
Audio playback
Audio decoder
Channel decoding
Wireless or wired network communication device 130
Digital channel
Second terminal device 120
Audio playback
Audio decoder
Channel decoding
Audio capture
Audio encoder
Channel encoding
Wireless or wired network communication device 140

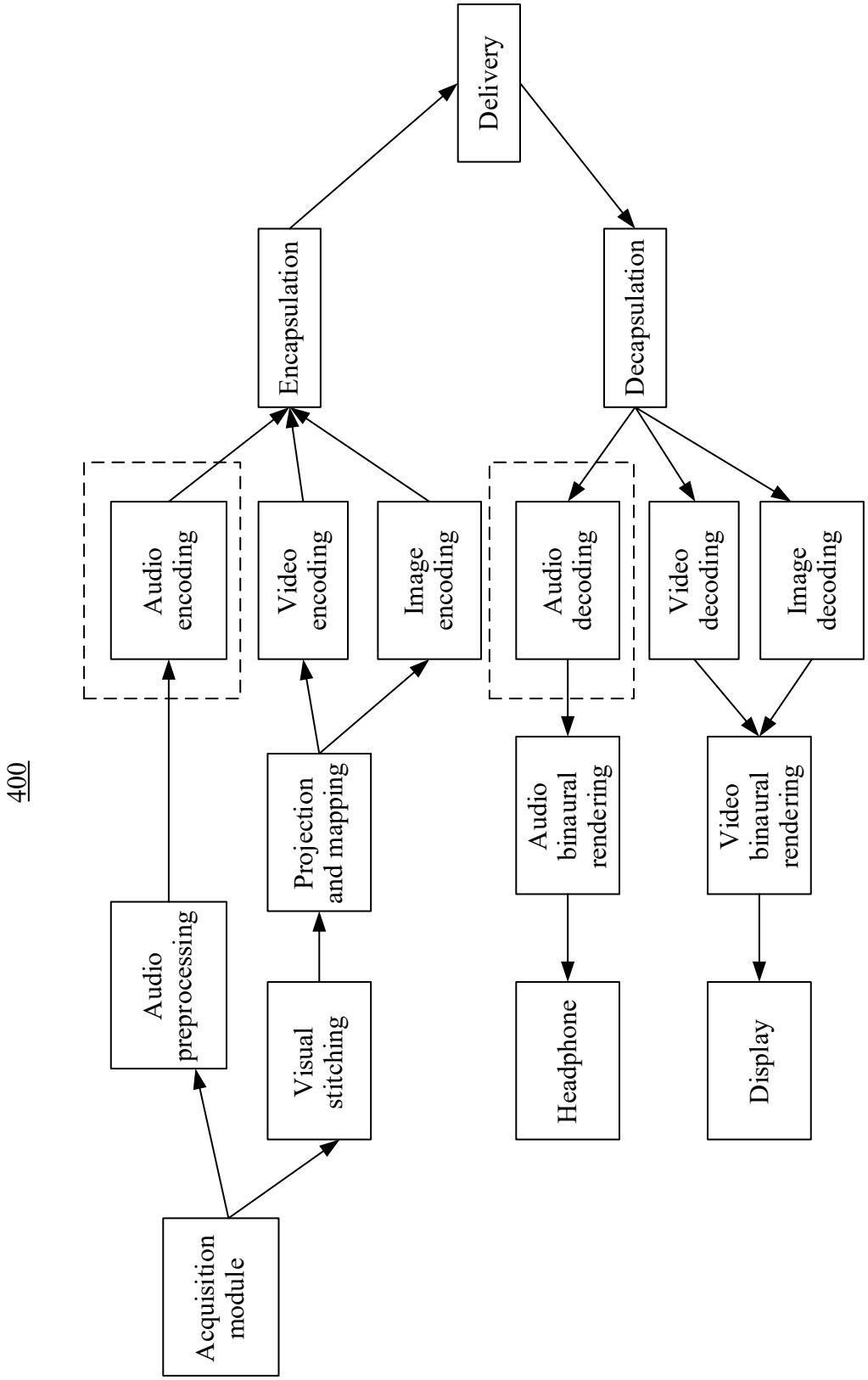
[FIG. 2]


200
Radio access network device or core network device
Channel decoding
Another audio decoder
Audio encoder
Channel encoding

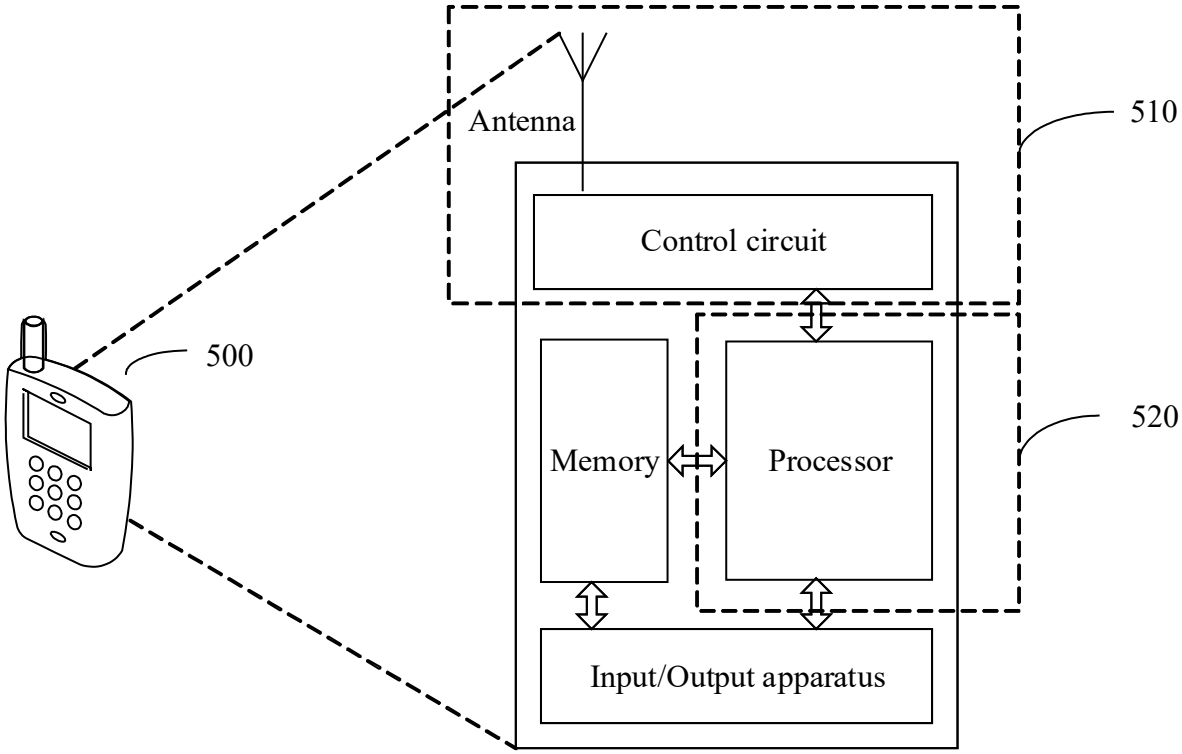
[FIG. 3]


300
Radio access network device or core network device
Channel decoding
Audio decoder
Another audio encoder
Channel encoding

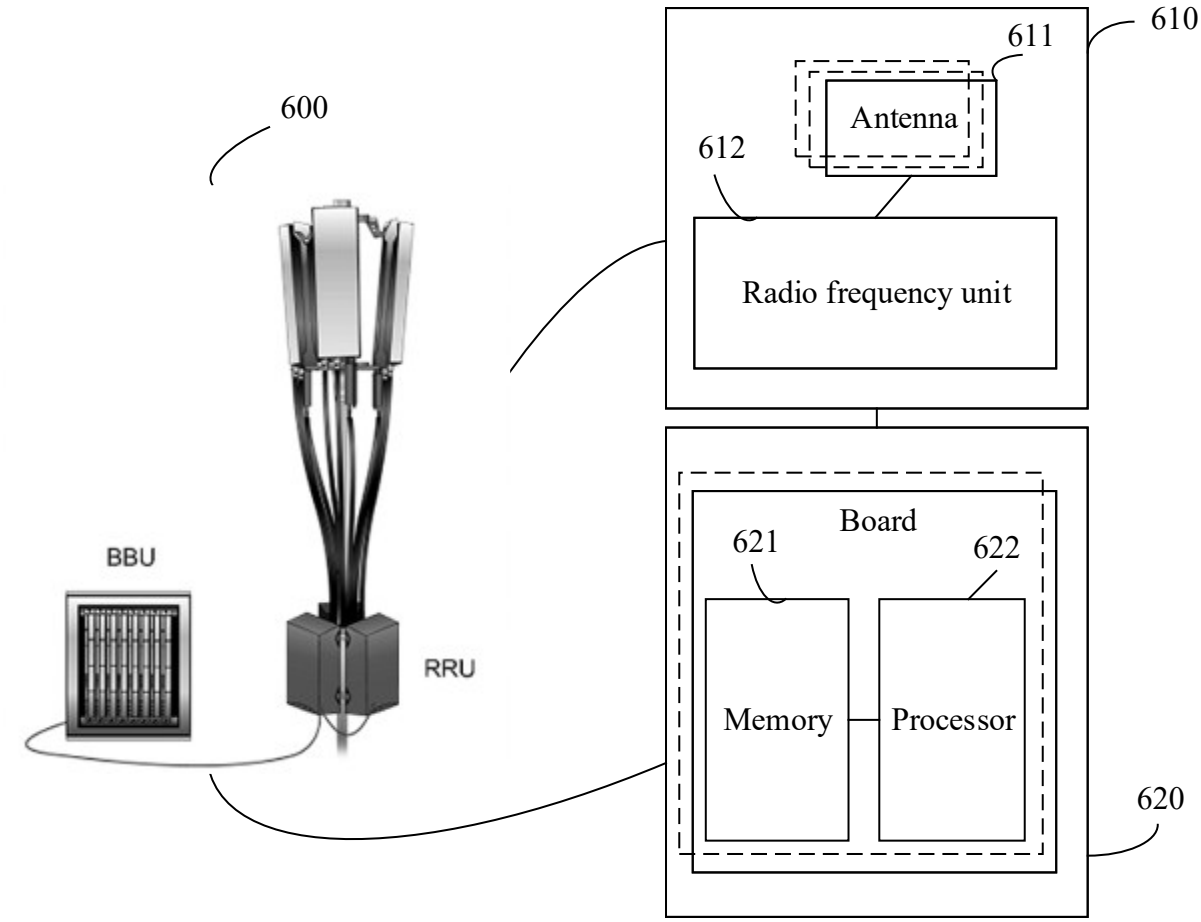
[FIG. 4]


400
Acquisition module
Audio preprocessing
Visual stitching
Projection and mapping
Audio encoding
Video encoding
Image encoding
Encapsulation
Delivery
Decapsulation
Audio decoding
Video decoding
Image decoding
Audio binaural rendering
Video binaural rendering
Headphone
Display

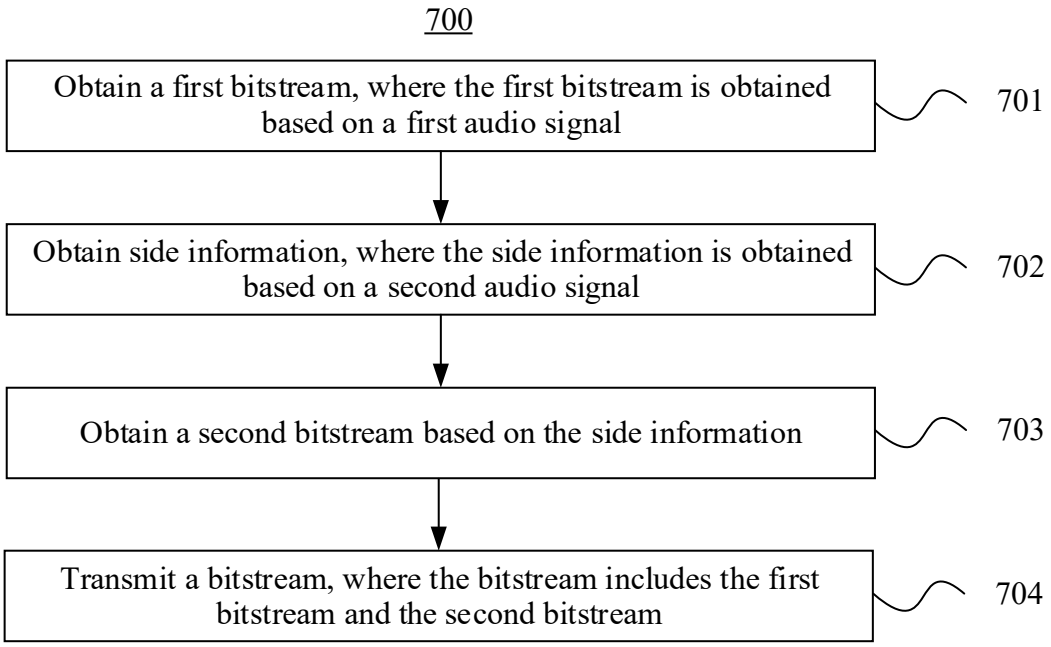
[FIG. 5]


Antenna
510
Control circuit
500
Memory
Processor
520
Input/Output apparatus

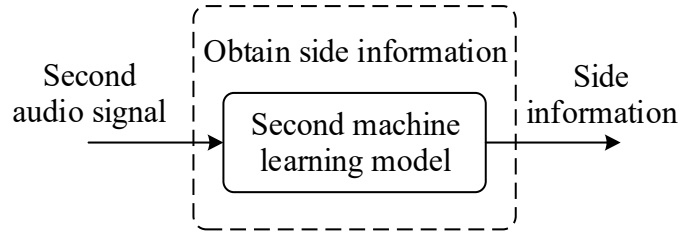
[FIG. 6]


600
610
611
Antenna
612
Radio frequency unit
BBU
RRU
Board
621
622
Memory
Processor
620

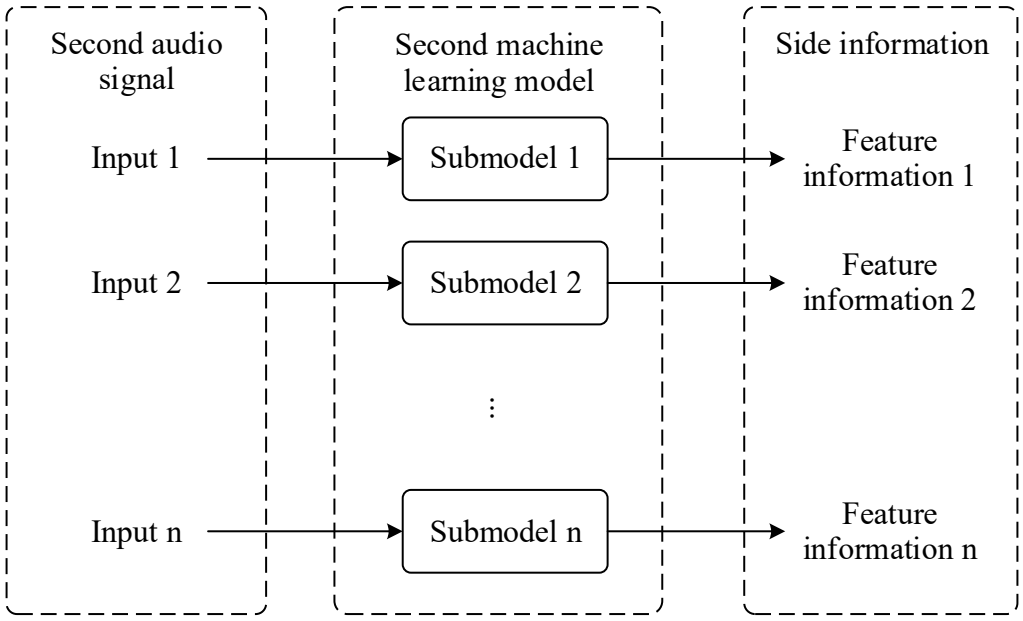
[FIG. 7]


700
Obtain a first bitstream, where the first bitstream is obtained based on a first audio signal
701
Obtain side information, where the side information is obtained based on a second audio signal
702
Obtain a second bitstream based on the side information
703
Transmit a bitstream, where the bitstream includes the first bitstream and the second bitstream
704

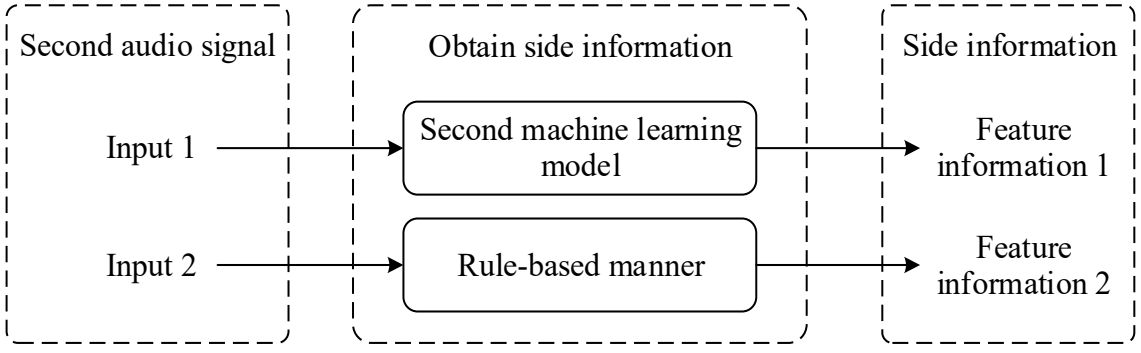
[FIG. 8a]



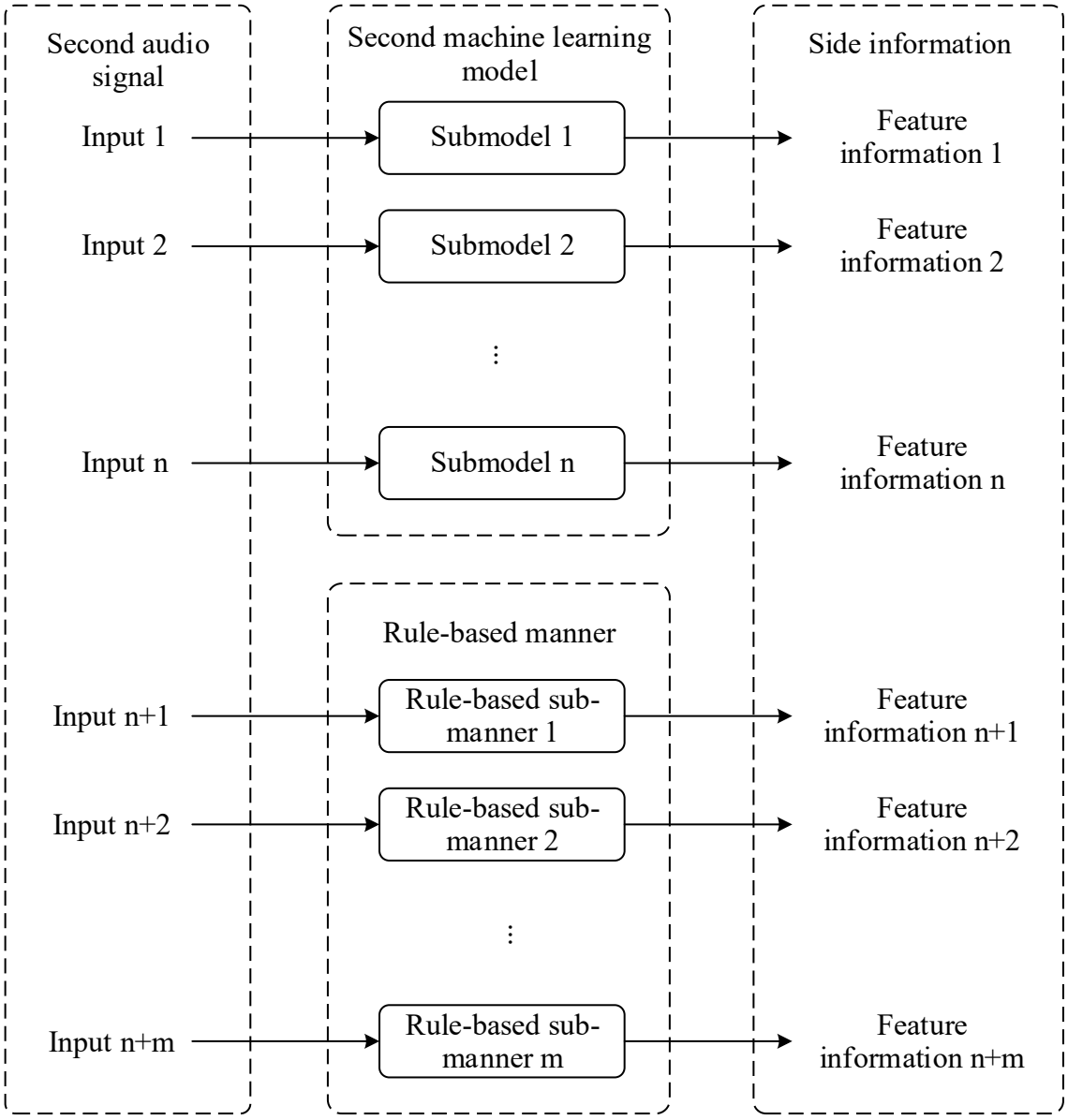
[FIG. 8b]



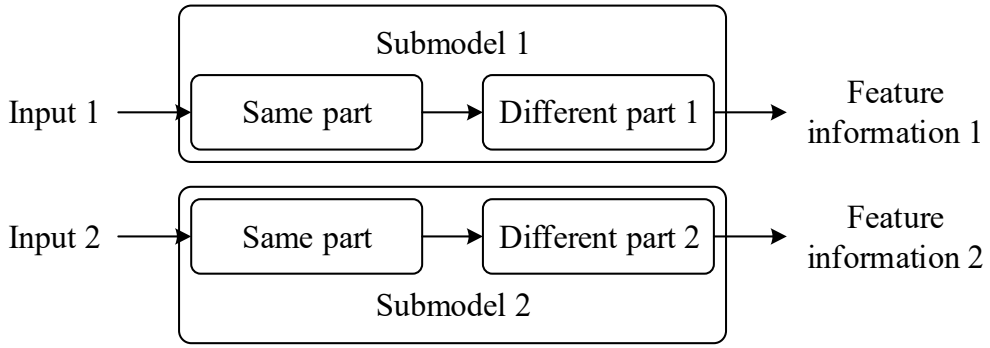
[FIG. 8c]



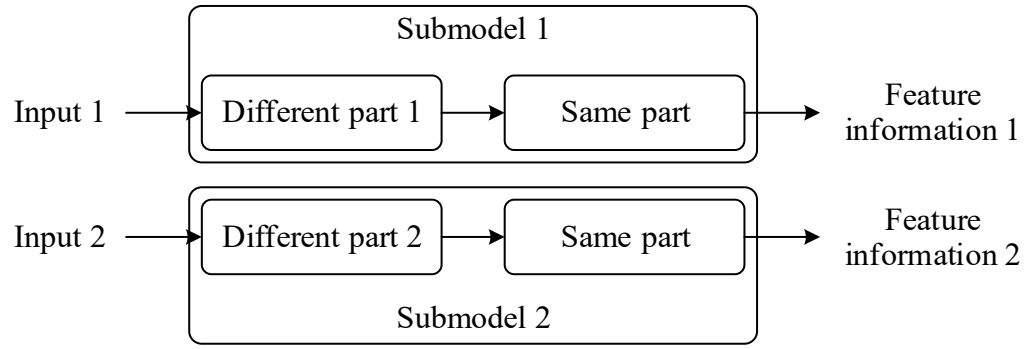
[FIG. 8d]


Second audio signal
Second machine learning model
Side information
Input 1
Submodel 1
Feature information 1
Input 2
Submodel 2
Feature information 2
Input n
Submodel n
Feature information n
Rule-based manner
Input n+1
Rule-based sub-manner 1
Feature information n+1
Input n+2
Rule-based sub-manner 2
Feature information n+2
Input n+m
Rule-based sub-manner m
Feature information n+m

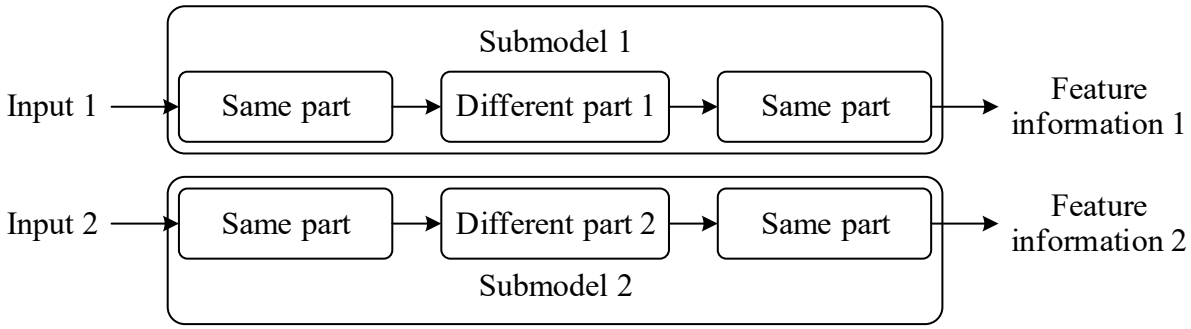
[FIG. 9a]


Submodel 1
Input 1
Same part
Different part 1
Feature information 1
Input 2
Same part
Different part 2
Feature information 2
Submodel 2

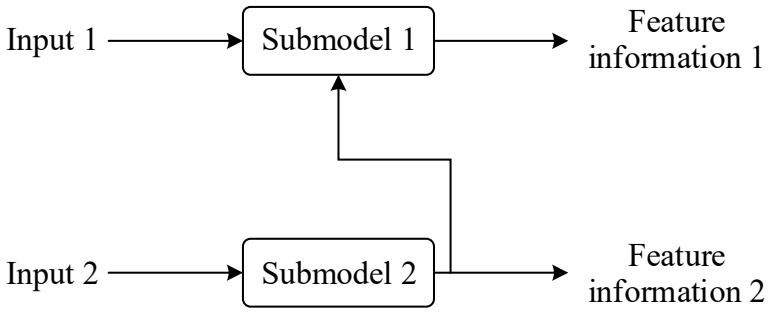
[FIG. 9b]



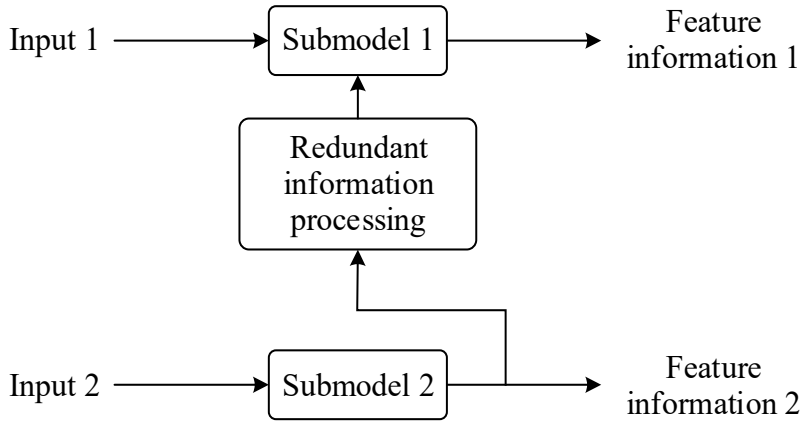
[FIG. 9c]



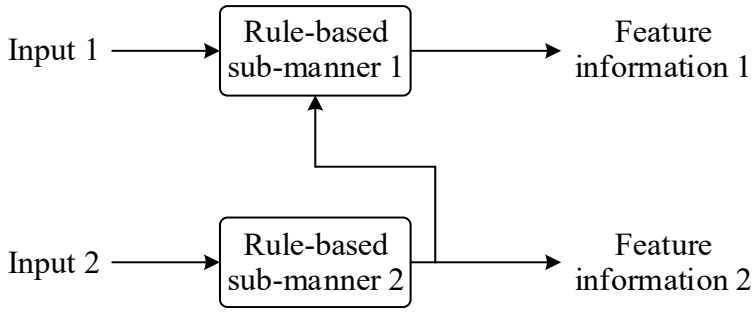
[FIG. 10a]



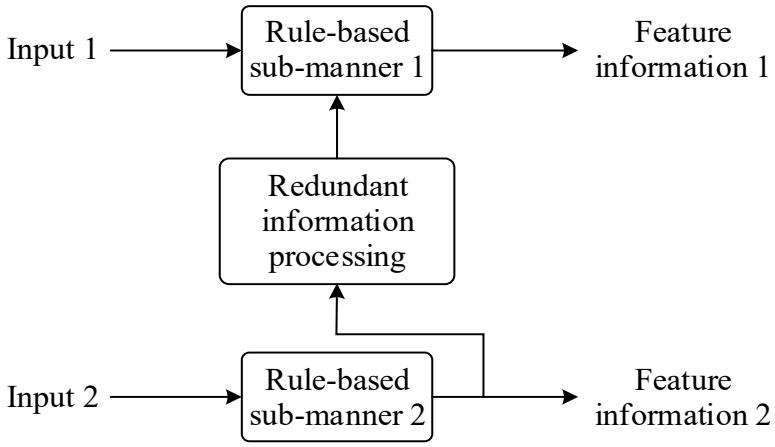
[FIG. 10b]



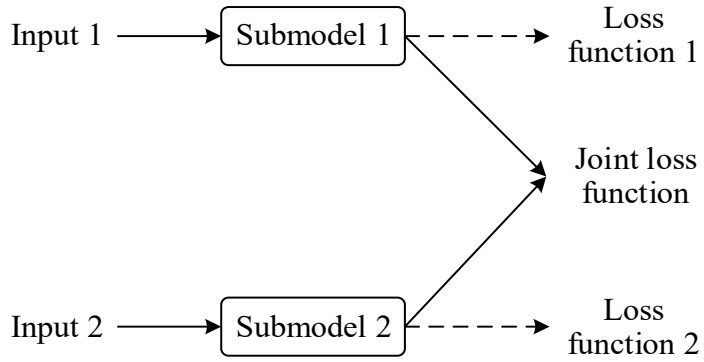
[FIG. 11a]



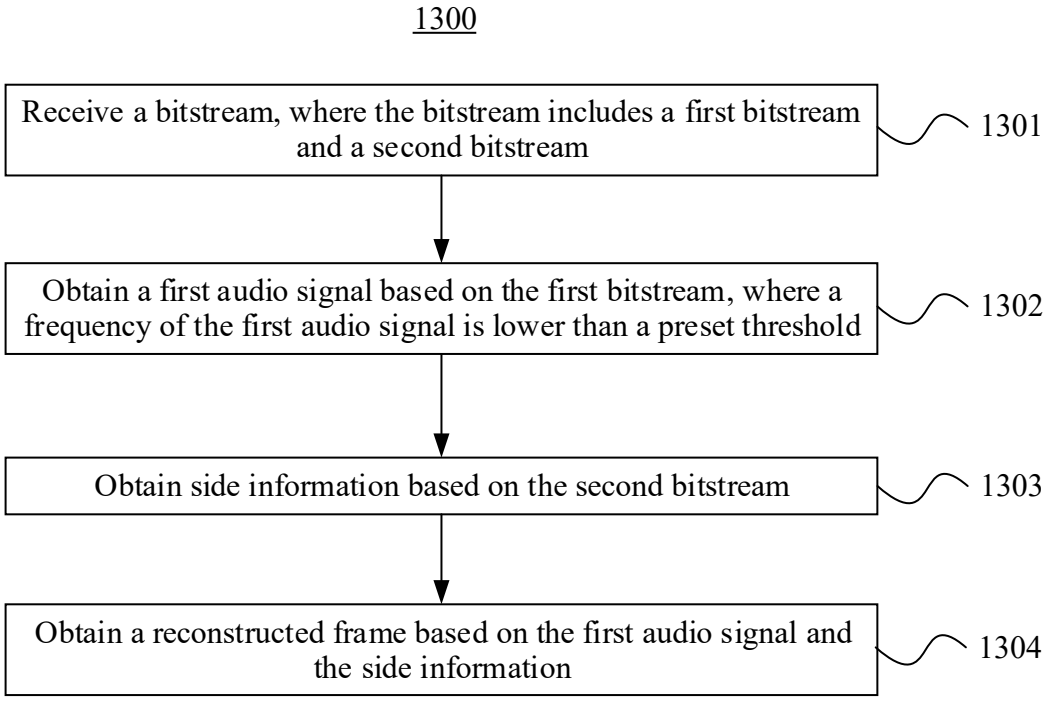
[FIG. 11b]



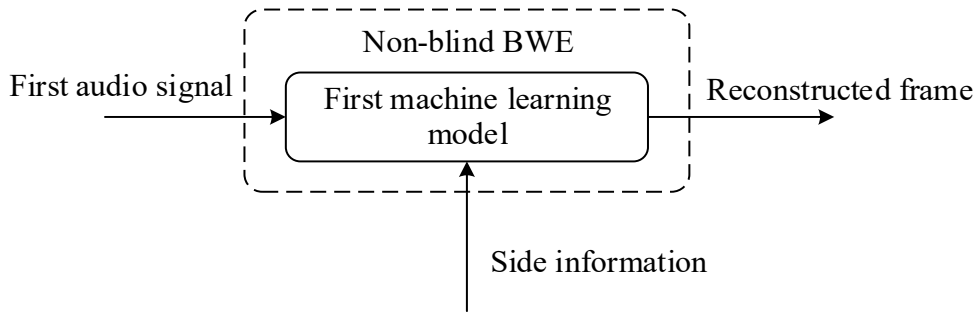
[FIG. 12]



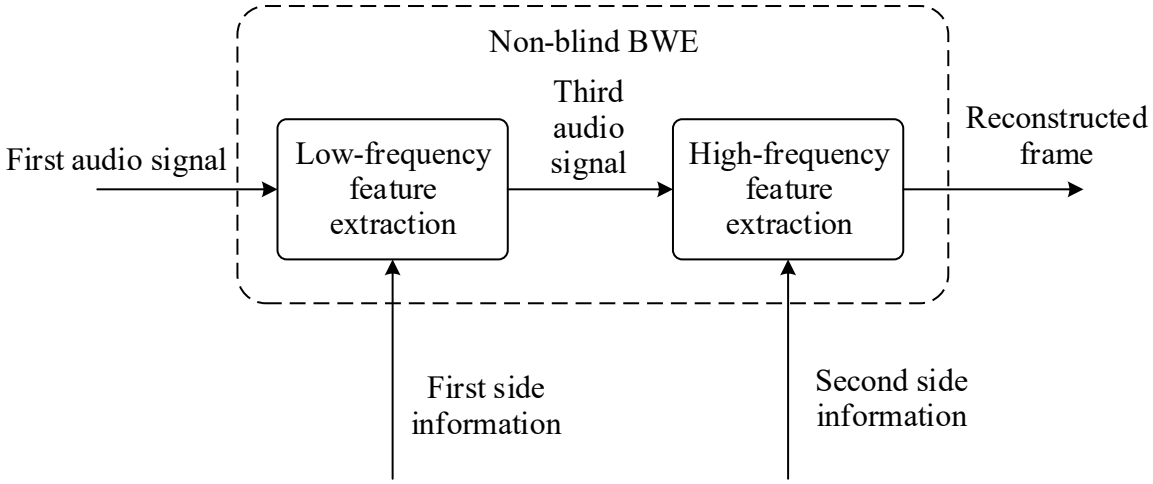
[FIG. 13]



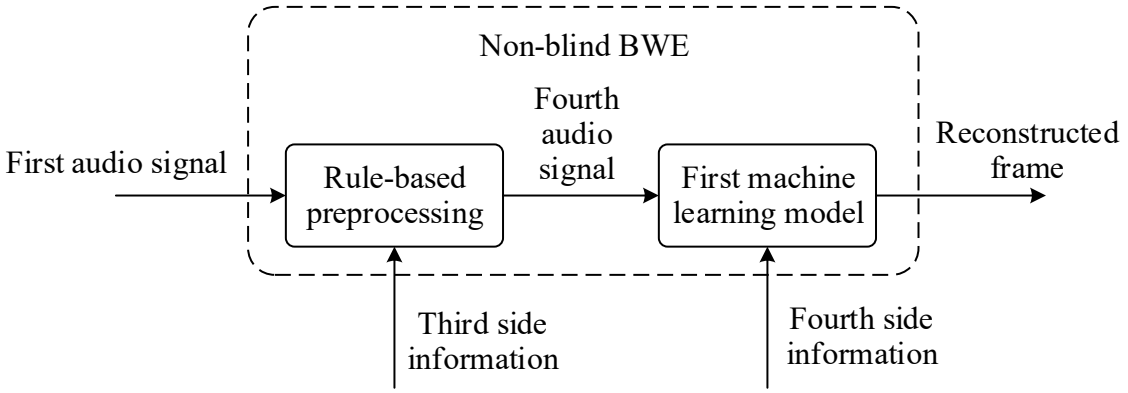
[FIG. 14a]



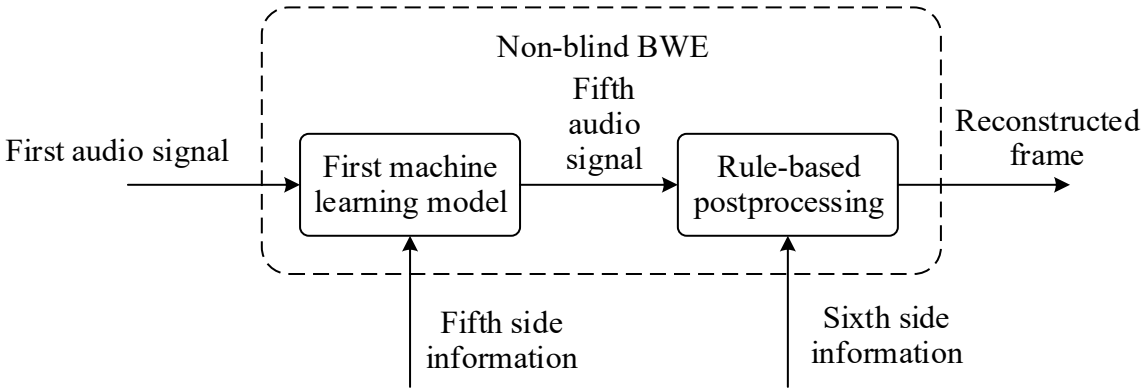
[FIG. 14b]



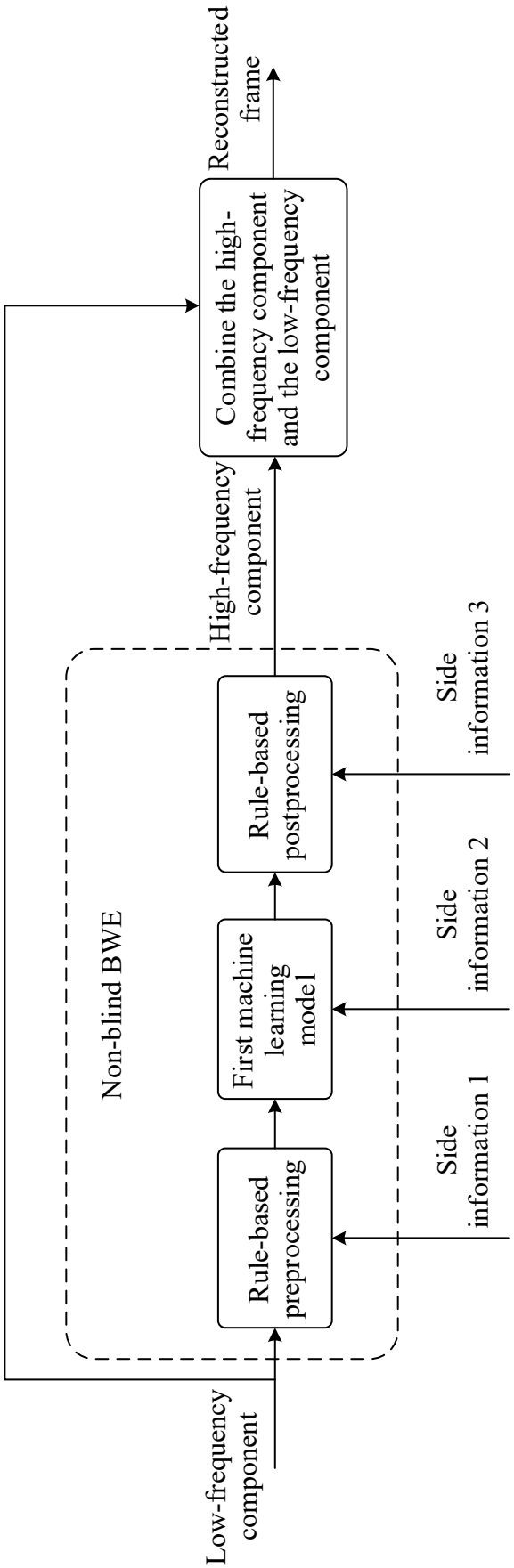
[FIG. 14c]



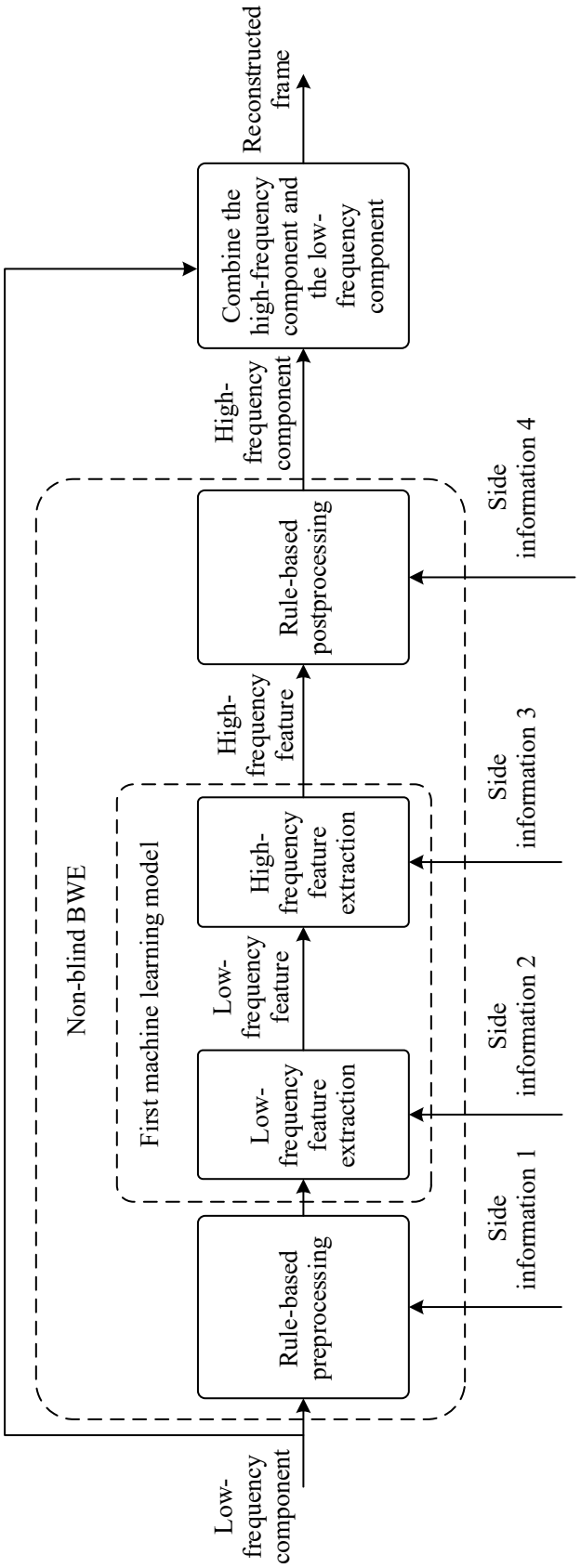
[FIG. 14d]



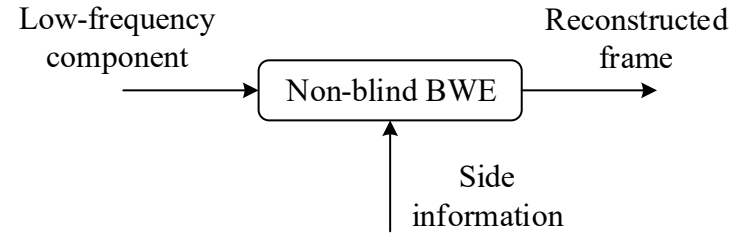
[FIG. 14e]


Low-frequency component
Non-blind BWE
Rule-based preprocessing
First machine learning model
Rule-based postprocessing
Side information 1
Side information 2
Side information 3
High-frequency component
Combine the high-frequency component and the low-frequency component
Reconstructed frame

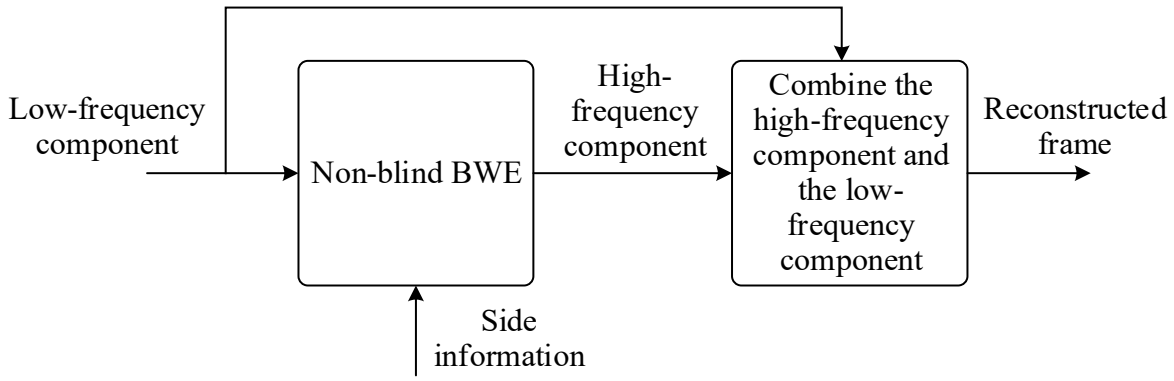
[FIG. 14f]


Low-frequency component
Non-blind BWE
First machine learning model
Rule-based preprocessing
Low-frequency feature extraction
Low-frequency feature
High-frequency feature extraction
High-frequency feature
Rule-based postprocessing
High-frequency component
Combine the high-frequency component and the low-frequency component
Reconstructed frame
Side information 1
Side information 2
Side information 3
Side information 4

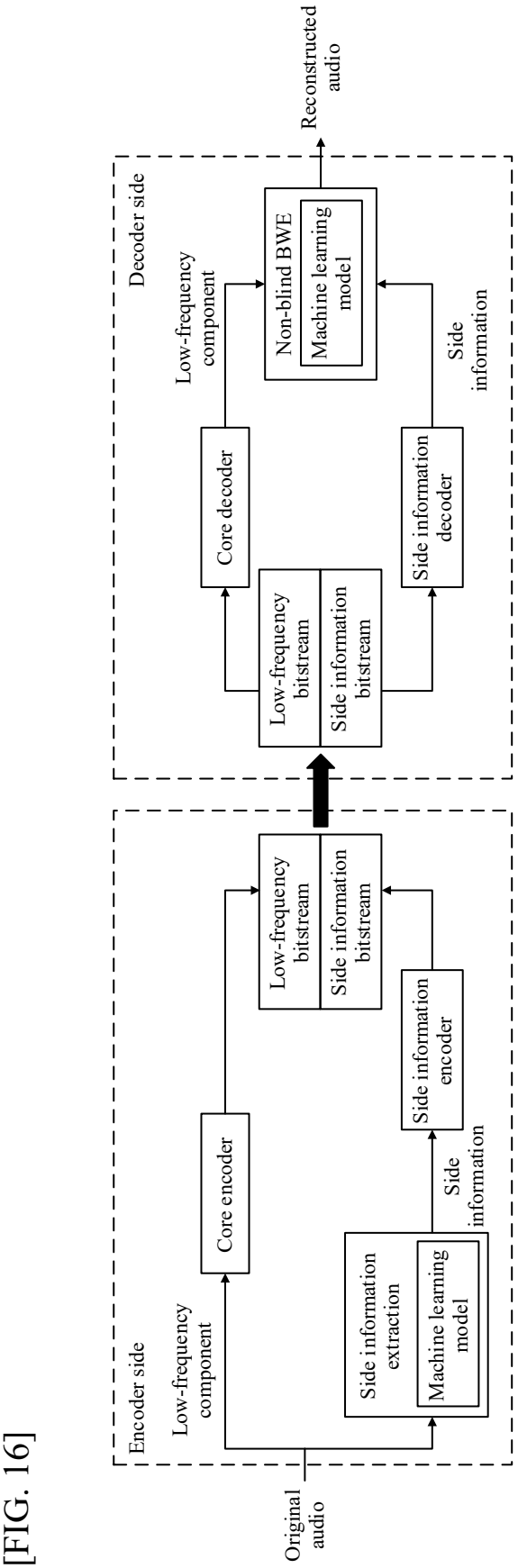
[FIG. 15a]



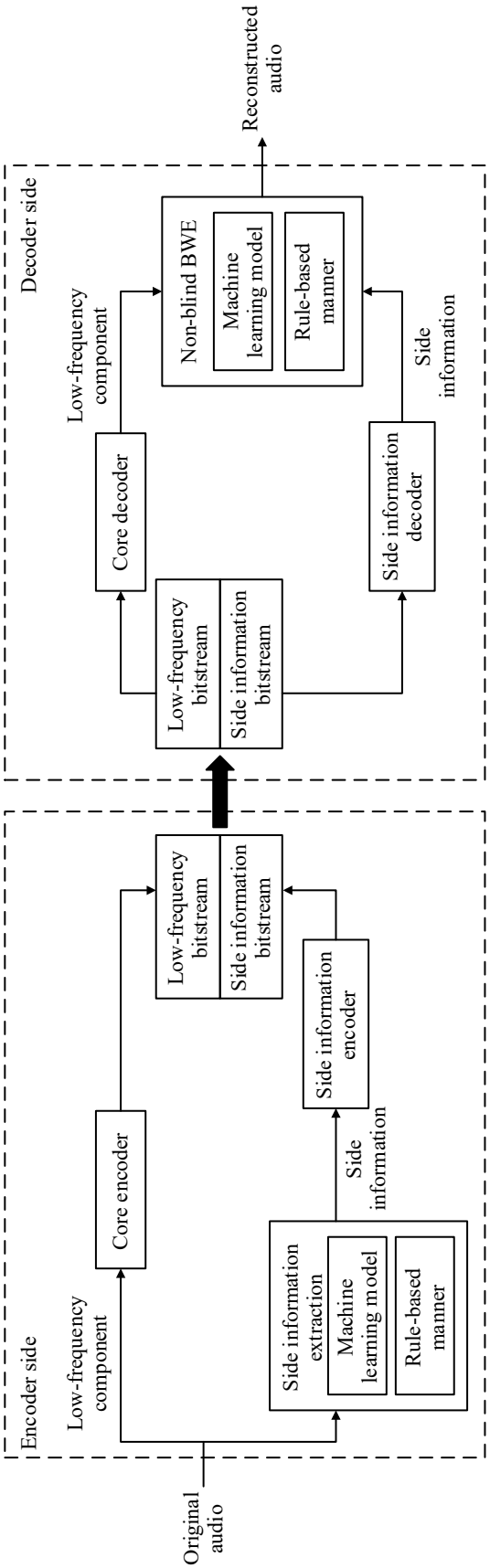
[FIG. 15b]



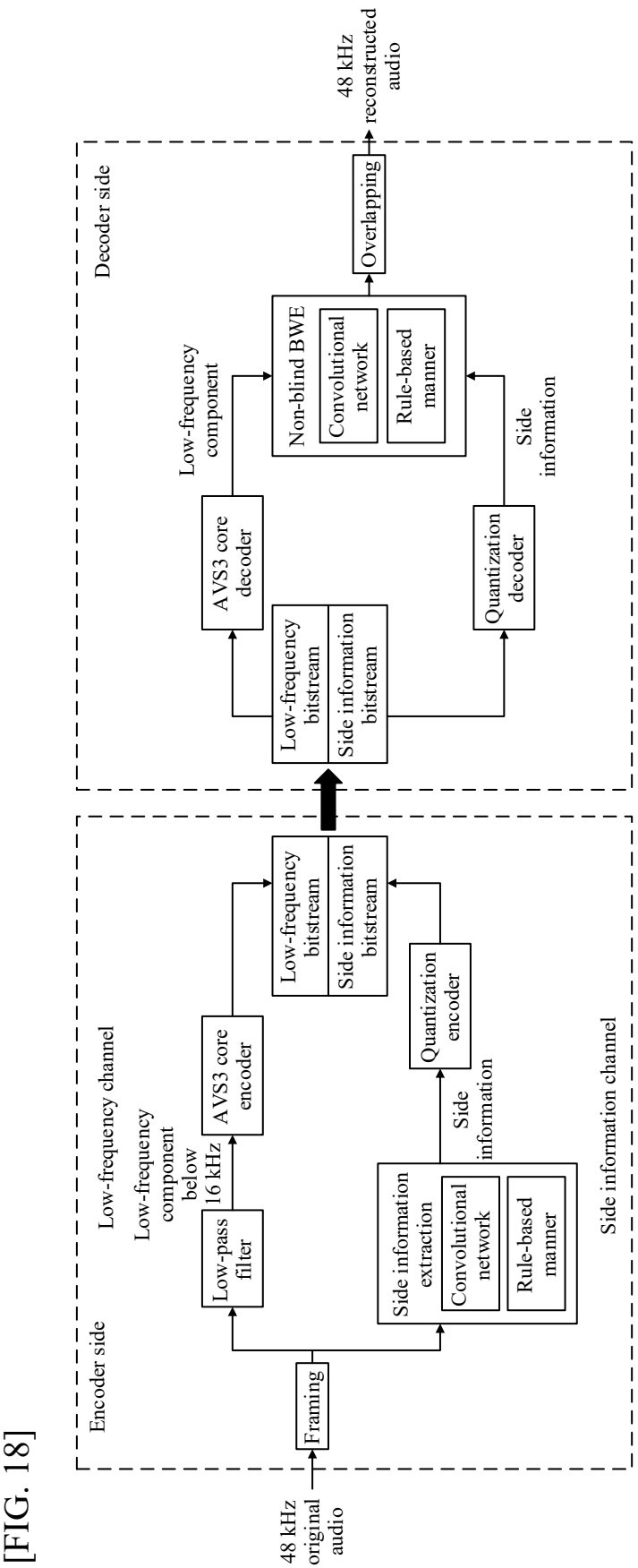
[FIG. 16]


Original audio
Encoder side
Low-frequency component
Core encoder
Side information extraction
Machine learning model
Side information
Side information encoder
Low-frequency bitstream
Side information bitstream
Decoder side
Low-frequency component
Core decoder
Side information
Side information decoder
Low-frequency bitstream
Side information bitstream
Non-blind BWE
Machine learning model
Reconstructed audio

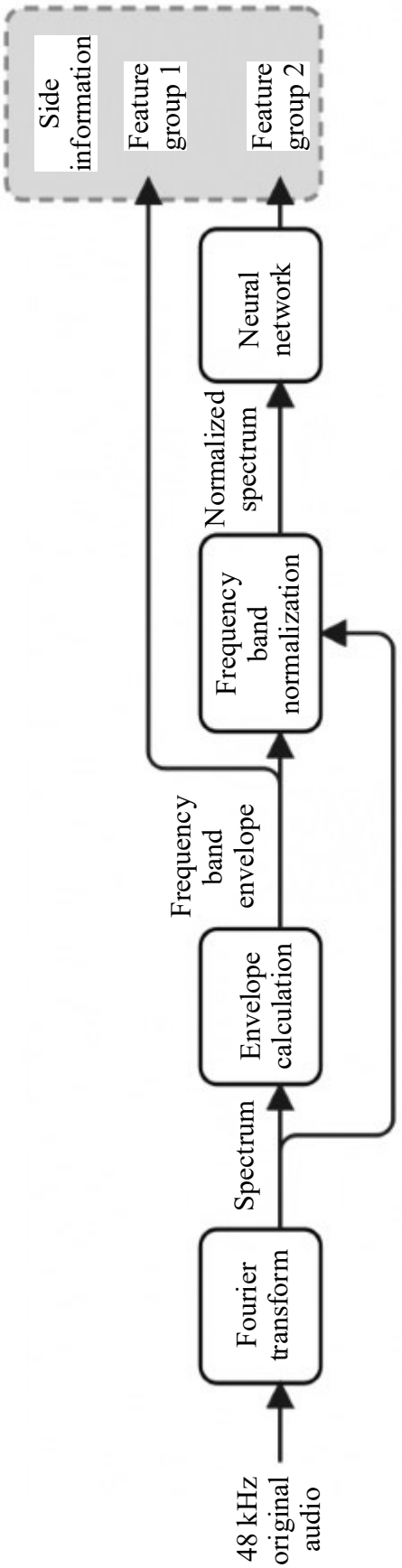
[FIG. 17]


Original audio
Encoder side
Low-frequency component
Core encoder
Side information extraction
Machine learning model
Rule-based manner
Side information
Side information encoder
Low-frequency bitstream
Side information bitstream
Decoder side
Low-frequency component
Core decoder
Side information decoder
Side information
Non-blind BWE
Machine learning model
Rule-based manner
Reconstructed audio

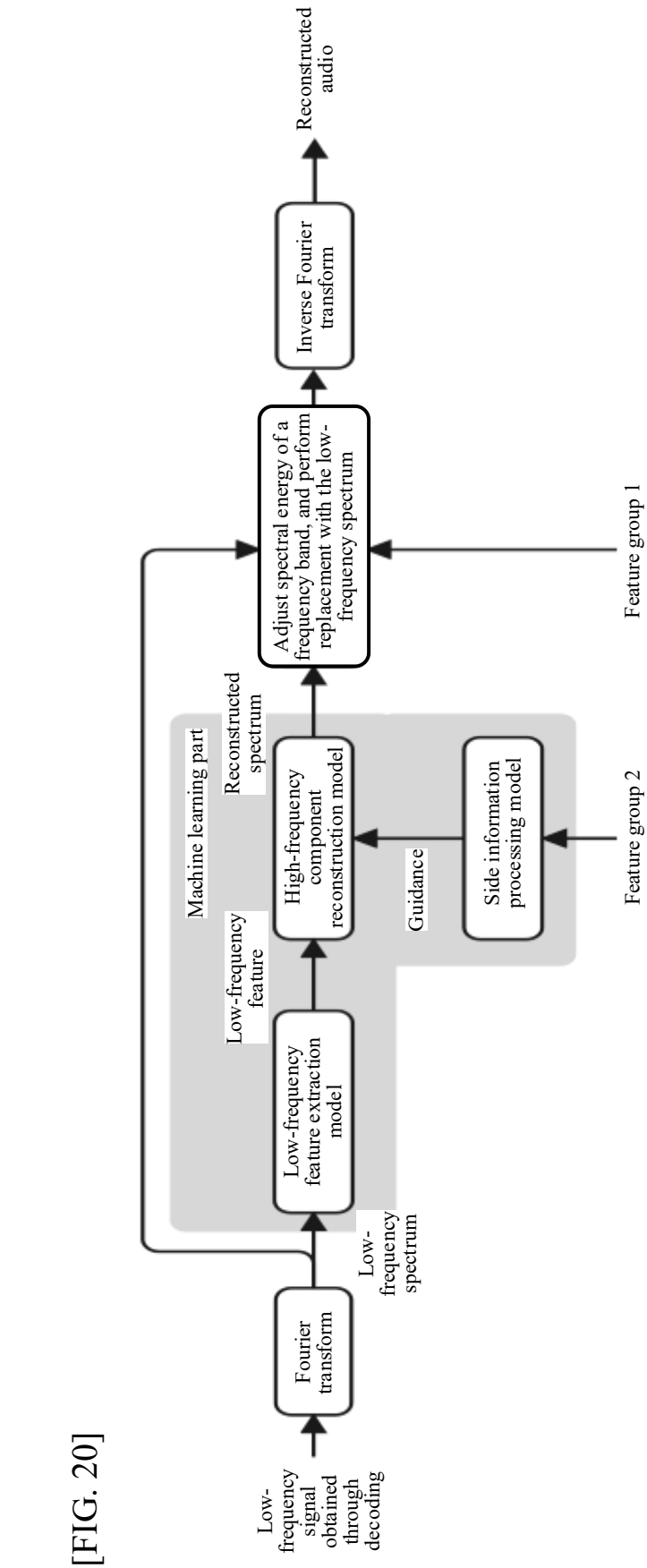
[FIG. 18]


48 kHz original audio
Encoder side
Framing
Low-frequency channel
Low-frequency component below 16 kHz
Low-pass filter
AVS3 core encoder
Low-frequency bitstream
Side information bitstream
Side information channel
Side information extraction
Convolutional network
Rule-based manner
Side information
Quantization encoder
Decoder side
Low-frequency component
AVS3 core decoder
Low-frequency bitstream
Side information bitstream
Quantization decoder
Side information
Non-blind BWE
Convolutional network
Rule-based manner
Overlapping
48 kHz reconstructed audio

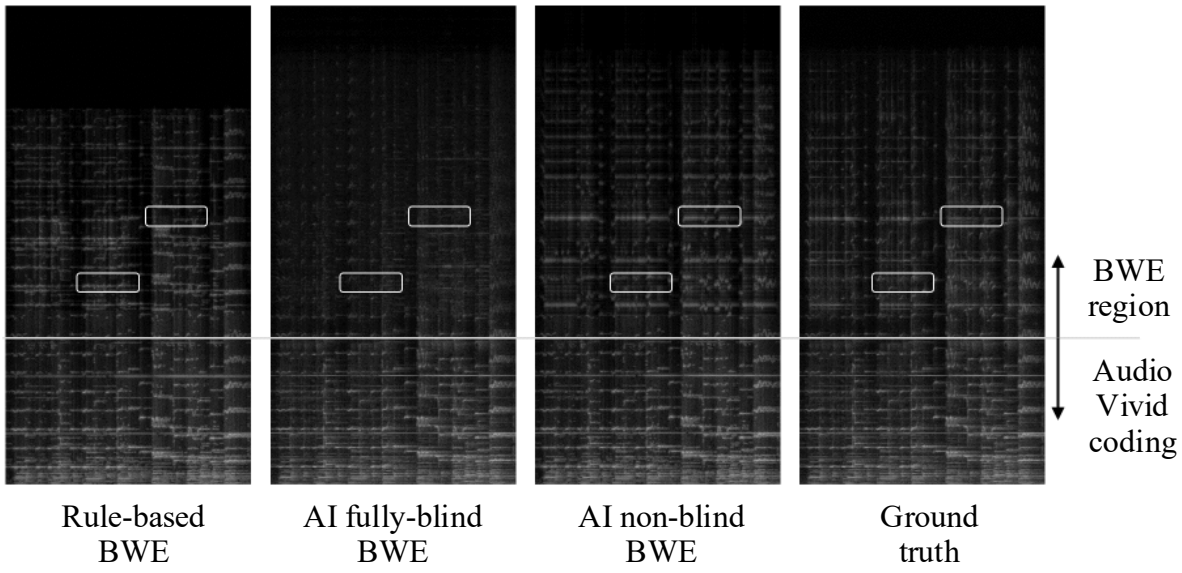
[FIG. 19]


48 kHz original audio
Fourier transform
Spectrum
Envelope calculation
Frequency band envelope
Frequency band normalization
Normalized spectrum
Neural network
Side information
Feature group 1
Feature group 2

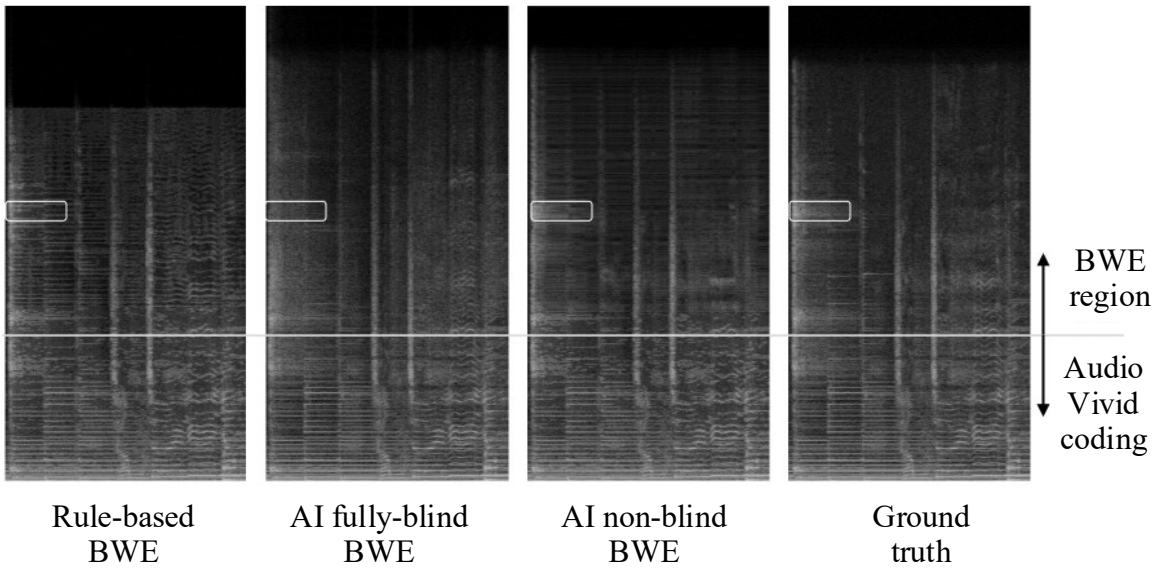
[FIG. 20]


Low-frequency signal obtained through decoding
Fourier transform
Low-frequency spectrum
Machine learning part
Low-frequency feature
Low-frequency feature extraction model
High-frequency component reconstruction model
Reconstructed spectrum
Guidance
Side information processing model
Feature group 2
Feature group 1
Adjust spectral energy of a frequency band, and perform replacement with the low-frequency spectrum
Inverse Fourier transform
Reconstructed audio

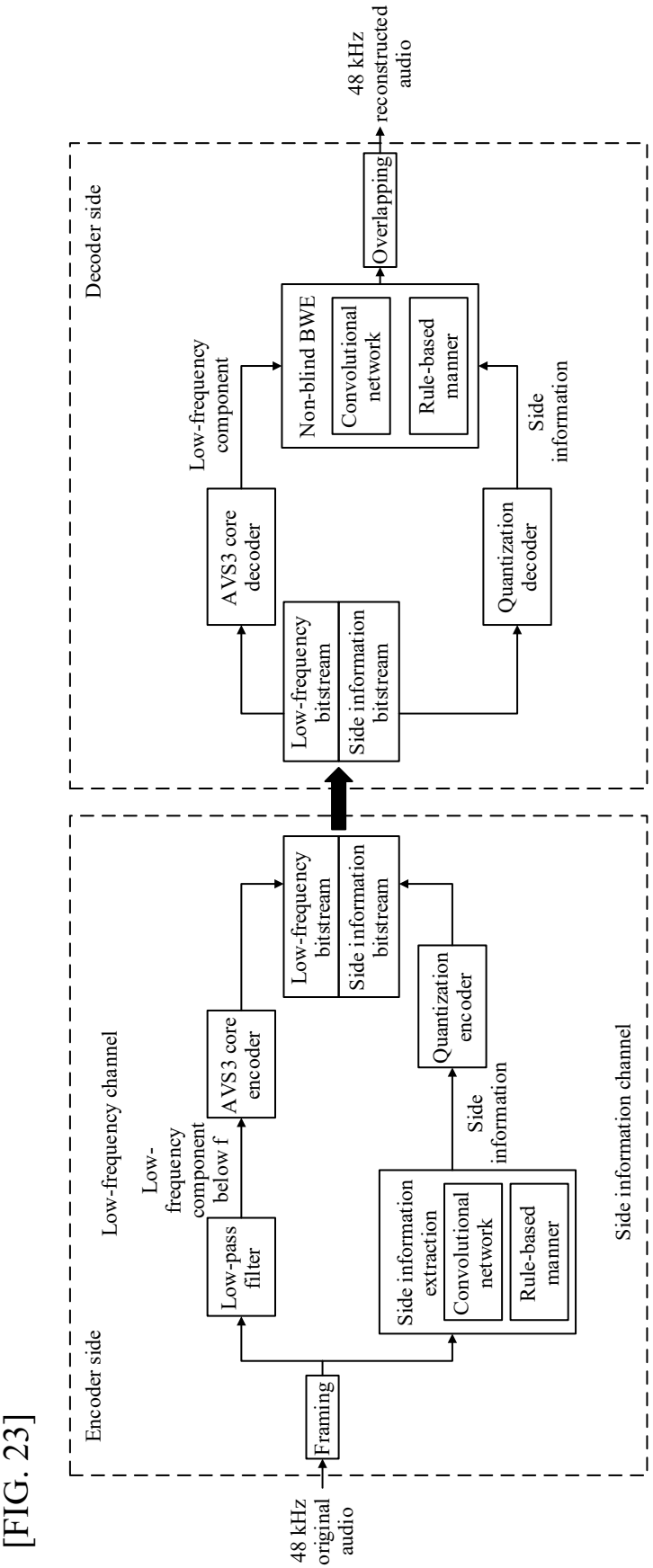
[FIG. 21]


BWE region
Audio Vivid coding
Rule-based BWE
AI fully-blind BWE
AI non-blind BWE
Ground truth

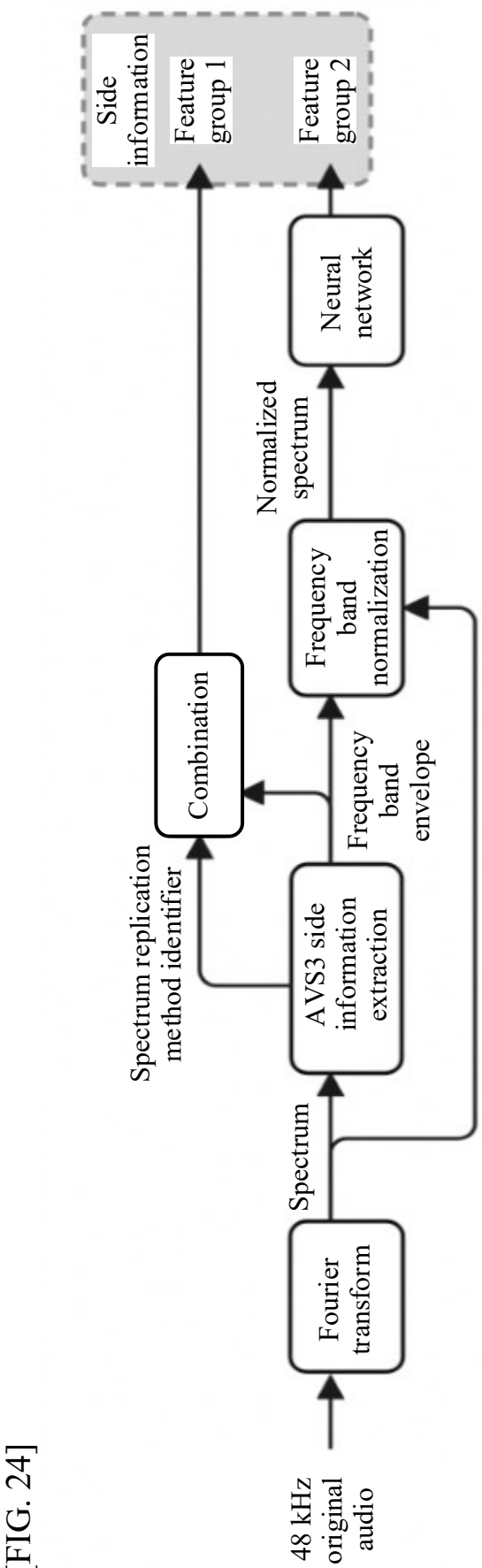
[FIG. 22]


BWE region
Audio Vivid coding
Rule-based BWE
AI fully-blind BWE
AI non-blind BWE
Ground truth

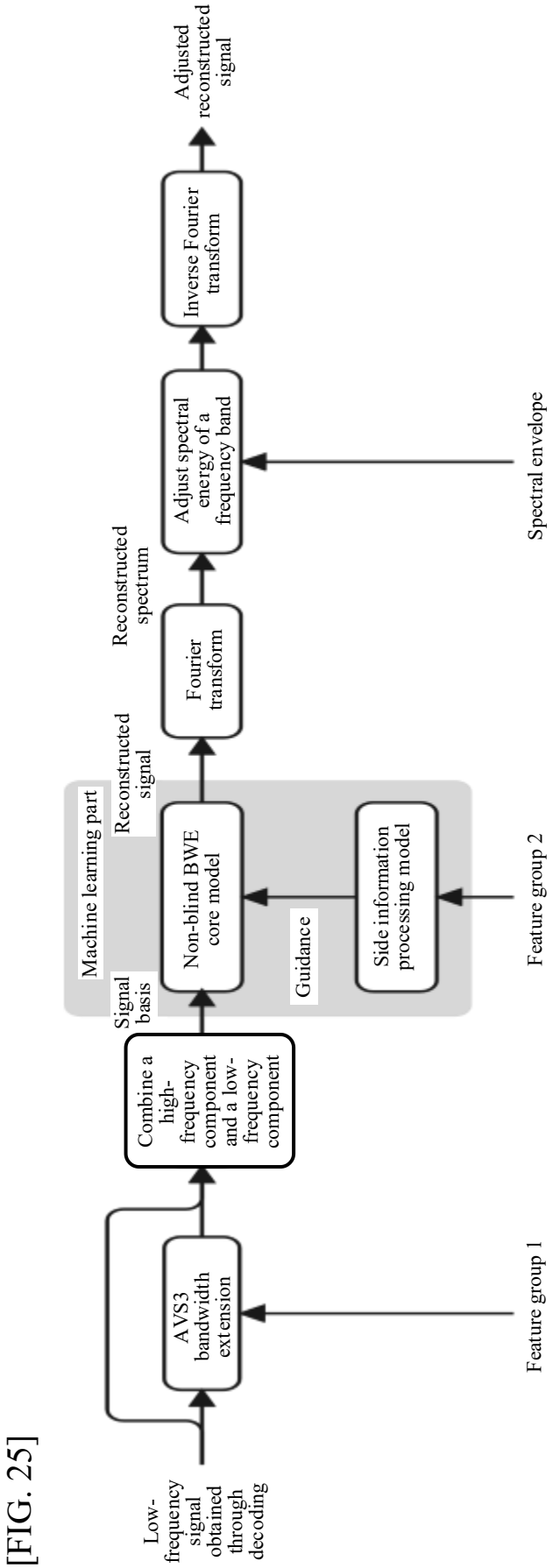
[FIG. 23]


48 kHz original audio
Framing
Encoder side
Low-frequency channel
Low-pass filter
Low-frequency component below f
AVS3 core encoder
Side information extraction
Convolutional network
Rule-based manner
Side information
Quantization encoder
Side information channel
Low-frequency bitstream
Side information bitstream
Decoder side
AVS3 core decoder
Low-frequency component
Quantization decoder
Side information
Non-blind BWE
Convolutional network
Rule-based manner
Overlapping
48 kHz reconstructed audio

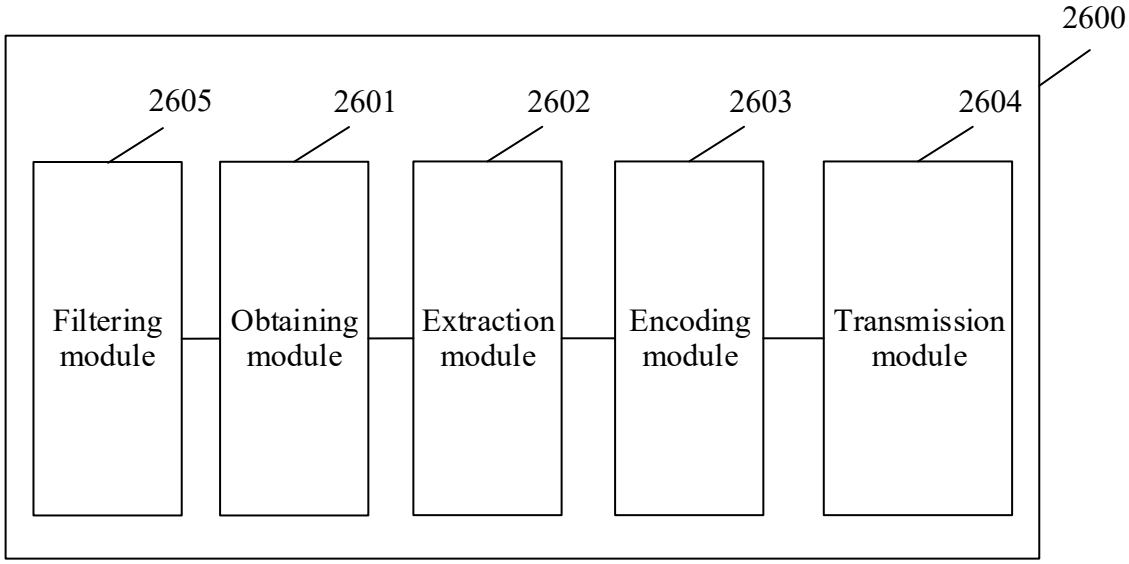
[FIG. 24]


48 kHz original audio
Fourier transform
Spectrum
AVS3 side information extraction
Spectrum replication method identifier
Combination
Frequency band envelope
Frequency band normalization
Normalized spectrum
Neural network
Side information
Feature group 1
Feature group 2

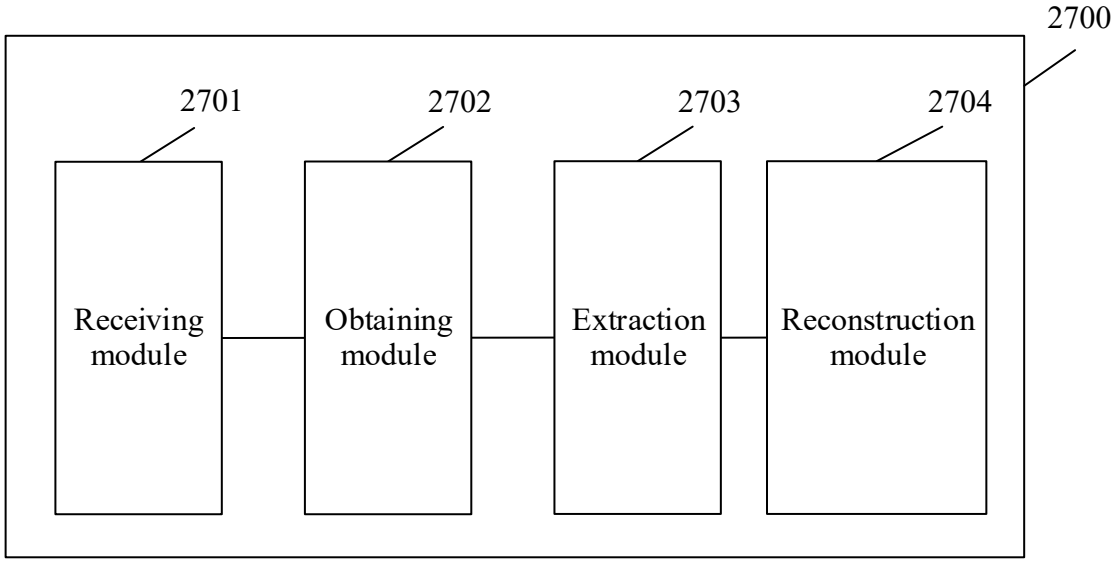
[FIG. 25]


Low-frequency signal obtained through decoding
AVS3 bandwidth extension
Feature group 1
Combine a high-frequency component and a low-frequency component
Machine learning part
Signal basis
Non-blind BWE core model
Guidance
Side information processing model
Feature group 2
Reconstructed signal
Fourier transform
Reconstructed spectrum
Adjust spectral energy of a frequency band
Spectral envelope
Inverse Fourier transform
Adjusted reconstructed signal

[FIG. 26]


2600
2605
2601
2602
2603
2604
Filtering module
Obtaining module
Extraction module
Encoding module
Transmission module

[FIG. 27]


2700
2701
2702
2703
2704
Receiving module
Obtaining module
Extraction module
Reconstruction module