Computing Platforms

- Example: audio player

Audio theory of operation

- MP3 is widely used audio format, many other formats are in use.

- Audio compression uses perceptual coding.
  - Some features of audio may not be perceptible.
  - Removing unnecessary features can reduce size of the data.

MPEG audio standards

- Layer 1:
  - Lossless compression of subbands + optional simple masking model

- Layer 2:
  - More advanced masking model.

- Layer 3:
  - Additional processing for lower bit rates.

MPEG audio rates

- Input sampling rates:
  - 32, 44.1, 48 kHz.
- Output bit rates:
  - 23, 48, 64, 96, 112, 128, 192, 256, 384 kbits/sec.
- Output can be mono, dual-channel (bilingual, etc.), stereo.

Other standards

- Dolby Digital (AC-3):
  - Uses modified discrete cosine transform.
- ATRAC (MiniDisc):
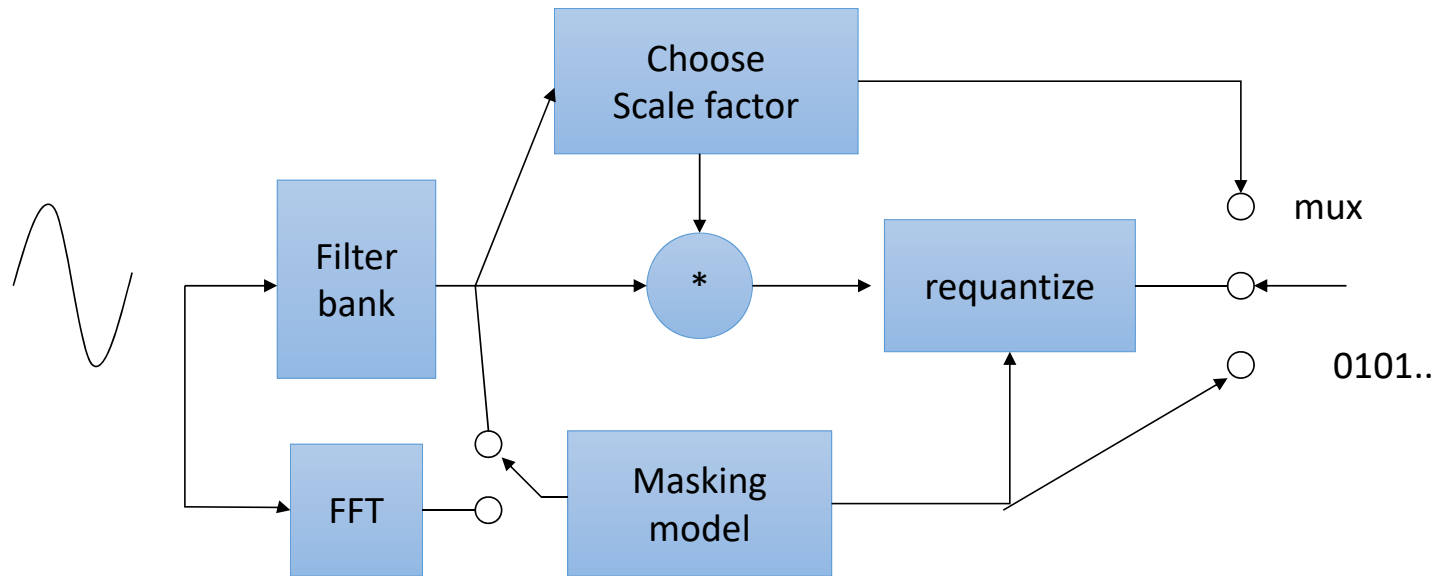 - Uses subband + modified DCT.
- MPEG-2 AAC.

MPEG Layer 1

- 384 samples/block at all frequencies.
  - Equals 8 ms at 48 kHz.
- Optional masking model.
  - Driven by separate FFT for better accuracy.

MPEG Layer 1 data frame

- Bit allocation codes specify word length in each subband.
- Scale factors give gain for each band.

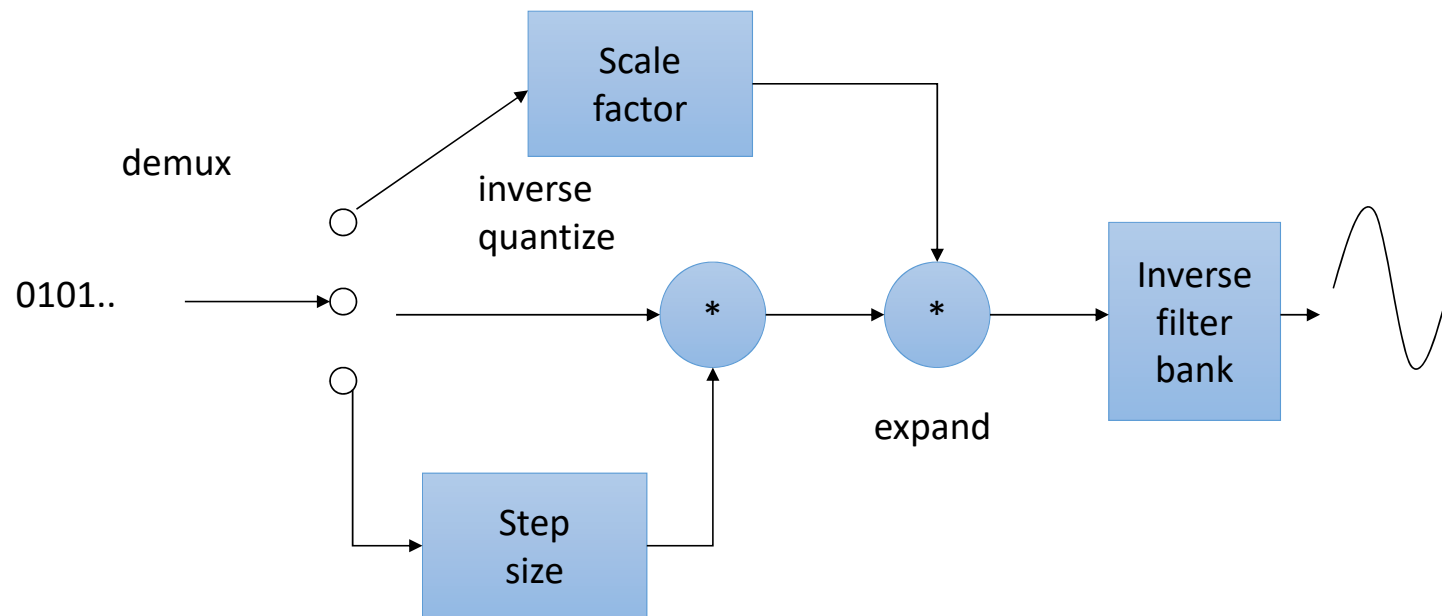| header	CRC	bit allocation	scale factors	subband samples	aux data

MPEG Layer 1 encoder

MPEG Layer 1 encoder operations

- Filter bank divides signal into subbands.
- Masking model chooses audio features to ignore.
- Quantizer chooses number of bits.
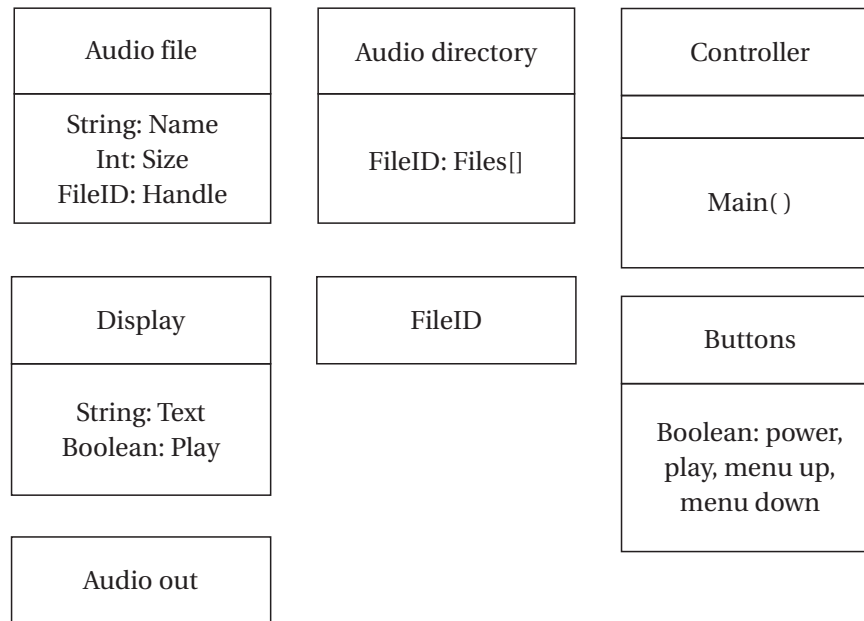- Scale factor fits signal within 6 bit range.

MPEG Layer 1 decoder

MPEG Layer 1 decoder operations

- Decoding is less computationally expensive:
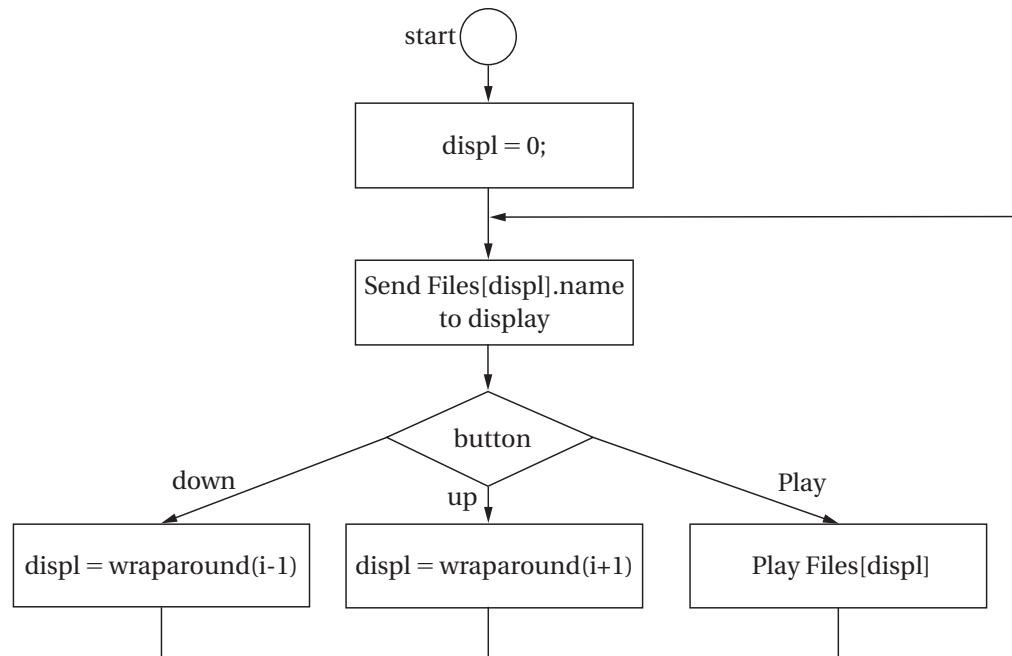 - Apply step size, scaling, inverse quantization.
  - Combine subbands.

Audio player requirements

Category	Description
Name	Audio player.
Purpose	Play audio from file.
Inputs	Flash socket, on/off, play/stop, menu up/down.
Outputs	Speaker
Functions	Display list of files in memory, select file to play, play file.
Performance	Sufficient for audio playback.
Power	1 AAA battery.
Physical weight/size	Approx. 1" x 2", less than 2 oz.

Audio player classes

Audio file
String: Name Int: Size FileID: Handle

Audio directory
FileID: Files[]

Controller
Main( )

Display
String: Text Boolean: Play

FileID

Buttons
Boolean: power, play, menu up, menu down

Audio out

File display/state selection

start

displ = 0;

Send Files[displ].name to display
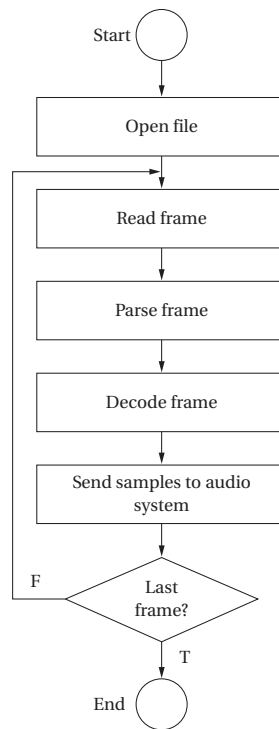
button

down

up

Play

displ = wraparound(i-1)

displ = wraparound(i+1)

Play Files[displ]

Audio playback

Component design and testing

- Audio decompression, file system can be acquired as software IP or created from scratch.

- If flash is not transferrable, non-standard file system may be useful.

- File system and audio decompression can be tested separately.

Cirrus platform architecture

RISC processor	DSP	Audio interface
CD interface	Memory controller	SRAM
I/O		ROM

CD drive

flash, DRAM, SRAM