Inter-Frame Coding - Cheat Sheet

Motion estimation, P/B-frames, search patterns - one page for live and VOD tuning

Companion to article 4.3 of Block 4. Print on A4 or US Letter.

Frame types and typical bit budget

I-frame	Intra-coded. No references. Baseline = 100% of an I-frame.
P-frame	Predicts from past references. ~50% of I-frame size.
B-frame	Predicts from past AND future. ~25% of I-frame size.

Rule of thumb:
Disabling B-frames (low-latency live) typically costs 30-50% more bitrate at matched visual quality.

Where the encoder spends its time

Motion estimation = 60-80% of total encoder time. Every preset is a motion-estimation knob.

x264 / x265 motion-estimation presets

me=	Name	Speed	Quality	Use case
`dia`	Diamond	Fastest	Lowest	Live, ultrafast/superfast
`hex`	Hexagon	Fast	Good	Default; live and VOD fast
`umh`	Uneven Multi-Hex	Medium	+0.1 dB PSNR	VOD slow/slower/veryslow
`esa`	Exhaustive search	Slow	Marginal gain	Archive only; rarely worth it
`tesa`	Transformed exhaustive	Slowest	Placebo	Bragging rights only

Settings that move bitrate and encode time

Search range (merange)	Wider = lower bitrate, quadratically slower. 16-24 live; 32-64 VOD.
Sub-pixel depth	1/2 pix gains ~1 dB; 1/4 pix gains another 0.5-0.8 dB. Cheap to enable.
Reference frames	More refs = lower bitrate, diminishing returns past 4-8.
B-frame count	0 for live; 2-3 for VOD; 16 for archival. Each costs decoder buffer.
Affine / warped motion	+5-15% encode time; big wins on pans, zooms, rotations.
Rate-distortion optimisation	Slower preset = more RDO = better quality at same bitrate.

Live vs VOD - typical tuning

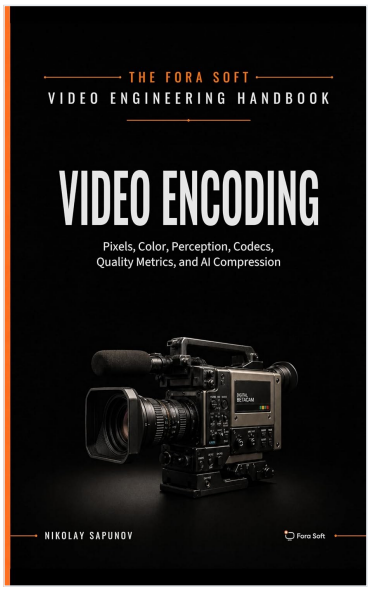
Setting	Live / low-latency	VOD / VOD-quality
B-frames	0	2 or 3
ME pattern	hex (or dia)	umh
Search range	16-24	32-64
Reference frames	1-3	4-8
Sub-pixel	1/4	1/4 or 1/8
Preset	veryfast / faster	slow / slower / veryslow

Modern motion tools (by codec)

H.264 (2003)	variable blocks, multi-reference (up to 16), 1/4-pixel motion vectors
HEVC (2013)	quad-tree blocks, advanced motion-vector prediction, weighted prediction
AV1 (2018)	7 references, global/warped motion, OBMC, compound prediction modes
VVC (2020)	affine motion model, BDOF, DMVR, decoder-side refinement
AV2 (2025)	extended reference buffer, learned modes, finer affine, improved compound

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Companion to: 'Inter-Frame Coding and Motion Estimation'
www.forasoft.com/learn/video-encoding/articles/inter-frame-coding-motion-estimation



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This sheet keeps frame-type bit budgets, motion-estimation presets and live versus VOD tuning on one page. Volume 1 explains why those knobs behave the way they do: how H.264, HEVC and AV1 predict between frames, how rate control spends bits across I, P and B frames, and how to check the result with quality metrics.

WHAT YOU WILL FIND INSIDE

- Motion search and inter prediction in H.264, HEVC and AV1
- Rate control for live and VOD encodes
- GOP structure, B-frames and reference choices
- Checking tuning changes with PSNR, SSIM and VMAF

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