RDO and encoder-preset tuning — cheat sheet

Mode decision, lambda, RDOQ, presets — one page. Companion to article 4.12 of Block 4. Print on A4.

1. Lambda from QP (HEVC reference, x265, VVenC, SVT-AV1 tuned variant)

```
lambda_mode = 0.85 * 2^((QP - 12) / 3)        lambda_motion = sqrt(lambda_mode)
```

QP	lambda_mode	lambda_motion	Use case
17	1.7	1.30	Visually lossless mezzanine, mastering
22	6.8	2.61	High-quality VOD (Netflix premium tier)
27	27.2	5.21	Streaming mainline (1080p H.264 / HEVC)
32	108.8	10.43	Mobile, bandwidth-constrained streaming
37	435	20.86	Bandwidth-limited surveillance, fallback

2. The cost equation

- **Per candidate:** J = D + lambda × R, where D = SSD vs original, R = entropy-coded bits.
- **Per coefficient (RDOQ):** pick level that minimizes J including CABAC context cost; trellis-zeroes the tail.
- **Per block:** enumerate → SATD pre-filter to top-K → full RDO on survivors → pick min J → commit.

3. Encoder presets (BD-rate vs CPU, indicative)

Encoder	Preset / flag	BD-rate vs slowest	CPU vs fastest
x264 (H.264)	`--preset medium`	+1–3%	~6×
x264 (H.264)	`--preset placebo`	0%	~80×
x265 (HEVC)	`--preset medium --rd 3`	+6%	~6×
x265 (HEVC)	`--preset slower --rd 5`	+1%	~20×
x265 (HEVC)	`--preset placebo --rd 6`	0%	~120×
SVT-AV1	`--preset 8 --rdoq-level 1`	+5%	~4×
SVT-AV1	`--preset 4 --rdoq-level 1`	+1%	~18×
libaom (AV1)	`--cpu-used 4`	+3%	~10×
VVenC	`fast`	+7%	~6×
VVenC	`medium`	+3%	~14×

4. RDOQ knobs — which flag turns it on

- **x264** — --trellis 0 / 1 / 2 (default 1 at medium; 2 at slow and above).
- **x265** — --rdoq-level 0 / 1 / 2; implicitly enabled at --rd 4, 5, 6.
- **libaom (AV1)** — on by default at slow presets; disable with --disable-trellis-quant.
- **SVT-AV1** — --rdoq-level 0 / 1; default 1 at preset ≤ 8.
- **VVenC** — --rdoq 0 / 1 / 2; default 1 at preset ≥ fast.
- **VTM (VVC reference)** — RDOQ config key in cfg file; default ON in Random Access.

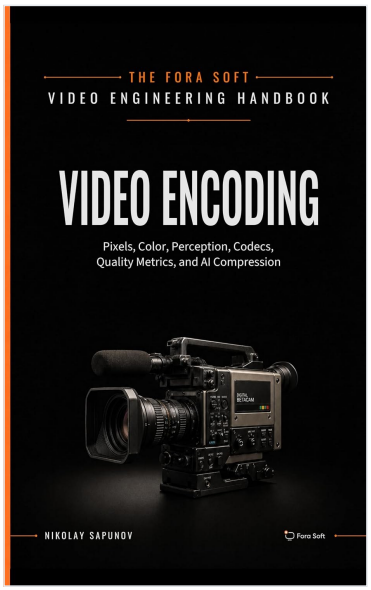
5. Debugging quick reference

- **Visible blocking at expected QP** — check that deblocking and RDOQ are both on; not all presets enable RDOQ.
- **Slower preset increases bitrate** — you compared at the same CRF, not the same VMAF; compare at iso-quality.
- **Screen content looks crunchy** — enable --tune zerolatency + --tune-content screen (or codec equivalent).
- **x265 logs show ME/ME-RD ratios** — high MV cost ratio means lambda_motion is dominating; investigate --psy-rd.
- **Aurora1 / neural mode aides** — 1–2% BD-rate gain on top of fast presets; SATD replacement is the visible win.
- **Compare presets only at iso-bitrate or iso-VMAF**, never iso-CRF; iso-CRF is misleading by design.

6. One-line CI contract

- Run two encodes of the same source: preset A vs preset B at iso-bitrate; compute VMAF on both.
- **Assertion:** VMAF(B) ≥ VMAF(A) − delta_target; CPU(B) ≤ cpu_budget; bitrate within ±2% of target.
- Catalog the (encoder, preset, CRF, VMAF, CPU) tuple in a benchmark table and re-run quarterly.

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This sheet gives the lambda-from-QP table, the RD cost equation, preset trade-offs and RDOQ flags per encoder. Volume 1 covers the encoder internals behind them: mode decision and rate-distortion optimization, quantization and RDOQ, x265, SVT-AV1 and VVenC presets, and quality metrics for fair comparisons.

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