In-loop filter tuning - cheat sheet

Deblocking, SAO, ALF, CDEF, Loop Restoration - one page

Fora Soft Learn

Companion to article 4.11 of Block 4. Print on A4.

1. Filter chain per codec (execution order is fixed)

Codec	Chain	Total saving	Decode share
H.264 / AVC	deblocking	~5-8%	~3%
HEVC (2013)	deblocking + SAO	~7-11%	~5%
AV1 (2018)	deblocking + CDEF + Loop Restoration	~9-13%	~6%
VVC (2020)	deblocking + SAO + ALF + CC-ALF	~10-14%	~8-10%
AVS3 (2019)	deblocking + SAO + ALF	~9-12%	~7%

2. What each filter does

Deblocking - smooths the step at coded-block boundaries; decision uses boundary strength, activity, QP.
SAO (Edge Offset) - five neighbour-relative categories, signal one offset per non-flat category, ~30-60 bits/CTU.
SAO (Band Offset) - 32 bands across luma range, signal offsets for four consecutive bands.
ALF (VVC) - 7-tap diamond luma, 5-tap diamond chroma; coefficients trained per frame, pool of up to 25 alternatives.
CC-ALF (VVC) - luma-driven correction added to chroma; ~0.5-1% chroma bitrate saving on top.
CDEF (AV1) - 8-direction estimation per 8x8 block, primary strength along edge, secondary across; fixed kernel.
Loop Restoration (AV1) - 7-tap Wiener or 2-parameter self-guided filter; +1-2% on top of CDEF.

3. Encoder flags (turn each filter on or off)

x264 - deblock=alpha:beta (default 0:0); --no-deblock disables; do not ship --no-deblock to production.
x265 - --deblock=alpha:beta (default 0:0); --no-deblock; --no-sao disables SAO; --sao-non-deblock for content tuning.
VVenC / VTM - SAOEnabled, ALFEnabled, CCALFEnabled config keys; all default ON in standard presets.
SVT-AV1 - --enable-restoration, --enable-cdef, --film-grain (separate, but kept off by default); deblocking always on.
aomenc - --deblocking=1, --enable-cdef=1, --enable-restoration=1; all on by default at default speed.
FFmpeg passthroughs - -deblock 0:0 (x264), -x265-params no-deblock=1, -svtav1-params enable-restoration=0.

4. Pipeline-debugging quick reference

Visible 16x16 grid on flat content at low bitrate (H.264) - check deblocking_filter_disabled_flag in slice header.
Block grid on AV1 streams - check loop_filter_level in uncompressed_header; >0 expected for normal content.
Ringing halo around captions persists in AV1 - confirm CDEF strengths non-zero in frame header.
VVC stream looks slightly soft in flat skies vs HEVC - this is ALF working as designed; verify by toggling ALF off.
Chroma bleed at high QP in VVC - confirm CC-ALF is enabled and the chroma filter shape is signalled.
ffprobe -show_streams -show_frames | grep -i filter - quick sanity check for filter state on a single sample.

5. One-line CI contract test

ffprobe -v error -select_streams v:0 -show_entries stream=codec_name -of csv=p=0 sample.mp4
  then run a codec-specific bitstream parser - mediainfo --Inform='Video;%Format_Settings_GOP%' for H.264/HEVC
Assertion: bitstream's deblocking flag = enabled; SAO present (HEVC/VVC); CDEF strengths > 0 (AV1).
Add to nightly encode regression suite - one test per codec, one test per typical preset. Cost: ms per encode.