

4:2:2

KAMERA/TECHNIK

4:2:2 Chroma-Subsampling reduziert die horizontale Chrominanzauflösung um 50% bei vollständiger vertikaler Auflösung. Es stellt den professionellen Rundfunkstandard dar und balanciert Qualität und Bitrate-Effizienz.

4:2:2 Chroma Subsampling (Professional Standard) 4:2:2 represents the professional broadcast and cinema standard for chroma subsampling, reducing horizontal chrominance resolution by 50% while maintaining full vertical resolution. This ratio provides the optimal balance between color quality and bitrate efficiency for professional production and delivery. Technical Specification 4:2:2 defines a precise sampling pattern: Sampling Arrangement : Luminance (Y) : Full resolution horizontal and vertical Chrominance (Cb) : Half horizontal resolution, full vertical Chrominance (Cr) : Half horizontal resolution, full vertical Pattern : For every 4 luminance samples, 2 Cb and 2 Cr samples Notation Explanation : First "4": Luminance sampling rate (baseline) "2" (second): Chrominance horizontal at 50% of luminance "2" (third): Chrominance vertical at 100% of luminance Visual Perception Human Visual System Advantages : Eye less sensitive to horizontal color detail than luminance 4:2:2 reduction imperceptible to most viewers Vertical color resolution fully maintained Professional standard reflects human perception Practical Quality : Indistinguishable from 4:4:4 for most content Color artifacts minimal even on large screens Fine color detail preserved adequately Professional-grade color grading possible Data Efficiency 4:2:2 offers practical bitrate benefits: Storage Requirements : Uncompressed : 32 bits per 2 pixels (16 bits per pixel) Compression : Various codecs with different approaches Bitrate Examples (1080p/24fps): Uncompressed 4:2:2: ~82 Mbps Compressed 4:2:2: 50-100 Mbps (depending on codec) Comparison : 50% reduction vs. 4:4:4 2x bitrate vs. 4:2:0 Practical compromise between quality and efficiency Industry Standards Using 4:2:2 Broadcast Television : HD broadcast standard globally Professional production standard Satellite and cable delivery IPTV services Digital Cinema : DCI specifications often use 4:2:2 Professional digital cinema cameras Cinema mastering workflows Theatrical deliverables Professional Video : Professional camcorders Studio recording equipment Broadcast graphics and animation Professional video editing Post-Production : Color-grading workflows Professional NLE operations Intermediate mastering format Professional archive format 4:2:2 Codec Examples Lossless Codecs : ProRes 422/422 HQ (Apple) DNxHD 422 (Avid) JPEG2000 (Cinema applications) DNxHR (newer alternative) Compressed Codecs : H.264 4:2:2 profile H.265 4:2:2 profile YUV-based broadcast codecs AVID codec (MXF format) 4:2:2 in Production Workflows Acquisition to Delivery Pipeline : Acquisition : Professional camera in 4:2:2 format Editing : 4:2:2 native edit timeline Color Grading : 4:2:2 or higher for grading Final Output : 4:2:2 for professional delivery Distribution : 4:2:2 for broadcast/theatrical Advantages : Sufficient for professional work Reduced storage vs. 4:4:4 Wide hardware support Established standards and infrastructure Professional Equipment Using 4:2:2 Professional Cameras : Sony EX3, PMW series Panasonic Varicam RED Komodo Many professional cinema systems Recorders and Storage : Professional external recorders Archive mastering systems Broadcast playout systems Professional editing systems Monitoring and Grading : Professional color-grading monitors support 4:2:2 Broadcast monitoring systems Professional verification equipment Comparison with Adjacent Standards Ratio

Chroma Horiz Chroma Vert Bitrate Quality Broadcast 4:4:4 Full Full High Highest Mastering 4:2:2
 50% Full Medium High Professional 4:2:0 50% 50% Low Good Consumer Color Subsampling Artifacts
 4:2:2 Artifacts Compared to 4:4:4 : Minimal horizontal color fringing possible Typically
 imperceptible at viewing distance Fine color detail slightly reduced Generally acceptable for
 professional work When Artifacts Visible : Large screens viewed closely Extreme color saturation
 Fine colored details (impossible to avoid perfectly) Professional color comparison work On-Set
 Monitoring with 4:2:2 Color Management : 4:2:2 monitoring displays standard Professional reference
 monitors support 4:2:2 Focus assist and peaking work with 4:2:2 Color reference verification
 appropriate Workflow Efficiency : Bitrate manageable for real-time monitoring Wireless
 transmission feasible Recording to high-speed storage practical Immediate playback and review
 possible Why 4:2:2 Dominates Professional Technical Advantages : Proven standard for decades
 Universal hardware support Established quality assurance protocols Wide software and tool support
 Economic Advantages : Significantly smaller files than 4:4:4 Manageable storage costs Faster
 transfer and backup Practical bitrate for workflows Quality/Efficiency Balance : Imperceptibly
 different from 4:4:4 for viewers Sufficient color information for professional grading Good for
 archive preservation Future-proof color preservation 4:2:2 and HDR HDR with 4:2:2 : Works well
 with Rec.2020 color space Effective for PQ and HLG transfer 10-bit 4:2:2 increasingly standard
 Professional HDR delivery format Practical Implementation : 10-bit 4:2:2 HDR standard Maintains
 color accuracy for HDR Compatible with emerging displays Sustainable bitrate for delivery Future
 of 4:2:2 4:2:2 will remain professional standard because: Proven Track Record : Decades of
 successful use Quality Standard : Accepted globally as professional Equipment Base : Universal
 hardware support Efficiency : Practical balance for workflows Archive Standard : Long-term
 preservation format Unlike 4:2:0 (consumer) or 4:4:4 (mastering), 4:2:2 serves as the stable
 professional middle ground.