



# Wide Gamut & HDR with iccMAX (ICC version 5) Color Management

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# Encoding Versus Rendering

## Encoding (ITU)

- **Defines what a pixel is**
  - Explicit definition of pixel encoding
    - number of bits
    - number of samples
    - sample order
    - bit formatting
  - Implied transforms
    - The system needs to understand the various encoding format identifiers in order to “do the right thing” when making conversions as needed
    - Changes of identifiers requires changes to the system
    - Each system needs to implement the same transforms to get interoperable results
  - ICC HDR WG proposal to put ITU encoding identifiers into a CICT tag

## Rendering (ICC)

- **Defines the appearance of a pixel**
  - ICC profile is abstracted away from device pixel encoding
    - Pixel encoding is a separate part of the CMM programming interface
    - Integer samples mapped to range of 0.0 to 1.0 by CMM
    - Floating point samples passed through to profile
  - Defines transforms from device to colorimetry (PCS) and PCS to device
    - PCS defines appearance
    - HDR based PCS needed for HDR color management
    - CMM simply applies transforms defined in profile
      - Using different transforms (different profiles) doesn't require CMM changes



# An HDR Friendly Profile Connection Space (PCS)

- **ICC color management uses “media relative” colorimetry for Relative, Perceptual and Saturation rendering intents**
  - The white points map to one another to provide interoperability (taking advantage of adaptation in the human visual system)
- **Relative HDR**
  - Media white point colorimetry corresponds to HDR Graphics White
  - Peak white maps to colorimetric values above media white
  - This results in relative SDR white point mapping to HDR Graphics White
  - Suitable for HLG encoding
- **Luminance Based HDR**
  - Profile contains (or assumes) luminance for media white point
  - Luminance matching is performed in CMM by scaling by luminance points of connected profiles
  - Required for PQ encoding
- **Tone mapping and gamut mapping can conceptually be done in abstract (PCS) profiles**



# Benefits of iccMAX (version 5 ICC) for Wide Gamut and HDR color management

- **ALL transforms are based on floating point**
  - PCS encoding uses the entire floating-point range
  - Floating point device values can utilize the entire floating-point range
    - Example: floating point sRGB values can map to Wide Gamut and HDR PCS
- **Flexible definition of PCS colorimetry**
  - Arbitrary choice of illuminant and observer with “pluggable” transforms to get to standard PCS colorimetry
    - PCS can be D65!
    - Custom observer color matching functions can be supported
- **Flexible transform encoding**
  - Arbitrary sequences of various processing elements
    - Curves, matrices, lookup tables, etc.
  - Stack based calculator element
    - Direct encoding of arbitrary functions
    - CMM environment variables provide for parameters in functions



# Interoperability Conformance Specifications (ICS)

- The ISO 20677 (iccMAX) specification encompasses an extremely large set of color management possibilities
- ICS documents provide the means of defining limited subsets of iccMAX for specific workflows and use cases
- Provides basis for standardizing narrow color management workflows using iccMAX
- An ICS defines or provides:
  - Header contents
  - Required elements and their contents
  - Optional elements and their contents
  - Workflow including connections to color spaces and other profiles (both V4 and iccMAX)
  - Example profiles that conform to the ICS
- **Core ICS documents have been approved by the ICC**
  - Colorimetric, SpectralReflectance, ExtendedOutput, and Extended Range
  - See: <http://www.color.org/iccmax/ics.xalter#icsdocs>
- Other organizations can define ICSs and register them with the ICC



# The “ExtendedRange Display and ColorSpace” ICS

- **Provides a multi-part set of specifications that are potentially useful for Wide Gamut and HDR color management**
  - See: <http://www.color.org/iccmax/ics.xalter#icsdocs>
  - Part 1: Basic encoding
    - Limited to curves, matrices and N-D LUT processing elements
    - Floating point encoding using an HDR PCS with D50 colorimetry for Std. 2-deg. obs.
  - Part 2: Custom PCS
    - Limited to curves, matrices and N-D LUT processing elements
    - HDR PCS with arbitrary illuminant and observer color matching
  - Part 3: Advanced encoding
    - Full set of processing element support with spectrally based modeling of displays and calculator element for functional modeling
    - HDR PCS with arbitrary illuminant and observer color matching



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# Thank You!

**Discussion?**