

ICC Votable Proposal

Amendment to the cicpTag: interpretation of ColourPrimaries value 2 (Unspecified) as referring to the profile's redMatrixColumnTag, greenMatrixColumnTag, and blueMatrixColumnTag.

Proposer

Luke Wallis (Apple)

Approved:

2026-08-20

1. Introduction

1.1. Summary

This proposal amends the definition of the cicpTag (ICC.1:2022, 9.2.17) and the corresponding cicpType (ICC.1:2022, 10.3) so that, for matrix/TRC-based ICC profiles, the Unspecified value (2) of the ColourPrimaries field shall be interpreted as a directive to derive the source colour primaries from the profile's own redMatrixColumnTag ('rXYZ'), greenMatrixColumnTag ('gXYZ'), and blueMatrixColumnTag ('bXYZ'), together with the profile's adopted white point information.

This turns the "Unspecified" code point into a precisely-defined, profile-aware escape hatch that lets the cicpTag describe ICC profiles whose primaries do not correspond to any pre-defined Recommendation ITU-T H.273 ColourPrimaries enumerated value.

1.2. The problem to be solved

The cicpTag added to ICC.1:2022 (9.2.17) provides the long-needed bridge between ICC profiles and video pipelines compliant with Recommendation ITU-T H.273. However, the ColourPrimaries field of the cicpType is an 8-bit enumerated value whose non-reserved, non-unspecified entries (Recommendation ITU-T H.273, Table 2) enumerate only a finite, fixed set of chromaticities:

- 1 — Rec. ITU-R BT.709 / sRGB / sYCC
- 4 — Rec. ITU-R BT.470-6 System M
- 5 — Rec. ITU-R BT.470-6 System B, G / Rec. ITU-R BT.601-7 625
- 6 — Rec. ITU-R BT.601-7 525 / SMPTE ST 170
- 7 — SMPTE ST 240
- 8 — Generic film (Wratten filters)
- 9 — Rec. ITU-R BT.2020 / Rec. ITU-R BT.2100

- 10 — SMPTE ST 428-1 (CIE XYZ)
- 11 — SMPTE RP 431-2 (DCI P3)
- 12 — SMPTE EG 432-1 (Display P3)
- 22 — a specific non-industry set

An ICC three-component matrix-based Input or Display profile (ICC.1:2022, 8.3.3 and 8.4.3), however, encodes its source colour primaries directly as real-valued CIEXYZ tristimulus values in `redMatrixColumnTag`, `greenMatrixColumnTag`, and `blueMatrixColumnTag`, using the computational model of Annex F.3. These primaries can be, and frequently are, chromaticities that do not correspond to any enumerated `ColourPrimaries` value in Recommendation ITU-T H.273:

- camera characterisation profiles whose primaries are derived from sensor spectral sensitivities,
- scanner profiles,
- custom-calibrated display profiles whose primaries deviate from the nominal gamut due to ageing, panel-to-panel variation or calibration to a non-standard white,
- wide-gamut working spaces such as Adobe RGB (1998), ROMM RGB, eciRGB, ACEScG, etc., that have no `ColourPrimaries` code point assigned in Recommendation ITU-T H.273.

In the current ICC.1:2022 text, an author of such a profile who wishes to include a `cicpTag` (for example to convey a matching `TransferCharacteristics` and `VideoFullRangeFlag`, or to be recognised by a video-style processor as per the original CACP Votable Proposal) has no correct value to put in the `ColourPrimaries` field:

- Choosing the numerically nearest enumerated value silently misrepresents the gamut and produces colour errors in any receiver that takes the `cicpTag` at face value.
- Choosing 0 (Reserved) is non-conforming.
- Choosing 2 (Unspecified) is, under the current ICC.1:2022 text, the only defensible choice, but it leaves the receiver without any way to recover the primaries, which makes the rest of the `cicpTag` effectively useless for gamut mapping.

1.3. The solution

The proposal adds to clause 9.2.17 and clause 10.3 of ICC.1:2022 a normative interpretation of `ColourPrimaries` equal to 2 that is specific to ICC profiles: the value 2 shall be interpreted as "the source colour primaries shall be derived from this ICC profile's `redMatrixColumnTag`, `greenMatrixColumnTag` and `blueMatrixColumnTag`, together with the profile's adopted-white-point information".

This proposal takes advantage of the existing Recommendation ITU-T H.273 semantics for `ColourPrimaries` equal to 2 — "Image characteristics are unknown or are determined by the application" — and specify, for the ICC "application", exactly how those characteristics are determined.

2. Summary of proposed changes to ICC specification

The proposal amends ICC.1:2022 clauses 9.2.17 (cicpTag) and 10.3 (cicpType) to add:

- a normative condition under which ColourPrimaries may be set to 2,
- a normative procedure for a receiver to recover the primaries in that case,
- an informative note explaining why this interpretation is consistent with the existing Recommendation ITU-T H.273 definition of value 2.

No existing cicpTag encoding is invalidated. Profiles with ColourPrimaries set to any H.273-defined chromaticity value continue to behave exactly as before. The additional interpretation only applies when ColourPrimaries is 2, which previously had no operational meaning for an ICC profile.

There are no required changes for CMMs that do not act on the cicpTag. CMMs that do implement cicpTag-driven behaviour (for example the video-style processor switching described in the original CICP Votable Proposal) require the small additional code path described in clause 3 below to resolve ColourPrimaries equal to 2 against the matrix column tags.

3. Nature of the proposal

This proposal amends the normative text of an existing Version 4 tag (cicpTag) and its corresponding tag type (cicpType) in ICC.1. It does not define any new tag, tag type, or enumerated value, and it does not impact ICC registries.

It does not change the binary layout of the cicpType. A pre-amendment parser reading a post-amendment profile observes a cicpTag with ColourPrimaries equal to 2, which is already a legal value under ICC.1:2022, and falls back to its existing "Unspecified" handling (typically by using the profile's matrix/TRC transform in the conventional way). Post-amendment parsers gain an additional, well-defined option.

4. Votable Proposal

4.1. Scope

The amendment applies to cicpTag data contained in ICC Version 4 Input and Display profiles whose data colour space in the profile header is RGB and for which the profile contains the tags redMatrixColumnTag, greenMatrixColumnTag and blueMatrixColumnTag (i.e. three-component matrix-based profiles as defined in ICC.1:2022, 8.3.3 and 8.4.3).

For profiles whose data colour space is YCbCr or XYZ, or for RGB profiles that are not three-component matrix-based (i.e. LUT-based profiles that do not contain the three matrix column tags), the value 2 of ColourPrimaries retains its original "unknown or determined by the application" meaning and this amendment places no additional requirement on a receiver.

4.2. Proposed normative text (additions to ICC.1:2022, 9.2.17 cicpTag)

Append the following paragraphs to clause 9.2.17 immediately after the existing paragraph beginning "This tag may be present when the data colour space in the profile header is RGB, YCbCr, or XYZ...":

When the ColourPrimaries field in the cicpTag is equal to 2 (Unspecified), the chromaticity coordinates of the source colour primaries shall be derived from the profile's redMatrixColumnTag, greenMatrixColumnTag, blueMatrixColumnTag, mediaWhitePointTag, and (where present) chromaticAdaptationTag as described in 10.3.

NOTE Setting ColourPrimaries to 2 does not affect the remaining fields of the cicpTag (TransferCharacteristics, MatrixCoefficients, VideoFullRangeFlag); those fields remain signalled unambiguously for profiles whose primaries do not correspond to any chromaticity value enumerated in Table 2 of Recommendation ITU-T H.273.

4.3. Proposed normative text (additions to ICC.1:2022, 10.3 cicpType)

Append the following paragraphs to clause 10.3 immediately after the existing paragraph beginning "The fields ColourPrimaries, TransferCharacteristics, MatrixCoefficients, and VideoFullRangeFlag shall be...":

When ColourPrimaries in the cicpType is equal to 2, the profile's redMatrixColumnTag, greenMatrixColumnTag and blueMatrixColumnTag are used as in any other three-component (Display or Input) profile.

The chromaticity coordinates (x_R, y_R), (x_G, y_G), (x_B, y_B) of the source red, green and blue primaries, and (x_W, y_W) of the associated white point, are recovered from the profile as follows:

1. Obtain the CIEXYZ tristimulus values of the red, green and blue primaries and of the profile's actual adopted white, expressed relative to the profile's actual adopted white, from the profile's redMatrixColumnTag, greenMatrixColumnTag, blueMatrixColumnTag, mediaWhitePointTag, and chromaticAdaptationTag (when present). The relationship between these tags, the PCS adopted white, and the profile's actual adopted white — including the media-relative colorimetric interpretation of the chromaticAdaptationTag — is fully specified in ICC.1:2022, 9.2.15 (chromaticAdaptationTag), 9.2.36 (mediaWhitePointTag) and Annex F.3, and is not restated here.
2. Convert each of those CIEXYZ tristimulus values (X, Y, Z) to CIE chromaticity coordinates in the conventional way:
 - $x = X / (X + Y + Z), y = Y / (X + Y + Z)$.

The recovered white-point chromaticity (x_W, y_W) is the value to be used together with the recovered primaries (for example to compute the matrix coefficient constants K_R and K_B per Equations (32) and (33) of Recommendation ITU-T H.273).

NOTE 1 When no chromaticAdaptationTag is present, the profile’s actual adopted white is the PCS adopted white (D50); the CIEXYZ tristimulus values of step 1 are then the values of redMatrixColumnTag, greenMatrixColumnTag, blueMatrixColumnTag and mediaWhitePointTag as encoded in the profile, and the recovered white point is D50.

NOTE 2 The recovered primaries (xR, yR), (xG, yG), (xB, yB) have the same semantic role as the values listed in Table 2 of Recommendation ITU-T H.273 — i.e. they are the chromaticity coordinates of the *source* colour primaries — and may be used in any downstream processing that would otherwise consume the chromaticity pair listed for a defined ColourPrimaries enumerated value.

4.4. Applications and Workflows

The original CIEP Votable Proposal targeted frame-grabs and ICC-tagged stills that can be re-inserted into a video timeline. This amendment broadens the scope of that same workflow to a large family of ICC profiles that today fall outside the reach of the cicpTag:

- **Camera DCP-style profiles.** A digital-cinema or photography workflow can emit an ICC profile whose primaries correspond to the camera’s actual colour response, and use the cicpTag to simultaneously signal an H.273 transfer function (for example PQ or HLG) and matrix encoding, without being forced to misrepresent the primaries as BT.709 or BT.2020.
- **Custom-calibrated reference monitors.** Display profiles produced by instrumentation typically differ from the nominal BT.2020 / DCI-P3 primaries by measurable amounts. With this amendment, the cicpTag can carry the correct transfer and matrix metadata while the primaries are read from the profile’s own measurement data.
- **Wide-gamut working spaces with no assigned CIEP code point.** Profiles for working spaces such as Adobe RGB (1998), ROMM/ProPhoto, ACEScsg, ITU-R BT.2020 scaled variants, etc., can carry a meaningful cicpTag today only by lying about the primaries; with this amendment, they can correctly declare ColourPrimaries = 2 and still be consumed by a video-style processor.
- **Round-tripping through graphics tools.** An image edited in a matrix/TRC-based wide-gamut working space can be re-introduced into a video pipeline at the correct transfer function and matrix without the primaries being silently coerced to a nearby enumerated gamut.

4.5. Issues

- A receiver that implements the cicpTag but not this amendment will see ColourPrimaries equal to 2, treat the primaries as unknown, and either refuse the tag or fall back to a default (typically BT.709). This is the same failure mode such receivers already exhibit today for any value of 2; this proposal does not worsen it.
- The recovery procedure delegates the media-relative / chromatic-adaptation math to ICC.1:2022, 9.2.15, 9.2.36 and Annex F.3. Any ICC implementation that already supports three-component matrix-based profiles in accordance with Annex F.3 already has, or already needs, that facility; no new mathematical operation is introduced by this amendment.
- The recovered primaries depend on the accuracy with which the measurement data were encoded into the matrix column tags and, if applicable, the precision of the chromaticAdaptationTag. Authors who want tight agreement with the CIEP interpretation

should encode these tags with their full available precision.

- If the redMatrixColumnTag, greenMatrixColumnTag or blueMatrixColumnTag tags are absent, or the profile is not three-component matrix-based, the amendment does not apply and ColourPrimaries equal to 2 retains its existing "unknown" meaning. This preserves behaviour for LUT-based and YCbCr profiles.

5. Normative references

- Recommendation ITU-T H.273 (07/2021), *Coding-independent code points for video signal type identification*.
- ICC.1:2022, *Image technology colour management — Architecture, profile format and data structure*. In particular clauses 8.3.3, 8.4.3, 9.2.4 (blueMatrixColumnTag), 9.2.15 (chromaticAdaptationTag), 9.2.17 (cicpTag), 9.2.31 (greenMatrixColumnTag), 9.2.36 (mediaWhitePointTag), 9.2.46 (redMatrixColumnTag), 10.3 (cicpType), Annex F.3.

6. Bibliography

- ICC CICP Votable Proposal (2021-01-13), *Coding-independent code points (CICP) for video signal type identification*.