# Broadcast Profiles Definition

Three sub-profiles are described in this section for Broadcast use of CLF:

* Live\_Broadcast\_LUT33\_10-bit,
* Live\_Broadcast\_LUT65\_10-bit, and
* Live\_Broadcast\_Advanced\_10-bit.

The Use Case Description and Additional XML Elements are common to all three sub-profiles.

## Use Case Description

For use in real-time processing of baseband video signals in 10-bit Y’CbCr 4:2:2 format e.g. SMPTE ST 2082.  This limited profile is intended to replace Adobe Cube format files, operate on FPGA and ASIC based hardware and provide a more automated experience for users.

This LUT profile operates on R’G’B’ 4:4:4 inputs and outputs and operates over the entire signal range (10-bit code values 0-1023). It can be used for nominal range signals (Black 10-bit code value 64 maps to 64.0/1023.0 and White 10-bit code value 940 maps to 940.0/1023.0) with processing of sub-black and super-white values, or for full range signals.

As the baseband video format is Y’CbCr 4:2:2, a matrix conversion and reconstruction/destruction filter to and from R’G’B’ 4:4:4 is required at both the input and output. Additional XML tags are included within the info block to allow automatic Y’CbCr <-> R’G’B’ parameter setting. The Broadcast CLF listed within a conformant file expects the hardware to produce an R’G’B’ 4:4:4 input and provides a R’G’B’ 4:4:4 output. These additional XML tags also allow for correct format signalling via, for example, SMPTE SDI VPIDs.

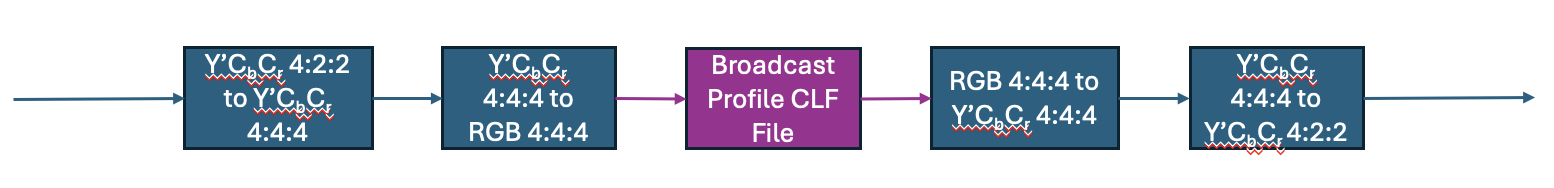


Figure 1: Block diagram showing required hardware modules required before and after CLF processing module. These modules’ parameters are set based on metadata stored in the <info> tags of the CLF file.

## Additional XML Elements

Additional metadata can be added within the <info> tags to allow automation of the Y’CbCr <-> R’G’B’ conversions and video format signalling.

* InputCharacteristics
* OutputCharacteristics
* VideoRange
* ColorPrimaries
* CodingEquations
* TransferCharacteristic
* Keywords
  + Human readable keywords which are used to explain the operation of this CLF file, non-exhaustive examples include:
    - Down-map
    - Direct-map
    - Up-map
    - Scene-referred
    - Display-referred
    - HDR type conversion
    - SDR type conversion
    - Test LUT

The linear input scaling shall be undertaken such that input code value 0 is mapped to 0.0/1023.0 and input code value 1023 is mapped to 1023.0/1023.0, i.e. the entire signal range is always processed.

Definitions of VideoRange labels are given in Table xx.

Table xx: VideoRange labels

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Label Name** | **White Level** | **Black Level** | **Low Clip** | **High Clip** |
| st2136\_full\_range | 0 | 1 | 0 | 1 |
| st2136\_full\_range\_sdi | 0 | 1 | 4/1023 | 1019/1023 |
| st2136\_nominal\_range | 64/1023 | 940/1023 | 0 | 1 |
| st2136\_nominal\_range\_sdi | 64/1023 | 940/1023 | 4/1023 | 1019/1023 |
| st2136\_nominal\_range\_ebur103 | 64/1023 | 940/1023 | 20/1023 | 984/1023 |

When ColorPrimaries, CodingEquations, TransferCharacteristic and VideoRange are present within an InputCharacteristics clause:

* the values shall be used to correctly convert the input Y’CbCr 4:2:2 signal to RGB 4:4:4 as required by the ProcessList, and
* the values should be used to validate the signalling present in the input video.

The linear output scaling shall be undertaken such that 0.0/1023.0 is mapped to output code value 0 and 1023.0/1023.0 is mapped to output code value 1023.

When ColorPrimaries, CodingEquations, TransferCharacteristic and VideoRange are present within an OutputCharacteristics clause:

* the values shall be used to correctly convert the ProcessList output RGB 4:4:4 to Y’CbCr 4:2:2 as required by the baseband video output, and
* the values should be used to generate the signalling to be inserted in the output video.

#### Warning – Conversion between Linear and Non-Linear using a 1D LUT

When converting between linear and non-linear formats using 1D LUTs in hardware implementations that don’t use floating point arithmetic, it is possible that quantisation noise can cause visible artefacts, especially in shadow regions. Care should be taken to ensure that such artefacts are not visible in LUTs being created.

## Sub-profiles

### Live\_Broadcast\_LUT33\_10-bit

**URI:** <http://www.smpte-ra.org/ns/2136/2023#Live_Broadcast_LUT33_10-bit>

**Constraints on XML elements:**

The ProcessList is limited to the following ProcessNodes in the following order:

* LUT1D (optional, inBitDepth and outBitDepth 32f)
* LUT3D (mandatory, array dim 33 33 33 3, interpolation tetrahedral, inBitDepth and outBitDepth 32f, range 0.0 – 1.0)
* LUT1D (optional, inBitDepth and outBitDepth 32f)

Where used, inverseOf should link to the preferred inverse conversion which may not necessarily be the mathematical inverse.

**Example XML:**

<?xml version="1.0" encoding="UTF-8"?>  
<ProcessList name="SMPTE Example Live Broadcast LUT33 10-bit Profile" xmlns="http://www.smpte-ra.org/ns/2136/2023" id="urn:uuid:b0454eca-cffa-4745-b85d-773d95cfba9c">  
  
 <Profile>http://www.smpte-ra.org/ns/2136/2023#Live\_Broadcast\_LUT33\_10-bit</Profile>  
  
 <Description>Demo 33 cubed LUT with dummy values</Description>  
  
 <Info>  
 <AppRelease>SMPTE\_10E\_Example</AppRelease>  
 <Copyright>SMPTE MMXXIV</Copyright>  
 <Revision>1.0</Revision>

<InputCharateristics>

<ColorPrimaries>ColorPrimaries\_ITU709</ColorPrimaries>

<TransferCharacteristic>TransferCharacteristic\_ITU709</TransferCharacteristic>

<CodingEquations>CodingEquations\_ITU709</CodingEquations>  
 <VideoRange>st2136\_nominal\_range\_sdi</VideoRange>

</InputCharateristics>  
 <OutputCharateristics>

<ColorPrimaries>ColorPrimaries\_ITU2020</ColorPrimaries>

<TransferCharacteristic>TransferCharacteristic\_SMPTEST2084</TransferCharacteristic>

<CodingEquations>CodingEquations\_ITU2100\_ICtCp</CodingEquations>  
 <VideoRange>st2136\_full\_range\_sdi</VideolRange>

</OutputCharateristics>  
 <Keywords>Test LUT, Scene Referred</Keywords>  
 </Info>  
   
 <LUT3D name="Linear LUT 3D" interpolation="tetrahedral" inBitDepth="32f" outBitDepth="32f" id="urn:uuid:781115c9-7c6c-4fed-8950-84bf2bdfdcb4">   
 <Description>3d-LUT with extended range values</Description>   
 <Array dim="33 33 33 3">  
 0.000000 0.000000 0.000000  
 0.000000 0.000000 0.031250  
 0.000000 0.000000 0.062500  
 0.000000 0.000000 0.093750  
 ... ... ... <!-- Multiple rows removed for brevity in example -->  
 1.000000 1.000000 0.906250  
 1.000000 1.000000 0.937500  
 1.000000 1.000000 0.968750  
 1.000000 1.000000 1.000000  
 </Array>  
 </LUT3D>  
</ProcessList>

### Live\_Broadcast\_LUT65\_10-bit

**URI:** <http://www.smpte-ra.org/ns/2136/2023#Live_Broadcast_LUT65_10-bit>

**Constraints on XML elements:**

The ProcessList is limited to the following ProcessNodes in the following order:

* LUT1D (optional, inBitDepth and outBitDepth 32f)
* LUT3D (mandatory, array dim 65 65 65 3, interpolation tetrahedral, inBitDepth and outBitDepth 32f, range 0.0 – 1.0)
* LUT1D (optional, inBitDepth and outBitDepth 32f)

Where used, inverseOf should link to the preferred inverse conversion which may not necessarily be the mathematical inverse.

**Example XML:**

<?xml version="1.0" encoding="UTF-8"?>  
<ProcessList name="SMPTE Example Live Broadcast LUT65 10-bit Profile" xmlns="http://www.smpte-ra.org/ns/2136/2023" id="urn:uuid:b0454eca-cffa-4745-b85d-773d95cfba9c">   
  
 <Profile>http://www.smpte-ra.org/ns/2136/2023#Live\_Broadcast\_LUT65\_10-bit</Profile>  
  
 <Description>Demo 65 cubed LUT with dummy values</Description>  
  
 <Info>  
 <AppRelease>SMPTE\_10E\_Example</AppRelease>  
 <Copyright>SMPTE MMXXIV</Copyright>  
 <Revision>1.0</Revision>

<InputCharateristics>

<ColorPrimaries>ColorPrimaries\_ITU709</ColorPrimaries>

<TransferCharacteristic>TransferCharacteristic\_ITU709</TransferCharacteristic>

<CodingEquations>CodingEquations\_ITU709</CodingEquations>  
 <VideoRange>st2136\_nominal\_range\_sdi</VideoRange>

</InputCharateristics>  
 <OutputCharateristics>

<ColorPrimaries>ColorPrimaries\_ITU2020</ColorPrimaries>

<TransferCharacteristic>TransferCharacteristic\_SMPTEST2084</TransferCharacteristic>

<CodingEquations>CodingEquations\_ITU2100\_ICtCp</CodingEquations>  
 <VideoRange>st2136\_full\_range\_sdi</VideolRange>

</OutputCharateristics>  
 <Keywords>Test LUT, Scene Referred</Keywords>  
 </Info>  
 <LUT3D name="Linear LUT 3D" interpolation="tetrahedral" inBitDepth="32f" outBitDepth="32f" id="urn:uuid:781115c9-7c6c-4fed-8950-84bf2bdfdcb4">   
 <Description>3d-LUT with extended range values</Description>   
 <Array dim="65 65 65 3">  
 0.000000 0.000000 0.000000  
 0.000000 0.000000 0.015625  
 0.000000 0.000000 0.031250  
 0.000000 0.000000 0.046875  
 ... ... ... <!-- Multiple rows removed for brevity in example -->  
 1.000000 1.000000 0.953125  
 1.000000 1.000000 0.968750  
 1.000000 1.000000 0.984375  
 1.000000 1.000000 1.000000  
 </Array>  
 </LUT3D>  
</ProcessList>

### Live\_Broadcast\_Advanced\_10-bit

**URI:** <http://www.smpte-ra.org/ns/2136/2023#Live_Broadcast_Advanced_10-bit>

**Constraints on XML elements:**

The ProcessList is limited to the following ProcessNodes in the following order:

* LUT1D (optional, inBitDepth and outBitDepth 32f)
* Matrix (optional, inBitDepth and outBitDepth 32f)
* LUT1D (optional, inBitDepth and outBitDepth 32f)
* LUT3D (optional, interpolation tetrahedral, inBitDepth and outBitDepth 32f, range 0.0 – 1.0)
* LUT1D (optional, inBitDepth and outBitDepth 32f)
* Matrix (optional, inBitDepth and outBitDepth 32f)
* LUT1D (optional, inBitDepth and outBitDepth 32f)

Where used, inverseOf should link to the preferred inverse conversion which may not necessarily be the mathematical inverse.

**Example XML:**

<?xml version="1.0" encoding="UTF-8"?>  
<ProcessList name="SMPTE Example Live Broadcast Advanced 10-bit Profile" xmlns="http://www.smpte-ra.org/ns/2136/2023" id="urn:uuid:b0454eca-cffa-4745-b85d-773d95cfba9c">   
  
 <Profile>http://www.smpte-ra.org/ns/2136/2023#Live\_Broadcast\_Advanced\_10-bit</Profile>  
  
 <Description>Demo Advanced Broadcast CLF with dummy values</Description>  
  
 <Info>  
 <AppRelease>SMPTE\_10E\_Example</AppRelease>  
 <Copyright>SMPTE MMXXIV</Copyright>  
 <Revision>1.0</Revision>

<InputCharateristics>

<ColorPrimaries>ColorPrimaries\_ITU709</ColorPrimaries>

<TransferCharacteristic>TransferCharacteristic\_ITU709</TransferCharacteristic>

<CodingEquations>CodingEquations\_ITU709</CodingEquations>  
 <VideoRange>st2136\_nominal\_range\_sdi</VideoRange>

</InputCharateristics>  
 <OutputCharateristics>

<ColorPrimaries>ColorPrimaries\_ITU2020</ColorPrimaries>

<TransferCharacteristic>TransferCharacteristic\_SMPTEST2084</TransferCharacteristic>

<CodingEquations>CodingEquations\_ITU2100\_ICtCp</CodingEquations>  
 <VideoRange>st2136\_full\_range\_sdi</VideolRange>

</OutputCharateristics>  
 <Keywords>Test LUT, Scene Referred</Keywords>  
 </Info>

<LUT1D name="Linear LUT 1D" interpolation="linear" inBitDepth="32f" outBitDepth="32f" id="urn:uuid:781115c9-7c6c-4fed-8950-84bf2bdfdcb5">  
 <Description>1d-LUT with extended range values</Description>  
 <Array dim=" 5 1">  
 0.000000  
 0.250000  
 0.500000  
 0.750000  
 1.000000  
 </Array>  
 </LUT1D>  
  
 <Matrix name="identity" inBitDepth="32f" outBitDepth="32f" id="urn:uuid:781115c9-7c6c-4fed-8950-84bf2bdfdcb6">  
 <Description>Identity Matrix 3x3</Description>  
 <Array dim="3 3">  
 1.000000 0.000000 0.000000  
 0.000000 1.000000 0.000000  
 0.000000 0.000000 1.000000  
 </Array>  
 </Matrix>  
  
 <LUT1D name="Linear LUT 1D" interpolation="linear" inBitDepth="32f" outBitDepth="32f" id="urn:uuid:781115c9-7c6c-4fed-8950-84bf2bdfdcb5">  
 <!-- Where/How do we generate the id -->  
 <Description>1d-LUT with extended range values</Description>  
 <Array dim=" 5 1">  
 0.000000  
 0.250000  
 0.500000  
 0.750000  
 1.000000  
 </Array>  
 </LUT1D>  
   
 <LUT3D name="Linear LUT 3D" interpolation="tetrahedral" inBitDepth="32f" outBitDepth="32f" id="urn:uuid:781115c9-7c6c-4fed-8950-84bf2bdfdcb4">   
 <Description>3d-LUT with extended range values</Description>   
 <Array dim="65 65 65s 3">  
 0.000000 0.000000 0.000000  
 0.000000 0.000000 0.015625  
 0.000000 0.000000 0.031250  
 0.000000 0.000000 0.046875  
 ... ... ... <!-- Multiple rows removed for brevity in example -->  
 1.000000 1.000000 0.953125  
 1.000000 1.000000 0.968750  
 1.000000 1.000000 0.984375  
 1.000000 1.000000 1.000000  
 </Array>  
 </LUT3D>  
   
 <LUT1D name="Linear LUT 1D" interpolation="linear" inBitDepth="32f" outBitDepth="32f" id="urn:uuid:781115c9-7c6c-4fed-8950-84bf2bdfdcb5">  
 <Description>1d-LUT with extended range values</Description>  
 <Array dim=" 5 1">  
 0.000000  
 0.250000  
 0.500000  
 0.750000  
 1.000000  
 </Array>  
 </LUT1D>  
  
 <Matrix name="identity" inBitDepth="32f" outBitDepth="32f" id="urn:uuid:781115c9-7c6c-4fed-8950-84bf2bdfdcb6">  
 <Description>Identity Matrix 3x3</Description>  
 <Array dim="3 3">  
 1.000000 0.000000 0.000000  
 0.000000 1.000000 0.000000  
 0.000000 0.000000 1.000000  
 </Array>  
 </Matrix>  
  
 <LUT1D name="Linear LUT 1D" interpolation="linear" inBitDepth="32f" outBitDepth="32f" id="urn:uuid:781115c9-7c6c-4fed-8950-84bf2bdfdcb5">  
 <Description>1d-LUT with extended range values</Description>  
 <Array dim=" 5 1">  
 0.000000  
 0.250000  
 0.500000  
 0.750000  
 1.000000  
 </Array>  
 </LUT1D>  
</ProcessList>