Apple Log Profile

White Paper
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Contents

Introduction **3**

Transfer Function **4**

Encoding function 5

Decoding function 5

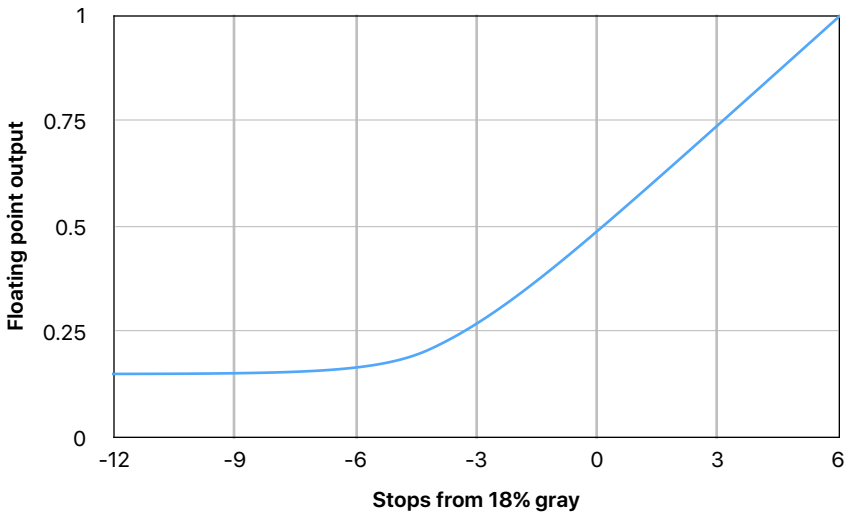
Color Space **6**

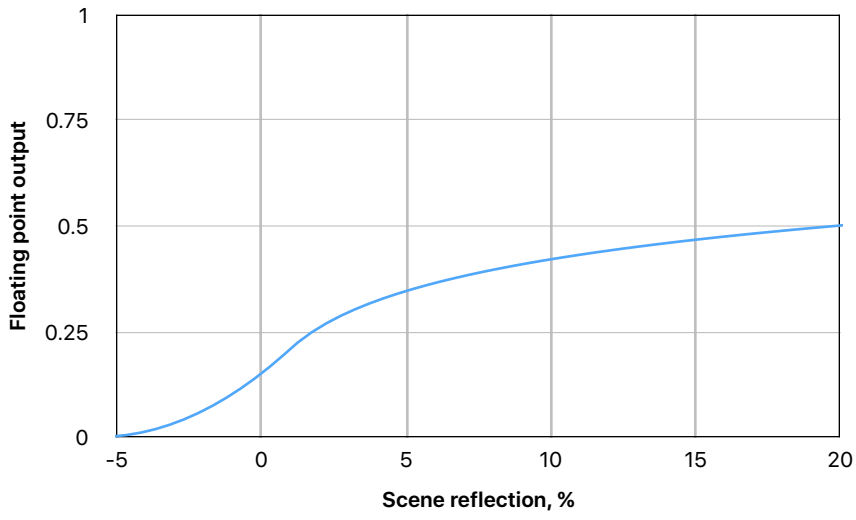
Introduction

The Apple Log profile is a scene-referred encoding using a logarithmic curve and a wide color gamut. The purpose of using this type of profile is to best preserve video data at capture time, with minimal processing. Log captures are not intended for direct viewing, but rather as source clips used in post-production workflows, where the desired rendering look and feel are applied during color grading. These captures are characterized by a transfer function and a color space.

Transfer Function

The transfer function converts between the signal proportional to the scene reflectance and the pixel values saved in the movie file. The Apple Log transfer function has been optimized for sensors with pixel sizes typically found in mobile devices such as iPhone. The function is a logarithmic curve smoothly transitioning into a parabola in order to better capture negative signal values for improved preservation of the noise signal component.





Scene reflection	Encoded signal	
	Float	10-bit, full range
0%	0.150477	154
18%	0.488272	500
90%	0.681686	697
1200%	1.0	1023

Encoding function

The encoding function is implemented inside the camera and is provided for informational purposes only. This function converts linear scene reflection values to the output data captured by the camera. The conversion is given by the equation:

$$\mathrm{P} = f(\mathrm{R}) = \begin{cases} \gamma \log_2(\mathrm{R} + \beta) + \delta, & \text{if } \mathrm{R} \geq \mathrm{R}_t \\ c(\mathrm{R} - \mathrm{R}_0)^2, & \text{if } \mathrm{R}_0 \leq \mathrm{R} < \mathrm{R}_t \\ 0, & \text{if } \mathrm{R} < \mathrm{R}_0 \end{cases}$$

with

$$\begin{aligned} \mathrm{R}_0 &= -0.05641088 \\ \mathrm{R}_t &= 0.01 \\ c &= 47.28711236 \\ \beta &= 0.00964052 \\ \gamma &= 0.08550479 \\ \delta &= 0.69336945 \end{aligned}$$

The scene reflection signal R captured by the camera is represented using a floating point encoding. The R value of 0.18 corresponds to the signal produced by an 18% reflectance; reference gray chart.

Decoding function

The decoding function can be applied to the captured footage in order to recover the linear scene reflection signal. The decoding function is given by the equation:

$$\mathrm{R} = f^{-1}(\mathrm{P}) = \begin{cases} 2^{\frac{\mathrm{P} - \delta}{\gamma}} - \beta, & \text{if } \mathrm{P} \geq \mathrm{P}_t \\ \sqrt{\frac{\mathrm{P}}{c}} + \mathrm{R}_0, & \text{if } 0 \leq \mathrm{P} < \mathrm{P}_t \\ \mathrm{R}_0, & \text{if } \mathrm{P} < 0 \end{cases}$$

where

$$\mathrm{P}_t = c(\mathrm{R}_t - \mathrm{R}_0)^2$$

The captured pixel value P is using a floating point encoding normalized to the $[0,1]$ range.

Color Space

The color space describes how colors are represented. Apple Log uses RGB primaries and color space conversion matrices as defined in the ITU-R BT. 2020-2 specification. The white point is set to the D65 illuminant.

	CIE chromaticity coordinates	
	x	y
Red primary (R)	0.708	0.292
Green primary (G)	0.170	0.797
Blue primary (B)	0.131	0.046
White point (D65)	0.3127	0.3290

The conversion between the RGB and luminance-chrominance YC_BC_R representation is governed by the following formula:

$$Y = 0.2627R + 0.6780G + 0.0593B$$

$$C_B = \frac{B - Y}{1.8814}$$

$$C_R = \frac{R - Y}{1.4746}$$

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