Canon

Canon Log
Gamma Curves

Description of the Canon Log, Canon Log 2 and Canon Log 3 Gamma Curves

November 1st, 2018

Content   **Page**

1. Overview

The Canon Log, Canon Log 2 and Canon Log 3 are logarithmic gamma curves designed to achieve very wide dynamic ranges and be compatible with cinema production workflows.

Canon Log is featured in all of Canon's Cinema EOS cameras, the XC15 and XC10 professional-use digital video cameras and the ME series of multi-purpose cameras. This gamma curve achieves a wide dynamic range of 800%, opening the door to image quality adjustments by way of relatively simple grading.

The Canon Log 2 gamma curve was included with the release of the EOS C300 Mark II, and is also featured in the C700 and C700FF. This gamma curve opens the door to compatibility with Cineon workflows by extending the dynamic range by 6400% over Canon Log and achieving an even fuller expression of the gradations in the dark areas.

The Canon Log 3 gamma curve is available in the EOS C300 Mark II after updating the firmware. This gamma curve extends the dynamic range up to 1600% while retaining the same operational ease of Canon Log. It is available also (without a firmware upgrade) on the EOS C700 FF, EOS C700, and XF705.

Canon Log is recorded in the models mentioned above in the XF-AVC, ProRes, XF-MPEG, AVCHD, MP4 or Motion JPEG video format or recording format.

In contrast, Canon Log 2 and Canon Log 3 are recorded as the "XF-AVC" video format in the EOS C300 Mark II, and as "ProRes" video format in the EOS C700 FF and EOS C700. In terms of RAW data, the data is output using Canon Log in the EOS C500 and Canon Log 2 in the EOS C300 Mark II. RAW data in the EOS C700 uses a unique gamma curve, exclusively for RAW video, that is different from the Canon Log curves. Canon Log 3 data cannot be output as RAW data, but by using the LUTs (look-up tables) that have been released and can be downloaded from Canon's official web site, it is possible to convert Canon Log 2 data into Canon Log 3 data for use.

Following are the camera models and the Canon Log gamma curves featured in each model.

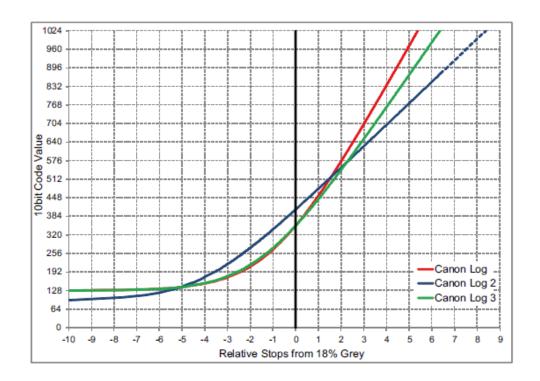| Camera Models	Canon Log	Canon Log 2	Canon Log 3
EOS C700 FF	✓	✓	✓
EOS C700	✓	✓	✓
EOS C500	✓		
EOS C300 Mark II	✓	✓	✓*
EOS C300	✓		
EOS C200	✓		✓
EOS C100 Mark II	✓		
EOS C100	✓		
EOS-1D C	✓		
XF705			✓
XC15	✓		
XC10	✓		
ME200S-SH	✓		
ME20F-SH	✓		

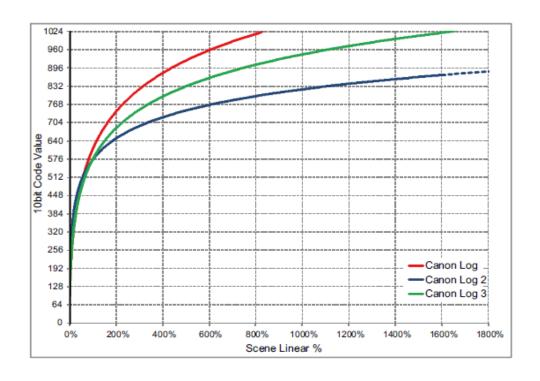*Firmware update is required (Version 1.0.4.1.00).

2. Comparison of Canon Log, Canon Log 2 and Canon Log 3 Characteristics

Use of the Canon Log gamma curve presupposes that the images will be graded at the post-production stage, but only simple grading to the extent of exercising control over the dark areas for the adjustment of the gradations is factored into the characteristics of this curve, possibly keeping down the costs incurred at the post-production stage. It uses Code 128 (10 bits) for 0% black, and it is designed so that when images are to be monitored without conversion into a format with a different Canon Log, the dark areas will become bright enough to enable what is apparent in these areas to be identifiable.

Canon Log 2 uses the Cineon digital negatives as a basis and with its use of Code 95 (10 bits) for 0% black; it is designed to fit in well with the Cineon digital film system. Its use presupposes that image quality will be enhanced by grading at the post-production stage, and the region forming a straight line on a semi log graph is wide, presenting characteristics similar to those of film. Consequently, when grading images in log spaces, this is a gamma curve which is easier to use intuitively than Canon Log. Furthermore, compared with Canon Log, the 18% gray is brighter, and the dynamic range is extended by an amount equivalent to 3 steps to 6400% (compared with 1600% which is the maximum dynamic range of the camera output in the EOS C300 Mark II, EOS C700, and EOS C700 FF. It is therefore possible to maintain the gradations of the high-brightness areas even when steps have been taken to raise the brightness during grading.

The Canon Log 3 gamma curve has characteristics which have some similarities to those of Canon Log. Compared with Canon Log, it extends the dynamic range by an amount equivalent to one stop while retaining the dark area and 18% gray characteristics. Its use presupposes that the images will be graded at the post-production stage, but this curve is designed with only simple grading, just as with Canon Log, factored into making adjustments to the image quality. It is a gamma curve with an extended dynamic range while retaining the operational ease of Canon Log.

Images Taken to Compare the Log Gamma Curves

Canon Log 2

Canon Log 3

Shooting conditions for the EOS C300 Mark II
Lens: PRIME Lens CN-E35mmT1.5 LF
Color gamut: Cinema Gamut
Color Matrix: Neutral
ISO sensitivity: ISO800
Recording: XF-AVC, size: 3840 x 2160
Bit rate: 410 Mbps Intra-frame

Saturation has been corrected using DaVinci Resolve for the shots taken under the above conditions. The amount by which the saturation has been corrected is the same for all the gamma settings.

Images are simulated

3. FAQ

Q1: Is Canon Log 3 the successor to and an improved version of the existing Canon Log 2?
A: Canon Log 3 is not the successor to Canon Log 2 but the successor to Canon Log. It extends the dynamic range by the equivalent of one stop compared with Canon Log.

Q2: Which log gamma curve: Canon Log, Canon Log 2 or Canon Log 3, would you recommend that users should use?
A: For users who have a camera with all the log curves installed, we would recommend that Canon Log 2 or Canon Log 3 be used. Users can choose to use either the Canon Log 2 or Canon Log 3 gamma curve depending on their workflows. Canon Log 2 is suited to those workflows where image quality can be enhanced by grading at the postproduction stage whereas Canon Log 3 is suited to cases where users want to create the final "look" of their images by means of simple grading without investing too much time at the post-production stage.

Q3: What is the relationship between the camera's ISO sensitivity setting and the dynamic range?
A: By setting the camera's ISO sensitivity to the reference sensitivity, users can shoot at the maximum dynamic range. When a setting higher than the reference sensitivity is selected, the dynamic range and gradation characteristics in the dark areas are kept in the same status as when the reference sensitivity is set, and the sensitivity can be increased while minimizing any increases in noise. On the other hand, when a setting lower than the reference sensitivity is selected, the dynamic range is narrowed down depending on the ISO sensitivity. This reference sensitivity differs from one model to another. With the EOS C300 Mark II, for instance, Canon Log delivers a maximum dynamic range of 800% at ISO400 while Canon Log 2 and Canon Log 3 deliver a maximum dynamic range of 1600% at ISO800. For details pertaining to other models, please refer to the operating instructions of the model concerned.

Q4: What's the situation with the nonlinear editing applications and grading applications to which Canon Log is applied?
A: Canon has supplied the application vendors with information on Canon Log, Canon Log 2 and Canon Log 3. Please contact the application vendors.

Q5: Does Canon make available the LUTs for converting the log curves to other curves?
A: Yes, it does. Canon has released 1D LUTs for conversion from Canon Log, Canon Log 2 and Canon Log 3 to Linear, Cineon, BT.709, Wide DR[*], DCI and PQ (Only Canon Log 2 or Canon Log 3). It has also released 3D LUTs that include color gamut conversion. For further details, please visit Canon's official web site.

[*] *A gamma curve equivalent to BT.709, which extends the dynamic range up to 800%.*

Q6: Is Canon Log / Canon Log 2 / Canon Log 3 video data "Full Range" or "Video Range[*]"?
A: In card, the clips are recorded on the card using full range levels. Video output from the camera's SDI OUT terminals will also use full range. Full range/Video range levels cannot be selected. On the EOS C700, video output from the SDI terminals during ProRes recording will use full range. However, during ProRes playback only, the video output's log curve will be compressed to video range.

[*] *Video Range is also known as "Narrow Range" or "Limited Range".*

Q7: In ProRes files, is the Canon Log / Canon Log 2 / Canon Log 3 data "Full Range"? (Information for developers.)
A: For ProRes files, in accordance with QuickTime specifications, the log curve is changed automatically to full range or video range depending on the readout API used. During YUV readout, the log data is converted to video range; during RGB readout, it is converted to full range. To ensure log data is correctly treated as full range, it is recommended to use RGB readout for all ProRes formats (including ProRes 422). For details, refer to the QuickTime API specifications.

Q8: What would be the best setting when applying the log curves to ACES workflows?
A: In the case of a model (such as the EOS C300 Mark II) in which all the log curves are installed, we would recommend Canon Log 2. Also, select "Cinema Gamut[*]" for the color gamut setting and "Neutral" for the color matrix setting. Select Canon Log when using the EOS C100, EOS C100 Mark II, EOS C300 or EOS C500. When a combination of these log curves is to be used, data can be converted into a format that can be handled by ACES workflows using the Input Transform files that have been released. For further details, please visit Canon's official web site.

[*]*Refer to the technical document or operating instructions provided for the EOS C300 Mark II.*

Q9: Which log curve would be best for HDR productions?
A: We recommend Canon Log 2 or Canon Log 3. With these curves, the maximum dynamic range of the camera output is 1600% which makes it possible to record a wider range. As to whether Canon Log 2 or Canon Log 3 is to be selected, please refer to the answer given to Q2 ("Which log gamma curve—Canon Log, Canon Log 2 or Canon Log 3—would you recommend that users should use?").

Q10: Is the RAW data output as scene linear data?
A: No, it is not. In order to improve the accuracy, a unique digitization curve is applied to RAW data output. Additionally, with the EOS C300 Mark II and EOS C500, the color space is defined as well.

4. Appendix

[1] Canon Log (Full %)

[a] Canon Log

$$x_\% < 0$$
$$y_\%(x_\%) = -0.45310179 \times Log_{10}(1 - 10.1596x_\%) + 0.12512248$$
$$0 \le x_\%$$
$$y_\%(x_\%) = 0.45310179 \times Log_{10}(10.1596x_\% + 1) + 0.12512248$$

[b] Canon Log -1

$$y_\% < 0.12512248$$
$$x_\%(y_\%) = -(10^\wedge((0.12512248 - y_\%)/0.45310179) - 1)/10.1596$$
$$0.12512248 \le y_\%$$
$$x_\%(y_\%) = (10^\wedge((y_\% - 0.12512248)/0.45310179) - 1)/10.1596$$

($x_\%$:Scene Linear % / $y_\%$:Full Range %)

[2] Canon Log 2 (Full %) （The following numerical formula was revised)

[a] Canon Log 2

$$x_\% < 0$$
$$y_\%(x_\%) = -0.24136077 \times Log_{10}(1 - 87.099375x_\%) + 0.092864125$$
$$0 \le x_\%$$
$$y_\%(x_\%) = 0.24136077 \times Log_{10}(87.099375x_\% + 1) + 0.092864125$$

[b] Canon Log 2 -1

$$y_\% < 0.092864125$$
$$x_\%(y_\%) = -(10^\wedge((0.092864125 - y_\%)/0.24136077) - 1)/87.099375$$
$$0.092864125 \le y_\%$$
$$x_\%(y_\%) = (10^\wedge((y_\% - 0.092864125)/0.24136077) - 1)/87.099375$$

($x_\%$:Scene Linear % / $y_\%$:Full Range %)

[3] Canon Log 3 (Full %)

[a] Canon Log 3

$$x_{\%} < -0.014$$
$$y_{\%}(x_{\%}) = -0.36726845 \times Log_{10}(1 - 14.98325x_{\%}) + 0.12783901$$
$$-0.014 \leq x_{\%} \leq 0.014$$
$$y_{\%}(x_{\%}) = 1.9754798x + 0.12512219$$
$$0.014 < x_{\%}$$
$$y_{\%}(x_{\%}) = 0.36726845 \times Log_{10}(14.98325x_{\%} + 1) + 0.12240537$$

[b] Canon Log 3 -1

$$y_{\%} < 0.097465473$$
$$x_{\%}(y_{\%}) = -(10^{\wedge}((0.12783901 - y_{\%})/0.36726845) - 1)/14.98325$$
$$0.097465473 \leq y_{\%} \leq 0.15277891$$
$$x_{\%}(y_{\%}) = (y_{\%} - 0.12512219)/1.9754798$$
$$0.15277891 < y_{\%}$$
$$x_{\%}(y_{\%}) = (10^{\wedge}((y_{\%} - 0.12240537)/0.36726845) - 1)/14.98325$$

($x_{\%}$:Scene Linear % / $y_{\%}$:Full Range %)

[4] Canon Log /Canon Log 2 /Canon Log 3 _ 10bit Code Values (0%, 20%, 100%, 800%,1600%, 6400%)

Input Scene Linear	0% (0% Black)		20% (18% Grey)		100% (90% White)		800%		1600%		6400%	
Output	Full %	10bit CV	Full %	10bit CV	Full %	10bit CV	Full %	10bit CV	Full %	10bit CV	Full %	10bit CV
Canon Log	12.5%	128	34.3%	351	60.0%	614	99.3%	1016	-	-	-	-
Canon Log 2	9.3%	95	39.8%	407	56.2%	575	77.9%	797	85.2%	871	99.7%	1020
Canon Log 3	12.5%	128	34.3%	351	56.4%	577	88.7%	908	99.7%	1020	-	-

reflection = Scene Linear * 0.9