

# Dolby® Professional Reference Monitor PRM-4220



## Overview: The Video Monitor Situation

When Sony stopped making cathode ray tube (CRT) monitors in 2007, postproduction facilities and other critical viewing environments that depended on Sony's BVM line of CRT monitors had to find a replacement.

Subsequent efforts by manufacturers to produce a new reference-standard video monitor did not succeed. LCD-based solutions typically exhibited elevated, milky blacks and poor off-axis color accuracy. Plasma-based solutions poorly rendered the image coming up out of black, lacking detail in the darker ranges. They also suffered from shifting luminance levels over time and screen burn-in.

The situation opened up a clear opportunity for the development of a new monitor technology that could meet the demanding needs of postproduction professionals and also carry the professional community into the future. Since the CRT demise, the postproduction industry had moved beyond HD to 2K and 4K workflows, with the digital intermediate (DI) process becoming ubiquitous. Any new display technology would need to support DCI P3 and other emerging 12-bit formats, as well as provide new capabilities and workflow opportunities for the color-critical viewing community.

Dolby surveyed the professional video monitor landscape and decided the time was right to leverage its deep engineering expertise and begin work on what would become the Dolby® Professional Reference Monitor PRM-4220.

## The Market

The EBU has a three-tiered standard for monitors, with Grade 1 monitors being the measuring instruments for critical visual evaluation of image quality.

However, recent years have seen a growing divide between how professional colorists and consumers view the same material. While color grading is performed on reference CRTs, the home viewer has consistently been moving away from CRTs to LCD and plasma TVs. This “viewing gap”—the clear difference between what the colorist sees and what the home consumer sees—has been growing wider each year.

The Dolby Professional Reference Monitor PRM-4220 is a Grade 1 monitor that offers a new standard for critical viewing applications. The monitor renders true black levels, highly accurate dark detail, and the most precise color accuracy possible, across a wide dynamic range at all luminance levels and in all formats.

Its support of 3D LUTs means the monitor can be calibrated to exactly match digital screening environments and emulate the response of film-print stocks during the DI process. With this capability, production and postproduction facilities can establish accurate color grading suites without installing a costly DCI P3 projection system. On set, the support of 1D and 3D LUTs allows the monitor to display color looks and previsualization with absolute accuracy.

The Dolby Professional Reference Monitor meets the range of video viewing needs from all HD formats, 2K, and DCI P3. Further, the PRM-4220, with its LCD and Plasma emulation modes, allows the colorist to emulate the types of displays commonly found in the home environment, closing the “viewing gap” between the colorist and end user. The PRM-4220 eliminates the need to use separate monitors for different tasks.

## Dolby PRM-4220 Specifications

The Dolby Professional Reference Monitor PRM-4220 is the first monitor that can actually display 100 percent of DCI P3 with linear color accuracy across the entire gray scale.

Featuring a 42-inch (1,067 mm) diagonal LCD flat-panel screen with a resolution of 1920 × 1080 pixels and a refresh rate of 120 Hz, the Dolby Professional Reference Monitor delivers a wide viewing area of plus or minus 45 degrees.

An external remote controller handles all control functions, so there are no onscreen displays to interfere with the image on the monitor. The remote may be rack-mounted or used on the desktop, and it gives immediate, intuitive access to all of the monitor’s features, functions, and parameters through a simple, easy-to-use menu structure.

In today’s postproduction environment where versatility is an important requirement, the Dolby Professional Reference Monitor is equipped to support most configurations. Two digital video input connectors support 1.5G and 3G SDI, single and dual link for SMPTE 295M, 294M, 292M, 372M, 424M, and 425M. Video scanning formats include ITU-R BT.601, SMPTE 293M, ITU-R BT.1358, SMPTE 274M, and SMPTE RP211. There are two output connectors with support for 1.5G and 3G SDI, single and dual link.

Power consumption is 1,000 VA maximum, with line voltage compatibility of 85 to 260 VAC, 50 to 60 Hz. The operating temperature range is 0 to 35 degrees Celsius, with the optimum temperature at 20 degrees Celsius (plus or minus 5 degrees), and a storage temperature range of -20 to +70 degrees Celsius. It weighs 150 lb (68 kg).

## Dual Modulation

Dolby's patented dual modulation process is the key to how the Professional Reference Monitor provides unprecedented black levels, precise color accuracy at all luminance levels, and extended dynamic range. The modulated LCD, in concert with a dynamically modulated LED backlight unit, forms the dual modulation process that is directly responsible for the exceptional image quality.

The first element of dual modulation is the unique 12-bit backlight unit, consisting of approximately 1,500 RGB LED triads that directly illuminate the LCD panel. The monitor supports a wide variety of professional gamuts, including SMPTE C, EBU, Rec. 709, and DCI P3.

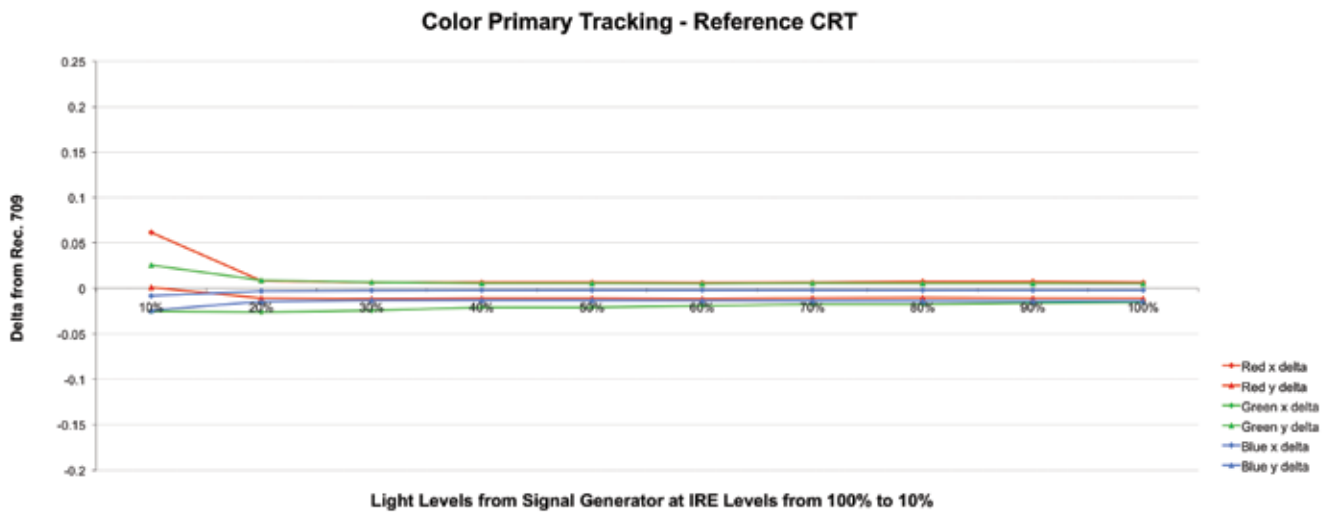
Within each LED, the output of each R, G, and B element is dynamically modulated on a frame-by-frame basis with respect to the image content for each frame, controlled by more than 4,500 separate signals going to the backlight unit in real time. When the image requires that any portion of the screen go dark, the LEDs are dimmed, so that no light will pass through the LCD to the viewer. This delivers absolute black levels that challenge the accurate measurement capabilities of most instruments.

The backlight's full-color backlight image is then modeled as part of the algorithm to generate the LCD image.

The second element of dual modulation is the LCD panel itself, which is modulated in real time based on a complex algorithm composed of a variety of matrix and 2D filtering operations. The computational power that makes this modulation possible originally required nearly two TFLOPs to operate, but is now implemented in state-of-the-art, field-programmable gate arrays (FPGAs).

## Linear Color Response

Traditionally, reference monitors are evaluated via gray scale to ensure they maintain linearity and don't crush the blacks or clip the whites. Of the many performance metrics of a CRT-based reference display, perhaps the most significant is its linear color response over the full luminance range. The Sony®BVM-D series monitors had outstanding linear response and color accuracy to 10 IRE.

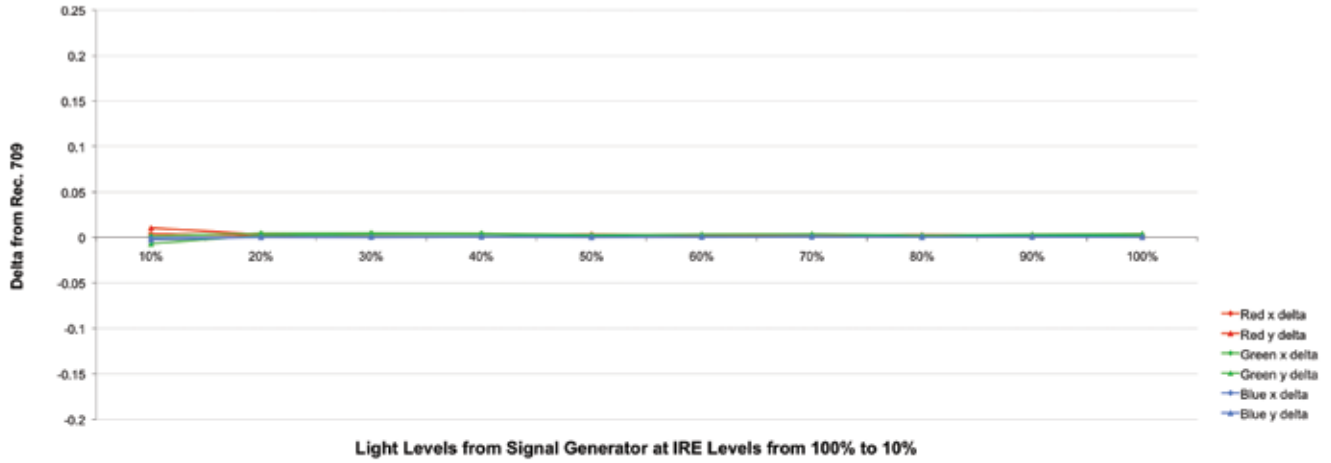


	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Red x delta	0.0616	0.0083	0.0066	0.0066	0.0066	0.0061	0.0064	0.0076	0.0075	0.0066
Red y delta	0.0011	-0.0108	-0.0113	-0.0108	-0.0108	-0.0112	-0.0106	-0.0101	-0.0108	-0.0109
Green x delta	-0.0251	-0.0262	-0.0243	-0.0209	-0.0209	-0.0192	-0.0176	-0.0176	-0.0161	-0.0154
Green y delta	0.0256	0.0089	0.0068	0.0056	0.0056	0.0052	0.0058	0.0055	0.0054	0.0052
Blue x delta	-0.0082	-0.0031	-0.0023	-0.002	-0.0019	-0.0019	-0.0019	-0.002	-0.002	-0.002
Blue y delta	-0.0243	-0.0144	-0.013	-0.013	-0.0131	-0.0133	-0.0136	-0.0138	-0.014	-0.0139

The PRM-4220 delivers exceptionally linear color accuracy across the full luminance range, even at extreme low light levels.

The Dolby monitor's visual performance exceeds established Grade 1 Reference Monitor specifications. Color accuracy for Rec. 709 and DCI P3 primaries is extremely tight across the entire luminance range, with unprecedented deltas on the order of 0.0002 to 0.02.

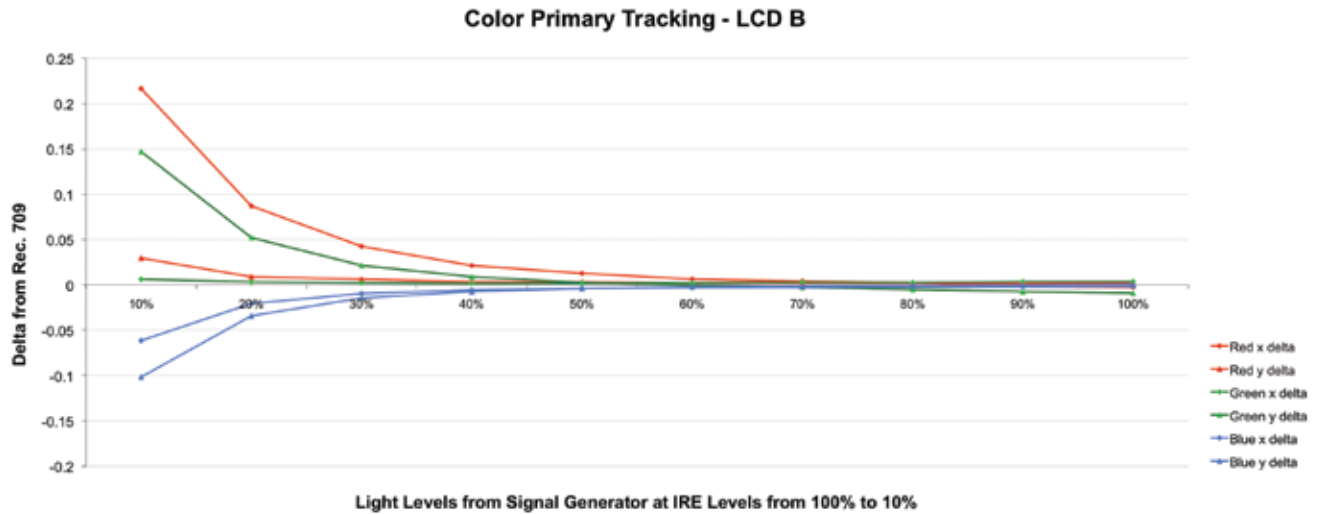
### Color Primary Tracking - Dolby Prototype



	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Red x delta	0.004	0.0022	0.0033	0.0034	0.0035	0.0023	0.0032	0.0025	0.0029	0.0027
Red y delta	0.0105	0.0034	0.0032	0.0035	0.0028	0.0031	0.003	0.003	0.0025	0.002
Green x delta	0.0016	0.0047	0.0049	0.0046	0.0029	0.0032	0.0035	0.0025	0.0026	0.0021
Green y delta	-0.0069	0.0025	0.0033	0.0035	0.002	0.0036	0.0039	0.0022	0.0035	0.0042
Blue x delta	-0.0008	0.0003	0.0002	0.0005	0.0003	0.0004	0.0005	0.0005	0.0005	0.0004
Blue y delta	-0.0024	0.0006	0.0009	0.0012	0.0005	0.0009	0.0012	0.0006	0.0009	0.0006

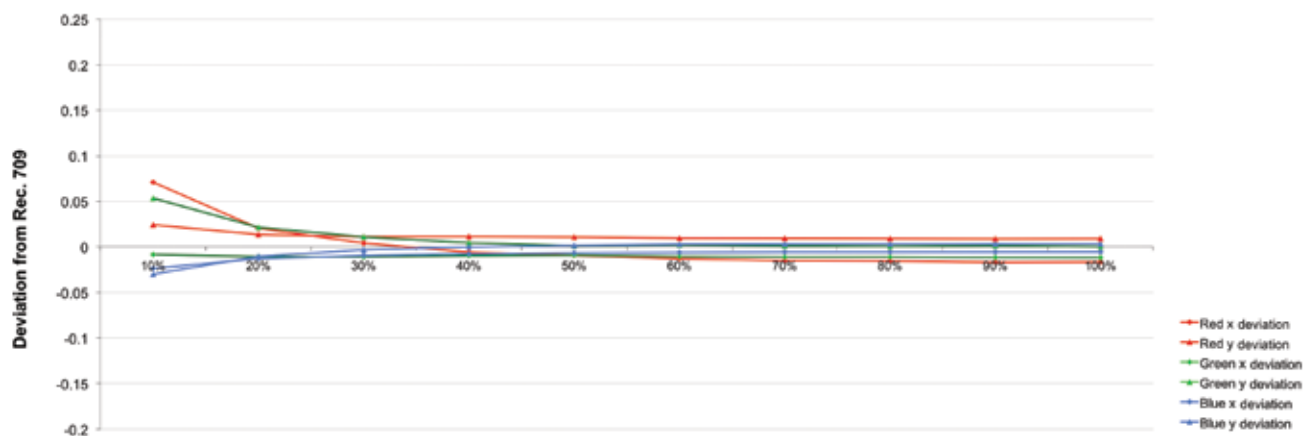
In contrast, measurements made on several leading monitors designed for color-critical applications reveal how their color accuracy degrades as it travels down the luminance scale. For every monitor, color accuracy begins to break in the mid-tones, diverging sharply from the desirable target of a Grade 1 monitor.

The three graphs that follow show the color performance across the luminance range of three competing monitors.



	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Red x delta	0.2166	0.0871	0.0426	0.0214	0.0128	0.0064	0.0041	0.0027	-0.0018	-0.0026
Red y delta	0.0296	0.009	0.0064	0.0035	0.0034	0.002	0.0025	0.0022	0.0015	0.002
Green x delta	0.0063	0.0034	0.0023	0.0016	0.0019	0.0023	0.003	0.0028	0.0036	0.0037
Green y delta	0.1471	0.0522	0.0215	0.009	0.0027	-0.0003	-0.0026	-0.0051	-0.0073	-0.0091
Blue x delta	-0.0614	-0.0205	-0.0095	-0.0056	-0.0037	-0.0028	-0.0026	-0.0022	-0.0021	-0.0017
Blue y delta	-0.1016	-0.0341	-0.0144	-0.0073	-0.004	-0.002	-0.0015	-0.0007	-0.0001	0.0006

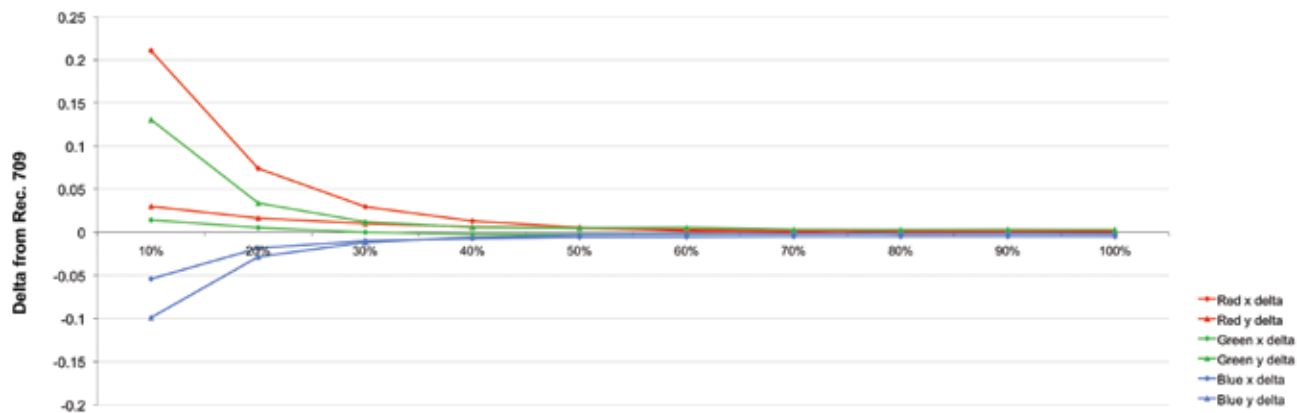
### Color Primary Tracking - LCD H



Light Levels from Signal Generator at IRE Levels from 100% to 10%

	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Red x deviation	0.071	0.0205	0.0042	-0.0059	-0.0093	-0.013	-0.0151	-0.0155	-0.0169	-0.0166
Red y deviation	0.0243	0.0136	0.0111	0.0114	0.0108	0.0096	0.0095	0.0092	0.0089	0.0091
Green x deviation	-0.0083	-0.0106	-0.011	-0.0096	-0.0091	-0.0105	-0.0111	-0.0111	-0.0116	-0.0118
Green y deviation	0.0535	0.0215	0.0109	0.0045	0.0011	0.0022	0.0012	0.0006	0.0013	0.0003
Blue x deviation	-0.0236	-0.0129	-0.0095	-0.0076	-0.0067	-0.0061	-0.0057	-0.0057	-0.0056	-0.0055
Blue y deviation	-0.0299	-0.0104	-0.0032	0	0.0015	0.0029	0.0032	0.0032	0.0033	0.0032

### Color Primary Tracking - LCD S

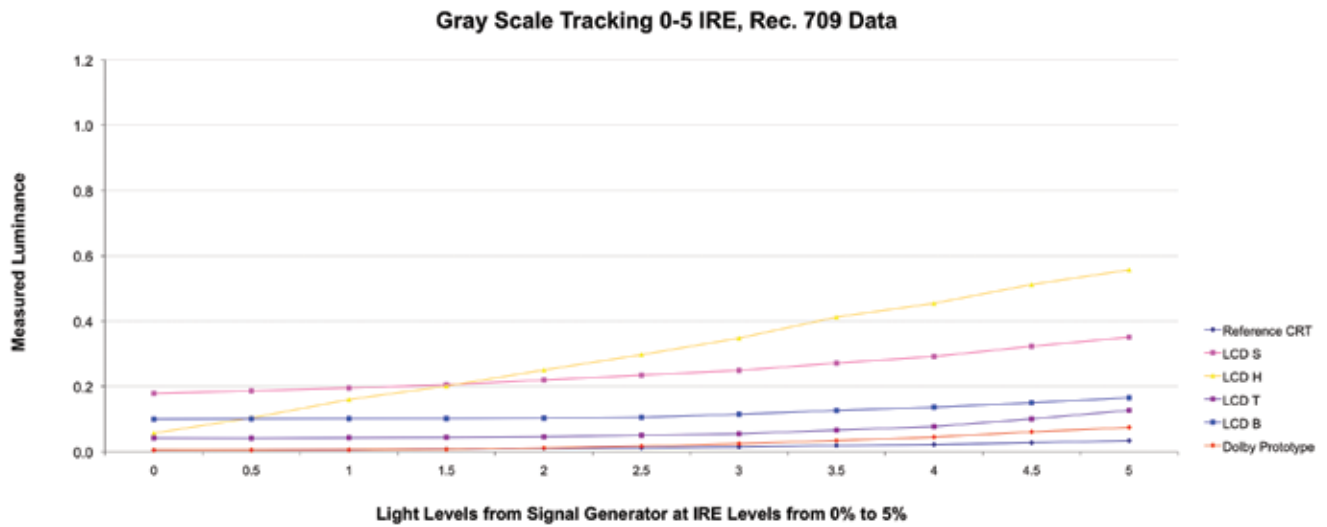


Light Levels from Signal Generator at IRE Levels from 100% to 10%

	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Red x delta	0.2104	0.074	0.0296	0.013	0.0056	0.0013	0.0003	-0.002	-0.0018	-0.001
Red y delta	0.03	0.0164	0.0101	0.0065	0.0049	0.0031	0.0019	0.0012	0.0011	0.0013
Green x delta	0.0142	0.0054	0	-0.0025	-0.0025	-0.0025	-0.0018	-0.0015	-0.0017	-0.0018
Green y delta	0.1305	0.0339	0.0121	0.0057	0.005	0.0056	0.0034	0.0032	0.0034	0.0031
Blue x delta	-0.054	-0.0185	-0.01	-0.0073	-0.0058	-0.0055	-0.005	-0.005	-0.0049	-0.005
Blue y delta	-0.0989	-0.0284	-0.0117	-0.0058	-0.003	-0.0023	-0.0016	-0.0016	-0.0017	-0.0019

All of these monitors also suffer from poor color accuracy as they come up from black, falling far short of the standard required for critical viewing applications for cinematographers and directors, as well as high definition and DI colorists. None of these products match the performance benchmark of the CRT.

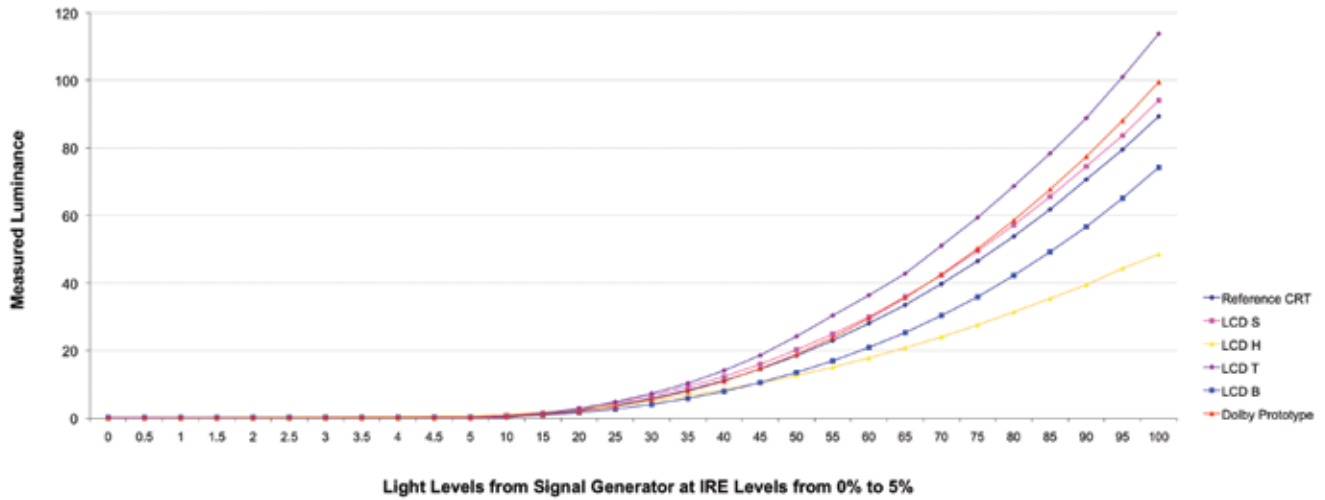
The two graphs that follow illustrate the variation to be found in these competing monitors.



	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
Reference CRT	0.0052	0.0055	0.0061	0.0079	0.0105	0.0122	0.0147	0.0191	0.0218	0.0277	0.0337
LCD S	0.1787	0.1864	0.1952	0.205	0.2198	0.2345	0.249	0.2715	0.2917	0.3228	0.3507
LCD H	0.0570	0.1035	0.1598	0.2012	0.2504	0.2971	0.3478	0.4124	0.4546	0.5120	0.5571
LCD T	0.0420	0.0414	0.0430	0.0441	0.0458	0.0504	0.0550	0.0663	0.0770	0.1005	0.1268
LCD B	0.0998	0.1009	0.1014	0.1018	0.1028	0.1053	0.1148	0.1265	0.1363	0.1499	0.1652
Dolby Prototype	0.0050	0.0054	0.006	0.0073	0.0114	0.0171	0.0245	0.0341	0.0449	0.0610	0.0744



Gray Scale Tracking 0-100 IRE, Rec. 709 Data



0-25	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	10	15	20	25
Reference CRT	0.0052	0.0055	0.0061	0.0079	0.0105	0.0122	0.0147	0.0191	0.0218	0.0277	0.0337	0.1781	1.172	2.298	3.847
LCD S	0.1787	0.1864	0.1952	0.205	0.2198	0.2345	0.249	0.2715	0.2917	0.3228	0.3507	0.8846	1.472	2.747	4.484
LCD H	0.0570	0.1035	0.1598	0.2012	0.2504	0.2971	0.3478	0.4124	0.4546	0.5120	0.5571	1.0790	1.7500	2.5910	3.6660
LCD T	0.0420	0.0414	0.0430	0.0441	0.0458	0.0504	0.0550	0.0663	0.0770	0.1005	0.1268	0.5258	1.4670	2.8370	4.7780
LCD B	0.0998	0.1009	0.1014	0.1018	0.1028	0.1053	0.1148	0.1265	0.1363	0.1499	0.1652	0.4134	0.8745	1.6230	2.6820
Dolby Prototype	0.0050	0.0054	0.006	0.0073	0.0114	0.0171	0.0245	0.0341	0.0449	0.0610	0.0744	0.3749	1.0660	1.9840	3.4600

30-100	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
Reference CRT	5.815	8.255	11.12	14.55	18.48	22.97	28.06	33.5	39.77	46.5	53.82	61.8	70.65	79.51	89.33
LCD S	6.649	9.312	12.29	15.93	20.17	24.89	29.93	35.93	42.33	49.53	57.19	65.58	74.52	83.67	94.07
LCD H	5.0420	6.6310	8.3980	10.4000	12.6200	15.0900	17.8300	20.7900	24.0400	27.5800	31.4600	35.4000	39.4800	44.3200	48.5300
LCD T	7.2440	10.3100	14.0700	18.6000	24.1800	30.3600	36.3700	42.7900	51.0700	59.3900	68.6800	78.3800	88.8400	101.0000	113.8000
LCD B	4.0590	5.8270	7.9240	10.5300	13.5300	16.9300	20.9300	25.3000	30.3600	35.8700	42.2500	49.2200	56.6400	65.1000	74.2300
Dolby Prototype	5.4500	7.9550	10.9500	14.6500	18.8900	23.8300	29.5100	35.6100	42.5200	50.1800	58.5700	67.7000	77.4300	88.0800	99.4900

In a significant advancement for the postproduction industry, the Dolby PRM-4220 hits the DCI P3 primaries within an average tolerance of 0.002, with high linearity across the full luminance range and thus faithful colorimetry for digital cinema applications.

## Improving on the CRT Monitor

The Dolby Professional Reference Monitor not only matches the former CRT-based monitor, it offers improvements in several key areas. On the practical side, the LCD/LED display technology used by the PRM-4220 eliminates the expensive retubing of reference monitors that was required every 18 to 24 months. Similarly, the short life cycle of today's plasma technology, due to burn-in and other issues, means plasma-based monitors must also be frequently replaced.

The PRM-4220 also overcomes many of the CRT's negative performance metrics, including MTF rolloff, excessive glare from thick front glass, limits of the SMPTE C gamut, and the constant need to calibrate and compensate for an essentially unstable technology.

For the first time, critical viewing can take place in daylight environments, including on set. The monitor offers two main operational modes, CRT and DYN, with a maximum luminance of 120 cd/m<sup>2</sup> in CRT mode and 600 cd/m<sup>2</sup> in DYN mode. The extended luminance ceiling of the DYN mode allows images to be clearly viewed even under elevated and challenging ambient light.

To ensure optimal viewing conditions, the maximum luminance in both modes is continuously variable from 40 cd/m<sup>2</sup> up to the maximum for each mode. Crucially, as the maximum luminance level is raised, the absolute black level remains constant and will not elevate with the raised luminance ceiling. The colorimetry also stays consistent and accurate. These are true firsts in monitor design.

With a continuously variable maximum luminance range of 40 to 600 cd/m<sup>2</sup>, the Dynamic Reference mode not only allows color grading in high ambient environments, but also the ability to view the full dynamic range of the latest high-end digital cameras such as the ARRI® Alexa, Red Epic®, and Sony F35.

Further, the Dolby Professional Reference Monitor includes generic LCD and plasma emulation modes for quick consumer-based quality control checks in the grading room, emulating consumer monitor performance in the typically brighter home-viewing environment. The monitor also provides support, via 3D LUTs, for emulation of specific display devices for quality assessment, for viewing of dailies while on set, and for emulation of film stocks during DI workflows.

For the first time, postproduction facilities can utilize a cost-efficient monitor as a viewing device for DCI P3 work, creating another DI suite while freeing up the more expensive screening room for work requiring large-screen display. In addition, a cinematographer, director, or colorist can now see a brighter image when working in a higher ambient light environment, without losing accuracy within the black levels and while maintaining a precise colorimetry.

## The Path to the Future

In addition to the benefits described above, the Dolby PRM-4220 also offers a clear path to the future. The new wave of high-resolution digital cameras feature extended dynamic range performance. Until now, monitors have only been able to display a small portion of these high-resolution images. The Dolby PRM-4220 is the first monitor capable of fully displaying the extended dynamic range that the latest leading-edge cameras can capture.

The Dolby Professional Reference Monitor already supports native viewing of both 10-bit and 12-bit formats. As advanced 12-bit high-dynamic-range workflows such as the AMPAS IIF ACES and OpenEXR replace existing 10-bit workflows, the Dolby PRM-4220 is uniquely positioned to fully integrate into these emerging industry standards. It is the only Grade 1 monitor on the market that already supports these new workflows.

In conclusion, the Dolby Professional Reference Monitor both replaces and improves upon CRT monitors, and offers a pathway to the future of high-resolution digital acquisition and postproduction. Combine this with robust, long-life manufacture and compliance with emerging formats including the AMPAS IIF standard, and the Dolby Professional Reference Monitor will provide high-level, long-lasting functionality in the production and postproduction environments.



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