HDTV calibration

To Calibrate, or Not to Calibrate?

HDTV calibration services are a profitable up-sell for retailers. Do consumers really care about or need them?

by Pete Putman

The explosive growth in sales of HDTVs in the past 5 years has largely been driven by falling prices and the desire of consumers to upgrade older TV sets with HDTV capability. The current economic slump has forced prices down even more on larger screen sizes. As of late October 2008, when this article was written, it was possible to buy a 42-in. 1080p flat-panel HDTV for well under $1000 at wholesale clubs, while 50-in. plasma and 52-in. LCD TVs with 1080p resolution are now retailing for less than $2000.

These aggressive prices do not return as much profit to retailers as they would like. Consequently, the purchase of a new TV presents other incremental revenue opportunities, such as the sale of a Blu-ray DVD player, subscriptions to direct-broadcast-satellite or cable TV services, accessory AV cables (often way overpriced), and white-glove installation services.

One add-on service that major retailers such as Best Buy and Circuit City now offer through their Geek Squad and Firedog brands is calibration. In theory, the calibrator sets up the HDTV to provide the best possible picture quality for the customer’s viewing environment, making adjustments in both the TV’s user and service menus to brightness, contrast, gamma, sharpness, and white balance. But is calibration necessary? If so, for which technologies and which TV models?

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The Need for Accuracy

Calibration services got their start back in the 1990s with the Imaging Science Foundation, which was started by SMPTE member and consultant Joseph Kane, Jr. His concept was that TV manufacturers were not calibrating their models to any particular set of standards, but rather were just trying to obtain the brightest picture with lots of edge enhancement—one that might attract a buyer on the showroom floor.

Kane’s idea had plenty of merit. Most TVs sold to consumers had one or two picture presets at best, and some models did not have any at all! Viewer adjustments were limited to contrast (“picture”), brightness, color saturation, tint, and sharpness. The gamma of these sets was typically set to an S-curve response, coming out of black slowly to about 20% illuminance and then climbing quickly to about 80% where it flattened out (Fig. 1).

In addition to non-linear gamma, tube (CRT) TVs of the 1980s and 1990s often had their color temperature set very high, resulting in a “cold” picture with a bluish color cast. Other circuits exaggerated flesh tones and warm colors by boosting the levels of red; using bandpass filtering and peaking to create artificial detail around text, people, and objects; and elevating low levels of gray to provide more shadow detail.

Kane’s system of education and calibration attempted to turn the TV business on its head by stressing accuracy and fidelity to the con-

Fig. 1: Typical “S-curve” response (luminance vs. video level).
tent being viewed, whether it originated on video or on film. He used existing standards for professional video monitors and called for manufacturers to turn off or remove altogether these image enhancements, which were actually degrading picture quality.

Calibration was a tough sell to buyers of generic TVs, but it gained a foothold in the rapidly growing home-theater market, particularly among dealers of high-end front- and rear-projection TVs. These products, which cost considerably more than everyday TVs and were often part of a complete system-integration sale, benefited greatly from calibration.

Technology Catches Up

The need for calibration became even more apparent when first the laser-disc (LD) format and then digital videodiscs (DVDs) came to market. Laserdiscs, although limited to NTSC 480i image playback, offered more picture detail than the VHS and Betamax tape formats.

DVDs had an even greater impact, introducing component video, progressive scan, and anamorphic widescreen video to the mass market. It was now possible to double effective picture resolution from the 200 lines of videotape to 450+ lines on DVDs, in many cases obviating the need for edge enhancement and peaking.

Progressive-scan capability and widescreen transfers of film to video were significant drivers for the early generations of rear-projection and flat-panel HDTVs. The adoption of a digital HDTV standard and the start of HDTV broadcasts in the late 1990s provided even more impetus for sales in both the home-theater market and to everyday consumers.

It is worth pausing to consider just how much TV picture quality has improved in the past 20 years! Back in the late 1980s, laserdisc players were expensive toys for the affluent, while VHS players were growing in popularity as the movie-rental business expanded.

Today, anyone can purchase a small widescreen HDTV for less than $500 and play back movies from $130 upconverting DVD players that offer 1080p output resolution or download HD movies over high-speed Internet connections to hard-drive players, avoiding the rental stores entirely.

In Vogue, or Passe?
The question now is this: Do HDTVs still need to be calibrated? Or are manufacturers now focusing on image quality as a selling point just as important as screen size, resolution, footprint, and price?

The answer is “yes” in both cases. Some sets still benefit from calibration; in particular, front projectors that are part of a home-theater installation. And many manufacturers have gotten the message, including one or more picture presets on their new TVs that are already calibrated closely to industry standards for brightness, gamma, and color temperature.

The rapid move to 1080p resolution in every type of HDTV display has also come with a heightened awareness of picture quality. It is not unusual to find one or more factory picture presets (often marked “Cinema” or “Movie”) that are very close to ideal in terms of calibration. These presets use a linear gamma response and turn contrast back down below “blowtorch” mode to reasonable levels.

More importantly, the HDTV’s color temperature is set close to the D6500 standard used for professional video monitors. Edge enhancement is turned off; sharpness is set to minimal levels; and the red, green, and blue color matrix is weighted correctly in a 30/59/11 RGB color ratio for greater accuracy.

That’s not to say that TV manufacturers have eschewed bright picture modes—they have not. “Dynamic” factory settings that result in bright pictures with S-curve gamma and a cold color temperature can still be found. “Sports” and “Game” modes, which are also brighter overall with higher black levels, and equally funky gamma curves are also likely to be found.

For the majority of HDTV purchasers, image quality can be improved by several magnitudes with a five-step quick fix: (1) Set the HDTV’s contrast between 60 and 80 and brightness between 50 and 60. (2) Switch from “Dynamic” to “Standard” or “Cinema/Movie” picture mode. (3) Select a warmer-color-temperature preset. (4) Turn down the sharpness control to 20% or less. (5) Turn off any other edge-enhancement processing.

(Think about it: Why would HDTV content need detail enhancement?)

The fact that the customer’s new HDTV looks so much better than their old tube TV makes the calibration up-sell a difficult task for retailers. Hook up a new HD cable or satellite box or Blu-ray player to that 42-in. 1080p LCD HDTV and it’s like having filet mignon for the first time after years of living on “Hamburger Helper.”

Never mind that a filet cooked medium rare tastes so much better than one cooked well done. Our new HDTV buyer simply does not understand any benefit to calibration and may perceive the offered service as simply another way to line the pockets of the salesperson with little in the way of results to show for it.

Make It a Little Better

There will always be those, however, who want to know their direct-view, rear-projection, or front-projection HDTV is set up accurately. These videophiles will justify the extra dollars for calibration; one that, if done correctly, will also take into account ambient room lighting and signal levels from set-top boxes and media players.

The advances in technology that have clobbered retail pricing on HDTVs (making them a “must have” on everyone’s shopping list these days) have also brought down the costs of precision test equipment. It is now possible to buy an accurate, stable test-pattern generator for about $1600 and notebook-computer colorimeter software for $2000 that will suffice for a home-theater calibration (Fig. 2).

But equipment alone does not make anyone a certified calibrator. Some knowledge of how displays are supposed to look, and how each of the mainstream display technologies (LCD, plasma, CRT, DLP, LCoS, and HTTPS-LCD) creates images, is a must.

It is not enough to simply re-balance RGB levels to achieve the desired color temperature. The display’s gray scale must first be set up correctly to achieve the widest possible dynamic range while remaining linear, achieving...
ing the desired gamma response and producing photorealistic images.

After years of testing fixed-pixel HDTV displays, I have noticed that many flat-panel sets are capable of good gray-scale performance when they are not operated as tanning lamps. That usually means dialing back contrast levels and setting peak brightness somewhere in the area of 100–130 nits (29–35 fL) — not bright enough for “Dynamic” mode on the retail floor, but more than adequate for everyday viewing in brightly lit rooms.

Excessive contrast levels always result in S-curve gamma response, with resulting compression of white and near-white values and corresponding “black crush” at the low end of the gray scale. The resulting images do not look natural to the eye. Black-stretch and dynamic-gamma options only make the problem worse, elevating low level and compressing high-level gray-scale values.

The audio equivalent would be using an equalizer to limit frequency response to midrange octaves, similar to what can be heard through a telephone, and then running the amplifier near its power limit, which inevitably creates harmonic distortion. It’s loud, all right, but not faithful to the original program content.

Once the gray scale has been set correctly for that particular HDTV (and that can be a tricky job), the next step is to adjust the red, green, and blue drive (contrast) and gain (brightness) so that the HDTV tracks a consistent color temperature from black to white. This is not always possible — some technologies do this much better than others — so a compromise may be needed, usually in the range of 50–70% gray.

Additional steps would be to dial back or shut down every possible form of artificial image enhancement. This can include dynamic gamma, black-stretch modes, color transient improvement (only needed with analog composite and S-video inputs), and any other form of video AGC that will distort carefully tweaked gray scale. Sharpness and edge enhancement should also be minimized.

Depending on the sophistication of the HDTV’s menus, one may be able to set the absolute coordinates for values of red, green, and blue. These, in turn, determine the displayable color gamut for HDTV, or possible shades of all three colors when mixed. These points usually cannot be changed and are a function of the particular color filters, LEDs, or color phosphors chosen by the manufacturer.

Those colors may not correspond to international standard color gamuts such as the ITU BT.709 color space for digital HDTV signals. Indeed, many LCD and plasma HDTVs have too much cyan mixed into their greens. While this results in a brighter, cleaner-appearing image, adding cyan results in a brighter image, but an inaccurate one because the green locus is shifted.

While this certainly adds to eye appeal, it is not accurate. A better choice would be to add more yellow and subtract cyan, which improves the rendering of flesh tones and shades of red, orange, and yellow. The advantages of staying close to a standard gamut will become more apparent as wider gamuts (such as xYCC and the digital Cinema P3 color gamut) are encoded onto consumer media such as Blu-ray discs.

A good calibrator will not only make these adjustments once, but for every piece of equipment connected to the HDTV. Video signal levels vary from set-top box to DVD player, and one set of adjustments may not work for all video inputs.

It is worth mentioning that calibrated HDTVs do not use as much power as they do out of the box with factory “blowlamp” settings — a plus in a day and age where being “green” is of increasing importance.

**Nobody’s Perfect**

There is one problem calibration cannot fix: upscaling problems with analog, standard-definition TV, and it’s a major reason why HDTVs are returned to the store. The legacy NTSC system was designed for a maximum screen size of about 20 in. — nothing more — with a viewing distance of about 7 ft.

It’s no surprise, then, that NTSC video is going to look soft and be riddled with cross-color and cross-luminance picture artifacts on a brand-new 52-in. 1080p LCD. Viewing photographs in a magazine with a magnifying glass would yield a similar sight — a bunch of coarse colored dots.

The key here is to make sure the customer isn’t buying more TV than needed, particularly if all that’s going to be connected is a basic cable service and a red-laser DVD player. In that case, an HDTV with 720p/768p resolution is more than adequate.

Believe it or not, the same quick fix can make low-resolution video look better on these sets — softening the image minimizes many of the signal artifacts. Turning down sharpness also minimizes digital (MPEG) video artifacts, such as mosquito noise and macroblocking from excessive compression.

**Conclusion**

Is calibration much ado about nothing or is it a worthwhile expenditure? As someone who has held the ISF certification since 1995 but does not perform calibrations for a living, I would say calibration is always worth it for home-theater front projectors, which is admittedly a very small market. However, based on the wider range of factory image presets I am seeing on current models of HDTVs, including variations on low-level Cinema and Movie modes, the answer for them is “probably not.”

The quick five-step fix outlined earlier in this article makes such an improvement to image quality that the extra expense of a full-blown calibration usually is not warranted for casual viewers — only those videophiles who can’t sleep at night unless they know for certain that their TV has been fine-tuned as much as possible.

Oh well, there are always those gold-plated Teflon-insulated HDMI cables to blow your cash on.