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The Secrets of Professional TV Calibration : Mysteries Explained

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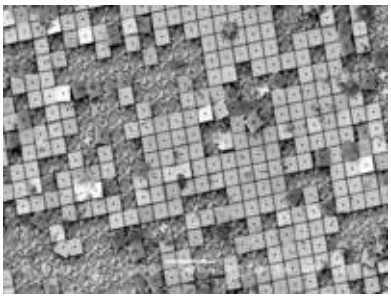


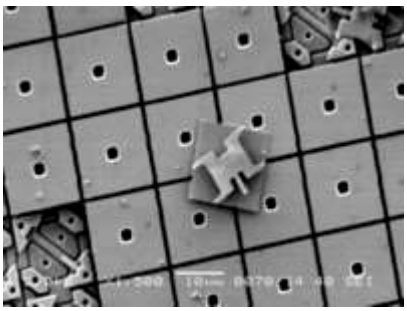
Learn to calibrate a TV or monitor? No big deal–or so I thought. The two days (and evenings) I spent listening to Joel Silver, co-founder and president of Imaging Science Foundation (ISF), were literally eye-opening. Over 30 interested students, from across the United States and overseas, gathered at a home-theater store on the outskirts of Las Vegas for the ISF Certification Course. This is normally a 5-day course, but ours was crammed into two days.

The depth of the course was astonishing, from the history of TV to film resolution to differing

standards. For example, this course taught me to quash the videophile's cherished belief that film is the gold standard of image quality. But a simple test reveals something else. The next time you go to a movie, close your non-dominant eye, pick some words on the screen, make a "V" with your two index fingers, hold your arms out in front of you, and focus on one letter. What will you see? The letter jumps around - a lot. Most people think film is a pristine 24 frames per second. It's actually 48. There's a black shutter that comes into play after near each frame. The effect you see is due to the imperfect alignment of sprockets and gates involved with the projection mechanism. Hardly perfect.

I also learned another seldom stated fact: HDTV has existed since the 1930s!

In between all these topics, Joel regaled us with stories of interesting clients, how to handle the stickiest of home-theater problems, and TV manufacturer's shocking lack of technical know-how. Each story had a point to help us remember a particular principle about customer service or calibration. We learned about color matching and test patterns before we were cut loose to fix the classroom TVs that were expertly "mucked up" by several Sencore representatives who had joined to help.



A scanning electron micrograph of a TI DLP chip.

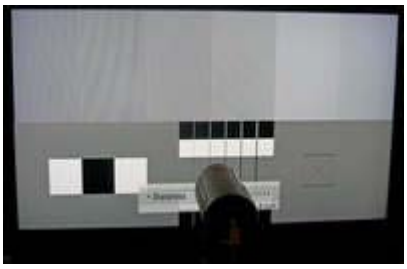
2. Why Calibrate?

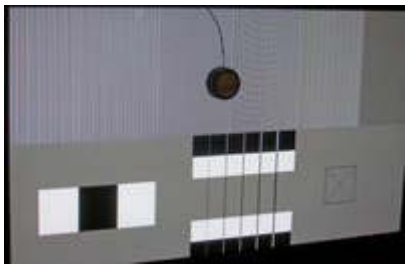
So why calibrate? The analogy used in class was like bringing home an air conditioner without setting the thermostat. Manufacturers of TVs and projectors want to show the consumer the brightest image, with the most "pop." In almost all TVs, this sadly means the TV in the store and what you bring home will not reveal proper shadow detail and the color balance will be too blue, adjusted for a less-than-optimal higher Kelvin rating. This is also known as red push.

The ISF mantra was: Dynamic Range, Color Saturation, Colorimetry, and Resolution. So how

does one adjust these to optimize settings for a room's conditions? Can room conditions be improved to create a better picture and audience experience?

Some of the main reasons to properly calibrate TVs and monitors include extending the life of your monitor and reducing energy consumption.





3. Simple Controls?

Brightness and Contrast are misused terms from a calibration point of view. Brightness should really be called Black Level, while Contrast should be called White Level, but Sony, and later Panasonic called this "Picture." On many TVs, White Level and Black Level interact, and maybe even level shift with either dark or bright content. Understanding this and colorimetry makes the calibration sequence easier to remember.

To calibrate Black Level, we used an old BBC Picture Line Up and Generating Equipment (PLUGE) pattern. These grayscale patterns are generated by test equipment such as Sencore generators. A popular PLUGE pattern consists of stacked rectangles varying from white to dark gray and two black adjacent bars or rectangles of differing values.

Uniformity in the display, as well as test patterns, is always an issue, and you need a reference for white and black. We used Institute for Radio Engineers levels, known as IRE, for uniformity. Here, zero equals Black and 100 equals white. For the U.S. standard NTSC TV, 7.5 IRE equals black, due to picture-synchronization voltage traveling with the video signal.

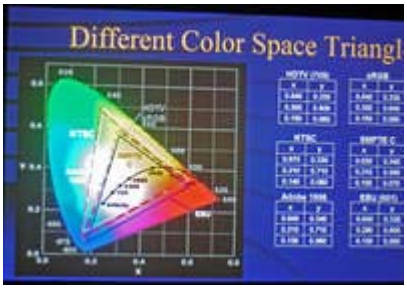
Panel TVs and projectors, though, are RGB displays, where zero equals black. These displays could be adjusted to show both 4% below (blacker than black) and 4 % above. We set the displays so that the under black just disappeared, and the above black was still distinct. Then, white is adjusted (contrast), so there is no blooming (CRT), no color shifting, no clipping (digital), and no missing bright detail or poor gray-scale tracking. Other tidbits we gleaned

include never using the keystone correction, as it destroys resolution, while LCD panels for dark rooms should have both a LCD black level and LCD backlight controls.

4. Microsoft

There's a new Microsoft/ISF lab that was created to provide a better way for consumers to calibrate monitors. Within Microsoft Windows XP Media Center 2005, there's a widely unknown ISF calibration setup, comprising a series of clips similar to what is shown in the Monster Cable ISF how-to DVD that we describe below. In Vista, go to Control Panel, Hardware and Sound, and then Color Management, and select the Advanced and All Profiles tab. Sadly, Microsoft has changed what was in Media Center, but added Windows Color System (WCS). Presumably this is because it supports many more color standards. The world of digital photography moves faster than the time it takes Microsoft to upgrade its operating systems, so some of the rationale used to move to a new color management system has changed. However, you can at least change to Adobe RGB color space.

5. Color Science

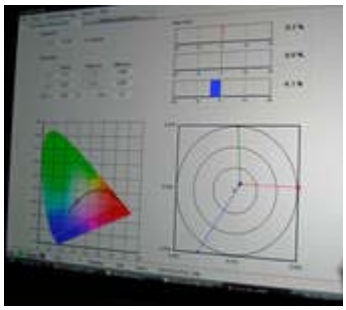


As I alluded to above, a full suite of color standards exists. ISF uses a traditional CIE color chart, based on 1931 standards. That color space is reduced compared to Adobe or other standards, but has served as the basis for most professional motion-picture applications and for the other standards we describe below.

ISF is based on black body radiation, which is the color given off by a perfect radiator when heated to differing temperatures. If you designate RGB as primary colors and place each at an apex, join them, and draw to equal energy points, you then define the secondary colors: cyan, magenta, and yellow. There are also different ways to describe color, such as using Subtractive (RYB and CMYK) versus Additive (RGBW) colors. What we use today is partially based on government-mandated standards that were used during the beginning of color TV in the 1950s, how the human eye perceives colors (we see with RGB colors), and the fact that we look at emissive devices.

The CIE chart became our bible. Rather than talking about Kelvin values, we instead calibrated using colors mapped with x, y coordinates on the chart. It is important to view–and calibratein the light that you will view the image. Some TVs could not be adjusted even close to perfection, while others yielded superb results with a little bit of tweaking.

6. Meters



The mandated price for ISF calibration is tied to how time consuming and tedious it is to do a proper calibration and to equipment costs. The role of the ISF professional calibrator is to educate the consumer and education should be part of any calibration process. Another reason is the cost of the equipment. The price of suitable meters ranges from $5,000 to $15,000, in addition to a pattern or test generator.

Our favorite was the Sencore “Hubble,” or OTC1000 ColorPro Optical Tri-stimulus Colorimeter. This meter is a non-contact device, has a laser pointer for alignment, and acquires accurate, repeatable readings very quickly, down to 0.01 ft-Lamberts. An alternative is the CP6000 ColorPro V. This is a contact device, doesn’t read quite as quickly, and doesn’t have the same sensitivity, but is half the price. Both come with ColorPro 6000 software that makes adjustment of colors much easier. Compared to the consumer-grade contact devices, these sensors are far more accurate and repeatable and calibrate to a known standard.

Your eyes can be fooled easily when doing color calibration, as we don’t see differences in luminosity and color the same way. Some of the test patterns we used involved peering through colored gels to compare differences in intensity. However, the meters were always

more accurate. We also discussed using a known light source and calibrated “swatches” as a means to compare color. 

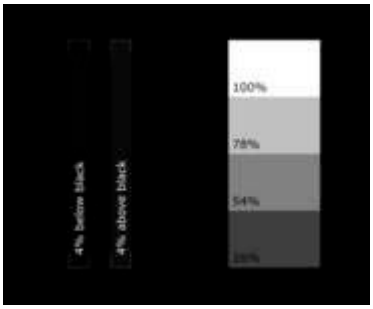
7. Meter Substitutes

If you don’t have $5,000 to $15,000 to invest in calibration equipment and meters, what can you do? ISF collaborated with Monster Cable to produce a consumer-friendly how-to DVD called HDTV Calibration Wizard, which retails for $29.95. They hired several models and a narrator, Jenna Drey. One of her YouTube videos even has the ISF logo! You are guided through a complete calibration using on-screen images, rather than with test patterns.

For example, the male model has a very white shirt –so you adjust the white level until you can distinguish his white buttons and shirt folds. For color calibration, since we are sensitive to flesh tones, Joel gathered three models who coincidentally showed up with different skin tones. Make-up then accentuated their normal skin tones to exaggerate their respective colorations. Joel labeled one model with very light skin tone as “sallow or vampire.” Another model had a red complexion (exaggerated with more blush), which Joel labeled as “bozo.” Joe labeled the middle model with an extraordinary complexion as “babe.”

This won’t do the precise calibration that an ISF procedure does, but will significantly improve your picture if you don’t have the standard $250-$500 fee for an ISF-certified calibrator. Compared to other how-to DVDs, this one is far easier to use and has voice-guided narration.

8. CES Show Floor



Armed with this new knowledge, I hit the CES floor, and bombarded manufacturers with questions. I was appalled that more than one manufacturer representative told me that they had been selling TVs for more than 25 years, were familiar with ISF, and knew what the consumer wanted, while claiming that ISF calibration did not sell TVs. Another manufacturer refused to acknowledge that consumers even wanted calibration. They were the engineers, and the consumer should be happy with what they picked for the consumer, they said. Who is the consumer to question an engineer? In their view, consumers want bright TVs, colors that pop, and a blue tint. Other manufacturers, with a little prodding, said they had staffers who had been through ISF training, and lamented they were fighting the good fight, and in one case, showed me some models that supported 20 IRE levels for calibration.

Joel also taught us to see artifacts in scaling and to examine fine details in moving images. I was ruined. I could see artifacts in TVs claiming to have 240 Hz “motion flow,” also known as the refresh rate—the number of times per second that a screen's image is redrawn.

9. Contrast Ratios

As part of the course, we measured contrast ratios on most of the TV samples. What became immediately clear was that manufacturers measure TVs very differently than we do. Manufacturers' claims about contrast ratios range from wildly exaggerated to simply unbelievable. Indeed, it seems that marketing departments have taken over and label this "dynamic contrast." I asked every single manufacturer I spoke with to explain what dynamic contrast is and none could explain it.

In a nutshell, contrast ratio is simply the light level of the brightest white square divided by the darkest area, while we measured a white square and adjacent black areas. With better TVs, we obtained ratios of around 4000 to one, which is a very good ratio, according to Joel.

One manufacturer representative told me his firm measures from two TVs–one in a totally

dark room, the other in a normally lit room. In class, there was some speculation about how at least one manufacturer measured with the TV off. Other manufacturers don't measure the dark area with a meter, but rely instead on theoretical calculations of minimal light output. Simply stated, the contrast ratios quoted by some manufacturers involve a denominator below the noise floor of the most sensitive meter available to measure TV light output.

10. Conclusion


Adjusting each of the colors in turn. We would adjust each color to center the dot.

Some TVs and projection systems have ISF or other modes that are better calibrated than store-demo modes. Realize that the mode names vary markedly from manufacturer to manufacturer, and none of them accurately describe what they do. Sadly, all TVs are adjusted to look good in stores, but not in your home.

The next time you wonder about something as seemingly esoteric as Nyquist sampling, Planck blackbody radiation, and what it has to do with TV calibration, you'll need to turn to an ISF-certified calibrator. Calibration isn't cheap, but the benefits are substantial. You can go part of the way by paying attention to standard criteria in any of a variety of test DVDs. One of the easiest to use is the Monster Cable and ISF DVD discussed above.