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ASA CAVE, SUMMER MORNING, 1988
Platinum/palladium print

A Light Meter Practicum

PART III: INFRARED LIGHT AS A METERING PROBLEM

by William Schneider

If you have ever pointed an infrared remote control into the photocell of your light meter and compared the readings when some of the remote's buttons are pushed, you might not be too surprised at what I found concerning the infrared sensitivity of light meters. For the record, the remote-control-in-the-photocell is a severe test, one that elevates the light reading of some of my meters by 8 stops. The remote emits no light that is visible to the eye, but my light meter sure sees it.

Want to try another experiment? In a dimly lit room, point your meter at an electric stove burner when it is cold, and take a reading. Then compare that reading with others as the burner heats up, but before it starts to glow. If your light readings go up as mine do, it is certainly caused by invisible infrared radiation.

No meter I have yet tested is completely immune to infrared's effects. Even those that have been corrected with infrared absorbing filters show some infrared sensitivity, especially when the portion of infrared light is high compared to the amount of visible light. High infrared sensitivity is a problem when meters are used to read light that is rich in red light (e.g. very early morning, late evening, tungsten light) or when they are pointed at subjects that reflect a high percentage of infrared light (e.g., foliage). Because the silicon cells of light meters see infrared very easily but most film is blind to it, the high indicated light levels lead to underexposed film. With some poorly filtered meters on the market, this is a very serious problem.

I once owned a light meter that always underexposed photos made in late evening light or with tungsten light. When calculating the effective EI of Tri-X sheet film, I tested the film once for daylight and again for tungsten light. The difference in effective EI speeds was incredible—EI 160 for daylight and EI 40 for tungsten light. I determined later that the lion's share of the difference was caused by the meter's extreme sensitivity to infrared-rich tungsten light, and not by the film's own spectral response.

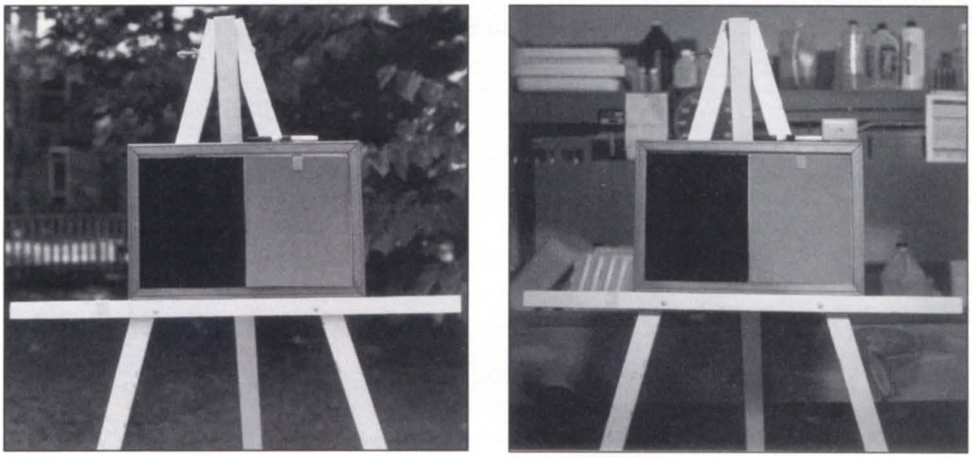

Figure 1. Kodak gray card and black felt-like cloth photographed in daylight (left) and in tungsten light (right). The eye and film both see a large difference between the black and gray, but some light meters don't.

For me, the last straw came when I metered a black sock and a gray card in tungsten light, and the meter indicated that they were the same shade of gray. That was obviously very wrong, and I started investigating how infrared light affected light meters. My first step was to find a system for determining relative meter sensitivity to red and infrared light.

The solution came quite by accident when searching for a dark material to use as a Zone I target for film speed tests. I didn't want to underexpose a gray card by 4 stops because that forced me to use higher than normal shutter speeds. I wanted to stay within the range of shutter speeds and apertures that characterized a typical subject to avoid introducing other errors. A material several stops darker than a gray card was sought to simulate a dark tone in a shadow area, on which I usually base exposures. I grabbed some black felt-like material from my darkroom and used that, but the tests produced underexposed negatives when using previously correct EIs. I was sure that my EI hadn't dropped a couple stops overnight. Something was wrong!

I compared readings between a Kodak gray card and the mysterious black cloth indoors using tungsten light, and one light meter reported that there was only a 1 stop difference between the two. Another light meter saw a 2 stop difference between the gray card and the cloth. Oddly, both meters read the gray card identically—only the black cloth indicated differently.

There was a much smaller discrepancy between the two meters when I tried the same test outdoors, and both meters showed a greater spread between the black and gray readings when compared to the results found indoors. I was on to something, and I suspected infrared effects. Perhaps the black cloth was reflecting a sizeable portion of the infrared light that fell on it, absorbing most of the visible light. As a result, light meters that were overly sensitive to infrared light would report artificially high light levels when metering the cloth. They were measuring light that neither film nor the human eye could see.

The test that I now use compares the readings between a black, felt-like cloth and a Kodak gray card under two types of light—daylight and tungsten. The felt material apparently reflects a great deal of the infrared light that strikes it and absorbs much of the visible light. It appears very dark to the eye, and also photographs very dark. The felt material is glue-mounted to a card and placed next to the Kodak gray card. Velcro holds the two cards in place on a frame. Figure 1 (left and right) show the frame and the two cards in place for testing.

I must confess that I don't know the original source for the infrared-reflecting black cloth. Several yards of the cloth came with darkroom equipment that I bought some years back. I have visited a fabric supply shop in an effort to match the material without success. Even if you can't find the same black material that I used, try some inexpensive black or dark brown acrylic socks from your local discount store. These synthetic fabrics exhibit nearly the same characteristics that my dark cloth does.

Even though infrared light is invisible to the eye, there is one clue that my black cloth reflects red better than other colors. In tungsten light, it appears warm-brown when compared to a small piece of black Velcro adjacent to it. This indicates an abundance of red light. When illuminated by daylight, it is a neutral black, nearly matching the black of the Velcro. Red and infrared represent a smaller percentage in daylight when compared to tungsten light. If you are curious about the spectral distribution of sunlight, tungsten light, and fluorescent light, be sure to look at the charts on page 108 in Henry Wilhelm's book *The Permanence and Care of Color Photographs* (Preservation Publishing Company, Grinnell, Iowa, 1993).

While the black cloth reflects much infrared light and little visible light, the gray card reflects all wavelengths (colors) equally. A spectral reflectance curve included in the package with the Kodak Gray Card shows that the reflectance is very constant, at least in the visible wavelengths. Judging from the flatness of the spectral reflectance in the visible range, one can assume that it extends into the infrared as well.

Judging the Results

In infrared-rich tungsten light, some meters can't see much difference between the black cloth and the gray card, indicating nearly the same reflectance for both. The meter is actually reading the high amount of infrared light reflecting from the black cloth, inflating the light reading. Neither film nor the eyes record the infrared light, so the improperly filtered meters produce exposure errors.

In daylight, all meters that I have tested show at least a 2 stop difference between the black cloth and the gray card. This better matches the visual appearance and approaches the film's actual response. While daylight has infrared light present in its spectrum, it doesn't have nearly as much percentage-wise when compared to tungsten light. Less infrared (percentage-wise) reflecting from the black cloth means less error.

Tables I and II show the various meter readings made in tungsten light and in daylight. Look at the difference between the gray card reading and the black cloth reading made under both lighting conditions. A well-corrected meter should show a significant differ-

Table I. Meter readings made in tungsten light

Light 100 Watt Tungsten in plastic utility reflector, 5 feet from target.

Meter	Gossen Luna Lux	ZVI Pentax Spot	Minolta Spotmeter F	Minolta Flashmeter III w 10° attach.	ZVI Soligor Spot	Minotlta SRT 201 Camera 50mm Rokkor f/1.7 lens
Gray Card (EV)	8	6.7	7.1	7.1	7.4	$1/8$ @ f/2.8-$1/3$
Black Patch (EV)	7.7	5	6.2	4.9	6	$1/2$ @ f/2.8-$1/2$
Difference (Stops)	0.3	1.7	0.9	2.2	1.4	1.8

T-Max 100 film records a 4 stop negative density difference in this light.

Table II. Meter readings made outdoors

Light Outdoors, open shade 5:30 p.m., Columbus, Ohio, July 14th, 1994.

Meter	Gossen Luna Lux	ZVI Pentax Spot	Minolta Spotmeter F	Minolta Flashmeter III w 10° attach.	ZVI Soligor Spot	Minotlta SRT 201 Camera 50mm Rokkor f/1.7 lens
Gray Card (EV)	12	12	12.4	12.4	12.3	$1/60$ @ f/8
Black Patch (EV)	10.8	9	10.0	9.4	9.7	$1/60$ @ f/4
Difference (Stops)	2.2	3.0	2.4	3.0	2.6	2.0

T-Max 100 film records a 3 stop negative density difference in this light.

ence between the gray card reading and the black cloth reading regardless of the type of light used for illumination. Density measurements of T-Max 100 film itself show a 4 stop difference between the gray card and the black cloth under tungsten illumination, and a 3 stop difference in daylight. Gray card densities match in both tungsten light and in daylight. Note that no meter came very close to matching film's response under tungsten light. All appeared to be affected by the infrared reflected from the black cloth. If you practice the Zone system with a spotmeter, you can appreciate the difficulty of trying to predict the value of the black cloth under tungsten light when the meter sees it lighter than normal and film sees it darker than normal. My experiments show that the error is almost 2 stops even when using the best meter.

Both Zone VI meters showed fair infrared filtration, as did the discontinued Minolta Flashmeter III with the 10° spot attachment. (Note: I did not test the Minolta Flashmeter IV, which replaced the Flashmeter III several years ago. It would be interesting to see if Minolta retained its color filtration with the newer model.) The Minolta Spotmeter F did not perform as well as its better-corrected sibling, and the Gossen meter performed abysmally, indicating about the same luminance coming from the gray card and the black cloth under tungsten illumination. Interestingly, the built-in meter in a 15-year old Minolta SRT 201 camera handled the tungsten lighting situation almost as well as the best performing light meter.

In an unsuccessful attempt to correct the infrared response of poorly filtered meters, I tried heat absorbing glass from an enlarger lamphouse, and a cold mirror obtained from Edmund Scientific. Neither made any significant difference, but neither is designed for meter filtration. I suspect that the offending infrared wavelengths aren't affected by these readily available devices.

Literature advertising Zone VI modified Pentax spotmeters states that custom-made interference filters are fitted to filter out infrared light. The test results show that these filters work well, almost as well as the filter incorporated in the Minolta Flashmeter III. The filter on the Minolta Flashmeter can be seen as a small, bluish rectangle positioned directly over the sensor. It changes color when viewed off-axis, indicating that it is also an interference type filter.

Conclusions

Manufacturers of light meters haven't yet matched the spectral response of light meters to film. Disturbingly, some meters from one supplier are fairly well corrected for color, while other models in the line are not. In my opinion, there is no excuse for not applying available technology to all newer meters made by the company. The Zone VI modified spotmeters perform about as well as the best-corrected meters from major manufacturers.

Metering a small part of a scene with a spotmeter and tungsten light can produce substantial exposure errors. Lighter objects that reflect substantial visible light would be better to meter than darker objects. With a lighter object, the amount of visible light would swamp the infrared reflecting from the surface, resulting in a higher signal-to-noise ratio. A gray card, having a constant spectral reflectance throughout a wide range of wavelengths, makes an ideal metering target with infrared-rich tungsten light. Averaging meters used at a distance would probably not be affected as much as spotmeters, for the errors would average out as well as the reflected light values.

Outdoors, most meters perform acceptably, and some closely match film's response to differing wavelengths of light. This is where a spotmeter reaches its full potential for predicting print values using the zone system.

In these articles over the past several issues, I have discussed the effects of meter linearity, flare light, and color. The perfect light meter does not yet exist commercially. The Minolta Spotmeter's flare handling capability is superb and the color filtration of the discontinued Minolta Flashmeter III and the Zone VI meter are the best available. If I could combine these features into one meter, I would be much closer to what I believe a good meter should be.

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