Some Notes Concerning

FILM SENSITOMETRY AND EXPOSURE

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INTRODUCTION

It is important to remember the following:

Exposure errors cannot be corrected

Incorrect film gamma (gradient) can be corrected using multigrade papers.

Towards the end of the heyday of film photography, there was a consistent recommendation in the literature that to obtain the best performance from negative material it is necessary to expose accurately to ensure that the compression of tones in the toe of the characteristic curve is correctly utilised. The counter intuitive result of over exposure is less shadow detail and wasted film speed. This means having little or no margin for exposure error.

To do this, a good understanding of negative materials is necessary, combined with some testing.

Print dynamic range is controlled by a combination of film and paper characteristics with a strong emphasis on paper characteristics, which may dominate the overall process.

Extending the modelling process to the final print enables the investigation of different measures of print quality in a way that perhaps should have been attempted in the early zone system.

We appear to have only two 'absolute' parameters at our disposal. One is the supposition that a final overall gamma of 1 should give the most natural looking print .

The second proposal may be expressed as a requirement to adjust the film gamma so that we can simultaneously print a test image of a grey and white card correctly on to grade 2 paper.

In the rest of this document, this gamma is called G2 and depends on the type of enlarger used.

Unfortunately, the two parameters conflict. An overall average gamma of 1 will always print the grey card far too light if the white card is printed correctly.

G2, on the other hand, specifically measures the region between the grey and white cards on the negative and lets the shadow area take care of itself.

Dunn & Wakefield in their excellent book "Exposure Manual" often refer to a technique which they call "exposing for the mid tones" as opposed to the more traditional approach of exposing for the high lights and shadow area of a scene. With a normal developer of sufficient strength to avoid premature entry into the shoulder area, the G2 gradient is essentially the same as mid tone gradient which is also very close to a best fit gradient from the mid tones to a film density of 1.2 .

Using the correct value of G2 works well in all situations and can be adopted as a single parameter that is used to determine the correct film processing time.

It is also assumed that all processing times are calculated for grade 2 paper. Different times are used for condenser and diffuser enlargers which will be automatically taken care of if an **enlarger densitometer** is used to measure film densities .

It is difficult to get much more than a 6 stop dynamic range, especially with a condenser enlarger. Also, bear in mind that any under development of the negative will introduce progressively lower and unacceptable gammas into our final print.

One conclusion we have to accept, is that photographing difficult scenes, previously described as 'high contrast' or 'high dynamic range', may require a combination of the use of graduated filters, dodging or burning in during printing, or the use of lower grade papers.

An obvious advantage of this approach is that we are concentrating on grade 2 papers which means that high quality graded papers become a viable alternative to multigrade.

The G2 gamma of a film can be easily measured using an enlarger densitometer and sacrificing just one frame in a roll of film for a photograph of a specially designed and calibrated test card and densitometer as supplied by b-wtechnik.

Enter these density measurements into the spreadsheet available for download and the appropriate gammas are calculated.

The spreadsheet will also calculate the dynamic exposure range that corresponds to the use of spot meters. In other words, it predicts the exposure range of the predicted shadow area in the scene.

This will be discussed later in the discussion about spot metering.

PHOTOGRAPHIC LIGHT METERS

Much has been written on this topic so I will only discuss particular points of immediate interest.

Typical 30 degree angle reflection light meters, as opposed to spot meters, have limited use for accurate exposure as they are only calibrated for an average scene. They will not be discussed further.

Incident light meters or spot meters will be assumed to be used in the remainder of the article.

Several types of meters will be discussed:

- flat cosine responding sensors which are 1 stop down at 60 degrees and no response at 90 degrees. These do not appear to be available commercially for photographic use but are common in light level measurement.
- meters with fully integrating spheres with a cardioid response. These are 1 stop down at 90 degrees. A good example is the Weston Master V with a modern Invercone fitted or Gossen products.
- spot meters with typically 1% angle of coverage for example the early Pentax spot meter.

Figure 2 shows the three types of response including a hemisphere.

The cosine meter is primarily intended to be pointed at either the light sources or in the direction of the camera.

When correctly used, all the incident light meters will give similar results in most situations but for critical work there are exceptions.

Consider Figure 1. which is an extreme example.

The total relative output from each incident

Figure 1 Incident Light Meter Anomalies

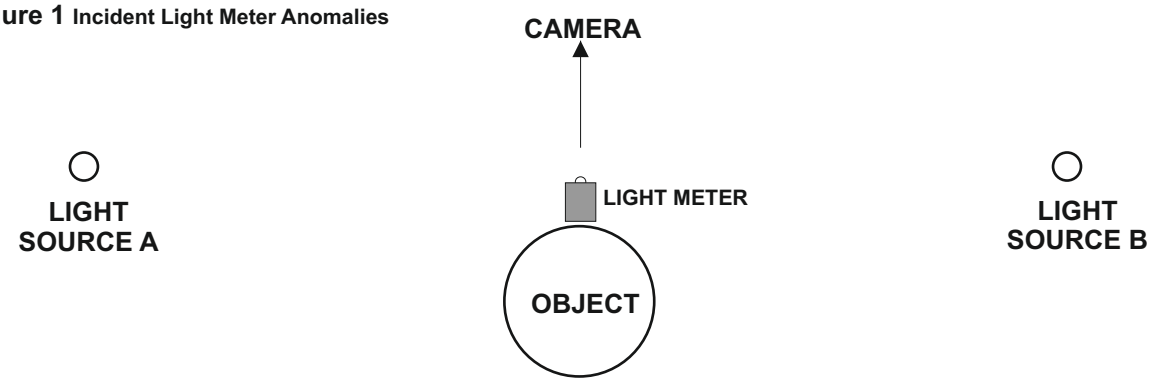
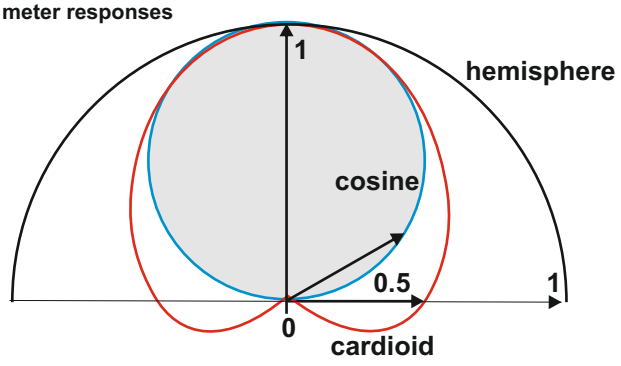


Figure 2 Various incident meter responses



meter would be as follows

a. Cosine pointing at camera: 0
b. Cosine pointing at either source: 1
c. Cardioid pointing at camera: 1
d. Hemisphere pointing at camera: 2
e. Cosine in duplex mode : 1
(Average of both light sources)

Turn off one of the lights and repeat.

f. Cosine pointing at camera: 0
g. Cosine pointing at source: 1
h. Cardioid pointing at camera: 0.5
i. Cardioid pointing at source: 1
j. Hemisphere pointing at camera: 1
k. Cosine in duplex mode, not applicable
(Only 1 light source)

The old style hemisphere records twice as much light in case (d) which is clearly wrong so it should be eliminated from the contest .

The cardioid pointed at the camera in case (h) is also going to lead to under-exposure.

The cardioid when pointed at the light source (i) will give the correct exposure.
Note the cardioid response is unsuitable for duplex measurements.
As you can see there is scope for errors with integrators. Duplexing with the cosine will most likely give the optimum exposure as was discovered by Dunn but it is unfortunate that light meters with flat integrators are a rarity. I have modified my Gossen meter by adding a flat diffuser in place of the cardioid one and then re-calibrating.

One cosine meter duplex technique is where an average of a measurement facing the camera and another measurement facing the subject is used. However an adjustment should still be made, typically 1 stop, if the subject is biased towards low key or high key.

It is a tried and tested compromise and is worth considering as a simple technique. Note the average has to be on a logarithmic scale i.e. in stops.
For example, f/8 is the average between f/5.6 and f/11 .

An alternative is to measure the incident light from the primary light source to the subject, but where there are multiple sources, scan the scene to find the maximum light source and direction before deciding on the exposure required.

Spot Meters are advocated by users of the zone system primarily for determination of the dynamic range between a selected highlight and shadow areas . As this meter type is still available, it is a replacement for the Duplex system.
On their own, spot meters cannot be used to determine the absolute exposure required but all we need, though, is a standard grey card or preferably, a white card . If the card is not fully diffusing and has specular reflections, care has to be taken as to the angle that may exist between the card, source and spot meter.

However, tests have shown that using good quality matt photo ink jet paper gives an accurate cosine response, which is the theoretical requirement, and is suitable for up to 80 degrees off axis making spot meter measurements easy and reliable.

As Kodak Grey cards are expensive, using a white card is a suitable low cost alternative. All we have to do is subtract 2.4 stops from the measurement, assuming we want to emulate an 18% grey card, and that will give us our normal exposure value.

In fact, genuine Kodak grey cards are not fully matt and have significant specular reflections so they would have to used with some care.

Alternatively, highlight and shadow areas in the scene can be selected and measured, the difference being the dynamic range which is typically 5 to 6 stops. Deciding

on which shadow region to use is a problem both for this method and the "Zone" system.

Following on from the G2 discussions at the end of the introduction, there is a way of calculating the shadow keytones if the average gamma for the film is known.

This is also mentioned in the website downloads.

(See 7_step_test_chart_calculations.ods and film_id11b_v13_5pl_12_1_20240111_template)

The formula is:

G2 Dynamic range = 3.45 / (Av. Gradient)

measured in stops.

Measure the high keytone, which may be a white card, subtract the above dynamic range and that will indicate the location of the shadow keytone based on an accepted film density of 0.2.

The range usually falls between 5 and 6 stops. Alternatively a black card with a reflection density of 2% can be used.

This is 3.2 stops below an 18% grey card and 5.5 stops below a white card.

I strongly recommend the book by J.F. Dunn and G.L Wakefield for a full explanation of the more advanced exposure techniques but in the meantime here is a resume of the adjustments required to give the best exposure in more difficult circumstances.

Dunn & Wakefield describe the following scenarios as leading to incorrect exposure

"Long Range Subjects" which means a print dynamic range greater than 50:1 (log density range 1.7). Using lower grade papers will give a flat print lacking in brilliance. It is better to develop the film normally and burn in or hold back affected tones accordingly.

Likewise, if the highlights are important then expose for the highlights and ignore the shadow areas.

If the shadow areas are important, expose for the shadow areas and ignore the highlights.

There is no point exposing for the shadows if they are going to be ignored.

Controlled lighting subjects i.e. in the studio are adequately measured using a cardioid (or cosine) meter which should automatically place the toe exposure in the optimum position.

Expose for the MIDDLE tones if possible

This is one of Dunn's favorite topics. There is his original paper called **"Exposure for the Middle Tones"** on the **b-wtechnik** download page. He says;

"There is some doubt as to the general use of "expose for the highlights" or "expose for the shadows." Neither include the wider scope of directional side and contre-jour lighting. "

Use either the Duplex cosine method, or, although not ideal, Duplex cardioid integrators.

Using this method spreads the effect of over or under-exposure between the toe and shoulder of the film dynamic range.

Extreme scenes with an extreme tone unbalance. For example; back lit sea, snow, glassware.

The solution here suggested by Dunn is:

Take a reflected reading of the foreground and a normal incident reading pointing at the camera. Use the center reading as in the Duplex method.

We can now move on the use of spot meters. "The method with spot meters is 100% keytone pegging" which normally means pegging the shadow detail and highlights. Pegging the highlight is usually easy or we can use a white card. The shadow pegging is usually 5 to 6 stops lower so you can then shift around the keytones depending on which part of the scene is important. The rest is similar to the other meters with the following considerations.

Note scenes with low dynamic range i.e. snow with 1:20 range (log density range 1.3) and no black objects, the scene would all be

placed in the toe. Add 2 or more stops to move the range to the center of the film characteristic.

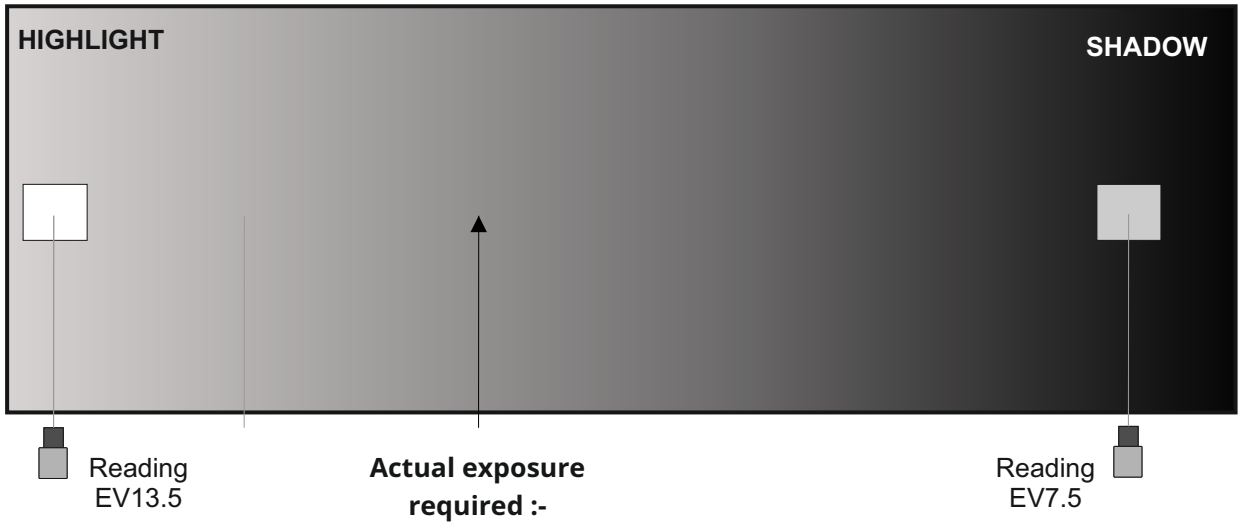
"Blended Scene Luminance" occurs in landscapes where, for example, a tree trunk gets progressively darker when measured with a spot meter. So if you want to use a tree trunk as a shadow keytone, use one at a reasonable distance.

Distant scenes

Use the spot meter shadow method but if the tone range is small, increase the exposure by 1 - 2 stops due to distance effects.

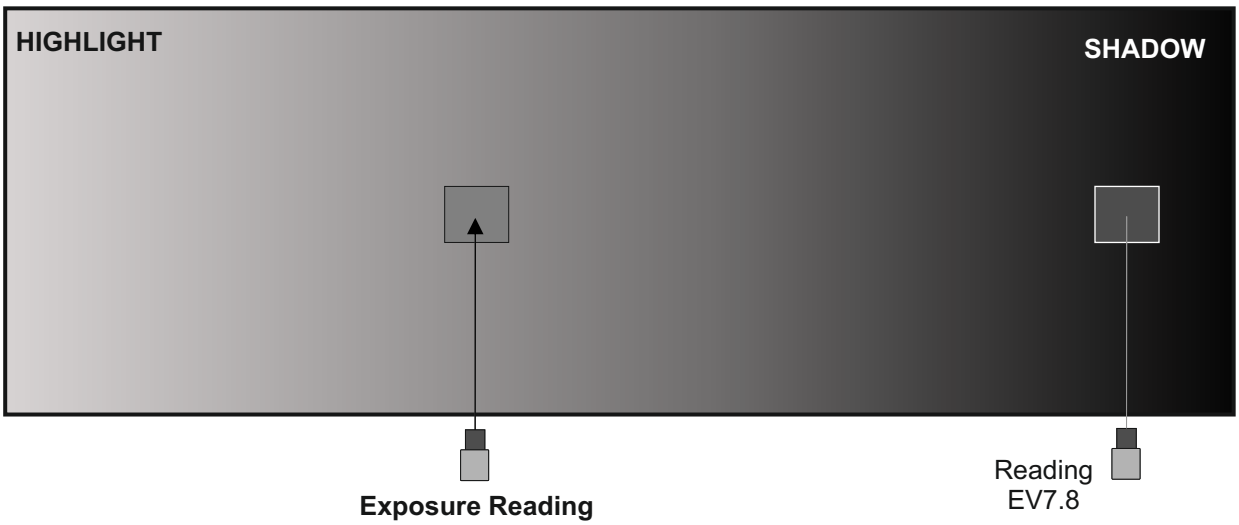
The use of a white card in place of an 18% grey card can be confusing so I have added two examples below which should make the procedure clear.

SPOT METERING USING A WHITE CARD



Place the white card in the shadow area that gives an EV reading 5 to 6 stops below the highlight reading which is the shadow keytone.

SPOT METERING USING AN 18%GREY CARD



Place the grey card in the shadow area that gives an EV reading 3.2 stops below the grey card reading which is the shadow keytone.