# The GE "DW" line of photographic exposure meters

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## ABSTRACT AND INTRODUCTION

General Electric made a line of photographic exposure meters with model numbers beginning with "DW" from 1937 thorough the 1950s. They were widely used, especially by amateur photographers. In this article, I describe the evolution of this line, pointing out interesting and curious technical wrinkles that emerged along the way.

## 1. GENERAL

### 1.1 Background

Appendix A gives some background in Photographic Exposure Metering.

### 1.2 Incremental descriptions

When a certain feature is introduced at a particular model of the line, it will be discussed there. If there is no mention of this feature in the description of a following model, we may in general assume that it is still in play there.

### 1.3 Our personal collection

We have specimens of several of the meter models discussed here in our personal collection. These are indicated by a "smiley face" next to the main photograph of the model. The photo is not of our specimen unless indicated.

### 1.4 Photo credits

Except where indicated otherwise, all photos in this article are copyright James Ollinger, and are used by permission. Thanks, James.

### 1.5 The light measurement system

All the meters described in this article use a selenium photovoltaic photocell, which generates an electrical voltage when exposed to light. Its output is directly read by a microammeter. No battery is involved.

## 2. THE GE DW SERIES OF PHOTOGRAPHIC EXPOSURE METERS

### 2.1 The progenitor

The progenitor of the GE DW line of photographic exposure meters was not a photographic exposure meter at all but rather a meter intended to measure the illuminance of the illumination on, for example, a work surface, in connection with workplace and home lighting design, the DW-40. It was introduced in 1935. We see it in Figure 1.


**Figure 1. GE DW-40 light meter**

This instrument has at its top a rectangular selenium photovoltaic photocell, which generates an electrical voltage when exposed to light. Its output is read by a microammeter. No battery is involved. This same arrangement is followed by all the exposure meters described in this article.

The meter scale is marked in footcandles, a widely used non-SI unit of illuminance. Different ranges are arranged for by small clip-on masks which block all but a fraction of the photocell, thus making the actual range 10, 20, or 100 times that marked on the meter dial.

### 2.2 The DW-47 photographic exposure meter

#### 2.2.1 *Introduction*

Figure 2 shows the GE DW-47 photographic exposure meter (introduced in 1937). The basic mechanism of the DW-40 light meter was adapted to reflected light photographic exposure metering by equipping it with a "hood" over the photocell. This controls the field of view of the meter.


**Figure 2. GE DW-47 exposure meter**

The "business end" of the hood has a small door, with slots (called the "cover"), which when closed attenuates the light by a factor of 10, thus changing the range of the instrument to one 10 times as great as in its basic mode.

Two scales are provided on the meter face, one for each range. The scales are denominated in footcandles, notwithstanding the fact that the basic role of the meter was to measure luminance, while the footcandle is a unit of illuminance. This anomaly really didn't matter, since in customary operation the meter indication is taken to be an arbitrary number.

### 2.2.2 *The exposure calculator*

On the front of the hood is the "exposure calculator", a specialized circular slide rule. Its job is to work the exposure equation and deliver the exposure recommendation. It has a single moving dial.

The exposure calculator is organized in a way that makes its use exceedingly clumsy. There are two ways to work it.

- If the photographer has in mind the exposure time (shutter speed) to be used, he turns the dial until, in the upper portion of the calculator, that shutter speed falls opposite (on the adjacent fixed ring) the exposure index for the film being used. Then, after the meter has read the luminance of the scene, the photographer notes the meter reading (in "footcandles", although that unit is inappropriate here), and, in the lower portion of the calculator, finds alongside that "light value" the f-number to be used.

- If the photographer has in mind the aperture (f-number) to be used, after the meter has read the luminance of the scene, the photographer notes the meter reading and turns the dial until, in the lower portion of the calculator, that "light value" is alongside

the chosen f-number. Then, in the upper portion of the calculator, he finds, alongside the exposure index for the film, the shutter speed to be used.

Now suppose the photographer does not have in advance an idea of either the shutter speed or f-number to be used. How can he, after the meter has made its reading, see all the equivalent combinations of shutter speed and f-number that will constitute the recommended photographic exposure? With this type of calculator, he cannot do that.

Could a calculator of this general design, with only one dial, have been arranged so that the results were presented so that the photographer could see all the combinations of shutter speed and f-number (as we have in later years come to expect)? Yes.

The specific arrangement of the calculator, together with the actual sensitivity of the meter, implements the manufacturer's choice of K

2.2.3 *Basis of exposure index*

The exposure index in this model is in the GE system. An index of 125 roughly corresponds to ASA 100 or ISO 100.

2.2.4 *Incident light metering*

To use incident light metering, the hood is removed altogether. The meter is placed so that the face of the photocell is exposed to the illumination to be measured.

The exposure calculator is used as before, the meter reading (from the 0-70 scale) being entered in the usual way. Then, the user is instructed to use "20 times the indicated exposure".

A much easier scheme is to enter into the calculator 1/20 of the meter reading (from the 0-70 scale) and then use the exposure as indicated.

The specific arrangement of the calculator dials is predicated on the manufacturer's choice of a value for C.

2.2.5 *Zero adjust*

On the rear there is a small slide used to adjust the zero position of the meter.

2.2.6 *Closing up*

When the meter is not in used, the hood is slid down until it covers the meter window, protecting the window and making the unit more compact for storage. Reports are that this sliding of the hood was

often problematical, perhaps due to shrinking or warping of the hood, which (like the meter case itself) was made of Bakelite.

## 2.3 The DW-49 photographic exposure meter

### 2.3.1 *General*

The GE DW line of photographic exposure meters got its own physical design (some would say in "art deco" style) with the model DW-48, introduced in 1940. The meter housing is Bakelite, but the hood is made of die-cast metal (as is true of all further members of the series). The range-changing door works exactly as on the DW-47 (it is seen closed in the figure). The hood does not slide for storage of the unit.

The meter proper carries two scales, one for each range (as controlled by the cover.)

This model includes the same clumsy arrangement of the exposure calculator used on the DW-47, but with some upgrades in the aesthetics and markings.

Figure 3 shows this model.


**Figure 3. GE DW-49 exposure meter**

On the left of the exposure calculator dial we see a small lever. When raised, it locks the calculator dial in position. We have no idea what the point of that is.

### 2.3.2 *Incident light metering*

For incident light work, the hood can be removed entirely, it being held on by a very nice detent system. Calculator operation in this mode is exactly as described above for the DW-47

The exposure index in this model is in the GE system.

### 2.3.3 *Calibration constants*

By "reverse engineering" of the exposure calculator, it can be seen that the intended values of the two calibration constants for this meter are:

- K (reflected light mode)—15.2
- C (incident light mode)—120

That value of K is in the general region widely used today (certain exposure meter manufacturers have standardized on a K value of 14, and others on a value of 12.5).

But that value of C is quite low by today's standards—typical modern exposure meters have a value of C of perhaps 270 (340 if they have the cardioid directivity pattern)!

We can well imagine that users of the DW-49 in the incident light mode were regularly treated to substantial underexposure.

The determination of these constants here is subject to experimental error owing to curiosities in the relationship between the GE film speed system and the ASA speed.

## 2.4 The DW-48 photographic exposure meter

### 2.4.1 *General*

The DW-48 was also introduced in 1940. We believe, despite the sequence of model numbers, it was introduced slightly after the DW-49 (thus its position in this article). Figure 4 shows this model.


**Figure 4. GE DW-48 exposure meter**

The meter has only one scale. To accommodate the closing of the "cover" to get a 10-times greater range, with the cover closed the

user uses a different red arrow ("cover closed") to point to the meter reading on the calculator. Its position is such that using it is exactly the same as multiplying the meter reading by 10 and setting it with the regular "cover open" arrow. The specific arrangement of the calculator, together with the "sensitivity" of the meter, implements the manufacturer's choice of a value of K.

### 2.4.2 *The exposure calculator*

The exposure calculator is a far-improved design compared to that used on the DW-47 and DW-48. Essentially this same calculator design was later used in the DW-58 and DW-68.

The exposure calculator has two movable dials, although in use they travel together. The exposure index is explicitly set by moving one of the movable dials with respect to the other, using a small double tab, until the applicable exposure index appears in a little window between the two tabs.

After the meter has regarded the scene, the user turns the dial (two dials, actually, but appearing to be one) until a red pointer ("cover open", or "cover closed", depending on the position of the range extension cover) points to the meter reading (on the "light values" scale).

Now, on two adjacent rings, all appropriate combinations of f-number and shutter speed appear adjacent. The user can choose the pair that best meet his various criteria.

As with the DW-49, on the left of the exposure calculator dial we see a small lever. When raised, it snaps counterclockwise and locks the calculator dial in position. To release the lock, the lever is pushed clockwise and allowed to drop down. We have no idea what the point of this feature is.

### 2.4.3 *Exposure index*

The exposure index in this model is in the GE system.

### 2.4.4 *Incident light metering*

For incident light work, the hood can be removed entirely, it being held on by a very nice detent system. Now, the user uses a third red arrow ("hood off") to point to the meter reading on the calculator. Its position is such that using it is exactly the same as dividing the meter reading by 20 and setting it with the regular "cover open" arrow.


**Figure 5. GE DW-58 exposure meter**

## 2.5 The DW-58 photographic exposure meter

### 2.5.1 *Basics*

The Model DW-58 was introduced in 1946. It has essentially the same overall design as the DW-49, but is equipped with a far superior exposure calculator (essentially that introduced on the DW-48). Figure 5 shows this model.

The exposure calculator used in this model follows the improved design introduced on model DW-48. However, there is no dial lock lever.

### 2.5.2 *Incident light metering*

For incident light work, the hood can be removed entirely, it being held on by a very nice detent system. Now, the user uses a third red arrow ("hood off") to point to the meter reading on the calculator. Its position is such that using it is exactly the same as dividing the meter reading by 20 and setting it with the regular "cover open" arrow.

### 2.5.3 *Calibration constants*

By "reverse engineering" of the exposure calculator (together with some information from the manual), it can be determined that the intended values of the two calibration constants for this meter are:

- K (reflected light mode)—14.1
- C (incident light mode)—110

That value of K is in the general region widely used today (certain exposure meter manufacturers have standardized on a K value of 14, and others on a value of 12.5).

But that value of C is quite low by today's standards—typical modern exposure meters have a value of C of perhaps 270!

We can well imagine that users of the DW-58 in the incident light mode were regularly treated to substantial underexposure.

2.5.4 *Basis of exposure index*

Early production of this model had a calculator based on the GE system for exposure indexes. Those manufactured after January, 1946 were based on the ASA speed. (Figure 5 shows the latter arrangement.)

2.5.5 *Zero adjust*

The slide on the rear used in prior models to adjust the zero position of the meter has been replaced by a "screw" on the front, as is familiar in electrical panel maters.

**2.6 The DW-68 photographic exposure meter**

Model DW-68 was introduced in 1948. It is almost identical to the DW-58, except for a reversal of the color scheme on the exposure calculator, and the use of a wrinkle finish rather than the gloss finish used in the prior models. Figure 6 shows this model.


**Figure 6. GE DW-68 exposure meter**

With regard to the reflected light metering mode, it seems that the value of K is unchanged from the previous model (14.1).

But, with respect to operation in the incident light metering mode, its value of C (220) is exactly twice that of the DW-58! Thus, for a given illuminance and exposure index, this model would recommend an exposure one stop "hotter" than the various prior models.

This is a result of the "hood off" arrow being in a position such that using it is exactly the same as dividing the meter reading by **40** and setting it with the regular "cover open" arrow. (On the earlier models, this ratio was 20.)

We assume that this change was made in response to complaints of substantial underexposure with the DW-48, DW-49, and DW-58 when used in the incident light mode.

The new value of C, 220, is, however, still substantially lower than what is typically used today for exposure meters with a nominal cosine response (often in the range 250-270).

2.6.1 *Basis of exposure index*

The exposure index in this model is in terms of ASA speed.

## 3. UPDATED CALCULATORS

As January, 1946, GE moved to the use of the ASA film speed, rather than their own film values, in their meters. The exposure calculators of DW-58 meters made after that date, and of the DW-68, were based on ASA speed.

GE subsequently made available hoods that carried new calculators, based on the use of ASA speed, for the DW-48, DW-49, and earlier DW-58s. The replacement calculators for the DW-48 and DW-49 had the improved arrangement originally introduced on the DW-58.

### 3.1 The end of the DW road

The DW-68 was the last model of the DW series. I do not know when it was last manufactured. Various other lines of exposure meters were made by GE after that time, but they are outside the scope of this article.

## 4. DIRECTIVITY PATTERN

We have no information on the directivity pattern of any of these meters when operated in the incident light metering mode. It is likely that they roughly approximate a cosine pattern, as would be needed for the meter to respond to the actual illuminance on a plane parallel to the photodetector. But probably for larger angles, the directivity falls faster than that of an actual cosine pattern (typically true of simple flat photocells without auxiliary elements

## 5. ACKNOWLEDGEMENT

Thanks again to James Ollinger for the many fine photos and permission to use them, and for the wealth of information on his

site about exposure meters. Much of my research was guided by that information.

His exposure meter site can be found here:

http://www.jollinger.com/photo/meters/meters/ge_dw68.html

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# Appendix A

## Basic Background in Photographic Exposure Metering

### A.1 General

In photographic exposure metering, we use an instrument to measure either the light emitted by of reflected from the subject or the light falling on the subject, and from that, plus knowledge or assumption about the sensitivity of the film (or digital sensor) being used, the instrument issues a recommended photographic exposure, usually in the form of a collection of equivalent combinations of exposure time (shutter speed) and aperture (f-number). Two basic techniques are used.

Here is some basic information about this topic, pertinent to the discussions in the body of the article. It is beyond the scope of this article to discuss at length the details, relative advantages, and the limitations, of each technique.

### A.2 Reflected light exposure metering

#### A.2.1 General

This is the technique used in most photography (especially "amateur" photography). In it, the instrument measures the average *luminance* of the scene (hopefully, with a field of view matching that of the camera). From that, plus the "exposure index" (what the photographer has told the meter is the sensitivity of the film or digital sensor), the meter issues a recommended photographic exposure.

The name of the technique comes from the fact that the luminance of the subject is often a manifestation of light reflected from it, although of course some subjects are self-luminous (the shade of a table lamp, for example).

#### A.2.2 The result

The result of a reflected light metered exposure (in a digital camera) is that the average photometric exposure on the sensor (over the entire image) is a certain fraction of the "saturation" photometric exposure. The fraction is largely a function of the value of K used by the meter (see section A.4 ).

#### A.2.3 Implications

The assignment of different photometric exposures (and thus different exposure results) to scene elements of different reflectance is dependent on the average reflectance of the scene.

One impact of this is often summarized thus: A photo of a white cat on a snowdrift comes out looking like a gray cat on an ash heap; a photo of a black cat on a coal pile comes out looking like a gray cat on an ash heap.

## A.3 Incident light exposure metering

### A.3.1 General

In this technique, simplistically, the meter determines the *illuminance* of the light that illuminates the subject (the *incident light*). From that, plus the "exposure index", the meter issues a recommended photographic exposure.

### A.3.2 The result

The result of an incident light metered exposure is that, if all elements of the scene are equally illuminated, the photometric exposure given each element of the scene is proportional to its individual reflectance.[1] The exact proportional relationship is largely a function of the value of C used by the meter (see section A.4 ).

### A.3.3 Implications

One impact of this technique is often summarized thus: A photo of a white cat on a snowdrift comes out looking like a white cat on a snowdrift; a photo of a gray cat on an ash heap comes out looking like a gray cat on an ash heap; a photo of a black cat on a coal pile comes out looking like a black cat on a coal pile.

## A.4 Exposure equations and calibration constants

In each case, the development of a photographic exposure recommendation is done following a straightforward linear equation. The exact relationship between a certain combination of measured luminance or illuminance, plus a certain exposure index, and the issued photographic exposure recommendation is controlled by an *exposure metering calibration constant*, which has the symbol K for the reflected light mode and C for the incident light mode.

The greater the value of K [or C], then for a given average scene luminance [or illuminance on the scene], and a given exposure index, the greater will be the recommended photographic exposure.

No "correct" value for K or C can be derived mathematically, owing to the fact that there can be different "strategies" with regard to the

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[1] This is very similar to the underlying concept of the “Zone System”, a scheme of exposure planning popularized by famed photographer Ansel Adams and others.

desirable exposure result. Thus, over the years, exposure meter manufacturers have each chosen a value of K and or C for their exposure meters based on their own thoughts as to what value will produce exposure results they feel their users will most often enjoy.

That having been said, in recent decades, most exposure meter manufacturers have used fairly consistent values of K and/or C.

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