Exposure Triangle Calculator

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Correct image rendition can be achieved by changing three variables commonly called the "exposure triangle" (shutter speed, aperture and ISO) so that middle gray records as a middle value in a JPEG - at about 127 on a range of 0-255[1].

An exposure of one second is given a value of 0. Each doubling of the shutter speed increases the value[2] by one:

1 sec	1/2	1/4	1/8	1/15	1/30	1/60	1/125	1/250	1/500
0	1	2	3	4	5	6	7	8	9

An aperture of f/1 is given a value of 0. Each full stop of reduced aperture increases the value by one:

f/1	f/1.4	f/2	f/2.8	f/4	f/5.6	f/8	f/11	f/16	f/22
0	1	2	3	4	5	6	7	8	9

The shutter speed and aperture values are added together to get the exposure value (EV). You can see how aperture and shutter speed are combined as EV in this table from the back of a Rolleiflex TLR:

F:	2.8	3.5	4	5.6	8	11	16	22
1 sec	3	3.5	4	5	6	7	8	9
/2	4	4.5	5	6	7	8	9	10
/4	5	5.5	6	7	8	9	10	11
/8	6	6.5	7	8	9	10	11	12
/15	7	7.5	8	9	10	11	12	13
/30	8	8.5	9	10	11	12	13	14
/60	9	9.5	10	11	12	13	14	15
125	10	10.5	11	12	13	14	15	16
250	11	11.5	12	13	14	15	16	17
500	12	12.5	13	14	15	16	17	18

You can expose with an EV of 10 at several offsetting shutter speed and aperture combinations. In some film camera lenses (like Hasselblad) EV is mechanically linked so that you can change both shutter speed and aperture while keeping the EV constant.

ISO can also be expressed it as a logarithmic series:

25	50	100	200	400	800	1600	3200	6400	12800
2	1	0	-1	-2	-3	-4	-5	-6	-7

When everything is combined:

1/500 sec	9
f/16	8
EV (subtotal)	17
ISO 400	-2
Light Value	15

If you change the shutter speed, aperture and ISO by offsetting values you can record the same light value (LV) but with a different depth of field (DOF) or motion blur:

1/125 sec	7
f/11	7
EV (subtotal)	14
Filter	0
ISO 50	+1
Light Value	15

A spreadsheet shows how this works:

The values displayed above are for the Sunny 16 rule (LV=14.667). It recommends setting the shutter speed to the reciprocal of the ISO at f/16 for broad daylight. An EV of 15 is also recommended for broad daylight at ISO 100 (where the log adjustment is 0) and that is 1/125 sec @ f/16, almost the same as Sunny 16.
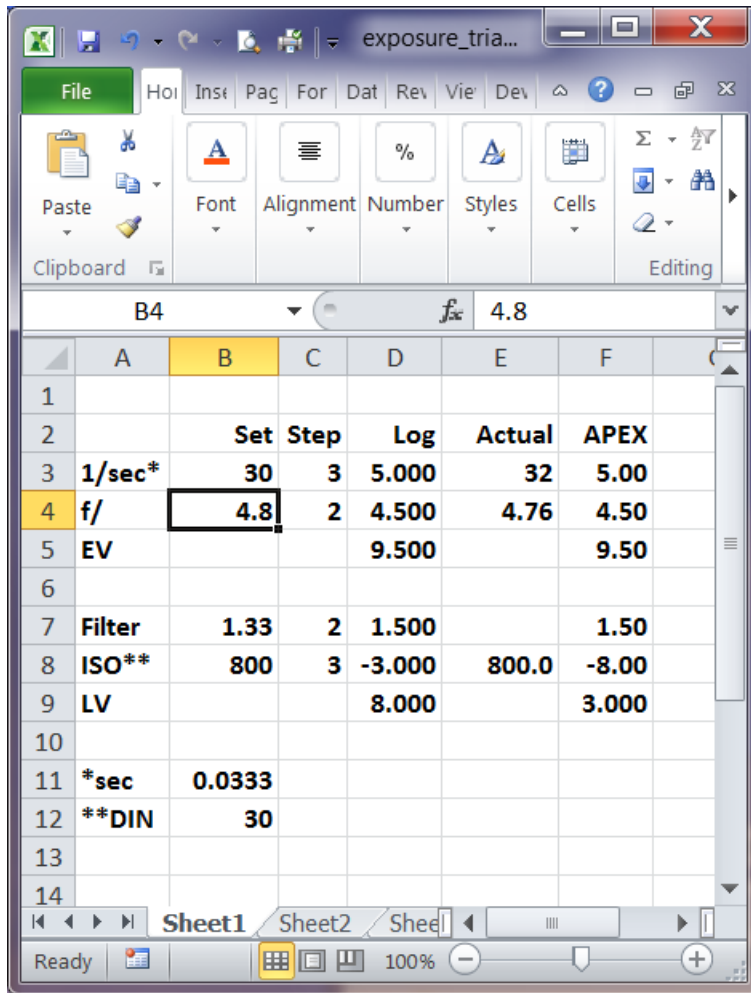
The Filter row is a place to enter your filter factor[4]. For example, a polarizer might need a filter factor of 1.33 and color filters used with black and white film can each have a different filter factor.

The spreadsheet is protected (no password) except for seven input fields in the **Set** and **Step** columns.

Shutter speed, aperture and ISO are entered in the **Set** column. The spreadsheet's **Step** column determines how many steps or increments are used between whole stops – how the values in the **Log** column are rounded. You can leave the shutter speed and aperture steps at 3 (1/3 stop increments) or change them to 2 (half stop increments) or 1. The ISO steps are locked at 3.

An example with different light level might be a bright street scene at night with a polarizer attached. The usual EV recommendation for ISO 100 is EV=7-8 but at ISO 100 you could end up with 1/8 sec @ f/4.5. You might prefer a higher shutter speed and ISO, especially if you want to use a filter:

	A	B	C	D	E	F
1						
2		Set	Step	Log	Actual	APEX
3	1/sec*	30	3	5.000	32	5.00
4	f/	4.8	2	4.500	4.76	4.50
5	EV			9.500		9.50
6						
7	Filter	1.33	2	1.500		1.50
8	ISO**	800	3	-3.000	800.0	-8.00
9	LV			8.000		3.000
10						
11	*sec	0.0333				
12	**DIN	30				
13						
14						

The **Actual**[3] column shows the result of reversing the logarithm (which has been rounded) back to the entered shutter speed, aperture or ISO. The differences between the commonly named values and the actual values are insignificant.

The APEX column shows the same information as the Log column except for the ISO log values are 5 units different. DIN is another way to represented ISO as a logarithmic sequence.

Shutter speed	1/4	1/8	1/15	1/30	1/60	1/125	1/250	1/500	1/1000
Actual	1/4	1/8	1/16	1/32	1/64	1/128	1/256	1/512	1/1024

Aperture	f/2	f/2.8	f/4	f/5.6	f/8	f/11	f/16	f/22	f/32
Actual	f/2	f/2.83	f/4	f/5.66	f/8	f/11.31	f/16	f/22.63	f/32

ISO	100	125	160	200	250	320	400	500	640
Actual	100	126	159	200	252	318	400	504	635

You can also find intermediate steps:

f/ 1 2 step	f/2	f/2.38	f/2.83	f/3.36	f/4	f/4.76	f/5.66	f/6.73	f/8
f/ 1/3 step	f/2	f/2.24	f/2.52	f/2.83	f/3.17	f/3.56	f/4	f/4.49	f/5.04

ss 1/2 step	1/4	1/5.7	1/8	1/11.3	1/16	1/22.6	1/32	1/45.3	1/64
ss 1/3 step	1/4	1/5	1/6.3	1/8	1/10.1	1/12.7	1/16	1/20.2	1/25.4

Notes:

1. The value recorded in the digital raw file depends on the camera bit depth. For a Nikon or Sony sensor a 14-bit raw file the value for middle gray will be between 1000 and 2000.

2. Expressing shutter speed, aperture and ISO as logarithms makes it easy to calculate the exposure triangle values. Logarithms allow us to express multiplication and division as simple addition and subtraction.

- The log value for shutter speed is calculated as the base 2 logarithm of the denominator of the shutter speed.
- The log value for aperture is calculated as the base 1.14132 (square root of 2) logarithm of the f-stop value
- The log value for ISO is minus the base 2 logarithm of ISO/100

The resulting logarithms are rounded based on the number of steps or increments.

3. The actual values are calculated from the rounded logarithms by raising the corresponding base to the power of the logarithm. For example:

LOG(80,2) rounded to the nearest third = 6.33333 and 2^6.33333 = 80.635

4. You can enter the filter factor as a positive or negative value and it does not matter. Only the absolute value is used.

Recommended Exposure Values

You will often see published EV tables based on ISO 100. So long as you adjust for ISO, these can be used as a reality check or for actually getting a starting exposure in unfamiliar situations. For example:

LV	Lighting Conditions*
16	Light sand or snow in full or slightly hazy sunlight (distinct shadows)
15	Typical scene in full or slightly hazy sunlight (distinct shadows) Rainbows: Clear sky background
14	Typical scene in hazy sunlight (soft shadows) Side lighting in full sunlight Rainbows: Cloudy sky background
13	Typical scene, cloudy bright (no shadows) Back lighting in full sunlight
12	Typical scene, heavy overcast, Areas in open shade, clear sunlight Sunset
11	Subjects in deep shade
10	Neon lights at night
9	Night sports, ice shows
8	Night street scenes, window displays, circuses
7	Fairs and amusement parks at night
6	Home interiors
5	Christmas tree lights outdoors, night vehicle traffic, subjects lit by bonfires
4	Floodlit buildings, monuments and fountains
3	Fireworks
2	Distant view of lighted buildings

* Taken from the Wikipedia article on Exposure value where you can find additional information.

Revision 12/27/2023

The original spreadsheet let you calculate the Light Value (LV) from the shutter speed, aperture and ISO. It showed the relationship between those three independent variables and LV.

For example, Sunny 16: 1/ISO at F/16 for full daylight will render a neutral gray card as middle gray (LV 14.67) in direct sunlight. If you don't have a gray card you can now specify the LV as 14.67 and calculate any of the other variables.

The updated spreadsheet lets you pick the dependent variable while changing any of the other three. There now four tabs named for the dependent variable.

All four allow you to enter exposure compensation (EC) or a filter factor. The variables you can change are unlocked and **green**. The dependent value is locked and colored **red**.

Calculate Light Value (LV)

		Set	Step	Log	Actual	APEX
1	Calculate Light Value (LV)					
2						
3		Set	Step	Log	Actual	APEX
4	1/sec*	100	3	6.667	101.594	6.67
5	F/	16.0	3	8.000	16.00	8.00
6	EV			14.667		14.67
7						
8	Filter, EC	0	3	0.000		0.00
9	ISO**	100	3	0.000	100.0	-5.00
10	LV			14.667		9.667
11						
12	*sec	0.01				
13	**DIN	21				
14						

Light Value / ISO / Shutter Speed / Aperture

Calculate ISO

	A	B	C	D	E	F
1	Calculate ISO					
2						
3		Set	Step	Log	Actual	APEX
4	1/sec*	1600	3	10.667	1625.5	10.67
5	F/	8.0	3	6.000	8.00	6.00
6	EV			16.667		16.67
7						
8	Filter, EC	0	3	0.000		0.00
9	ISO**	400	3	-2.000	400	-7.00
10	LV	14.7	3	14.667		9.667
11						
12	*sec	0.0006				
13	**DIN	27				
14						

Light Value / ISO / Shutter Speed / Aperture

Calculate Shutter Speed (1/sec)

	Set	Step	Log	Actual	APEX
Calculate Shutter Speed (1/sec)					
	Set	Step	Log	Actual	APEX
1/sec*	4032	3	12.000	4031.75	12.00
F/	1.4	3	1.000	1.41	1.00
EV			13.000		13.00
Filter, EC	1	3	1.000		1.00
ISO**	64	3	0.667	63	-4.33
LV	14.7	3	14.667		9.667
*sec	0.0002				
**DIN	19				

Light Value / ISO / Shutter Speed / Aperture

Calculate Aperture (F/)						
	Set	Step	Log	Actual	APEX	
1/sec*	8000	3	13.000	8192	13.00	
F/	1.8	3	1.667	1.78	1.67	
EV			14.667		14.67	
Filter, EC	0	3	0.000		0.00	
ISO**	100	3	0.000	100	-5.00	
LV	14.7	3	14.667		9.667	
*sec	0.0001					
**DIN	21					

Light Value / ISO / Shutter Speed / **Aperture**

By default are three incremental steps per stop. You can change that to 2 or anything else but it can get confusing.

The spreadsheet may not be compatible with all versions of Excel or some browsers. Here are links to two versions:

Exposure_triangle.xls

Exposure_triangle.xlsx