Tlahuilli

A Photography incident light exposure meter

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Overview.

For those that don't know the meaning of this word, Tlahuilli is "light" in Nahuatl. Nahuatl is the language of central México Aztec tribe.

An incident light meter is a photography tool used to estimate the correct exposure settings needed on a camera based on a measurement of incident light falling on the subject. A picture of the device on this particular project is shown below:

1. Power switch
2. Device browsing switches on the side of box
3. Lumisphere
4. Measuring mode icon
5. Step increments

6. Battery charge status
7. Camera sensor ISO speed
8. Exposure value measured
9. Calculated F-stop
10. Exposure time

No need to explain power switch. Item number 2 above is 5 switches in one package used like a mouse to navigate the configurable fields and set the right one moving up/down and left/right, light is measured by pushing the button in.

Light sensor used is an Adafruit Industries TSL2591, the lumisphere provides a spatial average of light falling on the scene, it is used to minimize errors introduced by size of light sensor, which is just a few squared millimeters and may catch more light or less than the average on scene.

Rest of items belong to information shown in OLED display, Mode, Step, ISO and Time can be modified using switches on side of meter, selected field currently being modified is displayed in reverse video, like mode in photograph above.

There are three measuring modes:

-  Ambient
-  Cordless electronic flash
-  Infrared

Cameras usually have step increments of full half and one third, any of those three can be used in this meter and will allow user to choose ISO, Time Exposure and resulting aperture with those increments.

Battery charge status is informational only, battery voltage is sampled soon after power button is pushed, current drain from batteries is very low, less than 20 mA, battery used is Lithium Polymer type with capacity of 1.2 AH and it must last a long time, any battery above 6V should work fine.

Sensor speed range can go from ISO 50 to 51200, with increments as explained above.

Exposure time has a range from 30 seconds to 1/8000 second, it is possible to have different limits, selected those because that is what my camera use.

Exposure Value is a calculated parameter using an equation that can be found at several places in the Internet:

$$EV = \log_2 \left[\frac{E\ S}{C} \right]$$

Where:

- E is illuminance in lux
- S is camera sensor speed (ISO)
- C is a constant

Value of "C" used here is the same one used by Sekonic (340). There is one more factor (not shown) due to lumisphere attenuation, the light measured by sensor is less than what it's

actually falling on the scene, it is a multiplicative factor, constant and easy to know, with just two measurements, with and without lumisphere in place:

$$E = KE_m$$

Where:

- K is attenuation factor of lumisphere
- E_m is illuminance measured value

F-stop is the calculated lens aperture from the EV and exposure time, using the equation:

$$N = \sqrt{T\ 2^{EV}}$$

Where:

- T is exposure time in seconds
- EV is the previously calculated Exposure Value

Aperture range is from 1 to 64, out of range values are displayed as "F<1" and "F>64".

Operation

Tlahuilli is a meter that operates in time exposure priority mode, this means that user sets time exposure and ISO, and after a light measurement meter calculate correct aperture. There are three modes available: Ambient, Flash and Infrared.

Ambient light mode

For ambient light mode:

1. Set mode to 
2. Step increment to 1, 1/2 or 1/3
3. Desired ISO
4. Exposure time
5. Push sample button

To move from one field to next, move cursor across device box, moving along length will select different value on selected field. Think on values like they are a list and moving up and down the list, if either end is reached selection will continue from the other end.

When sample button is pressed, Tlahuilli will first save current settings (time, ISO and step) to EEPROM, so next time it is powered on, it will return to saved values, then a unity gain illuminance sample is taken and value is used to set a new gain in sensor if needed. Illuminance is sampled again and value discarded to give sensor time to settle to new gain.

Sensor is sampled again and value is used in exposure value and lens aperture calculations, those are shown in display. If lens aperture is not the desired one or is out of range of lens being used, ISO and exposure time can be modified using same sampled value and new exposure value (if ISO was modified) and lens aperture are calculated and displayed using current sample until user is agree with shown values.

Flash mode

To measure in flash mode, set:

- Mode to 
- Step increment to 1 1/2 or 1/3
- ISO
- Exposure time
- Push sample switch

Same as before meter will save current settings. There is no link between meter and flash, meter will measure ambient light for 1 second (10 samples) and average those to get an estimate of ambient light, it will configure the sensor to set a flag when sampled light is more than twice ambient light, meter will wait for wait 60 seconds for this to happen. If a light change is detected, meter will read illuminance and calculate aperture as before, sampling will be aborted if no sample exceed that amount within 60 seconds.

In this mode if exposure time is changed after a measurement, it will clear current exposure value and aperture, this is because light pulse last a few microseconds and if a different exposure time is wanted, then it is safer to make a new measurement.

Infrared mode

For infrared:

1. Set mode to 
2. Step increment to 1, 1/2 or 1/3
3. Desired ISO
4. Exposure time
5. Push sample button

IR mode behaves similar to ambient light, a measurement is made to set appropriate gain, first sample after gain is set is discarded and a new one taken to calculate EV and aperture.

Tests

Several tests were done in ambient and flash mode, meter behavior is stable and accurate, IR mode was not tested yet until I have access to an IR modified camera, it should work fine, but it is possible a constant factor is needed.