I would really be grateful if you start to build the Shutter, that you go to the Photrio thread and say hi. Also please post photos of your completed tester.
[Build a shutter tester for Focal Plane shutters - Cheap, Easy & it Works | Page 18 | Photrio.com Photography Forums]

Please refer to Photrio for further build help Doc Ver 1.0

ESP32 Shutter Tester Operating Guide V4 01/07/2025

(Firmware 4_1_0_0 onwards)

First use after loading firmware

Assuming the build has been completed correctly and the firmware loaded, when the Shutter Tester is connected to the computer via the USB cable, TFT & LCD should light & there will be output to the pc monitor.

Please note, some of the photos are of previous firmware versions, so will not look identical to your tester.

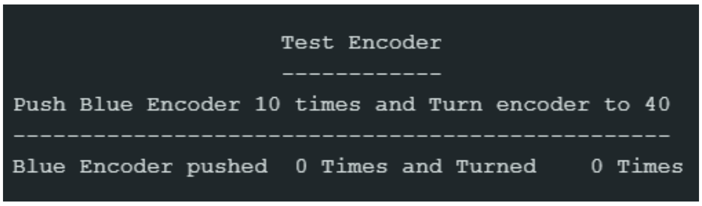
Note on LCD
The LCD is not required for V4. Some users may have it from V3, or would like to add it anyway.
If the LCD lights, but no text can be seen, try adjusting the contrast screw on the back. As an initial setting, turn fully clockwise and then just a small amount back.

Step 1 is to test the encoder, which is the **Blue Button**. A screen as shown as in the pictures below, will appear on first use.
Turning the **Blue Button** will increase or decrease the value between 0-9999. Pushing the **Blue Button** will increase the button count from 1-10. (Pushing again returns to 0).

Following the on-screen instructions, press the encoder to show 10 and turn the encoder to show 40.

TFT showing encoder test.

LCD showing encoder test.



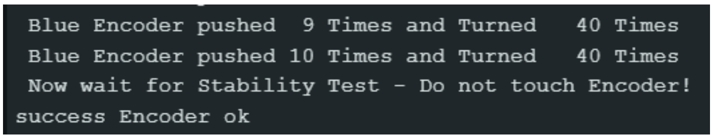
PC screen showing encoder test.

The screen will now change asking the user to wait, whilst a stability test is carried out. This ensures the encoder is not receiving errant input, from poor connections, for example. If all is well, the screens will change for step 2.

If the encoder test fails, The Shutter Tester will restart.

(photo of TFT to follow)

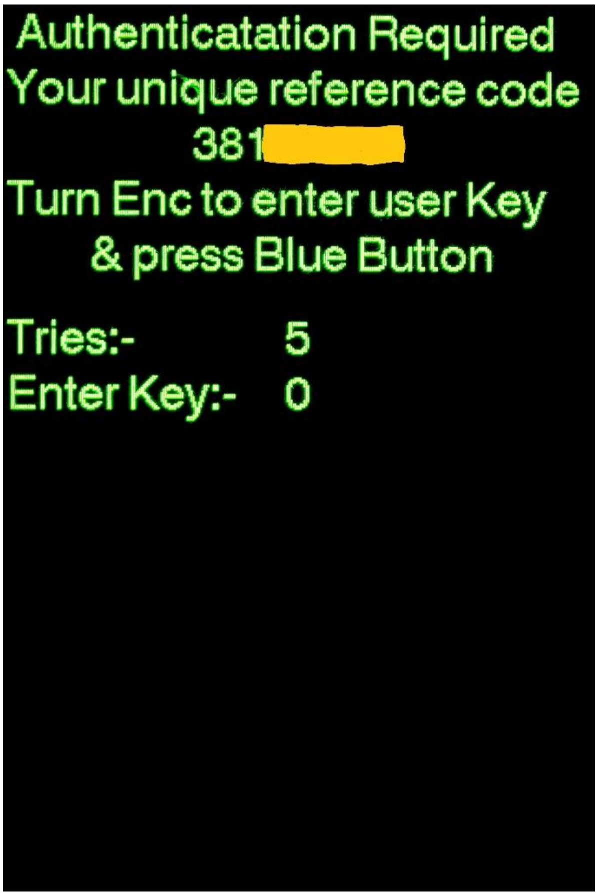
LCD showing encoder test passed.



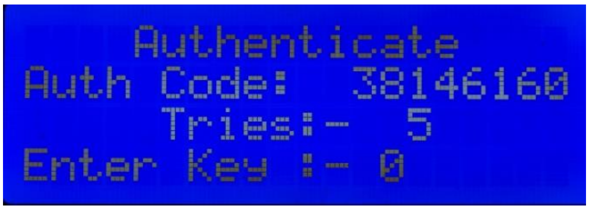
PC screen showing encoder test passed.

Step 2 is to input the user-key. This is supplied free of charge upon request. Make a note of it, in case you ever perform a factory reset. For the key, post a request on the Photrio thread. Link at the top of this document.

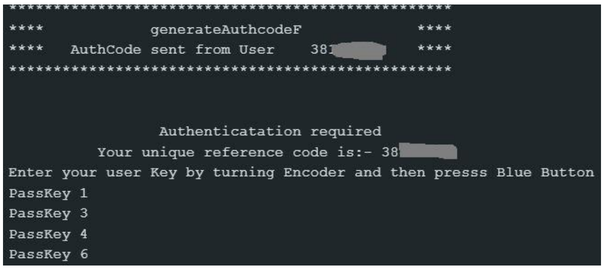
Following the on-screen prompts, turn the encoder to show the user key value. Then press the encoder.
If correct, the Shutter Tester will restart.



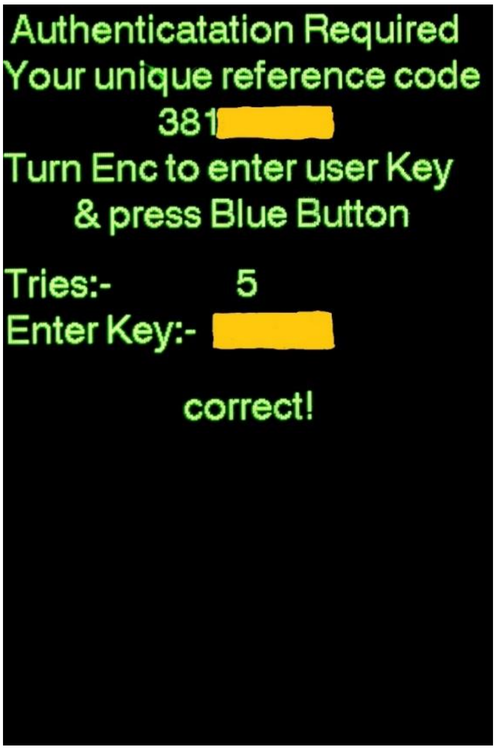
TFT showing user key input screen.



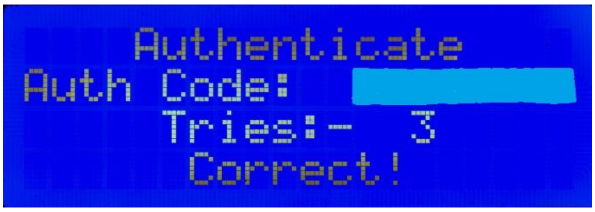
LCD showing user key input screen.



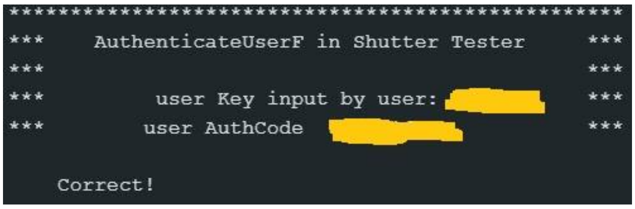
PC showing user key input screen.



TFT showing user has input correct user key.



LCD showing user has input correct user key.



PC showing user has input correct user key.

If the user key has been entered correctly, ‘Correct! Will be displayed’ and the Shutter Tester will restart in normal operation mode.

Note: - Sometimes a firmware upgrade will require the Shutter Tester is reset to default factory settings, so ensure you keep a note of your user-key.

Normal use.

An initial splash screen is shown on TFT, LCD & PC screen. The LED Matrix will display firmware version.

This is displayed for a set period, before changing to the Testing Screen.
Note pressing the Black Button or Touching the screen will jump straight to the Testing Screen.

TFT splash screen.

PC splash screen.

LCD splash screen, due to size limitation only subset of info can be displayed.

Alignment & Setup Utility

Pressing the **Black Button** will take you to the Setup & Alignment Utility.
This is the first screen to go to when initially using the Shutter Tester.

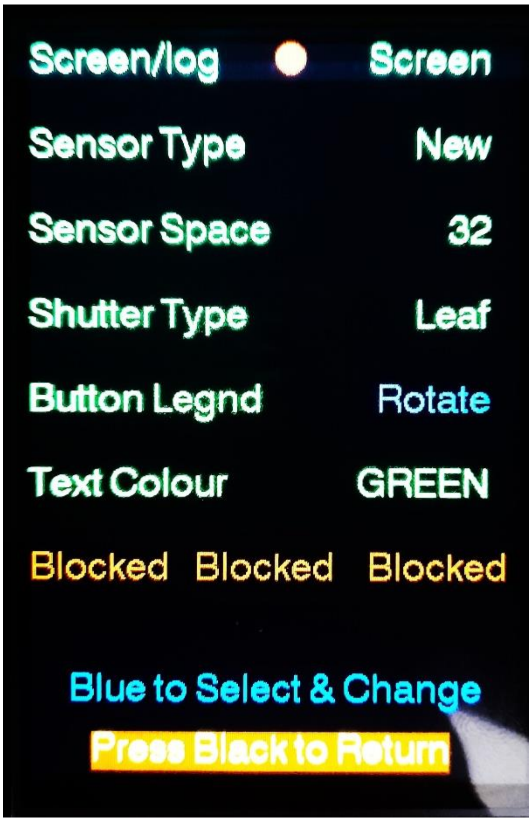
The TFT, LCD & PC screen will show the current settings.

***To select a setting, press the* Blue Button.**
On the TFT screen, a red marker will appear next to 'Screen/Log'. Indicating this is the setting to be changed.
On each press of the **Blue Button**, the red marker will move to the next menu item, to select it.

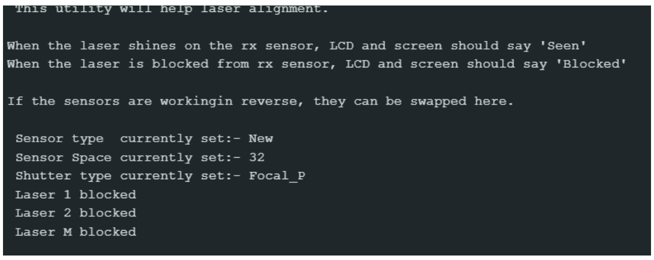
The lower line of the LCD will change, showing which setting is being changed.

The PC screen will give a text prompt.

Turning the **Blue Button** will change the selected setting.
Each of the settings are described below: -



TFT showing Settings & Alignment screen.



PC screen showing Settings & Alignment screen.

LCD showing Settings & Alignment screen.

Screen/log – This allows the user to set the data logging functions.
'Screen' will send test data to the PC screen (using a suitable serial monitor) in a humanised display format.
'ScreenSD' output is sent as above and to the SD card in csv format.
'USB' will send test data to the USB port as a csv file. *Note the humanised PC screen cannot be used at the same time.*
'USB&SD' will send test data in csv format to the USB port and SD card. *Note the humanised PC screen cannot be used at the same time.*

Sensor Type. There are two different versions of the sensor, referred to as 'original' and 'new'. Both look identical, so there is no way to tell by looking, which type they are. The only difference between the two is that one has an inverse output to the other. If the Laser Alignment Utility seems to be working backwards, it means you have the other type of sensor.

Sensor Space This is the distance in millimetres between the two sensors, measured centre to centre. The standard is usually 32mm for horizontal and 20mm for vertical shutters.

Shutter Type Focal Plane, Leaf, or single sensor (sensor no. 1 is used for single sensor readings).

Button Legend Shows the initial splash screen detailing Button use.

Text Colour Allows the default TFT text colour of Green to be changed.

To exit the utility, press **Black Button** or Touch the screen at the bottom.

A **Default Settings Reset** can be performed by pressing the **Red** button and turning the **Blue** knob when in the Alignment & setup utility. Note this resets all settings to default. Your User Key is retained, so re-authentication is not required.

At the bottom of the TFT screen, the state of each sensor is shown (**Blocked or Seen**) This is to allow the sensors and Lasers to be correctly aligned. If the legends are working in reverse, then change the sensor type setting as detailed above.

Below the sensor state, will be a ***flicker warning*** if interference is being detected by the sensors. The most common cause for this is LED lighting (including computer screens) that use PWM to control brightness. It can also be caused by electrical interference being picked up on the wiring to the sensors.

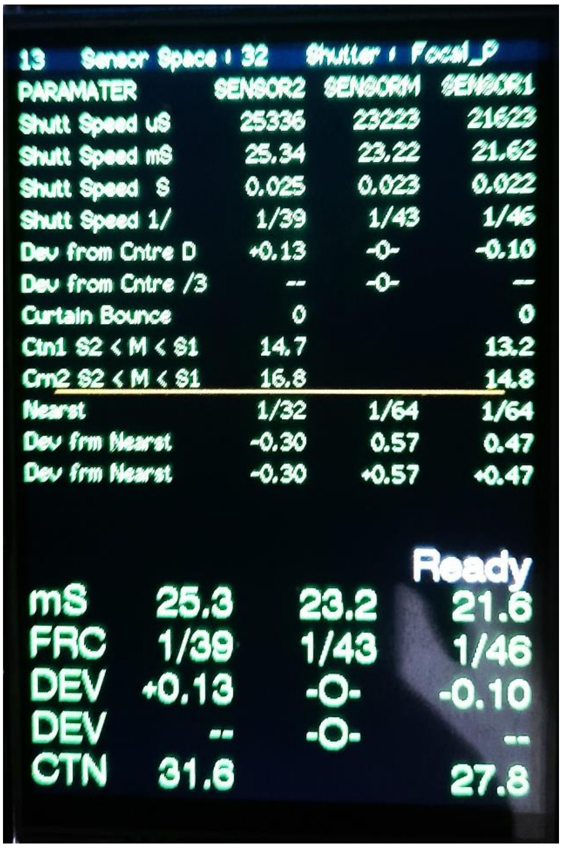
Touch Functionality
Touching the left side of the screen will scroll down the parameter list, the same as pressing the **Blue Button**

Touching the right side of the screen will toggle though the selected parameter options, the same as rotating the **Blue Button**

Touching the bottom of the screen will return to the main testing screen. Same as pressing the **Black Button**.

Testing screen. (Detailed)..

TFT The testing screen of the TFT is arranged into four columns. The first column describes the measurement and the next three columns show the readings, one from each sensor. 2, M, 1.



TFT showing completed test (note old firmware shown).

Shutter SpeeduS	calculated reading from each sensor in microseconds
Shutter SpeedmS	calculated reading from each sensor in milliseconds
Shutter Speed S	calculated reading from each sensor in seconds
Shutter Speed 1/	calculated reading from each sensor in milliseconds
Dev from Centre	calculated deviation from centre sensor in decimal stops
Dev from Centre	calculated deviation from centre sensor in 1/3 stops
Curtain Bounce	Number of times the curtain bounced on closure.
Curtain 1 Travel	Curtain1 travel time from right to centre (S1) and from centre to left (S2)
Curtain 2 Travel	Curtain2 travel time from right to centre (S1) and from centre to left (S2)

Shutter Nearest	Nearest standard shutter speed to actual reading
Dev from Nearest	Nearest Deviation from nearest standard shutter speed in decimal stops
Dev from Nearest	Nearest Deviation from nearest standard shutter speed in 1/3 stops

Below the detailed results, is the adjunct area, where errors and warnings will be displayed

If connection to the camera flash socket was detected, analysis of the flash will be shown.

The word ‘Ready will also appear here, in white, when the Shutter Tester is able to perform another test.

At the bottom of the screen, the main readings repeated, but in a larger typeface and the total curtain travel times.

Readings that are out of specification will be highlighted in **Yellow** or **Red**, on the TFT screen depending on how far off they are.

Autoscaling
The mS and Seconds display on the two TFT large typeface screens & LCD auto-scale, to allow better granularity.

Diagnostics
The Shutter Tester carries out verification and fault diagnostics of the shutter cycle results.
This includes full flash synchronisation testing and will detect slow or sticking curtains, shutter capping, shutter bounce etc.

All data is output to the PC screen, but due to size limitations, not all error diagnostics can be displayed on the simple TFT or LCD.

Due to screen size restrictions, some of the errors & diagnostics shown can be a little cryptic. A more detailed explanation will be displayed on the PC screen.

LCD The first row are the legends for sensor 2, M and 1.

Second shows the calculated reading for each sensor in milliseconds, third row is in fractional seconds.

The last row, C2 & C1 show the time each curtain took to travel the distance between the outer sensors, in milliseconds.

If ‘B’ appears in the top row of the LCD, it is indicating that shutter bounce has been detected.

H or V will be shown briefly on the top row of the LCD, if sensor space has been set to 32mm (H) or 20mm (V).
This is overwritten with R (ready) when The Shutter Tester is able to perform another test.

If ‘F’ appears in the top row of the LCD, it indicates that a successful flash sync was detected.

LCD showing a successful test

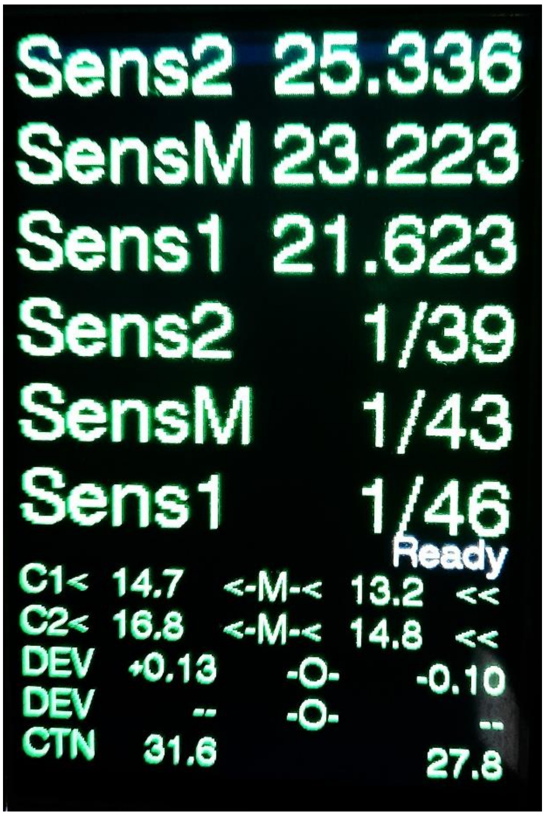
The PC screen gives a similar display to the TFT screen.

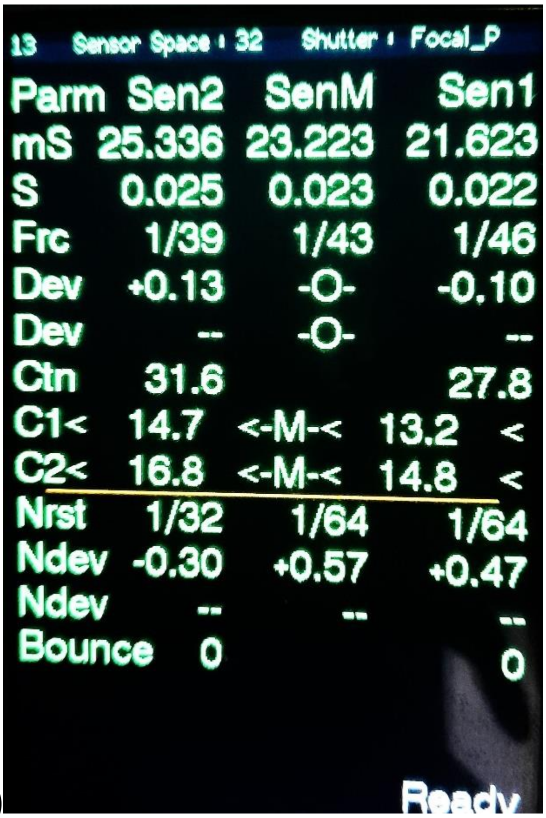
Each time the camera shutter is fired, the display will automatically update.

```
PARAMETER                         Sensor2      SensorM      Sensor1
□ Shutter Speed un-cal millis       728.5        741.5        753.4
 Shutter Speed un-cal Fraction      7/10         7/10         7/10

 Shutter Speed millis              726.9        740.0        751.8
 Shutter Speed Seconds             0.727        0.740        0.752

 Shutter Speed Fraction             7/10         7/10         7/10

 Deviation from centre decimal     -0.03         -O-          0.02
 Deviation from centre /3            --          -O-           --
 ----------------------------------------------------------------
 Shutter Speed Nearest               1/2          1/2            1

 Deviation from nearest decimal     0.54         0.54        -0.41
 Deviation from nearest /3        +0 1/3       +0 1/3       -0 1/3

 Curtain 2 & 1 Travel Millis        23.4                      48.3

 Curtain 1 travel time second half  26.7      first half      21.6
 Curtain 2 travel time second half  13.6      first half       9.8

 Curtains fully open (between the two sensors)
 Flash input not detected

 Curtain 1 travel time  2--<<<-- 26.7--<<<--M--<<<-- 21.6--<<<--1

 Curtain 2 travel time  2-<<<<<- 13.6--<<<--M--<<<--  9.8--<<<--1
 ================================================================
```

PC screen showing completed test.

Testing screen. (Simple Screens)





Whilst in the Testing Screen, pressing the **Blue** Button will cycle between the Detailed and the two Simple screens.

The two simple screens, show the basic results, but in a much larger typeface.
Note: - Due to limited space, flash & error details are not displayed.

Buttons.

Whilst in the Testing Screen, the Buttons have the following functions: -

Pressing Button1 **White** will show the average of (up to) the last ten readings.

Pressing Button2 **Yellow** whilst in the Average Screen, will clear the accumulated average readings.
Note this only works whilst in the Average screen.

Pressing Button3 **Green** will go to the Light-meter Utility

Pressing Button4 **Black** will go to the Alignment & Setup Utility.

Pressing Button5 **Red** will go to Optical LED Shutter Tester Utility.

Pressing Button6 **Blue** cycles between Detailed & Simple TFT displays.

Note: - Due to limitations of memory & speed, error checking cannot be performed for every permutation. So strange readings may occur for example, if fingers are waved across the lasers or a seriously badly behaving camera is being tested.

Testing Shutters.

For **Focal-Plane** horizontal shutters, the three sensors should be spaced the correct distance apart (32mm for horizontal cloth shutters, or as specified in the camera service manual). They should be around centre height of the film gate. With the Lasers also aligned in a similar manor.

For vertical shutters, the spacing is normally 20mm, with the sensors arranged vertically.

The Shutter Tester will then record multiple raw measurements from these three sensors during the shutter cycle to calculate the shutter speed and diagnose any issues that could not be seen with the naked eye. Shutter capping or sticky curtain, for example.

Within the build documents & Photrio thread, you will see many examples of how to mount the sensors and Lasers.

When using in **Single Sensor mode**, just Senor 1 is used. It can be useful for testing cameras like the Box Brownie, for example. If used for focal-plane shutters, the Laser/sensor pair can be placed anywhere within the film gate. This can be useful, for testing the mirror lift mech. For example, if the mirror is slow to lift and still within the film-gate when the curtains are open, a slower exposure would be recorded with the sensor at the top of the film gate, compared to that when in the middle. Note only raw readings will be given when using a single sensor. As this is an uncalculated value, the result will progressively under-read as shutter speed increases.

Leaf Shutters are a bit trickier to test. One has to measure the opening time of the shutter (T1) the fully open time (T2) and the closing time of the shutter (T3)
The formula to give shutter speed is then Te (effective exposure time) = T2 + (T1+T3)/2

For these measurements, Sensor 1 and Sensor 2 are used (Sensor M is not used).
Sensor 1 should be aligned dead centre of the leaf shutter, with Sensor 2 aligned on the extremity of the leaf opening. Ensure Leaf Shutter has been selected in the Alignment menu and also the Sensor Space parameter is set.

A quick alternate to lest leaf shutters, is to use Single Sensor Mode. you can measure the speed at the edge of the diaphragm stopped down by two to get a very close approximation of Te (effective shutter speed) with a single measurement. (Thanks to ic-racer for this information).

Note Leaf shutter functionality is experimental and has not been fully tested in the real world. So please be mindful of this when testing.

Data Logging.

The recorded test data can optionally be recorded to a csv file for reference or analysis.

Recording to SD card.
SD card must only be inserted when The Shutter Tester is powered off.
If an SD card is detected on power-on, a new csv file is created and the old one deleted.

The SD card must be pre-formatted in a PC to FAT32 and must be no larger than 32Gb.

In the Alignment & Setup Utility, selecting ScreenSD or USB&SD will cause the csv file to be appended with each set of test data, as it is performed.

This data can then be opened in a spreadsheet. Google sheets, Excel or Libre Office (a free & very good alternate to MS Office) for viewing & analysis.

Recording to USB.
In the Alignment & Setup Utility, selecting USB will cause the current test results to be written as a csv to the USB port. (also written to SD as described above if USB&SD is selected).

A suitable capture program will be required. Microsoft Excel has an add-in called 'Data Streamer' which will monitor and record the USB output directly to Excel.
Here is a video describing its setup & operation. Relevant information starts at 7.30
[(5) Arduino Data Logging with Microsoft Excel Data Streamer - YouTube]

An alternate is to use something like CoolTerm which records the output.
Relevant information starts at 7.30
[Save Arduino Serial Data to TXT, CSV, or Excel Using CoolTerm | Step-by-Step Guide]

Screen – output is sent to the PC screen (using a suitable serial monitor) in a humanised display format.
ScreenSD – output is sent as above and a csv log file is also written to the SD card.
USB – a csv log file is sent via the USB port. *Note the humanised PC screen will not be displayed.*
USB&SD csv log file is sent both to the USB port and SD card. *Note the humanised PC screen will not be displayed.*

Note :- whilst the file written to the SD card will be 'clean' without any additional text, some errors and messages are sent to the USB port (initial power-on, for example) and will be captured by a USB data logger.

TIME	CH1	CH2	CH3	CH4	CH5
19:15:10.84	Ready....				

Historical Data

TIME	CH1	CH2	CH3	CH4	CH5
19:15:01.56					
19:15:02.18	Ready....				
19:15:10.18	PARAMETER	Sensor2	SensorM	Sensor1	
19:15:10.18	Shutter Speed Millis	46.4	48.4	464.6	
19:15:10.19	Shutter Speed Fraction	1/22	1/21	1/2	
19:15:10.19	Deviation from centre decimal	-0.06	-O-	3.26	
19:15:10.20	Deviation from centre /3	--	-O-	3	
19:15:10.20	Curtain speed	2079.2	-O-	2497.4	
19:15:10.20	Curtain 1 speed	32.5	<<M<<	2464.9	
19:15:10.20	Curtain 2 speed	30.6	<<M<<	2048.6	
19:15:10.21	Curtain Bounce(s)	1	-O-	0	
19:15:10.21	Shutter Speed Av mS	236.9	64.4	270.2	
19:15:10.21	Shutter Speed Ave Frac	1/4	1/16	1/4	
19:15:10.21					
19:15:10.84	Ready....				

MS Excel Data Streamer

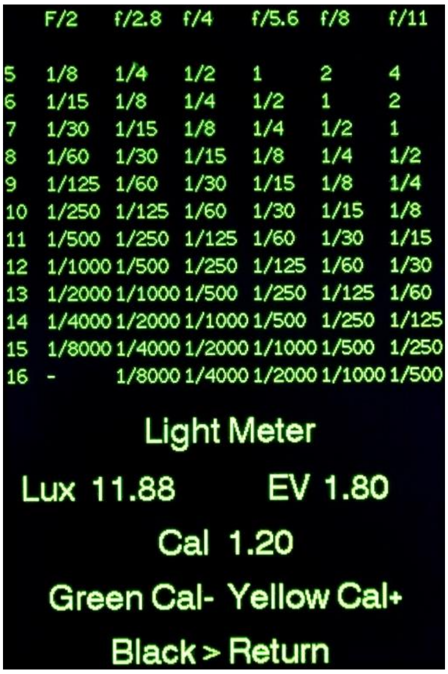
Testing Flash.

Connecting the Shutter Tester to the camera's flash socket will allow testing of the flash sync.
If a flash connection is detected, the tester will give a report after each shutter test.
It will detail the flash fired time in relation to the curtain travel & opening and whether flash sync is ok or not.

The report allows accurate setting of the camera flash contacts, to ensure the flash is trigged at the current time.
Both TFT and PC screen will show the report. Limitations of the LCD mean 'F' will be displayed if successful flash sync was seen

Note: - Flash sync is measured between the two outer sensors, so ensure the flash timing is not set at extremes of time measurements, else actual flash use may not be in sync.

Light-meter Utility.



	F/2	f/2.8	f/4	f/5.6	f/8	f/11
5	1/8	1/4	1/2	1	2	4
6	1/15	1/8	1/4	1/2	1	2
7	1/30	1/15	1/8	1/4	1/2	1
8	1/60	1/30	1/15	1/8	1/4	1/2
9	1/125	1/60	1/30	1/15	1/8	1/4
10	1/250	1/125	1/60	1/30	1/15	1/8
11	1/500	1/250	1/125	1/60	1/30	1/15
12	1/1000	1/500	1/250	1/125	1/60	1/30
13	1/2000	1/1000	1/500	1/250	1/125	1/60
14	1/4000	1/2000	1/1000	1/500	1/250	1/125
15	1/8000	1/4000	1/2000	1/1000	1/500	1/250
16	-	1/8000	1/4000	1/2000	1/1000	1/500

TFT Light-Meter screen

The Light-meter Utility will show the Lux light level and EV, based on 100 iso, in the range **EV 0 to 15**
The calibration value of the sensor is also shown. If the user has access to a calibrated Lux meter, calibration of the shutter tester light meter can be achieved by pressing **Yellow Button** or **Green Button** to change the calibration figure between the value of 0.94 and 1.44. Default setting is 1.20

The displayed light-meter reading is automatically updated as the light level changes.

The TFT shows an EV chart, based on 100 iso from EV 5 to 16. If the light-meter reading falls between **5-15**, the corresponding EV row will be highlighted.

Note :- Light-Meter reads from EV 0 to 15 only.

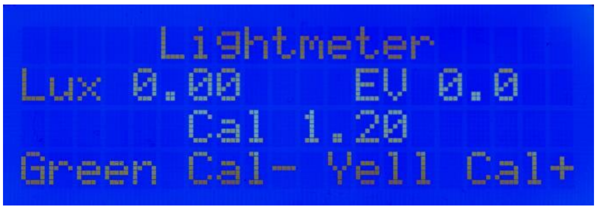
A full EV chart is included at the end of this document.

Pressing Button4 **Black** will exit the utility.

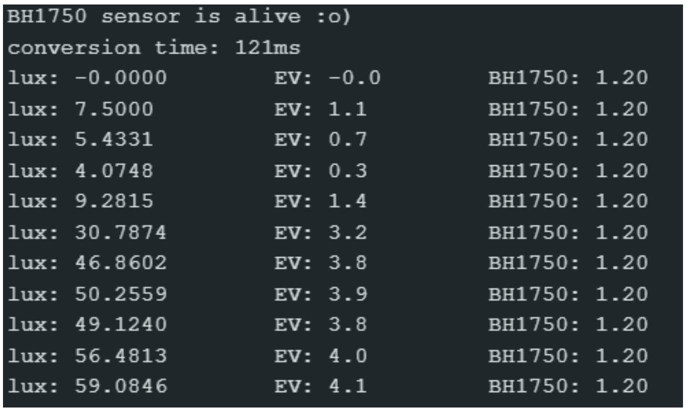
Pressing the **Green Button** will increase calibration value.

Pressing the **Yellow Button** will decrease calibration value.

The LCD shows Lux, EV, Cal value & button legends.



LCD showing Light-meter screen



```
BH1750 sensor is alive :o)
conversion time: 121ms
lux: -0.0000        EV: -0.0        BH1750: 1.20
lux: 7.5000         EV: 1.1         BH1750: 1.20
lux: 5.4331         EV: 0.7         BH1750: 1.20
lux: 4.0748         EV: 0.3         BH1750: 1.20
lux: 9.2815         EV: 1.4         BH1750: 1.20
lux: 30.7874        EV: 3.2         BH1750: 1.20
lux: 46.8602        EV: 3.8         BH1750: 1.20
lux: 50.2559        EV: 3.9         BH1750: 1.20
lux: 49.1240        EV: 3.8         BH1750: 1.20
lux: 56.4813        EV: 4.0         BH1750: 1.20
lux: 59.0846        EV: 4.1         BH1750: 1.20
```

PC screen showing Light-meter screen

Note:- DO NOT use the lasers as a light source. The user will have to provide their own light. Maybe a dimmable LED light panel or a photographic continuous light. Note some LED panels are PWM (which cause flickering) rather than current controlled, so can create issues and cause continually changing values.

Link to a good web recourse for measuring light & EV

[Understanding Exposure Value, with calculator and EV chart (including for third stops) (scantips.com)]

Optical Shutter Tester.

For full instructions on using the Optical Shutter Tester, please read the user guide for the stand-alone version.

The notes below are just a brief overview.

LCD screen when Optical Shutter Tester is selected

The LED matrix can be accessed by pressing the **Red Button**.

It works in the same way as the old idea of photographing a CRT (old fashioned television screen), the strobing effect can give an indication of the camera's shutter speed. It is not terribly accurate so should be used as an indication only. Whilst it shows shutters that are slower than the set speed, it will not show shutter speeds that are faster than the set value.

The matrix will display the speed 1/30s and then start strobing a row of LEDs moving to each new row at 1/30s intervals.

When photographing, or looking though the film gate of a film camera, if the shutter speed is correct, one or two rows of LEDs should be seen.

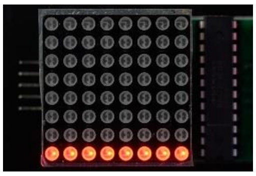
If more than two rows of LEDs are seen, it is an indication that the shutter speed is slow.

Pressing the **Red Button** will increase the strobing speed to the next standard shutter speed. Each shutter speed can be tested in a similar manor.

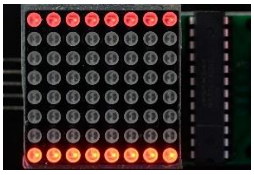
For a digital camera, take a photo & review it. For a film camera, open the back of the camera and look through the film gate when taking a photo.

Camera & tester set at

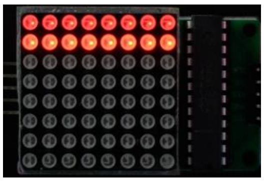
1/30s



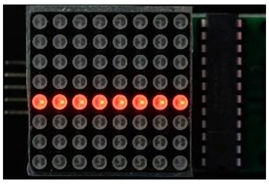
1/60s



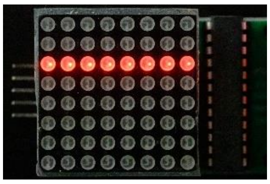
1/125



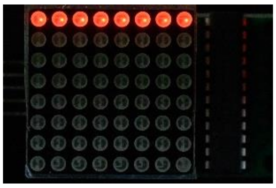
1/250s



1/500s



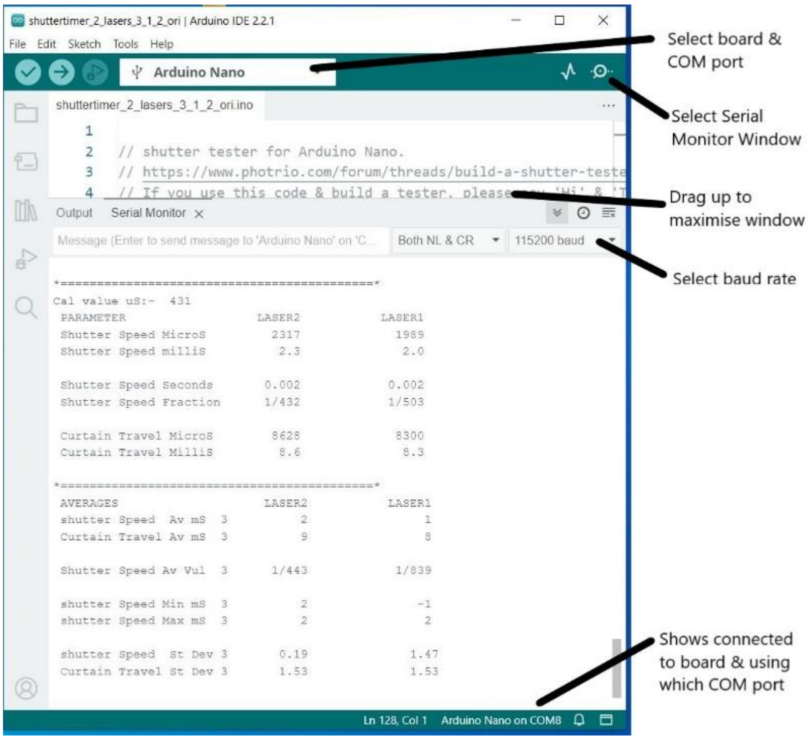
1/1000s



Computer Screen Display

Similar information as shown on the TFT can be displayed on the computer screen.
For this, a computer program called 'Arduino IDE' will be required. See separate document of how to install this program. You can use another serial monitor program if you wish.

In the top drop-down box, select your board and com-port. Note: - a new install of Arduino IDE will not recognise an ESP32 board. Just select Nano.
Select 'Serial Monitor by clicking the icon as shown.
The Serial Monitor window will be small, so drag the bar up, to make it larger
Select the correct baud rate of 115200 for Esp32.



The display follows a similar format to that of the TFT, but sometimes with more information.

Shutter bounces will be shown, as well as flash sync report.

Averages are updated and displayed. The number of cumulative tests used to calculate the average are shown (in this picture, 3 can be seen).

A maximum of ten individual tests are used to calculate the average. After this, the oldest is lost from the calculation and the latest reading added.

Note :- Output to a USB data-logger and a humanised PC display cannot be used simultaneously, as they both use the same USB port.

The Standard EV chart of Full stops

EV	EV Chart of Full stops										EV
	f/1.4	f/2	f/2.8	f/4	f/5.6	f/8	f/11	f/16	f/22	f/32	
0	2"	4"	8"	15"	30"	64"	128"	256"	512"		**0**
1	1 sec	2"	4"	8"	15"	30"	64"	128"	256"	512"	**1**
2	1/2	1 sec	2"	4"	8"	15"	30"	64"	128"	256"	**2**
3	1/4	1/2	1 sec	2"	4"	8"	15"	30"	64"	128"	**3**
4	1/8	1/4	1/2	1 sec	2"	4"	8"	15"	30"	64"	**4**
5	1/15	1/8	1/4	1/2	1 sec	2"	4"	8"	15"	30"	**5**
6	1/30	1/15	1/8	1/4	1/2	1 sec	2"	4"	8"	15"	**6**
7	1/60	1/30	1/15	1/8	1/4	1/2	1 sec	2"	4"	8"	**7**
8	1/125	1/60	1/30	1/15	1/8	1/4	1/2	1 sec	2"	4"	**8**
9	1/250	1/125	1/60	1/30	1/15	1/8	1/4	1/2	1 sec	2"	**9**
10	1/500	1/250	1/125	1/60	1/30	1/15	1/8	1/4	1/2	1 sec	**10**
11	1/1000	1/500	1/250	1/125	1/60	1/30	1/15	1/8	1/4	1/2	**11**
12	1/2000	1/1000	1/500	1/250	1/125	1/60	1/30	1/15	1/8	1/4	**12**
13	1/4000	1/2000	1/1000	1/500	1/250	1/125	1/60	1/30	1/15	1/8	**13**
14	1/8000	1/4000	1/2000	1/1000	1/500	1/250	1/125	1/60	1/30	1/15	**14**
15		1/8000	1/4000	1/2000	1/1000	1/500	1/250	1/125	1/60	1/30	**15**
16			1/8000	1/4000	1/2000	1/1000	1/500	1/250	1/125	1/60	**16**
17				1/8000	1/4000	1/2000	1/1000	1/500	1/250	1/125	**17**
18					1/8000	1/4000	1/2000	1/1000	1/500	1/250	**18**
19						1/8000	1/4000	1/2000	1/1000	1/500	**19**
20							1/8000	1/4000	1/2000	1/1000	**20**
EV	**f/1.4**	**f/2**	**f/2.8**	**f/4**	**f/5.6**	**f/8**	**f/11**	**f/16**	**f/22**	**f/32**	**EV**

Accuracy of The Shutter Tester.

There has been much comment on the accuracy of DIY shutter testers, and I agree with all of them.
Of all of the free tester designs & code I have looked at, not one discusses or accounts for the fundamental reason for inaccuracy. We are trying to measure a single photon, for practical purposes it has a width 0, with a sensor, whether it be a Light Dependant Resister (LDR) or a light switching transistor, which has width. Thus, one measures not only the width of the curtain gap, but also that of the sensor hysteresis.

As an example, a horizontal focal plane shutter with sync speed of 1/30s will have full curtain opening (we measure the curtain slot as 32mm between sensors).
With sensor spacing of 32mm, it gives us a ratio of 1:32 (assuming a 1mm sensor).

Now, take this to 1/500s. The slot width will be 2.25mm, so the ratio is now 1:2.25

So we see, as the speed increases (in reality the speed stays the same, it is the slot width that narrows), the ratio reduces, sensor width becomes an increasing part of the measurement, at 1/500s it adds almost 50% onto the reading!

Similarly, when I look at pre-built testers available today, not one of them discusses the issue above. Having not tested them myself, I cannot say whether the designer understands and accounts for the issues described above.

How do we correct for these errors? There is no simple solution. In the example above, this was for a flash sync speed of 1/30s. One cannot just add a bias or fixed calibration value. What if the sync speed is 1/25s, or the curtains are not adjusted to give specific gaps.

Some cameras also increase the curtain gap as the shutter travels. This is to even exposure as the curtains accelerate from stationary to their maximum speed across the film-gate.

The simplest way to reduce this error is to minimise the sensor area. However, light still has to get to the sensor, so making a mask with a hole can only be so small. Looking at the old professional testers form the 70s. They were filled with logic & counter chips, before the dawn of embedded microcontrollers.

They cleverly had bespoke LDRs which were long, but thin, hidden behind a long thin slot. This way much light in the same plane as the shutter could fall onto the sensor. Of course, these sensors are long out of production today and even then, as they still had width, would introduce error.

How does The Shutter Tester solve this issue? Using a fast, modern microcontroller, The Shutter Tester takes (up to) twelve separate readings during the shutter cycle. These readings are then verified and a computed shutter speed is calculated using the power of the microcontroller and an algorithm, to arrive at the actual shutter speed.

However, as a caveat, one must not get hung up on ultimate shutter accuracy. An older camera without electronic timing, relies on springs and clockwork. Temperature, humidity & how many times the shutter is fired in succession, will all vary the results. Trying to get an older camera spot on, will drive you mad. Just strive for consistency within the iso tolerance.

We also have to consider when and where to take the measurements. The curtains start from a speed of zero and accelerate. Depending on spring tension, they may continue to accelerate before hitting the end-stop. Or the spring may tire and they slow down part way through travel. The second curtain may be tensioned differently or snag slightly during its travel. So ‘accuracy’ can only go so far and one tester design may give slightly different results to another, but both maybe considered accurate.

Shutter Speed. We often use the term Shutter Speed, when we really mean exposure. In reality, it is the time before second curtain release, thus the gap between first and second curtain which determines exposure. The speed of the curtains should remain as constant as possible. In this document Shutter Speed has been used to mean exposure.

An extract from a kosmo foto article

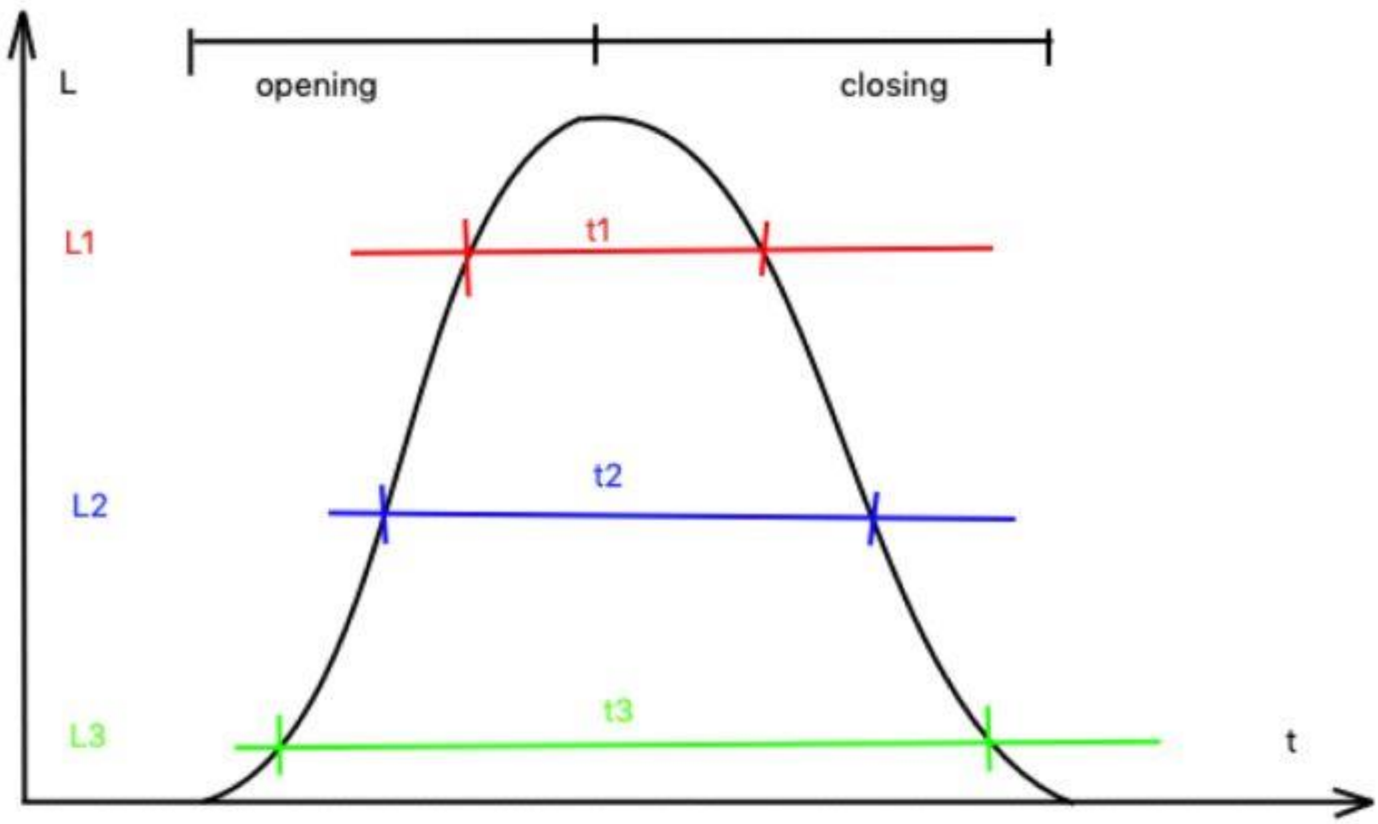
An extract from a kosmo foto article, detailing shutters and the testing of them. I agree with every word, **which is why the multitude of DIY shutter testers available, either to purchase or make oneself, are simply inaccurate at higher speeds.**

"The real switch of the sensor from light to dark comes not at the actual time of the curtain moving against the sensor, but at time when the actual light stream is reduced to what the sensor believes is dark, and sensor may have some inertia too. Also, the point of switching from light to dark is not the same as the point of switch from dark to light. So, sensors have their own characteristics that affect metering.

In this case we can reach an important conclusion: the shorter metered time, the more influence physical features of the device has on accuracy. In other words, the shorter the time measured, the more likely there will be an error in the metering".

And for leaf shutters, things get worse for leaf shutters

"And finally the case of the shortest speed. Leaves open – leaves close. No delay. Shutter did not stay in the fully opened position. And in this case the result of metering is not dependent on the shutter! The result is dependent on device characteristics only! In Picture 5 I show three possible levels of the switching sensor: L1, L2, L3. Using those levels we can get three values of the metered time t1, t2, t3. And all the values will be correct. But they will reflect not the shutter speed, but the internal setting of the metering device".



"And now some final conclusions:

- *The metered value always contains an error.*
- *With a faster shutter speed, the margin of error in the metered value is greater.*
- *Never use as the correct value the metered value based on the fastest shutter speed, especially for leaf-shutter cameras"*

Below is a diagram and explanation of leaf shutter testing

The diagram below illustrates the operating cycle of a leaf shutter and how effective exposure is determined. According to it, the formula of Te (effective exposure time) looks like this: Te = T2 + (T1+T3)/2.

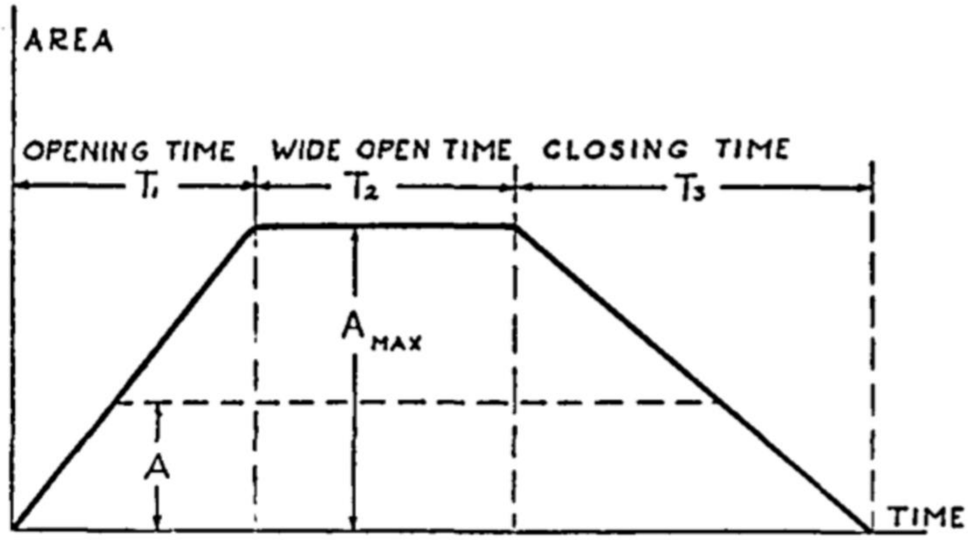


FIG. 1. Efficiency curve of a between-lens shutter.

ISO table showing shutter speed tolerance

Table A.1 — Calculated target values of exposure times over the range of 0 °C to 40 °C

Nominal exposure time values	Calculated exposure time values			Upper admissible values of exposure time			Lower admissible values of exposure times		
s	*n*	s	ms	*b*	s	ms	*b*	s	ms
8	− 3	8	8 000		9,85			6,50	
4	− 2	4	4 000		4,92			3,25	
2	− 1	2	2 000		2,46				1 625
1	0	1	1 000			1 231			812
1/2	1	1/2	500			616			406
1/4	2	1/4	250	− 0,3		308	+ 0,3		203
1/8	3	1/8	125			154			102
1/15	4	1/16	62,5			76,9			50,8
1/30	5	1/32	31,3			38,5			25,4
1/60	6	1/64	15,6			19,2			12,7
1/125	7	1/128	7,81			9,62			6,35
1/250	8	1/256	3,91			5,34			2,86
1/500	9	1/512	1,95			2,67			1,43
1/1 000	10	1/1 024	0,98	− 0,45		1,33	+ 0,45		0,71
1/2 000	11	1/2 048	0,49			0,67			0,36