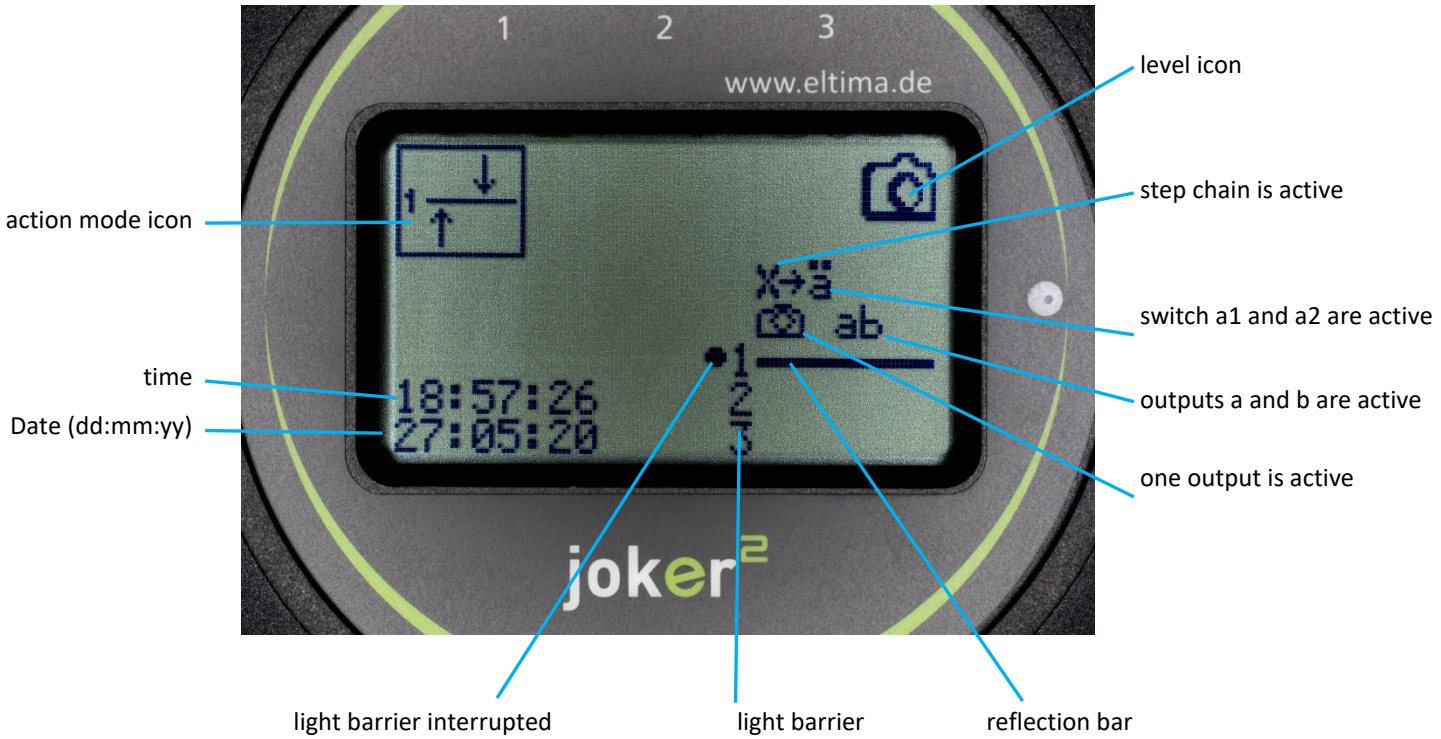
Instruction manual

Light barrier system joker²

Version 12. 2020

From software version: 2.2.2.0

eltima electronic



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Introduction

Dear Customer,

thank you for purchasing the **joker²** light barrier system. Developed and manufactured with great care, it should be a reliable tool, handy and easy to use, which leaves little to be desired.

If you have wishes and suggestions for improvement, please do not hesitate to share them with us, so this product may grow to meet your needs.

Please read the instruction manual carefully before you use the light barrier system. It will familiarize you with the operation and functioning of this system. This way you can fully use the advantages offered by this system.

Symbols


Note symbol for tips on handling of the device.


Important note on the function of the device.


Important note to avoid damage to the device or the devices connected to it.

Purpose of use

The light barrier system **joker²** is designed exclusively for triggering photographic equipment such as cameras, speedlights, filming devices, etc... Only use it for this purpose! The improper use of the device can cause damage to the light barrier system or the connected devices. In this case, the warranty will be void.

Maintenance and storage

- The light barrier system is not waterproof and is not suitable for use in the rain or under water. If the device gets wet, contact the manufacturer. Water drops can be wiped with a dry cloth.
- Never drop the device and avoid rough impacts or vibrations.
- This device is a precision electronic system. Do not attempt to make changes by yourself.
- If you plan to not use this device for a longer period of time, remove the batteries from the battery case to avoid leakage.
- Clean the lenses of the light barrier with a soft cloth from time to time.

Quick start

A chapter for those in a hurry…

Inserting the batteries

- Open the battery cover on the backside of the controller, Figure 1.

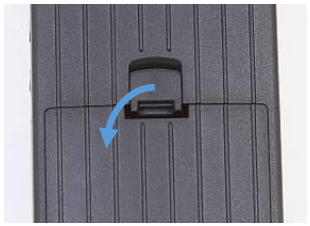


Figure 1: Opening the battery cover

- Insert three cells of the type AA/LR6 in the battery compartment. Put them into the outer slots first, then into the middle one, see Figure 2.

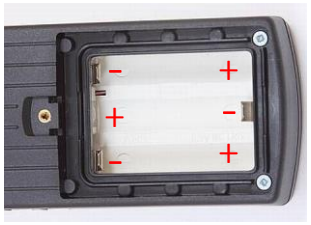


Figure 2: Inserting the batteries

Please observe the polarity!

- Close the battery cover.

Setting up the light barrier

- Plug one of the light barriers into the plug 1.
- Mount the light barrier and one reflector on a tripod each.
- Place the light barrier and reflector opposite to each other at a distance of about 1 m, see Figure 3.

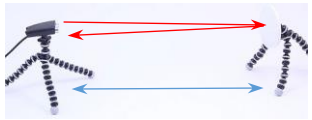


Figure 3: Setting up the light barrier

Note: This distance is arbitrary and is neither the smallest nor the greatest distance between light barrier and reflector that can be achieved.

- Turn on the **joker²** controller by pressing the ⏻ button for at least 2 seconds. The display will show the working level, see Figure 4, marked by the 📷 icon.

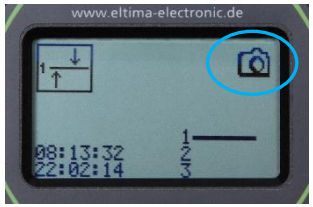


Figure 4: Working level

- Touch the ▲ button. The alignment level will show, marked by the icon, see Figure 5.

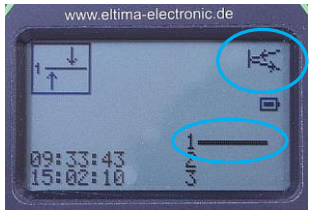


Figure 5: Alignment level

- Now point the beam of the light barrier at the reflector. The length of the reflection bar, Figure 5, indicates the degree of reflection coming from the reflector. Adjust the light barrier horizontally and vertically until the reflection is maximum, then tighten the barrier on the tripod.
- Connect the camera with the adapter set to one of the outputs a to d of the controller.
- Place the camera with the image plane parallel to the light beam, see Figure 6.

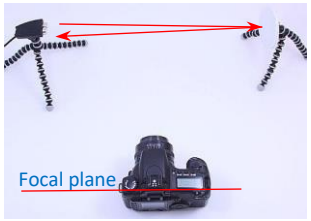


Figure 6: Setting up the camera

- Place a sharply contrasting object near the middle of the beam, turn on your camera, and focus on the object.
- Then set the autofocus on "manual" and remove the focus object.
- Touch the button to return to the working level. With this step, the light barrier is trained to the particular level of reflection when the beam is not interrupted. The system is now ready. Interrupting the beam will trigger the camera.

Taking photos

- Let your subjects interrupt the light beam.

The optimal framing of the camera (Zoom level or distance from the beam) and the plane of focus depend on the direction and speed of your subject, as well as on the shutter lag of the camera. Adjust the focus setting and the image frame after each shot, until you achieve the desired result.

- If you want to change the setup or the position of the light barrier, switch again to the alignment level. Change the setup and switch back to the working level

Turning off the controller

- Briefly press the ON/OFF button.

Operating concept of the joker² controller

The controller is operated and set up through a number of “levels”, in which the function of the system can be observed or parameters can be changed. Each level is marked by an icon in the upper right corner of the display.

Except for the on/off button all control buttons are designed as touch sensors (without tactile feedback).

The following levels are available in the specified order:

- Working and set-up levels:
  - Working level
  - Alignment level
- Parameter levels:
  - Basic Parameters
  - Parameters for output a
  - Parameters for output b
  - Parameters for output c
  - Parameters for output d
  - Parameters for experimental photography, steps, or X-levels X1 - X9
  - System parameters

To move along the levels, touch the ▲ or ▼ key.

The ESC key allows switching from any level, except the working level, to the alignment level.

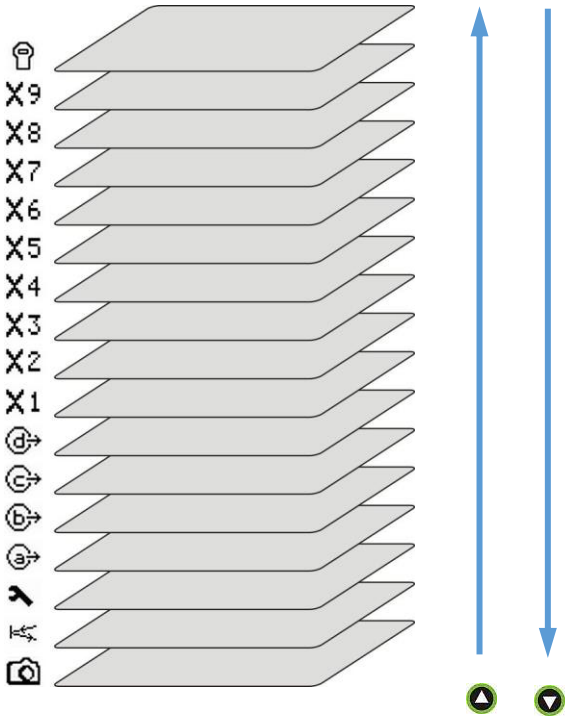


Figure 7: navigating through the levels

If the levels X1 - X9 for experimental photography are not needed these can be hidden. To do this set the system parameter "Exp mode" to "no", see *Displaying the X-Parameters* on page 38.

Changing a parameter value

The basic procedure to change a parameter value is described for the parameters for output level a as an example.

- To select a parameter, move the cursor up and down using the ↑ or ↓ keys, see Figure 8.
- Touch the → button, the cursor will move to the parameter value. If the parameter value is a multi-digit number, the cursor moves to the highest digit. You can reach the desired digit of a number using the → or ← key, see Figure 9.

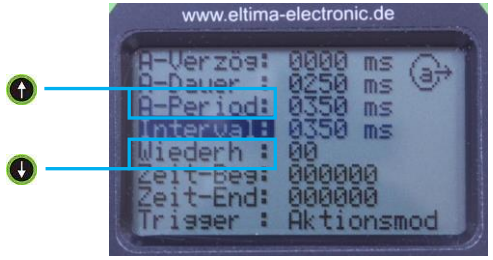


Figure 8: Selecting a parameter

For some parameters the units can also be set (µs=microseconds, ms=miliseconds, s=seconds or m=minutes). Use the → key to get to the units.

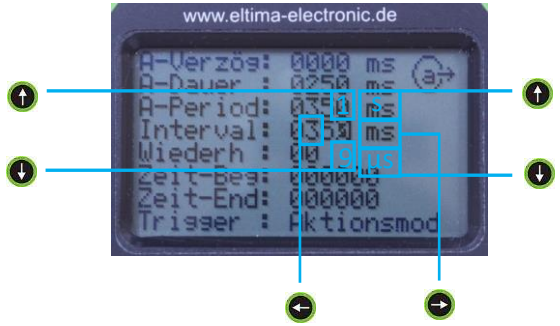


Figure 9: Selecting a parameter value

- To change a digit or units touch the ↑ or ↓ key, see Figure 9.
- To save the change, touch the OK button.
- To discard the change, touch the ESC button.

The action modes in the basic level are changed in the same way as other parameters. Select the action mode parameter in the parameter level the basic mode and touch the → button. Change the action mode touching the ↑ or ↓ button.

Functional principle of the joker² light barrier system

Functionally, the light barrier system consists of an analog and a digital part. The analog part controls and monitors the light barriers, the digital part controls the outputs.

The analog part

The analog part controls and monitors up to the three light barriers connected to the system. It captures their status and, if one has been interrupted, it passes this information as a trigger to the digital part.

The reflex barrier

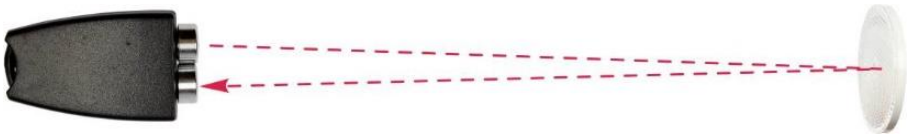


Figure 10: Reflex barrier

The light barriers of the joker² system are designed as reflex light barriers. The transmitter and receiver are in the same housing.

The transmitter emits fast successive infrared light pulses, which are reflected by a reflector and sent back to the receiver. The strength of the reflection is shown by the reflection bar, see Figure 11.

If at least one pulse is missing, or is received very weakly, e.g. because an object is in the beam, the light barrier is considered to be interrupted. This status is reported as a trigger to the digital part, which will now control the outputs a to d. At the same time, the interruption is indicated with a dot next to the reflection bar, see Figure 12.

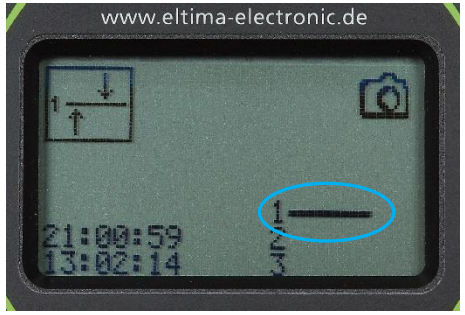


Figure 11: Reflexion bar

The subject itself can also serve as a reflector. In this case, the light barrier acts as a light sensor. This operating mode can be selected in the basic parameter level. It can be set individually for each of the three light barriers. In this mode, however, the range is much smaller in comparison with using a reflector. The range essentially depends on the reflective properties of the subject.

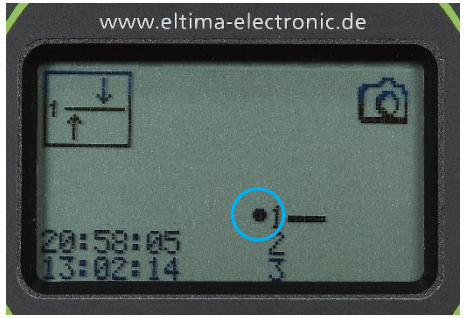


Figure 12: Light barrier interrupted

The light beam

As described, the light barrier emits fast successive invisible infrared light pulses (one pulse of 10 µs each 200 µs), which are sent back by a reflector to the receiver. The receiver needs to receive back a certain amount of the emitted light of each pulse. This amount of light is determined during the training process, see section *The training process*. If it changes by a measure that was defined with the **`sensitivity`** parameter, the light barrier is considered to be interrupted and a trigger is reported to the digital part.

Due to the characteristics of the optical components, combined with the reflective properties of the retro reflectors the beam path is fairly complex. However, in a simplified way, it can be explained as follows:

Figure 13: Sections of the light beam

The path between the light barrier and reflector, hereinafter called working distance, can be roughly divided into three sections.

The middle section marked green is the "normal" working section of the light barrier. Depending on the reflector and the selected working distance the effective "beam diameter" is about 2 - 5 mm. An object must cross this beam in order to trigger the light barrier. This small diameter leads to a very precise and reproducible switching point of the light barrier.

In the orange section, close to the reflector, the sensitivity decreases and small objects will no longer be reliably detected because light may be reflected around the object.

In the blue area near the light barrier, the outgoing beam from the transmitter, and the reflected beam coming to the receiver are farther apart, resulting in a more complex pattern, and less predictability as to where an object might trigger the light barrier.

In the green area, the two beams are so close together they can be considered as a single beam.

As a result, the system should optimally be set up so that the subjects will cross the light beams in the green area, which is roughly the middle one third to two thirds of the working area.

The reflectors

The scope of delivery of the **joker²** light barrier system includes three 8 cm retro-reflectors. They consist of a circular plate with many honeycomb corner reflectors.

Corner reflectors have the property that they reflect light back to its source with a minimum of offset. Figure 14 shows the operating principle of a corner reflector.

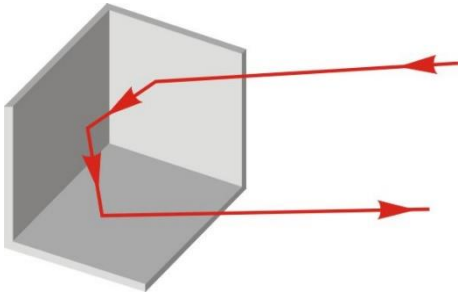


Figure 14: Corner reflector

Due to this property a retro reflector, in comparison to a mirror, does not need to be aligned exactly towards the light barrier. It is sufficient to be aligned roughly towards the light barrier. Only for reaching the maximum working distance does the reflector need to be aligned exactly.

The action modes

The **joker²** light barrier system offers the possibility to combine the three light barriers in different ways. Such a combination within this light barrier system we call an "action" mode.

Certain states of the light barriers involved are assigned to each action mode. As soon as these states become ‘true’, the action mode is considered to be met. This status is then reported to the digital part as a trigger for an action.

Each action mode is represented by a pictogram. In these pictograms, the numbers 1 to 3 indicate the light barriers involved.

A parameter set is saved for each action mode, which determines the optical and timing behaviour of the light barriers.

The one beam barrier

Symbol:  , Level: 🔧

The one beam barrier consists of the beam of the light barrier 1. If this is interrupted, the action mode is met.

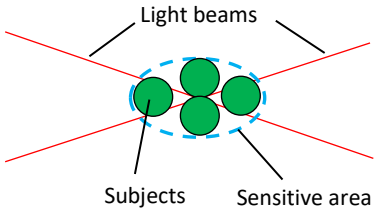
After the action mode is met, the light barrier must first be reset (the obstacle mist move from the beam) before a new action can be triggered.

The cross barrier

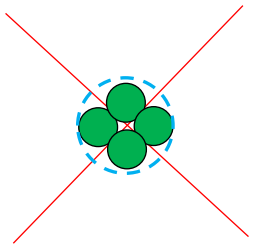
Symbol:  , Level: 🔧

In order to increase the selectivity, the cross barrier can be used. It is formed by the light barriers 1 and 2, which are linked by a logical AND. This means that the action mode is met if both light barriers are interrupted at the same time (1 AND 2).

The light beams are typically arranged crosswise and in one plane. The action mode is met, when the subject interrupts both light barriers at the crossing point. Thus it is possible to have more precision on the subject location and arrange the artistic composition of a picture



The point or rather the "sensitive" area in which the action mode can be met depends on both the size of the subject and the angle that the two beams form. If the light beams cross at an angle of 90°, the area is the smallest. Furthermore, the larger the subject, the larger the sensitive area.



However, the light beams do not necessarily have to be arranged crosswise in one plane. They can be arranged anywhere in space. The action mode will be met when both light beams are interrupted at the same time.

Once the action mode is met, both beams must be reset before a new action can be triggered.

The directional barrier

Symbol:  , Level: 🔧

The directional barrier is formed by the light barriers 1 and 2. The action mode is met if at first the light barrier 1 and subsequently the light barrier 2 is interrupted.

When light barrier 1 is interrupted, the system is activated and waits for light barrier 2 to be interrupted. If this happens, the action mode is deemed to be met and the status is reported to the digital part as a trigger.

If an object first moves through light barrier 2 and then through 1, i.e. in the opposite direction, no trigger is issued.

Once the action mode is met, both beams must be reset before a new action can be triggered.

When setting up the direction barrier, care must be taken to ensure that the objects move through both beams. If an object only interrupts light barrier 1 and not light barrier 2 (e.g. because it stops or changes direction) the system will still be activated. If an object then comes from the "wrong" direction, i.e. from 2 to 1, the action mode will be met and the trigger set when light barrier 2 is interrupted. If the object continues to move and now also interrupts light barrier 1, the system will be reactivated. So the direction becomed reversed!

To get back to the initial direction an object must cross the barriers from 1 → 2.

The curtain barrier with two or three beams

Symbols:  or  , level: 🔧

To increase the detection rate, a curtain barrier can be used. In this mode, the system effectively scans an area formed by two or three light beams. The light barriers are linked by a logical OR. This means that the action mode is met, any one of the light barriers is interrupted.

Usually the participating light barriers would be set up parallel in a plane (to make the position of the subject more predictable), but they could be set up facing any direction.

In this mode, any beam that is interrupted must be reset before a new action can be triggered even by a different beam.

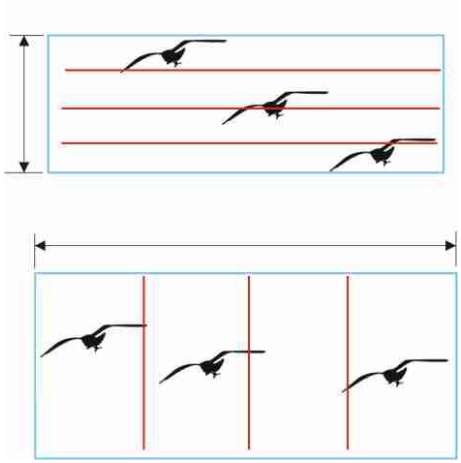


Figure 15: Curtain barrier

Note: Depending on the application, it can be advantageous to set up the light barriers vertically, as in the example in Figure 15. In this case the wide wingspan of the bird allows the beams to be placed farther apart, increasing the area of detection (blue rectangle). In the horizontal arrangement the birds present a narrower target, so the beams must be closer together and the active area is much smaller.

The three beam cross barrier

Symbol:  , Level: 🔧

Just like the simple cross barrier, the three beams barrier increases the selectivity of the system. The light barriers are linked by a logically AND. The action mode is met when all three light barriers are interrupted at the same time, at which point the trigger will be passed on to the digital part.

The light barriers do not need to cross in one point.

For example in the setup in Figure 16, the large animal is detected, because it interrupts all three light barriers, but the small is not because it could only interrupt at most one barrier.

Once the action is met, all three beams must be reset before a new action can be triggered.

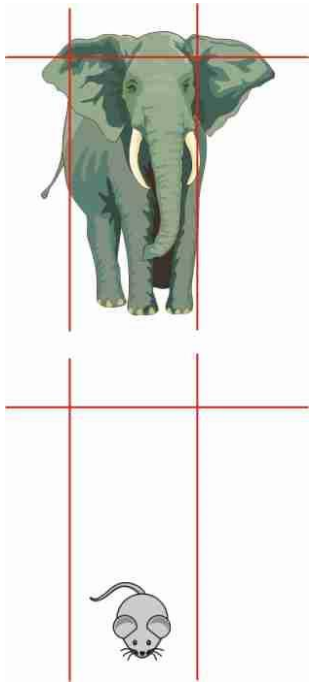


Figure 16: Blanking out of small objects

The directional cross barrier

Symbol:  , Level: 🔧

The directional cross barrier is a combination of a directional and a cross barrier. The action mode is met if at first the light barrier 1 and subsequently the cross barrier formed by 2 and 3 is interrupted.

When light barrier 1 is interrupted, the system is activated and waits for the cross barrier to be interrupted. Once this happens, the action mode is deemed to be met and the trigger is passed on to the digital part. As with the simple directional barrier, the action may not work as predicted if an animal interrupts barrier 1, but then does not pass the cross barrier.

Once the action mode is met, all three light barriers must be reset before the system is ready for the next sequence.

The time trigger

Symbol:  , Level: 🔧

Time-scheduled recordings can be made with the time trigger. For this a start time, an end time and a programmable trigger period are available. The action mode shall be deemed to be met, if the start time is reached and subsequently whenever the programmed period has expired until the end time is reached. This mode can be used for time lapse photography, for example.

For this action mode no light barriers are needed.

The parameters of the action modes

Each action mode has several parameters that determine their behaviour. Once they are changed, they are saved together with the respective action mode, and will be remembered even if the system is turned off.

Sensitivity 1 - 3

Name	Default setting	Range	Level
sensit 1	6	1 - 9	
sensit 2	6	1 - 9	
sensit 3	6	1 - 9	

The optical sensitivity of each individual light barrier can be set with this parameter. The value 1 represents the highest sensitivity, 9 the lowest. The smaller the value, the more sensitive the barrier will be to a small change in reflectance, allowing smaller objects to be detected. The larger the value, the less sensitive the barrier, and the larger an object must be.

In the case of working without a reflector, the parameter determines the minimum amount of light that must be reflected by the subject to set a trigger.

This parameter can be used, for example, to blank out small objects in favour of large ones. For example, when photographing mammals larger values should be set so there will be no false triggering due to small objects such as insects passing by.

Select the sensitivity as low as possible (the number should be as large as possible). The higher the sensitivity (lower the number), the more challenging the requirements are for the setup of the light barriers and reflectors. They must be very stable to minimize the risk of false triggers. If the sensitivity is at its highest level (i.e., 1), even slight vibrations or shocks can change the reflection enough to lead to unwanted triggers.

Range

Name	Default setting	Range	Level
Range	**distance**	**sensitive/ distance**	

The **range** parameter controls the power of light the infrared transmitter emits per pulse. The quantity of light affects both the range and the sensitivity of the light barriers.

The "normal" working range is **distance**. With this setting a range of approx. 10 m between the light barrier and the reflector can be achieved. The sensitivity is enough to photograph also small subjects like insects. With the setting **sensitive** the light barrier can react to objects down to 0.5 mm.

When photographing of very small objects at working distances less than 60 cm we recommend the use of 40 mm reflectors (not included in the scope of delivery).

Dwell Time

Name	Default setting	Range	Level
dwelltim	**0000**	**0 ms - 60 minutes**	

The **dwell time** determines the time an object must stay in the beam of the light barrier to be considered interrupted.

Using this parameter, fast moving objects can be blanked out in favour of slow ones.

For example, a longer res time can be used to prevent rain drops, snowflakes or insects buzzing around from causing unwanted triggers when photographing mammals.

Wherever a fast response time is important, this parameter should be set to 0 (the default).

Scanning mode

Name	Default setting	Range	Level
scan 1	**with refl**	**with refl, without ref, passive**	
scan 2	**with refl**	**ditto**	
scan 3	**with refl**	**ditto**	

This parameter defines the scanning method for the three light barriers, and has three different settings.

The typical scanning method is "**with reflector**". In this case, as already described, the light barrier works with a reflector. This setup allows for an extremely accurate switching point and a very high repeatability. In addition, the working distance is greatest when using a reflector.

When working **without a reflector** the subject acts as reflector. As soon as a certain amount of light, which is determined by the parameter **sensitivity** is detected by the receiver, a trigger will be issued.

In the mode **without reflector** the range essentially depends on the reflective properties of the subject. It is recommended to set the scanning method to **distance**.

Since no defined beam is interrupted in this operating mode and the reflection of the beam depends very much on the geometry of the subject, the switching point cannot be predicted as precisely, and some subjects may be missed.

Nevertheless, working without a reflector can be very useful in situations where no high range is required and the installation of a reflector causes problems. In that case, the inaccuracy of the switching point can be accepted and compensated with a higher depth of field.

In the **passive** scanning mode the IR transmitter is shut down and the receiver waits for rapid changes of light in the infrared range. This mode allows, for example, pictures of lightning by day or by night.

The digital part

The digital part receives the trigger of the analog part and controls the outputs.

The Outputs

The **joker²** light barrier system has four equivalent outputs, a to d, which can control various devices. These can be cameras, flash devices, solenoid valves, relays, etc...

Each output has two solid state switches to turn on and off the connected devices. If the connected device is a camera, then switch 1 is equivalent to half pushing the release button (which will activate the camera) while switch 2 is equivalent to fully pushing the release button, which will activate the shutter. Usually the two switches of the **joker²** system are turned ON or OFF at the same time.

A number of parameter determine the behaviour of the outputs. These are stored in a non-volatile memory as a parameter set for each output.

A trigger condition must be met for an output to switch. The trigger is set by the analog part, as previously described, if a light barrier has been interrupted or an action mode has been met. The switching behaviour then depends on the parameters described below.

The activity of the outputs is shown in the display, see Figure 17. The camera icon shows that at least one output is currently switched. Which one is indicated by the letters a to d.

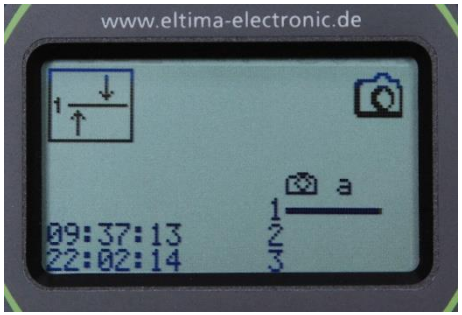


Figure 17: Icons for the outputs

Output parameters

Lag time

Name: **`lag time`**, Levels: ⓐ, ⓑ, ⓒ, ⓓ

Default setting: 0 ms

The lag time is the time that passes between the trigger and the switching of the contacts of an output.

range	unit	step
0- 8800	µs	200 µs
0 - 9999	ms	1 ms
0 - 3600	s	1 s
0 - 60	min	1 min

Release time

Name: **rel time**, Levels: ⓐ, ⓑ, ⓒ, ⓓ

Default setting: 250 ms

The release time determines the time for which the switches of an output are closed after a trigger. During this time, both switches are always closed at the same time.

range	unit	step
0- 8800	µs	200 µs
0 - 9999	ms	1 ms
0 - 3600	s	1 s
0 - 60	min	1 min

Release period

Name: **rel peri**, Levels: ⓐ, ⓑ, ⓒ, ⓓ

Default setting: 350 ms

An output can also switch several times after a trigger. The release period is the time from the start of one release to the start of the next release.

Since the release period, as defined above, includes the release time, the release period must be at least as long as the release time. This condition is ensured by the software. If the release time is changed to a value greater than the release period, the value of the release period is automatically increased by the software to the same value as the release time. However if the release time **is decreased**, the value of the release period will **not be** adjusted!

In the case of multiple releases, always set this parameter to a value greater than the release time. If the parameters have the same value, a multiple release will become one long release instead!

range	unit	step
0- 8800	µs	200 µs
0 - 9999	ms	1 ms
0 - 3600	s	1 s
0 - 60	min	1 min

Interval

Name: **`Interval`**, Levels: ⓐ, ⓑ, ⓒ, ⓓ

Default setting: 350 ms

The parameter **`interval`** specifies the time an output is considered to be busy and does not accept a new trigger.

This parameter can be used to avoid unwanted multiple releases, if one or more objects should cross the light barrier within a short time interval.

The minimum value of the parameter is calculated as follows:

$$interval \geq lag\ time + (repetitions \times release\ period)$$

The software here also takes care of the minimum value of the interval. Hence, if a parameter in the right part of the inequality is **increased**, the value of the interval parameter is adjusted, if necessary. However, when a value on the right side is **decreased**, the interval **will not be modified**.

When changing the values for lag time, release time, release period, interval and repetition, make sure when you are done that all parameters have the desired values!

range	unit	step
0- 8800	µs	200 µs
0 - 9999	ms	1 ms
0 - 3600	s	1 s
0 - 60	min	1 min

Repetitions

Name: **`repetit`**, Levels: ⓐ, ⓑ, ⓒ, ⓓ

Default setting: 0

The parameter specifies the number of repetitions for the release time. If the value of the parameter is 0, no repetitions will occur and the output is switched exactly once.

The total number of releases resulting is one more than the number of repetitions:

$$number\ of\ releases = repetitions + 1$$

range	unit	step
0- 99	---	1

Trigger

Name: **Trigger**, Levels: ⓐ, ⓑ, ⓒ, ⓓ

Values: **Act mode**, **barrier1**, **barrier2**, **barrier3**, **manual**, **none**.

Default setting: **Act mode**

The trigger is the event to which an output reacts. The following triggers are possible:

- **Act mode**: The output reacts to the action mode set in the basic parameter level.
- **barrier1**: The output reacts to the light barrier 1, regardless of which action mode is set.
- **barrier2**: The output reacts to the light barrier 2, regardless of which action mode is set.
- **barrier3**: The output reacts to the light barrier 3, regardless of which action mode is set.
- **manual**: The output reacts when the OK button is touched. The button press thus represents the trigger for the output.

With the manual trigger actions can be started at the push of a button.

- **none**: The output does not respond to a trigger. It is switched off.

Each trigger can be used for every output, even if it has been used already!
See also the advanced example on page 49.

Drive mode

Name: **drv mode**, Levels: ⓐ, ⓑ, ⓒ, ⓓ

Values: **single**, **contin**.

Default setting: **single**

Using the default setting **single** after a trigger the system will go once through the parameters **lag time**, **release time**, **release period**, **interval** and **repetition**.

In the **continuous** mode, the system will go through the parameters mentioned above, as long as the action mode is met or the specified light barrier is interrupted, depending on which trigger is set for the output.

In continuous mode, for example, the behaviour of animals eating at a feeding place could be documented.

For example, if three light barriers are installed as a curtain barrier around a feeding place then an output could release a camera as long as there are animals triggering the barrier.

Wake-up

Name: **wake-up**, Levels: ⓐ, ⓑ, ⓒ, ⓓ

Default setting: 0 s

Some camera models as well as some speedlights have a power saving feature, which put these devices into a sleep mode after a certain period of inactivity. They are not suitable for light barrier photography if they are asleep. Sometimes this setting can be turned off on the camera or speedlight. Otherwise, the wake-up function can be used to keep such devices constantly awake. It activates the camera, by “pushing the release button halfway”, i.e. switch 1 is turned ON, in an adjustable time interval thus keeping the camera in the wake state.

Speedlights cannot be kept awake directly, but only if they are attached to the camera and speedlight is activated periodically.

The value of the parameter determines the time interval in seconds in which the measurement function of the camera is activated (halfway button push). If the value is zero, the function is switched off.

range	unit	step
0- 99	s	1 s

Keep-active

The keep-active function is a part of the **wake-up** function. It is activated by setting the **wake-up** parameter to the value **99**.

Most cameras have two modes of operation: active and stand-by.

The active mode begins when the shutter button is pressed halfway and ends, depending on the camera model, either just after release of the button, or about 5 to 10 seconds after the release of the button. During this time e.g. the viewfinder display of the camera lights up. After the display is turned off, the stand-by starts.

If the cameras are triggered while they are in the active mode, the lag time of most cameras is much smaller as if they were triggered from stand-by mode.

By activating the keep-active function, the camera is put into the active mode after the training process and after the specified light barrier is interupted once. This state is maintained until the light barrier is interrupted again. The interruption will release the camera. After that, the output waits for about 1.5 seconds and the camera is put into active mode again.

The keep-active mode is therefore a very important function in order to significantly reduce the shutter lag of many cameras.

Time window

For each output a time window can be specified during which it is able to accept a trigger. The beginning of the time window is specified with the parameter **`sta-time`** and the end with the parameter **`end-time`**. If both parameters have the same value, the output is always active.

These settings can be used to ensure that the device will only be tripped at certain times of day, for example only in the evening when photographing bats.

If using these settings, it is important to ensure that the time of day on the device is set accurately.

range	unit	step
`00 00 00 - 23 59 59`	`hh mm ss`	`1h 1min 1s`

Link

Name: **`Link`**, Levels: ⓐ, ⓑ, ⓒ, ⓓ

Values: **`none`**, **`with a`**, **`with b`**, **`with c`**, **`with d`**

Default setting: **`none`**

The parameter gives the possibility of linking two outputs. An output that is linked to another is tripped at the same time as the other device.

An output cannot be linked to itself.

Inheritance is not intended to work. For example, if output c is linked to b and output b is linked to a, output c will not trip if output a trips.

Application example: The parameter **`link`** of the output b is set to **`with a`**. The trigger for output a is set to light barrier 1 and that for output b is set to light barrier 2.

Programmed in this way, output b trips when light barrier 2 is interrupted due to its own trigger, but also when light barrier 2 is interrupted because of the link to output a.

Practical example: The parameter can be used to set two different time windows for documenting the activities of animals.

For example, the same trigger can be assigned to the outputs a and b but each with a different time window (e.g., output a could be set from 19:00:00 - 21:00:00 when bats might be leaving a cave in the evening, while output b might be set from 05:00:00 to 07:00:00 when they are returning in the morning). Output b is linked to output a. Now, a camera connected to output b will be released in both time windows.

The open-shutter mode

Name: **open-shu**, Levels: ⓐ, ⓑ, ⓒ, ⓓ

Default setting: 0 s

For some subjects, it is desirable to reduce the delay of the entire system to an absolute minimum. This can be particularly important for photographing bats with their erratic flight paths.

Because these animals are nocturnal, keeping the camera shutter open for a longer period of time is possible if there are no other lights. If a bat flies through a light barrier while the shutter is open, the flash can be fired directly by the system. Since both the light barrier system and the flash have an extremely short delay (together usually < 0.3 ms), the travel distance of the bat during this time is negligible. The bat will be photographed while still being in the beam.

The open-shutter mode supports this strategy.

For the correct operation of the open shutter mode, the shutter speed of the camera must be set to "bulb"!

range	unit	step
0- 99	s	1 s

Using the default setting, with the parameter value = 0 the open shutter mode is off.

For values > 0 the mode is on. It can be activated for any of the outputs. The value of the parameter specifies the time in seconds for which the shutter will be kept open if the camera is not triggered.

Preparation: This mode requires connecting the speedlight to one output (e.g., output a) and the camera (of which the shutter speed is set to “bulb”) to a second output (e.g., output b).

The trigger for the speedlight output is set to an action mode or any of the three light barriers. The camera output is set to the same trigger as the speedlight output. Furthermore, the open-shutter mode is activated for the camera output by setting the parameter to a value between 1 and 99 seconds (e.g., to 30 s). This represents the time for which shutter of the camera is kept open cyclically if no trigger is detected. It is a good idea, to set this time to a value for which the sensor noise level is acceptable.

Process sequence: As soon as the light barrier system is switched to the working level, i.e. after training process, the camera is released for the time set in the parameter.

If, during this time, nothing flies through the light barriers specified as the trigger, the release of the camera is stopped (i.e., the shutter is closed) and after about 1 second (so the camera can save the image and reset the sensor), the shutter is opened again for the set time.

If the light barrier is interrupted while the shutter is open, the flash will fire and a few moments later the release of the camera is interrupted and the camera can save the image. After about 1 second, the next release will take place.

This cycle can (only) be interrupted by switching to the alignment level.

Copy function

Name: **copy**, Levels: ⓐ, ⓑ, ⓒ, ⓓ

Values: **No**, **to a**, **to b**, **to c**, **to d**

Default setting: **no**.

This function allows copying all of the parameter settings from one output to another.

The levels for experimental photography

An important challenge for experimental photography is to control rather complicated sequences by the help of a controlling system. The task is to control a large number of switching processes in order to achieve a desired result.

While trying to put these processes together in your thoughts and program these before starting the experiment, it is helpful to split the processes into a number of small steps. It is easier to understand and program small steps. When small steps are later linked to a “step chain”, complicated processes can be assembled.

This concept of thinking and programming in small steps has been put into practice in the **joker²** light barrier system. This gives the user an extremely powerful tool which makes it possible to control simple as well as highly complicated processes in an easy and comprehensible way.

The Steps

There are a total of 9 equivalent steps available, which can be used individually or, as described above, can be concatenated to a step chain. In the broadest sense, even a single step can also be considered as a step chain, consisting of just one step. In the following, therefore, we will speak of step chains, even if the chain consists of only one step.

A step chain can contain any number of steps and any number of step chains can run at the same time. The number of these combinations is only limited by the total number of 9 steps.

Important: The steps for controlling processes can and may be used in parallel with the outputs described in the previous chapters.

However, because the outputs access the same switches as the steps, undesired switching processes can occur if both work simultaneously.

Therefore, it is best to switch all triggers of the outputs that you do not need to **none**!

The parameter sets of the steps, hereinafter referred to as X-parameters, are each on one level, which are marked with the icons X1 - X9.

A trigger can be assigned to each step. As soon as this is asserted, the "activity" of the step begins.

Furthermore, a step consists of a set of three times: a delay time, an ON-time and a step duration time, see Figure 18.

Figure 18: Time-sets of a step: 1 - delay time, 2 - ON-time, 3 - step duration time

The step duration "3" specifies the total duration of a step. The ON-time runs within this.

It is the time for which the specified switch or switches are closed. Hence a connected device is active during this time.

The ON-time can be shifted within the step duration using the delay time. If the delay time is zero, the ON-time starts at the same time as the step duration.

A single switch or a pair of the 8 switches of the **joker²** controller can be assigned to each step.

A step or a sequence of steps can also be repeated. Even endless loops are also possible.

Once the step duration has expired, the step can be repeated, the sequence can continue with another step or it can end with this step.

A step or a sequence of steps can be repeated one or many times. Endless loops are also possible.

If several step chains that run in parallel are to be repeated, there is the option of synchronizing them. The step chains with the shorter step durations will then wait for the one with the longest duration to start again all at the same time.

The activity of the outputs is shown in the display. Figure 19 shows an example situation. The X-icon indicates that at least one step-chain is active. The switching state of the switch is indicated by the output letter and dots above it. The left dot represents switch 1, the right one switch 2.

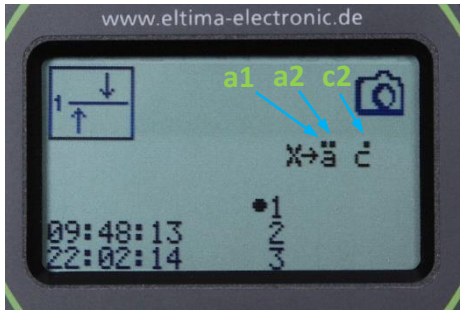


Figure 19: activity of the switches

An active step or a continuous sequence of steps can be interrupted by pressing the ESC-button.

With the introduction of the software version 2.2.2.0, the sequence can be started directly after confirming a value change with the OK key. It is therefore no longer necessary to switch down to the working level, as in older versions!

The X Parameters

Trigger

Name: **Trigger**, Levels: X1

Values: **None**, **act-mode**, **barrier1**, **barrier2**, **barrier3**, **manual**, **follow**

Default setting: **none**

A trigger starts a step. If the trigger is asserted, the step duration and the delay time begin immediately. After the delay time has expired, the on-time starts.

none: The step is switched off and does not respond to triggers. It cannot be started from another step either.

Act mode: The step is started when the action mode is met.

barrier 1 – 3: The step is started by the light barriers 1 to 3.

manual: The step is started by pressing the OK key.

follow: If a step is not the first one in a chain, it must have the trigger **follow**. This indicates that this step is being called up by another step.

Delay time

Name: **Delay**, Levels: X1 - X9

Default setting: **0 ms**

range	unit	step
0- 8800	µs	200 µs
0 - 9999	ms	1 ms
0 - 3600	s	1 s
0 - 60	min	1 min

The delay time determines the time offset between the trigger and the switching of the contacts.

The ON-time can be shifted within the step duration using the delay time. If the delay time is zero, the ON-time starts at the same time as the step duration.

Important: Delay and ON-time together must **not be longer** than the step duration! Values for the delay or ON-time whose sum is greater than the step duration, will not be accepted. The step duration must be modified first! The value is not modified automatically by the software, as it is done for the outputs!

ON time

Name: **ON time**, Levels: X1 - X9

Default setting: **250 ms**

range	unit	step
0- 8800	µs	200 µs
0 - 9999	ms	1 ms
0 - 3600	s	1 s
0 - 60	min	1 min

The **ON time** is the time for which the specified switch or switches are closed. A connected device is active during this time.

Important: Delay and ON-time together must **not be longer** than the step duration! Values for the delay or ON-time whose sum is greater than the step duration, will not be accepted. The step duration must be modified first!

Step duration

Name: **step dur**, Levels: X1 - X9

Default setting: **500 ms**

range	unit	step
0- 8800	µs	200 µs
0 - 9999	ms	1 ms
0 - 3600	s	1 s
0 - 60	min	1 min

The **step duration** specifies the total duration of a step.

In order to calculate the total length of a step chain, the step duration of the participating steps must be added.

Repetitions

Name: **repetit**, Levels: X1 - X9

Default setting: 00

range	unit	step
0- 99	---	1

Within a step chain individual steps can be repeated. Entire step chains can also be repeated.

If a repetition is set in a step, which is not the last step in a chain, then only this step is repeated.

If a repetition is set in the last step of a chain, the entire chain is repeated.

Switch

Name: **switch**, Levels: X1 - X9

Values: **None**, **a1**, **a2**, **b1**, **b2**, **c1**, **c2**, **d1**, **d2**, **a12**, **b12**, **c12**, **d12**

Default setting: **none**

The **joker²** light barrier system provides 4 outputs, each of which consists of two switches. A maximum of 8 different devices can be controlled, such as cameras, flashes, electric valves electro-magnets, relays, etc.

One of the eight switches or a pair of switches can be assigned to each step. These will be closed during the ON time.

All switches are solid state transistors in open-drain circuit.

2.5 mm jack plugs are used to connect the devices. The pin assignment is shown in Figure 20.

With each switch, loads with voltages up to 24 V and currents up to 300 mA can be switched permanently, while currents up to 500 mA can be switched for up to 1 second.

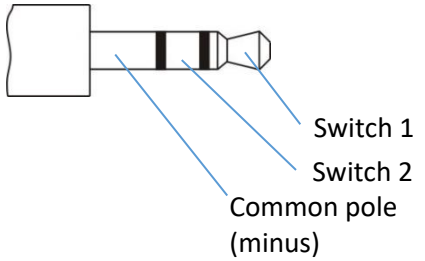


Figure 20: Pin assignment 2.5 mm jack plugs

Figure 21 shows a principle wiring diagram for the connection of two inductive loads (solenoid valves, solenoids, relays, etc.) to an output.

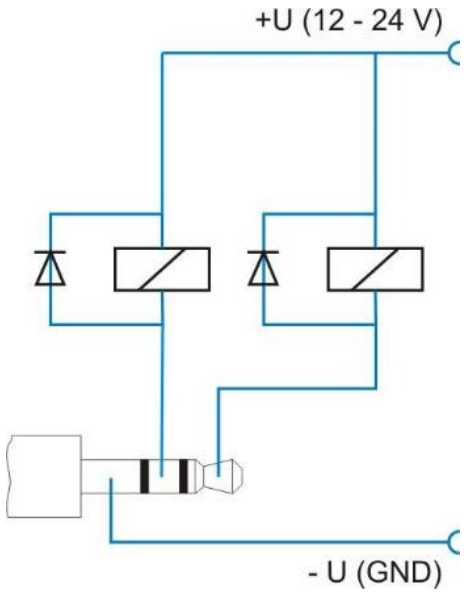


Figure 21: Connecting inductive loads (coils)

If inductive loads are connected, it is **mandatory** to connect a recovery diode in parallel to each inductor (coil), as shown in the wiring diagram. The correct polarity of the diode must be observed.

Next step

Description: **next ste**, Levels: X1 - X9

Values: **end**, **step 1** to **step 9**

Default setting: **end**

This parameter determines what shall happen after the end of the current step duration.

With the setting **end** the step chain is terminated.

If the step chain is to be continued, the next step is specified here. Steps can be concatenated in any order.

If a certain step was already used as a following step, it cannot be specified once more as next step. This will prevent cross-connections between step chains which can lead to unexpected behaviours.

If the first step of a chain is specified as the **next step** in the last step of a chain, an endless loop is created. This is started with the trigger condition specified in the first step and can only be interrupted in the working level by pressing the ESC or ▲ key (change to the Alignment level)!

Synchronization of step chains

Name: **synchron**, Levels: X1 - X9

Values: **no, yes**

Default setting: **no**

If several step chains are used in parallel, they very likely will have a different total duration, either because they consist of a different number of steps, or because the step duration of the participating steps is different.

In order to repeat such step chains or to run them in an endless loop, the new cycle must not start before the end of the longest chain is reached. This is ensured by the parameter **synchronization**.

In order to synchronize several step chains, the parameter **synchronization** must be set to **yes** in the first step of each of these chains.

This way the chains with the shorter total duration will wait for the slowest one, after which all chains start at the same time.

The system functions

The system functions determine the overall behaviour of the system, regardless of how the basic input and output parameters are set.

System parameters

Date and time

Name: **time**, **date**, level

These parameters can be used to set the time and date.

The **time** parameter is set in the format: hhmmss (hours, minutes, seconds), the **date** parameter in the format: YYMMDD (Year, Month, Day).

Display lighting

Name: **Lighting**, level,

Default setting: **10 seconds**

range	unit	step
0- 99	s	1 s

When there is low ambient light, the display and key illumination are switched on when a key is touched. The **lighting** parameter specifies the time for which the lighting remains on after a keypress.

If the parameter is set to **zero**, the function is switched off.

Ambient light threshold

Name: **light thr**, level

Default setting: **2**

range	unit	step
0- 9	---	1

The parameter determines the threshold for the ambient brightness from which the display and key lighting is switched on. The smaller the value, the darker the surroundings must be for the light to be switched on and vice versa.

Beeper

Name: **Beeper**, level:

Values: **Off**, **on align**, **on work**, **alw on**

Basic setting: **off**

The built-in beeper enables the status of the light barrier to be read without looking at the display. When the function is switched on, a specific tone sounds for each light barrier, depending on the operating mode:

- Light barrier 1: a beep with a low frequency
- Light barrier 2: two beeps with a medium frequency
- Light barrier 3: three beeps with a high frequency

The beeper has four operating modes:

off: The beep function is turned off.

On align: The beeper is active in the alignment level. It can help to find the reflector safely without observing the reflection bars in the display. The loudness increases with the amount of reflection. It behaves in the same way as the length of the reflection bar. If several light barriers are aligned, the beep signals of the light barriers will sound one after the other.

The "beep concert" stops when the training process is complete, i.e. when switching from the alignment to the working level.

On work: The beeper is active in the working level. It sounds while a light barrier is interrupted.

Alw on: The beeper is active in the alignment level as well as in the working level.

Beeper loudness

Name: **loudness**, level:

Default setting: **2**

range	unit	step
0- 3	---	1

With this parameter, the maximum loudness of the beeper can be set in three stages. If the value is 0, the beeper is silent.

Lag time measurement

Name: **meas lag**, level:

Values: **no, yes**

Default setting: **yes**

The **joker²** light barrier system, can measure the shutter lag of cameras or flash units.

yes: Measuring function is active.

no: Measuring function is switched off.

To measure the lag time, proceed as follows:

- First set up a light barrier, connect it to slot 1 and carry out the training process (changing from the alignment level to the working level). The light barrier system is now active.
- Attach a flash unit to your camera or flip the built-in flash.
- Connect the camera to the output a, and make sure that output a is set to be triggered by light barrier 1 and that the “lag time” for output A is set to 0.
- Point the flash unit at the controllers display at a distance of approx. 40 to 80 cm.
- Interrupt the light beam of the light barrier system. The camera will be released and the flash will fire. The device now measures the time between the triggering of the camera, and the arrival of the flash light on the display of the controller.
- Read the lag time from the display of the light barrier, for example: **td=145.60 ms**. If no camera is connected or the flashing light does not reach the display within two seconds, the display shows: **Td=-----ms**.

Some camera systems fire a pre-flash to measure the exposure. This function must be switched off when measuring the lag time! Since the pre-flash fires before the shutter is opened, it would falsify the measurement result towards shorter lag times.

Displaying the X-Parameters

Name: **exp mode**, level:

Values: **no, yes**

Default setting: **no**

no: The levels X1 - X9 for experimental photography will be hidden. The system level follows immediately after the level for output d.

yes: The levels X1 - X9 for experimental photography will be displayed.

Speed measurement

Name: **meas spe**, level:

Default setting: **0**

range	unit	step
0- 999	mm	1

The **joker²** light barrier system, can measure the speed of an object breaking through the light beams.

To measure the speed, proceed as follows:

- Set up light barrier 1 and 2 with the beams parallel to each other.
- Measure the distance between the two beams and set the parameter **mes spe** to this value.
- Carry out the training process.
- Let an object interrupt the light beams.
- Read the speed on the display.

Unit for speed measurement

Name: **Unit**, level:

Values: **km/h**, **m/s**

Basic setting: **km/h**

The parameter specifies the unit in which the speed should be displayed.

Language

Name: **Language**, level:

Values: **Deutsch**, **English**, **Francais**, **Italiano**, **Nederlands**, **Spanish**, **Letzebuerg**, **Portugues**

Default setting: **deutsch**

The light barrier system currently supports the following languages: German, English, French, Italian, Dutch, Spanish and Luxembourgish.

Resetting the parameters

Name: **Res Para**, level:

Values: **no yes**

Default setting: **no**

When setting the parameters, typing or thinking errors can creep in and the light barrier system may not react at all as expected. This can be for example, due to the fact that one or more parameters have values that are unsuitable for the intended purpose. Other sources of error can also be incorrect units of measurement or mismatched triggers.

If the search for the cause of a strange behaviour gets difficult, all parameters of the basic level, the outputs and the X-parameters can be reset to the delivery status. Then the light barrier system will behave again "normally", and the program can be entered again.

To reset all user parameters, set the parameter **res para** to **yes** and press the OK key. After the reset operation is completed, the parameter will be reset to **no**.

Reset to factory

Name: **Res fact**, level:

Values: **no yes**

Default setting: **no**

This parameter resets **all** parameters, including the system parameters, to the delivery state.

To reset the parameter, set the parameter **res fact** to **yes** and press the OK key.

Software version:

Name: **Soft-Ver**, level:

The parameter displays the software version and can only be read.

Taking pictures with the joker² light barrier system

Setup and alignment of the light barrier

In nature photography, light barriers are usually set up in places where it is known exactly where and in which direction the animals are moving. Examples could be feeding places, nests, caves, trails, etc. In experimental photography, the light beam is placed in the trajectory of the object to be detected. This is usually also known.

Setup

The light barrier and reflector are usually mounted on tripods or clamps. The more stable the setup is, the less likely unwanted releases will occur.

Install the reflector at a location where it will not be visible in the camera frame and align it so that it points approximately towards the intended location of the light barrier. An exact alignment is only required if the highest range is to be achieved.

Then install one of the light barriers pointed approximately towards the reflector and connect it to one of the light barrier slots 1 - 3. Connect the camera to one of the outputs a to d.

The light barriers can also be plugged in and out while the system is turned on.

Alignment of the light barrier

Turn on your device, and switch with the -button to the alignment level.

Then point the beam intentionally above the reflector and move the light beam towards the reflector in a meandering movement, see Figure 22. The distance a between the horizontal travels should be smaller than the diameter d of the reflector, see Figure 22, otherwise the beam could “drive around” the reflector, see Figure 23.

While doing this, observe the deflection of the reflection bar on the display. The larger the deflection of the beam, the better the reflection. If the bar reaches a maximum, the light barrier is aligned.

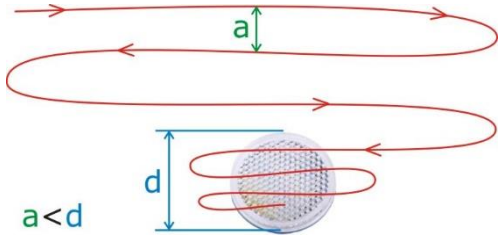


Figure 22: Finding the reflector

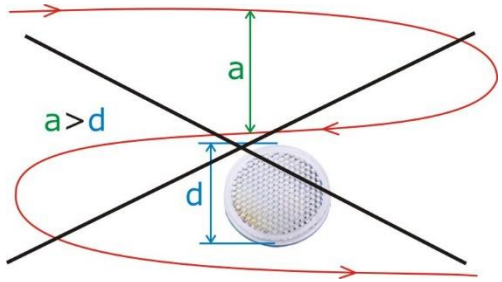


Figure 23: Driving the beam “around” the reflector

Improving the alignment of the reflector

If the distance between the light barrier and the reflector is greater than 3 - 4 m, it makes sense to point the light beam exactly at the centre of the reflector.

To achieve this, swivel/pivot the light barrier to the right, starting from the previously determined position, until the length of the reflection bar begins to decrease and remember this point. Then swivel the light barrier to the left, also to the point at which the length of the reflection bar begins to decrease. The centre between these two points is the horizontal midpoint of the reflector.

Now align the light barrier to the vertical centre. To do so proceed as described above, but in the vertical direction.

Minimum distance to the reflector and sensitivity

When photographing small objects, such as water drops, small insects, etc., it is advisable to choose a distance of less than 1 m between the light barrier and the reflector. Furthermore, it is advisable to use a 40 mm reflector (Art. No.: 50018, not included in the scope of delivery).

In principle it is also possible to use a 80 mm reflector for this purpose, however it will be necessary to work with a very high sensitivity level (level 1-2), due to the high amount of reflected light. That in turn requires a very steady setup completely free of vibrations.

The training process

After the light barriers have been aligned, switch to the working level by touching the  -key. Now the light barriers are ready to work. An interruption of a beam sets a trigger and this in turn leads to the switching of one or more outputs.

During the training process, the light barrier system measures the amount of light received and remembers it. Changes of this over a measure, which is predetermined by the parameter **`sensitivity`** will lead to a trigger.

The training must be carried out again after every change of the setting, such as changing the position of a light barrier or a reflector, insertion or removal of a light barrier, etc.

Important camera settings

Autofocus

When taking pictures with light barriers, it is mostly necessary to set the autofocus of the camera to "manual". If you don't, the camera will most likely not release!

This principle applies to all operating modes of the light barrier.

Reason: In most cases, the autofocus is too slow for the objects to be photographed, despite the latest technology in the camera and lens. The light barrier replaces the autofocus of the camera!

Focus the lens to a point at which you expect your subject, when the image is taken. You must take into account the movement direction and speed of the subject as well as the cameras shutter lag.

Depending on the speed of the subject and the shutter lag of the camera, the image may be created only at some distance from the beam of the light barrier. The optimum focus setting is determined by trying it out.

As noted earlier, the lag of the system can be reduced to almost zero if you are shooting in a dark environment, by opening the camera shutter on ‘bulb’ and using the barrier to trigger flashes instead.

Speedlight, Flash

If you are photographing fast-moving objects, such as birds, bats or insects, flashes (speedlights) can be a valuable way to “freeze” the movement of the subject while still keeping a good depth of field. In most cases, the flash should be set to manual exposure as the object may be moving too quickly for automatic flash exposure to work properly. Setting the flash to the minimum power, i.e. 1/64th or 1/128th, results in an exposure time around 1/20,000 second, which is fast enough to freeze most flying animals. Multiple flashes, wirelessly synchronized, can be used to increase the overall amount of light and improve the lighting pattern

Alignment of the light barrier to the camera and the subject

Depending on the direction of flight of the subjects, the position of the camera and of course the desired result, there are various strategies for how the light barriers can be positioned.

Plane of focus is parallel to the IR-beam

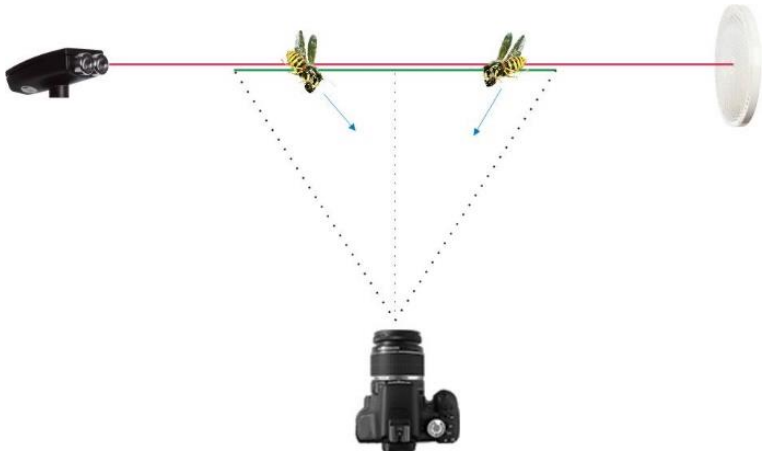


Figure 24: Focus plane is parallel to the beam

If the camera´s focal plane is parallel to the light beam, the subject can be depicted sharply from the left to the right edge of the image, no matter where it breaks the light beam, see Figure 24.

In this context it is irrelevant whether the light beam itself is installed horizontally or vertically.

If the plane of focus and the light beam intersect at an angle, the subject is only sharply imaged when it interrupts the light beam at the point of intersection of the focal plane and the light beam, see Figure 25.

Figure 25: The plane of focus intersects the light beam

Plane of focus is parallel to the flight path

For subjects moving at high speeds, if possible, the flight path should be parallel to the plane of focus. Using the example of bird photography, the advantages of this setup becomes clear.

Due to the shutter lag of the camera and the birds speed, in a situation as in Figure 26 the bird will be imaged some distance away from the light barrier.

As long as the flight path is in the plane of focus, the bird will be photographed in focus regardless of its speed.

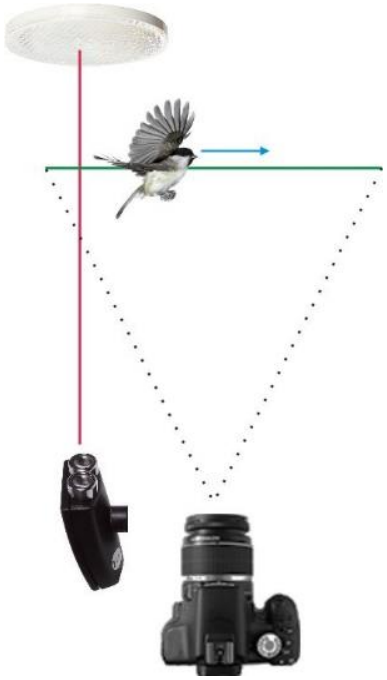


Figure 26: The plane of focus is parallel to the flight path

Taking advantage of the geometry of the subject

The detection rate will be at its highest when the light beam is oriented so that it crosses the broadest side of the subject profile. This becomes clear in the following example.

Birds in flight with their wings spread out are much wider than tall when viewed from the front.

If the light barrier is positioned vertically, then with only **one** beam an area, here marked blue, can be covered which is almost twice as wide as the wingspan of the bird, and as high as the working distance, see Figure 27.

With a horizontal beam, the area covered with a single beam is much more limited because the bird can easily fly over or below the beam, see Figure 28.

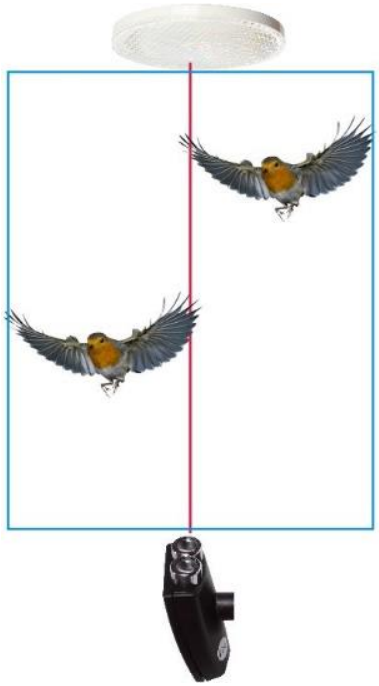


Figure 27: Bird photography with vertical light beam

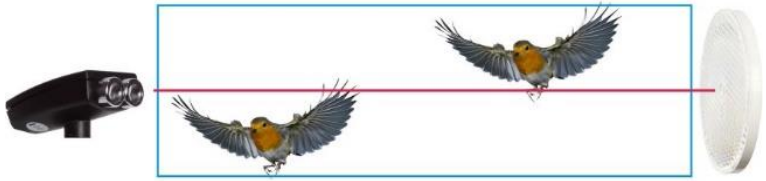


Figure 28: Bird photography with horizontal beam

Photographing without a reflector

In situations where installing a reflector is difficult or even impossible and where the distance between light barrier and subject is small, it is possible to work without a reflector.

The range of the light barrier in this case depends very much on the reflectivity of the subject, but is typically no more than 0.3 to 0.6m even for a highly reflective subject with **range** set to **distance**.

Also the precision of the system in this mode is not as high as when operating with a reflector, since it is difficult to predict which parts of the subject will cross the beam and how well it will reflect.

Nevertheless, this mode may be very attractive in some circumstances. It can work especially well when working with a large depth of field or if the subjects are small in relation to the depth of field.

For this mode set the parameters **`scan`** for the light barrier in use to **`without reflector`**.

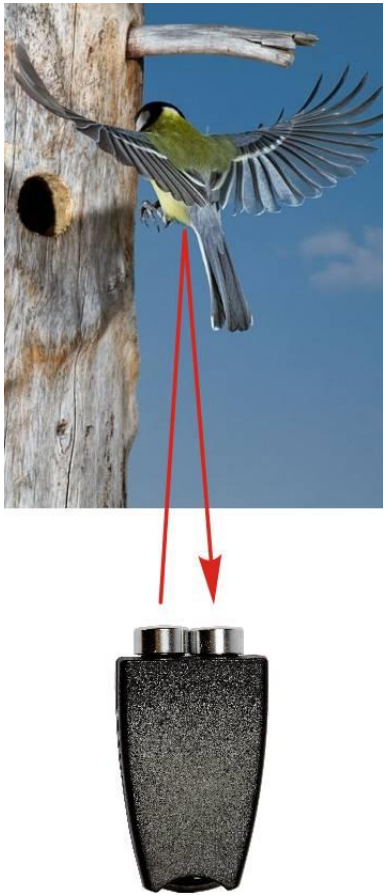


Figure 29: Operation without reflector

The parameter **`sensitivity`** has the following effect: The smaller the value, the less reflection is necessary for detecting a subject and vice versa. Hence with small values for the sensitivity the range increases.

Programming examples

The following examples, which are taken from practical experience, are intended to show how the values of the parameters affect the function of the light barrier system.

The symbols used are shown in the following table.

Symbol	Meaning
	interruption of the light beam
	dwell time
	trigger, action mode met
	lag time
	output switch is ON, release time
	release period
	interval
	time window

Taking pictures using the factory settings

The following table shows the factory settings of the basic and output parameters:

Basic Parameters	**Value**			
action mode	one beam barrier			
sensitivity 1 - 3	6			
range	distance			
dwell time	0 ms			
scanning mode	with reflector			
Output parameters	**a**	**b**	**c**	**d**
lag time	0 ms	0 ms	0 ms	0 ms
release time	250 ms	250 ms	250 ms	250 ms
release period	350 ms	350 ms	350 ms	350 ms
interval	350 ms	350 ms	350 ms	350 ms
repetitions	0	0	0	0
trigger	act mode	act mode	act mode	act mode
drive mode	single	single	single	single
wake-up	0	0	0	0
start time	00 00 00	00 00 00	00 00 00	00 00 00
end time	00 00 00	00 00 00	00 00 00	00 00 00
link	no link	no link	no link	no link
open shutter	0	0	0	0

Operation principle of the factory settings:

The interruption of the light barrier at the time of 0 ms leads to an immediate trigger, because no dwell time is programmed. Subsequently all outputs will switch to ON immediately for 250 ms, because there is no lag time programmed. A second interruption of the beam at 270 ms leads to a new trigger, which is not accepted since the time for the interval has

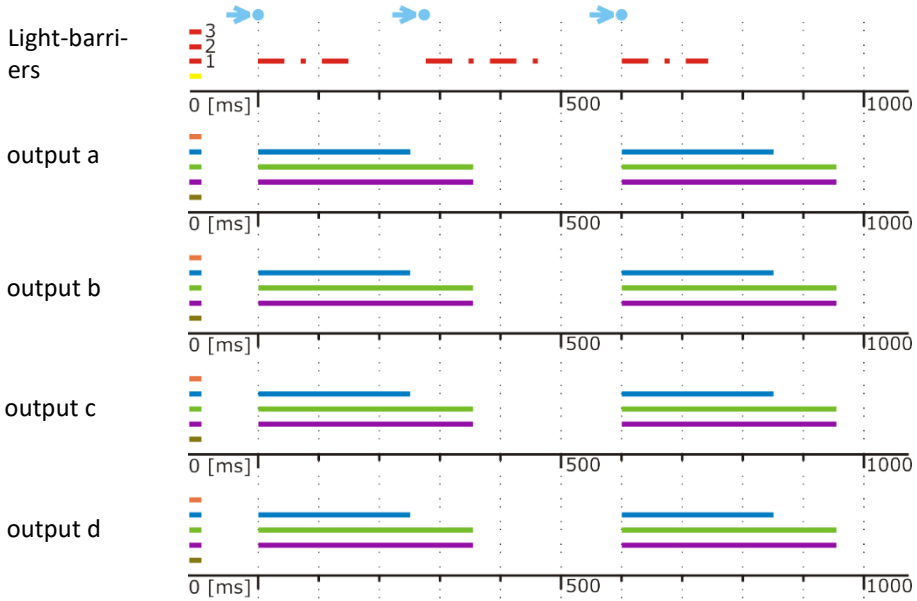


Figure 30: Sequence diagram with the factory settings

not yet expired. Only the next interruption at the time of 600 ms leads to a new release, because all times have elapsed and the light barrier was free again.

Since the parameter **`drive mode`** is set to **`single`** and because no repetitions are set, the programmed cycle runs once.

The light barrier system triggers regardless of a time window, because the start and end time of the time window are the same.

Advanced example with a cross barrier

Task:

- A camera should take pictures of a subject when it passes a specific point. The cross light barrier is ideal for this. After a picture has been taken, the camera should not be able to be released again for at least 500 ms. Since this is a fast moving subject, the shutter lag of the camera should be kept as low as possible.
- A second camera, from a different perspective, shall take, with a delay of 200 ms, two shots in succession with a gap of of 300 ms, also triggered by the cross light barrier. The waiting time for a next shot shall be 100ms.
- A third camera, equipped with a wide angle, should record all movements over the entire beam length of light barrier 2 (part of the cross light barrier) without any delay. Therefore, it should be possible to release the camera again immediately after taking a picture.
- A fourth camera should work independently of the events described above, e.g. take pictures of an animal feeding nearby, which is detected by the light barrier 3. As long as there are animals in the beam, the camera should take a picture every 2 seconds so that a motion profile of the animals during the feeding can be created.

Setting up the system: The light barriers 1 and 2 are arranged crosswise at the desired location, light barrier 3, as a one beam barrier, is installed at the feeding place. The 80 mm reflectors are used.

Parameter list: The table below shows a possible setting of the parameters for this task.

Basic Parameters	**Value**			
action mode	cross barrier			
sensitivity 1 - 3	9			
range	distance			
dwell time	0 ms			
scanning mode 1	with reflector			
scanning mode 2	with reflector			
scanning mode 3	with reflector			
Output parameters	**a**	**b**	**c**	**d**
lag time	0 ms	200 ms	0 ms	0 ms
release time	200 ms	200 ms	200 ms	200 ms
release period	200 ms	300 ms	200 ms	200 ms
interval	700 ms	900 ms	200 ms	2000 ms
repetitions	0	1	0	0
trigger	act mode	act mode	barrier 2	barrier 3
drive mode	single	single	single	continu-ous
wake-up	99	0	0	0
start time	00 00 00	16 28 42	00 00 00	08 53 09
end time	00 00 00	16 28 42	00 00 00	08 53 09
link	no link	no link	no link	no link
open shutter	0	0	0	0

Basic parameters:

- The **action mode** is set to **cross barrier** according to the task.
- Because the expected subjects are bigger than 4 - 5 cm, the sensitivity of all three light barriers is set to 9 in order to avoid false triggers caused by vibrations or small insects that could buzz through the beams.
- The **range** is set to **distance** to allow a working distance of several meters.
- The **dwell time** remains set to **zero**, since the trigger for the outputs should be set without any delay.

Output a

- The **shutter lag** is set to **zero** because the output should switch immediately after the trigger.
- Most of the cameras can be triggered with a **release time** of **200 ms**. Professional cameras will release even with a much lower release time, but to be sure we use here **200 ms**.
- Since no further triggering of the camera will follow, the **release period** is set equal to the **release time**.
- Because after each release 500 ms must pass before a new release, the **interval** is set to 500 ms + Period (200 ms) =**700 ms**.
- Since only one release is wanted, the **repetition** is set to **0**.
- The **trigger** is set to **action mode**.
- In order to achieve the lowest possible shutter lag, the camera is kept in the active mode with the **keep-active** function.
  The **wake-up** parameter is therefore set to 99.
- A time window is not required, so the start and end times are the same.
- The **open-shutter** function is not used in this example.

Output b

- As required, the **lag time** is set to **200 ms**.
- **Release time** = **200 ms**, see above.
- In this case, the **release period** is **300 ms** to add a 100 ms delay before the second repetition.
- The **interval** is calculated from: **Lag time** + 2 x **period** + waiting time = 200 ms + 2 x 300 ms + 100 ms = **900 ms**.
- Two releases means **1 repetition**.
- The **trigger** is set to **action mode**.
- A time window is not required, so the start and end times are the same.
- The **open-shutter** mode and **keep-active** function are not needed in this example.

Output c

- The **shutter lag** is set to **zero** because the output should switch immediately after the trigger.
- **Release time** = 200 ms, see explanation under output a.
- Since no further triggering of the camera will follow, the **release period** is set equal to the **release duration**.
- In order to enable a fast trigger sequence in the case of interruptions in quick succession, the **interval** is set equal to the **period** to **200 ms**.
- The **trigger** is set to **barrier 1**.
- A **time window** is not required, so the **start-** and **end-time** are the same – the values of start and end time do not matter if they are both the same.
- The **open-shutter** mode and **keep-active** function are not needed in this example.

Output d

- The **shutter lag** is set to **zero** because the output should switch immediately after the trigger.

- **Release time** = **200 ms**, see explanation under output a.
- The **release period** is set equal to the **release time**.
- Because the camera shall only make a picture every 2 seconds, the **interval** is set to **2000 ms**.
- The **trigger** is set to **barrier 1**.
- The **drive mode** is set to **continuous**, so that the camera can take multiple pictures while the light barrier remains interrupted.
- A **time window** is not required, so the **start-** and end-time are the same.
- The **open-shutter** mode and **keep-active** function are not needed in this example.

Process sequence:

Analog part

The light barrier 1 is interrupted at the time 0 ms. Thereupon the analog part sets trigger 1. Because no output triggers on light barrier 1, it has no effect.

With the interruption of the beam 2, at 100 ms, the analog part sets trigger 2 and reports both the fulfilment of the action mode, here the cross barrier, as well as the interruption of the beam 2. Outputs a, b and c react to this trigger. Strictly speaking, three triggers are set at this time: one for the action mode and one for each of the light barriers 1 and 2.

At 200 ms, the light barrier 3 is interrupted and issues the trigger 3, to which output d reacts.

Trigger 4 is set at 500 ms, because the light barrier 2 has been interrupted again.

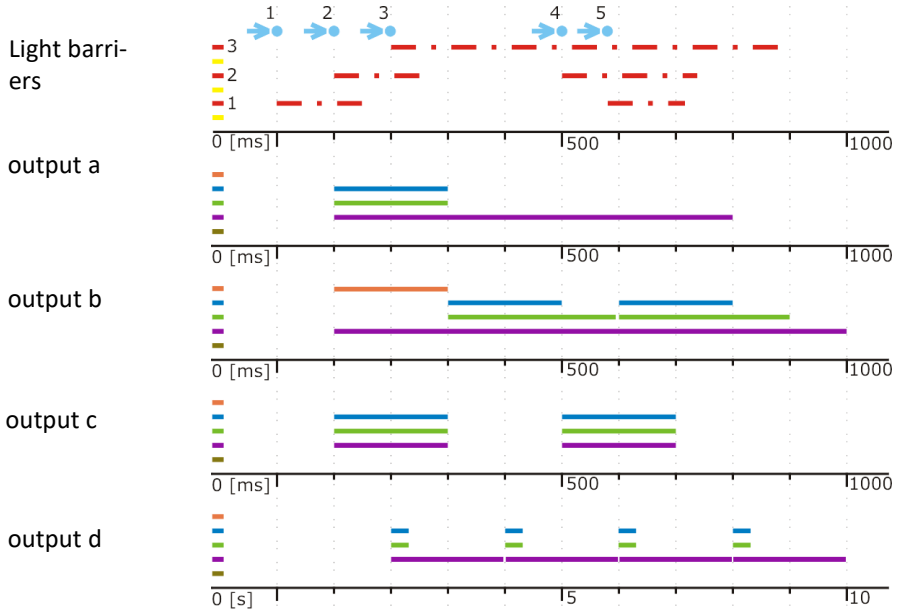


Figure 31: Sequence diagram - example with cross barrier

Trigger 5, at approximately 580 ms, reports the fulfilment of the action mode again, but remains without effect, because the outputs a and b are still busy.

Digital Part

Output a reacts to the trigger 2, triggered by the action mode and switches immediately for 200 ms. However, the output does not react to trigger 5 because the interval has not yet elapsed. At the earliest after the time of 800 ms a next trigger could cause a new switching operation.

Output b also reacts to the trigger 2, i.e. the action mode is met. First, the delay time of 200 ms elapses, then the output switches twice for 200 ms, with a period of 300 ms and is ready for a new trigger at the time of 1000 ms after the interval has elapsed.

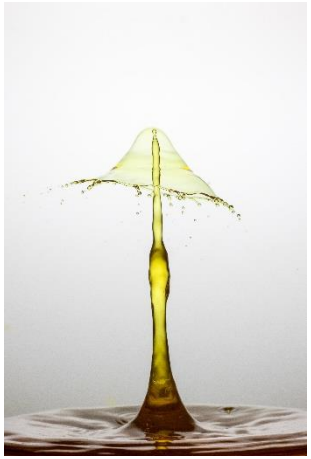
Output c reacts to the trigger 2, triggered by the light barrier 2 and switches immediately at 100 ms for 200ms.
Because the release time, period and the interval are equal, the output is immediately ready for a new trigger. This is set at 500 ms.

Output d reacts to the trigger 3, triggered by the light barrier 3 at 2 seconds (note: the time axis of the output d is specified in seconds). The output switches immediately for 200 ms and waits for the interval of 2 seconds to elapse. Because the light barrier is still interrupted hereafter, a new cycle begins and the output switches again. This continues as long as the light barrier 3 is interrupted.

Example for drop photography with X-parameters

Task: A drop dispenser with a solenoid valve (eltima item no.: 50049) should be used to create two drops of different sizes that fall into a water pot. These shall create a drop collision water sculpture. A camera and a speedlight should be triggered at the right moment to capture the sculpture.

In this **setup** a drop dispenser is mounted at a height of about 42 cm above the water level. The camera takes pictures of the drop sculpture in a flat angle from a front perspective. Two speedlights illuminate the scene from behind through a diffuser of acrylic glass.



The process is time-controlled, i.e. without a light barrier.

Process sequence: A cycle is started with the OK-button. The camera, whose shutter speed is set to bulb, is released without delay for a time of 500 ms. At the same time, the drop dispenser is triggered for 68 ms to generate the first drop. 140 ms after the beginning of the first drop the dispenser is triggered again for the duration of 50 ms.

With a delay of 389 ms, the speedlights are fired to take the image.

After the 500 ms elapses, the camera output is switched off and the camera shutter closes.

Although the drop collision shown was achieved with the times given in this example, they are only for guidance. The times to be used depend very much on factors such as the viscosity of the water, the exact falling height and so on. It is necessary to experiment to find the timing that works best.

Important: For the X-parameters to become visible, set the system parameter **`Exp mode`** to **`yes`**.

With the introduction of the software version 2.2.2.0, a sequence can be started directly after confirming a value change with the OK key. It is therefore no longer necessary to switch down to the working level, as in older versions!

Parameter list: The table below shows a possible setting of the parameters for this task.

Basic Parameters	**Value**			
action mode	one beam barrier			
sensitivity 1 - 3	6			
range	distance			
dwell time	0 ms			
scanning mode 1 - 3	with reflector			
Output parameters	**a**	**b**	**c**	**d**
trigger	none	none	none	none
X-Parameters	**X1**	**X2**	**X3**	**X4**
device controlled	flashlight	drop dispenser	drop dispenser	camera
trigger	manual	manual	follow	manual
delay	389 ms	0 ms	0 ms	0 ms
ON time	50 ms	68 ms	50 ms	500 ms
step duration	1000 ms	140 ms	500 ms	1000 ms
repetitions	0	0	0	0
switch	a2	b1	b1	c12
next step	end	step3	end	end
synchronization	no	no	no	no

Basic Parameters

Since in this example no light barriers are used, the basic parameters are irrelevant. They were left in the delivery state.

Output parameters

Since in this example the X parameters are used, the outputs are switched off by setting the **trigger** of the outputs to **none**.

X-Parameters

In this example, three step chains are used. Two chains with one step each and one chain with two steps.

First step chain

The first step X1 will fire the flashlight at the right moment.

The **trigger** is set to **manual**, so that the sequence can be started with the OK-key.

The delay time is determined by trying it out. The best results in this case were at **389 ms**.

An **ON time** of **50 ms** is sufficient to trigger a flashlight.

The **step duration** of **1000 ms** was chosen arbitrarily. It should only be longer than the largest assumed **delay** plus **ON time** so that it no longer needs to be changed.

Since the step chain should be run through once, there is **no repetition**.

When using an eltima flash adapter **switch a2** must be chosen.

The step chain ends here, so the next **step** is set to **end**.

Second step chain

The second step chain, consisting of X2 followed by X3, controls the drop dispenser.

It starts with X2 and is triggered **manually**. Without a delay time, b1 switches for 68 ms. This time was also determined by tests.

The step duration determines the time between the beginning of the first drop and the beginning of the second one.

After the step duration has elapsed, step 3 follows. Switch b1 closes again without a delay. This time for 50 ms, thereby creating a smaller drop than before.

The step duration was also chosen arbitrarily. The step chain ends here.

Third step chain

The last step chain with step X4 controls the camera. The parameters of this step will not change during the experiment.

The step chain is triggered manually and releases the camera with the switch pair c12. Since the shutter speed of the camera is set to bulb, the shutter is opened for the ON time of 500 ms.

Electrical connections

Camera/device connection

The camera/device is connected via a 2.5 mm stereo jack plug with the pin assignment as shown in Figure 32, see also section *Switch*.

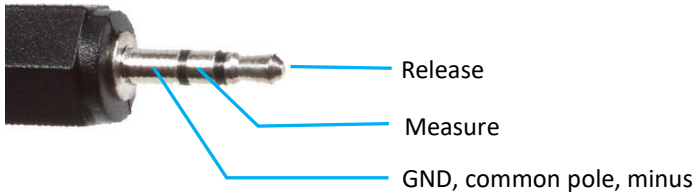


Figure 32: Pinning of the camera connector

Power Supply

The power supply is reverse polarity protected and is connected via a DC plug with 4.75 mm outer and 1.7 mm inner diameter.

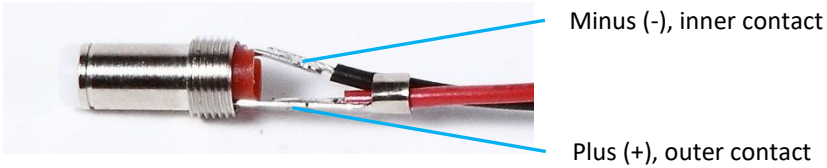


Figure 33: Pinning DC plug

Specifications

Type

Reflex light barrier system with pulsing infrared light
Pulsing frequency: 5 kHz
Wave length: 850 nm
Light barriers: 3
Outputs: 4
Switches: 8

Action Modes

One beam barrier
Cross barrier
Directional barrier
Two beam curtain barrier
Three beam cross barrier
Directional cross barrier
Three beam curtain barrier
Time trigger

Dimensions:

Controller (l x w x h): 199 mm x 94/58 mm x 40/28 mm
Light barrier (l x w x h): 64 mm x 36 mm x 35 mm
Cable length of the light barriers: 3 m

Weight

joker² controller (without batteries): 190 g
Light barrier with cable: 80 g each

Power Supply

3 AA batteries or rechargeable batteries
External power supply: 3.2 - 15 V DC
Current consumption: max. 55 mA

Range

Maximum approximately 10 m

Smallest detectable object

Approximately 0.2 mm

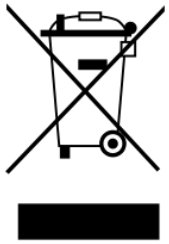
Shortest response time

200 µs

Scope of delivery

1 **joker²** controller
3 light barriers with 3 m cable
3 80 mm reflectors

Disposal of electronical devices



In accordance with Directive 2002/96 / EC and national laws, electrical and electronic equipment must be disposed separately from the general household waste. This can be done by returning the product to an authorized collection point for the reprocessing of electrical and electronic equipment.

Improper handling of old equipment can have harmful effects on human health and the environment.

By properly disposing of this product, you make an important contribution to the effective use of natural resources.

Do not dispose of batteries or electronics in domestic waste!

As consumer you are legally bound to return batteries and rechargeable batteries for recycling. Return them to designated collection points or to places where batteries or rechargeable batteries are sold – in many countries these stores are obliged to accept and recycle old batteries for free.

Contact

eltima electronic
Hans Gierlich
Staufenstraße 10
73230 Kirchheim unter Teck

Tel: +49 7021-863444
mail@eltima.de
www.eltima.de