Lighting control with the Busch EIB Installation Bus® and the Busch EIB Powernet®
Dear Customer,

Since the introduction of computer technology into buildings, electrical installation has been making rapid advances. The Busch EIB Installation Bus® and the Busch EIB Powernet® now enable the various concepts for lighting control, which have already been around for a quite a long time, to be used efficiently and economically in luxury and medium-class residential and functional buildings.

This brochure tells you about the possibilities of controlling lighting - especially interior lighting - economically and comfortably by means of the Busch EIB Installation Bus®. The operation concepts have been standardised in this version, something which facilitates commissioning.

Chapter 1 first of all gives you a brief introduction to the three concepts, presents arguments for the system and shows on the basis of calculation examples how a lighting control system pays for itself.

Chapter 2 tells you about the start-up procedure and operation - in simple and easy to understand terms.

Chapter 3 describes the technical details of the individual applications.
1 Concepts – Arguments – Examples

No matter whether you are on holiday or at home in front of an open fire, at work in a factory or an open plan office, at a sports ground, at the doctor’s, in a restaurant, at school, in a garage, or window shopping, light is the element which not only has the greatest fascination for mankind, but also forms an aesthetic element of architecture, provides the necessary illumination at the workplace and generates atmosphere, because 80 % of human sensory perception is visual.

A great variety of lighting concepts for natural and artificial light sources have been developed, perfected and tailored to the respective area of application, whereby the emphasis can lie on functional or aesthetic design features. Workplace regulations, accident prevention regulations and technical electrical operating conditions place heavy demands on lighting installations at the workplace. The growing awareness of architectural quality has also had the effect that modern buildings incorporate a different lighting concept. In addition to these aspects, individuality is required. The objective of all this is to obtain good illumination which makes people feel at home.

In addition to these developments, interest in environmental protection and energy-saving by using resources more efficiently with the objective of reducing the running costs of properties of all kinds has been increasing in recent years. The quality standards for environmental management in industry are an important indication of this.

The individual planning aspects of design, appearance, individuality, investment and running costs, functionality and environmental protection, however, often seem to be incompatible with each other and can frequently only be considered in connection with each other by making compromises.

The development of building systems engineering was a milestone on the way to solving these problems. With the development of the X-1 0 net bus more than 10 years ago, Busch-Jaeger paved the way for modern EIB technology. Building systems engineering without the Busch EIB Installation Bus® is unthinkable today, since, once it has been installed, it enables the flexible and decentralized control of all building functions (and also their modification). The development of the low voltage mains supply as a second medium for the EIB, the Busch EIB Powernet®, is ideal for cost-effective retrofitting in older buildings without the need to lay additional cables.

Busch-Jaeger has taken on the task of solving the conflict of objectives of „comfort, reduction in running costs and environmental protection“ by means of „intelligent lighting control“ with the Busch EIB Installation Bus® or the Busch EIB Powernet®.

For example, how many users of a large office building with open plan offices take the responsibility for switching off the lights, when the outside light is bright enough to allow this? Do you always switch off the lights, when you don’t need them any more? In generally used areas, such as entrance halls or corridors, lights are normally never switched off.

• Busch-Jaeger offers 3 concepts:
• Outside brightness dependent switching of the interior lighting
• Outside brightness dependent dimming of the interior lighting
• Constant brightness control
1.1 Outside brightness dependent switching

The concept of „Outside brightness dependent switching of the interior lighting“ provides a simple and cost-effective way of saving energy.

In an open plan office, it is possible to switch off e.g. the lights nearer to the window side earlier than the lights located further away from the window by setting various switching thresholds. Since this takes place automatically, all the lights which are not needed are switched off, including those which may be overlooked as the daylight level increases. Of course, this also functions in buildings with a large number of small individual offices, when, as always happens, someone leaves a room without switching off the light just as the daylight level is increasing.

The money-saving potential which is lies behind outside brightness dependent switching of the interior lighting can be roughly calculated:

Lighting units are planned in accordance with the so-called „daylight quotient“. Using this, it can be ascertained how much outside brightness is needed to arrive at the illumination intensity level required at a workplace under e.g. the workplace regulations. The daylight quotient is stated in percent and places the outside light illumination intensity level $E_{outside}$ and the inside illumination intensity level $E_{inside}$ in the following relation:

$$T = \frac{E_{inside}}{E_{outside}} \times 100 \%$$

A daylight quotient of 10 % means e.g. that an outside brightness level of 5,000 lux is required to reach the required inside illumination intensity level of 500 lux. The lighting system is specified accordingly. However, worst-case considerations have to be taken as a basis, i.e. the „darkest operating case“ is supposed.

Natural light curves can be obtained by measuring the outdoor illumination intensity level over the entire year. For the sake of simplification, the year is divided into summer months (March to September) and winter months (October to February), from which in each case the lower limits are selected as a basis of calculation.

![Daylight curves for summer and winter months as a basis of calculation](image)
1.1 Outside brightness dependent switching

If a requisite outdoor illumination intensity level of 5,000 lux is assumed, the artificial lighting can be switched off in the summer months between 7.00 a.m. and 5.00 p.m. (= 10 hrs). In the winter months, the current-off time is between 10.00 a.m. and 3.00 p.m. (= 5 hrs). If 250 working days are assumed, this means that, under optimum conditions, the lighting can be switched off for

- 1,450 hours in the summer months (145 days),
- 525 hours in the winter months (105 days),

a year i.e. 1,975 hours. The saving is calculated from the power consumption of the lamps used and the kilowatt-hour rate of the power supply company.

Example:
With a lighting system of 200 fluorescent lamps à 58 W and a rate of 0.40 DM/kWh, the result is a per annum saving of $11.6 \text{ kW (output rating of lamps)} \times 1,975 \text{ h} \times 0.40 \text{ DM/kWh} = 9,104 \text{ DM}$

The calculation was simplified by taking the respective lowest outside brightness level value for the summer and winter months as a basis (December and March). A higher saving can therefore be expected.

Further potential possibilities for saving arise through the use of lamps with electronic ballast units. An additional energy saving of more than 20 % and a further increase in the service life up to 30 % can be achieved compared to lamps with conventional ballast units.
1.2 Outside brightness dependent dimming

With simple outside brightness dependent switch-off of the lighting system, energy-saving begins only when the outside brightness level has increased enough for the lights to be switched off without lowering the brightness of the room to a level which is too dark. If the lighting system is set so that it is progressively dimmed in dependence on the outside light, the energy-saving effect is correspondingly higher, since in this case, components of the artificial lighting can be turned off much earlier if the outside brightness level increases. Dimmers enable the infinitely variable setting of the interior lighting and are also available in EIB execution. In this connection, lighting units with fluorescent lamps must be equipped with dimmable electronic ballast units (0-10 V interface).

Another advantage: during work which requires concentration, e.g. VDU work, tradesman’s work, etc., sudden switch-off of the lighting can be disturb people working in the rooms and divert their attention from their work. The same applies for representative areas in which the requirements of the lighting control system are much higher.

Experience has shown that a saving of 35 % to 50 % in power costs can be achieved merely by outside brightness dependent dimming of groups of lights. The diagram can taken be as a basis for the approximate calculation of the money-saving potential.

![Diagram: Money-saving potential of an outside brightness dependent lighting control system](image)

**Fig. 3**
Money-saving potential of an outside brightness dependent lighting control system
1.2 Outside brightness dependent dimming

The connected load of the lighting installation, the annual working hours and the kilowatt-hour rate which the power supply company charges for the energy provided are known.

Example:
A floor has 4 open plan offices, each equipped with 3 lines of fluorescent luminaires à 10 58 W lamps, has a connected load of 7 kW. With an average daily working time of 10 hours and 220 days use a year, the installation is in service for approximately 2,200 hours per annum. The calculation of the kilowatt-hour rate and the proportional price per kilowatt charged by the power supply company results in an average of 0.37 DM/KWh. If an energy saving of only 30 % is assumed against investment costs of approx. 4,000.00 DM (1 x 6157 EB, 12 x 6153 EB), the result is an annual saving of 4,600 KWh, corresponding to 1,800.00 DM per annum. This means that the installation has paid for itself after approx. 2 1/2 years.

Outside brightness dependent dimming using the Busch EIB Installation Bus® combines ease of operation, lighting comfort and energy-saving.
1.3 Constant brightness controller

Constant brightness controllers take the actual local light conditions into account and not just the outside brightness level. Thus, the light conditions can be adapted to the actual requirements, and individual influences such as reflectance from fixtures, settings of the blinds and ageing and soiling of lamps and bulbs can also be considered.

<table>
<thead>
<tr>
<th>Area</th>
<th>Guide values for the illumination intensity level [lx]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corridors, entrance halls stairs and rooms used for a short time</td>
<td>50</td>
</tr>
<tr>
<td>(e.g. photo-copying rooms, rooms for cleaning materials)</td>
<td>100</td>
</tr>
<tr>
<td>Areas not in constant use (entrance halls, rooms with public access)</td>
<td>200</td>
</tr>
<tr>
<td>Office with daylight-oriented workplaces, conference rooms, salesrooms</td>
<td>300</td>
</tr>
<tr>
<td>Office area, data processing</td>
<td>500</td>
</tr>
<tr>
<td>Open plan office, drawing office and design office</td>
<td>750</td>
</tr>
<tr>
<td>Workplaces for jobs with a high degree of difficulty (precision assembly, colour testing)</td>
<td>1,000</td>
</tr>
</tbody>
</table>

Table 1
Guide values for the illumination intensity level for various areas of work in accordance with DIN 5053 T2.

In the near future, constant brightness controllers will be prescribed for sports grounds in accordance with EU Directives.

New lighting installations are usually planned in such a way that the illumination intensity level is approx. 25 % higher than the value actually required, since the efficiency of lamps and bulbs decreases during operation. However, this also means that at the initial stage new installations can reach the requisite illumination intensity level using 80 % of the energy which is otherwise supplied.

The diagram shows the typical progression of the illumination intensity level in a conventionally planned lighting system and the possibility for saving by regulating out the planning factor. After start-up and maintenance, the lamps do not require full power to reach the illumination intensity level which is actually required - depending on size of the installation, a considerable money-saving potential!

**Fig. 4**
Money-saving potential of constant brightness controllers under consideration of the planning factor
1.3 Constant brightness controllers

**Summarized:**
Compared to a traditional lighting system with conventional ballast units, an energy-saving potential of more than 65% can be achieved through the constant brightness controllers in combination with modern electronic ballast units. And no additional installations or control lines are necessary in a building which has been fitted with the Busch EIB Installation Bus®.

Other aspects, such as the creation of a comfortable ambience in which people - residents, employees, customers - have a feeling of well-being and like being in, cannot of course be expressed purely in figures.
Lighting control with the Busch EIB Installation Bus® and the Busch EIB Powernet®

2 Technology - the Busch-Jaeger concept

The central unit for lighting control in the Busch EIB Installation Bus® or Busch EIB Powernet® is the EIB analog input 6157 EB / 6957 EB, which is suitable for the connection of a large number of physical sensors.

In outside brightness dependent control of the interior lighting, the outside brightness level is measured and the interior illumination regulated accordingly. Any number of lamps can be actuated via a photosensor using the fundamental principle of building systems engineering. Thus only one photosensor is required to control the entire front of a building. The Busch-Jaeger concept enables the sensor value to be variably customised to the local light conditions. For example, the lights can be lowered earlier in higher parts of the building than in the basement or on the second floor, if there is a tree in front of the window.

A constant brightness controller measures the actual brightness value in the room, compares it with a default value and adapts the room brightness through appropriate dimming. This solution requires one photosensor in every room which is equipped with a constant brightness controller. The analog input 6157 EB / 6957 EB *) can operate four control loops, i.e. an analog input is to be provided for every four photosensors. In this manner, precise light control is possible for each room, independent of the positions of the blinds, ageing and degree of soiling of the lamps.

*) For installations with the Busch EIB Powernet®, please note that, as a result of the cyclic sending of the analog inputs 6957 EB, a max. of 1 telegram every 2 seconds may be sent. Please take the number of devices and channels into account without fail.
2.1 Selection and installation of the photosensor

A number of photosensors are suitable for use in lighting control systems:

<table>
<thead>
<tr>
<th>Application</th>
<th>Manufacturer</th>
<th>Type</th>
<th>Article no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside light dependent control</td>
<td>Theben-Werk</td>
<td>Lux-sensor, surface-mounted for external installation</td>
<td>907 0 008</td>
</tr>
<tr>
<td>Constant brightness control, indoors, with one control loop per room</td>
<td>Theben-Werk</td>
<td>Flush-type photo-receiver with wide detection zone</td>
<td>907 0 011</td>
</tr>
<tr>
<td>Constant brightness control, indoors, with several control loops per room</td>
<td>Philips Licht</td>
<td>LRL 8101 photosensor with stray light tube for switching off side light</td>
<td>136.2811</td>
</tr>
</tbody>
</table>

Table 2
Photosensors for use in Busch-Jaeger lighting control systems

The selection, positioning and installation are of critical importance for the function of the installation. The most important aspects which have to be considered are as follows:

**Outside brightness dependent switching/dimming:**
- The outside brightness level must be measured by the sensor.
- Direct illumination e.g. by sunlight should be avoided.
- Artificial light sources near the sensor which influence or interfere with the measurement of the outside brightness level should be considered.

**Constant brightness control:**
- The inside brightness must be measured by means of a reference area.
- The measured reference area may not be illuminated by the light of another control loop (the controller can otherwise begin to oscillate). The distances of the regulated lamps from each other should be considered for constant brightness control for workplaces in open plan offices.
- In the case of several control loops per room, the following applies:
  - The sensor may only measure the area whose line of fluorescent luminaires it controls.
  - The characteristic of the sensor, i.e. the sensitivity in dependence on the angle of incidence is therefore important.
  - The selection of the reference area (measuring surface) is critical, since its reflectance value is included in the measurement. In practice, this means that e.g. papers of various colour lying on a desk - brochures in high-gloss white or dark grey files - may result in various brightnesses of the regulated lamps. The type and use should be considered.
  - Which lamps should be included in the control system? If components of the lighting system are used for aesthetic aspects, e.g. decorative accent lighting of pictures or flowers, they should not be regulated.
2.1.1 Application examples for sensors

2.1.1.1 Application example for outside brightness dependent switching/dimming

Use of an LDR with measuring range setting by means of an additional resistance

![Diagram of circuitry of the analog input 6157 EB for the outside brightness dependent control of interior lighting](image)

Fig. 5

Circuitry of the analog input 6157 EB for the outside brightness dependent control of interior lighting

The measuring range is set by mounting a resistance between the input terminals „U1“ and „-“. In this manner, the analog input can be operated in dim light (2... 700 lux) or in the daylight range. The measured voltage 0...10 V is converted internally to the range 0...127. Good results are obtained at „medium-bright“ locations with Rp = 4.3 kW. A lower Rp (typically 1.2 kW) must be selected for use under fairly direct sunlight, and a higher Rp (typically 10 kW) for installation in shadier locations.

<table>
<thead>
<tr>
<th>Range: 20 ... 20,000 lx, Rp = 2.7 kΩ</th>
<th>Range: 5 ... 5.000 lx, Rp = 10 kΩ</th>
<th>Range: 2 ... 700 lx, without Rp</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>0.24</td>
<td>3</td>
</tr>
<tr>
<td>50</td>
<td>0.42</td>
<td>5</td>
</tr>
<tr>
<td>100</td>
<td>0.69</td>
<td>8</td>
</tr>
<tr>
<td>200</td>
<td>0.96</td>
<td>11</td>
</tr>
<tr>
<td>500</td>
<td>1.91</td>
<td>24</td>
</tr>
<tr>
<td>1.000</td>
<td>2.96</td>
<td>37</td>
</tr>
<tr>
<td>2.000</td>
<td>4.13</td>
<td>51</td>
</tr>
<tr>
<td>5.000</td>
<td>5.86</td>
<td>62</td>
</tr>
<tr>
<td>10.000</td>
<td>7.96</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 3

Measurement of brightness in various measuring ranges with the Theben lux-sensor on the analog input 6157 EB
### 2.1.1.2 Application example for constant brightness control

Constant brightness control for application in individual rooms

In principle, the measuring range is selected as described in chapter 2.1.1.1. Please remember that measurements are taken indoors and not outdoors for constant brightness control. The measuring range 5...5,000 lux is suitable for the constant brightness control application, i.e., the resistance $R_p = 10 \, \text{k}\Omega$.

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#### Fig. 6

Circuitry of the analog input 6157 for constant brightness control in individual rooms
2.1.1.2 Application example for constant brightness control

This sensor must also be modified to the measuring task. The adjustment is made directly on the sensor by means of an integrated trim potentiometer, instead of with an additional ohmic resistance. The photo-receiver is calibrated, when the red LED is neither fully on nor off at the desired brightness. Proceed as follows:

Set the desired indoor brightness. When the LED is lit, turn the trim potentiometer to the left until the LED goes out. Then turn the potentiometer to the right until the LED just starts to light up.

When the LED goes out, turn the potentiometer to the right until the LED just starts to light up.
To ensure the quality of the measurement, the signal line between the photo-sensor and the analog input should not be exposed to electromagnetic disturbance.

If the distance between the photo-sensor and the analog input is more than 1 m and if the cable is to be laid together with power supply lines, the sensor must be connected to a screened cable with an earthed shield (the shield can be connected to the "-" terminal of the analog input), as well as twisted pair lines (e.g. EIB bus line J-Y[St]Y 2 x 2 x 0.8 LG).

The protective provisions and distance regulations which apply for data lines must be complied with for the line routing. The maximum line length may not exceed 30 m per sensor.
2.2 Start-up and operation - the „quick way”

The following pages tell you how to put lighting installations into service quickly and safely in accordance with the BJE concept.

Please see chapter 3 for a detailed explanation of the individual applications.

2.2.1 Outside brightness dependent switching with one channel

The application „Outside brightness dependent switching 1 channel /1“ administers a brightness sensor and makes functions available for greater ease of operation (activation function, separate communication object for upper/lower switching threshold, sending of the actual value).

- To begin with, leave the parameters of the EIB devices in the factory setting.
- Switch on the brightness sensor on input 1. (See also chapter 2.1.)

- Link the communication objects
  - Telegram switch lower threshold (6x57 EB)
  - Telegram switch upper threshold (6x57 EB)
  - Switching (6x51 EB)
  - Telegram switch (6115)

  to a common group address.

- Link the communications object
  - Actual value cyclic. (6x57 EB)

  to a group address (for calibration purposes).

- If the function „Outside brightness dependent switching“ is to be activated/deactivated from a central position, link the communications object
  
  – Activate (6x57 EB)

  to the group address of the corresponding central function.

- Put the installation into service and test the function.

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<table>
<thead>
<tr>
<th>Devices:</th>
<th>Applications</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog input 6x57 EB</td>
<td>Outside brightness dependent switching 1 channel /1</td>
<td></td>
</tr>
<tr>
<td>e. g. switching actuator 6x51 EB</td>
<td>Switching …</td>
<td>or another application or device</td>
</tr>
<tr>
<td>e. g. switching actuator 6115</td>
<td>Switching …</td>
<td>for local manual operation (switching)</td>
</tr>
</tbody>
</table>

Table 4
Applications for outside brightness dependent switching with one channel
2.2.1 Outside brightness dependent switching with one channel

**Fine adjustment:**

- If the switching thresholds are too high or too low, change the respective parameters in ETS2 or change the position of the sensor.
  
  Use the function „Record telegrams“ of ETS2 for this. Determine the outside brightness level which you wish to use as a switching threshold.
  
  Enter the value sent by the analog input as the „actual value“ at this brightness in the parameter window.
  
  When calibration has been completed, you can - if you do not wish to display the current actual value - unlink the assigned group address from this communication object. You thereby reduce the load on the bus. Do not forget to download the change to the device.

- Select the desired operating mode using the parameters in the tab „Activation, start-up behaviour“.

- Change the lag of the control system by means of the switching delay parameters in the tab „General“.

- If the analog input is to „correct“ the manual local switching, activate the cyclic sending in the tab „Upper threshold“ and/or „Lower threshold“, depending on requirement. If manual local switching is to be suppressed in general for high outside brightness levels, parameterize an AND operation in the actuator and link the analog input to the link object of the actuator.

- Set the time for the sending cycle by means of the parameters in the tab „General“. The setting refers to the switching commands and the actual value. The default is approx. 1 second.

- (Refer to Chapter 3.1 and 3.1.3. for technical details about the system and this application.)
2.2.2 Outside brightness dependent switching with two channels

The application „Outside brightness dependent switching 2 channels /1“ can operate two brightness sensors and thus control two channels.

- To begin with, leave the parameters of the EIB devices in the factory setting.
- Switch on the brightness sensors on input 1 and input 2. (See also chapter 2.1.)
- For both channels to be controlled: Link the communication objects for each channel
  - Telegram switch (6x57 EB)
  - Switching (6x51 EB)
  - Telegram switch (6115)

  to a common group address.

- Put the installation into service and test the function.

<table>
<thead>
<tr>
<th>Devices:</th>
<th>Applications</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog input 6x57 EB</td>
<td>Outside brightness dependent switching</td>
<td></td>
</tr>
<tr>
<td>2 channels /1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. g. switching actuator 6x51 EB</td>
<td>Switching ...</td>
<td>for each controlled circuit</td>
</tr>
<tr>
<td>e. g. switching actuator 6115</td>
<td>Switching ...</td>
<td>for local manual operation (switching) for each controlled circuit</td>
</tr>
</tbody>
</table>

Table 5
Applications for outside brightness dependent switching with two channels
2.2.2 Outside brightness dependent switching with two channels

Fine adjustment:

- If the switching thresholds are too high or too low, change the respective parameters in ETS2 or change the position of the sensor. You can use the application „Outside brightness dependent switching 1 channel /1“ to determine the measured values for the switching thresholds. Proceed as described there.

- Select the desired operating mode using the parameters in the tab „Activation, start-up behaviour“.

- Change the lag of the control system by means of the switching delay parameters in the tab „General“.

- If the analog input is to „correct“ the manual local switching if the outside brightness level is exceeded, activate cyclic sending in the tab „Upper threshold“ and/or „Lower threshold“, depending on the system requirement.

- You can influence the „lag“ of the analog input by means of the parameters in the tab „General“. The shorter the cycle time or the lower the damping which is set, the faster the analog input will operate. Take the load on the bus into account when setting the cycle time.

(Refer to Chapter 3.1 and 3.1.4. for technical details about the system and this application.)
2.2.3 Outside brightness dependent dimming

To begin with, leave the parameters of the EIB devices in the factory setting.

Switch on the brightness sensors on input 1.

Link the communication objects

- Telegram actual value input A (6x57 EB)
- Actual value input (6x53 EB)

to a common group address.

If local operation is desired (switching, dimming), link the communication objects

- Telegram switch left pushbutton (6118)
- Switching output (6x53 EB)
and
- Telegram relative dimming right pushbutton (6118)
- Relative dimming input (6x53 EB)

to a common group address in each case.

If the user wishes to modify the dimming characteristic to suit his requirements locally, link the communication objects

- Telegram save left upper pushbutton long (6118)
- Save input (6x53 EB)

to a common group address.

In the parameter window of the 6x57 EB, select the parameter „Surrounding brightness at installation site (1-10)“ appropriate to the installation location of the sensor.

Put the installation into service and test the function.

<table>
<thead>
<tr>
<th>Devices:</th>
<th>Applications</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog input 6x57 EB</td>
<td>Outside brightness dependent lighting control /2</td>
<td>max. 4 channels</td>
</tr>
<tr>
<td>Dimming actuator 6x53 EB (or 6x55 EB)</td>
<td>Outside brightness dependent lighting control /2</td>
<td></td>
</tr>
<tr>
<td>Dimming pushbutton/pushbutton for blinds 6118 UP</td>
<td>Outside brightness dependent lighting control /2</td>
<td>for local manual operation. Switching, dimming, changing the setpoint or another operating element; depending on the desired range of function of the installation</td>
</tr>
</tbody>
</table>

Table 6
Applications for outside brightness dependent dimming
2.2.3 Outside brightness dependent dimming

Fine adjustment:

- If the control system is to switch back into automatic mode by means of a central switching command (e.g. time switch), link the communication object
  - Reset of manual control input (6x53 EB)
  to the corresponding group address.

- Change the lag of the control system by means of the parameters in the analog input. The shorter the cycle time or the lower the damping which is set, the faster the analog input will operate. Take the load on the bus into account when setting the cycle time.

(Refer to Chapter 3.2. for technical details about the system and the individual applications.)
2.2.4 Constant brightness control with manual change of the setpoint

Use the applications „Constant brightness save setpoint /1“ if comfortable local operation is desired.

<table>
<thead>
<tr>
<th>Devices:</th>
<th>Applications</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog input 6x57 EB</td>
<td>Constant brightness save setpoint /1</td>
<td>max. 4 channels</td>
</tr>
<tr>
<td>Dimming actuator 6x53 EB</td>
<td>Constant brightness save setpoint /1</td>
<td></td>
</tr>
<tr>
<td>Dimming pushbutton/ pushbutton for blinds 6118 UP</td>
<td>Constant brightness save setpoint /1</td>
<td>for local manual operation. Switching the controller on and off, dimming, changing the setpoint or another operating element; depending on the desired range of function of the installation</td>
</tr>
</tbody>
</table>

Table 7
Applications for constant brightness control with manual change of the setpoint

- To begin with, leave the parameters of the EIB devices in the factory setting.
- Switch on the brightness sensor on input A. (See also chapter 2.1.)
- Link the communication objects
  - Telegram actual value input A (6x57 EB)
  - Actual value input (6x53 EB)

  to a common group address.
- If local operation is desired (switching, dimming), link the communication objects
  - Telegram switch left pushbutton (6118)
  - Switching output (6x53 EB)
  - Telegram relative dimming right pushbutton (6118)
  - Relative dimming input (6x53 EB)
  - Link to relative dimming input (6x57 EB)

  to a common group address in each case.
- If a brightness value should be saved locally as a new setpoint, link the communication objects
  - Telegram save pushbutton upper left long (6118)
  - Save input (6x53 EB)

  to a common group address.
- Put the installation into service and test the function.
2.2.4 Constant brightness control with manual change of the setpoint

**Fine adjustment:**

- The switch-on brightness of the lamps is adjusted by means of the parameter in 6x53 EB.
  
- You adjust the control speed by means of the parameters „Telegram repetition time for each input“ (6x57 EB) and „Telegram repetition time of the analog valuator device“ (6x53 EB).

  **Note:** Change both parameters in both devices!

- If the controller oscillates in spite of this, increase the parameter in the dimming actuator.

- If the control system is to switch back into automatic mode by means of a central switching command (e.g. time switch), link the communication object

  – Reset of manual control input (6x53 EB)

  to the corresponding group address.

- You can choose whether the 6x53 EB switches off at high brightness or remains switched on at basic brightness. Use the parameter „Automatic switch-off at high brightness“ for this.

(Refer to Chapter 3.3 and 3.3.4 for technical details about the system and the individual applications.)
2.2.5 Constant brightness control with setpoint selection

Use the applications „Constant brightness setpoint selection /1” if the setpoint, e.g. for various room uses, is to be changed via a system control centre or time-controlled by a time switch.

<table>
<thead>
<tr>
<th>Devices:</th>
<th>Applications</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog input 6x57 EB</td>
<td>Constant brightness setpoint selection /1</td>
<td>max. 4 channels</td>
</tr>
<tr>
<td>Dimming actuator 6x53 EB (or 6x55 EB)</td>
<td>Constant brightness setpoint selection /1</td>
<td></td>
</tr>
<tr>
<td>Dimming pushbutton/ pushbutton for blinds 6118 UP</td>
<td>Constant brightness setpoint selection /1</td>
<td>for local manual operation. Switching the controller on and off, dimming or another operating element; depending on the desired range of function of the installation</td>
</tr>
</tbody>
</table>

Table 8
Applications for constant brightness control with setpoint selection

- To begin with, leave the parameters of the EIB devices in the factory setting.
- Switch on the brightness sensor on input A. (See also chapter 2.1.)
- Link the communication objects
  - Telegram actual value input A (6x57 EB)
  - Actual value input (6x53 EB)
  to a common group address.
- If local operation is desired (dimming), link the communication objects
  - Telegram relative dimming right pushbutton (6118)
  - Relative dimming input (6x53 EB)
  - Link to relative dimming input (6x57 EB)
  to a common group address in each case.
- If the default value is to be altered from a central location, link the communication object
  - Setpoint value (1... 127) (6x53 EB)
  to the corresponding group address.
- If the default value is also to be modified locally, link the communication object
  - Telegram value left pushbutton (6118)
  to the same group address.
- Put the installation into service and test the function.
2.2.5 Constant brightness control with setpoint selection

**Fine adjustment:**

- The switch-on brightness of the lamps is adjusted by means of the parameter in 6x53 EB.

- You adjust the control speed by means of the parameters „Telegram repetition time for each input“ (6x57 EB) and „Telegram repetition time of the analog valuator device“ (6x53 EB).

  **Note:** Change both parameters in both devices!

- If the controller oscillates in spite of this, increase the parameter in the dimming actuator.

- If the control system is to switch back into automatic mode by means of a central switching command (e.g. time switch), link the communication object
  - Reset of manual control input (6x53 EB)
  - to the corresponding group address.

- You can choose whether the 6x53 EB switches off at high brightness or remains switched on at basic brightness. Use the parameter „Automatic switch-off at high brightness“ for this.

(Refer to Chapter 3.3 and 3.3.5 for technical details about the system and the individual applications.)
3 Reference: applications, uses, objects, parameters

In this section you will find detailed explanatory information on the function of the individual applications as well as some application examples.

3.1 Outside brightness dependent switching of interior lighting

3.1.1 Overview

The outside brightness level is measured with the analog input 6x57 EB and a photo-sensor. When a specified outside brightness level is exceeded, any number of consumers can be switched off and also re-connected to the system. The consumers can be operated via any desired switching actuators (also dimming actuators as an option).

Fig. 8 „Outside brightness dependent switching“ – overview
3.1.2 Functional principle

The analog input is operated as a threshold switch. The upper and lower switching points, the switching characteristics with restoration of supply to the bus and the activation of the device are specified by means of the parameter setting.

Operating elements and switching actuators are user selectable.

Fig. 9 shows the functional principle and the interaction of the communication objects. If an operating element and the analog input control the same communication object („Switching“) of the actuator and the analog input cyclically transmits, local operation is not disabled but is always overridden (a.). When using an AND operation in the actuator (b.), local operation can be totally suppressed.

![Functional principle diagram]

*Fig. 9 „Outside brightness dependent switching“ - functional principle (a)***
3.1.3 Outside brightness dependent switching with one channel

Only one photosensor is administered with this application.

The measured and converted value is sent with the communication object „Actual value cyclic“ (1 byte). The upper and lower switching thresholds each have their own communication object „Telegram switch lower [upper] thresh.“ (both 1 bit). Sending of the switching telegrams and the actual value can be disabled by means of the communication object „Activation“ (1 bit) by transmitting the value „0“ to this object.
### 3.1.3 Outside brightness dependent switching with one channel

Parameters for selection of the input which the photosensor is connected to, as well as for the switching delay and the cyclic sending mode can be found in the tab “General”. A kind of pre-filtering is achieved through the adjustable “switching delay”, so that short-term changes in brightness do not cause switching telegrams.

![Edit Parameters](image)

**Fig. 12**

*Analog input 6x57 EB „Outside brightness dependent switching 1 channel /1 - parameter window 2*

You can specify the behaviour on bus/mains recovery as well as on receipt of an activation telegram by means of the parameters in the tab “Activation, start-up behaviour”. After a bus/mains recovery, the automatic transmit mode can be immediately started, or alternatively an activation telegram must be first of all received. If switching commands are to be updated on bus/mains recovery or on receipt of an activation telegram, the device transmits the respective telegrams immediately after the respective event. If the measured brightness is between the upper and lower switching threshold at this point, the switching characteristic should be stated.
3.1.3 Outside brightness dependent switching with one channel

The contents of the tabs „Upper threshold“ and „Lower threshold“ are essentially the same. The values for the switching thresholds and the switching telegram which is sent if the respective thresholds are crossed are to be stated. The hysteresis is a product of the subtraction of the values upper threshold - lower threshold.

The cyclic sending mode is activated or disabled separately for both switching thresholds. Cyclic sending is ended if the upper switching threshold or the lower switching threshold is crossed. For example, if cyclic sending was parameterized for the crossing of the lower threshold and no reaction parameterized for the crossing of the upper threshold, the sending of cyclic telegrams is ended if the upper threshold is crossed.

Fig. 13
Analog input 6x57 EB „Outside brightness dependent switching 1 channel /1“ - parameter window 3
3.1.3 Outside brightness dependent switching with one channel

The following example should make this clear:

The lighting is to be switched off automatically once the brightness level is high enough. This command is to be sent cyclically.

Parameter setting (cf. Fig. 13):
- „Switching characteristic for crossing the upper threshold“ = „off“
- „Send switching telegrams cyclically“ = yes

After crossing the upper threshold, the analog input also continues to send telegrams in the hysteresis range. The analog input stops cyclically sending OFF telegrams only when the lower threshold is crossed and the reaction parameterized for the lower threshold (a non-recurring ON telegram) is carried out. If „no telegram“ has been selected for the lower threshold, only the cyclic sending of OFF telegrams is ended.
3.1.4 Outside brightness dependent switching with two channels

This application can be operated with two brightness sensors.

Fig. 15
Analog input 6x57 EB „Outside brightness dependent switching 2 channels /1“ - communication objects

A communication object „Telegram switch“ (1 bit), through which the switching telegrams are sent if the respective threshold value is crossed, is available for each input.

Fig. 16
Analog input 6x57 EB „Outside brightness dependent switching 2 channels /1“ – parameter window 1
3.1.4 Outside brightness dependent switching with two channels

You will find parameters for the cyclic sending mode and the „damping“ in the tab „General“. Values between 3 (weak damping) and 36 (very high damping) are available for the latter. Pre-filtering is obtained by means of this, with the result that switching operations arising from short-term fluctuations in brightness (passing of a cloud) are avoided. The smaller the damping, the more sensitively and more quickly the system reacts.

Since the set cycle time also determines the measuring interval in the analog input, the „lag“ of the system results from both parameters.

The shorter the cycle time or the lower the damping which is set, the faster the analog input will operate. Take the load on the bus into account when setting the cycle time.

![Edit Parameters](image)

**Fig. 17**

Analog input 6x57 EB „Outside brightness dependent switching 2 channels /1“ - parameter window 2

The contents of the tabs „Channel 1“ and „Channel 2“ are essentially the same. An unused channel should be disabled. The values for the switching thresholds and the switching telegram which is sent if the respective thresholds are crossed are to be stated.

The cyclic sending mode is activated or disabled separately for each channel.
3.1.4 Outside brightness dependent switching with two channels

Fig. 18
Analog input 6x57 EB „Outside brightness dependent switching 2 channels /1“ - parameter window 3
3.1.5 Application example

Application example 1:

An office complex has nothing but offices on one side of the building, each of which are equipped with two groups of luminaires (one on the window side, the other on the corridor side). The lines of fluorescent luminaires near the window should be switched off as soon as the outside brightness level exceeds 1,000 lux; those on the corridor side should switch off at 2,000 lux. The lamps should be re-connected to the supply at 500 lux, respectively 1,000 lux. The outside brightness level is measured by means of a photo-sensor, which is attached to the front of the building.

- Application used: “Outside brightness dependent switching 2 channels /1”
- The sensor is connected to terminals U1 and U2
- Channel 1 switches the lights on the window side
- Channel 2 switches the lights on the corridor side
- Both channels active
- The values for the switching thresholds must be ascertained in coordination with the photosensor and the measuring range used (or as an alternative, the application: „Outside brightness dependent switching 1 channel /1”; cyclic sending of the actual value and recording with ETS)
- Switching characteristic on crossing the upper threshold (both channels): off
- Switching characteristics on crossing the lower threshold (both channels): on
- Send switching telegrams cyclically:
  - for channel 1 (window side): on crossing the upper threshold
  - for channel 2 (corridor side): never

In order that the lights in the entire building do not switch on after the onset of darkness after the end of the working day, the function is limited to office hours by means of a time switch. The channels of the analog input are not linked directly to the switching objects of the actuators by group addresses but via the AND operation in the actuator. As an alternative to this, the switching characteristic for crossing the lower threshold (both channels no reaction) and cyclic sending on crossing the upper threshold (both channels) can be selected. In this way, the lighting is automatically switched off; it must be switched on again locally after the onset of darkness.
3.2 Outside brightness dependent switching and dimming of interior lighting

3.2.1 Overview

The outside brightness level is again measured by the analog input 6x57 EB. Use the application „Outside brightness dependent lighting control /2“. You require locally in each case a dimming actuator 6x53 EB or 6x55 EB with the application „Outside brightness dependent lighting control /2“ and a dimming pushbutton sensor 6118. The latter serves as an operating element for the system user. Other operating elements from the Busch EIB Installation Bus® product range (e.g. 6117 4x pushbutton sensor or Busch triton®) can of course also be selected.

---

*Fig. 20
„Outside brightness dependent dimming“ – overview*
3.2.2 Functional principle

The functional principle of the system is as follows:

- The analog input signals the current outside brightness level („Actual value“) to the bus as a 1 byte value.
- The dimming actuator adjusts its initial brightness level to the received actual value. A dimming characteristic adapts the progression of the brightness level to the local light conditions.
- If required, the user can locally adjust the lighting independent of the automatic control system by means of the dimming pushbutton 6118. It is even possible to alter the dimming characteristic after start-up.

Note: Depending on customer requirements, other operating elements (e.g. Busch triton®) can of course also be used.

---

**Fig. 21**

„Outside brightness dependent dimming“ - functional principle
3.2.3 Analog input

Up to four sensors can be connected to the analog input 6157 EB.

A communication object "Telegram actual value" (1 byte) exists for each input.

The telegram repetition time is adjustable. In this connection, you have to take account of the resulting load on the bus. The number of inputs used results from the group addresses assigned. The setting "12 s" means that a telegram is sent every 4 seconds when three inputs are used (see Fig. 22).

By means of the parameter "Damping" a pre-filtering is obtained, with the result that abrupt changes in brightness of the interior lighting as a result of short-term fluctuations in the outside brightness level (passing of a cloud) are avoided. The smaller the damping, the more sensitively and more quickly the system reacts. Values £ 20 may result in disturbing abrupt changes in brightness.
3.2.4 Dimming actuator

The dimming actuator allows automatic and manual modes of operation. The communication objects „Actual value“ (1 byte), „Switching“ (1 bit), „Relative dimming“ (4 bits) and „Reset of manual control“ (1 bit) are used for this purpose. The function of the communication objects is explained in Chapter 3.2.4.1.

The object „Save“ (1 bit) is used to change the dimming characteristic.
3.2.4 Dimming actuator

The dimming characteristic is stored in each actuator. It is used to select the inside brightness level which corresponds to the outside brightness level. Thus, non-linearities arising from the brightness sensor, actuators or electronic ballast units can be compensated for or lamps on the window side can be controlled with a different dimming profile to those located further in the room.

The basic brightness parameterizes the value of the manipulated variable for the minimum brightness of the dimmer. This adjusts the actuator to the lamps used.

<table>
<thead>
<tr>
<th>Type of lamp</th>
<th>Recommended basic brightness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluorescent lamps</td>
<td></td>
</tr>
<tr>
<td>Incandescent lamps</td>
<td></td>
</tr>
<tr>
<td>Halogen lamps</td>
<td></td>
</tr>
</tbody>
</table>

Table 9
Recommended basic brightness for various types of lamp

The lighting can be automatically switched off at higher outside brightness levels. The parameter „Switch-off delay at high outside brightness“ is available to ensure that this does not occur on sunny days with a few clouds, when the outside brightness level is subject to higher fluctuations. The switch-off delay is started as soon as the basic brightness is reached. Values between 5 and 60 minutes are possible.

Automatic switch-off is suppressed, when the value 255 is entered for the parameter „Switch-off at actual value“.
In automatic control the dimming actuator receives the measured outside brightness by means of the communication object „Actual value“ (1 byte) and adjusts its initial brightness level accordingly.

The user can locally adjust the brightness directly via the communication objects „Switching“ and „Dimming“. On receipt of a dimming telegram (4 bits corresponding to EIS2), the actuator switches from automatic control to manual control and sets the appropriate brightness. The receipt of an ON telegram at the switching object switches back into automatic control again. The receipt of an OFF telegram switches off the connected lamp.

If the actuator is switched on when the outside brightness level is so high that a switch-off would take place, the actuator immediately switches off again without waiting for the switch-off delay time.

The actuator can be shifted back to automatic control from manual control, e.g. from a central unit, by means of the object „Reset of manual control“ . This has no effect when the actuator is switched off.
3.2.4.2 Setting the dimming characteristic

The actual value is assigned to a dimming value by means of a dimming characteristic.

At the start of commissioning, the dimming characteristic is determined by the following 3 values:

1. Max. brightness at outside brightness level =...
2. Half brightness at outside brightness level =...
3. Switch-off at outside brightness level =...

It is assumed that the lighting is activated at the maximum value, i.e. 255, at outside brightness level = 0. Depending on the type and site of installation of the photosensor and position of the controlled lighting system (i.e. of the dimming actuator), it is also necessary to continue to control the lighting system with 255, until it becomes so bright that dimming down can begin. The starting point for control is entered for 1.

At the start of commissioning, the values 1, 2 and 3 should form a straight line as far as possible, in order to assess the quality of the controlled system. This is assured by the default settings (Fig. 27, respectively Table 10). The dimming characteristic can be subsequently corrected and re-parameterized. Point (2) can be altered in service by starting a specified brightness in manual control and the actuator subsequently receiving a „1” telegram to the communication object „Save”. The current values for the outside brightness level („Actual value”) and the set brightness are then stored.
3.2.4.2 Setting the dimming characteristic

The outside brightness value, at which the room is so bright that the light switched can be off, is entered for 3. the analog input sends the value 254 as the maximum value for the outside brightness level. Therefore, if you enter 255 for the switch-off brightness, the lighting is never switched off but stays switched on.

The brightness of the room without artificial light (1: very dark, 10: very bright) is stated by means of the parameter „Basic brightness at installation site (1...10)”, and one of the pre-parameterized dimming characteristics is selected. These can be manually re-set by the user in each case.

<table>
<thead>
<tr>
<th>Surrounding brightness at the installation site</th>
<th>① Max. brightness at ...</th>
<th>② Half brightness at ...</th>
<th>③ Switch-off at ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Window side, bright</td>
<td>15</td>
<td>58</td>
<td>100</td>
</tr>
<tr>
<td>9</td>
<td>20</td>
<td>73</td>
<td>125</td>
</tr>
<tr>
<td>8</td>
<td>25</td>
<td>88</td>
<td>150</td>
</tr>
<tr>
<td>7</td>
<td>30</td>
<td>103</td>
<td>175</td>
</tr>
<tr>
<td>6</td>
<td>35</td>
<td>118</td>
<td>200</td>
</tr>
<tr>
<td>5 Middle of the room</td>
<td>40</td>
<td>133</td>
<td>225</td>
</tr>
<tr>
<td>4 Standard</td>
<td>46</td>
<td>148</td>
<td>250</td>
</tr>
<tr>
<td>3</td>
<td>50</td>
<td>153</td>
<td>255</td>
</tr>
<tr>
<td>2</td>
<td>55</td>
<td>155</td>
<td>255</td>
</tr>
<tr>
<td>1 Door side, dark</td>
<td>60</td>
<td>158</td>
<td>255</td>
</tr>
</tbody>
</table>

Table 10
Pre-parameterized dimming characteristics
3.2.4.2 Setting the dimming characteristic

In principle, the dimming characteristic should be selected initially from the pre-parameterized characteristics. In doing so, it is always better to parameterize the room „too dark“ (i.e. a smaller value for „Surrounding brightness...“) than too bright. Nothing is worse than when the light simply goes out, when it is still needed! Once switch-off values drawn from past experience are available, the beginning of control and the switch-off point can be re-parameterized. Fine tuning can be effected by the user during operation.

The parameterization of the dimming characteristic by means of ETS2 should always be effected in such a way that manual corrections are only necessary „in moderation“. „Illegal“ characteristics are excluded in all probability by setting the parameter values for „Max. brightness..“ and „Switch-off“ as close as possible to the limits 0 and 254.

Fig. 28
Shifting of the dimming characteristic during operation
3.2.5 Dimming sensor

The application „Outside brightness dependent lighting control /2“, was developed for the dimming sensor 6118 and especially tailored for this purpose. Other operating elements can of course also be used.

The communication objects „Telegram switch“ (1 bit) and „Telegram relative dimming“ (4 bits) are used for local operation of the lighting. The communication object „Telegram save“ (1 bit) transmits the value „1“, when the upper left-hand button is pressed for approx. 5 seconds. The LED integrated in the button is addressed through the communication object „LED colour change“ (1 bit).

**Fig. 29** Dimming sensor 6118 „Outside brightness dependent lighting control /2“ - communication objects

The communication objects „Telegram switch“ (1 bit) and „Telegram relative dimming“ (4 bits) are used for local operation of the lighting. The communication object „Telegram save“ (1 bit) transmits the value „1“, when the upper left-hand button is pressed for approx. 5 seconds. The LED integrated in the button is addressed through the communication object „LED colour change“ (1 bit).

**Fig. 30** Dimming sensor 6118 „Outside brightness dependent lighting control /2“ – parameter window 1
3.2.5 Dimming sensor

The function of the LED is set by means of the parameters in the tab „LED“. The LED can alternatively be used for status indication (the colour changes between red and green) or as a pilot light.

![Edit Parameters](image)

Fig. 31
Dimming sensor 6118 „Outside brightness dependent lighting control /2“ - parameter window 2

The actuating time during which the left-hand rocker button has to be pressed until the telegram „Save“ is transmitted can also be individually specified in the tab „Save“. To confirm the „Save“ telegram, the LED changes colour until the button is released.
3.2.6 Application examples for outside brightness dependent lighting control

Application example 1:

An office complex is equipped with an outside brightness dependent lighting system. One photosensor, which is placed in the upper area of the front of a building and connected to the analog input, suffices for the measuring of the outside brightness level.

The facade with windows faces south-west and is located in a medium-densely built-up residential and office development (approx. four storeys high). Trees planted along the road shade the lower 1 1/2 floors. The dusk sensor is therefore positioned in the middle of the facade (between the second and third floor). The brightness sensor is adjusted for dusk range measurement (5... 5,000 lux, Rp = 10 kW).

Pursuant to standards and workplace regulations, the inside illumination intensity level should not be below 300 lux. 400 lux is measured at window 1 at an outside brightness level of 1,000 lux. From this results the daylight quotient:

\[ T = \frac{E_{\text{inside}}}{E_{\text{outside}}} \times 100\% = \frac{400\text{ lx}}{1000\text{ lx}} \times 100\% = 40\% \]

This information must be allowed for in the planning of the lighting system!
3.2.6 Application examples for outside brightness dependent lighting control

**Figure 32**
Outside brightness dependent dimming with one photosensor and various dimming characteristics
3.2.6 Application examples for outside brightness dependent lighting control

The dimming characteristics must be selected in such a way that lamps located further away from the window dim down or switch off later than those near the window. This also applies for rooms which are located on lower floors and may shaded by trees in front of the window; here, the lights on the window side are controlled by dimming characteristic 2. The lamps on the corridor side are controlled by a correspondingly higher level (dimming characteristic 3). An average of 200 lux is measured in area 2 and an average of 100 lux at the door on the lower floor (3). The dimming characteristics are selected from the pre-parameterized characteristics:

- Characteristic no. 1
- Characteristic no. 2
- Characteristic no. 3

Using this solution, the money-saving effect is high and the hardware expenditure very low: one analog sensor with a connected photo-sensor is sufficient for outside brightness dependent control of the interior lighting for the complete front of the building or even the whole building.

Application example 2:

In a free-standing office building, the rooms on all four sides are used for office space. The centrally positioned analog input 6157 EB is connected on the incoming side to four photosensors, which are installed on the sides of the building or centrally on the roof. Thus, the money-saving potential for the offices located on the respective sunny side of the building, depending on the time of day and year, can always be exploited to the full extent. Various room uses, e.g. office space, sensitive rooms (e.g. design offices, management offices), corridors, can be considered by means of the individual dimming characteristics stored in the dimming actuators.

![Diagram of lighting control with photosensors](image-url)
3.3 Constant brightness control

3.3.1 Overview

The advantage of constant brightness control is that the available energy-saving potential is always fully utilized.

The principle of control comprises the feedback of the initial value of a system to the input and adjustment to a setpoint.

The functional principle of the Busch-Jaeger constant brightness control is as follows:

- The analog input signals the measured brightness to the bus as an „Actual value“.
- The dimming actuator compares the received actual value with the setpoint and brightens or dims the connected lamp(s).
- By means of the dimming pushbutton sensor 6118, the user can locally tailor the lighting system to his personal requirements independent of the control system. Moreover, he can also change the setpoint in the dimming actuator.

Note: Depending on the system or customer requirements, other operating elements (e.g. Busch triton®) can of course also be used.

Busch-Jaeger offers two applications which have different methods of selecting the setpoint. Irrespective of the application variant, the constant brightness control can be centrally switched on or off at the gatekeeper’s office or locally by means of a button on an EIB switching sensor. The requisite brightness can also be influenced locally or centrally by the user and thus adapted to various room uses or time profiles:

- An illumination intensity level of 500 lux is required on the shop floor of a manufacturing plant during working hours and only 100 lux at night for the security duties of the gatekeeper or the factory security office.
- In a drawing office, work is carried out in turn on the drawing board and on the monitor. Discussions with employees or customers are also carried out occasionally. The user can choose between the brightness levels for discussions (300 lux), VDU work (500 lux) and drawing board work (750 lux) for the individual tasks.
3.3.2 Positioning of the photosensor

The photosensor measures the physical dimensions of the luminous density and considers the following during the measurement:

- the daylight falling directly on the work surface,
- the light of the controlled lamps,
- the light which is reflected onto the work surface from walls and fixtures,
- and the reflectance of the work surface.

The impression of brightness which the human eye perceives is therefore measured, and the lighting is thus directly adapted to the requirements of personnel and the visual task, be it office work, VDU work, working on the drawing board, etc.

The sensor must be very carefully selected and positioned. There should be as little influence as possible from e.g. paper lying on a desk or different coloured articles of clothing. Direct reflection onto the eye of the sensor from the window pane, the window sill or other reflecting surfaces must be avoided without fail!

**In particular, the sensor must not pick up light from adjacent control loops!**
3.3.3 Information for configuration and planning

Extensive calibration of the constant brightness controller is not necessary. The sensor only has to be adjusted to the desired brightness. Proceed as described in chapter 2.1.1.2. The dimensioning of the lighting system for the respective application case, e.g. approx. 300 lux in a restaurant, 500 lux on a shop floor or 1,000 lux in a drawing office, takes place during the planning of the lighting system. This must of course take the use and relevant fixtures of the rooms (fitted carpet, wall arrangement, e.g. wallpaper, light or dark built-in cupboards) into account.

Attention!
The following information is to be considered during the planning and design without fail:

- On account of the expected telegram load, no more than five analog inputs (i.e. 20 constant brightness controllers) may be connected in one line!
- Constant brightness controllers in a Busch EIB Powernet® may only load the network with one telegram every two seconds. This refers to the total number of installed constant brightness controllers!
- Constant brightness controllers may not be configured across lines!
- Line couplers are to be loaded by means of the filter table without fail and may not be set to „relay“!
3.3.4 Constant brightness control with manual change of the setpoint

The application „Constant brightness save setpoint /1“ enables comfortable local operation of the lighting system. The setpoint can be changed and stored during operation. The lighting can be operated manually or switched off entirely by means of the dimming pushbutton.

Fig. 34
Application „Constant brightness save setpoint /1“ - functional principle
3.3.4.1 Analog input

Up to four brightness sensors can be connected to one analog input 6157 EB, i.e. the lighting in four offices or four workplaces can be measured with one analog sensor. There is a communication object „Telegram actual value“ (1 byte) for each input.

Fig. 35

Analog input 6157 EB - „Constant brightness save setpoint /1“ – communication objects

The group addresses for local dimming must be assigned to the communication object „Link to relative dimming“ (4 bits) for all control loops. In addition, the receipt of a „Stop“ telegram effects the transmission of the current actual values, so that they can be stored in the dimmer.
3.3.4.1 Analog input

The cycle time is to be stated, i.e. the sending interval of the sensor. Please note that this entry refers to all active channels, i.e. with 4 active channels and the setting 12 s, a telegram is sent to the bus every 3 seconds. The cycle time for each active channel should not exceed 15 seconds to ensure that the controller does not operate too slowly.

Fig. 36
Analog input 6157 EB - „Constant brightness save setpoint /1“ - parameter window
3.3.4.2 Dimming actuator

The dimming actuator allows automatic and manual control modes of operation. The communication objects „Actual value“ (1 byte), „Switching“ (1 bit), „Relative dimming“ (4 bits) and „Reset of manual control“ (1 bit) are used for this.

A manually pre-set dimming value can be stored as a new setpoint by means of the object „Save“ (1 bit).
3.3.4.2 Dimming actuator

The setpoint for the room brightness at initial start-up is entered in the parameter window of the dimming actuator. The default is 63. If a higher brightness is desired, the setpoint should be increased. If a lower brightness is required, it should be reduced. This setpoint can be subsequently changed during operation by means of the save function.

The parameter „Switch-on brightness“ is used for adjusting the connected lamps and electronic ballast units. This value is started when the lighting system is switched on, and control proceeds from it.

The switch-on brightness must always be higher than the parameterized „Basic brightness“. The latter parameter is the minimum brightness, with which the connected lamps are operated. Values between 20 and 130 are available for this.

The dimming actuator must be synchronized with the analog input in the cycle time. In this connection, the telegram repetition time of the analog input is also entered in the dimming actuator. Values which are lower than the analog input may cause the dimmer to oscillate, i.e. the brightness does not reach a firm value but fluctuates around the setpoint. Values which are too large slow down the controller.

The analog input can automatically switch off if the outside brightness is sufficient. If „no“ has been parameterized for this, the lighting system will remain switched on at basic brightness, even if the outside brightness is sufficient.

Automatic switch-off occurs under consideration of the time interval parameterized as „Switch-off delay“. This parameter is only noticeable if automatic switch-off has been activated.
3.3.4.2.1 Automatic and manual control
In automatic control, the controller functions as described, i.e. the interior lighting is readjusted locally if the lighting conditions change.

The user can adjust the brightness to his personal requirements by means of the communication objects „Switching“ and „Dimming“. On receipt of a dimming telegram (4 bits in accordance with EIS 2), the actuator switches from automatic control into manual control and brightens or dims the connected lamps. A change in the light conditions now has no effect on the dimming value.

Reset to automatic control takes place locally by means of an ON telegram. The object „Reset of manual control“ is used to switch back into automatic control from a central location.

Switch-on does not take place automatically after an automatic or manual switch-off; it must be effected by means of a switching „1“ telegram.

3.3.4.2.2 Setting the setpoint
If the room lighting is permanently too bright or too dark in automatic control, the setpoint can be re-programmed by means of the operating element. For this, dimming is carried out until the desired brightness has been set. If the actuator now receives a „1“ telegram at the communication object „Save“ (1 bit), it will store the currently set brightness in the place of the existing setpoint.

3.3.4.2.3 Control system speed
The determining parameter for the speed of the control system is the cycle time of the analog input. The dimming actuator must be synchronized with the set cycle time!

If a high cycle time was parameterized for the analog value transfer, a sudden change in brightness (e.g. through blinds) will be compensated for only slowly.
3.3.4.3 Dimming sensor

As a result of the application „Constant brightness save setpoint /1“, the dimming pushbutton sensor 6118 is optimally tailored to this purpose. However, other operating elements can be used without problems, be it for switch design reasons or in order to adapt the installation to the individual requirements. For example, individual elements, such as the local save function or the dimming function, can be dispensed with. If local control of the installation is not desired, the operating element can be dispensed with completely.

The communication objects „Telegram switch“ (1 bit) and „Telegram relative dimming“ (4 bits) are used for local operation of the lighting.

The communication object „Telegram save“ (1 bit) transmits the value „1“, when the left upper push button is actuated for a longer time. The LED integrated in the button is addressed through the communication object „LED colour change“ (1 bit).
3.3.4.3 Dimming sensor

The function of the LED is set by means of the parameters in the tab „LED“. The LED can alternatively be used for status indication (the colour changes between red and green) or as a pilot light.

Fig. 40
Dimming sensor 6118 - „Constant brightness save setpoint /1“ - parameter window 1
3.3.4.3 Dimming sensor

The actuating time during which the left-hand rocker button has to be pressed until the telegram „Save“ is transmitted can also be individually specified in the tab „Save“. To confirm the „Save“ telegram, the LED changes colour until the button is released.

Fig. 41
Dimming sensor 6118 - „Constant brightness save setpoint /1“ - parameter window 2
3.3.5 Constant brightness control with setpoint selection

The application „Constant brightness setpoint selection /1“ is preferably to be used when the setpoint is to be changed by means of a system control centre or time-controlled by a time switch. The dimming pushbutton sensor 6118 enables local manual operation as well as the selection of two different setpoints.

Fig. 42
Application „Constant brightness setpoint selection /1“ - functional principle
3.3.5.1 Analog input

Up to four brightness sensors can be connected to one analog input 6157 EB, i.e. the lighting in four offices or four workplaces can be measured with one analog sensor. There is a communication object „Telegram actual value“ (1 byte) for each input.

Fig. 43
Analog input 6157 EB - „Constant brightness setpoint selection /1“ - communication objects

The group addresses for local dimming must be assigned to the communication object „Link to relative dimming“ (4 bits) for all control loops. In addition, the receipt of a „Stop“ telegram effects the transmission of the current actual values, so that they can be stored in the dimmer.
3.3.5.1 Analog input

The cycle time is to be stated, i.e. the sending interval of the sensor. Please note that this entry refers to all active channels, i.e. with 4 active channels and the setting 12 s, a telegram is sent to the bus every 3 seconds. The cycle time for each active channel should not exceed 15 seconds to ensure that the controller does not operate too slowly.

Fig. 44
Analog input 6157 EB - „Constant brightness setpoint selection /1“ - parameter window
3.3.5.2 Dimming actuator

The dimming actuator allows automatic and manual control modes of operation. The communication objects „Actual value“ (1 byte), „Relative dimming“ (4 bits) and „Reset of manual control“ (1 bit) are used for this.

Fig. 45
Dimming actuator 615x EB - „Constant brightness setpoint selection /1“ - communication objects

A new setpoint can be set via the bus by means of the object „Default value (0..127)“ (1 byte). The value „0“ corresponds to the OFF condition.

Fig. 46
Dimming actuator 615x EB - „Constant brightness setpoint selection /1“ - parameter window
3.3.5.2 Dimming actuator

The setpoint for the room brightness at bus recovery is entered in the parameter window of the dimming actuator. The default is 0 (= switched off). If a higher brightness is desired, the setpoint should be increased. If a lower brightness is required, it should be reduced. The setpoint can be subsequently changed during operation by means of the object „Default value (0..127)“.

The parameter „Switch-on brightness“ is used for adjusting the connected lamps and electronic ballast units. This value is started when the lighting system is switched on, and control proceeds from it.

The switch-on brightness must always be higher than the parameterized „Basic brightness“. The latter parameter is the minimum brightness, with which the connected lamps are operated. Values between 20 and 130 are available for this.

The dimming actuator must be synchronized with the analog input in the cycle time. In this connection, the telegram repetition time of the analog input is also entered in the dimming actuator. Values which are lower than the analog input may cause the dimmer to oscillate, i.e. the brightness does not reach a firm value but fluctuates around the setpoint. Values which are too large slow down the controller.

The analog input can automatically switch off if the outside brightness is sufficient. If „no“ has been parameterized for this, the lighting system will remain switched on at basic brightness, even if the outside brightness is sufficient.

Automatic switch-off occurs under consideration of the time interval parameterized as „Switch-off delay“. This parameter is only noticeable if automatic switch-off has been activated.

3.3.5.2.1 Automatic and manual control

In automatic control, the controller functions as described, i.e. the interior lighting is readjusted locally if the lighting conditions change.

The user can adjust the brightness to his personal requirements by means of the communication object „Dimming“. On receipt of a dimming telegram (4 bits in accordance with EIS 2), the actuator switches from automatic control into manual control and brightens or dims the connected lamps. A change in the light conditions now has no effect on the dimming value.

Reset to automatic control takes place through receipt of a new default value or a telegram to the object „Reset of manual control“.

Switch-on does not take place automatically after an automatic or manual switch-off. It must be effected by means of a switching „1“ telegram.

3.3.5.2.2 Control system speed

The determining parameter for the speed of the control system is the cycle time of the analog input. The dimming actuator must be synchronized with the set cycle time!

If a high cycle time was parameterized for the analog value transfer, a sudden change in brightness (e.g. through blinds) will be compensated for only slowly.
3.3.5.3 Dimming sensor

The dimming pushbutton sensor 6118 with the application „Constant brightness setpoint selection /1” for local operation can be assigned with two default values, or dim the lighting. You can also use other operating elements which can send 1 byte values to adapt the installation to your requirements.

Fig. 47
Dimming sensor 6118 - „Constant brightness setpoint selection /1” - communication objects

The communication objects „Telegram value” (1 byte) and „Telegram relative dimming” (4 bits) are used for local operation of the lighting. The left push button operates the value object, the right push button the dimming object.

The LED integrated in the button is addressed through the communication object „LED colour change” (1 bit).

Fig. 48
Dimming sensor 6118 - „Constant brightness setpoint selection /1” - parameter window 1
3.3.5.3 Dimming sensor

The left-hand rocker switch of the sensor can be pre-assigned with two 1 byte values which are called up and sent by pressing the button up (Pushbutton „I“) or down (Pushbutton „0“). The values are entered in the tab „Left pushbutton“.

![Edit Parameters](image)

Fig. 49
Dimming sensor 6118 - „Constant brightness setpoint selection /1“ - parameter window 2

The function of the LED is set by means of the parameters in the tab „LED“. The size of the LED object can be 1 bit or 1 byte. The LED can alternatively be used for status indication (the colour changes between red and green) or as a pilot light in both cases.