



Operation Manual DLS2

Digital Line and Edge Sensor

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Firmware Version 1.3



Diese Bedienungsanleitung ist auch in Deutsch erhältlich.
Bitte kontaktieren Sie Ihren nächstgelegenen FMS Vertreter.

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1 Safety Instructions

1.1 Description Conditions

a) Danger of health injury or loss of life



Danger

This symbol refers to high risk for persons to get health injury or loss life. It has to be followed strictly.

b) Risk of damage of machines



Caution

This symbol refers to information, that, if ignored, could cause heavy mechanical damage. This warning has to be followed absolutely.

c) Note for proper function



Note

This symbol refers to an important information about proper use. If not followed, malfunction can be the result.

1.2 List of Safety Instructions



If a Digital Line Sensor DLS2 is used in combination with older web guide controllers of the types BKS110C and BKS309 V1.63 or older, a wire bridge needs to be added in the 24 V controller supply. Consult the wiring diagram and wire terminal arrangement in the operation manual of the respective controller to apply the bridge.



With special web guide controllers e.g. of the type BKS020.xxx.480.75.D.582339 (ABG) the DLS2 sensor must be mounted on the right side of the steering frame.



In web guiding systems all equipped with FMS components and a DLS2 sensor it may happen that the web guide controller blocks the steering frame. This protective function is activated when the line is interrupted and impossible to be detected. It avoids the steering frame from skittering away and material loses. In addition the DLS2 generates at permanent line interruption an alarm signal that can be used to shutdown the production line

2 Functional Description DLS2

The DLS2 sensor is a digital line and edge sensor for web guiding applications. The sensor recognizes different lines and can be setup to follow either the middle of a line, the edge of a line or the edge of web. DLS2 can handle intermittent lines and also lines that are being touched or crossed by a pattern.

The sensor works with a LED CCD-array with different colours for best illumination and maximum contrast on the material. It is able to choose the best illumination by means of powerful Digital Signal Processing algorithm.

The parameters for optimal contrast, control mode, line parameters, etc. will be stored fail-safely after a calibrations process and are the reference for the following web guiding process.

A LED-Display shows the position of the line as a moving point according to its position within the detection range of the sensor. An edge is being displayed as a moving bar from either side (depending on contrast polarity).

The sensor can easily and accurately be positioned with a light spot and the focussing function. The line position can be optimised and made visible on the LED display.



Note

The DLS2 sensor cannot be combined with the web guiding controller for motorized traverses BKS309.W.M

3 Dimensions

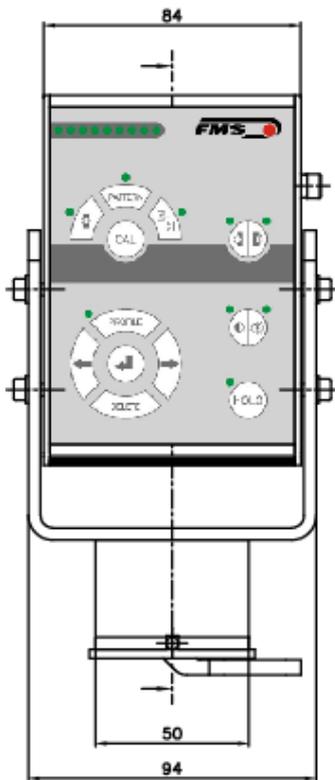
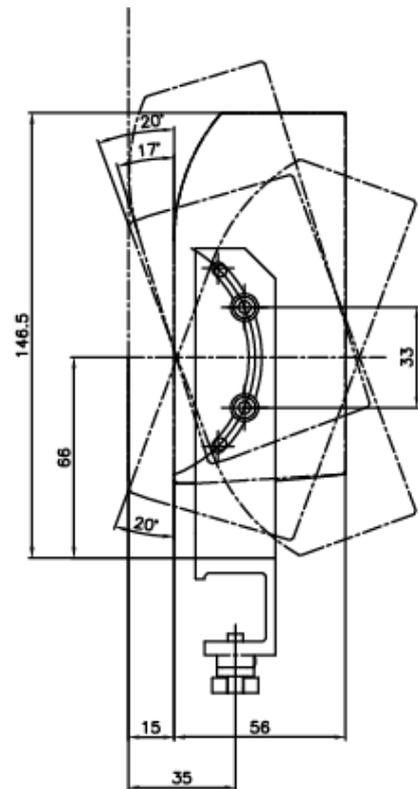


Fig 1: Dimensions DLS2



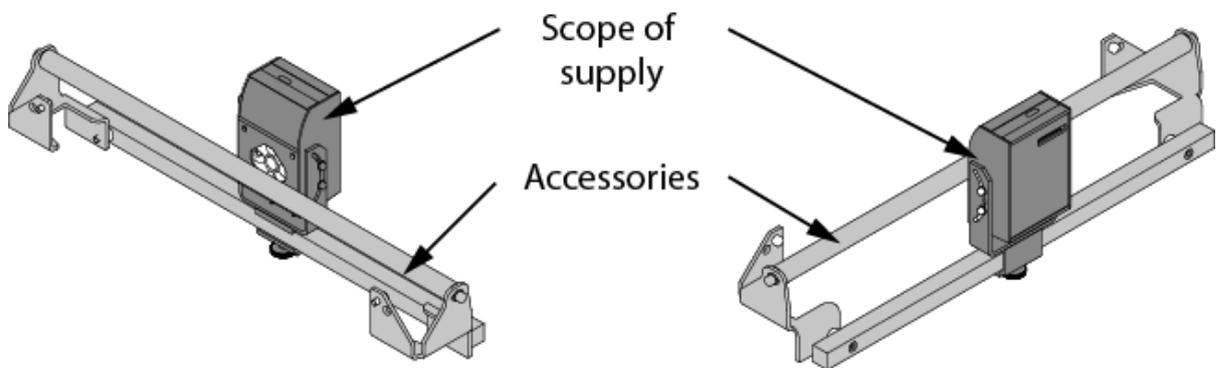
DLS2_Dimensionen.ai

4 Scope of Delivery

- Sensor DLS2
- Mounting bracket (BKS.W.V.A.20x20.DLS2)
- Operation Manual

Not in the scope of delivery are:

- Connection cable (length according to customer specification).
- Sensor adjustment / mounting (BKS.W.DLS2.020.2.XXX.YYY)
Length of guiding rod depends from the webMASTER type.



5 Installation

5.1 Mounting the Sensor

The sensor requires a square 20x20mm fixation bar that is mounted on the steering frame according to picture (Fig. 2). The sensor itself is fixed by four M4 screws on the fixation bracket which is attached to the square bar.



Fig. 2: Mounting of sensor on the square bar, view of tilting device DLS200005

The distance between DLS2 and material web should be 16 mm [0.62"].

The 4 screws on the side of the sensor allow tilting the sensor around the focus point. This can be required with reflective materials.

5.2 Right or left hand position of the sensor

Definition of Left and Right

Left and right are always seen in direction of the running web (Fig. 3).

The DLS2 line sensor can be used on both sides of the steering frame. The line sensor can replace an ultrasonic sensor US01/04B or an optical sensor AZS01/04A. No reconfiguration of the web guide controller is necessary after the replacement.

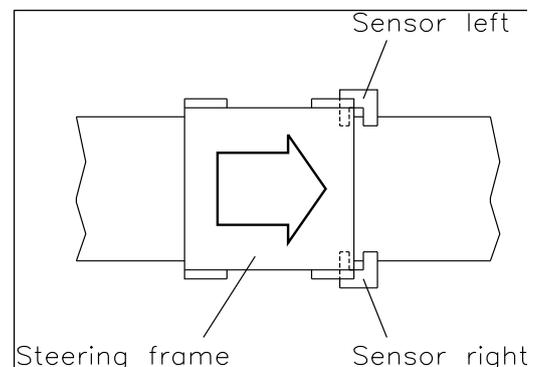


Fig. 3: Left and right K100007e



Note

Regardless of the mounting side, the DLS2 line sensor must always be connected to the socket for the RIGHT material sensor.

5.3 Wiring

Electrical connections:

If the sensor is used with a web guide controller built-in in a FMS steering frame of the webMASTER series, the sensor is connected with a cable 4x0.14mm² of the respective length. We recommend using FMS original cables. The cables can be ordered at FMS.

Fig. 4 shows the sensor connector in front view with its pin assignment. The table lists the wire colour corresponding to the signal names.

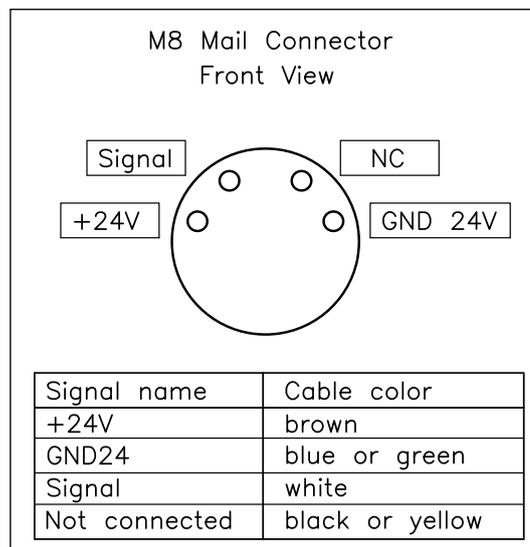


Fig. 4: Pin assignment DLS00008e

5.4 Using the DLS2 with FMS Web Guide Controllers

If using the DLS2 sensor with older web guide controllers of the types BKS110C and BKS309, it may be necessary to adapt the driver strength of the 24 VDC supply of the controller to the new sensor requirements. This is achieved by adding a wire bridge in the 24V supply. The table below indicates in which cases this modification is necessary and where the bridge has to be applied.

Used Controller in Web Guide	Serial number on Web Guide Frame	Wire bridge between wire terminals	Remark
BKS309	Lower than 106745	4 and 13	
BKS309	Higher than 106745	-	No wire bridge
BKS309	Firmware 2.43		Set operating parameter "DLS"
BKS110C.582339	All Web Guides	10 and 56	
BKS110C	All Web Guides	20 and 56	



Caution

If a Digital Line Sensor DLS2 is used in combination with older web guide controllers of the types BKS110C and BKS309 V1.63 or older, a wire bridge needs to be added in the 24 V controller supply. Consult the wiring diagram and wire terminal arrangement in the operation manual of the respective controller to apply the bridge.

6 Operation

6.1 Operational Parameters

(SW) Sensing Width: 8mm

(FD) Focal Distance: 16mm typical
(14mm min., 18mm max.)

(LW) Line Width: min. 0.5mm, max. 5.0mm

(LL) Line Location: Minimum 8mm from the material edge (or from adjacent printing that may cause interference)

Line Break: DLS2 recognizes unintentionally interrupted lines. With a break in the line the sensor provides a square wave output signal. This alarm signal can be used to shutdown the production line and prevent material losses (ref. to **8.6 Normal Operation**).

Line Contrast: High contrast between the line colour and the background colour (for example a black line on a white background) will provide for optimum operation of the sensor. The DLS2 sees colours differently as the human eye. Colour combinations (red and brownish colours) are under certain circumstances not easily recognized. In particular, if there is little contrast between the background printing and the printed line, a disturbance can occur. For optimum performance where low contrast is a factor, the line location (distance between background printing and the line) can be increased e.g. from 8 to 10mm. This will benefit the operation of the sensor.

Clear Material: Tracking a line of sufficient contrast on clear material is typically straightforward provided that a background is utilized with good contrast to the line colour (e.g. black line – white background, white line – black background). A distance of approximately 3mm between clear film and background (behind the film) is recommended.

Reflective Material: It may be beneficial to adjust the sensor at an angle to the material in order to reduce reflections.

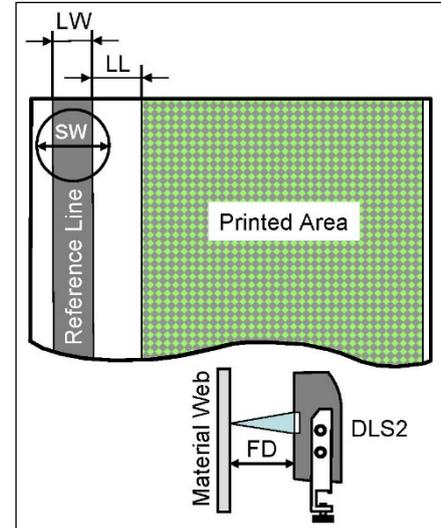


Fig. 5: Operational Parameters
DLS2012e



Note

FMS will evaluate your product in order to confirm suitability with the Digital Line Sensor. Please contact your local FMS Representative or FMS directly for further information.

6.2 Operation Panel

The operation panel (**Fig. 6**) consist of a foil type key pad and a LED-Display. The later is used to display the actual line or edge position or status information of the sensor e.g. in form of a LED pattern. A small green LED is assigned to all keys that own an operation. These LEDs confirm the function that was activated

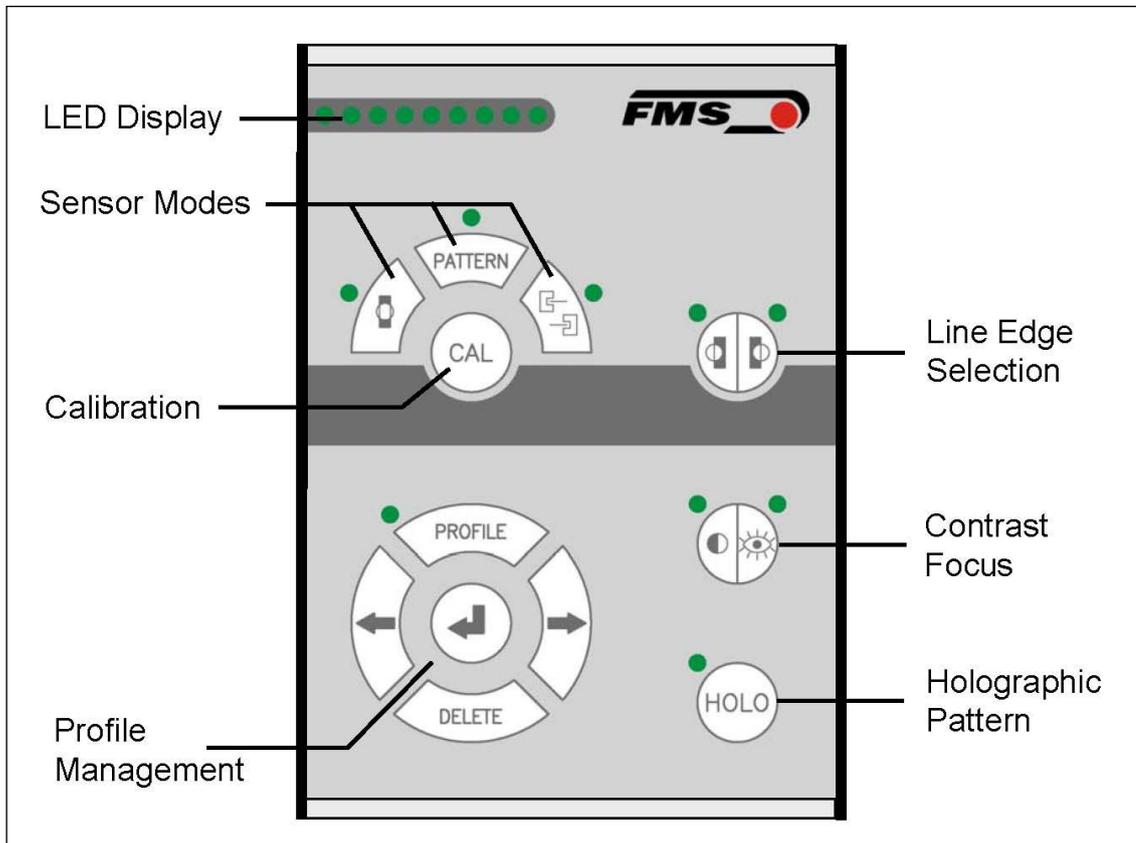
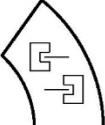
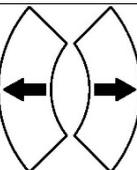
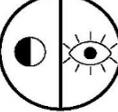


Fig. 6: Front panel

DLS20006e

6.3 Operating the DLS2 via the Front Panel

Key	Key function during operation
	Enter Calibration Procedure
	Line detection mode (guides centre of line)
	Pattern recognition (not operational)
	Material edge mode
	Line Reference Position (guides on the edge of line)
	Enter profile management (list of predefined profiles)
	Select previous / next profile from the list
	Enter / implement / store profile
	Delete profile from list
	Measure contrast Adjust focus Sensor Detection Range Lights Spots
	Change to hologram detection

7 Commissioning of the DLS2

7.1 Initialisation Phase



Note

If you retrofit a DLS2 sensor to an existing controller you have to restart the controller after the installation of the sensor. This will allow the controller to detect the DLS2 sensor correctly.

When powered up the DLS2 will initialise all parameters and will load the last profile used. If no profiles or calibration data are available (e.g. when used the first time), the sensor can't go to Detection Mode and it needs to be calibrated. In this case the LED display will indicate un-calibrated status with a light pattern with even and odd LEDs flashing in alternation.



All even LEDs shining



All odd LEDs shining

In order to enter the Detection Mode the DLS2 needs to be calibrated. The following **section 7.2** describes how to initialise and calibrate the DLS2 sensor. If an existing profile with calibration data was loaded the sensor will change to the Detection Mode. The LED line will in this case display the position of the line or edge depending of the used mode.

7.2 Quick Installation Guide / Initialisation Procedure

The following procedure deals with commissioning the DLS2 sensor in line detection mode. The initialisation in other modes (e.g. edge detection) is carried out analogous. Instructions and information for the other modes can be found in **section 8** „Different Operation Modes“.

Initialisation Procedure:

1. Mount the sensor on the steering frame (see **section 5.1** and **5.2**)
2. Wiring the sensor (see **section 5.3**)
3. Choice of material: Choose a white paper web with a printed black line of 2 mm [0.08“]
4. Perform Horizontal Positioning of DLS2 (see **section 7.3**)
5. Perform Focus Adjustment Procedure (see **section 7.4**)
6. Do Contrast Measuring (see **section 7.5**)
7. Perform Calibration Procedure (see **section 7.6**)
8. If necessary store profile of calibration (see **section 9.3**)

7.3 Horizontal Positioning

In Normal Operation Mode an adjustment add can be called up by pressing **three times**

the  key. The two small green LEDs above the key will light indicating that the adjustment mode was activated. The sensor will project two small red light dots which are vertically staggered. The sensor can be positioned by moving it along the rail until the dots cover the object (line or edge) it has to recognise on the material. Once aligned, the sensor can be locked by a corrugated-head screw.

The horizontal adjustment mode can be terminated by either pressing the  key once or waiting 30 sec.

7.4 Adjustment of Focus

The quality of the line or edge detection depends form several parameters. The focus is an important parameter for proper functioning of the sensor. The focus is given by the correct distance between sensor and material web. The best way of adjusting the focus distance is by using a suitable material with a printed straight line with good contrast. There is a procedure to set the correct focus distance. The procedure is started by

pressing **twice** the  key. The small green LED on the right side of the key will light. The focus quality can be influenced by moving the sensor closer or farther away from the material. The improvement of the focus is indicated by the LED pattern as follows:

Focus Quality	LED-Display
Badly adjusted focus	<p>→ improving ←</p> 
Well adjusted focus	
Best achievable focus	

The focus adjustment procedure can be terminated by either pressing the  key once or waiting 30 sec.

7.5 Contrast Measuring

The contrast describes the transition of the printed line and its background (dark - bright intersection). The higher the contrast the better will be the detection of the line. The

contrast can be measured by pressing **once** the  key. The small green LED on the left side of the key will light. The contrast quality is visualised by the LED pattern as follows:

Contrast Quality	LED-Display
Very bad contrast	<p>None LED is shining</p> 
Bad contrast	<p>→ improving →</p> 
Good contrast	
Excellent contrast	

The Contrast Measuring can be terminated by either pressing the  key once or waiting 30 sec.

7.6 Sensor Calibration

The Calibration Procedure can be considered as a learning and optimisation process of the sensor. The DLS2 gathers the characteristics of the line. Properties like line width, contrast on left line edges, contrast on the right line edge and line colour are measured and stored. The line must fulfil certain quality criteria (contrast, dimensions etc.) to be recognised as a line. If these criteria are not fulfilled the calibration will fail and an error pattern will appear on the LED-Display.

The calibration is started with the selection of the operation mode (ref. to **section 8**). Press the key that complies with your application:



Line Detection (centre of line)



Pattern Recognition



Line Edge Detection



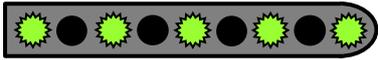
Hologram Detection



Material Edge Detection



After the operation mode choice start the calibration by pressing the  key for longer than half a second. During the calibration all LED will flash.

Calibration Result	LED-Display
If the calibration was successful, the sensor will display the actual line or edge position in relation to the sensor detection range.	<p>line detection</p>  <p>edge detection</p> 
At unsuccessful calibration the sensor will display an error pattern. Even and odd LED will flash alternating.	 

After a successful calibration and a test run the object data (calibration data) can be stored as a profile (ref. to **section 9** „Profile Management“)

8 Different Operation Modes

The DLS2 can detect different objects on a wide range of carrier materials. Following objects can be defined:

- Straight lines
- Intermittent lines
- Material edges
- Holographic lines
- Holographic pattern
- Printed pattern

In order to optimise the detection of above objects the DLS2 sensor must be set in the right operation mode. There are 5 operation modes:

- Line Detection
- Line Edge Detection
- Material Edge Detection
- Hologram Detection
- Pattern Recognition

8.1 Line Detection

In Line Detection Mode the sensor can detect lines from 0.5 mm to maximal 5.0 mm. The characteristics of a line are gathered in the Calibration Procedure. Properties like line width and the contrast on both line edges determine and describe each particular line. A line will only be recognised as line, if following limits are adhered:

1. The line width may not differ more then $\pm 35\%$ from the reference line.
2. The absolute contrast may not differ more then 40% from the reference line
3. The contrast steepness may not differ more then 40% from the reference line
4. The direction of contrast change must match on both sides with the reference line.

To bring the sensor in Line Detection Mode press the  key. The small green LED above the key will light to confirm that this mode is active. The sensor will always follow in this mode the centre of the line.

8.2 Line Reference Position

The line Detection mode distinguishes between three different reference positions:

- Line edge left
- Line edge right
- Line centre

The Reference Position can be chosen with the  key. The small green LEDs above the key indicate which Reference Positions is active.

8.3 Material Edge or Line Detection Mode

This operation mode enables to recognise an edge of a material web or the edge of a wide line. The edge must fulfil certain parameters to be recognised as an edge:

1. The absolute contrast may not be smaller than 50% from the reference edge
2. The contrast steepness may not be smaller than 50% from the reference edge
3. The direction of contrast change must match with the reference edge



The Edge Mode can be chosen with the key. The small green LED above the key will light to confirm that this mode is active.

Operation Mode	LED -Display
<p>The line detection mode is indicated by one shining LED that gives the position of the line in relation to the sensor detection range. If none LED is shining, the sensor can't recognise the line.</p>	<p style="text-align: center;">← moving →</p> 
<p>The edge detection mode is indicated by several shining LEDs that gives the position of the material edge in relation to the sensor detection range. If none LED is shining, the sensor can't recognise the edge.</p>	<p style="text-align: center;">← moving →</p> 

8.4 Hologram Detection

Materials with holograms require different illumination conditions as material with printed lines. To accommodate for this requirements there is a dedicated operation mode.



The sensor can be set to this special operation mode by pressing the key. The small green LED above the key will light to confirm that the mode was activated. The switch to Hologram Detection requires a re-calibration of the DLS2, if no profile for such a material-object combination exists. The calibration in the Hologram Detection Mode is carried out analogous to the procedure described in **section 7.6** "Sensor Calibration".

8.5 Pattern Recognition

Not operational

8.6 Normal Operation

In normal operation the display shows the position of the line or the edge as described in **section 8.3**. If the line or edge is missing none LED will shine. Longer unintended line interruptions are recognised by the DLS2 and it sends a special signal to the web guide controller. In such a case the controller blocks the steering frame at the actual position until the line is recognised again.



Note

In web guiding systems all equipped with FMS components and a DLS2 sensor it may happen that the web guide controller blocks the steering frame. This protective function is activated when the line is interrupted and impossible to be detected.

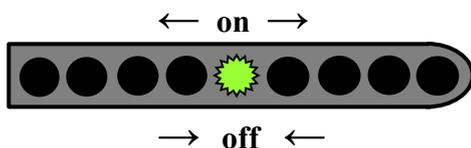
The DLS2 generates at unintentional line interruption an alarm signal that can be used to shutdown the production line preventing the steering frame skittering away and creating material losses.

8.7 Reset to Default Parameter Set

Factory settings of the DLS2 can be re-established by:

Holding the two keys  +  while powering-up the device.

The process will be confirmed by one LED light wandering from the middle to the ends of the row and back.



9 Profile Management

Once the material/line/edge combinations have been calibrated they can be stored as a profile. The profiles contain the most important properties of the calibration (contrast, line dimension, edge quality etc.). Profiles enable a quick and flexible use of the production line since they can quickly be accessed. Machine set-up for periodically used materials is simplified (no need for recalibration) resulting in considerable time savings.

9.1 Profile Management Panel

The rose-like control panel (see Fig. 7) is used for profile management. With it profiles can be stored, deleted or implemented. After entering the operation mode „Profile Management“ (by pressing the  key for longer than 0.5 sec.) the LED-Display will show the status of the profiles (see Fig. 8).

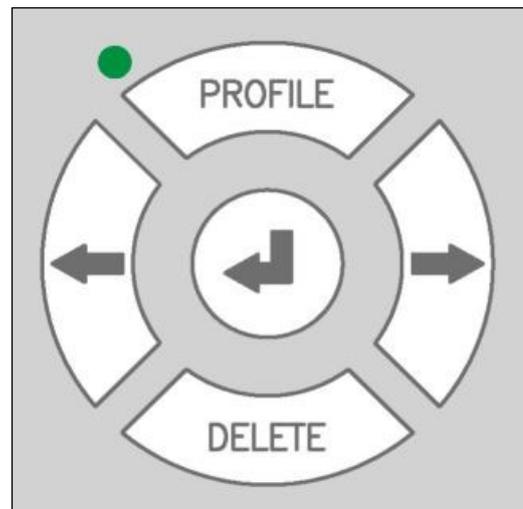


Fig. 7: Profile Management Panel
DLS2010

Each of the 9 elements on the LED-Display represents a profile. Hence the DLS2 can store 9 different profiles. The status of the profiles are visualised by the manner the LED-Element is shining. Following table shows the different profile states.

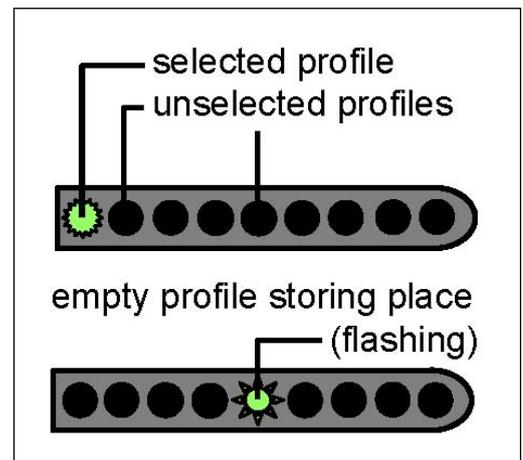


Fig. 8: Profile Storing Places
DLS2011e

LED-Element	Profile Status
Not shining	Unselected profiles
Flashing	Empty profile storing place
Permanently shining	Selected calibration data (profile)

9.2 Call Profile and Implement

If a profile is fetched from the memory and adopted, the actual calibration data of the DLS2 is overwritten.

1. Enter operation mode „Profile Management“ by pressing the  key for longer than 0.5 sec.

2. Select an existing profile with the  keys. An existing profile is marked by shining LED.

3. Press the  key for longer than 3 sec. to adopt the selected profile. This action terminates the Profile Management mode and brings the DLS2 to normal operation.

9.3 Save Profile

1. Calibrate DLS2 with material-reference-combination.
2. Check calibration with a test run.

3. Enter operation mode „Profile Management“ by pressing the  key for longer than 0.5 sec.

4. Select a free profile storing place with the  keys. A free profile storing place is marked by a flashing LED. It's not possible to overwrite an existing profile without deleting the profile beforehand. .

5. Press the  key for longer than 0.5 sec. to save the profile in the free storing place. The LED will change from flashing to permanent shining. If the saving process was successful, the DLS2 will go to normal operation mode.

9.4 Delete Profile

1. Enter operation mode „Profile Management“ by pressing the  key for longer than 0.5 sec.

2. Select an existing profile with the  keys. An existing profile is marked by shining LED.

3. Press the  key for longer than 3 sec. to delete the selected profile. The LED will change from permanent shining to flashing. The sensor will then go to normal operation mode.

10 Technical Data

Parameter	Value
Sensing width	8mm
Max. line width	5mm
Min. line width	0.5mm
Resolution	0.06mm
Measuring rate	2 ms
Output signal 0...10V	0...10V
Power supply	24VDC (18...30VDC)
Temperature range	-10 ...+50°C
Protection class	IP 54

11 Trouble Shooting

Error	Possible cause and solution
Wrong measuring results, malfunction of the sensor	<p>Electrostatic discharge of the web to the material sensor can lead to malfunctions. An additional electrostatic protection band can be used as illustrated below.</p> 



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