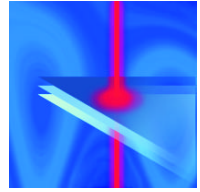


# Double Sheet Sensor

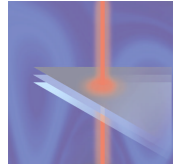
Accuracy - Reliability - Security



## DoubleSense® Model III User Manual

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## **DoubleSense Model III**

Detailed User Manual

Revision date: 11 May 1999

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### **EMC requirements**

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# 1 Product application

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The DoubleSense III is a double sheet sensor that can be used for detecting double sheets, missed sheets, paper jam, and the presence of a paper passing the sensor. Further useable functions are detection of pass time errors and the detection of one missing layer out of two or major paper opacity differences in the paper flow.

DoubleSense can be used in any type of sheet feeding process, e.g. in enveloping machines where it is extremely important that, for example, a confidential bank account draft does not end up in the wrong envelope. DoubleSense also ensures a higher quality in collating machines, foil wrapping machines and print feeders where the sensor checks the sheets at each feeder station.

Other applications are, for example, the detection of a plastic card or sticker on a letter, the detection of web splice pieces in a web offset system or recognition of a correct sheet fold. These applications are to a certain extent customer specific and require software adjustments for the due environment.

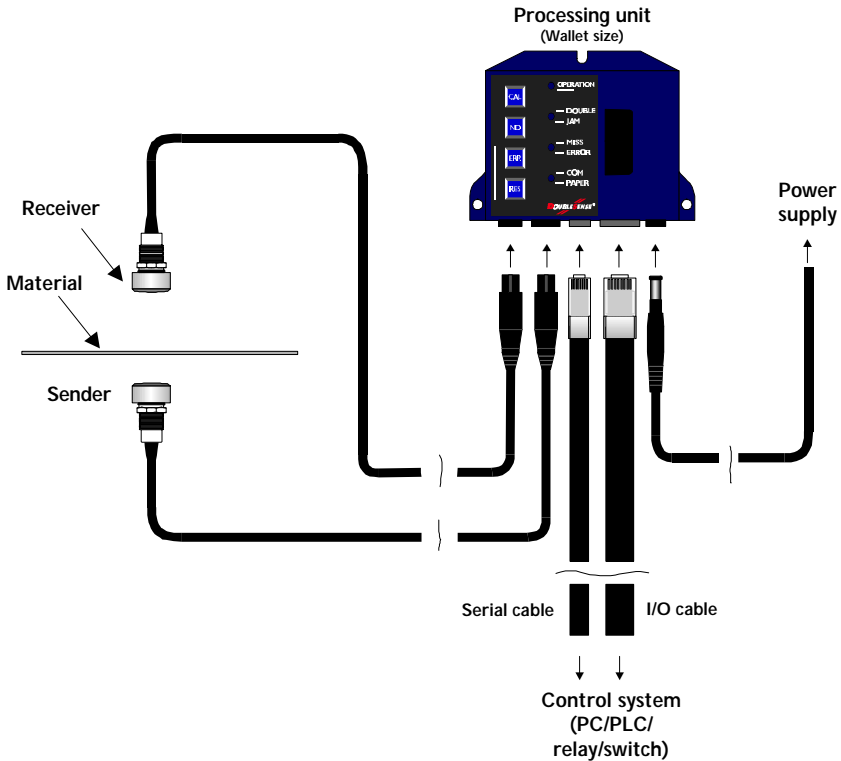


Diagram 1. DoubleSense system application.

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## 1.1 Sensor function

---

DoubleSense detects sheets by sending *invisible infrared light* through the paper. Without touching the paper the sensor can discover a double sheet on an early stage in the machine process.

The sensor collects opacity data, i.e. light reduction data on a path stretching from lead edge to trail edge of the sheet before it indicates the paper status. This method of scanning the entire sheet results in the most accurate and reliable detection that can be found on the market today.

The sensor is easily calibrated by pressing one single button – no other manual operation is needed. When the next paper sheet is run *completely through* the sensor, the paper opacity profile is automatically scanned, processed and stored in the sensor memory.

On the following papers in the feeding process data will be evaluated and compared to the calibrated value. If the sensor happened to be calibrated on a double sheet the user will get a warning from the sensor that a possible feeding failure might have occurred. Although the material is too thick or too dark for the sensor to beam through the sensor can continue to detect missed sheets, paper jam and signal whenever a sheet is present between the sender and receiver.

Thanks to the advanced data processing DoubleSense can handle sheets with varying print patterns in an accurate way. Therefore DoubleSense is not likely to deliver false error signals on black areas, unlike many other light sensors used in double detection. Neither is DoubleSense very sensitive to height variations, i.e. if the paper flutters, or to moist variations, such as is the case with some inductive sensors.

---

## 2 Installation

---

When installing **DoubleSense Model III** please follow the instructions in this chapter in chronological order.

The sensor consists of the following:

- Main processing unit.
- Sender and receiver (including cable and cable connector).

Additional equipment can be ordered from HMS Sensors:

- Power cable with battery eliminator connector.
- I/O cable with modular connector.
- Serial cable with modular connector.

---

### 2.1 Mechanical characteristics

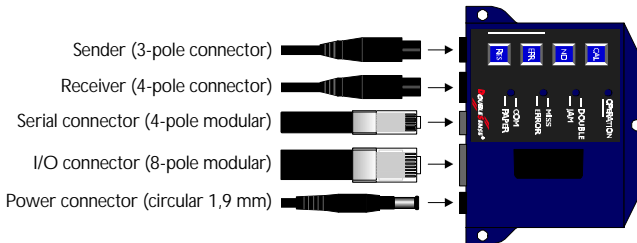
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#### 2.1.1 Cable connectors

---

All cable connectors are polarised and cannot be placed in the wrong connector. The sender has a 3-pole connector and the receiver has a 4-pole connector. The I/O (input/output) modular connector have 8 poles whereas the serial modular connector has 4 poles. The power connector is of battery eliminator type, often used as power connector in battery adaptors.



*Diagram 2. Connecting to the processing unit.*

---

## 2.1.2 Dimensions sender and receiver

---

DoubleSense has one infrared transmitter (sender) and one photoelectric receiver that are included in each delivery. The cable is shielded and 2 metres long for both sender and receiver.

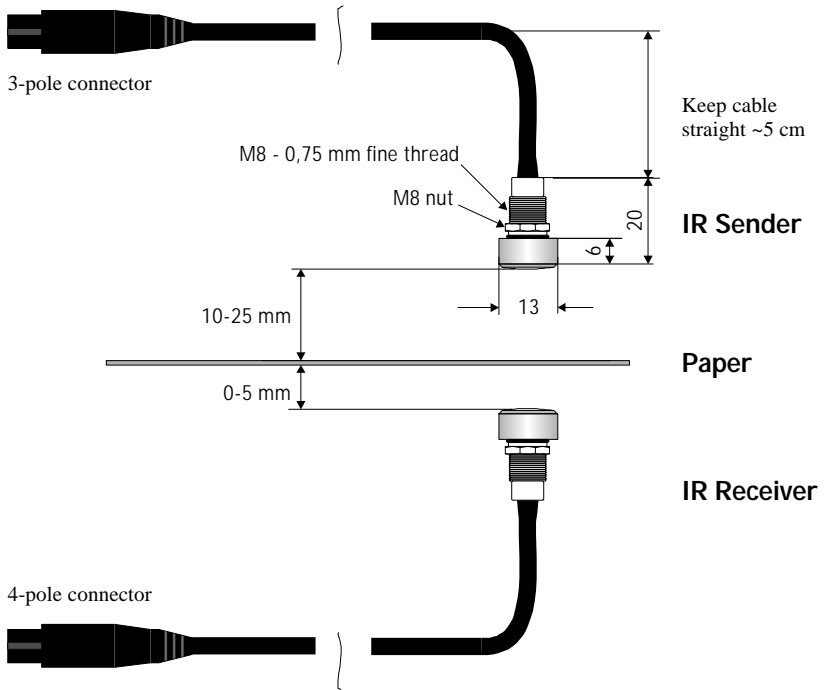


Diagram 3. Dimensions sender and receiver and location relative to paper.

---

## 2.1.3 Mounting the Sender and Receiver

---

For optimal beam through capacity the sender should be mounted 10 – 25 mm from the receiver and the paper surface should pass 0-5 mm above the receiver. Direct the light beam 90° to the paper surface. In order to keep the receiver away from stray light and direct light sources the receiver can be mounted above the sender as well as vice versa.

The sender and receiver lens housing is partly threaded  $\varnothing 8$  mm and delivered with an M8-nut, a washer and an O-ring attached. The units can for example be clenched mounted on a U-shaped or a key hole cut out.

The cable must not be bent to any side since it might effect the throughbeam capacity. Keep the cable straight (no bending angle) for at least 5 centimetres from the lens housing. Do not pull or twist the cables. *See chapter 2.3.2 for alignment check at installation.*



---

## 2.1.4 Dimensions processing unit

---

The following diagram shows the mechanical dimensions of the processing unit.

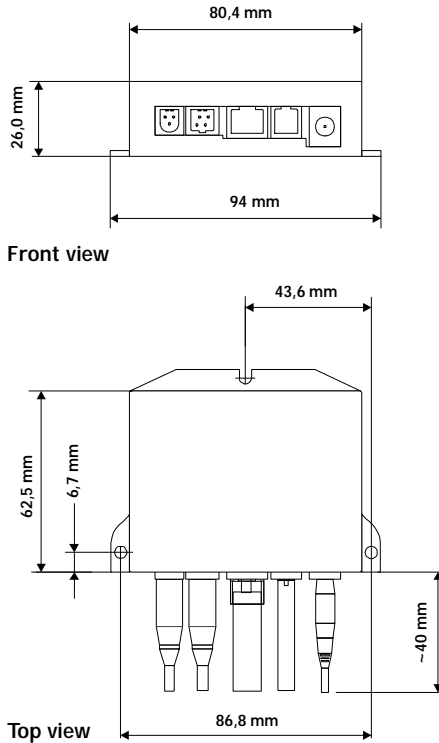


Diagram 4. Dimensional drawing processing unit.

---

## 2.1.5 Mounting instructions processing unit

---

The processing unit can be mounted on the outside of the machine to facilitate direct access to the sensor operator panel, or inside an electrical cabinet as a unit integrated with the machine control system. When placed out of reach for direct operation the sensor can be controlled via inputs/outputs or serial communication.

- The processing unit consists of sensitive electronic components. Please mount the unit steadily in a vibration free environment.
- All cable connectors have a security pull latch that prevent them from detaching during use. Make sure that the connectors are properly fastened to ensure that the pull latch is clenched into the connector.
- Use M3-M4 screws (metric system) to fasten the processing unit. Use washers to avoid that the plastic surface be damaged by the torque load.

---


## 2.2 Electrical characteristics

---

### 2.2.1 Power supply

---

The power connector is a battery eliminator type. Connect according to the following:

Connector	Symbol	Power ( $U_p$ )	Max	Average	Min
White (-)		+12 (+/- 5%)	600 mA	125 mA	80 mA
Black (+)		(Volt DC)	+24 (+/- 5%)	300 mA	70 mA

### 2.2.2 I/O connector

---

The inputs and outputs are located in the modular connector (8-pin) named **I/O connector**.

The **I/O cable connector** has the following standard configuration:

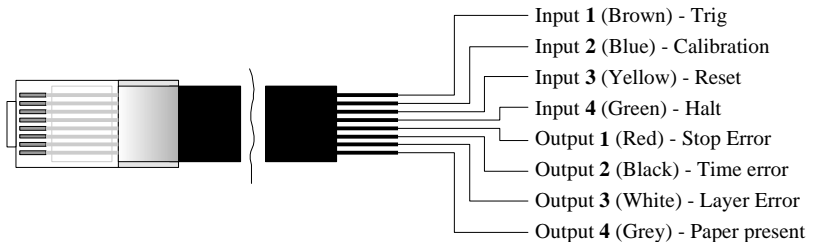


Diagram 5. I/O modular cable connector configuration.

### 2.2.3 Input and output connection

---

The outputs can be configured as PNP or NPN. Please restrict voltage for inactive inputs and outputs to between 0 V and  $U_p$  in order not to damage the unit.

Config.	Outputs active	Max output current
PNP	$U_p$ - residual voltage (1 V)	150 mA at $U_p = 12$ V
		250 mA at $U_p = 24$ V
NPN	0 V + residual voltage (1 V)	250 mA

The inputs are active at:

Config.	Inputs active	Inputs inactive
PNP	$> 0,8 \times U_p$	$< 0,5 \times U_p$
NPN	$< 0,2 \times U_p$	$> 0,5 \times U_p$

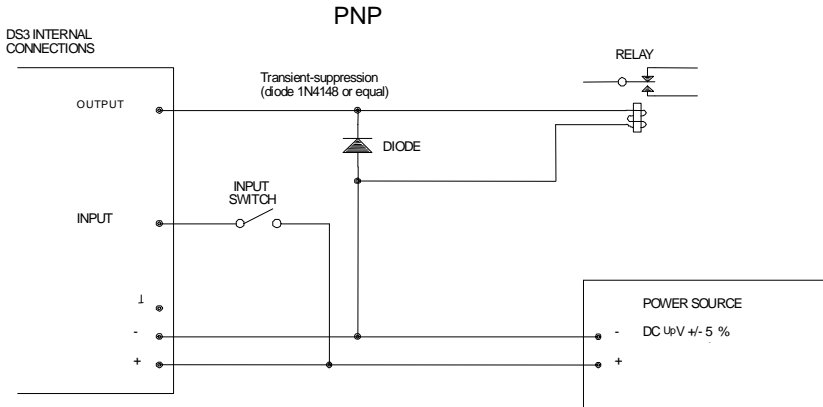


Diagram 6. Connection diagram PNP.

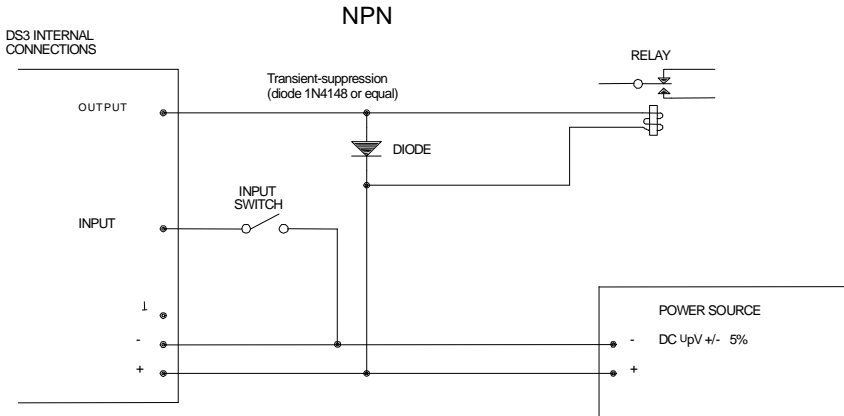


Diagram 7. Connection diagram NPN.

## 2.2.4 Additional sensor configuration

In order to adjust the sensor for specific machine conditions, a number of sensor configurations are available, e.g. NPN/PNP, signal duration etc.

Configurations can be made on the two DIP-switches located on the circuit board inside the processing unit.

Access the DIP-switches through the plastic plug on the processing unit. Set the switches carefully with the help of a small screw driver, pencil or other sharp pointing object. Find detailed description of the configurations in chapter 7.

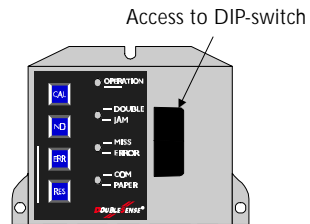


Diagram 8. DIP-switch access.

---

## 2.3 Power up

---

The sensor is automatically powered up when the power supply is turned ON. *Precaution!* The power supply source must be turned OFF (0 VDC) before the power connector is plugged into the processing unit in order to avoid damage.

At power up (power voltage turned on) the sensor automatically checks the alignment and function of the sender and the receiver, the function of the CPU and other hardware components.

The power up sequence:

1. All LED:s first turn **RED** (1 sec) and then **GREEN** (1 sec).
2. If the hardware is functional the Operation Mode LED will start indicating due mode directly after the power up sequence.

If the sender and the receiver are misaligned, or if dust or other articles hinder a sufficient amount of light to reach the receiver, the sensor will immediately show an error message, see Power up error indication menu on the next page. When the error has been removed the sensor will continue *for 3 seconds* to show the error message before it is turned off.

**To manually turn the sensor ON/OFF:** Press the keys **CAL** and **ND** simultaneously for 2 seconds. (The sensor will not perform the hardware check at manual ON/OFF).

**Alternative:** Activating Input 3 for more than 2 seconds will turn the sensor ON/OFF.

---

### 2.3.1 Error indications at Power Up

---

If the LED:s fail to go through the “RED - GREEN” sequence at power up and all LED:s are OFF the unit may be damaged.

If any errors are found at the power up sequence they will immediately be indicated on **LED 2** and **LED 3** and on the outputs. The error indication table (diagram 9) on the next page displays the possible error sources displayed with a combination of RED, GREEN, flashing RED and flashing GREEN on the two LEDs. See diagram 9, page 12 for Power up sub indication menu.

The sensor can be restarted by holding down **CAL** and **ND** simultaneously for more than 2 seconds.

---

### 2.3.2 Sender and receiver alignment check

---

At installation, check the alignment of the sender and the receiver:

1. Hold down the **CAL** and **RES** key simultaneously.
2. The LED:s will perform an alignment check to indicate optimal alignment:
  - If all LED:s are **GREEN** the alignment is 98-100% optimal.
  - If more than one (1) LED shows RED or OFF then there is dust or misalignment.

**Note!** All LED:s must show GREEN in order to reach optimal sensor performance. Please align the sender and the receiver so that all LEDs show GREEN. Be careful not to bend the sender and the receiver cables since a sharp bend might effect the alignment.

## Power up error indication menu

LED	Indication	Outputs	Error	Action
<b>LED 2</b>	γFlashing red	O1 and O4 active.  (1 0 0 1)	Dust or other articles (paper) in between the sender and the receiver.  Sender and receiver not properly aligned.	Remove dust or article hindering the infrared light.  Align sender and receiver.  The sensor continues to check for another 3 sec before indication is turned off.
<b>LED 3</b>	1 Red			
<b>LED 2</b>	γFlashing red	No indication	DIP-switch settings incorrect.	Check the DIP-switch settings.
<b>LED 3</b>	1 Green			
<b>LED 2</b>	1 Red	No indication	Hardware error RAM memory.	Sensor defect or damaged.
<b>LED 3</b>	1 Green			
<b>LED 2</b>	1 Red	O1 and O3 active.  (1 0 1 0)	Hardware error DA converter.	Sensor defect or damaged.
<b>LED 3</b>	γFlashing red			
<b>LED 2</b>	1 Red	No indication	Hardware error EEPROM.	Sensor defect or damaged.
<b>LED 3</b>	γFlashing green			

*Diagram 9. Power up error indication table.*

Contact Svensk Elektronikproduktion if the sensor indicates hardware error, +46-(0)300-70 000.

---

## 3 DoubleSense Detection Features

---

This chapter describes:

- What information the user can get from DoubleSense III.
- Definitions of what is meant by each information, e.g. a double sheet, a missed sheet or a layer error.
- Short description of how the sensor indicates the different situations and how they are displayed.

(A detailed table overview of LED indications is found in chapter 8. Input and output functions are found in chapter 5 and 6).

---

### 3.1 Double sheet

---

A double sheet is defined as the paper being twice as thick or twice as dark as the calibrated sheet. A double sheet can consequently be more than 4 sheets if the sensor was calibrated on 2 sheets, more than 8 sheets if the sensor was calibrated on 4 sheets, etc.

When a double sheet passes the sensor the infrared receiver receives approximately half of the light compared to the light it received during the calibration. The light reduction values (opacity) are processed in an algorithm to evaluate whether the reduced light is caused by the variations in the printed colours or by a “real” double sheet.

The indications for double sheets are:

1. LED 2 indicates **DOUBLE** (RED).
2. Stop Error Output or Logic I/O:s are active (see chapter 6 for details).

---

### 3.2 Paper Jam

---

Paper Jam is defined as the presence of a paper in the sensor when it is expected NOT to be there. In this situation it is possible that paper is stuck (jammed) or overlapped by another paper.

The sensor detects a Paper Jam when Trig Input is deactivated and a paper is still in between the sender and the receiver. The following indications are made for paper jam:

1. **LED 2** indicates **Paper Jam** (GREEN).
2. Stop Error Output or Logic I/O:s are active (see chapter 6 for details).

*Note!* The user must provide the sensor with an input signal in order for the sensor to know during what time to expect a paper between the sender and receiver. To use this function a selection must be made on the DIP-switch. See chapter 5 and chapter 7.

---

### 3.3 Missed sheet

---

A missed sheet is defined as the absence of a sheet in the paper feeding process.

The Trig Input on the sensor must be activated to inform the sensor when a sheet is expected to appear between the sender and the receiver. If no paper is found to be present when Trig Input is activated the following indications will be given:

1. LED 3 indicates **MISS** (RED).
2. Stop Error output or Logic I/O is active (see Chapter 6 for details).

*Note!* The user must provide the sensor with an input signal in order for the sensor to know when to expect a paper between the sender and receiver. To use this function a selection must be made on the DIP-switch. See chapter 5 and chapter 7.

---

### 3.4 Layer error

---

A layer error is defined as one (1) missing layer out of two (2), i.e. if the sensor calibrated on two layers of paper it will signal when only one layer passes the sensor. The missing layer is considered by the sensor as an opacity value that is twice as high as the stored calibration value, i.e. too light paper. Consequently, if the sensor is calibrated on four (4) layers of paper, it will detect if two (2) layers are missing, provided that the opacity of each layer is approximately the same.

This information can be used in three ways:

- As a warning that the calibration was possibly carried out on a double sheet.
- To warn if a paper set is missing one (1) layer out of two (2).
- To warn if the paper opacity is too light (wrong paper) compared to the calibrated opacity value.

The indications for a layer error are:

1. First: **LED 3** indicates **ERROR** (GREEN).
2. Second: When ERR key is held down **LED 2** is **GREEN** and **LED 3** is **GREEN**, the combination for missing layer/too light paper.
3. Layer Error Output (O3) is active.

---

### 3.5 Paper Present

---

Paper Present is defined as the presence of a paper between the sender and the receiver. The sensor detects the lead edge and signals until the trail edge.

The Paper Present detection can be used for:

- Detecting the presence of a paper.
- To count the number of paper sheets.

- To detect the length of the paper in terms of paper passing time, i.e. the time between positive and negative flank .
- To detect **missing sheets**, i.e. IF NOT Paper Present THEN Missed sheet.

Paper Present is indicated by:

1. LED 4 indicates **PAPER** (GREEN) for as long as the paper is present.
2. The Paper Present output (O4) active from lead edge to trail edge.

---

### 3.6 Calibration Errors

---

The sensor detects three (4) different calibration errors:

- **Paper stand still.** The paper was present for more than five (5) seconds between the sender and the receiver during calibration.
- **Paper passing time too fast.** The paper passing time was below the minimum of 23 ms from lead edge to trail edge which is insufficient for a successful calibration.
- **Paper too dark or too thick.** An insufficient amount of infrared light was received by the receiver during calibration.
- **Extended calibration values needed.** The paper print was complicated and the sensor needs another 1 – 4 sheets in order to process the calibration values correctly.
- **Halt input activated during calibration.** The sampling sequence was interrupted during calibration. It is not permitted to stop the paper in between the sender and the receiver during calibration.

The calibration errors are indicated by:

1. **LED 3 is GREEN** for general **ERROR**. Error *type* is shown at sub error level. Press **ERR** key to access *sub error level*. Go to APPENDIX 2 to read error type.
2. Stop Error output (O1) or Logic I/O active.

---

### 3.7 Pass time errors

---

The sensor can warn the operator if the passing time is shorter or longer than the previous pass time during detection. This can be used when checking for overlapping papers, damaged papers or for confirming that the right paper enters the sensor.

- If the paper pass time increases to more than 150% of the previous paper pass time.
- If the paper pass time decreases to less than 67% of the previous paper pass time.
- If the paper pass time during detection is less than 10% of the calibration pass time (10 times shorter).
- If the paper pass time during detection is 10 times the calibration pass time (10 times longer).



- If the paper has been present for more than five (5) seconds during detection .

The pass time errors are indicated by:

1. **LED 3** is **GREEN** for general **ERROR**. Error *type* is shown at sub error level. Press **ERR** key to access *sub error level*. Go to APPENDIX 2 to read error type.
2. Time Error output (O2) or Logic I/O active.

---

## 3.8 Limitations

---

The following factors influence the calibration and the detection of sheets:

1. The printed **colours** reduce the infra red light that is sent through the paper. A black printed paper reduces *approximately seven times* as much light as a white paper.
2. The **thickness** of the paper. DoubleSense can handle white paper less than 20 g/m<sup>2</sup> (e.g. bible paper) up to one *white* carton 1000 g/m<sup>2</sup>.
3. The **level of transparency** of the material. If a completely transparent sheet is put in the sensor the infrared light will *not* be reduced, i.e. all of the light will go through the material like sunlight through a window and detection is not possible. However, a faintly coloured sheet, e.g. plastic material will reduce the light to some extent and detection may be possible.
4. The **number of layers** in the paper set, e.g. how many sheets the sensor has to consider as being a single sheet. Folded sheets disperse the infra red light *more* than one, much thicker carton does. Each layer disperses the light to a certain angle, and that angle is consequently increased with each layer until the light is reduced to zero.
5. The **distance between folded sheets**. If the sheets in a folded paper set are not tightly pressed together the light is dispersed through each layer and reduced so much that the receiver receives little or no light at all.
6. The **distance between the sender and the receiver**. For optimal beam through capacity the sender should be mounted *aligned* with the receiver at a distance from lens to lens of 10-25 mm. The distance from the paper surface to the receiver should be 0-5 mm.
7. **Stray light** directed towards the receiver may be mistaken for light from the infra red sender since light bulbs or sunlight also contains frequencies of infra red light.

---

## 4 Operating the sensor

---

The sensor operates in four work modes: Calibration Mode, Extended Calibration Mode, Detection Mode and No Double Mode.

The sensor is automatically turned ON at power up. If the sensor has been manually turned OFF - then turn the sensor **ON** by pressing the keys **CAL** and **ND** on the operator panel for 2 seconds.

---

### 4.1 Calibration Mode

---

The **Operation Mode LED** indicates calibration mode when **RED** and the sensor is thereby ready to calibrate on the next passing sheet.

In Calibration mode DoubleSense collects opacity data from the paper on a path reaching from the *lead edge* to the *trail edge* of the paper (default). The collected opacity data is processed and stored as an opacity profile to be used as a comparison value in detection sheets.

If the sensor is configured to use the External Trig, the calibration begins at the Trig Input positive flank and ends at the trail edge of the paper. If the sensor is configured for Interval Detection (20 ms) the calibration starts at the paper edge or at the external trig, and ends after 20 ms. *See chapter 7 – Sensor configuration.*

---

#### 4.1.1 How to calibrate DoubleSense

---

First make sure that no paper or other article is in between the sender and the receiver before or at power-up.

If the sensor has pre-stored calibration values from previous runs, the **LED 1** will indicate **Detection mode** (GREEN) or No Double mode (flashing GREEN) when turned on.

Calibrate the sensor by going through the following steps or follow the quick guide:

1. Press the **CAL** key on the sensor or activate the calibration input ( $I2 < 2$  sec). The **Operation Mode LED** turns **RED** to indicate that the sensor is not yet calibrated and that the sensor is ready to calibrate on the next passing sheet.
2. Start the paper feeding sequence in your system and run one paper *completely through* the sender and the receiver at normal machine speed (0,5 – 4,5 m/s). The LED 4 indicates **PAPER** (GREEN) as long as the paper passes through. *Note!* The sensor does not allow paper stand-still during calibration!
3. The **Operation Mode LED** turns **GREEN** to indicate that the sensor is now in Detection Mode. *The calibration has been successfully achieved.*

Press CAL

Feed paper through

Calibration finished

**Note:** If a paper is in between the sender and receiver when the calibration is activated, the sensor will start calibration on the next following paper edge or Trig input.

---

### 4.1.2 Save calibration value

---

When a correct calibration is achieved the values are automatically saved in the internal sensor memory. When the sensor is powered up the latest calibration data will be restored and can be used again without re-calibrating the sensor.

The detection process can proceed without a new calibration, **PROVIDED THAT THE SAME PAPER IS BEING PROCESSED!** The Operation Mode LED will turn GREEN immediately after power up sequence to indicate that the sensor is in detection mode, i.e. already calibrated.

If the paper type, i.e. print pattern, colours or paper thickness, is changed **YOU MUST RE-CALIBRATE THE SENSOR!** Press the **CAL** key or activate the Calibration Input and follow the Calibration procedure previously described in chapter 4.1.1.

---

### 4.1.3 Indications during Calibration Mode

---

LED 1 is **RED** to indicate **Calibration Mode**.

When a paper passes through the sensor LED 4 will indicate **PAPER (GREEN)**.

Error indications during calibration mode are too long pass time, too short pass time, miss sheet, paper jam, extended calibration and Halt input active during calibration. See Indication menus in Appendix 1 and 2.

---

## 4.2 Extended Calibration Mode

---

If the paper has a complicated print the sensor requires more than one paper to complete the calibration. A complicated print can be defined as sharp changes between high and low opacity, for example when a smaller area at the lead edge is white and the rest is black. Other print changes can also evoke an Extended Calibration Mode.

In this case the sensor needs to complete the calibration on 1 - 4 subsequent paper sheets.

**NOTE!** During the extended calibration sequence double sheets are not detected. The operator must make sure that the calibrated sheets are single sheets.

---

### 4.2.1 Indications and operation in Extended Calibration

---

This situation is indicated and handled as follows:

1. LED 1 turns **flashing RED** to indicate that **Extended Calibration Mode** is required.
2. Stop Error Output (O1) or Logic I/O is active.
3. LED 3 indicates an **ERROR (GREEN)** after the first calibration paper has gone through. The sub error indication (press ERR key) shows the indication for **incomplete calibration**:
  - LED 2 is **flashing RED**
  - and
  - LED 3 is **RED**

4. Press **RES** key to reset the error indication and the outputs. *DO NOT press CAL in this sequence or else the sensor will have to start all over again!*
5. Feed 1 – 4 more papers completely through the sensor. The sensor will continue the calibration procedure, adding calibration values until a satisfactory data processing has been made.
6. When the calibration procedure is finished LED 1 will indicate **Detection Mode** (GREEN). This can take between 1 and 4 sheets added to the first sheet.

---

#### 4.2.2 Error indication after Extended Calibration Mode

---

If the sensor cannot calibrate on the due paper even after the extended calibration mode sequence, the following happens.

1. After feeding 1-4 sheets through, LED 1 still indicates **Calibration Mode** (RED).
2. LED 3 indicates **ERROR** (GREEN).
3. Stop Error Output (O1) or Logic I/O is active.
4. Press the **ERR** key and the sub error indication indicates one of the following errors:

<b>Too thick/too dark paper</b>	<b>Incomplete calibration</b>
LED 2 is <b>RED</b>	LED 2 is <b>flashing RED</b>
LED 3 is <b>RED</b>	LED 3 is <b>RED</b>

5. Press the **RES** key to reset error indications and outputs.
6. Try a new calibration. If the sensor fails to calibrate again then the sensor cannot calibrate on the due paper.
7. Press the **ND** key for 2 seconds to start **No Double Mode**. In this mode the sensor does not check for double sheets or layer error, but all other errors are still detected.

---

#### 4.3 Detection Mode

---

When the calibration is successfully achieved the sensor will automatically enter the Detection mode. During this mode the sensor samples opacity data over the whole sheet on each passing sheet (or from Trig input positive flank or during 20 ms depending on DIP-switch selections, see chapter 7). The data is first processed and then compared to the previously stored calibration data. When the processing is finished the sensor signals the status of the due paper sheet.

In Detection Mode the sensor detects:

1. Double Sheets.
2. Missed sheets (if Trig is active and selected on the DIP-switch, see chapter 7).
3. Paper Jam (if External Trig and Trig held are selected on the DIP-switch, see chapter 7, and Trig input is activated.).

4. The presence of a paper between the sender and the receiver (Paper Present).
5. Correlation of the paper passing time.
6. Missing layer/too light paper.

---

#### 4.3.1 Indication in Detection Mode

---

LED 1 is **GREEN** to indicate **Detection Mode**.

When a paper passes through the sensor LED 4 will indicate **PAPER (GREEN)**.

---

#### 4.4 No Double Mode

---

The paper is considered **too dark or too thick** in case an insufficient amount of infrared light reaches the receiver during calibration. The sensor must now be switched over to No Double Mode. In the No Double mode **no doubles are detected**, but the following situations will continue to be detected:

1. Missed sheets (if Trig is active and selected on the DIP-switch, see chapter 7).
2. Paper Jam (if External Trig and Trig held are selected on the DIP-switch, see chapter 7, and Trig input is activated).
3. The presence of a paper between the sender and the receiver (Paper Present).
4. Correlation of the paper passing time.

---

#### 4.4.1 Indication in No Double Mode

---

LED 1 is **flashing GREEN** to indicate **No Double Mode**.

If the sensor detected a too thick or too dark sheet during the calibration sequence or failed to carry out calibration in extended mode, the following indication will inform the user about the situation:

1. **LED 3 is GREEN** to indicate that an error has occurred and the Stop Error Output (O1) is activated.
2. Access the *sub indication menu* by holding down the **ERR** key.
3. The sub error indication indicates “**Too thick/too dark paper**” when:
  - **LED 2 is RED**  
and
  - **LED 3 is RED**

Any other combination by LED 2 and LED 3 indicates another error. See **APPENDIX 2** for a full description of sub indication errors.

---

#### 4.4.2 Switching to No Double Mode

---

When the sub error indication has indicated “**Too thick/too dark paper**” the sensor can be switched to **No Double Mode**.

1. *Manually* switch the sensor to **No Double Mode** by pressing the **ND** key on the sensor processing unit *for more than 2 seconds*.
2. Alternative: *Automatically* set the sensor to **No Double Mode** by activating the **Calibration Input (I2)** *for more than 2 seconds*.

---

## 5 Inputs

---

This chapter describes the four inputs on DoubleSense and the signal requirements for each input. Note that all inputs and outputs do not necessarily have to be used. However, in some applications the sensor requires certain signal inputs in order to perform functions selected on the DIP-switches.

The inputs and outputs are located in the 8-pole modular connector (I/O connector), see chapter 2 – Installation. The duration of the inputs and outputs can be set on the DIP-switch, see chapter 7.

Name	Position	Wire colour	Function
<b>Trig</b>	Input (1)	Brown	Starts detection (sampling) when activated.
<b>Calibration</b>	Input (2)	Blue	1. Sets sensor in Calibration mode when activated (pulsed >15 ms). 2. Sets the sensor in No Double mode when activated more than 2 sec.
<b>Reset</b>	Input (3)	Yellow	1. Resets latest error on positive flank. 2. Turns the sensor OFF when activated more than 2 sec.
<b>Halt</b>	Input (4)	Green	Stops (halts) sampling during paper stand-still. Used if paper stand-still is necessary.
<b>Note:</b> For all inputs 2 ms positive flank filter, 10 ms end flank filter.			

*Diagram 10. Table overview of sensor inputs.*

---

### 5.1 Trig input

---

The trig input (I1 – Brown) is used when:

1. **Detecting Paper Jam and Missing Sheets.** The Trig Input should be activated by the control system when a paper sheet *is expected to be present* between the sender and receiver. DIP-switch 2 must be set to ON, see chapter 7.
  - If Trig is *activated* and no sheet is detected by the sensor within 4 ms then *Miss sheet* error is indicated.
  - If Trig is *deactivated* and paper is found in between the sender and the receiver within 4 ms the sensor indicates *Paper Jam* error. In order to use the Paper Jam detection DIP-switch 2 and 3 must be set to ON, see chapter 7.
2. **Starting the detection on a specific position** on the paper. The sensor starts sampling when Trig is activated (on positive flank) and ends when the paper trail edge is detected.

*In order to use the Trig Input a selection must be made on DIP-switches 2 and 3, see chapter 7.*

*Application example:* In a horizontal collator the paper is transported through the sender and receiver by a metallic suction device. In this case the sensor would be unable to start detecting the lead edge *and* sample over the metallic suction device. Instead the Trig input starts the sampling directly after the suction device has passed the sender and receiver.

---

## 5.2 Calibration Input

---

The calibration input (I2 – Blue) is used for:

1. Setting the sensor in **Calibration mode**. Achieve Calibration mode by activating the Calibration Input for at least **15 ms**. (The Calibration mode can also be set by using the CAL key on the sensor operator panel).
2. Setting the sensor in **No Double mode** (when the sensor does not detect double sheets). Achieve No Double mode by activating the Calibration Input for more **than 2 seconds** (>2 sec).

---

## 5.3 Reset Input

---

The Reset Input (I3 – Yellow) has two basic functions:

1. To **reset** (deactivate) the error outputs. Pulse the Reset Input for **15 ms** to reset active error.
2. To turn the sensor **OFF** or **ON**. Activate the Reset Input for more than 2 seconds.

---

## 5.4 Halt Input

---

The Halt input (I4 – Green) is used when the paper repeatedly is brought to a stand-still in the machine. The Halt Input must be activated in order to interrupt the sensor detection sequence. Paper stand-still is only allowed during paper detection if the Halt Input is activated.

*Note 1!* In case the sensor does not receive information about paper stand-still it will not perform a correct double detection.

*Note 2!* Paper stand-still is only allowed during *detection* and *not* during *calibration*.

If the paper has been in between the sender and receiver for more than five seconds the sensor will indicate an error.

---

## 5.5 Signal requirements

---

The signal requirements for each input must be thoroughly followed by the installer. If the signal requirements are not fulfilled the sensor will not be able to perform detection with optimal function and reliability and perhaps, in some cases, not at all.

This chapter contains signal charts of each of the four inputs.

---

### 5.5.1 Trig Input

---

The Trig Input can be *pulsed* or *held* until after the paper trail edge, see chapter 7- Sensor configurations, DIP-switch 3. The Trig Input can be activated anywhere on the paper. The sensor must however receive a satisfactory amount of samples, at least 23 ms of paper sampling is required before the trail edge.

1. Trig *held* for miss sheet and paper jam detection:

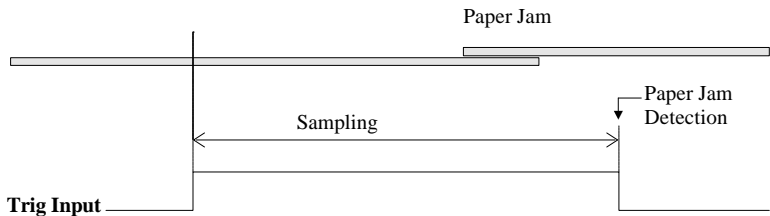


Diagram 11. Signal scheme for paper jam detection (DIP 2 – ON, DIP 3 – ON).

The Trig Input (I2) must be active until well after the paper has passed the sender and receiver. If the Trig is deactivated when the paper is still present in the sensor, then a Paper Jam error will be indicated.

2. Trig *pulsed* for miss sheet detection (min 10 ms).

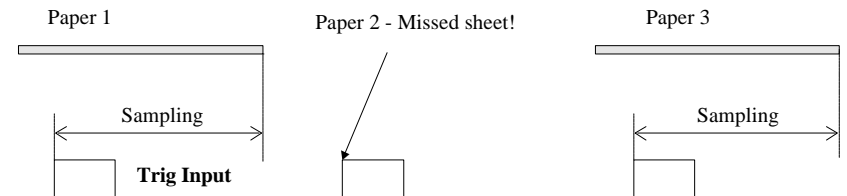


Diagram 12. Signal scheme for miss sheet detection (DIP 2 – ON, DIP 3 – OFF).

The sensor starts sampling at the positive flank and continues until the trail edge of the paper.



---

## 5.5.2 Calibration Input

---

Function	Signal time
Calibration	15 ms - 2 s
No Double Mode	> 2 s

- Activate the Calibration Input *at least* 20 ms before the paper lead edge. If the Calibration Input is activated when the paper is present between the sender and the receiver, the sensor will calibrate on the next following sheet.
- If the Trig Input is used for starting the detection sequence there must be *at least* 20 ms between the Calibration Input negative flank and the Trig Input positive flank.

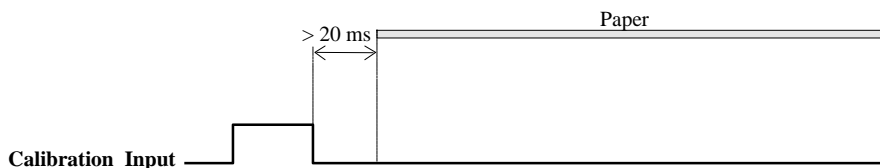


Diagram 13. Signal scheme for calibration input signal.

---

## 5.5.3 Reset Input

---

In default configuration (Grouped output signalling, DIP-switch 5 – OFF, see chapter 7) the reset input immediately resets all outputs when pulsed for at least 15 ms.

*Example:*

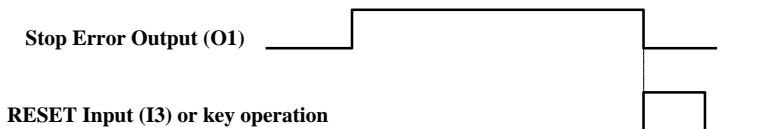


Diagram 14. Signal scheme for resetting outputs.

When Logic Output signalling is set on DIP-switch 5 (see chapter 7) then the RESET Input will reset the first error that occurred, if more than one occurred in a sequence. Immediately after the first error is reset the outputs will show the next error and so on until all errors in the buffer are reset.

---

### 5.5.4 Halt Input

---

The Halt Input (I4 – Green) stops the sampling sequence for *as long as the input is active*.

Activate the Halt input just before the paper speed is at 0 m/s and deactivate the Halt Input just before the paper starts accelerating again.

**Note!** If the acceleration or retardation is considerably slow compared to the normal speed the sensor will get inaccurate sampling data and will not be able to detect double sheets on a reliable basis.

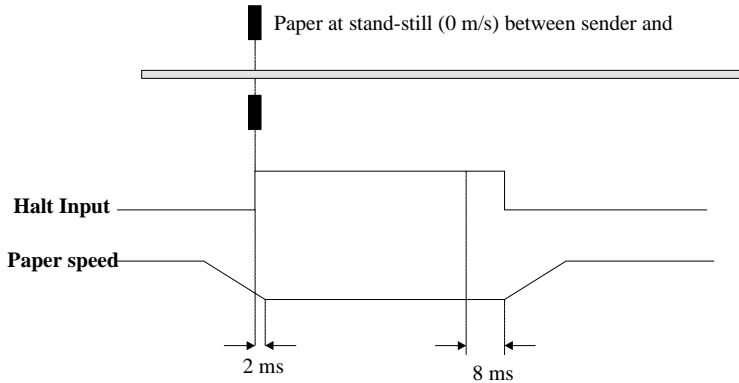


Diagram 15. Signal scheme for Halt input – paper speed.

---

## 6 Outputs

---

This chapter describes the four outputs on DoubleSense. Note that *all* outputs do not necessarily have to be used.

The inputs and outputs are located in the 8-pole modular connector (I/O connector), see chapter 2 – Installation. The duration of the outputs can be set on the DIP-switch, see chapter 7. However, in this chapter the signalling of the outputs will be shown as 15 ms.

---

### 6.1 Choosing *Grouped* or *Logic* Output Signalling

---

The input and output signalling can be used in two ways depending on how much information the user requires:

1. In the **Grouped output signalling** Output 1 signals for a group of 8 errors and Output 2 signals for a group of 5 errors. (Output 3 and 4 each signals for one situation each). This system provides the user the choice of connecting only one or a few outputs to the machine system.
2. The **Logic output signalling** is an array of logic combinations providing the user with information on all 16 occurring error types or function modes. The array is created by the 4 outputs together.

Both ways of obtaining information are described in this chapter. The selection between the two signalling ways is made on DIP-switch 5, see chapter 7.

---

### 6.2 Grouped Output signalling

---

The table below presents an overview of the Output functions in the *Grouped I/O signalling*:

Name	Position	Wire colour	Function
<b>Stop Error</b>	Output (1)	Red	Active for Double, Miss, Paper Jam and four (4) types of calibration errors.
<b>Time Error</b>	Output (2)	Black	Active for five (5) types of pass time errors during detection.
<b>Layer Error</b>	Output (3)	White	Active when the paper opacity value is twice as high as the calibrated value, e.g. one missing layer out of two, calibration made on double sheet etc.
<b>Paper Present</b>	Output (4)	Grey	Active when paper is present between the sender and receiver.

Diagram 16. Table overview of sensor outputs.

When the sensor is configured for pulsed outputs (see chapter 7.2.4) and more than one error occur, the sensor will automatically interrupt the first error to show the second one and so on. This means that, for example, error one (1) can be signalled for 4 ms and interrupted by a second error (2) that is shown for 15 ms.

---

## 6.2.1 Stop Error output (O1)

---

**Stop Error Output (O1 – Red)** is activated after the following seven *high priority errors* have been detected by the sensor:

1. **Double Error.** The sensor detected a double sheet. The signal is activated 13 ms after the paper trail edge.
2. **Miss Error.** The Trig input was active and no paper was found between the sender and receiver. Miss error signal is activated 1 ms after Trig input positive flank. *Note:* To use the Trig input a selection must be made on the internal DIP-switch.
3. **Paper Jam.** The Trig input was *deactivated* and a paper was still between the sender and receiver. *Note:* To use the Trig input a selection must be made on the internal DIP-switch.
4. **Paper stand-still.** The paper passing time exceeded 5 seconds (> 5 sec.) during calibration.
5. **Too short pass time.** The paper pass time was below the minimum for calibration, <23ms + paper edge delay (see chapter 7, DIP-switch settings). The sensor did not receive enough samples to create a calibration data.
6. **Too dark/too thick paper.** The paper was too dark or too thick to beam through.
7. **Incomplete calibration.** The paper print was complicated and the sensor needs more calibration data.
8. **Halt active during calibration.** The sensor does not allow paper stand-still during calibration and neither if the Halt Input (I4) is activated during calibration sequence.

---

## 6.2.2 Time Error Output (O2)

---

**Time Error Output (O2 - Black)** is activated for *pass time errors* during detection (not during calibration). The Time error output signals when:

1. The paper pass time has **increased** by more than **50%** compared to the previous paper passing time ( $t_{\text{present}} = t_{\text{previous}} \times 1,50$ ). This signal is activated while the paper is still present between the sender and receiver.

*Caused by:*

- Machine speed retardation (= paper speed retardation).
  - Overlapping papers (longer passing time).
2. The paper pass time has **decreased** by more than **33%** compared to the previous paper passing time ( $t_{\text{present}} = t_{\text{previous}} \times 0,67$ ). This signal is activated *after* the paper has left the sender and receiver.
    - Machine speed acceleration (= paper speed acceleration).
    - Damaged or wrong paper entering the sensor (too short, torn or ripped paper).
  3. The paper pass time was **below 10%** of the time during calibration. This signal is activated *after* the paper has left the sender and receiver.
    - Machine speed acceleration (10 times the calibration speed).

- Damaged or wrong paper entering the sensor (10 times shorter paper, torn or ripped).
4. The paper pass time was 10 times longer than the calibration pass time. This signal is activated while the paper is still present between the sender and receiver.
    - Possible paper stand-still (but shorter than 5 s).
    - Wrong paper entering the sensor (10 times longer paper).
    - Many overlapping papers in a row.
  5. Paper pass time longer than 5 seconds during detection. This signal is activated while the paper is still present between the sender and receiver.
    - Paper stand-still (not allowed unless Halt input is used to interrupt sampling sequence).

---

### 6.2.3 Layer Error output (O3)

---

The Layer error output (O3 – White) is active when:

1. The sensor detects a missing layer (e.g. one (1) sheet out of (2) missing). This can for example be used as a warning that the sensor was calibrated on a double sheet.
2. The sensor is not calibrated.

*Example:* The diagram below displays the Layer Error output signal position when the sensor calibrated on a double sheet. Note that the signal for a missing layer will appear after the first paper after calibration, i.e. the second paper in total and on every following paper.

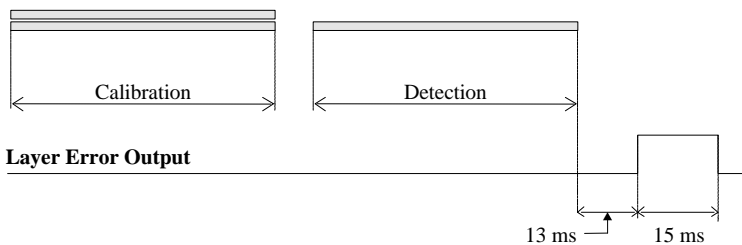


Diagram 17. Signal scheme for Layer error output signal.

The Layer Error signal will appear 13 milliseconds after the paper trail edge.

---

### 6.2.4 Paper Present output (O4)

---

The Paper Present Output (O4 - Grey) – is active when paper is present between the sender and receiver, i.e. from the lead edge to the trail edge.

The Paper Present indication can be used by the machine control system in several ways:

1. To count the number of paper sheets.

2. To register when a paper is in the sensor, i.e. at position A (positive flank) to B (negative flank).
3. To detect the paper passing time, i.e. the time between positive and negative flank .
4. To detect missing sheets, i.e. IF NOT Paper Present THEN Missed sheet. (alternative to using the Trig Input and the Stop Error Output for missing sheets).

The diagram below shows the Paper Present Output active. The output has a 4 ms filter for lead edge detection and 4 ms filter for trail edge detection.

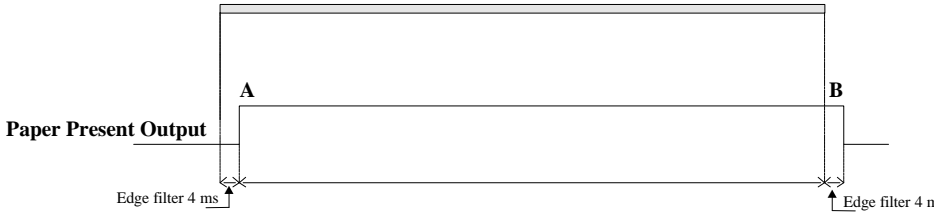


Diagram 18. Signal scheme for Paper Present output signal.

### 6.3 Logic Output signalling

The Logic output signalling is an array of logic combinations providing the user with information on all 16 occurring error types and operation modes. The 4 outputs create a logic array where each output will have the value of a digital “1” or “0”. When combined the errors or states will be indicated.

“1”=Active output

“0”=Deactive output

Signal	Output			
	1	2	3	4
1. Detection Mode	0	0	0	0
2. Paper Present	0	0	0	1
3. Double Off Mode	0	0	1	0
4. Calibration Mode	0	0	1	1
5. Layer Error	0	1	0	0
6. 67% Paper pass time	0	1	0	1
7. 150% Paper pass time	0	1	1	0
8. Too dark or too thick paper	0	1	1	1
9. Pass time 10/1 of calibration pass time	1	0	0	0
10. Pass time 1/10 of calibration/Halt active during calibration	1	0	0	1
11. >5 seconds, Maximum pass time exceeded	1	0	1	0
12. Incomplete calibration, continued calibration required	1	0	1	1
13. <23 ms + paper edge delay, Minimum time error	1	1	0	0
14. Missed sheet	1	1	0	1
15. Paper Jam	1	1	1	0
16. Double sheet	1	1	1	1

Since the outputs are used for modes and states as well as errors, the signals will be active in a certain priority order. The signals will be activated according to the following priority:

1. Errors – all errors.
2. Paper Present.
3. Operation Mode.

When the sensor is configured for pulsed outputs (see chapter 7.2.4 Error output duration) and more than one error occurs, the output signal for the first error will be pulsed 15 or 40 ms before the next error is shown.

---

## 6.4 Serial communication

---

The sensor unit is prepared for handling serial data communication. This can be done in two different ways:

- RS422 (half duplex)
- RS485 (full duplex)

The communication protocol will be implemented in co-operation with each machine manufacturer in order to optimise functionality.

When serial communication is used and more than 8 addresses are needed, the 8-pin DIP-switch can provide some additional addressing.

Contact Svensk Elektronikproduktion for information, +46-(0)300-70 000.

---

## 7 Sensor configuration

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This chapter will provide you with information about how to change the signalling time of the outputs, how to trig the detection at a certain spot on the paper and more.

**Note 1!** Before any configuration can be made the power has to be turned **OFF** otherwise the electronics may be damaged (CAL & ND).

**Note 2!** Please take ESD (Electrostatic Sensitive Devices) precautions when touching the electronics!

**Note 3!** The sensor only reads the new DIP-switch settings when the calibration routine is initiated.

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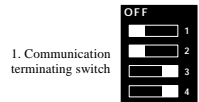
### 7.1 DIP-switch overview

---

Two DIP-switches are located inside the processing unit. Access the DIP-switches through the plastic plug at the right side of the operator panel (see figure in chapter 2.2.4 ).

The DIP-switches have the following function:

1. Terminating DIP-switch (4-pin), only used for serial communication.
2. 8-pin DIP-switch for configuration settings.



1. Communication terminating switch

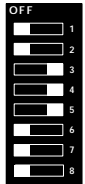


Diagram 19.  
DIP-switches.

---

### 7.2 DIP-switch configuration settings

---

This chapter explains the settings at hand when the sensor is using Inputs and Outputs (I/O) only or a combination of I/O and serial communication where no further addressing is needed. The diagram below shows an overview of the function of each switch on the 8-pin DIP-switch:









	OFF	
Interval Detection (20 ms)		1 Normal Detection (whole sheet)
Automatic Trig		2 External Trig
Pulsed Trig or 5 ms edge delay		3 Trig held or 25 ms edge delay
Error outputs active until Reset		4 Error Outputs pulsed 15/40 ms (DIP-6)
Grouped Output signalling		5 Logic Output signalling (O1, O2, O3, O4)
Output pulsed 40 ms		6 Output pulsed 15 ms
NPN (outputs active low)		7 PNP (outputs active high)
High detection accuracy		8 Standard detection accuracy

Diagram 20. DIP-switch definitions.



---

## 7.2.1 Sampling length

---

**DIP-switch one (1)** permits the user to choose between Normal Detection and Interval Detection.

At **Normal Detection (DIP 1 – ON)** the sensor samples over *the entire paper* or from the Trig Input positive flank before it indicates the status. At this choice the sensor has a 100% accurate picture of the paper at hand which results in that the reliability of the detection is equally high. If an error is found then Error Output is activated after the paper trail edge.

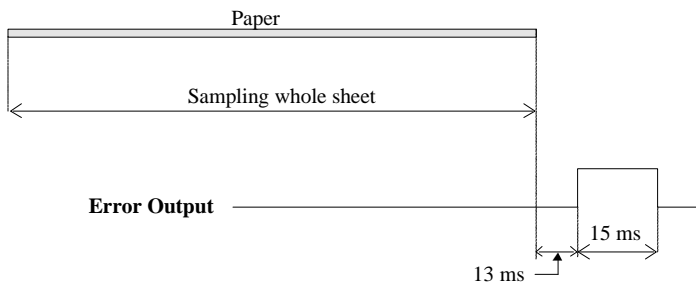


Diagram 21. Error output signal position at Normal Detection.

- At **Interval Detection (DIP 1 – OFF)** the sensor samples during a 20 ms interval starting from the paper lead edge or from Trig Input and signals status based on samples from this interval only. The Error outputs will signal the status directly after this interval. The sensor then waits until it detects the trail edge before it is ready to detect again.

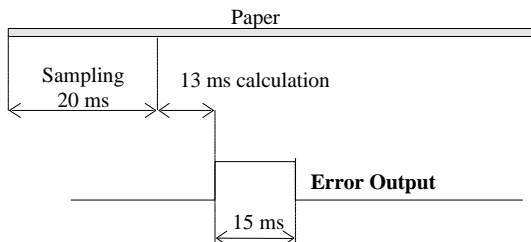


Diagram 22. Error output signal position at Interval Detection.

*Note:* The accuracy of the detection is only guaranteed when the paper speed is *absolutely* constant (same speed at calibration and detection).

If DIP-switch eight (8) is set to OFF when DIP-switch one (1) is OFF the sensor will operate on a special application mode program that is customer specific. *Please make sure that DIP-1 and DIP-8 is not set to OFF at the same time!* (Unless special application program is being used).

---

## 7.2.2 Trig selection

---

**DIP-switch two (2)** permits the user to choose between:

1. **Automatic Trig** (*default*). The sensor trigs on the lead edge of the paper and starts sampling automatically. **DIP 2 – OFF.**
2. **External Trig**. The sensor starts sampling only when the Trig Input (I1) is activated (sampling triggered by positive flank). **DIP 2 – ON.**

**Note:** External Trig is necessary in order for the sensor to be able to deliver an output signal for Miss sheet and Paper Jam. If the configuration is not made the sensor will not recognise the Trig input.

---

### 7.2.3 External trig signal duration

---

DIP-switch three (3) has two functions depending on the setting of DIP-switch two (2):

1. **If DIP 2 is set to Automatic trig** (DIP 2 – OFF) then DIP 3 sets the paper edge delay, i.e. the time it takes for the entire light beam area to enter the paper. The user can choose between 5 ms edge delay (DIP 3 – OFF) or 25 ms edge delay (DIP 3 – ON). The following situations require a choice on this switch:
  - When the feeding speed of an A4 sheet or US Letter is below 0,7 m/s then a 25 ms edge delay is recommended (DIP 3 – ON).
  - When the feeding speed of an A4 sheet or US Letter is above 0,7 m/s then a 5 ms edge delay is recommended (DIP 3 – OFF).
2. **If DIP 2 is set to External trig** (DIP 2 – ON) then DIP 3 permits the user to choose between using a pulsed (short) Trig signal or a long Trig signal (Trig held). The following situations require a choice on this switch:
  - When detecting Missed sheets a *pulsed* Trig Input signal is enough for the sensor to recognise the missing sheet. **DIP 3 – OFF.**
  - When detecting Missed sheets *and* Paper Jam the Trig Input must be held until after the paper has passed the sensor. If the paper is still present in the sensor when the Trig Input is deactivated – Paper Jam will be detected. **DIP 3 – ON.**

See chapter 5 - Inputs for signal description.

---

### 7.2.4 Error Output Duration

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**DIP-switch four (4)** permits the user to set the duration of the error outputs:

1. Error outputs **pulse for 15 or 40 ms** to indicate an error. **DIP 4 – ON.** The choice between 15 or 40 ms output pulse can be made on DIP-switch 6.
2. Error Outputs are held until Reset (Input 3) is activated or until the **RES** key is pressed. **DIP 4 – OFF.**

See chapter 6 Outputs for signal description.

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### 7.2.5 Selection of output signalling

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At default the sensor is operating on Grouped Output signalling (**DIP 5 – OFF**).

For the user who wishes to obtain extended information but cannot use the serial interface, the Logic Output signalling is an option (see Logic Output chapter 6.3). The Logic Output signalling is active when **DIP 5 – ON**.

See chapter 6 - Outputs for more information.

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## 7.2.6 Selection of communication

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If serial communication is used then **DIP 6 – OFF**. The outputs will however still be active also when the selection for serial communication is made. The serial interface can therefore be used together with the I/O:s so as to receive data bus information *and* real time signals simultaneously.

More information about serial protocols and the use of serial communication will be given on request since such applications are customer specific therefore requiring customised settings.

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## 7.2.7 Input and output configuration PNP/NPN

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DIP-switch no. 7 permits the user to set the output signalling configuration to NPN (inputs and outputs active low) or PNP (inputs and outputs active high). The power voltage ( $U_p$ ) is 12 – 24 V. See chapter 2.2.3 for details.

The inputs have a resistance (load) of approx. 12 kOhm.

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## 7.2.8 High detection accuracy - Standard detection accuracy

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DIP-switch no. 8 is used for two different settings, one when serial communication is used (Half or full duplex) and one when serial communication is not used (High and medium detection).

When serial communication is NOT used then the user can choose between the following detection principle modes:

- High detection accuracy: In this setting the sensor samples over the whole sheet and takes the status decision on three sampling levels. The double detection accuracy is 99,8% in this setting. **DIP-switch 8 = OFF**.
- Standard detection accuracy: In this setting the sensor samples over the whole sheet and takes the status decision on an average value of the total opacity variation. In this detection setting the accuracy of the decision may be somewhat reduced but the sensor is more tolerant to differences between papers. **DIP-switch 8 = ON**.

If DIP-switch eight (8) is set to OFF when DIP-switch one (1) is OFF the sensor will operate on a special application mode program that is customer specific. *Please make sure that DIP-1 and DIP-8 is not set to OFF at the same time!* (Unless customer specific application program is being used).

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# 8 Operator panel

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This chapter explains the functions of the sensor operator panel. When the sensor works as a stand alone unit the operator panel will be the main interface for the user. If the sensor is integrated with the machine and operated mainly via inputs/outputs or serial communication, the operator panel will be a help in error search situations.

From the operator panel several error types can be displayed and reseted, the error history buffer will be displayed and deleted and the sensor can be set to different work modes to mention a few of the possibilities.

## 8.1 Panel Overview

The operator panel is placed at the front of the processing unit Each LED can display two (2) colours, GREEN and RED. A combination of RED, GREEN, flashing RED, flashing GREEN and OFF indicate several error types.

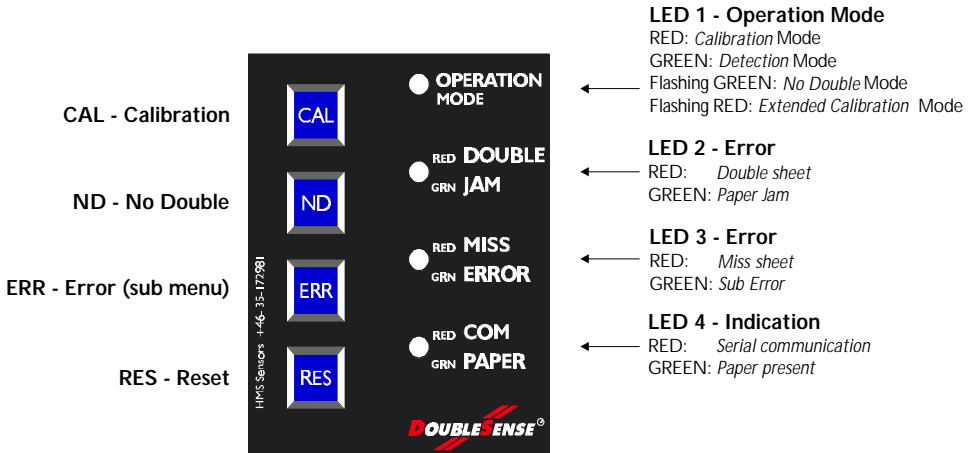


Diagram 23. Sensor operator panel.

## 8.2 LED Indications

### 8.2.1 Main indications

The four LED:s have the following functions:

1. **LED 1: Operation Mode LED** indicates which mode the sensor is currently in, Calibration mode, Detection mode, No Double mode and Continued Calibration mode.
2. **LED 2 and LED 3:** Indicate the three most common errors, **DOUBLE**, **PAPER JAM** and **MISS**. For all other errors (sub errors) the **ERROR** indication on LED 3 will be turned on. When holding down the **ERR** key the sub error type will be displayed on LED 2 and LED3.
3. **LED 4: Indication LED** shows when serial communication is used (**COM**) and when there is a paper between the sender and receiver (**PAPER**).

The *Main* indication menu is found in **APPENDIX 1**.

The *Sub* indication menu is found in **APPENDIX 2**.

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## 8.2.2 Sub error indications

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The diagram below shows a principal overview of how the sub error indication works. When LED 3 indicates ERROR (GREEN) a sub error has occurred. There are 11 types of sub errors. When holding down the ERR key, LED 2 and 3 will switch to sub error indication, showing a combination of red, green, flashing red, flashing green and Off. The Sub Error Indication Menu in **APPENDIX 2** displays which type of error has occurred.

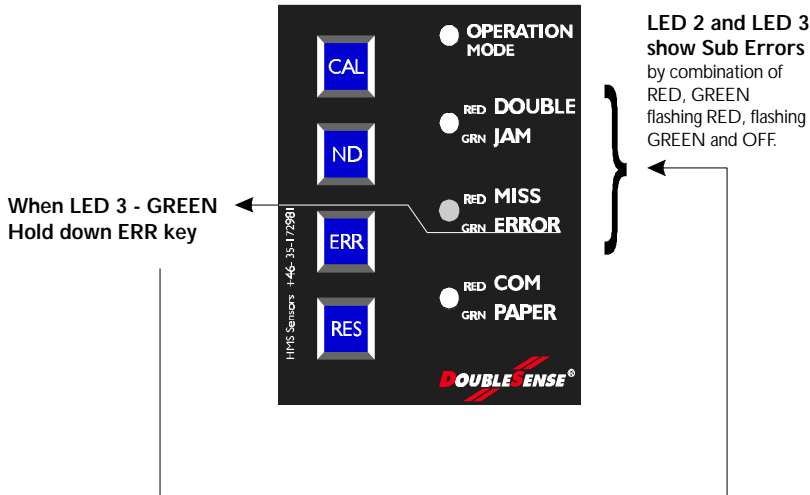


Diagram 24. Sub Error indication and operation.

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## 8.2.3 Sub Error Operation

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When LED 3 indicates ERROR (GREEN) follow the sequence below:

1. Hold down the **ERR** key on the operator panel. The LED:s will change and indicate the due sub level error for as long as the ERR key is held down.
2. Find the corresponding error in **APPENDIX 2 - Sub Error Indications**.
3. Remove the error or change the conditions that caused the **ERROR** indication.
4. Press the **RES** key to reset *each* error (more than one can occur, see chapter 8.3 below) or hold the key down for 2 seconds to reset *all* errors (if more than one occurred).
5. Continue in Detection Mode with previously saved calibration values (no action needed), or recalibrate the sensor (press CAL key or activate Cal Input).

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## 8.3 Error History search tool

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When errors occur, DoubleSense stores them in an internal memory error buffer. This function can be used in the adjustment phase during installation and test run.

Up to eight (8) errors are stored in the sensor memory allowing the user to conclude which errors are most common in the process. The machine can then be adjusted in order to avoid lowered performance due to frequent error sources.

When a new error occurs and the buffer is full, the sensor deletes the oldest error in the buffer.

Follow the steps below to access Error History:

1. If LED 3 shows ERROR - hold down the **ERR** key to display the error.
2. The error will be shown on **LED 2** and **LED 3**. Read the error type in the main indication menu **APPENDIX 1**, or the sub error menu **APPENDIX 2**.
3. Press the **RES** key shortly to reset the displayed error.
4. The next stored error will immediately be displayed. Press **RES** to reset it etc.
5. **To reset all stored errors at once** – press **RES** for more than two (2) seconds. *Note:* all stored errors in the Error History will be deleted.

**Note!**

- When *Grouped Output signalling* is used the sensor shows the *latest* error of maximum eight (8) in the error buffer. At RESET the sensor deletes the displayed error and resets *all* outputs. The next error from the buffer is then shown on the LED:s but not on the outputs.
- When *Logic Output signalling* is used the sensor shows the *oldest* error in the eight (8) error buffer. At RESET the sensor deletes the displayed error and resets the corresponding output signal. The next error from the buffer is then shown on both the LED:s and on the outputs.

When the error buffer is empty all error outputs are deactivated and error LED:s turned off.

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## 8.4 Operation keys

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There are four (4) operation keys on the sensor operator panel. Some of the keys have more than one function by touching the key shortly, holding it for more than 2 seconds or holding down 2 keys simultaneously.

The description of the key functions is found in **APPENDIX 3**.

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## APPENDIX 1 - Main Indication Menu

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The main indication menu explains each of the functions of the four LED:s, one by one.

LED	Indication	Function
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<b>LED 1: OPERATION MODE</b>	m OFF	1. Power OFF 2. Start-up sequence (hardware test) at power ON.
	1 Red	<b>Calibration mode</b> – the sensor is ready to calibrate on the next paper sheet that enters the sensor.  (The sensor has no previously stored calibration values).
	YFlashing Red	<b>Extended Calibration mode</b> – the sensor operates in the continued calibration sequence for complicated papers.
	1 Green	<b>Detection mode.</b> Detection program active (calibration values stored).
	YFlashing Green	<b>No Double mode.</b>  The sensor operates in No Double mode, i.e. no double sheets are detected. Other errors are still detected.
<b>LED 2: DOUBLE/ JAM</b>	m OFF	No double or jam error detected.
	1 Red	<b>Double sheet</b> – the sensor has detected a double sheet.
	1 Green	<b>Paper Jam</b> – the sensor has detected a paper jam (the paper was still in the sensor after the Trig Input was deactivated).
<b>LED 3: MISS/ ERROR</b>	m OFF	No miss or other error detected.
	1 Red	<b>Missed sheet.</b> Trig Input was activated and no paper found in between the sender and receiver.
	1 Green	<b>Other Error</b>  Hold down the <b>ERR</b> key on the sensor operator panel to display the error type at hand. Go to Error Sub Menu – APPENDIX 2 and read the error.
<b>LED 4: COM/ PAPER</b>	m OFF	1. No Paper in between the sender and receiver. 2. No serial communication.
	1 Red	<b>Serial communication</b> – the sensor is communicating via the serial interface.
	1 Green	<b>Paper Present</b> – the sensor has detected a paper in between the sender and receiver. The LED is ON for as long as the paper is present.

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## APPENDIX 2 - Sub Error Menu

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LED	Indication	Error	Action
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<b>LED 2</b>	1 Red	<b>Too dark/too thick paper</b> The calibrated paper is too thick or too dark for the infrared light to beam through.	Switch the sensor to <b>No Double</b> mode by pressing the <b>ND</b> key for more than 2 seconds or activating the Calibration Input for more than 2 seconds.  The sensor will only detect missed sheets, paper jam and time errors in this mode.
<b>LED 3</b>	1 Red		
<b>LED 2</b>	YFlashing Red	<b>Calibration incomplete – extended calibration required.</b>  Paper print is complicated and the sensor must collect more specific data. This can take up to 4 papers.	1. Press RES.  2. Run 1 – 4 more papers completely through the sensor.  3. Calibration is finished when LED 1 indicates Detection mode, otherwise press ND and enter No Double mode.
<b>LED 3</b>	1 Red		
<b>LED 2</b>	1 Red	<b>Total passing time too long during calibration (&gt; 5 seconds)</b>  The <i>calibration</i> sampling has lasted more than 5 seconds.	The sensor does <i>not</i> allow paper stand-still during calibration. Recalibrate the sensor by starting the machine and running a paper completely through the sensor at normal speed.
<b>LED 3</b>	m OFF		
<b>LED 2</b>	m OFF	<b>Total passing time too short.</b>  The sensor needs at least 23 ms sampling time (lead edge to trail edge) to collect enough opacity values to detect double sheets. The paper is too short, the paper speed is too high or a combination of both.	<ul style="list-style-type: none"> <li>• Lower the machine speed.</li> </ul> <i>or</i> <ul style="list-style-type: none"> <li>• Set the sensor to <b>No Double</b> mode by pressing the ND key. The sensor will then only detect missed sheets, paper jam and time errors.</li> </ul>
<b>LED 3</b>	YFlashing Red		

*Continued on next page...*



LED	Indication	Error	Action
LED 2	1 Green	<b>Missing layer/too light paper.</b> The sensor possibly calibrated on a double sheet and this sheet was single.	Recalibrate the sensor on a single sheet.
LED 3	1 Green	The paper was of lighter colour than the calibrated paper. There was one layer missing out of two.	
LED 2	1 Green	<b>Total passing time too long during detection (&gt; 5 seconds)</b> The <i>detection</i> sampling has lasted more than 5 seconds.	The sensor <i>allows</i> stand-still during Detection Mode <i>but</i> warns that a stand-still effects the detection accuracy if the Halt Input is not used.  The sensor will still try to continue the detection.
LED 3	m OFF		
LED 2	1 Green	<b>Passing time is 10 times longer than during calibration (10/1)</b> 1. The paper is 10 times longer that of the calibrated paper (the due paper does not correspond to the calibrated paper).	<ul style="list-style-type: none"> <li>• Check if the calibrated paper correspond to the latest fed paper.</li> <li>• Recalibrate the sensor on the right paper.</li> <li>• Do not stop the paper in between the sender and receiver unless the Halt Input is activated.</li> <li>• Check if a Paper Jam has occurred.</li> </ul>
LED 3	1 Red	2. The paper speed has decreased 10 times compared to the speed during calibration or the paper is at a stand-still. 3. Possible Paper Jam.	
LED 2	1 Green	<b>Passing time during detection is 10% of calibration time.</b>	<ul style="list-style-type: none"> <li>• Recalibrate the sensor by starting the machine and running a paper completely through the sensor at normal speed.</li> <li>• Check if the calibrated paper correspond to the calibrated paper.</li> </ul>
LED 3	YFlashing Red	1. The paper was at a stand-still during calibration and the following papers were run at normal speed. 2. The paper had 10% the length that of the calibrated paper (the due paper does not correspond to the calibrated paper). 3. The paper speed has increased 10 times compared to the speed during calibration.	

Continued on next page...

LED	Indication	Error	Action
<b>LED 2</b>	YFlashing Green	<b>Passing time too long during detection.</b>	If Paper Jam, remove error and Reset.
<b>LED 3</b>	1 Red	The paper passing time increased with more than 150% from one paper to the following.  1. The machine speed dropped.  2. The paper was longer than the previous (possible paper jam or overlapping papers).	Keep paper passing time within the range 0,67 – 1,5 times the previous paper.
<b>LED 2</b>	YFlashing Green	<b>Passing time too short during detection.</b>	If damaged paper, remove error and Reset error.
<b>LED 3</b>	YFlashing Red	The paper passing time decreased to less than 67% from one paper to the following.  1. The machine speed increased.  2. The paper was shorter than the previous (wrong paper or damaged paper).	Keep paper passing time within the range 0,67 – 1,5 times the previous paper.
<b>LED 2</b>	1 Red	<b>Halt input activated during calibration.</b>	Run the calibration paper <i>completely</i> through the sender and receiver.
<b>LED 3</b>	YFlashing Red	Paper stand-still is not allowed during calibration, only during detection (if Halt input is activated).	During detection – activate the Halt input at paper stand-still.

**End.**

## APPENDIX 3 - Operation Keys

The operation panel has four buttons with the following functions:

Key	Duration	Function	Comment
<b>CAL</b>	> 2 seconds	<b>Calibration</b>	Sets sensor in Calibration mode. (All errors reseted. Outputs and error LED:s inactivated).
<b>ND</b>	> 2 seconds	<p><b>No Double (ND) - Disables the double and layer detection.</b></p> <ol style="list-style-type: none"> <li>PAPER LED indication and Paper Output still active but no double sheets or layer errors are detected.</li> <li>The sensor only checks for missed sheets, paper jam and time errors in ND-mode.</li> </ol>	<p>Use when double detection is not wanted or necessary.</p> <p>For paper thickness at the ends of the opacity range the sensor can handle.</p> <p>The NoDouble mode is also achieved by activating the Calibration Input (I2) &lt; 2 seconds.</p>
<b>ERR</b>	Hold down	<p><b>Shows ERROR indication sub level</b></p> <p>(As long as the ERR key is held down).</p>	When the ERROR LED is GREEN the ERR key is used to find the due sub error. See <b>APPENDIX 2</b> .
<b>RES</b>	< 2 seconds	<b>Resets displayed error.</b>	Resets active outputs and LED:s.
	> 2 seconds	<b>Resets all errors</b> (if more than one has occurred on one paper).	Resets active outputs and LED:s.
<b>CAL &amp; RES</b>	> 2 seconds	<p><b>Alignment test</b></p> <p>If keys are held down simultaneously the sensor enters a routine where it checks if the sender and receiver are aligned and free from dust.</p> <p>The sensor enters calibration mode when CAL &amp; RES is held down again.</p>	If all LED:s are GREEN the alignment is correct. If one or more LED:s show RED or OFF then there is dust or misalignment.
<b>CAL &amp; ND</b>	2 seconds	<b>ON/OFF</b>	Inactivates and reactivates the sensor in all modes if pressed simultaneously.

## TECHNICAL SPECIFICATION

<b>Paper opacity</b>	From coloured plastic sheets or bible paper and up to 1000 g/m <sup>2</sup> white cardboard.			
	Coloured sheets up to 120 g/m <sup>2</sup> .			
	Folded sheets up to 7 layers depending on colour (opacity).			
<b>Pass time</b>	Edge delay (5/25 ms) + light strength setting (2-6 ms) + detection (min 14 ms whole sheet/at interval detection 20 ms). Max 5 seconds.			
<b>Distance</b>	Distance between paper sheets in a flow, minimum 13 milliseconds.			
<b>Power supply</b>	12-24 Volt DC (+/- 5%)			
<b>Power consumption</b>	+12 (+/- 5%)	Max 600 mA	Average 125 mA	Min 80 mA
	+24 (+/- 5%)	Max 300 mA	Average 70 mA	Min 40 mA
<b>Outputs</b>	PNP	Active at U <sub>p</sub> – residual voltage (1 V) 150 mA at U <sub>p</sub> = 12 V 250 mA at U <sub>p</sub> = 24 V		
	NPN	Active at 0 V + residual voltage (1 V) 250 mA/max U <sub>p</sub>		
<b>Inputs</b>	PNP	Active at U <sub>p</sub> > 0,8		
	NPN	Active at U <sub>p</sub> < 0,2		
<b>Serial interface</b>	RS485/RS422			
<b>Sender &amp; Receiver cable</b>	Type AWG 24 Max temperature 80°C Max 300 Volt			
<b>I/O and serial cable</b>	AWG 28, Modular			
<b>Operation temperature</b>	~70°C			
<b>EMC compliance</b>	EN50081-2 and EN50082-2			