Operating Instructions

PLC 4 Programmable Logical Control
with OP 7 Operator Panel
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1 OPERATION - GENERAL

1.1 AUTOMATIC BOOTH WITH PLC AND TEXT DISPLAY

The text display is a display screen, and an operating pad, where all data, and control commands for the automatic coating booth are input. The process control and process visualization simplify operations. Action messages give an overview and control. All functions of the coating booth can be controlled and monitored through the text display.

- Input errors are eliminated through process visualization.
- The operator is lead clearly through the process.
- Variable data can be called up or changed.
- Greater flexibility, simpler adaptation of new data inputs.
- Action messages appear on the text display, which help the operator when searching for errors, for example.
- Also legible under poor lighting conditions.
- IP 65 Type protection.
- Available in different languages.

The text display is a communications terminal based on an LCD display screen. Process control, and process visualization give the operator an overview and control over the whole coating sequence. Input errors are almost completely eliminated. Only valid keys appear on the display and are released.
2 FUNCTIONS

2.1 OPERATION WITH OP 7 OPERATOR PANEL

The power supply to the control unit is switched on at the control cabinet. This is indicated with a green pilot lamp in the switch unit.

The reciprocators can now be positioned manually to the Reference point. The booth can now be operated with the Operator Panel.

The following selection of operations are available:

- Automatic operation: The guns, and the axes are switched on or off with the Gap control.

- Manual operation: The guns are switched on. The axes must be switched on or off manually.

- Set up: All the necessary booth parameters can be input here with the Operator Panel.

2.2 INTERLOCKING

After switching on the booth with the Operator Panel the control unit is released for operation and fluidizing, and prefluidizing are started.

2.3 GAP CONTROL FOR MAX. 16 GUNS (PGC 1), 2 RECIPROCATORS, AND 2 TRANSVERSE X AXES

The workpiece data are "read-in" at the light barrier and the data are fed to the control unit. The guns, and the axes are switched on or off as a result of these data. When there is a gap the guns are switched off and individually rinsed (HRC 1). If a gap is sufficiently large, the axes are stopped at the lower reversing point.
2.4 CHAIN STOP

A chain stop is detected at the control unit with the aid of an incremental pulse generator fitted on the conveyor drive shaft. At a chain stop all guns are switched off and rinsed. The reciprocators stop at the lower reversing point and the X axes remain stopped. All guns are switched on after the conveyor is restarted. The reciprocators are also restarted after a delay.

2.5 CONTROL FOR TWO INDEPENDENT FRESH POWDER SYSTEMS

Two sensors are available for powder level monitoring for each of the two powder hoppers. The upper sensors regulate the fresh powder feed. A powder shortage is detected with the lower sensors. In this case a message to the Operator Panel is indicated and the signal horn is switched on.
3 MASK DESCRIPTION

3.1 OPERATION MASKS

As a rule, the operation masks have the following structure:

Top Line: Title line, Mask description (Capital letters)
Second line: Text and/or numbers
Third line: Text and/or numbers
Bottom Line: Menu points or information

All inputs are password protected. Password level 1 is necessary for data input and Password level 9 is necessary for System input. The Passwords can be edited by the user on the panel.

No password is required for operating the plant.

3.1.1 STATIC SCREEN DISPLAY

After the coating booth is switched on with the Main switch and the Key switch, the control and the text display switch on. After an internal test the STATIC SCREEN DISPLAY appears on the display.

By pressing the ENTER key the display returns to the Start display level.

This Mask is displayed when the plant is not switched on

3.1.2 SOFT KEYS

On the OP 7 Panel the Keys F1-F4 / K1-K4 are used as Soft keys to initiate functions or commands.
3.1.3 START DISPLAY

The plant is started and initialized with Soft key "F3". The text display switches to the OPERATING MODE mask. All previously read-in workpiece data are deleted.

3.1.4 OPERATING MODE

The booth is switched to automatic operation with the Soft Key "F1".

The booth is switched to manual operation with the Soft Key "F2".

Travel to Reference point by pressing Soft Key "F3".

The booth is switched to "Service" operation with Soft Key "F4".
3.1.4.1 AUTOMATIC OPERATION

All parts, which pass through the object recognition are detected and registered in the memory. Due to this data all the guns and Z-Axes are switched on or off, respectively.

```
AUTOMATIC
A=0000 Z=0000 B=0000
MANU <-> diag
```

- **Man**: The booth switches directly to manual operation with Soft Key 'F2'.
- **<->**: Switching to the 'X-Axis' Mask is done with Soft Key 'F3'.
- **Diag**: The booth switches directly to manual operation with Soft Key 'F4', without the lose of data in the memory.

3.1.4.2 MANUAL OPERATION

The operation of the Z-Axes is released and all guns are switched on. All parts, which pass through the object recognition are detected and registered as with the automatic operations.

```
MANUAL
AUTO guns diag
```

- **Auto**: The guns are switched to automatic mode with Soft Key 'F1'.
- **Gun**: The guns are switched to manual operation with Soft Key 'F2'.
- **<->**: Switching to the "X-Axis" Mask is done with Soft Key 'F3'.
- **Diag**: The diagnostic mode is entered to with Soft Key 'F4'.

3.1.4.3 X AXIS

In this mode the transverse axes can be moved continuously, manually. The axes designations "A" and "B" are in respect to the direction of the travel of the chain conveyor.

```
X-AXIS
```

(Continued)
3.2 SERVICE

<− With Soft Key "F1" the X - A axis moves away from the booth

−→ With Soft Key 'F2' the X - A axis moves towards the booth

<− With Soft Key "F3" the X - B axis moves towards the booth

−→ With Soft Key 'F4' the X - B axis moves away from the booth

ESC The display 'MANUAL OPERATION' is returned to with the Key 'ESC'

setup The input mode for "Set up" is entered with Soft Key "F1".

language The input mode for the 'Language' mode is entered with Soft Key "F3".

diag The input mode for "Diagnostic" is entered with Soft Key "F4".

↓ Indicates that further parameters are on a second Mask, which is browsed through with the Arrow Key ↓ (returned with Arrow Key ↑).

guns The parameters for "Guns" are entered with Soft Key 'F1'.

encoder The parameters for the "Encoder" mode are entered with Soft Key 'F3'.

axis The parameters for "Axes" are entered with Soft Key 'F4'.

↑ Indicates that further parameters are on a second Mask, which is browsed through with the Arrow Key ↓ (returned with Arrow Key ↑).
3.2.1 SET UP

The parameters of the booth must be reset for each customer and on every large scale change. When, for example, a gun is displaced the Start position of the gun must be reset. There is a Set up operation for these changes.

⚠️ NOTICE

This operation is reserved exclusively for ITW Gema Service engineers, because changes made in this area can lead to damage to the booth.

All the following values displayed are to be regarded as examples only. Actual input values vary from plant to plant and must be determined at the plant in question.

**SET UP**

<table>
<thead>
<tr>
<th>time</th>
<th>axis</th>
<th>guns</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>F2</td>
<td>F3</td>
</tr>
</tbody>
</table>

- **time**: The input mode for general parameters are entered with Soft Key "F1".
- **axis**: The input mode for axes parameters are entered with Soft Key "F2".
- **guns**: The input mode for gun parameters are entered with Soft Key "F4".
- **↓**: Indicates that further parameters are on a second Mask, which is browsed through with the Arrow Key ↓ (returned with Arrow Key ↑).

**object**

The object parameters can be input when the F1 key is pressed.

**LGrille**

The light barrier parameters can be input when the F4 key is pressed.

↑

Indicates that further parameters are on a second Mask, which is browsed through with the Arrow Key ↓ (returned with Arrow Key ↑).
3.2.1.1 TIME PARAMETERS

The remaining parameters can be input in this area. The display inputs can be browsed through with the ↑ and ↓ keys. As soon as the cursor starts to blink the desired values can be input through the key pad, and finally, acknowledged with the ENTER key. Incorrect input values can be corrected by pressing the ESC key.

The following parameters can be set:

- **Conveyor stop:**
  - max. Pulse time

  This time must be longer than two consecutive conveyor pulses at the slowest conveyor speed. If this time is oversstepped, then a conveyor stop is carried out.

- **Conveyor stop:**
  - Gun ON delayed

  This is the switching on delay for restarting the guns, and axes after a conveyor stop.

- **Horn frequency**

  The duration of the horn blast and the pause between. The horn should be switched off by inputting the value "0.00" at ON.
3.2.1.2 AXES PARAMETERS

All axes parameter can be input in this area. The display inputs can be browsed through with the Arrow keys ↑ and ↓. As soon as the cursor blinks, the desired values can be input on the key pad, and finally, acknowledged with the ENTER key. Incorrect input values can be corrected by pressing the ESC key.

The following parameters can be set (except "Code"):

- Positioning the axes
- Starting point X-Axis
- Rinsing value

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positioning</td>
<td>Must not be changed by the customer</td>
</tr>
<tr>
<td>Starting</td>
<td>Pulse intervals between the axis and object recognition</td>
</tr>
<tr>
<td>Rinsing</td>
<td>The length of pulses (in seconds) during which the gun groups are rinsed</td>
</tr>
<tr>
<td></td>
<td>(per booth side) with the aid of the HRC Rinsing control</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Axis</th>
<th>Start Code</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>First axis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Last axis</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Axis ON</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>[0=YES/1=NO pulse]</td>
<td></td>
</tr>
</tbody>
</table>

Blinking on the display
3.2.1.3 GUN PARAMETERS

All gun parameters can be input in this area. The screen inputs can be browsed through with the Arrow keys ↑ and ↓. As soon as the cursor blinks, the desired values can be input on the key pad, and finally, acknowledged with the ENTER Key. Incorrect input values can be corrected by pressing the ESC key.

The following parameters can be set (except "Code"): 

- Starting point Gun X Interval in pulses, between the gun and the object recognition. Must not be changed by the customer

<table>
<thead>
<tr>
<th>Gun</th>
<th>START</th>
<th>Code</th>
<th>POS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- A maximum of 16 guns are possible. Must not be changed by the customer

<table>
<thead>
<tr>
<th>GUNS</th>
<th>FIRST gun</th>
<th>LAST gun</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Light grille segments are matched to gun groups for corresponding object shapes etc. Each of the four groups has its own display window.

<table>
<thead>
<tr>
<th>GUNS</th>
<th>light beam</th>
<th>--</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>G-GROUP 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GUNS</th>
<th>guns ON</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>[0=YES/1=NO pulse]</td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>
3.2.1.4 **OBJECT PARAMETERS**

All object parameters can be input in this area. The screen inputs can be browsed through with the Arrow keys ↑ and ↓. As soon as the cursor blinks, the desired values can be input on the key pad, and finally, acknowledged with the ENTER Key. Incorrect input values can be corrected by pressing the ESC key.

The following parameters can be set:

- **Start-Offset Width A**
  The number of pulses before which the width A transverse axis is positioned ahead of the Object (only + values are possible)

- **Extension Width A**
  The number of pulses after which the width A transverse axis travels to the rest position behind the Object (Position 2). To get the sum of the Start-Offset and Extension the value of the extension must be input (only + values are possible)

- **Start-Offset Width B**
  see “Start-Offset width A” above

- **Extension Width B**
  see “Extension width A” above

Blinking on the display
• **Start Offset Z-Axis Stop / Start**
  The number of pulses required before the reciprocator begins to reciprocate in front of the object (+ and - values are possible).

• **Extension Z-Axis Start / Stop**
  The number of pulses, which the reciprocator switches off after the object again. For the value of the extension the sum of the Start Offset, and the Extension must be input (+ and - values are possible).

![Diagram](Continued)
• LB Check distance
When the light barrier beams remain interrupted for longer than the set check distance the message "LB Fault" is generated. It should be greater than the longest object.

\[
\begin{array}{c|c|c}
\text{CONTROL} & \text{dist} & \text{count} \\
\hline
\text{F1} & \text{F2} & \text{F3} & \text{F4} \\
\end{array}
\]

• Rinsing value
Number of pulses required for rinsing individual guns.

\[
\begin{array}{c|c|c}
\text{CONTROL} & \text{RINSINGdistance} & \\
\hline
\text{F1} & \text{F2} & \text{F3} & \text{F4} \\
\end{array}
\]

Blinking on the display
3.2.1.5 LIGHT BARRIER

- Light barrier test function: If no object is in the light barrier a "0" must be everywhere on the display. Another value indicates a fault. If the light barrier is covered by a hand, an object or similar, then the corresponding value is displayed.

A corresponding transverse axis position is determined for every workpiece to be coated in this mode, and this is dependent on the light beams which are covered by a workpiece in the light barrier. The number of light beams can vary from case to case.

---

**DETERMINING THE TRANSVERSE AXIS POSITIONS**

Example for light barrier with 12 light beams
The display entries can be browsed through with the Arrow keys ↑ and ↓. As soon as the cursor blinks, the desired values can be input with the key pad, and finally, acknowledged with the ENTER key. Incorrect input values can be corrected by pressing the ESC key.

<table>
<thead>
<tr>
<th>LIGHT GRILLE</th>
<th>X-A</th>
<th>Beam Pos. Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>↑</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Light grill Code</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

**F1**  **F2**  **F3**  **F4**

<table>
<thead>
<tr>
<th>LIGHT GRILLE</th>
<th>X-B</th>
<th>Beam Pos. Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>↑</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

|                  |
|                  |

**F1**  **F2**  **F3**  **F4**

<table>
<thead>
<tr>
<th>LIGHT GRILLE</th>
<th>Z</th>
<th>Beam Pos. Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>↑</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

|                  |
|                  |

**F1**  **F2**  **F3**  **F4**

- **None**  No light beams covered
- **2nd out.**  2nd light beam covered
- **21st out.**  21st light beam covered
- **A–X Pos.**  Position of the X transverse axis. This position corresponds to the end switch number on the X (see diagram above)

Blinking on the display
3.3 LANGUAGE

The desired operating language is selected in this mode.

<table>
<thead>
<tr>
<th>LANGUAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>german</strong></td>
</tr>
<tr>
<td><strong>lang3</strong></td>
</tr>
<tr>
<td><strong>english</strong></td>
</tr>
</tbody>
</table>

German is selected as the operating language with the Soft key ‘F1’.

English is selected as the operating language with the Soft key ‘F3’.

This key (Soft key ‘F4’) is reserved for customer specific languages. A programming device, and the specific language program are required for translating these languages.

ESC

The previous display is returned to by pressing the ESC key.

3.4 DIAGNOSTIC

PLC

The diagnostic mode for the PLC is entered with the Soft key ‘F1’.

conveyor

Display shows if the conveyor is standing or running.

I/O

The diagnostic mode for the digital inputs/outputs is entered with the Soft key ‘F4’.

3.5 GUN TEST

The High-voltage charging of the guns is tested, without spraying powder.

Blinking on the display
3.5.1 ENCODER TEST

The conveyor pulses used by the PLC can be counted and displayed in this mode in order to determine the relationship between the conveyor pulses, and the conveying distance in pulses per cm.

Procedure:
1. Define a measured distance on the conveyor (preferably over several metres).
2. Define the identification markers (chain links, hooks etc).
3. Delete the internal counter by pressing Key "F3" (reset).
4. When the identification marker reaches the starting point of the measured distance, press Key "F1" (strt). The internal counter starts. The values must be positive. If, however negative values are displayed, this is an indication that the incremental pulse generator is running in the wrong direction. The A, and B signals from the incremental pulse generator must be reversed.
5. When the identification mark reaches the end of the measured distance, Key "F2" (stop) is pressed.
6. The measured distance divided by the number of pulses gives the pulse length. e.g. A measured distance of 5 m and 50 pulses give a pulse length of 10 cm. If a pulse length of 2 cm is required, then the pulse division ratio in 'Time Parameters' must be decreased by a factor of 5.

strt The counting process is started with Key "F1".
stop The counting process is stopped with Key "F2".
reset The internal counter is deleted with Key "F3".
ESC The display is returned to the previous Mask with the Key ESC.

The axis is tested, without the guns being turned on
3.5.2 PLC

The speed, at which a PLC program is running, is displayed in this Mask

![PLC speed mask]

3.5.3 I/O

The condition of the digital inputs, and outputs are displayed in this Mask

![Input/Output mask]

3.5.3.1 INFORMATION

This gives information about the version of the PLC Software

![Information mask]

3.5.4 SYSTEM

The "Info" Mask is entered with the Soft Key "F1"
The "Dwnld" Mask is entered with the Soft Key "F2"
The "Pass" Mask is entered with the Soft Key "F3"
The "I/O" Mask is entered with the Soft Key "F4"
4 OPERATION MESSAGES

Faults can occur during operation, which appear as operation messages on the display. If an operation message is present, the operator panel changes from the display level to the message level. By pressing key "ENTER" the display level is returned to, that is, in the automatic or manual operation display. The signal horn can be acknowledged with Key "ACK". When more operation messages are present, the different messages can be viewed with the Arrow keys ↑ and ↓.

The messages are as follows, for example:

<table>
<thead>
<tr>
<th>Fault</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>01 motor protection NOK</td>
<td>Motor protection is activated</td>
</tr>
<tr>
<td>03 cabinet temp. NOK</td>
<td>Switch cabinet temperature too high</td>
</tr>
<tr>
<td>07 CRASH protection A</td>
<td>Collision protection activated</td>
</tr>
<tr>
<td>08 CRASH protection B</td>
<td>Collision protection activated</td>
</tr>
<tr>
<td>16 TOO LITTLE powder A</td>
<td>The powder level in Hopper A has sunk below the lower level sensor.</td>
</tr>
<tr>
<td>17 TOO LITTLE powder B</td>
<td>The powder level in Hopper B has sunk below the lower level sensor.</td>
</tr>
<tr>
<td>25 LOW Battery</td>
<td>The program memory is buffered with a battery. If this message appears on the display, the battery must be replaced.</td>
</tr>
<tr>
<td>26 light grille FAILURE</td>
<td>The Start light barrier is interrupted for longer than the set check distance. Check for defects, contamination or stray light reflections!</td>
</tr>
<tr>
<td>27 PRC-3 axis NOT ready</td>
<td>PRC 3 registering a fault</td>
</tr>
<tr>
<td>28 axis PROGRAM RUNNING</td>
<td>Axis is moving</td>
</tr>
<tr>
<td>29 booth NOT ready</td>
<td>The external signal &quot;Booth ready&quot; from the Booth Control not present</td>
</tr>
<tr>
<td>30 light barrier NOK</td>
<td>The Start light barrier does not function correctly. Check for defects, contamination or stray light reflections.</td>
</tr>
<tr>
<td>32 PRC-3 axis NOT ref.</td>
<td>PRC 3 not set to the Reference point</td>
</tr>
</tbody>
</table>
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