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# Distance and Level Measurement in Industrial Applications

LOGO! 8  
Set 3

<https://support.industry.siemens.com/cs/ww/en/view/21689394>

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# 1 Task

## Introduction

LOGO! sets are functioning and tested automation configurations for simple, fast and inexpensive implementation of automation tasks for small-scale automation. The sets help you to obtain answers with regards to required products and the question of how they function when combined.

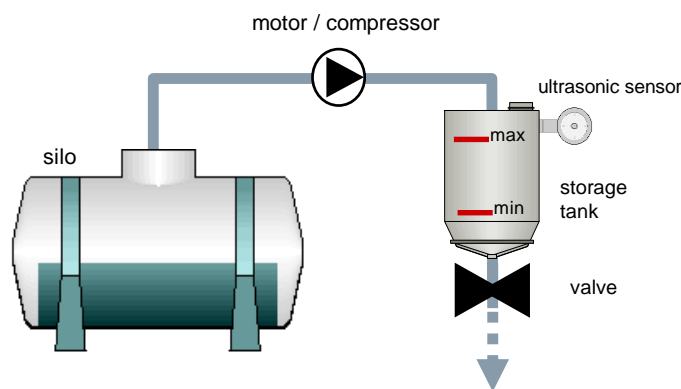
## Overview of the automation task

Plastic parts are to be produced in a factory.

The plastic granulate is transported from a central silo into a storage tank using a compressor. From there, it is fed into an injection molding machine via a valve.

An automatic filling-level monitoring of the storage tank shall ensure the availability of the plastic granulate for the injection molding machine.

Figure 1-1: Principle sketch of the application



Monitoring the filling level as well as automatic filling of the storage tank with plastic granulate is meant to reduce production downtimes.

The motor of the compressor shall switch on when falling short of the minimal filling level (switching on limit) of the storage tank and automatically switch off when exceeding the maximal filling level (switching off limit).

The switching on and off limits shall be displayed as a numerical percentage value on the LOGO! display. The current filling level shall additionally be represented as a bar chart diagram.

The switching on and off limits can be configured via the LOGO! display. The modes and the motor can be operated in LOGO! via the cursor keys.

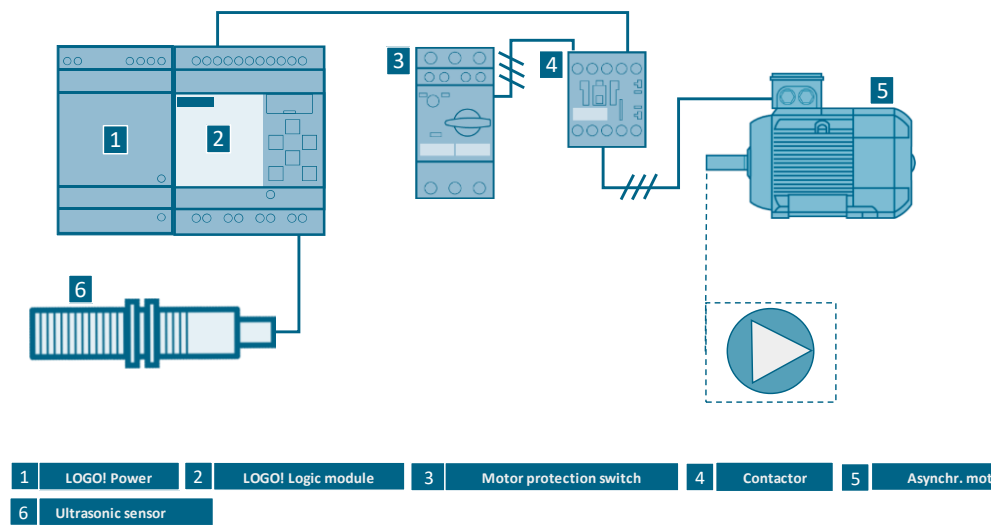
## 2 Solution

### 2.1 Overview of the general solution

A LOGO! is installed in the automation solution as a controller. An ultrasonic sensor is used for filling level monitoring and it is connected to an analog input at the LOGO! logic module.

In the LOGO! control program, the voltage signal of the ultrasonic sensor is evaluated. The motor of the compressor is controlled via the connected contactor.

Figure 2-1: Schematic structure of solution



## Application areas

### Tasks

- Filling level or height measurements
- Distance or level measurements

### Applications

- Collision monitoring
- Stacking height monitoring
- Bottling plants

## Advantages/Benefits

- Cost efficient, simple and expandable filling level monitoring with LOGO!
- Parameters changes (e.g. filling level limit values for switching the compressor on and off) can be performed via the integrated LOGO! operator panel.
- Changes of switching on or off limits (see Figure 3-2) do not require changes of the sensor configuration
- Direct display of messages and device states (e.g. operating hours of the motor, filling level of the storage tank) via the integrated LOGO! display as numerical value and/or bar chart diagram. The display has 4 lines with 16 characters each. In "ticker mode", up to 32 characters per line can be displayed (continuously by character or line).
- Manual controlling with the LOGO! cursor keys (e.g. the contactor of a compressor motor)
- Additional switching thresholds can be programmed in order to output further alarms.
- Free digital LOGO! outputs can be programmed for switching signal lamps, for example.

## 2.2 Hardware and software components used

### Products

Table 2-1

Manufacturer	Component	Qty.	Product No.	Note
Siemens	LOGO! Power 24V 1,3A	1	6EP3331-6SB00-0AY0	-
Siemens	LOGO! 12/24RCE	1	6ED1052-1MD08-0BA0	-
Siemens	LOGO! Soft Comfort V8.x	1	6ED1058-0CA08-0YE1	-
Pepperl + Fuchs	Ultrasonic sensor (proximity switch)	1	UC2000-30GM70-UE2R2-V15	100 ... 2000mm 0 ... 10V
Siemens	Contacteur (1RT10)	1	3RT2015-1BB42	-
Siemens	Circuit breaker for motor protection	1	3RV1011-0KA10	0.42A ... 0.73A
Siemens	Motor	1	1LA7060-4AB10	-
-	Standard Ethernet cable	1	-	LOGO! 0BA7



### Attention

**If you wish to use the application in a productive mode, you must adjust the motor and the ultrasonic sensor to the plant, if necessary.**

### Accessorial equipment

Table 2-2

Manufacturer	Component	Qty.	Product No.	Note
Siemens	Excess voltage limiter for contactor	1	3RT1916-1CB00	RC element
Siemens	Circuit-breaker	1	5SY6010-7	-
Pepperl + Fuchs	Cable plug, M12, 5-pole, PUR cable or cable plug, M12, 5-pole, PUR cable	1	V15-G-2M-PUR V15-W-2M-PUR	Straight connector Angled connector
Pepperl + Fuchs	Interface cable PC / ultrasonic sensor	1	UC-18/30GM-IR	5 pole, 5m
Pepperl + Fuchs	ULTRA-PROG-IR (Software)	-	Download <a href="http://www.pepperl-fuchs.com">http://www.pepperl-fuchs.com</a>	Optional (for configuring the sensors)
Pepperl + Fuchs	Mounting flange, 30 mm $\varnothing$ or universal mounting fixture 5 ... 30 mm $\varnothing$	-	BF 30 BF 5-30	Optional (for mounting cylindrical sensors)

### Sample files and projects

Table 2-3

Component	Note
21689394_LOGO!_Set3_Sonar_V3.2_en.lsc	LOGO! Soft Comfort configuration for the LOGO! 12/24 RC logic module

## 3 Functional Mechanisms of this Application

### 3.1 Ultrasonic sensor

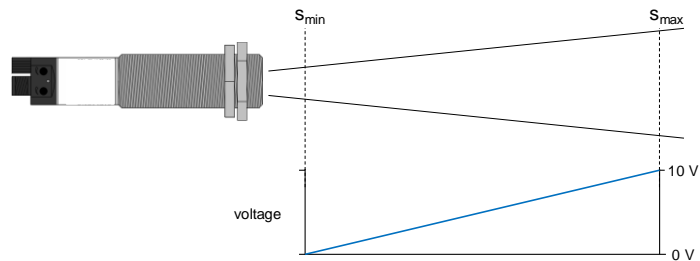
#### Measuring principle

The ultrasonic sensor sends ultrasonic pulses. These are reflected by an object. The ultrasonic sensor measures the time between sending the ultrasonic pulse and receiving the echo. The time interval is proportional to the distance between the ultrasonic sensor and the object.

#### Measuring signal

The measured distance is output as a voltage (a short distance corresponds to a low voltage).

Figure 3-1: Path voltage diagram of the sensor



#### Measuring field of the ultrasonic sensor

The propagation of the ultrasonic pulses from the source is referred to as sound cone. The sound cone is depicted in the data sheet of the ultrasonic sensor.

The used ultrasonic sensor has a measuring range of 100 to 2000 mm.

#### Mounting the ultrasonic sensor

For measuring the filling level, the ultrasonic sensor is installed at the top of the container (see Figure 3-2). The “Accessories” header of data sheet of the ultrasonic sensor contains details of suitable mounting and connection materials.



## 3.2 LOGO! logic module

### Inputs/outputs

Table 3-1

Inputs	Outputs
I1, contactor feedback (opener)	Q1 contactor control
I7, (corresponds to A11) ultrasonic sensor	

### Calculating the filling level

For a high filling level, the distance (S) from surface to the sensor is low (see Figure 3-2). Accordingly, the signal voltage of the ultrasonic sensor is low. In order to determine the actual filling level, the measured distance is subtracted from the maximal signal value in the program.

### Filling level control

The LOGO! function blocks “Analog comparator” (B034 and B033) detect whether the filling level exceeds the switching off limit (MAX) or falls short of the switching on limit (MIN). The hysteresis behavior of the process is due to using two switching limits (separate switching on and off limit). This prevents frequent switching on and off of the compressor motor

In automatic mode, the “Q1” output is set to ON when exceeding the switching on limit and the output “Q1” to OFF when exceeding the switching off limit. If the filling level is within the switching limits, an operation (see Table 5-1) via LOGO! cursor keys is possible. The automatic keeps the filling level within the switching limits (see Figure 3-2).

In manual mode, when exceeding the switching off limits, the “Q1” output is set to OFF. If the filling level is below the switching off limit, an operation via LOGO! cursor keys is possible. The manual mode keeps the filling level below the switching off limit.

The Q1 output controls the contactor of the compressor motor.

**Diagnostic functions**

Comparing the actual and setpoint state of the contactor enables deriving a diagnosis. An auxiliary contactor contact is read via the LOGO! input.

If this comparison yields a difference, a function error is suspected – a respective diagnostic message is then output via the LOGO! display.

Table 3-2: Diagnostics messages

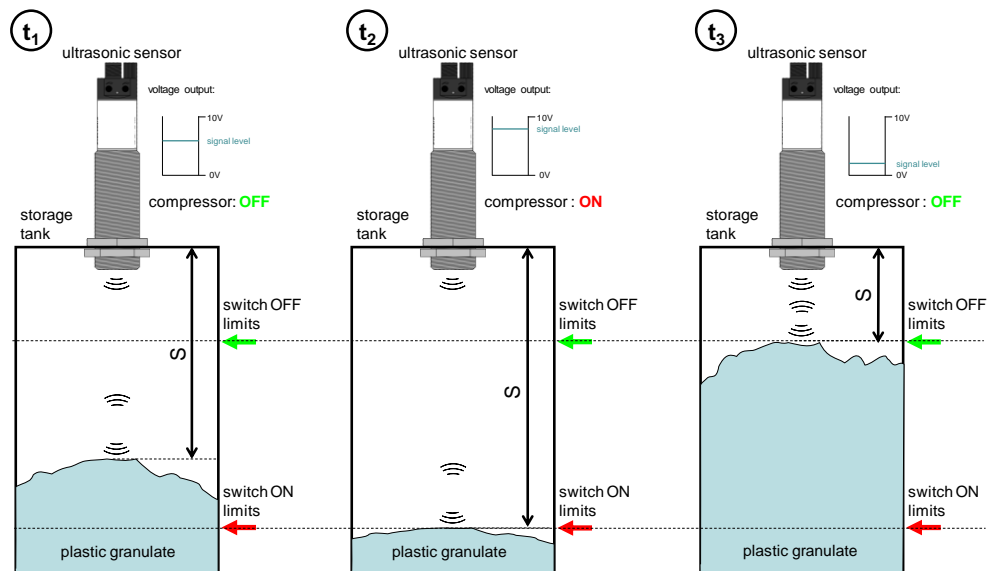
No	SETPOINT state	ACTUAL state	Diagnostic conclusion
1.	Contactor ON	Contactor OFF	Contactor does not pick up (e.g. wire break in the contactor control line)
2.	Contactor OFF	Contactor ON	Contactor jammed (e.g. contacts fused)

Figure 3-2: Mounting the ultrasonic sensor, switching limits of the compressor motor

(t<sub>1</sub>) Filling level drops

(t<sub>2</sub>) Filling level below switching on limit – Motor of the compressor starts

(t<sub>3</sub>) Filling level above switching off limit – Motor of the compressor stops

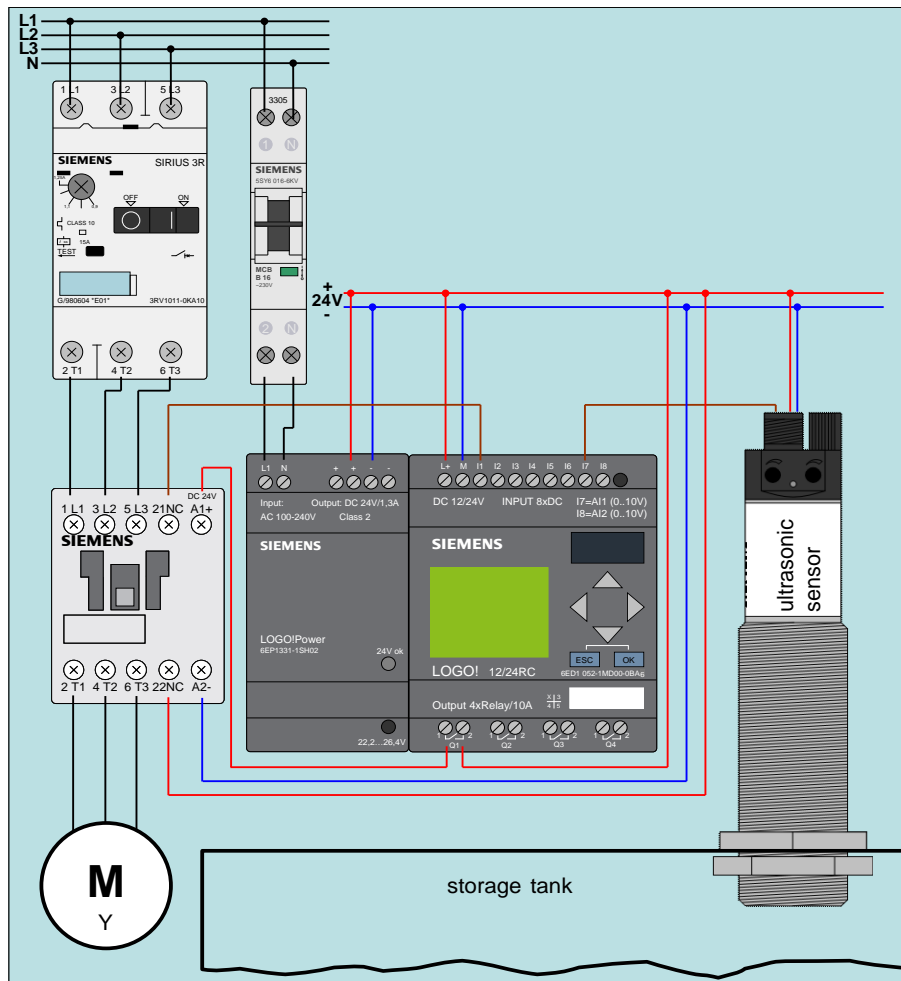


# 4 Installation

## 4.1 Hardware installation

The figure below illustrates the hardware structure of this application.

Figure 4-1: Wiring the hardware components



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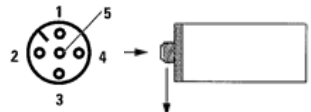
**Note**

The setup guidelines for LOGO! and the ultrasonic sensor must be generally observed (see section Fehler! Verweisquelle konnte nicht gefunden werden. \5).

## 4.2 Wiring ultrasonic sensor

In the following table it is described how the components from chapter 3 are set up and connected with each other.

Table 4-1

No	Action	Remarks
1.	Wire the components accordingly Figure 4-1.	Connect the ultrasonic sensor as follows:  1: L+ 20V ... 30V DC 3: M (L- 0V) 4: F <sub>A</sub> ( voltage signal) 

### Software installation

**Note** It is assumed that the necessary **LOGO! Soft Comfort V7** software has been installed on your PC and that you are familiar with handling this software.

## 4.3 Configuring LOGO!

The program mentioned in Table 2-3 contains a configuration for LOGO! 0BA6. When using LOGO! 0BA7, you need to set the following parameters:

Table 4-2

No	Action	Remarks
1.	In LOGO! Soft Comfort you go to menu item "Tools > Select Hardware ..."	
2.	Select the 0BA7 device	
3.	In LOGO! Soft Comfort you go to menu item Tools > Ethernet connections ...	
4.	Enter the IP address and subnet mask of your LOGO!	e.g. IP address: 192.168.1.11 subnet mask: 255.255.255.0 see Table 6-1 \9\

# 5 Operation of the Application

## 5.1 Functions

The following functions are contained in this application:

- Manual on and off switching of the motor (compressor)
- Automatic on and off switching of the motor (compressor)
- Configuring the switching limits for switching on and off
- Diagnosis “Contactor failure”

## 5.2 Operation

The application is operated via the LOGO! cursor keys:

Table 5-1

No	Description / Activity	Figure / Explanation
1.	Go to <b>“automatic mode”</b> with the key combination:  <b>ESC</b> + ▲  (and no diagnosis present)	<p>Line 2 is displayed as “ticker line for line” (changes between both displays)</p>
2.	Go to <b>“manual mode”</b> with the key combination:  <b>ESC</b> + ▼	
3.	<b>Switch on the contactor</b> with the key combination:  <b>ESC</b> + ►	
4.	<b>Switch off the contactor</b> with the key combination:  <b>ESC</b> + ◀	

### 5.3 Parameterization

The limit values (see Figure 3-2) can be set as follows:

Table 5-2

No	Description / Activity	Figure / Explanation
1.	Proceeding from "automatic mode" press the <b>ESC</b> key until the "parameter mode" is indicated in the display as "_" (blinking underscore).	<p>parameter mode</p>
2.	Use the cursor keys <b>▶</b> and <b>◀</b> to navigate to the "MIN" or "MAX" parameters.	<p>navigate cursor</p>
3.	If "_" is located left of the parameter to be changed, press the <b>OK</b> key to go to the Editor mode.	<p>editor mode</p>
4.	Use the cursor keys <b>▶</b> and <b>◀</b> to navigate to the digit you wish to change (digit blinking inverse).	<p>navigate cursor</p>
5.	Use the cursor keys <b>▲</b> and <b>▼</b> to change the value of the digit.	<p>change value</p>
6.	Confirm the settings with <b>OK</b> key, after the parameter has been edited completely.	<p>parameter mode</p>
7.	Quit the parameter mode with the <b>ESC</b> key. The display is represented again as in "operation".	

## 5.4 Diagnosis

When the actual state deviates from the setpoint state of the contactor, a diagnosis message is indicated in line 3 of the display.

Table 5-3

No	Description / Activity	Figure / Explanation
1.	<p><b>Switch on the contactor in “automatic mode”</b> using the key combination:  <b>ESC</b> + ►</p> <p>The same reaction occurs in <b>automatic mode when the switching on limit</b> is fallen short of.                      Fault scenario:                      Q1 is set, the contactor does not pick up.</p>	
2.	<p><b>Switch off the contactor in “automatic mode”</b> using the key combination:  <b>ESC</b> + ◀</p> <p>The same reaction occurs in <b>automatic mode when the switching off limit</b> is exceeded.                      Fault scenario:                      Q1 is reset, the contactor does not drop out.</p>	
3.	<p><b>Switch on the contactor in “manual mode”</b> using the key combination:  <b>ESC</b> + ►</p> <p>Q1 is set, the contactor does not pick up.</p>	
4.	<p><b>Switch off the contactor in “manual mode”</b> using the key combination:  <b>ESC</b> + ◀</p> <p>Q1 is reset, the contactor does not drop out.</p>	

## 6 Appendix

### 6.1 Service and Support

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## 6.2 Links and Literature

The following list is by no means complete and only provides a selection of appropriate information.

Table 6-1: Links and Literature

	Topic	Title
\1\	LOGO! Information	<a href="http://www.automation.siemens.com/mcms/programmable-logic-controller/en/logic-module-logo/Pages/Default.aspx">http://www.automation.siemens.com/mcms/programmable-logic-controller/en/logic-module-logo/Pages/Default.aspx</a>
\2\	LOGO! Starter Kit	<a href="http://www.automation.siemens.com/mcms/programmable-logic-controller/en/logic-module-logo/logo-starter-kit/Pages/Default.aspx">http://www.automation.siemens.com/mcms/programmable-logic-controller/en/logic-module-logo/logo-starter-kit/Pages/Default.aspx</a>
\3\	Link to this document	<a href="http://support.automation.siemens.com/WW/view/en/64143308">http://support.automation.siemens.com/WW/view/en/64143308</a>
\4\	Siemens Industry Online Support	<a href="http://support.automation.siemens.com">http://support.automation.siemens.com</a>
\5\	LOGO! Manuals	<a href="http://support.automation.siemens.com/WW/view/en/10805245/133300">http://support.automation.siemens.com/WW/view/en/10805245/133300</a>
\6\	LOGO! - Forum	<a href="http://www.automation.siemens.com/WW/forum/quests/Conferences.aspx?Language=en">http://www.automation.siemens.com/WW/forum/quests/Conferences.aspx?Language=en</a>
\7\	LOGO! Software Updates	<a href="http://www.automation.siemens.com/mcms/programmable-logic-controller/en/logic-module-logo/demo-software/Pages/Default.aspx">http://www.automation.siemens.com/mcms/programmable-logic-controller/en/logic-module-logo/demo-software/Pages/Default.aspx</a>
\8\	LOGO! Application Examples	<a href="http://www.automation.siemens.com/mcms/programmable-logic-controller/en/logic-module-logo/application-examples/Pages/Default.aspx">http://www.automation.siemens.com/mcms/programmable-logic-controller/en/logic-module-logo/application-examples/Pages/Default.aspx</a>
\9\	Data sheet ultrasonic sensor	<a href="http://files.pepperl-fuchs.com/selector_files/navi/productInfo/doct/doct2189a.pdf">http://files.pepperl-fuchs.com/selector_files/navi/productInfo/doct/doct2189a.pdf</a>

## 6.3 Change documentation

Table 6-2: Change documentation

Version	Date	Modifications
V1.0	01/2006	First version
V1.1	05/2006	Update
V2.0	08/2006	Revision of the "Applications & Tools" appearance
V2.0	01/2007	Update
V3.0	02/2013	Restructuring, adjustment to current components, new functions
V3.1	04/2014	Layout changes and addition of security advice, actualization of product no.s
V3.2	03/2019	Update to LOGO! 8 and textual changes