Control of AS-i position switch with interlock per MSS 3RK3

SIRIUS MSS 3RK3

FAQ 63111931 • March 2013

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Question

How will an operational interlock of an AS-i position switch 3SF1 be realised with the MSS 3RK3?

Answer

The MSS 3RK3 Advanced and the MSS 3RK3 ASIsafe feature a function block for protective door monitoring with an integrated function for monitoring and controlling protective door locking. This function block can be optimally used to control the conventionally wired 3SE5 position switch. If the 3SF1 position switch with tumbler is used in an application, the MSS cannot directly address the corresponding AS-i slave's output bit. This is due to the underlying design of AS-Interface. In this field bus system, only the AS-i master can actively write outputs. As a passive monitor on the AS-i bus, the MSS cannot execute this function. To enable use of the "protective door monitoring with tumbler" software block in combination with AS-i position switches with interlock as well, the signal for control of the solenoid must be sent from the MSS central module to the AS-i master.

The individual operating principles of the AS-i components and diverse solution approaches for realizing these functions are detailed in the following FAQ.

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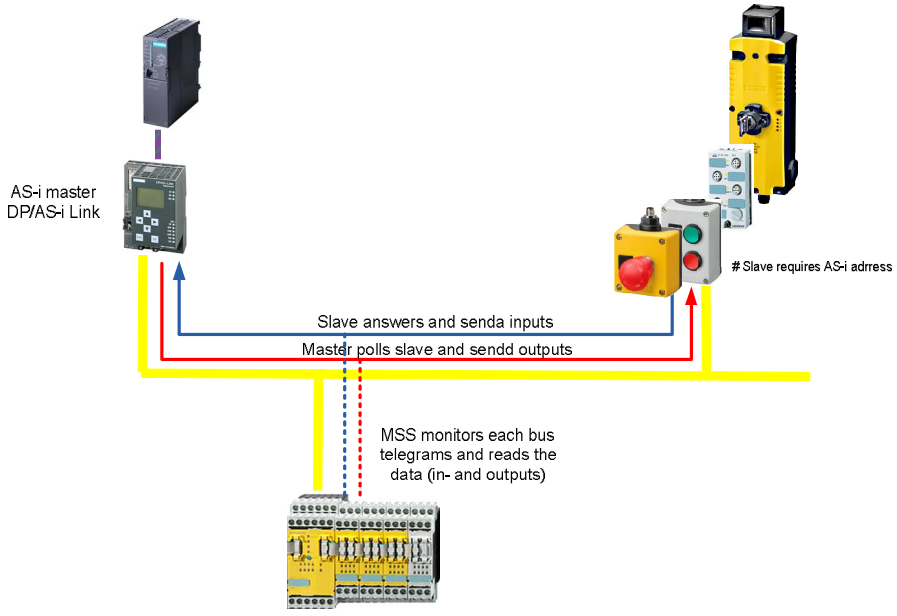
Table of contents

1 Introduction

The AS-Interface fieldbus system is a single master system. This means that the AS-i master is the central instance in the bus system. Further components are the AS-i slaves and passive devices that read out signal traffic as monitors on the bus. Components are also needed for the bus infrastructure (data decoupling, power supply, etc.). Each AS-i slave receives an individual address between 1 and 31 with which it is uniquely identifiable. Several slave profiles are available for diverse functions. Every slave has a data area of 4 bits input and 4 bits output, which are used differently depending on the slave profile. The AS-i master addresses each configured slave on the bus cyclically, sending it the 4 bits of output data and querying the 4 bits of input data. Transfer of failsafe data also uses the 4 bits of input data and the information is distributed across several bus cycles when transmitted. Thus, failsafe operation is achieved through a combination of several bits and several data telegrams.

Note To ensure failsafe operation during data transfer, both ASIsafe channels must always be evaluated for the same information. The use of only one channel is not permitted, and for this reason is also not possible in the logic of the MSS (e.g. one-channel evaluation of an ASIsafe signal).

Safety-related evaluation devices such as the MSS 3RK3 can read the so-called code sequences and can interpret the signals. This functionality is known as the monitor function. In this case, the MSS is a passive node on the bus and does not use up any resources (AS-i address). The MSS only has to appear on the AS-i bus as an active (simulated) slave if it wishes to send signals itself. To this end, an AS-i address is needed and the AS-i master includes the MSS in data traffic. Thus, it is possible that either the AS-i master sends data to the MSS or receives data from it.



The position switch with tumbler uses the AS-i slave profile "2F-DI". The failsafe information (position of the door or locked state of the actuator) is sent as an 8x4-bit code sequence on the AS-i bus. The 4 input bits are used for this. One output bit, which is controlled by the AS-i master, is used for control of the locking solenoid.

Note Code sequences are individual for each safe AS-i slave and must therefore be taught to the MSS during commissioning. You will find further information on the approach in Section 10.1 of the FAQ entitled
Failsafe and standard cross communication of the MSS 3RK3 via AS-Interface

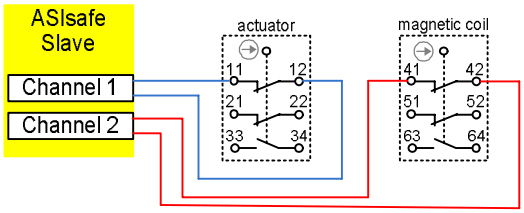
Note When the following text mentions SIL2 safety integrity in compliance with EN 62061 or PL d in compliance with ISO 13849-1, this can only be realized by exclusion of the "breakage of the actuator" fault. You will find further explanations of which engineering design measures have to be taken for this purpose in the FAQ: 3RK31 MSS: Monitoring and locking a protective door

1.1 Versions of the position switch with AS-Interface

There are different versions of the position switch with tumbler. These versions differ in the wiring of the switching elements. Their structure and characteristics are described below.

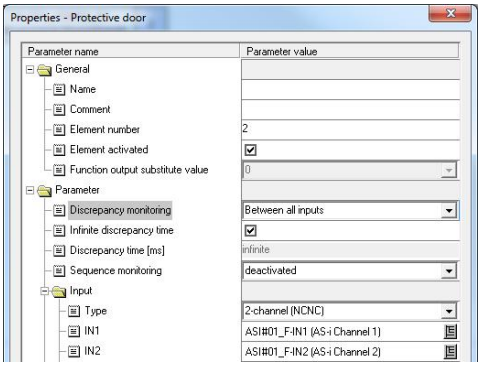
1.1.1 3SF13*4-1S*1-1BA1

In this device version, the position of the door (actuator inserted) and the excitation state of the solenoid are monitored. Every item of information occupies a single AS-i channel. As a result of incorrect closing protection (mechanical property of the position switch), two-channel position monitoring is achieved with this combination.



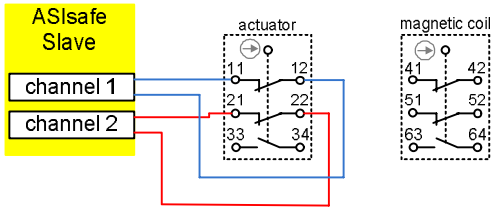
When the position switch 3SF13*4-1S*1-1BA1 is used, safety-related deactivation by the MSS takes place as soon as the door is unlocked by the AS-i master. For protective door monitoring from SIL 2 in acc. with EN 62061 resp. PL d in acc. with ISO 13849-1, discrepancy evaluation must be activated for the switch in the applicable MSS software element. This is why the door must be opened before reactivating the application. Otherwise, the MSS remains in the safe state (detection of a discrepancy error). This may lead to obstructive operation in systems with several door tumblers that are locked/unlocked via the same signal.

Parameterization of the MSS "protective door" software element for 3SF13*41S*1-1BA1 with discrepancy monitoring



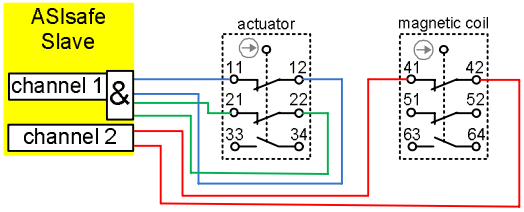
1.1.2 3SF13*4-1S*1-1BA3

This version monitors the position of the protective door only. To this end, both normally closed contacts for actuator monitoring are wired to the AS-i slave. The solenoid's feedback signal is not evaluated. Therefore, unlocking of the door has no influence on the safety function. Safety deactivation does not take place until the door is opened. For protective door monitoring from SIL 2 in compliance with EN 62061 or PL d in compliance with ISO 13849-1, discrepancy evaluation must also be activated for the switch. There is therefore no need for positive-opening of the door after unlocking.



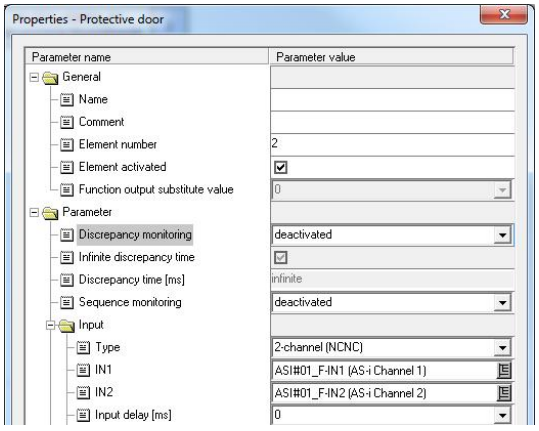
1.1.3 3SF13*4-1S*1-1BA4

The AS-i position switch 3SF13*4-1S*1-1BA4 evaluates the actuator in two channels and the solenoid feedback signal in one channel. The two actuator contacts are already monitored internally in the switch for simultaneity and the result is sent through an AS-i channel. The locking solenoid's switching position is sent through the second channel.



This is why discrepancy evaluation need not be activated in the software element of the MSS. Without discrepancy evaluation, releasing and opening of the door are decoupled. The door does not have to be opened after unlocking. Safety deactivation takes place when the door is unlocked.

Parameterization of the MSS "protective door" element for 3SF13*4-1S*1-1BA4 without discrepancy monitoring



2 Realization of the operational interlock

2.1 Separating operational and failsafe automation tasks

Control of the tumbler is not failsafe in the case of AS-i position switches. This is why the tumbler fulfils operational purposes only (e.g. protecting a production process). Therefore, it may certainly be the case that the output signal for solenoid control is generated in the control program of the standard PLC. For this use case, the "protective door monitoring" safety function and the "protective door tumbler" operational function can be executed separately.

In a safety-related fashion, the MSS monitors the door's position by monitoring the position switch's failsafe ASIsafe slave "2F-DI". The S7 program controls the solenoid via the non-failsafe output bit.

Note In addition to featuring safety diagnosis, the software elements for protective door monitoring have further diagnostics functions for faster recovery of system availability. The switching sequence of both channels is monitored with the integrated sequence monitoring. If an error should occur in the application that entails an incorrect switch-off sequence (actuator first, and then the solenoid), this can be detected and signalled.

2.2 Using the MSS function block to control the tumbler

In the case of applications in which a hazardous state persists for a certain time after deactivation of the drive energy, it may be necessary to also design the tumbler as a safety function. The "protective door monitoring with tumbler" logic element was developed especially for these applications.

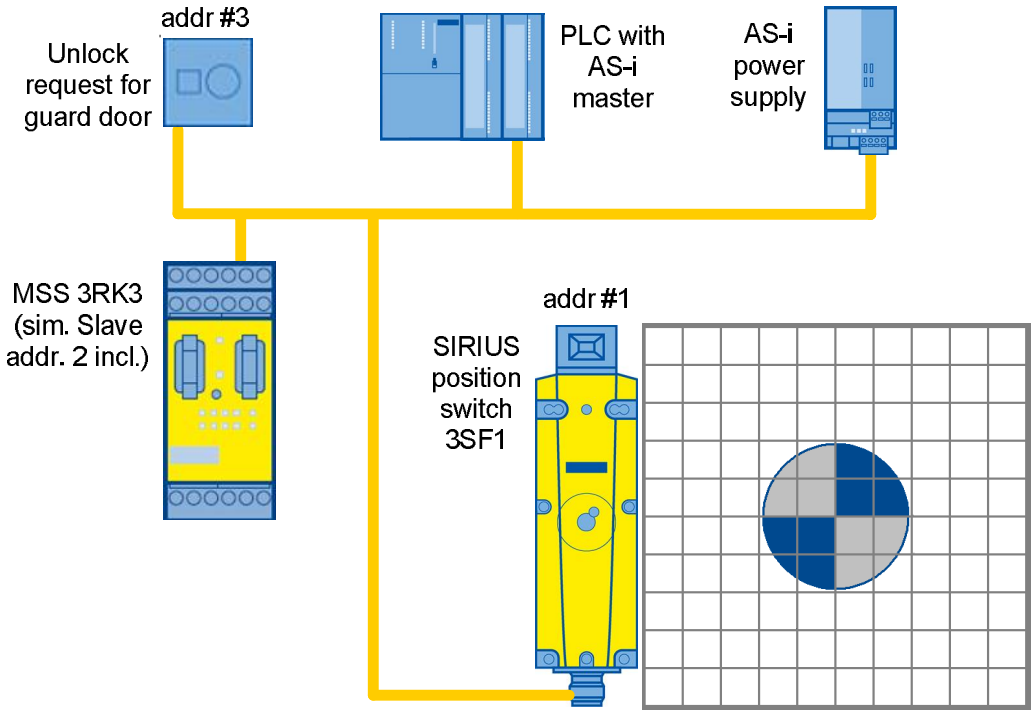
You will find a detailed description of a safety-related design of the tumbler with 3SE5 position switches in the FAQ: 3RK31 MSS: Monitoring and locking a protective door

The logic functionality of MSS can also be used for operational tumbler control via AS-i, however. To this end, the function block's "LOCK" control signal must be sent to the AS-i master, which then controls the applicable AS-i output.

Various ways of realizing an operational tumbler via AS-i with the MSS 3RK3 are outlined below.

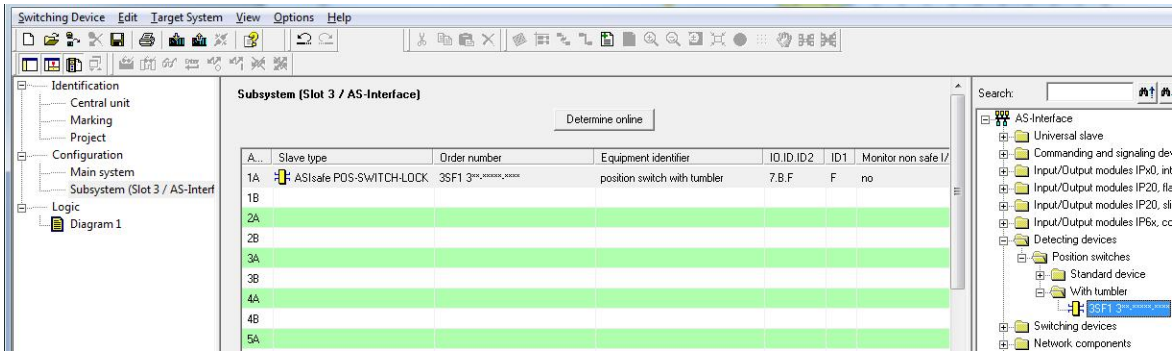
Application example

In the following example, the position of the door is monitored by the MSS 3RK3. If door release is requested via the command point 3SB3, the "protective door monitoring function block with tumbler" deactivates its output "Q". The function block outputs the door release signal with a delay of 1 second. The unlock signal is sent to the AS-i master via an input of the AS-i slave simulated by the MSS (address 2). In the PLC's control program, this input is assigned to the output (Addr.1_Q1), which controls the solenoid in the position switch.



1 Configuration of the AS-i bus in MSS ES 2008 SP2 or higher

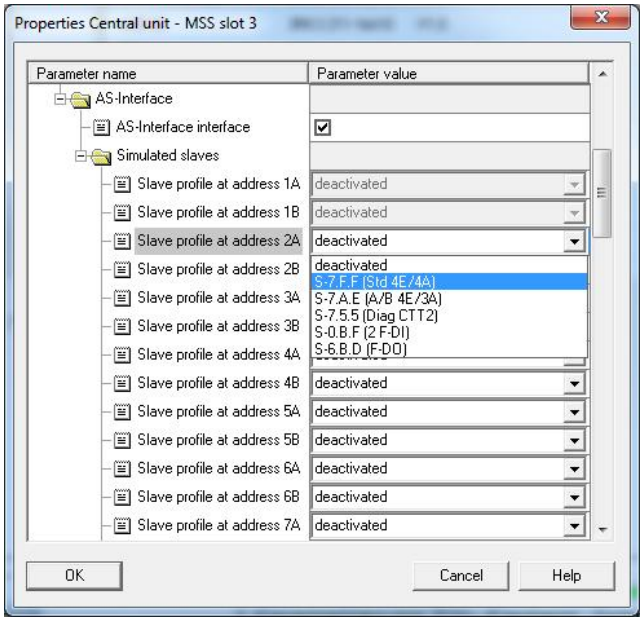
In the subsystem of the MSS 3RK3 Advanced or ASIsafe, the 3SF1 position switch from the catalog is inserted at the corresponding AS-i address (in this case address #1).



2 Creating a simulated slave in MSS ES 2008 for data transfer to PLC

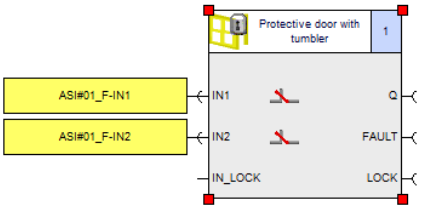
An AS-i slave is needed to transfer the MSS software element's "LOCK" signal. The MSS simulates this slave and can thus use the available inputs.

Double clicking the central module in the central system configuration menu opens the Properties dialog. At a free AS-i address (in this case #2) either the slave profile "Std4E/4A" or "A/B 4E/3A" is selected from the drop-down menu.



3 Parameterizing the "protective door with tumbler" software element

The software element “Protective door with tumbler” will be placed in the logic diagram. Per double click the properties of the element will be opened.



The input type must be set to "two-channel (NCNC)". Otherwise the failsafe AS-i slave cannot be linked to the function block's IN1 and IN2 inputs. The position switch is monitored in two channels for several reasons. These are:

- Diagnostics and error response (required for SIL 2/ Pl d)
- Transfer of two different items of information (door position and locking state)

Independently of the chosen position switch version, the tumbler's feedback circuit monitoring cannot be activated because both signals are already occupied by the sensor inputs.

"Tumbler with open protective door" parameter:

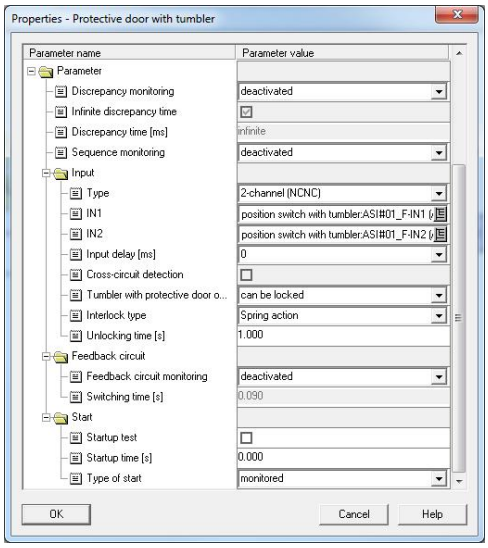
This parameter must be set to the "can be locked" value when the position switches are used with the MLFB endings "-1BA1" and "-1BA4". Otherwise, this will lead to the following error message of the software element when locking is requested.

Interlock not possible d...	The locking command cannot be executed because the protective door is still open. - Close the protective door.

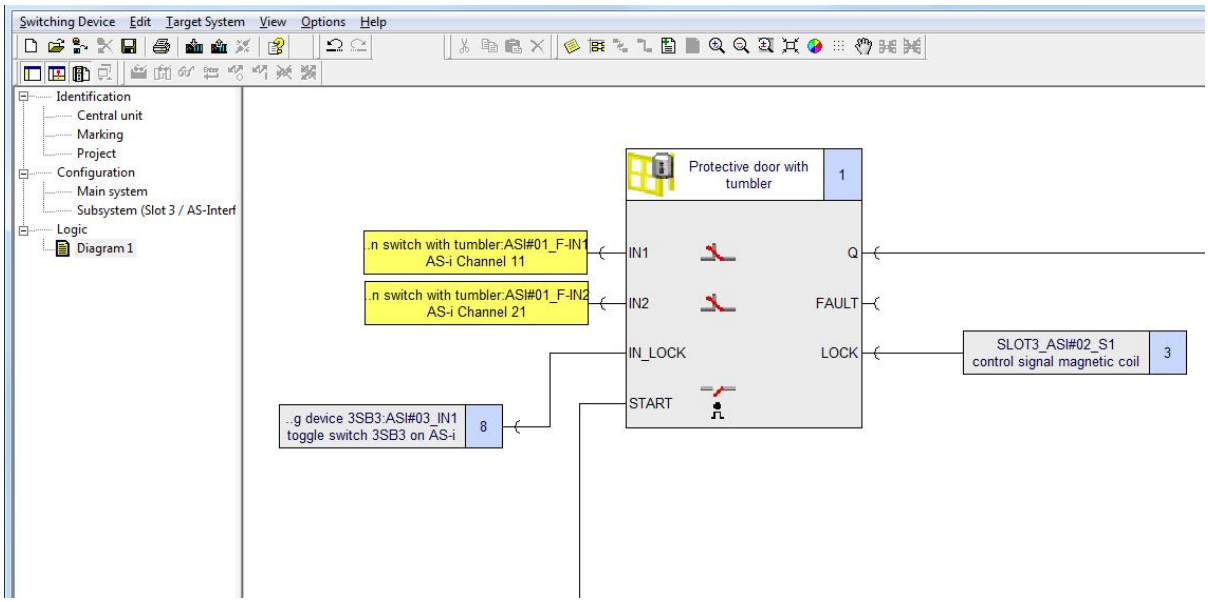
Other parameters:

(settings dependent on the hardware and/or the application)

- Discrepancy monitoring (see Section 1.1)
- Unlocking time
- Startup test
- Start time
- Start type

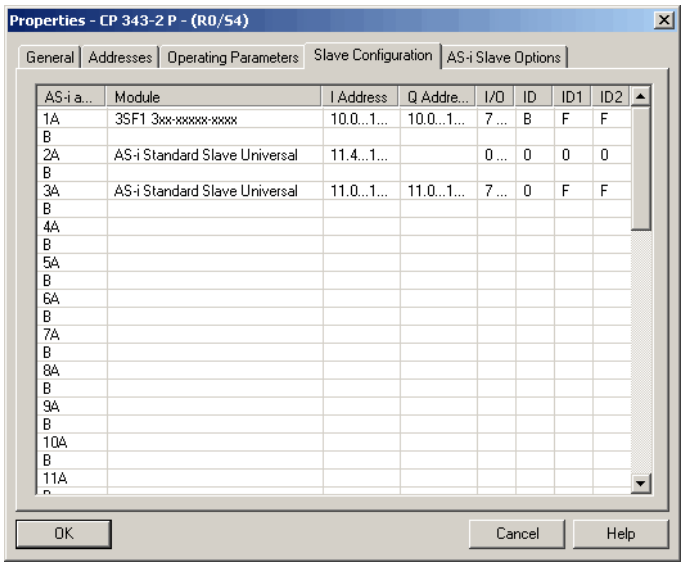


Wiring the monitoring function block in MSS ES



4 Hardware configuration of the AS-i bus system in SIMATIC S7

The AS-i position switch 3SF1, the simulated slave of the MSS central modules and the AS-i command point must be included in the configuration of the AS-i master. This is done either via the local operator control units (e.g. on the IE/AS-i link) or in the hardware configuration of the SIMATIC automation system.



I/O addressing of AS-i components in SIMATIC PLC process image

AS-i addressing		Process image of inputs/outputs	Explanation
AS-i #1	ASIsafe channel 1	I10.0 + I10.1	Two input bits of the AS-i slaves always map one ASIsafe channel. The 8x4-bit code sequence will be transferred in all four bits.
	ASIsafe channel 2	I10.2 + I10.3	
	Q_1	Q10.0	Control of magnetic coil
	Q_2-Q_4	Q10.1-Q10.3	Not used
AS-i #2 (sim. slave)	#2_S1	I11.4	Transfer of LOCK signal of MSS function block to PLC
	#2_S1-S4	I11.5- I11.7	Not used
	#2_Q1-Q4	Q11.4- Q11.7	Not used
AS-i #3	#3_IN1	I11.0	Switch on commanding device for unlock request
	#3_IN2-IN4	I11.1- I11.3	Not used
	#3_Q1-Q4	Q11.0-Q11.3	Not used

5 Program code in the PLC

In the controller's program, the input bit that reads the lock/unlock command from the MSS ("LOCK" function block output) must be transferred to the corresponding output bit of the solenoid. This requires a simple allocation.

AWL code for example application:

```
A     I11.4   "sim. slave #2 LOCK output"
=     Q10.0   "control of tumbler"
```

3 Contacts/Support

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