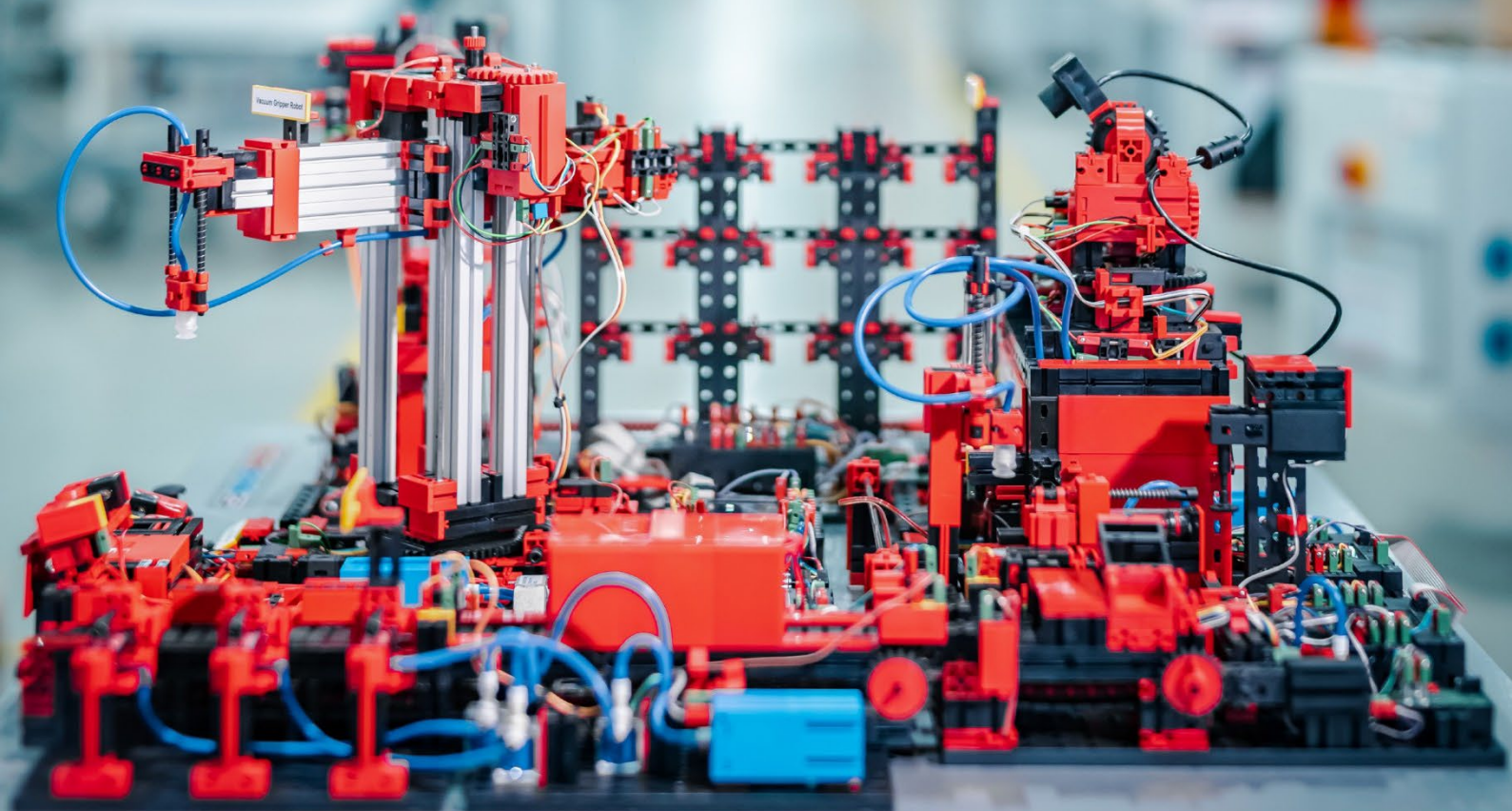


LEARNING FACTORY 4.0 24V

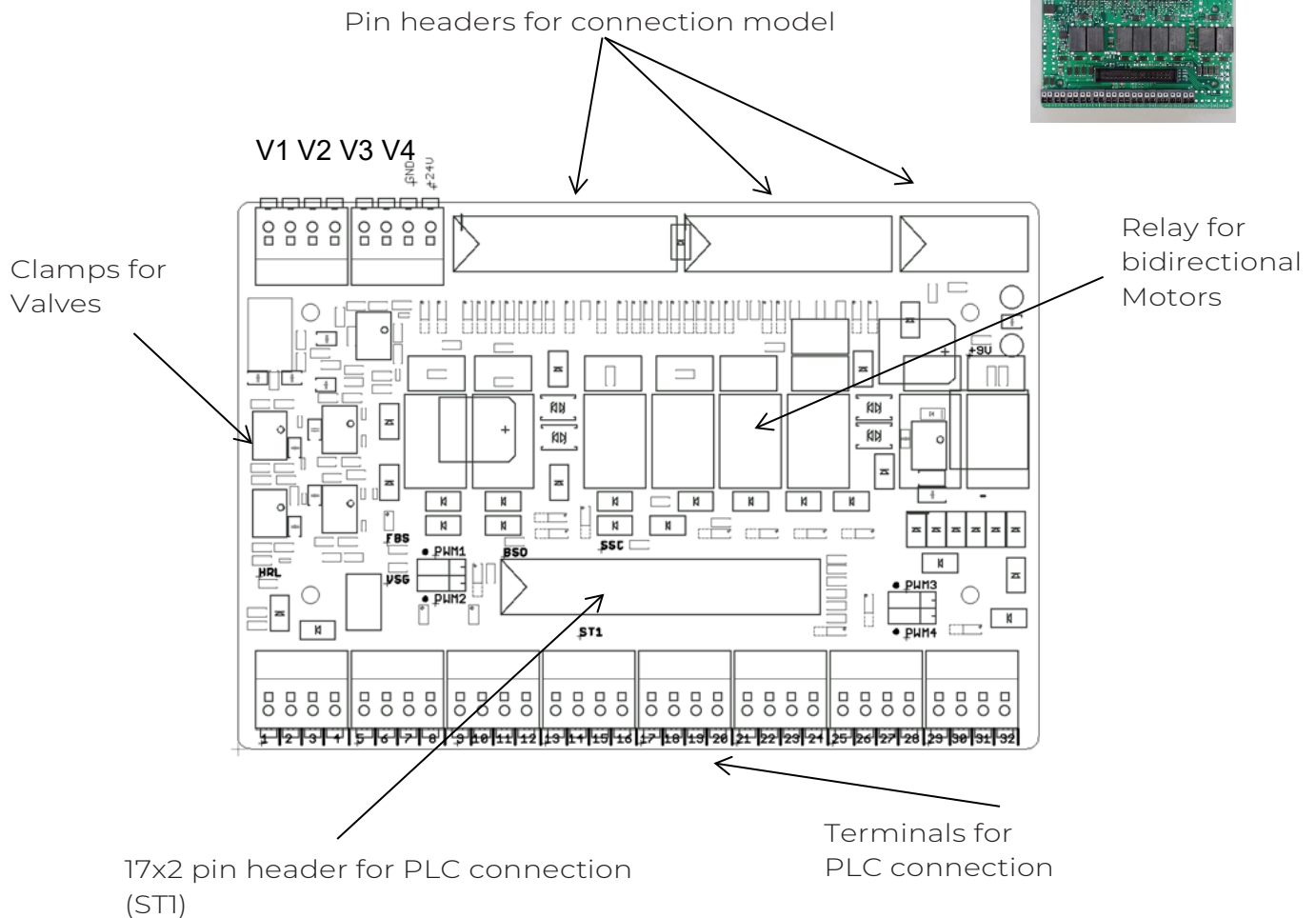
Accompanying booklet

Status: 22.03.2024



Adapter board 24V

There is an adapter board on each factory module for connection to the PLC, which is structured as follows:

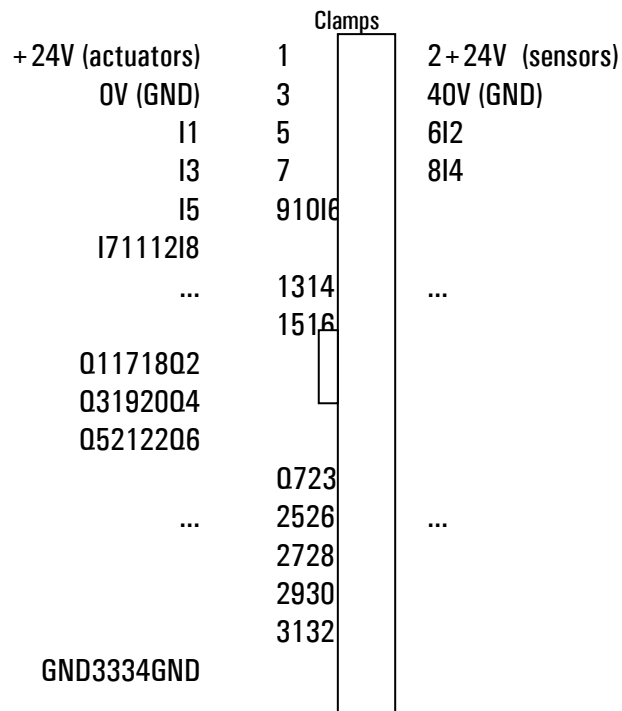


System requirements PLC / control system s:

If another controller such as an Arduino is used instead of a SIMATIC S7-1500 PLC, it must be ensured that the following requirements are met.

- Interface to the adapter board compatible with 24V
- Cycle time of maximum 10 ms

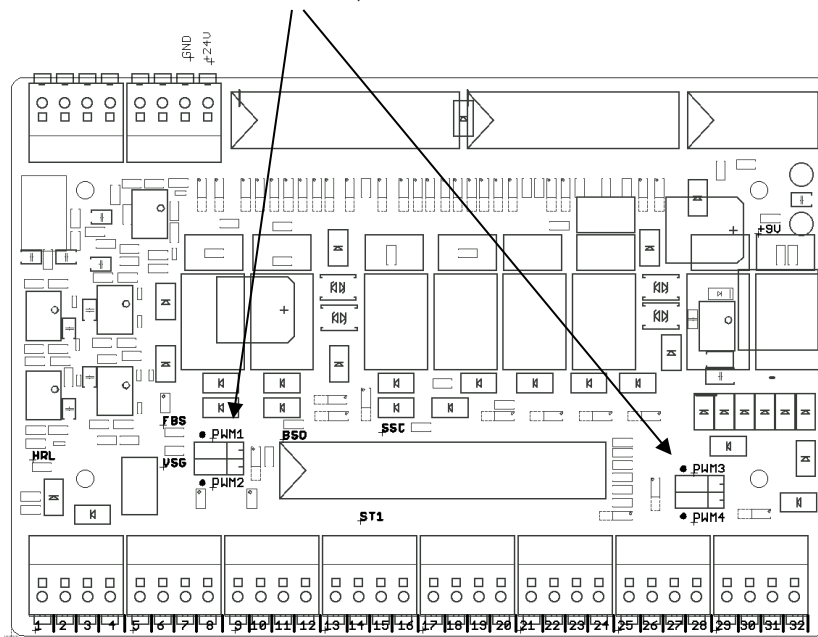
Assignment of the 17x2 pin header (ST1) for PLC connection:



Pulse width modulation:

Bidirectionally controlled motors are switched via relays and supplied either via the 24V (actuators) or via the associated PWM terminal.

The jumpers are located here on the adapter board



	High-bay warehouse (HBW)	Vacuum suction gripper (VGR)	Processing station (MPO)	Sorting line (SLD)	Sensor station with camera (SSC)
PWM 1	Conveyor belt	Y(Vertical)	Slewing ring	- not used -	- not used -
PWM 2	X(Horizontal)	Z(Horizontal)	- not used -	- not used -	Camera height
PWM 3	Y(Vertical)	X(Rotate)	- not used -	- not used -	Rotate camera
PWM 4	Outtrigger		Suction cup (horizontal)	- not used -	- not used -

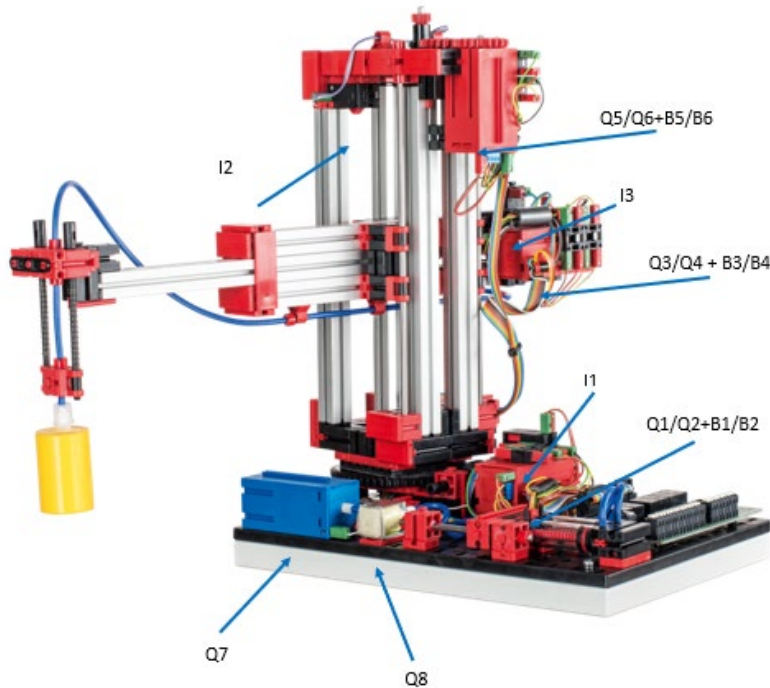
Assignment of the P W M jumpers:

Jumper left: PWM selected, motor is reversed via relay and supplied with voltage via associated PWM terminal

Jumper right: Power supply via +24V (actuators), motor can be reversed with relay

Assignment plans for the factory modules

Assignment plan for the vacuum suction pad



Terminal no. (ST1)	Function	Designation	PLC terminal	I/O address S7-1500	Variable name S7-1500
1	Power supply (+) Actuators	24V DC			
2	Power supply (+) Sensors	24V DC			
3	Power supply (-)	0V			
4	Power supply (-)	0V			
5	Vertical reference switch	I1	DI1.6	%I1.6	IX_VGR_RefSwitchVerticalAxis_I1
6	Horizontal reference switch	I2	DI3.6	%I3.6	IX_VGR_RefSwitchHorizontalAxis_I2
7	Turn reference switch	I3	DI3.7	%I3.7	IX_VGR_RefSwitchRotate_I3
9	Encoder vertical pulse 1	B1	DI6.0	%I6.0	IX_VGR_EncoderVerticalAxisImp1_B1
10	Encoder vertical pulse 2	B2	DI6.4	%I6.4	IX_VGR_EncoderVerticalAxisImp2_B2
11	Encoder horizontal pulse 1	B3	DI6.1	%I6.1	IX_VGR_EncoderHorizontalAxisImp1_B3
12	Encoder horizontal pulse 2	B4	DI6.5	%I6.5	IX_VGR_EncoderHorizontalAxisImp2_B4
13	Turn encoder Pulse 1	B5	DI6.2	%I6.2	IX_VGR_EncoderRotateImp1_B5
14	Turn encoder Pulse 2	B6	DI6.6	%I6.6	IX_VGR_EncoderRotateImp2_B6
17	Motor vertical high	Q1 (M1)	D02.0	%Q2.0	QX_VGR_M1_VerticalAxisUp_Q1
18	Motor vertical down	Q2 (M1)	D02.1	%Q2.1	QX_VGR_M1_VerticalAxisDown_Q2
19	Motor horizontal backwards	Q3 (M2)	D02.2	%Q2.2	QX_VGR_M2_HorizontalAxisBackward_Q3
20	Motor horizontal forward	Q4 (M2)	D02.3	%Q2.3	QX_VGR_M2_HorizontalAxisForward_Q4
21	Turn motor clockwise	Q5 (M3)	D02.4	%Q2.4	QX_VGR_M3_RotateClockwise_Q5
22	Turn motor counterclockwise	Q6(M3)	D02.5	%Q2.5	QX_VGR_M3_RotateCounterclockwise_Q6
23	Compressor	Q7	D02.6	%Q2.6	QX_VGR_Compressor_Q7
24	Vacuum valve	Q8	D02.7	%Q2.7	QX_VGR_ValveVacuum_Q8
25	PWM horizontal	PWM (M1)	D08.0	%QW15	QW_VGR_PWM_Vertical_M1
26	PWM vertical	PWM (M2)	D08.1	%QW17	QW_VGR_PWM_Horizontal_M2
27	Rotate PWM	PWM (M3)	D08.2	%QW19	QW_VGR_PWM_Rotate_M3

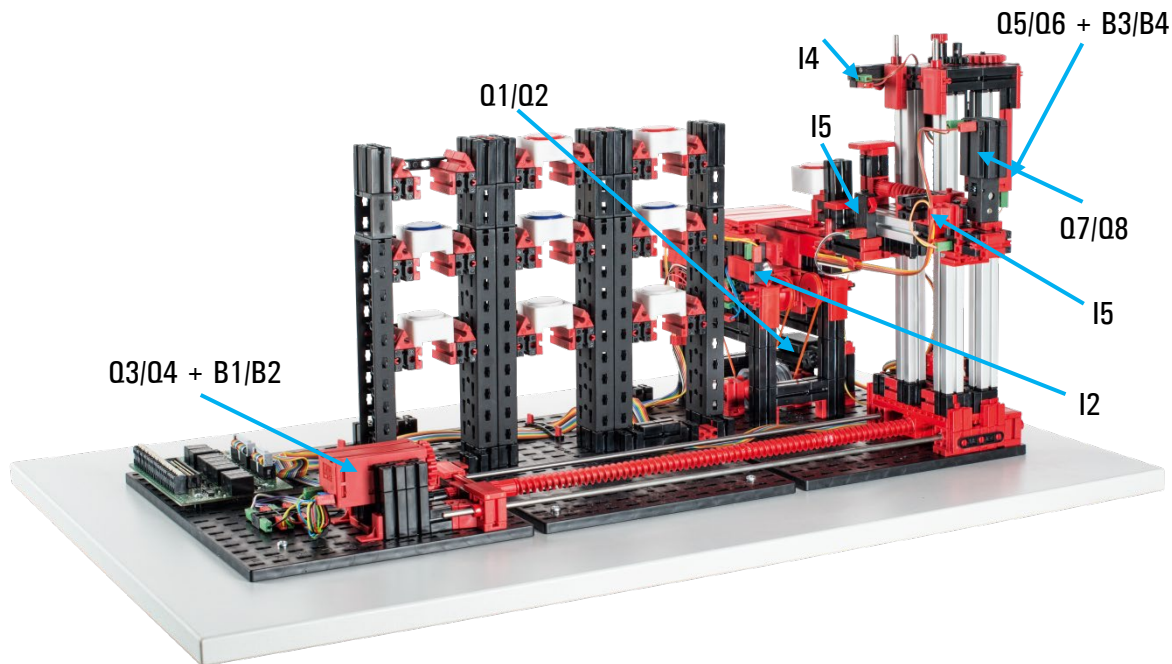
Wiring model

Clamp	Pin header ST1		Ribbon cable	Sensors + actuators Model		
17	Vertical high	1		Q1/Q2 (M1)		
18	Vertical down	2				
3,4	GND	3		Encoder Signal Signal B Power supply A		
2	24V (sensor)	4				
9	A	5				
10	B	6				
5	Vertical reference	7		I1		
2	24V	8				
19	Horizontal back	9		Q3/Q4 (M2)		
20	Horizontal in front	10				
3,4	GND	11		Encoder Signal Signal B Power supply A		
2	24V (sensor)	12				
11	A	13				
12	B	14				
6	Horizontal reference	15		I2		
2	24V (sensor)	16				
Pin header ST2						
7	Turn reference	1		I3		
2	24V (sensor)	2				
21	Turn clockwise	3		Q5/Q6 (M3)		
22	Turn counterclockwise	4				
3,4	GND	5		Encoder Signal Signal B Power supply A		
2	24V (sensor)	6				
13	A	7				
14	B	8				
3,4	GND	9		Q7 (compressor)		
23	Compressor	10				
3,4	Terminal V4			Q8 (vacuum valve)		
24						

red = power supply

yellow = motor polarity reversible via relay

Layout plan for automated high-bay warehouse (HBW)



Terminal no. (ST1)	Function	Designation	PLC terminal	E- / A address S7-1500	Variable name S7-1500
1	Power supply (+) Actuators	24V DC			
2	Power supply (+) Sensors	24V DC			
3	Power supply (-)	0V			
4	Power supply (-)	0V			
5	Horizontal reference switch	I1	DI1.0	%I1.0	IX_HBW_RefSwitchHorizontalAxis_I1
6	Light barrier inside	I2	DI1.1	%I1.1	IX_HBW_LightBarrierInside_I2
7	External light barrier	I3	DI1.2	%I1.2	IX_HBW_LightBarrierOutside_I3
8	Vertical reference button	I4	DI1.3	%I1.3	IX_HBW_RefSwitchVerticalAxis_I4
11	Encoder horizontal pulse 1	B1	DI5.1	%I5.1	IX_HBW_EncoderHorizontalAxisImp1_B1
12	Encoder horizontal pulse 2	B2	DI5.5	%I5.5	IX_HBW_EncoderHorizontalAxisImp2_B2
13	Encoder vertical pulse 1	B3	DI5.2	%I5.2	IX_HBW_EncoderVerticalAxisImp1_B3
14	Encoder vertical pulse 2	B4	DI5.6	%I5.6	IX_HBW_EncoderVerticalAxisImp2_B4
15	Front boom reference button	I5	DI1.4	%I1.4	IX_HBW_SwitchCantileverFront_I5
16	Rear boom reference button	I6	DI1.5	%I1.5	IX_HBW_SwitchCantileverBack_I6
17	Motor conveyor belt forward	Q1 (M1)	DO1.0	%Q1.0	QX_HBW_M1_ConveyorBeltForward_Q1
18	Motor conveyor belt backwards	Q2 (M1)	DO1.1	%Q1.1	QX_HBW_M1_ConveyorBeltBackward_Q2
19	Motor horizontal to the shelf	Q3 (M2)	DO1.2	%Q1.2	QX_HBW_M2_HorizontalTowardsRack_Q3
20	Motor horizontal to the conveyor belt	Q4 (M2)	DO1.3	%Q1.3	QX_HBW_M2_HorizontalTowardsConveyorBelt_Q4
21	Motor down vertically	Q5 (M3)	DO1.4	%Q1.4	QX_HBW_M3_VerticalAxisDownward_Q5
22	Motor vertical high	Q6 (M3)	DO1.5	%Q1.5	QX_HBW_M3_VerticalAxisUpward_Q6
23	Motor boom forward	Q7 (M4)	DO1.6	%Q1.6	QX_HBW_M4_CantileverForward_Q7
24	Motor boom backwards	Q8 (M4)	DO1.7	%Q1.7	QX_HBW_M4_CantileverBackward_Q8
25	PWM conveyor belt	PWM (M1)	DO7.0	%QW7	QW_HBW_PWM_ConveyorBelt_M1
26	PWM horizontal	PWM (M2)	DO7.1	%QW9	QW_HBW_PWM_HorizontalAxis_M2
27	PWM vertical	PWM (M3)	DO7.2	%QW11	QW_HBW_PWM_VerticalAxis_M3
28	PWM cantilever	PWM (M4)	DO7.3	%QW13	QW_HBW_PWM_Cantilever_M4

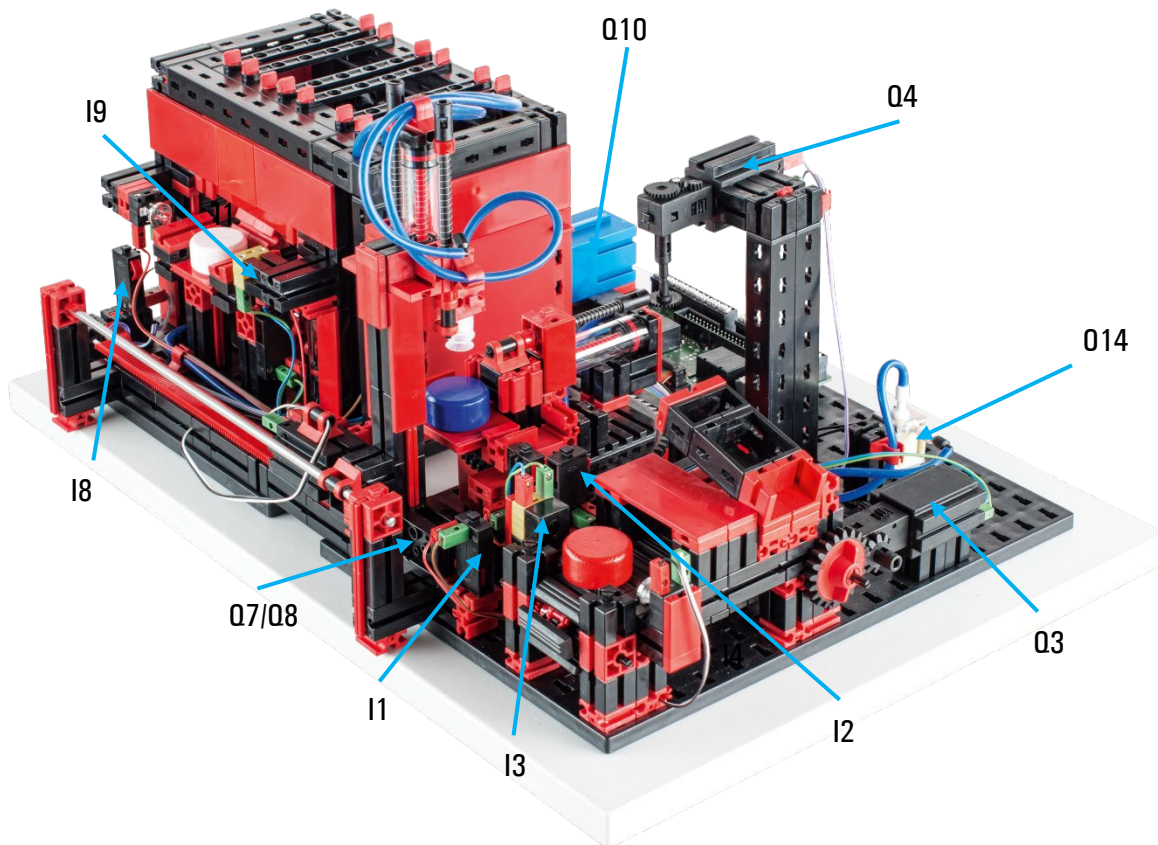
Wiring model

Clamp	Pin header ST1		Ribbon cable	Sensors + actuators Model
5	Horizontal reference	1		I1
2	24V (sensor)	2		
6	Phototransistor inside	3		I2
2	24V (sensor)	4		
7	External phototransistor	5		I3
2	24V (sensor)	6		
17	Conveyor belt forward	7		Q1/Q2 (M1)
18	Conveyor belt backwards	8		
3,4	GND	9		
2	9V (generated from 24V sensor)	10		reserved
9	reserved	11		
10	reserved	12		
3,4	GND	13		Lamps for light barrier
2	24V (sensor)	14		
19	Motor horizontal to the shelf	15		Q3/Q4 (M2)
20	Motor horizontal to the conveyor belt	16		
3,4	GND	17		
2	24V (sensor)	18		Encoder horizontal Power supply A
11	A	19		Signal Signal B
12	B	20		
Pin header ST2				
8	Vertical reference button	1		I4
2	24V (sensor)	2		
21	Vertical axis down	3		Q6/Q7 (M3)
22	Vertical axis up	4		
3,4	GND	5		
2	24V (sensor)	6		Encoder vertical supply A
13	A	7		Power Signal Signal B
14	B	8		
15	Front boom reference button	9		I5
2	24V (sensor)	10		
23	Outrigger in front	11		Q7/Q8 (M4)
24	Boom back	12		
16	Rear boom reference button	13		I6
2	24V (sensor)	14		

red = power supply

yellow = motor polarity reversible via relay

Layout plan for Multi Processing Station with Kiln (MPO)



Not pictured: Q1, Q2, Q5, Q6, Q9, Q11, Q12, Q13, I4, I5, I6, I7

Terminal no. (ST1)	Function	Designation	PLC terminal	E- / A address S7-1500	Variable name S7-1500
1	Power supply (+) Actuators	24V DC			
2	Power supply (+) Sensors	24V DC			
3	Power supply (-)	0V			
4	Power supply (-)	0V			
5	Reference switch slewing ring (suction cup position)	I1	DI1.7	%I1.7	IX MPO RefSwitchTurnTable PosVac I1
6	Reference switch slewing ring (conveyor belt position)	I2	DI2.0	%I2.0	IX MPO RefSwitchTurnTable PosBelt I2
7	Light barrier end of conveyor belt	I3	DI2.1	%I2.1	IX MPO LightBarrierEndOfConBelt I3
8	Reference switch slewing ring (saw position)	I4	DI2.2	%I2.2	IX MPO RefSwitchTurnTable PosSaw I4
9	Suction cup reference switch (swivel head position)	I5	DI2.3	%I2.3	IX MPO RefSwitchVac PosTurnTable I5
10	Reference switch oven slide inside	I6	DI2.4	%I2.4	IX MPO RefSwitchOvenFeederInside I6
11	External oven slide reference switch	I7	DI2.5	%I2.5	IX MPO RefSwitchOvenFeederOutside I7
12	Suction cup reference switch (kiln position)	I8	DI2.6	%I2.6	IX MPO RefSwitchVac PosOven I8
13	Light barrier kiln	I9	DI2.7	%I2.7	IX MPO LightBarrierOven I9
17	Motor slewing ring clockwise	Q1 (M1)	D03.0	%Q3.0	QX MPO M1 TurnTableClockwise Q1
18	Motor slewing ring counterclockwise	Q2 (M1)	D03.1	%Q3.1	QX MPO M1 TurnTableCounterclockwise Q2
19	Motor conveyor belt forward	Q3 (M2)	D03.2	%Q3.2	QX MPO M2 ConveyorBeltForward Q3
20	Motor saw	Q4 (M3)	D03.3	%Q3.3	QX MPO M3 Saw Q4
21	Retract motor oven slide	Q5 (M4)	D03.4	%Q3.4	QX MPO M4 OvenFeederRetract Q5
22	Extend motor oven slide	Q6 (M4)	D03.5	%Q3.5	QX MPO M4 OvenFeederExtend Q6
23	Motor suction cup to oven	Q7 (M5)	D03.6	%Q3.6	QX MPO M5 VacuumTowardsOven Q7
24	Motor suction cup to slewing ring	Q8 (M5)	D03.7	%Q3.7	QX MPO M5 VacuumTowardsTurnTable Q8
25	Oven light	Q9	D04.0	%Q4.0	QX MPO LightOven Q9
26	Compressor	Q10	D04.1	%Q4.1	QX MPO Compressor Q10
27	Vacuum valve	Q11	D04.2	%Q4.2	QX MPO ValveVacuum Q11
28	Lowering valve	Q12	D04.3	%Q4.3	QX MPO ValveLowering Q12
29	Valve oven door	Q13	D04.4	%Q4.4	QX MPO ValveOvenDoor Q13
30	Valve Gate valve	Q14	D04.5	%Q4.5	QX MPO ValveFeeder Q14
31	PWM slewing ring	PWM (M1)	D09.0	%QW23	QW MPO PWM TurnTable M1
32	PWM suction cup	PWM (M5)	D09.1	%QW25	QW MPO PWM Vacuum M5

Wiring model

Clamp	Pin header ST1		Ribbon cable	Sensors + actuators on the model
5	Reference switch slewing ring	1		I1
2	24V (sensor)	2		
6	Reference switch slewing ring	3		I2
2	24V (sensor)	4		
7	Light barrier end of conveyor belt	5		I3
2	24V (sensor)	6		
17	Turntable clockwise	7		Q1/Q2 (M1)
18	Turntable counterclockwise	8		
3,4	GND	9		
2	24V (sensor)	10		Light barrier lamp
9	Suction cup reference button	11		I5
2	24V (sensor)	12		
8	Reference button slewing ring Pos saw	13		I4
2	24V (sensor)	14		
3,4	GND	15		Q3 (M2)
19	Conveyor belt	16		
3,4	GND	17		Q4 (M3)
20	Saw	18		
	not used	19		
	not used	20		

ST2

	not used	1		
	not used	2		
21	Retracting the oven slide	3		Q5/Q6 (M4)
22	Extending the oven slide	4		
10	Oven slide inside	5		I6
2	24V (sensor)	6		
11	Oven slide outside	7		I7
2	24V (sensor)	8		
12	Suction cup for oven	9		I8
2	24V (sensor)	10		
23	Suction cup to the oven	11		Q7/Q8(M5)
24	Suction cup for slewing ring	12		
3,4	GND	13		Q9 (luminaire oven)
25	Oven light	14		
3,4	GND	15		Q10 (compressor)
26	Compressor	16		
13	Light barrier oven	17		I9
2	24V (sensor)	18		
3,4	GND	19		Light barrier lamp
2	24V (sensor)	20		

3,4
27
3,4
28
3,4
29
3,4
30

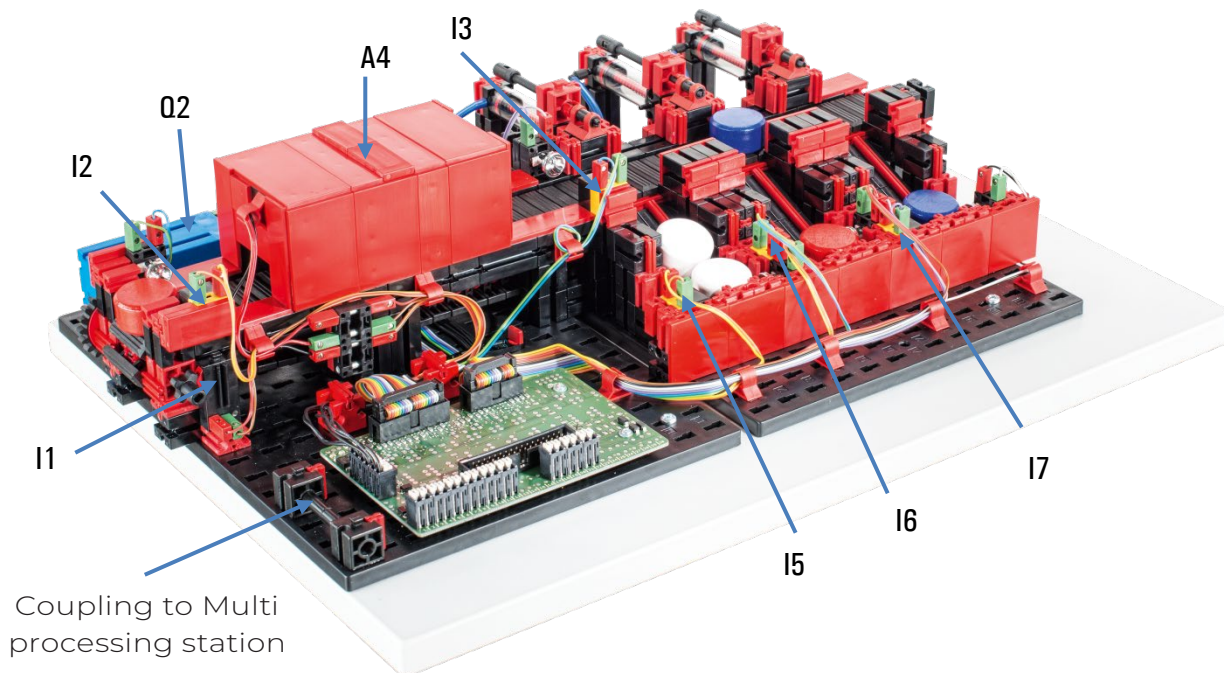
Terminal V1
Terminal V2
Terminal V3
Terminal V4

Q11 (vacuum valve)
Q12 (lowering valve)
Q13 (valve oven door)
Q14 (valve gate)

red = power supply

yellow = motor polarity reversible via relay

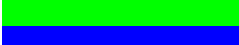
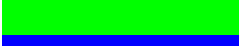
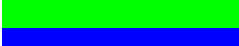
Assignment plan for the sorting line with color detection (SLD)



not shown: Q1, Q3, Q4, Q5

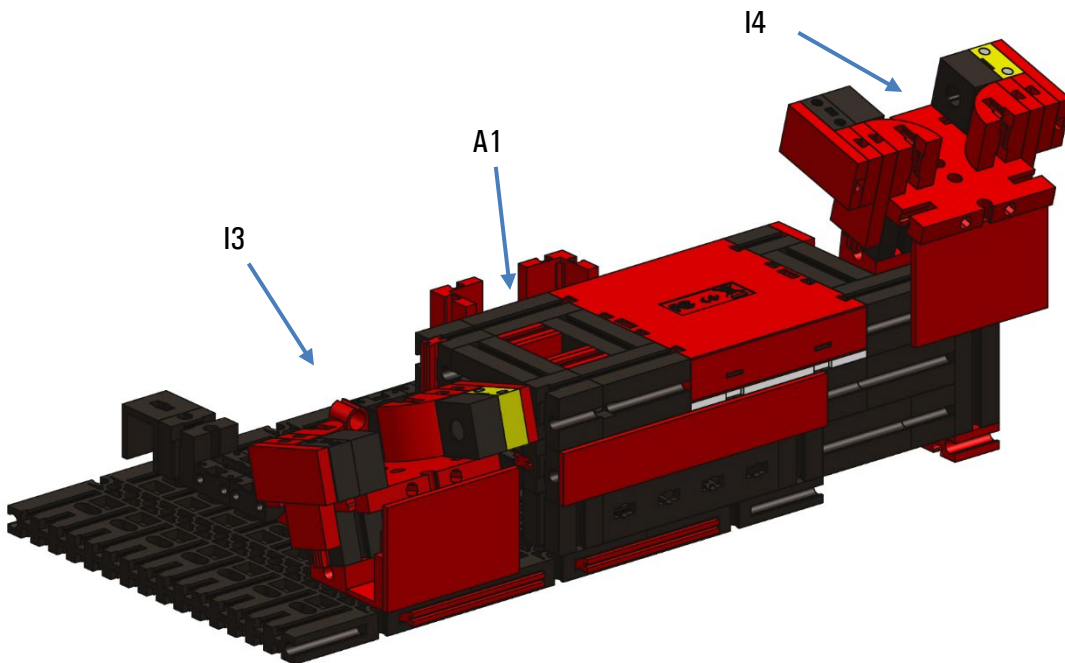
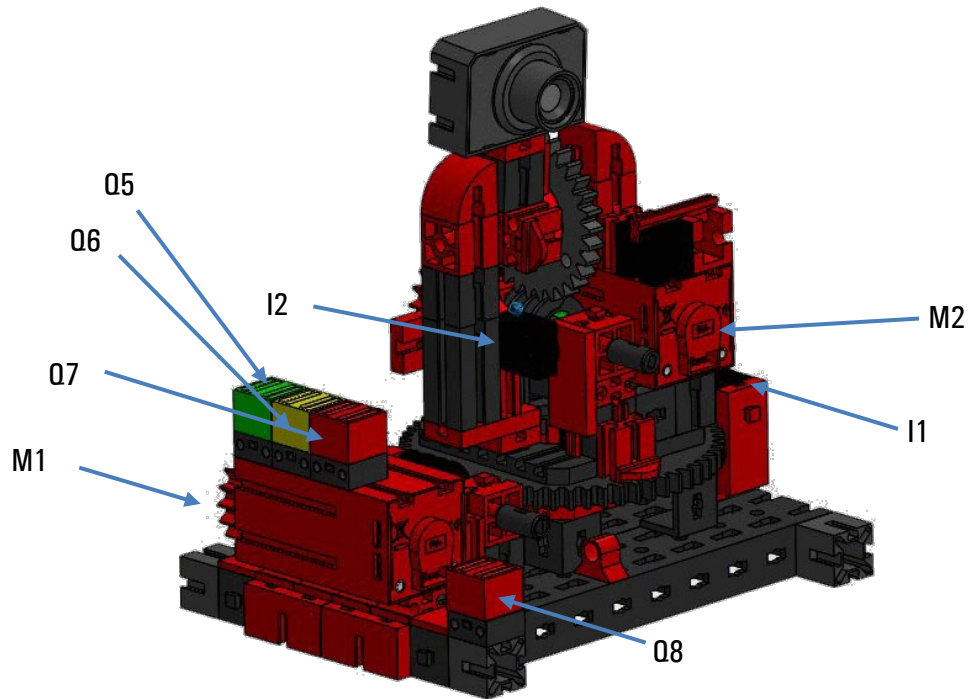
Terminal no. (ST1)	Function	Designation	PLC terminal	E- / A-address S7-1500	Variable name S7-1500
1	Power supply (+) Actuators	24V DC			
2	Power supply (+) Sensors	24V DC			
3	Power supply (-)	0V			
4	Power supply (-)	0V			
5	Pulse button	I1	DI3.0	%I3.0	IX_SLD_PulseCounter_I1
6	Light barrier input	I2	DI3.1	%I3.1	IX_SLD_LightBarrierInlet_I2
7	Light barrier after color sensor	I3	DI3.2	%I3.2	IX_SLD_LightBarrierBehindColorSensor_I3
9	Color sensor	A4 Analog 0-10VDC	AI1.0	%IW7	IW_SLD_ColorSensor_A4
10	Light barrier white	I5	DI3.3	%I3.3	IX_SLD_LightBarrierWhite_I5
11	Light barrier red	I6	DI3.4	%I3.4	IX_SLD_LightBarrierRed_I6
12	Light barrier blue	I7	DI3.5	%I3.5	IX_SLD_LightBarrierBlue_I7
17	Motor conveyor belt	Q1	D05.0	%Q5.0	QX_SLD_M1_ConveyorBelt_Q1
18	Compressor	Q2	D05.1	%Q5.1	QX_SLD_Compressor_Q2
20	First ejection valve (white)	Q3	D05.2	%Q5.2	QX_SLD_ValveFirstEjectorWhite_Q3
21	Second ejection valve (red)	Q4	D05.3	%Q5.3	QX_SLD_ValveSecondEjectorRed_Q4
22	Third ejection valve (blue)	Q5	D05.4	%Q5.4	QX_SLD_ValveThirdEjectorBlue_Q5

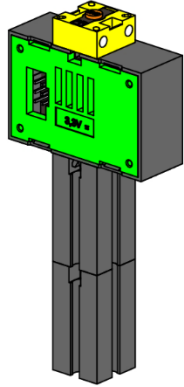
Wiring model

Clamp	Pin header ST1		Ribbon cable	Sensors + actuators Model
5	Pulse button	1		I1
2	24V (sensor)	2		
6	Light barrier input	3		I2
2	24V (sensor)	4		
7	Light barrier after color sensor	5		I3
2	24V (sensor)	6		
3,4	GND	7		Q2 (compressor)
18	Compressor	8		
3,4	GND	9		Q1(Conveyor belt)
17	Conveyor belt	10		
3,4	GND	11		Color sensor (A4)
2	9V (generated from 24V)	12		
9	Color sensor (0-10V)	13		
	not used	14		Light barrier lamp
3,4	GND	15		
2	24V (sensor)	16		Light barrier lamp
3,4	GND	17		
2	24V (sensor)	18		
	not used	19		
	not used	20		
Pin header ST2				
	not used	1		
	not used	2		
10	Light barrier white	3		I5
2	24V (sensor)	4		
12	Light barrier blue	5		I7
2	24V (sensor)	6		
11	Light barrier red	7		I6
2	24V (sensor)	8		
3,4	GND	9		Light barrier lamp
2	24V (sensor)	10		
3,4	GND	11		Light barrier lamp
2	24V (sensor)	12		
3,4	GND	13		Light barrier lamp
2	24V (sensor)	14		
3,4	Terminal V1			Q3 (first ejection valve, white)
20				
3,4	Terminal V2			Q4 (second ejection valve, red)
21				
3,4	Terminal V3			Q5 (third ejection valve, blue)
22				

red = power supply

Occupancy plan for sensor station with surveillance camera (SSC)





Environmental sensor



photoresistor

The NFC reader is connected to the TXT 4.0 controller via the I²C interface.
The mounted surveillance camera is connected to the TXT 4.0 Controller via a USB interface.
The data from the environmental sensor and photoresistor are also read in by the TXT 4.0 controller.

TXT 4.0 Controller (GatewayPLC)



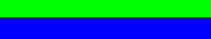
Terminal no. (ST1)	Function	Designation	PLC terminal	E- / A-address S7-1500	Variable name S7-1500
1	Power supply (+) Actuators	24V DC			
2	Power supply (+) Sensors	24V DC			
3	Power supply (-)	0V			
4	Power supply (-)	0V			
5	Reference switch 1	I1	DI4.0	%I4.0	IX_SSC_RefSwitchVerticalAxis_I1
6	Reference switch 2	I2	DI4.1	%I4.1	IX_SSC_RefSwitchHorizontalAxis_I2
7	Light barrier retrieval	I3	DI4.2	%I4.2	IX_SSC_LightBarrierStorage_I3
8	Light barrier storage	I4	DI4.3	%I4.3	IX_SSC_LightBarrierOutsourcing_I4
9	Color sensor	A1 Analog 0-10VDC	AI1.1	%IW9	IW_SSC_ColorSensor_A1
11	Encoder vertical pulse 1	B1	DI5.3	%I5.3	IX_SSC_EncoderVerticalAxisImp1_B1
12	Encoder vertical pulse 2	B2	DI5.7	%I5.7	IX_SSC_EncoderVerticalAxisImp2_B2
13	Encoder horizontal pulse 1	B3	DI6.3	%I6.3	IX_SSC_EncoderHorizontalAxisImp1_B3
14	Encoder horizontal pulse 2	B4	DI6.7	%I6.7	IX_SSC_EncoderHorizontalAxisImp2_B4
19	Motor vertical high	Q1 (M1)	DO6.0	%Q6.0	QX_SSC_M1_VeriticalAxisUp_Q1
20	Motor down vertically	Q2 (M1)	DO6.1	%Q6.1	QX_SSC_M1_VeriticalAxisDown_Q2
21	Turn motor counterclockwise	Q4 (M2)	DO6.2	%Q6.2	QX_SSC_M2_HorizontalAxisCounter clockwise_Q4
22	Turn motor clockwise	Q3 (M2)	DO6.3	%Q6.3	QX_SSC_M2_HorizontalAxisClockwise_Q3
23	LED green	Q5	DO6.4	%Q6.4	QX_SSC_LED_Green_Q5
24	LED yellow	Q6	DO6.5	%Q6.5	QX_SSC_LED_Yellow_Q6
25	LED red	Q7	DO6.6	%Q6.6	QX_SSC_LED_Red_Q7
26	LED red Online status	Q8	DO6.7	%Q6.7	QX_SSC_LED_Red_Online_Q8
27	PWM vertical	PWM (M1)	DO9.2	%QW27	QW_SSC_PWM_Veritical_M1
28	PWM cantilever	PWM (M2)	DO9.3	%QW29	QW_SSC_PWM_Horizontal_M2

Wiring model

Pin header ST1

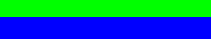
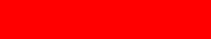
Clamp

5	Reference camera vertical	1
2	24V (sensor)	2
19	Camera up	3
20	Camera down	4
3,4	GND	5
2	24V (sensor)	6
11	A	7
12	B	8
6	Reference camera horizontal	9
2	24V (sensor)	10

Ribbon cable	Sensors/actuators on the model
	I1
	Q1/Q2 (M1)
	
	Encoder vertical Power supply Signal A Signal B
	
	
	
	I2
	

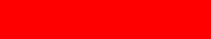
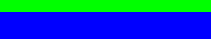
Pin header ST2

21	Camera left	1
22	Camera right	2
3,4	GND	3
2	24V (sensor)	4
13	A	5
14	B	6
3,4	GND	7
23	LED green	8
3,4	GND	9
24	LED yellow	10
3,4	GND	11
25	LED red	12
3,4	GND	13
26	LED red (camera)	14

	Q3/Q4(M2)
	
	Encoder horizontal Power supply A Signal Signal B
	
	
	
	Q5 LED green
	Q6 LED yellow
	
	Q7 LED red
	
	Q8 LED red (camera)
	

Pin header ST3

3,4	GND	1
2	9V (generated from 24V sensor)	2
7	Light barrier retrieval	3
2	24V (sensor)	4
3,4	GND	5
2	24V (sensor)	6
8	Light barrier storage	7
2	24V (sensor)	8
9	Color sensor	9
	not used	10

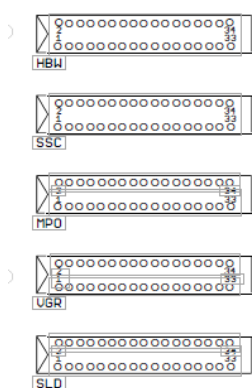
	Color sensor power supply
	
	I3
	Lamps for light barrier
	
	
	
	I4
	I5
	-

Assignment diagrams PLC connection board (560840 and 560841)

In this chapter you will find the wiring diagrams for the circuit board.

560841 Learning Factory 4.0 24V w. PLC connection board and
560840 Learning Factory 4.0 24V compl. w.
PLC S7-1500

On the model side, the distributor board is connected to the individual stations in the model via 5 ribbon cables. This is already included in the delivery of variant 560841 or 560840.



Wiring diagram distributor board on the model:

The PLC connection board is already wired in variant 560840. With the 560841 variant, the PLC must be connected to the distributor board via cables. These are divided into groups, e.g. DO1+2a, ..., A11b.

The cover can be removed from below by loosening the four Phillips screws. When the bottom part is removed, the plugs can be used to connect the inputs and outputs to the PLC modules.

Assignment board PLC connection board:

