

SkillsUSA 2015 Contest Projects

Mechatronics

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

ELECTRO- PNEUMATICS

MAX. TIME: 90
MINUTES

MECHANICAL SYSTEMS

MAX. TIME: 90
MINUTES

MECLAB STATION

**MAX. TIME: 30
MINUTES**

MOTOR CONTROL

**MAX. TIME: 30
MINUTES**

ORAL EXAM/INTERVIEW

MAX. TIME: 15
MINUTES

SIEMENS PLC

**MAX. TIME: 60
MINUTES**

TROUBLESHOOTING

MAX. TIME: 15
MINUTES

Mechatronics

[Download the CT files](#)

Team # _____

SKILLSUSA 2015

Mechatronics PLR Exercise - 1.0 hours

SIEMENS LOGO!

Objective 1: Programmable Logic Relay (PLR) Siemens LOGO!

Modify and test a program using Function Blocks which controls a simple traffic light. The traffic light is initiated with a single switch which then cycles the lights, RED – YELLOW – GREEN with a 5 second timer for each light color. Build a program that adds “Walk” and “Don’t Walk” elements to the program with flashing function. Add a counter to the program to count cycles

Objective 2: Message display

Bonus lab to complete an alarm message to display on the LOGO! display window when the cycle reaches a 5 count.

PLR Tasks	Points	Score
1. Build the logic circuit	20	
2. Set parameters of pulse generator blocks	10	
3. Test using the software simulator	5	
4. Add the Counter block	10	
5. Able to explain the final logic / Neatness of program	10	
6. Download, run and monitor the program	5	
7. Follows instructions	10	
8. Use the HELP functions for parameter definitions	10	
9. Review the explain the existing PLC program w/ judge	10	
10. Bonus task 1 – add the message display	10	
TOTAL	100	

Contestant Number _____, _____ Sec

**SkillsUSA
Mechatronics Competition**

**Construction Phase
Non-PLC**

You have been assigned a Stacking Module and a computer. At the station, you will start with manual control of one output. You will then add a second output. Then add an input to control the output.

You will be evaluated on the neatness of the station (wiring, tubing) and the performance of the task. You will also need to explain your logic and pneumatic schematic to the judge. A judge must be present to record your times for each task.

Time END: _____

Time START: _____

Time Elapsed: _____

STACK:

1. Using the given file (SkillsUSA Exercise 1), finish the schematic so that pressing the virtual button causes the virtual lamp to light.

Time Start: _____ Time End: _____ Elapsed Time: _____ (25)

2. Modify the circuit (SkillsUSA Exercise 2), so that pressing a virtual button causes the virtual cylinder to extend. Releasing the button causes the cylinder to retract.

Time Start: _____ Time End: _____ Elapsed Time: _____ (25)

3. Modify the circuit (SkillsUSA Exercise 3), so that pressing the virtual button extends the REAL single-acting cylinder. Releasing the virtual button causes the REAL cylinder to retract.

Time Start: _____ Time End: _____ Elapsed Time: _____ (50)

Contestant Number _____, _____ Sec

4. Modify the circuit (SkillsUSA Exercise 4), so that pressing one virtual button causes the REAL horizontal cylinder to extend. Pressing the other virtual button causes the REAL horizontal cylinder to retract.

Time Start: _____ Time End: _____ Elapsed Time: _____ (50)

5. Modify the circuit (SkillsUSA Exercise 5), so that pressing the virtual button will extend the REAL horizontal cylinder. A sensor at the end of the horizontal cylinder causes the horizontal cylinder to retract automatically.

Time Start: _____ Time End: _____ Elapsed Time: _____ (50)

6. Modify the circuit (SkillsUSA Exercise 6) so that pressing the virtual button will extend the REAL horizontal cylinder. When the cylinder is fully extended, it should retract and the REAL vertical cylinder will extend and stay extended for 3 seconds.

Your completion task is to place three caps into the stack. Place one cup onto the holder and press the virtual button. A cap should be ejected onto the cup and pressed into place.

Time Start: _____ Time End: _____ Elapsed Time: _____ (100)

Your scores are based on:

Proper operation of unit as described above. (Time will not be stopped until it has run properly)

Appearance (tubing and wiring neatly bundled; tubing and wiring bundled separately, blue tubing used to extend cylinders, black tubing to retract)

Diagram # 1

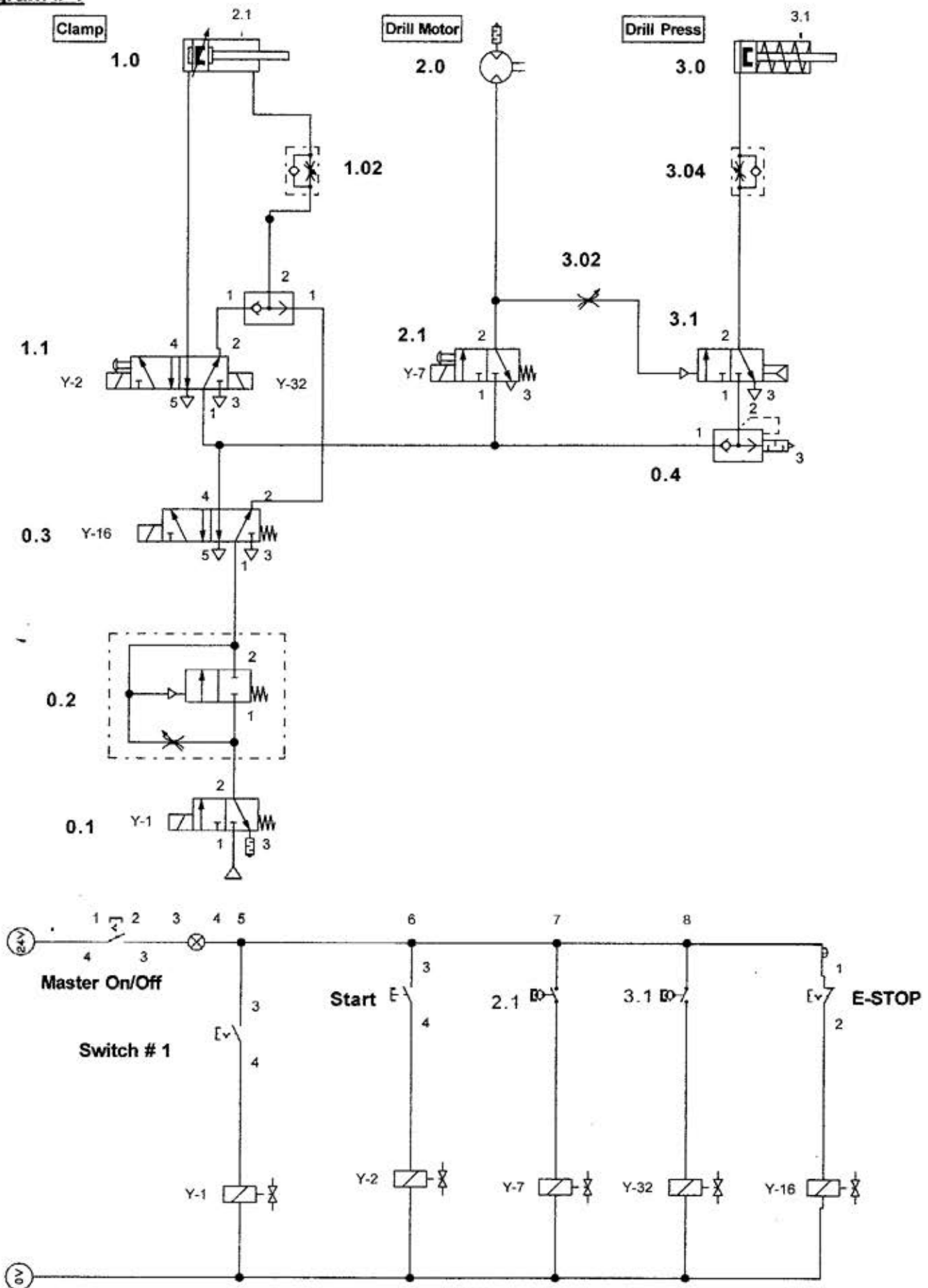


Diagram # 2

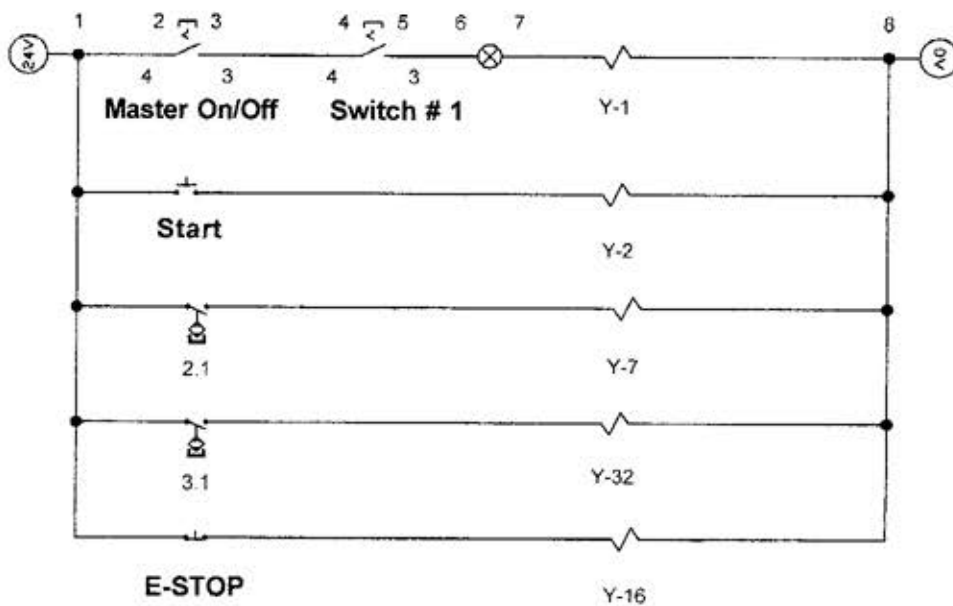
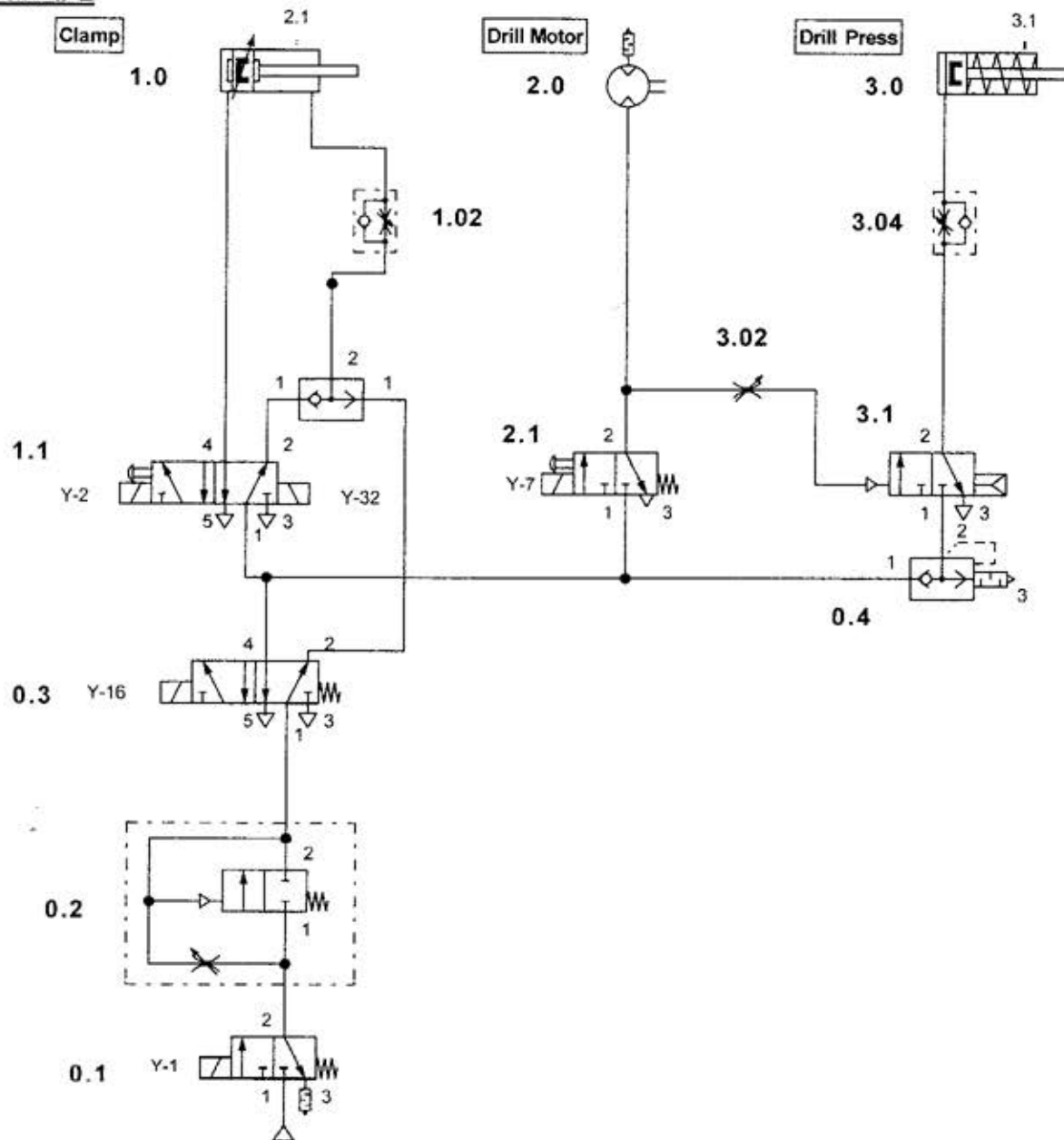


Diagram # 3

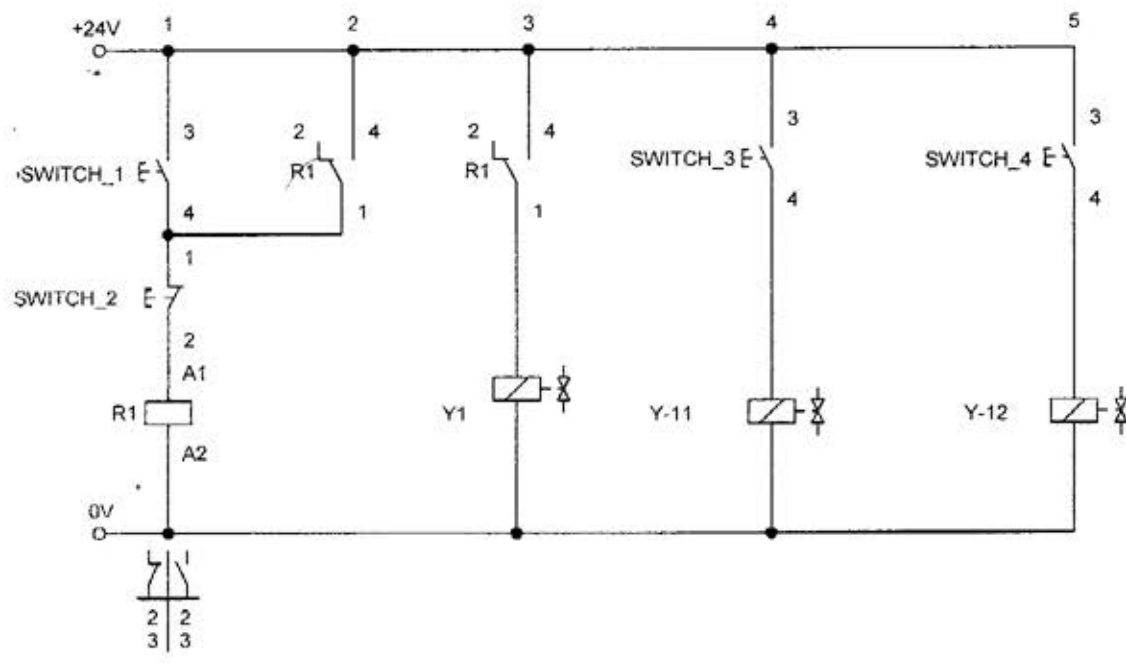
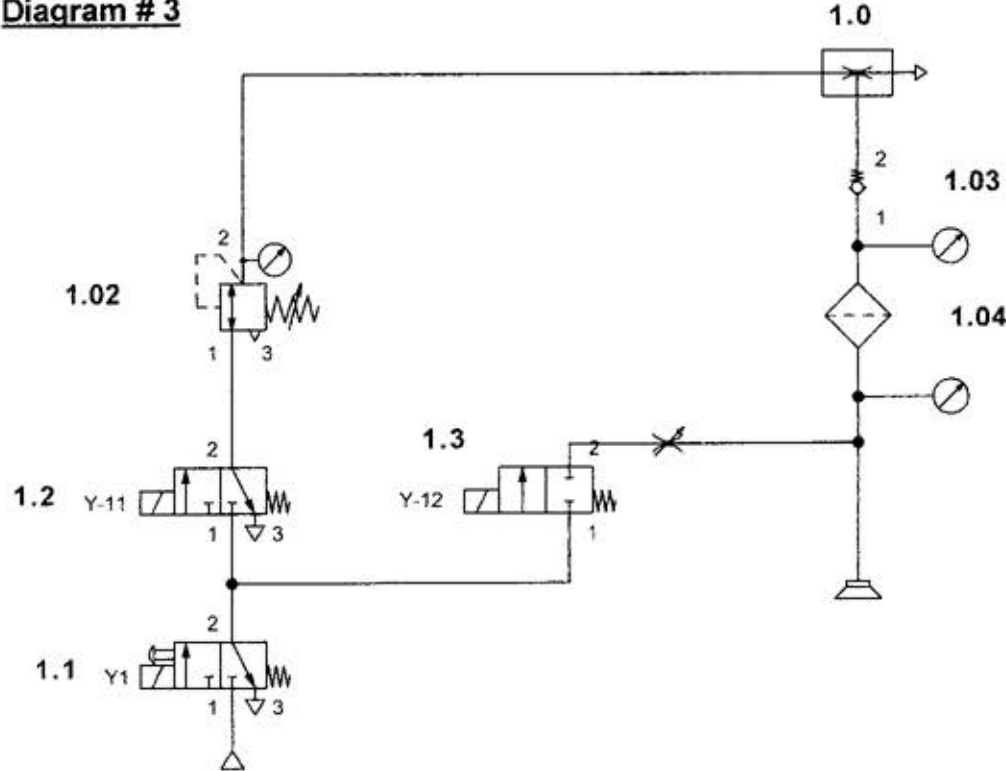


Diagram # 4

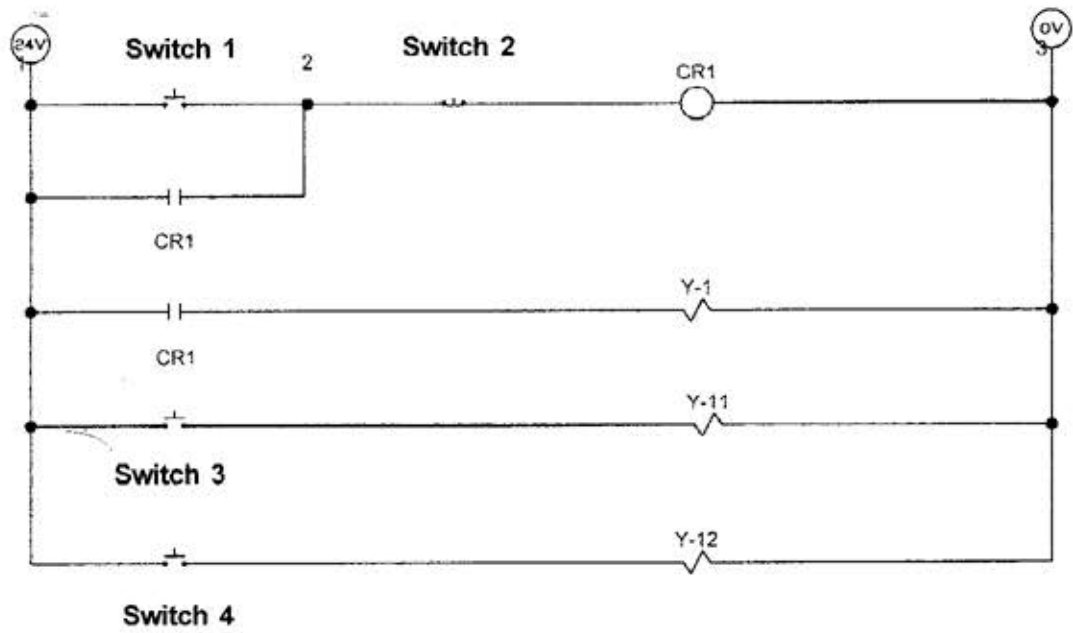
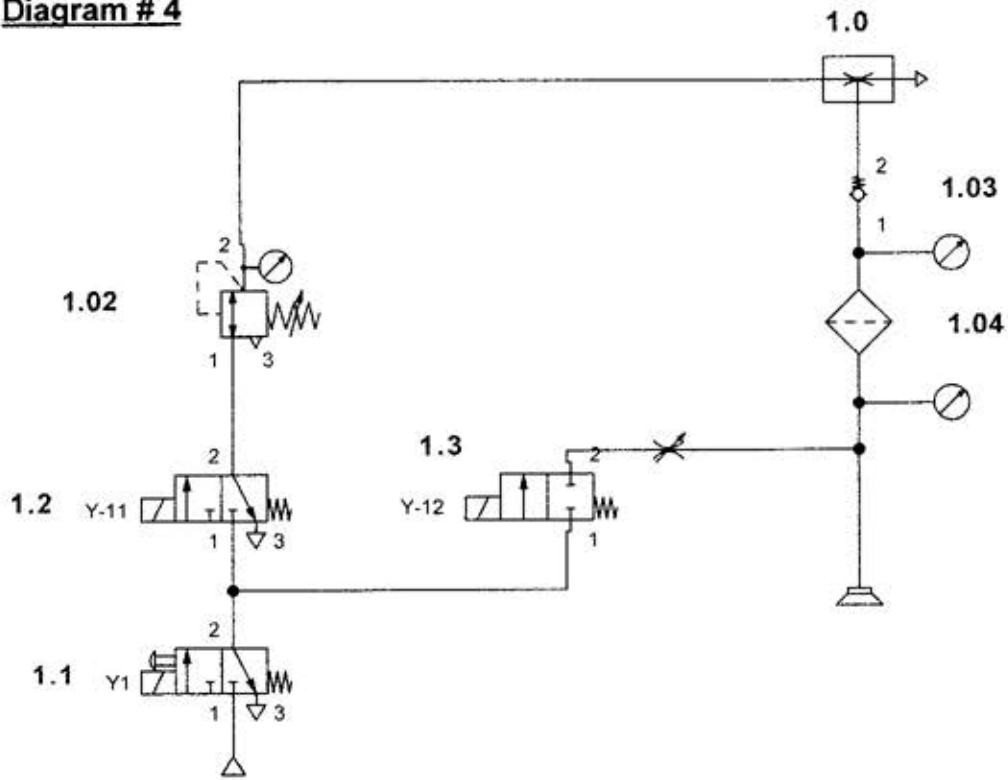


Diagram # 5

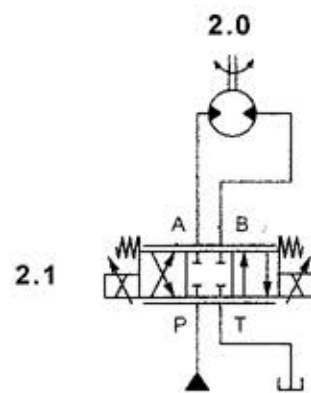
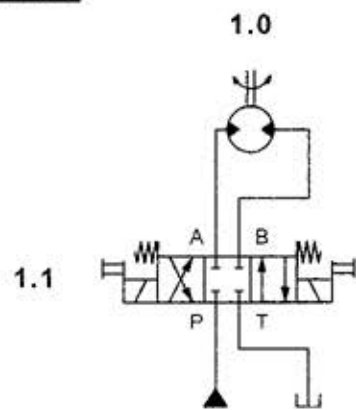
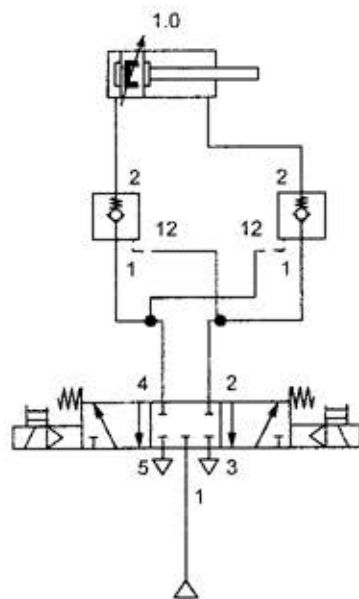
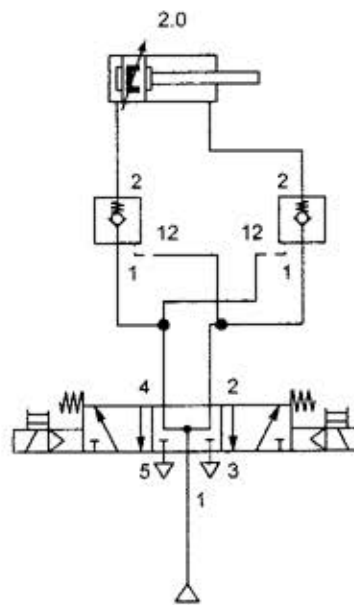


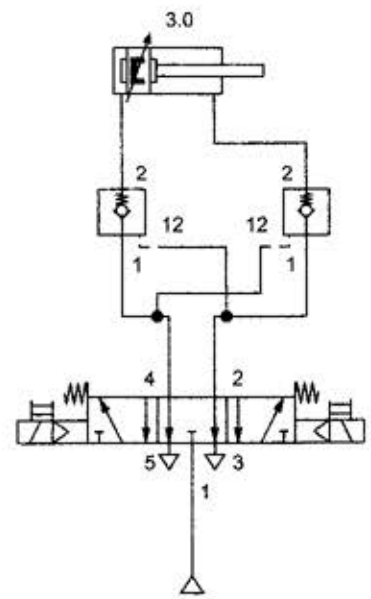
Diagram # 6



Situation # 1



Situation # 2



Situation # 3

Task #2: Integrating a Pick and Place Station to the Distribution Station for workpiece transfer

Points	500
t_{\min}	fastest team
t_{\max}	180 min

Situation

Your task is to add a partially assembled pick and place station so that a workpiece from the distribution station will be placed on the stage and the pick and place station will move the part from one stage to the other.

The task is fulfilled when the station is completely assembled and commissioned according to the professional practice agreement. The system has to fulfil the specifications according to the evaluation sheet.

Collisions are not allowed and will be heavily penalized.

Task Description

Three pieces are placed in the stack magazine of the Distribution station. The station will place the parts onto the stage of the pick and place station. The pick and place station will move each individual part from the outer stage to the inner stage.

The operator will remove the part from the second stage.

The distribution station must wait for the pick and place station to finish processing a part before another part can be introduced.

When the stack is empty, Q1 on the front of the panel must come on.

PLC program:

Initial situation:

A number (3) of workpieces are in the stack.

Max time: 150 min.

Team:

Description	Evaluation	Max. evaluation
Function will be checked by judge IDENTIFY SENSOR AND FUNCTION BELOW	achieved points (I/O must match print)	Max points 60
0		5
0		5
0		5
0		5
0		5
I		5
I		5
I		5
I		5
I		5
I		5
I		5
Total		

STOP

Have your table inspected
and initialed by a judge
before proceeding!

Make sure you have filed out
page 3 identically to this
page!

Time: _____

Judge: _____

Description	Evaluation	Max. evaluation
Function will be checked by judge	achieved points	Max points
IDENTIFY SENSOR AND FUNCTION BELOW	(I/O must match print)	60
O		5
O		5
O		5
O		5
O		5
O		5
I		5
I		5
I		5
I		5
I		5
I		5
Total		
Description	Evaluation	Max. evaluation
Function to check with plc program	achieved points	Max points
		300
Part deposited at pick and place outer platform		20
Distribution arm retracts		50
Gripper open		15
Cylinder out		15
Cylinder down		15
Gripper closes		15
Part lifted		50
Cylinder retracts in		15
Cylinder down		15
Gripper opens		15
Cylinder up		15
MPS station starts next cycle		60
Totals		

JUDGE COPY

Team: _____

Time: _____

Judge: _____

Description	Evaluation as a %-age of build completion	Max. evaluation
Professional practice		90
comments)		
All components securely mounted in correct position	30	
Professional appearance (cable guides, tie downs)	30	
Correct tubing: (blue to extend cylinders, black to retract)	30	
Collisions or Pinch Points: -5 each.		

Description	Evaluation	Max. eval.
Time evaluation		
Time points are only possible when all points for function (with SimuBox and with plc) and minimum 4 points for professional practice are achieved!		
act. time	____. ____min.	Max time: 180 min.
Points for time = (max. time – act.time)x max.points /(max.time – min.time) = (180.0 -) x 10 points / (180.0 -)	____. ____ points	Max 50 points

Total evaluation:

Description	evaluation	Max. eval.
Points for Function with I/O box	_____	60
Points for Function to check with plc board	_____	300
Points for professional practice	_____	90
Points for time evaluation	_____	50
Total points	_____	500

Expert evaluation team (names, signs):

Task #1: Assembly, commissioning and programming of Distribution Station

Points	400
t_{\min}	fastest team
t_{\max}	180 min

Situation

Your task is to assemble, commission and program the Distribution station.

The task is fulfilled when the station is completely assembled and commissioned according to the professional practice agreement. The system has to fulfill the specifications according to the evaluation sheet.

Task Description

Different workpieces (red, silver or black) are manually put into the stack magazine.

The parts are ejected from the magazine, picked up by the swing arm and then deposited to the right of the station.

The cycle continues until the stack is empty, at which point operation stops and the LED in the start button and the lamp Q1 are illuminated.

It is necessary to reload the stack magazine and press the start button again before the machine starts up and cycle resumes.

PLC program:

Initial situation:

No workpieces are on the station

On power up, LED in reset button is “on”

Press reset to reset machine. Part ejector cylinder is extended, rotary arm is to the right and vacuum is off.

If successful, LED in reset button goes “off” and green start button is lit up.

Place 3 parts in magazine

STOP

Have your table inspected
and initialed by a judge before
proceeding!

Make sure you have filled out
page 3 identically to this
page!

Time: _____

Judge: _____

Description	Evaluation	Max. evaluation
Function to check with SimuBox IDENTIFY SENSOR AND FUNCTION BELOW	achieved points (I/O MUST match print)	Max points 160
00		5
01		5
02		5
03		5
04		5
05		5
06		5
07		5
08		5
09		5
010		5
011		5
012		5
013		5
014		5
015		5
I0		5
I1		5
I2		5
I3		5
I4		5
I5		5
I6		5
I7		5
I8		5
I9		5
I10		5
I11		5
I12		5
I13		5
I14		5
I15		5
Total		

Description	Evaluation	Max. evaluation
Function to check with SimuBox IDENTIFY SENSOR AND FUNCTION BELOW	achieved points (I/O MUST match print)	Max points 160
00		5
01		5
02		5
03		5
04		5
05		5
06		5
07		5
08		5
09		5
010		5
011		5
012		5
013		5
014		5
015		5
10		5
11		5
12		5
13		5
14		5
15		5
16		5
17		5
18		5
19		5
110		5
111		5
112		5
113		5
114		5
115		5
Total		

JUDGE
COPY

Team: ____

Time: _____

Judge: _____

Description	Evaluation	Max. evaluation
Function to check with plc program	achieved points	Max points 100
Preparation: Connect PLC to the I/O-terminal of the station, prepare and start the PLC		
(remove all workpieces from the station)		
Power up: Is RESET on?		5
Part ejector cylinder extended		5
Rotary arm to right		5
Vacuum off		5
Green "Start LED" on		5
Place 3 parts in magazine		
Press Start		
Green "Start LED" off		5
Cycle Begins		5
Check to see if part is available?		10
If no, Turn on lamp Q1		5
If no, Turn on LED in start		5
Otherwise: part ejector cylinder retracts to eject part		10
Rotary arm to left		
Vacuum on		5
Part gripped?		5
Part ejector cylinder extends		
Swing arm to right		5
Vacuum off		10
No air flow (vacuum OR blow-off) at suction cup		10
RETURN TO "Cycle Begins"		
Total (100)		

Description	Evaluation	Max. evaluation
Professional practice	As a %-age of build completion	100
(comments)		
All components securely mounted in correct position	20	
Professional appearance (cable guides, tie downs)	50	
Correct tubing: (blue to extend cylinders, black to retract)	30	
Collisions or Pinch Points: -5 each.		

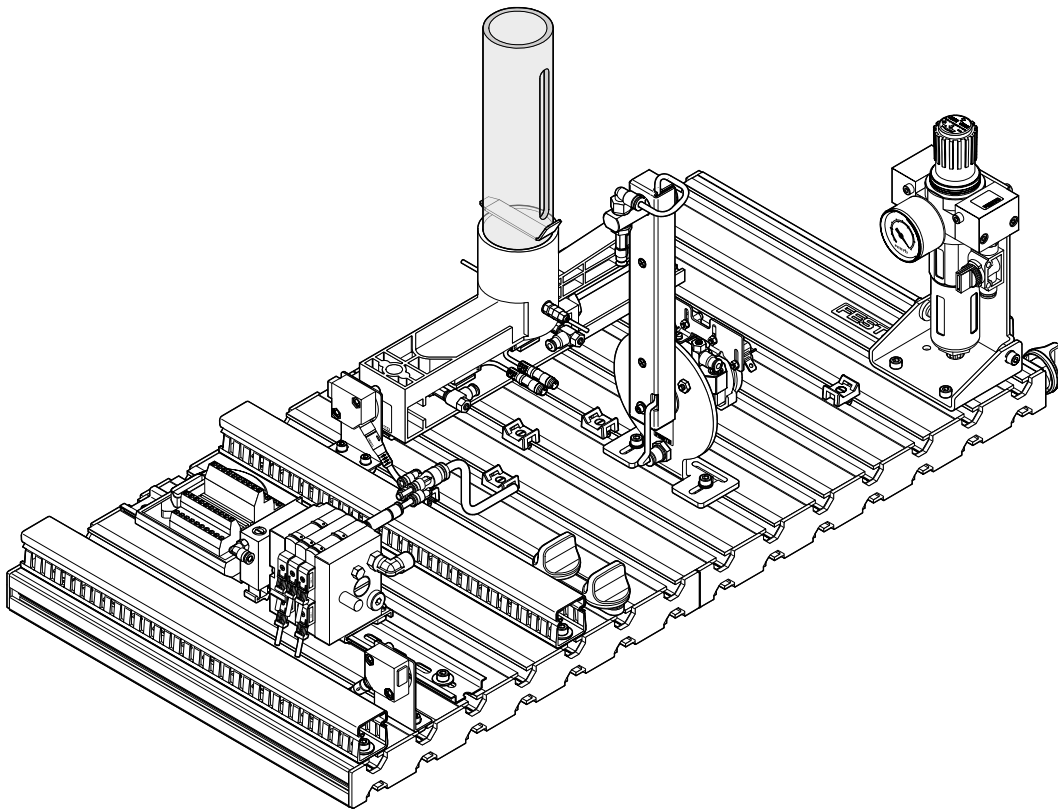
Description	Evaluation	Max. eval.
Time evaluation		40
Time points are only possible when all points for function (with SimuBox and with PLC) and minimum 4 points for professional practice are achieved!		
act. Time	____. ____min.	Max time: 180 min.
Points for time = (max. time – act.time)x max.points / (max.time – min.time) = (180.0 -) x 10 points / (180.0 -)	____. ____ points	Max 40 points

Total evaluation:

Description	evaluation	Max. eval.
Points for Function with I/O box	_____	160
Points for Function to check with PLC board	_____	100
Points for professional practice	_____	100
Points for time evaluation	_____	40
Total points	_____	400

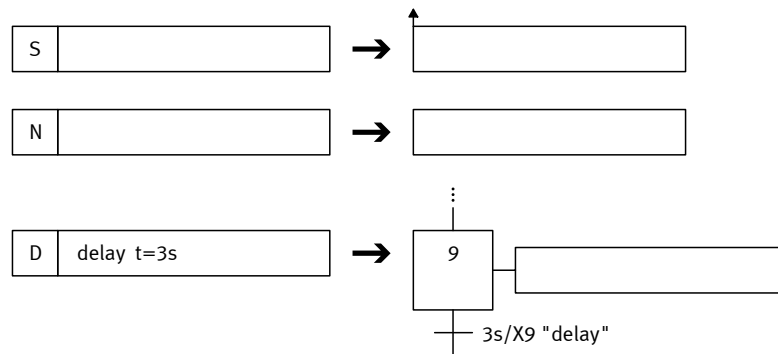
FESTO

Distribution station Function chart



Function chart according to DIN EN 60848

The following figure displays a comparison of symbols of DIN 40719-6 (1992-02) and symbols of DIN EN 60848 (2002-12).



Left: DIN 40719-6; right: DIN EN 60848

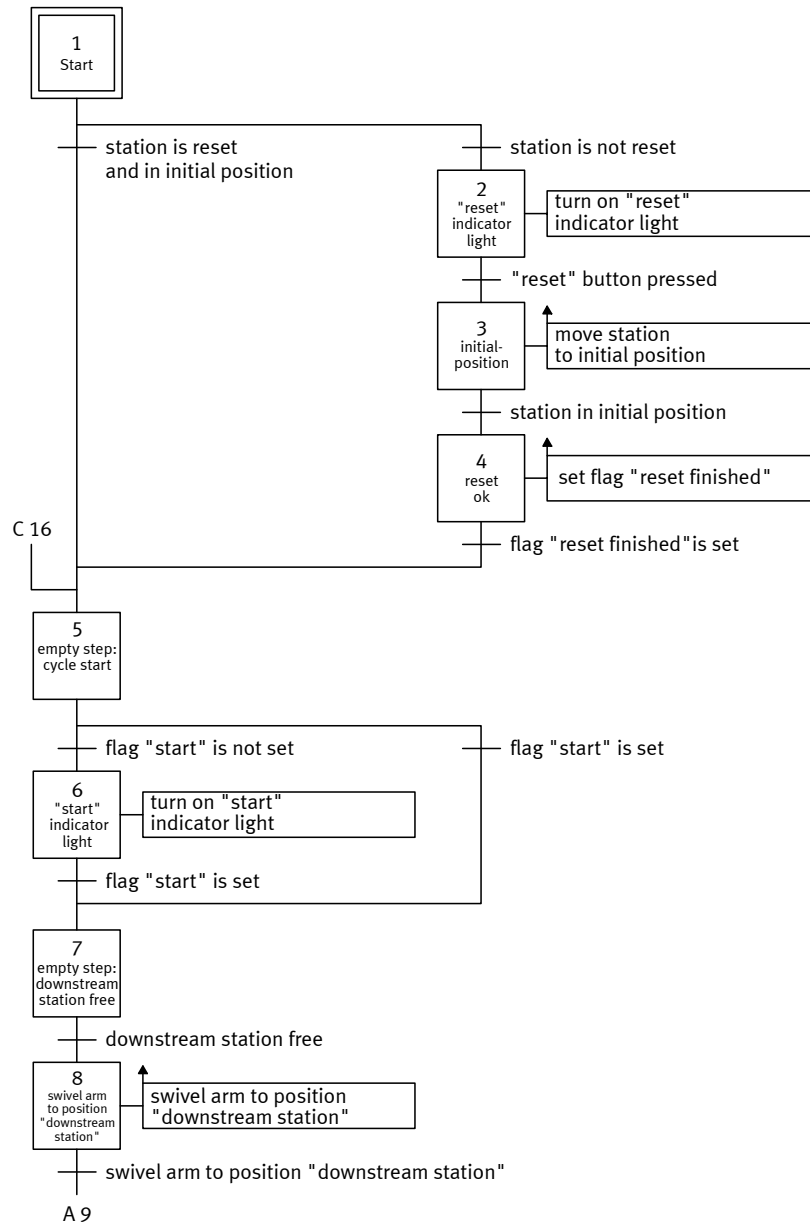
Note

The standard DIN 40719-6 is valid until 2005-04.

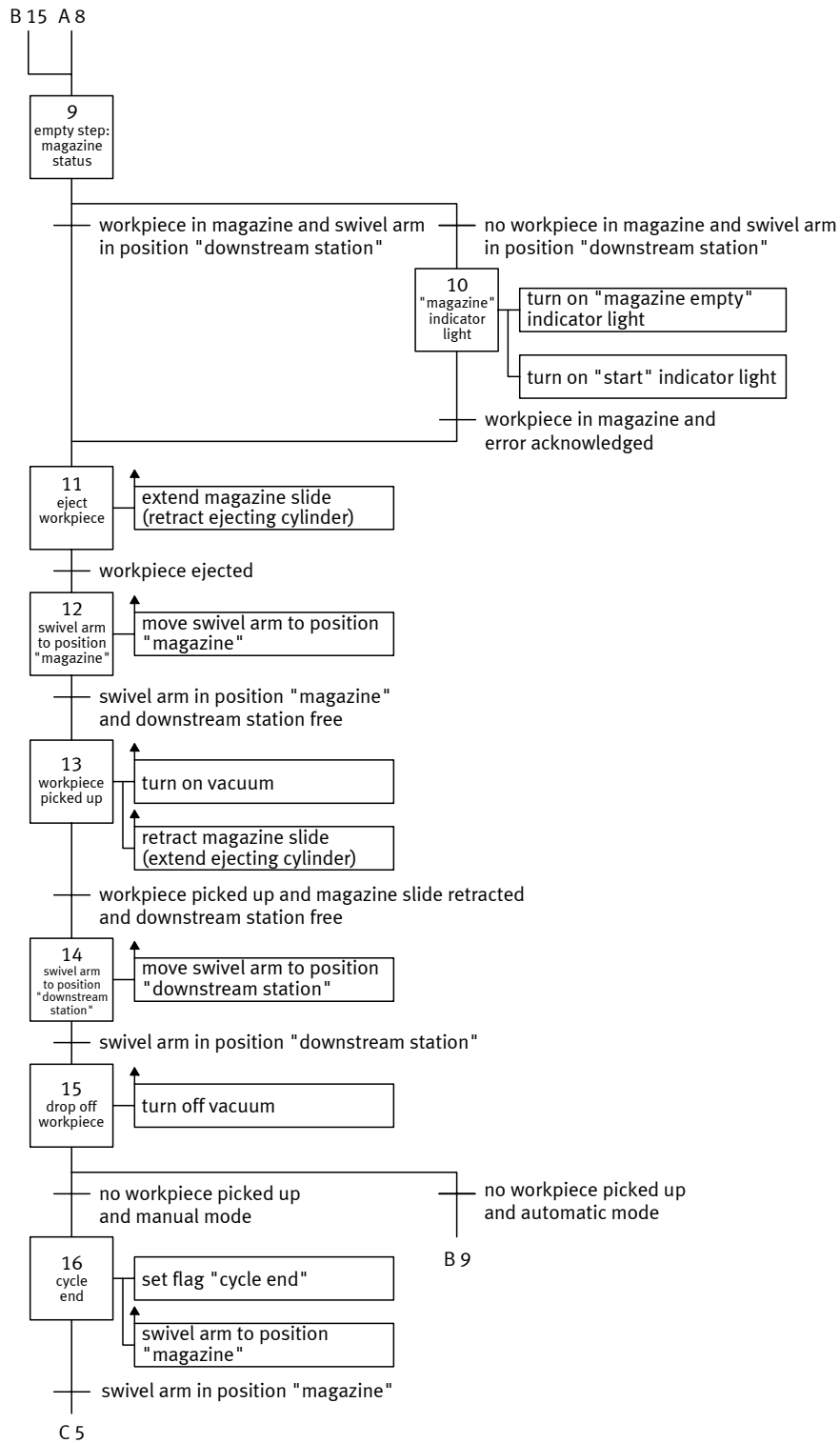
DIN 40719-6 1992-02	Diagrams, charts, tables; rules for function charts; (IEC 848 modified)
DIN EN 60848 2002-12	GRAFCET specification language for sequential function charts; (IEC 60848)

Function chart Distribution station

sequential function chart according to DIN EN 60848 (IEC 60848) for the Distribution station
1-bit-link

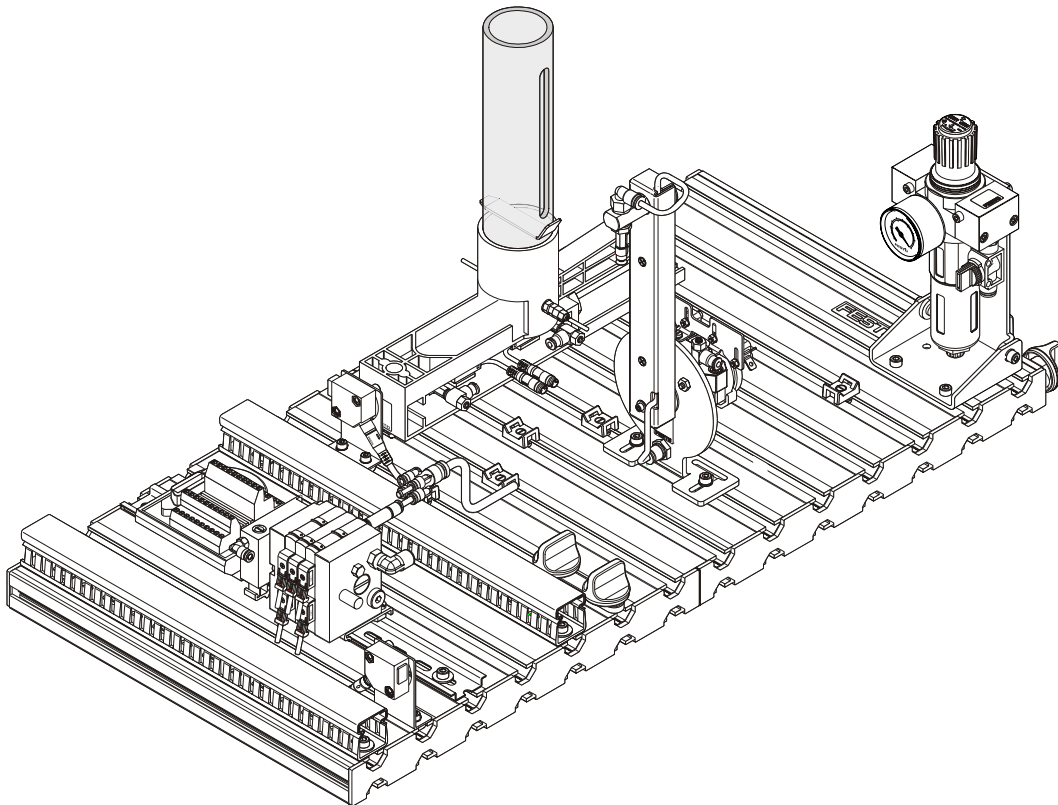


Function chart Distribution station



FESTO

Distribution station Assembly Instructions



Intended use

This station has been developed and produced exclusively for vocational and further training in the field of automation and communication. The training authority and/or the instructors are to ensure that trainees observe the safety instructions described in the manual provided.

Festo Didactic herewith rules out all liability for damage or injury to trainees, the training authority or other third parties which may occur during the use/operation of this equipment other than purely in a training situation, unless it can be proved that Festo Didactic has caused such damage or injury through malicious intent or gross negligence.

Description	MONT.ANLEIT
Designation:	D:MP-MA-S-VERT-1-GB
Status:	11/2002
Author:	Frank Ebel
Graphics:	Doris Schwarzenberger, Albert Sigel
Layout:	11/2002

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1. Notes on safety

In the interests of your own safety, please observe the following safety instructions:



General

- Trainees must only work on a station under the supervision of an instructor.
- Observe the data in the data sheets for the individual components, particularly all safety instructions!

Electrical

- Electrical connections are to be wired-up or disconnected only when the power supply is turned off!
- Use only extra-low-voltages of up to max. 24 V DC.

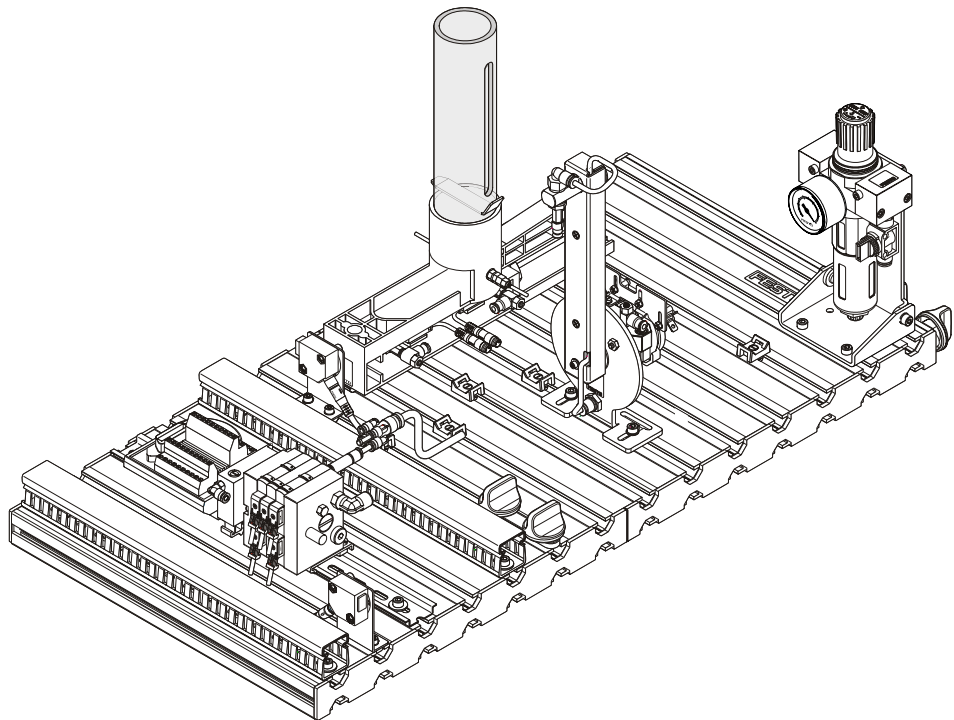
Pneumatic

- Do not exceed the maximum permissible pressure of 8 bar (800 kPa).
- Do not switch on the compressed air supply until you have established and secured all tubing connections.
- Do not disconnect air lines under pressure.
- Particular care is to be taken when switching on the compressed air supply. Cylinders may advance or retract as the compressed air is switched on.

Mechanical

- Attach all components securely on the mounting plate.
- No manual intervention is to take place unless the machine is at rest.

2. Short description



View of the Distribution station

The Distribution station is a feed device. According to VDI 3240, feed devices are defined as units which fulfill the function of bunkering, sorting and feeding of components. In addition, feed devices can facilitate the sorting of components according to various sorting characteristics (shape, weight etc. of the component).

The following are feed devices:

- Magazines with feed limiting,
- Vibratory bowl feeder,
- Inclined conveyors and
- Hoppers with sorting devices.

Workpieces handled by feed devices are

- Electroplated parts,
- Shaped parts made of plastic,
- Punched parts and
- Turned components.

Short description

The function fo the Distribution station is

- to separate out workpieces from a magazine and
- to transfer workpieces by means of a rotary drive using a suction cup.

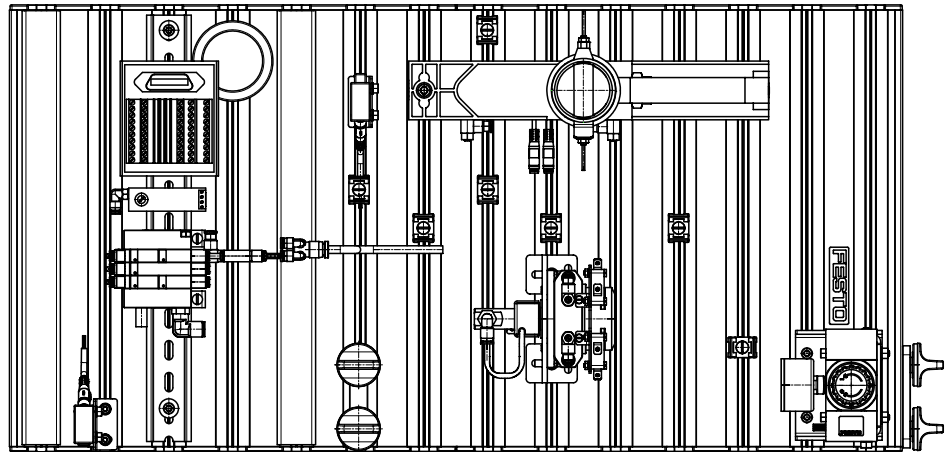
The Distribution station consists of the following:

- Stack magazine module
- Changer module
- Profile plate

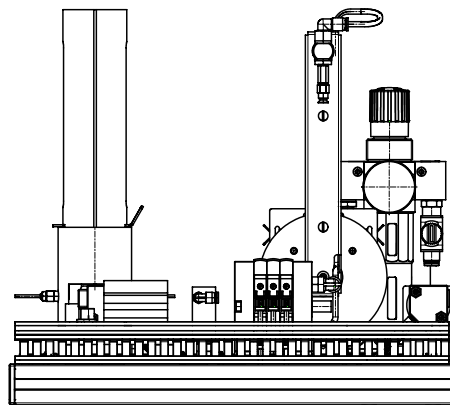
- Trolley
- Control console
- PLC board

3. Views and tools

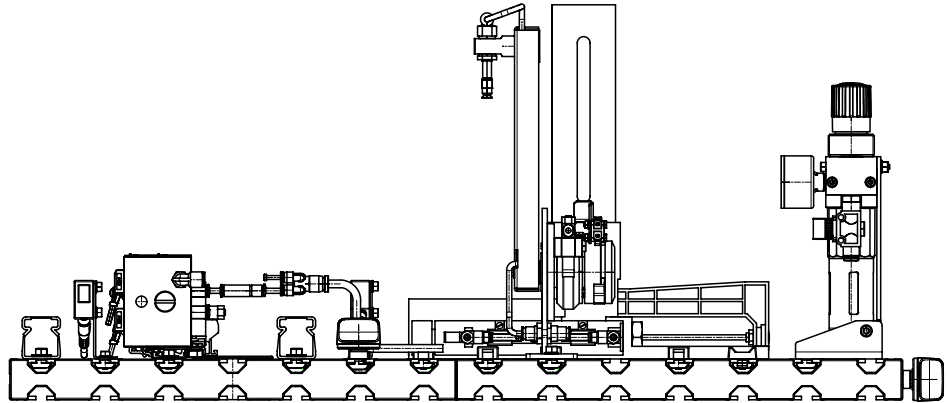
3.1 Views



Distribution station, plan view



Distribution station, r.h. side view



Distribution station, front view

3.2

Required tools

Tube spanner, 9 x 10 mm

Open-ended spanners 6 x 7, 12 x 13, 22 x 24 mm

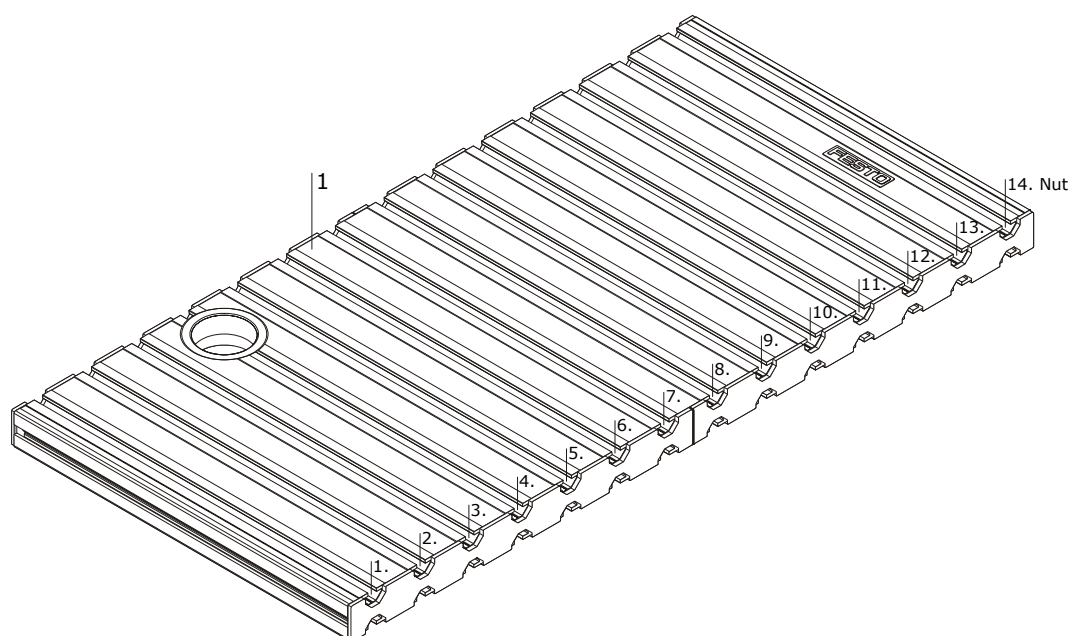
Slot-head screwdriver, 3.5 mm

Allen key, 5 mm

4. Assembling the station

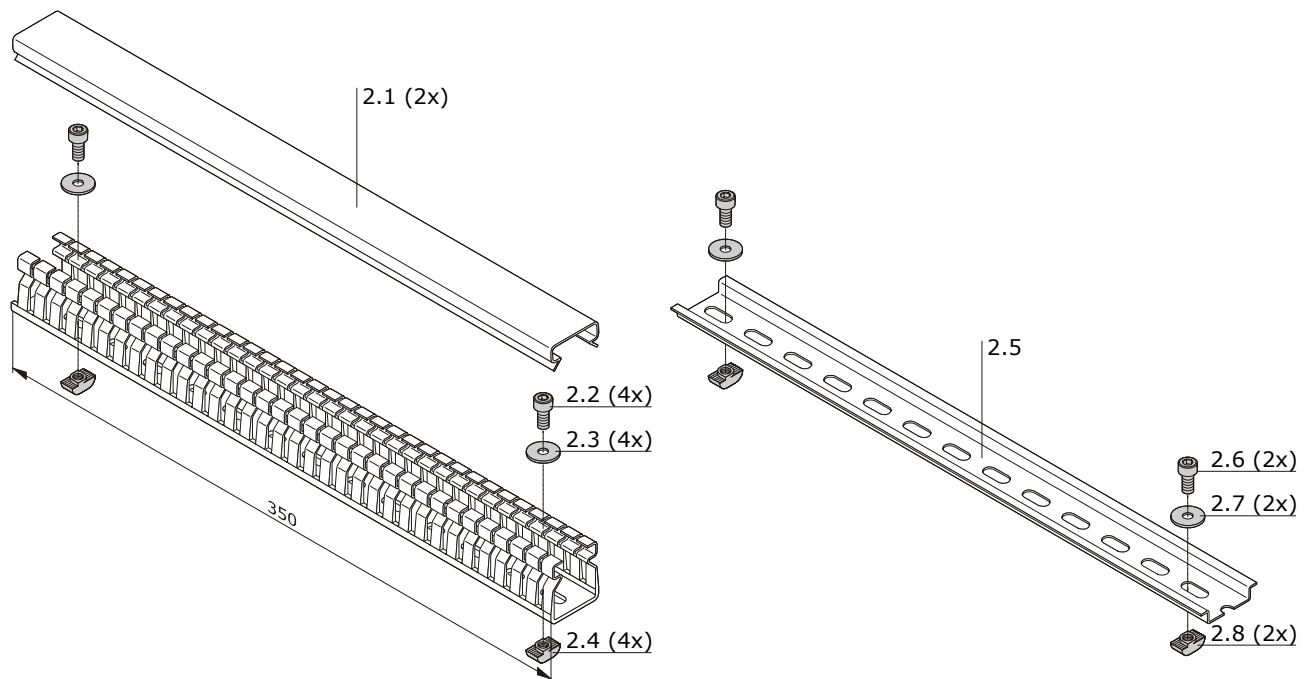
4.1

Step 1



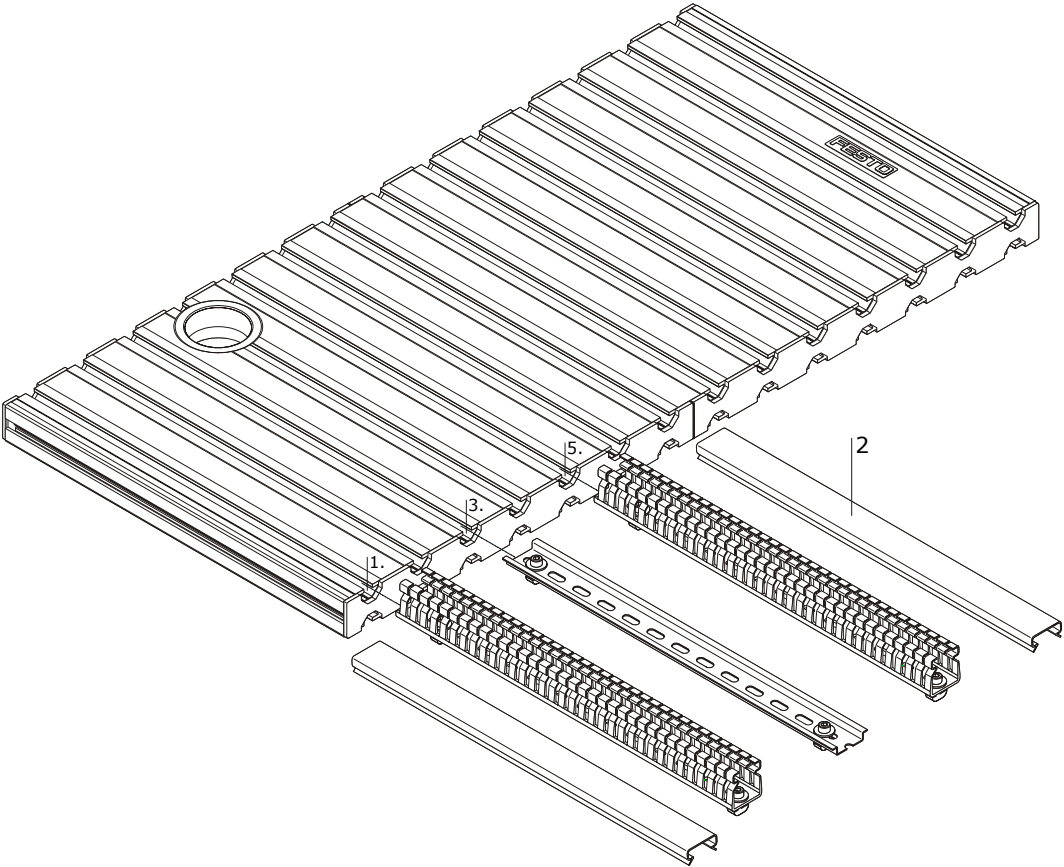
1 Profile plate

4.2 Step 2



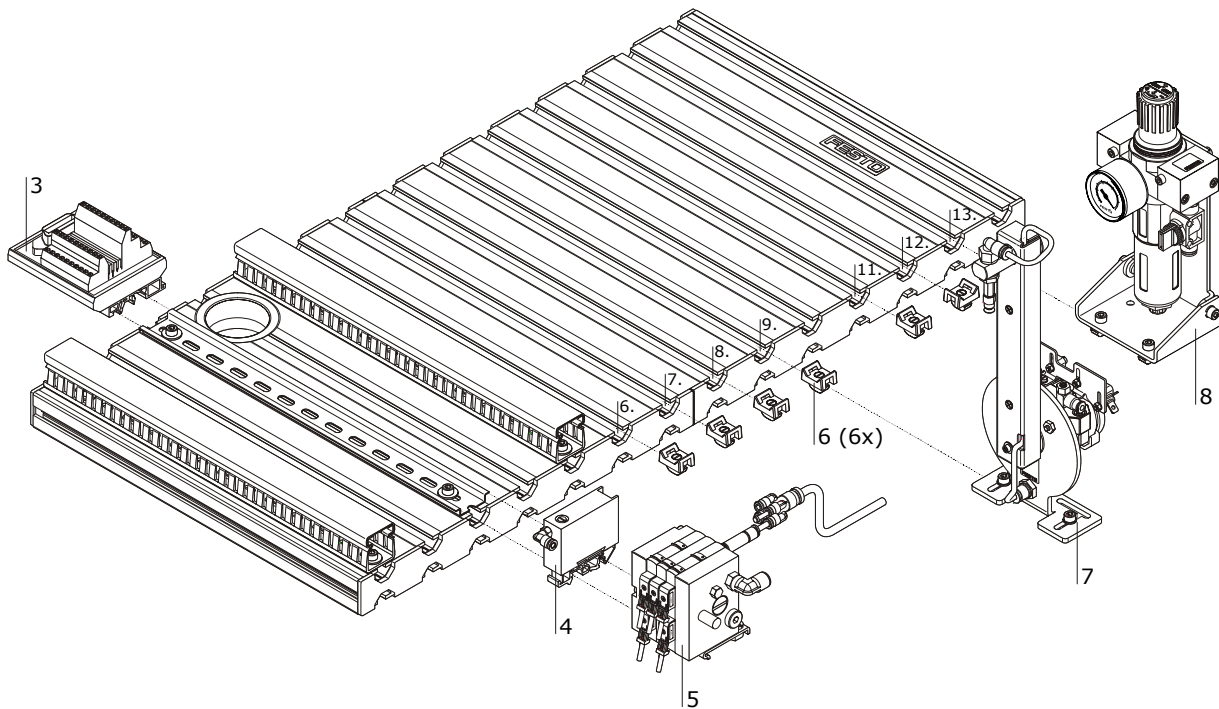
- 2.1 Cable duct
- 2.2 Socket-head screw M5 x 10
- 2.3 Washer B5.3
- 2.4 T-head nut M5-32
- 2.5 Mounting rail
- 2.6 Socket-head screw M5 x 10
- 2.7 Washer B5.3
- 2.8 T-head nut M5-32

4.3
Step 3



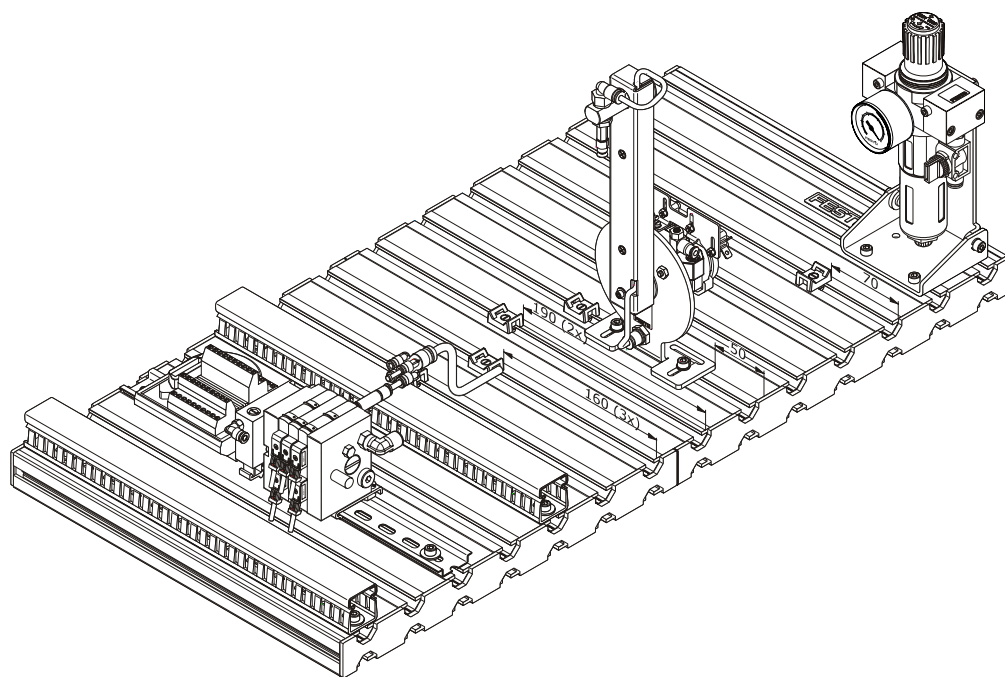
2 Mounting the electrical system

4.4
Step 4



- 3 I/O terminal
- 4 Vacuum switch
- 5 CP valve terminal
- 6 Cable clip (6x)
- 7 Changer module
- 8 Service unit

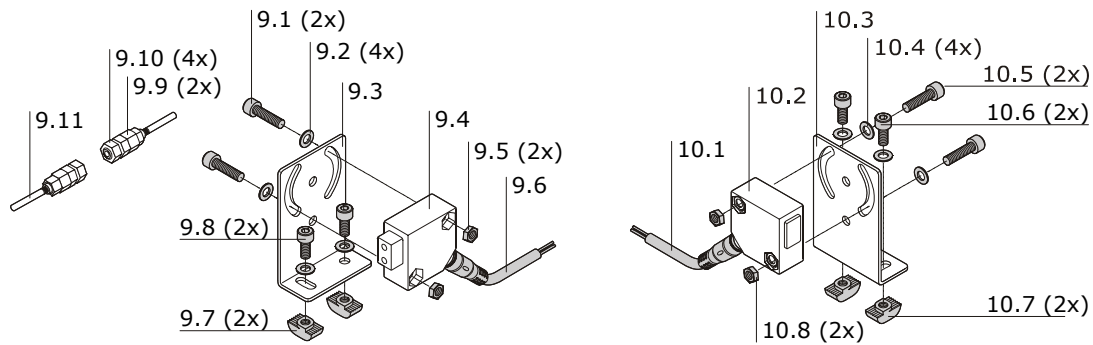
4.5
Step 5



Position of Changer module and cable clips

4.6

Step 6



9.1 Socket head screw M 4 x 16 (2x)

9.2 Washer B 4.3 (4x)

9.3 Mounting bracket

9.4 Fibre optic device

9.5 Nut M 4 (2x)

9.6 Socket connector cable

9.7 T-head nut M 4-32 (2x)

9.8 Socket head screw M 4 x 10 (2x)

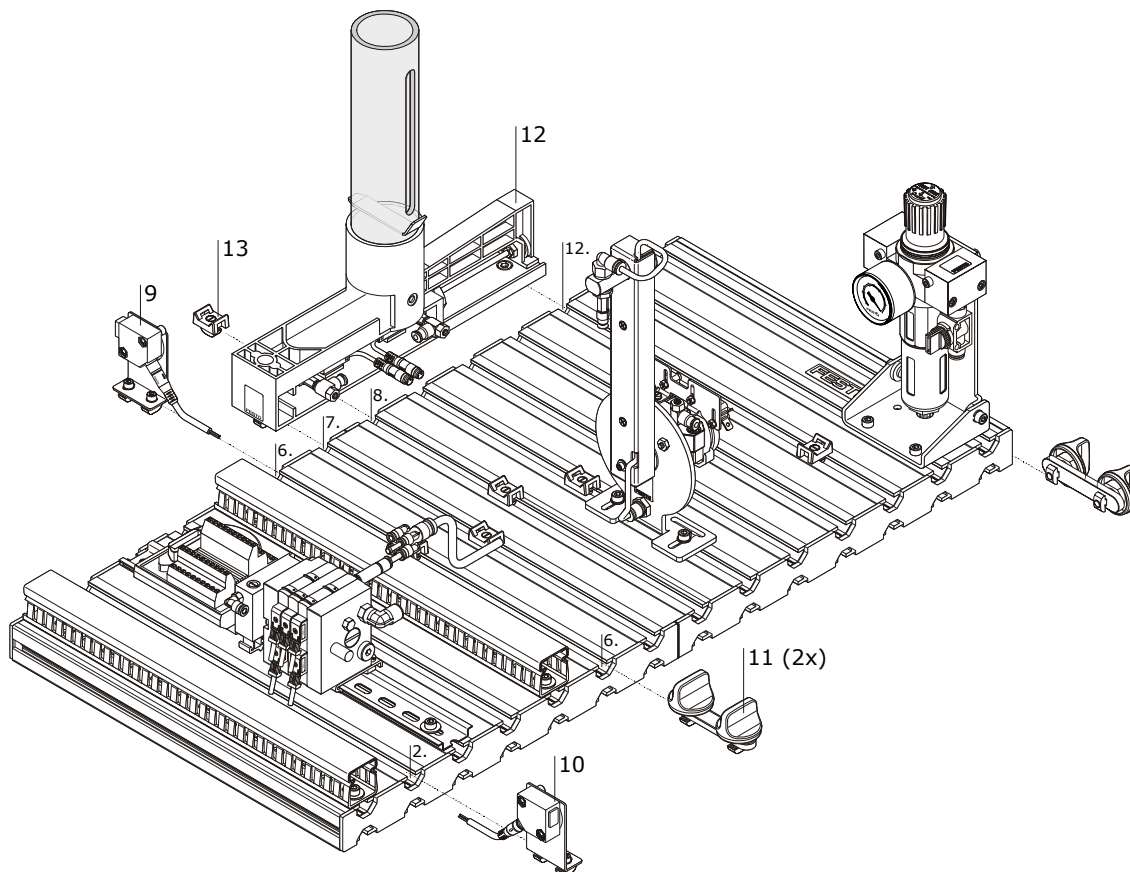
9.9 Adapter(2x)

9.10 Nut M 5 (4x)

9.11 Fibre optic cable "Light barrier"

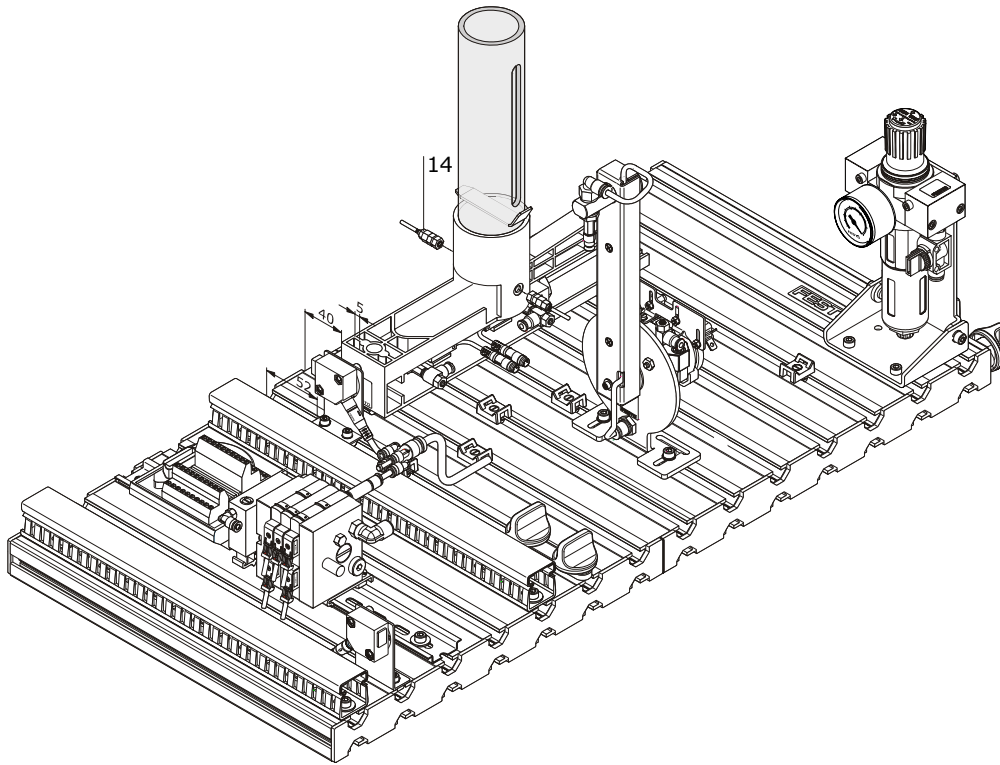
- 10.1 Socket connector cable
- 10.2 StationLink receiver
- 10.3 Mounting bracket
- 10.4 Washer B 4.3 (4x)
- 10.5 Socket head screw M 4 x 16 (2x)
- 10.6 Socket head screw M 4 x 10 (2x)
- 10.7 T-head nut M 4-32 (2x)
- 10.8 Nut M 4 (2x)

4.7
Step 7



- 9 Fibre optic device
- 10 StationLink receiver
- 11 Connector (2x)
- 12 Stack magazine module
- 13 Cable clip

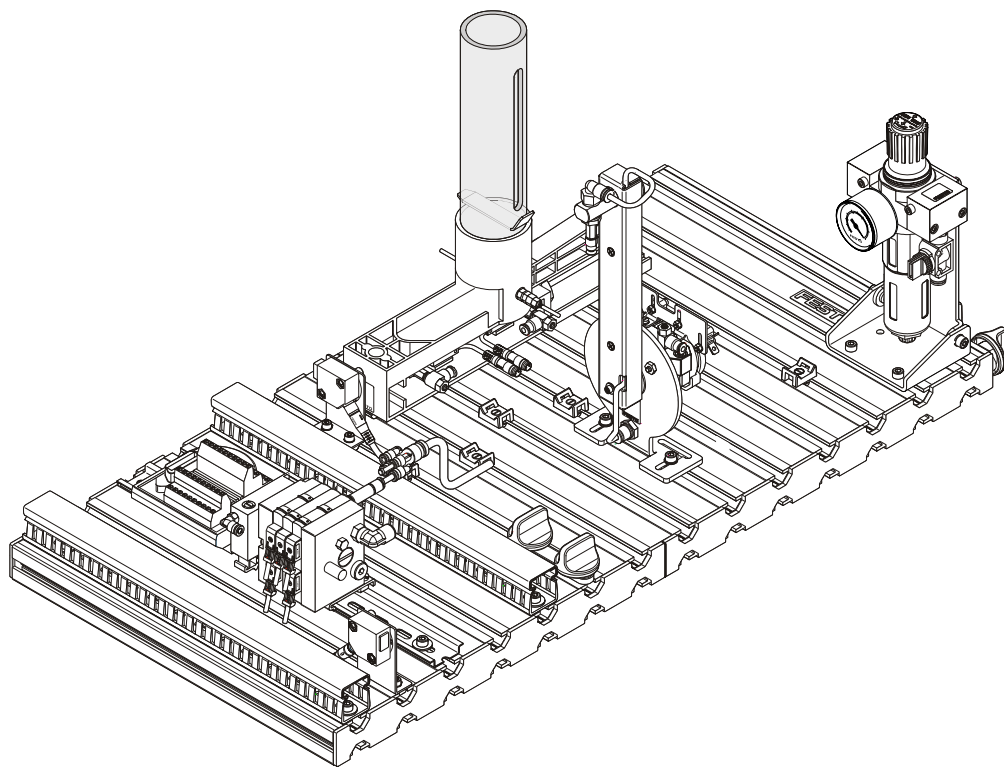
4.8
Step 8



Complete assembling of Stack magazine module and cable clips

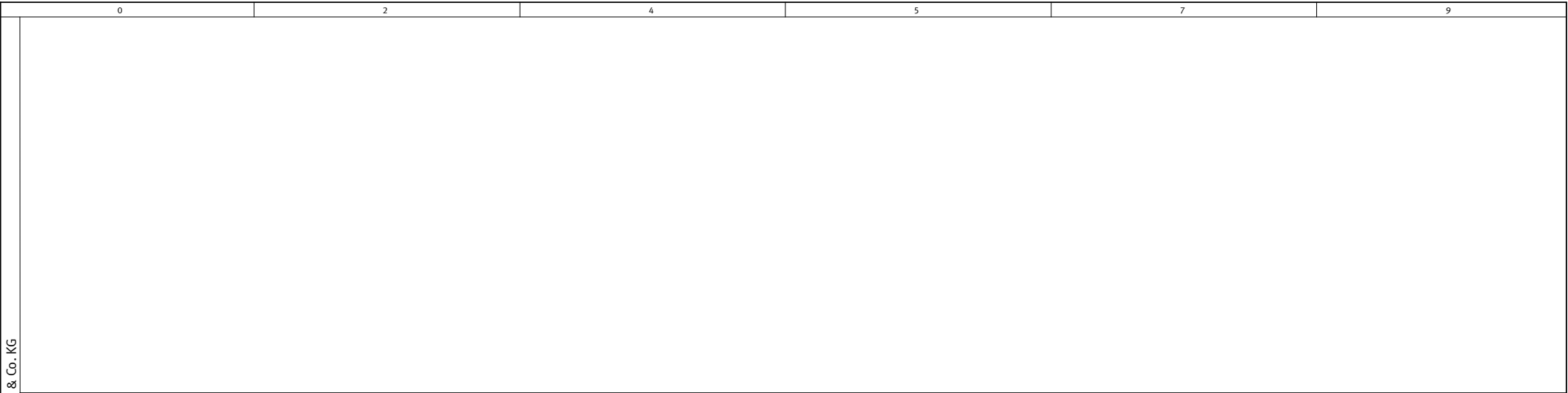
14 Fibre optic cable “Light barrier”

4.9
Step 9



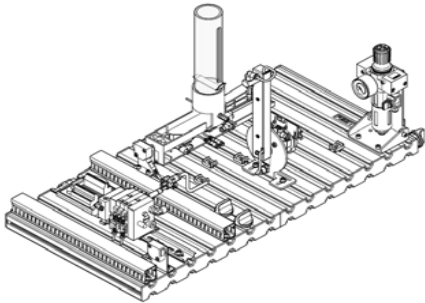
Station completely assembled

Diese Zeichnung ist Eigentum der Festo Didactic GmbH & Co. KG

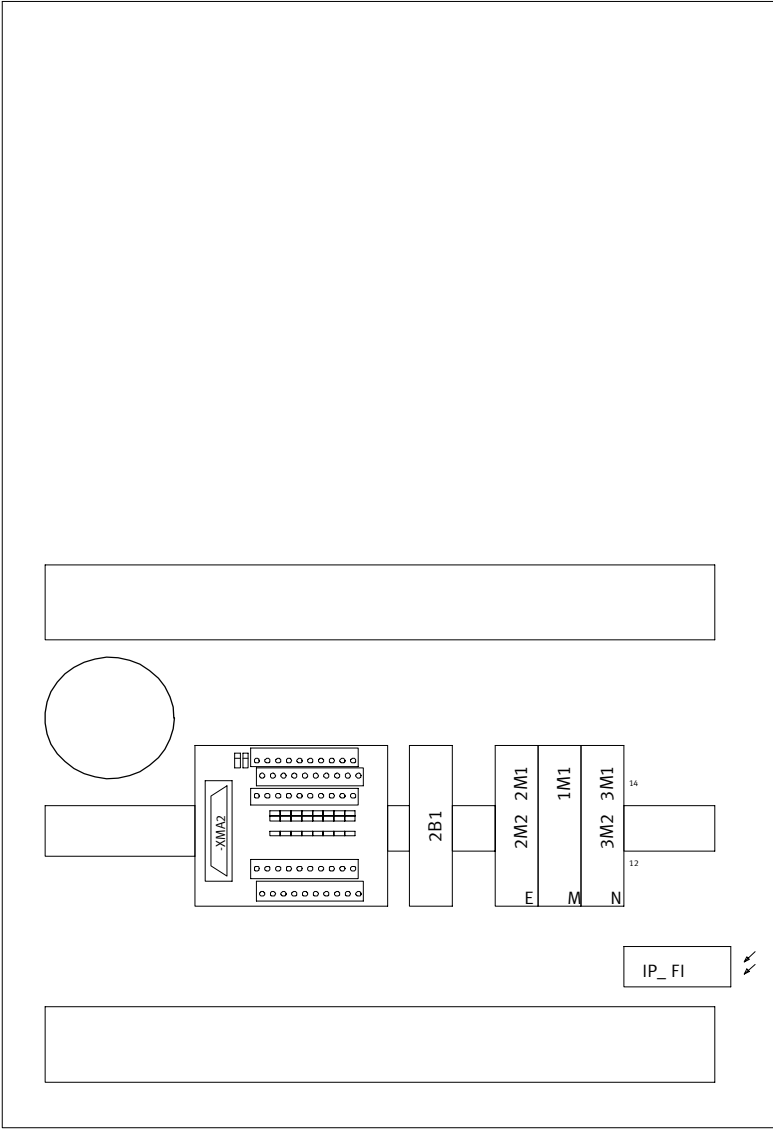


Schaltungsunterlagen / Circuit diagrams

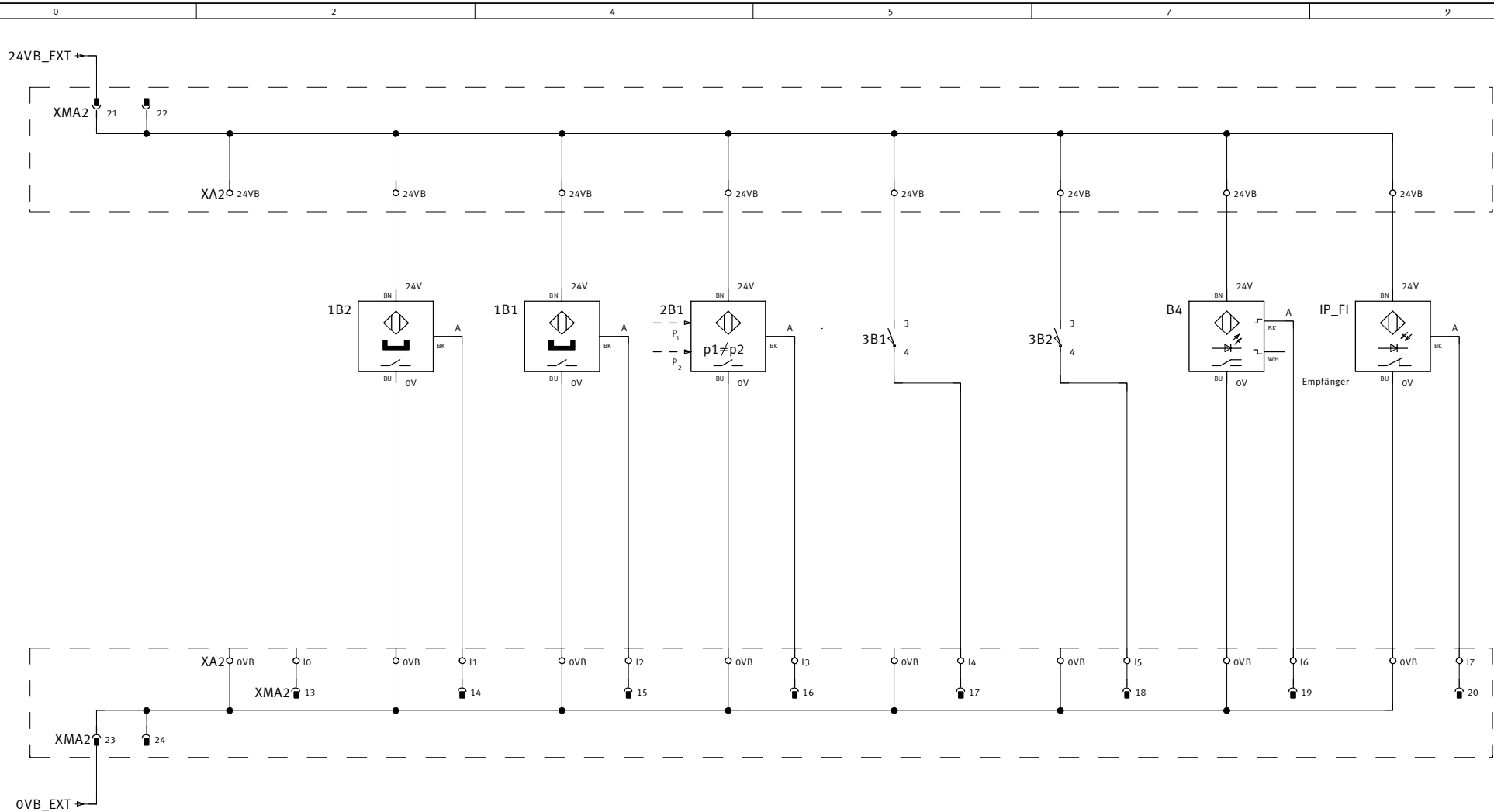
System MPS-C
MPS® Station Verteilen
MPS® Distributing station



[illegible]



XMA2 = Syslink Station / station
XMG1 = Syslink Bedienpanel / control console

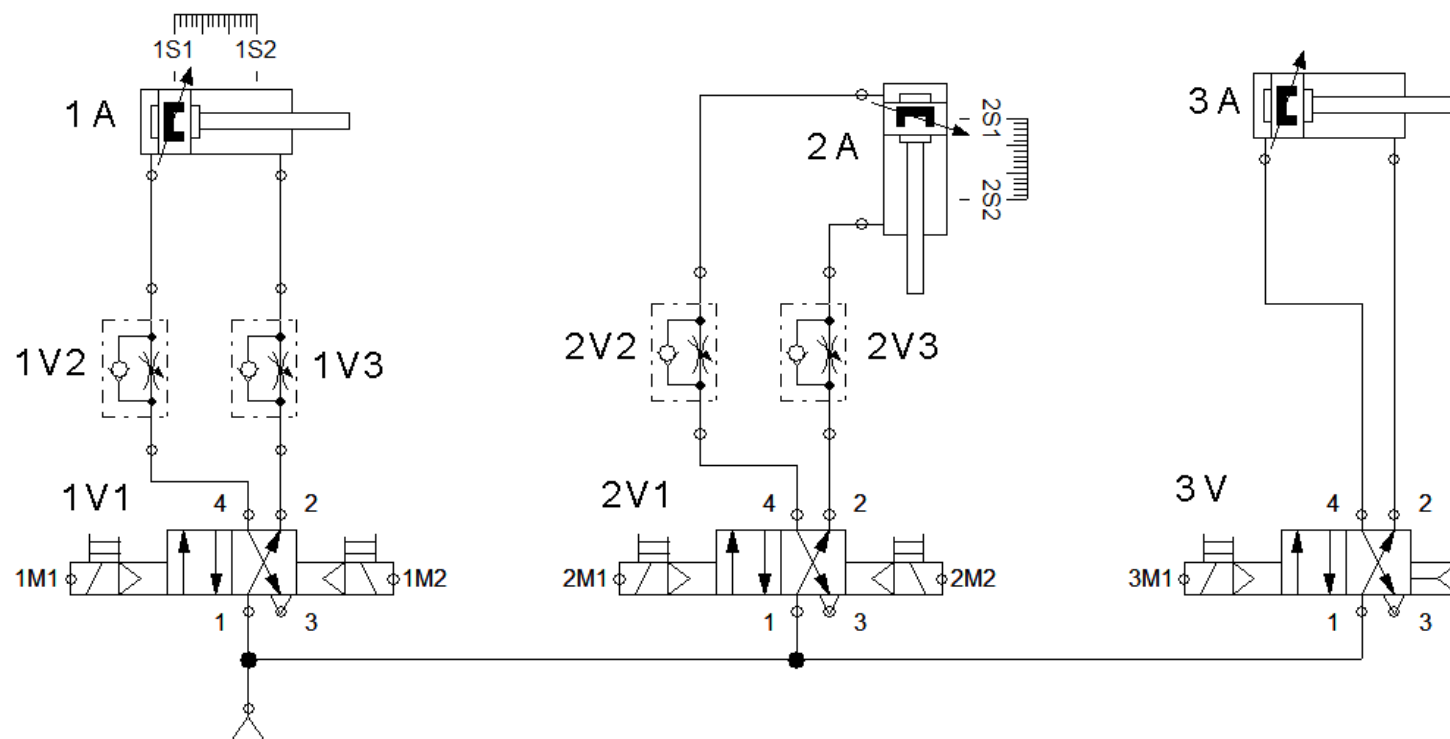
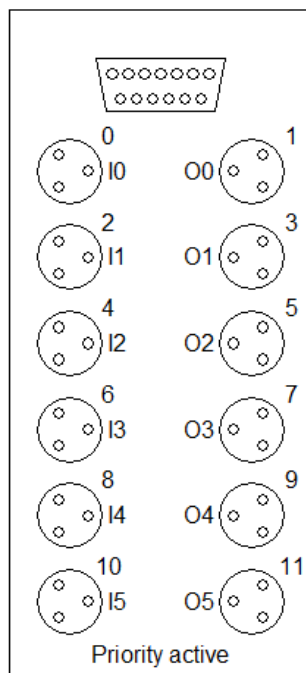


Spannungsvorsorgung	Ausschiebezylinder ausgefahren	Ausschiebezylinder eingefahren	Werkstück angesaugt	Schwenkzylinder in Position Magazin	Schwenkzylinder in Position Folgestation	Magazin leer	Folgestation frei
Power supply	Ejecting cylinder extended	Ejecting cylinder retracted	Workpiece gripped	Swivel drive in magazine position	Swivel drive in downstream station pos.	Magazine empty	Downstream station free



<< 4

<< 4



Connection to PC

The connection between the PC and the EasyPortMini process interface is established via the USB interface. The USB drivers required can be found in the 'Drivers' folder on the Fluidsim MecLab CD. These drivers generate a virtual COM interface on the PC.

The COM port number can be found on your PC under 'Settings/Control Panel/System/ Hardware/Device Manager/Ports USB Serial Port COM x'. Only one module can be connected to the PC at any given time.

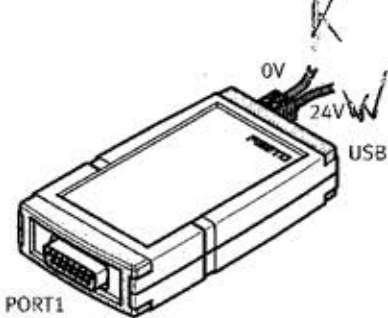
Display

A two-colour LED (green/red) signals the different states of the module:

- Green LED
 - Flashing 1 Hz: Status after being switched on, module not yet communicating
 - Intermittent flashing: Module addressed: The address is displayed at two-second intervals by a number of short LED pauses.

- Red LED
 - If a short circuit is detected at one of the outputs, the red LED lights up. The EasyPortMini outputs are then pulsed until the short circuit is eliminated. This LED also lights up for a short time when the module is switched on. It is extinguished during the power-on test before the output drivers are activated.

Anschlüsse Ports



Stromversorgung

Die 24 V DC Stromversorgung für EasyPortMini muss extern über einen 2pol Schraubklemmstecker, der an der Stirnseite des Moduls angebracht ist, zugeführt werden.

Datenschnittstelle

USB Anschluss über eine 5polige Mini USB Buchse

Der Anschluss am USB Port des PCs bzw. eines Hubs erfolgt über das mitgelieferte USB A/MiniB Kabel (Bestell-Nr. 549838).

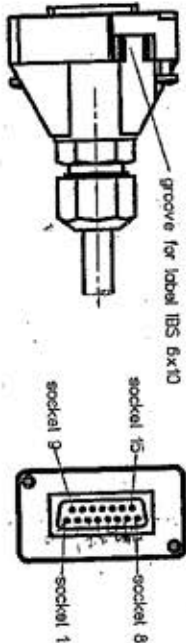
PORT1 Anschluss D-Submin 15pol. Buchse		
PORT1 – Sub-D min connection, 15-pin		
Digital PORT 1	PIN	
INPUT 0	1	
OUTPUT 0	2	
INPUT 1	3	
OUTPUT 1	4	
INPUT 2	5	
OUTPUT 2	6	
INPUT 3	7	
OUTPUT 3	8	
INPUT 4	9	
OUTPUT 4	10	
INPUT 5	11	
OUTPUT 5	12	
24V DC	13	
0V DC	14/15	

FESTO

Pin Assignment 377917

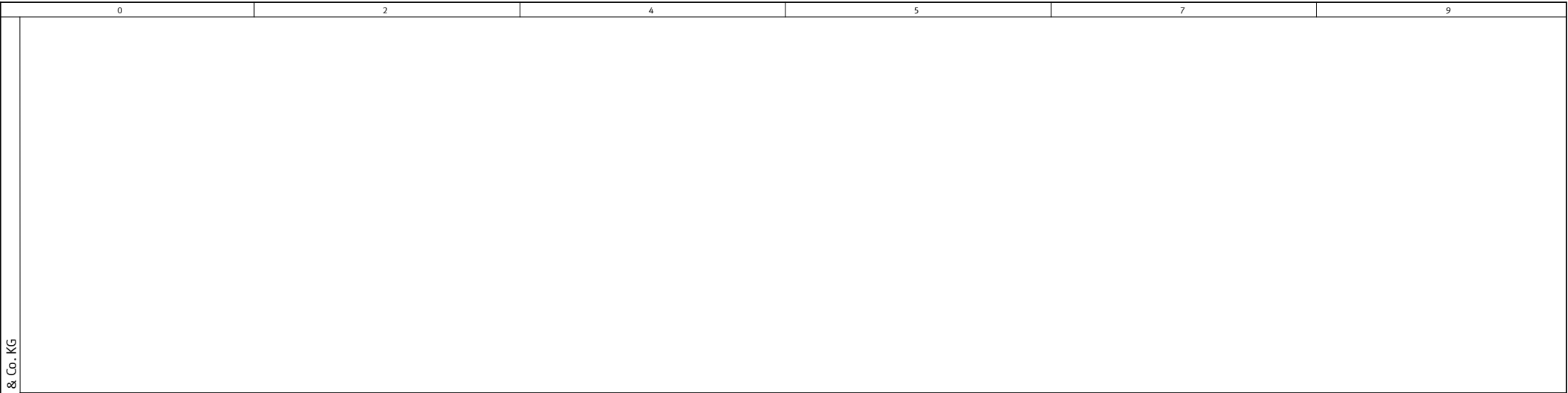
for cable 177673, 177674 and for socket 177675

Insert the cable through the conduit thread connector. Fit the D-sub plug with socket contacts (crimp) according to the pin assignment. Fasten the D-sub plug with tapping screws. Please note the groove for orientation ! Glue in the sealing.



Socket no.	Core colour
1	white
2	brown
3	green
4	yellow
5	grey
6	pink
7	blue
8	red
9	black
10	violet
11	grey-pink
12	red-blue
13	white-green
14	brown-green
15	white-yellow

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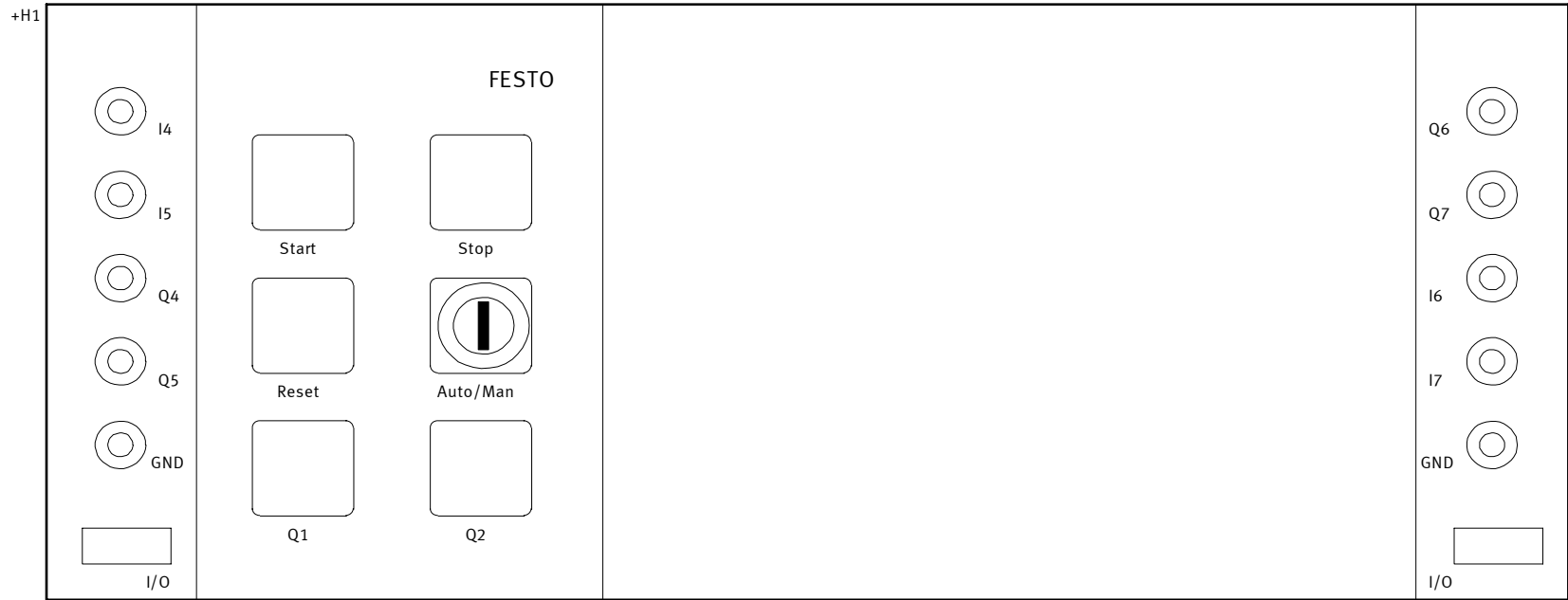


Schaltungsunterlagen / Circuit diagrams

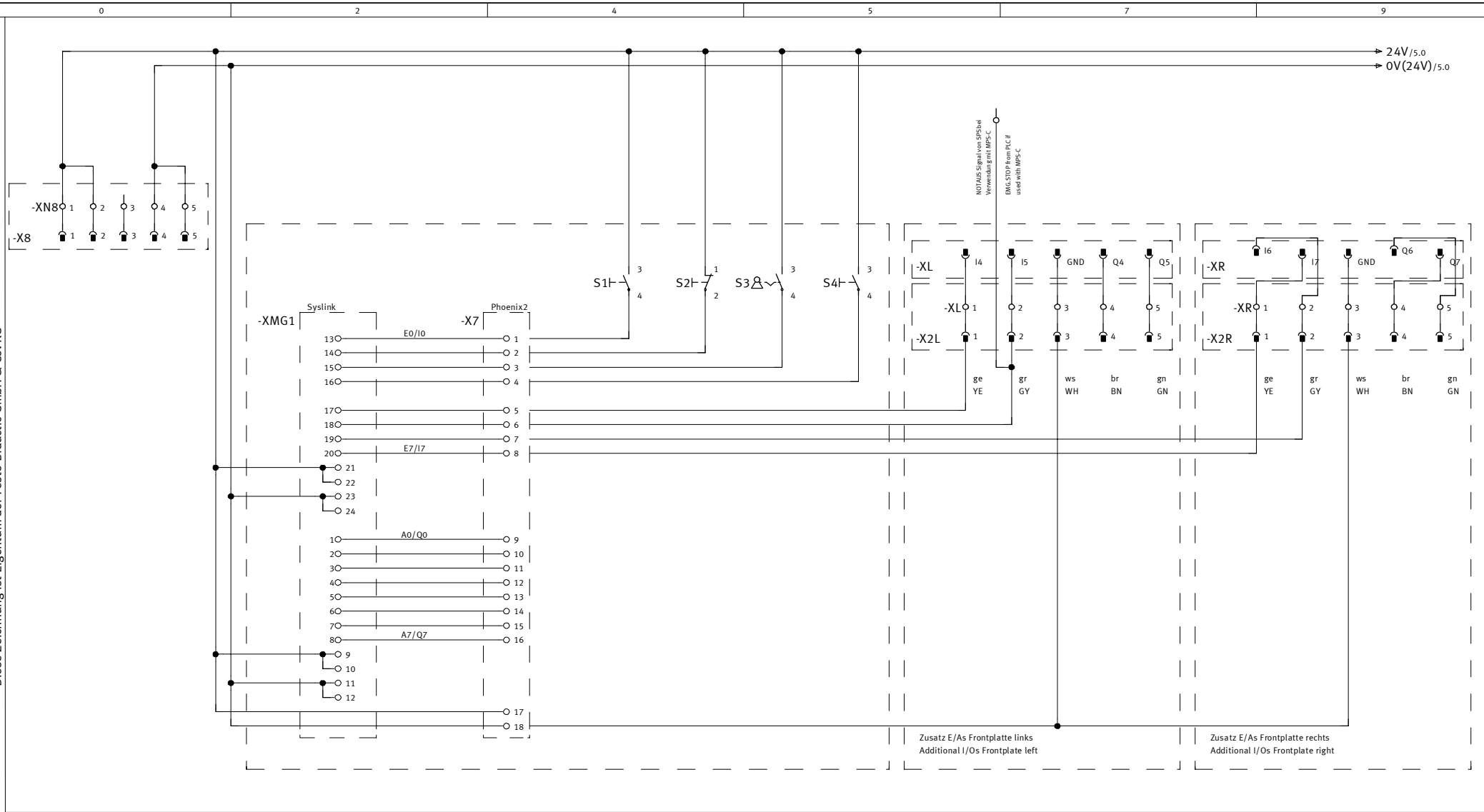
System MPS -C ®
Bedienpult
Control console



[illegible]



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Spannungsversorgung				Taster START	Taster STOP (Öffner)	Schalter AUTO/MAN	Taster RICHTEN	Externer Eingang E4	NOTAUS extern E5	Externer Eingang E6	Externer Eingang E7
Power supply				START button	STOP button (norm. closed)	Key switch AUTO/MAN	RESET button	External input I4	EMG STOP ext. I5	External input I6	External input I7

« 3		
Date	05.04.06	Festo Didactic GmbH & Co. KG Rechbergstraße 3 D-73770 Denkendorf
Konstr.	MBEL	
Certif.		
Drw-No		
R.: FDMR02E F.: R:\EPLANA\VP\FESTO\MPS\BEDIENEN\PULT.P		

FESTO

Eingänge
Inputs

MPS-C

DPJ VN

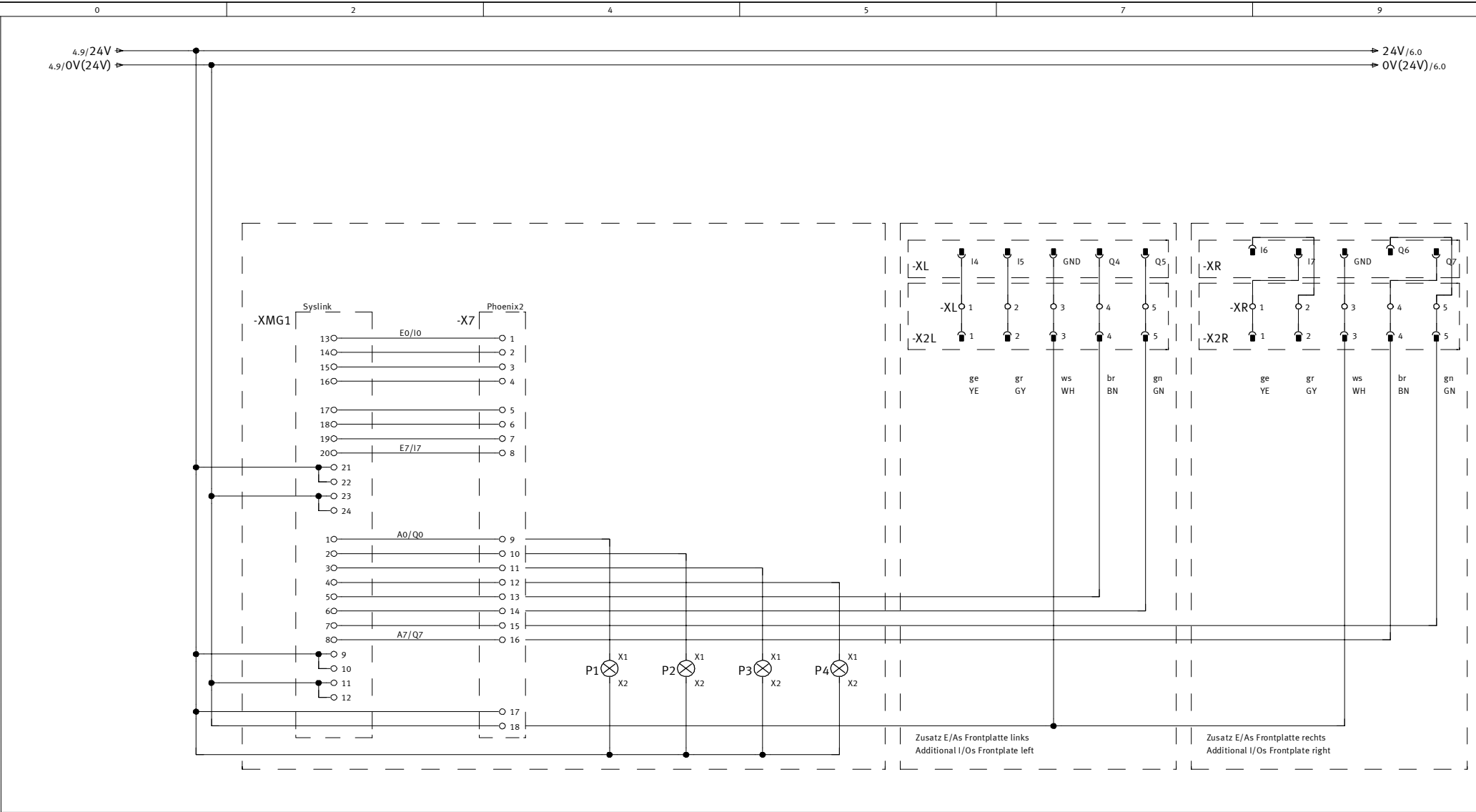
Bedienpult/Control console

= Pg. 4

+ last: 6

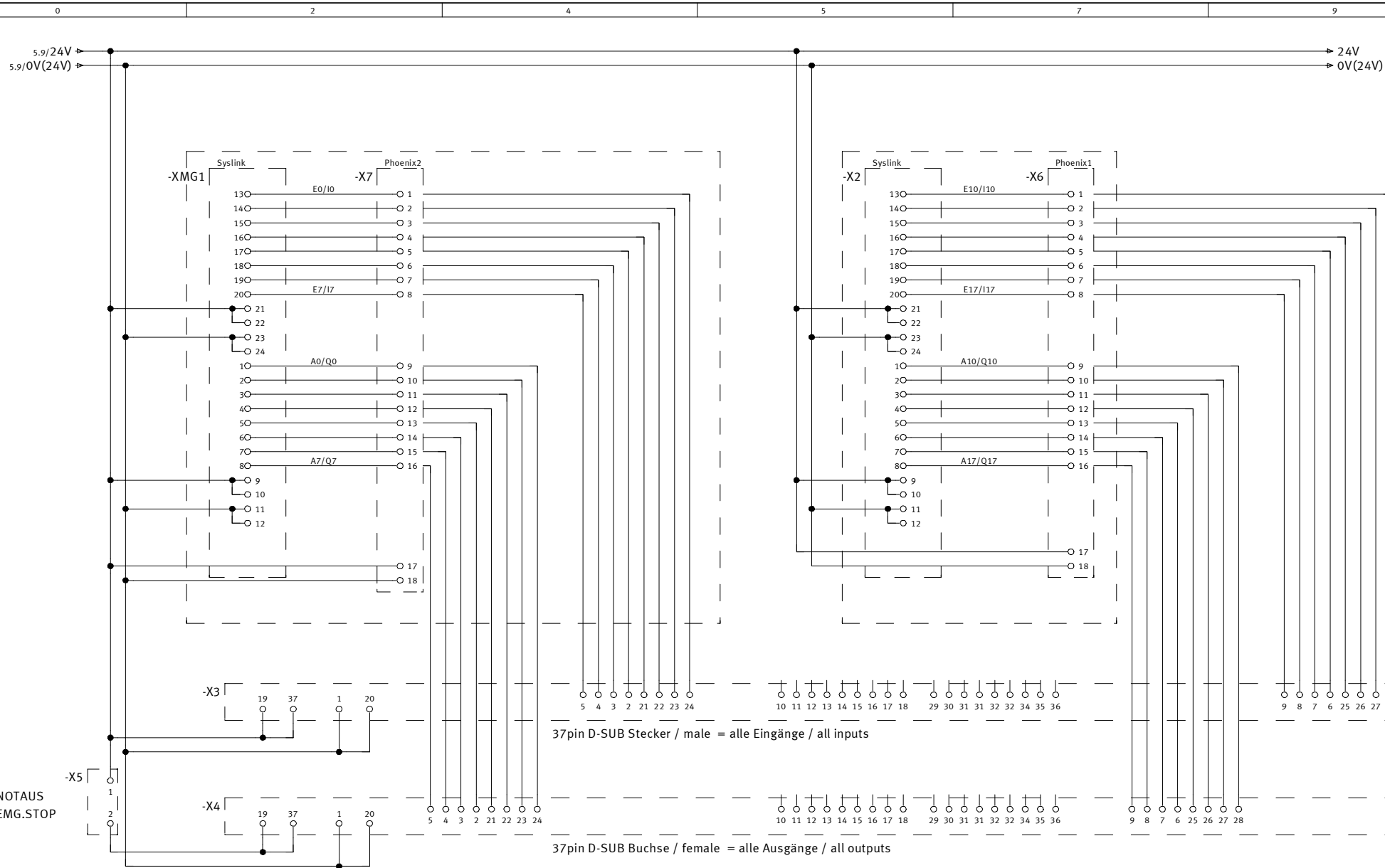
» 6

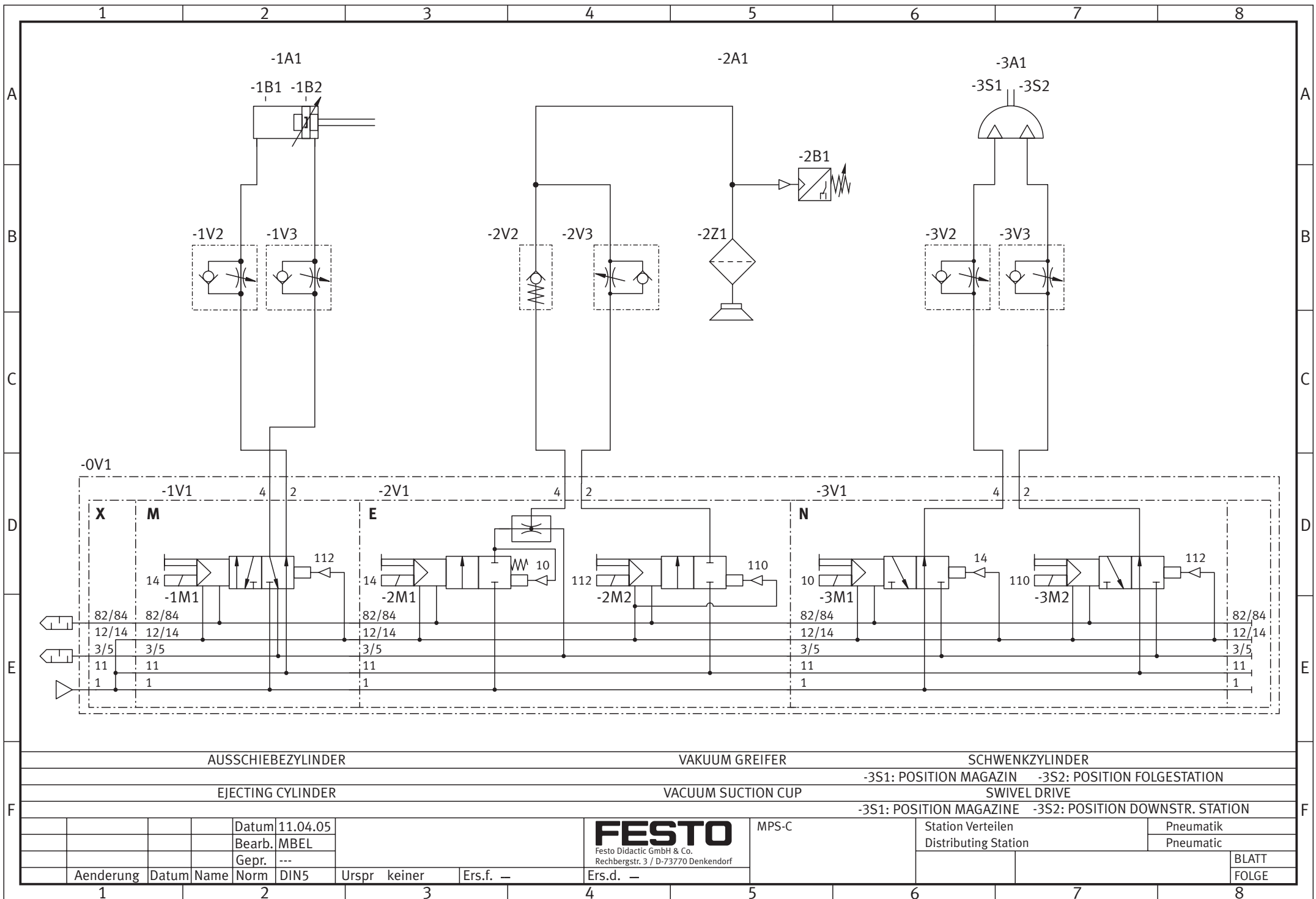
Diese Zeichnung ist Eigentum der Festo Didactic GmbH & Co. KG



Leuchtmelder START				Leuchtm. RESET	Leuchtm. Sonderf. Q1	Leuchtm. Sonderf. Q2	Externer Ausgang A4		Externer Ausgang A5		Externer Ausgang A6		Externer Ausgang A7		
START indicator light				RESET ind. light	Q1 special ind.light	Q2 special ind.light	External output Q4		External output Q5		External output Q6		External output Q7 ₆		
Date Konstr. Certif.		05.04.06 MBEL		Festo Didactic GmbH & Co. KG Rechbergstraße 3 D-73770 Denkendorf		FESTO		Ausgänge Outputs		MPS-C		Bedienpult/Control console			
Drw-No		R.: FDMR02E F.: R.: \EPLANA\PI\FESTO_MPS\BEDIENPULT.P		DPJ VN						=		Pg. 5			
										+				last: 6	

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Settings



Modules



Conn.



Display

IO sim



PORT 1

Output Bit 0. 0- - 8
Output Bit 1. 1- - 9
Output Bit 2. 2- - 10
Output Bit 3. 3- - 11
Output Bit 4. 4- - 12
Output Bit 5. 5- - 13
Output Bit 6. 6- - 14
Output Bit 7. 7- - 15

24 V - - 24 V

0 V - - 0 V

0 V - - 0 V

Input Bit 0. 0- - 8

Input Bit 1. 1- - 9

Input Bit 2. 2- - 10

Input Bit 3. 3- - 11

Input Bit 4. 4- - 12

Input Bit 5. 5- - 13

Input Bit 6. 6- - 14

Input Bit 7. 7- - 15

24 V - - 24 V

0 V - - 0 V

PORT 2

None / IO sim



Skills 2015 Oral Assessment

Note: Items in italics are judge's instructions and should not be read to the contestant. Items in normal type are to be read aloud. Give students both drawings. They may refer to either one, the difference being the electrical symbols are either ISO or JIC / ANSI formats.

Scoring Instructions: Each answer has a score value in parentheses. If the contestant answers the question correctly, then he/she earns the point value. Credit is allowed if the contestant has the proper thoughts but does not use the exact wording. Contestants may write on the diagrams but they are NOT allowed to keep them!

Simply mark off the point values as you go along. After the exam is finished, please total up points BY PAGE and insert in the total space at the bottom of each sheet. Enter the FINAL TOTAL OF ALL PAGES HERE >>> _____

In case of multiple questions – questions answered correctly but out of order deserve full credit.

Step 1: Introduce yourself and explain what the purpose is.

Good morning / afternoon. My name is _____ And I want to welcome you to the oral part of the competition. The purpose of this exercise is to serve as a review of some symbols for devices commonly used in electro-pneumatic systems and how they interact to accomplish a task. I will ask you some questions or make some statements. What I would like you to do is answer the questions and/or discuss the statements made. There is a 20 minute time limit. You may elect to skip a question. If time permits, you may go back to the skipped questions with no penalty.

Team # _____ Contestant # _____

Diagrams # 1 & 2

1. Find and identify components # 1.0, 2.0 3.0.

Component # 1.0 is a double acting cylinder () with adjustable cushioning () and a magnet on the piston to activate a proximity switch ()

Component # 2.0 is a rotary actuator “pneumatic motor” ()

Component # 3.0 is a single acting cylinder () with magnet on piston to actuate a proximity switch ()

2. Find and identify components # 1.1, 2.1, 3.1

Component # 1.1 is a 5-port/2-position valve () with dual solenoids () & manual override ()

Component # 2.1 is a 3-port/2-position, normally non-passing () valve () with a single solenoid () manual override () and spring return () and body exhaust

Component # 3.1 is a 3-port/2-position, normally non-passing () valve () air piloted () with an air spring return () threaded exhaust ports ()

3. Find and identify component # 0.2 – What is its purpose ?

Component # 0.2 is a soft-start valve (). Its purpose is to slowly pressurize the system to prevent rapid movement of the components to their last command position(s) before shut-down()

4. What happens when the “master on/off switch” is activated ?

The “master on/off switch” turns power on to the system () the light illuminates() and valve 0.3 shifts() because the E-stop switch is normally closed()

5. What type switch is “switch # 1” and what happens when it is pressed ?

Switch # 1 is a normally open () detented switch () that activates solenoid Y-1 () which shifts valve # 0.1 () and allows air to start flowing into the system()

6. Press the “start button – what happens ?

Solenoid Y-2 is activated and shifts valve 1.1 () allowing cylinder 1.0 to extend ()

7. What is component # 1.02 what is its purpose & is there a name we call this speed control technique ?

1.02 is a one-way flow control valve (). Its purpose is to regulate the speed of the cylinder in one direction only (). The technique shown is called "metering out" ().

8. What happens when cylinder 1.0 extends ?

Cylinder 1.0 extends and hits limit switch 2.1 (). Limit switch 2.1 activates solenoid y-7 () allowing valve 2.1 to shift (). When 2.1 shifts the drill motor 2.0 starts spinning () and air is sent () to 3.1 to start the drill press ().

9. What happens when valve 2.1 shifts ?

Valve 2.1 allows air flow to component 2.0 "drill motor" () and activates valve 3.1 ().

10. What is component # 3.02 and what is its purpose ?

Component 3.03 is a throttling valve or adjustable flow restrictor (). Its purpose is to slow the airflow to the downstream components ().

11. What happens when valve # 3.1 shifts ?

Valve 3.1 allows airflow to cylinder 3.0 ().

12. What is component 3.04 and what is its purpose and configuration ?

Component 3.04 is a one-way flow control valve () it is configured to "meter in" () to slowly extend the cylinder ().

13. What happens when cylinder 3.0 extends fully ?

Cylinder 3.0 extends and actuates limit switch 3.1 (). Limit switch 3.1 activates solenoid Y-32 () and cylinder 1.0 returns home (). As cylinder 1.0 returns, limit switch 2.1 de-activates () and valve 2.1 shifts, stopping airflow to the motor and drill press ().

14. What happens when the "E-STOP" is activated ?

Solenoid Y-16 is de-activated () and valve 0.3 shifts (). Air pressure is cut off to valves 1.1, 2.1 and 3.1 (). Air is exhausted out the quick exhaust valve # 0.4 (). Air pressure shifts the OR gate (shuttle valve) () and allows cylinder 1.0 to retract.

Diagrams # 3 & 4

1. What is component 1.0 ?

Component 1.0 is a vacuum generator ()

2. What happens when switch # 1 is pressed ?

Switch 1 actuates relay R-1 (). All points in that relay change state, one closes () and allows electricity to flow to R-1 () and to solenoid Y-1 ()

3. Is there a special name we give the circuit on the first two rungs of the ISO diagram?

This is called a "Latch or Latching Circuit" ()

4. Is this a dominant-on or dominant-off latch ?

This is a "dominant-Off" latch ()

5. What happens when Y-1 is actuated ?

Y-1 actuates valve 1.1 () which opens and allows air to flow to valves 1.2 () & 1.3 ()

6. If you press switch # 3 what do you expect to happen ?

Pressing switch 3 activates solenoid Y-11 () and valve 1.2 opens ()

7. What is component 1.02 ? What does

Component 1.02 is a pressure regulator ()

8. What does the regulator control (1.02) – pressure or volume of air flow ?

Component 1.02 controls pressure ()

9. If, after contacting an object and creating a vacuum – What would happen if you released switch # 3 ?

Vacuum would continue (), check valve 1.03 will maintain the vacuum ()

10. What is the purpose of switch # 4 ?

Switch 4 activates solenoid Y-12 () this will shift valve 1.3 allowing airflow into the vacuum line () this airflow will overcome the vacuum and release the part ()

11. What is component 1.04 and what is its purpose ?

Component 1.04 is a filter () its purpose is to prevent solid particles from entering the vacuum generator ()

12. Why are two gages included in this circuit ?

Gages before and after the filter will indicate the differential vacuum before and after the filter () This will tell if the filter is clogged ()

13. If in its original configuration, this circuit used a 4 inch suction cup – May we replace the 4 inch cup with two – 2 inch cups and expect the same results ?

NO () A 4 inch cup has a surface area of 12.56 sqin and a 2 inch cup has a surface area of 3.16 sqin. Two 2 inch cups would only provide 6.32 inches of surface area ()

Diagram # 5

1. What type circuits are these ? How can you tell ?

Hydraulic () The pressure symbol is solid not open (), the “exhaust” symbol shows “return to tank” ()

2. What type valves are shown ?

The valves are 4 port () 2 position () solenoid operated () spring centered () with manual override () valves

3. What is the difference between component 1.1 & 2.1 ?

Valve 2.1 is a proportional () valve with variable output solenoids ()

4. **Component 2.1 is definitely more expensive than component 1.1. What advantage(s) are gained by using this valve ?**

Valve 1.1 allows on/off operation only () valve 2.1 allows infinitely adjustable flow () and therefore speed to the motor ().

Diagram # 6

1. **What are we attempting to do in these circuits ?**

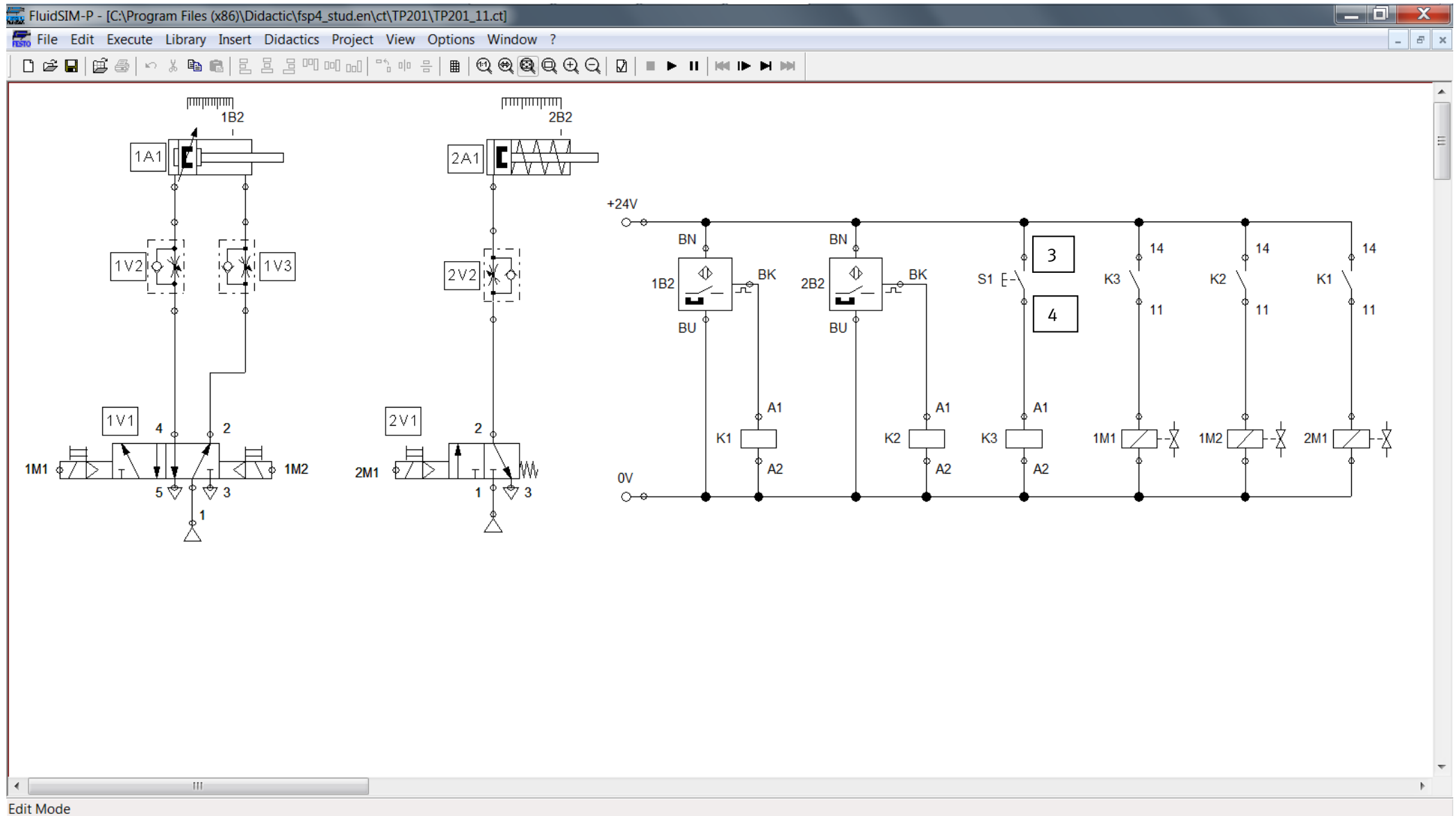
Control the cylinder's extension speed ().

2. **Which is the preferred design & why**

The right circuit is the preferred design ().

Because of the differential area (piston side vs annular side) a very large, dangerous over-pressurization is likely ().

<< END >>



Instructions:

Here is the schematic for a circuit .

You need to identify the proper components based on the schematic.

Connect them to the profile plate using the nuts and bolts provided. Make sure you place the components so they do not collide while moving.

All components are to be fully within the confines of the work surface, even when in motion.

All electrical wiring is to be run through the conduit and back to the terminal strip. Terminal strips are to get 24V and 0V from power supply. Do NOT cut any wires or cables, except for the blue hookup wire we have provided.

Compressed air lines are not routed through the conduit. Air lines must not be touched by moving parts.

Sequence of Operation: Pressing pushbutton causes cylinder 1A1 to extend. When it is fully extended, cylinder 2A1 is to extend. When 2A1 is fully extended, both cylinders are to retract.

All cylinder motion is to be smooth and under control. Speed adjustment is made via valves 1V2, 1V3 and 2V2.

You are ENCOURAGED to write on the schematic for planning purposes and to mark off completed connections.

Team Number: _____

Time Ended: _____

Operation correct? _____

Time Started: _____

Pneumatic? _____

Electrical? _____

Relays? _____

Total Time: _____

Cylinder motion controlled? _____



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Work Orders - Instructor

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36891-70



MECHANICAL TRAINING SYSTEM

BELT DRIVES 1

by
the Staff
of
Lab-Volt Ltd.

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**Printed in Canada
September 2007**

To the Instructor

- Before a student begins a work order, ensure that the equipment is in good condition and does not represent any risk when used.
- When a student has to complete a setup that is partially already mounted, ensure that the setup corresponds to the job description.
- This guide provides you with the answers to calculations, and measurements. Your evaluation, however, must relate to the quality of the accomplished work. Make sure that the objectives listed in the Work Assessment Table are met.
- When the jobs are performed in teams, ensure that each student has and installs a padlock when performing the lockout/tagout procedure.
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Belt Drives 1

WORK ORDER 1 INTRODUCTION TO BELT DRIVES

ANSWERS TO PROCEDURE STEP QUESTIONS

- ☐ 2. Gauge: V-belt and sheave gauge.
- ☐ 3. Belt Type: A, which has the same dimensions as a 4L V-belt.
- ☐ 4. Height: approximately 0.313 in.

Width measured on the outer face: approximately 0.5 in.

- ☐ 5.

SHEAVE O.D. in.	SHEAVE D. in.
3.75	3
4.75	4
5.75	5

WORK ORDER 2 SHEAVE AND BELT INSTALLATION

ANSWERS TO PROCEDURE STEP QUESTIONS

- ☐ 4. The tension adjustment screw is used to adjust the belt tension when all the screws are tightened.

WORK ORDER 3 SHEAVE ALIGNMENT

ANSWERS TO PROCEDURE STEP QUESTIONS

- ☐ 3. The three primary types of sheave misalignment are horizontal angular, vertical angular, and parallel.
- ☐ 4. Instrument: combination square with level
- ☐ 5. Misalignment: horizontal angular

Belt Drives 1

WORK ORDER 4 BELT TENSIONING

ANSWERS TO PROCEDURE STEP QUESTIONS

- ☐ 3. Under-tensioning a belt can cause slippage of the belt in the sheaves.
- ☐ 4. Varying the tension of a belt on the universal base can be performed by moving the motor or pillow block bearings, by adding another an idler, or by screwing the tension adjustment screw located on the motor mounting base.

WORK ORDER 5 SPEED, TORQUE, AND PULLEY RATIOS

ANSWERS TO PROCEDURE STEP QUESTIONS

- ☐ 3. Pitch diameter ratio: 1.3
- ☐ 4. Driven sheave speed: 1294 r/min
- ☐ 7. Driving sheave speed (n_1): approximately 1785 r/min
- ☐ 8. Driven sheave speed (n_2): approximately 2230 r/min
- ☐ 12. Speed ratio: approximately 0.8
- ☐ 15. Pitch diameter ratio (D_2/D_1): 0.8
- ☐ 17. Driving sheave speed (n_1): approximately 1785 r/min
Driven sheave speed (n_2): approximately 2230 r/min
- ☐ 20. Speed ratio: approximately 0.8

Belt Drives 1

WORK ORDER 6 SHEAVE AND BELT MAINTENANCE

ANSWERS TO PROCEDURE STEP QUESTIONS

□ 1.

SYMPTOMS	PROBABLE CAUSES				
	Misalignment	Worn sheave	Belt slip	Rubbing of belt against guard	Shock load
Premature wear	✓	✓	✓	✓	
Excessive noise	✓	✓	✓	✓	
High temperature			✓	✓	
Broken belt					✓

Belt Drives 1

WORK ASSESSMENT TABLE

The following table is a guide to evaluate the work done by the student. It covers the key elements that should be verified for each work order.

ELEMENTS TO VERIFY	WORK ORDER				
	1	2	3	4	5
The students have performed the Safety Procedures listed in Appendix D.	•	•	•	•	•
The Lockout/Tagout procedure is properly done.		•	•	•	•
A key is installed in the sheave keyseats.		•	•	•	•
The tension adjustment screw is oriented as shown in Figure 2-1.		•	•	•	•
There are four points of contact between the sheaves and the straightedge.			•	•	•
All screws and setscrews are tightened.			•	•	•
The deflection force on the belt is within the range determined.				•	•
A piece of reflective tape is present on both sheaves.					•
The output voltage selector is set to FIXED.					•
The safety panels are installed.					•



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36893-70



MECHANICAL TRAINING SYSTEM

GEAR DRIVES 1

by
the Staff
of
Lab-Volt Ltd.

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Gear Drives 1

WORK ORDER 1 INTRODUCTION TO GEAR DRIVES

ANSWERS TO PROCEDURE STEP QUESTIONS

☐ 2. Spur gear: 1

☐ 3.

GEAR	OUTSIDE DIAMETER in.	PITCH DIAMETER in.
12 P - 20 teeth - $14.5^\circ\phi$	1.833	1,667
12 P - 30 teeth - $14.5^\circ\phi$	2.667	2,5
12 P - 40 teeth - $14.5^\circ\phi$	3.5	3,333
16 P - 48 teeth - $20^\circ\phi$	3.12	3
16 P - 64 teeth - $20^\circ\phi$	4.12	4.0

☐ 4.

GEAR COMBINATION	D RATIO	O.D. RATIO	TEETH RATIO
12 P - 20 teeth - $14.5^\circ\phi$ 12 P - 30 teeth - $14.5^\circ\phi$	1.5	1.45	1.5
16 P - 48 teeth - $20^\circ\phi$ 16 P - 64 teeth - $20^\circ\phi$	1.33	1.32	1.33

☐ 5. Ratio: pitch diameter ratio

☐ 6.

GEAR COMBINATION	DO THE GEARS MESH CORRECTLY?	
	YES	NO
12 P - 20 teeth - $14.5^\circ\phi$ 12 P - 30 teeth - $14.5^\circ\phi$	✓	
12 P - 20 teeth - $14.5^\circ\phi$ 16 P - 48 teeth - $20^\circ\phi$		✓
16 P - 48 teeth - $20^\circ\phi$ 16 P - 64 teeth - $20^\circ\phi$	✓	

Gear Drives 1

- ☐ 7. Gears do not mesh correctly if they do not have the same pressure angle and diametral pitch.

WORK ORDER 4 BACKLASH ADJUSTMENT

ANSWERS TO PROCEDURE STEP QUESTIONS

- ☐ 3. Backlash is described as the amount by which the width of a tooth space exceeds the thickness of the engaged tooth on the pitch circle, or simply the play between mating teeth.
- ☐ 4. Excessive backlash can cause premature wear on the teeth, and is particularly detrimental on reversing mechanisms.
- ☐ 5. Instrument: dial indicator
- ☐ 7. Shaft center distance: 2.5 in.
- ☐ 8. Allowable backlash range: between 0.005 and 0.015 in.
- ☐ 9. Backlash: as measured.

WORK ORDER 5 SPEED, TORQUE, AND GEAR RATIOS

ANSWERS TO PROCEDURE STEP QUESTIONS

- ☐ 3. Teeth ratio: 0.5
Driven gear speed: 42 r/min
- ☐ 6. Driven gear turns: 2
- ☐ 11. Speed ratio: 0.5

Gear Drives 1

WORK ORDER 6 GEARS USING SPLIT TAPER BUSHINGS

ANSWERS TO PROCEDURE STEP QUESTIONS

- ☐ 3. Split portion: tapered
- ☐ 9. Torque: 95 lb·in.

WORK ORDER 7 GEAR TRAINS

ANSWERS TO PROCEDURE STEP QUESTIONS

- ☐ 3. The speed of gear N_3 depends only on the speed of gear N_1 and on their teeth ratio. Gear N_2 has no influence on the speed of gear N_3 .
- ☐ 4. The function of gear N_2 is to change the direction of rotation between the first and last gear.
- ☐ 5. Yes, however the gears of different diametral pitches or pressure angles cannot be assembled in series. They must be assembled in parallel.
- ☐ 10. Direction of rotation of the left gear as you face the universal base: counterclockwise

Direction of rotation of the right gear as you face the universal base: counterclockwise
- ☐ 12. Number of turns of the left gear as you face the universal base: 2.66

Number of turns of the right gear as you face the universal base: 2.66
- ☐ 13. Number of turns of the last driven gear: 8
- ☐ 15. Number of turns of the last driven gear: 8

Gear Drives 1

WORK ASSESSMENT TABLE

The following table is a guide to evaluate the work done by the student. It covers the key elements that should be verified for each work order.

ELEMENTS TO VERIFY	WORK ORDER						
	1	2	3	4	5	6	7
The students have performed the Safety Procedures listed in Appendix D.	•	•	•	•	•	•	•
The Lockout/Tagout procedure is properly done.		•	•	•	•		•
A key is installed in the gear keyseats.		•	•	•	•		•
Shims are installed under the variable speed motor.		•	•	•	•		
There are four points of contact between the gears and the straightedge.			•	•	•		•
All screws and setscrews are tightened.			•	•	•		•
The backlash is comprised between 0.005 and 0.015 in.				•	•		•
The capscrews on the split taper bushing(s) are tightened to approximately 95 lbf-in.						•	•
The output voltage selector is set to VARIABLE.					•		
The safety panels are installed.					•		

