######

1. INTRODUCTION

These instructions provide an overview of the structure of a Safety Buyoff and describe how it is to be tested on
The Safety Buyoff used in this manual is an example. A Safety Buyoff specially adapted to the machine is create

2. Safety Buyoff InOutData

Each security matrix contains "InOutData".
"InOutData" contains the following points that must be completed:

- Machine Information
- Safety Input
- Reset
- Bypass Key
- Teach Panel.
- Safety Output

2.1.1. Machine Information:

Complete the security matrix creator and publisher. Entered who programmed the safety logic and checked its fu

Machine:	TSL-999-ST099		
	Name	Date	Signature
Safety matrix designed:	M.Korres	16.10.2018	
Safety matrix released:	C.Brück	17.10.2018	
Safety logic programmed:	M.Mustermann	22.10.2018	
Function checked:	A. Schmitz	24.10.2018	
Signature of Safety program:	z736t0	22.10.2018	

2.2. Safety Input:

All inputs of the Safety Inputs are listed here with their designations and the associated symbols.

Safetyswitch				
No.	Name	Symbol	Input	Name Short
1	E-STOP channel1 +HM01	+HM01-ES01:11	1100.0/4	E-STOP channel1 +HM01
2	E-STOP channel1 +OPA01	+OPA01-ES01:11	1100.1/5	E-STOP channel1 +OPA01
3	E-STOP channel 1 +OPA03	+OPA03-ES01:11	1110.1/5	E-STOP channel 1 +OPA03
4	safety switch front cover closed +SDS01	+SDS01-SI01:X1:3	1120.0/4	safety switch front cover closed +SDS01
5	safety switch front control cover +SDS01	+SDS01-SI02:1	1110.0/4	Safety switch front control cover +SDS01
6	safety switch rear cover closed +SDS02	+SDS02-SI01:X1:3	1120.1/5	safety switch rear cover closed +SDS02
7	safety switch front door conveyor closed +SDS07	+SDS07-SI01:X1:3	1110.2/6	safety switch front door conveyor closed +SDS07
8	safety switch front door conveyor closed +SDS08	+SDS08-SI01:X1:3	1110.3/7	safety switch front door conveyor closed +SDS08
9	flow sensor exhaust plasma cleaning	+PLA01:PX10:4	65.6	flow sensor exhaust plasma cleaning

2.3. Reset/Power On:

Here are the inputs, their symbols and their designations with which the system can be switched on again.

Reset				
No.	Name	Symbol	Input	Name short
1	Pushbutton Power On +HM01	+HM01-PB04:14	52.3	Pushbutton Power On +HM01
2	Pushbutton Power On +OPA03	+OPA03-PB04:14	53.3	Pushbutton Power On +OPA03

2.4. Bypass Key:

The inputs, their symbols and their designations with which functions can be bypassed, are listed here.

Bypass Key				
No.	Name	Symbol	Input	Name short
1	Bypass key Enable +I-BM01	+I-BM01-SF01:I4	52.4/5	Bypass key Enable +I-BM01
2	Bypass key Enable +OPA03	+OPA03-SF01:I4	53.4/5	Bypass key Enable +OPA03

2.5. Teach Panel:

The inputs, their symbols and their designation for the reactivation and control of processes using the teach pan

Teach Panel				
No.	Name	Symbol	Input	Name short
1	Release Button Mobile Panel	+TPA01-TP01-S1:I4	1100.3/7	Release Button Mobile Panel
2	Release Button Mobile Panel	+TPA02-TP01-S1:I4	1120.3/7	Release Button Mobile Panel

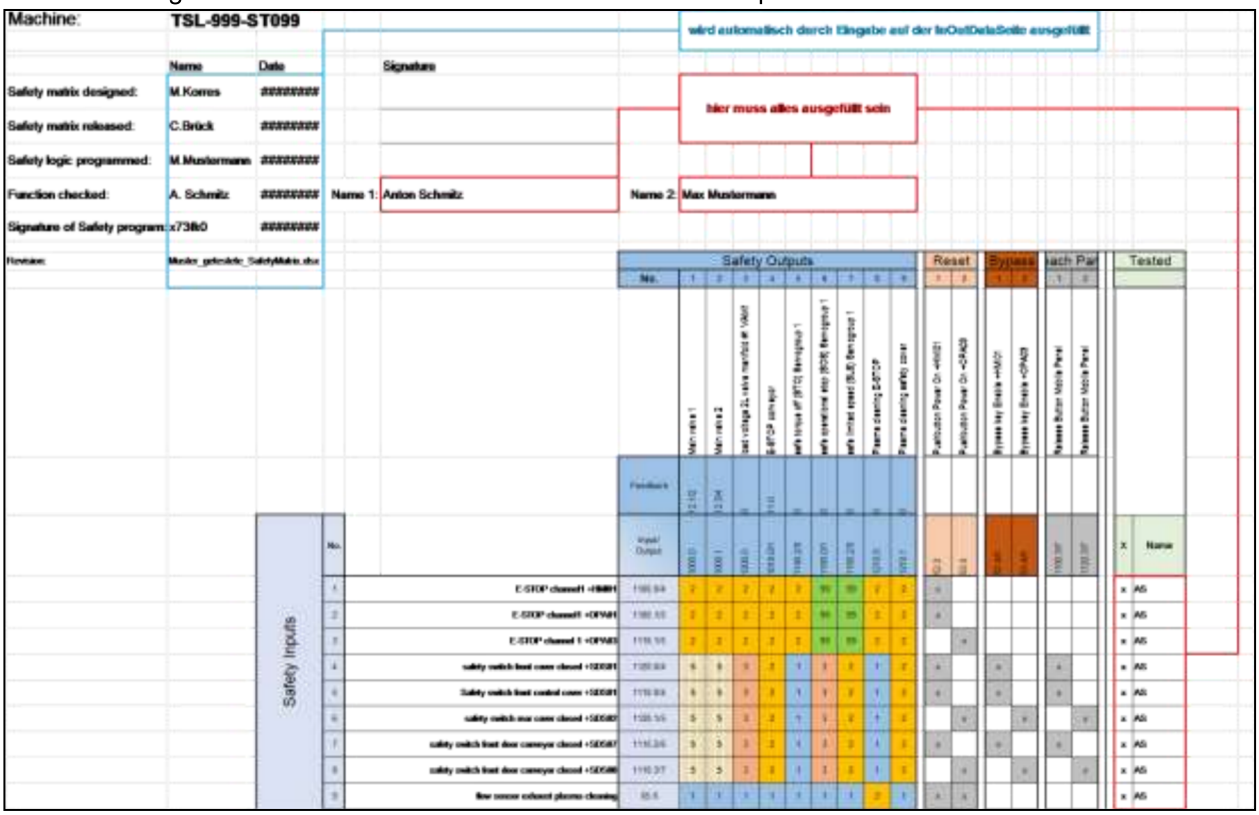
2.6. Safety Outputs:

The inputs, their symbols and their designation for the reactivation and control of processes using the teach pan

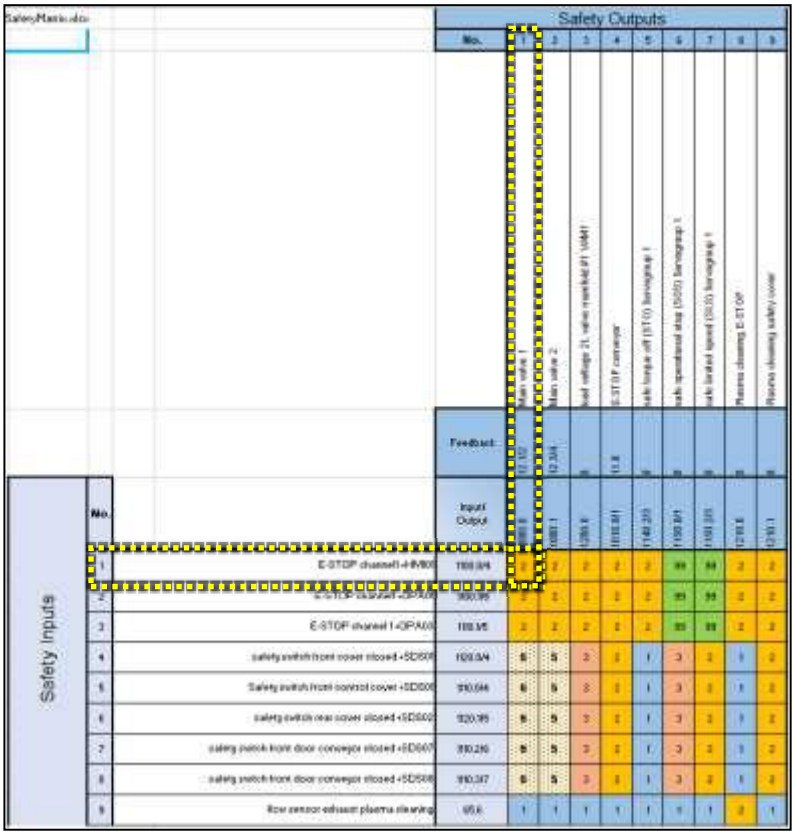
Safety actor					
No.	Name	Symbol	Output	Name short	Feedback 1
1	Main Valve 1	+MUP01-VLV01-X1:1	1000.0	Main valve 1	12.1/2
2	Main Valve 2	+MUP01-VLV02-X1:1	1000.1	Main valve 2	12.3/4
3	Load Valve VAM01	+VAM01-VM1:PWR:1	1200.0	load voltage 2/. valve manifold #1 VAM1	
4	E-STOP conveyor	+MCP01-CH03.V2:A1	1010.0/1	E-STOP conveyor	11.0
5	safe torque off (STO) Servogroup 1	+MCP01-SRV01.X4:17/18	1140.2/3	safe torque off (STO) Servogroup 1	
6	safe operational stop (SOS) Servogroup 1	+MCP01-SRV02-X4:14/15	1150.0/1	safe operational stop (SOS) Servogroup 1	
7	safe limited speed (SLS) Servogroup 1	+MCP01-SRV02.X4:17/18	1150.2/3	safe limited speed (SLS) Servogroup 1	
8	Plasma cleaning E-STOP	+MCP01-PIO1.7/0.0	1210.0	Plasma cleaning E-STOP	
9	Plasma cleaning safety cover	+MCP01-PIO1.7/1.0	1210.1	Plasma cleaning safety cover	

3. Safety Buyoff:

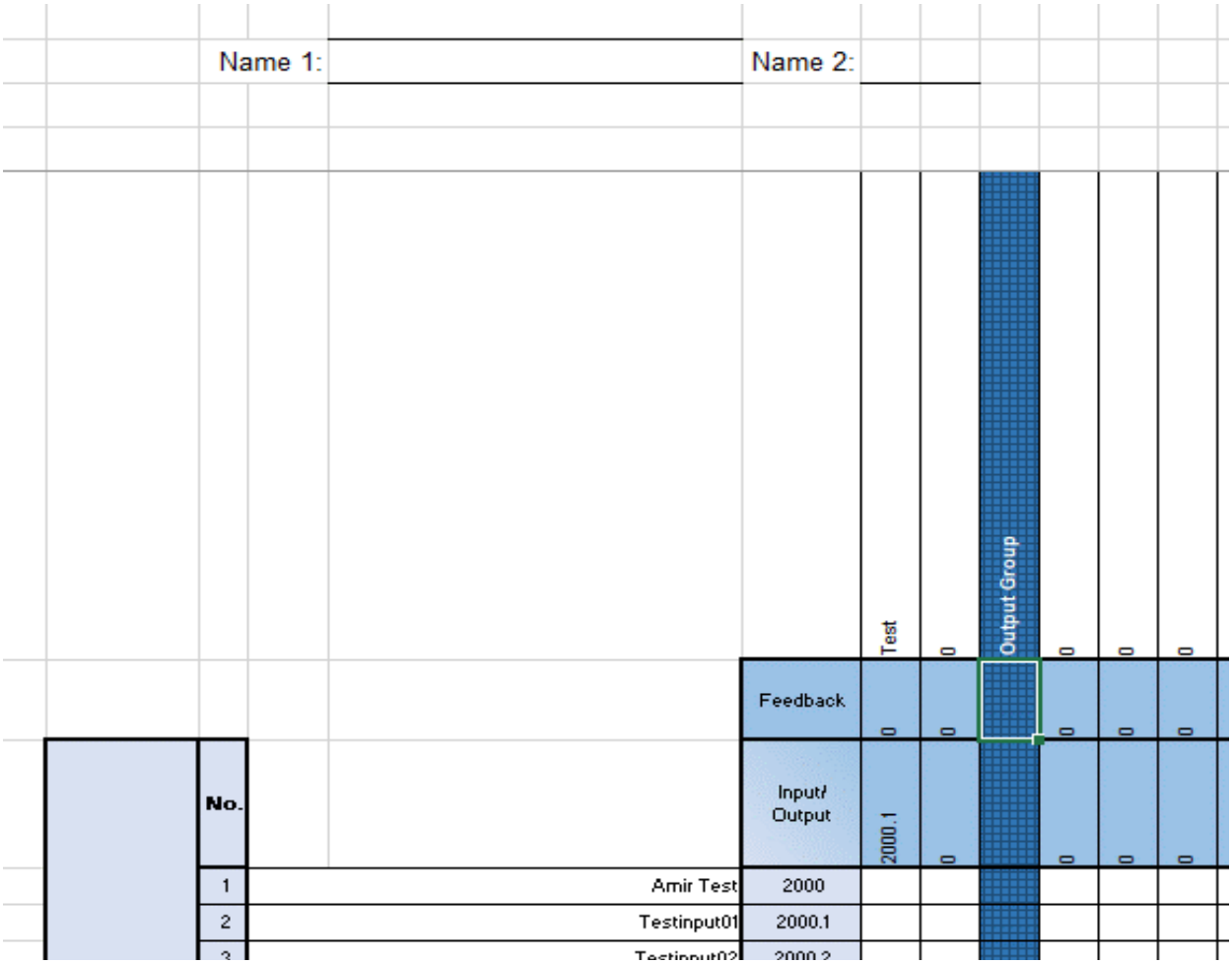
This graphic shows information marked in blue which is the same from the table "Information on the machine" a
The areas "Signature" and "Tested" marked in red must be completed.

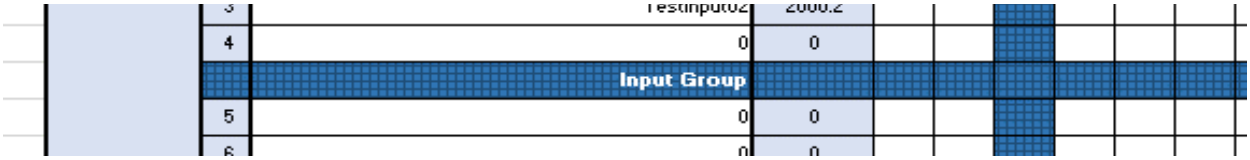


The adjacent figure of a Safety Buyoff illustrates which Safety Input addresses which Safety Output and how.



For zoning and grouping of inputs/outputs, right click and insert a row or column into the matrix. This row/columr





Hide and Unhide Rows to better view or print active content

Example:

- The Safety Input E-STOP channel1+HMI01 was activated.
  - ➢ Due to the selection of the code number in the Safety Buyoff, Main Valve 1 (and others) wa

Key Legend:

Type of Safety Check: (Uses conditional formatting - just type

1	Safety input does not switch off the actuator
2	Safety input switches off, no bypass of safety input
3	Safety input switches off, bypass with bypass switch is possible
4	Safety input switches off, bypass with bypass switch or bypass switch of robot in test mode possible
5	Safety input does not switch off the actuator, but needs to be ok to reactivated
6	Can be bypassed to reset emergency stop when feeder is away from machine
99	Status of safety output not relevant
22	Safety input switches off, maximum release time for laser source is limited to **60 seconds**

10	Maintenance bypass mo bypass key is switched
98	Function in a separate M
97	Safety input switches off off in the event of a yarn
12	First special fire handling
7	Safety input switches off pneumatic brake release
96	Input switches safety ou
8	Status of safety output w is possible
33	Run grounding sequenc

NOTE: The Safety Buyoff shown here has been used as an example for this description. It is adapte
For this reason, the exact positions of the channels or the respective E-Stops, reset buttons, bypass

3.1. Reset/Power On:

The Reset column shows which button can be used to switch the machine on again if a Safety Input/E-Stop has

3.2. Bypass:

The Bypass column shows whether or which key switch can be used to bypass functions.

3.3. Teach panel:

The Teach panel column shows whether or with which teach panel the safety input can be bypassed.

The example illustrates that if E-Stop 1 was pressed, the machine can only be switched on again by pressing th

SafetyMatrix.xlsx

			Safety Outputs									Reset		Bypass		each Par	
		No.	1	2	3	4	5	6	7	8	9	1	2	1	2	1	2
			Main valve 1	Main valve 2	load voltage 2L valve manifold #1 VAM1	E-STOP conveyor	safe torque off (STO) Servogroup 1	safe operational stop (SOS) Servogroup 1	safe limited speed (SLS) Servogroup 1	Plasma cleaning E-STOP	Plasma cleaning safety cover	Pushbutton Power On +HMI01	Pushbutton Power On +OPA03	Bypass key Enable +HMI01	Bypass key Enable +OPA03	Release Button Mobile Panel	Release Button Mobile Panel
		Feedback	12.1/2	12.3/4	0	11.0	0	0	0	0	0						
	No.	Input/ Output	1000.0	1000.1	1200.0	1010.0/1	1140.2/3	1150.0/1	1150.2/3	1210.0	1210.1	52.3	53.3	52.4/5	53.4/5	1100.3/7	1120.3/7
Safety Inputs	1	E-STOP channel1 +HMI01	1100.0/4	2	2	2	2	2	99	99	2	2	x					
	2	E-STOP channel1 +OPA01	1100.1/5	2	2	2	2	2	99	99	2	2	x					
	3	E-STOP channel 1 +OPA03	1110.1/5	2	2	2	2	2	99	99	2	2		x				
	4	safety switch front cover closed +SDS01	1120.0/4	5	5	3	2	1	3	2	1	2	x		x		x	
	5	Safety switch front control cover +SDS01	1110.0/4	5	5	3	2	1	3	2	1	2	x		x		x	
	6	safety switch rear cover closed +SDS02	1120.1/5	5	5	3	2	1	3	2	1	2		x		x		x
	7	safety switch front door conveyor closed +SDS07	1110.2/6	5	5	3	2	1	3	2	1	2	x		x		x	
	8	safety switch front door conveyor closed +SDS08	1110.3/7	5	5	3	2	1	3	2	1	2		x		x		x
	9	flow sensor exhaust plasma cleaning	65.6	1	1	1	1	1	1	1	2	1	x	x				

4. SafetyServoGrp

For each SafetyServoGrp, a servo group has been grouped together, which can consist of one or more axes. Ea
Always complete the information the red area.
All tested axes must be marked.

Machine:	TSL-999-ST099		
	Name	Date	Signature
Servo Safety programmed:	Max Mustermann	25. Okt	
Configuration CRC:	4176145868		
Program CRC:	742196466		
Transfer counter:	2		

hier muss alles ausgefüllt sein

Operating mode				Safety inputs			Machine condition	Safety outputs/status						
								IPC			Servo			
Bypass Key														
Automatic	Manual	Description	Speed	E-STOP	Cover	Mobile panel release button	Description	SLS	SOS	STO	Display Servo (digit 1)	Position control	Description	Tested (x)
								0	0	0				
1	0	Machine stands		1	1	0	All safety guards active + machine ready	1	1	1		1	Movement can be started	x
1	0	Move axis	> 50 mm/s	1	1	0	All safety guards active	1	1	1		1	Axis moves	x
1	0	Activate E-Stop during motion	> 50 mm/s	0	1	0	Machine stopps all movements	1	1	0	5	0	Axis stopps immediately, position control inactive	x
1	0	Reset E-Stop		R	1	0	Reset-Signal	1	1	1		1	Movement can be started	x
1	0	Move axis	100 mm/s	1	1	0	All safety guards active	1	1	1		1	Axis moves	x
1	0	Open cover during motion	100 mm/s	1	0	0	Safety switch detects open cover	0	0	1		0	Axis stopps immediately, Position control inactive	x
1	0	Reset error and enable servo		1	R	0	Servo switches back to SOS mode	0	0	1		1	Position control active	x
1	0	Move axis	> 50 mm/s	1	0	0	SOS monitoring switches servo to STO	0	0	1	5	0	Position control inactive	x
1	0	Reset error and enable servo		1	R	0	Servo switches back to SOS mode	0	0	1		1	Position control active	x
0	1	Switch to manual mode		1	0	0	Servo stays in SOS mode	0	0	1		1	Position control active	x
0	1	Move axis	> 50 mm/s	1	0	0	SOS monitoring switches servo to STO	0	0	0	5	0	Position control inactive	x
0	1	Reset Error and enable servo		1	R	0	Servo switches back to SOS mode	0	0	1		1	Position control active	x
0	1	Push mobile panel release button		1	0	1	Servo switches to SLS mode	0	1	1		1	Position control active	x
0	1	Move Axis	45 mm/s	1	0	1	Servo is in SLS mode	0	1	1		1	Axis is moving	x
0	1	Move Axis	51 mm/s	1	0	1	SLS monitoring switches servo to STO	0	1	0	5	0	Axis stopps immediately, position control active	x
0	1	Reset error		1	R	0	Servo switches back to SOS mode	0	0	1		1	Position control active	x

5. Check Safety Buyoff

5.1. E-Stop's:

5.1.1. Switch on the system.

5.1.2. Activate the first E-Stop.

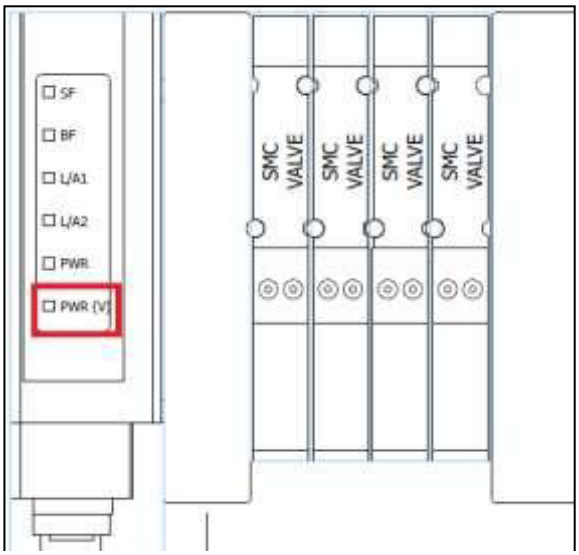
Example: E-Stop+HMI01

- Check on the PLC whether the corresponding inputs are de-energized.
  - ➢ Check that all outputs marked with the code number 2 in the Safety Buyoff are de-ene

Example:

- You actuate an E-Stop and check whether the voltage on the valve terminal drops.
  - ➢ The LED PWR (V) on the valve terminal switches off.

NOTE: If several actuators are connected in series, all must be checked.

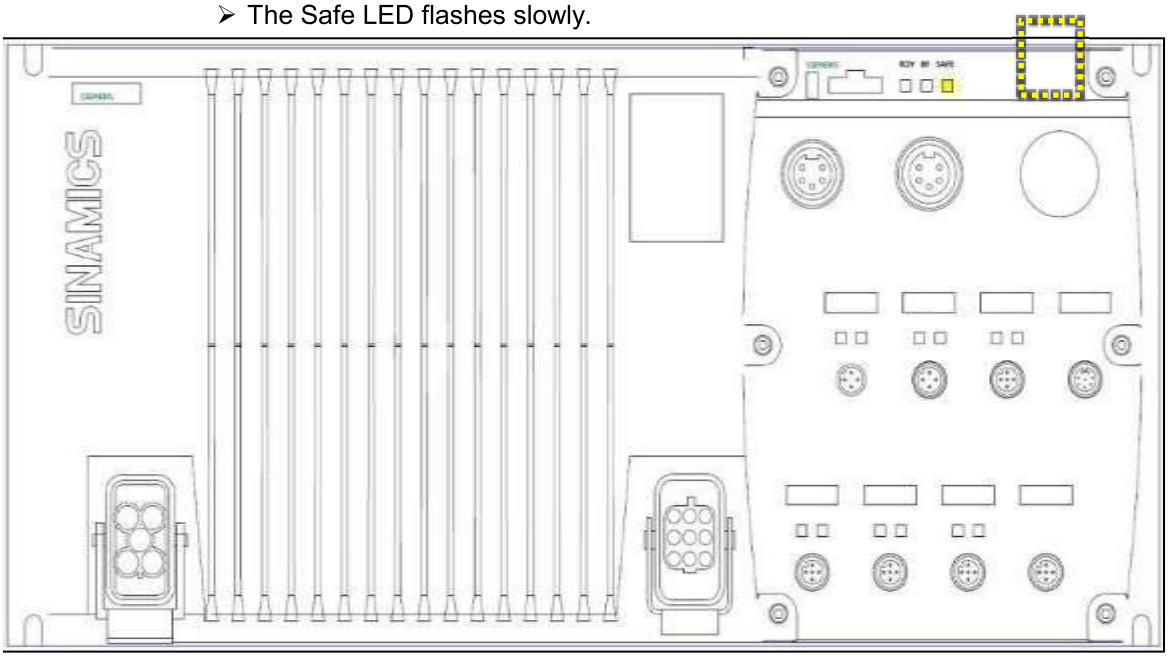


5.1.3. Check that all end consumers (actuators) connected to these outputs switch off.

5.1.4. Check the feedback signal if necessary, as described in chapter 2.3.3.

Example:

- You activate an E-Stop and check whether the frequency inverter has switched to the secured mod
  - ➢ The Safe LED flashes slowly.



NOTE: If it is possible to switch the machinery on again from several positions, each individual possil
If the machine is only to be switched on again from one or more specific points, this must also be tes

NOTE: Unlike before, now only the I/Os at the PLC have to be checked for the correct drop, since th

5.1.7. Actuate the next E-Stop.

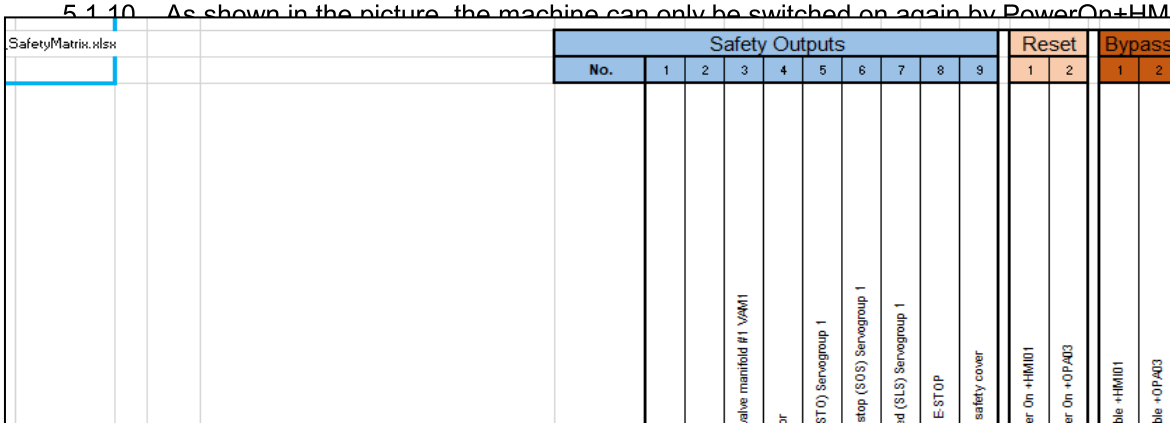
5.1.8. Check whether the corresponding inputs on the PLC are de-energized.

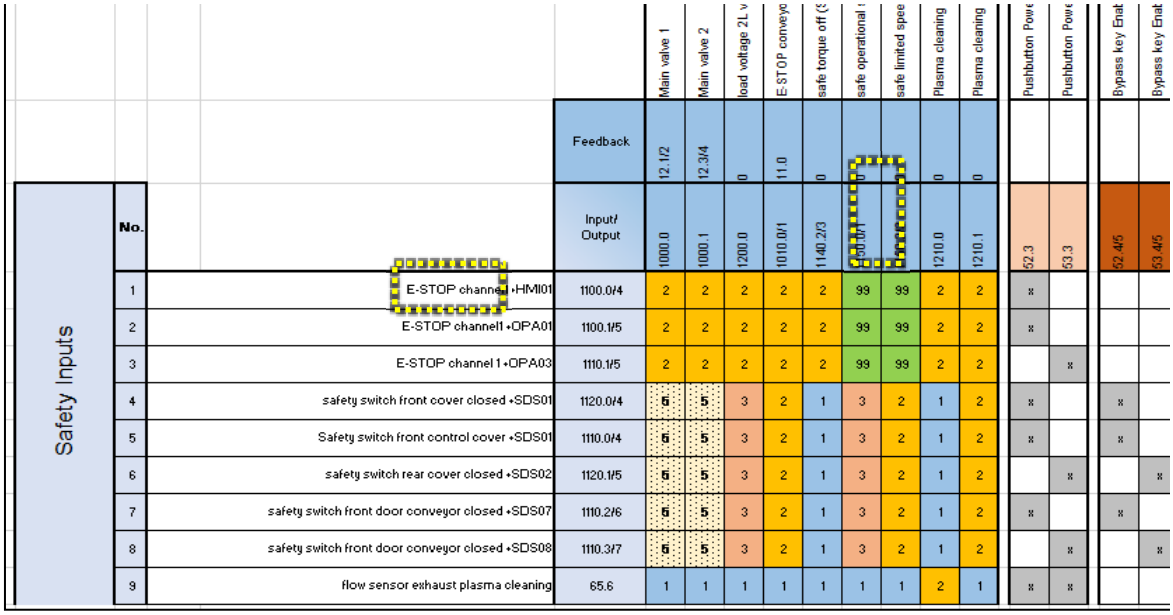
Example:

- E-Stop+OPA03 is actuated.
  - ➢ 1150.0 und 1150.4 are de-energized

5.1.9. Perform a plausibility check as described in Chapter 2.3.2.

5.1.10. As shown in the picture, the machine can only be switched on again by PowerOn+HM





Safety Inputs	No.		Input/ Output	Main valve 1	Main valve 2	load voltage 2L v	E-STOP conveyo	safe torque off (S	safe operational	safe limited spee	Plasma cleaning	Plasma cleaning	Pushbutton Powe	Pushbutton Powe	Bypass key Enat	Bypass key Enat
		Feedback		12.1/2	12.3/4	0	11.0	0	0		0	0				
				1000.0	1000.1	1200.0	1010.0/1	1140.2/3	1100.1/1		1210.0	1210.1	52.3	53.3	52.4/5	53.4/5
	1	E-STOP channel +HMI01	1100.0/4	2	2	2	2	2	99	99	2	2	x			
	2	E-STOP channel1 +OPA01	1100.1/5	2	2	2	2	2	99	99	2	2	x			
	3	E-STOP channel 1 +OPA03	1110.1/5	2	2	2	2	2	99	99	2	2		x		
	4	safety switch front cover closed +SDS01	1120.0/4	5	5	3	2	1	3	2	1	2	x		x	
	5	Safety switch front control cover +SDS01	1110.0/4	5	5	3	2	1	3	2	1	2	x		x	
	6	safety switch rear cover closed +SDS02	1120.1/5	5	5	3	2	1	3	2	1	2		x		x
	7	safety switch front door conveyor closed +SDS07	1110.2/6	5	5	3	2	1	3	2	1	2	x		x	
	8	safety switch front door conveyor closed +SDS08	1110.3/7	5	5	3	2	1	3	2	1	2		x		x
	9	flow sensor exhaust plasma cleaning	65.6	1	1	1	1	1	1	1	2	1	x	x		

NOTE: All other E-Stops will be tested like the second E-Stop! The I/O's are only checked at the PLC

Exception:

If a control area is so large that it consists of several E-Stop areas, each change to a new area requi

5.2. Plausibility check:

5.2.1. Remove a channel from an E-Stop.

5.2.2. Check that the machine is switched off.

Example:

- Channel 1100.1 is removed from E-Stop+OPA01.
  - ➢ The machine switches off (E-Stop).

5.3. Feedback Signals:

5.3.1. Switch the machine on again.

5.3.2. Remove a Feedback signal (Fig.16)

5.3.3. Actuate an E-Stop.

5.3.4. Check whether the machine switches.

Example:

- Remove feedback signal 12.1 from Main Valve 1

5.3.5. Try switching the machine on again.

➢ The control system must malfunction and the machine cannot be switched on again.

5.4. Safety Input (e.g. Covers):

5.4.1. Turn the machine on again.

5.4.2. Actuate a Safety Input (open a cover)

Example:

- You opened "Safety Input front cover closed+SDS01".
  - ➢ The functions defined in the matrix should be switched off.

5.4.3. Check whether the corresponding inputs at the PLC are de-energized.
5.4.4. Check that all outputs specified in the Safety Buyoff are de-energized at the PLC.
5.4.5. Check whether all actuators connected to these outputs switch off.
5.4.6. Switch the machine on again.

NOTE: Since opening a cover does not always switch off all areas of the machine, it is important to c
If certain actuators cannot be seen from the outside or if time is to be saved, an IO test must be carri

5.4.7. Actuate the next Safety Input.
5.4.8. Check the I/O for correct drop-out at the PLC.

5.5. Bypass-Function:

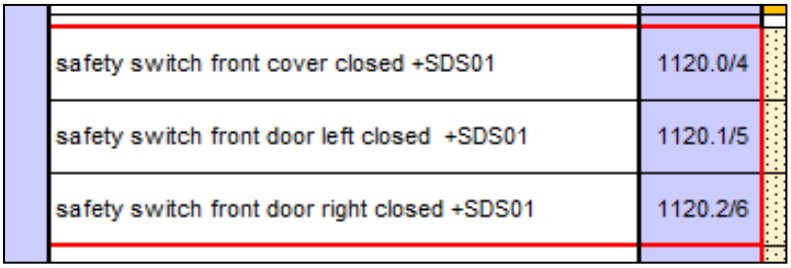
5.5.1. Actuate a Safety Input that can be bypassed according to the Safety Buyoff.
5.5.2. Turn the Bypass Key so that it clicks into place.
5.5.3. Press and hold the release button on the teach panel.
5.5.4. Press the corresponding Power On button.
5.5.5. Check whether the functions marked in the Safety Buyoff are switched on again.
5.5.6. Check that the non-bypassable actuators are not switched on.

5.6. Function: Not all components in known position:

NOTE: The risk analysis shows which cylinders are hazardous cylinders.

5.6.1. Disconnect an end position sensor from a dangerous cylinder, which is currently active
5.6.2. Switch the machine on.
5.6.3. Open the cover.
➢ The main valves switch off.

NOTE: As a rule, only one Safety Input (hood) can be bridged. If several Safety Inputs are actuated (
Exception:
If several Safety Inputs (covers) are marked with a red border in the Safety Buyoff, this means that th
Example:
There are 3 covers combined into one so that the hoods can be bridged regardless of whether only 1



NOTE: If there is more than one Bypass key/Teach panel, they are only responsible for a certain are
Example:
The Safety Inputs (covers) at the front have been combined to form a group. This means that this gr
All possibilities to activate the Safety Inputs (1, 2 or all three covers open) are now to be checked for

		afety actuato			Bypass Key		Teach Pane	
		main valve 1 compressed air on	main valve 1 compressed air on	Load voltage +VAM1 supply SM	Bypass key Enable +HMI01	Bypass key Enable +OPA03	Release button Mobile Panel 1	Release button Mobile Panel 2
	Feedback	12.1/2	12.3/4	0				
	Input/ Output	1000.0	1000.1	1200.0	52.4/5	53.4/5	1100.3/7	1110.3/7
safety switch front cover closed +SDS01	1120.0/4	5	5	3	x		x	
safety switch front door left closed +SDS01	1120.1/5	5	5	3	x		x	
safety switch front door right closed +SDS01	1120.2/6	5	5	3	x		x	
safety switch rear door left closed +SDS02	1120.3/7	5	5	3		x		x
safety switch rear door right closed +SDS02	1130.0/4	5	5	3		x		x
safety switch rear above +SDS02	1130.1/5	5	5	3		x		x
E-STOP Line	ProfiSafe	2	2	2				

Operating mode				Safety inputs			Machine condition	Safety outputs/status						Tested (x)
Bypass Key								IPC			Servo			
Automatic	Manual	Description	Speed	E-STOP	Cover	Mobile panel release button	Description	SLS	SOS	STO	Display servo (digit 1)	Position control	Description	
1	0	Machine stands		1	1	0	All safety guards active + machine ready	1	1	1		1	Movement can be started	
1	0	Move axis	> 50 mm/s	1	1	0	All safety guards active	1	1	1		1	Axis moves	
1	0	Activate E-Stop during motion	> 50 mm/s	0	1	0	Machine stopps all movements	1	1	0	5	0	Axis stopps immediately, position control inactive	
1	0	Reset E-Stop		R	1	0	Reset-Signal	1	1	1		1	Movement can be started	
1	0	Move axis	200 mm/s	1	1	0	All safety guards active	1	1	1		1	Axis moves	
1	0	Open cover during motion	100 mm/s	1	0	0	Safety switch detects open cover	0	0	1		0	Axis stopps immediately, Position control inactive	
1	0	Reset error and enable servo		1	R	0	Servo switches back to SOS mode	0	0	1		1	Position control active	
1	0	Move axis	> 50 mm/s	1	0	0	SOS monitoring switches servo to STO	0	0	1	5	0	Position control inactive	
1	0	Reset error and enable servo		1	R	0	Servo switches back to SOS mode	0	0	1		1	Position control active	
0	1	Switch to manual mode		1	0	0	Servo stays in SOS mode	0	0	1		1	Position control active	
0	1	Move axis	> 50 mm/s	1	0	0	SOS monitoring switches servo to STO	0	0	0	5	0	Position control inactive	
0	1	Reset Error and enable servo		1	R	0	Servo switches back to SOS mode	0	0	1		1	Position control active	
0	1	Push mobile panel release button		1	0	1	Servo switches to SLS mode	0	1	1		1	Position control active	
0	1	Move Axis	45 mm/s	1	0	1	Servo is in SLS mode	0	1	1		1	Axis is moving	
0	1	Move Axis	51 mm/s	1	0	1	SLS monitoring switches servo to STO	0	1	0	5	0	Axis stopps immediately, position control active	
0	1	Reset error		1	R	0	Servo switches back to SOS mode	0	0	1		1	Position control active	

5.7. Testing the axis amplifier

NOTE: These tests can only be performed by a programmer or in collaboration with a programmer.

The various axes are listed on the various pages of the "SafetyServoGrp" in the Excel table.
The steps contained in the tables must be checked in the given order.
All axes must be decoupled before testing. After the tests, make sure that the axes are recoupled!
After the test, sign off in the "Tested" column!

Example:

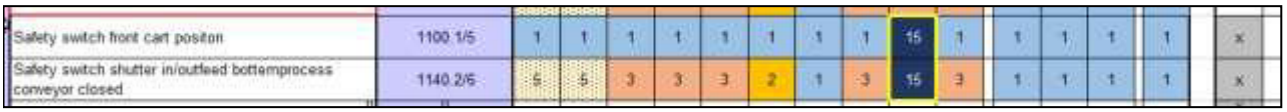
- Switch the machine on
- Open a cover during operation.
- Check whether the axis stops.
- Reset the Safety Input (Cover)
- Check that the position control is active and that the axis switches to SOS mode.
- Move the axis.
- Check whether the axis changes to STO mode and thus becomes de-energized.
  - ➢ A flashing "S" is shown on the axis amplifier.
- Switch the axis on again.
- Check if the position control is active and if the axis switches to SOS mode.

6. Special functions

The functions described below are not used in every machine. Here is an excerpt of the possibilities.

6.1. Safety Inputs that do not function as door switches:

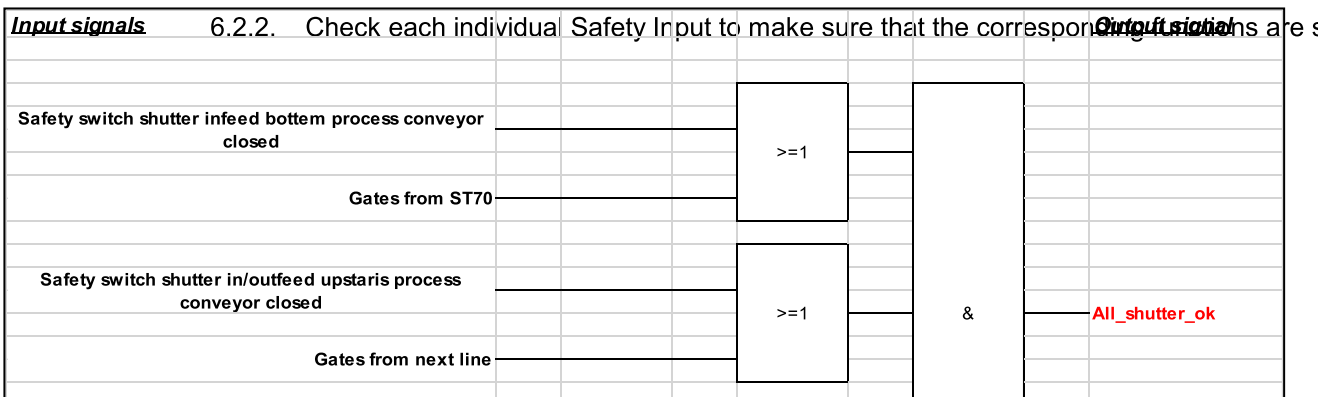
These Safety Inputs are never active alone. They are always active only in conjunction with another Safety Input
Only if both Safety Inputs are active together can, for example, an unloading trolley be undocked or docked.
These Safety Inputs are marked separately in the Safety Buyoff.



6.2. Shutter:

6.2.1. Check all shutters with the same procedure as the E-Stops.

NOTE: The shutter inputs usually have no direct effect on the Safety Buyoff
Instead, they are merged via a Shutter Safety Logic, which can only be checked at the PLC.
Each individual Shutter Safety Logic can be taken from the corresponding page of the Excel table.



6.2.2. Check each individual Safety Input to make sure that the corresponding functions are s

Safety switch shutter in/outfeed bottemprocess conveyor closed									

6.3. Flow sensor:

NOTE: The setting of the flow sensor must be adapted to the process or machine in advance.

6.3.1. Check the Flow sensors.

6.4. Smoke detectors:

NOTE: The settings for the alarm levels of the smoke detector must be preset.

6.4.1. Check the smoke detector e.g. using smoke sticks

6.5. Non-safe inputs for Z-axes:

NOTE: The Z-axis_safety_process_logic, as well as the Matrix_none_save_inputs are to be taken fr

6.5.1. Check the non-safe inputs for Z-axes.

ıs deactivated.

(Use Format Painter to

the number)

Special Input/Output C

ıde; safety input does not switch off actuator when conveyor

/latrix

, no bypass of Safety Input; the laser unit must be switched
break at the line of lamp or lamp-end defect.

g than COVER OPEN (see fire handling sheet)

, no bypass of safety input (200ms delay for switch-on after
e)

tput

/ill not change when doors open, bypass with bypass switch

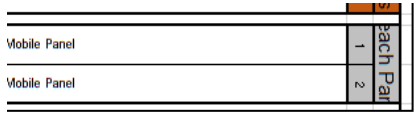
e

	If not all cylinders are in end position covers" is required
	Bypass with bypass switch is possibl
x	Line input signals, machine input sig
	Feedback error shuts off main valves
	Two-hand-function; both buttons mus button is released, the function is ab
	Light curtain directly connected to SI necessary, just testing
	Mobile panel will bypass marked outp
x	Door lock released with a delay of 2(
	Needs to be reset separately for rele

d specifically for each machine.

keys and connections for the teach panel can be found in the E-Plan of the respective machine.

been activated.


Mobile Panel
Mobile Panel
1
2
each Par

		x		x	x				1100.3/7		Release Button M
	x		x						1120.3/7		Release Button M

apply manually)

ategorization:

, the air must be switched off when "release

e (for framed group)

nals have a higher priority for bypass handling

s

st be pressed synchronously within 0.5s. If a
orted.

CK UE10 safety relay, no SW action at F-PLC

puts

) sec

asing main valves