

Safety PLC Pluto

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Pluto Safety PLC facilitates the design of your safety systems

Pluto is an All-Master system for dynamic and static safety circuits where inputs and other information are shared over the bus. Multiple safety sensors can be connected to a single input and still achieve the highest level of safety. Pluto has inputs suited for every safety product on the market, and each input function is configured in the accompanying software Pluto Manager.

Besides failsafe inputs (I) Pluto has a number of failsafe relay and transistor outputs (Q). On every Pluto unit there is also a possibility of using a number of terminals as failsafe inputs, non-failsafe outputs or both in and output simultaneously (IQ). The characteristics of the terminals are easily configured in Pluto Manager.

Safety in large and small systems

Pluto models with bus communication can be connected to the Pluto bus where up to 32 Pluto units can interact and control large as well as small safety systems. The fact that Pluto is an All-Master system means that each Pluto unit controls their outputs locally, while it is as easy to read other Pluto units' inputs as their own. It is also easy to both read and write to global memory locations available across the Pluto bus.

Gateways can be connected to the Pluto bus for communication with other systems. The gateway models GATE D2 and C2 can also be used as an extension of the bus cable to

Approvals:



Control of:

- Safety products in dynamic and static circuits
- Electrically controlled actuators such as contactors, valves, motors
- Indicators and buttons

Features:

- A Safety-PLC for each system part
- Dispersed constructions of machines
- Great flexibility
- Up to 10 sensors in series connected to one input
- Software Pluto Manager free of charge
- Handles conventional circuit breakers as well as dynamical sensors
- Custom made safety bus

extend the Pluto network. You can also connect speed and position sensors via the Pluto bus.

Pluto is primarily designed to satisfy the requirements of EU Machinery Directive (2006/42/EG) regarding safety in control systems, but the system can also be used in other areas as in the process industry, boiler plants etc which have similar requirements.

Single Pluto - Pluto without safety bus

The Pluto models S20 and S46 without bus communication are stand alone units which are perfectly suited for smaller systems that do not require communication with other Pluto units or gateways. In all other ways the S20 has the same functionality as the B20 model, and the S46 as the B46 model – but without a safety bus connection.

Current monitoring (Pluto A20 only)

Pluto A20 differs from the other models in that it can monitor the current through the IQ16 and IQ17 outputs. The function is designed for, but not limited to, ensuring that the muting lamps are working. The hardware for current monitoring is not designed with individual redundancy, which means that the function must be used dynamically if it is to be used in a

safety function. This means that the current must be read and evaluated both when the output is enabled and disabled.

Pluto for the AS-i system

Pluto AS-i can either be AS-i master on the AS-i bus or work together with an AS-i master as a monitor. It includes AS-i nodes, analogue and digital outputs, as well as safety outputs. Also available as Pluto B42 AS-i for more I/O. For more information see the AS-i safety chapter.

Pluto D20 and D45 - with analogue inputs

Pluto D20 is equipped with 4, and Pluto D45 with 8, safe 4-20mA/0-10V analogue inputs. These can be configured as either "ordinary" failsafe inputs, as analogue inputs 0-10V or as analogue inputs 4-20mA. For an application to reach SIL 3/PL e it is required that two sensors in parallel with one input each are being used.

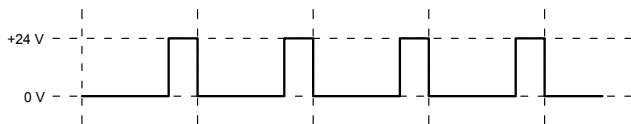
Counter inputs Pluto D45

For Pluto D45 four of the analogue inputs can be configured as counter inputs (pulse counting) which work for frequencies up to 14000 Hz. As counter inputs IA0 – IA3 can be used in two ways, Up counting or Up/Down counting.

Pluto B22 - expansion module with increased number of inputs

Pluto B22 is an expansion module without safety outputs. It is equipped with 14 safe inputs and 8 safe inputs or non-safe outputs.

Technical info - Dynamic signal



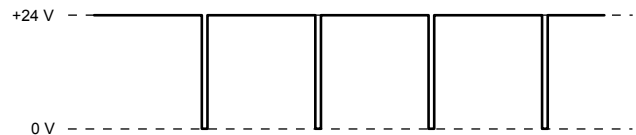
A dynamic signal makes it possible to achieve the highest level of safety with only one conductor. By transmitting a square wave and then evaluating the signal when it comes back to the controller you achieve the redundancy required. The signal is inverted once at each safety sensor (if the protection is OK) which makes it possible to detect short circuits across a sensor. When the signal switches between high (+24 V) and low (0V) it can be evaluated and tested about 200 times per second.

Pluto can generate three unique dynamic signals; A pulse, B pulse or C pulse. Short circuits between two different dynamic signals are detected whenever the signal that is created is different from the expected signal in Pluto. The kind of signal Pluto expects at the input terminal is determined in Pluto Manager (A, B or C pulse and if the signal should be inverted or not).

Technical info - Static signal

Static signals (+24 V or 0 V) can be connected to all inputs on Pluto. The kind of signal Pluto expects at the input terminal is determined in Pluto Manager. To achieve a two-channel structure according to EN ISO 13849-1 you need two inputs.

Technical info - OSSD-signal



There are safety products with internal monitoring of dual OSSD signals (the device detects its own faults rather than Pluto doing this). From these devices, at least one of the two signals is connected to an I-input in Pluto, i.e. both signals must not be connected to the IQ-terminals. The terminal blocks are then configured in Pluto Manager to expect static inputs (OSSD signals are filtered internally in Pluto).

IQ – individual failsafe inputs and non-failsafe outputs

The IQ terminals can be used either as individual failsafe input or non-failsafe output (e.g. for indicator light or status signal). The terminal blocks can also be used as both input and output simultaneously, which is useful for example for push buttons (input) with indicator light (output). This function is designed primarily for reset buttons to reduce the number of used terminal blocks on the controller.

Technical info - I - individual failsafe inputs

All inputs are individually failsafe as each input is connected separately to both processors in Pluto. In order to maintain the redundancy required for two-channel structure and the highest level of safety, the dynamic signal must be used. When using static signals, two inputs must be used to achieve two-channel structure. The expected signal to the terminals blocks is determined in Pluto Manager (static or dynamic signal).

Technical info - Q - individual failsafe outputs

All Q outputs are individually safe and are independently programmable. There are both relay outputs and transistor outputs.

Technical info - Transistor outputs (-24 VDC)

The transistor outputs are just like the relay outputs, that is individually safe and independently programmable. However, the transistor outputs are different from the relay outputs as the internal connection provides the nominal input voltage -24 VDC, which is primarily intended for controlling electromechanical components such as contactors and valves. As -24 VDC is a unique signal in the majority of electrical cabinets and the fact that the output is monitored by Pluto, short circuits with other potentials can be detected right away.

Technical info - Pluto-bus

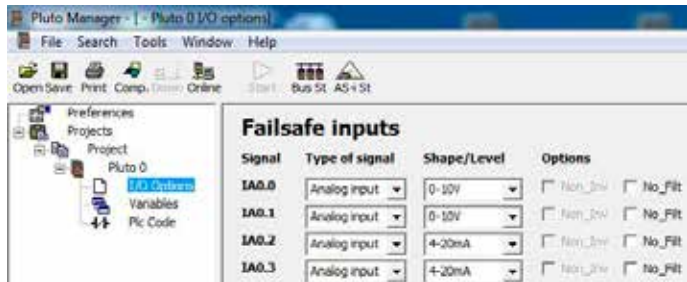
The Pluto-bus is a CAN-bus with its own safety protocol. The bus cable can be up to 600 m long at the minimum bus speed, and up to 150 m at 400 kb/s. The bus can be both extended and connected to other types of buses through gateways.

Function Blocks for Analogue inputs Pluto D20 and D45

Configuration in Pluto Manager

The inputs can be configured under “I/O Options” in Pluto Manager. As analogue inputs they can be configured either as 0-10V inputs, or as 4-20mA inputs. For Pluto D45 they can also be configured as Counter inputs.

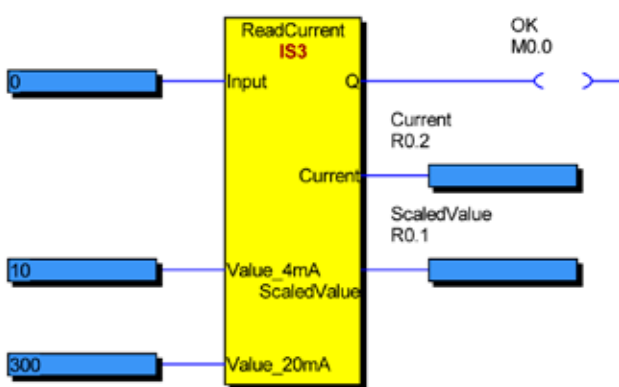
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IA0.0 and IA0.1 are configured as Analogue input 0-10V, and IA0.2 and IA0.3 are configured as Analogue input 4-20mA.

ReadVoltage and ReadCurrent function blocks

For analogue input 0-10V the function block “ReadVoltage” is needed, and for analogue input 4-20mA the function block “ReadCurrent” is needed. There are also 32-bit versions of these function blocks (“ReadVoltage_32” and “ReadCurrent_32”) for use with Double Registers. As output from the blocks there is one output with the absolute value in V or mA, and one output which can be scaled as desired. The picture and table below shows the “ReadCurrent” function block only, but “ReadVoltage” works in the same way.



ReadCurrent function block. Description of inputs and outputs:

inp	Input connected to the block.
Value 4mA	Input value for scaling. At 4mA the output “Scaled value” will show this value.
Value 20mA	Input value for scaling. At 20mA the output “Scaled value” will show this value.
Q	OK output. Value is within range.
Current	Output with calibrated absolute value in μ A.
Scaled Value	Output with scaled value.

Counter inputs Pluto D45

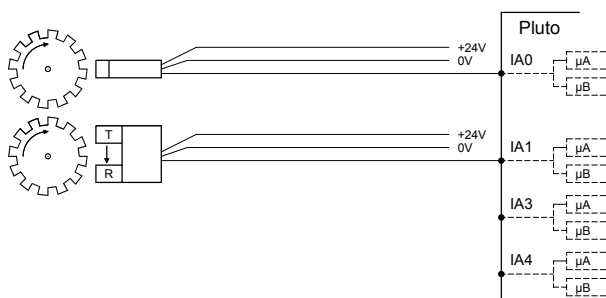
For Pluto D45 the inputs IA0 – IA3 can be configured as counter inputs (pulse counting). As counter inputs IA0 – IA3 can be used in two ways, Up counting or Up/Down counting.



Configuration of counter input

Up count

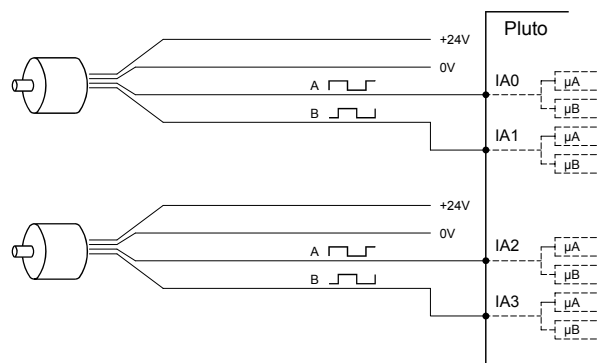
When the input is configured for Up count Pluto counts the pulses on the input. Via a function block the user gets the pulse rate which for example can represent a speed. The sensor can be anything, like an inductive sensor, photocell or incremental encoder (HTL, 24V).



Example of speed monitoring. The sensors can for example be proximity switches or photocells. Any of the inputs IA0..IA3 can be used.

Up/Down count

With the function Up/Down count it is possible to detect the direction of the movement. A pair of inputs, IA0/IA1 and/or IA2/IA3 can be configured as Up/Down counters. In order to make up/down counting it requires that the sensors can produce A/B-pulses. A/B-pulses are two square wave signals that are 90° phase shifted to each other. The sensor is typically an incremental encoder with HTL (24V) interface.



Example of speed monitoring with incremental encoders leaving A and B pulses to two inputs, IA0-IA1 or IA2-IA3. The direction is then possible to measure.

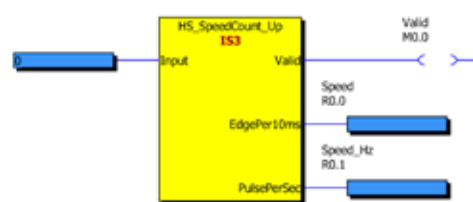
Sensor types

The upper frequency limit is dependent on the type of sensor. For incremental encoders with HTL output (“push – pull”) the counter inputs work for frequencies up to 14 kHz.

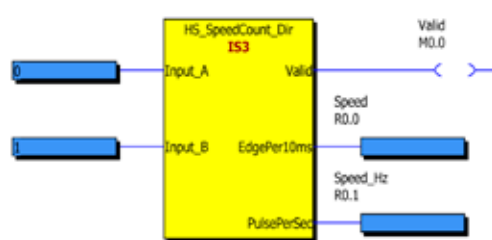
For photocells, proximity switches, inductive sensors etc. which normally do not have a “push – pull” output the maximum frequency might typically be 1 – 4 kHz, but the limit is also dependent on the output resistance, the cable length etc.

Function blocks for speed monitoring

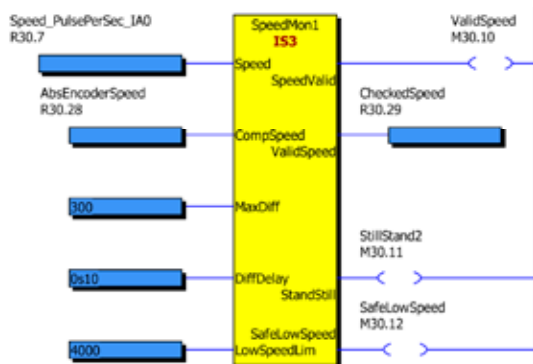
For inputs configured as Up count the function block “HS_SpeedCount_Up” shall be used.



For inputs configured as Up/Down count the function block “HS_SpeedCount_Dir” shall be used.



The function block “SpeedMon1” is intended to be used for redundant speed monitoring, but has also functions for stand still monitoring and safe low speed. It has two inputs for speed values. These input registers can take their values from different sources such as the function blocks for incremental encoders, absolute encoders, analogue inputs etc. The input “Speed” is a primary input for a speed value and “Comp-Speed” is a secondary channel for monitoring the correctness of the primary speed value.



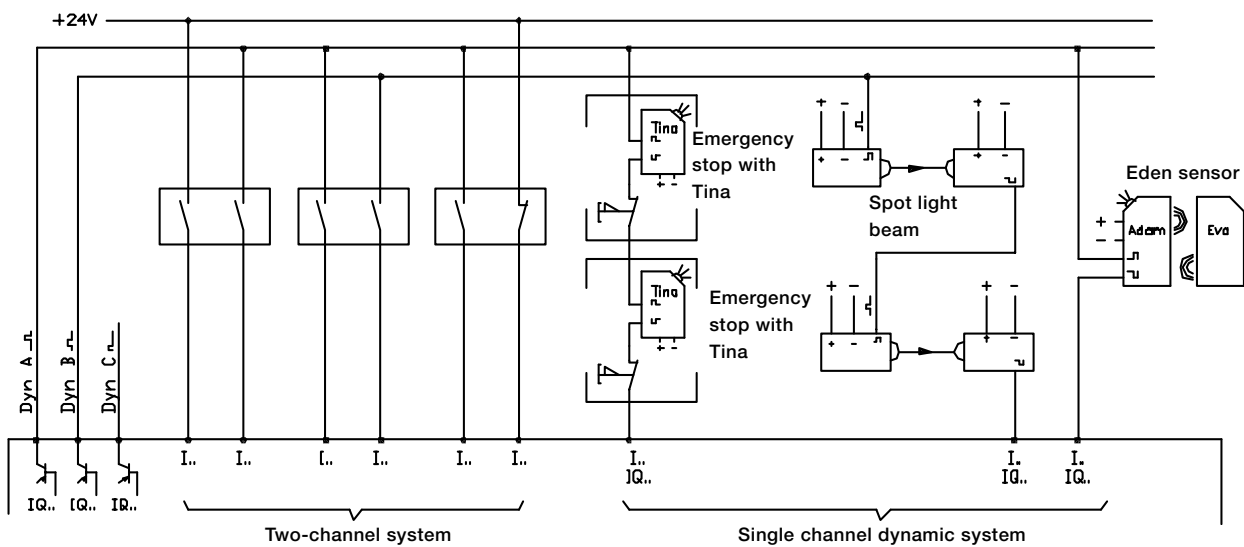
Input connection

The system offers solutions for both single and two-channel safety devices. In order to monitor wiring short-circuits it is possible to use up to three different dynamic signals and static voltage (+24 V) to supply the inputs. The inputs are then programmed to only accept one of the signal types.

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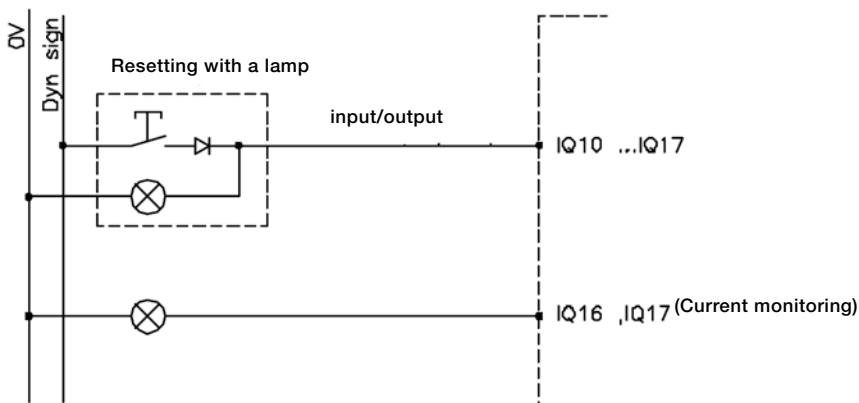
In a two-channel system both channels will be measured, using two different signals. The system will thereby be able to detect a short-circuit between the channels.

In a single channel system the dynamic signal is modified at each sensor. A short-circuit between the input and the output of the sensor will be detected at the Pluto input. PL e according to EN ISO 13849-1 can thus be achieved by using only one channel and one input.



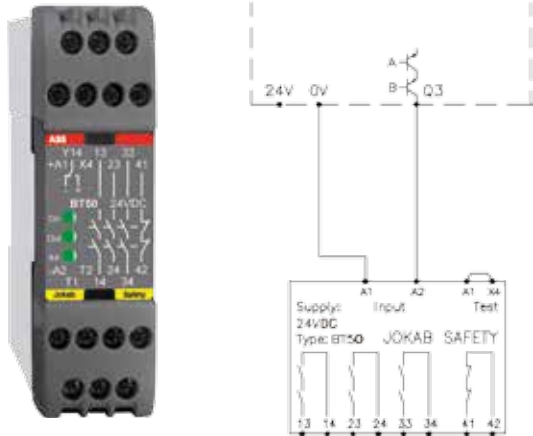
Input connection alternative in accordance with PL e EN ISO 13849-1.

Reset button that uses the combined input and output facility



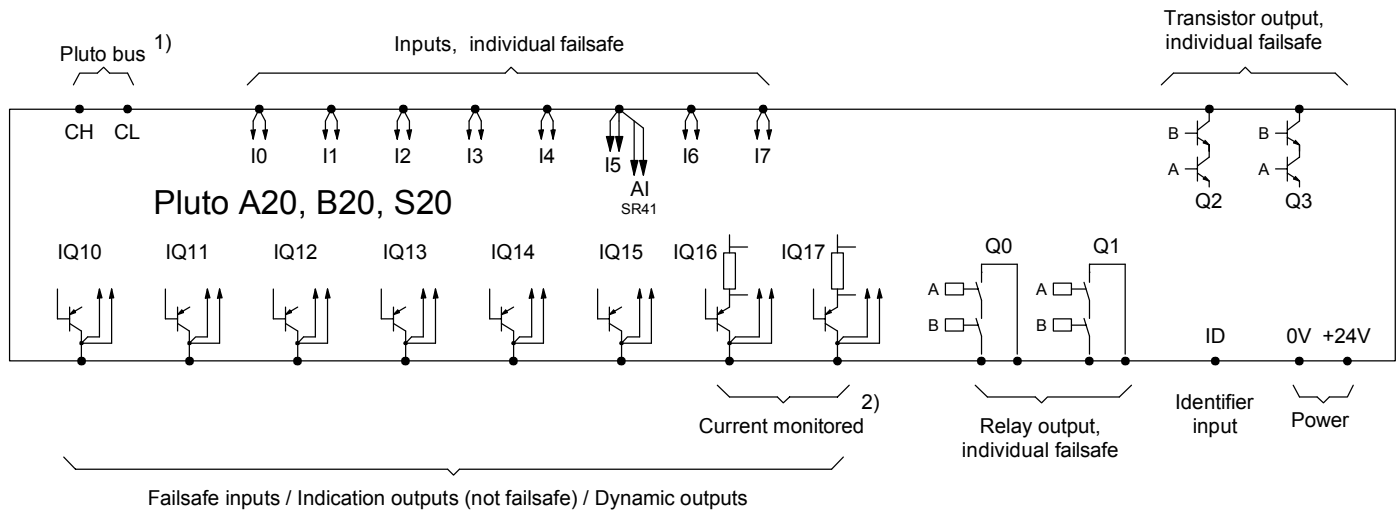
Both a lamp and a pushbutton can be connected to the same terminal. This function is for resetting safety devices and to reduce the number of I/Os used.

Output connector expansion



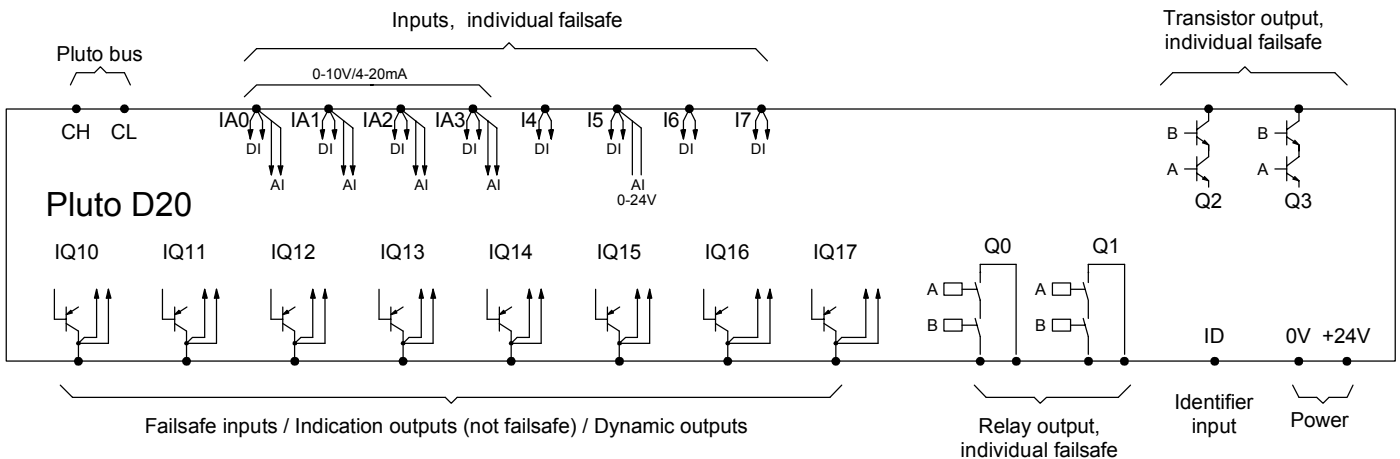
Using an expansion relay, such as BT50, the number of safe outputs in Pluto can be expanded. The connection shall be made as shown in the figure. Several expansion relays can be connected to a single Pluto safety output while retaining the safety level.

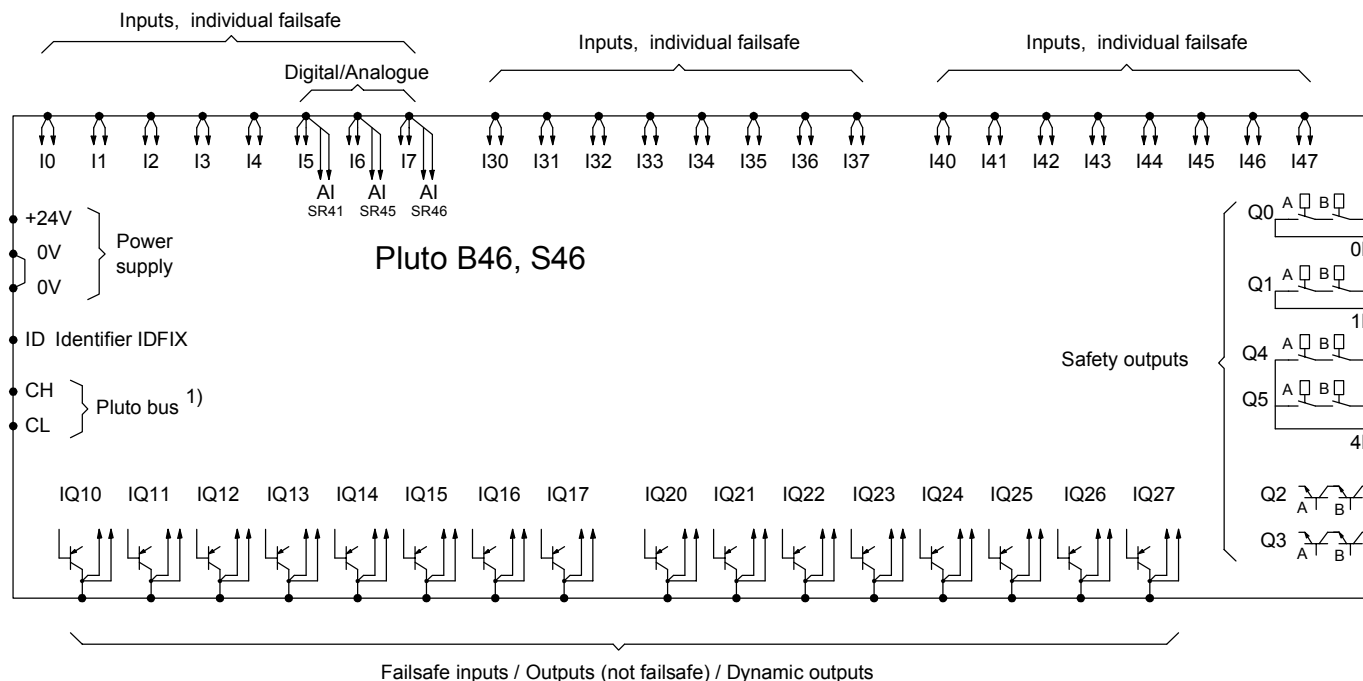
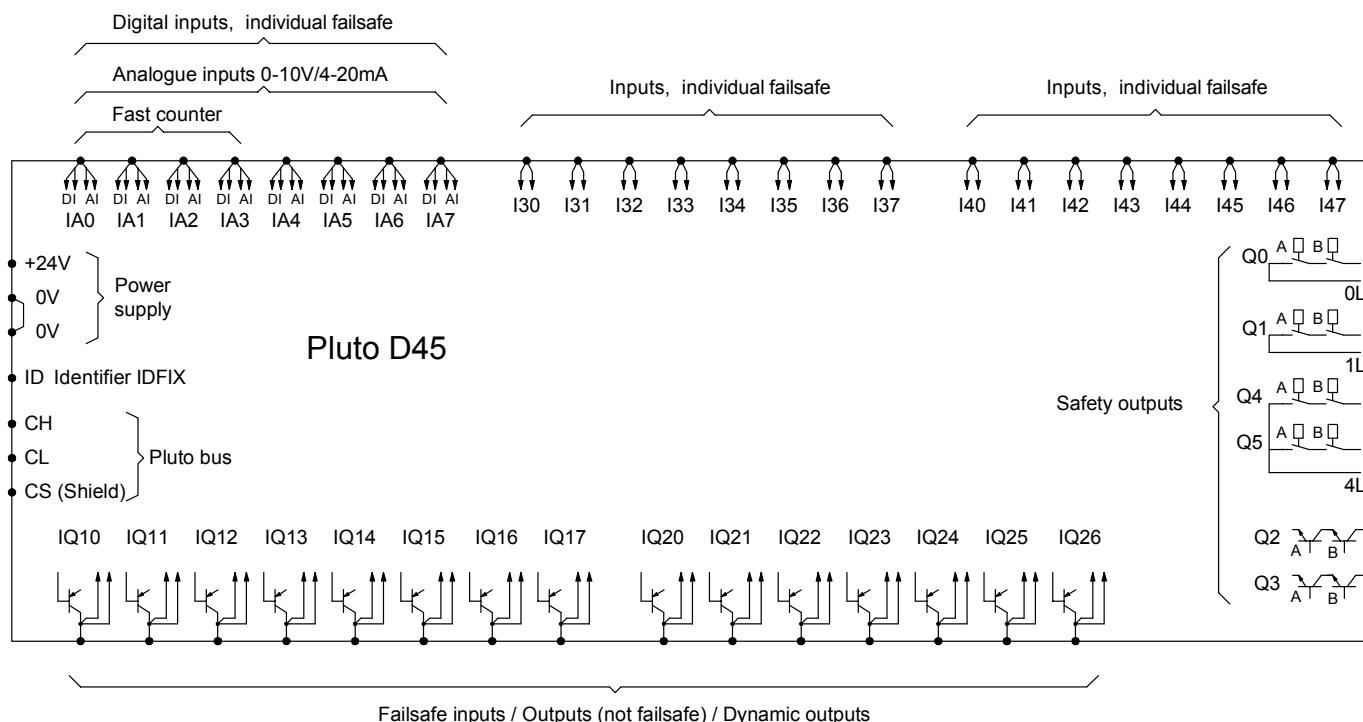
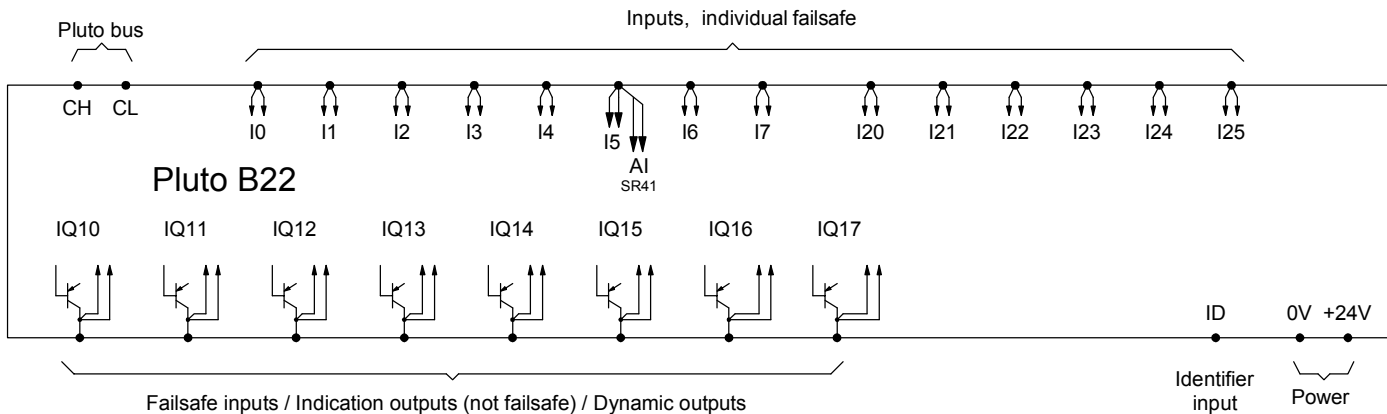
I/O Overview



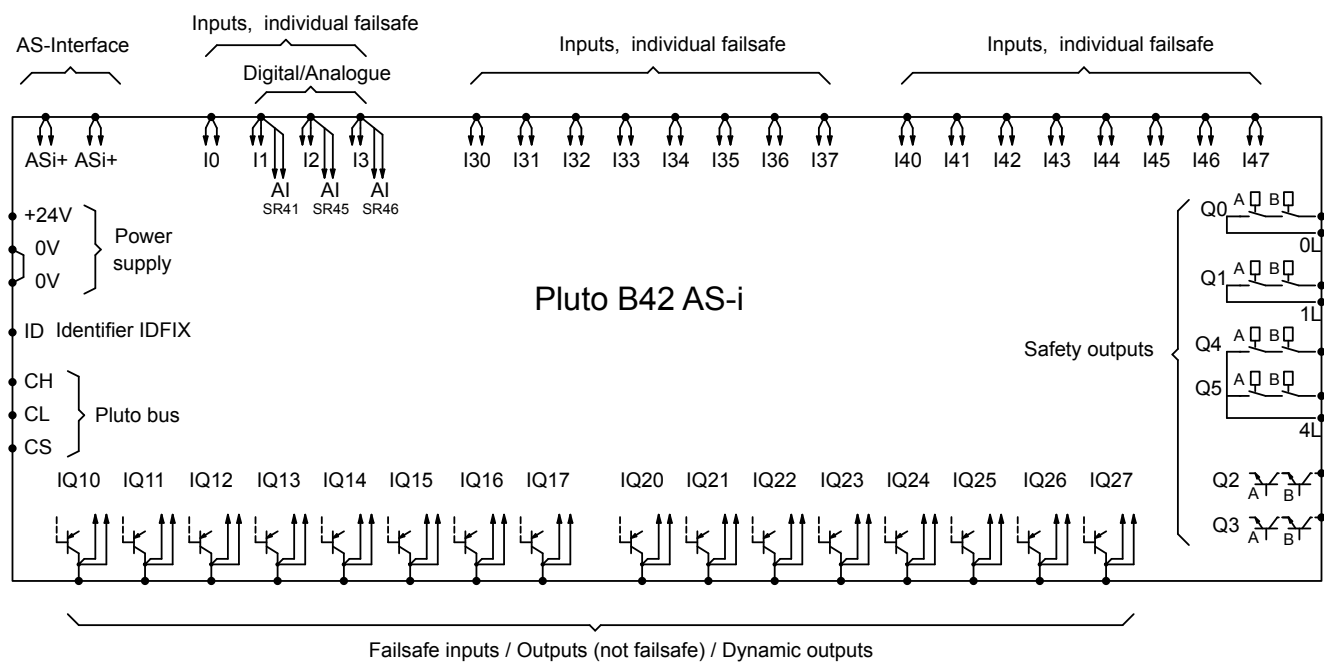
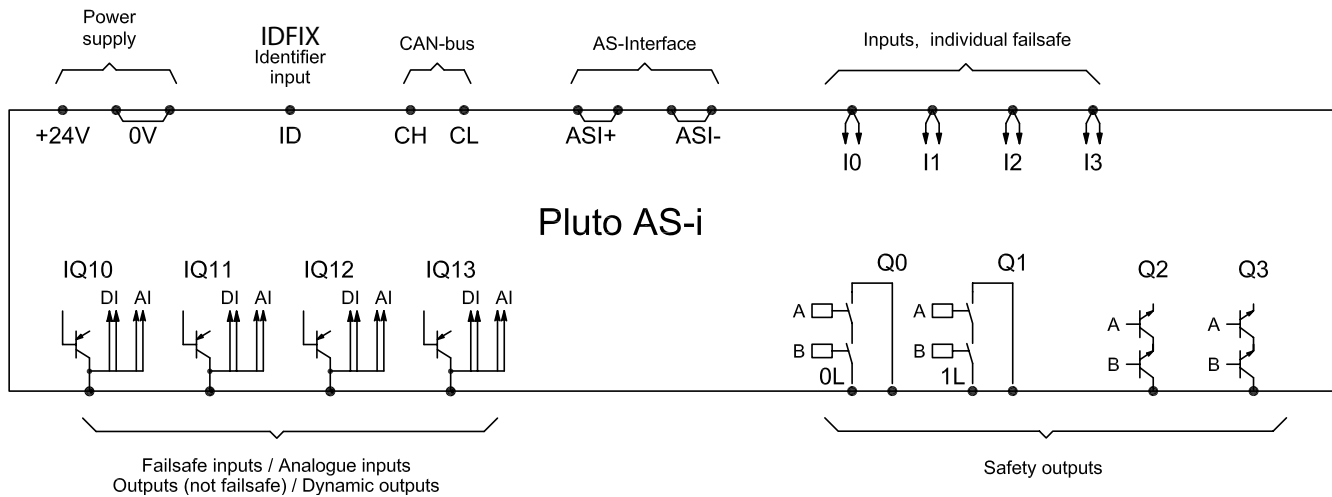
1) Not S-models, S20,...

2) Current monitored only on A20



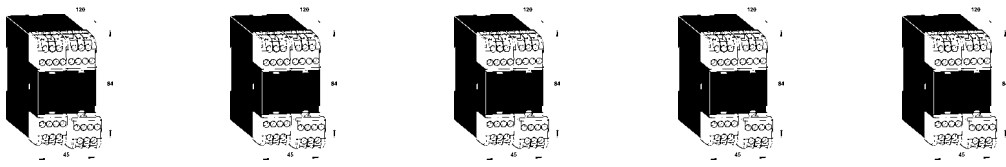


1) Not S46



- ID: Connection for identifier, which has a unique ID number that can be read by the system.
- I.. Safety inputs (24 VDC) that are individually failsafe. This means that the highest level of safety can be achieved with only one input if ABB Jokab Safety dynamic safety components are used. Otherwise two inputs are required for each safety function.
- IQ.. I/O that can be used for safety inputs or signal outputs, e.g. to indicate or control functions that are not safety-related. For IQ.. as safety inputs, refer to I..
- Q0, Q1: Failsafe relay outputs that are individually failsafe and individually programmable.
- Q2, Q3: Failsafe transistor outputs (-24 VDC) that are individually failsafe and individually programmable. Intended for electro-mechanical components such as contactors and valves.
- Q4, Q5 Failsafe relay outputs with common potential that are individually failsafe and individually programmable.

Technical data - type-specific

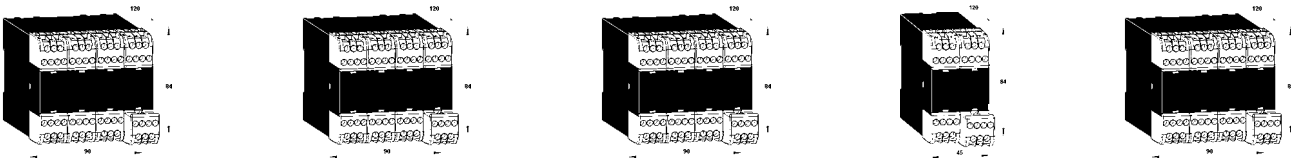


	Pluto A20	Pluto B20	Pluto B22	D20	S20
	20 I/O	20 I/O	22 I/O	20 I/O	20 I/O
	Current monitoring			Analogue inputs	Without safety bus
Article number	2TLA020070R4500	2TLA020070R4600	2TLA020070R4800	2TLA020070R6400	2TLA020070R4700
Failsafe inputs	8 (I0..I7)	8 (I0..I7)	14 (I0..I7, I20..I25)	8 (I0..I7)	8 (I0..I7)
Failsafe inputs or non-failsafe outputs	8 (IQ10..IQ17) Max total load 2.5 A	8 (IQ10..IQ17) Max total load 2.5 A	8 (IQ10..IQ17) Max total load 2.5 A	8 (IQ10..IQ17) Max total load 2.5 A	8 (IQ10..IQ17) Max total load 2.5 A
Analogue inputs (0-10V/4-20 mA)	-	-	-	4	-
Counter inputs	-	-	-	-	-
Analogue inputs (0-27V)	1 (I5)	1 (I5)	1 (I5)	1 (I5)	1 (I5)
Failsafe relay outputs	2 (Q0..Q1)	2 (Q0..Q1)	-	2 (Q0..Q1)	2 (Q0..Q1)
Failsafe transistor outputs	2 (Q2..Q3)	2 (Q2..Q3)	-	2 (Q2..Q3)	2 (Q2..Q3)
Current monitoring	2 (IQ16, IQ17) 0-1.0 A ±10%	-	-	-	-
Pluto safety bus	•	•	•	•	-
Pluto AS-i bus	-	-	-	-	-
Own current consumption	100...300 mA	100...300 mA	100...300 mA	100...300 mA	100...300 mA
Recommended external fuse	6A	6A	6A	6A	6A
Dimensions (w x h x d)	45 x 84 x 118 mm	45 x 84 x 118 mm	45 x 84 x 118 mm	45 x 84 x 118 mm	45 x 84 x 118 mm

Technical data - general

Colour	Grey
Operating voltage	24 VDC ±15%
Installation	35 mm DIN rail
Electrical insulation	Category II in accordance with IEC 61010-1
Safety level	
EN 954-1	Cat. 4
EN ISO 13849-1	PL e/Cat. 4
EN 61508	SIL 3
EN 62061	SIL 3
PFH _Q	
Relay output	2.00×10 ⁻⁹
Transistor output:0	1.50×10 ⁻⁹
Failsafe inputs I & IQ	
I0..7 (I30..37, I40..47)	+24 V (for PNP sensors)
IQ10..17 (IQ20..27)	+24 V (for PNP sensors) IQ also configurable as non-failsafe outputs.
Current at 24 V	5.1 mA
Max. overvoltage	27 V continuous

Failsafe outputs Q	
Q2, Q3	Transistor, -24VDC, 800 mA
Output voltage tolerance	Supply voltage - 1.5 V at 800 mA
Q0, Q1, (Q4, Q5)	Relay outputs VAC-12: 250 V/1.5 A VAC-15: 250 V/1.5 A VDC-12: 50 V/1.5 A VDC-13: 24 V/1.5 A
Non-failsafe outputs Q	
IQ10..17 (IQ20..27)	Transistor +24V, PNP "open collector" also configurable as failsafe inputs.
Max. current/output	800 mA
Indicator	
Input/output LED	1 per I/O (green)
Display	7-segments, two characters
Pluto safety bus	
Max number of Pluto units on the databus	32
Databus type	CAN
Databus speeds	100, 125, 200, 250, 400, 500, 800, 1000 kb/s
Databus cable length	Up to 600 m, 150 m at 400 kb/s



Pluto B46	Pluto D45	Pluto S46	Pluto AS-i	Pluto B42 AS-i
46 I/O	45 I/O Analogue/counter inputs	46 I/O Without safety bus	AS-i bus	AS-i bus
2TLA020070R1700	2TLA020070R6600	2TLA020070R1800	2TLA020070R1100	2TLA020070R1400
24 (I0..I7, I30..I37, I40..I47)	24 (I0..I7, I30..I37, I40..I47)	24 (I0..I7, I30..I37, I40..I47)	4 (I0..I3)	20 (I0..I3, I30..I47)
16 (IQ10..IQ17, IQ20..IQ27)	15 (IQ10..IQ17, IQ20..IQ26)	16 (IQ10..IQ17, IQ20..IQ27)	4 (IQ10..IQ13)	16 (IQ10..IQ27)
Max total load 2A	Max total load 2A	Max total load 2A	Max total load 2A	Max total load 2A
–	4*	–	–	–
–	8*	–	–	–
3 (I5..I7)	3 (IQ10..IQ12)	3 (I5..I7)	4 (IQ10..IQ13)	3 (I1..I3)
4 (Q0..Q1 & Q4..Q5)	4 (Q0..Q1 & Q4..Q5)	4 (Q0..Q1 & Q4..Q5)	2 (Q0..Q1)	4 (Q0..Q1 & Q4..Q5)
2 (Q2..Q3)	2 (Q2..Q3)	2 (Q2..Q3)	2 (Q2..Q3)	2 (Q2..Q3)
–	–	–	–	–
•	•	–	•	•
–	–	–	•	•
100...500 mA	100...500 mA	100...500 mA	100 mA	150 mA
10A	10A	10A	6A	10A
90 x 84 x 118 mm	90 x 84 x 118 mm	90 x 84 x 118 mm	45 x 84 x 118 mm	90 x 84 x 118 mm

*4 of the analogue inputs can be configured as counter inputs. The total number of analogue inputs + counter inputs = 8.

Pluto AS-i bus		Additional Response times	
Master profile	M2	Databus between Pluto units	10 ms
Number of slave units	31/62*	Databus between Pluto units at fault condition	10–40 ms
Bus operation mode	Master	Enclosure classification	
	Safety monitor	Enclosure	IP40, IEC 60 529
	Safety monitor, slave and safe I/O module.	Connection terminals	IP20, IEC 60 529
Bus cable length:	Up to 500 m 100 m between each repeater	The terminal blocks are detachable without needing to disconnect the wiring. The units shall be assembled with a gap of at least 5 mm.	
Temperature			
Ambient temperature	–10°C to +50°C		
Storage and transport	–25°C to +55°C		
Response times			
Dyn. A or static input to relay output	<20.5 ms + program exec. time		
Dyn. A or static input to transistor output	<16.5 ms + program exec. time		
Dyn. B or Dyn. C input to relay output	<23 ms + program exec. time		
Dyn. B or Dyn. C input to transistor output	<19 ms + program exec. time		
Software setting "NoFilt"	5 ms shorter response time on I & IQ inputs		
AS-i bus to relay output	<33 ms + prog. execution time		
AS-i bus to transistor output	<29 ms + prog. execution time		

APPLICATION EXAMPLE - Pluto

Robot cell with Pluto

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Description

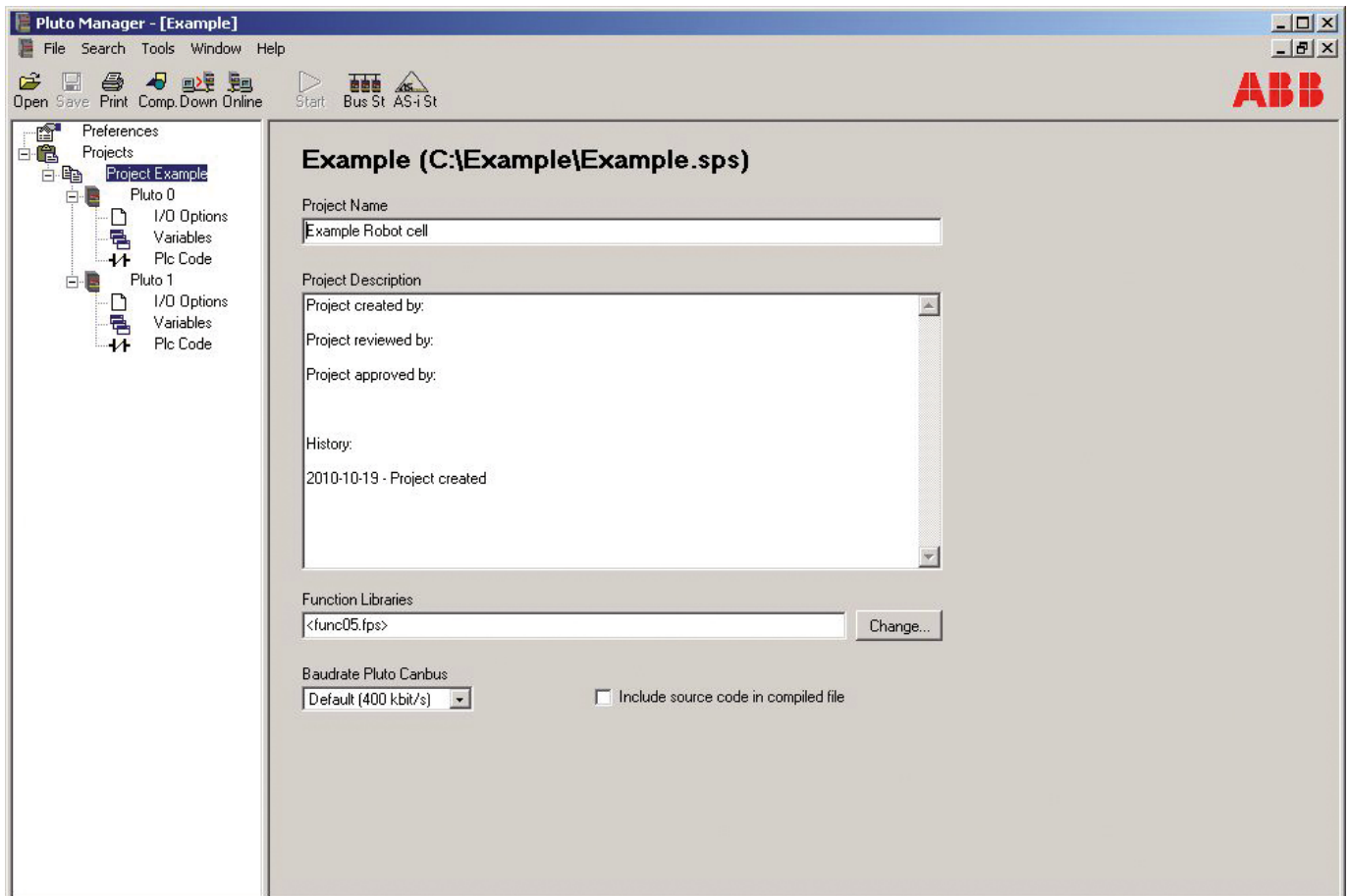
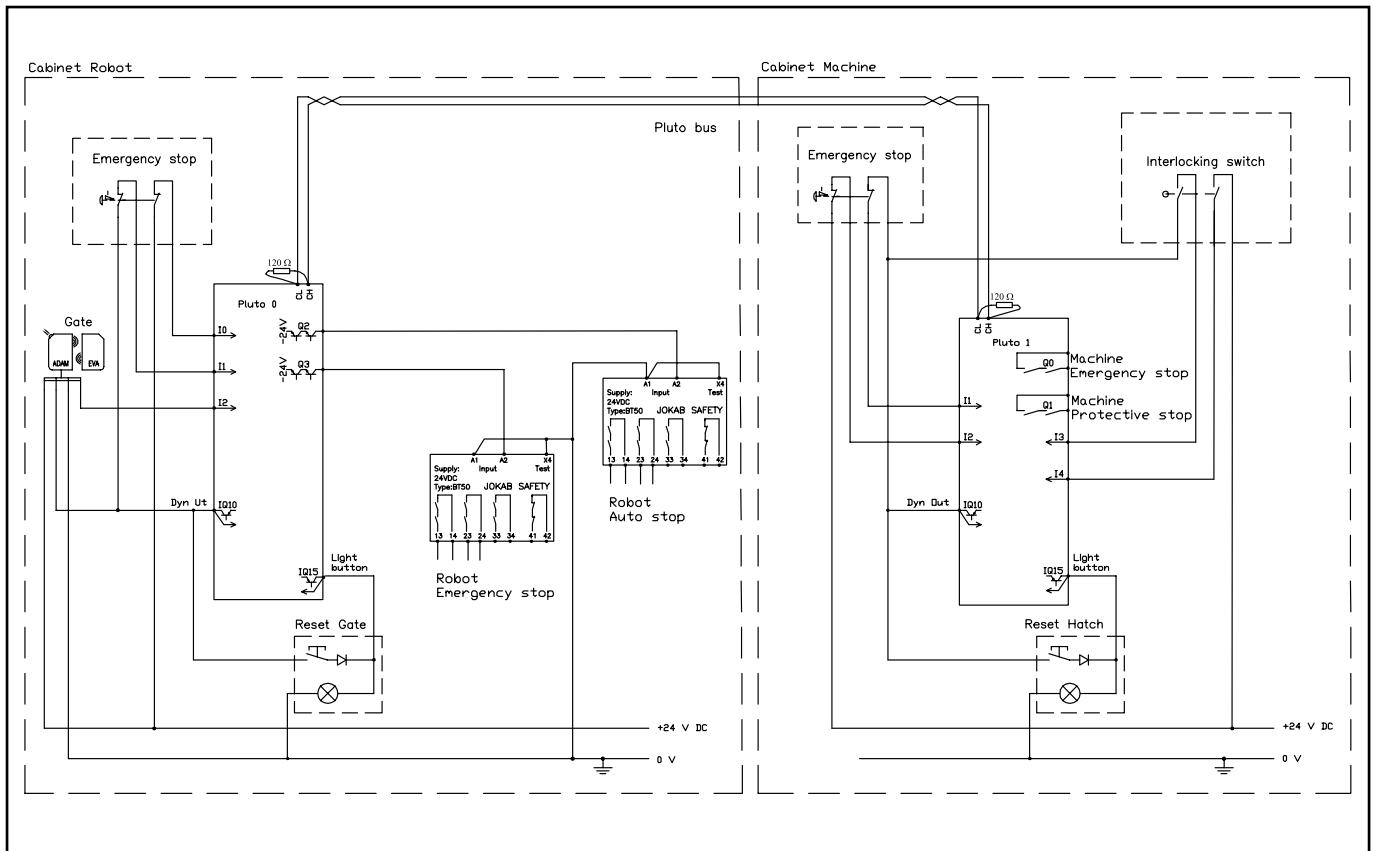
The example describes a processing machine served by a robot. The machine safety system consists of one (Pluto 1) to which all protection has been connected. The robot has been equipped with a (Pluto 0) to which the cell protection has been connected. The Pluto for the machine has been connected via a databus cable to the robot's Pluto so that common functions, such as emergency stop, can be used by the whole cell.

Function

Emergency stop takes priority and will stop both the machine and the robot. The machine hatch acts as the zone divider, when the hatch is closed the machine forms one zone and the robot another zone. When the machine hatch is open, both the machine and the robot belong to the same zone. If the door is opened when the machine hatch is open, the machine and the robot will both stop, but if the machine hatch is closed, only the robot will be stopped.

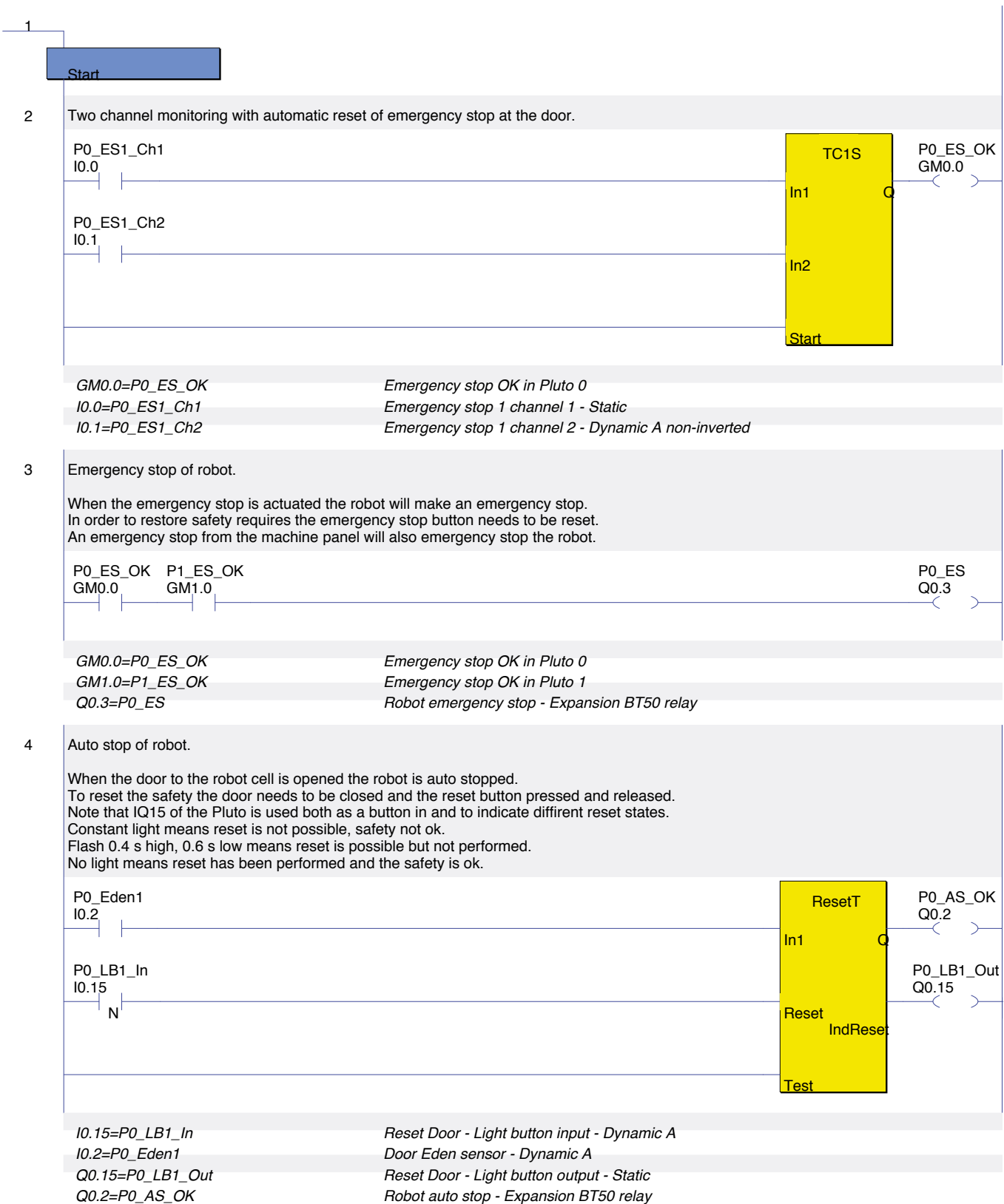
After the door has been opened, the system must be reset by means of the reset button on the outside of the door. Emergency stop is reset when the pressed-in button is pulled out. NOTE. The cell operating cycle must not however start immediately on resetting the emergency stop or the door.

Electrical connections



APPLICATION EXAMPLE - Pluto

PLC code Pluto 0 – Robot cabinet



5 Alarm 03 - Machine hatch open.

To generate User Errors (UE) a value of 200 - 299 can be written to the display of the Pluto.
A check of System Register 11 (SR11) in the Pluto prioritises errors from the Pluto itself over User Errors.

P1_Hatch_OK GM1.1	P0_AS_OK Q0.2	SR_ErrorCode=0 SR0.11=0		SR_PlutoDisplay=203 SR0.10=203
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<i>GM1.1=P1_Hatch_OK</i>	<i>Hatch closed</i>
<i>Q0.2=P0_AS_OK</i>	<i>Robot auto stop - Expansion BT50 relay</i>
<i>SR0.10=SR_PlutoDisplay</i>	<i>Pluto display figure. For user error: 200+no</i>
<i>SR0.11=SR_ErrorCode</i>	<i>Error code</i>

6 Alarm 02 - Door open.

To generate User Errors (UE) a value of 200 - 299 can be written to the display of the Pluto.
A check of System Register 11 (SR11) in the Pluto prioritises errors from the Pluto itself over User Errors.

P0_Eden1 I0.2	SR_ErrorCode=0 SR0.11=0		SR_PlutoDisplay=202 SR0.10=202
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<i>I0.2=P0_Eden1</i>	<i>Door Eden sensor - Dynamic A</i>
<i>SR0.10=SR_PlutoDisplay</i>	<i>Pluto display figure. For user error: 200+no</i>
<i>SR0.11=SR_ErrorCode</i>	<i>Error code</i>

7 Alarm 01 - Emergency stop actuated.

To generate User Errors (UE) a value of 200 - 299 can be written to the display of the Pluto.
A check of System Register 11 (SR11) in the Pluto prioritises errors from the Pluto itself over User Errors.

P0_ES_OK GM0.0	SR_ErrorCode=0 SR0.11=0		SR_PlutoDisplay=201 SR0.10=201
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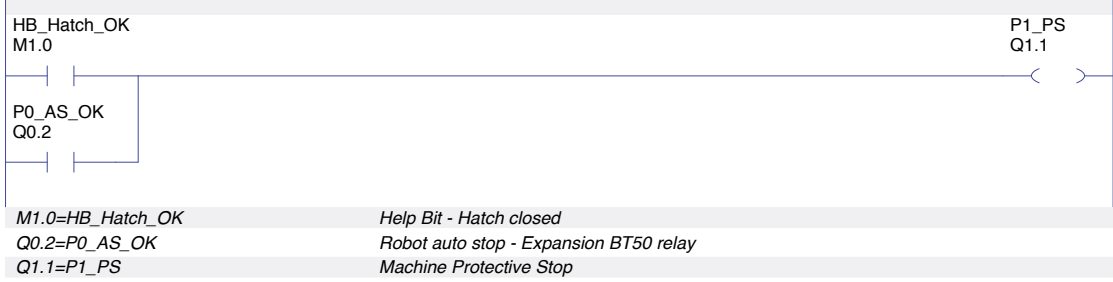
<i>GM0.0=P0_ES_OK</i>	<i>Emergency stop OK in Pluto 0</i>
<i>SR0.10=SR_PlutoDisplay</i>	<i>Pluto display figure. For user error: 200+no</i>
<i>SR0.11=SR_ErrorCode</i>	<i>Error code</i>

GM1.1=P1_Hatch_OK	Hatch closed
I1.15=P1_LB1_In	Reset Hatch - Light button input - Dynamic A
M1.0=HB_Hatch_OK	Help Bit - Hatch closed
M1.1=HB_Ind_Hatch_OK	Help Bit - Indication Reset Hatch

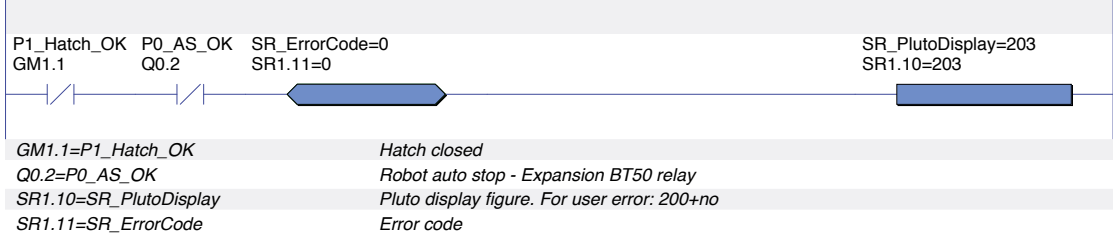
6 Light button indication of the reset of the hatch.
 If the robot cell's door is closed and reset no light indication is needed inside the cell.



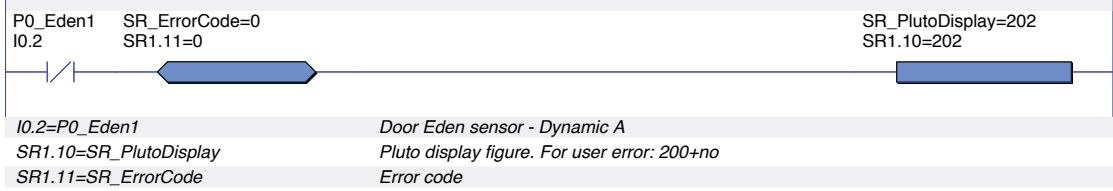
7 Protective stop of the machine.
 Either the hatch is closed and reset or the door to the robot cell is closed and reset.
 This means the cell can work with the hatch both open or closed as long as the cell's door is closed and reset.



8 Alarm 03 - Machine hatch open.
 To generate User Errors (UE) a value of 200 - 299 can be written to the display of the Pluto.
 A check of System Register 11 (SR11) in the Pluto prioritises errors from the Pluto itself over User Errors.



9 Alarm 02 - Door open.
 To generate User Errors (UE) a value of 200 - 299 can be written to the display of the Pluto.
 A check of System Register 11 (SR11) in the Pluto prioritises errors from the Pluto itself over User Errors.



10 Alarm 01 - Emergency stop actuated.
 To generate User Errors (UE) a value of 200 - 299 can be written to the display of the Pluto.
 A check of System Register 11 (SR11) in the Pluto prioritises errors from the Pluto itself over User Errors.

