WEST

Technical documentation

CSC-158-U-SSIC
plus PCK-308-C-PFN coupling module

Axis control system with synchronisation function, pressure limiting control,
SSI sensor interfaces and Profinet connection

Electronics
Hydraulics meets
meets Hydraulics
Electronics

CONTENTS

1 General information

1.1 Order number

CSC-158-U-SSIC - with universal/programmable analog output
(+/- 10V differential signal or 4... 20mA current signal)

PCK-308-C-PFN - Coupling module for Profinet interface (on CAN bus)

1.2 Scope of supply

The scope of supply includes the module including the terminal blocks which are a part of the housing.
The Profibus plug, interface cables and further parts which may be required should be ordered separately.
This documentation can be downloaded as a PDF file from www.w-e-st.de.

1.3 Accessories

WPC-300 - software, downloadable from our homepage:
https://www.w-e-st.de/wp/en/service/software-downloads/

Any standard cable with USB-A and USB-B plugs can be used as a programming cable.

1.4 Symbols used

General note

Safety-relevant information

1.5 Legal notice

W.E.St. Elektronik GmbH

Gewerbering 31
41372 Niederkrüchten

Phone: +49 (0)2163 577355-0
Fax: +49 (0)2163 577355 -11

Home page: www.w-e-st.de
EMAIL: contact@w-e-st.de

Date: 07.01.2025

The data and characteristics described herein serve only to describe the product. The user is required to evaluate this data and to check suitability for the particular application. General suitability cannot be inferred from this document. We reserve the right to make technical modifications due to further development of the product described in this manual. The technical information and dimensions are non-binding. No claims may be made based on them.

1.6 Safety instructions

Please read this document and the safety instructions carefully. This document will help to define the product area of application and to put it into operation. Additional documents (WPC-300 for the start-up software) and knowledge of the application should be taken into account or be available.
General regulations and laws (depending on the country: e.g. accident prevention and environmental protection) must be complied with.

These modules are designed for hydraulic applications in open or closed-loop control circuits. Uncontrolled movements can be caused by device defects (in the hydraulic module or the components), application errors and electrical faults. Work on the drive or the electronics must only be carried out whilst the equipment is switched off and not under pressure.

This handbook describes the functions and the electrical connections for this electronic assembly. All technical documents which pertain to the system must be complied with when commissioning.

This device may only be connected and put into operation by trained specialist staff. The instruction manual must be read with care. The installation instructions and the commissioning instructions must be followed. Guarantee and liability claims are invalid if the instructions are not complied with and/or in case of incorrect installation or inappropriate use.

CAUTION!
All electronic modules are manufactured to a high quality. Malfunctions due to the failure of components cannot, however, be excluded. Despite extensive testing the same also applies for the software. If these devices are deployed in safety-relevant applications, suitable external measures must be taken to guarantee the necessary safety. The same applies for faults which affect safety. No liability can be assumed for possible damage.

Further instructions

- The module may only be operated in compliance with the national EMC regulations. It is the user's responsibility to adhere to these regulations.
- The device is only intended for use in the commercial sector.
- When not in use the module must be protected from the effects of the weather, contamination and mechanical damage.
- The module may not be used in an explosive environment.
- To ensure adequate cooling the ventilation slots must not be covered.
- The device must be disposed of in accordance with national statutory provisions.

2 Characteristics

This system is a positioning control system with options for superimposed synchronization control and force or pressure limiting control of the individual axes.

Up to 4 axes can be controlled via the field bus.

- **Positioning**: As with our standard positioning controller, an axis can be operated as point-to-point control (stroke depended deceleration) and in NC mode (speed-controlled). The controller is optimized based on a few parameters; the motion profile is specified via the fieldbus (position and speed). The axes can be operated together or with individual setpoints.

- **Synchronization control**: If several axes are operated, a superimposed synchronization controller can be activated. A PI or PT1 controller is available as the control structure.
  Depending on the system requirements, both the master-slave concept and averaging (control of all axes to an internally calculated setpoint position depending on the individual positions and the setpoint position) are available.

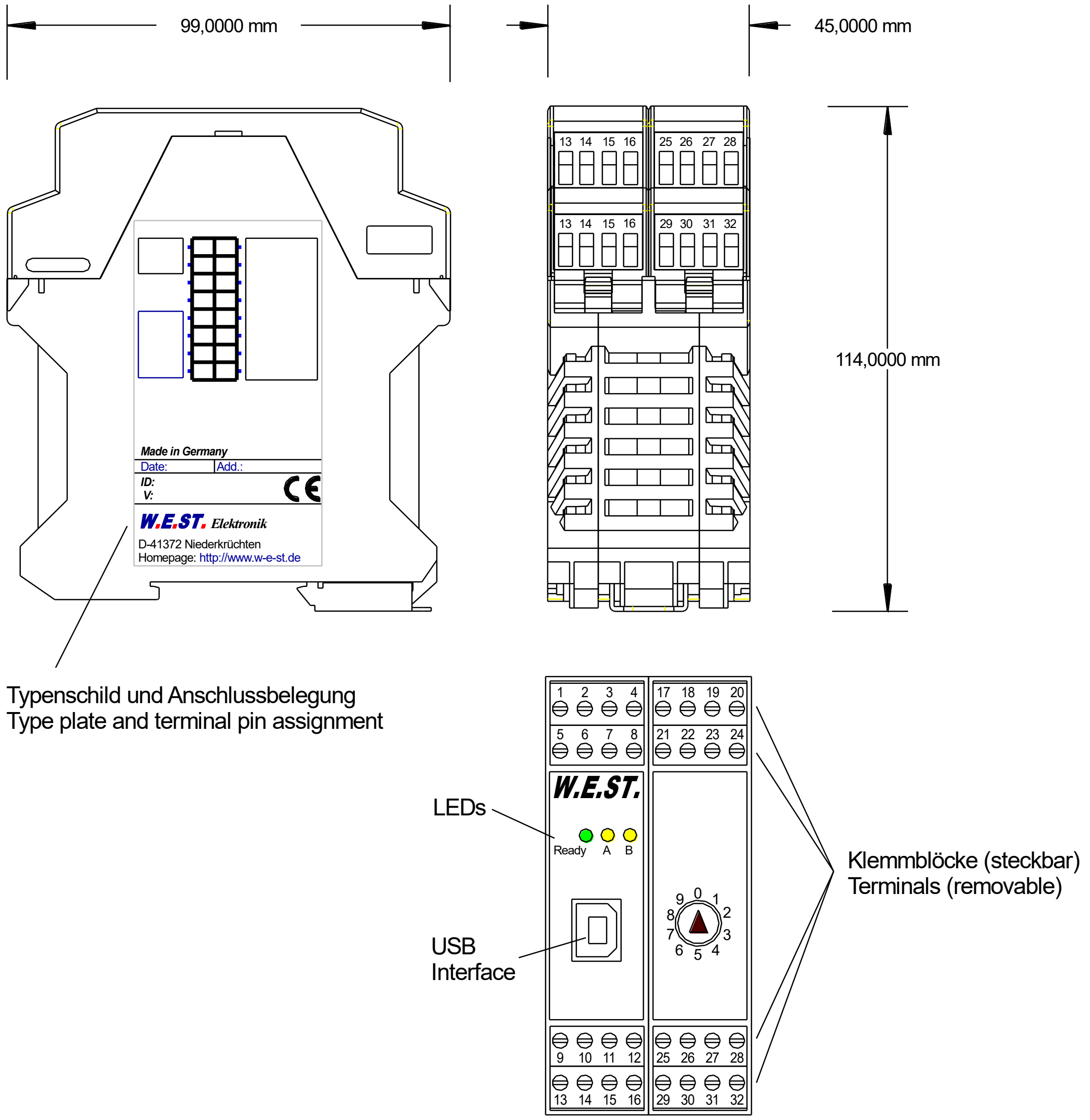
- **Pressure/force limitation control**: The force can be measured and limited via one or two pressure sensors. If the system switches from synchronization control to pressure/force control, this then has priority and replaces position control.

Features

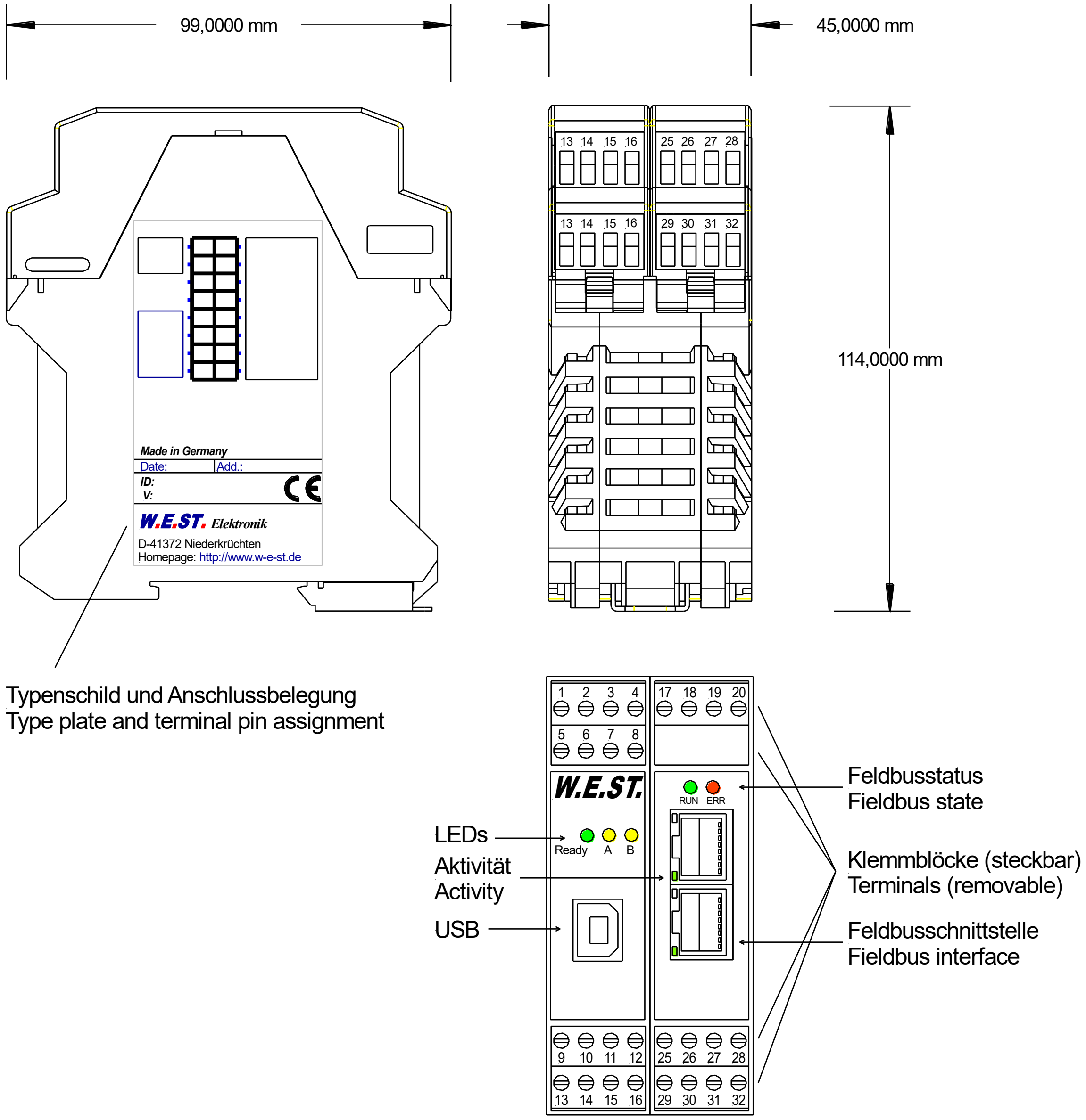
- **Setpoint setting, actual value feedback, control and status information via the fieldbus**
- **Position resolution up to 1µm**
- **Speed controlled positioning (alternative principle of stroke dependent deceleration)**
- **Synchronization control function as PI or PT1 controller**
- **Optional detaching pressure relief control**
- **Load pressure calculation and averaging for demand-based setpoint specification to the pressure supply**
- **Consideration of the real pressure difference at the valve control edges, compensation of the load pressure influence**
- **SSI interface or analog position sensors**
- **Internal profile definition by presetting acceleration and deceleration**
- **Optimal using with zero lapped control valves**
- **Simple parameterization with the WPC-300 software**

2.1 Device description

2.1.1 CSC-158-U-SSIC

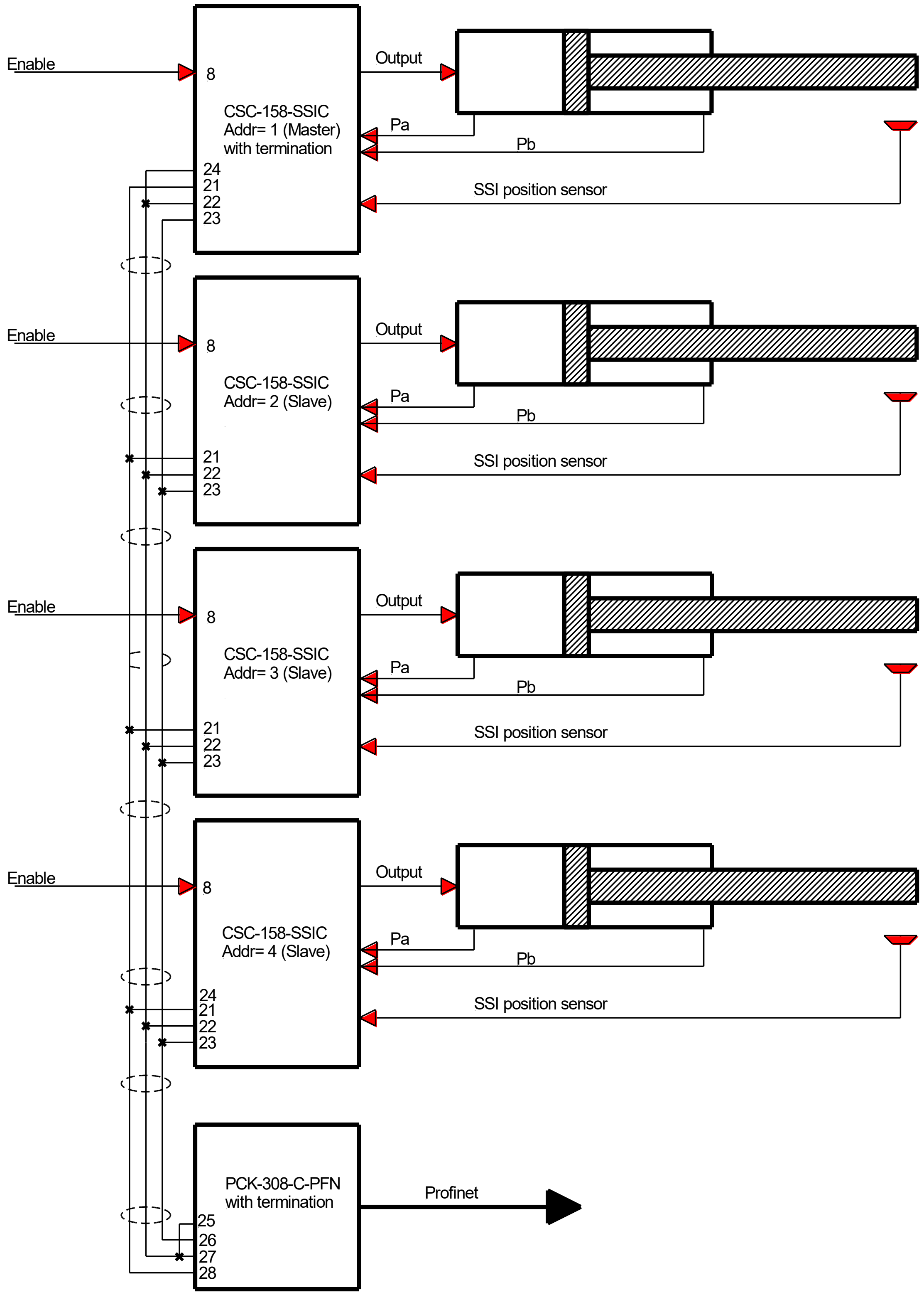


2.1.2 PCK-308-C-PFN



3 Use and application

3.1 Typical system structure



3.2 Functional description

With a system consisting of a PCK-308 and two to four CSC-158 modules, typical synchronisation applications such as press and calender control are possible. All or individual axes can also be operated completely independently of each other. In addition to positioning / synchronisation control, pressure limitation control (differential pressure control or force control) is also implemented. The function can be adapted to the respective requirements via the various control bits.

As the various operating modes are controlled via the fieldbus, please already refer to chapters 7 and 8.2 at this point. The individual control bits are listed there and categorised according to their significance for the operating modes.

3.2.1 Individual operation

Each axis has ENABLE and START control bits assigned to it as well as set values for speed, position and pressure. The pressure control is always an individual function, while the positioning control can also be controlled centrally.

The "SYNC" bit determines whether an axis is to work on its own or belong to a group of axes with common setpoint specification and synchronisation, and is therefore part of the individually transmitted data. If it is not set, it is possible to operate the axis independently.

A basic requirement for this operation is also that the "ENABLE" bit of the coupler is set. This serves as a central enable for the entire system. For individual operation, the individual axis must also be enabled via its own ENABLE control bit and via its ENABLE hardware input.

The latter enables the controllers to be integrated into a hard-wired switch-off logic, but can also be permanently connected to 24V if this is not required.

As soon as these enabling signals are available and the axis controller is error-free, this is signalled back via the individual "READY" bit and the green LED on the device lights up continuously. The current actual position is adopted as the setpoint when the READY status becomes available.

It is now possible to trigger a positioning process via the assigned START bit, setpoint position (1..4) and setpoint speed (1..4).

The START signal activates the setpoint position (1..4) value. The actuator moves immediately to the new target position, either in NC mode with controlled speed or in SDD mode, depending on the parameterisation. Reaching the target position can be monitored in the PLC by the existing feedback of the position and the current setpoint.

In manual mode (START is deactivated), the actuator can be moved via HAND-A or HAND-B. The actuator moves at the programmed manual speeds using open loop control. When the MANUAL (-A or -B) signal is switched off, the current actual position is adopted as the setpoint position and the drive stops in a closed-loop controlled manner.

At the same time, manual mode can also be used if the actual position is missing (in the event of a sensor error or if the normal working range has been left) in order to move the axis to a defined position.

3.2.2 Synchronised operation

The synchronised operation settings are made via the control bits in byte 5 and the cross-system setpoints for position and speed (bytes 40 ... 45).

To carry out a movement in synchronised operation, the SYNC control bits must be set for the axes that are to participate and the SYNC_ON bit must be set in byte 5. As a result, the LOCOP bit (local operation) is cleared from the status byte of the axes and the takeover of local operation (start RC mode of the axes concerned) is blocked. However, if an axis is in local RC mode (see below), it is blocked and the LOCOP bit remains set.

When all preselected axes are ready for synchronisation, this is signalled via SYNC_READY. A start of the movement in synchronisation can now be triggered in the same way as described above, but now via the START bits for a controlled positioning process or the manual commands SYNCH_A / SYNCH_B. In contrast to individual manual operation, the synchronisation controllers of the axes involved are still active in the case of manual operation.

3.2.2.1 Relative synchronisation with offset

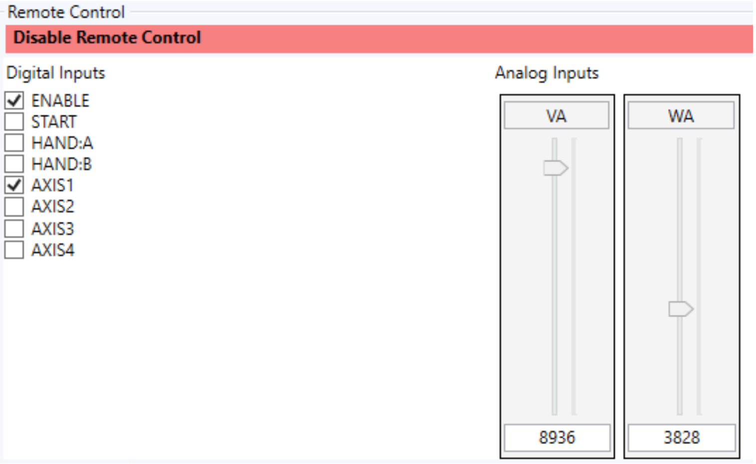
In some systems, the axes are to be moved synchronously with a certain constant offset. For this purpose, this system offers the option of storing a reference state and then executing movements at constant spacing with the staggered axis positions defined in this way.
The control bit SETREF is used to trigger this function.
Prerequisite: ENABLE of the corresponding axes and system is set. The SYNC bits of the axes to be considered are set. The SYNC_ON bit (system-wide) is not set.
The START bit in byte 5 (system-related) is not set.
In this state, the rising edge of the SETREF bit causes the respective axis to store the current position (X) as a reference for synchronism. This reference is stored as long as the SETREF bit remains set.
If the bit SYNC_ON is set, the current position of the axis corresponds to the desired synchronisation setpoint and the axis stops at the respective position. If a movement is then started, the axes move with the constant offset that they had when the ‘SETREF’ bit was set.

3.2.3 RC - Operation of the system

This can be activated for commissioning if you are connected to the PCK coupler via WPC. As fewer values can be specified here than via Profinet, certain logic relationships are preset.

Here too, the axes can be controlled individually or in a synchronised network.

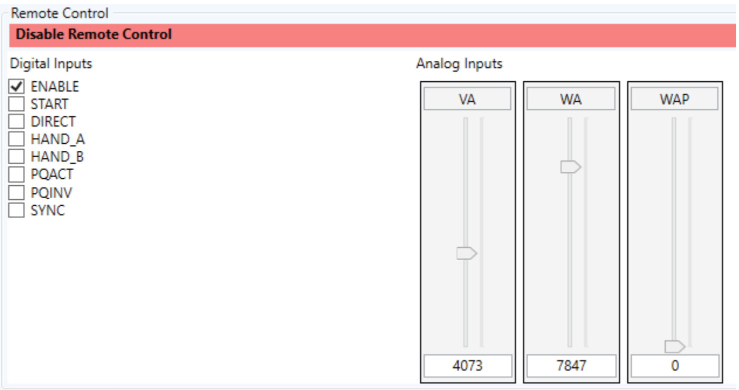
Example: Control of a single axis (1)



In addition to the ENABLE / START / HAND... control bits, the axes to which the specification relates must be marked. If there are more than one, the control bits and the setpoints are interpreted as system-wide and the axes are controlled in synchronisation. In the example on the left, this is not the case and an individual movement is performed on axis 1.

To simplify data exchange, the SYNCH_ON control bit is generated internally. The ENABLE refers to both the system and the selected axes. A preselection of the axes is only possible if ENABLE is already set. Otherwise the tick marks are automatically removed.

3.2.4 RC - Operation of individual axes



The RC mode of individual axes can be activated via WPC connection to the associated CSC-158 module.

If the coupler simultaneously requests synchronised operation of the corresponding controller via SYNC_ON, switching on the RC mode is blocked.

Functions triggered here are always only related to the respective axis, i.e. they are individual movements.

3.2.5 Pressure Control

This is a releasing control, i.e. the pressure controller can take over control in individual and synchronised operation as soon as the actual value exceeds the setpoint. This stops or at least slows down the movement. The pressure controller must be activated separately on each axis and supplied with a setpoint value via Profinet.

The special calculation of the actual value as a pseudo differential pressure controls a variable that is actually proportional to the force of the cylinder. This type of control is therefore very suitable for technological functions.

3.3 Installation instructions

- This module is designed for installation in a shielded EMC housing (control cabinet). All cables which lead outside must be screened; complete screening is required. It is also a requirement that no strong electro-magnetic interference sources are installed nearby when using our control and regulation modules.

- **Typical installation location:** 24V control signals area (close to PLC)
  The devices must be arranged in the control cabinet so that the power section and the signal section are separate from each other.
  Experience shows that the installation space close to the PLC (24 V area) is most suitable. All digital and analogue inputs and outputs are fitted with filters and surge protection in the device.

- The module should be installed and wired in accordance with the documentation bearing in mind EMC principles. If other consumers are operated with the same power supply, a star- connected ground wiring scheme is recommended. The following points must be observed when wiring:
  - The signal cables must be laid separately from power cables.
  - Analogue signal cables **must be screened**.
  - All other cables must be screened if there are powerful interference sources (frequency converters, power contactors) and cable lengths > 3m. Inexpensive SMD ferrites can be used with high-frequency radiation.
  - The screening should be connected to PE (PE terminal) as close to the module as possible. The local requirements for screening must be taken into account in all cases. The screening should be connected to at both ends. Equipotential bonding must be provided where there are differences between the connected electrical components.
  - With longer lengths of cable (>10 m) the diameters and screening measures should be checked by specialists (e.g. for possible interference, noise sources and voltage drop). Particular care is required with cables of over 40 m in length – the manufacturer should be consulted if necessary.

- A low-resistance connection between PE and the mounting rail should be provided. Transient interference is transmitted from the module directly to the mounting rail and from there to the local earth.
- Power should be supplied by a regulated power supply unit (typically a PELV system complying with IEC364-4-4, secure low voltage). The low internal resistance of regulated power supplies gives better interference voltage dissipation, which improves the signal quality of high-resolution sensors in particular. Switched inductances (relays and valve coils connected to the same power supply) must <u>always</u> be provided with appropriate overvoltage protection directly at the coil.

3.4 Commissioning

Step	Task
Installation	Install the device in accordance with the circuit diagram. Ensure it is wired correctly and that the signals are well shielded. The device must be installed in a protective housing (control cabinet or similar).
Switching on for the first time	Ensure that no unwanted movement is possible in the drive (e.g. switch off the hydraulics). Connect an ammeter and check the current consumed by the device. If it is higher than specified there is an error in the wiring. Switch the device off immediately and check the wiring.
Setting up communication	Once the power input is correct the PC (notebook) should be connected to the serial interface. Please see the WPC-300 program documentation for how to set up communication. Further commissioning and diagnosis are supported by the operating software.
Pre-parameterization	Now set up the following parameters (with reference to the system design and circuit diagrams): WORKING STROKE (SYS_RANGE), SENSOR SETTINGS, OUTPUT SIGNAL, POSITIONING MODE (VMODE), ACCELERATION and DECELERATION. Pre-parameterization is necessary to minimize the risk of uncontrolled move-ments. Parameterize specific settings for the control element (MIN for deadband compensation and MAX for maximum velocity).
Control signal	Check the control signal with a voltmeter. The control signal (PIN 15 to PIN16) lies in the range of ± 10V. In the current state it should show 0V. Alternatively, if current signals are used, approx. 0 mA should flow.
Switching on the hydrau-lics	The hydraulics can now be switched on. The module is not yet generating a signal. Drives should be at a standstill or drift slightly (leave its position at a slow speed).
Activating ENABLE	**CAUTION!** Drives can now leave their position and move to an end position at full speed. Take safety measures to prevent personal injury and damage. The drive is in the current position (with ENABLE the actual position is taken over as the command position). When the drive moves to an end position now proba-bly the polarity is wrong.
Command	Via the Profibus command position and speed can now be set. Reduce the speed to a value, which is uncritical for the application.
Activating START	With the start signal, the command value is taken over and the axis moves to the predefined target position. If START gets disabled the axis stops in the preset deceleration distance D:S.
Optimizing position control	Observe the synchronization behavior and the positioning and optimize the con-trol parameters according to your application and your requirements.
Optimizing pressure control	If needed now parameterize the pressure controller according to your application and your requirements.

4 Technical description

4.1 Input and output signals CSC-158-U-SSIC

Connection	Supply
PIN 3 and 19	Power supply (see technical data)
PIN 4 and 20	0 V (GND) Connection.
Connection	**Analog signals**
PIN 6	Actual pressure value sensor A (XP1), signal range 0... 10V or 4... 20 mA, scalable
PIN 13	Actual pressure value sensor B (XP2), signal range 0... 10V or 4... 20 mA, scalable
PIN 14	Position feedback value (X), signal range 0... 10V or 4... 20 mA, scalable
PIN 15 / 16 PIN 15 / 12	Control signal, output to the valve. Signal type and polarity selectable with SIGNAL:U
Connection	**SSI interface (RS422)**
PIN 25	CLK +
PIN 26	CLK -
PIN 27	Data +
PIN 28	Data -
PIN 31	Supply 24 V
PIN 32	Supply 0 V
Connection	**Local CAN bus**
PIN 21	CAN HIGH
PIN 22	CAN LOW
PIN 23	GND
PIN 24	Termination of the CAN bus. A bridge to CAN LO is required for the first and last module.
Connection	**Digital inputs and outputs**
PIN 8	**ENABLE input:** External enable input. For a running sytem always both enable signals are required, external and via profibus.
PIN 1	**READY output:** **ON:** Module is enabled, there is no recognizable error. **OFF:** ENABLE is deactivated or an error has been detected.
PIN2	**STATUS Output:** **ON:** CAN bus active and error-free **OFF**: CAN bus error

4.2 LED definitions CSC module

LEDs	Description of the LED function
GREEN	Identical to the READY output. **OFF:** No power supply or ENABLE is not activated **ON:** Axis controller is ready for operation **Flashing:** Error discovered (depending on the SENS command)
YELLOW A	Identical to the STATUS output. **ON:** CAN bus active and error-free **OFF**: CAN bus error
GREEN + YELLOW A+B	1. **Chasing light (over all LEDs):** The bootloader is active. No normal functions are possible. 2. **All LEDs flash shortly every 6 s:** An internal data error was detected and corrected automatically! The module still works regularly. To acknowledge the error the module has to be cycle powered.
YELLOW A + YELLOW B	**Both yellow LEDs flash oppositely every 1 s:** The nonvolatile stored parameters are inconsistent! To acknowledge the error, the data have to be saved with the SAVE command or the corresponding button in the WPC. If the function of the module has changed via the FUNCTION parameter, all parameters are deleted purposely and set to default values. In this case the LEDs indicate no error, but a desired state. To acknowledge please save.

4.3 Input and output signals PCK-308-C-PFN

Connection	Supply
PIN 3 and 31	Power supply (see technical data)
PIN 4 and 32	0 V (GND) Connection.
Connection	**Analog input**
PIN 13	Supply pressure (PP), signal range 0... 10V or 4... 20 mA, scalable
Connection	**Local CAN bus**
PIN 28	CAN HI
PIN 27	CAN LO
PIN 26	GND
PIN 25	Termination of the CAN bus. For the first and last module (PCK or CSC), a bridge to PIN CAN LO is required here.
Connection	**Digital inputs and outputs**
PIN 1	**READY output:** **ON:** Module is enabled, there is no recognizable error. **OFF:** Module is deactivated or an error has been detected.
PIN2	**STATUS Output:** **ON:** CAN bus active and error-free **OFF**: CAN bus error

4.4 LED definitions PCK module

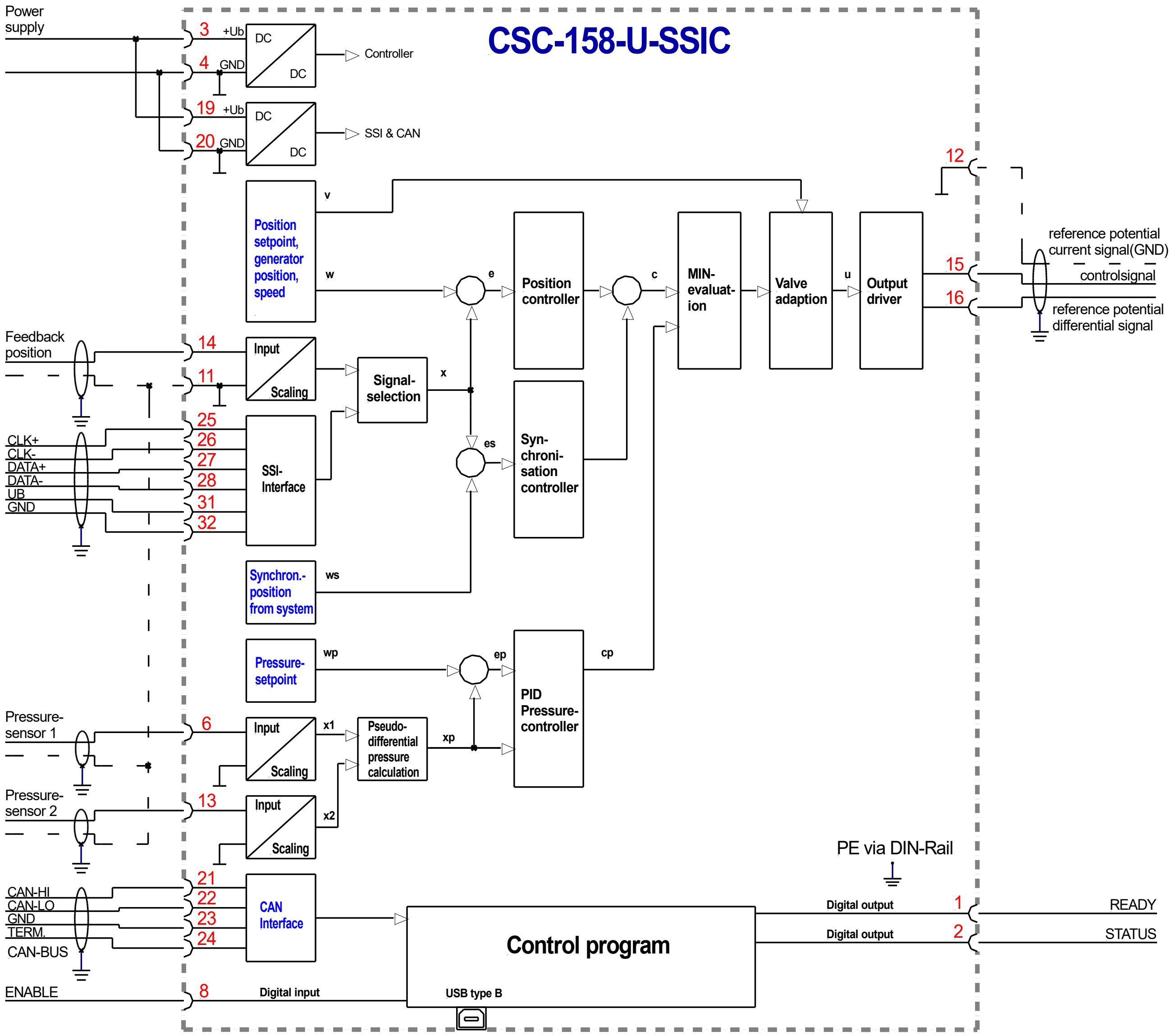
4.4.1 Level 1 USB

LEDs	Description of the LED function
GREEN	Function identical to the READY output except for the error message. **OFF:** No power supply or ENABLE is not activated **ON**: System is ready for operation **Flashing:** Slow flashing every second: Error detected (depending on the SENS command) Fast flashing: Bootloader active. No normal functions are possible.
	Identical to the STATUS output. **OFF:** CAN bus active and error-free **ON**: CAN bus error
GREEN + YELLOW A + B	**All LEDs flash briefly three times every 6 seconds:** An internal system error has been detected. To acknowledge the error message, the power supply to the module must be briefly switched off once.
YELLOW A + YELLOW B	**The two yellow LEDs flash alternately at 1 s intervals:** The non-volatile stored parameter data is inconsistent! To acknowledge this error, the data must be saved using the SAVE command/button in the WPC.

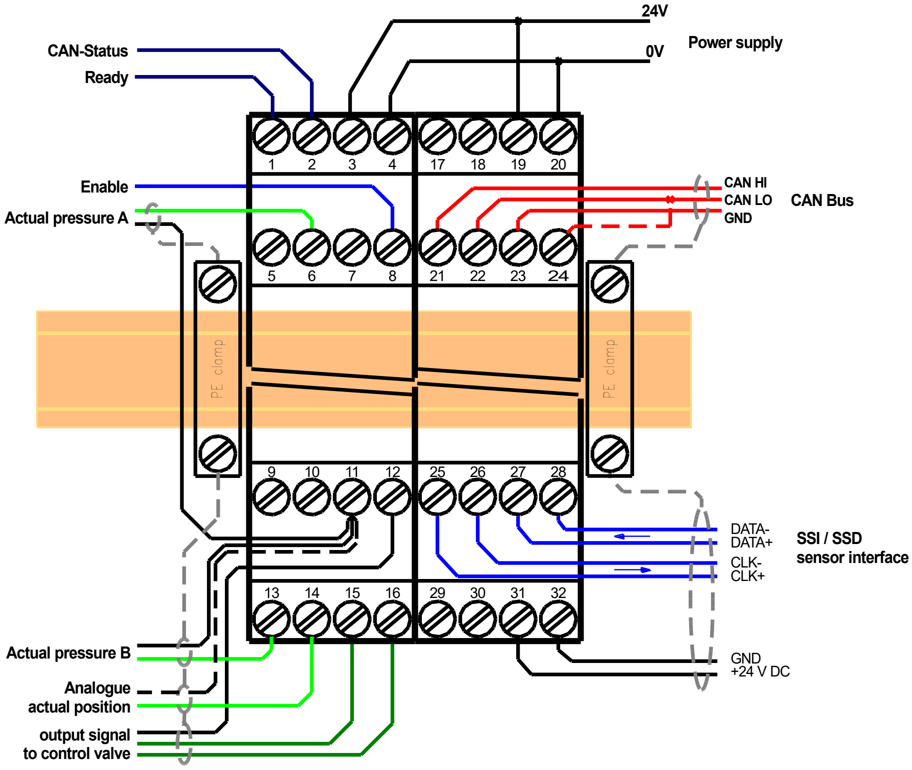
4.4.2 Level 2 Ethernet

LEDs	Description of the LED function
GREEN on the sockets	The green LED indicates data access via the data network at the corresponding port. **OFF:** No connection available **Flashing:** Profinet participant flashing test **ON:** Active network connected
GREEN	The green RUN LED shows the status of the central communication node. **OFF:** Bus not started **Flashing**: Profinet initialisation **ON**: Connected and active
RED	The red ERR LED indicates an error status. **OFF:** No error **ON:** Error in the fieldbus communication

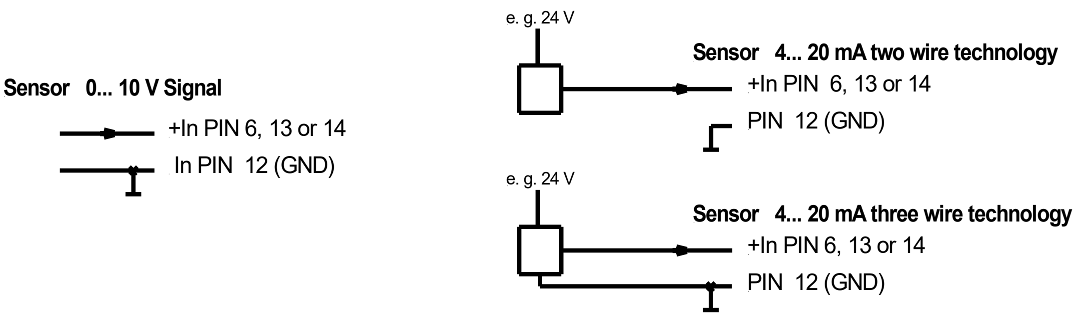
4.5 Block diagram CSC-158-U-SSIC

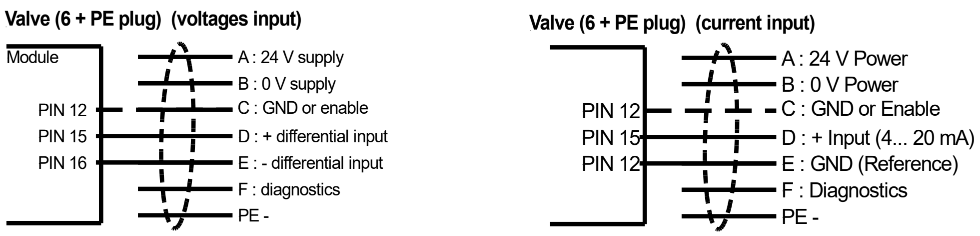


4.6 Typical wiring CSC-158-U-SSIC

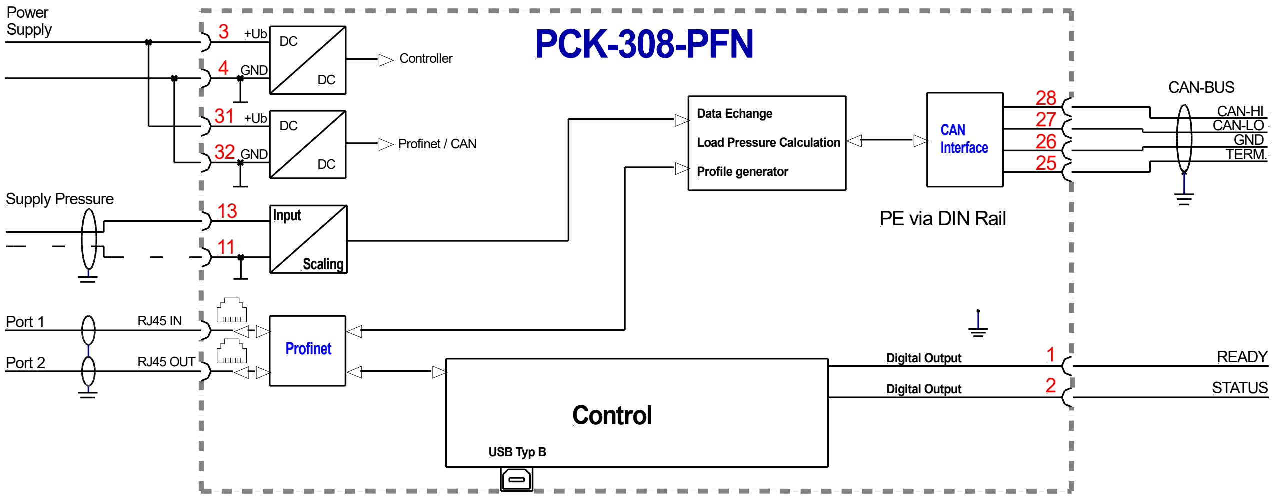


4.7 Connection examples

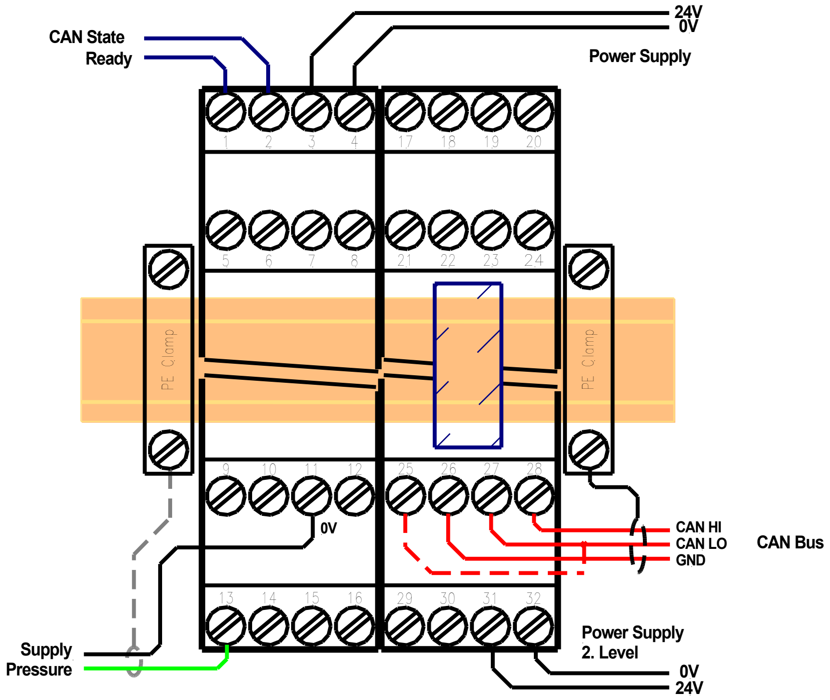




4.8 Block diagram PCK-308-C-PFN



4.9 Typical wiring PCK-308-C-PFN



4.10 Technical data

Supply voltage (V_{cc})	**[VDC]**	24 (±10 %)
Power consumption PCK-308	**[W]**	< 2,5
Power consumption CSC-158	**[W]**	max. 2.5 without sensor supply
External fuse protection (1 PCK + 2-4 CSC)	**[A]**	1-2 medium time lag
Digital inputs		
OFF	**[V]**	< 2
ON	**[V]**	> 10
Input resistance	**[kOhm]**	25
Digital outputs		
OFF	**[V]**	< 2
ON	**[V]**	max. V_{cc}
Maximum output current	**[mA]**	50
Analog inputs		Unipolar
Voltage	**[V]**	0... 10
Input resistance	**[kOhm]**	min. 25
Signal resolution	**[%]**	0.003 incl. oversampling
Current	**[mA]**	4... 20
Burden	**[Ohm]**	240 Ohm
Signal resolution	**[%]**	0.006 incl. oversampling
Analog outputs		
Voltage	**[V]**	0... 10, +/- 10 differential
Maximum load	**[mA]**	10
Current	**[mA]**	4... 20
Maximum load	**[Ohm]**	390
Signal resolution	**[%]**	0,007
Profinet IO		
Data rate	**[Mbit/s]**	100
Conformity class	**-**	CC-B
Redundancy (optionally usable)	**-**	S2
SSI interface		
Specification	**-**	RS-422
Transmission rate	**[kbit/s]**	120
CAN bus	**-**	CAN A 2.0
Transmission rate	**[Mbaud]**	1
Controller cycle time		
CSC-158	**[ms]**	1
PCK-308	**[ms]**	2
Serial interface	**-**	USB - Virtual COM port
Transmission rate	**[Baud]**	9,6... 115,2
Housing		Snap-on module according to EN 50022
Material	**-**	Polyamide PA 6.6
Flammability class	**-**	V0 (UL94)
Weight (PCK-308, CSC-158) per module	**[kg]**	0,285

Protection class Temperature range Storage temperature Air humidity	 **[°C]** **[°C]** **[%]**	IP20 -20... 60 -20... 70 <95 (non-condensing)
Connections Communication Plug connector PE Profinet	**-**	 USB type B 4-pin screw connections with pull sleeve (PCK-308 3 blocks, CSC-158 8 blocks) via the DIN mounting rail 2 x RJ45.
EMC	**-**	EN 61000-6-2: 8/2005 EN 61000-6-4: 6/2007 + A1:2011

5 Parameters

Please note: In older WPC versions, the numerical values are sometimes entered with a decimal point shift, for example: 100.00 % - > enter "10000". This can be seen from the comment text displayed there, in this case e.g. [0.01 %].

5.1 Parameter overview CSC-158-U-SSIC

Group	Command	Default	Unit	Description
Basic parameter				
	MODE	---	-	Parameter view
System parameters (MODE = SYSTEM)				
	LG	EN	-	Changing language help texts
	SENS	ON	-	Malfunction monitor
	EOUT	0.0	%	Output signal if not ready
	HAND:A	33.33	%	Manual speed
	HAND:B	-33.33	%	Manual speed
	VMODE	SDD	-	Positioning method
Input and output parameters (MODE = IO_CONF)				
	SYS_RANGE	100	mm	Axis working stroke
	SELECT:X	SSI	-	Sensor selection
	OFFSET:X	0	µm	Offset value
Analog sensor scaling				
	SIGNAL:X	U0-10		Type of input signal
	N_RANGE:X	100	mm	Nominal length of the sensor
	OFFSET:X	0	µm	Offset of the sensor
SSI sensor scaling				
	SSI:POL	+	-	Sensor polarity
	SSI:RES	1.0	µm	Resolution of the sensor
	SSI:BITS	24	-	Number of bits transmitted
	SSI:CODE	GRAY	-	Transmission coding
	SSI:ERRBIT	0	-	Position of the error bit
Pressure				
	PS_RANGE	100	bar	System pressure
	SIGNAL:X1	U0-10	-	Type of input signal
	N_RANGE:X1	100	bar	Nominal pressure of the sensor
	OFFSET:X1	0	mbar	Sensor offset
	SIGNAL:X2	U0-10	-	Type of input signal
	N_RANGE:X2	100	bar	Nominal pressure of the sensor
	OFFSET:X2	0	mbar	Sensor offset
Control output				
	SIGNAL:U	U+-10	-	Type and polarity of the output signal
Control parameters (MODE = CONTROL)				
Position controller				
	VRAMP	200	ms	Ramp time for external speed
Position controller				

Group	Command	Default	Unit	Description
	A:A A:B	100 100	ms ms	Acceleration times in SDD mode
	D:A D:B D:S	25 25 10	mm mm mm	Braking distance and overrun distance in SDD mode
	ACCEL	250	mm/s²	Acceleration (NC mode)
	VMAX	50	mm/s	Maximum speed (NC mode)
	V0:A V0:B V0:RES	8 8 1	1/s 1/s -	Loop gain in NC mode To adjust the resolution
	PT1	1	ms	Time constant (damping behavior) of the controller
	CTRL	SQRT1	-	Control characteristic
	PCOMP	VAR1	-	Supply pressure compensation
Synchronisation controller				
	SYNC_P	25	mm	Controller gain in SDD mode (braking distance)
	SYNC_V0	20	1/s	Controller amplification in NC mode (loop gain)
	SYNC_T1	20	ms	Time constant
	SYNC_C	PT1	-	Synchronisation control mode
Pressure controller				
	ARATIO	1.0	-	Area ratio of the cylinder
	RA:UP	100	ms	Time of the setpoint ramp (increase pressure)
	RA:DOWN	100	ms	Time of the setpoint ramp (reduce pressure)
	P_OFFSET	0	mbar	Print offset
	C:P C:I C:D C:D_T1 C:I_ACT C:I_ULIM C:I_LLIM	0.5 400.0 0.0 1.0 50.0 100.0 -100.0	- ms ms ms % % %	P gain Integrator reset time D Gain, derivative D Filter Integrator activation threshold Upper integrator limit Lower integrator limit
Valve adjustment				
	MIN:A MIN:B	0.0 0.0	% %	Overlap compensation or characteristic linearization
	MAX:A MAX:B	100.0 100.0	% %	Output signal scaling.
	TRIGGER	2.0	%	Response threshold of the overlap compensation
	OFFSET	0.0	%	Offset value for the output signal
Special units (TERMINAL)				
	DIAG	-	-	Call up information about the last shutdown causes
	SSI:BITMASK	0	-	Masking out bits from the SSI telegram
	TESTID	-	-	Output of the set CAN ID

ATTENTION: The parameters SYS_RANGE, PS_RANGE, VMODE, VMAX must be parameterized in the same way in the coupling module and in all axis controllers!

5.2 *Basic parameters*

5.2.1 MODE (parameter view)

Command	Parameters	Unit	Group
MODE x	x= SYSTEM|IO_CONF|CONTROL|ALL	-	BASIS

This command is used to switch parameter groups.

--- display (default)
SYSTEM System parameters
IO_CONF Definition of the input and output signals
CONTROL Parameterisation of the control functions
ALL all parameters visible

5.2.2 LG (switching the language for the help texts)

Command	Parameters	Unit	Group
LG x	x= DE|EN	-	SYSTEM

English or German can be selected for the help texts in the WPC.

5.2.3 SENS (Module monitoring)

Command	Parameters	Unit	Group
SENS x	x= ON|OFF	-	SYSTEM

This command is used to activate or deactivate monitoring functions.

ON: All functions are monitored and the ready or error message is sent to the coupling module. The coupling module can in turn switch off the entire system. The detected errors can be deleted by the ENABLE signal. The system can then go back into operation once the fault has been solved. This setting should be used for normal operation of the system.

OFF: No monitoring function is active. However, errors are sent to the coupling module, which, depending on the setting of its own SENS command, withdraws the enable from all axes (Enable).

AUTO: AUTO RESET mode, all functions are monitored. After the error status is no longer present, the module automatically switches to normal operating status when the coupling module sends an enable signal.

The monitoring function is normally always active, as otherwise no errors are signaled via the READY output. However, it can be deactivated for troubleshooting purposes. If the command is also set to OFF in the coupling module, all error messages are ignored.

5.2.4 EOUT (Output signal if not READY)

Command	Parameters	Unit	Group
`EOUT x`	`x= -100,0... 100,0`	%	**SYSTEM**

Output value when not ready (READY output is deactivated). This function can be used if the drive is to move (at a specified speed) to one of the two end positions.

ATTENTION: If the output signal is a 4... 20 mA output, the output is switched off if **|EOUT| = 0.** If a control signal of 12 mA is to be output in the event of an error, EOUT must be set to 0.01[1]. The effects must be evaluated by the user for each application with regard to safety. If the EOUT command is active, manual mode should not be used. After deactivating the manual speed, the output is reset to the programmed EOUT value.

5.2.5 HAND (Controller output in manual mode)

Command	Parameters	Unit	Group
`HAND:I x`	`i= A|B` `x= -100,0... 100,0`	 %	**SYSTEM**

These parameters are used to set the manual speeds. When the manual signal is activated, the drive moves in the defined direction in open loop control. The direction is determined by the sign of the parameter. After deactivating the manual signal, the drive remains controlled at the current position.

In the event of an error (sensor error in the position measuring system), the actuator can still be operated using the manual function. After deactivating the manual signals, the output is not activated.

The manual speed is simultaneously limited by the (external) speed specification (MIN evaluation). This makes it possible to control the hand speed externally.

ATTENTION: If the EOUT command is active, manual mode should not be used in the event of a fault. After deactivating the manual speed, the output is reset to the programmed EOUT value.

[1] This is necessary if the proportional valve has not implemented error detection - the input signal is less than 4 mA. If error detection is present in the proportional valve, it moves to a defined position after the output is switched off.

5.2.6 VMODE (positioning method)

Command	Parameters	Unit	Group
VMODE x	x= SDD|NC		**SYSTEM**

This parameter can be used to switch the basic control structure.

SDD: Stroke-Dependent-Deceleration. In this mode, "stroke-dependent braking" is activated. This mode is the standard mode and is suitable for most applications. With stroke-dependent braking, the drive moves to the target position in an open-loop controlled manner. From the set braking point, the drive then switches to closed-loop control and moves precisely to the desired position. This control structure is very robust and does not react sensitively to external influences such as fluctuating pressures.
The speed is not regulated.

NC: Numeric Controlled. In this mode, a position profile is generated internally. The system is always controlled and follows the position profile via the following error. magnitude of the following error is determined by the dynamics and the set control gain. The advantage is that the speed is constant due to the profile generator (independent of external influences). As a result of the permanent control, it is not necessary to run at 100 % speed, as otherwise an error cannot be corrected. Typical values are 70... 80 % of the maximum speed, but the system behavior and especially the load pressure must be taken into account when setting the speed.

5.3 Input and output parameters

5.3.1 SYS_RANGE (working stroke)

Command	Parameters	Unit	Group
SYS_RANGE X	x= 10... 10000	mm	**IO_CONF**

This command is used to specify the working stroke, which corresponds to 100 % of the input signal. Incorrect specifications lead to incorrect system settings and the dependent parameters such as speed and gain cannot be calculated correctly.

5.3.2 SELECT:X (type of position sensor)

Command	Parameters	Unit	Group
SELECT:X x	x= SSI|ANA	-	**IO_CONF**

This command determines the type of the position sensors' signal. Depending on the selected interface, the following parameters are displayed selectively, i.e. only the relevant ones.

ANA: The analog sensor interface (0... 10 V or 4... 20 mA) is active.

SSI: The SSI sensor interface is active. The SSI sensor is adapted to the interface via the SSI commands. The corresponding sensor data must be available.

5.3.3 SIGNAL:X (Type of analog input signal)

Command	Parameters	Unit	Group
SIGNAL:X x	x= OFF|U0-10|I4-20| U10-0|I20-4	-	**IO_CONF** **SELECT:X = ANA**

This command is used to define the type of input signal (current or voltage). At the same time, the signal direction can be reversed. In OFF mode, the analog input is deactivated.

5.3.4 N_RANGE:X (nominal length of the sensor)

Command	Parameters	Unit	Group
N_RANGE:X x	x= 10... 10000	mm	**IO_CONF** **SELECT:X = ANA**

This command is used to define the nominal length of the sensor. Incorrect specifications lead to an incorrect system setting and the dependent parameters cannot be calculated correctly. The parameter N_RANGE should always be equal to or greater than the parameter SYS_RANGE.

5.3.5

5.3.6 OFFSET:X (sensor offset)

Command	Parameters	Unit	Group
OFFSET:X x	x= -10000000... 10000000	µm	**IO_CONF**

This command is used to set the zero point of the sensor. The OFFSET:X is internally limited to SYS_RANGE.

5.3.7 SSI:POL (direction of the sensor signal)

Command	Parameters	Unit	Group
SSI:POL x	x= +|-	-	**IO_CONF** **SELECT:X = SSI**

To reverse the operating direction of the sensor, the polarity can be changed using this command. In this case, the OFFSET:X must also be adjusted.

5.3.8 SSI:RES (resolution of the sensor)

Command	Parameters	Unit	Group
SSI:RES x	x= 0,1... 100,0	µm	**IO_CONF** **SELECT:X = SSI**

The resolution of the sensor is entered via this parameter. The corresponding data can be found in the sensor data sheet.

5.3.9 SSI:BITS (bit width of the sensor signal)

Command	Parameters	Unit	Group
SSI:BITS x	x= 8... 31	bits	**IO_CONF** **SELECT:X = SSI**

This parameter is used to enter the number of data bits. The corresponding data can be found in the sensor data sheet.

5.3.10 SSI:CODE (signal coding of the sensor)

Command	Parameters	Unit	Group
SSI:CODE x	x= GRAY|BIN	-	**IO_CONF** **SELECT:X = SSI**

This parameter is used to enter the data coding. The corresponding format can be found in the sensor data sheet.

5.3.11 SSI:ERRBIT (position of the error bit)

Command	Parameters	Unit	Group
SSI:ERRBIT X	x= 0... 31	-	**IO_CONF** **SELECT:X = SSI**

This parameter is used to specify the position of the error bit (out of range). The position should be taken from the data sheet. If none is specified, the value should be left at 0.

5.3.12 PS_RANGE (nominal system pressure)

Command	Parameters	Unit	Group
PS_RANGE X	x= 10... 1000	bar	**IO_CONF**

This command is used to specify the working pressure, which corresponds to 100 %. Incorrect specifications lead to incorrect system settings and the dependent parameters cannot be calculated correctly.

5.3.13 SIGNAL:X1/X2 (type of pressure input signals)

Command	Parameters	Unit	Group
SIGNAL:X1 x SIGNAL:X2 x	x= OFF|U0-10|I4-20| U10-0|I20-4	-	**IO_CONF**

These commands are used to define the type of input signal (current or voltage). At the same time, the signal direction can be reversed. This command is available for the X1 and X2 inputs. In OFF mode, the analog input is deactivated.

5.3.14 N_RANGE:X1/X2 (nominal pressure of the sensors)

Command	Parameters	Unit	Group
N_RANGE:X1 x N_RANGE:X2 x	x= 10... 1000	bar	**IO_CONF**

These commands are used to set the nominal pressure of the sensors, i.e. the pressure at which they provide a 100 % output signal.

5.3.15 OFFSET:X1/X2 (pressure offset of the sensors)

Command	Parameters	Unit	Group
OFFSET:X1 x OFFSET:X2 x	x= -1000000... 1000000	mbar	**IO_CONF**

These commands can be used to adjust the zero points of the pressure sensors.

5.3.16 SIGNAL:U (type and polarity of the output signal)

Command	Parameters	Unit	Group
SIGNAL:U x	x= U+-10|I4-12-20| U-+10|I20-12-4	-	**IO_CONF**

This command is used to define the type of output signal (current / voltage and polarity).

Differential output ± 100 % corresponds to ± 10 V (0... 10 V at PIN 15 and PIN 16).
Current output: ± 100 % corresponds to 4... 20 mA (PIN 15 to PIN 12). 12 mA is the neutral position (U = 0 %, the valve should be in the middle position).

CURRENT OUTPUT: An output current of < 4 mA indicates that there is an error or that the module is not enabled. Make sure that the valve switches off at < 4 mA (if this is not the case, the EOUT command should be used to generate a defined output signal).

5.4 Control parameters

5.4.1 VRAMP (Ramp time for the external speed demand)

Command	Parameters	Unit	Group
VRAMP x	x= 10... 5000	ms	**CONTROL**

The rate of change of the external speed specification can be limited via this ramp time. In NC mode, this parameter should be set to 10 ms, as the profile generator already has an acceleration specification.

5.4.2 VMAX (max. speed for NC mode)

Command	Parameters	Unit	Group
VMAX x	x= 1... 2000	mm/s	**CONTROL/NC**

This parameter is entered in mm/s.

5.4.3 ACCEL (Acceleration in NC mode)

Command	Parameters	Unit	Group
ACCEL x	x= 1… 20000	mm/s²	**CONTROL/NC**

This command is used to define the acceleration in NC mode. The command is active if the VMODE has been parameterized to NC. The maximum acceleration has to be set to a value lower than the technically achievable acceleration in order to yield a stable and oscillation – free behavior.

5.4.4 A (acceleration time)

Command	Parameters	Unit	Group
A:I 3	i= A|B x= 1... 5000	ms	**CONTROL/SDD**

Ramp function for the 1st and 3rd quadrant.

The acceleration time for positioning depends on the direction. A corresponds to output pin 15 and B corresponds to output pin 16 (if POL = +).
Usually: A = flow P-A, B-T and B = flow P-B, A-T.

The parameters D:A and D:B are used as braking distance specifications for quadrants 2 and 4.

The acceleration times are only relevant for SDD mode.

5.4.5 D (deceleration distance / braking distance)

Command	Parameters	Unit	Group
D:I X	i= A|B|S x= 1... 10000	mm	**CONTROL/SDD** **D:S also NC**

This parameter is specified in mm.

The deceleration distance is set for each direction of movement (A or B). The control gain is calculated internally depending on this distance. The shorter the deceleration distance, the higher the gain. In the event of instability, a longer distance should be specified.
The parameter D:S is used as an emergency braking ramp when the START signal is deactivated. After deactivation, a new target position (current position plus D:S) is calculated in relation to the speed and specified as the target value.

$$G_{Intern} = \frac{STROKE}{D_i}$$ Calculating the control gain

ATTENTION: If the maximum stroke (STROKE command) is changed, the braking distance must also be adjusted. Otherwise, instability and uncontrolled movements may occur.

5.4.6 V0:RES (Scaling of the loop gain)

Command	Parameters	Unit	Group
V0:RES x	x= 1|1/100	-	**CONTROL/NC**

V0:RES = 1 The loop gain is specified in the unit s^{-1} (1/s).

V0:RES = 1/100 The loop gain is specified in the unit 0.01 s^{-1} [2] .

This switchover to 100 should only be carried out for very small values (V_0 < 4), as the input range is limited to 400.

5.4.7 V_0 (Loop gain setting)

Command	Parameters	Unit	Group
V0:I X	i= A|B x= 1... 400	s^{-1}	**CONTROL/NC**

This parameter is specified in s^{-1} (1/s).

In NC mode, the braking distance is not normally specified but the loop gain[3] .

Together with the VMAX parameter, the internal gain is calculated from this gain value.

$$D_i = \frac{v_{max}}{V_0}$$

$$G_{Intern} = \frac{STROKE}{D_i}$$

Calculation of the internal control gain

In NC Mode the following error at maximum speed is calculated by means of the loop gain. This following error corresponds to the deceleration stroke with stroke-dependent deceleration. The conversion and there-fore also the correct data demands related to the closed loop control system are relatively simple if the rela-tion-ship described here is taken into account.

5.4.8 PT1 (Transfer function of the controller)

Command	Parameters	Unit	Group
PT1 x	x= 1... 300	ms	**CONTROL**

This parameter can be used to adapt the transfer function of the control function.
Hydraulic drives are often critically to control, especially in case of very fast valves. The PT_1 filter can be used to improve the damping rate and allows therefore higher loop gains.

Requirements for the use are: The natural frequency of the valve should be equal or higher than the natural frequency of the drive.

[2] With very small circular gains, it may be necessary to set a value in the range from 1 s^{-1} to 3 s^{-1} . In this case, the resolu-tion of the input can be switched.

[3] The circular amplification is alternatively defined as a KV factor with the unit (m/min)/mm or as Vo in 1/s. The conversion is KV = Vo/16.67.

5.4.9 CTRL (Deceleration characteristics)

Command	Parameters	Unit	Group
CTRL x	x= LIN|SQRT1|SQRT2	-	**CONTROL**

This parameter is used to set the characteristics of the position controller. In the case of positively overlapped proportional valves, the SQRT function should be used. The non-linear flow function of these valves is linearized by the SQRT[4] function.

In case of zero lapped valves (control valves and servo valves), the LIN or SQRT1 function should be used, depending on the application. The progressive characteristic of the SQRT1 function has better positioning accuracy, but can also lead to longer positioning times in individual cases.

LIN: Linear braking characteristic (gain is factor 1).

SQRT1: Root function for the braking curve calculation. The gain is increased by a factor of 3 (in the target-position). This is the default setting.

SQRT2: Root function for the braking curve calculation. The gain is increased by a factor of 5 (in the target position). This setting should only be used if the flow function of the valve is clearly progressive.

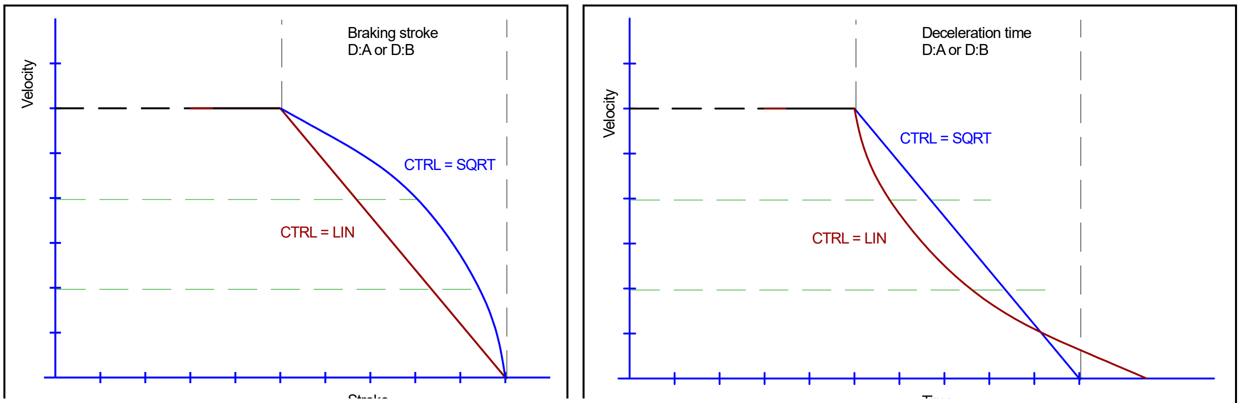


Illustration 1 (Comparison of the braking behavior over the stroke or over time)

5.4.10 PCOMP (pressure compensation)

Command	Parameters	Unit	Group
PCOMP x	x= OFF|VAR1|VAR2	-	**CONTROL**

In the position controller, the gain of the controlled system also depends on the load pressure or the pressure difference at the control edges of the valve. In order to achieve good control characteristics with reduced pressure differences, it is advantageous to adapt the controller gain to the existing pressure conditions. A standard value of 35 bar at the inlet edge is used as a reference. At this value, the set gain V0 or the braking distance D corresponds to the nominal value. The current value of the compensation factor is output as the process variable KPP. For high pressure differences, this value is less than 1.0, i.e. the controller gain is reduced. As the output of the positioning algorithm is limited to +/- 100%, the control range is restricted. This makes sense in most cases, as the travel speed remains relatively constant in SDD mode and the flow remains limited. However, if one always wants to use the option of full control, this is possible by selecting the VAR2 algorithm. A non-linear approach is selected here, in which compensation takes place at low levels, but this is reduced as

[4] The SQRT function generates a constant deceleration and therefore reaches the target position more quickly. This is achieved by increasing the gain during the braking process.

the signal increases. This results in progressive behavior.

The general prerequisite for pressure compensation is that pressure sensors are available for both cylinder ports and that the system supply pressure is transmitted by the coupler.

OFF: no compensation
VAR1: Compensation with limitation
VAR2: Compensation without limitation (non-linear special function)

5.5 Control parameter for synchronisation

5.5.1 SYNC_C (controller type)

Command	Parameters	Unit	Group
`SYNC_C x`	`x= PT1|PI`	-	**CONTROL**

Here, the controller structure can be switched between a PT1 and a PI controller.

5.5.2 SYNC_P (braking distance, amplification in SDD mode)

5.5.3 SYNC_V0 (loop gain in NC mode)

5.5.4 SYNC_T1 (time constant of the controller)

Command	Parameters	Unit	Group
`SYNC_P x`	`x= 1... 10000`	mm	**CONTROL/SDD**
`SYNC_V0 x`	`x= 1... 400`	s^{-1}	**CONTROL/NC**
`SYNC_T1 x`	`x= 1... 1000`	ms	**CONTROL**

These parameters set the synchronisation control gain.

In **SDD mode,** the SYNC_P parameter is specified in mm as the deceleration distance. The control gain is calculated internally depending on the braking distance. The shorter the braking distance, the higher the gain. In the event of instability, a longer braking distance should be specified.

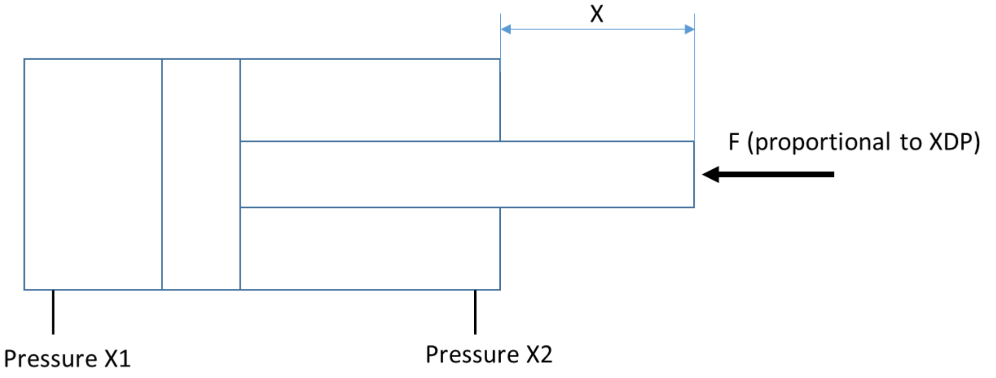
In **NC mode,** the SYNC_V0 parameter is specified in s^{-1} (1/s). In this mode, it is not normally the braking distance that is specified, but the loop gain.

The SYNC_T1 parameter causes the synchronization controller to intervene with a delay. The stability of the controller can be increased by the PT1 filter in critical cases.

5.6 Control parameters pressure / force

5.6.1 Operating direction / Inverting

In order to achieve a correct function in the interaction between pressure and position control, it is important that the direction of the actual value signals is determined according to this specification:



- A pressure at the measuring point "X1" causes the cylinder to extend (in this example) or to increase the measured displacement signal "X
- A pressure at measuring point "X2" causes the cylinder to retract or produce a reduction of the measured displacement signal "X", if signal X2 is present (omission e.g. in the case of plungers)
- A positive differential pressure XDP with "PQ Inverse" not set therefore corresponds to a force against the direction of movement of increasing actual position values X.

In a specific case, the sensors, the effective direction of the cylinder or the area ratio can deviate as long as these three principles are observed.

If, for example, the sensor polarity of the position measurement is inverted, it may be necessary to swap the connections of the pressure sensors on the module and change the parameter ARATIO to its reciprocal value.

Control of the pressure controller function by the bit "PQ_Inverse:

This bit is **not** suitable to enable a different assignment of the signals (see above). Instead, this bit can be used to determine whether the pressure controller should respond when the cylinder is extended or retracted (more precisely: during a movement with rising or falling "X").

If the bit is set, the calculation of XDP is inverted -> a positive value now corresponds to a force that is opposite to the retraction. At the same time, the coupling of the pressure controller signal into the signal path is carried out via a maximum value selection, so that the controller can influence the activation of the valve in the negative direction.

5.6.2 ARATIO (cylinder area ratio)

Command	Parameters	Unit	Group
ARATIO X	x= 0,05... 20,0	-	**CONTROL**

The ARATIO command makes it possible to calculate the cylinder areas for force control.
The ratio is specified as the quotient of the areas A to B.

Accordingly, an input of 1.0 corresponds to equal areas.

This parameter is used to calculate a pseudo differential pressure which, when multiplied by the larger of the two surfaces, gives the resulting force. This value becomes negative for forces in direction "B".

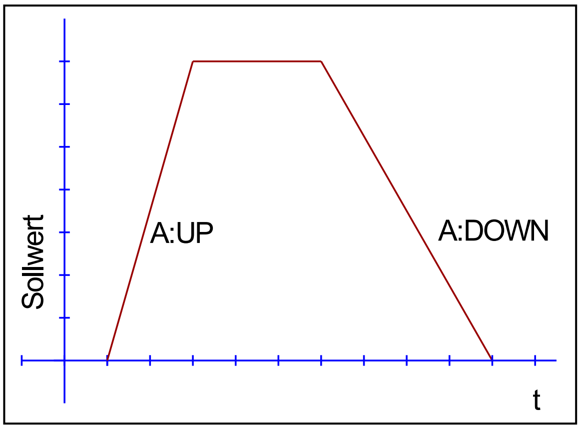
The pseudo differential pressure is the control variable for the pressure controller so that it can regulate the cylinder force.

ATTENTION: It is very important to enter this parameter correctly if you want to use pressure control. If the values are incorrect or the default value is not adjusted, the cylinder force will not be controlled as usually desired. In extreme cases, the controller may not operate stably.

5.6.3 RA (Command signal ramp time)

Command	Parameters	Unit	Group
RA:i x	i= UP|DOWN x= 1... 600000	ms	**CONTROL**

The ramp times for the pressure setpoint are defined here in the unit ms. Two separate times can be described for pressure build-up and pressure reduction.



5.6.4 P_OFFSET (pressure offset)

Command	Parameters	Unit	Group
P_OFFSET X	x= -50000... 50000	mbar	**CONTROL**

This parameter is entered in mbar.

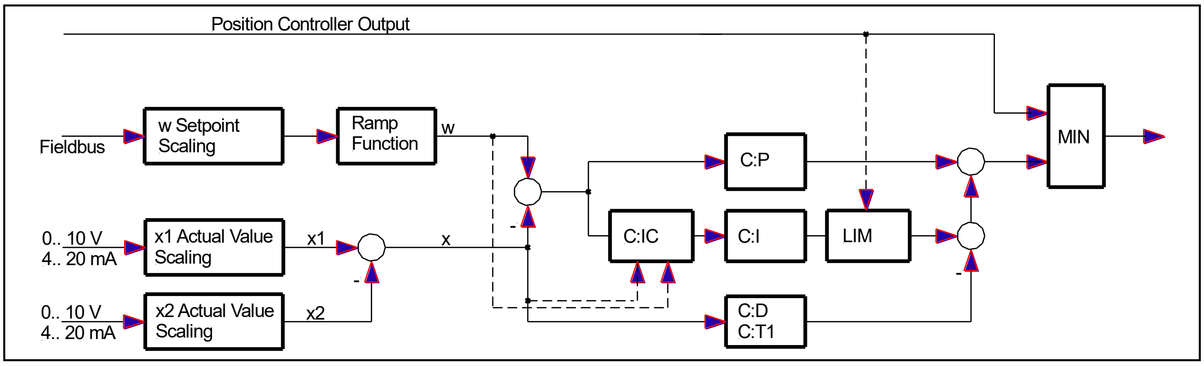
This parameter adds an offset value to the resulting actual pressure value signal. This makes it possible to eliminate external differences and thus perform an adjustment - for example, to compensate for external force differences (suspended loads, spring forces, etc.).

5.6.5 PID control parameters pressure

Command	Parameters	Unit	Group
C:i x	i= P|I|D|…		
	P x= 0.01... 100.0	-	**CONTROL**
	I x= 0.0... 3000.0	ms	
	D x= 0.0... 120.0	ms	
	D_T1 x= 0.5... 100.0	ms	
	I_ACT x= 0.0... 100.0	%	
	I_ULIM x= 0.0… 100.0	%	
	I_LLIM x= -100.0… 0.0	%	

These commands are used to parameterise the pressure controller.

The P, I and D components behave in exactly the same way as with a standard PID controller. The T1 factor is a filter for the D component to suppress high frequency noise. The I_ACT value is used to program a threshold at which the I component is activated. At 0, it is always active and large overshoots can occur when adjusting the pressure. At high values and a low P component, the speed of the actuator is limited. The I_ACT value activates the integrator as a % of the current setpoint.
In special cases, the integrator can be deactivated by setting the parameter C:I to a zero value.



The specifications C:I_ULIM and C:I_LLIM can be used to define the limits of the pressure controller respectively its integral part.

The upper limit ULIM is used to realise a continuous transition from position control to pressure control. If values < 10000 are set here, this means that the integrator no longer covers the entire control range of the position controller. If the actual pressure value now approaches the setpoint with full control from the position controller, the P component is reduced and the pressure controller takes over continuously as soon as the sum of this component and the limited integral component falls below the output signal of the position controller.

If it is desired to prevent or limit the pressure controller from controlling the valve beyond the zero point in the opposite direction (active pressure reduction), the parameter ...LLIM can be used. If it is set to the value "0", this is completely prevented.

5.6.6 PROFSTOP (stop the profile generator)

Command	Parameters	Unit	Group
PROFSTOP x	x= ON|OFF	-	**CONTROL/NC**

If the device is operated in NC mode with the pressure controller activated, the profile generator will continue to run when the pressure controller intervenes and the lag between the actual and setpoint values will therefore continue to increase. If the operating situation then changes and the position controller takes over again, this is accompanied by a rapid movement in the setpoint direction that does not follow the profile. To avoid this behavior, the "PROFSTOP = ON" parameter can be used to set up the device so that the profile generator stops as soon as it has lost control of the movement due to intervention by the pressure controller. If the pressure controller no longer intervenes, the profile is automatically released again.

5.7 Output signal adjustment

5.7.1 MIN (Deadband compensation)

5.7.2 MAX (Output scaling)

5.7.3 TRIGGER (Response threshold for the MIN parameter)

Command	Parameters	Unit	Group
	i= A|B	-	**CONTROL**
MIN:I X	x= 0,0... 60,0	%	
MAX:I X	x= 30,0... 100,0	%	
TRIGGER X	x= 0,0... 40,0	%	

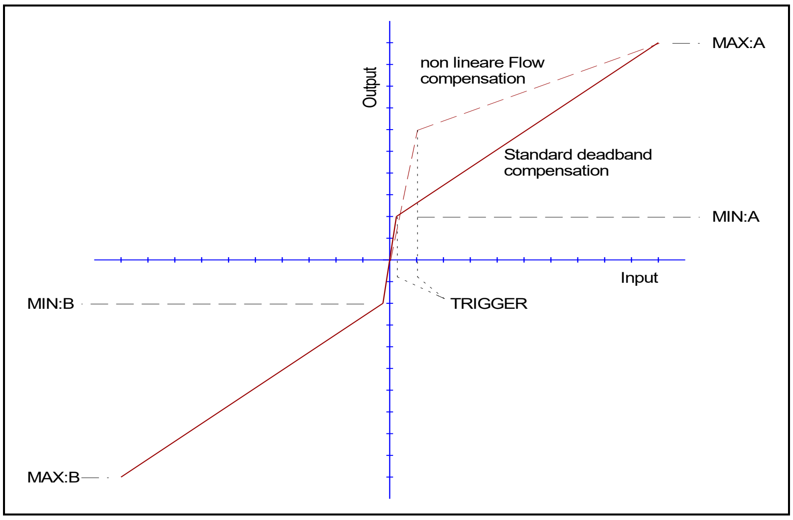
These commands are used to adapt the output signal to the valve. For positioning control, a kinked volume flow characteristic is used instead of the typical overlap jump. The advantage is a better and more stable positioning behavior. At the same time, this compensation can also be used to adapt kinked volume flow characteristics[5] of the valve.

ATTENTION: If there are also setting options for dead zone compensation on the valve or valve amplifier, ensure that the setting is made either in the power amplifier or in the module.

[5] Various manufacturers have valves with a defined kinked characteristic curve: e.g. a kink at 40 or 60 % (corresponding to 10 % input signal) of the nominal volume flow. In this case, the TRIGGER value must be set to 1000 and the MIN value to 4000 (6000).

When using zero-lapped valves or slightly under lapped valves, the volume flow amplification in the zero range is twice as high as in the normal operating range. This can lead to vibrations or nervous behavior. To compensate for this, set the TRIGGER value to approx. 200 and the MIN value to 100. This halves the gain at the zero point and a higher overall gain can often be set.

If the MIN value is set too high, this will affect the minimum speed, which can then no longer be set. In extreme cases, this leads to oscillation around the controlled position.



5.7.4 OFFSET (Valve zero point adjustment)

Command	Parameters	Unit	Group
`OFFSET X`	`x= -40,0... 40,0`	`%`	**CONTROL**

This parameter is entered in 0.01 %.
The offset value is added to the output signal. This parameter can be used to compensate for zero point shifts.

5.8 *Special commands*

5.8.1 DIAG (query of the last shutdown causes)

If this command is entered in the terminal window, the last 10 switch-offs (removal of *Ready* when *Enable* is applied) are displayed. However, the switch-off causes are not saved when the supply voltage is switched off. The last cause is displayed in the bottom line of the list. Entries "---" indicate unused memory cells.

One example:

```
>DIAG
---
---
---
---
---
---
---
---
SSI-Sensor
INPUT PIN 6
>
```

5.8.2 SSI:BITMASK (Masking out bits from the SSI telegram)

Command	Parameters	Unit	Group
SSI:BITMASK X	x=-2147483647 ... 2147483647	-	**TERMINAL**

Some SSI sensors provide several bits with diagnostic information. The SSI:ERRBIT parameter can be used to select one of these bits for error detection and remove it from the conversion of the measured value. If several bits need to be hidden, this can be done via this mask. Convert the bit pattern, in which a "1" marks the bits to be suppressed, into a decimal number and enter this number here.

5.8.3 TESTID (Query of the set CAN ID)

When this command is entered in the terminal window, the CAN ID set via the rotary switch on the 2nd level is displayed.

5.9 Process data CSC

Command	Parameters	Unit / Resolution
`WA`	Setpoint position synchronisation (input value)	0.01 mm
`WAI`	Setpoint position individual operation (input)	0.01 mm
`W`	Command value	0.01 mm
`WS`	Synchronisation setpoint	0.01 mm
`VA`	Speed specification	0,01 %
`X`	Actual position	0.01 mm
`E`	Position control deviation	0.01 mm
`ES`	Synchronization error	0.01 mm
`CS`	Synchronisation controller output	0,01 %
`WP`	Pressure setpoint	0.1 bar
`PP`	Supply pressure	0.1 bar
`X1`	Actual value pressure sensor 1	0.1 bar
`X2`	Actual value pressure sensor 2	0.1 bar
`XDP`	Pseudo - differential pressure	0.1 bar
`EP`	Pressure control deviation	0.1 bar
`CP`	Pressure controller output	0,01 %
`C`	Controller output (combined)	0,01 %
`U`	Control signal	0,01 %
`KPP`	Pressure – dependent gain	0,01
`VACT`	Actual speed	0.01 mm/s

The process data can only be read out. They show the current actual and set values.

5.10 Parameter overview PCK-308-C-PFN

Group	Command	Default	Unit	Description
Basic parameters				
	LG	EN	-	Language switching
	SENS	ON	-	Error monitoring
	PASSFB	0	-	Password for fieldbus parameterization
	MAXAX	2	-	Number of connected positioning axes
	P:CTRL	OFF	-	Pressure controller in the axes
	DISPAX	1	-	Axis for process value display
Load pressure calculation				
	ARATIO_1	1,0	-	Area ratio axis 1
	ARATIO_2	1,0	-	Area ratio axis 2
	ARATIO_3	1,0	-	Area ratio axis 3
	ARATIO_4	1,0	-	Area ratio axis 4
	VRATIO_1	1,0	-	Flow ratio valve axis 1
	VRATIO_2	1,0	-	Flow ratio valve axis 2
	VRATIO_3	1,0	-	Flow ratio valve axis 3
	VRATIO_4	1,0	-	Flow ratio valve axis 4
	FILTER:PLP	1.0	s	Time constant increase
	FILTER:PLM	60.0	s	Time constant drop
	PLSUBS	150.0	bar	Substitute value load pressure
	PDAK	35.0	bar	Pressure difference anti - cavitation
Analog input				
	SIGNAL:PP	U0-10	-	Type of input signal
	N_RANGE:PP	100	bar	Nominal pressure of the sensor
	OFFSET:PP	0	mbar	Sensor offset
Synchronisation control				
	SYS_RANGE	100	mm	Working stroke of the axles
	VMODE	SDD	-	Positioning method
	VRAMP	100	ms	Ramp time for the speed setting.
	ACCEL	250	mm/s^2	Acceleration in NC mode
	VMAX	250	mm/s	Maximum speed
	SYNCMODE	MS	-	Master-slave or averaging.
	SYNCERROR	1000	µm	Monitoring window for synchronization
	SYNCSTOP	OFF	-	Stop of all axes in case of synchronization error
	RMPLIM	100000	µm	Ramps - forward in NC mode
Special command (terminal)				
	ST	-	-	Status query of the fieldbus communication.

ATTENTION: The SYS_RANGE, VMODE, VMAX parameters must be parameterised in the same way for synchronous operation in the coupling module and in all axis controllers!

5.11 Basic parameters

5.11.1 MODE (parameter view)

Command	Parameters	Unit	Group
MODE x	x= STD|EXP	-	**STD**

This command is used to switch parameter groups.
As the number of available parameters is small, there is no difference between the STD / EXP settings.

5.11.2 LG (switching the language for the help texts)

Command	Parameters	Unit	Group
LG x	x= DE|EN	-	**STD**

English or German can be selected for the help texts in the WPC.

5.11.3 SENS (error monitoring)

Command	Parameters	Unit	Group
SENS x	x= ON|OFF|AUTO	-	**STD**

This command determines the behavior of the system's error monitoring. If SENS = OFF of the coupling module, any errors occurring on the individual axes are ignored; even if the CAN bus connection to the axes is faulty, an attempt is made to re-establish the connection every 10 ms. If, on the other hand, SENS = ON is selected, standby messages and errors occurring on the individual axes are evaluated and all axes are de-enabled in the event of an error. Once the error status has been cleared, the error memory must be acknowledged by an enable signal if SENS = ON is set for the axis that caused the error. The system can then be put back into operation by enabling it again. Acknowledging or resetting the error memory is not necessary if the SENS settings of the error-generating axis are set to SENS = OFF or SENS = AUTO.
If SENS = AUTO is set in the coupling module, the errors are automatically checked and acknowledged every 10 ms. The system restarts automatically. This setting is therefore not recommended for normal operation of the system.

5.11.4 PASSFB (password fieldbus)

Command	Parameters	Unit	Group
PASSFB x	x= 0... 10000000	-	**STD**

The number entered here serves as a password for parameterization via the fieldbus. To enable parameterization, the value specified here must be sent to the enable address via the fieldbus. Password protection is deactivated with the value "0".

5.11.5 MAXAX (number of axles)

Command	Parameters	Unit	Group
MAXAX x	x= 1... 4	-	**STD**

Number of connected axis control modules. These must be addressed upwards from 1. This means that if three modules are connected (MAXAX = 3), they must be assigned addresses 1, 2 and 3 using the selector switch on the front.

5.11.6 P:CTRL (pressure controller in the axis cards)

Command	Parameters	Unit	Group
P:CTRL x	x= OFF|ENABLED	-	**STD**

The connected axis assemblies contain pressure controllers for a limiting control. If these are not used, CAN communication can take place at a higher transmission rate as less data is transmitted. Therefore, the function of the pressure controllers must be enabled at this central point.

5.11.7 DISPAX (axis for process value display)

Command	Parameters	Unit	Group
DISPAX x	x= 1... 4	-	**STD**

Number of the axis whose process values can be displayed by the coupler in the WPC. Due to the large number of signals, the displays in the coupler must be switched in relation to the pressures. As this setting only relates to the display, it is not saved permanently.

5.12 Load pressure calculation

This function is used to calculate the minimum supply pressure required for the system (energy optimization). The minimum value required for a movement of the currently activated axes (ENABLE & (START OR HAND) = 1) is always calculated as the load pressure, disregarding the pressure losses at the valves. A system-dependent, constant value has to be added for this control pressure difference in the pressure supply control (PLC).

The direction of movement of the individual axes is taken into account in the calculation.

For axes with a momentary driving load, a pressure is also requested, namely the minimum pressure required to feed the cylinder chamber, which is enlarging, in order to avoid cavitation.

To be able to calculate this pressure, the area ratio of the control edges on the valve is also required.

While the load pressure of driven axes is the pressure at which a movement would just start (the control pressure difference must therefore be added), nothing needs to be added to the calculated pressure of the non-driven axes. This is taken into account by the parameter PDAK: The required pre-pressure of an axis with a driving load is reduced by this value and taken into account in the maximum value selection. The control pressure difference is then added back in the controller. PDAK can be set to the value of the control pressure difference.

5.12.1 ARATIO_1 ... _4 (cylinder area ratio)

Command	Parameters	Unit	Group
ARATIO_N x	N= 1... 4 x > 0.01	-	**STD**

The ARATIO command allows the cylinder areas to be calculated to determine the effective load pressure. The area ratio is always specified in the ratio of the areas A to B.

Accordingly, an input of the value A (ARATIO) of 1.0 corresponds to a double rod cylinder and a value greater than 1 corresponds to a differential cylinder with rod on side B.

5.12.2 VRATIO_1 ... _4 (flow ratio of the valves)

Command	Parameters	Unit	Group
VRATIO_N x	N= 1... 4 x= 0.1... 10.0	-	**STD**

The VRATIO specification is only used to calculate the required supply pressure with a driving load. The area ratio is always specified in the ratio of the flow values A to B. For valves with a symmetrical characteristic curve, the value is 1.0. Other common values are 2.0 and 0.5.

5.12.3 FILTER:PLP (time constant increase)

5.12.4 FILTER:PLM (time constant decrease)

Command	Parameters	Unit	Group
FILTER_PLP x FILTER_PLM x	x= 0.01... 10.0 x= 0.01... 300.0	s s	**STD**

The determined load pressure is fed to an asymmetrical filter function. The purpose of this is to obtain a smoothed value that rises sufficiently quickly so that the system can adapt to new pressure conditions without a drop in performance. The decrease can be delayed with a higher time constant, which serves to realize an almost constant supply pressure over the movement cycle at high setting values.

5.12.5 PLSUBS (substitute value load pressure)

Command	Parameters	Unit	Group
PLSUBS x	x= 0.0... 1000.0	bar	**STD**

This value is output if one of the sensors required to determine the load pressure has failed.

5.12.6 PDAK (Pressure difference anti-cavitation)

Command	Parameters	Unit	Group
PDAK x	x= 0.0... 1000.0	bar	**STD**

For the axes with a driving load, a pressure is also calculated, namely the minimum pre-pressure, so that no negative pressure can develop in the enlarging cylinder chamber. This pressure does not have to be increased by a control pressure difference (see above). The pressure entered here is therefore subtracted from the calculated value. If PDAK is set to 0.0, the consideration of anti-cavitation is switched off. Axes with a driving load are then not taken into account in the load pressure calculation.

5.13 Analog input (supply pressure)

5.13.1 SIGNAL:PP (type of input signal)

Command	Parameters	Unit	Group
SIGNAL:PP x	x= OFF|U0-10|I4-20|U10-0|I20-4	-	**STD**

This command is used to define the type of input signal (current or voltage). Also, the signal direction can be reversed. In OFF mode, the analog input is deactivated.

5.13.2 N_RANGE:PP (nominal pressure of the sensor)

Command	Parameters	Unit	Group
N_RANGE:PP x	x= 10... 1000	bar	**STD**

This command is used to enter the nominal pressure of the sensor at which it generates the full signal.

5.13.3 OFFSET:PP (sensor offset)

Command	Parameters	Unit	Group
OFFSET:PP x	x= -1000000... 1000000	mbar	**STD**

This command is used to set the zero point of the sensor if it needs to be corrected.

5.14 *Positioning (when using the synchronization function)*

The following parameters are only relevant if the synchronization function of the system is used.

5.14.1 SYS_RANGE (working stroke of the axes)

Command	Parameters	Unit	Group
SYS_RANGE X	x= 10... 10000	mm	**STD**

The working stroke is entered via this parameter.

5.14.2 VMODE (choice of control structure)

Command	Parameters	Unit	Group
VMODE X	x= NC|SDD	-	**STD**

The fundamental control structure can be changed with this parameter.

SDD: **S**troke-**D**ependent **D**eceleration. In this mode, stroke-dependent deceleration is activated. This mode is the default mode and is suitable for most applications. With stroke-dependent deceleration the drive comes to a controlled stop at the target position. From the deceleration setpoint the drive then switches to closed loop control mode and moves accurately to the desired position. This control structure is very robust and reacts insensitively to external influences such as fluctuating pressures. One disadvantage is that the speed varies with the fluctuating pressure as the system runs under open-loop control.

NC: **N**umerically **C**ontrolled. In this mode a position profile is generated internally. The system always works under control and uses the following error to follow the position profile. The magnitude of the following error is determined by the dynamics and the closed loop gain. The advantage is that the speed is constant (regardless of external influences) due to the profile demand. Because of continuous control, it is necessary not to run at 100 % speed, as otherwise the errors cannot be corrected. 70… 80 % of the maximum speed is typical although especially the system behavior and the load pressure should be taken into account when specifying the speed.

5.14.3 VRAMP (ramp time for the external speed specification)

Command	Parameters	Unit	Group
VRAMP X	x= 10... 5000	ms	**STD**

This parameter is entered in ms.
VRAMP limits the rate of change of the externally specified speed (via field bus).

5.14.4 ACCEL (acceleration)

Command	Parameters	Unit	Group
ACCEL X	x= 1... 20000	mm/s²	**VMODE = NC**

Specification of the acceleration for the profile generator in NC mode. The command is only active if VMODE = NC has been parameterized.

5.14.5 VMAX (maximum speed in NC mode)

Command	Parameters	Unit	Group
VMAX X	x= 1... 2000	mm/s	**VMODE = NC**

Specification of the maximum speed in NC mode. This value is defined by the hydraulics and should be specified as precisely as possible (never too high). The speed is scaled via the external speed setpoint. The value entered here therefore corresponds to a default value of 100%. The command is only active if the VMODE has been parameterized to NC.

5.15 Synchronization

5.15.1 SYNCMODE (synchronization mode)

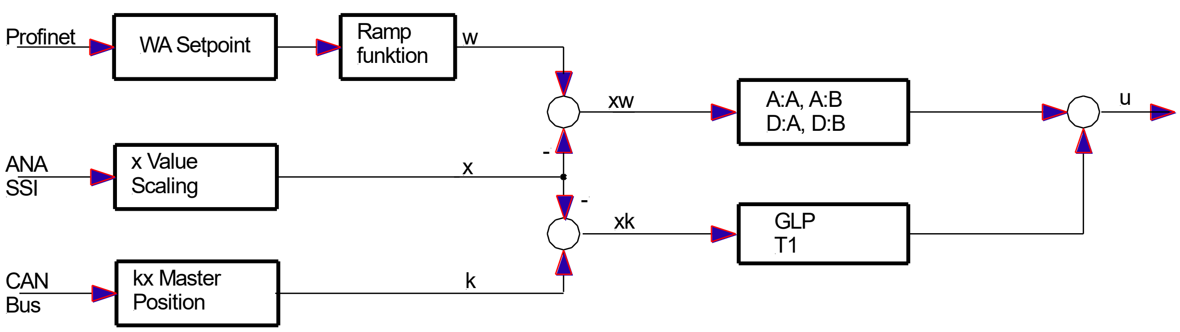
Command	Parameters	Unit	Group
SYNCHMODE X	x= MS|AV	-	**STD**

This parameter is used to set the synchronization control function.

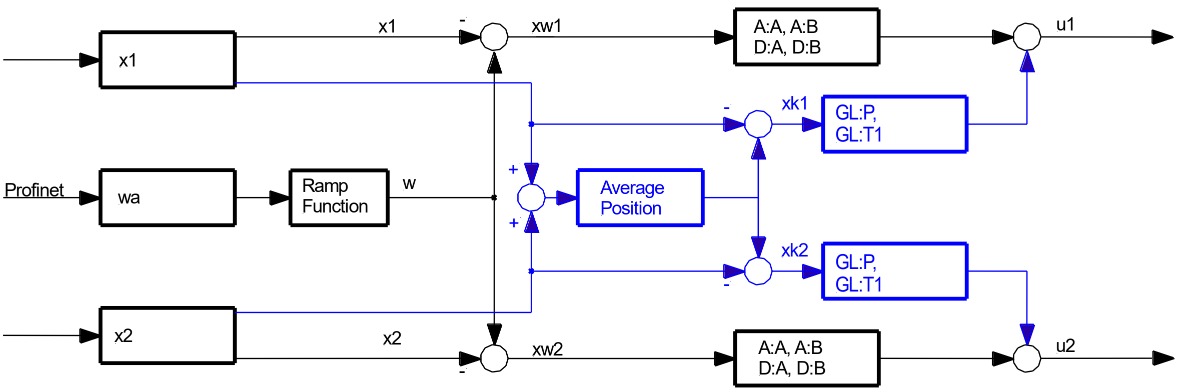
MS Master Slave: All axes follow the axis with CAN address 1 or the axis with the lowest CAN address participating in synchronisation.

AV Average Value: It is controlled to the mean position value of the axes participating in synchronisation.

Control structure master / slave (example structure for 2 axes)



Control structure: Mean value control (example structure for 2 axes)



5.15.2 SYNCERROR (synchronization window)

Command	Parameters	Unit	Group
SYNCERROR x	x= 2... 10000	µm	**STD**

Input is in µm.

The SYNCERROR command defines the window in which the SYNCERROR message is output. The control process is not affected by this message if SYNCSTOP (see below) is set to OFF.

5.15.3 SYNCSTOP (stop of all axes in case of synchronization error)

Command	Parameters	Unit	Group
SYNCSTOP x	x= OFF|ON	-	**STD**

In certain cases, it is desirable to at least temporarily interrupt the movement of the axes in the event of a synchronization error so that the error cannot increase further. The monitoring window, which is defined with SYNCERROR, is decisive for this.

This can be achieved by setting the SYNCSTOP parameter to ON. As soon as the synchronization window is exited, the setpoint is replaced by the current synchronization setpoint and the movement is aborted. A restart can then only be triggered again by a rising edge of the start signal.

5.15.4 RMPLIM (Ramp Forerun)

Command	Parameters	Unit	Group
RMPLIM x	x= 1000... 100000	µm	**VMODE = NC**

If one or more axes can no longer follow the movement specified by the profile generator in NC mode, either because the associated pressure controller has intervened or because the load is too high, it may be useful to slow down or stop the entire movement. In this way, the slower axes can determine the speed of the system. This behavior is achieved by allowing the profile generator to lead only a certain amount in relation to the axis that is lagging furthest behind. This distance can be specified with the parameter RMPLIM. The maximum value of 100000 µm as the preset value deactivates the function.

5.16 Special commands

5.16.1 ST (status query)

Command	Parameters	Unit	Group
ST	-	-	**Terminal**

Display of the control bits and setpoints transmitted by the fieldbus in itemized form.

5.17 Process data PCK

Command	Parameters	Unit / Resolution
WA	Target position (System)	0.01 mm
W	Setpoint position (internal)	0.01 mm
X1	Actual position axis 1	0.01 mm
X2	Actual position axis 2	0.01 mm
X3	Actual position axis 3	0.01 mm
X4	Actual position axis 4	0.01 mm
XAV	Synchronisation Setpoint (mean value or master position)	0.01 mm
V	Speed setpoint	0,01 %
P1S	Pressure P1 of the axis selected via DISPAX	0.01 bar
P2S	Pressure P2 of the axis selected via DISPAX	0.01 bar
PLS	Load pressure of the axis selected via DISPAX	0.01 bar
PWS	Set pressure of the axis selected via DISPAX	0.01 bar
VS	Set speed of the axis selected via DISPAX	0,01 %
WS	Target position of the axis selected via DISPAX	0.01 mm
PSYS	Current load pressure of the system	0.01 bar
PSYSM	Maximum load pressure of the system (filtered)	0.01 bar
PP	Supply pressure	0.01 bar

The process data can only be read out. They show the current actual and set values.

6 Appendix

6.1 Monitored error sources

The following possible sources of error are continuously monitored when SENS = ON/AUTO (if active):

CSC-158-U-SSIC

Source	Error	Behavior
Actual value PIN 14, 4... 20 mA	Not within the permitted range or cable break	The output is deactivated.
Actual value PIN 6, 4... 20 mA (pressure)	Not within the permitted range or cable break	The output is deactivated if the pressure controller is active (PQ_ACTIVE bit of the axis set)
Actual value PIN 13, 4... 20 mA (pressure)	Not within the permitted range or cable break	The output is deactivated if the pressure controller is active (PQ_ACTIVE bit of the axis set)
Actual value SSI	Not within the permitted range or cable break	The output is deactivated.
EEPROM (when switching on)	Data error	The output is deactivated. The output can only be activated by saving the parameters again!
CANbus	Faulty communication	The output is deactivated.

Attention: Note the setting of the EOUT command! Changes affect the behavior.

PCK-308-C-PFN

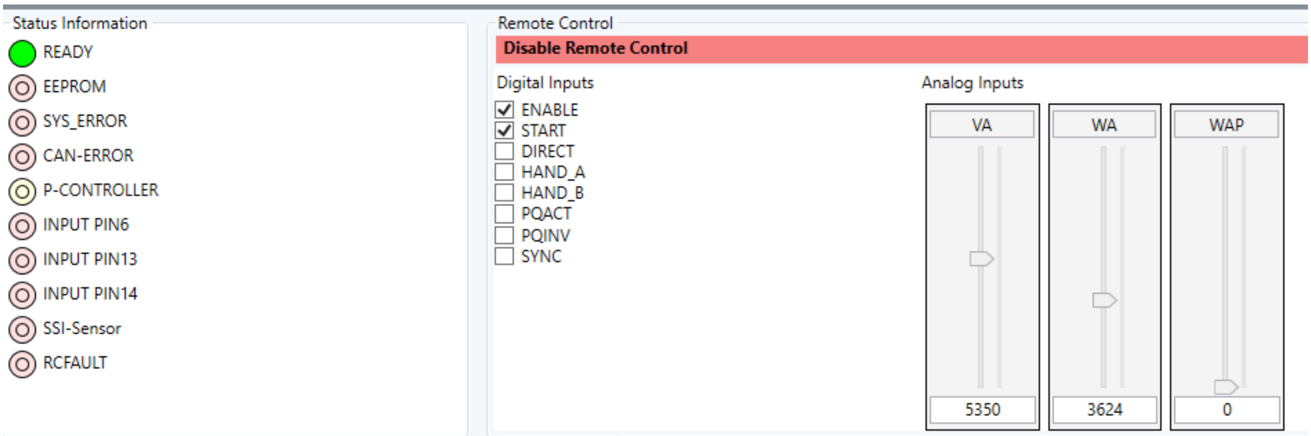
Source	Error	Behavior
Fieldbus	Faulty communication	The system is deactivated
CANbus	Faulty communication	The system is deactivated
EEPROM (when switching on)	Data error	The system is deactivated. The error can only be reset by saving the parameters again!

A fieldbus error is reset automatically. For information on acknowledging other errors, please read chapter 3.2.1.

6.2 *Possibilities for remote control via WPC*

It is possible to control either individual axes on their CSC module or the entire system from the coupler remotely via WPC. This is an operating mode without PLC signals, in which the setpoints are specified on the PC. This is particularly useful during commissioning if there is not yet a field bus connection and/or the user wishes to specify values completely independently of the PLC and the movement sequences programmed there.

6.2.1 Remote control of individual axis controllers



Here the corresponding operating screen is shown.

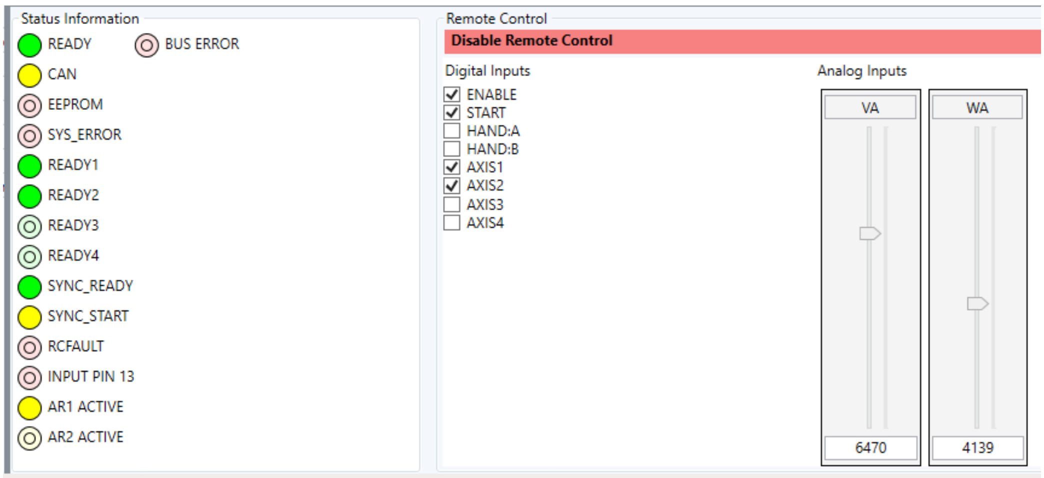
Remote control can only be activated if the "SYNC" fieldbus bit of the corresponding axis is not set, otherwise synchronised operation is requested and local control is blocked as a result.

If remote control of an axis with SYNC set is activated, synchronisation mode is blocked (no SYNC_READY feedback from the system, no synchronised positioning possible).

As can be seen above, it is possible to trigger a positioning process by specifying the set position and speed, but open loop manual operation and activation of the pressure controller are also possible.

Activating the "ENABLE" simulates both the hardware input and the fieldbus bit.

6.2.2 Remote control of the complete system



For this purpose, WPC must be connected to the coupling module. The AXIS1..4 checkboxes shown above are used to specify the axis(es) to which the specification should apply. If sever al are activated, as in this example, all specifications are interpreted as system-wide, i.e. the corresponding commands from fieldbus control byte 5 are given with the control bits and the set values VA / WA specified here overwrite the system set values in bytes 48..53. Synchronisation is also automatically requested for the activated axes. If only a single axis is activated, this is not the case and the individual control bits and setpoints can be specified.

Activating "ENABLE" only simulates the fieldbus bits for the coupler and axis module. The hardware input for ENABLE must be set there, otherwise the axis cannot be activated from the coupler.

7 Profinet IO RT interface

7.1 Profinet functions

PROFINET is a standard for Industrial Ethernet in accordance with IEEE 802.xx. and is based on the 100 Mb/s version of full-duplex and switched Ethernet. PROFINET IO is designed for fast data exchange between Ethernet-based controllers (master functionality) and field devices (slave functionality) with cycle times of up to 4 ms.

7.2 Profinet installation instructions

The Profinet field devices are connected exclusively via switches as network components. A Profinet network can be set up in a star, tree, line or ring topology. Profinet is based on Fast Ethernet standard transmission at 100 Mbit/s. CAT5 copper cables are approved as transmission media.
For the IP20 environment in the control cabinet, the CAT5 RJ45 connector is used in accordance with EN 50173 or ISO / IEC 11801. The contact assignment is compatible with the Ethernet standard (ISO / IEC 8802-3).

The connection between Profinet participants is referred to as a Profinet channel. In most cases, Profinet channels are set up with copper cables in accordance with IEC 61784-5-3 and IEC 24702. The maximum length of a Profinet channel that is set up with copper cables is 100 m.

7.3 Profinet access control

All PROFINET IO slave devices must be given a unique IP address and a name to enable communication. The IP address is assigned to the device by the Profinet IO controller (PLC). The device can be addressed with a name via the "gateway". The name of the PROFINET IO device is stored in the permanent memory of the device. It can be modified by an IO supervisor. This is usually the engineering system of the PLC used. Make sure that the IP address is not assigned twice during manual modification.

Standard address:	
IP Address:	0.0.0.0
Subnet mask:	0.0.0.0
IP Address Gateway:	0.0.0.0
Example address:	
IP address:	192.168.1.111
Subnet mask:	255.255.255.0
IP Address Gateway:	192.168.1.111

7.4 Device description file (GSDML)

The properties of an IO device are described by the device manufacturer in a *General Station Description* (GSD) file. The GSDML file (GSD Markup Language) is described for this purpose in a type of XML-based language. For the input and output data, the GSDML file describes the structure of the cyclic data accesses between the programmable logic controller and the PROFINET IO device. Any mismatch between the size and structure of the input and output data and the intended data structure generates a message to the controller.

For this system, 64 bytes are required for the input data and 64 bytes for the output data and must therefore be preset.

7.5 Description of the fieldbus interface

A resolution of 1 µm is used for the positions (regardless of the actual sensor resolution), max. 0x989680 (10,000,000). The target position is limited by the SYS_RANGE parameter.

The target speed is specified with a resolution of 0.01 %. The value 10000 (0x2710) therefore corresponds to 100 % speed.

Pressures are always interpreted as numerical values in the unit 0.1 bar.

The system is controlled via control bytes, which are described in tabular form below.

7.6 Specification from fieldbus

7.6.1 Definition of control bytes 1-4 (related to the individual axes)

Byte 0...Byte 3 - Control bytes			
No.	**Bit**	**Function**	
1	0	Hand-A	Manual mode with speed and direction as defined in the HAND:A parameter
2	1	Hand-B	Manual mode with speed and direction as defined in the HAND:B parameter
3	2	PQ_Inverse	Reversing the operating direction of the pressure controller
4	3	PQ_Active	Activating the pressure controller
5	4	SYNC	Axis participates in synchronisation
6	5	SETREF	Defines the current position as the reference position or sets the offset
7	6	START	Starts an individual positioning process for this axis (if SYNC = FALSE)
8	7	ENABLE	General release of the controller for this axis

7.6.2 Definition of control bytes 5-6 (related to the system)

Byte 5

No.	Bit	Name	Description	Type	Default
1	0	ENABLE	Release of the overall system (is AND - linked to the axes ENABLE signals)	BOOL	0
2	1	SYNCH_A	Manual mode in synchronisation, as defined with the SYNCH:A parameter	BOOL	0
3	2	SYNCH_B	Manual mode in synchronisation, as defined with the SYNCH:B parameter	BOOL	0
4	3	---		BOOL	0
5	4	---		BOOL	0
6	5	SYNC_ON	Request synchronization mode of the axes selected via the SYNC bit	BOOL	0
7	6	START	Starts a positioning process of the axes in synchronization	BOOL	0
8	7	DIRECT	Direct setpoint transfer and movement with continous START – signal (no rising edges required)	BOOL	0

Byte 6

No.	Bit	Name	Description	Type	Default
1	0	Livebit	Monitoring option for the driver module: The LIVEBIT_OUT status bit reports back the status of this bit so that the driver can use this to monitor the health of the Profinet communication[6].	BOOL	0
2	1	---		BOOL	0
3	2	---		BOOL	0
4	3	---		BOOL	0
5	4	---		BOOL	0
6	5	Para_Read	Reads out a parameter value. Reads the current value of the parameter specified by parameter index on a positive edge and outputs it at parameter value. If the address is invalid, "0xffffffffff" is returned.	BOOL	0
7	6	Para_Valid	Parameter transfer for parameterization (rising signal edge)	BOOL	0
8	7	Para_Mode	Activation of the parameterisation mode	BOOL	0

[6] If the bus communication fails, the received control bits and setpoints are reset to zero. This stops all movements; RC mode is not affected. When the bus communication is restored, the axes may restart unintentionally if the PLC program does not recognise the status and cancels the control there. We therefore recommend monitoring the status of the Profinet communication in the PLC. In the simplest case, this is done via the "BUS_VALID" output parameter of the S7 driver module.

7.6.3 Overview of the input data

A total of 64 data bytes are sent from the PLC to the system.

No.	Byte	Function	Type	Range	Unit
1	0	Control_1	UINT8		
2	1	Control_2	UINT8		
3	2	Control_3	UINT8		
4	3	Control_4	UINT8		
5	4	Control_5	UINT8		
6	5	Control_6	UINT8		
7	6				
8	7				
9	8	Setpoint position 1 High (MSB)	UINT32	0... 10000000	0.001 mm
10	9	- - -			
11	10	- - -			
12	11	Setpoint position 1 Low (LSB)			
13	12	Target speed 1 High	UINT16	0... 10000 (0... 100 %)	0,01 %
14	13	Target speed 1 Low			
15	14	Set pressure 1 High	UINT16	0...10000	0.1 bar
16	15	Set pressure 1 Low			
17	16	Setpoint position 2 High (MSB)	UINT32	0... 10000000	0.001 mm
18	17	- - -			
19	18	- - -			
20	19	Setpoint position 2 Low (LSB)			
21	20	Target speed 2 High	UINT16	0... 10000 (0... 100 %)	0.01 %
22	21	Target speed 2 Low			
23	22	Set pressure 2 High	UINT16	0...10000	0.1 bar
24	23	Set pressure 2 Low			
25	24				
26	25				
27	26	Parameter value High (MSB)	UINT32	Value range of the respective parameter	Parameter dependent
28	27	- - -			
29	28	- - -			
30	29	Parameter value Low (LSB)			
31	30	Parameter address High	UINT16		hex
32	31	Parameter address Low			

33	32	Setpoint position 3 High (MSB)	UINT32	0... 10000000	0.001 mm

34	33	- - -			
35	34	- - -			
36	35	Setpoint position 3 Low (LSB)			
37	36	Target speed 3 High	UINT16	0... 10000 (0... 100 %)	0,01 %
38	37	Target speed 3 Low			
39	38	Set pressure 3 High	UINT16	0...10000	0.1 bar
40	39	Set pressure 3 Low			
41	40	Setpoint position 4 High (MSB)	UINT32	0... 10000000	0.001 mm
42	41	- - -			
43	42	- - -			
44	43	Setpoint position 4 Low (LSB)			
45	44	Target speed 4 High	UINT16	0... 10000 (0... 100 %)	0.01 %
46	45	Target speed 4 Low			
47	46	Set pressure 4 High	UINT16	0...10000	0.1 bar
48	47	Set pressure 4 Low			
49	48	Target position system high (MSB)	UINT32	0... 10000000	0.001 mm
50	49	- - -			
51	50	- - -			
52	51	Setpoint position system low (LSB)			
53	52	Target speed System High	UINT16	0... 10000 (0... 100 %)	0.01 %
54	53	Target speed System Low			
55.. 64	54.. 63	Reserve			

7.7 *DATA on the FELDBUS*

7.7.1 Definition Status bytes 1-4 (related to the individual axes)

Byte 1-4 - Status			
No.	**Bit**	**Function**	
1	0	X_ERROR	No error of the position sensor
2	1	P_ERROR_1	No signal error at the analog pressure sensor input
3	2	P_ERROR_2	No signal error at the analog pressure sensor input
4	3	LOCOP	Independent operation, currently no SYNC mode possible
5	4	PQ-ACTIVE	Pressure regulator is active and has taken over control
6	5		
7	6		
8	7	READY	Axle is ready and error-free

7.7.2 Definition of status bytes 5-6 (related to the system)

Byte 5 - System status byte			
No.	**Bit**	**Function**	
1	0	ERROR PCK	No collective error in the coupling module
2	1	C-RUNNING	CAN bus communication error-free
3	2	PP-ERROR	No error in the supply pressure measurement
4	3	READY	Ready message of the coupling module
5	4	AX1_INSYNC	Axis is synchronized with the synchronization system
6	5	AX2_INSYNC	Axis is synchronized with the synchronization system
7	6	AX3_INSYNC	Axis is synchronized with the synchronization system
8	7	AX4_INSYNC	Axis is synchronized with the synchronization system

Byte 6 - System status byte			
No.	**Bit**	**Function**	
1	0	LIVEBIT_OUT	Feedback (= LIVEBIT), monitoring of communication
2	1	P_LOAD_OK	The load pressure determination provides a valid result
3	2	SYNC_READY	System ready for synchronization
4	3	SYNC_START	System in synchronized operation
5	4		
6	5		
7	6	PARA_READY	A parameter value was transferred correctly
8	7	PARA_ACTIVE	Parameterization mode is active

7.7.3 Overview of the output data

A total of 64 bytes are sent from the module to the field bus (to the controller).

No.	Byte	Function	Type	Range	Dim
1	0	Status_1	UINT8		
2	1	Status_2	UINT8		
3	2	Status_3	UINT8		
4	3	Status_4	UINT8		
5	4	Status_5	UINT8		
6	5	Status_6	UINT8		
7	6	Supply pressure Hi	INT16	-	0.1 bar
8	7	Supply pressure Lo			
9	8	Target position System Hi	INT32		0.001 mm
10	9	…			
11	10	…			
12	11	Target position System Lo			
13	12	Actual position 1 Hi	INT32		0.001 mm
14	13	…			
15	14	…			
16	15	Actual position 1 Lo			
17	16	Actual position 2 Hi	INT32		0.001 mm
18	17	…			
19	18	…			
20	19	Actual position 2 Lo			
21	20	Actual position 3 Hi	INT32		0.001 mm
22	21	…			
23	22	…			
24	23	Actual position 3 Lo			
25	24	Actual position 4 Hi	INT32		0.001 mm
26	25	…			
27	26	…			
28	27	Actual position 4 Lo			
29	28	Parameter value Hi	INT32	Value range of the respective parameter	parameter dependent
30	29	…			
31	30	…			
32	31	Parameter value Lo			
33	32	Pressure 1 Axis 1 Hi	INT16	-	0.1 bar
34	33	Pressure 1 Axis 1 Lo			
35	34	Pressure 2 Axis 1 Hi	INT16	-	0.1 bar
36	35	Pressure 2 Axis 1 Lo			
37	36	Pressure 1 Axis 2 Hi	INT16	-	0.1 bar

38	37	Pressure 1 Axis 2 Lo			
39	38	Pressure 2 Axis 2 Hi	INT16	-	0.1 bar
40	39	Pressure 2 Axis 2 Lo			
41	40	Pressure 1 Axis 3 Hi	INT16	-	0.1 bar
42	41	Pressure 1 Axis 3 Lo			
43	42	Pressure 2 Axis 3 Hi	INT16	-	0.1 bar
44	43	Pressure 2 Axis 3 Lo			
45	44	Pressure 1 Axis 4 Hi	INT16	-	0.1 bar
46	45	Pressure 1 Axis 4 Lo			
47	46	Pressure 2 Axis 4 Hi	INT16	-	0.1 bar
48	47	Pressure 2 Axis 4 Lo			
49	48	actual load pressure System Hi	INT16	-	0.1 bar
50	49	actual load pressure System Lo			
51	50	maximum load pressure System Hi	INT16	-	0.1 bar
52	51	maximum load pressure System Lo			
53.. 64	52.. 63	Free			

8 ProfiNet driver module for Simatic controllers

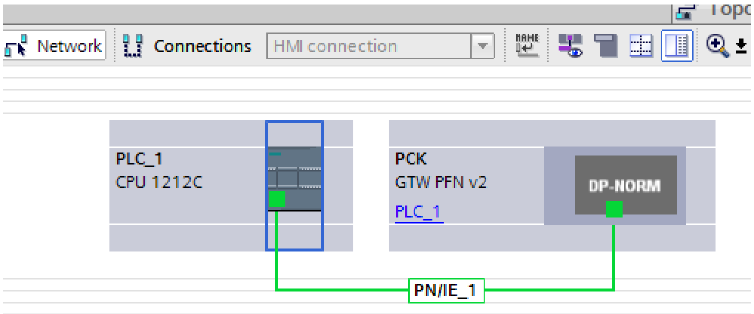
8.1 Integration into the project

For the "TIA Portal" software, we provide two driver modules for convenient access from the user program:

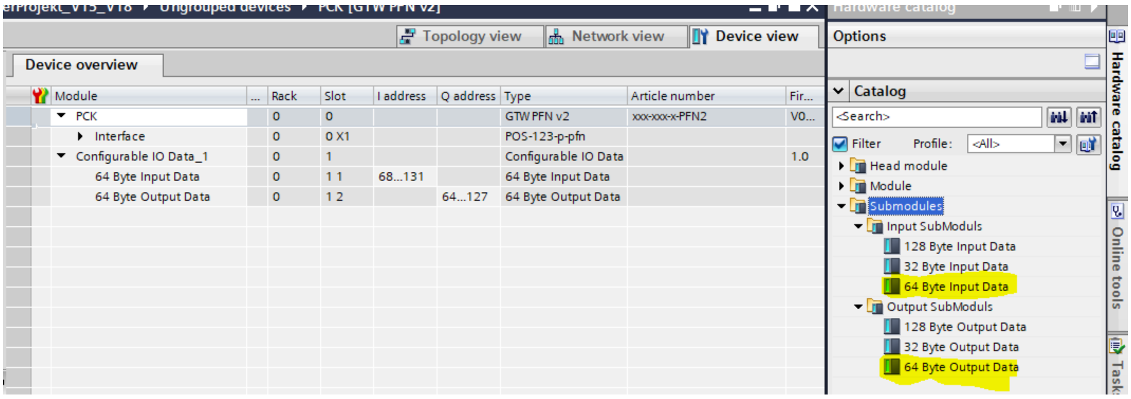
a) The WEST_PCK_308_PFN.scl source for S7-1200 and -1500 series controllers
b) The WEST_PCK_308_PFN_KLASSIK.scl source for S7-300 and -400 series controllers

Their installation in the user project and the wiring are explained below.

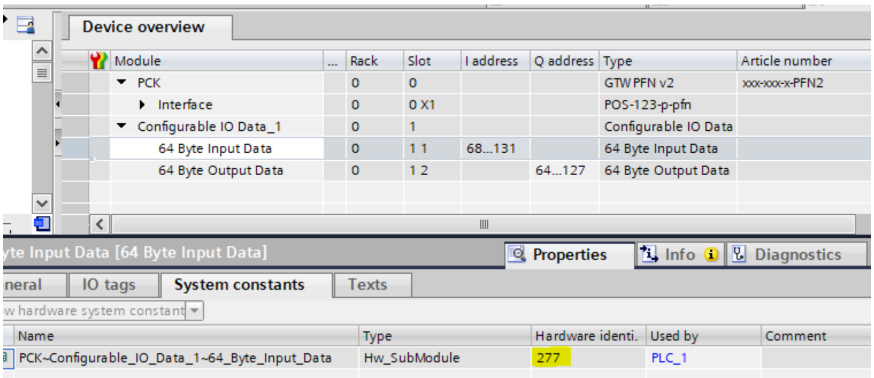
1.) GSDML - Import file
2.) Configure the connection between the control unit and the controller via ProfiNet:



3.) Install a module submodule in the device:
64 byte output data
64 byte input data



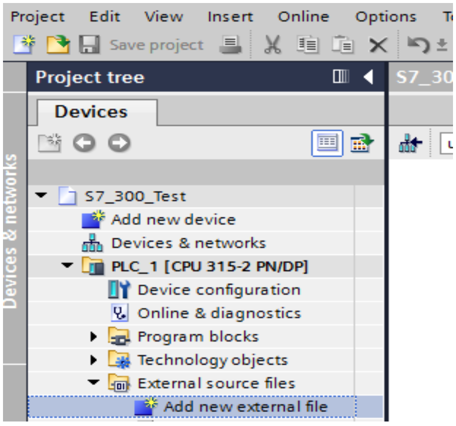
The addresses are assigned automatically. The automatically assigned *hardware identifiers* are also important for connecting the program module when using the S7-1200 / -1500. These can be determined by right-clicking on the two modules in the device overview and selecting the context menu item "Properties":



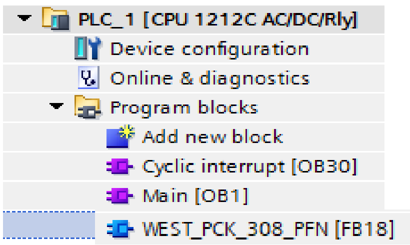
These numbers are different and must be noted separately for the input and output data.

If an S7-300 / -400 is used, the start values of the addresses (E address / A address) are required.

4.) The driver module is provided as an SCL source. This file must be added as a "new external file" in the TIA portal for installation in the project:

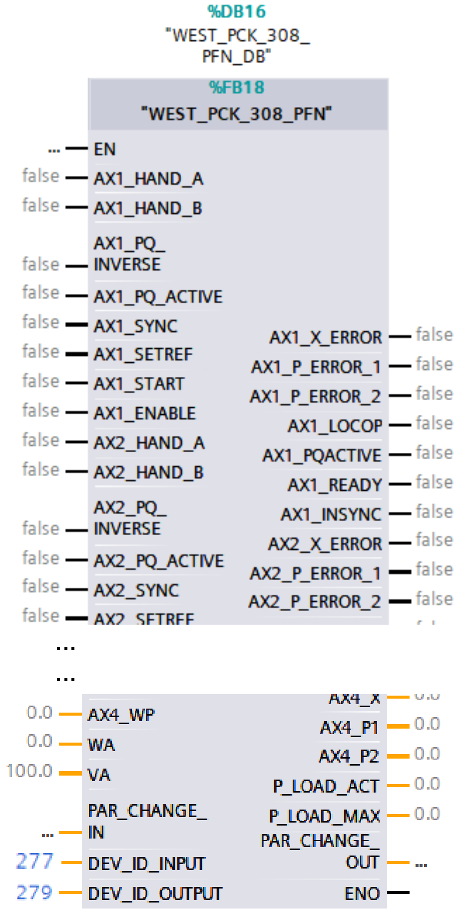


5.) Then right-click on the imported file and select the option "Generate blocks from source". After translation, the driver block is available in the block folder. The number may also differ.



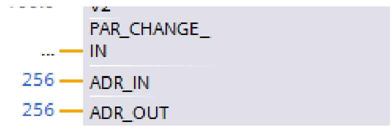
This FB can now be called up in the user program. This should be done in a wake-up alarm OB with a cycle time >= 4 ms.

View of the module in the FBD without wiring:



Here you can see the details of the previously read HW identifiers below. These must be adjusted accordingly.

Address specification for S7-300 / -400 (values differ):



8.2 Relevant signals

The driver module offers a wide range of connection options.

Which of these can be used sensibly depends on the application.

The following tables should make the selection easier.

A distinction is made between the control modes "individual operation" and synchronization. It is of course possible to use the system temporarily in one or the other operating mode and even to move some of the axes individually during synchronisation operation of the rest.

The programmer is responsible for determining which values are to be linked and/or visualized.

Legend

X = Use is absolutely necessary or strongly recommended

O = Use optional

F = Use only when using the corresponding special function

8.2.1 Control bits (inputs of the function block)

Designation	Individual operation	Synchronisation	Remarks
AX.._HAND_A	O		
AX.._HAND_B	O		
AX'.._PQ_INVERSE	F	F	
AX.._PQ_ACTIVE	F	F	
AX.._SYNC		X	
AX.._SETREF		F	
AX.._START	X		
AX.._ENABLE	X		No function without ENABLE
ENABLE	X	X	No function without ENABLE
SYNCH_A		O	
SYNCH_B		O	
SYNC_ON		X	
START		X	
DIRECT	O	O	has a system-wide effect, mostly fixed value

8.2.2 Setpoints (inputs of the function block)

Designation	Individual operation	Synchronization	Remarks
AX..WA	X		
AX..VA	X		preset 100.0%
AX..WP	F	F	for pressure control
WA		X	
VA		X	preset 100.0%
PAR_CHANGE_IN	Parameterisation (not yet supported)		

8.2.3 Status bits (outputs of the function block)

Designation	Individual operation	Synchronisation	Remarks
AX..X_ERROR	X	X	
AX..P_ERROR_1	F	F	if sensor present
AX..P_ERROR_2	F	F	if sensor present
AX.._LOCOP		O	
AX.._PQACTIVE	F	F	for pressure control
AX.._READY	X	X	
AX.._INSYNC		X	
ERROR_PCK	X	X	
C_RUNNING	O	O	
PP_ERROR	F	F	if sensor present
READY	X	X	
P_LOAD_OK	F	F	for load pressure calculation
SYNC_READY		X	
SYNC_START		X	
BUS_VALID	X	X	

8.2.4 Feedback values

Designation	Individual operation	Synchronisation	Remarks
PP	F	F	if sensor present
WS		O	
AX..X	X	X	
AX..P1	F	F	if sensor present
AX..P2	F	F	if sensor present
P_LOAD_ACT	F	F	Load pressure calculation
P_LOAD_MAX	F	F	Load pressure calculation
PAR_CHANGE_OUT	Parameterisation (not yet supported)		

9 Notes