WEST

Technical documentation

CSC-156-U-SSIC
plus PCK-306-C-PDP coupler

Synchronization system with pressure control, SSI Interface and Profibus Interface
for up to 4 axes

Electronics
Hydraulics meets
meets Hydraulics
Electronics

CONTENTS

1 General information

1.1 Order number

CSC-156-U-SSIC - with universal/programmable analogue output
(+/- 10V differential signal or 4… 20mA current signal)

PCK-306-C-PDP - Profibus / CAN Bus coupler

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: www.w-e-st.de/produkte/software)

Any standard cable with USB-A and USB-B connector can be used as the programming cable.

1.4 Symbols used

General information

Safety-related information

1.5 Legal notice

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Datum: 07.01.2025

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 module is a position controller with additional synchronization control and an integrated optional pressure limitation function.
Using the Profibus up to 4 axes can be controlled.

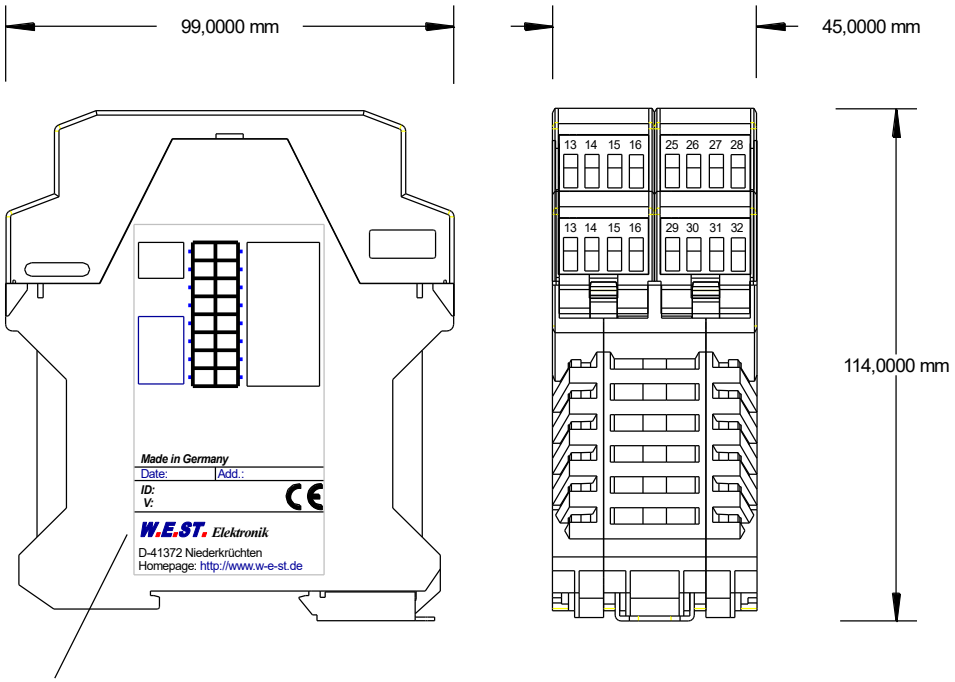
- **Positioning**: Similar to our standard positioning controller an axis can be used as point-to-point-control (stroke depended deceleration) or in NC-mode (speed controlled). By means of a few parameters the controller gets optimized, the profile generation is set via the Profibus (position and speed).
- **Synchronization control:** If controlling more axes additionally a superimposed synchronization control will be activated. As control structure a PI respectively PT1 controller is used. According to the requirements both master slave concept and average determination (control of all axes to an internal calculated demand position depending on the several single positions and the command position) are available.
- **Pressure/force control**: With one or two pressure sensors the force can be measured and limited. When the system switches over from synchronization control to pressure/force limitation control, the limitation controller has priority.

Features:

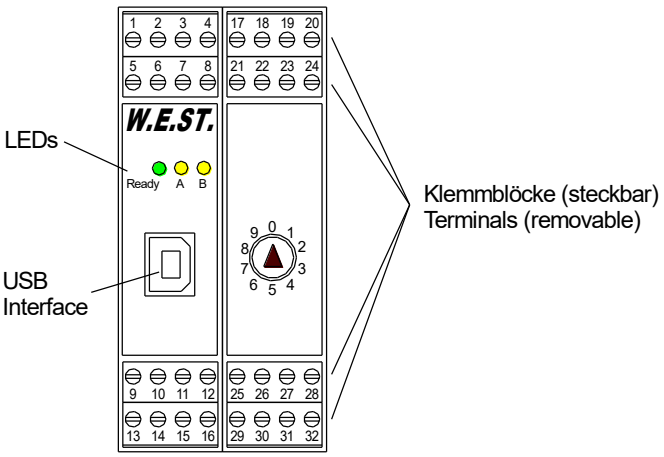
- **Command values, actual values, control word and status word via Profibus DP**
- **Sensorresolution up to 1µm**
- **Speed controlled positioning (alternative principle of stroke dependent deceleration)**
- **Synchronization control function as PI or PT1 controller**
- **Optional pressure limitation function**
- **SSI Interface or analogue position sensors**
- **Internal profile definition by presetting acceleration and deceleration**
- **Automatic zero point sensor setting**
- **Optimal using with zero lapped control valves**
- **Fault diagnosis and extended function checking**
- **Simplified parameterization with WPC-300 software**

2.1 Device description

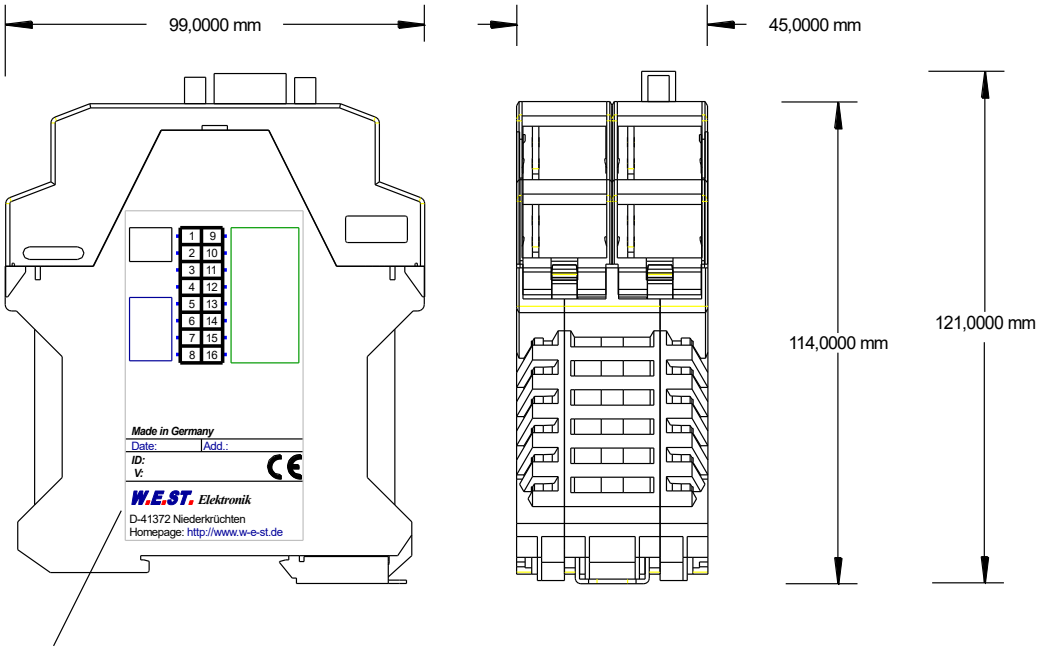
2.1.1 CSC-156-U-SSIC



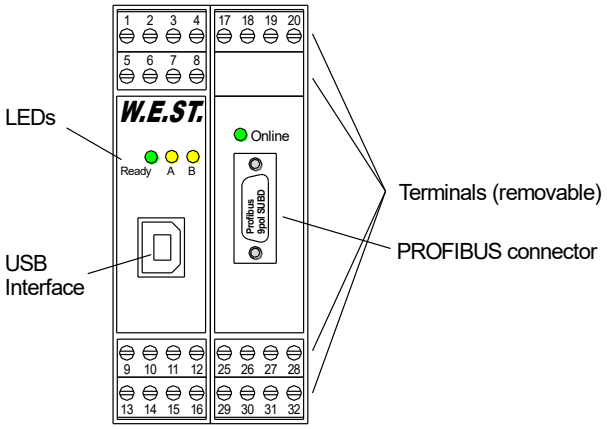
Typenschild und Anschlussbelegung
Type plate and terminal pin assignment



2.1.2 **PCK-306-C-PDP**

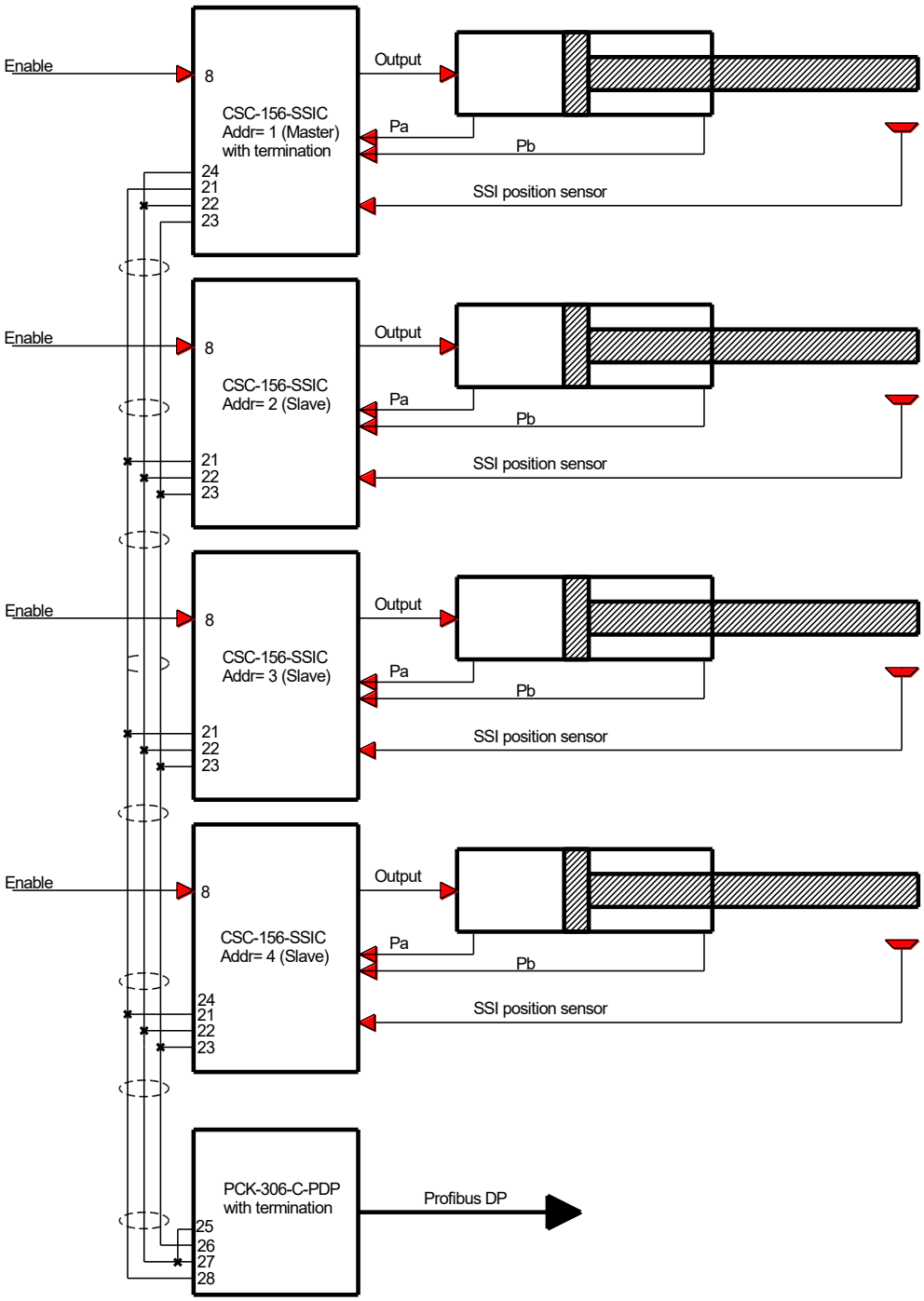


Type plate and terminal pin assignment



3 Use and application

3.1 Typical system structure



3.2 Method of operation

3.2.1 General process of function

With a system consisting of one PCK-306 and up to four CSC-156 modules typical synchronization applications like e.g. press and calender controls are possible. Additionally to the positioning and synchronization controller a pressure limitation controller (differential pressure or force control) is implemented. With help of the various control bits, the functionality can be adapted to the respective requirements.

3.2.1.1 Modes of function:

Positioning: With the control bits ENABLE, START, HAND_A, HAND_B and AXIS_X_ACT the single axes or all axes in combination can be driven.

ENABLE: general system approval.
The bits AXIS_1_ACT up to AXIS_4_ACT determine which axes are controlled. The manual speed values as well as the command positions are transferred only to the activated axes. All other axes stay at their actual position.

With the START signal (when changing from 0 to 1) the command position is taken over and the axes will approach it in synchronicity.
Deactivating the START signal during positioning will stop the system at the actual position using a braking ramp.
In manual operation the axes move open loop controlled in the respective direction. So there is no synchronization and the axes can move with different speeds. The programmed manual speed can be reduced by the speed defaults of the primary control.

In DIRECTMODE the command positions are taken over directly from the Profibus (without confirmation of changing START signal from 0 to 1).

PQ ON: With this bit the pressure limitation control gets activated. If the respective axis is in pressure control this is indicated by the bit **PQ x active.**

3.2.1.2 Special functions

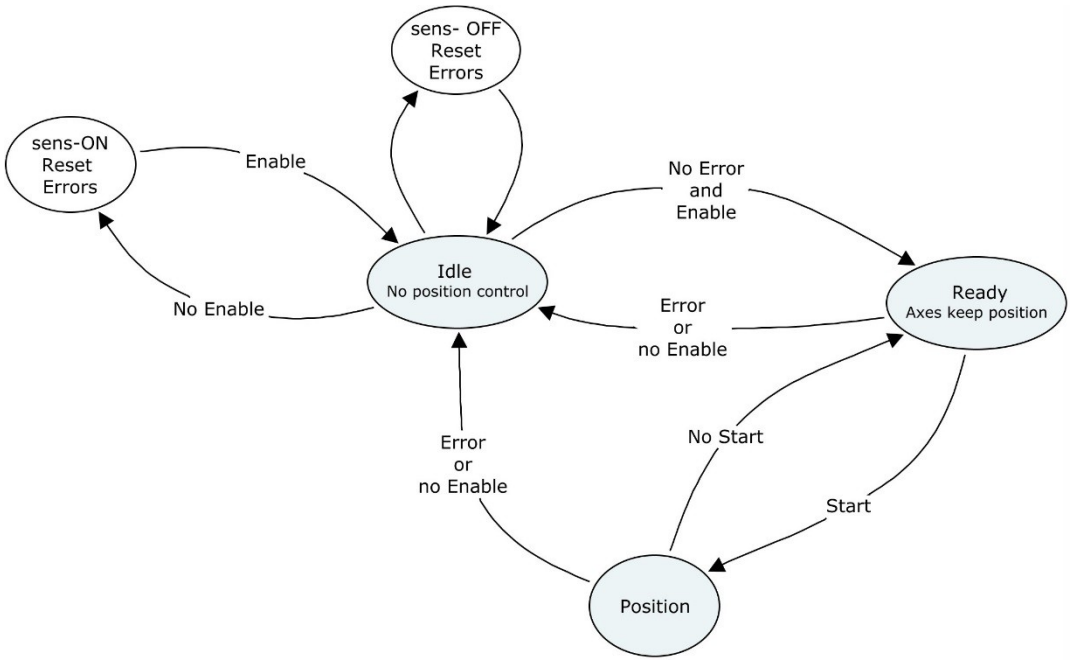
Zero point: Especially for exact synchronization controls the valve zero point has to be adjusted. This can be done automatically via the Profibus bits **DC active** and **DC freeze**.
To adjust the zero point START has to be deactivated and no HAND signal may exist. The axes have to be in position with no load. By activating the bit **DC active** the drift compensation is switched on. After adjusting the zero point (usually within a few seconds) the bit **DC freeze** has to be set to freeze the offset.
This process can be repeated depending on the temperature.
1. Deactivating BIT **DC active** and **DC freeze** (the offset is deleted)
2. Activating **DC active** (position integrator is started)
3. Activating **DC freeze** (integrator value is frozen)

3.2.2 Automatic mode

The whole system is controlled via the Profibus by setting demand values and control bits.
The system has three basic states:

- **Idle** System is waiting for ENABLE from the Profibus
- **Ready** System is ready and is waiting for START signal from Profibus
- **Positioning** System positions in synchronization mode.

When detecting an error, the system always goes back into the idle-state.
If SENS is parameterized to ON errors have to be acknowledged by resetting the ENABLE bit.
Setting SENS = OFF means resetting faults automatically and cyclically every 10ms.



3.2.3 Hand mode

To drive the system manually the profibus interface provides two control bits.

- Hand-A
- Hand-B

If the common readiness is available, means the necessary ENABLE signals are existing and no error has been detected, the activated axes can be driven in hand mode, means open loop controlled with the preset speed.

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 always 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 movements. With the command COPY the parameter list of the CSC module will be transferred to all modules. 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 hydraulics	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 probably 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 control 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-156--SSIC*

Connection	Supply
PIN 3 and 19	Power supply (see technical data)
PIN 4 and 20	0 V (GND) connection.
Connection	**Analogue signals**
PIN 6	Pressure actual value sensor A (XP1), signal range 0… 10V or 4… 20 mA, scalable
PIN 13	Pressure actual 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 valve. Type and polarity are 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. Bridge to CAN LO at first and last module is neccessary.
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:** The module is enabled; there are no discernable errors. **OFF:** Enable is not available or an error has been detected.
PIN 2	**STATUS output:** **ON:** CAN-Bus active and without fault **OFF**: CAN-Bus fault

4.2 LED definitions CSC module

LEDs	Description of the LED function
GREEN	**OFF:** no power supply or ENABLE is not activated **ON:** System is ready for operation (ENABLE=1), there is no error. **Flashing:** System was set to ready for operation (ENABLE=1), error occurred.
YELLOW	Identical to the STATUS output.

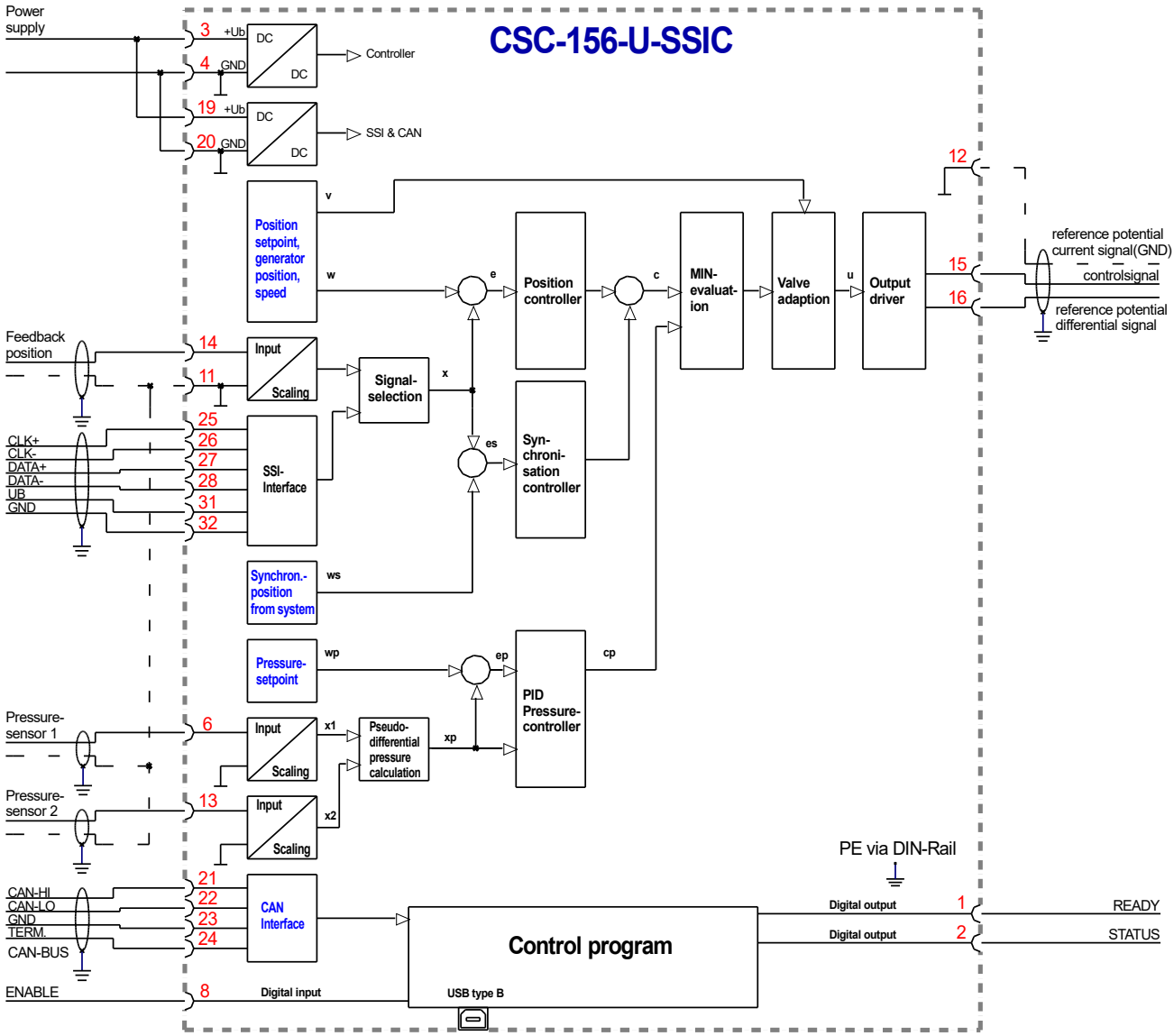
4.3 Input and output signals PCK-306-C-PDP

Connection	Supply
PIN 3 and 31	Power supply (see technical data)
PIN 4 and 32	0 V (GND) connection.
Connection	**Local CAN-bus**
PIN 28	CAN HI
PIN 27	CAN LO
PIN 26	GND
PIN 25	Termination of the CAN-bus. Bridge to PIN CAN LO at first and last module (PCK or CSC) is neccessary.
Connection	**Digital inputs and outputs**
PIN 1	**READY output:** **ON:** The module is enabled; there are no discernable errors. **OFF:** Enable is not available or an error has been detected.
PIN2	**STATUS output:** **ON:** CAN-Bus active and without fault **OFF**: CAN-Bus fault

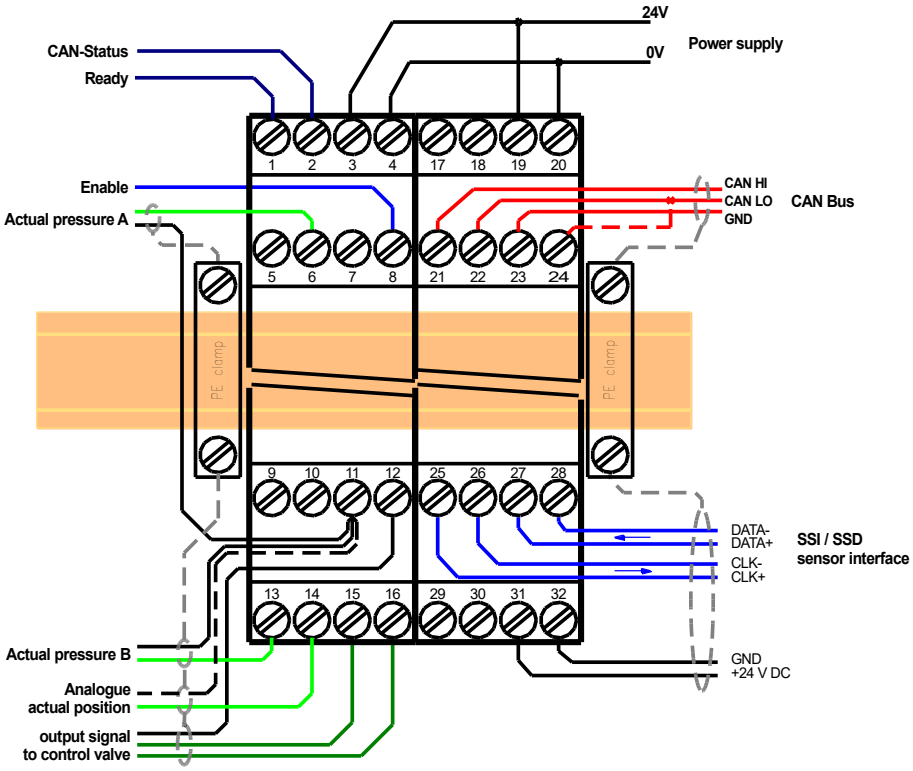
4.4 LED definitions PCK module

LEDs	Description of the LED Function
GREEN	**OFF:** no power supply or ENABLE is not activated. **ON:** System is ready for operation (ENABLE =1), there is no fault. **Flashing:** System was set to ready for operation (ENABLE =1), error occurred.
YELLOW	Identic with the status output (PIN2)

4.5 Circuit diagram CSC-156-U-SSIC

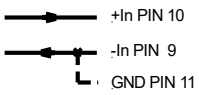


4.6 Typical wiring CSC-156-U-SSIC

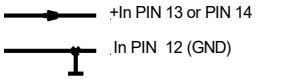


4.7 Connection examples

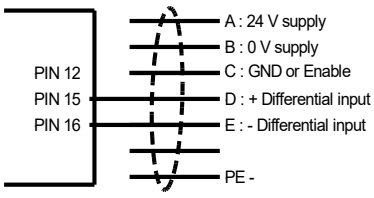
SPS / PLC 0... 10 V Velocity signal



SPS / PLC 0... 10 V Sensor- / Actual Value signal

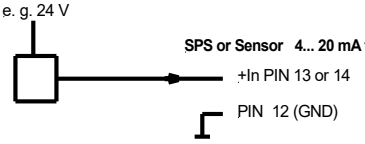


Valves (6 + PE plug) with integrated electronic



e. g. 24 V

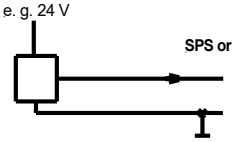
SPS or Sensor 4... 20 mA two conductor technique



AIN:W 2000 1600 2000 C (for 0... 100%)

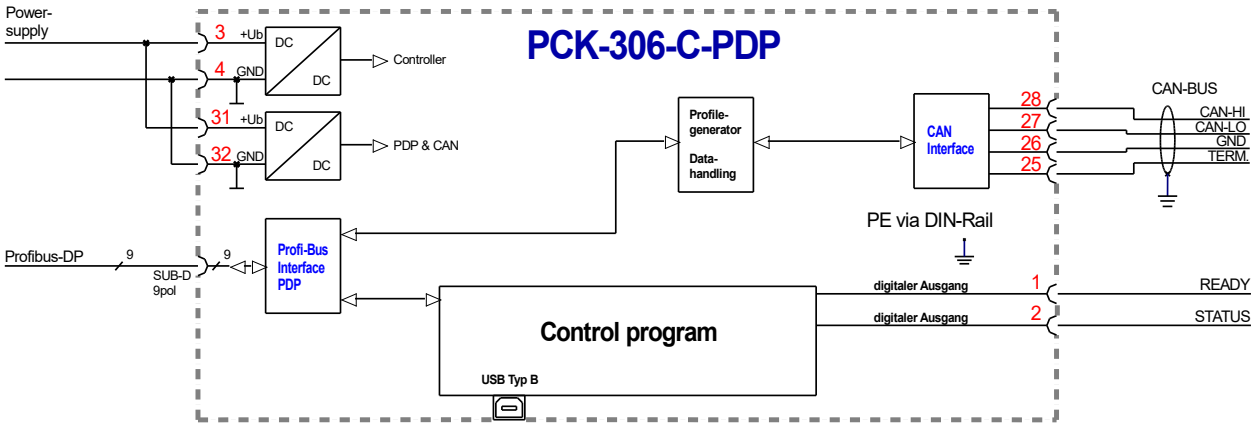
e. g. 24 V

SPS or Sensor 4... 20 mA three conductor technique

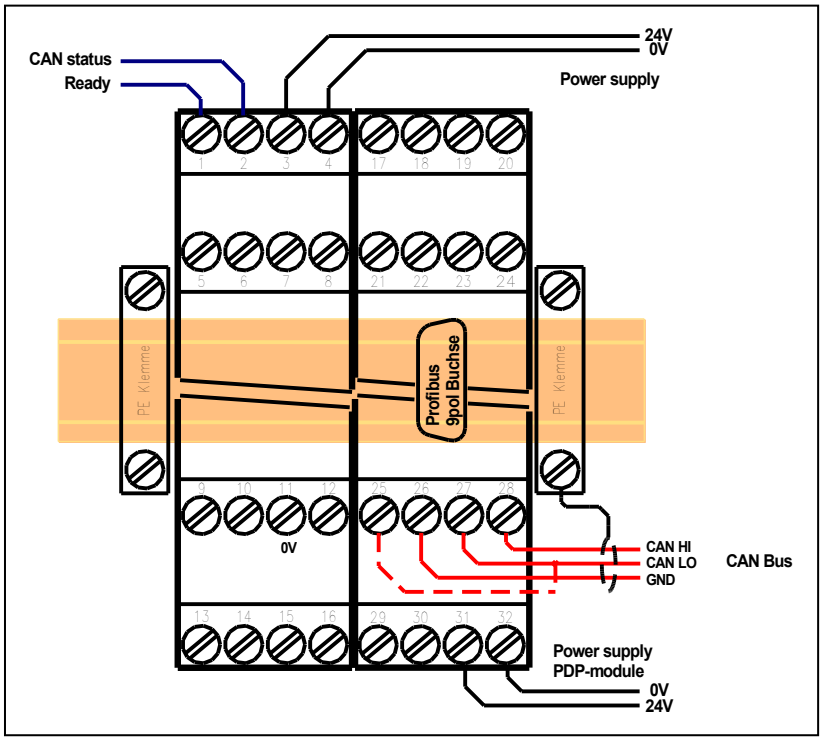


AIN:W 2000 1600 2000 C (für 0... 100%)

4.8 Circuit diagram PCK-306-C-PDP



4.9 Typical wiring PCK-306-C-PDP



4.10 Technical data

Supply voltage (U_b)	**[VDC]**	24 (±10 %)
Power consumption PCK-306	**[W]**	< 2,5
Power consumption CSC-156	**[W]**	max. 2.5 without sensor supply
External 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 current	**[mA]**	50
Analogue 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
Analogue outputs		
Voltage	**[V]**	0… 10, +/- 10 differential
Maximum load	**[mA]**	10
Current	**[mA]**	4… 20
Maximum load	**[Ohm]**	390
Signal resolution	**[%]**	0.007
Profibus DP interface		
Data rate	**[kbit/s]**	9.6,19.2, 93.75, 187.5, 500, 1500, 3000, 6000, 12000
ID-number		1810h
SSI-interface		
Specification	**-**	RS-422
Data rate	**[kbit/s]**	120
CAN-Bus	**-**	CAN A 2.0
Transfer rate	**[Mbaud]**	1
Controller sample time		
CSC-156	**[ms]**	1
PCK-306	**[ms]**	2
Serial Interface	**-**	USB - virtuel COM Port
Data rate	**[kBaud]**	9.6… 115.2
Housing		Snap-on module to EN 50022
Material	**-**	PA 6.6 polyamide
Flammability	**[class]**	V0 (UL94)
Weight (each module CSC and PCK)	**[kg]**	0.25

Protection class	**[IP]**	20
Temperature range	**[°C]**	-20… 60
Storage temperature	**[°C]**	-20… 70
Humidity	**[%]**	< 95 (non-condensing)
Connections	**-**	
Communication		USB Typ B
Plug connectors		4-pole terminal blocks (PCK-306 7 pieces, CSC-156 8 pieces)
PE		PE: via the DIN mounting rail
Profibus		D-Sub 9 pol.
EMC	**-**	EN 61000-6-2: 8/2005 EN 61000-6-4: 6/2007 + A1:2011

5 Parameters

5.1 Parameter overview CSC-156-U-SSIC

Group	Command	Default	Unit	Description
Basic parameter				
	LG	EN	-	Changing language help texts
	MODE	STD	-	Parameter view
	SENS	ON	-	Malfunction monitor
	EOUT	0	0,01 %	Output signal if not ready
Signal adaptation position control				
	SYS_RANGE	100	mm	Axis working stroke
	SELECT:X	SSI	-	Sensor section
	MINOFFSET	0	µm	Minimal position offset
Analogue sensor scaling				
	SIGNAL:X	U0-10		Type of input
	N_RANGE:X	100	mm	Nominal range
	OFFSET:X	0	µm	Offset value
SSI Interface				
	SSI:RANGE	0	µm	Nominal range
	SSI:OFFSET	0	µm	Position offset
	SSI:POL	+	-	Polarity
	SSI:RES	100	10 nm	Resolution of the sensor
	SSI:BITS	24	-	Number of data bits
	SSI:CODE	GRAY	-	Code
	SSI:ERRBIT	0	-	Position of the error bit
Profile generator				
	VMODE	SDD	-	Method of positioning
	VMAX	50	mm/s	Maximum speed in NC mode
Closed loop control parameter				
	A:A **A:B**	100 100	ms ms	Acceleration (ramp times) in SDD mode
	D:A **D:B** **D:S**	25 25 10	mm mm mm	Deceleration stroke in SDD mode
	V0:A **V0:A** **V0:RES**	10 10 1	1/s 1/s -	Closed loop gain in NC mode Can be used to adapt the resolution.
	PT1	1	ms	PT1 time constant
	CTRL	SQRT1	-	Control characteristics

Group	Command	Default	Unit	Description
Synchronous control parameters				
	SYNC:P	25	mm	Gain as deceleration stroke in SDD mode
	SYNC:V0	10	1/s	Closed loop gain in NC mode
	SYNC:T1	50	ms	Time constant
	SYNC:CTRL	PT1	-	Sync control mode
Signal adaptation pressure control				
	PS_RANGE	100	bar	System pressure
	ARATIO	1000	-	Ratio of the cylinder
	F_OFFSET	0	mbar	Offset compensation
Sensor scaling X1				
	SIGNAL:X1	U0-10	-	Type of input
	N_RANGE:X1	100	bar	Nominal pressure of the sensor
Sensor scaling X2				
	SIGNAL:X2	U0-10	-	Type of input
	N_RANGE:X2	100	Bar	Nominal pressure of the sensor
PID control parameters				
	C1:P **C1:I** **C1:D** **C1:D_T1** **C1:I_ACT**	50 4000 0 10 5000	0.01 0.1 ms 0.1 ms 0.1 ms 0.01 %	P Gain I Gain, reset time D Gain, derivative D filter Integrator activation
Output signal adaption				
	MIN:A **MIN:B**	0 0	0.01 % 0.01 %	Deadband compensation or flow characteristic linearization
	MAX:A **MAX:B**	10000 10000	0.01 % 0.01 %	Output scaling
	TRIGGER	200	0.01 %	Trigger point of MIN parameter
	OFFSET	0	0.01 %	Output offset value
	SIGNAL:U	U+-10	-	Type of output signal and polarity
Special parameters				
Drift compensator				
	DC:AV **DC:DV** **DC:I** **DC:CR**	0 0 2000 500	0,01 % 0,01 % ms 0,01 %	DC:AV = point of activation DC:DV = point of deactivation DC:I = reset time of the integrator DC:CR = output limit
AINMODE				
	AINMODE	EASY	-	Input scaling mode
	AIN:X **AIN:XP1** **AIN:XP2**	A: 1000 B: 1000 C: 0 X: V	- - 0,01 % -	Free scaling of the analogue inputs (MATH)

CAUTION: The parameters SYS_RANGE, PS_RANGE, VMODE, VMAX must be the same in the coupler and all axis controls!

5.2 Basic parameters

5.2.1 LG (Changing the language for the help texts)

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

Either German or English can be selected for the help texts.

5.2.2 MODE (Switching between parameter groups)

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

This command changes the operating mode. Various commands (defined via STD/EXP) are blanked out in Standard Mode. The commands in Expert Mode have a more significant influence on system behavior and should accordingly be changed with care.

5.2.3 SENS (Module monitoring)

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

This command is used to activate/deactivate the monitoring functions of the module.

ON: All functions are monitored and the standby or error message is sent to the coupling module. The coupling module itself can switch off the complete system. The detected faults can be cleared by the ENABLE signal. After this, the system can be restarted after a fault has been resolved. This setting should be used for the normal operation of the system.

OFF: No monitoring function is active. However, errors are sent to the coupling module, which deactivates all axes according to the setting of the own SENS command.

AUTO: AUTO RESET mode. All functions are monitored. After the fault condition is no longer present, the module automatically switches to the normal operating state when the coupling module transmits an enable.

Normally the monitoring functions are always active because otherwise no errors are detectable via the READY output. Deactivating is possible mainly for troubleshooting. If setting SENS to OFF also in the coupler all error messages will be ignored.

5.2.4 EOUT (Output signal if not READY)

Command	Parameters	Unit	Group
EOUT x	x= -10000… 10000	0.01 %	**EXP**

Output value in case of a detected error or a deactivated ENABLE input. This function can be used if the drive has to be moved to one of the two end positions (with defined speed).

CAUTION! If the output signal is 4… 20 mA, the output is switched off when **|EOUT| = 0**. If a null value = 12 mA is to be output in the event of an error, EOUT must be set to 1[1].

The output value defined here is stored permanently (independent from the parameter set). The effects should be analyzed by the user for each application from the point of view of safety.

5.3 Input signal adaption positioning

5.3.1 SYS_RANGE (Working stroke)

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

This command defines the full stroke, which corresponds to 100 % of the input signal. If the demand is set incorrectly, this leads to incorrect system settings, and the dependent parameters such as speed and gain cannot be calculated correctly.

5.3.2 SELECT:X (Defining type of sensor)

Command	Parameters	Unit	Group
SELECT x	x= SSI|ANA	-	**STD**

The appropriate sensor type can be activated with this command.

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

SSI: The SSI sensor interface is active. The SSI sensor is matched to the sensor with the SSI commands. The relevant sensor data must be available.

[1] This is necessary if using valves without error detection for signals lower than 4 mA. If the valve has an internal error detection, it moves into a defined position after switching off the output.

5.3.3 MINOFFSET (Minimal position offset)

Command	Parameters	Unit	Group
MINOFFSET X	x= -100000… 100000	µm	**STD**

This parameter is entered in µm.

When changing the Profibus bit SetOffsetX (see Profibus description) from 0 to 1 the actual position is set to zero and the MINOFFSET will be added.

When changing the Profibus bit ResetOffsetX from 0 to 1 the actual position is taken from the position sensor and the MINOFFSET will not have an effect anymore.

5.3.4 SIGNAL:X (Type of input signal)

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

This command can be used to change the type of input signal (voltages or current) and to define the direction of the signal. This command is available for the positioning analogue inputs.

5.3.5 N_RANGE:X (Nominal range of the sensor)

Command	Parameters	Unit	Group
N_RANGE:X x	x= 10… 10000	mm	**EASY**

N_RANGE (nominal range or nominal stroke) is used to define the length of the sensor. This value should always be equal or higher than SYS_RANGE. The control parameter cannot be calculated correctly in case of wrong values.

5.3.6 OFFSET:X (Sensor offset)

Command	Parameters	Unit	Group
OFFSET:X x	x= -100000… 100000	µm	**EASY**

Adjustment of the zero point of the sensor. This parameter is internally limited by SYS_RANGE.

5.3.7 SSI:RANGE (Nominal range of the sensor)

Command	Parameters	Unit	Group
SSI:RANGE x	x= 1… 10000	mm	**SSI**

The length of the sensor is preset with this parameter.

5.3.8 SSI:OFFSET (Sensor offset)

Command	Parameters	Unit	Group
SSI:OFFSET x	x= -10000000… 10000000	µm	**SSI**

Parameter for zero point adjustment of the sensor.

5.3.9 SSI:POL (Signal direction)

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

To reverse the sensor working direction. Consider the settings of the SSIOFFSET parameter.

5.3.10 SSI:RES (Signal resolution)

Command	Parameters	Unit	Group
SSI:RES x	x= 10… 10000	0.01 µm	**SSI**

The sensor signal resolution is defined with this parameter. Data is entered with the resolution of 10 nm (nanometer or 0,01 µm). This means that a value of 100 defines a sensor with 1 µm resolution. This also makes it possible to scale rotational sensors. The appropriate data can be found in the sensor data sheet.

5.3.11 SSI:BITS (Number of data bits)

Command	Parameters	Unit	Group
SSI:BITS x	x= 8… 31	bit	**SSI**

The number of data bits is entered with this parameter.
The appropriate data can be found in the sensor data sheet.

5.3.12 SSI:CODE (Signal coding)

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

The data coding is entered with this parameter.
The appropriate data can be found in the sensor data sheet.

5.3.13 SSI:ERRBIT (Position of the “out of range” bit)

Command	Parameters	Unit	Group
SSI:ERRBIT X	x= 0… 31	bit	**SSI**

The position of the error bit will be defined by this parameter. The appropriate data can be found in the sensor data sheet. In case of no error bit, the default value is 0.

5.4 Profile generator

5.4.1 VMODE (Activating of the NC Mode)

Command	Parameters	Unit	Group
VMODE X	x= SDD|NC	-	**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 approaches the target position open loop controlled. From the set deceleration point 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 set control 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. 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.

5.4.2 VMAX (Maximum speed in NC Mode)

Command	Parameters	Unit	Group
VMAX X	x= 1… 20000	mm/s	**VMODE=NC**

This parameter is entered in mm/s. It is only active when VMODE=ON.

5.5 Parameters positioning control

5.5.1 A (Acceleration time)

Command	Parameters	Unit	Group
A:I X	i= A|B x= 1… 5000	 ms	**STD**

Ramp function for the 1st and 3rd quadrant.

The acceleration time for positioning is dependent on the direction. A corresponds to connection 15 and B corresponds to connection 16 (if POL = +).

Normally A = flow P-A, B-T and B = flow P-B, A-T.

For quadrants 2 and 4, parameters D:A and D:B are used as the deceleration distance demand.

The acceleration times are only relevant for the SDD mode. In NC mode the value should be adjusted to 1 ms, because the acceleration comes directly out of the NC profile generator.

5.5.2 D (Deceleration / braking distance)

Command	Parameters	Unit	Group
D:I X	i= A|B|S x= 1… 10000	 mm	**VMODE = SDD**

This parameter is entered in mm.
The deceleration distance is set for each direction of movement (A or B). The control gain is calculated internally depending on the deceleration distance. The shorter the decelerations stroke the higher the gain. A longer deceleration stroke should be specified in the event of instability.

Parameter D:S is used as the emergency stopping ramp when disabling the START signal. After disabling, a new target position (current position plus D:S) is calculated in relation to the speed and is specified as a demand value.

$$G_{Intern} = \frac{STROKE}{D_i}$$ Calculation of control gain

CAUTION: If the maximum position (POSITION command) is changed, the deceleration distance must also be adjusted. Otherwise this can result in instability and uncontrolled movements.

5.5.3 V_0 (Loop gain setting)

Command	Parameters	Unit	Group
V0:I X	i= A|B x= 1… 200	s^{-1}	**VMODE = NC**

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

In NC mode normally the loop gain is specified rather than the deceleration distance[2].

The internal gain is calculated from this gain value together with the VMAX and POSITION parameters.

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

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

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 distance with stroke-dependent deceleration. The conversion and therefore also the correct data demands related to the control system are relatively simple if the relationship described here is taken into account.

5.5.4 V0:RES (Scaling of the loop gain)

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

V0:RES = 1 loop gain in s^{-1} (1/s) units.

V0:RES = 100 loop gain in 0,01 s^{-1} units[3].

The increased resolution should be used in case of $V_0 < 4$.

[2] The loop gain 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.

[3] In case of very low loop gains (1 s^{-1} to 3 s^{-1}) the better resolution of the adjustment should be selected.

5.5.5 CTRL (Control characteristic)

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

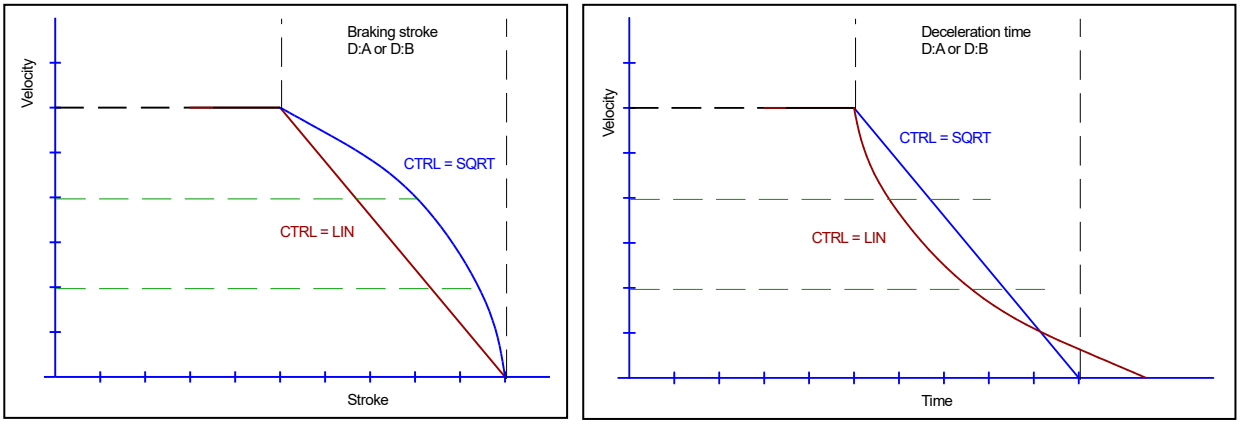
The control characteristic is set with this parameter. In the case of positively overlapped proportional valves the SQRT function should be used. The non-linear flow function of these valves is linearized by the SQRT[4] function.

In the case of zero lapped valves (control valves and servo valves) the LIN or SQRT1 function should be used corresponding to 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 deceleration characteristic (gain is increased by a factor of 1).

SQRT1: Root function for 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 braking curve calculation. The gain is increased by a factor of 5 (in the target position). This setting should only be used with a significantly progressive flow through the valve.



Braking function with respect to stroke and time

[4] The SQRT function generates constant deceleration and thus reaches the target position faster. This is achieved by increasing the gain during the deceleration process.

5.6 Parameters synchronous control

5.6.1 SYNC:CTRL (Sync control mode)

Commands	Parameter	Units	Group
SYNC:MODE x	x= PT1|PI	-	STD

Switching the control structure for the synchronous run between PI and PT1.

5.6.2 SYNC:P (Deceleration stroke, gain in SDD mode)

5.6.3 SYNC:V0 (Closed loop gain in NC mode)

5.6.4 SYNC:T1 (Filter constant)

Commands	Parameter	Units	Group
SYNC:P x	x= 1… 10000	mm	SDD
SYNC:V0 x	x= 1… 400	s^{-1}	NC
SYNC:T1 x	x= 1… 1000	ms	

These parameters are used to optimize the synchronization controller. The SYNC-controller works as a PT1 or PI compensator for optimized controlling of hydraulic drives. The parameter T1 effects a delayed action of the SYNC Controller. The stability of the compensator could be increased in critical cases with the T1 Filter.

In **SDD-mode** is specified with SYNC:P, the braking distance in mm. The gain will depend on the stopping distance is calculated internally. In short braking distance, the high gain is calculated. In the case of instability should be given a longer stopping distance.

In the **NC-mode** parameters of the SYNC: V0 is in s-1 (1 / s) specified. In this mode, the loop gain is entered.

The parameter SYNC: T1 causes a delayed action of the synchronized controller. The stability of the controller can be increased by the upstream T1-filter in critical cases.

5.7 Input signal adaption pressure

5.7.1 PS_RANGE (Reference pressure)

Command	Parameters	Unit	Group
PS_RANGE X	x= 10… 1000	bar	STD

Predefining the nominal pressure for 100% signal. This scaling enables the monitor displaying the pressure values also in real units [bar].

5.7.2 ARATIO (Cylinder area ratio)

Command	Parameters	Unit	Group
ARATIO X	x= 200… 6000	-	**STD**

In order to limit the output force in either direction correctly the parameter ARATIO provides the ratio of the two surfaces of the cylinders piston. A divisor of 1000 for area B to set base.
Accordingly, a corresponding entry of the value A (ARATIO) of 1000 a ratio of A / B = 1000/1000

For example: surface ratio A/B = 2.08: ARATIO has to be set on 2080
surface ratio A/B = 0,5: ARATIO has to be set on 500
surface ratio A/B = 1: ARATIO has to be set on 1000

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

5.7.3 F_OFFSET (Feedback offset)

Command	Parameters	Unit	Group
F_OFFSET x	x= -50000… 50000	mbar	**STD**

This parameter is entered in mbar.
This parameter adds an offset value to the resulting feedback signal. For example, to compensate external force differences (suspended loads, spring forces etc.).

5.7.4 SIGNAL (Type of input signal)

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

This command can be used to change the type of input signal (voltages or current) and to define the direction of the signal. This command is available for the positioning analogue inputs.

5.7.5 N_RANGE:X1 (Nominal range of the sensor)

5.7.6 N_RANGE:X2 (Nominal range of the sensor)

Command	Parameters	Unit	Group
N_RANGE:X1 x N_Range:X2 x	x= 10… 1000 x= 10… 1000	bar bar	**EASY**

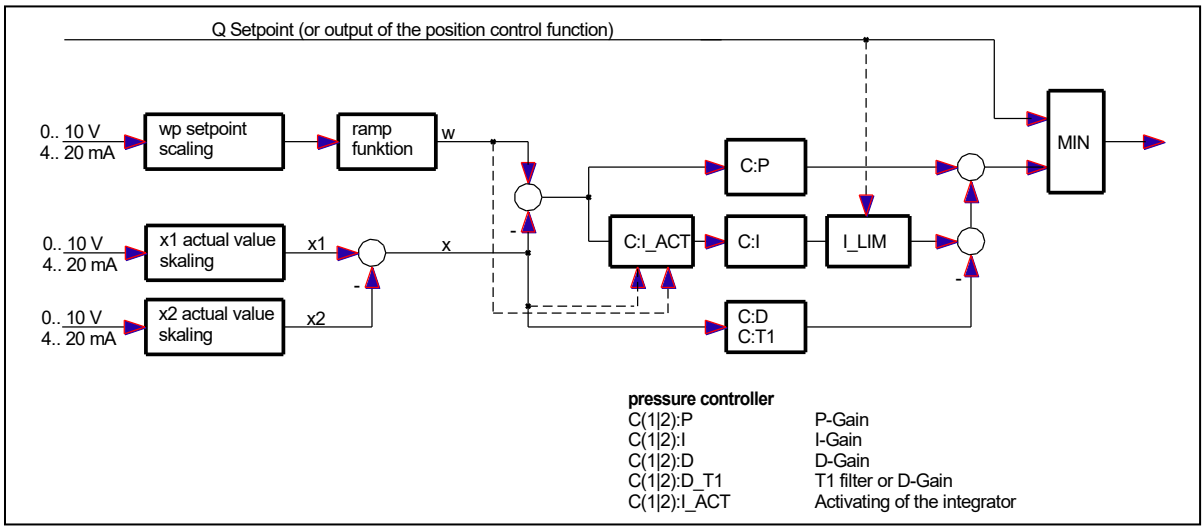
N_RANGE (nominal range) is used to define the nominal value of the sensor. This value should always be equal or higher than PS_RANGE. The control parameter cannot be calculated correctly in case of wrong values.

5.8 PID pressure control parameters

Command	Parameters	Unit	Group
C:i x	i= P|I|D|D_T1|I_ACT :P x= 1… 10000 :I x= 0… 30000 :D x= 0… 1200 :D_T1 x= 10… 1000 :I_ACT x= 0… 10000	 0.01 0.1 ms 0.1 ms 0.1 ms 0.01 %	**STD**

The pressure control function will be parameterized via this command.

The P, I and D gains are similar to a standard PID controller. The T1 factor is used for the D-gain in order to suppress high-frequency noise. I_ACT controls the integrator function. To reduce pressure overshoots, an activation point for the integrator can be programmed via the I_ACT value. The integrator is activated if the actual pressure is higher than the programmed threshold. The integrator function of the controller can be disabled in special cases by setting C:I to zero.



5.9 Output signal adaption

5.9.1 MIN (Overlap compensation)

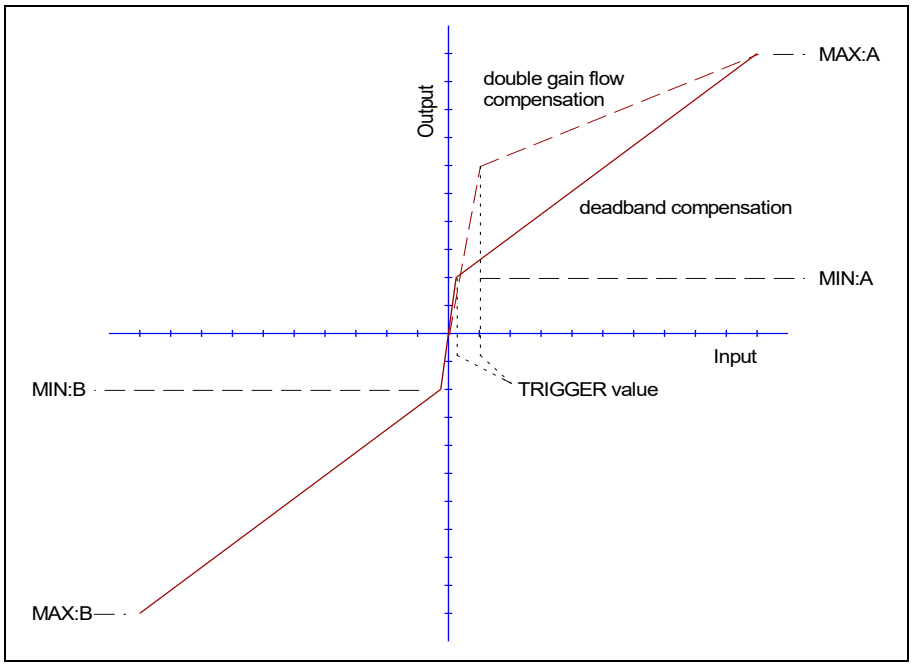
5.9.2 MAX (Limitation)

5.9.3 TRIGGER (Response threshold for the MIN parameter)

Command	Parameters	Unit	Group
	i= A|B	-	**STD**
MIN:I X	x= 0… 6000	0.01%	
MAX:I X	x= 3000… 10000	0.01%	
TRIGGER X	x= 0… 4000	0.01%	

The output signal to the valve is adjusted by means of these commands. A kinked volume flow characteristic is used instead of the typical overlap step for the position controls. The advantage is better and more stable positioning behavior. At the same time, kinked volume flow characteristics can also be adjusted with this compensation[5].

CAUTION: If there should also be adjustment options for dead zone compensation on the valve or valve amplifier, it must be ensured that the adjustment is performed either at the power amplifier or in the module.
If the MIN value is set too high this has an effect on the minimum speed, which can no longer be adjusted. In extreme cases this leads to oscillation around the controlled position.



[5] Various manufacturers have valves with a defined linear 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 should be set to 1000 and the MIN value to 4000 (6000).

If zero lapped or slightly underlapped valves are used, the volume flow gain in the zero range (within the underlap) is twice as high as in the normal working range. This can lead to vibrations and jittery behavior. To compensate for this, the TRIGGER value should be set to approximately 200 and the MIN value to 100. The gain in the zero point is thus halved and a higher overall gain can often be set.

5.9.4 OFFSET (Valve zero point adjustment)

Command	Parameters	Unit	Group
OFFSET x	x= -4000… 4000	0.01 %	**STD**

This parameter is entered in 0,01 % units.
The offset value is added to the output value. Valve zero offsets can be compensated with this parameter.

5.9.5 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	-	**STD**

This command is used to define the output signal (voltage or current) and to change the polarity.

Differential output ± 100 % corresponds with ± 10 V (0… 10 V at PIN 15 and PIN 16).
Current output ± 100 % corresponds with 4… 20 mA (PIN 15 to PIN 12). 12 mA (0 %) = center point of the valve.

Current output: An output current of << 4 mA indicates an error and the module is disabled. The current input of the proportional valves should be monitored by the valve. The valve has to be de-activated in case of < 4 mA input signal. Otherwise the EOUT command can be used to get a de-fined output signal.

5.10 Special commands

5.10.1 DC:AV (Activation value)

5.10.2 DC:DV (Deactivation value)

5.10.3 DC:I (Integrator time)

5.10.4 DC:CR (Integrator limitation)

Command	Parameter	Unit	Group
DC:AV x	x= 0… 2000	0.01 %	**STD**
DC:DV x	x= 0… 1000	0.01 %	
DC:I x	x= 0… 5800	ms	
DC:CR x	x= 0… 500	0.01 %	

DC:AV — This parameter is used to define the activation point (activation value). The DC function is completely deactivated in case of DC:AV = 0.

DC:DV — This parameter is used to define the deactivation point (DV = deactivation value) Within the deactivation window no compensation value will be calculated (frozen state).
DC:AV = 0 should be used for best positioning, but „limit cycling“ can occur. This value should be set to 50 % of an acceptable error.

DC:I — This parameter is used to define the integrator time. The lower this value the faster the compensation. Low values will result in „limit cycling“.

DC:CR — The output range of the DC function will be limited (CR = control range) by this parameter.

Typical setup

Valve pressure gain: 2,5 %; the activation point has to be set to 3… 5 % (DC:AV 300… 500).
Valve hysteresis: 0,5 %; the deactivation point has to be set to 0,7… 1,0 % (DC:DV 70… 100). The lower the value the better the accuracy.

DC:CR should be equal to DC:AV.

The optimum integrator time has to be determined experimentally. Starting with higher values is recommended.

5.10.5 Drift compensation / high accurate positioning

The high accurate positioning or the drift compensation can be used in case of external influence which is limiting the positioning accuracy. This function could be critical if limit cycling[6] by wrong parameterization or the system behavior was not taken into account.

Which positioning errors can be compensated[7]?

1. Zero point adjustment of the valve. By this kind of failure a constant offset between command and feedback signal remains. This failure is more or less constant.
2. Zero point failure depending on the temperature. The same behavior as point 1, but the failure is increasing slowly (over the temperature).
3. Position failure caused by an external force. All control and servo valves have a typical pressure gain characteristic. In case of external forces an output signal of 2…3 % has to be generated for the compensation of this force. And this signal is proportional to the positioning error. In opposite to point one and two the positioning failure generated by the force signal can vary cycle to cycle.

How does it work?

The position errors should be compensated when the axis is near by the target position. The output signal is going lower and lower but a system specific position error remains. At the activation point this function – a slowly working integrator – is active. This integrator signal is added to the output signal and will compensate offsets and other failure. To prevent instabilities, the integrator value will be frozen when the output value is lower than the deactivation point.

Drift compensation (to compensate failure of the zero point adjustment)

To compensate position errors of point one and two.

High accurate positioning (used at external forces or general drift compensation)

To compensate positions errors of point three. Alternatively of point one, two and three.

Positioning modules without fieldbus:

Only one function is implemented to compensate the positioning error of point one, two and three. The activation is controlled by the parameterization of DC:AV parameter.

Positioning modules with fieldbus:

Two functions are implemented to compensate offset/temperature dependent and/or force dependent positioning errors[8]. The activation is controlled by the parameterization of DC:AV parameter and the following fieldbus control bits:

DC_ACTIVE: General activation of the drift compensation and high accurate positioning.

DC_FEEZE: Freezing of the static drift compensation value.

F_POS: Activation of the high accurate positioning (dynamic drift compensation).

[6] The „limit cycling“ is a small and permanent oscillation around the target position. The main reason are static frictions and the hysteresis of the valve. By proper parameter setting, this can be avoided under the boundary condition that the desired accuracy is not achieved. In this case, the hydraulic system is the limiting factor in the accuracy.

[7] This is relevant for zero lapped control valves and servo valves.

[8] To prevent / minimize position overshoots the static drift compensation have to be done first.

5.10.6 AINMODE (input scaling mode)

Kommando	Parameter	Einheit	Gruppe
AINMODE x	x= EASY|MATH	-	**TERMINAL**

This command is used to switch over the kind of input scaling.

The AINMODE is used to define the kind of parameterizing of the analogue inputs. The EASY mode (DEFAULT) supports a simple and application oriented input scaling.
The MATH mode supports the free input scaling by a linear equation. This mode is compatible to our older modules.

Attention: This command can be executed in the terminal window only. In case of switching back, DEFAULT data should be reloaded.

5.10.7 AIN (Analogue input scaling)

Command	Parameters	Unit	Group
AIN:X AIN:X1 AIN:X2	a= -10000… 10000 b= -10000… 10000 c= -500… 10000 x= V|C	- - 0.01% -	**MATH**

This command offers an individual scalable input. The following linear equation is used for the scaling.

$$Output = A/B \cdot (Input - C)$$

The ***"C" value*** is the offset (e.g. to compensate the 4 mA in case of a 4… 20 mA input signal).
The variables ***A*** and ***B*** are defining the gain factor with which the signal range is scaled up to 100 % (e.g. 1.25 if using 4… 20mA input signal, defined in default current settings by A = 1250 and B = 1000). The internal shunt for the current measuring is activated with switching the ***X*** value.

The gain factor is calculated by setting the usable range (***A***) in relation to the real used range (***B***) of the input signal. Usable are 0… 20mA, means (***A***) has the value **20**. Really used are 4… 20mA, means (***B***) has a value of **16** (20-4). Not used are 0… 4mA. In a range of 20mA this is an offset of 20%, means a value of **2000** for (***C***). Last but not least (***X***) has to be set to **C** choosing current signal.

In this case AIN command would look like this:

AIN:I 20 16 2000 C or AIN:I 1250 1000 2000 C

Typical settings:

Command	Input	Description
AIN:X 1000 1000 0 V	0… 10V	Range: 0… 100%; gain is 1 (1000/1000) and offset is 0.
AIN:X 10 8 1000 V OR **AIN:X 1000 800 1000 V**	1… 9V	Range: 0… 100%; 1 V = 1000 used for the offset and gained by 10 / 8 (10V divided by 8 V (9V -1V)).
AIN:X 10 4 500 V OR **AIN:X 1000 400 500 V**	0,5… 4,5V	Range: 0… 100%; 0,5 V = 500 used for the offset and gained by 10 / 4 (10V divided by 4 V (4,5V -0,5V)).
AIN:X 20 16 2000 C OR **AIN:X 2000 1600 2000 C** OR **AIN:X 1250 1000 2000 C**	4… 20mA	Range: 0… 100% The offset will be compensated by 20% (4 mA) and the signal (16 mA = 20mA – 4 mA) will be gained to 100% (20 mA). Each of this parameterization for 4… 20 mA is setting the range to 0… 100%.

5.11 PROCESS DATA (Monitoring)

Command	Parameters	Unit
WA	Command position (input value)	0.01 mm
W	Command position	0.01 mm
WS	Synchronization position	0.01 mm
X	Actual position of the current axis	0.01 mm
E	Position error	0.01 mm
ES	Synchronization error	0.01 mm
C	Output synchronous controller	0.01 %
V	Actual speed limitation	0.01 %
WP	Pressure command value	0.1 bar
X1	Actual value pressure sensor 1	0.1 bar
X2	Actual value pressure sensor 2	0.1 bar
XP	Differential pressure (Sensor 1 – Sensor 2)	0.1 bar
EP	Control deviation pressure	0.1 bar
CP	Output pressure controller	0.01 %
U	Control signal / output	0.01 %

The process data are the variables which can be continuously observed on the monitor or on the oscilloscope.

5.12 Parameter overview PCK-306-C-PDP

Group	Command	Default	Unit	Description
Basic parameters				
	LG	EN	-	Changing language help texts
	SENS	ON	-	Malfunction monitor
	PDPADR	126	-	Profibus address
	MAXAX	2	-	Number of the connected positioning axes
	HAND:A **HAND:B**	3333 -3333	0.01% 0.01%	Output signal in manual Mode.
	POSWIN:S **POSWIN:D**	200 200	µm µm	Range for monitoring endposition. Range for monitoring tracking position.
	POSWINMODE	TRC	-	Evaluation relating to endposition (EPC) or tracking (TRC).
Positioning				
	SYS_RANGE	100	mm	Axis working stroke.
	VMODE	SDD	-	Method of positioning. Activating the speed control. Caution! Together with the pressure limitation control the use is limited.
	VRAMP	200	ms	Ramp time for the demand speed
	ACCEL	10	mm/s^2	Acceleration in NC mode
	VMAX	50	mm/s	Maximum speed in NC mode
Synchronous run				
	SYNCMODE	MS	-	Working mode of the synchronous controller. MS for master-slave principle or AV for calculating an average determination.
	SYNCERROR	1000	µm	Size of the synchronous control deviation window.
Pressure control				
	PS_RANGE	100	bar	System pressure.
	RA:UP **RA:DOWN**	100 100	ms ms	Two quadrant ramp for increasing and decreasing pressure.
Special ocmmands				
	ST	-	-	Status request of the Profibus communication. **CAUTION:** This command can only be used in the terminal window.

CAUTION: The parameters SYS_RANGE, PS_RANGE, VMODE, VMAX have to be the same in the coupler and all axis controllers!

5.13 Basic parameters

5.13.1 LG (Changing language help texts)

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

Either German or English can be selected for the help texts.

5.13.2 SENS (Malfunction monitor)

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

This command is used to determine the behavior of system fault monitoring. If SENS = OFF in the coupling module, occurred errors in the individual axes are ignored. Even in the case of a faulty CAN bus connection to the axes, an attempt is made to reestablish the connection every 10 ms. If, however, SENS = ON is selected, standby messages as well as occurring errors of the individual axes are evaluated and all axes are de-activated in the event of a fault. At setting SENS = ON of the fault-generating axis: after the error has been corrected, the error memory must be acknowledged by the enable signal. Afterwards, the system can be put into operation again by a new release. The acknowledgment or resetting of the fault memory is not necessary if the SENS settings of the fault-generating axis are SENS = OFF or SENS = AUTO. If the coupling module is SENS = AUTO, the faults are automatically checked and acknowledged every 10 ms. The system automatically returns to normal operation. This setting is therefore not recommended for normal operation of the system.

5.13.3 PBADR (Profibus slave address)

Command		Parameters	Unit	Group
PBADR	X	x= 1… 126	-	**STD**

With this command the Profibus slave address is set.

The default standard value is 126. This address allows the Profibus master to change the address of the coupler via the profibus.

5.13.4 MAXAX (Number of axes)

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

Number of the connected synchronization controllers. The modules have to be addressed up from “1”. That means if there are three connected controllers (MAXAX = 3) they have to be addressed with 1, 2 and 3 by using the front selection switches.

5.13.5 HAND1 / HAND2 (Manual speed)

Command	Parameters	Unit	Group
HAND:A X	x= -10000… 10000	0.01 %	**STD**
HAND:B X	x= -10000… 10000	0.01 %	

The manual speeds are set with these parameters. The free entering of speed and direction enables any assignment to the Profibus control bits.

The drive moves in an open loop controlled manner in the defined direction when the hand signal is active. After the hand signal has been removed, the drive remains under control in the current position.

In case of a fault (position sensor fails) the drive can still be moved with the hand function. The valve is no longer controlled after the manual signals have been disabled.

The manual speed is limited by the command speed (MIN evaluation) of the Profibus.

5.13.6 POSWIN:S (In position monitoring)

5.13.7 POSWIN:D (Dynamic position monitoring)

Command	Parameters	Unit	Group
POSWIN:S x	x= 2… 200000	µm	**STD**
POSWIN:D x	x= 2… 200000	µm	

This parameter is entered in µm.
The POSWIN command defines a range for which the INPOS message is generated. This function monitors the failure between the command and actual position. The positioning process is not influenced by this.

START must be activated to generate the INPOS messages.

POSWIN:S Standard InPos signal

POSWIN:D Dynamic InPos signal to monitor the following error in case of NC mode

5.13.8 POSWINMODE (Selcting POSWIN)

Command	Parameters	Unit	Group
POSWINMODE X	x= TRC|EPC	-	**VMODE=NC**

When operating as speed controlled axis (VMODE = NC) this parameter provides two sources for the InPos message. TRC (Tracking control) monitors the following error during positioning (POSWIN:D), EPC (End position control) allows monitoring the accuracy in end position (POSWIN:S). The InPos message is given to the Profibus.

Not active if VMODE is set to SDD.

5.14 Positioning

5.14.1 SYS_RANGE (Working stroke)

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

With this parameter the working stroke is set.

5.14.2 VRAMP (Ramp time for the external speed demand)

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

This parameter is entered in ms.
VRAMP limits the speed change of the external (with the fieldbus) set speed.

5.14.3 VMODE (Activating of the NC Mode)

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 set deceleration point the drive then switches to 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 set control 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. 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.

5.14.4 ACCEL (Acceleration)

Command	Parameters	Unit	Group
ACC x	x= 10… 10000	mm/s²	**VMODE=NC**

Presetting the acceleration for the profile generator in NC mode. This command is only active if VMODE is set to NC.

5.14.5 VMAX (Maximum speed in NC-mode)

Command	Parameters	Unit	Group
VMAX x	x= 1… 3000	mm/s	**VMODE = NC**

Specification of the maximum speed in NC mode. This value is defined by the drive system and should be specified as precisely as possible (not too high under any circumstances). The speed is scaled by means of the VELO value or via the external speed demand. The command is only active if the VMODE has been parameterized to NC.

5.15 Synchronous run

5.15.1 SYNCMODE (Synchronisation mode)

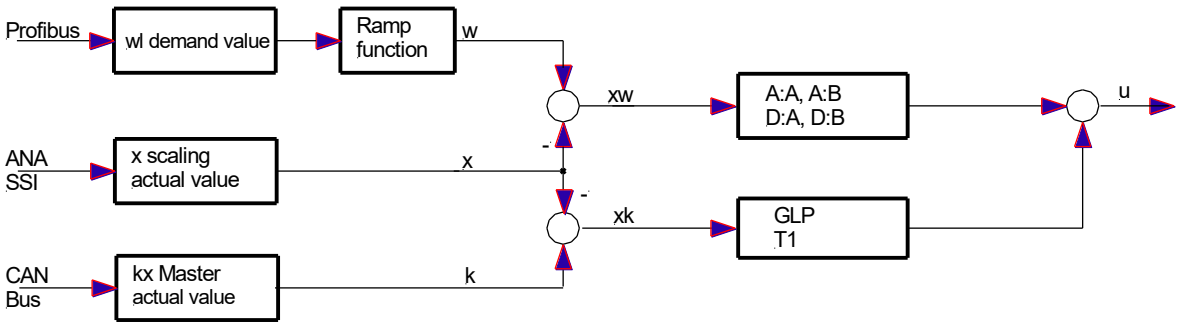
Command	Parameters	Unit	Group
SYNCHMODE x	x= MS|AV	-	**STD**

With this parameter the synchronization function is chosen.

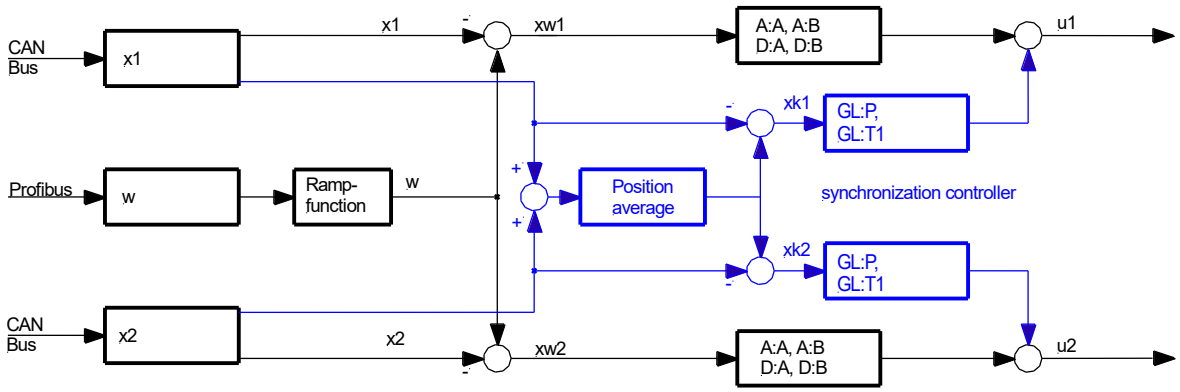
MS- Master Slave (all axes follow axis 1 on CAN).

AV- Average calculation (It will be controlled to a calculated average position).

Controller structure Master / Slave (Example structure for 2 axes)



Controller structure: Average calculation (Example structure for 2 axes)



5.15.2 SYNCERROR (Synchronization window)

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

This parameter is entered in µm.

The SYNCERROR command defines the allowed deviation window for not generating the SYNCERROR message. The positioning process will not be influenced by this message. The controller remains active.

5.16 Special commands

5.16.1 ST (Status request)

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

Display of the control words and the status words of the Profibus and the hardware connected inputs of the module in terminal window of the WPC-300 program after entering the command “ST”

DISPLAY at status command:

```
                    (high byte / low byte)
control word   :     1110 1000 / 0000 0000
control word 2:      0010 0000 / 0010 0000
status word    :     1101 0000 / 1101 0000
status word 2  :     0010 0000 / 0010 0000

position setpoint: 22400   (command position in HEX via the Profibus)
speed setpoint:    1fff    (command speed in HEX via the Profibus)
```

Please take the meaning of the single bits out of chapter 7.

5.17 Process data

Command	Parameter	Unit / Resolution
WA	Command position (target position)	0.01 mm
W	Command position (internally)	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	Actual position average value	0.01 mm
V	Command speed	0.01 %
WP	Pressure command value	0.01 bar

The process data are the variables which can be continuously observed on the monitor or on the oscilloscope.

6 Appendix

6.1 Failure monitoring

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

CSC-156-U-SSIC

Source	Fault	Characteristic
Actual value PIN 14, 4… 20 mA	Out of range or broken wire.	The output will be switched off.
Actual value PIN 6, 4… 20 mA	Out of range or broken wire.	The output will be switched off.
Actual value PIN 13, 4… 20 mA	Out of range or broken wire.	The output will be switched off.
Actual value SSI	Out of range or broken wire.	The output will be switched off.
EEPROM (at switching on)	Data error	The output will be switched off The module can be activated by saving new parameters.
CANbus	Communication fault	The output will be switched off.

Caution: Pay attention to the setting of the EOUT command. Changes influence the behavior.

PCK-306-C-PDP

Source	Fault	Characteristic
Profibus	Communication fault	The system goes into idle state
CANbus	Communication fault	The system goes into idle state
EEPROM (at switching on)	Data error	The system goes into idle state. This state can only be left by saving the parameters!
Positioning module	Fault in pressure or stroke sensor or EEPROM	The system goes into Idle state

A fault of the profibus will be reset automatically. Concerning the confirmation of other faults please read chapter 3.2.1.

6.2 Description of the command structure

The command structure:

[nnnn:i x] or
[nnnn x]

Meaning:

nnnn - used for an arbitrary command name
nnnn: - used for an arbitrary command name, expandable by an index.
Indexed commands are indicated by the sign ":"
i oder **l** - a dummy is for the index. E. g. an index can be „A" or „B", depending on the direction.
x - parameter value, in case of special commands more than one parameter are possible.

Examples:

MIN:A 2000 nnnn = "MIN", i = "A" and x = "2000"

OFFSET 50 nnnn = „OFFSET" and x = „50"

C:IC 2000 nnnn = "C", i = "IC" and x = "2000"

7 Profibus Interface

7.1 Profibus Funktionen

The profibus-module supports all baud rates from 9,6 kbit/s up to 12000 kbit/s with auto detection of the baud rate. The functionality is defined in IEC 61158. The Profibus address can be programmed by a terminal program, WPC-300 or online via the Profibus. A diagnostic LED indicates the online status.

7.2 Installation

A typical screened Profibus plug (D-Sub 9pol with switchable termination) is mandatory. Every Profibus segment must be provided with an active bus termination at the beginning and at the end. The termination is already integrated in all common Profibus plugs and can be activated by DIL switches. The bus determination needs a 5 Volt power supply for the correct function, which is supplied at PIN 6 of the D-sub-socket. The Profibus cable has to be screened at the determined contact clips in the Profibus plug.

7.3 Device data file (GSD)

The Profibus-DP features are documented in a device-data-file and provided to the user. Structure, content and code of this file (GSD) are standardized. They allow the projecting of any DP-slaves with projecting devices of several producers.

The GSD-data are read by a PROFIBUS-Master-configuration software and the correspondent settings are given to the master.

Enclosed is also the identification number of the Profibus knot. It is necessary for a master without significant report overhead to identify the types of the connected devices.

The GSD-file is available on the internet. The address is: http://www.w-e-st.de/files/software/hms_1810.gsd
file: **hms_1810.gsd**

In the setting of the transfer bytes 32 bytes (16 words consistent) are necessary as IN/OUT variables.

7.4 Description Profibus DP interface

At positioning a resolution of 1 µm (independent of the real sensor resolution), max. 0x989680 (10.000.000) is used. The command position is limited by the parameter STROKE.

The command speed and the command pressure are preset with a resolution of 0.01 %. The value 10000 (0x2710) thus corresponds to 100 % speed respectively 100% of the system pressure which is set with the parameter PS_RANGE.

The module is controlled with a **control word** consisting of following bits:

- **ENABLE:** general enabling of the system.
- **START:** at rising edge the actual command position is taken over, if START gets deactivated, the system will be stopped via a deceleration ramp, if the demand position is not reached yet.
- **DIRECT:** A new target position is directly overtaken (not only when switching START signal on). This bit applies to both axes.
- **HAND:A / HAND:B:** Command values to drive the axis manually.
- **Axis x active:** defines the corresponding axis as active. When START is available and other axis are active, they automatically will be driven in synchronous control.
- **PQ x ON:** activates the pressure limitation for the corresponding axis.
- **DC active:** activates the drift compensation for the participating axes.
- **DC freeze:** saves the drift compensation value as offset.
- **Set Offset X:** at rising edge the actual position is set to zero and the MINOFFSET will be added.
- **Reset Offset X:** at rising edge the actual position is taken from the position sensor and the MINOFFSET will have no effect anymore.
- **Set Offset**: at rising edge, the offset values “Offset Axis X” from Profibus will be transferred relating to the value of MAXAX and the MINOFFSET will be added.
- **Save Parameters**: at rising edge, the offset values that have been transferred before along with the parameters in the CSC-156 modules will be saved in EEPROM memory.

Command values:

- **Command position:** target position to drive to after „START“. (Resolution 1 µm).
- **Velocity:** 10000 corresponds to 100 % (resolution 0.01 %). To drive the axis the setting of a demand value is necessary (also in hand mode)
- **Command pressure:** pressure to which will be limited in PQ-mode (resolution 0.01% of P_NOM).
- **Offset Axis 1…**.4: Offset values in µm for each Axis module (CSC-156) running in Synchronization. The values are confined from -100000 to +100000.

Feedback of the status words and the actual positions:

- **INPOS x:** 1 = Axis x is within InPos-window.
  0 = Axis x is outside InPos-window.
- **READY x:** 1 = Axis x is ready with no fault.
  0 = Fault at Axis x.
- **D-ERROR PCK:** 1 = no data error in the coupler
  0 = data error in the coupler
- **C-ERROR:** 1 = no fault in the CAN-Bus communication.
  0 = fault in the CAN-Bus communication.
- **READY:** 1 = no fault in the coupler and enable is given (PB-Bit).
  0 = no enable or fault in the coupler.
- **SYNC-ERROR x:** 1 = axis x is within synchronization window and synchronal with the others
  0 = axis x is outside synchronization window and not synchronal.
- **D-ERROR CSC:** 1 = all axis modules no data error
  0 = at least one axis module has a data error.
- **X-ERROR:** 1 = all position sensors are OK.
  0 = at least one position sensor has a fault (analog or SSI-fault).
- **P-ERROR 1:** 1 = all pressure sensors P1 OK.
  0 = at least one pressure sensor P1 has a fault (4-20 mA fault).
- **P-ERROR 2:** 1 = all pressure sensors P2 OK.
  0 = at least one pressure sensor P2 has a fault (4-20 mA fault).
- **A-ERROR x:** 1 = Axis module x has no DERROR, XERROR, PERROR1 and PERROR2.
  0 = Axis module x has DERROR, XERROR, PERROR1 or PERROR2.
- **PQ active x:** 1 = Pressure limitation axis x active.
  0 = Pressure limitation axis x inactive.

Actual output data:

- **Command position**: corresponds to the demand value of the Profibus.
- **Actual position x**: corresponds to the actual position of axis x (resolution 0.1 mm).
- **Differential pressure x**: differential pressure of axis x, considering ARATIO.

7.5 Demand via PROFIBUS

7.5.1 Command value overview

32 data bytes are sent to the module

No.	Byte	Function	Typ	Range	DIM
1	0	Control word 1 Hi	int		
2	1	Control word 1 Lo			
3	2	Control word 2 Hi	int		
4	3	Control word 2 Lo (reserve)			
5	4	Command position Hi	long	0… 10000000	0.001 mm
6	5				
7	6				
8	7	Command position Lo			
9	8	Command speed Hi	int	0… 0x2710 (0… 100 %)	0.01 %
10	9	Command speed Lo			
11	10	Command pressure Hi	int	0… 0x2710 (0… 100 % P_NOM)	0.01%
12	11	Command pressure Lo			
13	12	Offset Axis1 Hi	long	-100000…..+100000	0.001 mm
14	13				
15	14				
16	15	Offset Axis1 Lo			
17	16	Offset Axis2 Hi	long	-100000…..+100000	0.001 mm
18	17				
19	18				
20	19	Offset Axis2 Lo			
21	20	Offset Axis3 Hi	long	-100000…..+100000	0.001 mm
22	21				
23	22				
24	23	Offset Axis3 Lo			
25	24	Offset Axis4 Hi	long	-100000…..+100000	0.001 mm
26	25				
27	26				
28	27	Offset Axis4 Lo			
29	28				
30	29				
31	30				
32	31				

7.5.2 Definition control word 1 -Bits

Byte 0 – control word 1 Hi-Byte			
No.	**Bit**	**Function**	
1	0	Hand-A	Manual drive with speed and direction as defined in parameter „HAND:A“
2	1	Hand-B	Manual drive with speed and direction as defined in parameter „HAND:B“
3	2		
4	3	DC freeze	Freezes the value of the drift compensation
5	4	DC active	Activates the drift compensation
6	5	Direct	If this bit is set, every change of the command position is taken over “on the fly” Not setting this bit means new command positions are only taking over when START signal is set from 0 to 1
7	6	START	Starts a positioning process
8	7	ENABLE	General enabling of the controller

Byte 1 – control word 1 Lo-Byte			
No.	**Bit**	**Function**	
1	0	Axis 1 active	Activates the axis
2	1	Axis 2 active	Activates the axis
3	2	Axis 3 active	Activates the axis
4	3	Axis 4 active	Activates the axis
5	4	PQ 1 ON	Switches on the pressure limitation control
6	5	PQ 2 ON	Switches on the pressure limitation control
7	6	PQ 3 ON	Switches on the pressure limitation control
8	7	PQ 4 ON	Switches on the pressure limitation control

7.5.3 Definition control word 2 -Bits

Control word 2 is reserved for extension functions

Byte 0 – control word 2 Hi-Byte			
No.	**Bit**	**Function**	
1	0	Set Offset X	Set of the position offset
2	1	Reset Offset X	Reset of the position offset
3	2	-	-
4	3	-	-
5	4	-	-
6	5	-	-
7	6	-	-
8	7	-	-

Byte 1 – control word 2 Lo-Byte			
No.	**Bit**	**Function**	
1	0	Set Offset	Transfer offset values (Byte 12 to Byte 27) on the rising edge of the bit
2	1	Save Parameters	Save offset values (and parametrization)
3	2	-	-
4	3	-	-
5	4	-	-
6	5	-	-
7	6	-	-
8	7	-	-

7.6 DATA to the PROFIBUS

7.6.1 Actual value overview

32 Byte will be sent to the Profibus (control)

Nr.	Byte	Function	Typ	range	Dim
1	0	Status word 1 Hi	int		
2	1	Status word 1 Lo			
3	2	Status word 2 Hi	int		
4	3	Status word 2 Lo			
5	4	Command position Hi	long		0.001 mm
6	5	…			
7	6	…			
8	7	Command position Lo			
9	8	Actual position 1 Hi	long		0.001 mm
10	9	…			
11	10	…			
12	11	Actual position 1 Lo			
13	12	Actual position 2 Hi	long		0.001 mm
14	13	…			
15	14	…			
16	15	Actual position 2 Lo			
17	16	Actual position 3 Hi	long		0.001 mm
18	17	…			
19	18	…			
20	19	Actual position 3 Lo			
21	20	Actual position 4 Hi	long		0.001 mm
22	21	…			
23	22	…			
24	23	Actual position 4 Lo			
25	24	Differential pressure 1 Hi	Int	-	0.1 bar
26	25	Differential pressure 1 Lo			
27	26	Differential pressure 2 Hi	int	-	0.1 bar
28	27	Differential pressure 2 Lo			
29	28	Differential pressure 3 Hi	int	-	0.1 bar
30	29	Differential pressure 3 Lo			
31	30	Differential pressure 4 Hi	int	-	0.1 bar
32	31	Differential pressure 4 Lo			

7.6.2 Definition statusword 1

Byte 0 - Statusword Hi-Byte			
No.	**Bit**	**Function**	
1	0	INPOS 1	The axis is within the Poswin -window
2	1	INPOS 2	The axis is within the Poswin -window
3	2	INPOS 3	The axis is within the Poswin -window
4	3	INPOS 4	The axis is within the Poswin -window
5	4	READY 1	Axis is working, no error detected
6	5	READY 2	Axis is working, no error detected
7	6	READY 3	Axis is working, no error detected
8	7	READY 4	Axis is working, no error detected

Byte 1 - Statusword Lo-Byte			
No.	**Bit**	**Function**	
1	0	D-ERROR PCK	EEPROM fault in the coupler
2	1	C-ERROR	No CAN bus communication
3	2	Sensor Error	Collection fault stroke/pressure sensors
4	3	READY	Ready message of the coupler
5	4	SYNC-ERROR 1	Axis is not synchronal with the others
6	5	SYNC-ERROR 2	Axis is not synchronal with the others
7	6	SYNC-ERROR 3	Axis is not synchronal with the others
8	7	SYNC-ERROR 4	Axis is not synchronal with the others

7.6.3 Definition statusword 2

Byte 0 - Statusword Hi-Byte			
No.	**Bit**	**Function**	
1	0	E-RROR 1	Stroke sensor fault axis 1 (see Bit 4-7)
2	1	E-RROR 2	Stroke sensor fault axis 2 (see Bit 4-7)
3	2	E-RROR 3	Stroke sensor fault axis 3(see Bit 4-7)
4	3	E-RROR 4	Stroke sensor fault axis 4 (see Bit 4-7)
5	4	D-ERROR CSC	Data Error (axis 1-4)
6	5	X-ERROR	Fault of the stroke sensor (axis 1-4)
7	6	P-ERROR 1	Pressure sensor fault 1 (axis 1-4)
8	7	P-ERROR 2	Pressure sensor fault 2 (axis 1-4)

Byte 1 - Statusword Lo-Byte			
No.	**Bit**	**Function**	
1	0	PQ 1 active	Pressure limitation active axis 1
2	1	PQ 2 active	Pressure limitation active axis 2
3	2	PQ 3 active	Pressure limitation active axis 3
4	3	PQ 4 active	Pressure limitation active axis 4
5	4	-	
6	5	-	
7	6	-	
8	7	-	

8 Notes