CEM-SA-B

Description:

This closed loop position module has been developed for controlling hydraulic positioning drives. Proportional valves with integrated or external electronics can be controlled with the differential output. Output is an analog signal of either voltage, 0 to +/- 10v or current 4-20mA, suitable for directly driving a proportional directional valve with on board electronics.

The internal profile generation is optimized for stroke-dependent deceleration or the NC control mode. The controller and the controller settings are factory preset to typical requirements and can be optimized for the control behavior as required. The optimized control function offers a high degree of precision together with high stability for hydraulic drives. The movement cycle is controlled via the external position and speed inputs.

The high resolution of the analogue signals ensures good positioning behavior. A wide range of analog signals are accepted. User may select either voltage or current input mode. These inputs are easily scaled to match system requirements.

Forward and Reverse “jog” inputs allow for manual load control. A user definable window for “in position” triggers an output for communication to the next machine function.

This module is easily adapted to a variety of system requirements. All variables are user adjusted with easy to use CHI-PC software on your Microsoft Windows laptop. Control variables are stored in non-volatile memory internal to the module. All variables can be read by the laptop, and reproduced exactly on other modules.

Table of Contents

Information Description	Page #

Technical Data - ……………… 3
Functional Diagram ……………… 4
Wiring Example……………… 4
Dimensions ……………… 4
Terminal Identification ……………… 5
Steps to install and configure a new application ……………… 6
Module Mounting Location ……………… 7
Power Supply ……………… 7
Wiring to valve ……………… 7
Parameter List ……………… 8
LED Indications ……………… 9
Command Parameter Descriptions

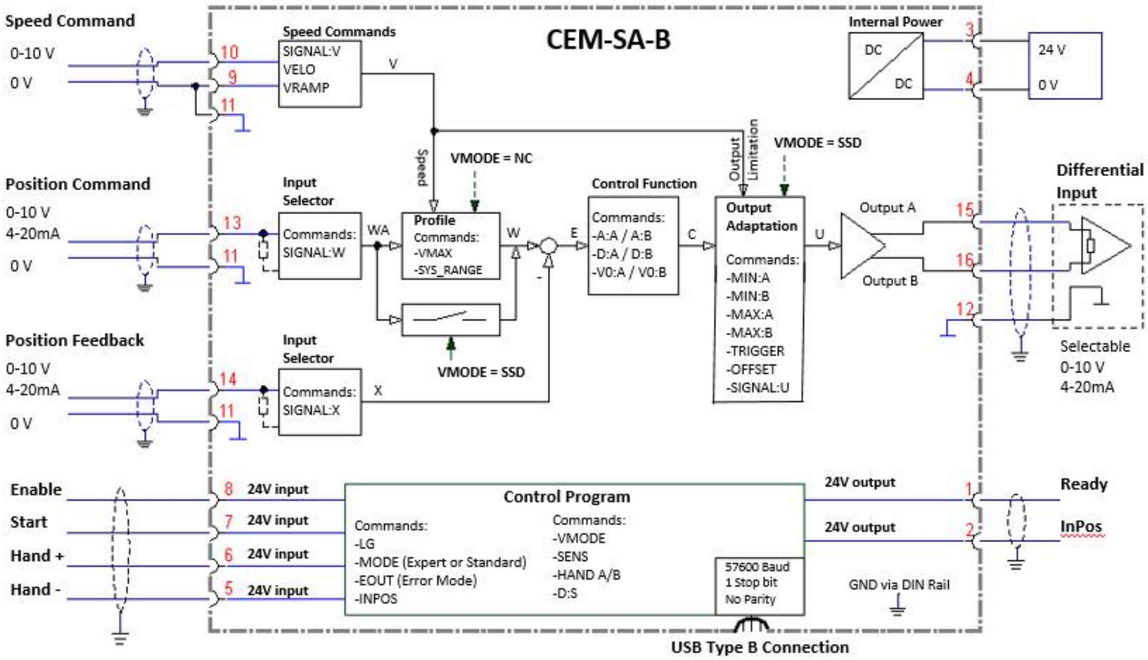
- LG (Language)……………… 10
- MODE……………… 10
- SENS ……………… 10
- EOUT ……………… 11
- ENABLE……………… 11
- START (RUN)……………… 11
- HAND:A / HAND :B……………… 12
- INPOS ……………… 12
- SYS_RANGE ……………… 12
- SIGNAL: W/X/V……………… 13
- N_RANGE:X ……………… 13
- OFFSET:X ……………… 13
- Using SYS_RANGE, N_RANGE and OFFSET ……………… 14
- Speed Commands SIGNAL:V ……………… 15
- VELO ……………… 15
- VRAMP ……………… 15
- VMODE ……………… 16
- ACCEL ……………… 16
- VMAX ……………… 16
- A:A and A:B……………… 17
- D:A / D:B / D:S ……………… 17
- V0:A / V0:B / V0:RES ……………… 18
- PT1 ……………… 18
- CTRL ……………… 19
- MIN:A / MIN:B ……………… 20
- MAX:A / MAX:B ……………… 20
- TRIGGER ……………… 20
- OFFSET ……………… 21
- SIGNAL:U ……………… 21
- Special Command descriptions ……………… 22
- DC:AV ……………… 23
- DC:DV ……………… 23
- DC:I ……………… 23
- DC:CR ……………… 23
- Process Data (Monitoring) ……………… 23
- AINMODE……………… 24-25

Troubleshooting ……………… 26-27

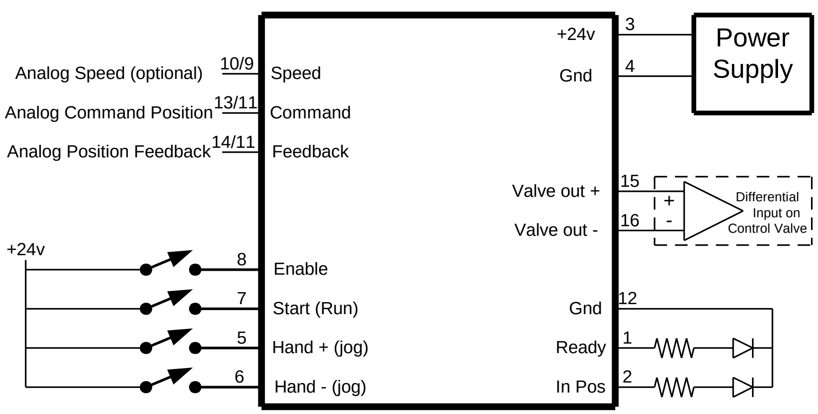
Technical data

Supply voltage	[VDC]	12… 30 (incl. ripple)
Current requirement	[mA]	<100
External protection	[A]	1 medium time lag
Digital inputs	[V]	logic 0: <2
	[V]	logic 1: >10
Input resistance	[kOhm]	25
Digital outputs	[V]	logic 0: <2
	[V]	logic 1: >12 (50 mA)
Analogue inputs (sensor and demand value signal)	[V]	0… 10; 25 kOhm
	[mA]	4… 20; 240 Ohm
Signal resolution	[%]	0,003 incl. Oversampling (*maximum resolution 1 µm*)
Speed input	[V]	0… 10; 90 kOhm
	[mA]	4… 20; 240 Ohm
	[%]	0,003
Analogue outputs		
Voltage	[V]	2 x 0… 10; differential output
	[mA]	10 (max. load)
Signal resolution	[%]	0,006
Current	[mA]	4… 20; 390 Ohm maximum load
Signal resolution	[%]	0,006
Controller sample time	[ms]	1
Serial interface		USB in RS 232C Emulation (9600… 57600 Baud, 1 stop bit, no parity, echo mode)
Housing		Snap-on module to EN 50022 PA 6.6 polyamide Flammability class V0 (UL94)
Weight	[kg]	0,170
Protection class		IP20
Temperature range	[°C]	-20… 60
Storage temperature	[°C]	-20… 70
Humidity	[%]	< 95 (non-condensing)
Connections		USB-B 4 x 4-pole terminal blocks PE: via the DIN mounting rail
EMC		EN 61000-6-2: 8/2005 EN 61000-6-4: 6/2007 ; A1:2011

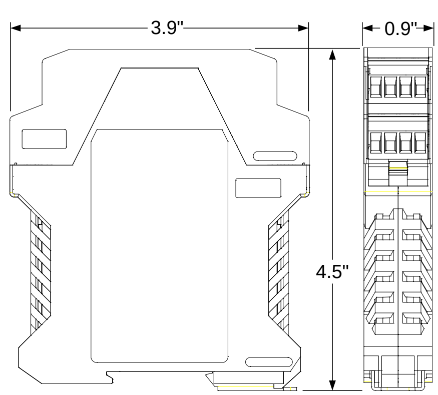
Functional Diagram:



Wiring Example:



Dimensions:



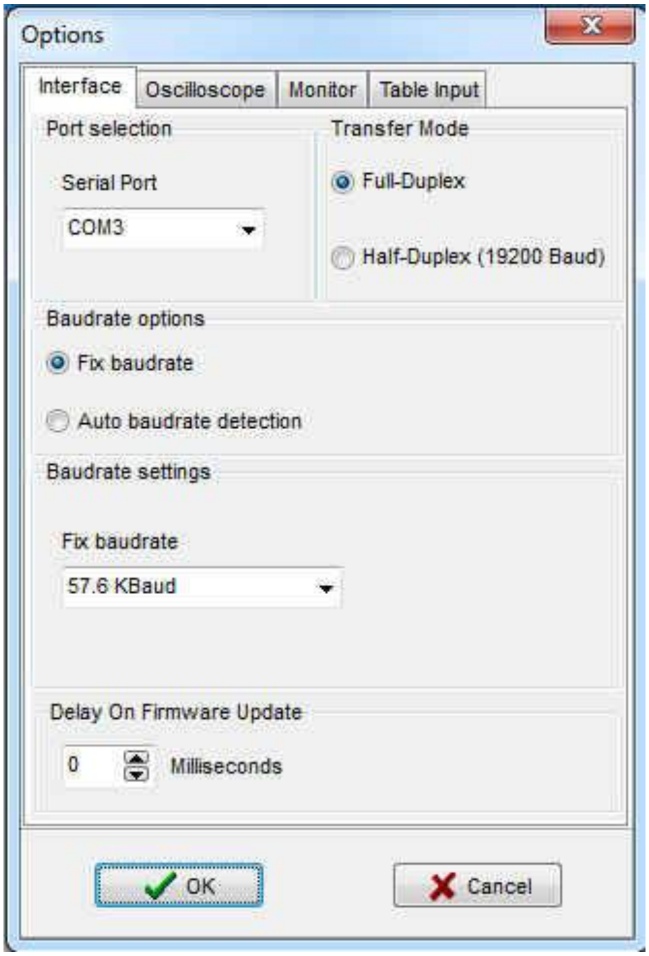
CEM-SA-B Input and output Terminal Identification

Connection	**Supply**
PIN 3	Power supply (see technical data)
PIN 4	0 V (GND) connection.
Connection	**Analogue signals**
PIN 9 / 10	External speed demand (V), range 0… 10 V or 4… 20 mA (scalable)
PIN 13	Position demand value (W), range 0… 10 V or 4… 20 mA (scalable)
PIN 14	Analogue position actual value (X), range 0… 10 V or 4… 20 mA (scalable)
PIN 11 / PIN 12	0 V (GND) connection for analogue signals
PIN 15 / 16	Valve control Output signal. Type of signal and polarity can be selected by the parameter SIGNAL:U.
Connection	**Digital inputs and outputs**
PIN 8	**Enable input:** This digital input signal initializes the application and error messages are deleted. The controller and the READY signal are activated. The output signal to the control element is enabled. The actual position is accepted as the command position and the drive remains stationary under control at this position. If the input is disabled, the output (control signal) is switched off(disabled). Take care of the EOUT-command!
PIN 7	**START (RUN) input:** The position controller is active and the external analogue demand position is accepted as the demand value. If the input is disabled during the movement, the system is stopped within the set emergency stopping distance (D:S).
PIN 6	**HAND + input:** Manual operation (START = OFF): the drive moves at the programmed speed in the programmed direction. After deactivation, the actual current position is accepted as the demand position. The START (RUN) input has priority over the HAND+ input. If the sensor signal is missing (external ENABLE signal = ON), the drive can be operated in manual mode.
PIN 5	**HAND - input:** Manual operation (START = OFF); the drive moves with the programmed speed in the programmed direction. After deactivation, the actual current position is accepted as the required position. The START (RUN) input has priority over the HAND- input. If the sensor signal is missing (external ENABLE signal = ON), the drive can be operated in manual mode.
PIN 1	**READY output:** **ON:** The module is enabled; there are no discernable errors. **OFF:** Enable (PIN 8) is disabled or an error (sensor or internal error) has been detected.
PIN 2	**STATUS output:** **ON: INPOS message.** The axis is within the INPOS window. **OFF: INPOS message.** The axis is outside the INPOS window.

Steps to install and configure a new application:

All parameters are adjusted using VEA-BUSB programming cable and CHI-PC Microsoft Windows application.

1. Mount the module in a suitable location
2. Connect the power supply and valve solenoids
3. Down load and open the GUI program (www.continentalhydraulics.com/wp-content/uploads/2015/01/setup-CEWMPC-10-v3.5.0.zip)
4. Connect to Laptop via USB to USB Type B communication cable.
5. Open the Options and check setting make sure the correct com port, full-Duplex and 57.6K Baud rate are selected.



Module Mounting Location:

This module is to be mounted in a cabinet for protection from the local environment.
Ensure there is adequate free space around the module to allow for cooling air flow.
This module is designed to snap onto an industry standard 35mm DIN rail.
Do not mount near other modules that emit high power electrical interference, such as motor controllers and high power contactors.

Power Supply:

This module is designed to operate on DC power from a regulated power supply ranging from 12 to 30 volts. Match valve solenoid voltage rating to power supply, typically 12 or 24 volts.

A 1 amp medium action fuse is recommended in the "+" power supply line.

Wiring to Valve:

Two conductors are required for each solenoid. There is no need for shielding on these power conductors.

Wire size is chosen to provide an acceptable voltage drop between the module and the valve solenoid. The following chart is based on 5% drop for 12v and 24v applications. The listed cable length is distance from module to valve, and includes the voltage drop of the return conductor.

Wire size	2.6A 12v	1.6A 24v	0.86A 24v
12 gauge	66 ft. max	215 ft. max	400 ft. max
14 gauge	49 ft. max	159 ft. max	295 ft. max
16 gauge	31 ft. max	100 ft. max	186 ft. max
18 gauge	19 ft. max	63 ft. max	117 ft. max
20 gauge	13 ft. max	39 ft. max	73 ft. max
22 gauge	8 ft. max	25 ft. max	46 ft. max

CEM-SA-B Function Parameter layout

				MODE		
Ref Page	Command	Parameter	Help / Description	STD	EXP-SDD	EXP-NC
10	**LG**	EN	EN English	X	X	X
10	**MODE**	EXP	Standard / Expert mode	X	X	X
10	**SENS**	ON	Malfunction monitoring [ON / OFF /AUTO]	X	X	X
11	**EOUT**	0	Output signal if not ready [0.01%]		X	X
12	**HAND:A**	3333	Manual speed [0.01%]	X	X	X
12	**HAND:B**	-3333	Manual speed [0.01%]	X	X	X
12	**INPOS**	200	In-position-window [µm]	X	X	X
12	**SYS_RANGE**	100	Axis working Stroke [mm]	X	X	X
13	**SIGNAL:X**	U0-10	Type of Input	X	X	X
13	**N_RANGE:X**	100	sensor nominal length [mm]	X	X	X
13	**OFFSET:X**	0	sensor offset [µm]	X	X	X
13	**SIGNAL:W**	U0-10	Type of Input	X	X	X
15	**SIGNAL:V**	OFF	Type of Input	X	X	X
15	**VELO**	10000	Internal speed limitation [0.01%]	X	X	X
15	**VRAMP**	200	Ramp time for the external speed [ms] **[SINGNAL:V - ON]**			X
16	**VMODE**	SDD	Method of positioning		X	X
16	**ACCEL**	250	Acceleration [mm/s^2]			X
16	**VMAX**	50	Maximum speed [mm/s]			X
17	**A:A**	100	Acceleration time [ms]	X	X	
17	**A:B**	100	Acceleration time [ms]	X	X	
17	**D:A**	25	Deceleration stroke [mm]	X	X	
17	**D:B**	25	Deceleration stroke [mm]	X	X	
17	**D:S**	10	Overtravel [mm]	X	X	
18	**V0:A**	25	Loop gain [1/s]			X
18	**V0:B**	25	Loop gain [1/s]			X
18	**V0:RES**	1	Loop gain resolution			X
18	**PT1**	1	PR1-filter time constant [ms]		X	X
19	**CTRL**	SQRT1	Control characteristic	X	X	X
20	**MIN:A**	0	Compensation of the Deadband in 0.01%	X	X	X
20	**MIN:B**	0	Compensation of the Deadband in 0.01%	X	X	X
20	**MAX:A**	10000	Output Scaling in 0.01%	X	X	X
20	**MAX:B**	10000	Output Scaling in 0.01%	X	X	X
20	**TRIGGER**	200	Trigger point of the MIN function in 0.01%	X	X	X
21	**OFFSET**	0	Output offset [0.01%]	X	X	X
21	**SIGNAL:U**	U+-10	Type and polarity of the output signal	X	X	X
23	**DC:I**	2000	Drift compensator, I-gain [ms]		X	X
23	**DC:AV**	0	Drift compensator, activation value [0.01%]		X	X
23	**DC:DV**	0	Drift compensator, deactivation value [0.01%]		X	X
23	**DC:CR**	500	Drift compensator, control range [0.01%]		X	X

LED Indications

LEDs	Description of the LED function
GREEN	Identical to the READY output. OFF: No power supply or ENABLE is not activated ON: System is ready for peration Flashing: Error discovered Only active when SENS = ON
YELLOW A	Identical to the STATUS output. OFF: The axis is outside the INPOS window. ON: The axis is within the INPOS window.
GREEN + YELLOW A+B	1. **Chasing light (over all LEDs):** The boot loader 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 have power cycled.
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 CHI-PC. 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.

Parameter Descriptions

LG (Changing the language)

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

Either English or German can be selected for the displayed texts.
After changing the language settings, the ID button in the menu bar (CHI-PC) must be pressed (module identification).

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. (see page 8)

SENS (monitoring of the modul functions)

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

This command is used to activate/deactivate the monitoring functions (4… 20 mA sensors, output current, signal range and internal failures) of the module.

ON: All monitoring functions are active. Detected failures can be reset by deactivating the ENABLE input PIN 8.

OFF: No monitoring function is active. The READY output will not function in OFF.

AUTO: Auto reset mode. All monitoring functions are active. If the failure doesn't exist anymore, the module automatically resumes to work without deactivating the ENABLE input PIN 8.

Normally the monitoring functions are always active because otherwise no errors are detectable via the READY output. Deactivating is possible mainly for troubleshooting.

EOUT (Output signal: READY = OFF)

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

Output value in case of a detected error or a deactive ENABLE input. A value (degree of valve opening) for use in the event of a sensor error (or the module is disabled) can be defined here. This function can be used if, for example, the drive is to move to one of the two end positions (at the specified speed) in case of a sensor error.

|EOUT| = 0 The output is switched off in the event of an error. This is normal behavior.

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 (independently of the parameter set). The effects should be analyzed by the user for each application from the point of view of safety.
Do not use the manual mode in conjunction with the EOUT command. After the deactivation of the HAND input the output is set to the EOUT value.

ENABLE (pin 8) digital input:

ENABLE is a digital input that is active high.
When the ENABLE input is low, there is no output to the valve. Command input and feedback input values are ignored. All other inputs are also ignored. To activate the HAND function, ENABLE must be held active.
If ENABLE is removed during an active motion profile, the output to the valve is instantly brought to zero.

START (RUN) (pin 7) digital input:

START (RUN) is a digital input that is active high.
Bringing pin 7 high (while holding pin 8 (ENABLE) high), forces the module into closed loop position control mode.

If RUN is removed during an active motion profile, the output to the valve is ramped to zero.

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

HAND (Manual speed)

The Hand functions are not active when Start PIN 7 is active, to use the Hand manual speed functions the Start function must be deactivated.

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

The manual speeds are set with these parameters. The drive moves in a controlled manner in the defined direction when the manual signal is active. The direction is defined by the sign of the parameters. After the manual signal has been disabled, the drive remains under control in the current position.

In case of a fault (position sensor fault), the drive can still be moved with the manual function. The output will be switched off when hand signals are turned off.

The manual speed is also limited by the (internal or external) speed demand (MIN evaluation).

Caution! Do not use the manual mode in conjunction with the EOUT command. After the deactivation of the HAND input the output is set to the EOUT value.

INPOS (In position range)

Command	Parameters	Unit	Group
INPOS x	**x= 2… 200000**	**µm**	**STD**

This parameter is entered in µm.
The INPOS command defines a range for which the INPOS message is generated. This function monitors the failure between the command and actual position. If the failure is less than the programmed value a INPOS message at the status output (see Pin description). The positioning process is not influenced by this message.
PIN 7 (START) must be activated to generate the INPOS messages.

SYS_RANGE (Working stroke)

Command	Parameters	Unit	Group
SYS_RANGE......	**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.

SIGNAL (Type of input)

Command	Parameter	Unit	Group
SIGNAL:i x	i= W|X|V x= OFF U0-10 U10-0 I4-20 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 all analog inputs (W, X, and V).
OFF= Deactivation of the input[2].
See **ANIMODE** section (page 24-25) if the Signals used are not listed above, for re-scaling as required.

N_RANGE: X (Nominal range of the sensor)

Command	Parameter	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 be always higher than SYS_RANGE. The control parameter cannot be calculated correctly in case of wrong values.

OFFSET: X (Sensor offset)

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

Adjustment of the zero point of the sensor.

[2] The deactivation can be used to deactivate the velocity (speed) input PIN_9/10 (the VELO value is active).

Using of the commands SYS_RANGE, N_RANGE: X and OFFSET: X

If the Cylinder stroke and the feedback device are matched, the standard factory settings will not require any changes.
In systems where these are not matched, the commands SYS_RANGE, N_RANGE: X and OFFSET: X must be scaled to match. The application scaling will be done by these three commands.

In this example (Figure 1) the system is defined by a length of 120 mm of the sensor, a working stroke of 100 mm of the cylinder and an offset of 5 mm. These parameters have to be typed in and the axis is driving between 5 mm and 105 mm of the sensor stroke and between 0 mm and 100 mm of the cylinder stroke.

Correct scaling:

SYS_RANGE	= 100	(mm)
N_RANGE: X	= 120	(mm)
OFFSET: X	= -5000	(µm)

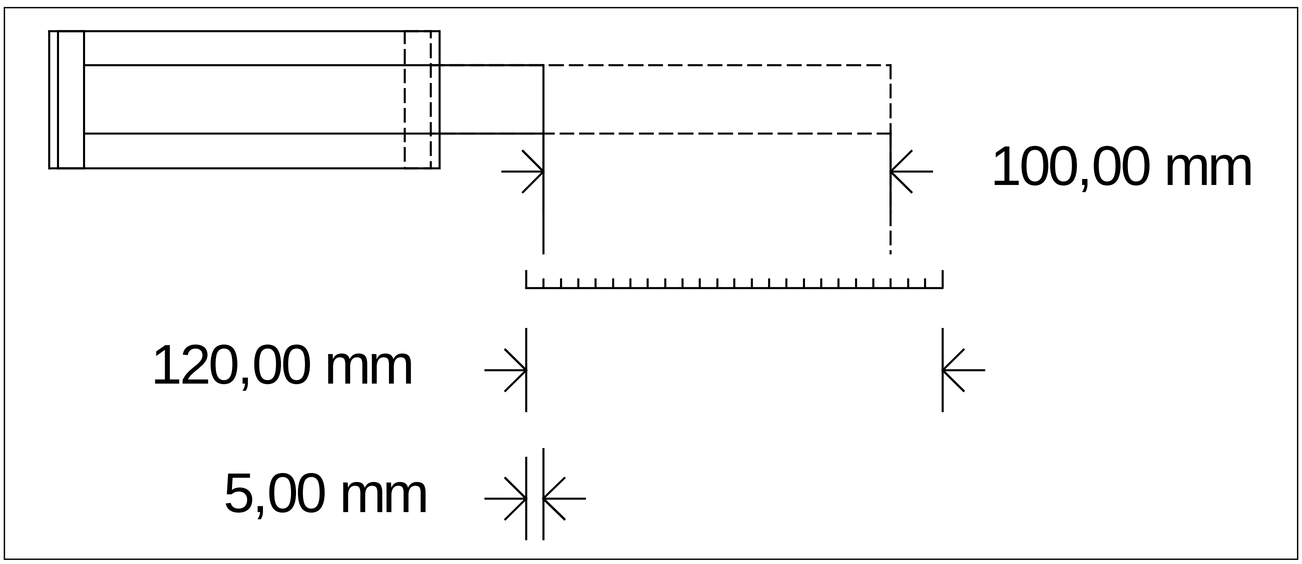


Figure 1 (Input scaling of the sensor)

Speed commands

The SIGNAL: V command is used to switch over between external or internal speed limitations.
SIGNAL: V = OFF Internal speed limitation (VELO command)
SIGNAL: V = U0-10 External speed limitation (0-10 Volt)

PIN 9/10 is used for external speed limitation[3].

See **ANIMODE** section (page 24-25) if the Signals used are not listed above, for re-scaling as required.

VELO (Internal speed demand value)

Command	Parameters	Unit	Group
VELO x	**x= 1… 10000**	**0.01 %**	**SIGNAL:V = OFF**

Specification of the internal speed limitation.

VRAMP (Ramp time for external speed demand)

Command	Parameters	Unit	Group
VRAMP x	**x= 10… 5000**	**ms**	**SIGNAL:V**

The rate of change of the external speed demand can be limited by this ramp time. The command is only active if external speed demand (SIGNAL:V <> OFF) has been parameterized.

[3] The output signal is directly limited in SDD mode (default mode). In NC mode the speed profile of the generator is limited. The lowest adjustable speed is 0.01 mm/s (VMAX = 1 mm/s and VELO = 1 %).

VMODE (Methode of positioning)

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

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 is insensitive 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 to run at less than 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.

ACCEL (Acceleration in NC mode)

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

This command is used to define the acceleration rate in NC mode. The command is only active if the VMODE has been parameterized to NC.

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 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 (PIN 10 and 9). The command is only active if the VMODE has been parameterized to NC.

A:A and A:B (Acceleration (ramp) time)

Command	Parameters	Unit	Group
A:i x	**i= A|B** **x= 1… 5000**	 **ms**	**VMODE=SDD**

Ramp function for the 1st (A solenoid) and 3rd (B solenoid) acceleration quadrants only.
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 when the SDD funcion is in control.

D:A / D:B / D:S (Deceleration / braking distance)

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

This parameter is specified in mm[4].
The deceleration stroke is set for each direction of movement (A or B). The control gain is calculated internally depending on the deceleration distance. The shorter the deceleration distance, the higher the gain. A longer deceleration distance should be specified in the event of instability.
Parameter D:S is used as the stopping ramp when disabling the START (PIN 7) signal. After disabling, a new target position (current position plus D:S) is calculated in relation to the speed and is specified as a command value.

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

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

[4] **CAUTION!** In older modules this parameter was specified in % of the maximum stroke. Since data specification for this module has now been converted to mm, the relationship between the stroke (SYS_RANGE command) and these parameters must be taken into account.

V0:A / V0:B (Loop gain setting)

Command	Parameters	Unit	Group
V0:i x	i= A|B x= 1… 400	 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 stroke[5].
The internal gain is calculated from this gain value together with the parameters VMAX and SYS_RANGE.

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

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

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 therefore also the correct data demands related to the closed loop control system are relatively simple if the relationship described here is taken into account.

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[6].

The increased resolution should be used in case of V0 < 4.

PT1 (Timing of the controller)

Command	Parameter	Unit	Group
PT1 x	x= 0… 300	ms	EXP

This parameter can be used to change the internal timing of the control function.
Hydraulic drives are often critical to control especially in case of high speeds and very fast valves. The PT1 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.

[5] The loop gain is alternatively defined as a KV factor with the unit (m/min)/mm or as V_0 in 1/s. The conversion is
KV = V_0/16,67.

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

CTRL (Deceleration characteristics)

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

The deceleration characteristic is set with this parameter. In 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[7] function.
In case of zero lapped valves (control valves and servo valves) the LIN or SQRT1 function should be used regardless of 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.

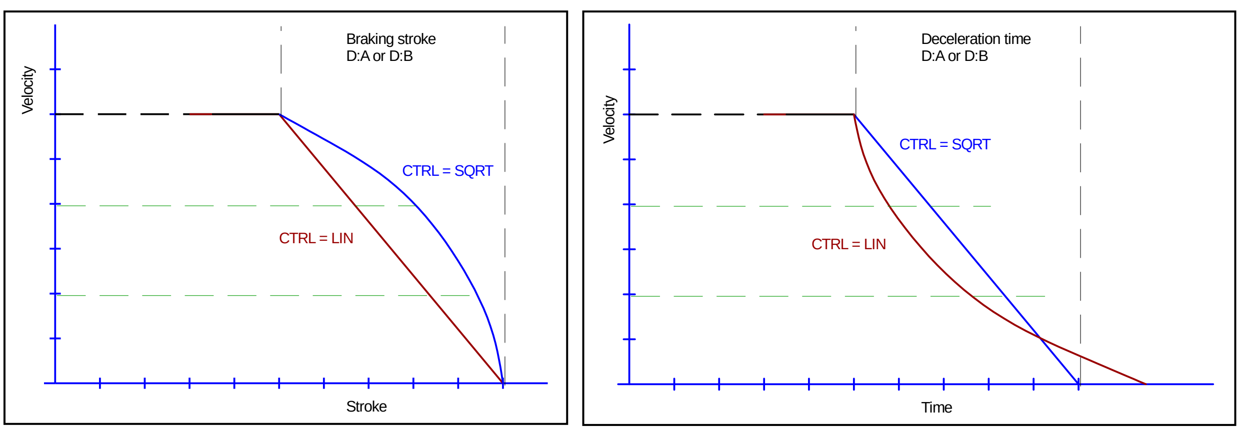


Figure 2 (Braking function with respect to stroke and time)

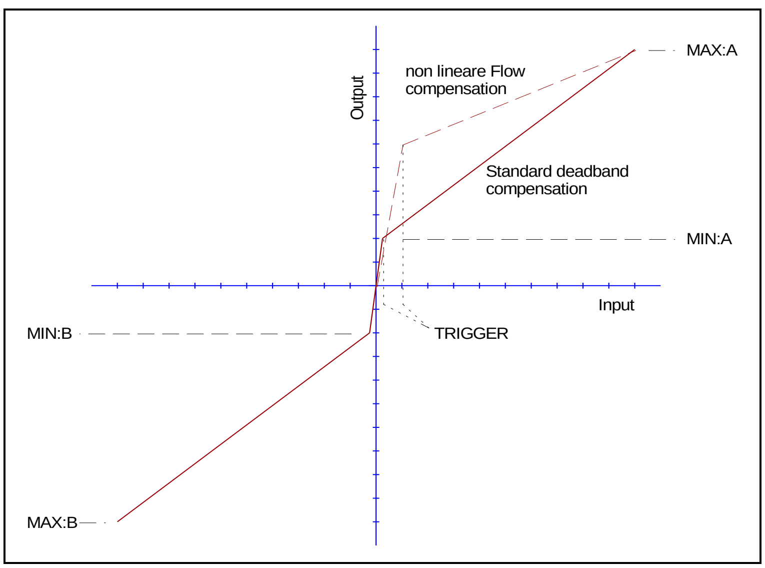
[7] The SQRT function generates constant deceleration and thus reaches the target position faster. This is achieved by increasing the gain during the deceleration process.

MIN:A / MIN:B (Dead band compensation)
MAX:A / MAX:B (Output scaling)
TRIGGER (Response threshold for the MIN parameter activation)

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[8].

If there should also be adjustment options for deadband 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 then no longer be adjusted. In extreme cases this leads to oscillation around the controlled position.



[8] Various manufacturers have valves with a defined nonlinear 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 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 an overall higher gain can often be set.

OFFSET (Zero correction)

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.

SIGNAL:U (Type and polarity of the output signal)

Command	Parameter	Unit	Group
SIGNAL:U x	**x= U+-10** **I4-12-20** **U-+10** **I20-12-4**	**-**	**EXP**

This command is used to define the output signal (voltage or current) and to change the polarity[9].

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.

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 have to be deactivated in case of < 4 mA input signal. Otherwise the EOUT command can be used to get a defined output signal.

See **ANIMODE** section (page 24-25) if the Signals used are not listed above, for re-scaling as required.

[9] The older POL command is removed.

Special commands

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[10] by wrong parameterization or the system behavior was not taken into account.
Which positioning errors can be compensated[11]?

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. Compared with point 1 and 2, the positioning failure generated by the force signal can vary cycle to cycle.

How does it work?

High accurate positioning

These kinds of 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.

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.

[10] 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.

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

DC:AV (Activation value)

DC:DV (Deactivation value)

DC:I (Integrator time)

DC:CR (Integrator limitation)

Command	Parameter	Unit	Group
DC:AV x	**x= 0… 2000**	**0.01 %**	**EXP**
DC:DV x	**x= 0… 1000**	**0.01 %**	
DC:I x	**x= 0… 2000**	**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.

PROCESS DATA (Monitoring)

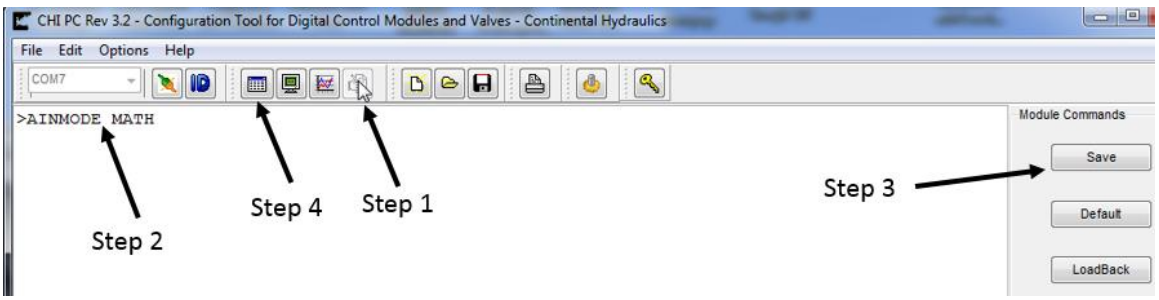
Command	Description	Unit
WA	Demand value (input signal)	mm
W	Demand value (according to the profile generator)	mm
V	Speed input	%
X	Actual value	mm
E	Error value	mm
C	Output of the controller	%
U	Output signal of the module	%
IA	Solenoid current A	mA (P Version only)
IB	Solenoid current B	mA (P Version only)

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

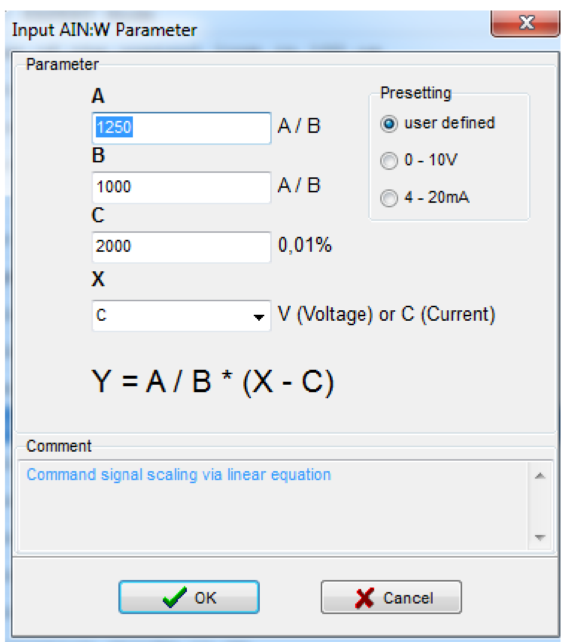
AINMODE

The AINMODE is used to define the type of analog input signals being used.
The standard default setting of AINMODE is EASY. In the EASY mode the SIGNAL:W/X/V (see page 13) are only available in the most commom 0-10 volt or 4-20mA values.
If the input signal being used are not as listed, the AINMODE is available in the MATH mode where the input signals can be scaled by a linear equation.

To enter the MATH option, you must change the AINMODE to MATH by use of the Terminal Window. (see steps 1-4 below)
Once in the Termainal Window screen type in AINMODE MATH and click the Save button. At this time you may go back to the Parameter screen where you can use the user defined scalling feature.



Once in the MATH mode you will be able to scale the various input signals as shown below.



Analogue input scaling parameters

Command	Parameters	Unit	Group	FUNCTION
AIN:I a b c x	**i = A|B**	-	**EXP**	**AA**
	a= -10000… 10000	-		**A-B**
	b= -10000… 10000	-		
	c= -10000… 10000	**0.01%**		
	x= **V|C**	-		

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 input signal is activated when parameters AIN:A and AIN:B are set to Current (X=C).

The gain factor is calculated by dividing total input signal range (**A**) by the actual input range (***B***). In the case of a 4-20mA with a single solenoid valve, the total range is 0-20mA, which means **A=20**. The actual range is 4-20 mA, therefore, **B= (20-4) =16**. An offset, **C**, must be added to compensate for the 0-4mA not being used of the full range. The offset is 4mA/20mA=0.2 or 20%. Therefore **C=2000** since the unit value for **C** is 0.01%.

Shown in the below table are the most common input command signal and the corresponding settings to be used.

Typical settings (examples):

Command	Input	Description
AIN:X 1000 1000 0 V	0… 10 V	Range: 0… 100 %
AIN:X 10 8 1000 V OR **AIN:X 1000 800 1000 V**	1… 9 V	Range: 0… 100 %; 1 V = 1000 used for the offset and gained by 10 / 8 (10 V divided by 8 V (9 V -1 V))
AIN:X 10 4 500 V OR **AIN:X 1000 400 500 V**	0.5… 4.5 V	Range: 0… 100 %; 0.5 V = 500 used for the offset and gained by 10 / 4 (10 V divided by 4 V (4.5 V -0.5 V))
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 on 20 % (4 mA) and the signal (16 mA = 20 mA – 4 mA) will be gained to 100 % (20 mA). Each of this parameterization for 4… 20 mA is setting the range to 0… 100 %.

Troubleshooting

It is assumed that the device is in an operable state and there is communication between the module and the CHI-PC. Furthermore, the valve control parameterization has been set with the assistance of the valve data sheets.

FAULT	CAUSE / SOLUTION
ENABLE is active, the module does not respond and the READY LED is off.	There is presumably no power supply or the ENABLE signal (PIN 8) is not present. If there is no power supply, there is also no communication via our operating program. If a connection has been made to the CHI-PC, then a power supply is also available. If the power supply exists, an attempt should be made to see whether the system can be moved by means of the HAND+ and HAND- inputs (measuring the output signal to the valve helps).
ENABLE is active, the READY LED is flashing.	The flashing READY LED signals that a fault has been detected by the module. The fault could be: • A broken cable or no signal at the input (PIN 13 or PIN 14), if 4… 20 mA signals are parameterized. • Internal data error: press the command/SAVE button to delete the data error. The system reloads the DEFAULT data. With the CHI-PC operating program the fault can be localized directly via the monitor.
ENABLE is active; the READY LED is on, the system moves to an end position.	The control circuit polarity is incorrect. The polarity can be changed with the POL command or by reversing the connections to PIN 15 and PIN 16.
ENABLE is active, the READY LED is on, the STATUS LED is not on, the system moves to the target position but doesn't reach it (positioning error).	Serious positioning errors can result from incorrect parameterization or incorrect system design. • Is the cylinder position specified correctly? • Are the deceleration strokes correct (to start the system, the deceleration distances should be set to approx. 20… 25 % of the cylinder position 12)? • Is the valve a zero lapped control valve or a standard proportional valve? In the case of a proportional valve, the valve overlap which may be present should be compensated for with the MIN parameters. Typical values are to be found in the valve data sheet.
ENABLE is active,	The system is working and also actuating the valve.

[12] The stability criterion of the hydraulic axes must be taken into account.

FAULT	CAUSE / SOLUTION
the READY LED is on, and the system oscillates on the target.	Various potential problems could be: • The parameterization is not yet adjusted to the system (gain too high). • There is severe interference on the power supply. • Very long sensor cables (> 40 m) and sensor signal interference. • The MIN setting to compensate the valve overlap is too high. As a basic principle, the parameterization of the sensor data and the controller settings must be carried out first (before switching on). An incorrect demand is equivalent to incorrect system design which then leads to incorrect operation. If the system oscillates, the gain should first be reduced (longer deceleration distances for D:A and D:B) and in the case of overlapped valves the MIN parameter should also be reduced.

Speed too low	The drive may be able to move to position but the speed is too low.
	• Check the control signal to the valve.
	  • Via the integrated oscilloscope (U variable).
	  • Measure the signal to the valve with an external oscilloscope / voltmeter.
	• If the control is within the range of ± 100 % (± 10 V), the fault must be sought in the hydraulics.
	• If the control signal is relatively low, the following points should be checked:
	  • Is the internal/external speed signal limiting the speed?
	  • Which setting has been specified for the deceleration distance in relation to the POSITION?

Speed too high	The drive should move to position. The drive moves in and out too fast leading to uncontrolled behavior. Reducing the speed (MAX or VELO parameter) has very little or no effect. • The hydraulic system is over-sized. The entire parameterization of the movement cycle cannot be reproduced (overlap and deceleration distance settings)