CEM-BPS-B

Description:

This closed loop position module has been developed for controlling hydraulic synchronization systems. The typical synchronization accuracy is about 0.1% to 1% of the sensor length (depending on the hydraulic system).   Proportional valve 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.

This module is designed for use within a flow divider circuit. A flow divider (valve or gear pump) will synchronize the axis but with limited accuracy. A proportional valve working in parallel to the flow divider is compensating the flow error in one or both cylinders. The flow rate of this valve should be in twice range of the flow error of the flow divider. This kind of synchronization control is extremely stable and simple to use.

With the **AUTO SETUP** input feature, the offset error between both sensors can be measured and compensated automatically. For this setup, the cylinders must be driven at the top or bottom end.

The internal profile generation is optimized for stroke-dependent deceleration 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 the high resolution of the analog signals ensures good positioning behavior. A wide range of analog signals are accepted. User may select either voltage or current input mode.

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.
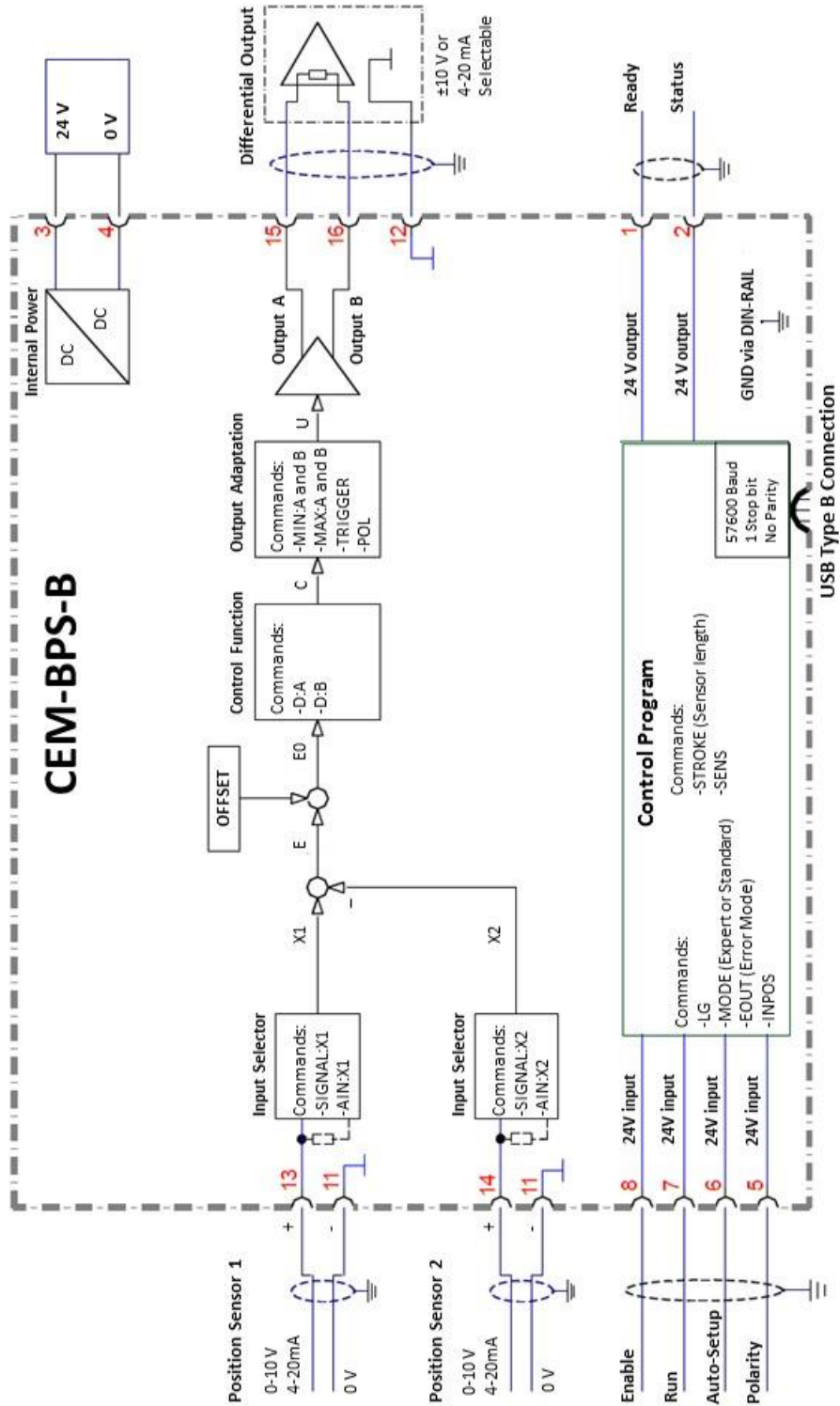
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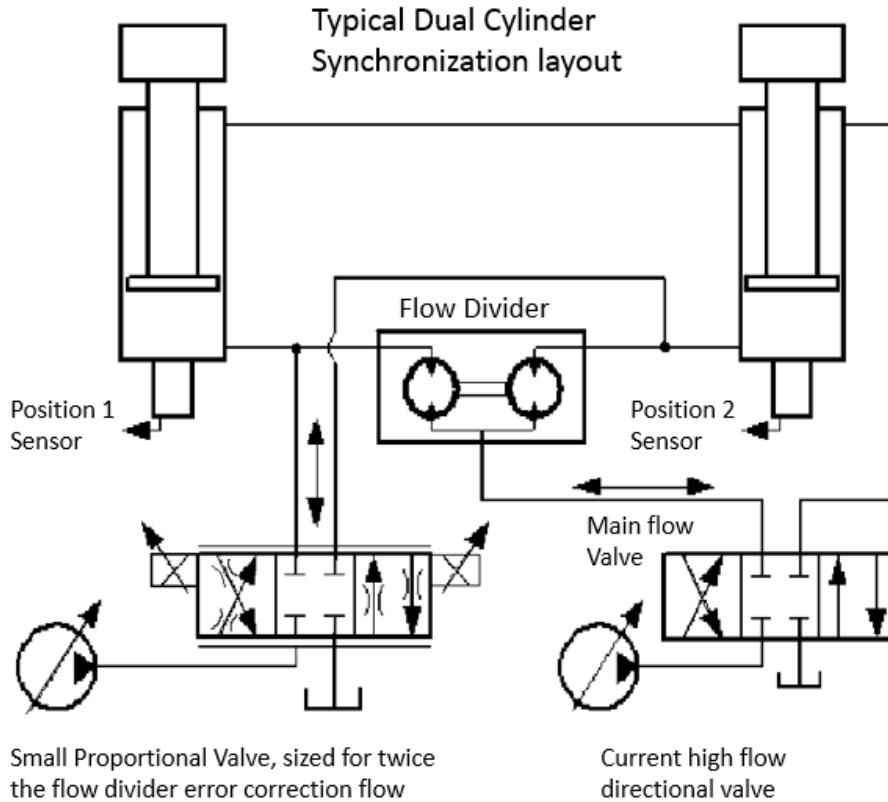**Information Description**   **Page #**

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
Signal resolution	**[mA]**	4… 20; 240 Ohm
	[%]	0.003 incl. Oversampling (maximum resolution 1 µm)
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]**	0.17
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:

Typical Schematic Example:

Typical Dual Cylinder Synchronization layout

Flow Divider

Position 1 Sensor

Position 2 Sensor

Main flow Valve

Small Proportional Valve, sized for twice the flow divider error correction flow

Current high flow directional valve
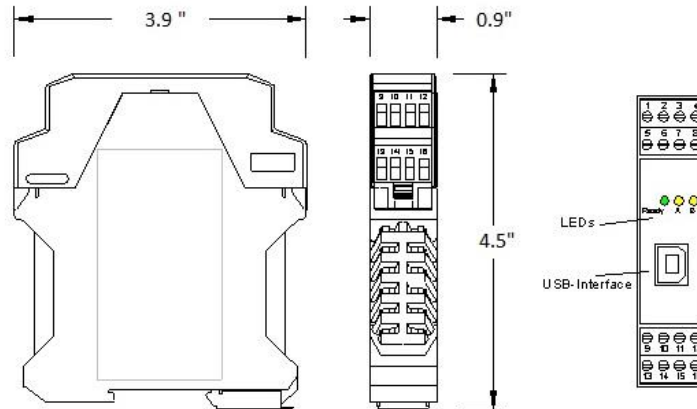
Typical Wiring Example:
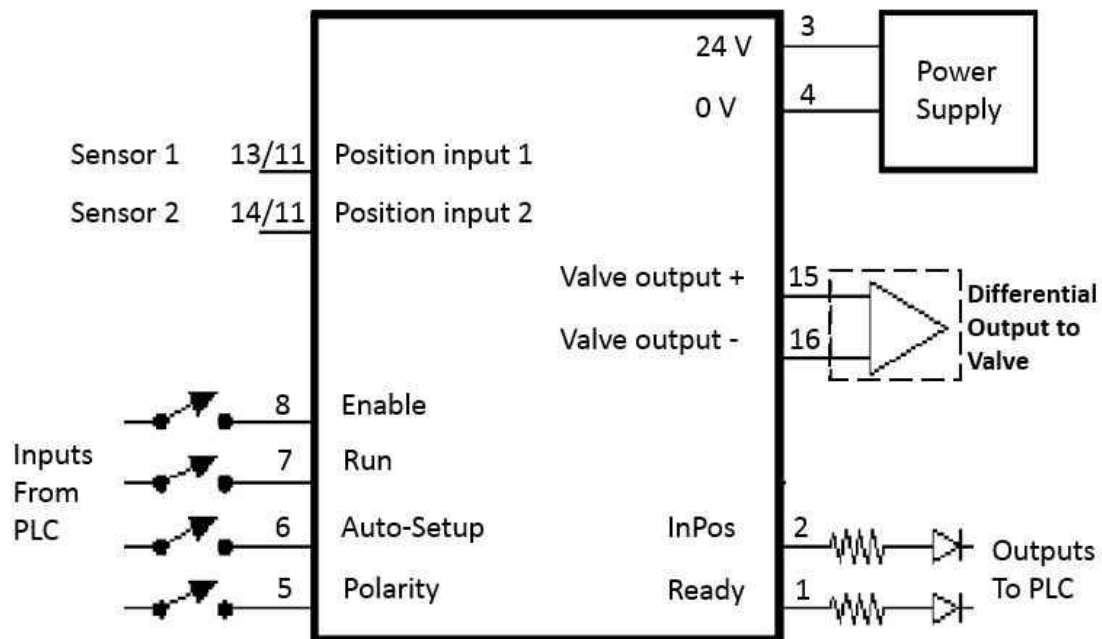
Dimensions:

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:
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-shaped 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 shielded**.

- All other cables must be shielded if there are powerful interference sources (frequency converters, power contactors) and cable lengths > 3 m. Inexpensive SMD ferrites can be used with high-frequency radiation.

- The shielding 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 shielding should be connected at both ends. Equipotential bonding must be provided where there are differences between the connected electrical components.

- If having 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). Special care is required if using cables of over 40 m in length, and if necessary the manufacturer should be consulted.

Wire size is chosen to provide an acceptable voltage drop between the module and the valve solenoid.
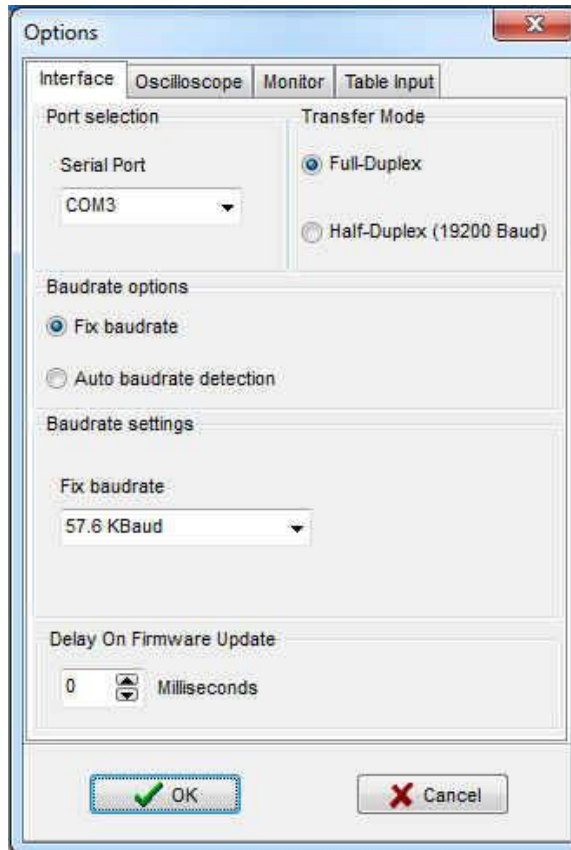
Terminal Identification

Connection	Supply
Terminal 3	Power supply connection (see technical data)
Terminal 4	0 V (GND) connection
Connection	**Analog signals**
Terminal 13	Actual value (X1), signal range 0-10 V or 4-20mA
Terminal 14	Actual value (X2), signal range 0-10 V or 4-20mA
Terminal 11	0 V (GND) connection for analog INPUT signals
Terminal 12	0 V (GND) connection for analog OUTPUT signals
Terminal 15/16	Valve control output signal
Terminal 15/12	Type of OUTPUT signal and polarity (Parameter SIGNAL:U)
Connection	**Digital inputs and outputs**
Terminal 8	**Enable** input: General enabling of outputs and the application
Terminal 7	**START (RUN)** input: **ON:** The Synchronization controller is active **OFF:** The Synchronization controller is not active. Auto setup Terminal 6 can be used
Terminal 6	**AUTO SETUP:** input The offset error between the two sensors is automatically measured and stored as a correction value. The input must be activated for longer than 1 second.
Terminal 5	**POLARITY** input: The polarity of the control loop can be switched on this input
Terminal 1	**READY** output: **ON:** The module is enabled with no discernable errors **OFF:** Enable (Terminal 8) is disabled or an error (sensor or internal error) has been detected
Terminal 2	**STATUS** output: **ON:** (CD window) The axis are within the set deviation window **OFF:** (CD window) The axis are outside the set deviation window

Steps for communication 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.

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 (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 CHI-PC Steps for communication and configure a new application 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): The STROKE, SENSOR SETTINGS and DECELERATION. Parameterize specific settings for the control element (MIN for deadzone compensation and MAX for maximum velocity). Pre-parameterization is necessary to minimize the risk of uncontrolled movements.
Control signal	Check the control signal with a voltmeter. The control signal (PIN 15 to PIN16) lies in the range of ± 10 V. In the current state it should show 0 V. Alternatively, if current signals are used, approx. 0 mA should flow (PIN 15 to PIN 12).
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. Take safety measures to prevent personal injury and damage.
Activating START	With the start signal the Auto setup signal is locked, so that there may be no unintentional offset settings. This signal sends the output signal of the controller to the output, often the START input is connected to the ENABLE input in parallel.
Optimize controller	Now optimize the controller parameters according to your application and your requirements.3

Parameter Overview:

Group	Command	Default	Unit	Description
Basic parameters				
	LG	EN	-	Changing language of help texts
	MODE	STD	-	Parameter view (STD / EXP)
	SENS	ON	-	Malfunction monitor
	INPOS	200	µm	Size of the control deviation window
Input signal adaptation				
	SYS_RANGE	100	mm	Axes working stroke
	Sensor scaling			
	SIGNAL:X1	U0-10		Type of input
	N_RANGE:X1	100	mm	Sensor nominal length
	OFFSET:X1	0	µm	Sensor offset
	SIGNAL:X2	U0-10	-	Type of input
	N_RANGE:X2	100	mm	Sensor nominal length
	OFFSET:X2	0	µm	Sensor offset
Closed loop control parameters				
	D:A	25	mm	Deceleration strokes
	D:B	25	mm	
	PT1	1	ms	PT1 time constant
	CTRL	SQRT1	-	Control characteristic
Output signal adaptation				
	MIN:A	0	0.01%	Deadband compensation
	MIN:B	0	0.01%	
	MAX:A	10000	0.01%	Output scaling
	MAX:B	10000	0.01%	
	TRIGGER	200	0.01%	Deadband compensation trigger point
	OFFSET	0	0.01%	Output offset value
	SIGNAL:U	U+-10	-	Type of output signal and polarity

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 opperation Flashing: Error discovered Only active when SENS = ON
YELLOW A	Identical to the STATUS output. OFF: The axis is outside the control deviation window. ON: The axis is within the control deviation 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.

SENS (monitoring of the module 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.

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.

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. All other inputs are also ignored.

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 synchronization control mode.

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

INPOS (Size of the control deviation window)

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

This parameter is entered in µm.
The INPOS command defines a monitoring range for which the INPOS message is generated. The monitoring window monitors the deviation between the feedback signal X1 and X2. If the deviation is within the INPOS window, the status output and INPOS LED (Yellow A) will be activated.

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=**	**X1 / X2**	**-**	**EASY**
	x=	**OFF**		
		U0-10		
		U10-0		
		I4-20		
		I20-4		

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 (X1, and X2).
OFF= Deactivation of the input.

N_RANGE: X (Nominal range of the sensor)

Command	Parameter	Unit	Group
N_RANGE: i x	**i = X1 / X2**		**EASY**
	x= 10… 10000	**mm**	

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: i x	**I = X1 / X2**		**EASY**
	x= -100000… 100000	**µm**	

Adjustment of the zero point of the sensor.

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

The application scaling will be done by these three commands. In this example 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:
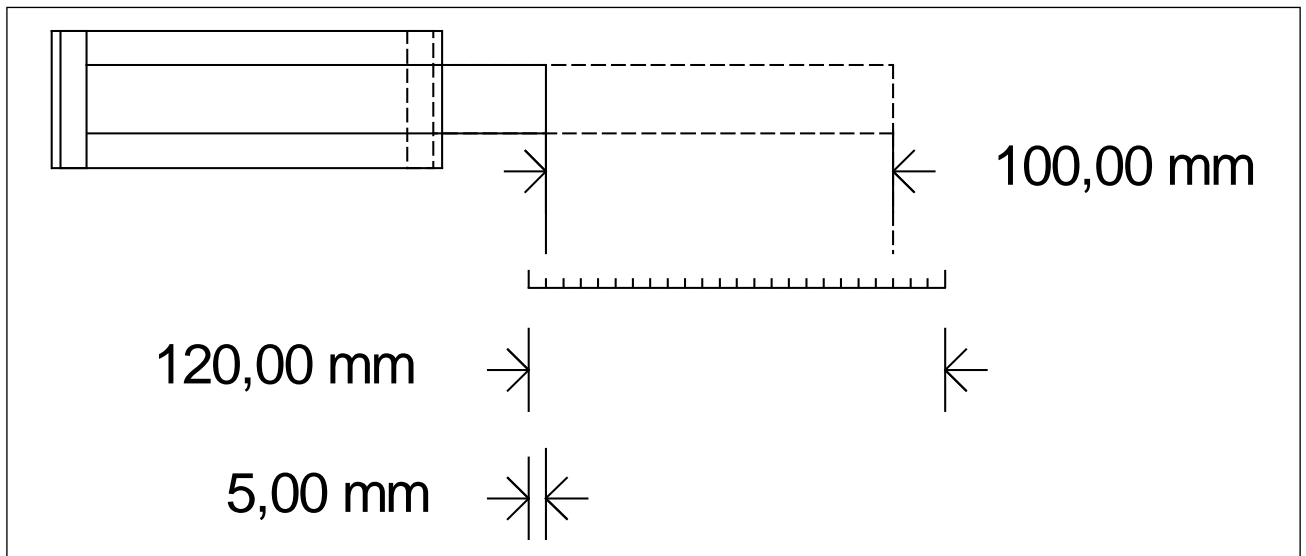SYS_RANGE = 100 (mm);   N_RANGE:X = 120 (mm);   OFFSET:X = - 5000 (µm)

Figure 1 (Input scaling of the sensor)

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

Command	Parameters	Unit	Group
D:i x	i= A / B		STD
	x= 1… 10000	mm	

This parameter is specified in mm[1].

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.

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

PT1   (Timing of the controller)

Command	Parameters	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 offten critical to control, especially in case of high speeds and very fast valves. The PT1 filter can be used to improve the dampening rate and allow for higher loop gains.

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

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[1] **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.

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[2] 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.
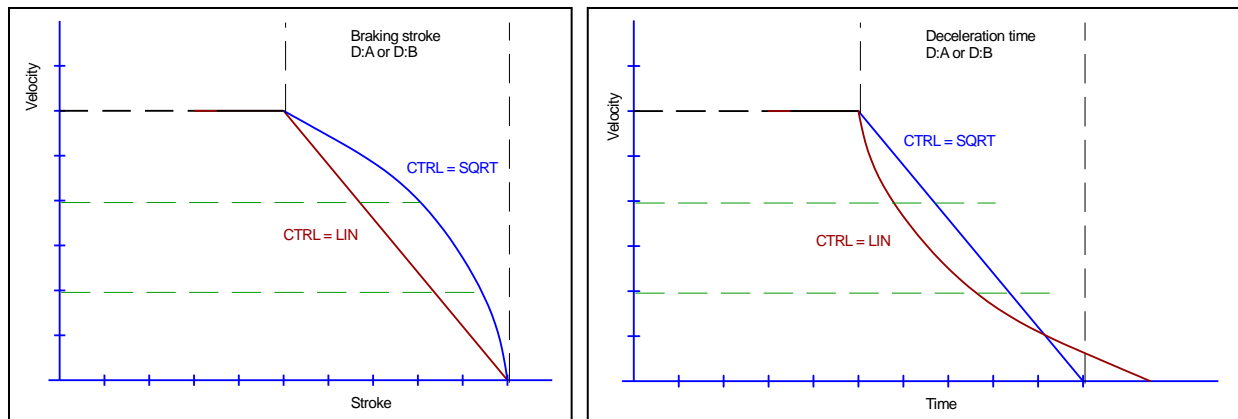

Figure 2 (Braking function with respect to stroke and time)

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[2] 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[3].

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.

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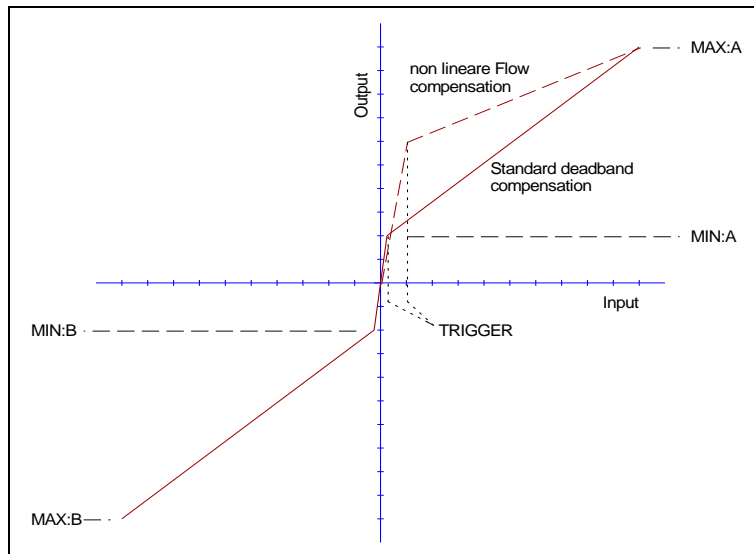
[3] Various manufacturers have valves with a defined nonlinear curve: e.g. a kink at 40 or 60 % (corresponding to 10 % input signal) of the nominal volume flow. In this case the TRIGGER value should be set to 1000 and the MIN value to 4000 (6000).

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[4].

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.

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[4] The older POL command is removed.

PROCESS DATA (Monitoring)

Command	Description	Unit
X1	Actual Position Value (input signal)	mm
X2	Actual Position Value (input signal)	mm
E	Error value	mm
C	Output of the controller	%
U	Output signal of the module	%

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

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.
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 and START are active, the READY LED is on, the STATUS LED is not on and a tracking error is not compensated.	The sychronization controller is in bypass to a flow divider. Synchronization is only possible durring the movement. This means that the error decreases continuously with a properly working system of the tracking error during the movement. As a result of an incorrect configuration or a faulty system design it can lead to larger position errors. • Selection of the cylinder stroke is correct? • Are the braking distances correct? For starting the system, the braking paths are to be set at about 20 – 25% of the cylinder stroke, the smaller the stopping distance is set, the more accurate the system will be. • 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 READY LED is on, and the system oscillates on the target.	Braking distance is too small or the correction valve is too large.(First adust the stopping distance should be increased.) The MIN parameter was set too high.