CEM-PA-B

Product Description:

This closed loop PID amplifier, drives a single solenoid proportional pressure or flow control valve coil up to 2.6A. It is suitable to provide precise closed loop control in pressure, force, or velocity systems. This module uses traditional PID error correction to provide stable control in dynamic systems.

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. Input command can be ramped. PID variables are adjustable over a wide range. The Amplifier is easily switched from open loop to closed loop control.

Min and Max output current are adjustable. Output characteristics can be independently customized. The module is disabled if the coil outputs are shorted or open. If command current signal is outside of the proper range, the module is disabled. PWM and Dither are user adjustable.

This module is easily adapted to a variety of system requirements. All variables are user adjusted with easy to use 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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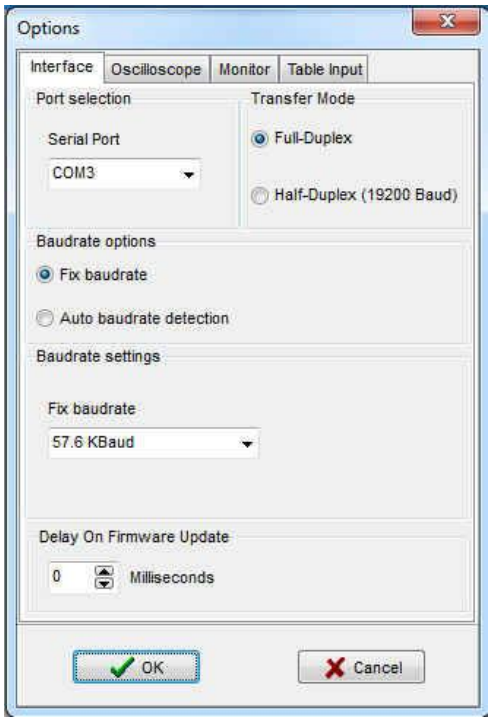
Technical data

Supply voltage	**[VDC]**	12… 30 (incl. ripple)
Current requirement	**[mA]**	60 + solenoid current
External protection	**[A]**	3 medium time lag
Reference voltage	**[V]**	8 (max. 25 mA load)
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:		
Command value	**[V]**	0… 10; 150 kOhm
	[mA]	4… 20; 390 Ohm
Signal resolution	**[%]**	0.006 incl. Oversampling
Sensor value	**[V]**	0… 10; 90 kOhm
	[mA]	4… 20; 390 Ohm
Signal resolution	**[%]**	0.006 incl. Oversampling
PWM output	**[A]**	0.5, to 2.6 Amp; broken wire and short circuit monitored
PWM frequency	**[Hz]**	61… 2604
Sample time (pressure control)	**[ms]**	1
Sample time (solenoid current control)	**[ms]**	0.125
Serial interface		USB type B Virtual COM port driver (CHI-PC): 9600… 57600 Baud (Default = 57600), 1 Stop bit, No parity, No handshake
Housing		Snap-on module to EN 50022 PA 6.6 polyamide Flammability class V0 (UL94)
Weight	**[kg]**	0,190
Protection class		IP20
Temperature range	**[°C]**	-20… 60
Storage temperature	**[°C]**	-20… 70
Humidity	**[%]**	< 95 (non-condensing)
Connections		USB Typ 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

Steps to install and configure a new application:

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

1. Mount the module in suitable location. See page 5.
2. Connect the power supply, valve connections and enable.
3. Download 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. Select com port in upper left hand corner of the GUI program.
6. Open the Options Tab and verify that the correct com port, full Duplex and 57.6K Baud rates are selected.



7. Connect with the CEM by selecting the connect button.
8. Click on the ID Button.
9. Adjust **CURRENT** parameter to match the nominal solenoid current.
10. Adjust dither amplitude, **DAMPL**, and dither frequency, **DFREQ**, to optimize performance of valve.
11. Set the SIGNAL type to voltage (0-10V) or current (4-20ma). See ANIMODE if the signals are other than standard. Some scaling may be required.
12. Set the **MIN, MAX,** and **TRIGGER,** for the desired system output.
13. Adjust the **SYS_RANGE** to the pressure output of the valve at rated current. For example, the Continental model VER03M-210-A-K1-24D is rated for 210 bar. Set the SYS_RANGE X to 210. The units on this parameter is bar.

14. Set the **N_RANGE:X** to the maximum pressure rating of the pressure sensor. For a 0-210 bar pressure transducer, set **N_RANGE:X** to 210 bar. This setting should be the same or greater than the **SYS_RANGE** value.
15. Use the **OFFSET:X** to compensate for the pressure transducer reading at actual 0bar pressure.
16. Adjust **RAMP** as required.
17. Set internal monitor function, **SENS**, as required.
18. Adjust PID error correction parameters, **(C:P, C:I, C:D, C:D_TI, C:FF),** to tune the system performance.

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

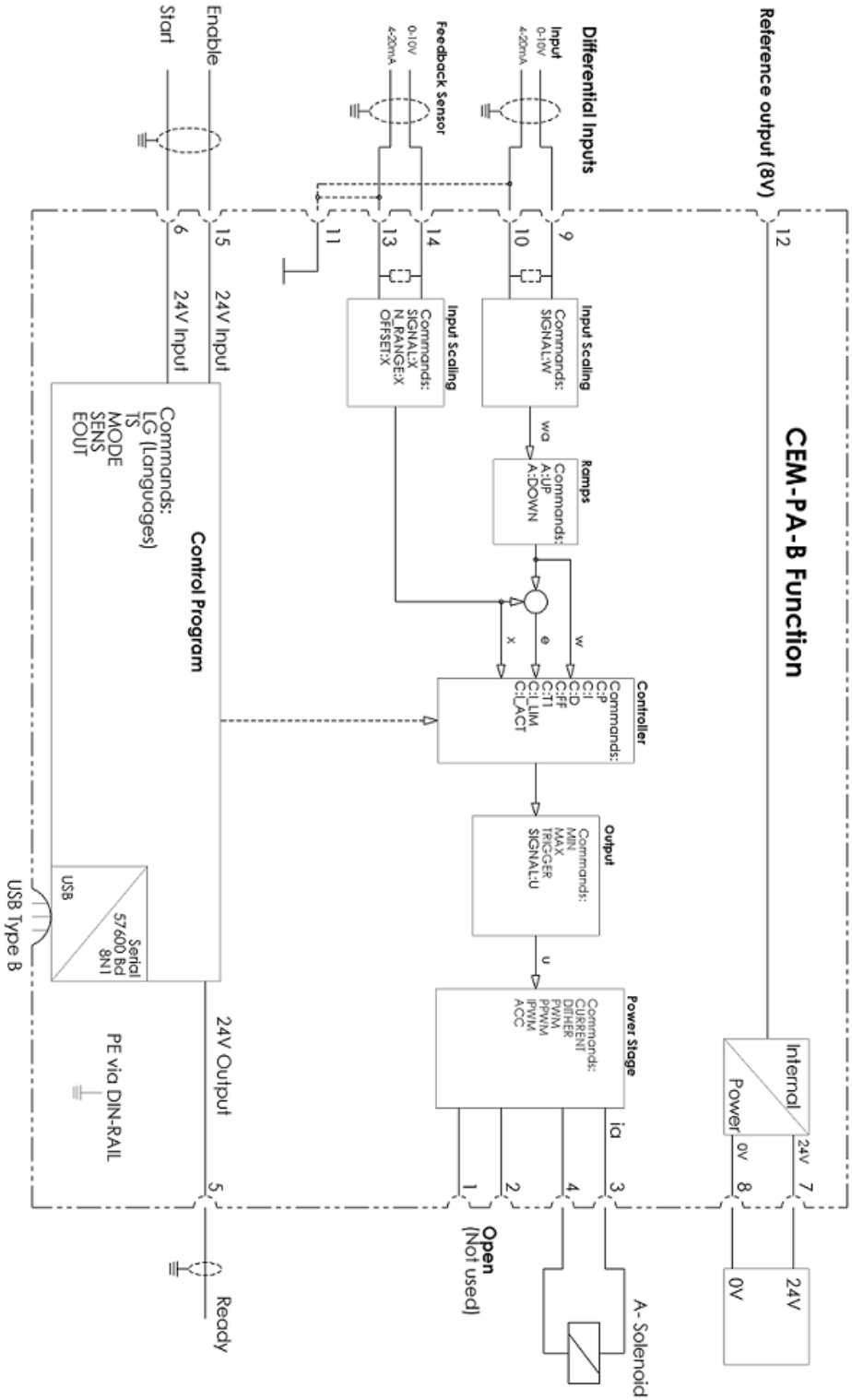
Wiring to Valve:

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

All analog input signal cables must be shielded!
Good analog system design requires that all analog signals in an electrically noisy environment be shielded. Long wires act like antennas that pick up analog noise. The wire connecting the analog command source to command this module must be shielded! Shielding a noise sensitive wire is accomplished by wrapping a noise blocking foil or braided shield around the signal wire. This shield must be grounded at only one end, usually the end that sends the signal. A control cable may have many individual conductors. The conductors may be shielded individually, or may be shielded as a group. Short signal wires in electrically quiet environments may not need to be shielded. The CEM family of modules all have an internal ground connection to the DIN rail. For this module ground to be effective, please insure the DIN rail is properly grounded.

Circuit Diagram



LED Definitions

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	Intensity of the solenoid current
GREEN + YELLOW A	1. **Chasing light (over all LEDs):** The bootloader is active. No normal functions are possible. 2. **All LEDs flash shortly every 6 s:** An internal data error was detected and corrected automatically! The module still works regularly. To acknowledge the error the module has to be cycle powered.
YELLOW A + YELLOW B	**Both yellow LEDs flash oppositely every 1 s:** The nonvolatile stored parameters are inconsistent! To acknowledge the error, data has to be saved with the SAVE command or the corresponding button in the CHI-PC.

Terminal Identification - Input and output signals

Connection	Supply
PIN 7	Power supply (see technical data)
PIN 8	0 V (GND) connection.
Connection	**Analogue signals**
PIN 9 / 10	Pressure command value (WA), signal range 0… 10 V or 4… 20 mA, scalable (SIGNAL W)
PIN 13 /14	Pressure feedback value (X), signal range 0… 10 V or 4… 20 mA, scalable (SIGNAL X)
PIN 11	0 V (GND) connection for analogue signals
PIN 12	8V reference voltage output
PIN 3 / 4	PWM output to the solenoid
Connection	**Digital inputs and outputs**
PIN 15	**Enable input:** Generally enabling of the application.
PIN 6	**RUN (Start) Input**: **ON:** The controller is active. **OFF:** The controller is not active.
PIN 5	**READY output:** **ON:** The module is enabled; there are no discernable errors. **OFF:** ENABLE (PIN 15) is not active or an error has been detected.

CEM-PA-B Function Parameter layout

Ref Page	Command	Parameter	Help / Description	MODE STD	MODE EXP
9	**LG**	EN	EN English	X	X
9	**MODE**	EXP	Standard / Expert mode	X	X
9	**SENS**	AUTO	Malfunction monitoring [ON / OFF /AUTO]	X	X
10	**EOUT**	0	Output signal if not ready [0.01%]		X
10	**SYS_RANGE**	100	System pressure [bar]	X	X
10	**SIGNAL:X**	U0-10	Type of Input	X	X
13	**N_RANGE:X**	100	Sensor nominal pressure [bar]	X	X
13	**OFFSET:X**	0	Sensor offset [mbar]	X	X
10	**SIGNAL:W**	U0-10	Type of Input	X	X
14	**RA:UP**	100	Command signal ramp time [ms]	X	X
14	**RA:DOWN**	100	Command signal ramp time [ms]	X	X
15	**C:P**	50	P gain [x 0.01]	x	X
15	**C:I**	4000	I gain [0.01ms]	X	X
15	**C:D**	0	D gain [0.1ms]	X	X
15	**C:D_T1**	500	D gain filter [0.1ms]	x	X
15	**C:FF**	8000	Feed forward [0.01%]	X	X
16	**C:I_LIM**	2500	Integrator limitation [0.01%]	X	X
16	**C:I_ACT**	2500	Integrator activation threshold [0.01%]	X	X
17	**MIN**	0	Deadband compensation [0.01%]	X	X
17	**MAX**	10000	Output Scaling [0.01%]	X	X
17	**TRIGGER**	200	Trigger point of the MIN function in 0.01%	X	X
18	**SIGNAL:U**	+	Output polarity	X	X
18	**CURRENT**	1000	Rated solenoid current [mA]	X	X
18	**DFREQ**	121	Dither frequency [Hz]	X	X
18	**DAMPL**	500	Dither amplitude [0.01%]	X	X
19	**PWM**	2604	PWM frequency [Hz]	X	X
19	**ACC**	ON	Auto Adjustment of the current loop [OFF / ON]		X
20	**PPWM**	7	P-Gain of the current loop		X
20	**IPWM**	40	I-Gain of the current loop		X

Command 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 help texts.
After changing the language settings, the ID button in the menu bar (CHI-PC) must be pressed (module identification).

MODE (Parameter view)

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 (Malfunction monitor)

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.

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.

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 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 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. 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.

SYS_RANGE (System pressure)

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

This command defines the maximum pressure of the selected valve at rated current applied, which corresponds to 100 % of the input signal. If the demand is set incorrectly, this leads to incorrect system settings, and the dependent parameters cannot be calculated correctly.

SIGNAL (Type of input signal)

Command	Parameters	Unit	Group
SIGNAL:I X	i= W|X x= OFF|U0-10|I4-20	-	**EASY**

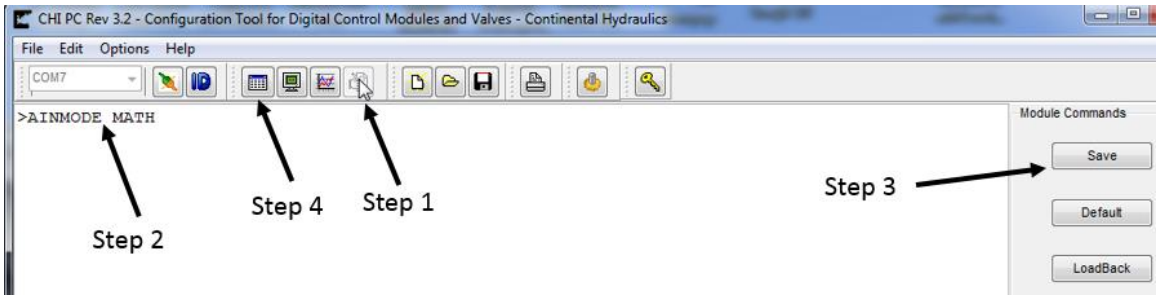
This command can be used to change the type of input signal (voltages or current) and to define the direction of the signal. This command is available for all analogue inputs (W and X).
OFF= Deactivation of the input

See **ANIMODE** section if the signals used are not listed above, for re-scaling as required.

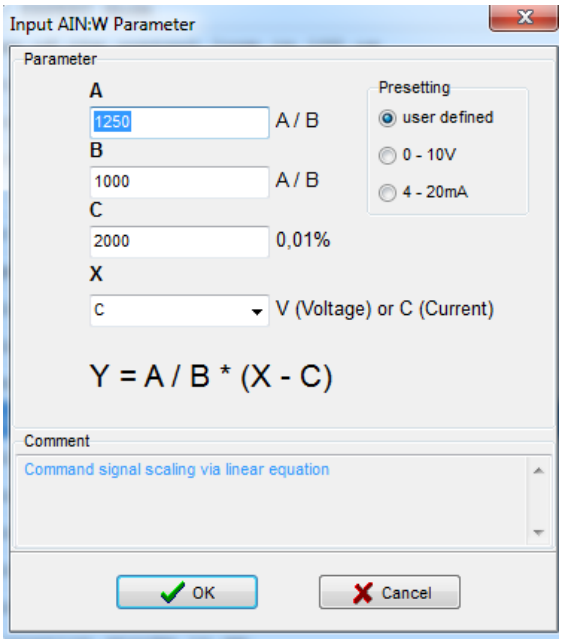
AINMODE

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 **(ENTER),** 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.



AINMODE - 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 %.

N_RANGE:X (Sensor nominal pressure)

Command	Parameter	Unit	Group
N_RANGE:X X	x= 10… 10000	bar	**EASY**

N_RANGE (nominal range) is used to define the pressure range of the sensor. This value should be always same as or 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= -60000… 60000	mbar	**EASY**

Adjustment of the zero point of the sensor. If the command signal and feedback signals are not zeroed to each other this offset should be used.

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

Example of use:
With these commands, the feedback sensor is scaled. Suppose you have a pressure control with the following characteristics:

- The system pressure is 350 bar
- The pressure sensor has a 4-20mA current output
- The nominal pressure of the sensor is 600bar (20mA at 600bar)
- The sensor has an offset of 3bar (at 0bar real pressure 3bar is displayed)

To scale this sensor correctly the following settings should be made:

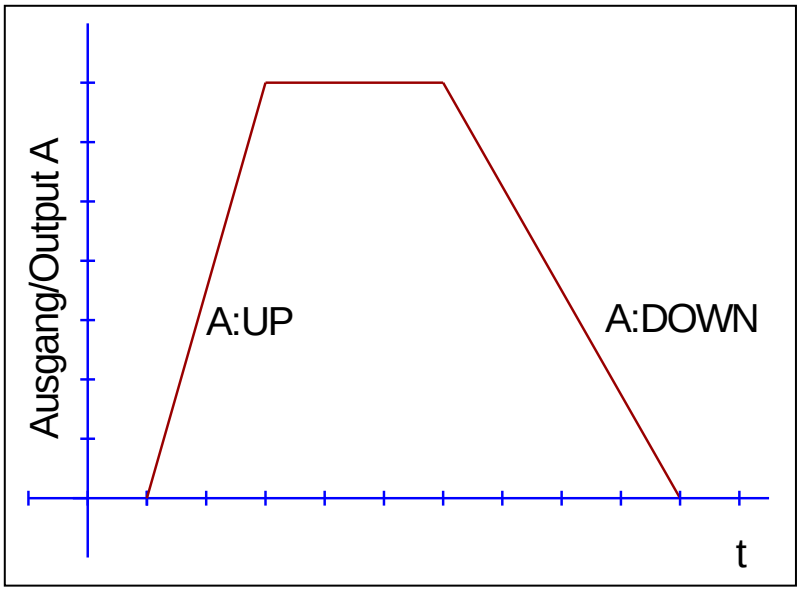
- SYS_RANGE 350 bar
- SIGNAL:X I4-20
- N_RANGE:X 600 bar
- OFFSET:X -3000 mbar

RA (Command signal ramp time)

Command	Parameter	Unit	Group
RA:I X	i= UP|DOWN x= 1… 600000	ms	**STD**

Two quadrant ramp function.

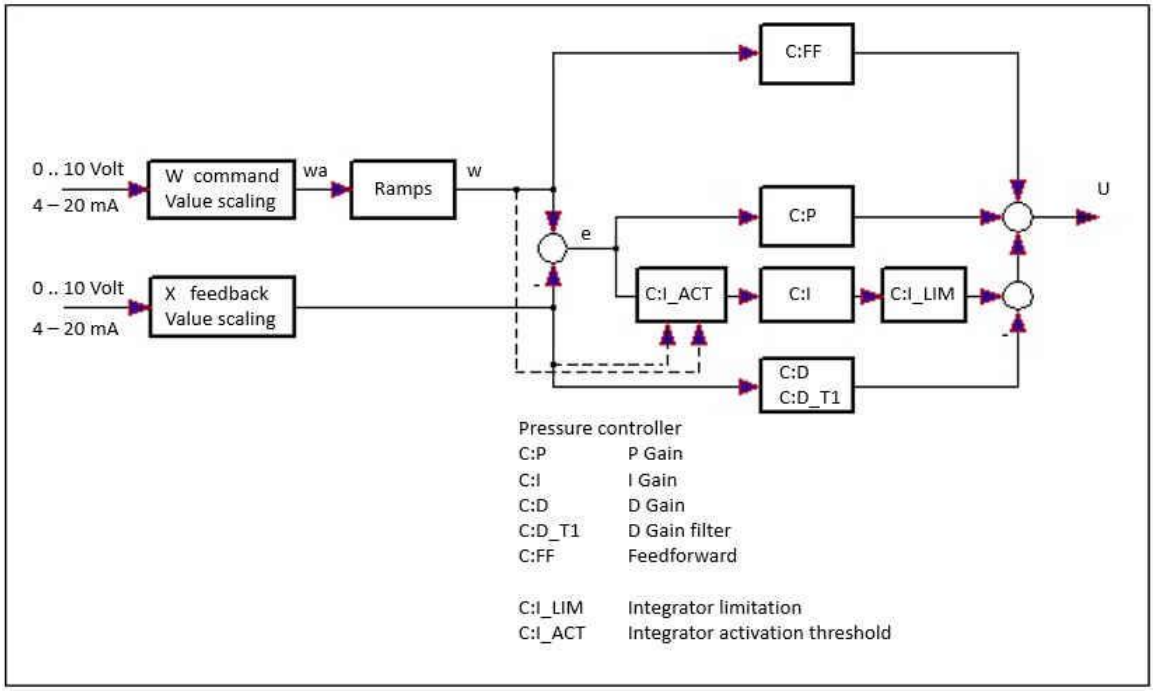
The ramp time is separately set for UP and DOWN ramps.



C:P, C:I, C:D C:D_TI, C:FF Control parameters (PID controller)

Command	Parameter	Unit	Group
C:I X	I= P|I|D|D_T1|FF		**STD**
	:P x= 0… 10000	0.01	
	:I x= 0… 30000	0.1 ms	
	:D x= 0… 1200	0.1 ms	
	:D_T1 x= 0… 1000	0.1 ms	
	:FF x= 0… 10000	0.01 %	

The control function will be parameterized via this command.
The C:P, I and D gain are similar to a standard PID controller.
The T1 factor is used for the D-gain in order to suppress high-frequency noise.
The FF value is a forward control value to control the output by the input signal directly.
The PID closed loop control function has only to adjust the difference (the error).
Value 0 deactivates the integrator.



C:I_LIM, C:I_ACT Integrator control function

Command	Parameter	Unit	Group
C:I_LIM X	x= 0… 10000	0.01 %	**STD**
C:I_ACT X	x= 0… 10000	0.01 %	

The integrator function is controlled by this command.

C:I_LIM Limitation of the integrator range (faster control function by reduced pressure overshoots). By a high nonlinearity of the valve the LIM value must be sufficient to compensate it.

C: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:

MIN (Deadband compensation)

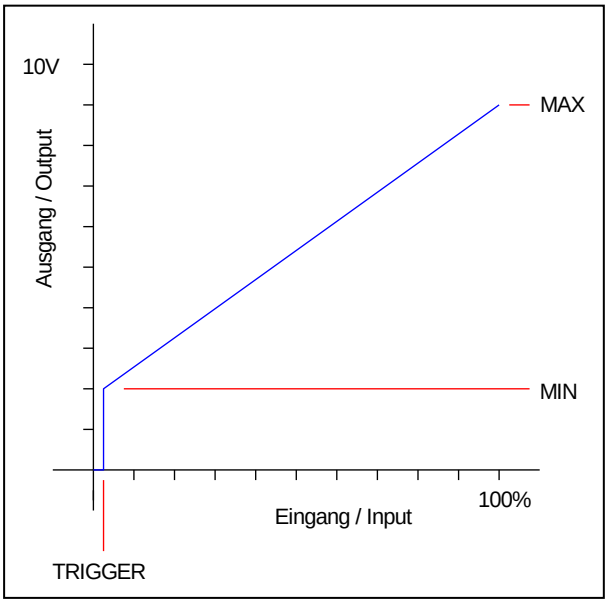
MAX (Output scaling)

TRIGGER (Response threshold for the MIN parameter)

Command	Parameters	Unit	Group
MIN:I X	x= 0… 6000	0.01 %	**STD**
MAX:I X	x= 3000… 10000	0.01 %	
TRIGGER X	x= 0… 3000	0,01 %	

With this command, the output signal is adjusted to the valve characteristics. With the MAX value the output signal (the maximum valve current) will be defined. With the MIN value the overlap (dead band of the valve) will be compensated. Via the TRIGGER the activation point of the MIN function is set and so a non-sensitive range around the zero-point[1] can be specified.

If the MIN value is set too high, it influences the minimal pressure, which cannot be adjusted any longer. In extreme case this causes to an oscillating at small input values.



[1] This dead band is necessary, in order to avoid unrequested activations caused by small variations of the input signal. If this module is used in pressure controls, the TRIGGER value should be reduced (typical: 1…10).

SIGNAL:U (Output polarity)

Command	Parameter	Unit	Group
SIGNAL:U X	x= + | -	-	**EXP**

This command is used to define the output polarity.
+ 0 % to 100 %, normal output
- 100 % to 0 %, changed output polarity

CURRENT (Rated solenoid current)

Command	Parameters	Unit	Group
CURRENT X	x= 500… 2600	mA	**STD**

The nominal output current is set. Dither and also MIN/MAX always refer to this current range.

DFREQ (Dither frequency) / DAMPL (Dither amplitude)

Command	Parameters	Unit	Group
DFREQ X	x= 60… 400	Hz	**STD**
DAMPL X	x= 0… 3000	0.01 %	

The dither[2] can be defined with this commands. Different amplitudes or frequencies may be required depending on the valve.
The dither amplitude is defined in % (peak to peak value) of the nominal output current[3] (see: CURRENT command).
The dither frequency is defined in Hz. Depending on the internal calculations, the frequency is adjustable in steps only[4].

The PPWM and IPWM parameters influence the effect of the dither setting. These parameters should not be altered again after the dither has been optimized.

[2] The dither is a ripple signal which is superimposed on the current set point and is defined by the amplitude and frequency: the dither frequency and the PWM frequency. The dither frequency should not be confused with the PWM frequency. In some documentations the PWM frequency is described as a dither. This can be recognized by the lack of the dither amplitude.

[3] The dither amplitude is a command signal. Derivations between the commanded amplitude and the real amplitude are possible, depending on the dynamic of the solenoid.

[4] The lower the dither frequency, the smaller the steps. Therefore no practical problems are expected.

PWM (PWM Frequency)

Command	Parameter	Unit	Group
PWM X	x= 61… 2604	Hz	**EXP**

The frequency can be changed in defined steps (61 Hz, 72 Hz, 85 Hz, 100 Hz, 120 Hz, 150 Hz, 200 Hz, 269 Hz, 372 Hz, 488 Hz, 624 Hz, 781 Hz, 976 Hz, 1201 Hz, 1420 Hz, 1562 Hz, 1736 Hz, 1953 Hz, 2232 Hz and 2604 Hz). The optimum frequency depends on the valve.

If the PWM frequency is less than 500 Hz, the dither amplitude DAMPL should be set to zero.

The PPWM and IPWM parameters should be adapted when using low PWM frequencies because of the longer dead times which forces a reduced stability of the closed loop control.

ACC (Current loop auto adjustment)

Command	Parameter	Unit	Group
ACC X	x= ON|OFF	-	**EXP**

Operation mode of the closed loop current control.
ON: In automatic mode PPWM and IPWM are calculated depending on the pre-set PWM-frequency.
OFF: Manual adjustment.

PPWM (P gain of the current loop)

IPWM (I gain of the current loop)

Command	Parameters	Unit	Group
PPWM X	x= 0… 30	-	**EXP**
IPWM X	x= 1… 100	-	

The PI current controller for the solenoids is parameterized with these commands.

These parameters should not be changed without adequate measurement facilities and experience.

Attention, if the parameter ACC is set to ON, these adjustments are done automatically.

If the PWM frequency is < 250 Hz, the dynamic of the current controller has to be decreased.
Typical values are: PPWM = 1… 3 and IPWM = 40… 80.

If the PWM frequency is > 1000 Hz, the default values of PPWM = 7 and IPWM = 40 should be chosen.

PROCESS DATA (Monitoring)

Command	Description	Unit
WA	Input signal	mm
W	Command value	mm
X	Feedback value	mm
E	Control error	mm
U	Output	%
IA	Solenoid current[5]	mA

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

[5] The display of the solenoid current (in CHI-PC program) is damped in order to be able to bring out a stable signal.

Failure monitoring

Following possible error sources are monitored continuously when SENS = ON/AUTO:

Source	Fault	Characteristic
Command signal PIN 9/10 4... 20 mA	Out of range or broken wire	The output will be switched off.
Feedback signal PIN 14 4… 20 mA	Out of range or broken wire	The output will be switched off.
Solenoids on PIN 3-4	Wrong cabling, broken wire	The power stage will be deactivated.
EEPROM (when switching on)	Data error	The output is deactivated. The module can only be activated by saving the parameters again!

CAUTION: Take care of the EOUT command. Changes will influence the behavior.

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 no ENABLE signal (PIN 15) present. Other faults are signalized with a flashing READY LED.
ENABLE is active, the READY LED is flashing.	The flashing READY LED signals that a fault is detected by the module. The fault could be: • A cable breakdown or no signal at the inputs (PIN 9 or PIN 14) if 4… 20 mA signals are parameterized. • A cable breakdown or incorrect cabling to the solenoids (in the P version only). • Internal data error: press the 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 active; no current to the solenoid (no pressure-build-up).	To locate errors in the pressure-control-circuit, it is useful to start with the open loop pressure control (PIN 6 is not activated). In this case the module works like a power amplifier. • No pressure command input is available or the parameterization is incorrect. With the CHI-PC tool you can check if a command input is available. If not, you should check the wiring and/or the command set-point (in the PLC for example). • If the command input is correct, you have to check the valve control parameter. If the current is set too low (parameter CURRENT), the output current and the expected pressure are too low. • Wrong configured pressure sensor (if PIN 6 is active). If the input-scaling is set to voltage (V) and the pressure sensor supplies a current signal (4... 20mA), the measured pressure value is always high. The output signal to the valve is therefore low. For further checking: disable PIN 6. • The pressure valve is controlled correctly (the output is going up to the nominal current). In this case you may have a hydraulic problem or you are using free-wheeling-diodes in the solenoid plug. Please remove the free-wheeling-diodes to allow a correct current measurement.

FAULT	CAUSE / SOLUTION
ENABLE is active, the READY LED is active and the pressure is instable.	In many cases you may have a hydraulic problem. Electrical problems may be: • Electrical noise at the wire of the power supply. • Very long solenoid wiring (> 40 m), disturbance in the current control loop[6]. • Unstable current control loop. The adjustments of the PWM-frequency and the dither (frequency and amplitude) have to be checked carefully. Good experiences are made with: a. PWM-frequency = 2600 Hz (higher frequency), the dither has to be aligned to the valve (amplitude and frequency). b. PWM-frequency = 100… 400 Hz (lower frequency), the dither amplitude is set to 0 % (disabled)[7].
ENABLE and START (PIN 6) are active, READY LED is ON, the pressure control works, but the pressure is not equal to the command input.	The system works generally, but wrong control loop settings or wrong adjustment of the input signals cause control errors. 1. The feedback pressure is proportional to the command input pressure, but the values are too high or too low. The scaling of the pressure valve is affected by the adjustment of the output current and the parameter **MAX**. The valve has a nominal range of 320 bar and the working pressure range is 240 bar, the parameter MAX has to be decreased. Procedure: Deactivate PIN 6, set the command input to 100 % and adjust the correct pressure by reducing the **MAX** parameter.

[6] Maybe you have to adjust / optimize the solenoid control loop (P and I).

[7] In most applications (particularly pressure-actuated pumps) with pressure valves a lower PWM-frequency is the better solution.

FAULT	CAUSE / SOLUTION
ENABLE and START (PIN 6) are active, the READY LED is active, the pressure control loop works, but the pressure is oscillating or the pressure UP and DOWN time is too slow.	The capability of the hydraulic system has to be checked. Deactivate PIN 6 for open loop control and check the pressure build up and down time. If the system is in open loop still unstable, check the hydraulic and the dither/ PWM setup first. 1. Check the parameters C:I, C:P and C:SC.The parameter C:SC has the following relevance: With this parameter you can increase or decrease the feed forward gain to the valve. C:SC 8000 (80 %) means, the remaining 20 % must be provided by the PID compensator. The integrator limitation should be set to 2500... 3500 (25 % ... 35 %)[8]. 2. The C:P (P-gain) is to increase in steps[9] to the point where the pressure is going to be unstable. At this point, C:P should be decreased for 30… 50 % to get an effectual stability margin. 3. The integrator time constant C:I fixes the static error. Typical values are: 100 ms to 1200 ms. Optimize this parameter by monitoring the transient response.
ENABLE and START (PIN6) are active, the READY LED is active, and the pressure control loop works, but there are high errors mainly at lower or higher command pressure.	The non-linearity of the valve is higher than the controlling range of the integrator. The parameter LIM:I should be increased.
ENABLE and START (PIN 6) are active, the READY LED is active, and the pressure control loop works. Lower pressure at the beginning causes that the system is not actuated and that no pressure build-up occurs.	In this case, the integrator threshold (activation point of the integrator) in combination with the controller setting is too high. The parameter LIM: S should be reduced.

[8] The limit value should be higher than the remaining control range (100 % - C:SC), additionally you have to add a value to compensate the non-linearity of the valve.

[9] Optimizing in steps is a general description. Our experience: you can change the parameters in steps from +20 % or rather -20 % for a rough adjustment of the actual value. For a fine adjustment you can select smaller steps.