Digitaler Reglerverstärker ER9.3-10
zur elektrohydraulischen Pumpenreglung
der EATON Axialkolbenpumpen
X und W Design

Digital Amplifier And Controller ER9.3-10
For Displacement Control of EATON Variable
Piston Pumps in X and W Design

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Features

The digital amplifier and controller card ER9.3-10 is used for displacement control SP of EATON variable piston pumps in X and W design. The swash plate is positioned by a Vickers Proportional Valve KDG4V-3. The digital amplifier and controller card meet the industrial standard for EMC EMV 89/336/EEC, which ensures a high interference security and low interference emission. The electronic card is tested according to DIN EN 60068-2-6 (vibration) and DIN EN 60068-2-27 (mechanical shock). The electronic card features a display and six buttons to change the card parameters. Parameterisation of the digital amplifier and controller card is also possible by using the enclosed software tool ***ER9.3-Tool*** via a serial RS232 interface.
The system features are:

- Differential amplifier input for set points in the range of 0 … ± 10V, 14 bit resolution.
- Additional single ended, independent set point inputs, (one for the range of 0 … ± 10V, 14 bit resolution; the other for the range of 0 ... 20 mA / 4 ... 20 mA , 14 bit resolution).
- Integrated reference supply voltage of ± 10 V (10 mA max.), to supply set point potentiometer or actual value transducer.
- Four storable and adjustable digital set points (one additional point is optional)
- Two, independent, analog set point inputs with 14 bit resolution and a high adjustment range (depending on input 0 ... 12 V or 0 ... 20 mA / 4 ... 20 mA).
- Direction externally set through “+“ and “-“ inputs.
- Enable signal for output stages.
- Ramp function and Reset-Ramp for fast ramp function zeroing.
- Status outputs: Error and Comparator
- All digital inputs and outputs are optically isolated for functional security.
- Four 7-segment displays and six buttons for display and functionality ease.
- Function indication through front panel by LEDs.
- Additional switching output (24 V, max 1A) to directly disable safety valve.
- Additional front panel test jacks for easy commissioning.
- Serial interface RS232.

Function

Fig. 1 shows an EATON swash plate pump in W design with proportional valve adjustment displacement control SP. The ER9.3-10 card measures the actual position of the swash plate using a swash plate sensor, compares the swash plate angle with the set value, and drives a Vickers proportional valve (KDG4V-3). The valve ports are connected to the servo cylinder of the pump. The position of the swash plate angle, the displacement and the pump outlet flow are proportionally changed to the set value. In the static state condition (i.e. set value is equal to actual swash plate angle) the valve spool is in middle position. If the set value is changing, the valve is working until the desired value is reached.

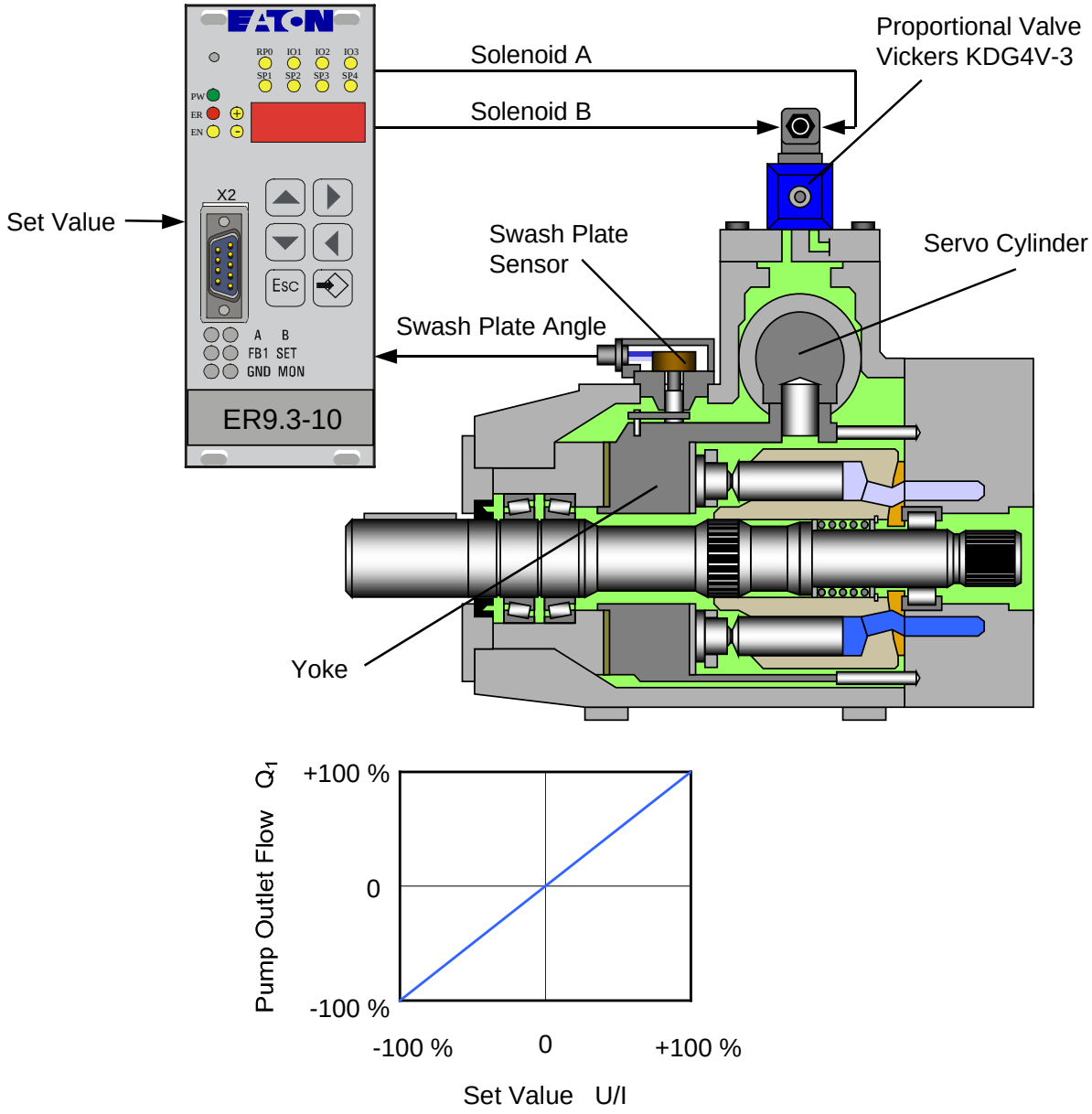


Fig. 1: Function of SP-Control

Technical Data

Parameters	**Range, characteristics**
Supply voltage	DC 18 ... 30 V, residual ripple < 10%
Solenoid systems selection	0.8 A / 1.1A / 1.3 A / **1.6 A** / 2.4 A / 2.7 A / 3.5 A
Power input	Max. 50 VA
Applicable fuse (quick)	3.15 A
Auxiliary voltage	± 10 V, max. load 10 mA.
Control voltage for external recallable set point	24 V ±10%, residual ripple ≤ 10% current input ≤ 20mA each
Ambient temperature	0 °C ... 50 °C(other range on request)
Storage temperature	- 20 °C ... 60 ° C
Plug connection	DIN 41 612, 48 pol. form F gold plated
EMC	
Protection	Burst on wires as per EN 61000-4-4 HF-Field as per EN 61000-4-3 ESD as per EN 61000-4-2
Emissions	Emissions depending on power as per EN 50011 Radiated emissions as per EN 55011
Additional Certifications	
Vibration	All directions as per DIN EN 60068-2-6
Shock	All directions as per DIN EN 60068-2-27
Dimensions	
Front panel/ PCB	50,5 x 128,4 mm; 10 TE / 3 HE / 100 x 160 mm Euro format
Input signals	
Analogue set values	1 input, differential 14 Bit resolution, 0 ... ± 10 V 1 input, single ended 14 Bit resolution, 0...± 10 V 1 input, single ended 14 Bit resolution, 0 or 4...20 mA
Analogue feedback (sensor input)	1 input, 14 Bit resolution, 0... ± 12 V, 0...20 mA / 4...20 mA, Offset: 3..10 V, Gain: ca. 0 ...14 (R=100 Ohm) 1 input, 14 Bit resolution, 0... ± 10 V
Digital inputs	8 inputs, voltage level 0 V / 24 V 10 mA (Set point S1.01 ... S1.04, ENABLE, RAMP 0 , SIGN + , SIGN -)

Parameters	Range, characteristics
Output signals	
Solenoid current	2 output stages for up to 3.5 A; with over-energization and quick de-energization
Analog output	1 output, 12 Bit resolution, 0 .. ± 10 V for controlling subsequent electronics
Monitor output	1 output, 12 Bit resolution, 0 ... ± 10 V; for monitoring internal values
Digital outputs	2 outputs, voltage level 0 V / 24 V, 10 mA (Error, Comparator)
Test jacks	Solenoid current, sensor 1, set value, monitor and GND
Auxiliary voltage	± 10 V, max. load 10 mA
Interface	RS232 with 9-pol Sub-D connector on front panel and a second connector is available on the back
Display and operation	4 digit display, 6 buttons (up, down, left, right, enter and Esc) Status-LED's: PW (Power), ER (Error), EN (Enable), SP1 ...SP4 (S1.01 ... S1.04), RP0 (Ramp = 0),
Frequencies and cycle times	
PWM Frequency	18 kHz
Cycle times	Current controller ca. 0,22 msec Inner closed loop controller ca. 0,22 msec (for valve feedback) External closed loop controller 2 ca. 0,44 msec

Table 1: Parameters of digital controller card ER9.3-10

Pin Assignment on Back Connector X1

Table 2 shows the pin assignment on the 48 pin connector of card holder **HC000000315303**. Values in brackets {} have no function in proportional valve adjustment displacement control mode (SP). The wiring scheme, necessary for SP-Control is shown in **Fig. 7**. Additional wiring, e.g. to use monitoring function, can be done optional by customer.

Pin	d	b	z
2	0 V (External)	DIO 1 (S1.08 if activated)	- Sign (direction) digital set values
4	Digital set value 2 (S1.02)	{DIO 2 / Channel-B}	+ Sign (direction) digital set values
6	Digital set value 3 (S1.03)	{DIO 3 / 0-Pulse}	Digital set value 4 (S1.04)
8	ENABLE (DI 1)	Reserved	Digital set value 1 (S1.01)
10	Sensor 1 (FB 1) U_E, I_E	Analog output	{RxD (RS232)}
12	Analog set value 6 U_{E+} (S1.06)	{TxD RS232}	Analog set value 5 U_{E+} (S1.05)
14	ERROR (DO 1)	COMPARATOR (DO 2)	{Sensor 2 (FB 2) U_E}
16	Analog set value 6 U_{E-} (S1.06)	{reserved}	Analog set value 7 I_E (S1.07)
18	Digital GND	PE	Ramp = 0 (DI 2)
20	Reference output - 10.0 V	Break output 24 V / 1 A	Reference output + 10.0V
22	Solenoid output A -	Solenoid output A -	Solenoid output A -
24	Solenoid output B -	Solenoid output B -	Solenoid output B -
26	0 V (Power)	0 V (Power)	Analog GND
28	Solenoid output A +	Solenoid output A +	Solenoid output A +
30	Solenoid output B +	Solenoid output B +	Solenoid output B +
32	+ 24 V (Power)	+ 24 V (Power)	24 V (External)

Table 2: Pin Assignment 48 pin connector

Display and Keypad

ATTENTION

The electrical wiring must be checked before switching on the supply voltage. Limit switches and safety devices must be activated to avoid uncontrolled movements. Carefully follow relevant safety regulations. Suitable emergency stop measures must be taken.

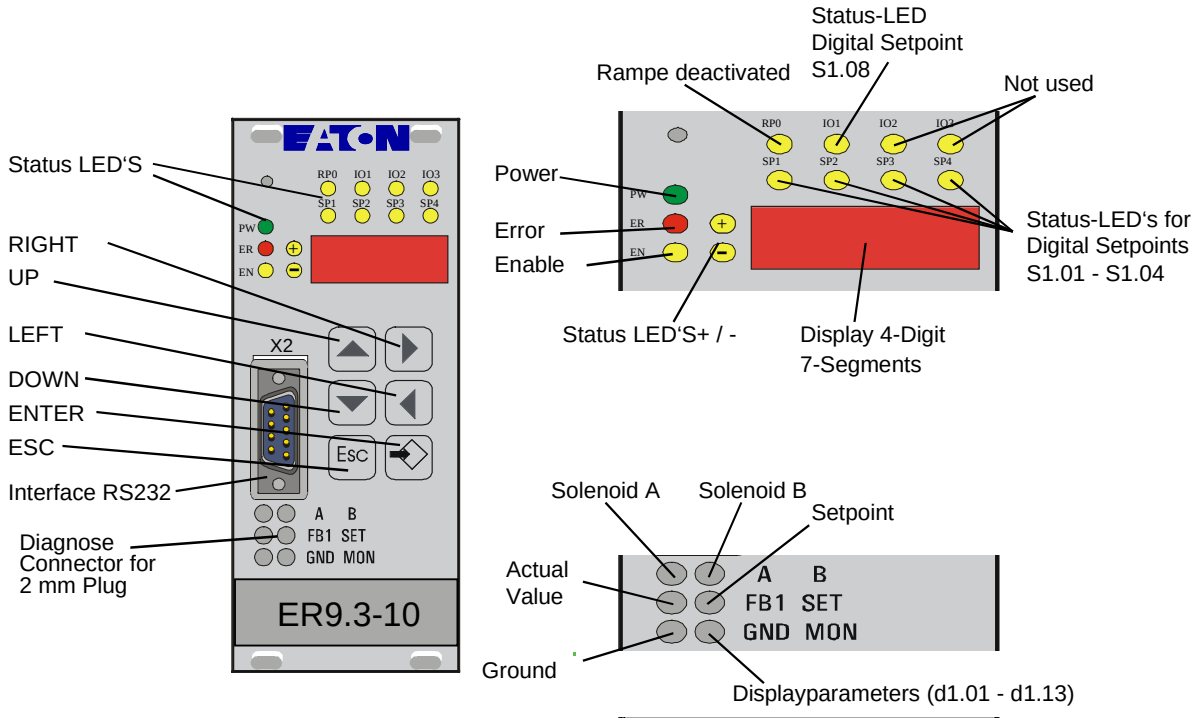


Fig. 2: Display and keypad

Fig. 2 shows the front face of the ER9.3-10 card. The function of these elements is described in **Table 3**. The sockets "A" and "B" can be used to measure the solenoid currents independently. The voltage is approximately 1V at 1A. The analogue set point "S1.06" can be measured at the socket "SET". The representation is 1:2 proportional to the measured value (half the set point voltage). At the socket "FB1" the actual analog feedback value (d10) can be measured. The reading is proportional to the actual value and has the relation of 1:2.

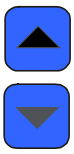
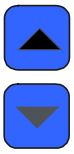
Element	Function
Status LED's	display the status and signals Power, Error, Ramp zeroing and digital I/O
± LED's	display the set point direction through polarity signs for parameters and measured values
Display	4-digit display of parameters and measured values
Buttons UP, DOWN, LEFT, RIGHT, ESC and ENTER	all operating, programming and saving may be performed with the buttons UP, DOWN, LEFT, RIGHT, ESC and ENTER
Serial interface	RS232 - programming and accessing parameters via PC, communications to machine, or from amplifier to amplifier
Measuring and test jacks	Direct measurement of set point (SET), actual value (FB1), solenoid currents (A and B) and internal values via the monitor output. (d1.01 ... d2.13) (Use 2 mm sockets)

Table 3: Function of display components

Setting of Parameters

The digital controller and amplifier ER9.3-10 has a display and keypad to change the card parameters. Additionally, it is possible to change the card parameters using the enclosed ***ER9.3-Tool*** with a PC via the RS232 serial interface on the front.

Setting of Parameters Using the Keypad

Step	Action	Result
1	Select parameter with cursor keys 	Parameter number is displayed,e.g. S1.03 
2	Display current value of parameter with key "ENTER" 	Value e.g. 2.345 
3	Activate to alter content with key "ENTER" 	Last digit of current value starts flashing, e.g. 2.345 
4	Alter content with keys "UP" or "DOWN" 	Value is changed e.g. To 2.348 
5	Select higher digit if necessary with key "LEFT" 	New digit starts flashing e.g. 2.348 
6	Alter content with keys "UP" or "DOWN" 	Value is changed e.g. 2.738 
7	Store new value with "ENTER" or cancel with "ESC" 	Value is stored or canceled, parameter number is displayed, e.g. S1.03 

Recall Default Values of a Single Parameter

Step	Action	Result
1	Se ect parameter with cursor keys 	Parameter number is displayed e.g. S1.03 
2	Display curreent value of parameter with key "ENTER" 	Value, e.g. 2.345 
3	Activate to alter content with key "ENTER" 	Last digit of current value starts f ashing, e.g 2 345 
4	Press both keys "UP" and "DOWN" at the same timet to recall default value of parameter 	Value will be altered to default value, here e.g 0.000 
5	Store default value with "ENTER" or cancel with "ESC" 	Value is stored or canceled, parameter number is displayed, e.g. S1.03 

Recall Default Values of all Parameters

Step	Action	Result
1	Press all 4 cursor keys at the same time 	Recall code is displayed 
2	Recall function succesfully performed	Display VErS 
3	Press key "UP" to display parameter d1.01 	Display d1.01 

Setting Parameters Using RS232 Serial Interface and PC

Remote operation or remote parameter adjustment may be executed through the RS232 serial interface. The following transmission parameters are applicable:

Transmission rate: 19200 baud
Data format: 8 data-bits, 1 stop-bit, no parity
Terminal emulation: TTY
Voltage level: 12 V
The connection cable must meet the following requirements:

- Use a null modem cable
- The card connection is a 9-pole SUB-D female connector
- For the connection use a 3-poled cable
- Pins 1, 7 and 9 should be unassigned
- RxD is assigned to pin 2
- TxD is assigned to pin 3
- GND is assigned to pin 5
- The pins 4, 6 and 8 are internally shorted (null modem cable).

Table 4 Shows the pin assignments for the 9-pin socket on the front panel.

Pin	Signal
1	Reserved
2	RxD
3	TxD
4	Connected with Pin 6 and Pin 8
5	GND
6	Connected with Pin 4 and Pin 8
7	Reserved
8	Connected with Pin 4 and Pin 6
9	Reserved

Table 4: Pin connections

Wrong pin assignments will result in the following fault messages:

Display
- ---d there is an error at pin 1 (wrong data)
- ---c there is an error at pin 7 (time out)
- no display possible error at pin 9 (short circuit at GND).

The proper cable to connect the ER9.3 card and a PC is also available from Eaton Fluid Power GmbH, Germany (Order number: **HC000000316911**). The length of the cable is about 2.50 m. Parameter editing can be done using the enclosed ***ER9.3-Tool***. The tool allows editing, downloading, uploading and saving single parameters or parameter sets. The software tool includes a comprehensive online help.

Setting Values

The ER9.3 card offers the possibility to set three analog and 4 + 1 digital values. Fig. 3 shows the block structure and links between values.

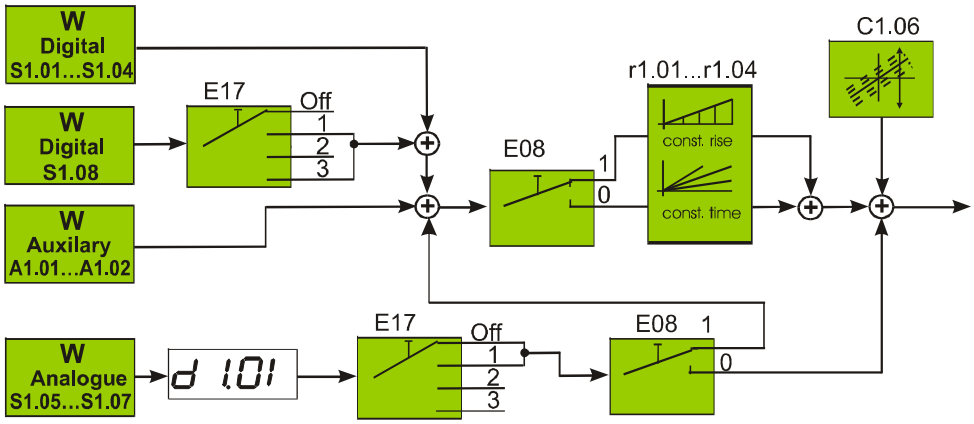


Fig. 3: Block diagram of Input Signals

Digital Set Values

Digital set points are programmable, and are activated by digital inputs. Four (optionally five) of these programmable set points can be selected with the respective input and an associated direction "+" or "-". Digital set points are assigned and saved in parameters S1.01, S1.02, S1.03, S1.04 and S1.08. The optional use of set point S1.08 is selected with parameter E17. The inputs are opto-decoupled and can be controlled directly from the PLC.
If both directions "+" and "-" are selected at the same time, none of the selected set points will be activated. If no direction is selected, no set point will be activated. All four (or five) digital set points are passed through the ramp function generator. All set points are additive and include no direction information themselves. If several set points are selected at the same time, the sum of these set points is subsequently processed. With binary combinations a total of 16 values can be selected. When parameter S1.08 is activated 32 different set points can be selected.

Analog Set Values

The set points S1.05 and S1.06 are designed for voltage signals 0 ... ± 10 V. The set point S1.07 is designed for a current signal 0 ... 20 mA (or 4 ... 20 mA), with a resistance of 250 Ω. By selecting the corresponding offset, the base current of 4 mA can be compensated. If E08 = 1, the set points are passed through the ramp function generator (ramp). If parameter E08 = 0, the analog set points bypass the ramp function. The set points S1.05, S1.06 and S1.07 are calculated according to their polarity with the other set points. The input S1.05 is measured against analog GND (terminal 26z) The input for S1.06 is designed as a differential input within the operating voltage range ± 15 V. The signals for set points S1.05 and S1.06 must be standardized to ± 10 V otherwise the A/D converter is overloaded.

ATTENTION!

To suppress interference unused analog set points must be bridged to analog GND or be deactivated with parameter E17.

The analog set points S1.05, S1.06 and S1.07 are not real parameters; they represent an external set.

Ramp Function

Digital set points are integrated according to the ramp function generator. For each change in direction the ramp time can be independently set from 0 to 39.5 sec (0.01 sec resolution).
The ramp characteristics are as follows:

r1.01 0 to negative values
r1.02 negative values to 0
r1.03 0 to positive values
r1.04 positive values to 0

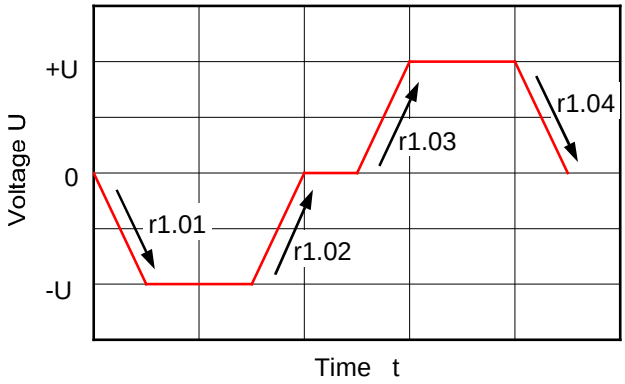


Fig. 4: Explanation of Ramp Parameters

E08 = 0 effects only digital set points, constant time base and linear
E08 = 1 effects all set points, constant rise rate and linear
E08 = 2 not used

The ramp function generator can be immediately set to 0 with a “high” signal at the terminal 18 z.

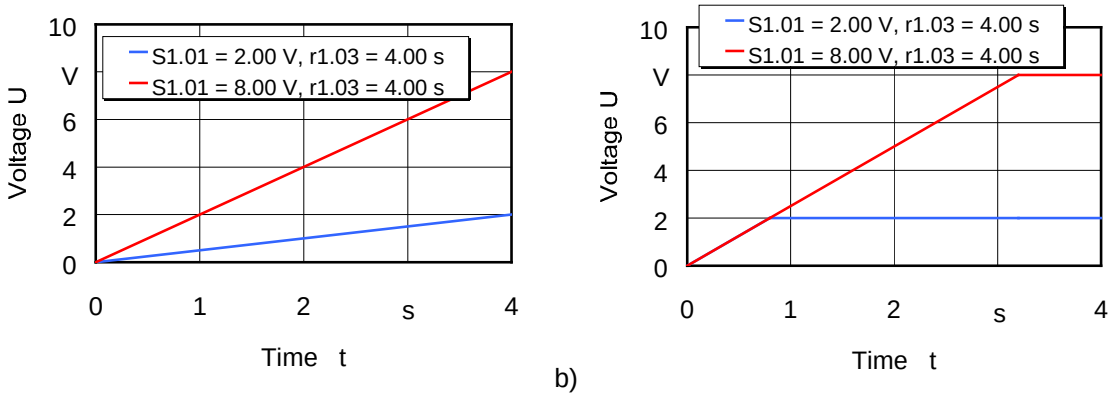


Fig. 5: Ramp function: a) E08 = 0, constant time base, b) E08 = 1, constant rise rate

Controller Structure

Fig. 6 shows the complete controller structure for a proportional valve adjustment displacement control. It also gives information about the definition and mode of action for the controller parameters.

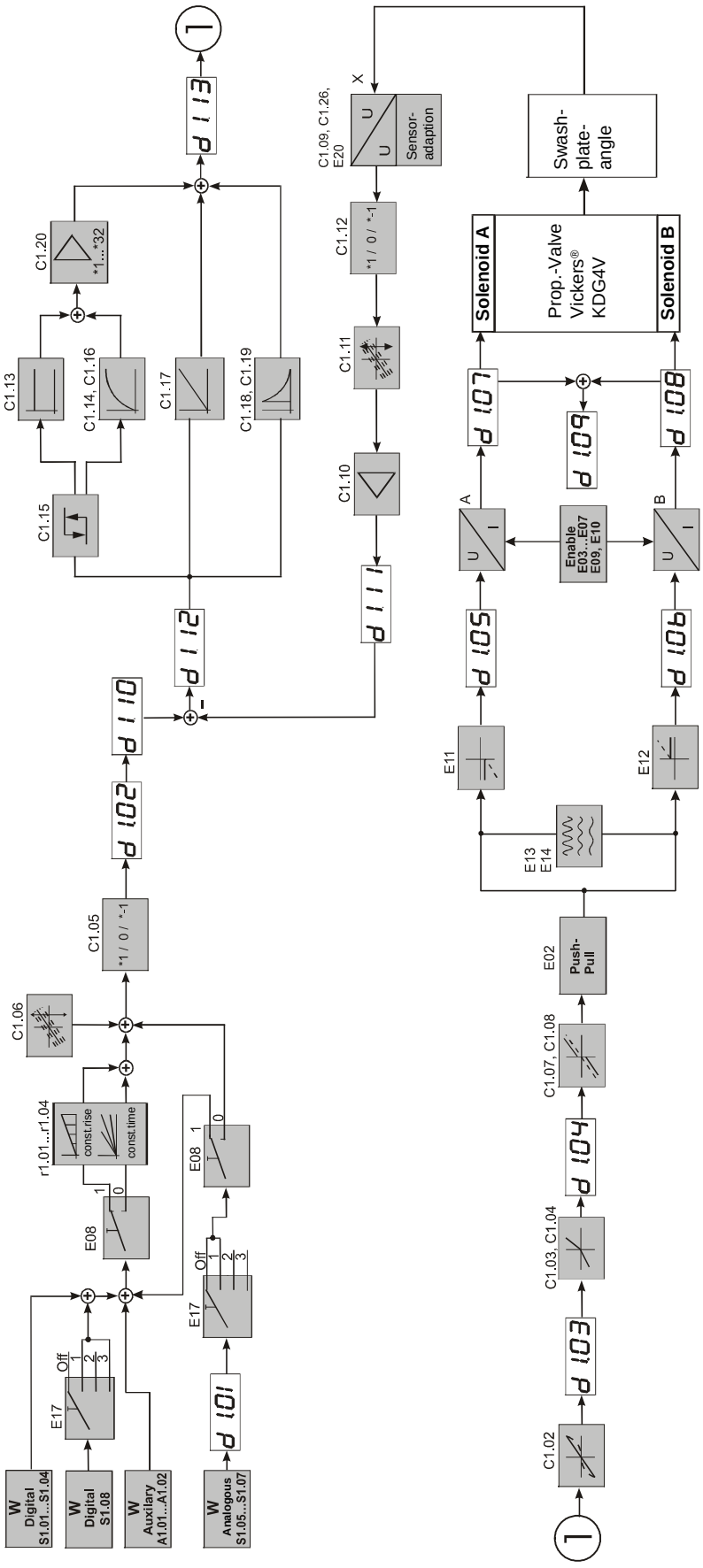


Fig. 6: Controller structure and definition of parameters

Test Jacks

The sockets “A” and “B” can be used to measure the solenoid currents independently. The voltage is approximately 1V at 1A. The analogue set point “S1.06” can be measured at the socket “SET”. The signal is proportional to the measured value (1:2\half the set point voltage). At the socket “FB1”, the actual analog feedback value (d10) can be measured. The reading is proportional 1:2 to the actual value.
At the monitor socket “MON”, all display parameters are accessible as an analog voltage being between 0-10V. The adjusted display parameter (dx.xx see also chapter Display Parameters) is switched to the monitor socket “MON”.

Display Parameters

Internally calculated values can be displayed on the 4 digit display during normal operation and are especially helpful during commissioning and troubleshooting. The values should be interpreted as voltage or current with a standardized display resolution of 1 mV to 9.999 V for currents between 0.001A to 4.000A. The polarity signs are represented through the LEDs “+” and “-“. Available display parameters are shown in **Table 9**.

ATTENTION!

This is only an auxiliary function. For technical reasons, precise measured values, comparable to a multimeter, are not possible.

Analog Output

Using parameter E01 (analog output), each of the display values d1.01 to d1.13 can be displayed as an analogous voltage on contact 10b. This signal has a voltage of 0 to 10 V with12 bit resolution, and for example, can control subsequent electronics. Parameter E18 can assign an output gain to the output signal and therefore, adapt the output signal to the demands of subsequent electronics.

Comparator

Comparator function of digital controller and amplifier card ER9.3-10 is used in connection with the fail safe function. If the lag error value (set value – actual value) is greater or less than the values set in parameters C1.21 and C1.22 for longer than the time set in parameters C1.23 and C1.24, then the comparator value is changing until it reaches the set parameter values. The comparator value can be measured directly on pin 14b of the back socket. In connection with the break function, the fail safe valve can be activated directly via the switching output (break output 20b, see chapter Break Function on page 40).

Break Function

The break function on digital controller and amplifier card ER9.3-10 is used in connection with the fail safe function. Depending on the value of the comparator function, the break output can directly drive a fail safe valve (24V and 1A max). (Pin 20b).

Fail Safe Function

In the case of a disturbance, the fail safe valve tilts the swash plate on the pump to zero. The fail safe function controls the lag error value (set value – actual value). If the lag error is greater or less than the values set in parameters C1.21 and C1.22 for longer than the time set in parameters C1.23 and C1.24, the fail safe function will de-energize the solenoid on the fail safe valve. Port A and B of the servo cylinder will be connected and the pump tilts in zero position. For proper operation of the fail safe function it is necessary to set the parameter E18 = 3. This is in accordance to the delivered parameter value in **Table 6**. The electrical parameters of the fail safe valve are V = 24 V and I_{max} = 1 A. The proper fail safe valve can be ordered from Eaton Fluid Power GmbH, Wehrheim (order number **HC000000316951**).

List of Parameters – as delivered condition

The following tables show function, units and range of the parameters available in this controller. Modifying the parameters is possible by using the keypad on the front of the card or by using the ***ER9.3-Tool***.

There are 4 different parameter types:

- C-parameter C1.00 – C1.26: parameters to change the control behavior (**Table 5**)
- E-parameter E00 – E20. parameters for extended setting (**Table 6**)
- S-parameter S1.01 – S1.04 and S1.08: digital set values (**Table 7**)
- R-parameter r1.01 –r1.04: ramp parameters (**Table 8**).

Column "Value" in **Table 5** and **Table 6** contains the recommended values for SP control by Eaton Fluid Power GmbH. These values are chosen to establish stable working conditions.

Controller-Parameters							
No.	**Function**	**Unit**	**Step**	**Min**	**Max.**	**Code**	**Value**
C1.00	Controller selection	---	1	0	4	0 = off 1 = P-PT$_1$-I-DT$_1$ 2 =Remote 3 =dff 4 =Remote + dff	**1**
C1.01	Safety function	---	---	0	1	off = off; on = on	**off**
C1.02	Linearization	---	1	0	5	off = linear; 1 ... 5 = curve	**2**
C1.03	Gain A	V/V	00.01	00.00	02.00	---	**01.00**
C1.04	Gain B	V/V	00.01	00.00	02.00	---	**01.00**
C1.05	Set value sign	---	---	- 1	+ 1	- 1 = negative off = off + 1 = positive	**Customer**
C1.06	Set value offset	V	0.001	-9.999	+9.999	---	**0.000**
C1.07	Dead band compensation A	V	0.001	0.000	+9.999	9.999 V = max. current depending on solenoid selection	**0.000**
C1.08	Dead band compensation B	V	0.001	0.000	+9.999		**0.000**
C1.09	Sensor type Attention: No negative controller output possible when 10, 11 or 12 is selected! If E20 = 0 than type 1 to 12 available! If E20 = 1 than only type 4 to 7 and 12 available!	---	1	1	12	1 = 0 ... 20 mA 2 = 4 ... 20 mA 3 = 12 mA ± 8 mA 4 = 0 ... 10 V 5 = 0 ... ± 10 V 6 = 6 V ± 2,5 V 7 = 7,5 V ± 2,5 V 8 = 6 V ± 5 V 9 = 7,5 V ± 5 V 10 = 0 ... 20 mA 11= 4 ... 20 mA 12 = 0 ... 10 V	**6**
C1.10	Actual value gain	V/V	00.01	00.00	04.00	---	**1.8**
C1.11	Actual value offset	V	0.001	-9.999	+9.999	---	**0.000**
C1.12	Actual value sign	---	---	- 1	+ 1	- 1 = negative off = off + 1 = positive	**1**
C1.13	P-Portion K$_{P1}$	V/V	00.01	00.00	04.00	---	**02.00**
C1.14	T-Portion for PT1 (to C1.16)	S	00.01	00.00	04.00	---	**00.15**
C1.15	Threshold (C1.13, C1.16)	V	0.001	0.000	+9.999	---	**0.050**
C1.16	P-Portion K$_{P2}$	V/V	00.01	00.00	04.00	---	**00.60**
C1.17	I-Portion	V/s	00.01	00.00	04.00	---	**0.000**
C1.18	D-Portion	Vs	00.01	00.00	04.00	---	**00.00**

Controller-Parameters							
No.	**Function**	**Unit**	**Step**	**Min**	**Max.**	**Code**	**Value**
C1.19	T-Portion for DT1	S	00.01	00.00	10.00	---	**00.00**
C1.20	Gain (C1.13 and C1.16)	V/V	2^n	1	32	---	**8**
C1.21	Comparator upper level	V	0.001	-9.999	+9.999	---	**0.500**
C1.22	Comparator lower level	V	0.001	-9.999	+9.999	---	**-0.500**
C1.23	Comparator delay into window	S	00.01	00.00	+99.99	---	**00.10**
C1.24	Comparator delay out of window	S	00.01	00.00	+99.99	---	**00.10**
C1.25	Comparator selection	---	1	0	3	off = off 1 = Set value 2 = Actual value 3 =Lag error	**3**
C1.26	Cable fracture detection feedback	---	---	off	1	off = off; 1 = active	**off**

Table 5: Controller Parameters – as delivered condition

Extended-Parameters							
No.	**Function**	**Unit**	**Step**	**Min**	**Max.**	**Code**	**Value**
E00	Operation mode Note: 5 = Reserved and 9 = Reserved	---	1	1	11	1 = Open loop one valve 2 = Open loop two valves 3 = Closed loop one valve 4 = Closed loop one application 6 = Closed loop valve/application 7 = Closed loop valve/valve 8 = Closed loop application/ application 10 = Closed loop no valve one feedback 11 = Closed loop no valve two feedback.	**4**
E01	Analog output	---	1	1 and 14	13 and 21	1 = d1.01 to 13 = d1.13 and 14 = d2.01 to 21 = d2.13	**11**
E02	Push-Pull function	---	---	off	1	Off = off; 1 = active	**off**
E03	Solenoid selection	---	---	0.800	3.500	0.800 = 0,8 A 1.100 = 1,1 A 1.300 = 1,3 A 1.600 = 1,6 A 2.400 = 2,4 A 2.700 = 2,7 A 3.500 = 3,5 A	**1.600**
E04	P-Portion current contr. energize	---	0001	0000	9999	---	**0800**
E05	I-Portion current contr. energize	---	0001	0000	9999	---	**1000**
E06	P-Portion cur. contr. de-energize	---	0001	0000	9999	---	**1500**
E07	I-Portion cur. contr. de-energize	---	0001	0000	9999	---	**1000**

Extended-Parameters							
No.	**Function**	**Unit**	**Step**	**Min**	**Max.**	**Code**	**Value**
E08	Ramp selection	---	1	0	2	0 = digital set v. (time constant) 1 = all set v. (rise constant.) 2 = no function	**1**
E09	Time delay enable signal	s	0.001	0.000	+9.999	---	**0.000**
E10	Solenoid current adaptation	---	00.01	00.50	01.10	Variable adjustment of max. current	**01.00**
E11	Initial current	V	0.001	0.000	+3.000	3.000 V = 30 % of max. rated current	**2.000**
E12	Initial current	V	0.001	0.000	+3.000		**2.000**
E13	Dither Amplitude	V	0.001	0.000	+3.000	3.000 V = 30 % of max. rated current	**2.000**
E14	Dither Frequency	Hz	0001	0001	0300	---	**0130**
E15	Select load/store	---	1	0	1	0 = Store into goal 1 = Load from goal	**0**
E16	Action load/store	---	1	0	1	0 = no action; 1 = Start action	**0**
E17	Set value activation mode	---	1	off, 1	3	off = 4 digital, 3 analogue active 1 = 5 digital SP, 3 analogue active 2 = only 4 digital active 3 = only 5 digital active	**Off**
E18	Break output	---	1	off, 1	5	off = break off, comp. Positive logic 1 = break on, comp. Positive logic 2 = break follows comparator 3 = break not and comp. Positive logic 4 = break and comp. Negative logic 5 = break not and comp neg. logic	**2**
E19	Output factor analog output	---	00.01	00.00	02.00	---	**01.00**
E20	Swap feedback branch 1 / branch 2	---	1	0	1	0 = Current feedback addressed to branch 1 1 = Current feedback addressed to branch 2	**0**
E21	Password	---	0001	0000	9999	To protect parameters	

Table 6: Extended Parameters – as delivered condition

Parameter for digital set values					
No.	**Function**	**Unit**	**Step**	**Min**	**Max**
S1.01	Internal set value 1	V	0.001	0.000	+9.999
S1.02	Internal set value 2	V	0.001	0.000	+9.999
S1.03	Internal set value 3	V	0.001	0.000	+9.999
S1.04	Internal set value 4	V	0.001	0.000	+9.999
S1.08	Internal set value 8	V	0.001	0.000	+9.999

Table 7: Parameters for digital set values

Ramp parameters					
Nr.	**Function**	**Unit**	**Step**	**Min**	**Max**
r1.01	Ramp from 0 ⇒ –	s	0.001	0.000	39.50
r1.02	Ramp from – ⇒ 0	s	0.001	0.000	39.50
r1.03	Ramp from 0 ⇒ +	s	0.001	0.000	39.50
r1.04	Ramp from + ⇒ 0	s	0.001	0.000	39.50

Table 8: Ramp parameters

Display parameters					
#	Function	Unit	Step	Min	Max
d1.01	Sum of analog set value	V	0.001	-9.999	+9.999
d1.02	Sum of all post ramp set values	V	0.001	-9.999	+9.999
d1.03	Set values after linearization	V	0.001	-9.999	+9.999
d1.04	Value after gain adjustment.	V	0.001	-9.999	+9.999
d1.05	Signal A	---	0.001	-9.999	+9.999
d1.06	Signal B	---	0.001	-9.999	+9.999
d1.07	Current A	A	0.001	0.000	5.000
d1.08	Current B	A	0.001	0.000	5.000
d1.09	Total current	A	0.001	0.000	5.000
d1.10	Desired value	V	0.001	-9.999	+9.999
d1.11	Actual value, feedback value	V	0.001	-9.999	+9.999
d1.12	Lag error	V	0.001	-9.999	+9.999
d1.13	Controller output	V	0.001	-9.999	+9.999

Table 9: Display parameters

Commissioning

Non Warranty

This operating manual represents the knowledge of Eaton and during the drafting of this manual, the greatest possible care was taken. Nevertheless, Eaton disclaims any responsibility and liability claims for individual applications of the user. This is particularly true in cases of non-compliance, omissions, faults, misinterpretations and misunderstandings.

Wiring

Card holder **HC000000315303** has to be wired according to **Fig. 7**.
The supply voltage for the unit at terminals 26bd = 0V and 32bdz = +UB is 18 V to 32V DC, residual ripple <10%.
Output stages are electronically protected against short circuit. The amplifiers should be protected with a quick-acting preliminary fuse.

The solenoids are connected at terminals 22bdz and 28bdz for solenoid A; terminals 24bdz and 30bdz for solenoid B. The terminals bdz are bridged on the amplifier. We recommend using all three terminals. The solenoid connections with the output terminals of the electronic card, and the sign of actual value C1.12 are chosen for use with a Vickers proportional valve KDG4V-3 according to ANSI-B93.9. Using any other proportional valve that does not meet ANSI-B93.9 standard, may require a change to the sign of the actual value **or** a change to the solenoid connection wiring.
Terminal 18d is the digital output of GND. This terminal is used as a point of reference for the serial interface.
When using digital set values (S1.01 to S1.04 and S1.08) the recommendations in chapter “Digital Set Values” on page 37 need to be considered. If the digital set values are not used, the terminals 8z, 4d, 6d, 6z, 2b, 4z and 2z have not been connected. Enable signal (18d) must be energized in SP control mode.
When using analog set values, the recommendations in chapter “Analog Set Values” on page 37 need to be considered. Analog set values can be activated by:

1. using a potentiometer (Set value S1.05, terminals 12z, 20z and 20d),
2. using an external voltage source ±10 V (Set value 1.06, terminals 12d and 16d) or
3. using an external current source 4...20 mA (Set value S1.07, terminals 16z and 26z).

The swash plate sensor power supply is terminals 20z (+10 V to pin 1 of sensor) and 26z (analog GND to pin 3 of sensor). The actual value (pin 2 on sensor) should be connected to terminal 10d of the card holder.
By using the fail safe function, as shown in **Fig. 7**, the switching output on terminal 20b and 26bd should be connected to the fail safe valve solenoid. NOTE: The switching output 20b can drive an inductive load with 24V and1A max. If the fail safe valve solenoid has variant electrical values, the control needs to be done using additional electrical devices (i.e. relay).

Installation of Electronic Card

After correctly wiring the card, insert it carefully in the card holder. After switching on the power and the enable signal, the power supply LED (PW) and the enable LED (EN) for should flash.

Verification of Parameters

Before using the electronic card and swash plate pump, compare the controller parameters C1.00 to C1.26 and the extended parameters E00 to E20 to the values in **Table 5** and **Table 6**. Correct any differences in the parameters according to the table.

Switching on the Pump

Before switching on the pump, make certain that all hydraulic connections to the pump have free conjunction with the tank. There should not be a closed valve, ball valve or other device between the pump outlet port and the tank to prevent unallowable pressure during commissioning.
The set value of the pump is adjusted to zero first. If the pump is tilted out to maximum displacement change the sign of the set value (C1.12) **or** change the solenoid connections.

Adjustment of Zero Point on Swash Plate Angle Sensor

During assembly and testing of the pump, the swash plate sensor neutral is calibrated to the zero position (displacement and flow equal zero) of the pump. If mechanically loaded or remounted, the swash plate sensor can lose its zero position. If this occurs it may be necessary to readjust the neutral position of the swash plate sensor.
The actual value of the swash plate sensor can be observed by displaying parameter D1.11. If the actual value D1.11 is more than 1V and the pump is tilted to its zero position, it is recommended that the sensor be readjusted. If the actual value D1.11 is less than 1V, the zero position can also be adjusted by the offset parameter C1.11.

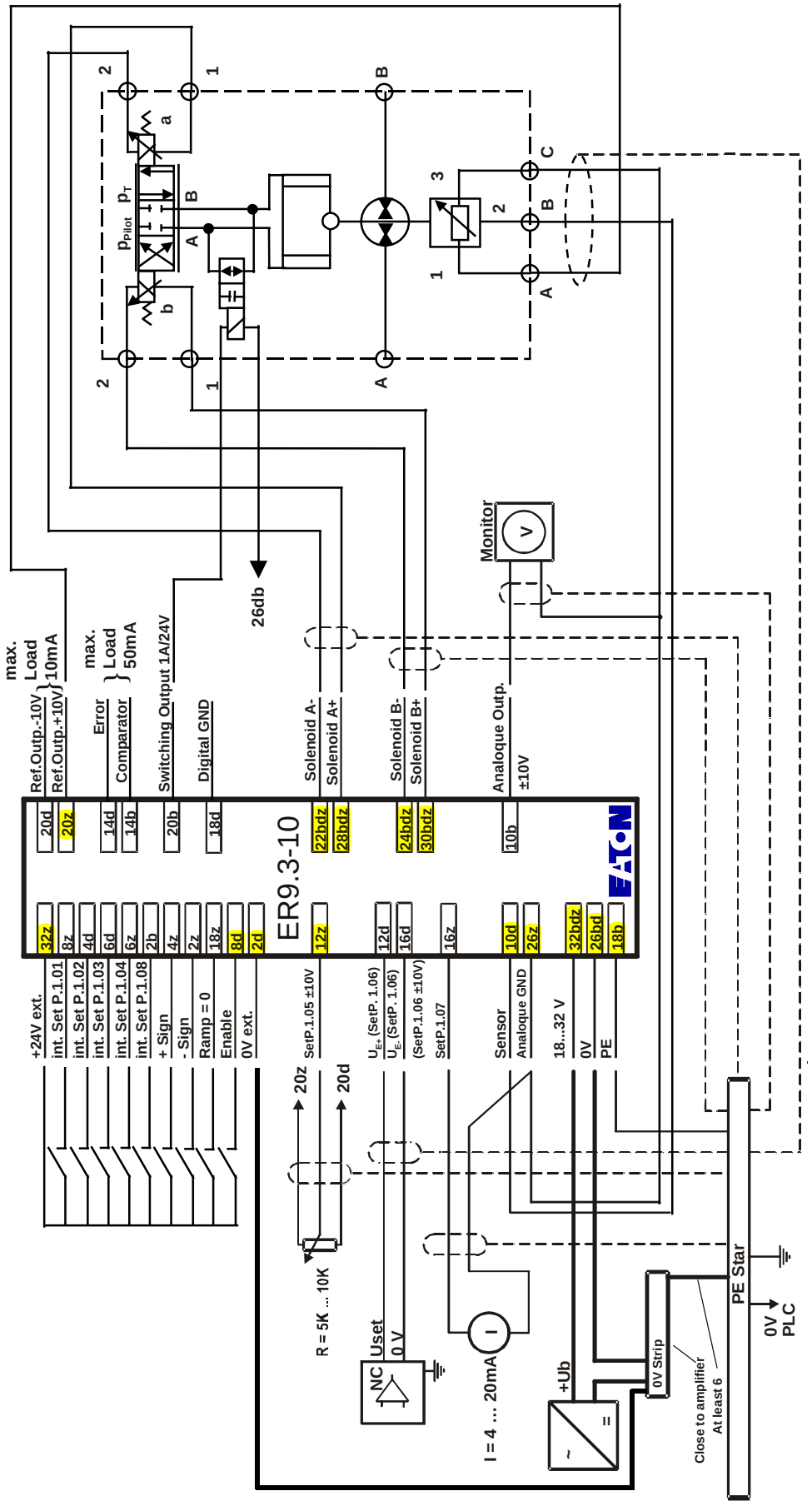


Fig. 7: Wiring scheme (no galvanic isolation)

Verification of Control Behavior

To verify the control behavior of the pump, carefully increase the set value. The control works proper if the swash plate angle and the pump outlet flow are also increased. If this is not the case please check all hydraulic connections (pump inlet and outlet port) and the electrical connections to the solenoids.

Modifying Sensor Gain

The actual gain value needs to be adjusted in this way, so that the maximum output signal of the sensor corresponds to maximum displacement. If different maximum displacements for side A and B exist, it is only possible to adjust the sensor gain for the side with the greater maximum displacement. To adjust the sensor gain, tilt the pump out about 80% of its maximum displacement. Display parameters D1.10, D1.11 and D1.12 will show set value, actual value and lag error. If the set value is equal to actual value (lag error = 0) the sensor gain is adjusted correctly.
If the actual value is greater than the set value (lag error is negative), the sensor gain is too large. In this case scale down the sensor gain C1.10 by 0.1V steps until the lag error D1.12 is set to zero.
If the actual value is smaller than the set value (lag error is positive), the sensor gain is too small. In this case increase the sensor gain C1.10 by 0.1V steps until the lag error D1.12 is set to zero.
Please pay attention that proper adjustment of the sensor gain is only possible for one maximum displacement. If the pump has alternating pressure sides (A and B) with different maximum displacements, the sensor gain is the same in both directions. In this case the maximum flow of the smaller maximum displacement side is already reached before the maximum set value (example: Side A: V_{1Amax} = 100 % at set value 10 V, V_{1Bmax} = 80 % * V_{1Amax}, V_{1Bmax} is reached at set value –8 V).

Closed Loop Function

After adjusting the pump and controller card test your application in closed loop function.

Saving Parameters

All parameters that have been changed during commissioning should be noted and saved. Using the ***ER9.3-Tool*** it is possible to save the parameter set on a PC and download it in other applications.

Hint

Description of function, wiring, commissioning and parameters in this manual represent the state of the art to use a proportional valve for displacement control (SP) with the recommended components from EATON. The digital controller and amplifier card ER9.3-10 is capable of many more functions than described in this manual. Therefore, it is possible to use a second controller loop. If you are interested in using additional functions of the digital controller and amplifier card ER9.3-10 please contact the EATON Fluid Power GmbH, Wehrheim.

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