BUCHER hydraulics

Operating Instruction

Universal power amplifier for proportional valves

Series EVS-AU1-2500… & EVS-AI1-2500…

Published by

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1 General Information

1.1 Order number

EVS-AU1-2500-1-30D-A1	-	Universal power amplifier with 0... 10V input for proportional valves

1.2 Alternative products

EVS-AI1-2500-1-30D-A1	-	Universal power amplifier with 4...20mA input for proportional valves

1.3 Scope of supply

The scope of supply includes the module. Cables, adapters and further parts which may be required should be ordered separately. This documentation can be downloaded as a PDF file from www.bucherhydraulics.com.

1.4 Accessories

PS1	-	GUI for parametrization and monitoring of the power amplifier (free download from www.bucherhydraulics.com)
EKL-USB-LIN-1-30D-A1	-	Programming adapter with USB interface

1.5 Safety instructions

Please read this document and the safety instructions carefully. This document will help to define the product area of application and to put it into operation. Additional documents and knowledge of the application should be taken into account or be available. General regulations and laws (depending on the country: e.g. accident prevention and environmental protection) must be complied with.

These modules are designed for hydraulic applications in open or closed loop control circuits. Uncontrolled movements can be caused by device defects (in the hydraulic module or the components), application errors and electrical faults. Work on the drive or the electronics must only be carried out whilst the equipment is switched off and not under pressure.

This handbook describes the functions and the electrical connections for this electronic assembly. All technical documents which pertain to the system must be complied with when commissioning.

This device may only be connected and put into operation by trained specialist staff. The instruction manual must be read with care. The installation instructions and the commissioning instructions must be followed. Guarantee and liability claims are invalid if the instructions are not complied with and/or in case of incorrect installation or inappropriate use.

All electronic modules are manufactured to a high quality. Malfunctions due to the failure of components cannot, however, be excluded. Despite extensive testing the same also applies for the software. If these devices are deployed in safety-relevant applications, suitable external measures must be taken to guarantee the necessary safety. The same applies for faults which affect safety. No liability can be assumed for possible damage.

Further instructions

- The module may only be operated in compliance with the national EMC regulations. It is the user's responsibility to adhere to these regulations. The device is only intended for use in the commercial sector.
- The module may not be used in an explosive environment.
- The device must be disposed of in accordance with national statutory provisions.

2 Characteristics

This amplifier plug is used to control proportional valves with one solenoid. The compact solution will be mounted directly on the solenoid.

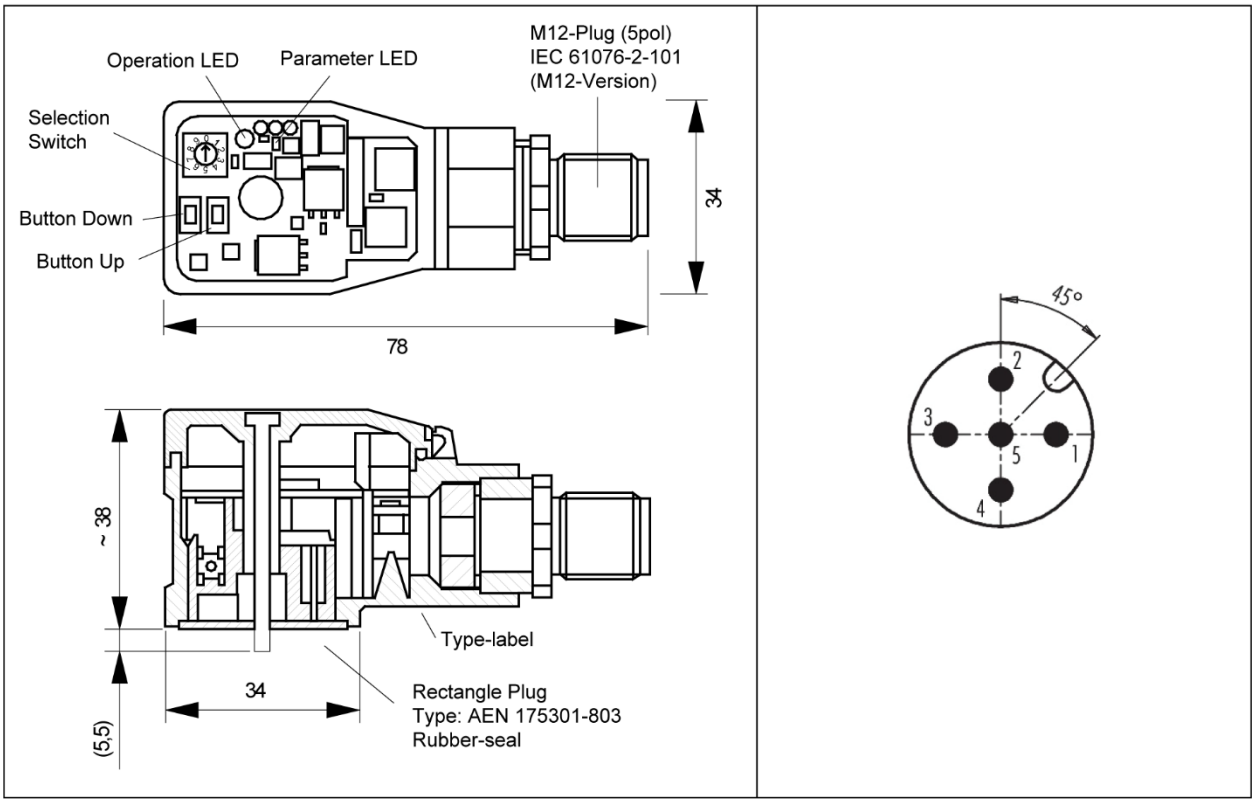
A typical input signal of 0…10 V (optional 4…20mA) can be used. The output current is closed loop controlled and therefore independent from the supply voltage and a varying solenoid resistance.

The parametrization can be done via the PC interface and the EKL-USB-LIN-1-30D-A1 programming adapter or internally via the UP and DOWN buttons.

2.1 Features

- Power amplifier for proportional valves located in a DIN EN 175 301-803-A plug housing
- Digitally reproducible adjustments
- Free scaling of the input signal
- Also usable as Soft-Switch-amplifier (soft switch-on and switch-off)
- M12 connector
- Programmable via USB/LIN bus
- Free parameterization of Ramps, Minimum- and Maximum current, Dither (frequency, amplitude) and PWM frequency
- Parameter settings via integrated buttons and a selector switch (reduced functionally against the USB / LINbus)
- Nominal output current range: 0.5… 2.5 A

2.2 Device description



3 Use and application

3.1 Installation instructions

- All cables which lead outside must be shielded; a complete shielding is required. It is also a requirement that no strong electro-magnetic interference sources are installed nearby when using our control and regulation modules.

- The equipment should be installed and wired in accordance with the documentation bearing in mind EMC principles. If other consumers are operated with the same power supply, a star- connected ground wiring scheme is recommended. The following points must be observed when wiring:
    - Analogue signal cables must be screened.
    - All other cables must be screened if there are powerful interference sources (frequency converters, power contactors) and cable lengths > 3m. Inexpensive SMD ferrites can be used with high-frequency radiation.
    - The screening should be connected to PE (PE terminal) as close to the equipment as possible. The local requirements for screening must be taken into account in all cases. The screening should be connected to at both ends. Equipotential bonding must be provided where there are differences between the connected electrical components.
    - With longer lengths of cable (>10 m) the diameters and screening measures should be checked by specialists (e.g. for possible interference, noise sources and voltage drop). Particular care is required with cables of over 40 m in length

- A low-impedance connection between PE and valve must be provided. Transient interference voltages are conducted from the device directly to the valve and thus to local grounding.

- Power should be supplied by a regulated power supply unit (typically a PELV system complying with IEC364-4-4, secure low voltage) or by a battery. The low internal resistance of regulated power supplies gives better interference voltage dissipation, which improves the signal quality of high-resolution sensors in particular. Switched inductances (relays and valve coils connected to the same power supply) must always be provided with appropriate overvoltage protection directly at the coil.

3.2 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.
Switching on for the first time	Ensure that no unwanted movement is possible in the drive (e. g. switch off the hydraulics). Connect an amperemeter 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 via the USB interface and the programming adapter EKL-USB-LIN-1-30D-A1. Please see PS1 software documentation for how to set up communication.
	The communication works in a “half duplex” process. Further commissioning and diagnosis are supported by the operating software. Alternatively, the set-up can be done by the internal parameter selector and the “up” and “down” buttons.
Pre-parameterization	Parameterize now (with the help of the system redundancy and the connection diagram) the following parameters: The “analog input”, the output “current” and the typical valve parameter “dither” and “min/max”. Pre-parameterization is necessary to minimize the risk of an unintentional movement.
Control signal	Check the control signal (output signal). The control signal (solenoid current) lies in the range of 0... 2.5 A. In the current state it should show around 0 A. The valve current can also be monitored in the PS1 software.
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 command signal	The output current to the valve will follow the input signal proportionally.
	The power stage is always active when power supply exists. Drives can now leave their position and move to an end position at full speed. Take safety measures to prevent personal injury and damage.
Optimize settings	Now optimize the remaining parameters according to your application and your requirements.

4 Technical description

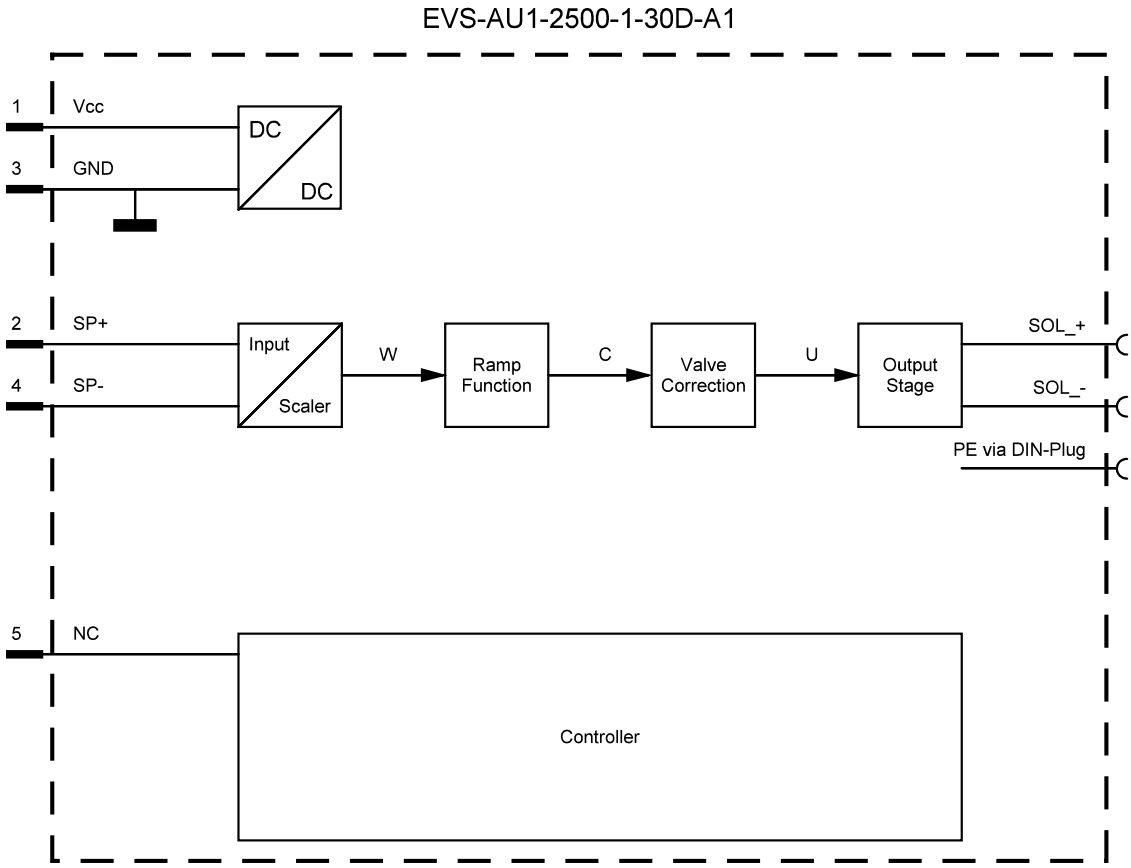
4.1 Input and output signals

Connection	Supply
PIN 1	Power supply (see technical data)
PIN 3	0 V (GND) Power supply (ground).
Connection	**Analogue signals**
PIN 2	Command signal input +, signal range 0… 10 V, scalable
PIN 4	Command signal input -, signal range 0… 10 V, scalable
Connection	**Communication**
PIN 5	LIN-bus communication port Via EKL-USB-LIN-1-30D-A1 programming adapter the plug can be read out and parameterized.

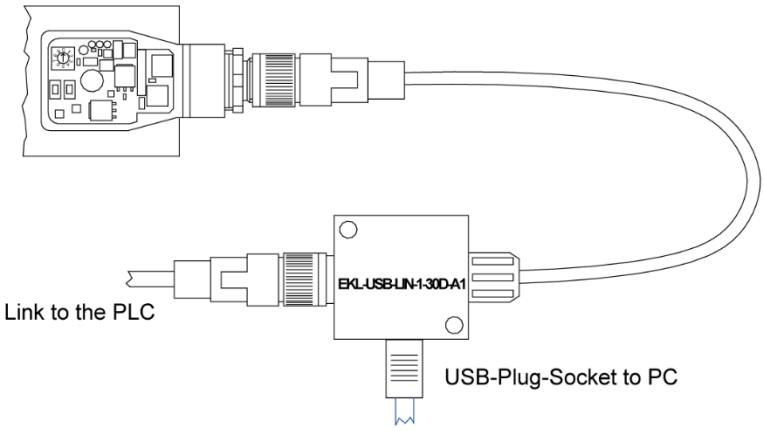
4.2 LED definitions

LEDs	Description of the LED function
YELLOW (THT)	READY display OFF: No power supply ON: System is ready for operation Flashing: Error discovered
YELLOW (SMD)	Operational mode Off: Normal operation Flashing sequences at rotary switch position 0...6: Manual parameter setting mode is active At rotary switch position 8: from indication "Off" via increasing flashing duration to continuous light, the "output current" is displayed. At rotary switch position 9: from indication "Off" via increasing flashing duration to continuous light, the "setpoint" is displayed

4.3 Block diagram



4.4 Typical wiring



4.5 Technical data

Supply voltage (Ub)	[VDC]	12… 30 (incl. ripple)
Current consumption (w/o solenoid)	[mA]	< 50
External fuse	[A]	3 medium time lag
Analog inputs:		Unipolar / differential
Voltage	[V]	0…10
Input resistance	[kOhm]	> 90
Signal resolution	[%]	0.026
Current	[mA]	4…20
Burden	[Ohm]	240
Signal resolution	[%]	0.055
PWM output		Wire break and short circuit monitored
Max. output current	[A]	2.5
Frequency	[Hz]	61...2604 selectable in defined steps
Sample times		
Solenoid current control	[µs]	167
Signal processing	[ms]	1
Serial Interface	-	LIN-Bus
Transmission rate	[kBaud]	19.2
Housing acc. DIN EN 175301-803-A	-	3-pole 2 P+E
Material	-	PA 6.6 polyamide
Color	-	black
Flammability class	-	V0 (UL94)
Weight	[g]	80
Protection class	-	IP65 with gasket (with appropriate mating connector and proper fitting and sealing)
Temperature range	[°C]	-20… +65
Storage temperature	[°C]	-20 …+70
Humidity	[%]	<95 (not condensing)
Connections		M12, 5pole (DESINA standard)
EMC		EN 61000-6-2: 8/2005 EN 61000-6-4: 6/2007 + A1:2011

5 Manual parametrization

5.1 Parameter overview

The manual adjustment is comparable with the adjustment via potentiometer. Not all parameters of the power plug are available in this mode. For full functionality, the use of the PC interface is necessary.

Switchposition	Parameter	Range	Remarks
0	DEFAULT	-	Released only by pressing the button "up" and "down" simultaneously. Response: A short and fast flashing of the LED.
1	CURRENT	0 | 1	0 = low current range; press „down“ 1 = high current range; press „up“
2	MIN	0…60%	Deadband compensation in relation to the current range
3	MAX	30…100%	Reduction in the maximum current in relation to the current range
4	R:UP	50ms…5sec	Ramp time up
5	R:DOWN	50ms…5sec	Ramp time down
6	PWM	61…2604 Hz	PWM output frequency
7	-		No function
8	-		Current monitoring, no parameter input, see LED definitions.
9	-		Setpoint monitoring, no parameter input, see LED definitions.

5.2 Procedural method

Task	Parameter
1	Press a button or turn the selector switch, which activates the manual adjustment mode. The parameter-LED flashes.
2	Select the desired parameter (1… 6) by the selector switch.
3	The parameter LED indicates - by flashing - the parameter mode. a. At the lower boundary the LED lights only briefly b. At the upper boundary the LED lights almost continuously
4	Press the UP or DOWN button. a. A short activation of one of the buttons will change the parameter by a value of app. 1%. b. A continual activation of one of the buttons will change the parameter continually (up to the point where the upper or lower boundary is reached).
5	The parameters are stored automatically (app. 1 second after the last parameter adjustment). The manual adjustment will be finished after 60 seconds.

6 Parameters

6.1 Parameter list

Command	Default	Unit	Description
LG	EN	-	Changing language help texts
MODE	STD	-	Parameter mode (standard or expert)
AIN:W	a: 1000 b: 1000 c: 0 X: V	- - 0.01 % -	Free scaling of the analogue input signal
LIM	0	0.01%	Signal monitoring function (e.g. joystick error)
R:UP R:DOWN	100 100	ms ms	Command signal ramp times
MIN	0	0.01 %	Compensation of the dead band
MAX	10000	0.01 %	Scaling of the max. output signal
TRIGGER	200	0.01 %	Trigger point for activating the MIN value.
POL	+	-	Output polarity
CURRENT	0	-	Current output range
DAMPL	0	0.01 %	Dither amplitudes. Related to the nominal output

Command	Default	Unit	Description
			current.
DFREQ	120	Hz	Dither frequency
PWM	488	Hz	PWM frequency
PPWM IPWM	1 40	- -	Parameters for the closed loop current controllers

7 Parameter description

7.1 LG (Changing language)

Command		Parameter	Unit	Group
LG	x	x= DE | EN	-	STD

Either German or English can be selected for the help texts in the PS1 software.

After changing the language settings, the parameter list has to be updated by pressing the speed button “ID” in the PS1.

7.2 MODE (Switching between parameter groups)

Command		Parameter	Unit	Group
MODE	x	x= STD | EXP	-	STD

This command changes the parameter mode. Various commands (defined via STD/EXP) are blanked out in standard mode. The several commands in expert mode have more significant influence on the system performance. Therefore they should be changed with care.

7.3 AIN ((Analogue input scaling)

Command	Parameter	Unit	Group
AIN:W a b c x	 a= -10000… 10000 b= -10000… 10000 c= -10000… 10000 x= V | C	 - - 0.01 % -	STD

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

$$Output = \frac{A}{B} * (Input - C)$$

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

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

In this case AIN command would look like this:

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

FUNCTION = 195				**Input signal**	**Description**
AIN:X	1000	1000	0 V	0… 10 V	Range 0...100%
AIN:X	10	8	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))
		OR			
AIN:X	1250	1000	1000 V		
AIN:X	10	4	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))
		OR			
AIN:X	2500	1000	500 V		
AIN:X	20	16	2000 C	4… 20 mA	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 %.
		OR			
AIN:X	2000	1600	2000 C		
		OR			
AIN:X	1250	1000	2000 C		

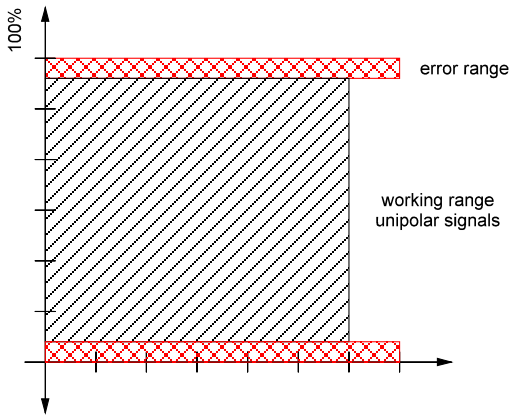
7.4 LIM (Signal monitoring)

Command	Parameter	Unit	Group
LIM x	x= 0… 2000	0.01 %	EXP

The signal monitoring deactivates the output current if the input signal leaves the permitted range after scaling. This function makes it possible to detect a short circuit or cable break of a joystick or potentiometer.

Example: LIM 500 (5% lower/upper limitation)

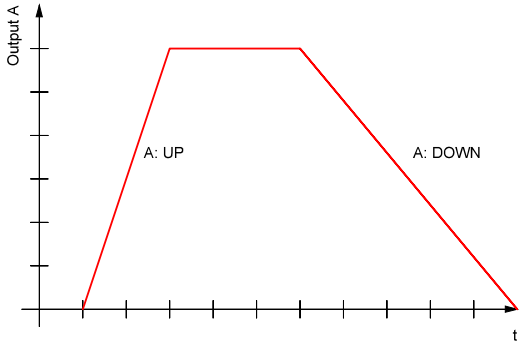
If the input signal gets higher than 95 % or lower than 5%, it leaves the permitted range and the outputs will switch off.



7.5 R (Command signal ramp time)

Command	Parameter	Unit	Group
R:I x	i= UP | DOWN x= 50… 10000	ms	STD

The ramp time is set separately for the rising (UP) and falling ramp (DOWN).
The ramp time is related to 100 % signal step.

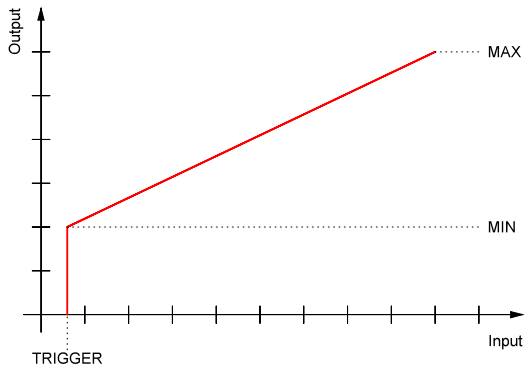


7.6 MIN (Overlap compensation) / MAX (output scaling) / TRIGGER (Threshold value of MIN)

Command		Parameter	Unit	Group
MIN	x	x= 0… 6000	0.01 %	
MAX	x	x= 2000… 10000	0.01 %	STD
TRIGGER	x	x= 0… 3000	0.01 %	

The output signal is adapted to the valve by these commands. 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 command the activation point of the MIN function is set and so a non-sensitive range around the zero-point can be specified. This threshold is necessary, in order to avoid unrequested activations caused by small variations of the input signal.



If the MIN value is set too high, it influences the minimal velocity, which cannot be adjusted any longer.

7.7 POL (Output polarity)

Command		Parameter	Unit	Group
POL	x	x= + | -	-	EXP

This command allows a switch over of the output signal direction (after the MIN-MAX function).

Example: POL:A + Input signal 0… 100 %, nominal output current 0… 100 %.

POL:A - Input signal 0… 100 % nominal output current 100… 0 %.

7.8 CURRENT (Rated current range)

Command	Parameter	Unit	Group
CURRENT x	i= 0 | 1	-	STD

The nominal current range is set with this parameter. Dither and also MIN/MAX always refer to the selected current range.

0 = 1.0 A range

1 = 2.5 A range

7.9 DAMPL / DFREQ (Ditheramplitude and Dither frequency)

Command	Parameter	Unit	Group
DAMPL x DFREQ x	x= 0… 3000 x= 60… 400	0.01 % Hz	EXP

The dither can be defined freely with this command. The DITHER is a superimposed signal to reduce the hysteresis. This function is defined by the amplitude and frequency. The DITHER frequency should not be confused with the PWM frequency.

Different amplitudes or frequencies may be required depending on the respective valve. The dither amplitude is defined in % of the nominal current.

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

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

7.10 PWM (PWM Frequenz)

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

This parameter is entered in Hz. The optimum frequency depends on the valve.

Due to the longer dead times at low PWM frequencies the stability of the control circuit is reduced. When using low PWM frequencies the PPWM and

IPWM parameters should be adjusted.

The PWM frequency can only be set in defined steps. This means that there are deviations between the specified and the actual frequency. The next highest frequency step is always used.

7.11 PPWM / IPWM (Solenoid current controller P gain and I-gain)

Command	Parameter	Unit	Group
PPWM x IPWM x	x= 0… 30 x= 1… 100	- -	EXP

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

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

If the PWM frequency is < 250 Hz, the dynamic of the current controller has to be decreased. Typical values are:

PPWM = 1… 3

IPWM = 40… 80.

If the PWM frequency is > 1000 Hz, the default values of

PPWM = 7

IPWM = 40

should be chosen.

7.12 PROCESS DATA (Monitoring)

Command	Description	Unit
W	Command value after input scaling	%
C	Command value after linearization	%
U	Command value to current controller	%
IA	Output current of solenoid	mA

The process data are the variable values which can be continuously observed on the monitor or on the oscilloscope of the PS1 software

8 Appendix

8.1 Failure monitoring

Following possible error sources are monitored continuously:

Source	Fault	Characteristic
Command signal PIN 2 / 4 LIM command	Out of range	The output will be switched off and the FUNKTION LED flashes.
Command signal PIN 2 / 4 4… 20 mA	Out of range or broken wire	The output will be switched off and the FUNKTION LED flashes.
Solenoids output	Wrong cabling, broken wire	The output will be switched off and the FUNKTION LED flashes.
EEPROM (when switching on)	Data error	The output will be switched off and the FUNKTION LED flashes.The module can only be activated by saving the parameters again.

8.2 Troubleshooting

Initial situation is an operable status of the device and existing communication between the module and the PS1 software. Furthermore, the parameterization of the valve control has to be done with the assistance of the valve data sheets.

The RC mode in monitor can be used to analyze faults.

If using the RC (Remote Control) mode, all safety aspects have to be checked solidly. In this mode the module is actuated directly and the machine control has no influence on the module.

FAULT	CAUSE / SOLUTION
FUNKTION LED is off.	Presumably no power supply is present. If there is no power supply there is also no communication via our operating program. If a connection has been made to the PS1 software, then a power supply is also available.

FAULT	CAUSE / SOLUTION
FUNKTION LED is flashing.	The flashing READY LED signals that a fault is detected by the equipment. The fault could be: • Solenoid error or no signal at the input, if 4… 20 mA signals • LIM monitored input signals are parameterized. • Internal data error: press the command/SAVE button to delete the data error. The system reloads the DEFAULT data. With the PS1 software and EKL-USB-LIN-1-30D-A1 programming adapter the fault can be localized directly via the monitor.

9 History

Revision	Date	Short mark	Comment
00	01.12.2021	FT / MAK	Initial version