Operating Instruction

Universal power amplifier for proportional valves

Series EVM-UIS-2600…

Published by

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General information

1.1 Order Number

EVM-UIS-2600-2-30D-A1	-	Universal power amplifier with USB-interface for proportional valves

1.2 Alternative products

EVM-UIH-2600-2-30D-A1	-	Universal power amplifier for proportional valves
EVM-ETC-2600-2-30D-A1	-	Universal power amplifier with EtherCAT-interface for proportional valves

1.3 Scope of supply

The scope of supply includes the module plus the terminal blocks which are a part of the housing. Interface cables 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)

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.
- When not in use the module must be protected from the effects of the weather, contamination and mechanical damage.
- The module may not be used in an explosive environment.
- To ensure adequate cooling the ventilation slots must not be covered.
- The device must be disposed of in accordance with national statutory provisions.

2 Characteristics

This module is used for the control of one directional valve with two solenoids or one/two independent pressure or throttle valves with one solenoid each. Various adjustable parameters allow for an optimized adaptation to the respective valve. The integrated power amplifier with a short cycle time of 125 µs for the current loop is an inexpensive and space-saving solution.

2.1 Function modes

Function 195 — The amplifier can be used to control one directional valve. The current is controlled by a +/- 10 V (or 4… 20 mA with cable breakdown monitoring) input signal.

Function 196 — The amplifier can be used to control one/two throttle or pressure valves. The output current is controlled by 0...10 V (or 4… 20 mA with cable breakdown monitoring) input signal.

Function 197 — The amplifier can be used to control proportional valves with one or two solenoids by three digital input signals to select up to eight pre-programmed command and ramp values.

The output current is closed loop controlled and therefore independent from the power supply and the solenoid resistance. The output stage is monitored for cable breakdown, is short circuit proof and disables the power stage in case of an error.

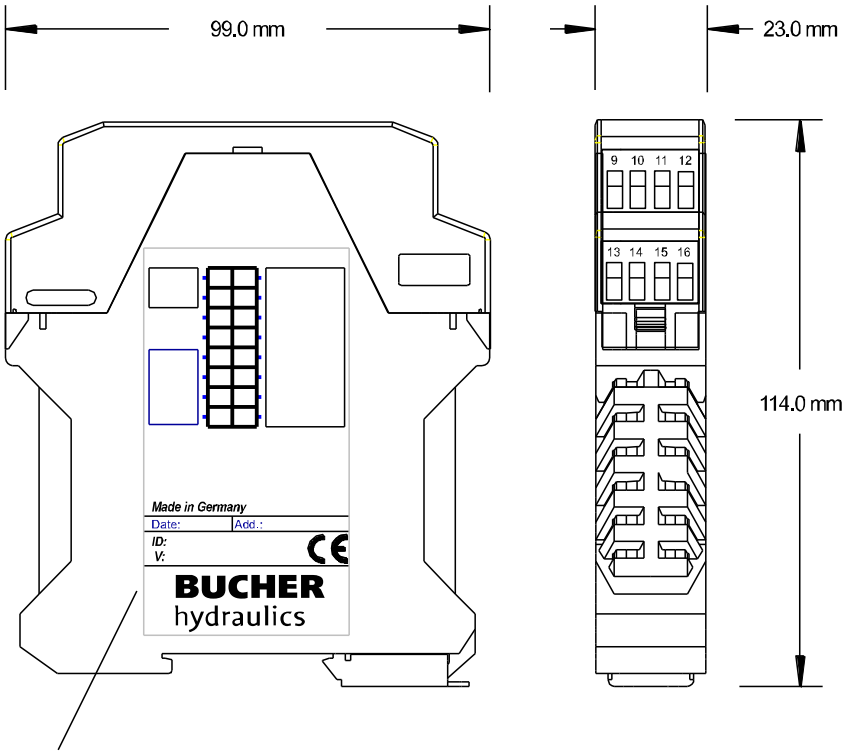
RAMP, MIN and MAX, the DITHER (frequency and amplitude) and the PWM frequency are programmable. In addition, the valve characteristics can be linearized via 10 XY-points. For example: using pressure valves a linear behavior between input signal and pressure can be reached.

Typical applications: Control of directional, throttle and pressure valves, which need a flexible adaptation of the solenoid control.

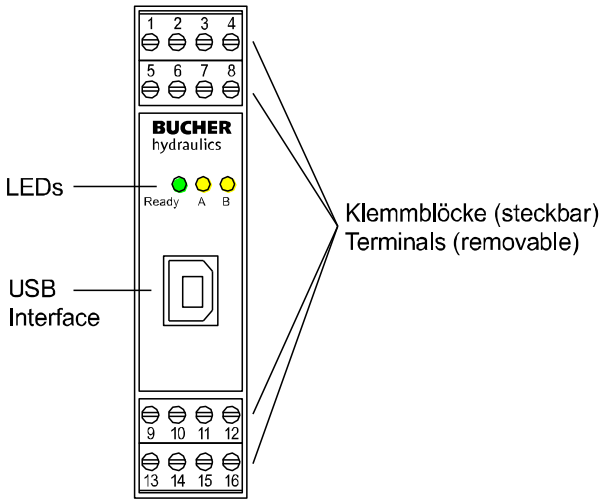
2.2 Features

- General power amplifier, one unit for all applications
- Control of directional valves or two pressure or throttle valves
- Controlled by analogue or digital inputs
- Compact housing
- Digital reproducible adjustments
- Free scaling of the analogue inputs
- Range monitoring of the input signal
- Characteristics linearization via 10 XY-points per direction
- Free parameterization of RAMPS, MIN und MAX, output current, DITHER (frequency, amplitude)
- Nominal output current up to 2.6 A
- Simple and application orientated parameter settings via PS1 software
- Failure monitoring and extended function check

2.3 Device description



Typenschild und Anschlussbelegung
Type plate and terminal pin assignment



3 Use and application

3.1 Installation instruction

- This module is designed for installation in a shielded EMC housing (control cabinet). All cables which lead outside must be screened; complete screening is required. It is also a requirement that no strong electro-magnetic interference sources are installed nearby when using our open and closed loop control modules.

- The devices must be arranged in the control cabinet so that the power section and the signal section are separate from each other. Experience shows that the installation space close to the PLC (24 V area) is most suitable. All digital and analogue inputs and outputs are fitted with filters and surge protection in the device.

- 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-connected 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 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 module 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).

- A low-resistance connection between PE and the mounting rail should be provided. Transient interference is transmitted from the module directly to the mounting rail and from there to the local earth.

- Power should be supplied by a regulated power supply unit (typically a PELV system complying with IEC364-4-4, secure low voltage). 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. 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 (e.g. 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 software documentation for how to set up communication. Further commissioning and diagnosis are supported by the PS1 software.
Pre-parameterization	Now set up (with reference to the system design and circuit diagrams) the the nominal output CURRENT and the typical valve parameters such as DITHER and MIN/MAX. Pre-parameterization is necessary to minimize the risk of uncontrolled movements.
Control signal	Check the control signal with an amp meter. The control signal (the current of the solenoid) is within the range of 0... 2.6A. In the actual status it should show approximately 0 A. You can monitor the current of the solenoids also 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) if it is a proportional valve.
Activating ENABLE	The drive can now be commanded by the analog setpoint.
	The drive can now leave its position and move to an end position with full speed or the pressure can reach maximum. Take safety measures to prevent personal injury and damage.
Optimization	Optimize your settings related to your application

4 Function modes and technical description

4.1 General information

The EVM-UIH-2600-2-30D-A1 has three different function modes on his disposal. The functionality can be chosen by the command FUNCTION (195, 196 or 197). After this selection the settings have to be saved before the module may be loaded with a previously saved parameter set.

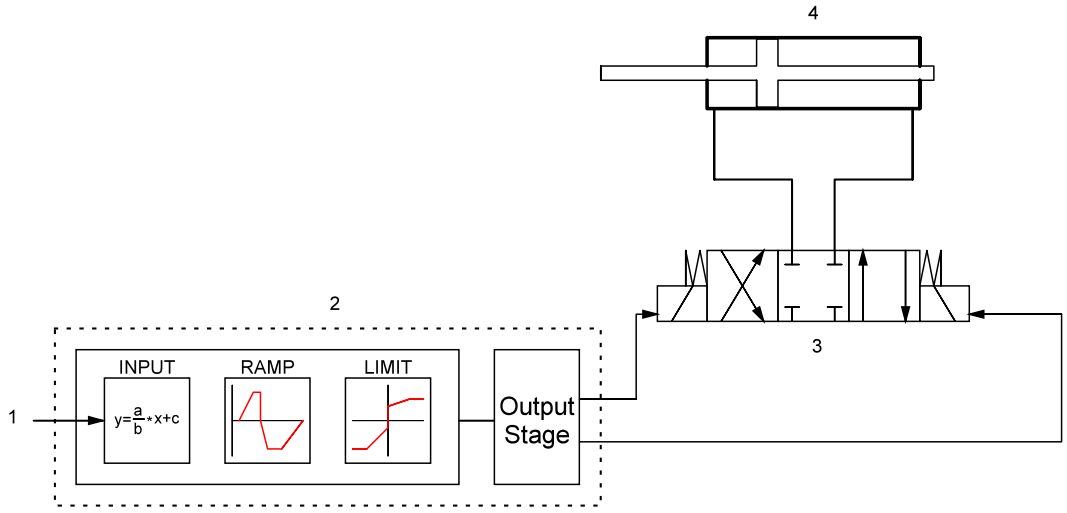
Due to safety reasons the switching takes places within protected conditions.

4.2 LED indications

LEDs	**Description of the LED function**
GREEN + YELLOW	Chasing light (over all LEDs): The bootloader is active. No normal functions are possible. 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 + YELLOW	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 PS1 software. 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.
GEEN	Identical to the READY output. OFF: No power supply or ENABLE is not activated ON: System is ready for operation Flashing: Error detected (e. g. valve solenoid or 4… 20 mA INPUT). Not active when SENS = OFF.
YELLOW	LED in the middle position = Current, Channel A; the intensity is proportional to the output current LED in the right position = Current, Channel B; the intensity is proportional to the output current

4.3 Control of directional valves (Function 195)

4.3.1 Typical system structure



This system consists of the following components:

1. Interface to PLC with analog and digital signals
2. Power amplifier EVM-UIS-2600-2-30D-A1
3. Proportional valve
4. Hydraulic cylinder

4.3.2 Method of operation

This power amplifier is controlled by an analogue signal (from the PLC, from a joystick or a potentiometer). An ENABLE signal (typically 24V) activates the module and the READY output indicates this, if no internal or external error was detected.

The integrated standard functions will be configured via different parameters.

In case of a fault, the power output stage will be deactivated and the fault will be indicated through a deactivated READY output and a flashing READY LED. To leave the error state the ENABLE has to be reset.

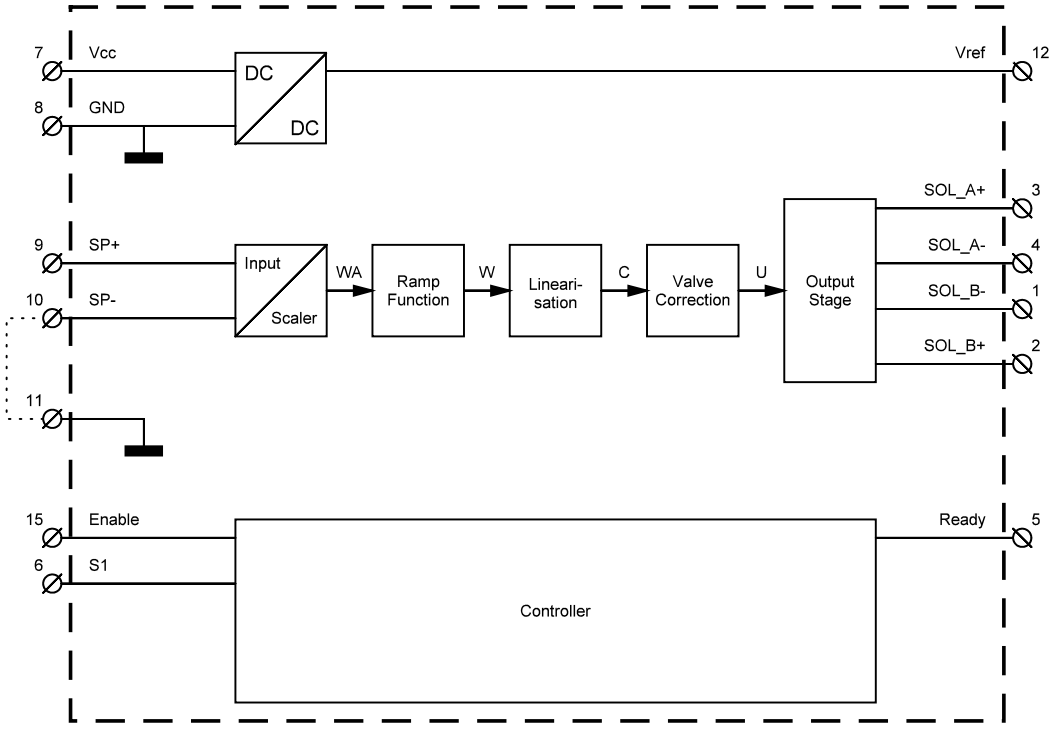
The output current is closed loop controlled whereby a high accuracy and a good dynamic will be obtained. All custom proportional valves (up to 2.6A) may be controlled with this power amplifier.

4.3.3 Input and output signals

Connection	Supply
PIN 7	Power supply (see technical data)
PIN 8	0 V (GND) Power supply (ground).
Connection	**Reference voltages output**
PIN 12	Reference output voltage (8 V).
Connection	**PWM output**
PIN 3 / 4	Current controlled PWM outputs for solenoid A.
PIN 1 / 2	Current controlled PWM outputs for solenoid B.
Connection	**Analogue input signals**
PIN 9 / 10	Command signal (W), range -100…100 % corresponds with -10…10 V or 4…20 mA, scalable.
PIN 11	0 V reference for the signal inputs (potential from PIN 8).
Connection	**Digital inputs and outputs**
PIN 15	Enable Input: General enabling of the application.
PIN 6	S1 input: Function depends on parameter PIN 6 (USCALE/RAMP). OFF: Output current depends on parameter USCALE; ramp function is deactivated. ON: Output current is not scaled by USCALE, ramp function is activated.
PIN 5	READY output: ON: Module is ready, no errors are detected OFF: ENABLE is deactivated or an error is detected.

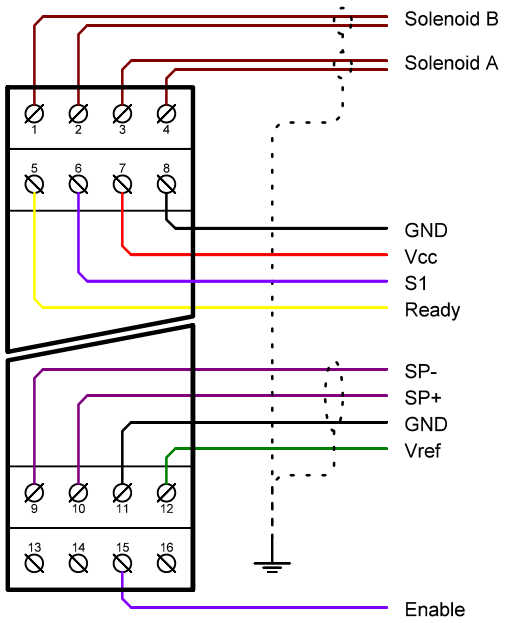
4.3.4 Block diagram

EVM-UIS-2600-2-30D-A1 [Function 195]



4.3.5 Typical wiring

EVM-UIS-2600-2-30D-A1 [Function 195]



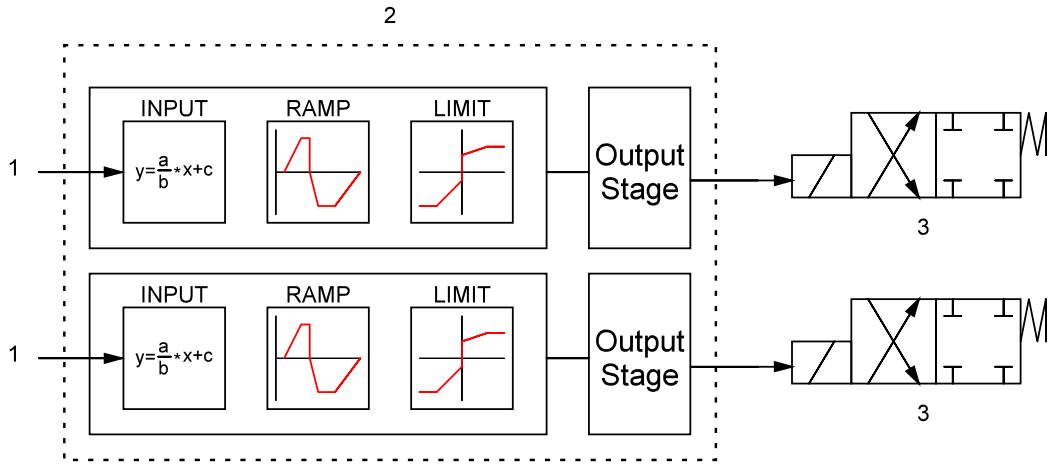
4.3.6 Parameter list

Command	Default	Unit	Description
FUNCTION	195	-	Defining functionality
LG	EN	-	Changing language help texts
MODE	STD	-	Parameter mode (standard or expert)
SENS	AUTO	-	Activation and deactivation of the monitoring functions
CCMODE	OFF	-	Activation and deactivation of the characteristic linearization
PIN 5	RDY	-	Switching function of PIN 5
PIN 6	USCALE	-	Switching function of PIN 6
USCALE	10000	0.01 %	Output current scaling depending on PIN:6
LIM	0	0.01 %	Range of the input signal monitoring (e. g. detecting failures of joysticks)
POL	+	-	Changing output polarity
AINA	V	-	Simple input switchover between current (4...20 mA) and voltage (±10 V)
AIN:A	A: 1000 B: 1000 C: 0 X: V	-	Free scaling of the analogue input signal.
AA:1 AA:2 AA:3 AA:4	100 100 100 100	ms ms ms ms	Four quadrant ramp times
CC:-10…+10	X Y	-	Linearization function
MIN:A MIN:B	0 0	0.01 % 0.01 %	Zero-point adjustment / Compensation of the deadband
MAX:A MAX:B	10000 10000	0.01 % 0.01 %	Scaling of the maximum output signal
TRIGGER	200	0.01 %	Trigger point for activating the MIN value
CURRENT	1000	mA	Nominal output current
DAMPL	500	0.01 %	Dither amplitude
DFREQ	121	Hz	Dither frequency
PWM	2604	Hz	PWM frequency.

Command	Default	Unit	Description
ACC	ON	-	Automatic adjustment of PPWM and IPWM parameters
PPWM IPWM	7 40	- -	Control parameter for the current control loop

4.4 Control of two throttle or pressure valves (Function 196)

4.4.1 Typical system structure



This system consists of the following components:

1. Interface to PLC with analog and digital signals
2. Power amplifier EVM-UIS-2600-2-30D-A1
3. Proportional valves

4.4.2 Method of operation

This power amplifier is controlled by an analogue signal (from the PLC, from a joystick or a potentiometer). ENABLE signals (typically 24V) activate the power stages and the READY output indicates this, if no internal or external error was detected.

The integrated standard functions will be configured via different parameters.

In case of a fault, the power output stage will be deactivated and the fault will be indicated through a deactivated READY output and a flashing READY LED. To leave the error state the ENABLE has to be reset.

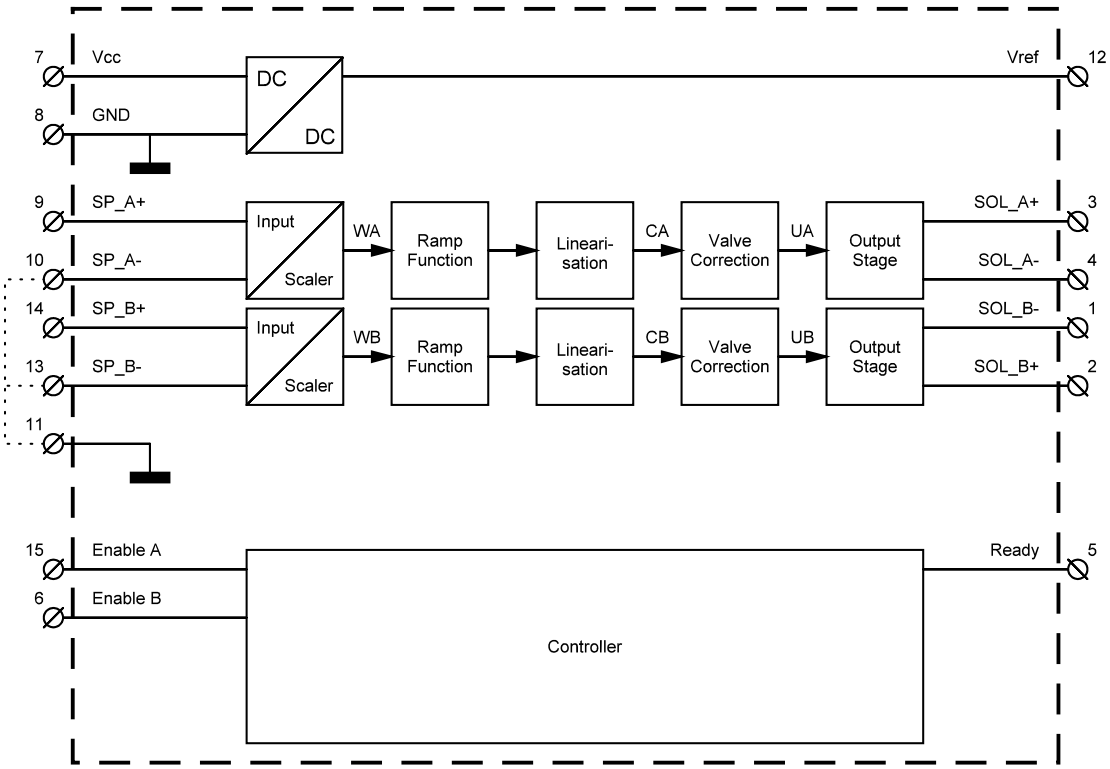
The output current is closed loop controlled whereby a high accuracy and a good dynamic will be obtained. All custom proportional valves (up to 2.6A) may be controlled with this power amplifier.

4.4.3 Input and output signals

Connection	Supply
PIN 7	Power supply (see technical data)
PIN 8	0 V (GND) Power supply (ground).
Connection	**Reference voltages output**
PIN 12	Reference output voltage (8 V)
Connection	**PWM output**
PIN 3 / 4	Current controlled PWM outputs for solenoid A
PIN 1 / 2	Current controlled PWM outputs for solenoid B
Connection	**Analogue input signals**
PIN 9 / 10	Command (input) signal A, 0…100 % corresponds with 0…10 V or 4…20 mA, scalable.
PIN 13 / 14	Command (input) signal B, 0…100 % corresponds with 0…10 V or 4…20 mA, scalable.
PIN 11	0 V reference for the signal inputs (potential from PIN 8).
Connection	**Digital inputs and outputs**
PIN 15	Enable Input Channel A/B or Channel A (dependent on ENABLE_B): General enabling of the application (Channel A).
PIN 6	Enable Input Channel B (dependent on ENABLE_B): General enabling of the application of Channel B.
PIN 5	READY output: ON: No internal or external errors are detected. OFF: Both power stages are deactivated or an error is detected.

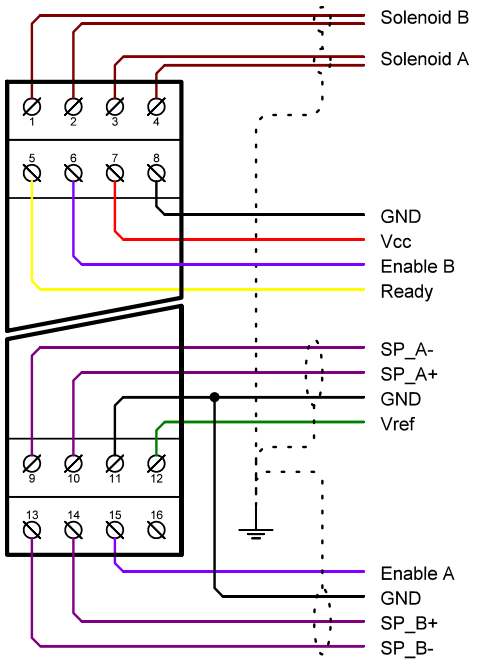
4.4.4 Block diagram

EVM-UIS-2600-2-30D-A1 [Function 196]



4.4.5 Typical wiring

EVM-UIS-2600-2-30D-A1 [Function 196]



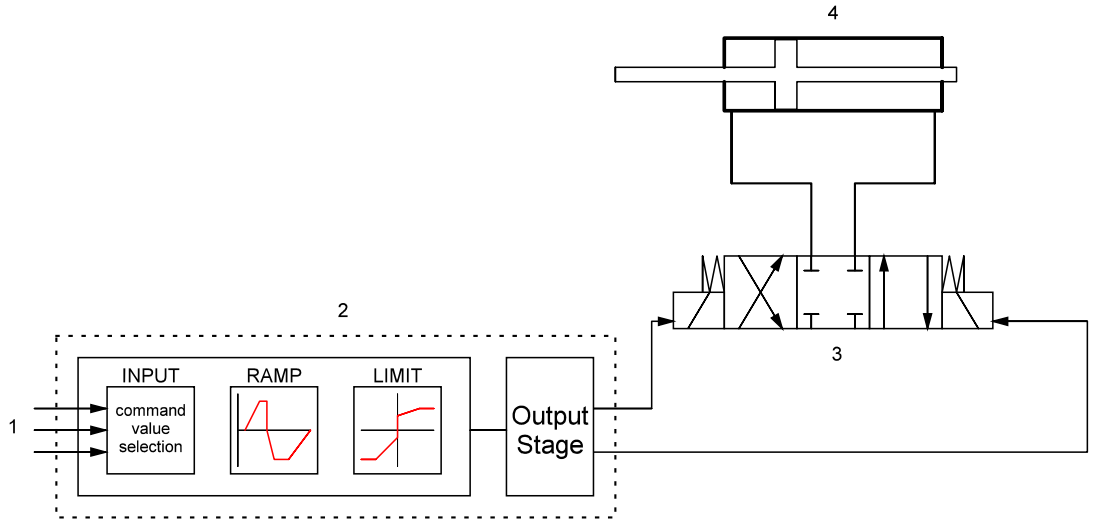
4.4.6 Parameter list

Command	Default	Unit	Description
FUNCTION	196	-	Defining functionality
LG	EN	-	Changing language help texts
MODE	STD	-	Parameter mode (standard or expert)
SENS	AUTO	-	Activation and deactivation of the monitoring functions
CCMODE	OFF	-	Activation and deactivation of the characteristic linearization
ENABLE_B	OFF		OFF = Enable for both channels via PIN 15
LIM:A LIM:B	0 0	0.01 % 0.01 %	Range of the input signal monitoring (e. g. detecting failures of joysticks)
POL:A POL:B	+ +	- -	Changing output direction
AINA AINB	V V	- -	Simple input switchover between current (4...20 mA) and voltage (±10 V). Command is active if MODE = STD.
AIN:B AIN:B	a: 1000 b: 1000 c: 0 X:V	0.01 %	Free scaling of the analogue input signal
AA:UP AA:DOWN	100 100	ms ms	Two quadrant ramp Channel A
AB:UP AB:DOWN	100 100	ms ms	Two quadrant ramp Channel B
CCA CCB	x y x y	- -	Linearization function
MIN:A MIN:B	0 0	0.01 % 0.01 %	Compensation of the dead band
MAX:A MAX:B	10000 10000	0.01 % 0.01 %	Scaling of the max. output signal
TRIGGER	200	0.01 %	Trigger point for activating the MIN value.
CURRENT:A CURRENT:B	1000 1000	mA mA	Nominal output current.
DAMPL:A DAMPL:B	500 500	0.01 % 0.01 %	Dither amplitudes. Related to the nominal output current.
DFREQ:A DFREQ:B	121 121	Hz Hz	Dither frequency

Command	Default	Unit	Description
PWM:A PWM:B	2604 2604	Hz Hz	PWM frequency
ACC	ON	-	Automatic adjustment of PPWM and IPWM parameters
PPWM:A PPWM:B IPWM:A IPWM:B	7 7 40 40	- - - -	Parameters for the closed loop current controllers

4.5 Control of proportional valves by preprogrammed values and ramp times (Function 197)

4.5.1 Typical system structure



This system consists of the following components

1. Interface to PLC with three digital input signals to select eight demand values
2. Power amplifier EVM-UIS-2600-2-30D-A1
3. Proportional valve
4. Hydraulic cylinder

4.5.2 Method of operation

This power amplifier is controlled by 3 digital signals (e. g. from the SPS/PLC). An ENABLE signal (typically 24 V) activates the module and the READY output indicates this, if no internal or external error was detected.

The integrated standard functions will be configured via different parameters.

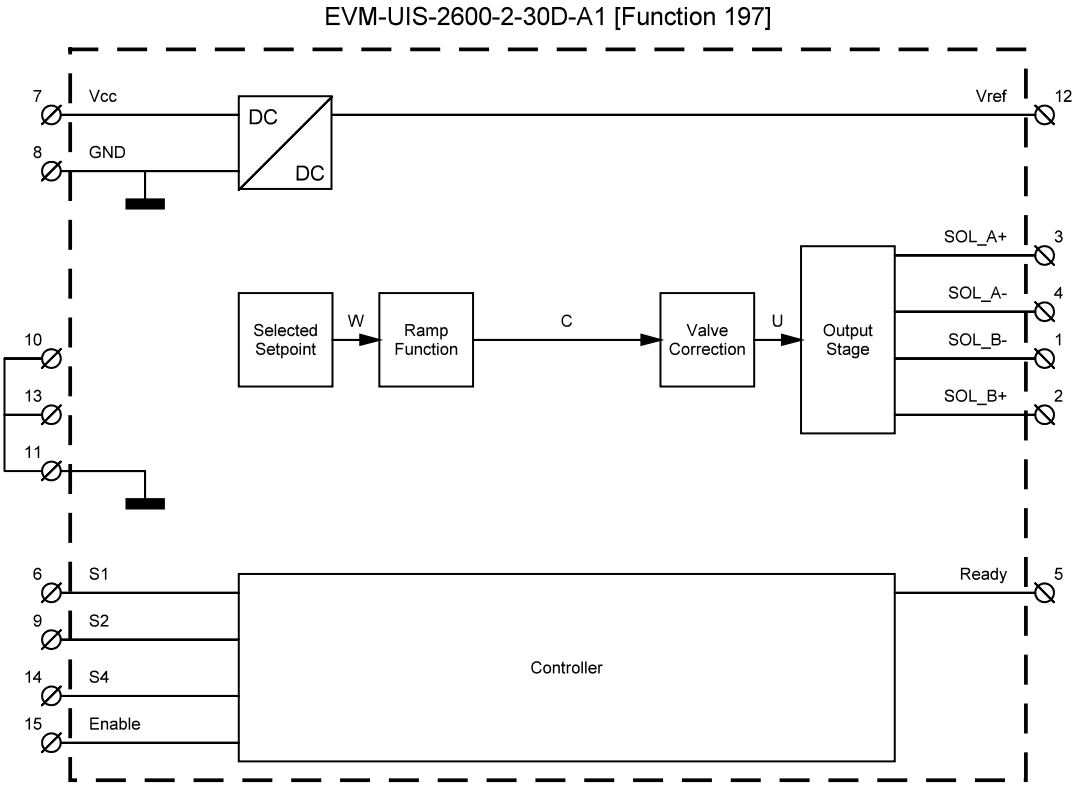
In case of a fault, the power output stage will be deactivated and the fault will be indicated through a deactivated READY output and a flashing READY LED. To leave the error state the ENABLE has to be reset.

The output current is closed loop controlled whereby a high accuracy and a good dynamic will be obtained. All custom proportional valves (up to 2.6A) may be controlled with this power amplifier.

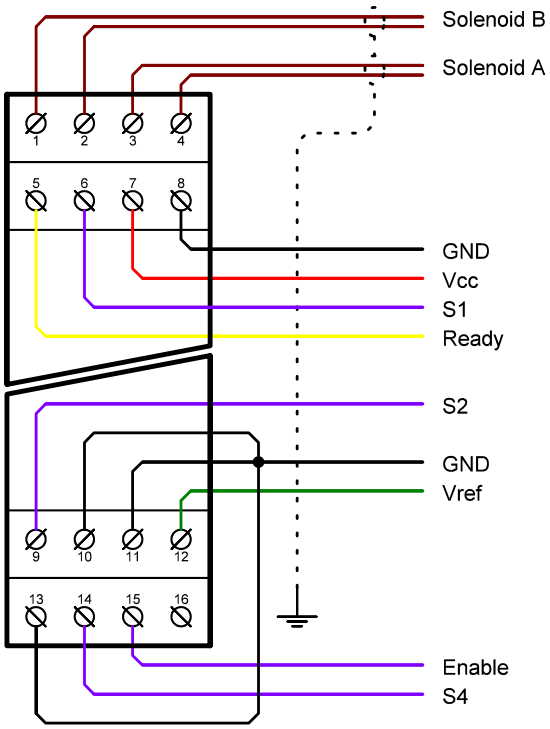
4.5.3 Input and output signals

Connection	**Supply**
PIN 7	Power supply (see technical data)
PIN 8	0 V (GND) Power supply (ground).
Connection	**Reference voltages output**
PIN 12	Reference output voltage (8 V).
Connection	**PWM output**
PIN 3 / 4	Current controlled PWM outputs for solenoid A
PIN 1 / 2	Current controlled PWM outputs for solenoid B.
Connection	**Analogue input signals**
PIN 6 / 9 / 14	Digital gate inputs for selecting the command value: PIN 6: S1 PIN 9: S2 PIN 14: S4 The whole range of set points can be chosen by binary coding of these inputs.
PIN 11	0 V reference for the signal inputs (potential of PIN 8).
Connection	**Digital inputs and outputs**
PIN 15	Enable Input: General enabling of the application.
PIN 5	READY output: ON: No internal or external errors are detected OFF: ENABLE is deactivated or an error is detected

4.5.4 Block diagram



4.5.5 Typical wiring

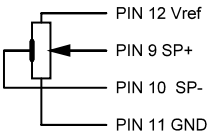


4.5.6 Parameter list

Command	Default	Unit	Description
FUNCTION	197	-	Defining functionality
LG	EN	-	Changing language help texts
MODE	STD	-	Parameter mode (standard or expert)
SENS	AUTO	-	Activation and deactivation of the monitoring functions
PIN 5	RDY	-	Switching function of PIN 5
SOLENOIDS	2	-	Switchover between one and two solenoids
RMODE	SD	-	Ramp function
S:0…7	0	0.01 %	Command values selectable by switching inputs
RA:0…7	100	ms	Ramp times
AA:1 AA:2 AA:3 AA:4	100 100 100 100	ms ms ms ms	Four quadrant ramp time
MIN:A MIN:B	0 0	0.01 % 0.01 %	Compensation of the dead band
MAX:A MAX:B	10000 10000	0.01 % 0.01 %	Scaling of the max. output signal
TRIGGER	200	0.01 %	Trigger point for activating the MIN value
CURRENT	1000	mA	Nominal output current
DAMPL	500	0.01 %	Dither amplitude
DFREQ	121	Hz	Dither frequency
PWM	2604	Hz	PWM frequency.
ACC	ON	-	Automatic adjustment of PPWM and IPWM parameters
PPWM IPWM	7 40	- -	Control parameter for the current control loop

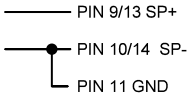
4.6 Examples for Input connections

Joystick



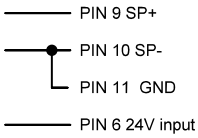
AIN: W 2000 800 4000 V (for ±100%)

PLC 0...10V / ± 10V



AIN: W 1000 1000 0 V (for ±100%)

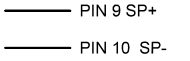
0...10V to ±100% with polarity switch



AIN: W 1000 1000 0 V (for 0...100%)

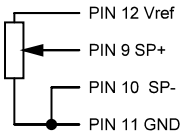
Parameter S1=-10000

4...20mA input



AIN: W 2000 1600 2000 C (for 0...100%)
AIN: W 2000 800 6000 C (for ±100%)

Potentiometer



AIN: W 1000 800 0 V (for 0...100%)
AIN: W 2000 800 4000 V (for ±100%)

4.7 Technical data

Supply voltage (Ub) Current consumption w/o solenoid External protection	[VDC] [mA] [A]	12… 30 (incl. ripple) < 30 3 medium time lag
Reference output Voltage Max. load	 [V] [mA]	 8 25
Digital inputs OFF ON Input resistance	 [V] [V] [kOhm]	 < 2 > 10 25
Digital outputs OFF ON Max. output current	 [V] [V] [mA]	 < 2 max. Ub 50
Analog inputs: Voltage Input resistance Current Burden Signal resolution	 [V] [kOhm] [mA] [Ohm] [%]	Unipolar/differential 0… 10 / -10… 10 min. 90 4...20 390 0.03
PWM output Max. output current Frequency	 [A] [Hz]	Wire break and short circuit monitored 2.6 61… 2604 selectable in defined steps
Controller cycle times Solenoid current control Signal processing	 [µs] [ms]	 125 1
Serial interface Transmission rate	- [Baud]	USB - virtual COM Port 9600… 115200
Housing Material Color Flammability class	 - - -	Snap-on module acc. EN 50022 PA 6.6 polyamide black V0 (UL94)
Weight	[g]	190
Protection class Temperature range Storage temperature Humidity Vibration resistance	[IP] [°C] [°C] [%] -	20 -20… 60 -20… 70 < 95 (non-condensing) IEC 60068-2-6 (Category C)

Connections Communication Plug connectors PE	-	 USB type B 4 x 4-pole terminal blocks via the DIN mounting rail
EMC		EN 61000-6-2: 8/2005 EN 61000-6-4: 6/2007 + A1:2011

5 Parameter description

5.1 FUNCTION (Function mode)

Command	Parameter	Unit	Group	FUNCTION
FUNCTION x	x= 195|196|197	-	STD	195 196 197

The general function of the module will be defined by this command.

195 Functionality for directional valves with two solenoids and analogue input signals

196 Functionality for two pressure/throttle valves with analogue input signals

197 Functionality for directional, pressure and throttle valves with pre-programmed values, selectable by digital inputs.

After changing this parameter the speed button "ID" in the PS1 software has to be pressed in order to rebuild the parameter table and a SAVE has to be conducted.

5.2 LG (Changing the language for the help texts)

Command	Parameter	Unit	Group	Function
LG X	x= DE | EN	-	STD	195 196 197

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 software.

5.3 MODE (Switching between parameter groups)

Command	Parameter	Unit	Group	Function
MODE x	x= STD | EXP	-	STD	195 196 197

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.

5.4 SENS (Failure monitoring)

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. This mode should be used in case of active enabling and monitoring by a PLC (READY signal).
OFF	No monitoring function is active.
AUTO	Auto reset mode. All monitoring functions are active. If the failure does not 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 especially for troubleshooting.

AUTO MODE: The module checks each second the actual failure status, which will (in case of a persistent error) trigger the LED and the READY output for a short time.

5.5 CCMODE (Activation of the characteristic linearization)

Command	Parameter	Unit	Group	Function
CCMODE x	x= ON | OFF	-	EXP	195 196

This command will be used for activation or deactivation of the characteristics linearization (CC, CCA and CCB). Through deactivating this parameter a simple and quick estimation of the linearization is possible.

5.6 SOLENOIDS (One or two solenoids)

Command	Parameter	Unit	Group	Function
SOLENOIDS x	x= 1 | 2	-	STD	197

This parameter allows you to adapt the amplifier to valves with one solenoid (e.g. pressure valves) or to such with two solenoids (directional valves).

5.7 PIN 5 (Choice of the additional function of PIN 5)

Command	Parameter	Unit	Group	Function
PIN 5 x	x= RDY | SOL	-	EXP	195

Über dieses Kommando werden optionale Funktionen des PIN 5 ausgewählt:

RDY: Standard READY output.

SOL: Detection of the activated solenoid.

0 = solenoid A is active

1 = solenoid B is active

5.8 PIN 6 (Choice of the additional function of S1/PIN 6)

Command	Parameter	Unit	Group	Function
PIN:6 x	x= USCALE | RAMP	-	EXP	195

This parameter defines the functionality of digital input PIN 6:

USCALE: PIN 6 = active, USCALE will not scale the output

PIN 6 = inactive, the output may be scaled by the USCALE parameter.

Ramps are active.

RAMP: PIN 6 = active, the internal ramp generator is activated.

PIN 6 = inactive, the internal ramp generator is deactivated.

USCALE is inactive.

5.9 USCALE (Output current scaling depending on PIN 6)

Command	Parameter	Unit	Group	Function
USCALE x	x= -10000… 10000	0.01 %	EXP	195

If the parameter PIN 6 is set to USCALE and the digital input S1 (PIN 6) is off, this parameter scales the output current. The default setting is 10000 (100 %) which does not change the output.

If USCALE is set to -10000 the polarity of the output will be flipped by switching the digital input S1, which allows for controlling the module with a unipolar analogue signal.

5.10 ENABLE_B (Switching of the ENABLE Function)

Command	Parameter	Unit	Group	Function
ENABLE_B x	x= ON | OFF	-	EXP	196

The setting of this parameter activates independent enable signals for channel A and B. If set to OFF, digital input PIN 15 enables both output channels. If set to ON, digital input PIN 15 enables only channel A and digital input PIN 6 enables channel B. If only one solenoid is to be controlled, ENABLE_B has to be set to ON and only the corresponding digital input has to be switched on.

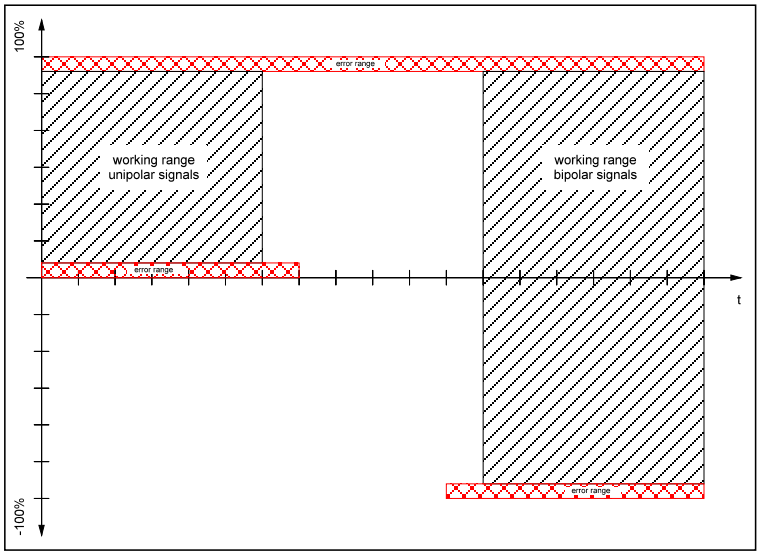
5.11 LIM (Signal monitoring)

Command	Parameter	Unit	Group	Function
LIM:I x	i= A | B x= 0… 2000	0.01 %	EXP	196
LIM x	x= 0… 2000	0.01 %	EXP	195

The signal monitoring deactivates the output current and the READY output 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.



5.12 POL (Output reversal)

Command	Parameter	Unit	Group	Function
POL:I x	i= A | B x= + | -	-	STD	196
POL x	x= + | -	-	STD	195

Valves with one solenoid:

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 %.

This command allows a switch over of the output polarity.

5.13 AINA / AINB (Choice of Current- / Voltage input)

Command	Parameter	Unit	Group	Function
AINA x AINB x	x=V | C	-	STD	195 196

By the use of this command the type of input signal may be chosen between voltage (0...10 V or +/- 10 V) or current (4…20mA). If current is chosen, the shunt will be activated automatically.

5.14 AIN (Analogue input scaling)

Command	Parameter	Unit	Group	Function
AIN:I a b c x	i= A | B a= -10000… 10000 b= -10000… 10000 c= -10000… 10000 x= V | C	- - - 0.01 % -	EXP	 195 196

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). Last but not least (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.

Typical examples:

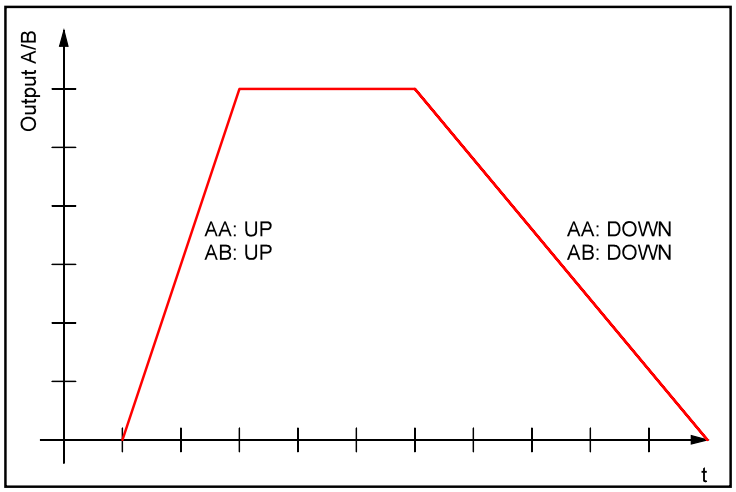
FUNCTION = 195				Input signal	Description
AIN:I	20	20	0 V	-10… 10 V	Voltages input: Usable -10… 10V (20V) for a working range of -100… 100% (two solenoids).
		OR			
AIN:I	1000	1000	0 V		
AIN:I	20	10	0 V	-5… 5 V	Voltages input: Usable -10… 10V (20V) for a working range of -100… 100% (two solenoids). Really used are -5… 5V (10V).
		OR			
AIN:I	2000	1000	0 V		
AIN:I	20	10	5000 V	0… 10 V	Voltages input: Usable -10… 10V (20V) for a working range of -100… 100% (two solenoids). Really used are only 0… 10V for both solenoids with 5V zero point setting (e.g. for joystick use).
		OR			
AIN:I	2000	1000	5000 V		
AIN:I	20	8	6000 C	4… 20 mA	Current input: theoretically usable range -20… 20mA (40mA) for a working range of -100… 100% (two solenoids). Really usable are only 4… 20mA (16mA) for both solenoids with 12mA zero point setting.
		OR			
AIN:I	2500	1000	6000 C		
FUNCTION = 196				**Input signal**	**Description**
AIN:I	10	5	0 V	0… 5 V	Voltages input: Usable 0… 10V for a working range of 0… 100% (one solenoid). Really used are 0… 5V for 0… 100%.
		OR			
AIN:I	2000	1000	0 V		
AIN:I	10	8	1000 V	1… 9 V	Voltages input: Usable 0… 10V for a working range of 0… 100% (one solenoid). Really used are 1… 9V (8V) for 100% with 10% offset.
		OR			
AIN:I	1250	1000	1000 V		
AIN:I	20	16	2000 C	4… 20 mA	Current input: theoretically usable range 0… 20mA for a working range of 0… 100% (one solenoids). Really usable are 4… 20mA (16mA).
		OR			
AIN:I	1250	1000	2000 C		

5.15 AA / AB (Ramp function / Acceleration time)

Command	Parameter	Unit	Group	Function
	i= UP | DOWN			
AA:I x	x= 1… 120000	ms	STD	196
AB:I x	x= 1… 120000	ms		

Two quadrant ramp function.

The first quadrant means the ramp up and the second quadrant means the ramp down time. The ramp time is related to 100 % signal step.

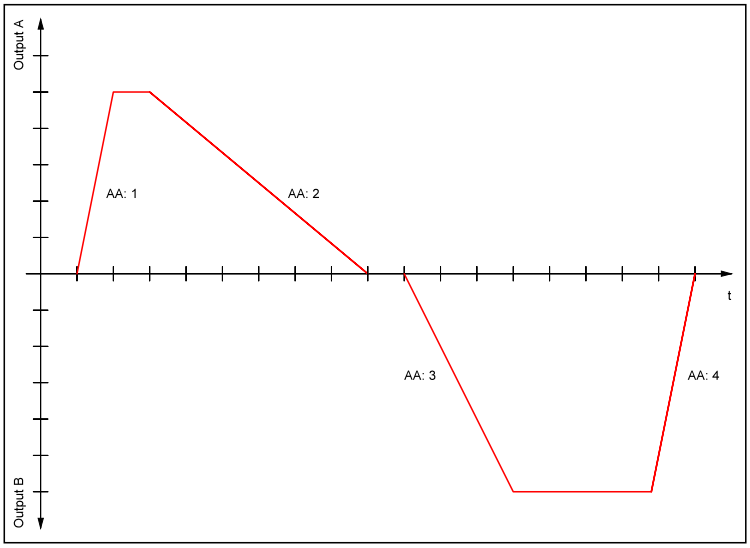


5.16 AA (Ramp function)

Command	Parameter	Unit	Group	Function
AA:I x	i= 1… 4 x= 1… 120000	- ms	STD	195 197

Four quadrants ramp function.

The first quadrant means the acceleration ramp for solenoid A and the second one stands for the deceleration ramp of solenoid A. According to this the third quadrant represents the acceleration ramp for solenoid B so that the fourth quadrant remains for the deceleration ramp for solenoid B.



5.17 RMODE (Choosing ramp function)

Command	Parameter	Unit	Group	Function
RMODE x	x= SD | 4Q	-	STD	197

This command allows the switching between a set point related ramp function (SD), which makes it possible to assign an individual ramp time for each command value, and a four quadrant ramp function (4Q) with set point independent ramp times for acceleration and deceleration in both directions.

5.18 S (Presetting command values)

Command	Parameter	Unit	Group	Function
S:I x	i= 0… 7 x= -10000… 10000	- 0.01 %	STD/EXP	197

With this parameter eight possible command values can be set. The binary value of the three digital inputs S1, S2 and S4 determines the setpoint.

Setpoint >	S:0	S:1	S:2	S:3	S:4	S:5	S:6	S:7
Input S1	0	1	0	1	0	1	0	1
Input S2	0	0	1	1	0	0	1	1
Input S4	0	0	0	0	1	1	1	1

5.19 RA (Ramp function / Acceleration time)

Command	Parameter	Unit	Group	Function
RA:I x	i= 0… 7 x= 1… 120000	- ms	STD	197

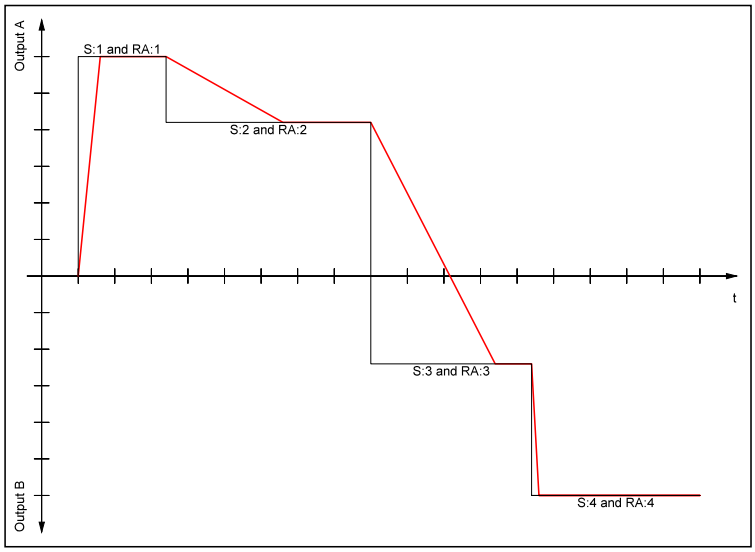
Presetting of the ramp times. Functionality depends on command RMODE.

RMODE = SD: In this mode every command value has its own ramp time. For example: if you choose set point S:1 also ramp time RA:1 is chosen.

RMODE = 4Q Four quadrants ramp function. See command AA (chapter 5.16)

5.20 CCA / CCB (Characteristics linearization)

Command	Parameter	Unit	Group	Function
CCA:I x y CCB:I x y	i= 0… 10 x= -10000… 10000 y= -10000… 10000	- 0.01 % 0.01 %	CCMODE=ON	196



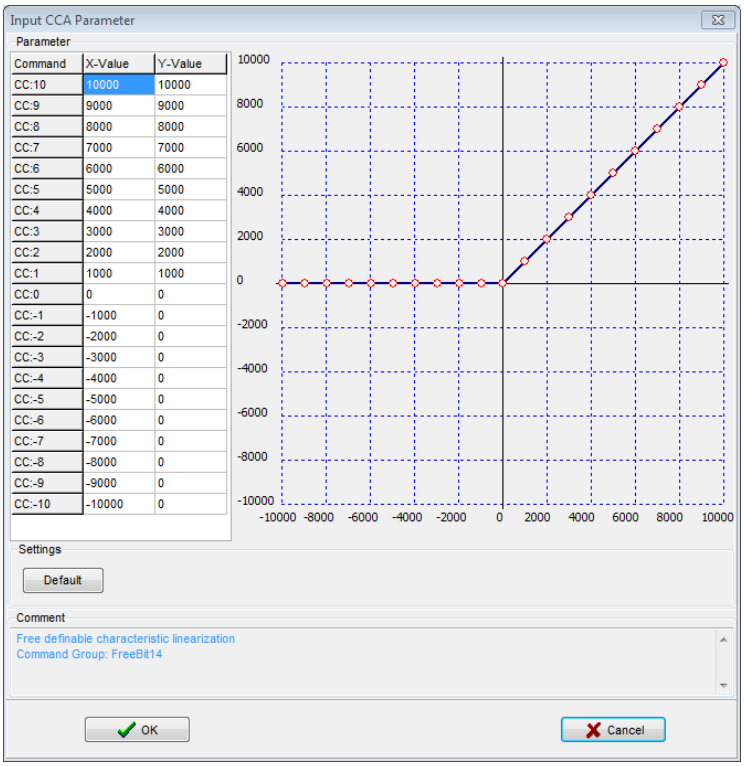
A user defined signal characteristic can be set by this function. For activating the parameter CCMODE has to be switched to ON.

In case of using single solenoid valves, only the first quadrant is active. The curve is calculated according to the equation of the linear interpolation

$$y = \frac{(x - x1) * (y1 - y0)}{(x1 - x0)} + y1$$

The influence of the linearization can be estimated via the process data on the monitor or on the oscilloscope.

For the input of the characteristics linearization, the PS1 provides a table and a graphic data input. The input signal is mapped on to the X-axis and the output signal is mapped on to the Y-axis.



5.21 CC (Characteristics linearization)

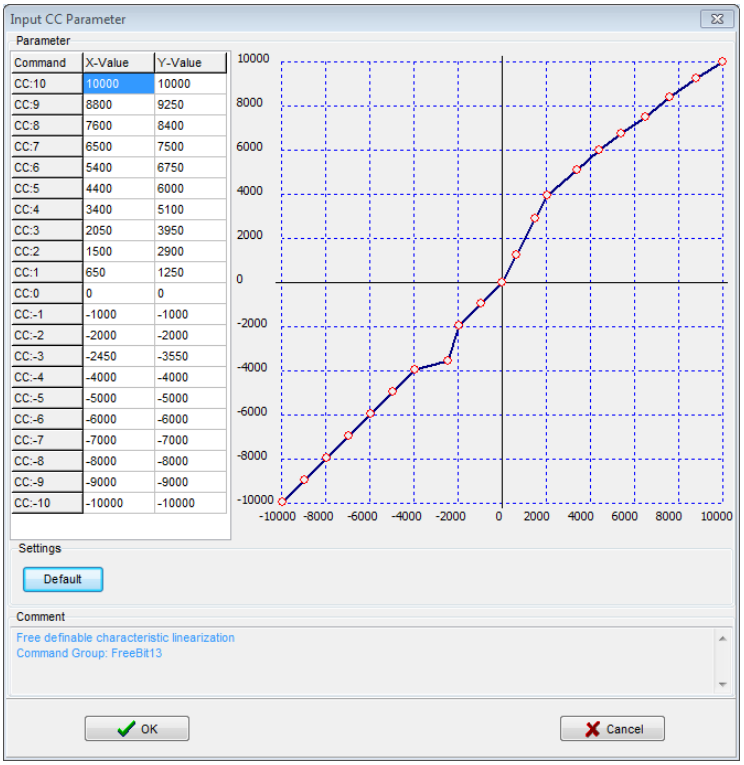
Command	Parameter	Unit	Group	Function
CC:I x y	i= -10… 10 x= -10000… 10000 y= -10000… 10000	- 0.01 % 0.01 %	CCMODE=ON	195 197

A user defined signal characteristic can be set by this function. For activating the parameter CCMODE has to be switched to ON. The positive indexes stand for the solenoid A, the negative ones represent the solenoid B. The curve is calculated according to the equation of the linear interpolation

$$y = \frac{(x - x1) * (y1 - y0)}{(x1 - x0)} + y1$$

The influence of the linearization can be estimated via the process data on the monitor or on the oscilloscope.

For the input of the characteristics linearization, the PS1 provides a table and a graphic data input. The input signal is mapped on to the X-axis and the output signal is mapped on to the Y-axis.

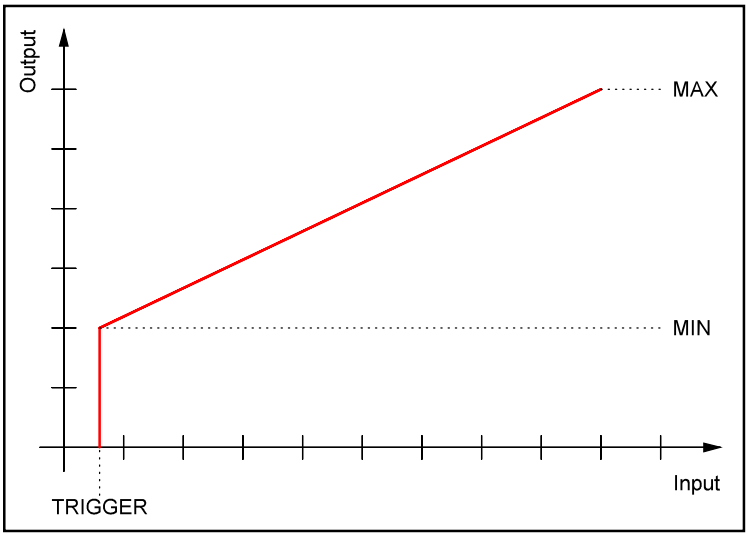


5.22 MIN (Overlap compensation) / MAX (output scaling) / TRIGGER (Threshold value of MIN)

Command	Parameter	Unit	Group	Function
	i= A | B	-	STD	196
MIN:I x	x= 0… 6000	0.01 %		
MAX:I x	x= 5000… 10000	0.01 %		
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 dead band is necessary, in order to avoid unrequested activations caused by small variations of the input signal.



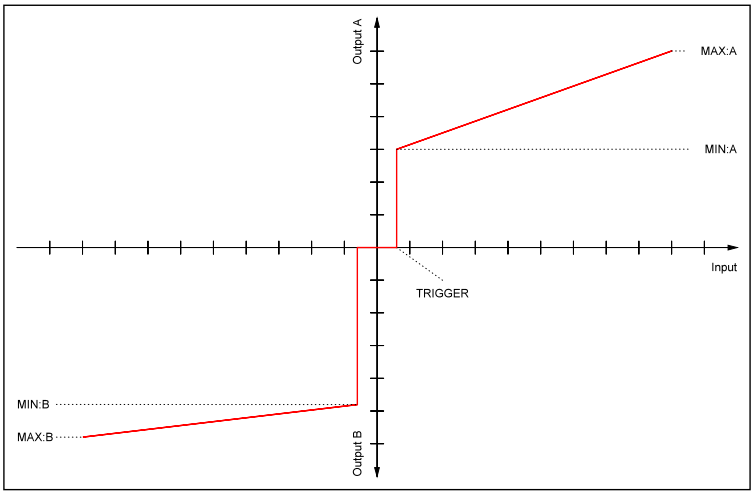
If the MIN value is set too high, it influences the minimal velocity, which cannot be adjusted any longer.

5.23 MIN (Overlap compensation) / MAX (Output scaling) / TRIGGER (Threshold value for MIN)

Command	Parameter	Unit	Group	Function
	i= A | B	-		
MIN:I x	x= 0… 6000	0.01 %	STD	195
MAX:I x	x= 5000… 10000	0.01 %		197
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 the activation point of the MIN function is set and so a non-sensitive range around the zero-point can be specified. 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 a position controls, the TRIGGER value should be reduced (typical: 1…10).



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

5.24 CURRENT (Nominal output current)

Command	Parameter	Unit	Group	Function
CURRENT:I x	i= A | B x= 500… 2600	mA	STD	196
CURRENT x	x= 500… 2600	mA	STD	195 197

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

5.25 DAMPL / DFREQ (Dither amplitude and Dither frequency)

Command	Parameter	Unit	Group	Function
DAMPL:I x DFREQ:I x	i= A | B x= 0… 3000 x= 60… 400	- 0.01 % Hz	STD	196
DAMPL x DFREQ x	x= 0… 3000 x= 60… 400	0.01 % Hz	STD	195 197

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.

5.26 PWM (PWM Frequenz)

Command	Parameter	Unit	Group	Function
PWM:I x	i= A | B x= 61… 2604	- Hz	EXP	196
PWM x	x= 61… 2604	Hz	EXP	195 197

The frequency can be changed in the 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.

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.

5.27 ACC (Auto adaptation of the closed loop current controller)

Command	Parameter	Unit	Group	Function
ACC x	x= ON | OFF	-	EXP	195 196 197

Operation mode of the closed loop current control.

ON	In automatic mode PPWM and IPWM are calculated depending on the preset PWM-frequency.
OFF	Manual adjustment

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

Command	Parameter	Unit	Group	Function
	i= A | B	-		
PPWM:I x	x= 0… 30	-	EXP	196
IPWM:I x	x= 1… 100	-		
PPWM x	x= 0… 30	-	EXP	195
IPWM x	x= 1… 100	-		197

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

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

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

IPWM = 40… 80.

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

PPWM = 7

IPWM = 40

should be chosen.

5.29 PROCESS DATA (Monitoring)

Command	Description	Unit	Function
W	Command value after input scaling	%	
C	Command value after linearization	%	
U	Command value to current controller	%	**195**
IA	Output current of solenoid A	mA	
IB	Output current of solenoid B	mA	
Command	**Description**	**Unit**	**Function**
WA	Command value after input scaling channel A	%	
CA	Command value after linearization channel A	%	
UA	Command value to current controller channel A	%	
WB	Command value after input scaling channel B	%	
CB	Command value after linearization channel B	%	**196**
UB	Command value to current controller channel B	%	
IA	Output current of solenoid A	mA	
IB	Output current of solenoid B	mA	
Command	**Description**	**Unit**	**Function**
W	Chosen command value	%	
C	Command value after ramp function	%	
U	Command value to current controller	%	**197**
IA	Output current of solenoid A	mA	
IB	Output current of solenoid B	mA	

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

6 Appendix

6.1 Failure monitoring

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

Source	Fault	Characteristics
Command signal PIN 9 / 10 or Command signal PIN 14 / 13, 4...20mA	Out of range	The power stage is deactivated.
Command signal PIN 9 / 10 or Command signal PIN 14 / 13, LIM function	Out of range	The power stage is deactivated.
Solenoid A PIN 3 / 4 Solenoid B PIN 1 / 2	Broken wire	The power stage is deactivated.
EEPROM (monitored during power on procedure)	Data error	The power stage is deactivated. The module can be activated by saving new parameters (pressing of the SAVE Button).

6.2 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
ENABLE is active, the module does not respond, and the READY LED is off.	Probably the power supply is disconnected or the ENABLE signal is not present. If there is no power supply there is also no communication via our operating program. If the connection to the PS1 exists, the power supply is also available. In this case the availability of the ENABLE signal can be checked via the monitor.
ENABLE is active, the READY LED is flashing.	The flashing READY LED indicates that a fault is detected by the module. The fault could be: • Failure detection in case of current input. Input signal below 3 mA. • Failure detection in case of active LIM function (for example joystick monitoring) Input signals are out of range. • A broken cable or incorrect wiring to the solenoids. • Internal data error: execute the command / press the button SAVE to delete the data error. The system reloads the DEFAULT data. With the PS1 software the failure can be localized directly via the monitor.

7 History

Revison	Datum	Kurzzeichen	Bemerkung
00	30.08.2021	FT / MAK	Initiale Version