INSTRUCTION MANUAL FOR THE USE OF

Digital Module Amplifier for Proportional (with feedback)

EL8

EN

Important! Read the instructions carefully before using the product.
Save the instructions for future reference.

If the instructions of use are lost, new ones can be found on the ARGO-HYTOS website www.argo-hytos.com.

This is the original instruction manual number 19155 _2en_de_cz_06/2024, issued by the manufacturer:

ARGO-HYTOS s.r.o.
Dělnická 1306, CZ 543 01 VRCHLABÍ
Info.cz@argo-hytos.com
☎ **+ 420 499 403 111**

HCS
Hydraulic Control Systems

EC Declaration of Conformity in accordance with EMC Directive 2014/30/EU

HCS Hydraulic Control Systems GmbH
Neuffener Str. 29
D-72636 Frickenhausen

hereby declares that the product described as follows complies in terms of its design, as well as in the version placed in the stream of commerce by us, with the relevant requirements of the directive. This declaration is void in the event of any change to the product without our written agreement.

Product:	Digital Amplifier and Controller Module
Intended use:	Automation systems (industrial applications)
Model:	DMA-22(A)-x
Rated voltage:	24 V DC; SELV
Rated power:	max. 100 W
Protection class:	III
Protection degree:	IP00 (IP20 on request)
Relevant EU Directive:	EMC Directive 2014/30/EU
Applicable EU Standards:	
Emissions:	EN 61000-6-3:2007 + A1:2011 EN 61000-6-4:2007 + A1:2011
Immunity:	EN 61000-6-2: 2005

Date/manufacturer's signature

01.08.2021

Details of signatory: Dipl.-Ing. (FH) Peter Deuschle (General Manager)

Figure 1: Declaration of conformity

Follow–up documents:
Product catalogue EL8_ha9155

1. List of Figures

Table 1: List of figures

2. List of Tables

Table 2: List of tables

3. Abbreviations

Abbreviation	Description
EL8	Electronic control unit 8
EMC	Electro Magnetic Compatibility; properties of the unit in order to comply with the EMC directive
USB	Universal Serial Bus; interface for communication between a PC and the EL8
PC	Personal Computer
µC	Micro Controller; CPU used inside the unit to control all functions
mamsl	meters above median sea level
IP65	Protection Class; solid particle protection and protection level against water ingress
LED	Light Emitting Diode
PWM	Pulse Width Modulation; method to control the output current at low power losses
Ub	Supply voltage
FS	Full Scale

Table 3: Abbreviations

4. Terms and Definitions

Term	Description
Amplifier module	Amplifier for proportional valves which has modular structure
AH Hub	Software tool provided by Argo-Hytos in order to adjust and parametrize EL8 units
CANopen	Bus interface for digital communication
USB-C connector	Connector type used on the USB interface

Table 4: Term and Definitions

5.1 Abstract

This document describes the function of the Argo-Hytos electronic control unit 8 "EL8".

This manual was prepared with great care and the contents reflect the author's best knowledge. However, the possibility of error remains and improvements are possible. Please feel free to submit any comments regarding errors or possibly incomplete information to Argo-Hytos GmbH.

DANGER!	**Read this manual carefully before working with the electronic control unit 8!** **The general and especially the safety instructions of this manual have to be observed in any case!** **Electronic equipment of all kind can have component failures or software may lead to unpredictable reactions. Secondary safety measures must be taken in order to ensure safety under all circumstances. This is especially the case for safety critical applications.** **Furthermore, it is the responsibility of the user to always comply with applicable safety standards (e.g. EN 13849) and to implement a system architecture capable to cover all safety requirements. The unit itself does not comply with and performance level given in EN 13849 or any SIL level as per EN 61508.** **Applicable laws and safety standards have to be observed at any time. Before commissioning or using the equipment the necessary risk analysis must be conducted and suitable protection measures must be taken.** **Argo-Hytos GmbH refuses any liability in case of omission to comply with these requirements**

5.2 Scope

With the help of this document a professional, competent and trained user should be able to install, wire, connect, commission, set parameters, perform fault analysis and fix issues. Also the document will provide the user any technical and operational details necessary to safely operate the product. It remains the users responsibility to set-up a safe working environment while operating the product.

The information contained in this manual is valid at the time of this version's release. See footer for version number and release date of this manual.

It is applicable for "EL8" Electronic control unit 8 with software version V1.02* or higher.

5.2.1 Copyright

5.2.2 Documents place of storage

This manual and all other associated documentation for hardware and software must always be kept in a location where they will be readily accessible and close to the digital amplifier module EL8 or the equipment in which it is installed.

5.2.3 Warning signs, symbols and notes

DANGER	Identifies safety instructions that are intended to warn of an immediate and impending danger to life and limb. Failure to observe these safety instructions will inevitably lead to death, serious personal injury (disablement)!
WARNING	Identifies safety instructions that are intended to warn of potential danger to life and limb. Failure to observe these safety instructions might lead to death, serious personal injury (disablement)!
CAUTION	Identifies safety instructions that are intended to warn of slight personal injury. Failure to observe these safety instructions might lead to slight personal injury
NOTICE	Failure to observe this safety notice can result in property damage!

Other identifiers (when applicable):

Identifier	Description
•/ -	Listings
□	References to another chapter, page, table or figure in this manual
blue text	Hhyperlink within the document
1., 2., …	Steps in a procedure that should be performed in consecutive order
'STATE'	States of a state machine
«ES»	LEDs of the amplifier (for example, «ES»)
< >	parameter name
"…"	Used for references

Table 5: Identifiers

5.2.4 Safety and liability

NOTICE

The information in this document is subject to change without further notice.
Argo-Hytos assumes no responsibility for any faults that may appear in this manual.

This operating manual represents the knowledge of Argo-Hytos and during the drafting of this operating manual the greatest possible care was taken. Nevertheless, Argo-Hytos 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.

Applicable laws and safety standards have to be observed at any time. Before commissioning or using the equipment the necessary risk analysis must be conducted and suitable protection measures must be taken.

This manual only describes the functionality and influence of the parameters. The described software functionality can be used in various amplifier models which can be implemented in a vast range of applications. Hence it is not possible to assume liability for the influence of the parameters.

Argo-Hytos GmbH refuses any liability in case of omission to comply with these requirements.

WARNING

In the case of applications with critical safety requirements or where accident prevention regulations must be observed, it may be necessary to isolate the components from the solenoids with relays in e-stop circuits.

To switch off the enable signal (0 V at terminal X3/1) is insufficient. In these cases, hydraulic and/or mechanical safety measures to stop the drive must be provided (e.g. through switching valves with position monitoring).

WARNING

All types of proportional directional valves, which may be used in all kinds of different environments and applications, can eventually fail and hence are able to cause damage.

It is the customers obligation to analyze all safety related aspects of the application. It is within the full responsibility of the machine builder and or system integrator to make the final selection of products and reassure and confirm that all requirements regarding safety and performance are met.

The procedure of selecting the proper control system and related safety levels is covered by the machine directive EN 13849.

NOTICE

Liability for any content of this document is rejected!

Any claims against Argo-Hytos GmbH – based on whatever legal reason – resulting from the use of the information, programs, engineering and performance data etc., described in this document shall be excluded. Exclusion in such cases shall not apply for mandatory liability, e.g. under the "Product Liability Act", in case of intent, gross negligence, or injury of life, body or health, guarantee for the quality of a product, fraudulent concealment of a deficiency or breach of a condition. Damages for breach of a substantial contractual obligation are, however, limited to the foreseeable damage, typical for the type of contract, except in the event of intent or gross negligence or injury to life, body or health. The above provisions do not imply a change of the burden of proof to your detriment.

We reserve the right to make changes to this document at any time without prior notice.

5.2.5 General information

WARNING	ESD (electrostatic discharge) may damage components with the module. In order to prevent any damage please always follow the recommendations below! Discharge static voltage from your body by using best practice. Work in safe environment and do not use any devices in the working surrounding which could generate or hold static charge. Avoid using the product in areas where floors or surfaces are composed of materials that could generate static charges. Handly all equipment very carefully and do not touch exposed pins or components. Store and transport the units only in its original packaging.

WARNING	During commissioning, particular attention must be paid to the correct design and realization of the wiring. This must be checked before applying the supply voltage. To avoid collisions, the safety devices and limit switches must be activated. All safety regulations are to be observed. Monitoring the fault signal (terminal X3/2 (10)) is recommended.

Malfunctions can occur with the following:

- Changes to the settings made by the supplier.
- Neglecting of operating parameters (e.g. supply voltage, application of inadmissible signals on inputs or outputs, ambient conditions, wiring, unsafe loads such as motors, contactors, relays, ohm loads, etc.)
- Faults in series-connected controls components and set points or actual values
- Faults in the subsequent hydraulic components
- Removing of solenoids connections

5.3 Terms and conditions

Please pay attention to our general terms and conditions (available on request).

5.4 Delivery state (default setting)

The product is shipped in a ready-to-use state (default settings). After correct installation and setting of all parameters relevant for the application, the amplifier module is ready for use.

5.5 Correct product use

The digital amplifier modules "EL8" are used for the following applications:

- Controlling of proportional valves (namely directional control valves); with feedback
- To convert set point signals into a current signal to control one proportional valve with two solenoids and a spool position feedback in the aforementioned valves.
- For industrial applications only.

The operation of other inductive or resistive loads is not recommended (motors, heaters, etc.). If you are considering any applications like this please contact Argo-Hytos GmbH.

If used correctly, the safety of the user as well as the safe and proper function of the amplifier EL8 is given.

5.6 Non-intended product use

The digital amplifier modules "EL8" should not be used in the following cases:

- if noticeably damaged
- when the electrical connections are damaged
- if they do not function correctly
- after incorrect handling or storage
- in non-appropriate applications or environments.

In these cases, the digital amplifier module must be disabled and secured against accidental restarting.

In the case of applications with critical safety requirements or where accident prevention regulations must be observed, it may be necessary to isolate the components from the solenoids with relays in e-stop circuits. In these cases, hydraulic and/or mechanical safety measures to stop the drive must be provided (e.g. through switching valves with position monitoring).

During commissioning, particular attention must be paid to the correct design and realization of the wiring. This must be checked before applying the supply voltage.

To avoid collisions, the safety devices and limit switches must be activated. All safety regulations are to be observed.

Malfunctions can occur when:

- Changes to the settings made by the supplier.
- Neglecting of operating parameters (e.g. supply voltage, application of inadmissible signals on inputs or outputs, ambient conditions, wiring, unsafe loads such as motors, contactors, relays, ohm loads, etc.)
- Faults in series-connected controls components and set points or actual values
- Faults in the subsequent hydraulic components
- Removing of solenoid connection.

5.7 Selection and qualification of personnel

Only qualified users may work with the amplifier. Qualified users are properly trained experts with the required knowledge and experience. In particular, these experts must have the authorization to bring into operation systems and power circuits in accordance with safety engineering standards. They must be familiar with safety concepts common in automation.

5.7.1 Inquiries and ordering

To order the product, the complete order code is requested.
See □ Chapter „6.4 Ordering code“, page 11

5.7.2 Service and repair

WARNING	Do not attempt - under any circumstances - to repair the product yourself

After repair, certain adjustments and test procedures must be performed; this can only be made by qualified and authorized personnel. Products that need repair can be sent to the addresses:
See □ Chapter „5.7.1 Inquiries and ordering“, page 9

Please enclose a detailed description of the error, malfunction or failure with the sent item and state the serial number and the purchase date. This will speed up the process and guarantees a fast and reliable repair.
See □ Chapter „5.7.1 Inquiries and ordering“, page 9

In the case of a fault or a malfunction, your distributor can give you instructions on the phone or in writing before accepting a repair order. For service and repair, we offer experienced and qualified personnel. In case you need our assistance, please contact the address:
See □ Chapter „5.7.1 Inquiries and ordering“, page 9

5.7.3 Cleaning, storage, transport

The product should only be transported and stored in the original packaging to ensure suitable protection against mechanical damage as well as electrostatic discharge.

› Keep the amplifier module away from moisture and dust
› Observe the allowed storage and transportation temperature range
› If it should be necessary to clean the amplifier, we recommend sending it back to the manufacturer or any distributor and partner:

See □ Chapter „5.7.1 Inquiries and ordering“, page 9

CAUTION	Unpacking and handling should be left to suitably trained personnel. Beware of damaging the amplifier by electrostatic discharge

5.7.4 Delivery state (default setting)

The product is shipped in a ready-to-use state (default settings). After correct installation and setting of all parameters relevant for the application, the digital amplifier module is ready for use.

5.8 Introduction

The digital amplifier module EL8 features leading edge technology. This electronic device meets the industrial standards for EMC. This ensures a high interference security and low interference emission.

The performance characteristics are possible through the use of the most current microprocessor technology (32 bit floating point CPU) combined with other state of the art components. In addition to all control functions, the microprocessor also handles closed-loop control. The system features are essentially determined by the software and provide reserve capacity for further developments and adaptations.

The following features distinguish the EL8 series:

› fully digitized amplifier module with the advantage of
  - no on-board potentiometer
  - no jumper settings required
  - digital setting and display of all parameters by means of PC with AH Hub
  - user safety during parameterization
› flexible and reliable system:
  - use of a modern 32 Bit floating point µC
  - high performance and yet power reserve
  - high reliability and safety through the use of a integrated watch-dog and reset function
  - variable settings for magnetic systems making high flexibility possible
› functional use of the interface:
  - change of selected parameters “on-the-fly” without interference or interruptions of the working cycle
  - analyzing of system performance through selection of display parameters with the PC and by using the 4-channel oscilloscope function included in AH Hub
  - bus interfaces available (PROFIBUS/PROFIDRIVE, PROFINET, ETHERNET/IP, CAN-OPEN)

5.9 General Applications

The amplifier module EL8 is used for

- proportional directional valves direct and pilot operated with feedback
- proportional flow control valves with feedback
- proportional cartridge valves with feedback
- proportional pressure reducing valves with feedback
- proportional pressure regulating valves with feedback
- cartridge valves with feedback
- all kinds of valves used in applications with process value feedback (e.g. cylinder position, pressure, velocity, rpm, etc.)

For versions to be used in open loop applications please contact your distributor or Argo-Hytos GmbH for further information.

5.10 Software version attribution

This manual is applicable for EL8 with software version V1.02* or higher!

6. Product overview and description

6.1 Technical Features

- External electronics for DIN rail is designed for control of single or double solenoid hydraulic valves in open or closed loop with spool position feedback
- The electronics continuously control the position of the valve spool proportional to the size of the input signal with minimal hysteresis
- The output control current for the solenoid coil is independent of temperature changes and changes in load impedance
- Control of the coil using a PWM signal reduces the hysteris characteristics of the valve and optimizes the accuracy of spool positioning
- At the core of the reliable and flexible electronics is a 32-bit processor with high performance reserve.
- The electronics are resistant to transmission errors. Intergrated algorithm for error correction prevents signal distortion during data transmission or storage

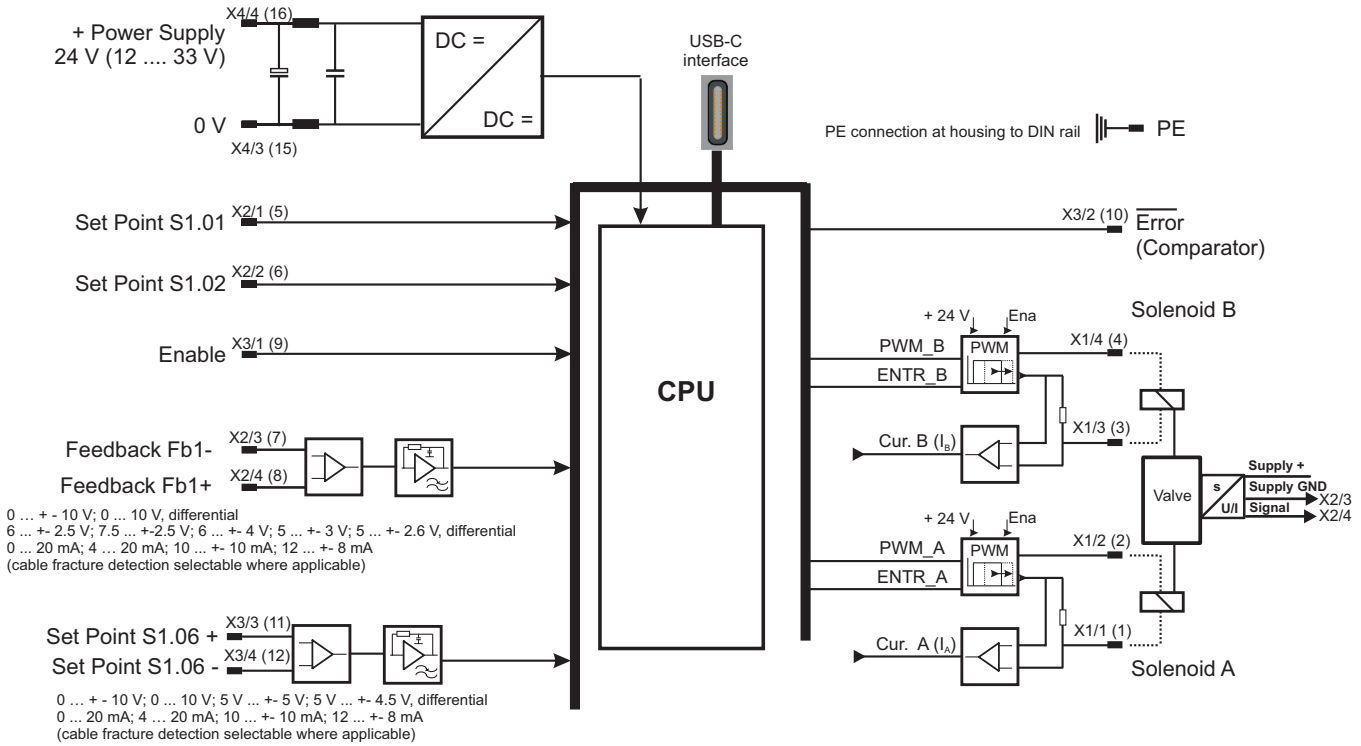
The correct connection is shown in the connection diagram.
See □ Chapter „7.4 Connectors for PRL2“, page 16

6.2 Technical Data

Electrical connection		16 (4 x 4) connecton pins 0,2 …2,5 mm²	
		Phoenix Combicon MSTBT 2,5/4-ST	
Processor resolution	bit	32-bit	
Resoloution of A/D converters	bit	16-bit	
PWM frequency	kHz	up to 22,2	
Connection for parameterization		USB-C	
Recommended cable cross section		For power supply: 1.5mm² (AWG16) for power suppply and coil; max. length = 50 m, For control signal : 0.5mm² with maximum length = 50 m.	
Cycle rate	ms	0,1	
Nominal coil voltage STD	V DC	12	24
Nominal coil voltage PRL	V DC	24 (+/- 10 %)	
LED signalization		Multi-colour status LED: Green = Working fine Yellow = Active input „ENABLE“ Red = Error	
Compensated temperature	°C (°F)	-40 ... +85 (-40 ... 185)	
Operating temperature	°C (°F)	-40 ... +70 (-40 ... 158)	
Air humidity		max. 95 % (uncondensed)	
Casing material		PA 66 - FR	
Dimensions	mm (in)	22,5 x 100 x 114 (0.89 x 3.94 x 4.49) [š x v x h (W x H x D)]	
Weight	kg (lbs)	0,13 (0.287)	
EMC resistance		EMC 2014/30/EU	
Degree of coverage		IP20	
Electrical parameters			
Supply voltage STD	V DC	10,8 … 28,8	
Supply voltage PRL	V DC	21,6 ... 28,8	
Analogue input signal		±10 V DC ; 4…20 mA	
Analogue input signal for feedback		±10 V DC ; 4…20 mA	
Input impedance (voltage; current)		U = 200 kΩ ; I = 255 Ω	
Digital output signal		2x PWM = 0,8 … 3,5 A	
Number of digital inputs		3 (S1.01; S1.02; ENABLE)	

Table 6: Technical Data

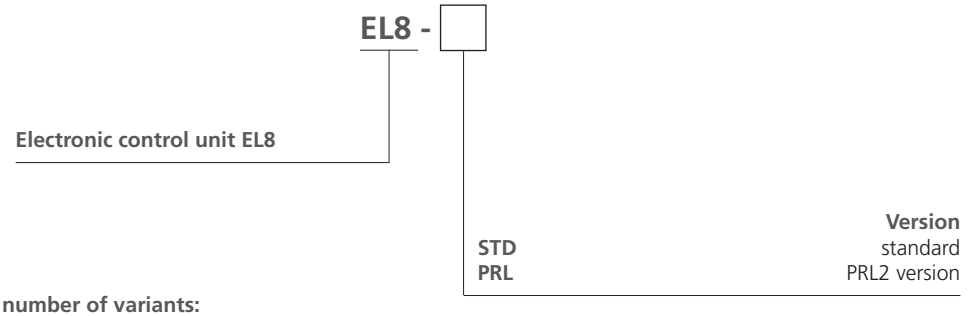
6.3 Hardware-Block Diagram (for operation mode 04)



Numbers in brackets do indicate numbers printed on the connectors!

Figure 2: Hardware block diagram

6.4 Ordering Code



Total number of variants:

12 / 24V DC; STD / PRL
EL8-STD
EL8-PRL (only with 24V coil!)

Figure 3: Ordering Code

7. Installation

7.1 Mounting

- Compare module type (refer to label on side of the module) with part list / diagram
- The module can be mounted in any direction. Vertical is preferred for better convection cooling
- The module should be mounted in a shielded environment (e.g. control cabinet)
- The module has to be mounted on a assembly rail (EN50022)

Dimensions assembly rail:

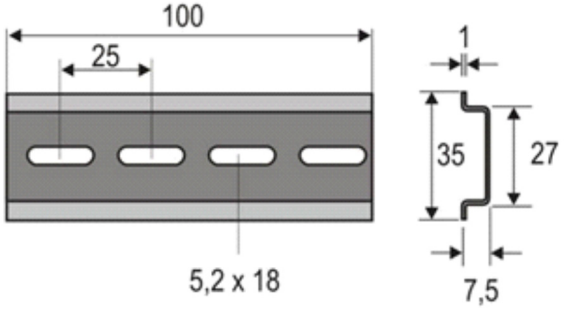


Figure 4: Dimensions assembly rail (DIN hat rail)

7.2 Connection

7.2.1 General recommendations

The general supply voltage for the unit is at the terminals:
X4/3 (15) = 0 V and X4/4 (16) = +UB is 18 V to 28V DC, residual ripple <10%.

Operation at supply voltage down to 12 V DC is also possible. In this case some limitations may be applicable.

Output stages are electronically protected against over-current and short circuit.
Further-on amplifier modules should be protected with a quick-acting fuse.

The solenoids are connected at the terminals:

X1/1 (1) and X1/2 (2) → solenoid A	X1/3 (3) and X1/4 (4) → solenoid B

7.2.2 Wires and preparation

Connection wires have to comply to the following specifications:

Feature	Required
Wire type	Hookup cable; stranded
Cross section: Solenoids and supply	min AWG 16 / 1.5 mm²
Cross section: Signal, command and sensor:	min AWG 20 / 0.5 mm²
Wire length	Max. 50 m (> 50 m consult factory)
Skinning length	7 mm
Soldering of wires	Not permitted!

Table 7: Terms and definitions

The screw terminals are designed in order to accept all kinds of copper wires. Wires with sleeve can be used as conductor stripping protection for stranded wires.

For more details refer to Phoenix Contact product catalog.

WARNING

The assembly contains electronic components. Incorrect handling or operation can lead to damage through electrostatic discharge (ESD). Only trained personnel should work with the unit. All safety instructions must be observed. Damage may result if the module is disconnected while the power supply is still on. Avoid such actions under all circumstances. The information in this document is subject to change without notice.

7.2.3 EMC

Devices EL8 series are class "A" equipment and therefore only suitable for industrial surroundings.

The distance between a source of interference (device emitting interference) and an interference sink (a device under the influence of interference) is very important. The greater the distance between the source of interference and the sink, the smaller the effects on the equipment will be. In other words, the closer a device is placed to the source of interference, the greater the interference amplitudes. For this reason, a minimum gap of 0.25 m should be kept between the amplifiers and strong sources of interference. The following devices are to be regarded as strong sources of interference:

- Switching power supply units
- Frequency converters
- Digital drive modules
- Mains filters with wiring (even if shielded)
- AC/DC commutator motors
- Motor cables (even if shielded)
- Switched inductances, even if anti-interference measures have been taken (solenoid valves, contactors, relays, etc.)

One of the most common input points for interference is wiring. If interfering cables are laid at least 0.25 m away from cables susceptible to interference, the influence on each other can be minimized. Parts of the amplifier wiring may be susceptible to interference (analog set point and actual value, solenoid cables). If these cables are laid parallel over a distance longer more 10 m, the necessary distance between them must be increased. Cables susceptible to interference should never be laid parallel to motor cables. The influence is the least when the cables cross particularly at an angle of 90°.

However, interference can also arise from cables in the amplifier wiring system, in particular solenoid cables.
Examples of devices which are particularly susceptible to interference:

- Office PC's
- Sensors with small output voltages / currents
- Capacity proximity switches
- Audio equipment (television, hi-fi, radio, etc.)
- Devices which do not meet the EMC guidelines

7.2.4 Specific recommendations for wiring and control cabinets

The following rules and tips are by no means to be complete. Since various electronic components are used in a variety of different ambient conditions, these guidelines only represent a compromise. The actual design of the wiring also depends on the interference emission and interference sensitivity of each individual component.

- Use shielded and twisted-pair cables for the solenoid connections. The shield must be grounded (PE Protective Earth) at both ends. The capacity should be ca. 120 pF/m. If the cables are up 100 m long, their cross-section has to be 1.5 mm 2 and 2.5 mm 2 for cables longer than 100 m.
- Shields of digital signal lines are to be connected at both ends to a PE, a good conductivity of the connection should be provided.
- Set point and actual value connections should have shielded and twisted-pair cables. The analog signal line shields are to be connected, with low impedance, at both ends to PE
- In environments with high interference, use double shielded cables for set point and actual value connections. The inner shield is only grounded at one end, the outer at both ends.
- In the event of low-frequency interference on the analog signal lines (measured value fluctuations), the shield should be connected at one end. Preferably, use a corresponding compensation of potential (see also the following point).
- Analog GND (terminal 26z) is the reference point for set point and actual value signals. All set point and actual value transmitters are to be connected to this terminal to avoid offsets and incorrect measurements.
- Use only cables with a Cu shielding grid and a covering of > 85 %. Avoid screening films. Metal foils must be avoided.
- The shield should not be interrupted along the entire length of the cable. If contactors, safety switches, chokes, etc. have to be used in the wiring, the installation of a metallic housing with a high HF shield may be necessary.
- Shield terminals are to be connected over a large area to the shield rail to function well.
- The shield rail must be installed close to the cable duct in the control cabinet.
- The metallic parts of the electrical cabinet are to be connected with low impedance on large areas. Make the desired connection with mechanical aids such as scratch plates if necessary. Connect the doors of the cabinet with the shortest possible homogeneous tapes (multiple).
- Solenoid valves, contactors, relays, brakes, etc. must be suppressed directly at the interference source. Suitable suppression devices are, for example, RC networks, diodes or varistors.
- Analog and digital signal lines should preferably enter the control cabinet from only one side.
- Non-shielded lines of an electric circuit must be twisted.
- Auxiliary wires are to be grounded at both ends.
- Avoid unnecessarily long lines. This keeps the coupling impedance low.
- Wiring should preferably not be freely hanging in the cabinet. Lay cables, including auxiliary cables, as close as possible to mounting plates and cabinet housing.
- In the case of a potential difference between the shield connections, a compensation conductor of <10 mm^2 should be laid parallel to the shield to reduce the transient current. A multiple connection of the shield to the cabinet casing and thus PE is generally possible. Also, a multiple connection of the shield outside the cabinet is possible.
- If filters are installed, place them close to the source of interference and keep a good surface contact to the cabinet or mounting plate.
- If converters are used, converter filters must be provided. Variable speed motors may have to be connected using shielded lines. All further instructions of the converter manufacturer have to be observed.

The following two pages show illustrations of:

- The most important types of interference and their remedies
- Construction of EMC suitable electric cabinets and systems

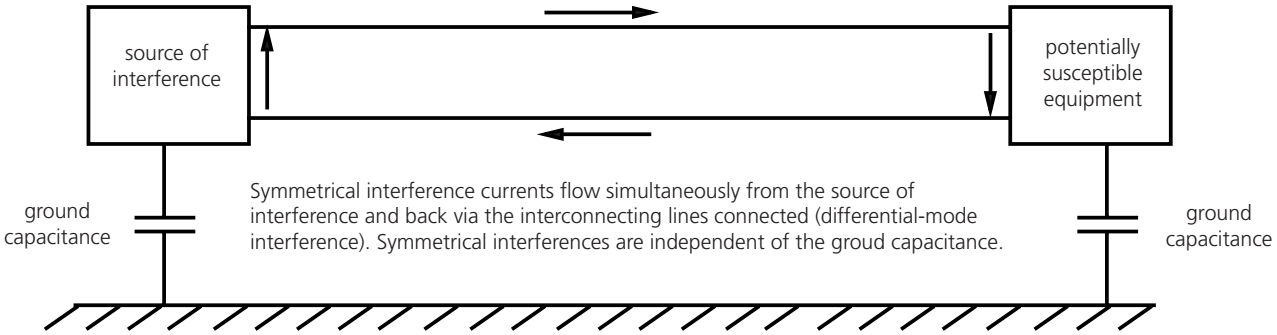
The diagrams have been provided by our competent partners for all questions regarding EMC:

NKL GmbH
Birckichstr. 15
D-74549 Wolpertshausen
Tel.: (+49) 7971 - 96810
Fax.: (+49) 7971 - 968150

WARNING	Avoid under all circumstances to use logical signals from the module (i.e. "Error") for switching machine safety circuits (refer also to EU standard EN13849)!

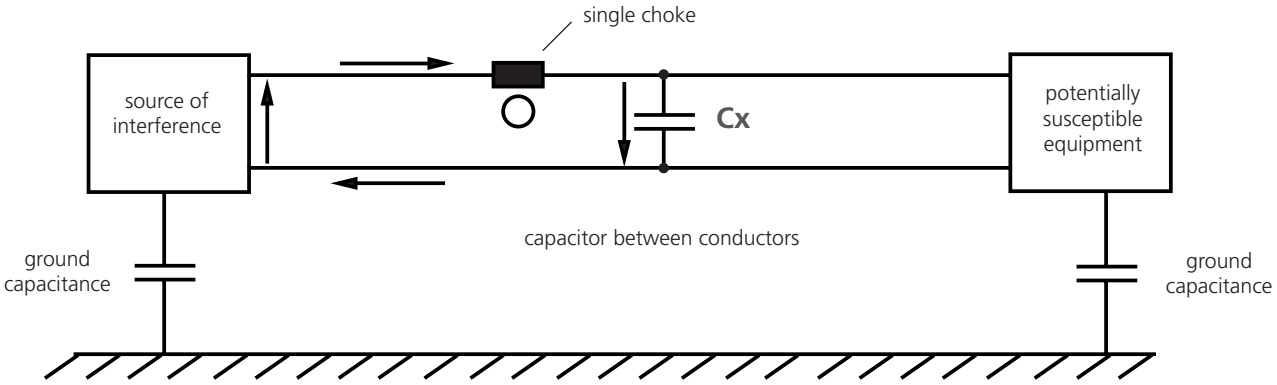
The most important types of interference and remedies:

Symmetrical interference:



Typical sources of symmetrical interferences:

All types of rectifiers, thyristor controls such as e.g. generalized phase controls, semiconductor relays, etc. In practice, symmetrical interferences occur mainly as conducted interference in the lower frequency range up to abunt 1 MHz.



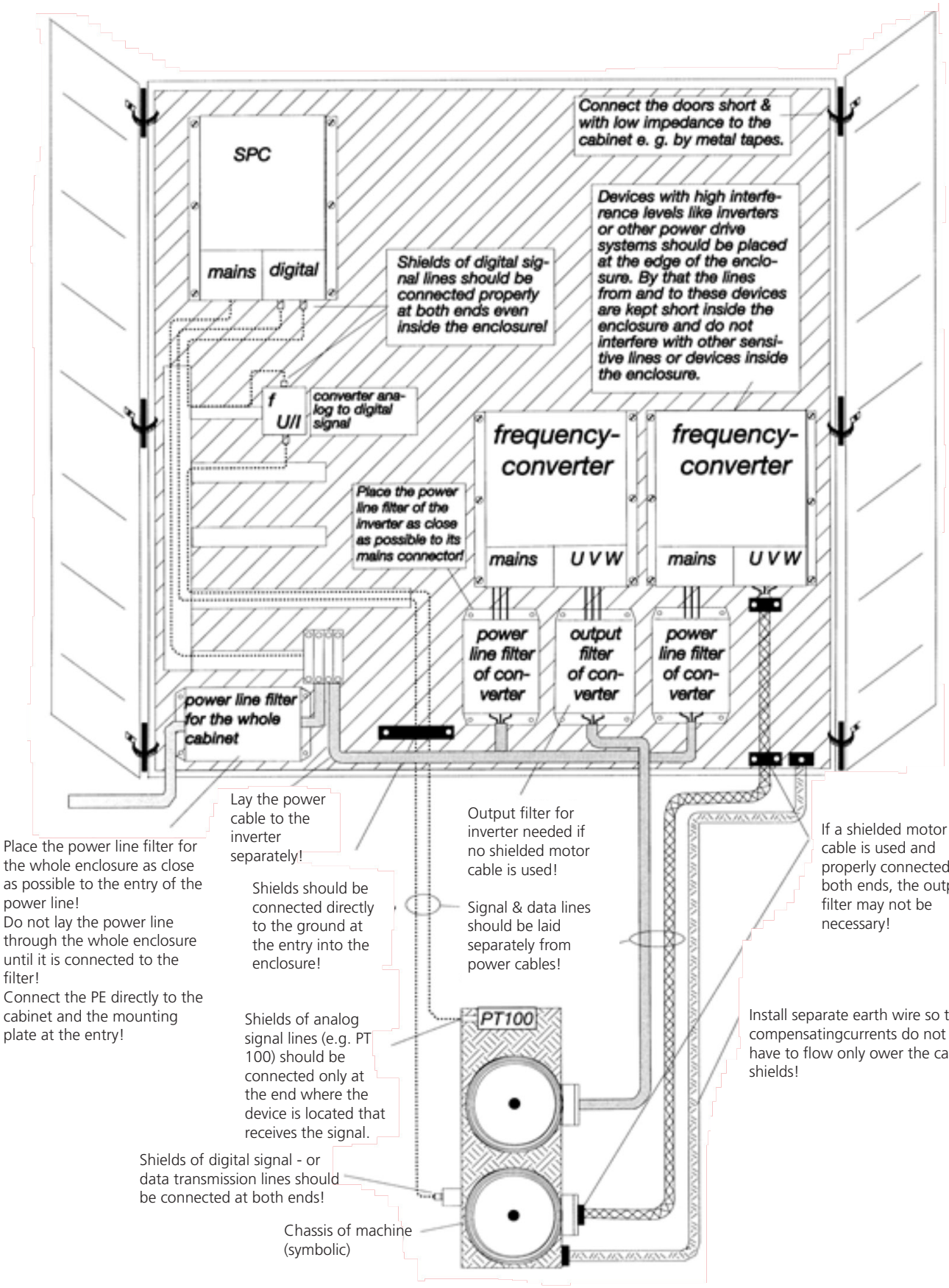
Symmetrical interferences are suppressed by:

› capacitors between the terminals („X" capacitors):
they short-circuit the interference currents just before they reach the potentially susceptible equipment.

› single chokes in the current path of the incoming and outgoing lines. These chokes are effective for symmetrical interferences and increase the impedance of the symmetrical interference circuit.

Figure 5: EMC – interferences and remedies

All devices with a metal housing or a connector for PE should be connected properly, i.e. short and with a large contact area to the mounting plate of the cabunet or the chassis of the machine to ensure a proper potential equalisation.
For that the insulation of the mounting plate has to be removed, especially below power drive systems and their respective filters.
The best solution is to use a conducting mounting plate that is zinc coated.



Place the power line filter for the whole enclosure as close as possible to the entry of the power line!
Do not lay the power line through the whole enclosure until it is connected to the filter!
Connect the PE directly to the cabinet and the mounting plate at the entry!

Lay the power cable to the inverter separately!

Shields should be connected directly to the ground at the entry into the enclosure!

Shields of analog signal lines (e.g. PT 100) should be connected only at the end where the device is located that receives the signal.

Shields of digital signal - or data transmission lines should be connected at both ends!

Chassis of machine (symbolic)

Output filter for inverter needed if no shielded motor cable is used!

Signal & data lines should be laid separately from power cables!

If a shielded motor cable is used and properly connected at both ends, the output filter may not be necessary!

Install separate earth wire so that compensatingcurrents do not have to flow only ower the cable shields!

Figure 6: EMC – adequate design of switchgear cabinets and facilities

7.3 Pin assignment for EL8-STD

Connector X1	Terminal X1/1 (1)	Terminal X1/2 (2)	Terminal X1/3 (3)	Terminal X1/4 (4)
	Solenoid A-	Solenoid A+	Solenoid B-	Solenoid B+
Connector X2	Terminal X2/1 (5)	Terminal X2/2 (6)	Terminal X2/3 (7)	Terminal X2/4 (8)
	N/C	N/C	Feedback Fb1- (Sensor Input)	Feedback Fb1+ (Sensor Input)
Connector X3	Terminal X3/4 (12)	Terminal X3/3 (11)	Terminal X3/2 (10)	Terminal X3/1 (9)
	Set point S1.06-(Analog Input)	Set point S1.06+(Analog Input)	Error / Comp.	Enable
Connector X4	Terminal X4/4 (16)	Terminal X4/3 (15)	Terminal X4/2 (14)	Terminal X4/1 (13)
	Power supply + 24 V	Power supply 0 V	Set point 2 (S1.02)	Set point 1 (S1.01)

Table 8: Pin assignment

Pictures of connectors with numbering 1 to 16:

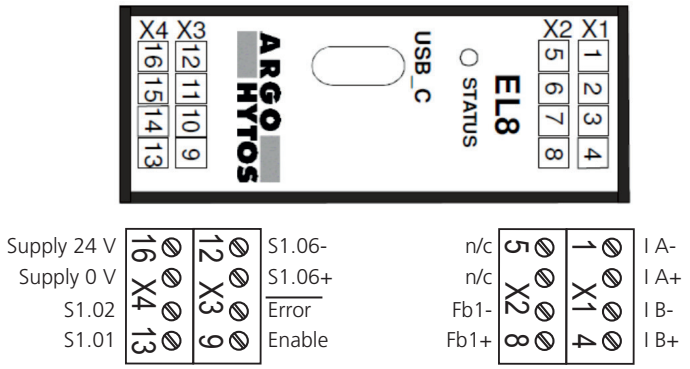
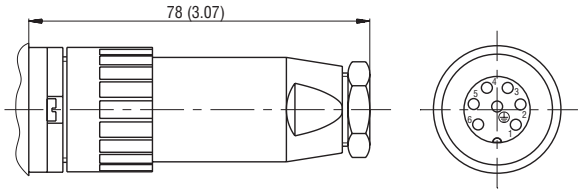


Figure 7: Connectors for EL8-STD

7.4 Pin assignment for EL8-PRL2

Signal	Contact - conductor colour
Output from inverting sensor(IN+)	1 - black
Output from non-inverting sensor (IN-)	2 - green
Power supply sensor 24 V	3 - red
Power supply sensor 0 V	4 - white + shading
Input 1 for linear motor PRL2 (+)	5 - bright white
Input 2 for linear motor PRL2 (-)	6 - bright red



PRL2 Valve connector pin	Description	EL8 pin	Description
-	-	X1/1	Not connected
6	OUT-	X1/2	Input 2 for linear motor PRL2 (-)
-	-	X1/3	Not connected
5	OUT+	X1/4	Input 1 for linear motor PRL2 (+)
-	-	X2/5	AGND (Analog Ground)
-	-	X2/6	Ana Out, analog output (Signal defined by parameter E 01)
2	IN+ (LVDT reference U/2)	X2/7	Output from non-inverting sensor (+)
1	IN- (LVDT actual value)	X2/8	Output from inverting sensor (-)
-	-	X3/9	Enable input, activation of the output stages
-	-	X3/10	Error output, all ok → 24 V
-	-	X3/11	Setpoint, S1.06+ / IN+
-	-	X3/12	Setpoint, S1.06- / IN-
4	Transd. Supply 0 V	X4/13	Power supply sensor 0 V
3	Transd. Supply 24 V	X4/14	Power supply sensor 24 V
-	-	X4/15	EL8 Supply 0 V
-	-	X4/16	EL8 Supply 24 V

Please pay attention to the correct polarity of the feedback connection!

Table 9: Connecting table EL8-PRL2

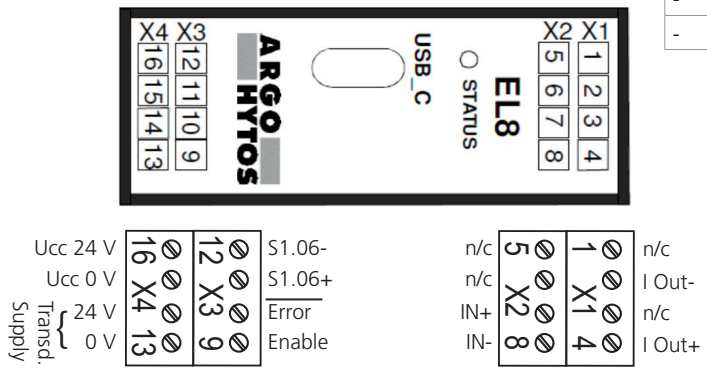
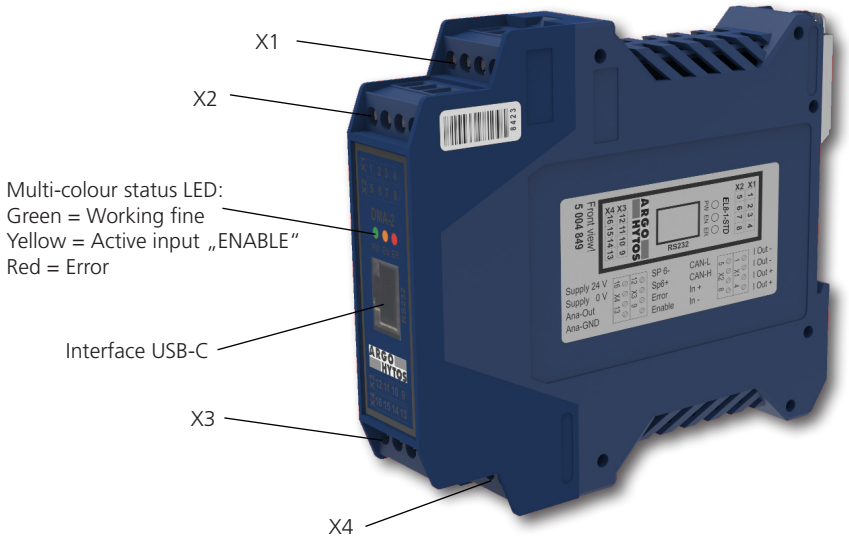


Figure 8: Connectors for EL8-PRL2

8.1 Front elements

WARNING

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.



Element	Function
Status LED's	display of status
USB-C interface	For setting of parameters via PC or communications to machine. Also for diagnosis function with oscilloscope built into AH Hub

Figure 9: Front view of unit

8.2 Parameter setting

Available parameters for version EL8:

display	Set point / ramps	Controller	Extended
d1.01	S1.01	C1.00	E00
d1.02	S1.02	C1.01	E02
d1.03	r1.01	C1.02	E03
d1.04	r1.02	C1.03	E04
d1.05	r1.03	C1.04	E05
d1.06	r1.04	C1.05	E06
d1.07		C1.06	E07
d1.08		C1.07	E08
d1.09		C1.08	E09
d1.10		C1.09	E10
d1.11		C1.10	E11
d1.12		C1.11	E12
d1.13		C1.12	E13
		C1.13	E14
		C1.14	E15
		C1.15	E17
		C1.16	E18
		C1.17	E19
		C1.18	
		C1.19	
		C1.20	
		C1.21	
		C1.22	
		C1.23	
		C1.24	
		C1.25	
		C1.26	
		C1.27	
		C1.33	
		C1.36	
		C1.37	
		C1.38	
		C1.40	
		L1	

A complete list of parameters is available. Refer to:
See Chapter „12 Complete parameter list“, page 32

Table 10: Parameter overview

8.3 Operation modes

The setting of parameter E00 is determining which operation mode is activated. This parameter is factory preset!
Only the mode relevant parameters are made available for each of the modes.

Mode	Description / Module Version
3	Closed loop, 1 proportional valves with 2 solenoid and one valve feedback (version EL8)

Table 11: Operation modes

8.4 Description of software program

8.4.1 General availability and assignment of parameters

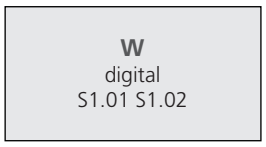
In operation mode 3, all set points (analog and digital → S1.06, S1.01, S1.02) are assigned to one functional branch. The other analog input is used as feedback input (Fb1).

In the standard setting with parameter C1.05 = + 1.00 , all positive set points activate solenoid B and all negative set points activate solenoid A. Parameter C1.05 = -1.00 inverts this assignment and with parameter C1.05 = 0.00, all set points are deactivated.

WARNING

Only trained staff should make changes of the parameters. While adjusting, the drive should be switched off.
Every parameter change is immediately effective

8.4.2 Programmable set points (S1.01, S1.02)



Digital set points are internal programmable set points, activated by digital inputs. Two of these programmable set points can be selected with the respective input. These set points are assigned and saved in parameters S1.01 and S1.02.

- The inputs can be controlled directly from the PLC.
- If electrical isolation between the PLC and the amplifier is required than external means of isolation must be applied.
- Both digital set points are passed through the ramp function generator.
- All set points are additive and include the 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 4 values can be selected.

8.4.3 Analog set point (S1.06)

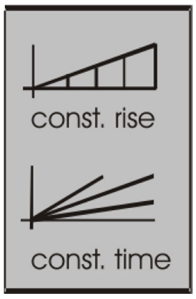
- The set point S1.06 is designed for voltage and current signals (differential input). Resolution of input: 16 bit.
  Signal range is: 0 ... ± 10 V or 0 ... 20 mA or 10 mA ± 10 mA or 4 ... 20 mA or 12 mA ± 8 mA
- Selection of cable fracture detection for current input and selection of set point type by means of parameter E15.
- If for S1.06 the current range is selected than a measuring resistance of 255 Ω is automatically activated.
- In case of activated cable fracture detection a current below the trigger level will switch off the amplifiers enable signal and the error output will automatically drop to 0 V. At the same time the status LED will lit in red.
- When a current input is selected than the inputs are monitored for over-current. If an over current should occur than the input is automatically switched off in order to prevent damages to the input. At the same time the enable is switched off and the error output will drop to 0 V and the status LED will lit in red.
- The set point is passed through the ramp function generator (ramp) if E08 = 1. If parameter E08 = 0, than the analog set point bypasses the ramp function.
- The set point S1.06 is calculated according to the polarity with the other set points.
- The input for S1.06 is designed as a differential input within the operating voltage range of ± 15 V.
- The signal for set point S1.06 must be standardized to ± 10 V otherwise the A/D converter is overloaded.
- In case of usage of current input signals the inputs are protected for overload. An error will be triggered at currents above approx. 25 mA. Cable fracture detection if activated will trigger an error for currents below approx. 2 mA. For information about error codes refer to:

See □ Chapter „10.5 Display and error messages“, page 30

To suppress interference, an unused analog set point S1.06 must be deactivated with parameter E17.
The analog set point S1.06 is not a real parameter; it represents external set points.

8.4.4 Ramp function (r1.01 to r1.04)

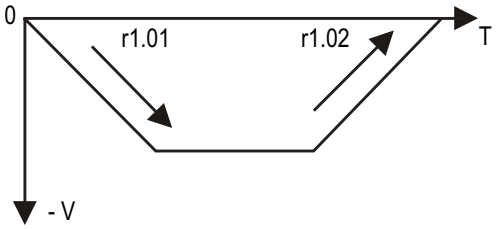
r1.01 to r1.04



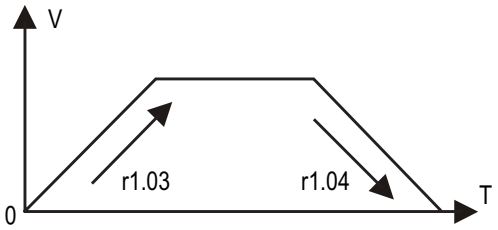
Set points are integrated accordingly to the ramp function generator. For each change of direction, the ramp time can be set independently. Times from 0 to 39.5 s can be set. The resolution is 0.01 s.

The ramp characteristic is assigned as follows:

r1.01 ramp from 0 to negative values
r1.02 ramp from negative values to 0



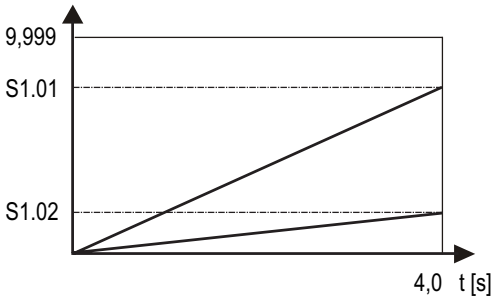
r1.03 ramp from 0 to positive values
r1.04 ramp from positive values to 0



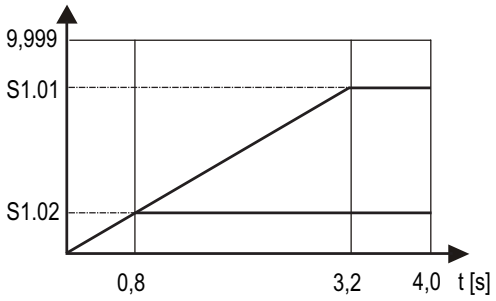
E08 = 0 effects only digital set points, constant time base and linear
E08 = 1 effects all set points, constant rise rate and linear
E08 = 2 selectable ramp times
- ramp function can be switched
- The input S1.01 selects ramp r1.01 and r1.02.
- The input S1.02 selects ramp r1.03 and r1.04.
- If S1.01 and S1.02 are offline, no ramp is activated.
- If both, S1.01 and S1.02 are online, ramp r1.01 and r1.02 are activated.
- The selected parameters S1.01 and S1.02 are still active and must be set to 0 if they should not be used.

8.4.5 Examples for ramps

Example 1:
E08 = 0, ramp with constant time base
S1.01 = 8.00 V; S1.02 = 2.00 V; r1.03 = 4.00 sec



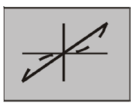
Example 2:
E08 = 1, ramp with constant rise rate
S1.01 = 8.00 V; S1.02 = 2.00 V; r1.03 = 4.00 sec



	The analog set pointS1.06 is excluded from the ramp function.	The ramp influences the digital set points S1.01 and S1.02 as well as the Analog set point S1.06

8.4.6 Characteristic curve (C1.02)

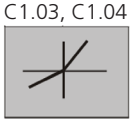
C1.02



There are five characteristic curves available for the linearization of the valves characteristics:
Curve #1: general linearization for NC curve
Curve #2: linearization for proportional directional valves with flow characteristic > 10 l/min (size 06)
Curve #3: linearization for proportional directional valves with flow characteristic < 10 l/min (size 06)
Curve #4: linearization for proportional directional valves with flow characteristic > 50 l/min (size 06)
Curve #5: linearization for proportional pressure valves

8.4.7 Direction dependent amplification (C1.03, C1.04)

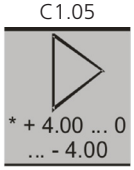
C1.03, C1.04



The amplification can be programmed with the parameters C1.03 and C1.04, for both directions, "+" and "-". These parameters are used for amplification adjustment (e.g. balance the speed of differential cylinders).

8.4.8 Set value sign / factor (C1.05)

C1.05



The set value sign and factor function is used to exchange the polarity sign of the set points or to adapt the signal or in order to completely deactivate the signal. This enables to change the direction of a valve as well as the scaling of the set point signals. Scaling for the set point is in the range of 0.00 … ± 4.00.

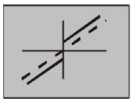
8.4.9 Offset for set point (C1.06)

C1.06

A drift of the drive or the hydraulic system can be corrected with the offset parameter.
The offset-set point can be regarded as an additional set point. This allows a very fine positioning of the system e.g. if it is used on a NC axis.

8.4.10 Spool overlap compensation (C1.07, C1.08)

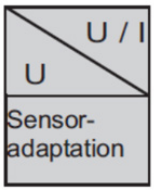
C1.07, C1.08



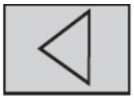
These parameters compensate a possible spool overlap independently for each solenoid. The compensation works as an additional set point that is activated as soon as the polarity of the set point changes. Overlaps of valve are empirically around 10 % to 15 % of full stroke (depending on manufacturer and valve type!). The setting has a decisive effect on the quality (precision and speed) when positioning the axis drives. The amplification in the small signal range is essentially determined by this function.
The pre-set value is directly applied as a current on the solenoids. The programming is standardized in volt, 10 V equals the maximum set current.

8.4.11 Sensor adjustment (C1.09, C1.10, C1.11, C1.26, C1.36)

C1.09, C1.26



C1.10



C1.11

C1.36

The following types of sensors are available:

Selection	Input signal range	Wire monitor	Comment
1	0 ... 20 mA	No	---
2	4 ... 20 mA	Yes	---
3	12 mA ± 8 mA	Yes	---
4	0 ... 10 V	No	---
5	0 ... ± 10 V	No	---
6	6 V ± 2,5 V	Yes	---
7	7,5 V ± 2,5 V	Yes	---
8	6 V ± 4 V	Yes	---
9	7,5 V ± 2,5 V	Yes	---
10	0 ... 20 mA	No	With selection 10, 11 and 12: Only positive controller output possible!
11	4 ... 20 mA	Yes	
12	0 ... 10 V	No	

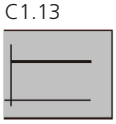
Table 12: Feedback sensor selection

- Feedback 1 input is designed for voltage and current signals (differential input). Resolution of Analog input: 12 bit. Signal range is: 0 ... ± 10 V or 0 ... 20 mA or 10 mA ± 10 mA or 4 ... 20 mA or 12 mA ± 8 mA) selection of cable fracture detection for current input by means of parameter C1.26.
- If for Fb1 the current range is selected than a measuring resistance of 255 Ω is automatically activated.
- In case of activated cable fracture detection a current below the trigger level will switch off the amplifiers enable signal and the error output will automatically drop to 0 V. At the same time the Status LED is lit red.
- When a current input is selected than the input is monitored for over-current. If an over current should occur than the input is automatically switched off in order to prevent damages to the input. At the same time the enable is switched off and the error output will drop to 0 V and the Status LED is lit red.
- The feedback 1 input is designed as a differential input within the operating voltage range of ± 15 V.
- The selections 10 to 12 are for control loops where no negative value appears; therefore no negative controller output is possible (e.g. pressure control loops).
- If a sensor signal shows different gains or asymmetrical behavior than compensation can be done by means of parameter C1.36. Sensor gain for positive and negative signals can be adjusted independently.
- In case of usage of current input signals the inputs are protected for overload. An error will be triggered at currents above approx. 25 mA. Cable fracture detection if activated will trigger an error for currents below approx. 2 mA. For information about error codes refer to:

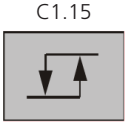
See □ Chapter „10.5 Display and error messages“, page 30

8.4.12 P-portion, PT1-portion (C1.13, C1.16)

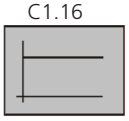
C1.13



C1.15



C1.16



C1.14, C1.16

When programming the parameters C1.13 and C1.16 then also the setting of parameter C1.00 (controller setting) is of importance.
If C1.00 = 3 or C1.00 = 4 (dff controller), than C1.13 is the amplification of the dff controller and C1.16 is the P-amplification of the remaining PT1-I-DT1 controllers. C1.15 will be without effect in these cases

If C1.00 = 1 or 2 (P-PT1-I-DT1 controller):

› C1.13 is the P-amplification (KP_1) for minor control deviations (proportional controller)
› C1.14 cooperates with C1.16 and forms therefore a PT_1 term
› C1.15 is the threshold to control the operation of C1.13 (KP_1) or C1.16 (KP_2)
› C1.16 is the P-amplification (KP_2) for major control deviations, results with C1.14 as a PT_1 part

Description of the threshold function C1.15 and the resulting effect of C1.13 and C1.16:
Case 1, the control deviation is smaller than the threshold (I w-x I < C1.15): only the P-portion KP_1 is activated (w-x* KP_1).
Case 2, the control deviation is larger than the threshold (I w-x I > C1.15): from the threshold C1.15 on, the P-portion KP_1 is activated with the value (w-x* KP_1). The other P-portion KP_2 only functions with the value ([[w-x] - C1.15] * KP_2). The complete portion of both controllers is an addition of these values. See the following graph for an explanation:

Example:
C1.15 = 0,500
C1.13 = 2,000
C1.16 = 0,500
d1.12 = 4,000 V (lag error w-x)

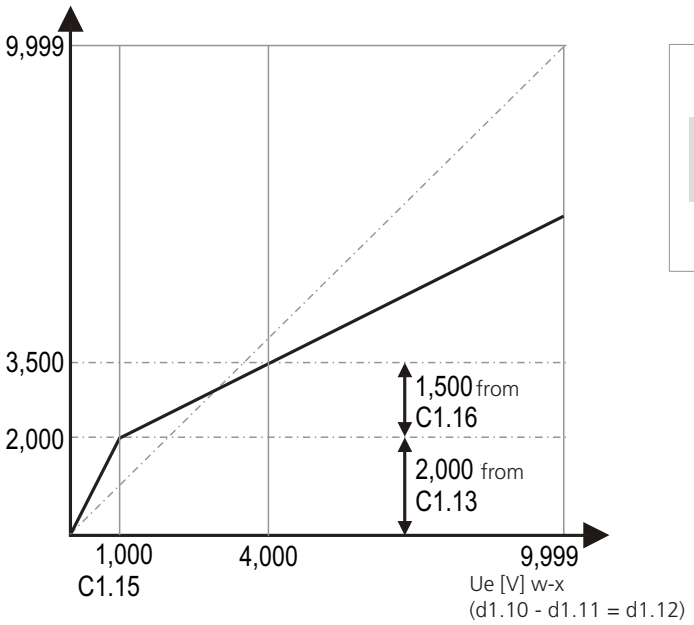


Figure 10 : Diagram function C1.13 / C1.15 / C1.16

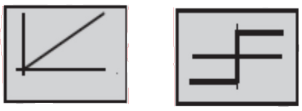
The division into two individually adjustable amplifications allows a more stable adjusting of the controller in non-linear systems (which is often the case for hydraulic applications), even if the control deviations are large.
The possibility to suppress (attenuate) C1.16 (KP2) with a time relay supports this effect and results in adjustable moderate (smooth) PT1-characteristics.

If C1.00 = 3 or 4 (dff controller):

› C1.13 is the P-amplification with direct feed forward (proportional controller)
› C1.14 cooperates with C1.16 and therefore forms a PT_1 term
› C1.15 is not taken into consideration
› C1.16 is the P-amplification of the remaining PT_1-I-DT_1 controller

8.4.13 I-portion, I-portion limiter (C1.17, C1.33)

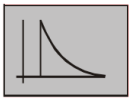
C1.17 C1.33



› C1.17 is the I-portion of the controller (integrating controller). C1.17 is limited to the maximum value to avoid an overdrive or saturation. Small values do indicate a slow reaction. Large values do indicate a fast reaction
› C1.33 is the limiting level for the I-portion of the controller in order to prevent saturation of the integral part.

8.4.14 D-portion, DT1-portion (C1.18, C1.19)

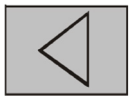
C1.18, C1.19



› C1.18 is a D-portion and together with Cx.19 forms a PT1 term (differential controller).
› C1.19 is a T-portion for Cx.18 to form a DT1 term.

8.4.15 Additional (P-) multiplier (C1.20)

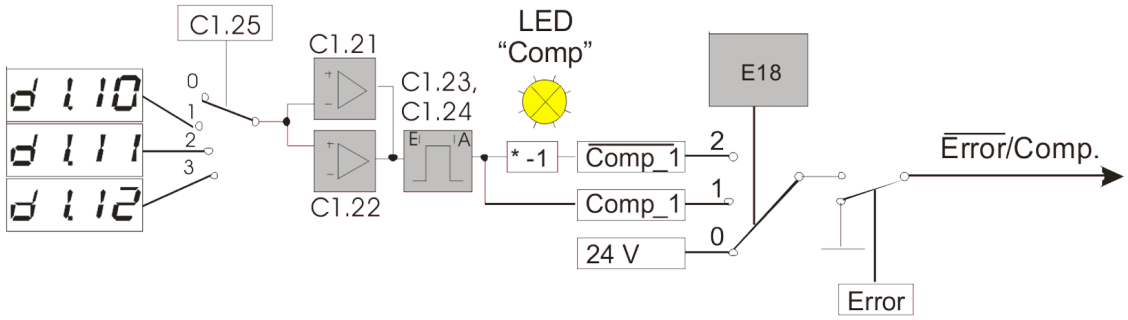
C1.20



› C1.20 additional proportional factor to increase the effect of C1.13 and C1.16, especially for process control.

8.4.16 Comparator (C1.21 to C1.25, E18)

LED only available via AH Hub monitor function!



› C1.21 / C1.22 are the comparator thresholds. If the signal reaches this comparative value, the comparator changes its signal

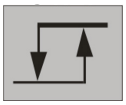
› C1.23 / C1.24 are delay times. The signal is changed only when the threshold value had been reached for a longer time than the time programmed

› C1.25 is a switch that defines, which one of the signals will be compared with the comparator values.

› E18 Selects if the output Error / Comp. is following only the error status or also the status of the comparator. It also defines the logic of the comparator signal (positive or negative)

8.4.17 Set value dead-band (C1.27)

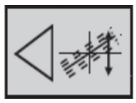
C1.27



› With C1.27 a "artificial deadband can be applied to the command input. This will ensure that for input signal "0" the output of the amplifier will be also "0" even if spool overlap comepensation is applied (C1.07 and C1.08 > 0)!

8.4.18 Semi-automatic calibration for Fb1 (C1.39, C1.40)

C1.39, C1.40



semi-automatic calibration
(w. AH Hub only!)

› The semi-automatic feedback calibration function supports the user in correctly scaling the feedback singal for offest and gain and such allows the closed loop work as intended. The procedure is performed by means of AH Hub.

DANGER

When running this function, make sure that no unintended rection at the system can occur e.g. by locking the drive or similar measures in order to prevent dangerous situations.

Semi-automatic feedback calibration procedure with AH Hub:

Step	Action
1	**Pre-Set parameters:** C1.00 off C1.09 Select 21 C1.26 off C1.39 Start calibration process
2	Bring sensor signal to maximum "A" side Click 1 – wait for green checkmark
3	Bring sensor signal to maximum "B" side Click 2 – wait for green checkmark
4	Keep sensor signal at maximum "B" side Click 3 – wait for green checkmark
5	Bring sensor signal to "center position" value ("zero position") Click 4 – wait for green checkmark
6	Bring sensor signal to maximum "A" side Click 5 – wait for green checkmark
7	Verify procedure

Table 13: Semi-automatic feedback calibration procedure

8.4.19 Push – pull / Short circuit, over current and open loop detection (E02)

E02

Pusch-Pull

E02	Description
Off	The function is bypassed.
1	The push-pull function is activated, the solenoid current is divided between both solenoids, the set point = 0. If the set point value is raised, the solenoid current of one solenoid is also automatically raised, while the solenoid current of the other solenoid is reduced accordingly. The push-pull function sends an initial current to the solenoid and increases therefore the dynamic response. This function only applies for the appropriate valve types.
2, 3	Not applicable and reserved for special applications! These values cannot be activated by means of AH Hub.
4	The solenoids with independent connection are used. The difference to E02 = off is that here the special short circuit, overload and open loop protection is also activated and also short circuits and overloads between the outputs and GND or power supply lines is detected.
5	The push-pull function is activated . Same as "1". The difference to E02 = 1 is that here the special short circuit, overload and open loop protection is also activated and also short circuits and overloads between the outputs and GND or power supply lines is detected.

Table 14: E02 selection

WARNING

If short circuit and/or overload can occur also between the outputs and either GND or supply and if this can cause any risk or damage than E02 = 4 or E02 = 5 must be activated.

These settings also must be activated in cases of possible open circuits causing critical conditions in the application.

CAUTION

For E02 = 4 and E02 = 5 an error will only be detected if the difference between the desired current and the actual output current of the modules is > 250 mA and at the same time active for a duration of approximately 100 ms. Only in this cases the output stages will be shut off automatically.

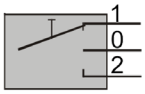
It is always recommended to have a fuse (quick reacting, 3.15 A) in the + power supply line to the EL8.

Error message in case of short circuits, overloads or open circuits is either "- - 3" or "- - 8".

-

8.4.20 Type of ramp (E08)

E08



This parameter defines the type of ramp that should be used, see also sections 3.4.4 and 3.4.5.

- E08 = 0: constant time base (effects only digital set points)
- E08 = 1: constant rise rate (effects all set points, digital and analog) E8 = 1
- E08 = 2: ramp function can be switched (attention: is not shown in block structures and diagrams of operation modes)

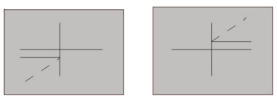
8.4.21 Output stage parameters (E1.03 to E1.07, E1.10, E09)

Output Stage control
E1.03 ... E1.07, E1.10

- Each solenoid is activated by a PWM output stage that has over-energization and high-speed de-energization. The solenoid current is measured, compared with the set point (activation value for the output stages) and controlled by a PI controller. This helps to avoid deviations of the solenoid current, e.g. through warming of the coil. Additionally, the programming of the controller has an important influence on the dynamic and static performance. Parameters E1.04 to E1.07 set the controller for energization as well as for de-energization.
- Parameter E1.03 selects the maximum current and therefore defines the amount of current available at set point = 10 V.
- Parameter E1.10 allows a fine and variable adjustment of the solenoid current and this allows adjusting the already set maximum current. Independently of all the settings, the minimum current is limited to 600 mA in any case.
- Parameter E09 sets the time delay of the enable signal. The activation of the output stages will be delayed even though the enable signal is active.

8.4.22 Initial current (E11, E12)

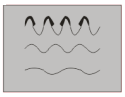
E11 E12



- Initial current is used to keep the bolt of the magnet always at the spool. This places the spool solidly between the solenoids and prevents the spool being hit by the bolt of the magnet. An initial magnetizing helps to improve the reaction of the solenoids.
  The programming is done in Volt: the programmable maximum current is 10 V.

8.4.23 Dither signal (E1.13, E1.14)

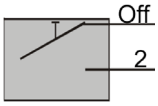
E1.13, E1.14



› The dither function can be matched to the valve or to the process with the parameters E1.13 (for the amplitude) and E1.14 (for the frequency). The frequency of the signal is adjusted stepwise. The dither signal reduces the hysteresis of the valve or drive movement and improves the reaction of the system. This has positive effects on the precision and repeatability. In general, low frequency signals are more effective, but they can result in noticeable disturbances (noise, oscillations). Values less than 100 Hz are for systems with a low characteristic frequency, higher values are used for systems with a high characteristic frequency. Dither amplitudes are set for a range of 2% to 12% (related to current or set point). Dither signals have an influence on the characteristic curve of the current caused by a physical dynamic correlation. In some cases, this has an effect on the linearity from U to I.

8.4.24 Activation of set points (E17)

E17

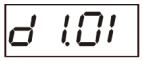


Parameter E17 is used for the selection or the activation of the set points. The following correlations apply:

E17	Analog set points	Digital set points
0ff	Set point S1.06 is activated	2 digital set points are activated (S1.01, S1.02)
2	Analog set point is not activated	2 digital set points are activated (S1.01, S1.02)

Table 15: E17 selection

8.4.25 Display (d1.01 to d1.13)



Example:
These parameters are used to display all parameter and internal digital values (for programming, commissioning and diagnosis).

8.5 Other parameters

8.5.1 Selection of controller (C1.00)

This parameter activates the required controller function (Structure).

The controller can be activated or deactivated independently of the selected operation mode. The parameter C1.00 deactivates closed loop operation. Thus the card works in open loop mode.

There are four different controller structures available.

› C1.00 = 1 "standard" controller function with PPT1-I-DT1 architecture
› C1.00 = 2 "remote" controller function. Controller can be switched from open to closed loop and vice versa
› C1.00 = 3 "dff (direct feed forward)" controller function.
Command signal is using by-bass function parallel to PT1-I-DT1 architecture
› C1.00 = 4 "remote controller with dff structure". Combination of selection "2" and "3".

8.5.2 Safety function (C1.01)

This function offers an "enable mode" or a sequence that allows a controlled shifting from the deactivated position to the activated position which is especially helpful for a restart after an emergency stop.

CAUTION	The usage of the safety function together with remote loop control (C1.00 = 2 or C1.00 = 4) must be avoided

8.5.3 Operation mode (E00)

This parameter is predetermined by selection of the module version.
For modules version EL8-STD it is "1" and for modules version EL8-PRL it is "2".

8.5.4 Selection of set point (E15)

This parameter is used in order to select the type of Analog set point. Either a voltage input (0 … ± 10 V) or a current input can be selected. If the current input is selected than the measuring resistance of 250 Ohm is automatically activated. The following selection for the input is possible with parameter E15:

0 = S1.06 is activated as voltage input; range: 0 … ± 10 V
1 = S1.06 is activated as current input; range: 0 … 20 mA, **no** cable fracture detection is possible
2 = S1.06 is activated as current input; range: 10 mA ± 10 mA, **no** cable fracture detection is activated
3 = S1.06 is activated as current input; range: 4 … 20 mA **no** cable fracture detection is activated
4 = S1.06 is activated as current input; range: 4 …. 20 mA cable fracture detection is activated
5 = S1.06 is activated as current input; range: 12 mA ± 8 mA **no** cable fracture detection is activated
6 = S1.06 is activated as current input; range: 12 mA ± 8 mA cable fracture detection is activated.

8.5.5 Selection of digital output signal; Error / Comparator (E18)

This parameter is used in to select the logic of information about the status of the comparator.
The following selection for the output is possible with parameter E18:
0 = off → output reflects only status of error signal
1 = comparator positive logic
2 = comparator negative logic

If an error occurs than the output "Error / Comparator" will be switched to logical "0" independent from the status of the comparator.

8.5.6 Password (E21)

This parameter activates a numeric password to prevent an unauthorized access to the card parameters. It can only be activated by means of a terminal program (e.g. Hyperterminal).
If the password E21 = 9000 is entered than only the display parameters and parameter E21 are accessible all other parameters are locked.
If again E21 = 9000 is entered than all parameters are "unlocked" and open for changes again.

8.6 Evaluation of the current controller parameters

Current controller

e(t) > 0: → $t_{pwm}(t) = kp_{err} * e(t) + ki_{err} * e(t)$
kp_{err} = E04; ki_{err} = E05 * T_{ab}

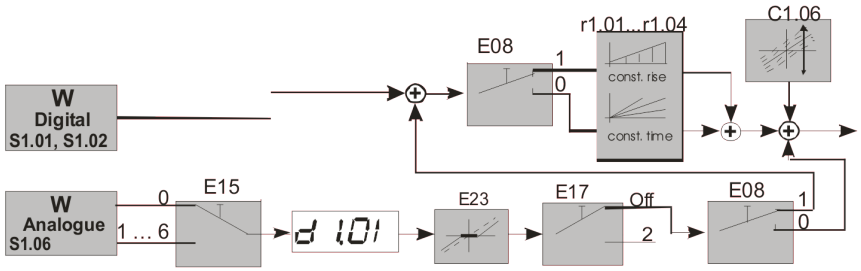
e(t) < 0: → $t_{pwm}(t) = kpent * e(t) + ki_{ent} * e(t)$
kp_{ent} = E06; ki_{ent} = E07 * T_{ab}

T_{ab} = 80µs

8.7 Block structures

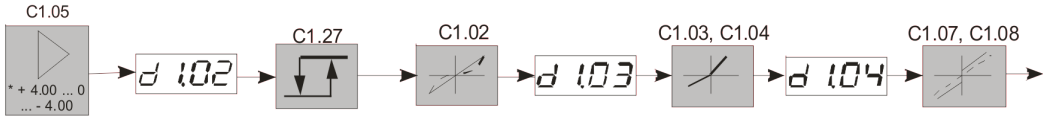
All block diagrams of software functions can be derived by combination of the following blocks.

8.7.1 Set points

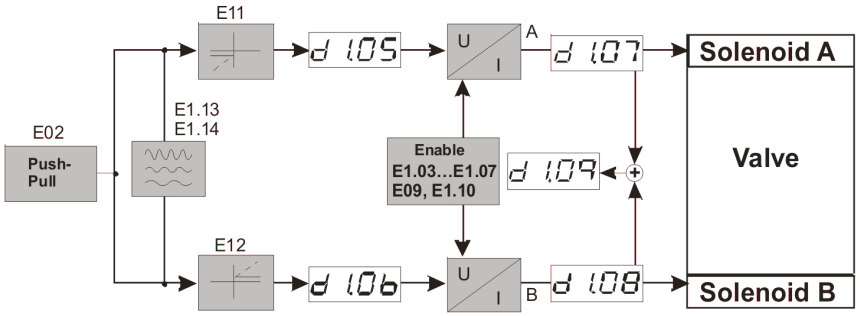


0 = 0 ... ± 10 V
1 = 0 ... 20 mA
2 = 10 ... ± 10 mA
3 = 4 ... 20 mA w/o cable fracture detection
4 = 4 ... 20 mA with cable fracture detection
5 = 12 mA ± 8 mA w/o cable fracture detection
6 = 12 mA ± 8 mA with cable fracture detection

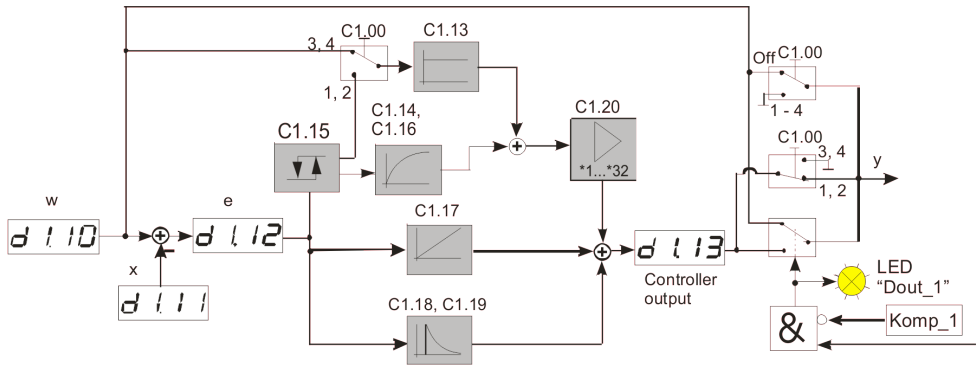
8.7.2 Processing of set points



8.7.3 Solenoid current processing and outputs

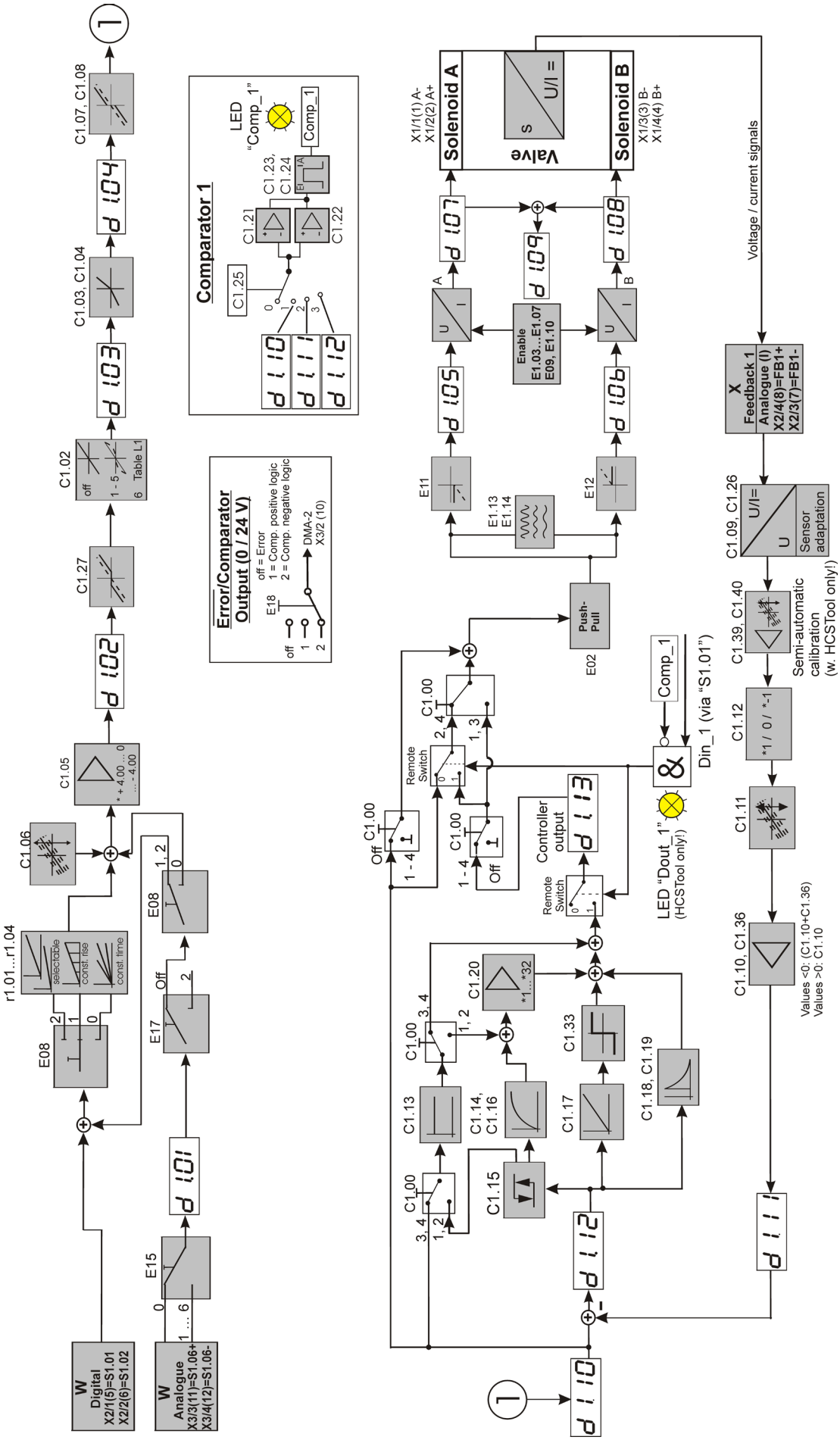


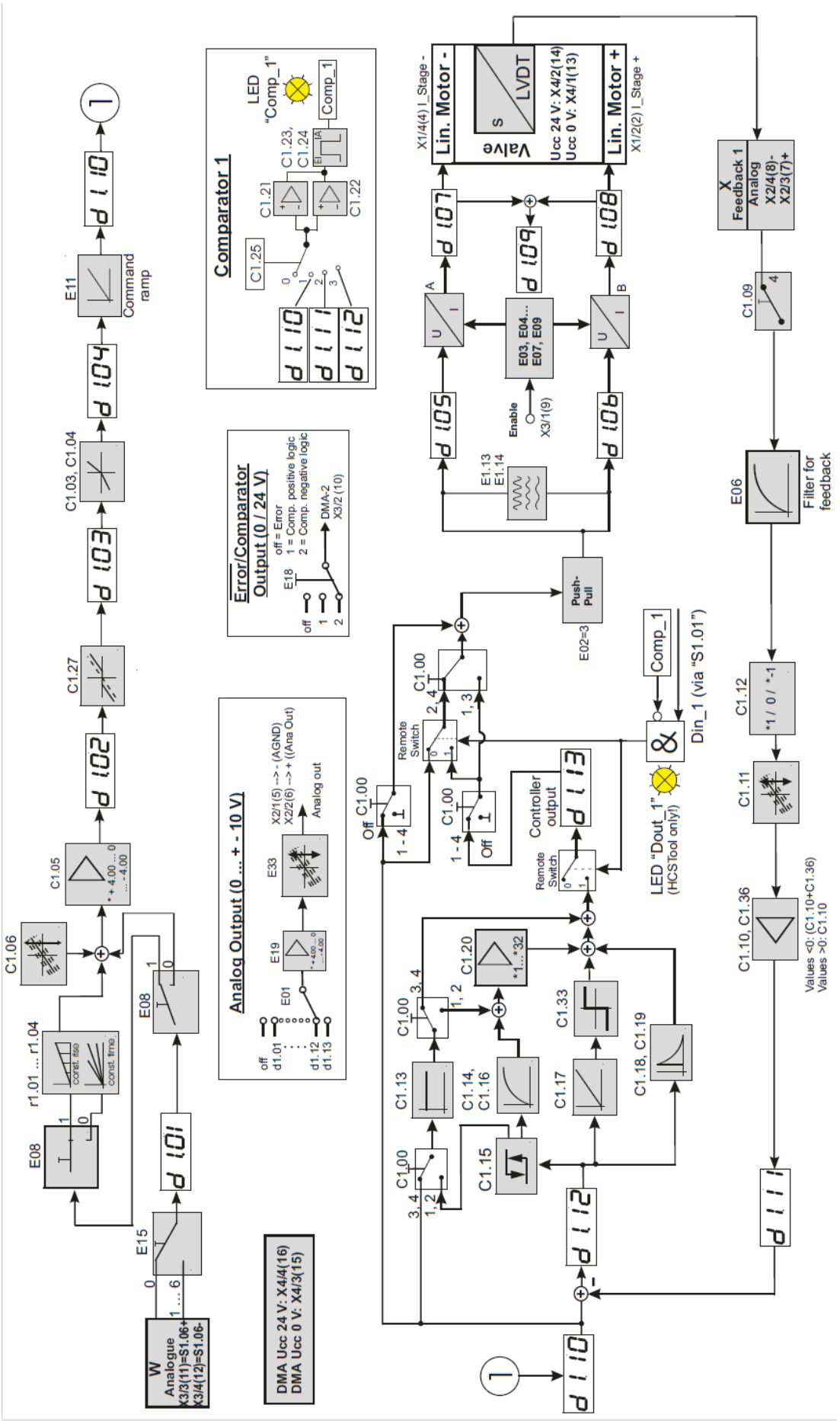
8.7.4 Controller structure



8.8 Software block diagram

Mode 3, valve with 2 solenoids and spool position feedback (EL8-STD)




Comparator 1
LED "Comp_1"
C1.21
C1.22
C1.23, C1.24
C1.25
Comp_1
Error/Comparator Output (0 / 24 V)
off = Error
1 = Comp. positive logic
2 = Comp. negative logic
E18
DMA-2 X3/2 (10)
Analog Output (0 ... + - 10 V)
X2/1(5) --> - (AGND)
X2/2(6) --> + ((Ana Out)
Analog out
E33
E19
E01
off
d1.01
d1.12
d1.13
DMA Ucc 24 V: X4/4(16)
DMA Ucc 0 V: X4/3(15)
W Analogue X3/3(11)=S1.06+ X3/4(12)=S1.06-
E15
E08
r1.01 ... r1.04
const. res
const. time
C1.06
C1.05
C1.27
C1.03, C1.04
E11 Command ramp
d 101
d 102
d 103
d 104
d 110
d 111
d 112
d 113
C1.00
Off
Remote Switch
Controller output
Push-Pull
E02=3
Comp_1
Din_1 (via "S1.01")
LED "Dout_1" (HCSTool only!)
C1.20
C1.33
C1.13
C1.14, C1.16
C1.17
C1.18, C1.19
C1.15
Valve
Lin. Motor -
Lin. Motor +
LVDT
Ucc 24 V: X4/2(14)
Ucc 0 V: X4/1(13)
X1/4(4) I_Stage -
X1/2(2) I_Stage +
d 107
d 108
d 109
d 105
d 106
E03, E04... E07, E09
Enable
X3/1(9)
E1.13
E1.14
X Feedback 1 Analog X2/4(8)- X2/3(7)+
C1.09
E06
Filter for feedback
C1.12
*1 / 0 / *-1
C1.11
C1.10, C1.36
Values <0: (C1.10+C1.36)
Values >0: C1.10

9.1 Display parameter

Internally calculated values can be displayed during normal operation and are especially helpful for commissioning and troubleshooting. The values can be displayed by use of AH Hub monitor function.

The values should be interpreted as voltage or current with a standardized display resolution of 1 mV to 9.999 V for currents between 0.001 A to 4.000 A. The relevant position in the software functions can be taken from the block diagrams.

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

Display-Parameter	Function
d1.01	Sum analogous set values
d1.02	Sum set values after ramp function
d1.03	Set points after linearization
d1.04	Set values after gain adjustment
d1.05	Signal to solenoid A
d1.06	Signal to solenoid B
d1.07	Current solenoid A
d1.08	Current solenoid B
d1.09	Total current solenoid A and B
d1.10	Set point, reference input (w)
d1.11	Actual value, feedback input (x)
d1.12	Lag error, deviation between command and feedback (e)
d1.13	Controller output (y)

Table 16: Display parameters

9.2 Output stages

- PWM output stages are used to reduce power losses
- The pulse frequency is 24 kHz
- The output stages are equipped with over drive and high-speed breaking to increase dynamic response
- The output stages are designed for constant currents of 3.5 A. each
- Parameter Ex.03 sets the nominal solenoid current. There are different standard settings available (0.8 / 1.1 / 1.3 / 1.6 / 2.4 / 2.7 and 3.5 A).
  Further, there is an infinitely variable reduction possible with the parameter E1.10
- All settings are concurrent for both solenoids

9.3 Control circuits with feedback signal adjustment

Closed-loop control can be switched on or off using the parameter C1.00.

9.3.1 Adjustment of the actual value signal Fb1

Selections 10, 11 and 12 at C1.09 are for pressure control loops using pressure control valves. In this instance, the control output is limited to the positive range and therefore controlling only one solenoid (B).

Selections 1 to 9 are for valves using LVDT or for applications that might cause negative signals at the controller output. For these selections the controller output can be positive or negative, depending on the difference between actual value and set point, energizing solenoid A or B.

To ensure utmost safety and best possible reproduction in a user-friendly way, all settings and adjustments are done digitally, supported by the hardware. Through combination of hardware and software functions for the actual value adjustment guarantees highest resolution and precision. Therefore, the advantages to a system with analogous adjustment using potentiometers are obvious.

Adjustment:

CAUTION	Activate the “enable” signal. If C1.09 = 10, 11 or 12, d1.11 will not show any values < 0.000.

Step	Adjustment
1. Zero point adjustment / general case	
1.1	place the output signal of the sensor in its zero position
1.2	set AH Hub monitor function (or EKB) to d1.11
1.3	save inverted d1.11 value in C1.11
1.4	check d1.11 again, repeat step 1.2 and 1.3 if necessary
2. Zero point adjustment / valves with spool position feedback	
2.1	set initial current by E11 = E12 = 200 mA (centering the valve)
2.2	deactivate controller C1.00 = 0
2.3	switch on enable and leave solenoid plug connected
2.4	repeat steps 1.2 to 1.4 according to "1. Zero point adjustment / general case"
amplifier adjustment	
2.5	set the system to achieve a maximum actual value
2.6	check d1.11 display
2.7	adjust amplifying with C1.10
2.8	check d1.11 result
2.9	repeat steps 2.7 and 2.8 if necessary

Table 17: Feedback signal adjustment

To invert the actual value signal, use parameter C1.12. If necessary, invert the set point signal with C1.05 to determine and correct the controller direction.

9.3.2 Standard controller setting (C1.00, C1.01)

The controller and its general functions are activated using parameter C1.00. There are four different types of controller configurations:

C1.00	Controller function	Description
1	P-PT1-I-DT1 – controller	Standard controller with various options
2	remote loop control	The Controller is activated or deactivated by reaching a threshold value and/or by the status of a digital input. Structure of controller is the same as "1"
3	direct feed forward controller (dff controller)	This is a controller where a portion of the set point (depending on C1.13) is switched directly on the output stage. The remaining portion is a standard P-PT1-I-DT1 controller; further referred to as a dff controller (direct feed forward).
4	combination of "1" and "2"	this is a combined dff controller and P-PT1-I-DT1 controller (that can be activated as described in "2").

Table 18: Controller selection

The safety function is activated by the parameter C1.01 and will be described in the following section.

9.3.3 Remote loop control

To activate this function, chose parameter C1.00 = 2 or C1.00 = 4.

Initially, the amplifier is in an open loop mode. The solenoid current is a direct function of the set point (e.g. resulting in a specific pressure when using pressure valves). By activating the "S1.10" input, the amplifier is in stand by and may be switch to closed loop controlling. The comparator monitors the feedback value signal. If the feedback value now exceeds this comparative value, the closed loop is activated.

	When C1.17 > 00.00, the output of the I-controller (C1.17) is programmed with the set point. This ensures a smooth change from open loop to closed loop.

Even if the feedback value drops below the switching threshold, the control remains active. A "low" signal at the "S1.01" is required to switch off the closed loop function.

By setting the threshold value of the comparator (C1.21 and C1.22) = 0, the "S1.01" input can be used directly to activate the controller. This allows to activate the controlling by to external factors.

	C1.23 does not have any function when the "switching controller" is activated. C1.24 can be used to delay controller activation

The status is displayed with the LED "Dout_1" (only available in the monitor function of AH Hub).

Input "S1.01"	actual value > or < switching threshold	Function	"LED" Dout_1
Low	<	open loop	off
High	<	open loop	on
High	>	closed loop	flashes

Table 19: Switching controller status

9.3.4 Direct feed forward controller (dff)

Fundamentally the dff controller can always be used instead of a standard controller (P-PT1-I-DT1), simply set C1.00 = 3 or C1.00 = 4.
The dff controller is designed as a parallel circuit of a P term with a PT1-I-DT1 controller. The processed set point of d1.10 is hereby used directly as an input to the P-amplifier. Following an addition with the dff branch P-factor, the signal is added to the adjusting signal of the PT1-I-DT1 controller. The result can be verified with d1.13. The PT1-I-DT1 controller is supplied with the control deviation d1.12.

This operating mode enables enhanced dynamic performance with simplified parameter setting. Following a general formula, 80 % of the output signal should be supplied by the dff controller, the remaining 20% should come from the PT1-I-DT1 controller

10. Inputs, outputs and messages

10.1 General

› The output "Error / Comp" is short circuit protected.

10.2 Supply

› The multi-color LED "STATUS" lights up in green when the supply voltage is present.

10.3 Enable

› After the enable signal has been applied to terminal X3/1, the LED "STATUS" lights up in yellow. If a time delay had been set in parameter E9, LED "STATUS" flashes yellow for the period of the delay.
› Once the time delay elapses, the flashing signal becomes a continuous signal and the output stages are enabled

10.4 Fault (error)

› The current in the output stages is monitored in the amplifier. If the total current exceeds a specific threshold value, the output stages are switched off automatically. At the same time, the signal at the output "Fault" (terminal X3/2) is set to 0 V. The LED "STATUS" will be lit red. This will remain until the cause of the error was corrected and the error was reset be disabling/enabling the module.
› If the Analog command input (S1.06) is used as current input with cable fracture detection activated than under current is also monitored. The respective error is triggered if the current drops below approx. 2 mA.
› The input is also protected for overload. So if the signal current exceeds approx. 25 mA the input will be automatically switched off in order to protect the hardware. Also an error is triggered and the respective error message is generated.
› Malfunction signals should not be corrected by switching off the supply voltage but by taking off the enable signal (after correcting the cause of the malfunction), otherwise a diagnosis is no longer possible.
› It is possible to continue the setting of the module even though the malfunction is still present. This allows to find the cause of the error and to correct it. Afterwards, the enable has to be reset (deactivated and activated).
› For special function of the output as comparator output refer to

See □ Chapter „8.4.16 Comparator (C1.21 to C1.25, E18)", page 22

› All fault messages as well as the status of the comparator can be monitored with the software **AH Hub.**

10.5 Display and error messages

› Defined error and other messages:

Display with software **AH Hub**	Description of error/message
1	Error of operation
2	Wire break sensor 1 (Fb1)
3	Excess current or short circuit at the output stages
4	n/a
5	Wire break or over voltage at set value input (S1.05)
6	Wire break or over voltage at set value input (S1.06)
7	n/a
8	Wire break at the output stages
9	n/a
10	n/a
11	Negative or overload current >22 mA sensor FB1 (Input Fb1)
12	n/a
13	n/a
14	n/A
15	Negative or overload current >22 mA at input (Input S1.05)
16	Negative or overload current >22 mA at input (Input S1.06)

Table 20: Error list

11.1 General

Remote operation or remote parameter adjustment may be executed through the USB-C interface.

The amplifier module contains a simple monitoring program, see section 6.3 for details. With the use of the program **AH Hub**, all the parameters may be manipulated. It enables the editing, download and upload parameters and sets of parameters and also has a wide range of other functions. The parameters of the amplifier module can be changed by a superior control (e.g. PLC) with a defined protocol. This way, the amplifier card can be inserted into the machine process in automated systems. For further information about the program **AH Hub** and the protocol please contact the manufacturer.

CAUTION	Any change of parameters with the USB-C interface should be carried out by trained personnel only. If possible, the drive must be stopped during parameter changes. Deactivation of the enable signal is recommended.

11.2 Physical interface data

The connection cable must the following conditions:

› USB-C connector on the EL8 side
› Depending on the PC the other side of the cable has to be selected (USB-A; USB-B or USB-C)

11.3 Parameterization Tool

Figure 11 : Parameterization Tool screen

After starting AH Hub the program can either be used "offline" (without having a unit connected) or "online" in direct operation with a module.

After connection of the module with the USB-C interface it is the best to select the "Upload parameter from device" button to establish communication between the AH Hub and the unit. In this case the software and module version are automatically detected.

Example of Argo Hytos parametrization tool (AH Hub).

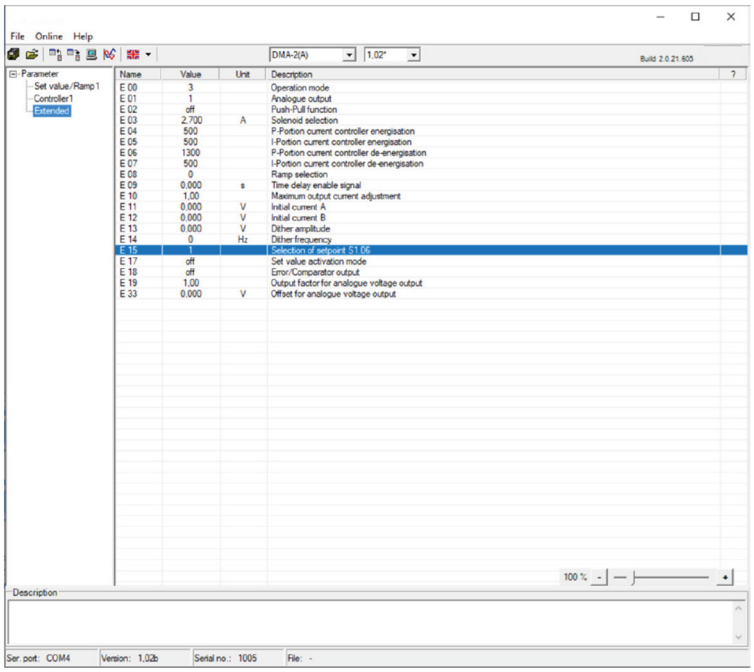


Figure 12 : AH Hub working area screen

Each parameter can be edited individually and either directly changed in the module (selecting download) or only in the PC list (OK). In the latter case the parameter will be highlighted. Finally all changed parameters can be downloaded.
Example for editing of parameter C1.05:

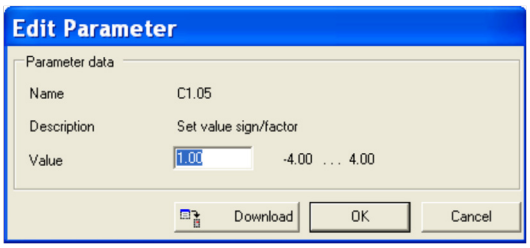


Figure 13 : AH Hub Parameter editing

In order to get information about internal values the display parameters can be used. For this purpose the "Monitor" function must be activated ("Monitoring internal values).
Remark: The monitor also will display error codes and status of digital inputs.

For further information about AH Hub please contact the manufacturer or any of our distributors and partners.

12. Complete parameter list

Parameter list for version EL8

Display-Parameters:					
#	Function	Unit	Step	Min	Max.
d1.01	Analog set value (S1.06)	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 (w)	V	0.001	-9.999	+9.999
d1.11	Actual value, feedback value (x)	V	0.001	-9.999	+9.999
d1.12	Lag error (e)	V	0.001	-9.999	+9.999
d1.13	Controller output (y)	V	0.001	-9.999	+9.999

Set value parameters: Digital set values					
#	Function	Unit	Step	Min	Max.
S1.01	Internal set value 1	V	0.001	-9.999	+9.999
S1.02	Internal set value 2	V	0.001	-9.999	+9.999

Ramp parameters for set values					
#	Function	Unit	Step	Min	Max.
r1.01	Ramp from 0 ⇒ -	S	0.01	0000	39.50
r1.02	Ramp from – ⇒ 0	S	0.01	00.00	39.50
r1.03	Ramp from 0 ⇒ +	S	0.01	00.00	39.50
r1.04	Ramp from + ⇒ 0	S	0.01	00.00	39.50

Controller parameters:						
#	Function	Unit	Step	Min	Max.	Code
C1.00	Controller selection	---	1	0	4	0 = off 1 = P-PT1-I-DT1 2 = Remote 3 = dff 4 = Remote + dff
C1.01	Safety function	---	---	0	1	off = off; on = on
C1.02	Linearization	---	1	0	5	off = linear; 1 ... 5 = curve
C1.03	Gain A	V/V	00.01	00.00	02.00	---
C1.04	Gain B	V/V	00.01	00.00	02.00	---
C1.05	Set value sign and factor	---	00.01	-04.00	04.00	---
C1.06	Set value offset	V	0.001	-9.999	+9.999	---
C1.07	Dead band compensation A	V	0.001	0.000	+9.999	9.999 V = max. current depending on solenoid selection
C1.08	Dead band compensation B	V	0.001	0.000	+9.999	
C1.09	Sensor type *1 *1, Attention: No negative controller output possible when 10, 11 or 12 is selected!	---	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 ± 4 V 9 = 7,5 V ± 2,5 V 10 = 0 ... 20 mA 11 = 4 ... 20 mA 12 = 0 ... 10 V
C1.10	Actual value gain	V/V	00.01	00.00	04.00	---
C1.11	Actual value offset	V	0.001	-9.999	+9.999	---
C1.12	Actual value sign	---	---	- 1	+ 1	- 1 = negative off = off + 1 = positive
C1.13	P-Portion KP1	V/V	00.01	00.00	04.00	---
C1.14	T-Portion for PT1 (to C1.16)	S	00.01	00.00	10.00	---
C1.15	Threshold (C1.13, C1.16)	V	0.001	0.000	+9.999	---
C1.16	P-Portion KP2	V/V	00.01	00.00	04.00	---
C1.17	I-Portion	V/s	0.001	0.000	4.000	---
C1.18	D-Portion	Vs	00.01	00.00	04.00	---
C1.19	T-Portion for DT1	S	00.01	00.00	10.00	---
C1.20	Gain (C1.13 and C1.16)	V/V	0001	0001	0032	---
C1.21	Comparator upper level	V	0.001	-9.999	+9.999	---
C1.22	Comparator lower level	V	0.001	-9.999	+9.999	---
C1.23	Comparator delay into window	S	00.01	00.00	+99.99	---
C1.24	Comparator delay out of window	S	00.01	00.00	+99.99	---
C1.25	Comparator selection	---	1	0	3	off = off 1 = Set value 2 = Actual value 3 = Lag error
C1.26	Cable fracture detection feedback	---	---	off	1	off = off; 1 = active
C1.27	Command signal hysteresis	V	0.001	-9.999	+9.999	---
C1.33	I-Portion output value limitation	V	0.001	0.000	+9.999	---
C1.36	Sensor signal correction factor for values < 0 (related to C1.10)	V/V	0.01	-1.00	+1.00	
L1	Table for linearization	---	---	---	---	Adjustment of 8 individual points

Extended-Parameters: Basic adjustments						
#	Function	Unit	Step	Min	Max.	Code
E00	Operation mode	---	---	3	3	Mode 3 → valve spool position feedback
E02	Push-Pull function	---	---	Off	5	Off = off 1 = Push-Pull function active 4 = Push-Pull function off and special short circuit detection 5 = Push-Pull function active and special short circuit detection
E1.03	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
E1.04	P-Portion current contr. Energization	---	0001	0000	9999	---
E1.05	I-Portion current contr. Energization	---	0001	0000	9999	---
E1.06	P-Portion cur. contr. de- energization	---	0001	0000	9999	---
E1.07	I-Portion cur. contr. De- energization	---	0001	0000	9999	---
E08	Ramp selection	---	1	0	2	0 = digital set values (time constant) 1 = all set values (rise constant.) 2 = selectable ramp function
E09	Time delay enable signal	s	0.001	0.000	+9.999	---
E1.10	Solenoid current adaptation	---	00.01	00.50	01.10	Variable adjustment of max. current
E11	Initial current solenoid A	V	0.001	0.000	+9.999	3.000 V = 30 % of max. rated current
E12	Initial current solenoid B	V	0.001	0.000	+9.999	
E1.13	Dither Amplitude	V	0.001	0.000	+3.000	3.000 V = 30 % of max. rated current
E1.14	Dither Frequency	Hz	1	1	300	---
E15	Selection set point input S1.06	---	1	Off, 1	11	off = deactivated 1 = - 10 V ... + 10V 2 = 0 ... 10 V 3 = 5 V ± 5 V 4 = 5 V ± 4.5 V w/o signal observation 5 = 5 V ± 4.5 V with signal observation 6 = 0 ... 20 mA w/o cable fracture detect. 7 = 10 ± 10 mA w/o cable fracture detect. 8 = 4 ... 20 mA w/o cable fracture detect. 9 = 4 ... 20 mA with cable fracture detect. 10 = 12 ± 8 mA w/o cable fracture detect. 11 = 12 ± 8 mA with cable fracture detect
E17	Set value activation mode	---	1	off, 1	3	off = 2 digital, 1 Analog active 2 = only 2 digital active
E18	Error / Comparator output selection	---	1	off, 1	2	off = only “error” signal relevant 1 = comparator positive logic 2 = comparator negative logic
E21	Password	---	0001	0000	9999	To protect parameters

Table 21: Parameter list

13. Contact to manufacturers, distributors, service, repairs department, complaints

ARGO-HYTOS s.r.o.
Dělnická 1306
CZ - 543 01 VRCHLABÍ
Czech Republic
Tel. +420 499 403 111
E-mail: info.cz@argo-hytos.com