Manual for
DMA-22(A)

Digital Module Amplifier for proportional valve in operation mode 01, 02, 03, 04, 05 and 10

Applicable for SW Versions

Model Code	Mode	SW Version	Remarks
DMA-22(A)-03-x-SANAout DMA-22(A)-04-x-SANAout DMA-22(A)-10-x-SANAout	03 04 10	V 01.xx*	Analog Output available
DMA-22(A)-03 DMA-22(A)-04	03 04	V 03.xx*	
DMA-22(A)-03-x-SANAout DMA-22(A)-04-x-SANAout DMA-22(A)-10-x-SANAout	03 04 10	V 04.xx*	Analog Output available Polarity crossed of FB1 input (connection compatible to old DMA)
DMA-22(A)-05-x-SHPR-ANAout	04 05	V 39.xx*	
DMA-22(A)-03 DMA-22(A)-04	03 04	V 05.xx*	Polarity crossed of FB1 input (connection compatible to old DMA)
DMA-22(A)-05-x-SHPR	04 05	V 35.xx*	
DMA-22(A)-02	02	V 06.xx*	
DMA-22(A)-01	01	V 07.xx*	

xx = 01 or higher
* = a, b, ….
x = additional options
Bus versions not mentioned

HCS Hydraulic Control Systems GmbH
Neuffener Str. 29
D-72636 Frickenhausen
Germany
Email: info@h-c-s-gmbh.de
Web: www.h-c-s-gmbh.de

Revision History

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01	03.07.2024	Bm	First preliminary release,
01	04.09.2024	Bm	Update to new parameter list; minor editorial changes made
02	01.03.2026	Deu	Thoroughly revised and edited

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1 Abbreviations

Abbreviation	Description
DMA	**D**igital **M**odular **A**mplifier
EMC	**E**lectro **M**agnetic **C**ompatibility; properties of the wire break to comply with the EMC directive
USB	**U**niversal **S**erial **B**us; interface for communication between a PC and the DMA-22(A)
PC	**P**ersonal **C**omputer
µC	**M**icro **C**ontroller; CPU used inside the wire break to control all functions
mamsl	**m**eters **a**bove **m**edian **s**ea **l**evel
IP65	Protection Class; solid particle protection and protection level against water ingress
LED	**L**ight **E**mitting **D**iode
PWM	**P**ulse **W**idth **M**odulation; method to control the output current at low power losses
Ub	Supply voltage
FS	**F**ull **S**cale

Table 1: Abbreviations

2 Terms and Definitions

Term	Description
Amplifier module	Amplifier for proportional valves which has modular structure
Torque motor	In the torque motor, an electric current is converted to a mechanical torque that generates the mechanical displacement of a flapper or jet pipe.
HCSTool	Software tool provided by HCS in order to adjust and parametrize DMA-22(A) units
CANopen	Bus interface for digital communication, defined by CiA. CAN in Automation is the international user and manufacturer association responsible for the dissemination and standardization of CAN.
PROFIBUS	Process Field Bus interface for digital communication, defined by BMBF (German department of education and research) and used by Siemens
PROFINET	Process Field Net interface for digital communication, the standard is maintained and supported by PROFIBUS & PROFINET International
EtherNet/IP	(IP = Industrial Protocol) is an industrial network protocol that adapts the Common Industrial Protocol to standard Ethernet
USB-C connector	Connector type used on the USB interface

Table 2: Terms and definitions

3 General information

3.1 Abstract

This document describes the function of the HCS digital amplifier module “DMA-22(A)”.

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. Users are encouraged to submit any comments regarding errors or possibly incomplete information to HCS GmbH.

⚠ DANGER

Read this manual carefully before working with the digital amplifier modules.

All general and, in particular, safety instructions contained in this manual must be strictly observed at all times.

Electronic equipment of any kind may be subject to component failure or software-related malfunctions, which can result in unpredictable behavior. Therefore, appropriate secondary safety measures must be implemented to ensure safe operation under all circumstances. This is particularly important for safety-critical applications.

Furthermore, it is the responsibility of the user to comply with all applicable safety standards (e.g., EN 13849) and to implement a system architecture that fulfills all relevant safety requirements. The wire break itself does not comply with any performance level according to EN 13849 or any Safety Integrity Level (SIL) as defined in EN 61508.

All applicable laws and safety standards must be observed at all times. Prior to commissioning or using the equipment, a risk assessment must be performed and appropriate protective measures must be implemented.

HCS GmbH assumes no liability for any damage or loss resulting from failure to comply with these requirements.

3.2 Scope

This document is intended to enable qualified, competent, and trained users to install, wire, connect, commission, parameterize, perform fault analysis, and troubleshoot the product. It also provides all technical and operational information required for the safe use of the product.

It remains the responsibility of the user to ensure a safe working environment during operation.

The information contained in this manual is valid at the time of its release. Please refer to the footer for the version number and release date of this manual.

This manual applies to digital modular amplifiers “DMA-22(A)-x” with software for proportional valve control, excluding bus versions. The DMA-22(A) with integrated bus connection is described in the corresponding bus documentation.

3.2.1 Copyright

3.2.2 Documents place of storage

This manual and all associated documentation for hardware and software must be kept in a location where they are readily accessible and in close proximity to the digital amplifier module DMA-22(A) or the equipment in which it is installed.

3.2.3 *Warning signs, symbols and notes*

DANGER

Indicates safety instructions that warn of an immediate and imminent danger to life and limb.

Failure to comply with these safety instructions will result in death or serious personal injury.

WARNING

Indicates safety instructions that warn of a potentially hazardous situation involving a risk to life or limb.

Failure to comply with these safety instructions may result in death or serious personal injury.

CAUTION

Indicates a potentially hazardous situation that may result in minor personal injury.
Failure to comply with these safety instructions may result in minor personal injury.

NOTICE

Failure to comply with this notice may result in property damage!

Identifies important information

Other identifiers (when applicable):

Identifier	Description
●/ -	Listings
□	References to another chapter, page, table or figure in this manual
blue text	Hyperlink 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 3: Identifiers

3.2.4 Safety and liability

NOTICE

The information contained in this document is subject to change without prior notice. HCS assumes no responsibility for any errors that may appear in this manual.

This operating manual reflects the current state of knowledge of HCS at the time of its preparation. The greatest possible care has been taken in its compilation. Nevertheless, HCS assumes no responsibility or liability for specific user applications. This applies in particular in cases of non-compliance, omissions, errors, misinterpretations, or misunderstandings.

All applicable laws and safety standards must be observed at all times. Prior to commissioning or use of the equipment, a risk assessment must be performed and appropriate protective measures must be implemented.

This manual describes the functionality and effects of the parameters only. The described software functions may be used in various amplifier models and implemented in a wide range of applications. Therefore, no liability can be assumed for the effects of parameter settings.

HCS GmbH assumes no liability for any damage or loss resulting from failure to comply with these requirements.

⚠ WARNING

In applications with critical safety requirements or where accident prevention regulations must be observed, it may be necessary to isolate the components from the solenoids using relays within emergency stop circuits.

Switching off the enable signal (0 V at terminal X3/1) is not sufficient. In such cases, additional hydraulic and/or mechanical safety measures must be implemented to bring the drive to a safe stop (e.g., by means of switching valves with position monitoring).

⚠ WARNING

All types of proportional directional valves, which may be used in a wide range of environments and applications, can fail and may therefore cause damage.

It is the responsibility of the customer to analyze all safety-related aspects of the application. The machine builder and/or system integrator bear full responsibility for the final selection of products and must ensure that all safety and performance requirements are met.

The process of selecting the appropriate control system and defining the required safety levels is governed by EN 13849..

NOTICE

Liability for the content of this document is excluded.

Any claims against HCS GmbH, regardless of the legal grounds, arising from the use of the information, programs, engineering data, or performance data described in this document, are excluded. This exclusion shall not apply in cases of mandatory liability, for example under the Product Liability Act, in cases of intent, gross negligence, or injury to life, body, or health, in the event of a guarantee for the quality of a product, fraudulent concealment of a defect, or breach of a fundamental contractual obligation.

However, damages resulting from the breach of a fundamental contractual obligation shall be limited to the foreseeable damage typical for the type of contract, except in cases of intent, gross negligence, or injury to life, body, or health. The above provisions do not imply any change in the burden of proof to the detriment of the user.

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

3.2.5 General information

⚠ WARNING

Electrostatic discharge (ESD) may damage components within the module. To prevent damage, always observe the following precautions:

Discharge any static electricity from your body using appropriate grounding methods (e.g., wrist straps or grounded surfaces).

Work in an ESD-safe environment. Do not use devices or materials in the work area that may generate or retain static charges. Avoid operating the product in areas where floors or surfaces are made of materials that can generate static electricity.

Handle all equipment with care and avoid touching exposed pins or components.

Store and transport the units only in their original packaging.

⚠ WARNING

During commissioning, particular attention must be paid to the correct design and implementation of the wiring. The wiring must be verified before applying the supply voltage.

To prevent collisions, all safety devices and limit switches must be active. All applicable safety regulations must be observed.

Monitoring of the fault signal (terminal X3/2 (10)) is recommended.

Malfunctions can occur with the following:

- Changes to the settings made by the supplier.
- Neglecting 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 setpoints or actual values
- Faults in the subsequent hydraulic components
- Removing solenoids connections.

3.3 Terms and conditions

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

3.4 Delivery state (default setting)

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

3.5 Correct product use

The digital amplifier modules “DMA-22(A)-x” are intended for the following applications:

- Control of servo valves (in particular directional control valves), with or without feedback depending on the operating mode.
- Conversion of setpoint signals into a current signal to control a servo valve with a torque motor and spool position feedback.
- Use in industrial applications only.

The operation of other inductive or resistive loads (e.g., motors, heaters) is not recommended. For such applications, please contact HCS GmbH.

When used as intended, the safety of the user and the proper and reliable operation of the amplifier DMA-22(A)-x are ensured.

3.6 Non-intended product use

The digital amplifier modules “DMA-22(A)-x” must not be used under the following conditions:

- If visibly damaged
- If the electrical connections are damaged
- If they do not function properly
- After improper handling or storage
- In unsuitable applications or environments

In such cases, the digital amplifier module must be switched off and secured against unintended restart.

In applications with critical safety requirements or where accident prevention regulations must be observed, it may be necessary to isolate the components from the solenoids using relays within emergency stop circuits. In such cases, additional hydraulic and/or mechanical safety measures must be implemented to bring the drive to a safe stop (e.g., by means of switching valves with position monitoring).

During commissioning, particular attention must be paid to the correct design and implementation of the wiring. The wiring must be verified before applying the supply voltage.

To prevent collisions, all safety devices and limit switches must be active. All applicable safety regulations must be observed.

3.7 Selection and qualification of personnel

Only qualified personnel may work with the amplifier. Qualified personnel are trained specialists with the necessary knowledge and experience.

In particular, such personnel must be authorized to commission systems and power circuits in accordance with applicable safety standards. They must be familiar with safety concepts commonly used in automation technology.

3.7.1 Inquiries and orders

To order the product, the complete order code is requested.

See □ Chapter "4.3 Model code", page 16

Please refer to our general terms and conditions (available upon request) and direct all orders and inquiries to the companies listed on our website.:

Sales Partners (h-c-s-gmbh.de)

They are our official distributors/partners. We reserve the right to forward any direct inquiries or orders to our distributors/partners. Nevertheless, we remain available to provide any necessary technical support.
Germany and other countries without a distributor/partner:

Neuffener Strasse 29
D-72636 Frickenhausen
Tel: (+49) 7025 - 911 007
Fax: (+49) 7025 - 911 008
Email: info@h-c-s-gmbh.de
www.h-c-s-gmbh.de

3.7.2 Service and repair

⚠ WARNING

Do not attempt to repair the product under any circumstances!

After repair, certain adjustments and test procedures must be performed; these may only be carried out by qualified and authorized personnel. Products requiring repair may be sent to the addresses listed below:

See □ Chapter "3.7.1 Inquiries and orders", page 11

In particular, such personnel must be authorized to commission systems and power circuits in accordance with the applicable safety standards. They must be familiar with the safety concepts generally accepted in automation technology.

Please enclose a detailed description of the error, malfunction, or failure with the returned item, and include the serial number and date of purchase. This will help to facilitate prompt processing and ensure an efficient and reliable repair service.

In the event of a fault or malfunction, your distributor may provide instructions by telephone or in writing before processing a repair request. For service and repair, appropriately qualified personnel are available. If you require assistance, please contact the address listed below:

See □ Chapter "3.7.1 Inquiries and orders ", page 11

3.7.3 Cleaning, storage, transport

The product should only be transported and stored in its original packaging to ensure adequate protection against mechanical damage and electrostatic discharge (ESD).

- Keep the amplifier module away from moisture and dust.
- Observe the permitted storage and transportation temperature range.
- If cleaning of the amplifier is required, it is recommended to return the wire break to the manufacturer or an authorized distributor/partner:

See □ Chapter "3.7.1 Inquiries and orders", page 11

⚠ CAUTION

Unpacking and handling may only be performed by suitably trained personnel. Risk of damage to the amplifier due to electrostatic discharge (ESD).

3.8 Introduction

The digital amplifier module DMA-22(A) is based on state-of-the-art technology. This electronic device complies with industrial EMC standards, ensuring high immunity to interference and low emission levels.

The performance characteristics are achieved through the use of modern microprocessor technology (32-bit floating-point CPU) in combination with advanced electronic components. In addition to control functions, the microprocessor also performs closed-loop control tasks. The system functionality is largely determined by software, providing sufficient capacity for future developments and adaptations.

The DMA-22(A) series offers the following key features:
• Fully digital amplifier module with the following advantages:
– No on-board potentiometers
– No jumper settings required
– Digital parameter setting and visualization via PC using HCSTool
– Enhanced user safety during parameterization
• Flexible and reliable system design:
– Use of a modern 32-bit floating-point microcontroller
– High performance with sufficient power reserves
– High reliability and safety through integrated watchdog and reset functions
– Flexible parameterization for different magnetic systems
• Advanced interface functionality:
– Adjustment of selected parameters “on-the-fly” without interrupting operation
– System analysis via selectable display parameters using a PC and the integrated 4-channel oscilloscope function in HCSTool
• Optional fieldbus interfaces:
– PROFIBUS / PROFIDRIVE
– PROFINET
– EtherNet/IP
– CANopen

3.9 General Applications

The amplifier module DMA-22(A) is intended for:
- With or without electrical feedback transducers
  - Proportional directional valves (direct operated and pilot operated)
  - Proportional flow control valves
  - Proportional pressure reducing valves
  - Proportional pressure control valves
  - Cartridge valves
  - Servo valves with torque motors
- Control of hydraulic motors, systems and installations, e.g.:
  - Position
  - Speed
  - Pressure
  - Rotational speed (rpm)
  - Torque
  - Power

- Flow and pressure control of pumps (including optional power limiting and spool position control)
- Control of various process variables:
  - P or Q control
  - Pump control
  - Pressure control
  - Control of pilot or main stages

4 Product overview and description

4.1 Technical features

The DMA-22(A) system features include:

- One analog input each for setpoint (command signal; S1.06) and feedback (sensor signal; Fb1), configurable via parameters.
  Supported input signal ranges (differential inputs):
  - – 0 ± 10 V
  - – 0 … 20 mA, 10 mA ± 10 mA, 4 … 20 mA, or 12 mA ± 8 mA
  - – Cable break detection for current inputs configurable via parameter E15 (setpoint) and parameters <C1.09> and <C1.26> (feedback)
  - – Analog input resolution: 16 bit

- 2 or 4 (depending on the operating mode) selectable and digitally adjustable setpoints within a range of 0 … ±10 V (<S1.01>, <S1.02>)
  – In operating mode 1, two additional setpoints are available (<S1.03>, <S1.04>)
- Enable signal for output stages
- Status output “Error”
- Status indication via multi-color LED on the front panel
- USB interface with USB-C connector
- Optional fieldbus interfaces:
  - PROFIBUS / PROFIDRIVE
  - PROFINET
  - EtherNet/IP
  - CANopen

4.2 Technical data

4.2.1 General technical data

Feature	Range, characteristics
Model	Modular digital amplifier in snap-on mounting technology
Supply voltage	10 V DC - 32 V DC; residual ripple < 10 % (max. 50 VA power draw) *1
Duty cycle	100 %
Preliminary fuse	3.15 A; quick blowing
Ambiant operating temperature	- 40 °C ... + 70 °C
Storage temperature	- 45 °C ... + 85 ° C
Humidity (relative air humidity)	max. 95 % non condensing
Max. elevation	2,000 m (mamsl)
Class of protection	IP20 (EN60529)
EMC	In accordance with the applicable industrial standards (CE - conformity) *2
Connection, type of connector	16 pole (4 x 4); screw terminals for 0.2 - 2.5 mm² (AWG 24 -12) Phoenix Combicon connector with screw terminals, type: MSTBT 2,5/ 4-ST for detailed technical data refer to Phoenix Contact Combicon Product Catalog
Cable specification	1.5 mm² (AWG16) for supply and solenoids, shielding recommended, max length: 50 m 0.5 mm² (AWG20) for analog and digital signals, shielding mandatory, max length: 50 m
Mounting/housing	Mounting: top-hat rail (mounting rail) in accord. with EN50022 with integrated PE contact Housing configuration: ventilated (IP20) Material: PA 66 - FR (blue); flammability in accordance with UL94V0 Dimensions approx.: (w x h x d) 22,5 x 100 x 114 mm Weight: approx. 0.13 kg (inlcuding mating connectors)
Mounting postion	Any; preferably vertical for better heat dissipation through convection
Analog inputs	2 inputs with 16 Bit resolution (differential; 0 ... ± 10 V, 0/4 ... 20 mA)
Digital inputs	3 inputs (S1.01, S1.02, ENABLE);
Solenoid current (output)	2 PWM output stages, each for up to 3.5 A (with over-energ. and quick de-energization) Servo valves current ranges from 20 mA to 550 mA also available on request
Digital output	1 voltage output e.g. for signaling error, comparator status
Reference output (option)	+ 10 V output, e.g. for potentiometer application
Analoge output (option)	1 output with 12 Bit resolution, 0 ... ± 10 V, for monitoring o forwarding to other devices
Status signals	1 multi color „STATUS“ LED at front. Run/OK = green; Enable = yellow; Error = red
Interface	USB-C at front
Interface 2 Versions with Bus-Interface only!	PROFIBUS-DP: RS485, Sub-D 9-pole female PROFINET (in/out): 2 x RJ45 (integrated switch) ETHERNET/IP: RJ45 CAN-OPEN: Sub-D 9-pole male
Dither frequency range	1 ... 300 Hz - independant from PWM frequency (other frequency range on request)

Table 4: Technical Data

Detailed electrical information:
See □ Chapter "10 Detailed electrical data“, page 71

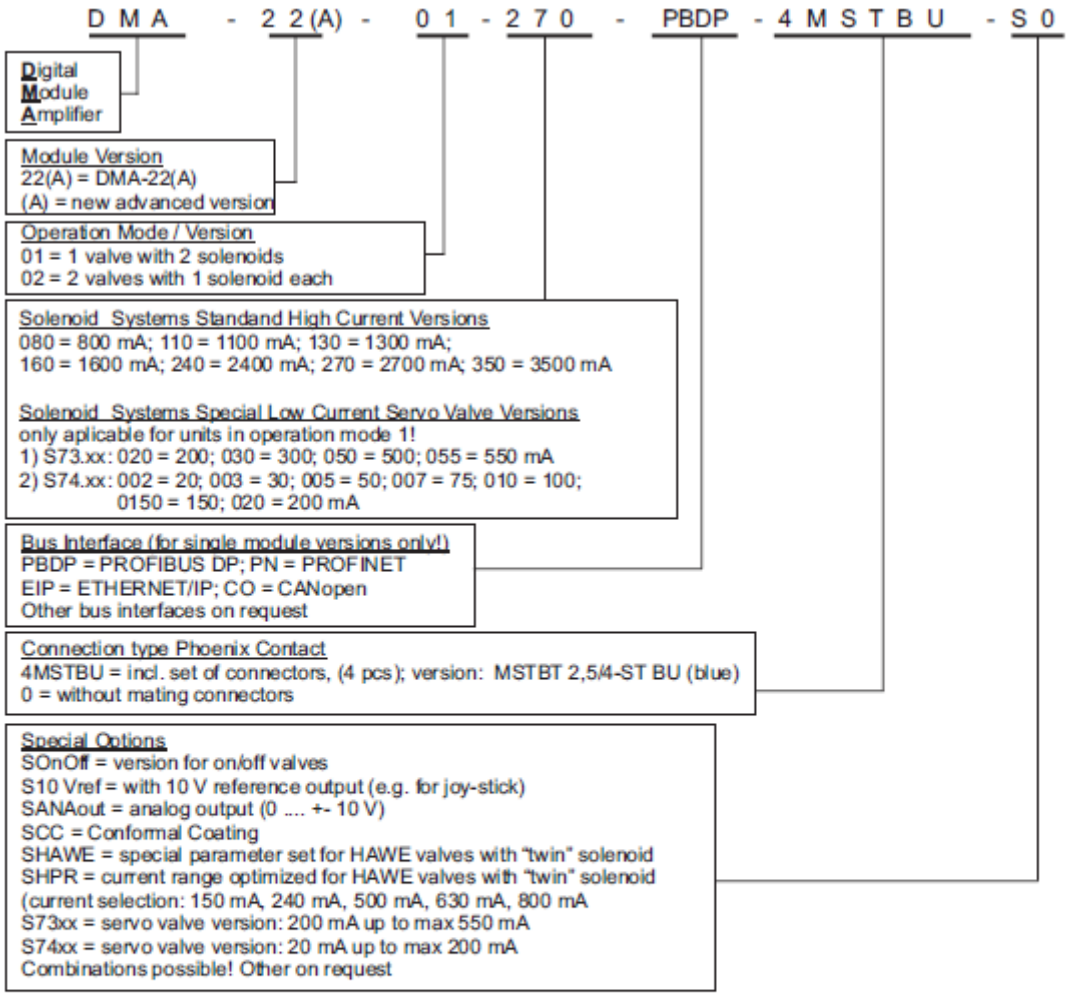
4.2.2 Technical data for optional bus interfaces

Bus interface	Range, characteristics	
Supply voltage	Via DAC-4(A) motherboard	
Temperature ranges, EMC, Mounting/housing	Refer to page 2	
PROFIBUS-DP	- Certified by PNO - Supports PROFIBUS-DP Slave in accordance with IEC 61158 - Supports PROFIBUS DPV1	- Maximum 244 Byte in-/output data - Supports up to 12 Mbaud (autodetect) - Electrical isolated and opto-decoupled
Connection / Type of connector	RS485, Sub-D 9-pole female	
Status signals	LED „Buserror" (red): DAC-4 error LED is used	
Address selection	DIP switch 1- 8, each on/off	
PROFINET	Approved by PNO - Meets the standard IEC 61158 and IEC 61784 - LAN 10/100Base-T(X) - 2 x RJ-45 LAN (Daisy Chain) - Cycling data exchange RT and IRT with PROFINET IO-Controller - Sending and receiving of diagnostic	and process alarms - I&M0...4-data available - Supporting of PROFINET naming (device name) and TCP/IP addressing - Fast Startup functionality supported - Shared Device supported - Media Redundancy Protocol support. - Electrical isolated interface
Connection / Type of connector	In/Out: 2 x RJ45 (integrated switch)	
Status signals	Power (green), Error (red), Maint (yellow), Sync (yellow), Status (yellow)	
Future usage	DIP switch 1- 3, each on/off	
Ethernet-IP	- Electrical isolated and opto-decoupled - supports all speeds - supports 10 and 100 MBit/s auto detect - 2 x RJ-45 LAN - DHCP functionality in preparation (on request)	- input-object instance 100 - output-object instance 101 - Full performance range of Ethernet/IP is supported - Electrical isolated interface
Connection / Type of connector	In/Out: 2 x RJ45 (integrated switch)	
Status signals	Status (geen)	
Future usage	DIP switch 1- 8, each on/off	

Table 5: Technical Data for Optional Bus Interfaces

4.3 Model code

4.3.1 Model code DMA-22(A) operation mode 01, 02; single-module bus versions

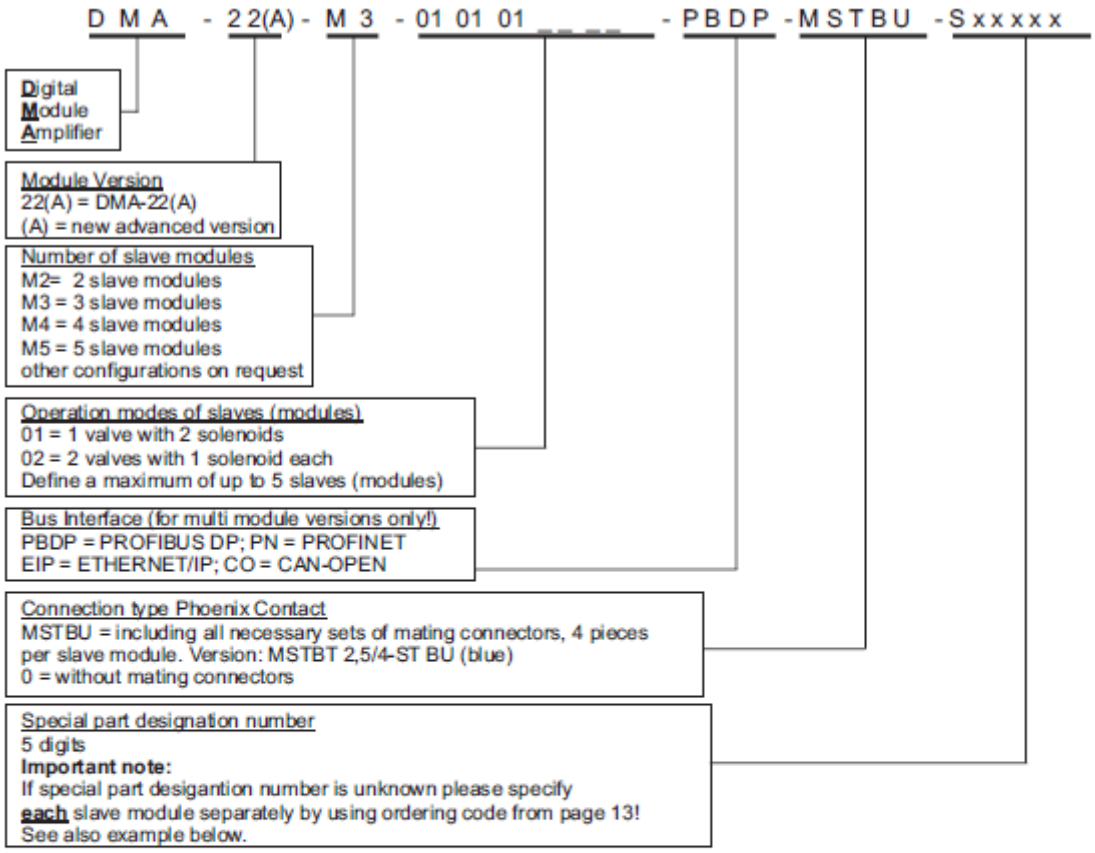


Ordering code examples:

Version for one valve with 2.7 A solenoid; operation in mode 1, including connectors	Version with PROFIBUS for two valves and 0.8 A solenoids; operation in mode 2, including connectors
DMA-22(A)-01-270-4MSTBU-S0	***DMA-22(A)-02-080-PBDP-4MSTBU-S0***

Figure 1 : Model code mode 01, 02, single-module bus versions

4.3.2 Model code DMA-22(A) operation mode 01, 02; multi-module bus versions



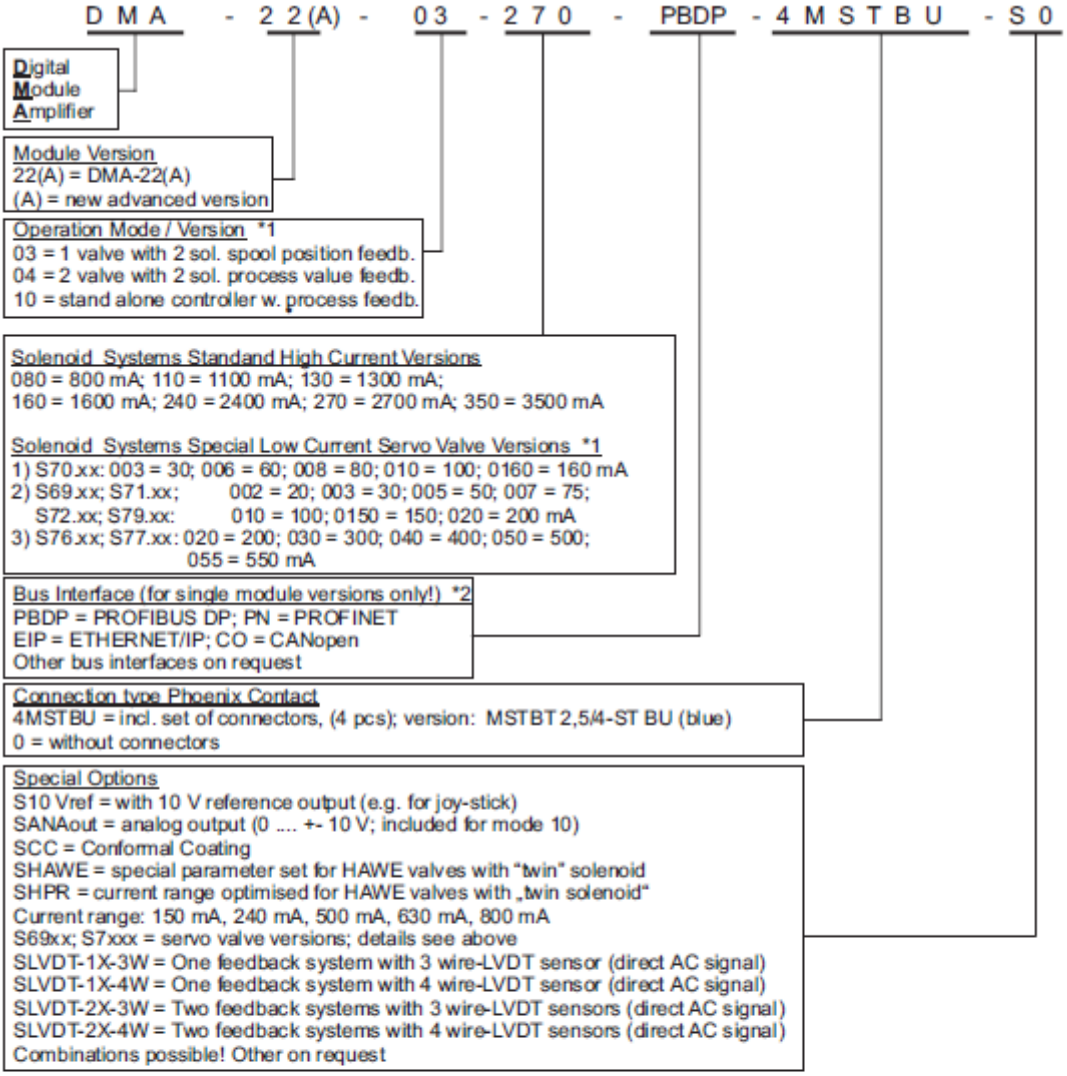
Ordering code example:

PROFIBUS version with 3 slaves (DMA-22(A) modules). Each of the 3 slaves (modules) is the same version for valves with two coils each with 2.7 A including the connectors.
Please specify each of the modules.

DMA-22(A)-M3-010101-PBDP-MSTBU-Sxxxxx containing
DMA-22(A)-01-270-x-S0 (module in operation mode 1)
DMA-22(A)-01-270-x-S0 (module in operation mode 1)
DMA-22(A)-01-270-x-S0 (module in operation mode 1)

Figure 2 : Model code mode 01, 02, multi-module bus versions

4.3.3 Model code DMA-22(A) operation mode 03, 04, 10; single-module bus versions



*1: all servo versions @ 50 kHz current controller frequency
Version S70.xx --> analog/linear output stage and SANAout included.
Version S69.xx / S71.xx / S72.xx / S76.xx / S77.xx / S79.xx: PWM output stage; S71.xx / S77.xx / S79.xx: SANAout included
Version S72.xx: for PROFINET applications; S79.xx: for PROFIBUS applications

*2: For versions with bus interfaces following modes on request:
06 = double closed loop, 1 x spool a. 1 x process control loop system, 08 = double closed loop, 2 x valves with process control loop
11 = stand alone controller double closed loop

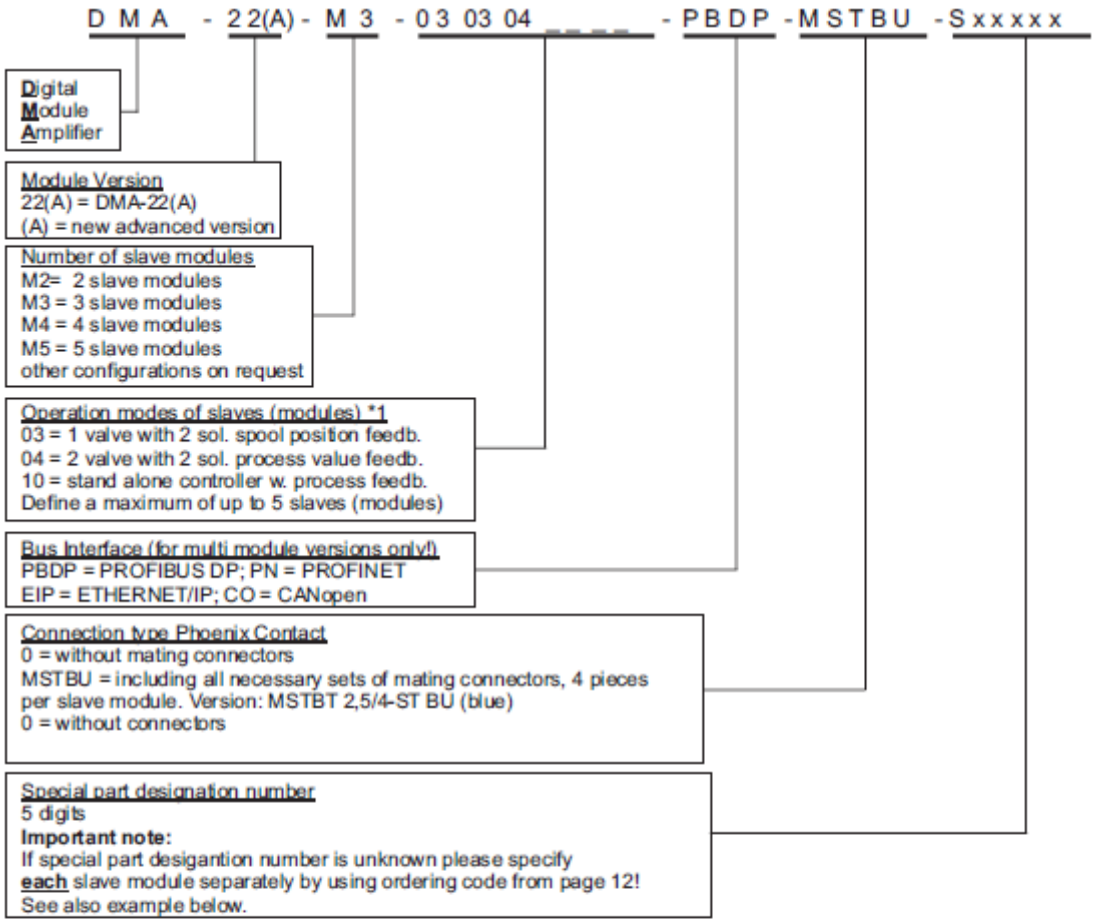
Ordering code examples:

Version for one valve with 2.7 A solenoid; operation in mode 3, including connectors
DMA-22(A)-03-270-4MSTBU-S0

Version with PROFIBUS for process control and 0.8 A solenoids; operation in mode 4, including connectors
DMA-22(A)-04-080-PBDP-4MSTBU-S0

Figure 3 : Model code mode 03, 04, 10, single-module versions

4.3.4 Model code DMA-22(A) operation mode 03, 04, 10; multi-module bus versions



*1:
For versions with bus interfaces following modes on request:
06 = double closed loop, one spool and one process control loop system
08 = double closed loop, two valves with a process control loop system
11 = stand alone controller double closed loop

Ordering code example:

PROFIBUS version with 3 slaves (DMA-22(A) modules). Each of the 3 slaves (modules) is the same version for valves with two coils each with 2.7 A and spool position feedback and including the connectors.
Please specify each of the modules.

DMA-22(A)-M3-030303-PBDP-MSTBU-Sxxxxx containing
DMA-22(A)-03-270-x-S0 (module in operation mode 3)
DMA-22(A)-03-270-x-S0 (module in operation mode 3)
DMA-22(A)-03-270-x-S0 (module in operation mode 3)

Figure 4 : Model code mode 03, 04, 10, multi-module versions

5 Installation

5.1 Mounting

- Verify that the module type (see label on the side of the module) matches the parts list and/or diagram.
- The module may be mounted in any orientation; however, vertical mounting is preferred to improve convection cooling.
- The module should be installed in a shielded environment (e.g., a control cabinet).
- The module must be mounted on a DIN rail (EN 50022).

Dimensions assembly rail (example):

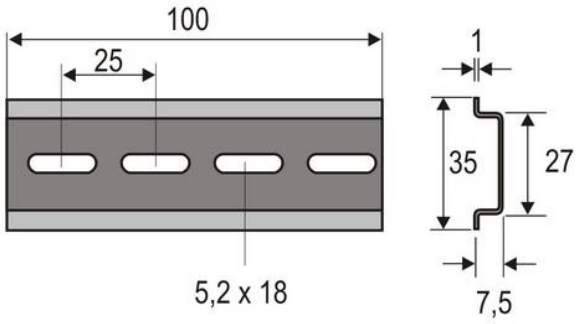


Figure 5 : Dimensions assembly rail (DIN hat rail)

5.2 Connection

5.2.1 General recommendations

5.2.1.1 General supply connection

The output stages are electronically protected against overcurrent and short circuits.
Additionally, the amplifier modules should be protected by a fast-acting fuse.

Terminal	Specification
X4/4 (16)	+UB is 10 V to 33V DC, residual ripple <10%.
X4/3 (15)	0 V

Table 6: External supply

5.2.1.2 DMA-22(A) powered via the USB connection.

⚠ WARNING

The DMA USB port is not electrically isolated.
For protection, the use of an isolation adapter is strongly recommended.
For more information:

See □ Chapter "11.2 Importance of Galvanic Isolation", page 72

- The green power LED is illuminated.
- Full parameterization can be performed using HCSTool. Parameter files can be loaded onto the module.
- The sensor input Fb1 (if available) can be configured and tested when a voltage input type is selected. Current-type sensors require the enable signal to activate the shunt resistor.
- The DMA-22(A) cannot be enabled without an external supply voltage.
- The current outputs for the solenoids are inactive.
- The error output is not energized. .

5.2.2 Wires and preparation

Connection wires must comply with the following specifications::

Feature	Requirement
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: Wiring requirements

The screw terminals are designed to accept various types of copper conductors. For stranded wires, the use of ferrules is recommended to protect the conductor ends.

For more details, refer to the Phoenix Contact product catalog.

⚠ WARNING

The assembly contains electronic components that may be damaged by electrostatic discharge (ESD).

Improper handling or operation can result in damage. Only trained personnel must work with the unit. All safety instructions must be observed.

Damage may occur if the amplifier card is disconnected while the power supply is active. Such actions must be avoided under all circumstances.

The information in this document is subject to change without prior notice.

⚠ WARNING

Under no circumstances should logical signals from the module (e.g., “Error”) be used to switch machine safety circuits (see also EN 13849).

5.2.3 EMC

Devices of the DMA-22(A) series are classified as Class A equipment and are therefore intended for use in industrial environments only.

The distance between a source of interference (emitting device) and an interference sink (affected device) is critical. The greater the distance between the source and the sink, the lower the impact of interference. Conversely, the closer a device is to a source of interference, the higher the interference levels.

For this reason, a minimum distance of 0.25 m must be maintained between the amplifier modules and strong sources of interference. The following devices are considered significant sources of interference:

- Switching power supplies
- Frequency converters
- Digital drive modules
- Mains filters with connected wiring (even if shielded)
- AC/DC commutator motors
- Motor cables (even if shielded)
- Switched inductive loads, even with suppression measures applied (e.g., solenoid valves, contactors, relays)

One of the most common paths for interference is via wiring. If interfering cables are routed at least 0.25 m away from susceptible cables, mutual interference can be minimized.

Certain parts of the amplifier wiring are particularly susceptible to interference (e.g., analog setpoint and feedback signals, solenoid cables). If such cables are routed in parallel over distances exceeding 10 m, the required separation distance must be increased accordingly.

Cables susceptible to interference must not be routed parallel to motor cables. The influence of interference is minimized when cables cross each other at an angle of 90°.

Interference may also originate from cables within the amplifier wiring system itself, particularly solenoid cables.

Examples of devices that are especially susceptible to interference include:
- Office PCs
- Sensors with low output voltage or current
- Capacitive proximity switches
- Audio equipment (e.g., televisions, hi-fi systems, radios)
- Devices that do not comply with EMC standards

5.2.4 Specific recommendations for wiring and control cabinets

The following rules and tips are by no means complete. Since various electronic components are used under a wide range of ambient conditions, these guidelines represent only a compromise. The actual design of the wiring also depends on the interference emission and susceptibility of each individual component.

- Use shielded twisted-pair cables for the servo valve connections. The shield must be connected to protective earth (PE) at both ends. The capacitance should be approx. 120 pF/m for cable lengths up to 100 m.
- Shields of digital signal lines must be connected to PE at both ends; ensure a low-impedance connection.
- Setpoint and feedback connections should use shielded twisted-pair cables. The shields of analog signal lines must be connected to PE at both ends with low impedance.
- In environments with high interference levels, use double-shielded cables for setpoint and feedback connections. The inner shield should be connected at one end only, the outer shield at both ends.
- In the event of low-frequency interference on analog signal lines (e.g., measured value fluctuations), the shield should be connected at one end only. Preferably, provide appropriate potential equalization (see also the following point).
- Use only cables with a copper braided shield and a coverage of > 85%. Avoid shield films; metal foils should not be used.
- The shield should not be interrupted along the entire cable length. If contactors, safety switches, chokes, etc. must be integrated into the wiring, the installation of a metallic enclosure with high-frequency shielding may be required.
- Shield connections should be made over a large surface area to the shield rail to ensure proper functionality.
- The shield rail should be installed close to the cable duct within the control cabinet.
- Metallic parts of the control cabinet must be connected over a large surface area with low impedance. Use mechanical means such as contact washers if necessary. Cabinet doors should be connected using the shortest possible grounding straps (multiple connections recommended).
- Solenoid valves, contactors, relays, brakes, etc. must be suppressed directly at the source of interference. Suitable suppression devices include RC networks, diodes, or varistors.
- Analog and digital signal lines should preferably enter the control cabinet from one side only.
- Non-shielded conductors of a circuit should be twisted.
- Auxiliary conductors must be grounded at both ends.
- Avoid unnecessarily long cables to minimize coupling impedance.
- Wiring should not be freely suspended inside the cabinet. Route cables, including auxiliary cables, as close as possible to mounting plates and the cabinet housing.
- In the event of a potential difference between shield connections, an equipotential bonding conductor of ≥ 10 mm² should be installed parallel to the shield to reduce transient currents. Multiple connections of the shield to the cabinet housing and thus to PE are generally permissible. Multiple grounding points outside the cabinet are also possible.
- If filters are installed, they should be placed close to the source of interference and ensure good surface contact with the cabinet or mounting plate.
- If converters are used, appropriate converter filters must be provided. Variable speed drives may require shielded motor cables. All additional instructions from the converter manufacturer must be observed.

The following pages contain illustrations of:

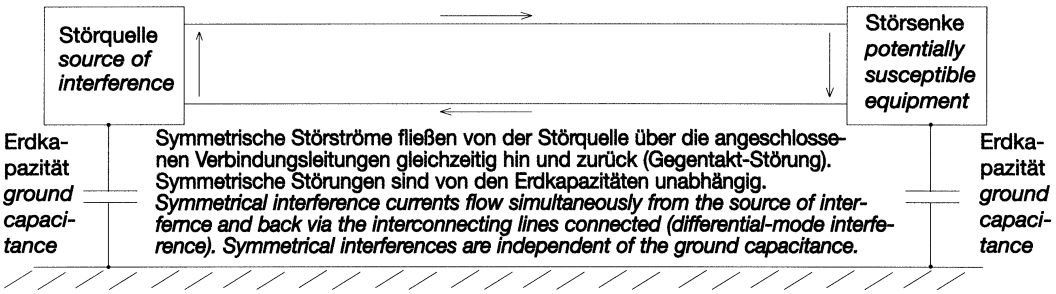
- The most important types of interference and their mitigation
- Design of EMC-compliant control cabinets and systems

The diagrams have been provided by our competent partner for all EMC-related matters:

NKL GmbH
Birckichstr. 15
D-74549 Wolpertshausen
www.nkl-emv.de

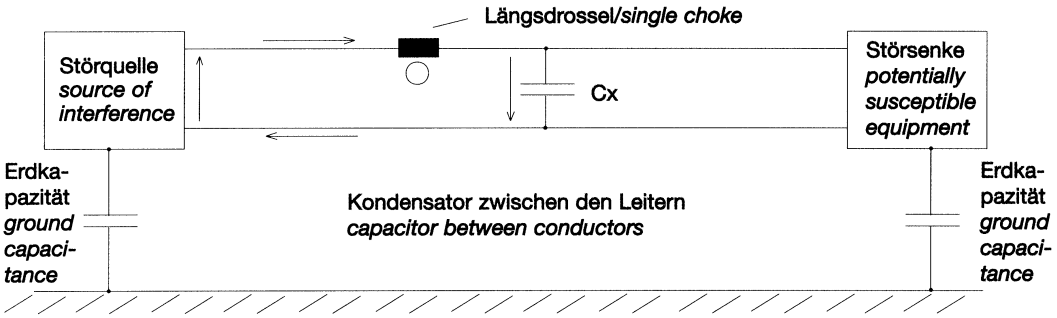
Die wichtigsten Arten von Störungen und Abhilfen:
The most important types of interference and remedies:

Symmetrische Störungen:
Symmetrical interference:



Typische Störquellen, die symmetrische Störungen erzeugen, sind:
Typical sources of symmetrical interferences:

Alle Arten von Gleichrichtern, Thyristor-Steuerungen wie z. B. Phasenanschnitt-Steuerungen, Halbleiter-Relais etc.
Symmetrische Störungen treten in der Praxis hauptsächlich leitungsgebunden im unteren Frequenzbereich bis ca. 1 MHz auf.
All types of rectifiers, thyristor controls such as e. g. generalized phase controls, semiconductor relays, etc.
In practice, symmetrical interfernces occur mainly as conducted interference in the lower frequency range up to about 1 MHz.



Symmetrische Störungen werden entstört durch:
Symmetrical interferences are suppressed by:

- Kondensatoren zwischen den Anschlüssen („X"-Kondensatoren): Diese schließen die Störströme kurz, bevor sie die Störsenke erreichen.
- *capacitors between the terminals („X" capacitors):*
  they short-circuit the interference currents just before they reach the potentially susceptible equipment.

- Einzel-Drosseln im Strompfad der Zu- und Ableitungen. Diese Drosseln sind für symmetrische Störungen wirksam und erhöhen die Impedanz des symmetrischen Störstromkreises.
- *single chokes in the current path of the incoming and outgoing lines. These chokes are effective for symmetrical interferences and inrease the impedance of the symmetrical interference circuit.*

Figure 6 : EMC – interferences and remedies

EMC adequate design of switchgear cabinets and facilities

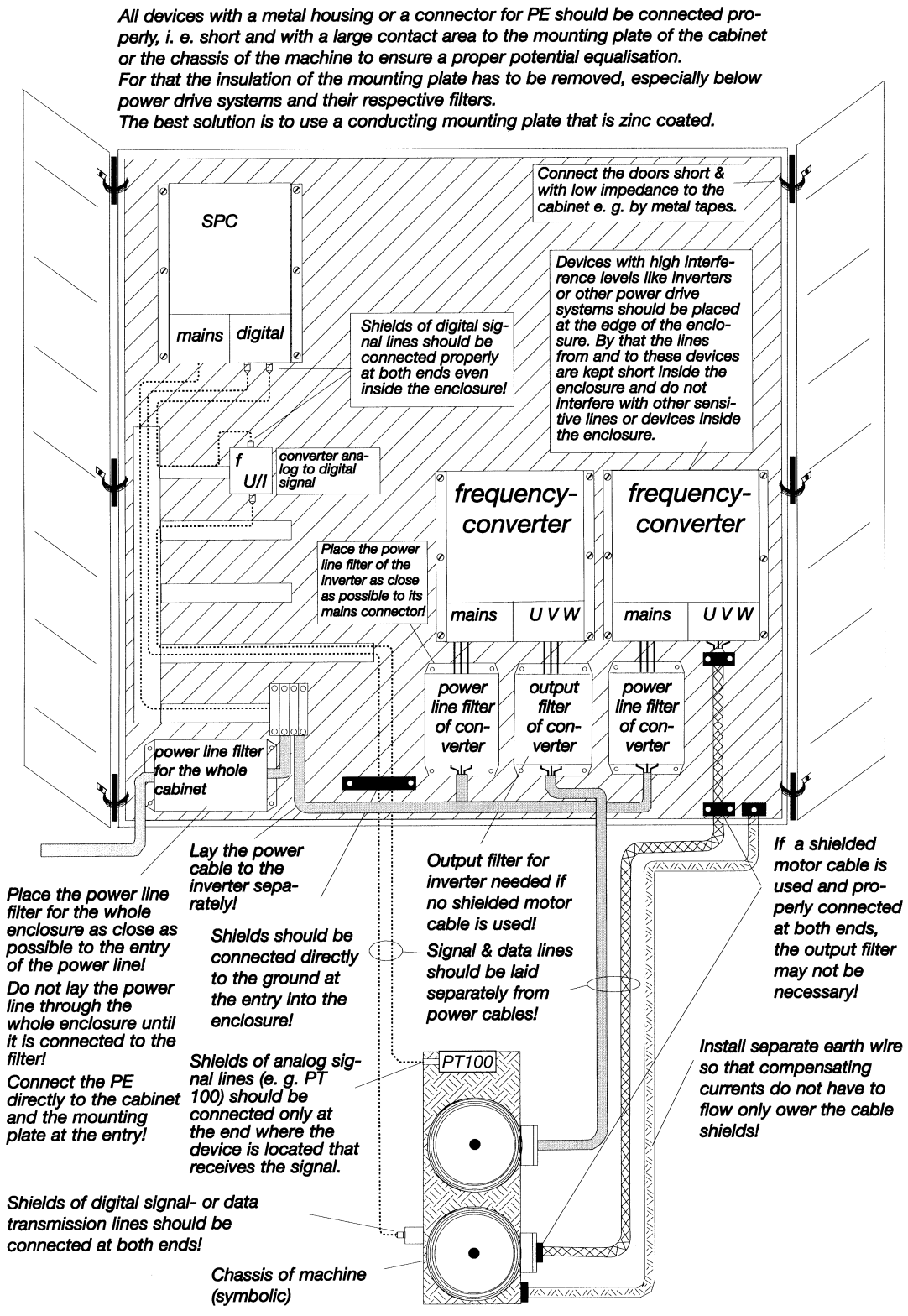


Figure 7 : EMC – adequate design of switchgear cabinets and facilities

5.3 *Front elements*

⚠ WARNING

The electrical wiring must be verified before applying the supply voltage. Limit switches and safety devices must be active to prevent uncontrolled movement. All relevant safety regulations must be strictly observed. Appropriate emergency stop measures must be implemented.

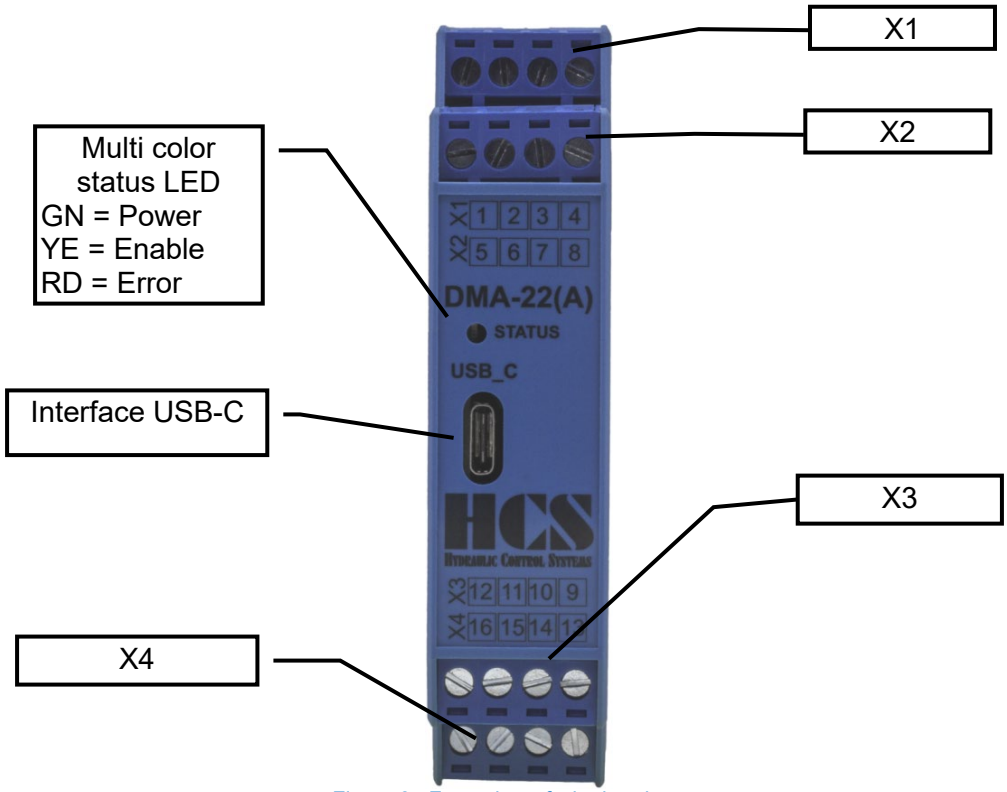


Figure 8 : Front view of wire break

Element	Function
Status LED's	display of status
USB-C interface	For parameter setting via PC or communication with the machine. Also for diagnostic functions using the oscilloscope integrated in HCSTool.

Table 8: Front elements

5.4 Terminal assignment

NOTICE

The following connection diagrams are based on the standard version of the respective software version. In the case of customer-specific adaptations, the terminal assignment may differ from these diagrams.

Please refer to the connection diagram label attached to the side of each DMA-22(A). This label always indicates the valid terminal assignment.

This table shows the possible terminal assignments:

Connector	Terminal pin	Possible meaning				
X1	1(1)	Solenoid A-	GND			
	2(2)	Solenoid A+	ANAOut			
	3(3)	Solenoid B-				
	4(4)	Solenoid B+				
X2	1(5)	S1.01	AGND			
	2(6)	S1.02	ANAOut			
	3(7)	S1.03	S1.05-	Fb1 U+/I-	Fb1-	+10Vout
	4(8)	S1.04	S1.05+	Fb1 U-/I+	Fb1+	AGND
X3	1(9)	Enable				
	2(10)	\Error				
	3(11)	S1.06+				
	4(12)	S1.06-				
X4	1(13)	n/c	S1.01	ANAOut		
	2(14)	n/c	S1.02	AGND		
	3(15)	0V				
	4(16)	Supply 10 … 32 V				

Table 9: Possible terminal assignment

The color-highlighted rows indicate the signals that are always assigned in the same manner.

6 Wiring diagrams

6.1 Operation mode 01

1 proportional valve in open-loop

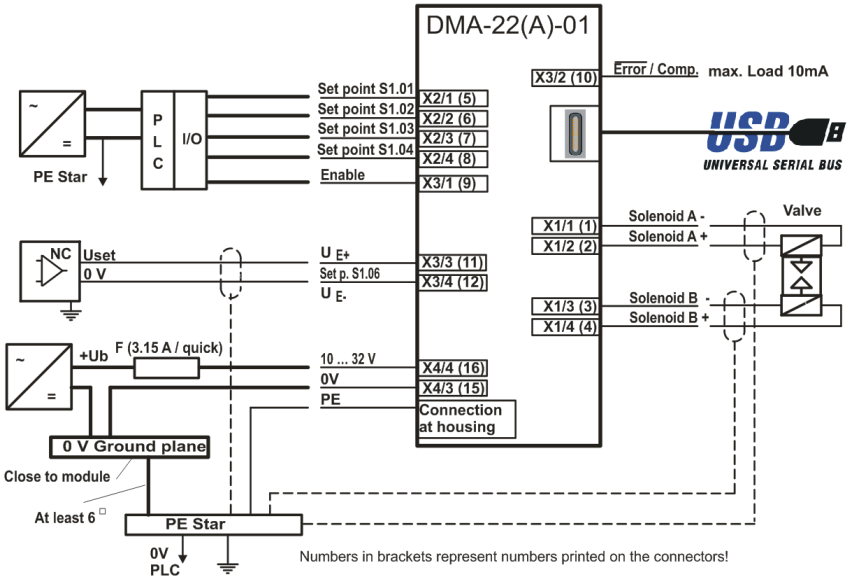


Figure 9 : Wiring diagram Mode 01

6.2 Operation mode 01 (with 10V reference output)

1 proportional valve in open-loop, and 10 V reference output

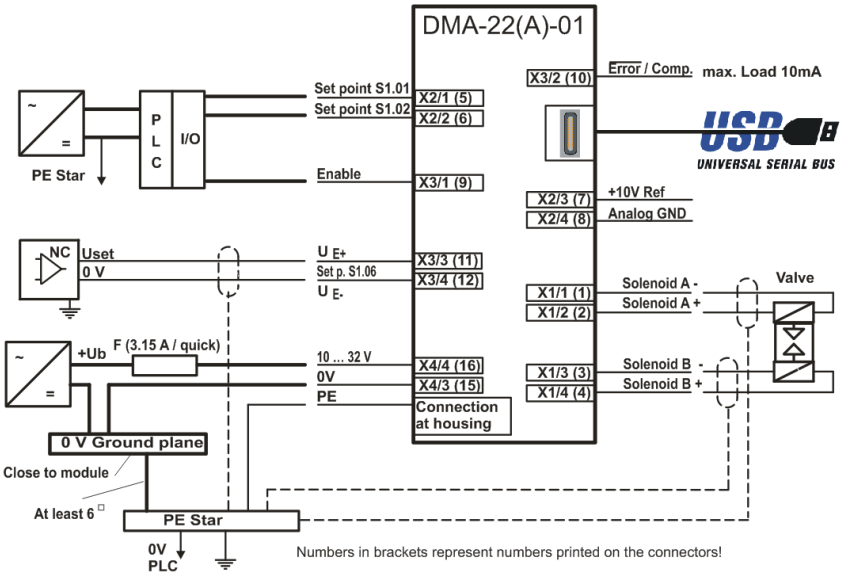


Figure 10 : Wiring diagram Mode 01 with 10Vref

6.3 Operation mode 02

2 pressure valves in open-loop

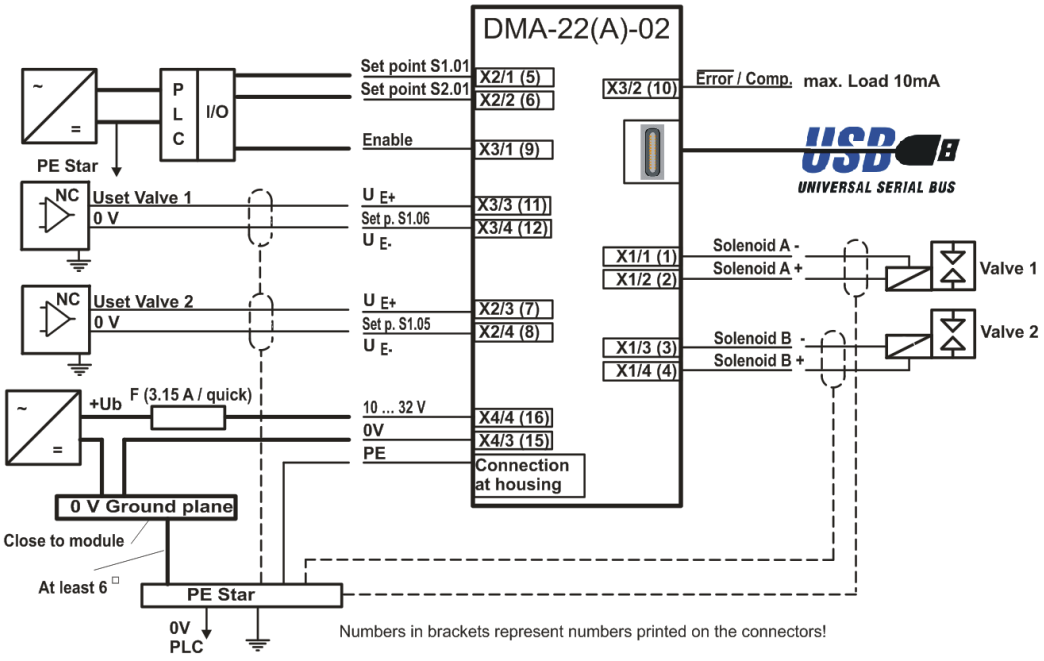


Figure 11 : Wiring diagram Mode 02

6.4 Operation mode 03, 04

1 proportional valve in closed-loop with spool position feedback at valve

6.4.1 For SW V01.xx* (with analog output)

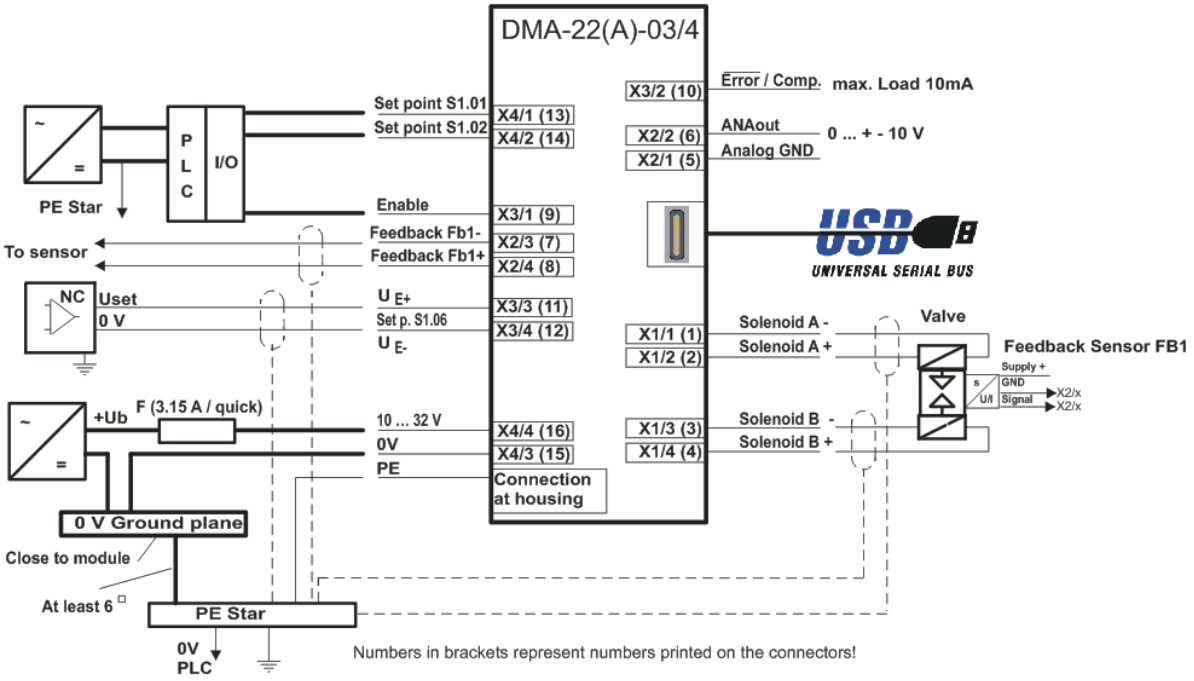


Figure 12 : Wiring diagram Mode 03, 04 SW V01.xx*

6.4.2 For SW V03.xx*

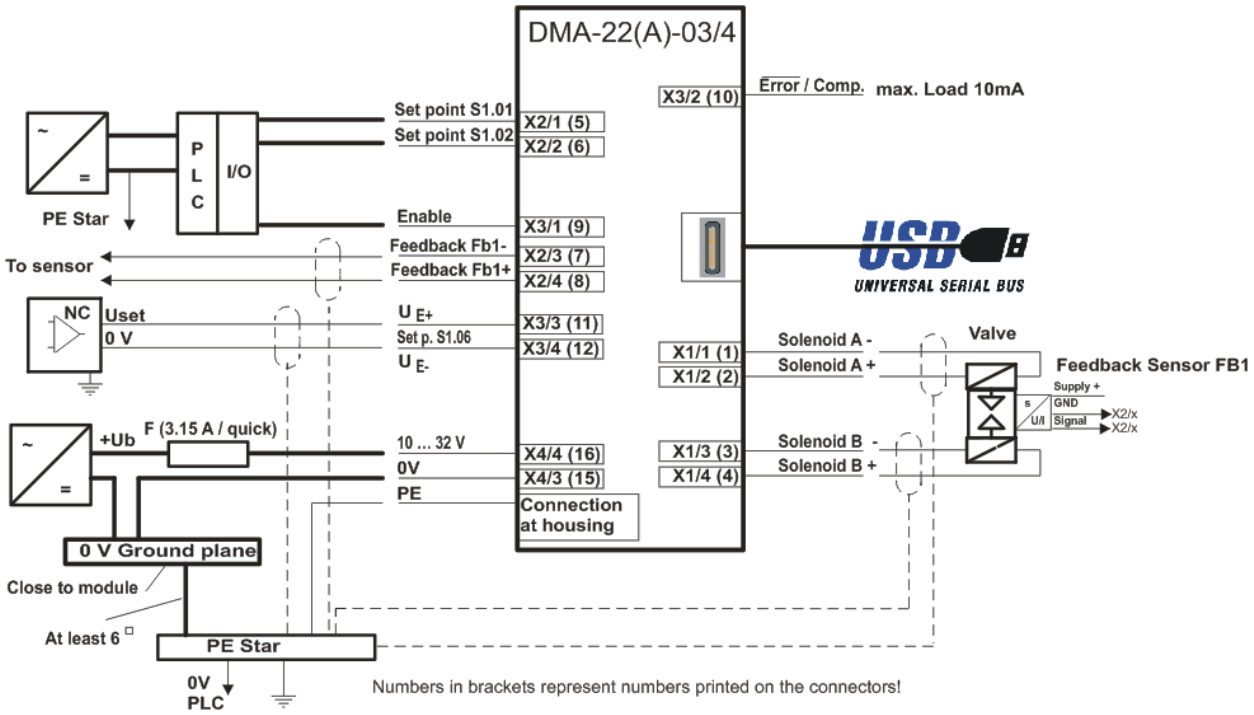


Figure 13 : Wiring diagram Mode 03, 04 SW V03.xx*

6.4.3 For SW V04.xx* (with analog output)

In this software version, the FB1 input has a different polarity for the voltage or current input to ensure compatibility with the older DMA-22 hardware version. (Depending on the hardware version, the digital inputs may also be not connected (n/c).)

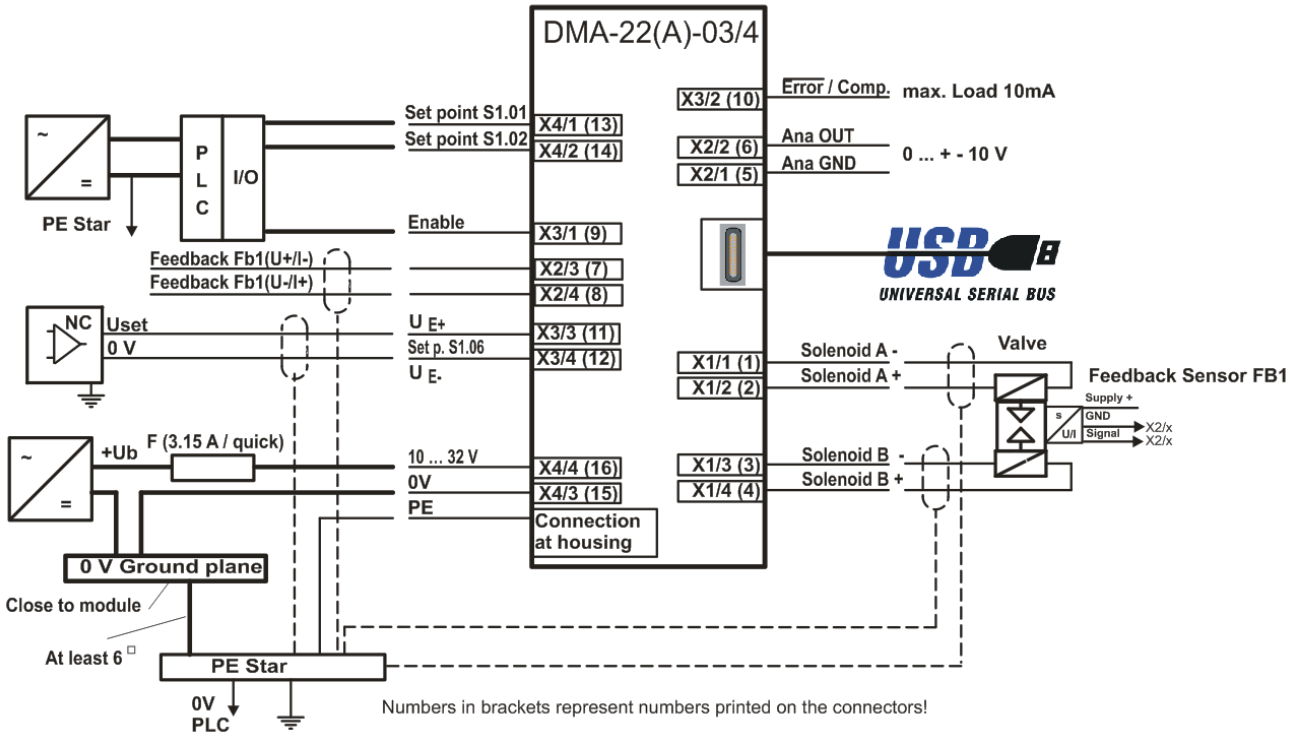


Figure 14 : Wiring diagram Mode 03, 04 SW V04.xx*

6.4.4 For SW V05.xx*

In this software version, the FB1 input has a different polarity for the voltage or current input to ensure compatibility with the older DMA-22 hardware version. (Depending on the hardware version, the digital inputs may also be not connected (n/c).)

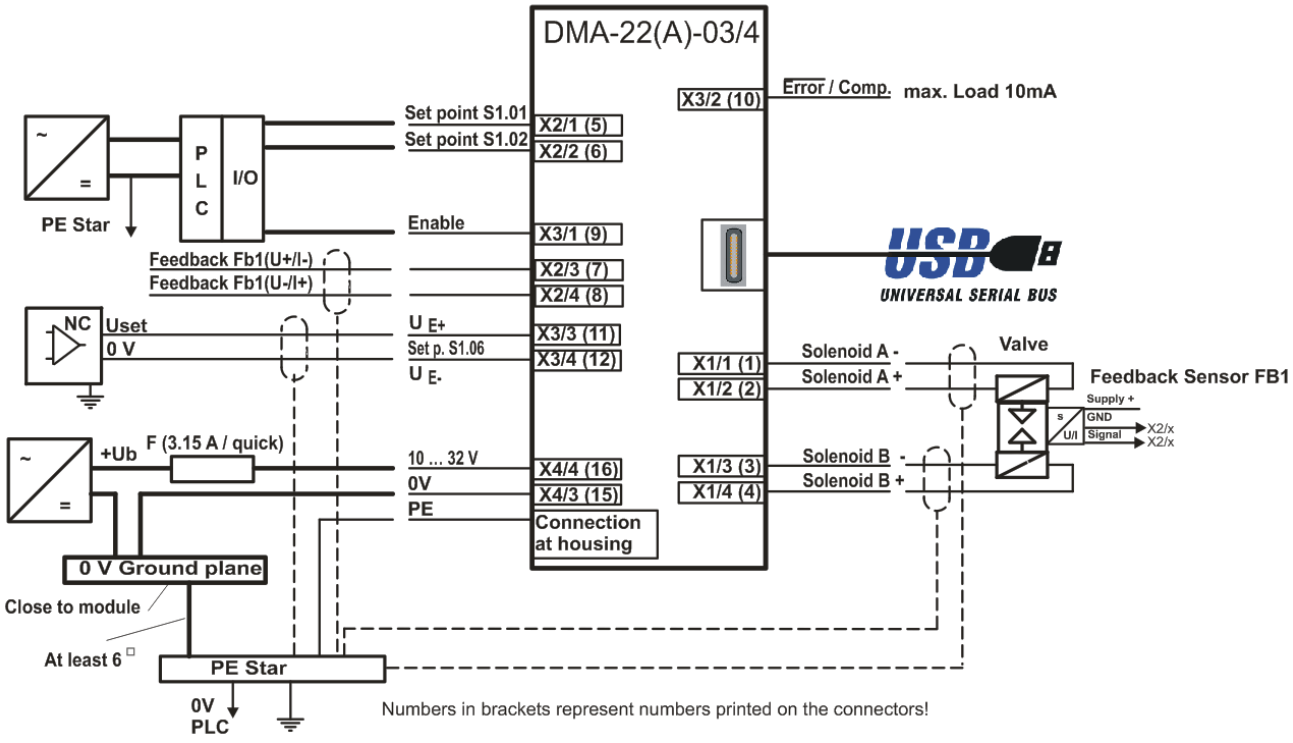


Figure 15 : Wiring diagram Mode 03, 04 SW V05.xx*

6.4.5 For SW V05.xx* with 10 V reference output

In this software version, the FB1 input has a different polarity for the voltage or current input to ensure compatibility with the older DMA-22 hardware version. (Depending on the hardware version, the digital inputs may also be not connected (n/c).)

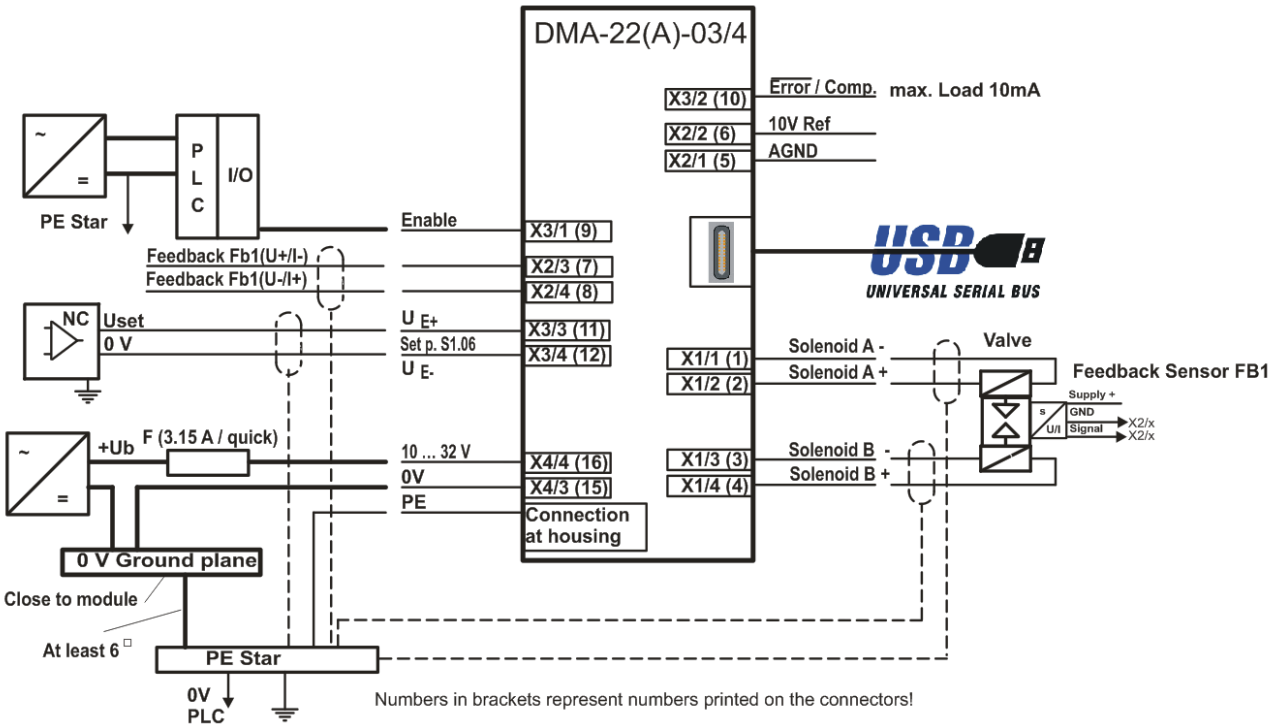


Figure 16 : Wiring diagram Mode 03, 04 SW V05.xx* with 10V ref

6.5 Operation mode 05

1 proportional HPR valve in closed-loop with spool position feedback at valve

6.5.1 For SW V35.xx* (with 10V reference output)

In this software version, the FB1 input has a different polarity for the voltage or current input to ensure compatibility with the older DMA-22 hardware version. (Depending on the hardware version, the digital inputs may also be not connected (n/c).)

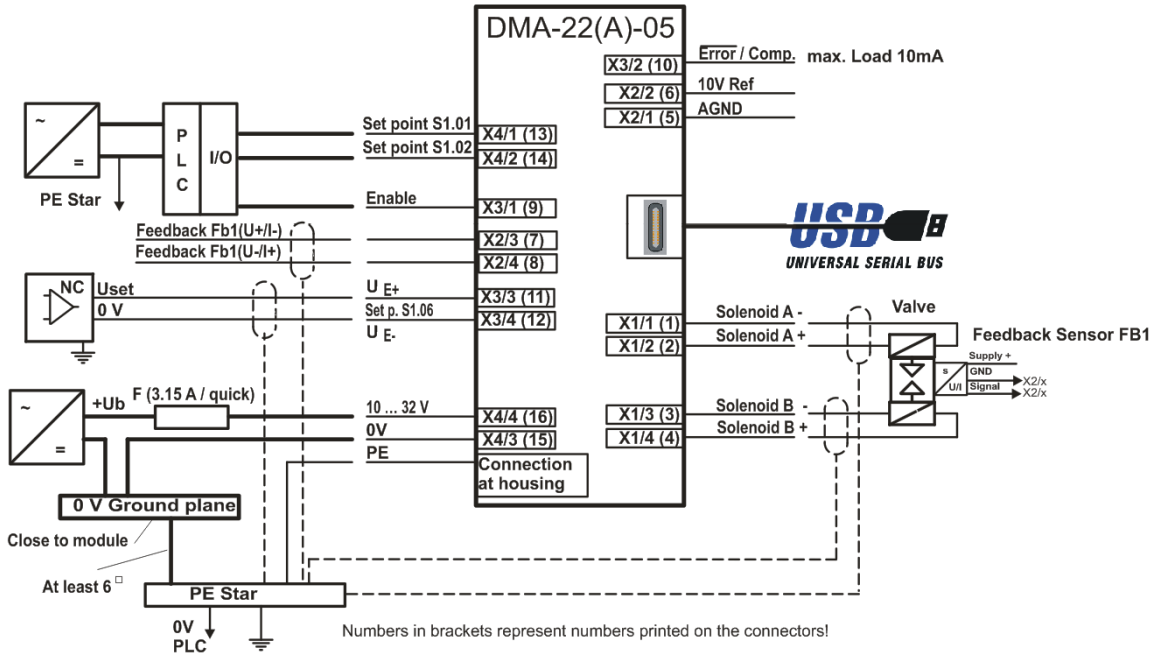


Figure 17 : Wiring diagram Mode 05 SW V35.xx* with 10V ref

6.5.2 For V39.xx* (with analog output and 10V ref)

In this software version, the FB1 input has a different polarity for the voltage or current input to ensure compatibility with the older DMA-22 hardware version. (Depending on the hardware version, the digital inputs may also be not connected (n/c).)

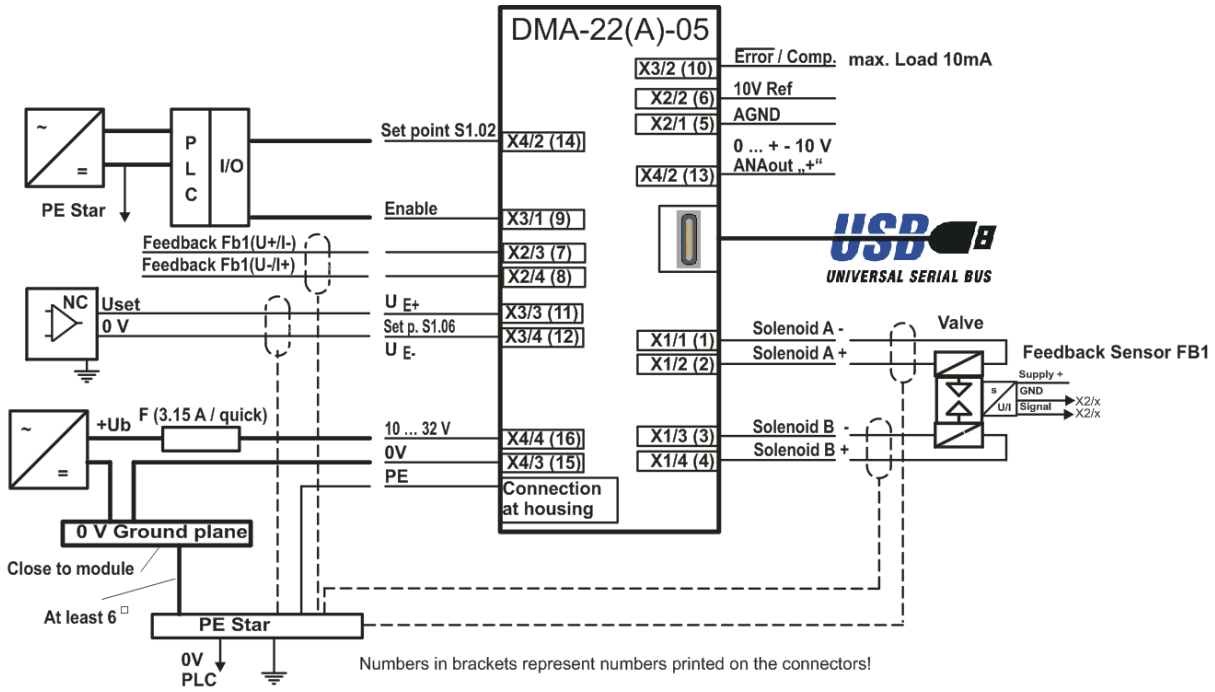


Figure 18 : Wiring diagram Mode 05 SW V39.xx* with Analog and 10V ref output

6.6 Operation mode 10

1 analog output for process control in a closed-loop with feedback from the process sensor

6.6.1 For SW V01.xx* (with analog output)

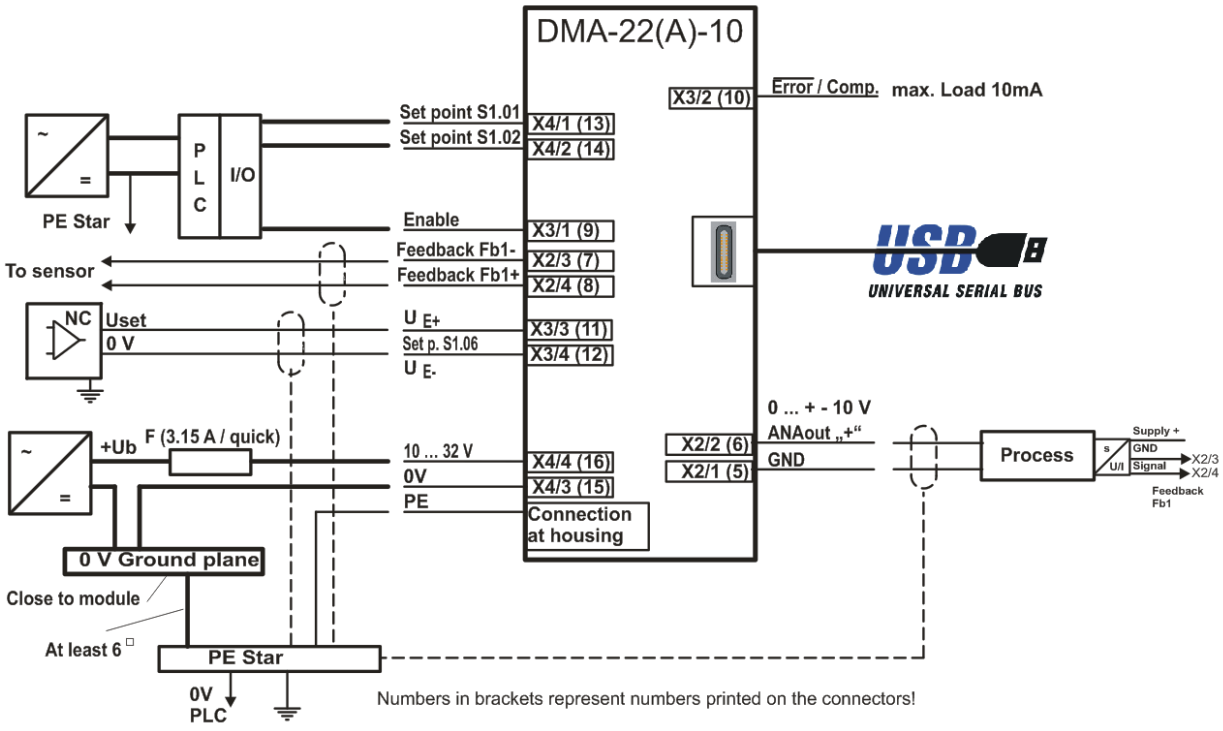


Figure 19 : Wiring diagram Mode 10 SW V01.xx*

6.6.2 For SW V04.xx* (with analog output)

In this software version, the FB1 input has a different polarity for the voltage or current input to ensure compatibility with the older DMA-22 hardware version. (Depending on the hardware version, the digital inputs may also be not connected (n/c).)

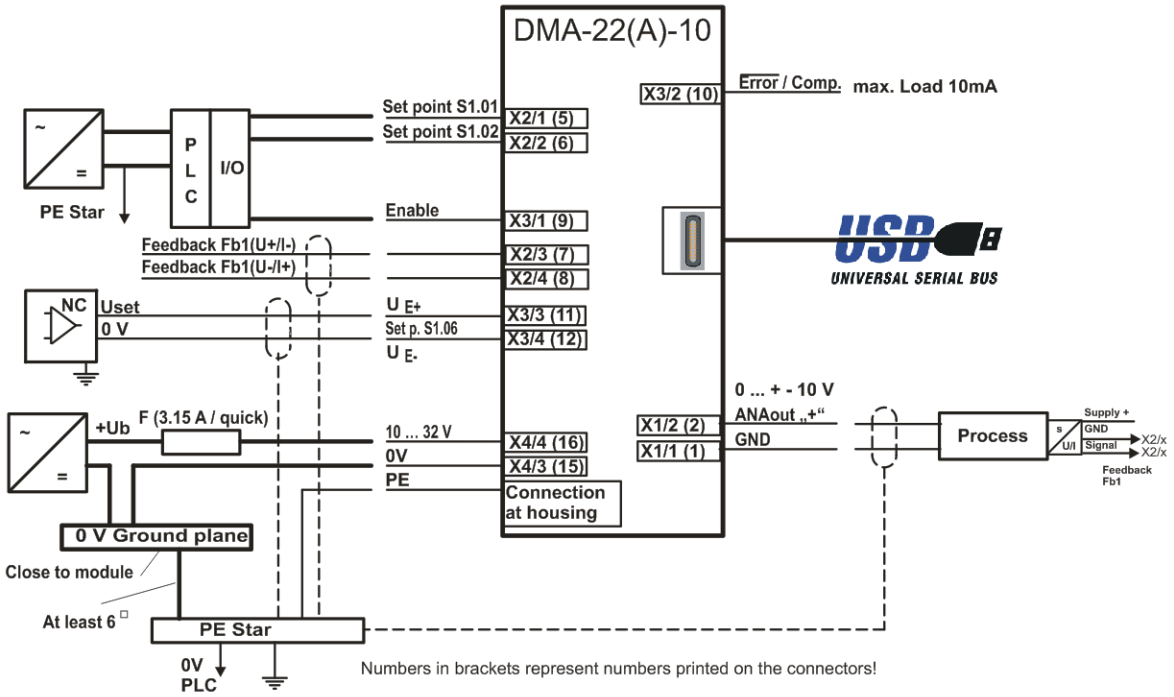


Figure 20 : Wiring diagram Mode 10 SW V04.xx*

7 Commissioning

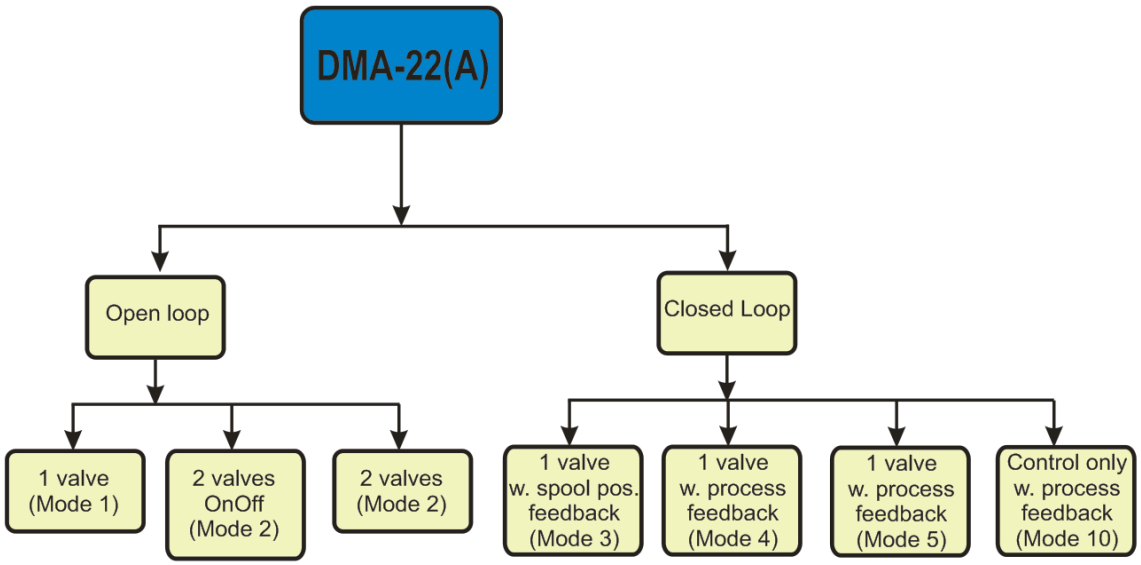
7.1 Operation modes

The setting of parameter <E00> determines which operating mode is activated. This parameter is factory-set.
Only the parameters relevant to the selected operating mode are available.

The operating modes available for the DMA-22(A) module depend on the installed firmware version and the hardware configuration. In “closed-loop” versions, operating modes 3 and 4 or operating modes 3 and 5 are generally available. The operating mode specified in the order code is preset according to the order designation.

<E00>	Mode description
1	Open loop, 1 proportional valve with 2 solenoids without feedback
2	Open loop, 2 proportional valves with 1 solenoid each without feedback
2	On/off, 2 switching valves (version DMA-22(A)-02-x-SonOff)
3	Closed loop valve, single, 1 proportional valve with 2 solenoids and feedback of spool position
4	Closed loop process, single, 1 proportional valve with 2 solenoids and feedback of process value (position, velocity, pressure, force, torque etc.)
5	Closed loop, 1 HPR valve and one valve feedback (version DMA-22(A)-05-x)
10	Controller function without valve, controlling one process value; provides a setpoint signal to downstream electronics (e.g. valve with integrated electronics, frequency converter for AC motor, etc.).

Table 10: Operation modes



7.2 Parameter setting

		Mode
1	Available parameters for SW version V07.xx*,	01
2	Available parameters for SW version V06.xx*,	02
3	Available parameters for SW version V01.xx*, V03.xx*, V04.xx*, V05.xx*, V35.xx*	03, 04, 05
4	Only available parameters with analog output on board SW V01.xx*, V04.xx*, V39.xx*	03, 04, 05, 10
5	Only available parameters for Profinet, Profibus, Ethernet/IP, CANopen versions	all

display		display		Setpoint / ramps		Setpoint / ramps		Controller		Controller		Extended	
d1.01		d2.01	2	S1.01		S2.01	2	C1.00	3			E00	
d1.02		d2.02	2	S1.02	1 3			C1.01	3			E01	4
d1.03		d2.03	2	S1.03	1			C1.02		C2.02	2	E02	
d1.04		d2.04	2	S1.04	1			C1.03		C2.03	2	E03, E1.03	
d1.05				r1.01				C1.04		C2.04	2	E2.03	2
d1.06				r1.02				C1.05		C2.05	2	E04, E1.04	
d1.07				r1.03		r2.03	2	C1.06		C2.06	2	E2.04	2
d1.08				r1.04		r2.04	2	C1.07	1 3			E03, E1,03	
d1.09								C1.08		C2.08	2	E2.03	2
d1.10		d2.10	2					C1.09	3			E04, E1.04	
d1.11	3							C1.10	3			E2.04	
d1.12	3							C1.11	3			E08	
d1.13	3							C1.12	3			E09	
								C1.13	3			E10, E1.10	
								C1.14	3			E2.10	2
								C1.15	3			E11	
								C1.16	3			E12	
								C1.17	3			E13, E1.13	
								C1.18	3			E2.14	2
								C1.19	3			E14, E1.14	
								C1.20	3			E2.14	2
								C1.21	3			E15	
								C1.22	3			E16	2
								C1.23	3			E17	
								C1.24	3			E18	3
								C1.25	3			E19	4
								C1.26	3				
								C1.27	3	C2.27	2		
								C1.33	3			E22	5
								C1.36	3			E23	5
								C1.37	3			E24	5
								C1.38	3			E25	5
								C1.39	3			E26	5
								C1.40	3			E27	5
								L1		L2	2	E28	5
												E29	5
												E30	5
												E33	4

Table 11: Parameter overview

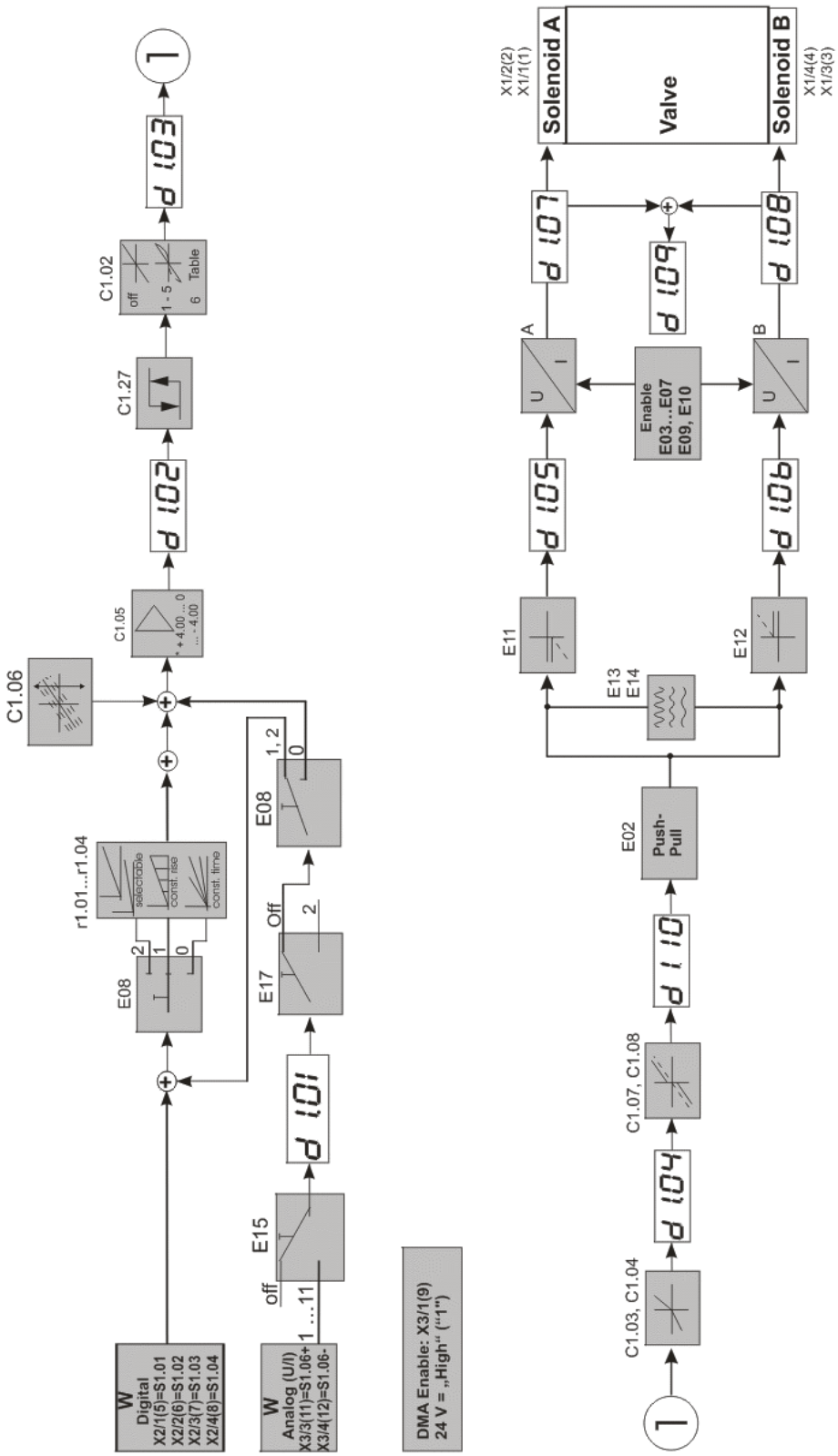
A complete list of parameters is available. Refer to HCSTool and:

See □ Chapter "12 Complete parameter list", page 75

7.3 Software block diagram

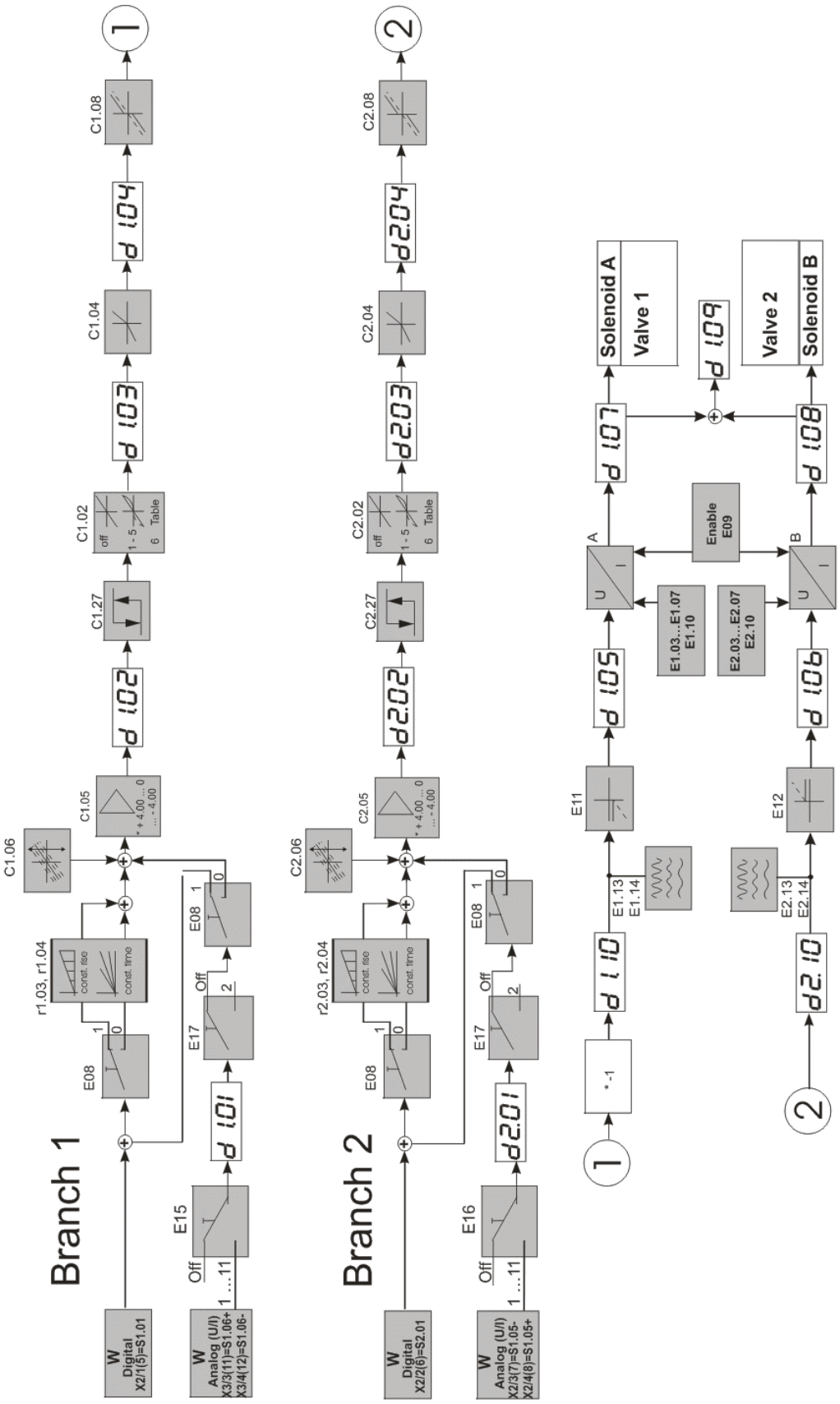
7.3.1 Operation Mode 1, SW V07.xx*

1 valve with 2 solenoids, open loop



7.3.2 *Operation Mode 2, SW V06.xx**

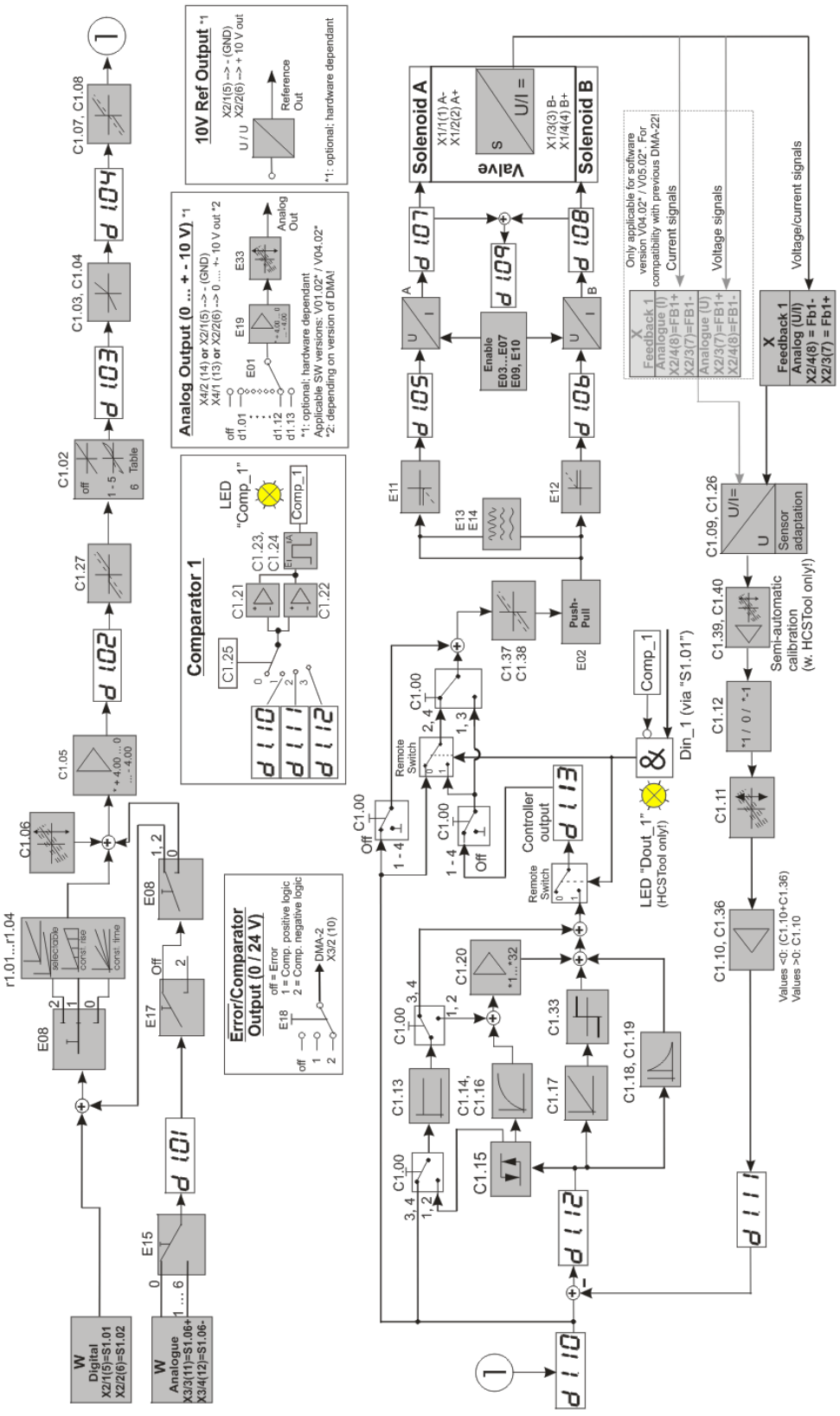
2 valves with 1 solenoid each, open loop



7.3.3 Operation Mode 3, SW V01,V03,V04,V05.xx*

1 valve with 2 solenoids and spool position feedback

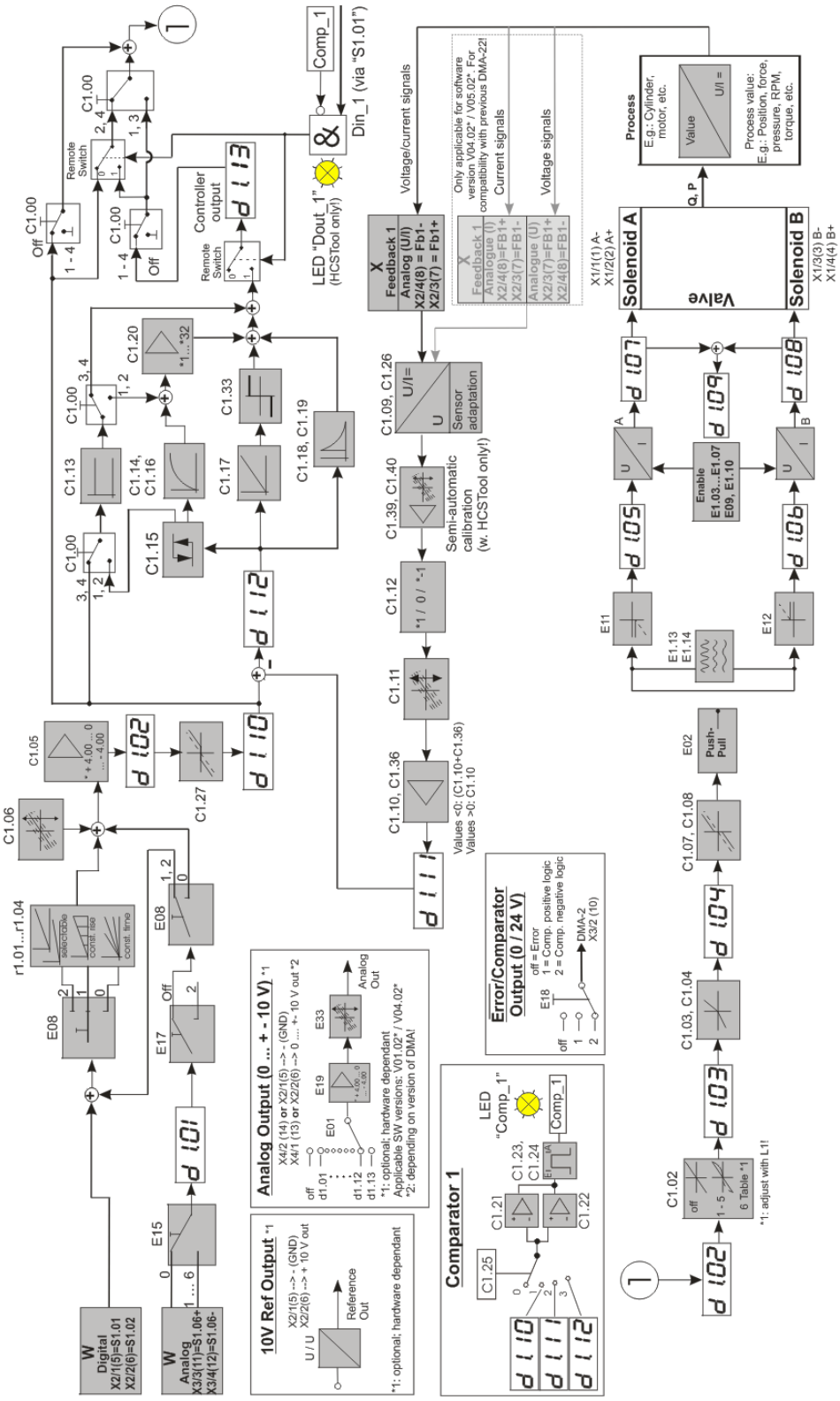
SW version V04.xx* and V05.xx*, the FB1 input has a different polarity for the voltage or current input due to compatibility with the old DMA-22 hardware version.
The analog output is only available for SW V01,V04.xx*



7.3.4 Operation Mode 4, SW V01,V03,V04,V05.xx*, 1 valve with 2 solenoids and process value feedback

1 valve with 2 solenoids and process value feedback

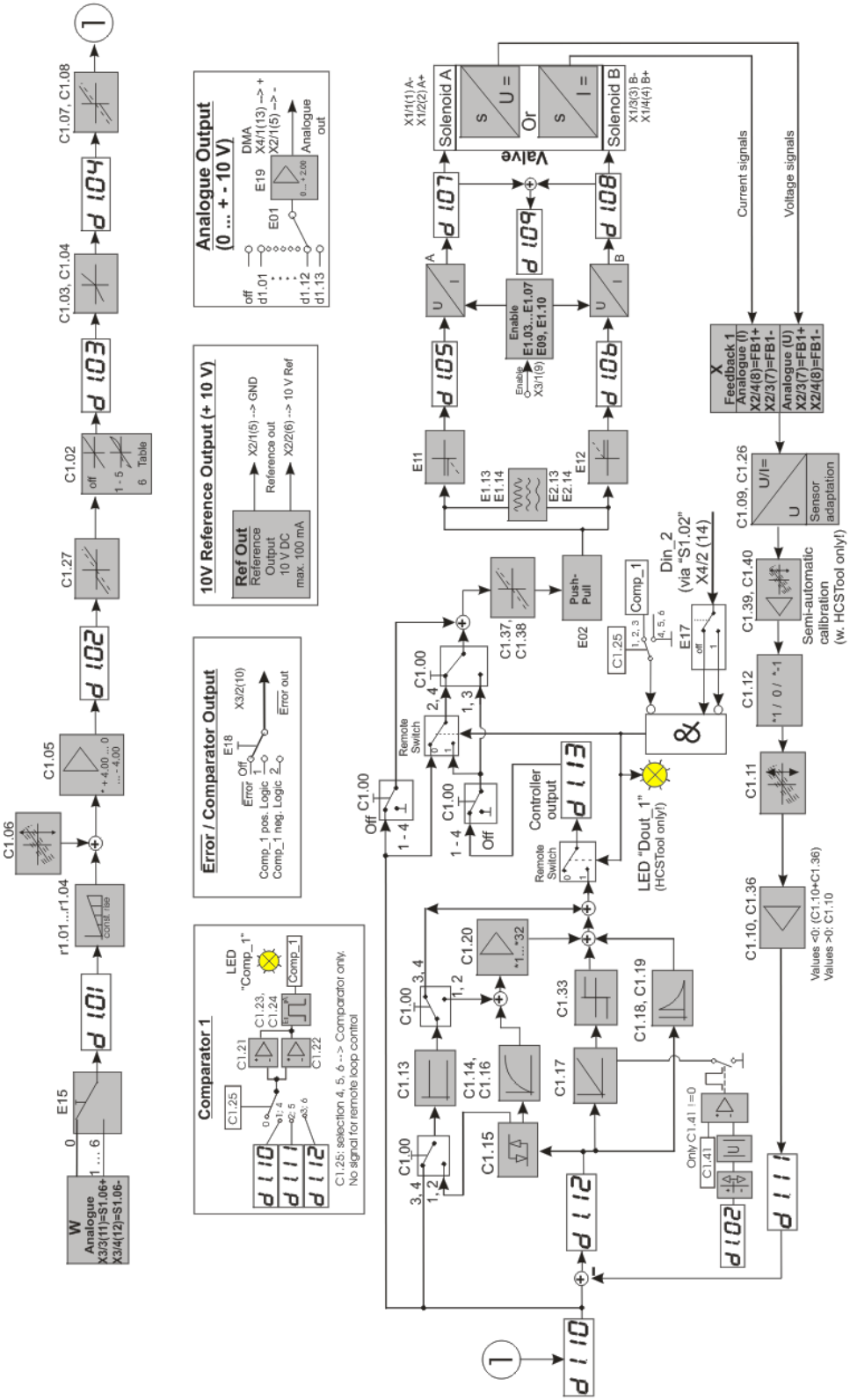
SW version V04.xx* and V05.xx*, the FB1 input has a different polarity for the voltage or current input due to compatibility with the old DMA-22 hardware version.
The analog output is only available for SW V01,V04



7.3.5 Operation Mode 5, V35,V39.xx*

1 valve with 2 solenoids and spool position feedback

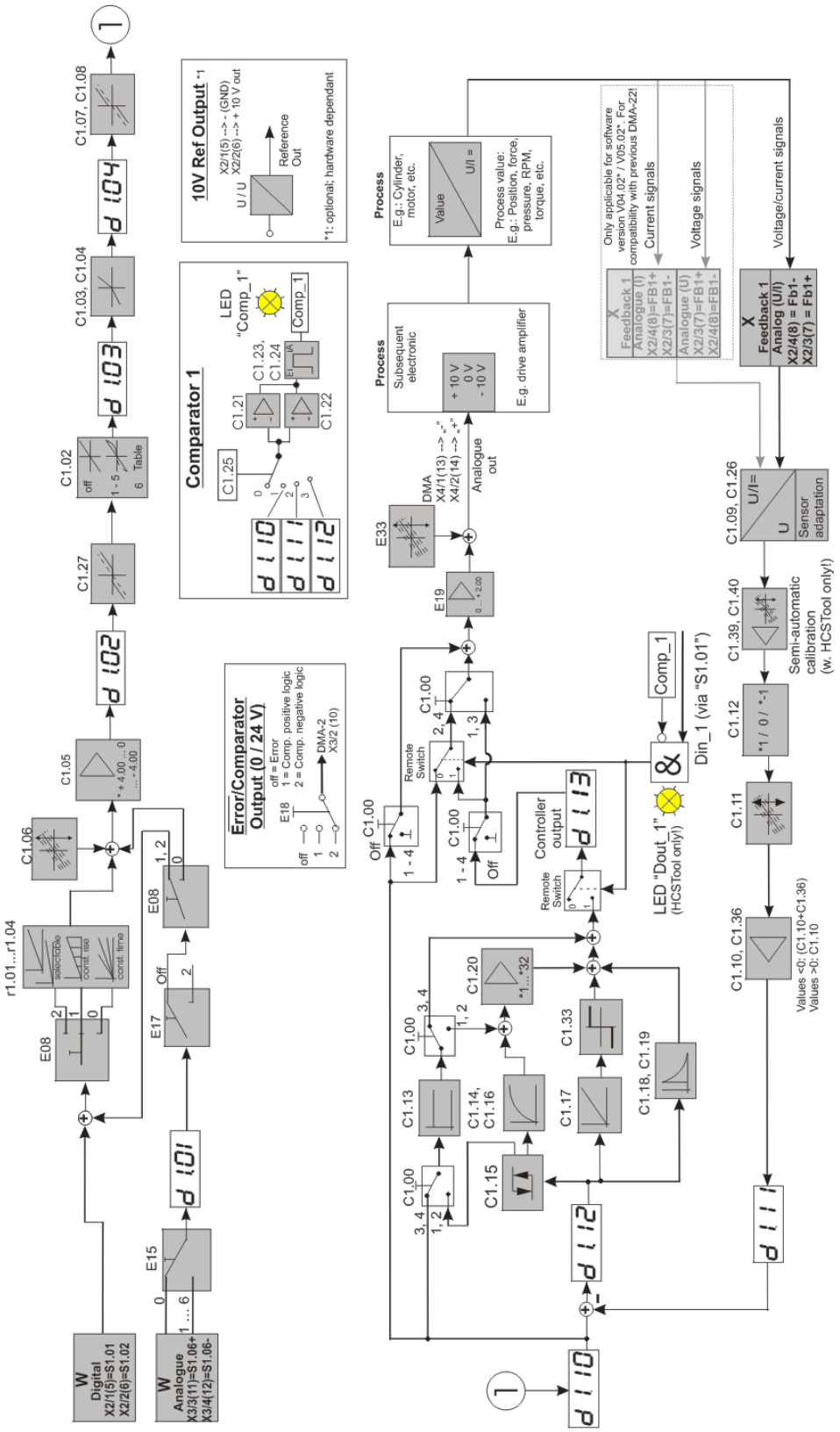
SW version V35.xx* and V39.xx*, the FB1 input has a different polarity for the voltage or current input due to compatibility with the old DMA-22 hardware version.
The analog output is only available for SW V39.xx*



7.3.6 Operation Mode 10, SW V01,V04.xx*

stand-alone controller with process feedback

SW version V04.xx* and V05.xx*, the FB1 input has a different polarity for the voltage or current input due to compatibility with the old DMA-22 hardware version.

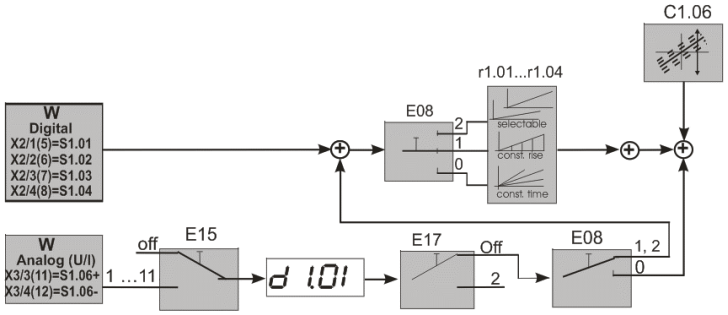


7.4 Block structures

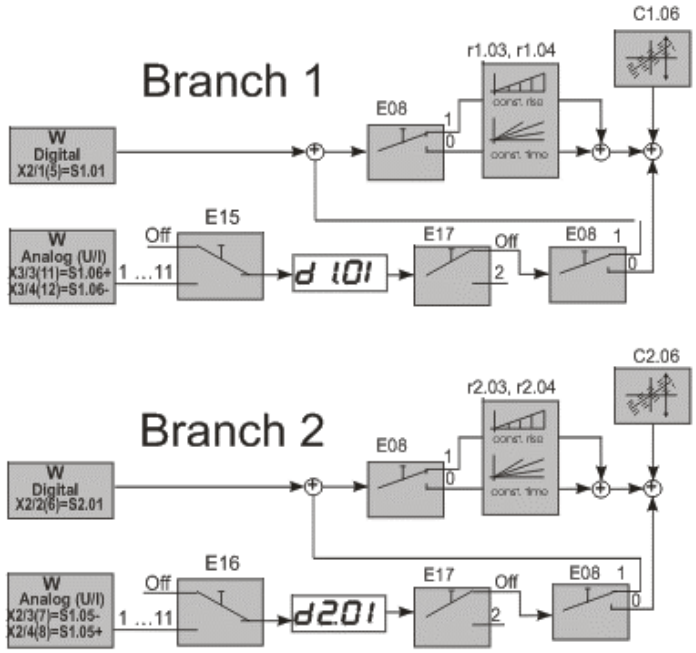
All block diagrams of the software functions can be derived by combining the following blocks.

7.4.1 Setpoints

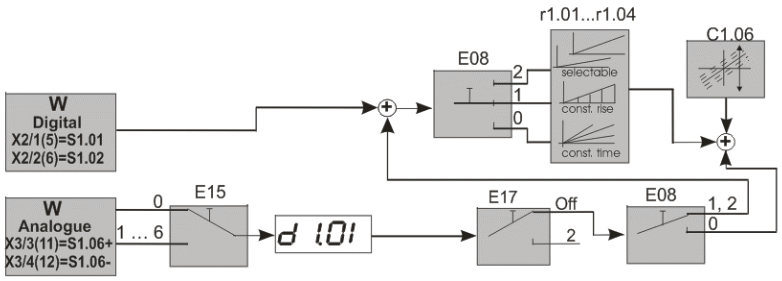
		Mode
1	For version SW V07.xx*	01



		Mode
2	For version SW V06.xx*	02

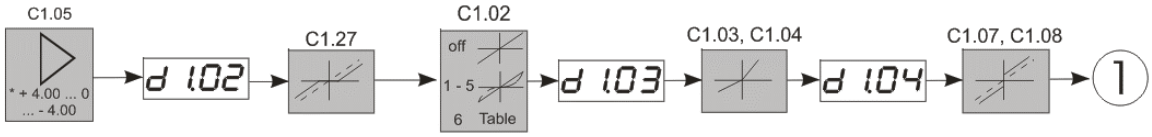


		Mode
3	For version SW V01.xx*, V03.xx*, V04.xx*, V05.xx*, V35.xx*, V39.xx*	03, 04, 05, 10

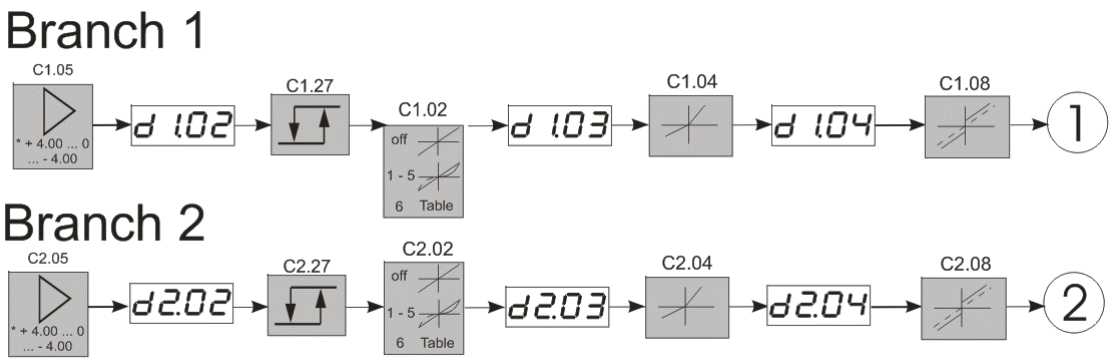


7.4.2 Processing of setpoints

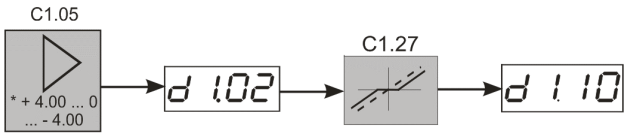
		Mode
1	For SW version V07.xx*	01
3	For SW version V01.xx*, V03.xx*, V04.xx*, V05.xx*, V35.xx*, V39.xx*	03, 05, 10



		Mode
2	For SW version V06.xx*,	02

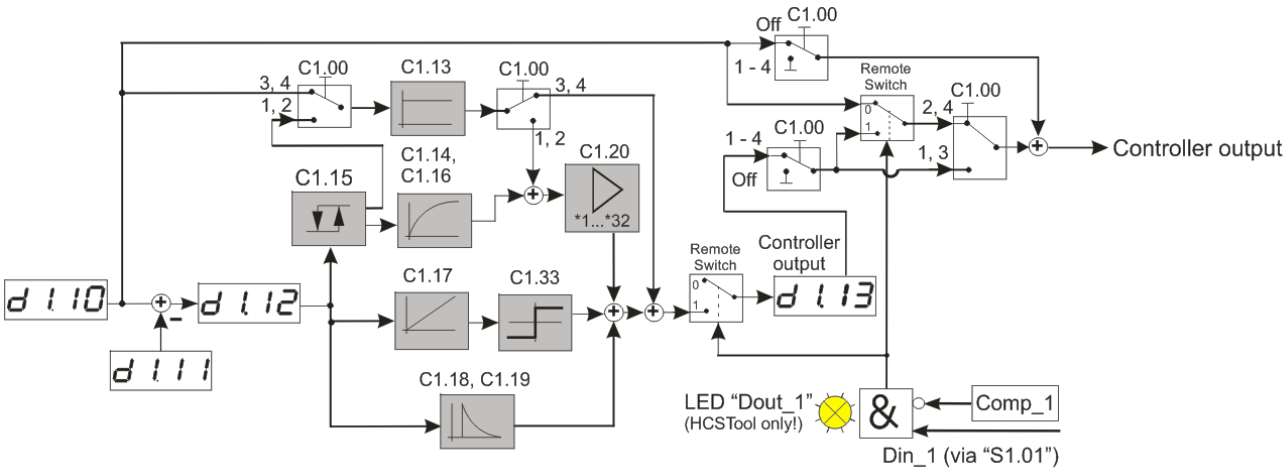


		Mode
3	For SW version V01.xx*, V03.xx*, V04.xx*, V05.xx*, V35.xx*, V39.xx*	04



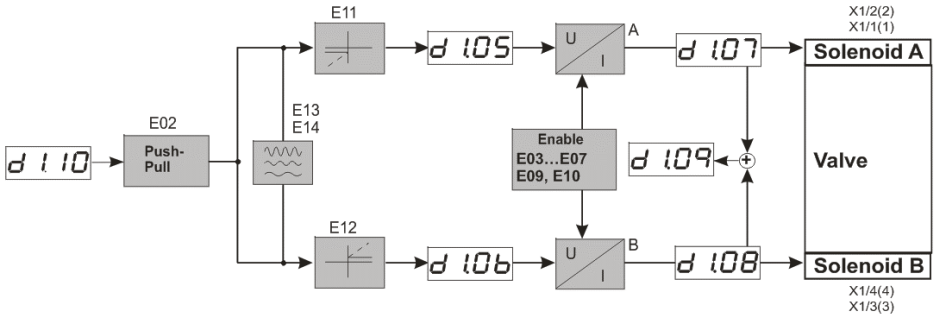
7.4.3 Controller structure

		Mode
3	For SW version V01.xx*, V03.xx*, V04.xx*, V05.xx*, V35.xx*, V39.xx*	03, 04, 05, 10

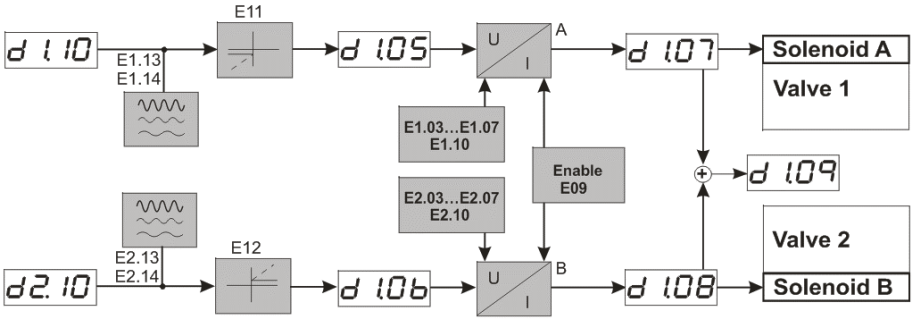


7.4.4 Current processing and output stages

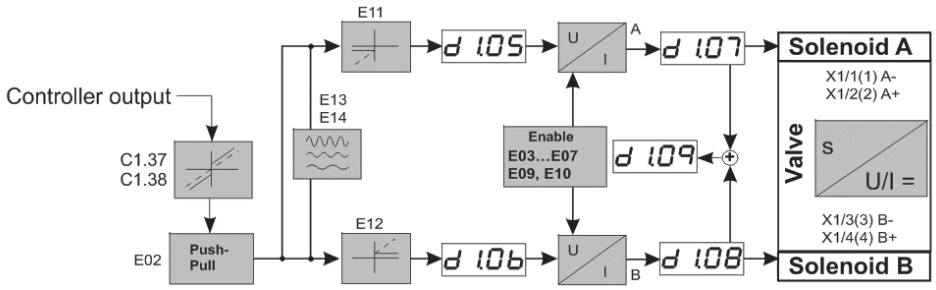
		Mode
1	For SW version V07.xx*	01



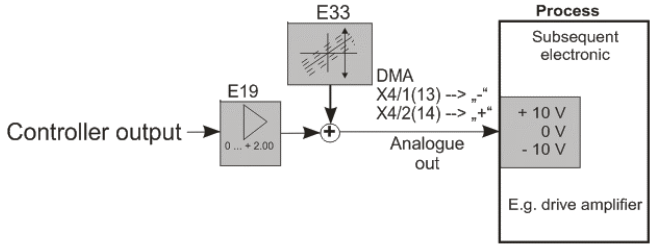
		Mode
2	For SW version V06.xx*,	02



		Mode
3	For SW version V01.xx*, V03.xx*, V04.xx*, V05.xx*, V35.xx*, V39.xx*	03, 04, 05



		Mode
3	For SW version V01.xx*, V04.xx*	10



7.5 Description of software program

7.5.1 General availability and assignment of parameters

In operating mode 1:
All setpoints (analog and digital → <S1.06>, <S1.01>, <S1.02>, <S1.03>, <S1.04>) are assigned to one functional branch.

In operating mode 2:
The setpoints (analog and digital → <S1.06>, <S1.01>) are assigned to functional branch 1.
The setpoints (analog and digital → <S1.05>, <S2.01>) are assigned to functional branch 2.

In operating modes 3, 4, 5, and 10:
All setpoints (analog and digital → <S1.06>, <S1.01>, <S1.02>) are assigned to one functional branch. The other analog input is used as the feedback input (Fb1).

⚠ WARNING

Only trained personnel must make parameter changes.
During parameter adjustment, the drive should be switched off.
Each parameter change takes effect immediately.

7.5.2 Programmable setpoints

Digital setpoints are internally programmable setpoints activated by digital inputs. Two or four of these programmable setpoints can be selected via the respective inputs.

- The inputs can be controlled directly by the PLC.
- If electrical isolation between the PLC and the amplifier is required, external isolation measures must be applied.
- All digital setpoints are processed through the ramp function generator.
- All setpoints are additive and include direction information.
- If multiple setpoints are selected simultaneously, their sum is processed.
- Using binary combinations, a total of 4 (16) values can be selected.

		Mode
1	For SW version V07.xx*	01

W
digital
S1.01, S1.02
S1.03, S1.04

		Mode
2	For SW version V06.xx*	02

Branch 1

W
digital
S1.01

Branch 2

W
digital
S2.01

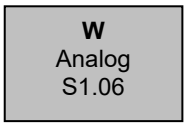
		Mode
3	For SW version V01.xx*, V03.xx*, V04.xx*, V05.xx*, V35.xx*, V39.xx*	03, 04, 05, 10

W
digital
S1.01, S1.02

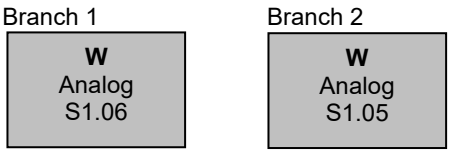
7.5.3 Analog setpoints <S1.05>, <S1 06>

- All analog setpoints are designed for voltage and current signals (differential inputs). Input resolution: 16 bit. The signal range is: 0 … ±10 V, 0 … 20 mA, 10 mA ± 10 mA, 4 … 20 mA, or 12 mA ± 8 mA.
  Cable break detection for current inputs and selection of the setpoint type are configurable via parameters <E15> and <E16>.
- If a current range is selected, a measuring resistor of 255 Ω is automatically activated when the enable signal is applied to the module.
- If wire break detection is enabled and the signal value falls below the threshold, the amplifier is disabled automatically and the error output switches to a low level. The status LED also lights up red.
- If a current input is selected and the DMA-22(A) is enabled, the input is continuously monitored for overcurrent. If overcurrent is detected, the input is automatically disabled to prevent damage. The enable signal is deactivated, the error output switches to a low level, and the status LED lights up red.
- The setpoint is processed by the ramp function generator if <E08> = 1. If parameter <E08> = 0, the analog setpoint bypasses the ramp function.
- The inputs are designed as differential inputs within an operating voltage range of ±15 V.
- The setpoint signal must be limited to ±10 V; otherwise, the A/D converter may be overloaded.
- When using current input signals, the inputs are protected against overload. An error is triggered at currents above approx. 25 mA. If wire break detection is enabled, an error is triggered at currents below approx. 2 mA. For information on error codes, refer to: See □ Chapter "9.5 Display and error messages", page 70

		Mode
1	For SW version V07.xx*	01
3	For SW version V01.xx*, V03.xx*, V04.xx*, V05.xx*, V35.xx*, V39.xx*	03, 04, 05, 10



		Mode
2	For SW version V06.xx*	02



To suppress interference, an unused analog setpoint <S1.05> or <S1.06> must be deactivated with parameter <E15>, E16> or <E17>.

Analog setpoints are not actual parameters; they represent external setpoint signals.

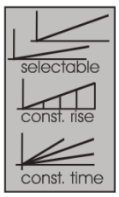
See □ Chapter "7.5.29 Selection of setpoint S1.06 <E15>", page 60
See □ Chapter "7.5.30 Selection of setpoint S1.05 <E16>", page 61

7.5.4 Ramp function <rx.xx> and <E08>

Setpoints are processed by the ramp function generator. For each change of direction, the ramp time can be set independently. Ramp times from 0 to 39.5 s can be configured. The resolution is 0.01 s.

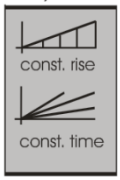
		Mode
1	For version SW V07.xx*	01
3	For SW version V01.xx*, V03.xx*, V04.xx*, V05.xx*, V35.xx*, V39.xx*	03, 04, 05, 10

r1.01...r1.04

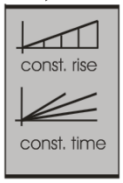


		Mode
2	For SW version V06.xx*	02

Branch 1 r1.03, r1.04

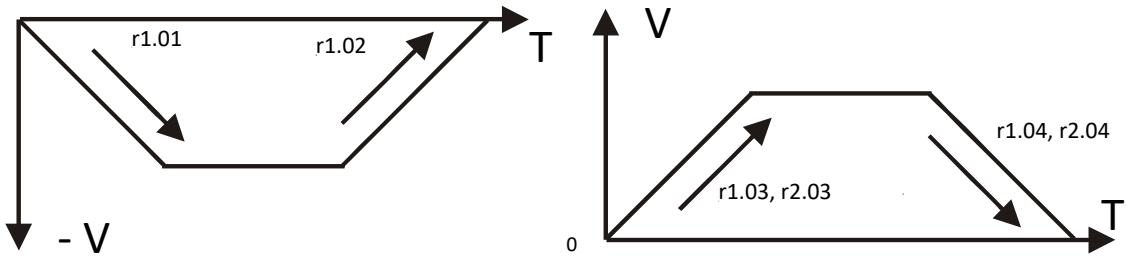


Branch 2 r2.03, r2.04



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>, <r2.03> ramp from 0 to positive values
<r1.04>, <r2.04> ramp from positive values to 0



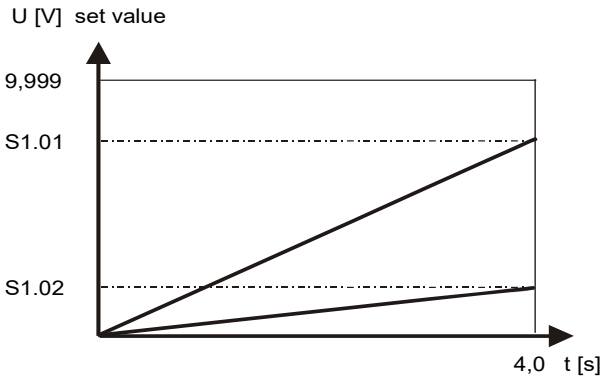
<E08> = 0 affects digital setpoints only; constant time base and linear
<E08> = 1 affects all setpoints; constant rise rate and linear
<E08> = 2 selectable ramp times

The ramp function can be switched.

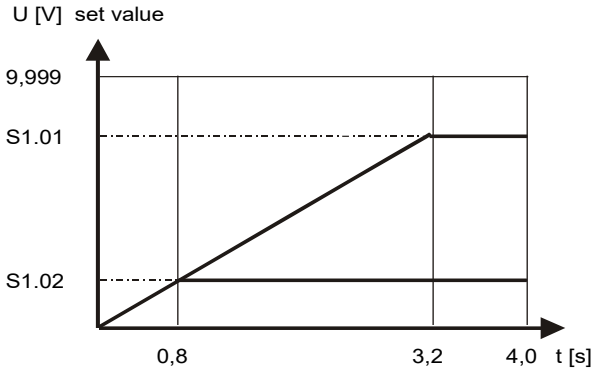
The input <S1.01> selects ramp (in sec.) <r1.01> and <r1.02>.
The input <S1.02> selects ramp (in sec.) <r1.03> and <r1.04>.
If <S1.01> and <S1.02> are offline, **no** ramp is activated.
If both, <S1.01> and <S1.02> are online, ramp <r1.01 and <r1.02> are activated.
The selected parameters <S1.01> and <S1.02> are still active and must be set to 0 if they should not be used.

7.5.5 Examples for ramps (operation mode 1, 3, 4, 5, 10)

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

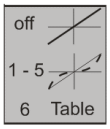


The analog setpoint <S1.06> excluded from the ramp function.	**The ramp influences the digital setpoints <S1.01> and <S1.02> as well as the analog setpoint <S1.06>**

7.5.6 Characteristic curve <C1.02>, <C2.02>

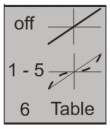
		Mode
1	For version SW V07.xx*	01
3	For SW version V01.xx*, V03.xx*, V04.xx*, V05.xx*, V35.xx*, V39.xx*	03, 04, 05, 10

C1.02

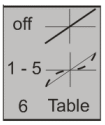


		Mode
2	For SW version V06.xx*	02

Branch 1
C1.02



Branch 2
C2.02



Five characteristic curves are available for valve linearization:

<Cx.02>	Description
off	No linearization active
1	General linearization for NC characteristic curve
2	Linearization for proportional directional valves with flow rate > 10 l/min (NG6)
3	Linearization for proportional directional valves with flow rate < 10 l/min (NG6)
4	Linearization for proportional directional valves with flow rate >50 l/min (NG10)
5	linearization for proportional pressure valves
6	User-defined characteristic curve (table L1)

Table 12: <C1.02> selection

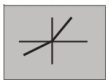
How to define custom specific curve:
See □ Chapter "7.5.21 Custom specific curve L1", page 56

7.5.7 Direction dependent gain <C1.03>, C1.04>, <C2.04>

The gain can be adjusted using parameters <C1.03> and <C1.04> for both directions (“+” and “–”). These parameters are used to adjust the gain (e.g., to balance the speed of differential cylinders).
Parameter <Cx.03> applies to negative values, while <Cx.04> applies to positive values.

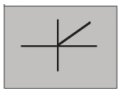
		Mode
1	For version SW V07.xx*	01
3	For SW version V01.xx*, V03.xx*, V04.xx*, V05.xx*, V35.xx*, V39.xx*	03, 04, 05, 10

C1.03, C1.04

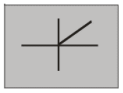


		Mode
2	For SW version V06.xx*	02

Branch 1 C1.04



Branch 2 C2.04



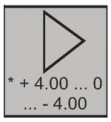
7.5.8 Setpoint sign / factor<C1.05>, <C2.05>

The setpoint sign and scaling factor function are used to invert the polarity of the setpoints, adapt the signal, or completely disable the signal. This allows the direction of a valve to be changed as well as the scaling of the setpoint signals.

The scaling factor for the setpoint can be set within a range of 0.00 … ±4.00.

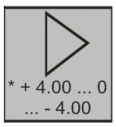
		Mode
1	For version SW V07.xx*	01
3	For SW version V01.xx*, V03.xx*, V04.xx*, V05.xx*, V35.xx*, V39.xx*	03, 04, 05, 10

C1.05

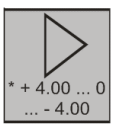


		Mode
2	For SW version V06.xx*	02

Branch 1 C1.05



Branch 2 C2.05



7.5.9 Offset for setpoint <C1.06>, <C2.06>

Drift of the drive or hydraulic system can be corrected using the offset parameter.

The offset setpoint can be regarded as an additional setpoint. This allows very precise positioning of the system, e.g., when used on an NC axis.

		Mode
1	For version SW V07.xx*	01
3	For SW version V01.xx*, V03.xx*, V04.xx*, V05.xx*, V35.xx*, V39.xx*	03, 04, 05, 10

C1.06

		Mode
2	For SW version V06.xx*	02

Branch 1 C1.06

Branch 2 C2.06

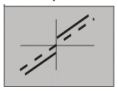
7.5.10 Spool overlap compensation <C1.07>, <C1.08>, <C2.08>

The compensation acts as an additional setpoint that is activated as soon as the polarity of the setpoint changes.

The preset value is applied directly as a current to the torque motor. The programming is standardized in volts; 10 V corresponds to the maximum set current.

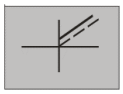
		Mode
1	For version SW V07.xx*	01
3	For SW version V01.xx*, V03.xx*, V04.xx*, V05.xx*, V35.xx*, V39.xx*	03, 04, 05

C1.07, C1.08

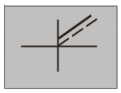


		Mode
2	For SW version V06.xx*	02

Branch 1 C1.08



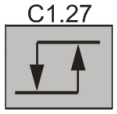
Branch 2 C2.08



7.5.11 Setpoint dead-band <C1.27>

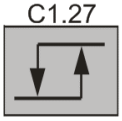
		Mode
1	For version SW V07.xx*	01
3	For SW version V01.xx*, V03.xx*, V04.xx*, V05.xx*, V35.xx*, V39.xx*	03, 04, 05

C1.27

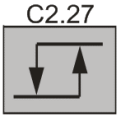


		Mode
2	For SW version V06.xx*	02

Branch 1 C1.27



Branch 2 C2.27



Parameter <C1.27> allows an artificial deadband to be applied to the setpoint input.
This ensures that an input signal of “0” results in an output of “0”, even if spool-overlap compensation is active (<C1.07> and <C1.08> > 0).)!

For clarity, the parameters shown in the following chapters are only available for operation modes: “03, 04, 05, 10 “

7.5.12 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. Setting parameter <C1.00> to 0 deactivates closed-loop operation; in this case, the amplifier card operates in open-loop mode.

Parameter <C1.00> is used to select and activate the controller configuration. Four different controller configurations are available:

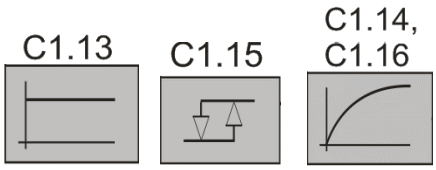
<C1.00>	Controller function	Description
off	--	No controller active; the DAC-4x(A) operates in open-loop mode.
1	P-PT1-I-DT1 – controller	Standard controller with various configuration options
2	remote loop control	Controller activated or deactivated depending on a threshold value and/or the status of a digital input. The controller structure is identical to mode 1
3	direct feed forward controller (dff controller)	Direct feed-forward (dff) controller. A portion of the setpoint (defined by <C1.13>) is applied directly to the output stage. The remaining portion is controlled by a standard P-PT1-I-DT1 controller
4	combination of “1” and “2”	Combined controller consisting of a dff controller and a P-PT1-I-DT1 controller, which can be activated as described in mode 2

Table 13: Controller selection

7.5.12.1 P-PT1-I-DT1 controller <C1.00> = 1 or 2

		Mode
3	For SW version V01.xx*, V03.xx*, V04.xx*, V05.xx*, V35.xx*, V39.xx*	03, 04, 05, 10

P-portion, PT1-portion <C1.13>, <C1.14>, <C1.15>, <C1.16>



When programming parameters <C1.13> and <C1.16>, the setting of parameter <C1.00> (controller configuration) must also be considered.

If <C1.00> = 3 or <C1.00> = 4 (dff controller), then <C1.13> defines the gain of the dff controller, and <C1.16> defines the P-gain of the remaining PT1-I-DT1 controller. In these cases, <C1.15> has no effect.

- <C1.13> defines the P-gain (KP1) for small control deviations (proportional controller)
- <C1.14> interacts with <C1.16> and forms a PT1 element
- <C1.15> defines the threshold for switching between <C1.13> (KP1) and <C1.16> (KP2)
- <C1.16> defines the P-gain (KP2) for large control deviations; together with <C1.14>, it forms a PT1 element

Description of the threshold function <C1.15> and the resulting behavior of <C1.13> and <C1.16>:

Case 1: The control deviation is smaller than the threshold (|w − x| < <C1.15>):
- Only the proportional component KP1 is active: (w − x) × KP1

• Case 2: The control deviation is greater than the threshold (|w − x| > <C1.15>):
- Up to the threshold <C1.15>, the proportional component KP1 is active: (w − x) × KP1
- The additional proportional component KP2 acts only on the exceeding portion: (|w − x| − <C1.15>) × KP2

The total controller output is the sum of both components.

The division into two independently adjustable gains allows more stable controller tuning in non-linear systems (which is often the case in hydraulic applications), even for large control deviations.

The option to suppress (attenuate) <C1.16> (KP2) using a time delay further enhances this effect and results in adjustable, smooth PT1 characteristics.

See the following graph for an explanation:

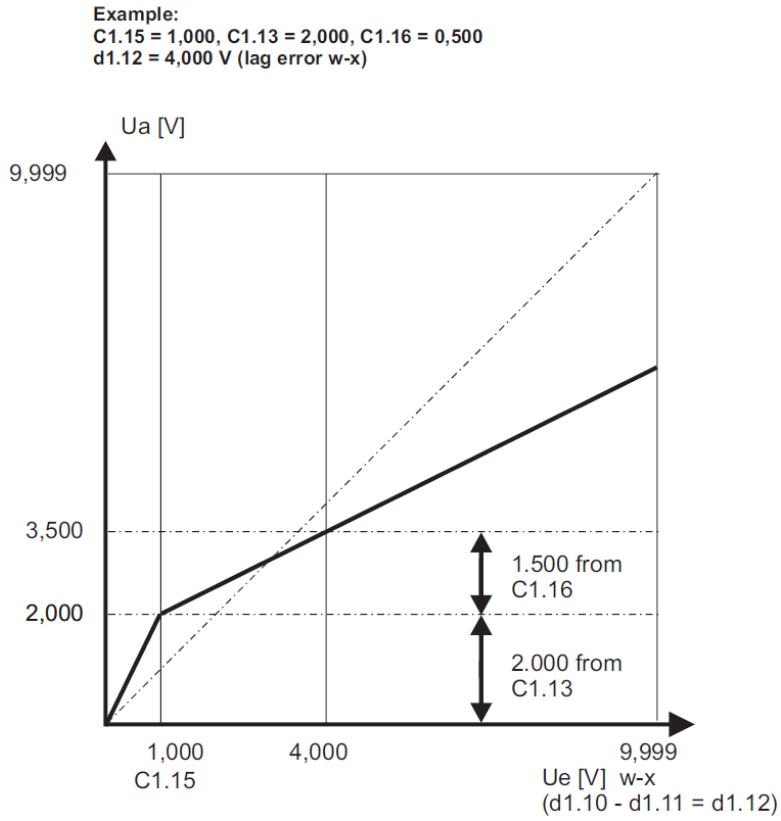


Figure 21 : Diagram function <C1.13> / <C1.15> / <C1.16>

7.5.12.2 Dff controller <C1.00> = 3 or 4

		Mode
3	For SW version V01.xx*, V03.xx*, V04.xx*, V05.xx*, V35.xx*, V39.xx*	03, 04, 05, 10

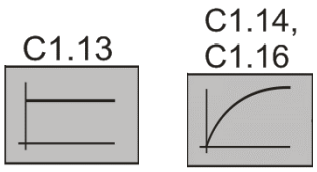
DFF stands for direct feedforward controller.

In principle, 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 implemented as a parallel structure consisting of a P term and a PT1-I-DT1 controller.

The processed setpoint d1.10 is applied directly to the P-gain of the dff branch. After scaling with the dff P-factor, the resulting signal is added to the control output of the PT1-I-DT1 controller. The resulting signal can be monitored via d1.13. The PT1-I-DT1 controller is supplied with the control deviation d1.12.

This operating mode enables improved dynamic performance with simplified parameterization. As a general guideline, approximately 80% of the output signal should be provided by the dff controller, while the remaining 20% should be generated by the PT1-I-DT1 controller.

P portion, PT1 portion <C1.13>, <C1.14>, <C1.15>, <C1.16>



- <C1.13> defines the P-gain of the direct feedforward (proportional) controller
- <C1.14> interacts with <C1.16> and forms a PT1 element
- <C1.15> is not taken into account
- <C1.16> defines the P-gain of the remaining PT1-I-DT1 controller

7.5.12.3 Remote loop control <C1.00> = 2 or 4

		Mode
3	For SW version V01.xx*, V03.xx*, V04.xx*, V05.xx*, V35.xx*, V39.xx*	03, 04, 05, 10

Initially, the amplifier operates in open-loop mode. The solenoid current is a direct function of the setpoint (e.g., resulting in a specific pressure when using pressure valves).

By activating the “activation input”, the amplifier enters standby mode and can be switched to closed-loop control. The comparator monitors the feedback signal. If the feedback value exceeds the comparison threshold, closed-loop control is activated.

For more information about the comparator functionality,
see □ Chapter "8.2.2 Comparator for remote-loop controllers <C1.00> = 2 or 4", page 64

7.5.13 Safety function <C1.01>

		Mode
3	For SW version V01.xx*, V03.xx*, V04.xx*, V05.xx*, V35.xx*, V39.xx*	03, 04, 05, 10

This function provides an “enable mode” or sequence that allows controlled transition from the deactivated state to the activated state, which is especially useful for restarting after an emergency stop.

⚠ CAUTION

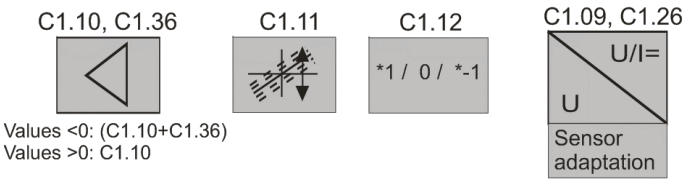
The use of the safety function in combination with remote loop control (C1.00 = 2 or C1.00 = 4) must be avoided.

For more information about the safety functionality:
See □ Chapter “8.3 Process control loops and safety function” page 65**Fehler! Textmarke nicht definiert.Fehler! Textmarke nicht definiert.**

7.5.14 Sensor adjustment <C1.09>, <C1.10>, <C1.11>, <C1.26>, <C1.36>

To select the appropriate type of sensor for the feedback signal, use parameter <C1.09>.

		Mode
3	For SW version V01.xx*, V03.xx*, V04.xx*, V05.xx*, V35.xx*, V39.xx*	03, 04, 05, 10



The following types of sensors are available:

<C1.09>	Input signal range	Wire monitor <C1.26>	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	Only positive controller output possible!
11	4 ... 20 mA	Yes	
12	0 ... 10 V	No	
14	5V ± 3.0 V	Yes	
21	Bipolar voltage	Yes	
22	Unipolar voltage	Yes	
23	Unipolar voltage	Yes	Only positive controller output possible!
24	Bipolar current	Yes	
25	Unipolar current	Yes	
26	Unipolar current	Yes	Only positive controller output possible!
28	5V ± 2.6 V	Yes	

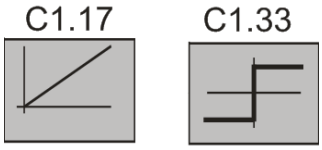
Table 14: Feedback sensor selection

- The Feedback 1 (Fb1) input is designed for voltage and current signals (differential input). The resolution of the analog input is 16 bit. Cable break detection can be configured using parameter <C1.26>.
- When a current range is selected for Fb1 and the DMA-22(A) is enabled, a measuring resistor of 255 Ω is automatically activated. If the DMA-22(A) is then disabled, the resistor is automatically deactivated to prevent damage.
- The Feedback 1 input is designed as a differential input within an operating voltage range of ±15 V.
- If wire break detection is enabled and the signal value falls below the threshold, the amplifier is disabled automatically and the error output switches to a low level. The status LED also lights up red.
- If a current input is selected and the DMA-22(A) is enabled, the input is continuously monitored for overcurrent. If overcurrent is detected, the input is automatically disabled to prevent damage. The enable signal is deactivated, the error output switches to a low level, and the status LED lights up red.
- The selections 10, 11, 12, 23, and 26 are intended for control loops in which no negative values occur; therefore, no negative controller output is possible (e.g., pressure control loops).
- If a sensor signal exhibits different gains or asymmetrical behavior, compensation can be performed using parameter <C1.36>. Sensor gains for positive and negative signals can be adjusted independently.
- When using current input signals, the inputs are protected against overload. An error is triggered at currents above approx. 25 mA. If wire break detection is enabled, an error is triggered at currents below approx. 2 mA. For information on error codes, refer to:

See □ Chapter "9.5 Display and error messages", page 70

7.5.15 I portion, I portion limiter <C1.17>, <C1.33>

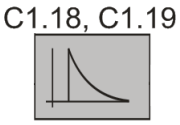
		Mode
3	For SW version V01.xx*, V03.xx*, V04.xx*, V05.xx*, V35.xx*, V39.xx*	03, 04, 05, 10



- <C1.17> defines the I-component of the controller (integral controller). The value of <C1.17> is limited to prevent overdrive or saturation. Small values indicate a slow response, while large values indicate a fast response.
- <C1.33> defines the limiting level for the I-component of the controller to prevent saturation of the integral part. .

7.5.16 D portion, DT1 portion <C1.18>, <C1.19>

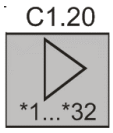
		Mode
3	For SW version V01.xx*, V03.xx*, V04.xx*, V05.xx*, V35.xx*, V39.xx*	03, 04, 05, 10



- <C1.18> defines the D-component of the controller and, together with <C1.19>, forms a DT1 element (differential controller).
- <C1.19> defines the time constant for <C1.18> to form a DT1 element.

7.5.17 Additional (P) gain <C1.20>

		Mode
3	For SW version V01.xx*, V03.xx*, V04.xx*, V05.xx*, V35.xx*, V39.xx*	03, 04, 05, 10

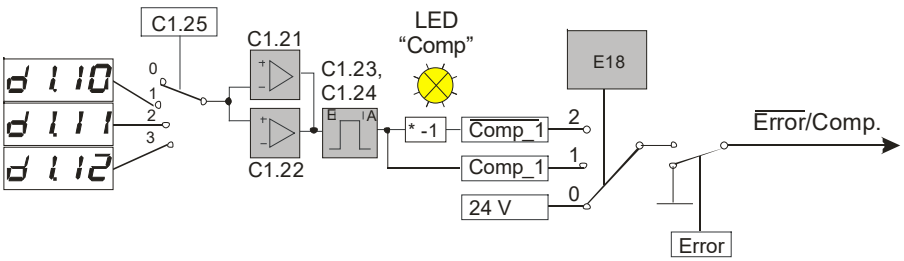


• <C1.20> defines an additional proportional gain to increase the effect of <C1.13> and <C1.16>, particularly for process control applications.

7.5.18 Comparator <C1.21> to <C1.25>

		Mode
3	For SW version V01.xx*, V03.xx*, V04.xx*, V05.xx*, V35.xx*, V39.xx*	03, 04, 05, 10

LED only available via HCSTool monitor function!



- Parameter <C1.25> is a switch that defines which signal is compared with the comparator values.

<C1.25>	Input signal range
0	Comparator is deactivated
1	Comparator compares with the current setpoint (d1.10)
2	Comparator compares with the current actual value (d1.11)
3	Comparator compares with the current deviation (d1.12)

Table 15: The available values for <C1.25>

- Parameters <C1.21> and <C1.22> define the comparator window. Both can be set within a range of 0 … ±9.999 V. It is also possible to define a positive, negative, or asymmetrical window. Parameter <E18>, together with <C1.21> and <C1.22>, defines the logic of the comparator output. Note the following dependencies:
- If <C1.21> < <C1.22>, the output logic is inverted.
- When comparing the comparator value with the control deviation, the window center is defined as:
- Actual value = setpoint or (actual value − setpoint) = 0.
- Therefore, the window is “floating” and dependent on the setpoint. Depending on the setpoint, the window is centered around it.
- An on/off switching delay, defined by parameters <C1.23> and <C1.24>, can be adjusted up to a maximum of 9.99 s with a resolution of 10 ms. The optically isolated comparator output signal is available at terminal [14b]. Otherwise, parameter <E18> is active:
- <E18> = off: positive comparator logic, meaning that if the comparison value lies within the defined limits, the comparator output is “high”.
- In general, the comparator output is logically ANDed with the “enable” signal. Therefore, if the “enable” signal is “low”, the comparator output is also “low”.

For more information about the comparator functionality, see □ Chapter “8.2 Comparator“, page 63

7.5.19 Additional spool overlap compensation <C1.37>, <C1.38>

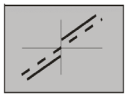
The compensation function acts as an additional setpoint that is activated when the polarity of the setpoint changes.

The preset value is applied directly as a current to the torque motor. The parameterization is standardized in volts; 10 V corresponds to the maximum set current.

This function is only applicable in operating modes 03 and 05.

		Mode
3	For SW version V01.xx*, V03.xx*, V04.xx*, V05.xx*, V35.xx*, V39.xx*	03,05

C1.37
C1.38

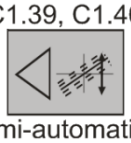


7.5.20 Sensor semi-automatic calibration <C1.39>, <C1.40>

The semi-automatic feedback calibration function supports the user in correctly scaling the feedback signal in terms of offset and gain, thereby ensuring that closed-loop control operates as intended. The procedure is performed using HCSTool.

		Mode
3	For SW version V01.xx*, V03.xx*, V04.xx*, V05.xx*, V35.xx*, V39.xx*	03, 04, 05, 10

C1.39, C1.40



Semi-automatic calibration (w. HCSTool only!)

DANGER

When performing this function, ensure that no unintended reactions of the system can occur, e.g., by locking the drive or implementing similar measures to prevent hazardous situations.

Semi-automatic feedback calibration procedure with HCSTool:

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”) This step is only displayed, when an “Bipolar” sensor is selected. Click 4 – wait for green checkmark
6	Bring sensor signal to maximum “A” side Click 5 – wait for green checkmark
7	Verify procedure

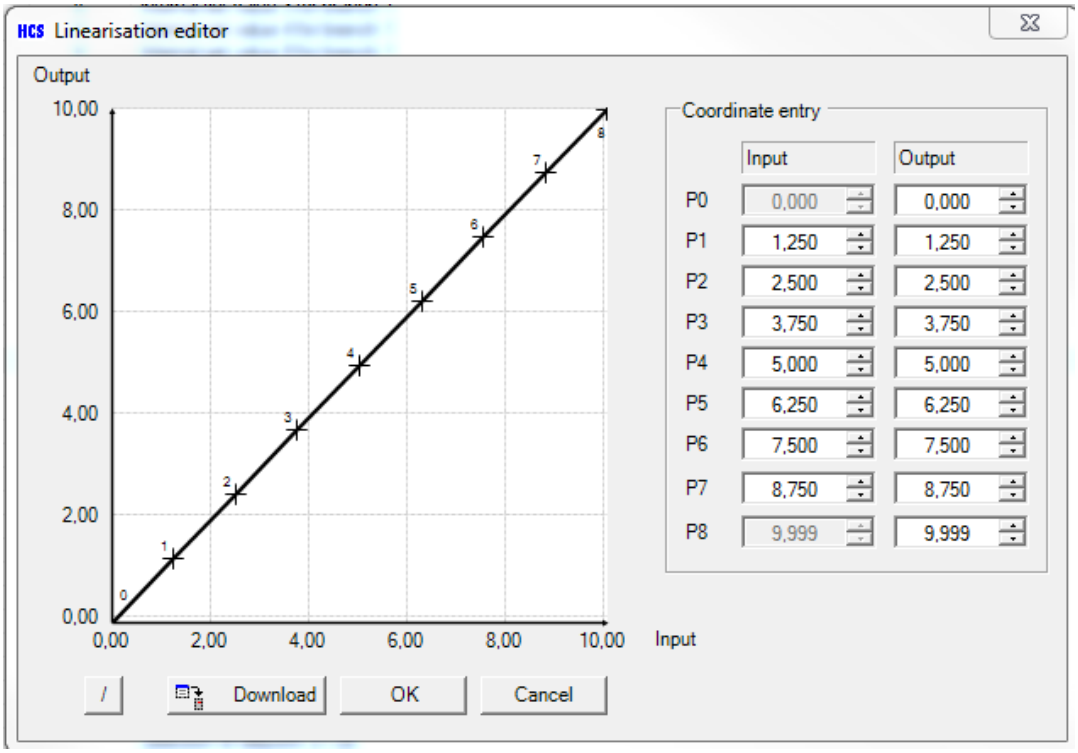
Table 16: Semi-automatic feedback calibration procedure

7.5.21 Custom specific curve L1

When the parameter

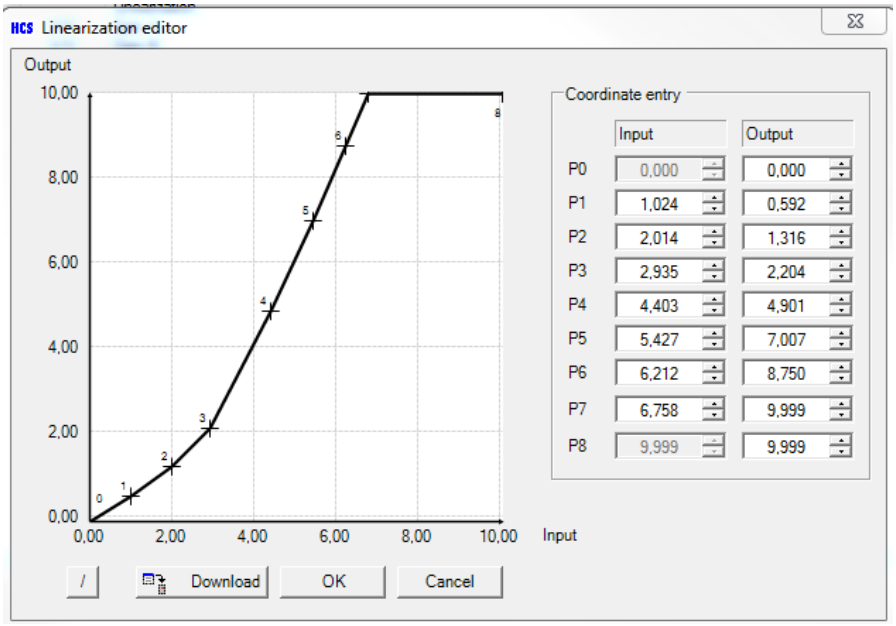
L1 table of linearization for C1.02 = 6

in the HCSTool is selected, the “Linearization editor” appear.



Here, you can create a custom table according to your requirements. You can move one of the eight points in the coordinate window or enter the corresponding values directly into the table on the left.

Here is an example of a custom curve:



The button  allows you to reset the curve to the linear version.

7.5.22 Operation mode <E00>

At the beginning of the commissioning process, the application type must be defined, which determines the operating mode of the module. This is configured using parameter <E00>.
Normally, this parameter is predefined based on the selected module version. For module versions DMA-22(A)-01-x-Sxxx, the preset is “mode 01”, and for module versions DMA-22(A)-03-x-Sxxx, it is “mode 03”.
The available modes, see □ Chapter "7.1 Operation modes", page 3345

7.5.23 Analog output <E01>

		Mode
4	Only available parameters with analog output on board SW V01.xx*, V04.xx*, V39.xx*	03, 04, 05, 10

Any internal measured value can be output as an analog signal via the analog output using parameter <E01>. This signal is available as a voltage or current signal with a resolution of 12 bit. The default signal type is voltage in the range of ± 10 V.

This signal can be used as an independently calibrated representation of the feedback signal. If the amplifier module is used as a controller without a valve, this signal can be used to control the subsequent electronics.

Parameter <E01> selects the display parameter. It can be used to output all internal voltage values <dx.xx> available in the corresponding operating mode.

The output value can be adjusted using an offset and/or an additional scaling factor.
see □ Chapter "7.5.33 Voltage analog output, offset and factor <E19>, <E33>", page.62

7.5.24 Push-pull / Short-circuit, overcurrent, and wire break detection <E02>

E02

Push-Pull

<E02>	Description
off	Push-Pull function off. Normal operation mode.
1	Push-Pull function is activated. Only applicable for specially designed valves.
4	Push-Pull function off. Wire break detection to the solenoid is activated.
5	Push-Pull function is activated. Wire break detection to the solenoid is activated.

Table 17: <E02> selection

⚠ WARNING

If a possible open circuit may lead to critical conditions in the application, it is imperative to set <E02> = 6.

⚠ CAUTION

For E02 = 3 and E02 = 6, an error will only be detected if an overcurrent greater than 5 times of the rated maximum current will be reached. After the first overcurrent detection, the module will try to turn on again 5 times before going into the error state. Only in this case will the output stages be shut off automatically.

It is always recommended to have a fuse (quick acting, 3.15 A) in the + power supply line to the DAC-4x(A).

In the event of a short circuit, overload, or open circuit, the error message is either "- - 3" or "- - 8".

7.5.25 Output stage parameters <Ex.03>, <Ex.04> to <Ex.07>, <E09>, <Ex.10>

		Mode
1	For version SW V07.xx*	01
3	For SW version V01.xx*, V03.xx*, V04.xx*, V05.xx*	03, 04, 10

Output Stage Control
E03, E04 ... E07
E09, E10

- <E03> defines the nominal current through the valve at maximum setpoint.
- <E04> defines the proportional (P) component for solenoid energization.
- <E05> defines the integral (I) component for solenoid energization.
- <E06> defines the proportional (P) component for solenoid de-energization.
- <E07> defines the integral (I) component for solenoid de-energization.
- <E10> enables variable adjustment of the solenoid current.

		Mode
2	For SW version V06.xx*	02
3	For SW version V35.xx*, V39.xx*	05

Output Stage Control
E1.03, E1.04 ... E1.07
E09. E1.10

Output Stage Control
E2.03, E2.04 ... E2.07
E09, E2.10

Solenoid A:
- <E1.03> defines the nominal current through the valve at maximum setpoint.
- <E1.04> defines the proportional (P) component for solenoid A energization.
- <E1.05> defines the integral (I) component for solenoid A energization.
- <E1.06> defines the proportional (P) component for solenoid A de-energization.
- <E1.07> defines the integral (I) component for solenoid A de-energization.
- <E1.10> enables variable adjustment of the solenoid A current.

Solenoid B:
- <E2.03> defines the nominal current through the valve at maximum setpoint.
- <E2.04> defines the proportional (P) component for solenoid B energization.
- <E2.05> defines the integral (I) component for solenoid B energization.
- <E2.06> defines the proportional (P) component for solenoid B de-energization.
- <E2.07> defines the integral (I) component for solenoid B de-energization.
- <E2.10> enables variable adjustment of the solenoid B current.

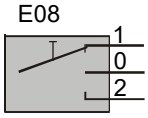
Each current output is driven by a PWM output stage with over-energization and fast de-energization. The solenoid current is measured, compared with the setpoint (activation value for the output stages), and controlled by a PI controller. This helps to minimize deviations in the solenoid current, e.g., due to coil heating.

In addition, the controller parameterization has a significant influence on dynamic and static performance. Parameters <Ex.04> and <Ex.05> define the controller behavior for energization, while <Ex.06> and <Ex.07> define it for de-energization.

Parameter <Ex.10> allows fine and variable adjustment of the solenoid current, enabling adjustment of the previously defined maximum current. Regardless of the settings, the minimum current is always limited to 0.5 times the nominal output current (defined by <Ex.03>).

Parameter <E09> defines the delay time of the enable signal. Activation of the output stages is delayed even if the enable signal is active.

7.5.26 Type of ramp <E08>



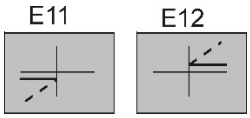
<E08>	Description
0	Constant time base (affects only digital setpoints)
1	Constant rise rate (affects all setpoints, digital and analog)
2	The ramp function can be enabled or disabled (note: this is not shown in the block diagrams of the operating modes).

Table 18: <E08> selection

More information about the ramp function, see □ Chapter "7.5.4

Ramp function <rx.xx> and <E08>", page 45

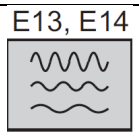
7.5.27 Initial current <E11>, <E12>



This parameter specifies the initial current of up to 30% of the nominal output current.
The offset current is used to adjust the center position of the proportional valve or the system, if required.

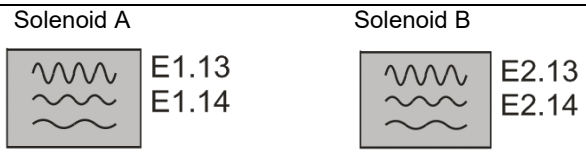
7.5.28 Dither signal <Ex.13>, <Ex.14>

		Mode
1	For version SW V07.xx*	01
3	For SW version V01.xx*, V03.xx*, V04.xx*, V05.xx*, V35.xx*, V39.xx*	03, 04, 05, 10



<E13> Dither amplitude, <E14> Dither frequency

		Mode
2	For SW version V06.xx*	02



<E1.13> Dither amplitude, solenoid A <E1.14> Dither frequency, solenoid A	<E2.13> Dither amplitude, solenoid B <E2.14> Dither frequency, solenoid B

The dither function can be adapted to the valve or the process using parameters <Ex.13> (amplitude) and <Ex.14> (frequency). The signal frequency is adjusted in discrete steps.

The dither signal reduces valve hysteresis or drive friction and improves the system response, resulting in enhanced precision and repeatability.

In general, low-frequency signals are more effective; however, they may cause noticeable disturbances (e.g., noise or oscillations). Frequencies below 100 Hz are typically used for systems with a low characteristic frequency, while higher values are used for systems with a high characteristic frequency. The dither amplitude is typically set within a range of 2% to 12% (relative to current or setpoint).

Dither signals influence the current characteristic due to physical dynamic effects. In some cases, this may affect the linearity between voltage (U) and current (I).

7.5.29 Selection of setpoint S1.06 <E15>

This parameter is used to select the type of analog setpoint S1.06. If a current input is selected, the measuring resistor is automatically activated. The following input options are available with parameter <E15>:

<E15>	S1.06 Input signal range	Cable fraction detection
off	Input is deactivated	-
1	Voltage input - 10 V … + 10 V.	-
2	Voltage input 0 V … + 10 V.	-
3	Voltage input 5 V ± 5 V	-
4	Voltage 5 V ± 4.5 V	-
5	Voltage 5 V ± 4.5 V	Yes
6	Current 0 … 20 mA	-
7	Current 10 ± 10 mA	-
8	Current 4 … 20 mA	-
9	Current 4 … 20 mA	Yes
10	Current 12 ± 8 mA	-

11	Current 12 ± 8 mA	Yes

Table 19: <E15> selection

7.5.30 Selection of setpoint S1.05 <E16>

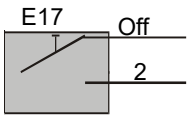
		Mode
2	For SW version V06.xx*	02

This parameter is used to select the type of analog setpoint S1.05. If a current input is selected, the measuring resistor is automatically activated.

<E16>	S1.05 Input signal range	Cable fraction detection
off	Input is deactivated	-
1	Voltage input - 10 V … +10 V.	-
2	Voltage input 0 V … +10 V.	-
3	Voltage input 5 V ± 5 V	-
4	Voltage 5 V ± 4.5 V	-
5	Voltage 5 V ± 4.5 V	Yes
6	Current 0 … 20 mA	-
7	Current 10 ± 10 mA	-
8	Current 4 … 20 mA	-
9	Current 4 … 20 mA	Yes
10	Current 12 ± 8 mA	-
11	Current 12 ± 8 mA	Yes

Table 20: <E16> selection

7.5.31 Activation of setpoints <E17>



Parameter <E17> is used to select or activate the setpoints. The following relationships apply:

<E17>	Analog setpoints	Digital setpoints
off	All analog setpoints are activated	digital setpoints are activated
2	All analog setpoints are deactivated	digital setpoints are activated

Table 21: <E17> selection

7.5.32 Selection of digital output signal; Error / Comparator <E18>

This parameter is used to select the logic for the status information of the comparator and the brake output.
Parameter <E18> determines which signal is used to control the comparator and/or the brake output.

The availability of the various selection options depends on the selected operating mode.

If an error occurs, the “Error / Comparator” output is set to logical “0”, regardless of the comparator status.

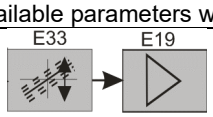
<E18>	Error/ Comparator output
off	Error signal controls the output
1	Comp. positive logic

2	Comp. negative logic

Table 22: <E18> selection

7.5.33 Voltage analog output, offset and factor <E19>, <E33>

		Mode
4	Only available parameters with analog output on board SW V01.xx*, V04.xx*, V39.xx*	03, 04, 05, 10



A separate offset of −10 V to +10 V can be added to the output signal using parameter <E33>. Parameter <E19> allows scaling of the output signal with a factor from 0.00 to 2.00.

7.6 Evaluation of 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: → $t_{pwm}(t) = kp_{ent} * e(t) + ki_{ent} * e(t)$
kp_{ent} = E06; ki_{ent} = E07 * T_{ab}

T_{ab} = 80µs

8 Functions

8.1 Display parameter d1.01> to <d1.13>

Internally calculated values can be displayed during normal operation and are especially useful for commissioning and troubleshooting.

The values can be displayed using the **HCSTool** monitor function.
The values should be interpreted as voltage or current with a standardized display resolution from 1 mV up to 9.999 V, corresponding to currents from 0.001 A up to the nominal output current defined by <E03>. The relevant signal positions within the software can be identified using the block diagrams.

⚠ CAUTION

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

Display-Parameter	Function
d1.01	Sum analog setpoints
d1.02	Sum setpoints after ramp function
d1.03	Setpoints after linearization
d1.04	Set values after gain adjustment
d1.05	Signal to solenoid A
d1.06	Signal to solenoid B
d1.07	Actual current A
d1.08	Actual current B
d1.09	Total current
d1.10	Setpoint, reference input (w)

		Mode
3	For SW version V01.xx*, V03.xx*, V04.xx*, V05.xx*, V35.xx*, V39.xx*	03, 04, 05, 10

d1.11	Actual value, feedback input (x)
d1.12	Lag error, deviation between command and feedback (e)
d1.13	Controller output (y)

Table 23: Display parameters

8.2 Comparator

		Mode
3	For SW version V01.xx*, V03.xx*, V04.xx*, V05.xx*, V35.xx*, V39.xx*	03, 04, 05, 10

The description is provided for branch 1 only. The comparator of the second branch operates analogously to that of the first.

8.2.1 Comparator for standard controllers <C1.00> = 1 or 3

The monitoring function is used in control loops (position, velocity, and pressure control).

The comparator can be used to generate a “setpoint reached” signal (e.g. “in position” for position control).
It also enables simple feedback signal monitoring, such as clamping pressure monitoring.
The control deviation <d1.12> is the most suitable comparison value (<C1.25> = 3). The comparator output signal depends on the comparison result.
When the value is within the defined window (parameters <C1.21> and <C1.22>), the “Reset Ramp” LED flashes slowly.
If the “Reset Ramp” signal is also active, the LED flashes quickly..

8.2.2 Comparator for remote-loop controllers <C1.00> = 2 or 4

		Mode
3	For SW version V01.xx*, V03.xx*, V04.xx*, V05.xx*, V35.xx*, V39.xx*	03, 04, 05, 10

To activate this function, select parameter <C1.00> = 2 or <C1.00> = 4.

Initially, the amplifier operates in open-loop mode. The solenoid current is a direct function of the setpoint (e.g., resulting in a specific pressure when using pressure valves).

By activating the “activation input”, the amplifier enters standby mode and can be switched to closed-loop control. The comparator monitors the feedback signal. If the feedback value exceeds the comparison threshold, closed-loop control is activated.

When <C1.17> ≠ 0.000, the output of the I-controller is initialized with the setpoint. This ensures a smooth transition from open-loop to closed-loop operation.

Even if the feedback value drops below the switching threshold, the control remains active. A “low” signal at the “activation input” is required to deactivate the closed-loop function.

By setting the comparator threshold values <C1.21> and <C1.22> to 0, the “activation input” can be used directly to activate the controller. This allows the control loop to be activated by external signals.

<C1.23> has no function when the “switching controller” is activated.

<C1.24> can be used to delay controller activation.

The status is indicated by the LED “Dout_1” (only available in the HCSTool monitor function).

“Activation input”	actual value > or < switching threshold	Function	“LED” Dout_1
Low	<	open-loop	off
High	<	open-loop	on
High	>	closed-loop	flashes

Table 24: Switching controller status

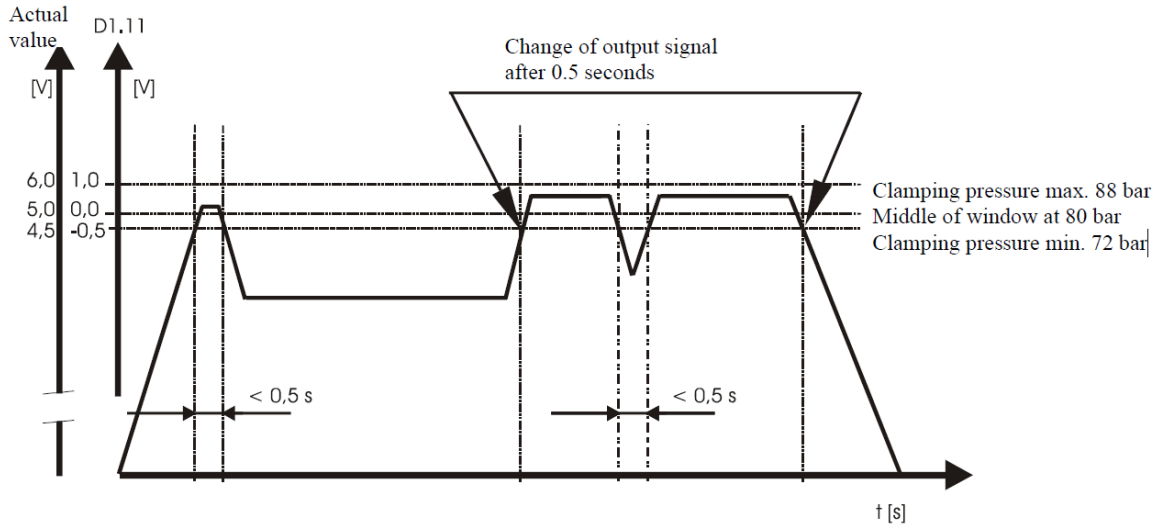
The definition of the “Activation input”

SW Version	Connector/Terminal	Activation input
V01.xx* V03.xx* V04.xx* V05.xx*	X2/1 (5) or X4/1 (13) depending on HW design	S1.01
V35.xx* V39.xx*	X4/2 (14)	S1.02

Table 25: Activation input depending on SW version and HW design

8.2.3 Example (comparator for process controlling)

Example: Clamping pressure monitor
Specification: 10 V = 160 bar
Selected pressure: 80 bar = 5 V (setpoint and window center)
Adjustments: C1.21 = 1.00 = 16 bar
C1.22 = 0.50 = approx. 8 bar
C1.23 = 0.05 s
C1.24 = 0.50 s



8.3 Process control loops and safety function

This function provides an “enable mode” or a sequence that allows a controlled transition from the deactivated state to the activated state, which is especially useful for restarting 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.

**The internal setpoint used after the emergency stop defines the machine end position, preferably the ‘home position’.
The drive speed is regulated by the ramp**

This special safety function ensures that uncontrolled movements are avoided. It is activated via parameter <C1.01> (see logic table).
The general sequence is as follows: after a restart (power supply on or enable signal activated), all digital setpoints must be inactive. As a result, the controller output (d1.13) is set to 0.000, preventing any drive movement.
Once a setpoint and a direction signal are activated, the controller is re-enabled and the drive moves to a position defined by the sum of all active setpoints.

Step	programming	Input	Signal
1	emergency-stop activated power off	U-supply	0 V
		Enable	0 V
2	supply on enable activated setpoint inputs at 0 V	U-supply	high
		Enable	high
		“Activation input”	0 V
3	The controller setpoint is internally set to the actual feedback value, independent of the externally applied setpoint. As a result, the control deviation is 0 V.		
4	The controller maintains the position and compensates for any drift.		
5	Activate normal operation; all setpoints are processed again.	U-supply	high
		Enable	high
		“Activation input”	high
5	The drive moves to the start position, which corresponds to the active setpoints. The selected digital and analog setpoints are used.		

Table 26: Safety function logic table

The definition of the “Activation input”

SW Version	Connector/Terminal	Activation input
V01.xx* V03.xx* V04.xx* V05.xx*	X2/1 (5) or X4/1 (13) depending on HW design	S1.01
V35.xx* V39.xx*	X4/2 (14)	S1.02

Table 27: Activation input depending on SW version and HW design

8.4 Output stages

- PWM output stages are used to reduce power losses at higher output currents and are designed for continuous currents up to 3.5 A.
- Linear output stages are used for lower output currents and are designed for continuous currents of 0.1 A each. Current outputs up to 0.2 A for less than 30 s are possible.
- The switching frequency is up to 50 kHz.
- The output stages are equipped with overdrive and fast de-energization to improve dynamic response.
- Parameter <E03> defines the nominal solenoid current. Various standard settings are available.
- Furthermore, a continuous (stepless) reduction is possible using parameter <E10> (not available in SW version V70.xx*).

8.5 Process control system; pressure control

Pressure sensors are typically designed using either two-wire or three-wire technology. The transducer signal can be provided as a voltage signal (0 … 10 V) or as a current signal (0 … 20 mA or 4 … 20 mA).

The pressure valves used (pressure relief valves or pressure limiting valves) are equipped with a solenoid. To activate the sensor, parameter <C1.09> must be set to 10, 11, or 12. In the case of current signals, parameter <E20> must first be set to 1.
This ensures correct processing of the sensor signal and prevents the controller output (<d1.13>) from becoming negative. Wire break monitoring is only available when using sensor type <C1.09> = 11 (4 … 20 mA).

When connecting the pressure transducer, special care is required. Proper zero-volt wiring, shielding, and PE (protective earth) connections are critical. Signal faults may trigger the wire break monitoring function or lead to instability in the control loop.

Accurate scaling of the actual value signal is essential for high-quality pressure control and ensures optimal use of the available resolution. The maximum pressure to be controlled is a key factor. The sensor’s measuring range should be as close as possible to the maximum control pressure and must be properly matched to the process pressure range.

In addition, particular attention must be paid to the actual value amplification setting. At maximum controlled pressure, monitor <d1.11> should display a value of 9.900.

When setting the zero point, pressure valves often do not allow adjustment to 0 bar due to their design..

The controller configuration is identical to that of other process controllers.

The dynamics of pressure control loops are largely determined by system characteristics (e.g. capacitance, valve type). Therefore, a factory preset is not possible.

If gain calculation is not feasible, the controller must be tuned by trial and error.

Avoid control loop instability during adjustment, as it may cause damage to the drive or the machine.

In some systems, proportional pressure valves may be unstable.

This behavior can significantly affect the control loop and, in certain cases, can be compensated using the dither function (<E13>, <E14>).

8.5.1 Remote loop control

To activate this function, set parameter <C1.00> to 2 or 4.

Initially, the amplifier operates in open-loop mode. The solenoid current is directly determined by the setpoint (e.g. resulting in a specific pressure when using pressure valves).

When the “Reset Ramp” input (18z) is activated, the amplifier enters standby mode and can switch to closed-loop operation.

The comparator monitors the feedback signal. If the feedback value exceeds the defined threshold, closed-loop control is activated.

When <C1.17> > 0.00, the output of the I-controller is initialized with the setpoint. This ensures a smooth transition from open-loop to closed-loop operation..

Even if the feedback value falls below the switching threshold, the control remains active. A “low” signal at the “Reset Ramp” input (18z) is required to deactivate the closed-loop function.

By setting the comparator thresholds (<C1.21> and <C1.22>) to 0, the “Reset Ramp” input can be used directly to activate the controller. This allows the control function to be triggered by external signals.

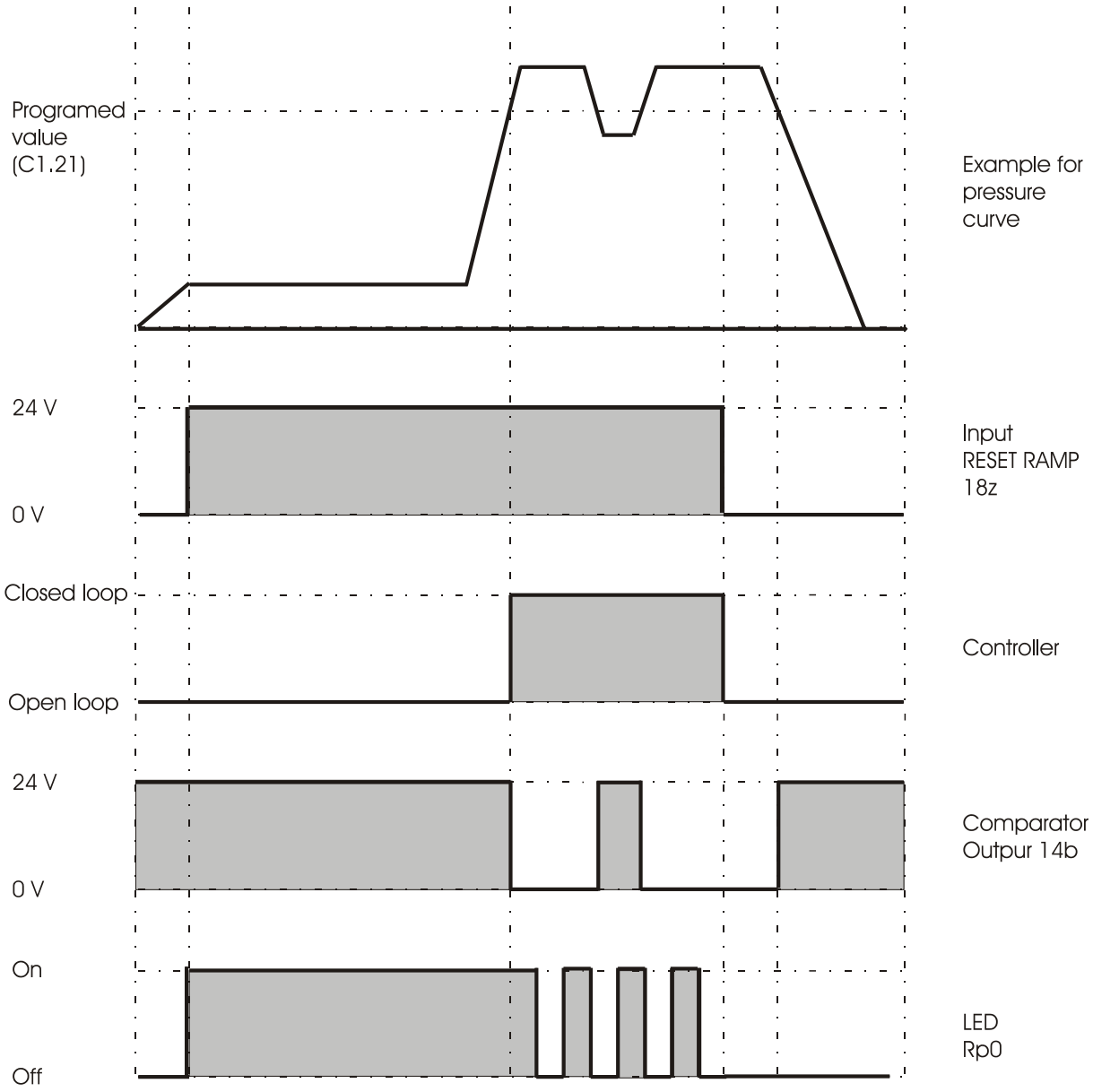
<C1.23> has no function when the “remote loop controller” is active. <C1.24> can be used to delay controller activation.

The status is indicated by the LED “RP0”.

Input reset ramp (18z)	actual value > or < switching threshold	Function	LED RP0
Low	<	Open-loop	off
High	<	Open-loop	on
High	>	Closed-loop	flashes

8.5.2 Functional diagram for remote loop control

Note: The comparator output is shown using positive logic (parameter <E18>



8.6 Control circuits with feedback signal adjustment

Closed-loop control can be enabled or disabled using parameter <C1.00>.

8.6.1 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 current output on stage “Solenoid-B”.

Selections 1 to 9 under <C1.09> apply to valves that use sensors with analog output signals such as voltage or current, or for applications that can generate negative signals as a feedback signal. With these choices, the controller output current can be output either through stage “Solenoid-B” or through stage “Solenoid-A”. Depending on whether the difference between the actual value and the setpoint is positive or negative.

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 analog adjustment using potentiometers are quite obvious.

Adjustment:

⚠ CAUTION

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

Step	Adjustment
1. Zero-point adjustment / general case	
1.1	place the output signal of the sensor in its zero position
1.2	set HCSTool monitor function to <d1.11>
1.3	save the inverted <d1.11< value in parameter <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 28: Feedback signal adjustment

To invert the actual value signal, use parameter <C1.12>. If necessary, invert the setpoint signal using <C1.05> to determine and correct the controller direction.

9 Inputs, outputs and messages

9.1 General

- The “Error / Comp” output is short-circuit protected.

9.2 Supply

The multi-color LED “STATUS” lights up green when the supply voltage is present.

9.3 Enable

- After the enable signal has been applied to terminal X3/1, the LED “STATUS” lights up yellow. If a time delay is set in parameter <E09>, the LED “STATUS” flashes yellow for the duration of the delay.
- Once the time delay has elapsed, the flashing signal becomes steady and the output stages are enabled.

9.4 Fault (error)

- The current in the output stages is monitored by the amplifier. If the total current exceeds a defined threshold, the output stages are automatically switched off. At the same time, the signal at the “Fault” output (terminal X3/2) is set to 0 V. The LED “STATUS” lights up red. This state remains until the cause of the fault has been corrected and the error has been reset by disabling and re-enabling the module.
- If the analog command input (S1.06) is used as a current input with wire break detection enabled, the input is also monitored for undercurrent. An error is triggered if the current falls below approx. 2 mA.
- The input is also protected against overload. If the signal current exceeds approx. 25 mA, the input is automatically disabled to protect the hardware. An error is also triggered and the corresponding error message is generated.
- Malfunction signals should not be reset by switching off the supply voltage, but by disabling the enable signal (after correcting the cause of the malfunction); otherwise, proper diagnosis is no longer possible.
- It is possible to continue parameterization of the module even if the malfunction is still present. This allows the cause of the error to be identified and corrected. Afterwards, the enable signal must be reset (deactivated and activated again).
- For the special function of the output as a comparator output, refer to:

See □ Chapter ”7.5.18 Comparator <C1.21> to <C1.25>", page 54

- All fault messages, as well as the status of the comparator, can be monitored using the HCSTool software.

9.5 Display and error messages

Defined error and status messages:

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

Table 29: Error list

10 Detailed electrical data

(For applications outside these parameters, please contact us!)

Feature	Range, characteristics
Power consumption	1.2 VA, solenoid not energized 41 VA, one sonenoid energized with 3,5 A 81 VA, both solenoids energized with 3,5 A
Solenoid output Iout PWM frequency Cycle time current controller	Rectangular voltage, pulse-modulated, with over-energization and quick de-energization Output stages are released on the hardware side by enable signal I_{max} = 4.5 A 22 kHz 45 µs
Analog input Voltage is selected Current is selected over current protection	U_{max} = + 28 V U_{min} = - 15 V Typ. R_{in} = 200 kΩ Differential Typ. R_{in} = 5 MΩ Input Fb1, Fb2 Typ. R_{in} = 255 Ω All inputs Typ. > 23 mA
Digital input Supply 10 V Supply 24 V Low level High level	U_{max} = + 28 V Typ. I_{in} = 0.5 mA Typ. I_{in} = 1.1 mA U_{in} < 2.6 V U_{in} > 9.2 V
Digital Output Supply 24 V Supply 12 V	Protected at I_{outmax} typ. 40 mA Typ. U_{out} > 18 V @I_{out} 2 mA Typ. U_{out} > 15 V @I_{out} 10 mA, Protected at Ioutmax typ. 20 mA Typ. U_{out} > 8 V @I_{out} 2 mA Typ. U_{out} > 5 V @I_{out} 10 mA
Analog output (option)	The analog output is released on the hardware side by the CPU - 10 V … + 10 V, tol. ± 0.020 V
Reference output (option)	+ 10 V, tol. ± 0.1 V - 10 V, tol. ± 0.1 V I_{outmax} < 10 mA

11 USB-C interface

11.1 Introduction

In industrial environments, reliable and safe data and power transmission are essential. USB Type-C, a versatile connector standard, is widely used due to its high data transfer rates and power delivery capabilities.
However, in harsh industrial applications, electronic systems are often exposed to electromagnetic interference (EMI), voltage transients, ground potential differences, and surge events. These conditions can lead to malfunction or permanent damage of electronic components.
Galvanic isolation is a key technology used to mitigate these risks. It electrically separates different parts of a system, preventing unintended current flow between them. This improves system robustness, enhances safety, and protects sensitive electronics from damage.

⚠ WARNING

The DMA's USB port is not galvanically isolated.
For protection, the use of a USB isolator (adapter) is strongly recommended.

11.2 Importance of Galvanic Isolation

Galvanic isolation is a technique used to prevent direct electrical current flow between different parts of a system. It protects equipment and personnel from electric shock, reduces the risk of damage caused by voltage transients and surge events, and minimizes interference from ground loops and electromagnetic noise. In industrial environments, where power lines and machinery can introduce significant electrical interference, galvanic isolation ensures reliable and accurate data transmission.

Applications in Industrial Environments

In industrial applications, **USB Type-C** ports are commonly used to connect devices such as sensors, controllers, and computers. By incorporating galvanic isolation, these systems can achieve the following benefits:

- **Protection against surges:** Industrial environments are prone to voltage transients and surge events that can damage sensitive electronics. Galvanic isolation protects USB-connected devices from these effects.
- **Noise reduction:** Industrial machinery and long cable runs can introduce electromagnetic interference (EMI). Galvanically isolated USB connections help maintain signal integrity.
- **Enhanced safety:** Galvanic isolation prevents direct electrical coupling between high-voltage and low-voltage circuits, reducing the risk of electric shock.

The **HCS GmbH Galvanically Isolated USB Adapter** is designed for industrial applications requiring reliable data transfer between devices with different ground potentials. The adapter provides galvanic isolation up to **1.5 kV**, protecting both the host and connected devices from voltage transients, ground loops, and noise interference.

Ordering Information

The HCS GmbH *Galvanically Isolated USB Adapter* can be ordered directly from HCS GmbH or through authorized distributors. For bulk orders or technical inquiries, please contact the HCS GmbH sales team.

Key Features USB Adapter:

- **Isolation voltage:** 1.5 kV RMS
- **Data transfer rate:** Supports USB 2.0 with data rates up to 480 Mbit/s
- **Compatibility:** Compatible with USB 1.1 and USB 2.0 devices
- **Power supply:** Bus-powered; no external power supply required
- **Connectors:** USB Type-A (male) to USB Type-A (female)
- **Operating temperature:** –20 °C to +70 °C
- **Housing:** Robust, industrial-grade enclosure
- **Application:** Suitable for industrial control systems

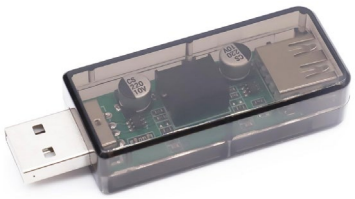


Figure 22 : Galvanically Isolated USB Adapter

11.3 General

Remote operation and parameter adjustment can be performed via the USB Type-C interface.
Using the **HCSTool** software, all parameters can be configured. The software supports editing, downloading, and uploading of individual parameters as well as parameter sets, and provides a wide range of additional functions.
The parameters of the amplifier card can also be accessed and modified by a higher-level control system (e.g. PLC) via a defined communication protocol. This allows seamless integration of the amplifier card into automated machine processes.
For further information about the **HCSTool** software and the communication protocol, please contact the manufacturer.

⚠ CAUTION

Any parameter changes via the USB Type-C interface should only be performed by trained personnel. If possible, the drive should be stopped before making parameter changes. Deactivation of the enable signal is recommended.

11.4 Physical interface data

The connection cable must meet the following requirements:

- USB Type-C connector on the DAC-4x(A) side
- The connector on the PC side must be selected according to the interface available (USB Type-A, USB Type-B, or USB Type-C).

11.5 Downloading HCSTool

Please follow the link below to download the latest version of **HCSTool** free of charge.:

http://www.h-c-s-gmbh.de/en/download

11.6 Using HCSTool

Figure 23 : HCSTool start screen

After starting **HCSTool**, the software can be operated either in offline mode (without a connected device) or in online mode with a connected card.

After connecting the card via the USB Type-C interface, it is recommended to select the “Upload parameters from device” function to establish communication between **HCSTool** and the unit. In this case, the software version and the device version are detected automatically.

Example of HCSTool main screen (DMA-22(A)-03 with software version V71.01 connected).

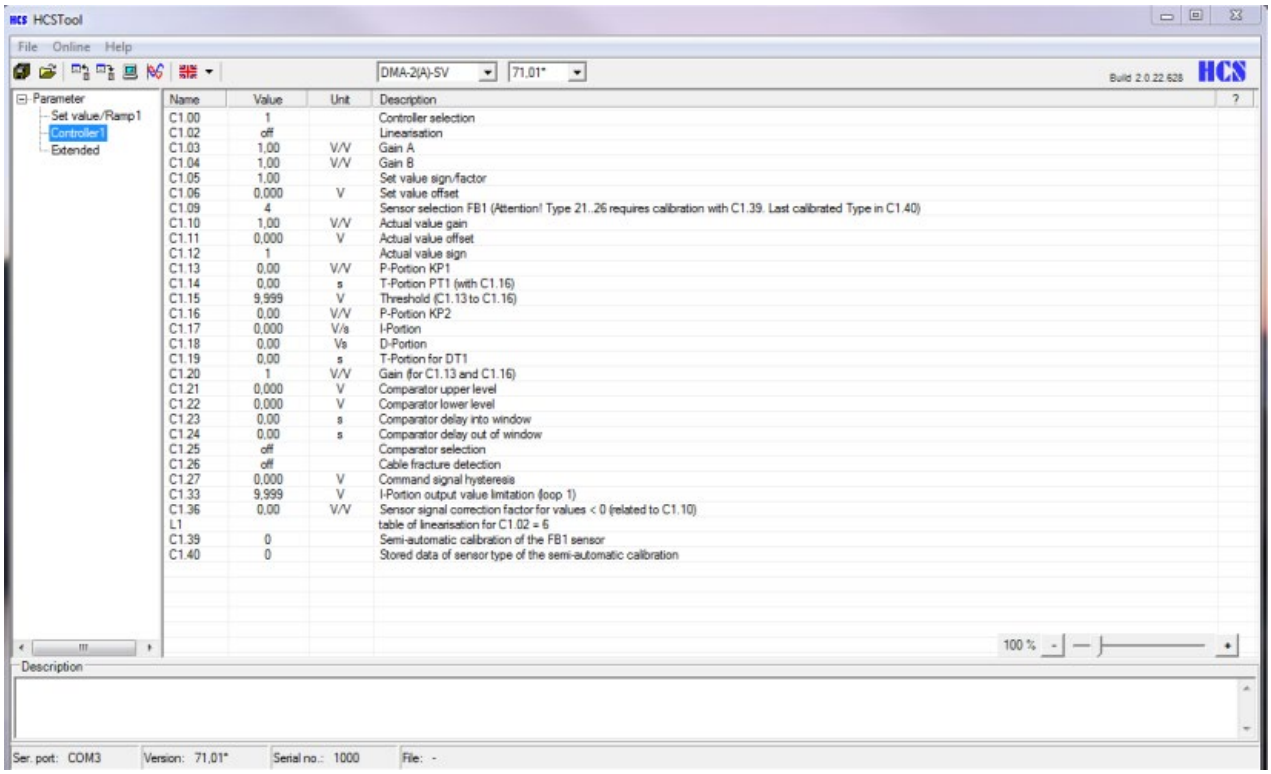


Figure 24 : HCSTool working area screen

Each parameter can be edited individually and either written directly to the device by selecting “Download”, or modified locally in the PC parameter list by selecting “OK”.

In the latter case, the modified parameter is highlighted. All pending changes can then be downloaded to the device in a single step.

Example for editing parameter <C1.05>:

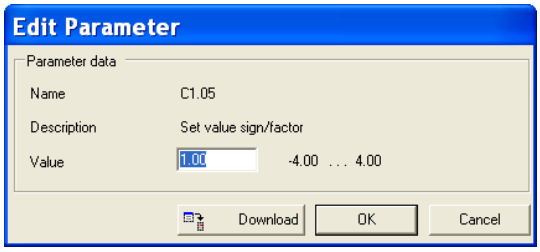


Figure 25 : HCSTool Parameter editing

To obtain information about internal values, the display parameters can be used. For this purpose, the “Monitor” function must be activated (“Monitoring internal values”).

The monitor also displays error codes and the status of digital inputs.

For further information about **HCSTool**, please contact the manufacturer or one of our distributors or partners.

12 Complete parameter list

		Mode
1	Available parameters for SW version V07.xx*,	01
2	Available parameters for SW version V06.xx*,	02
3	Available parameters for SW version V01.xx*, V03.xx*, V04.xx*, V05.xx*, V35.xx*	03, 04, 05
4	Only available parameters with analog output on board SW V01.xx*, V04.xx*, V39.xx*	03, 04, 05, 10
5	Only available parameters for PROFINET, PROFIBUS, Ethernet/IP, CANopen versions	all

Display-Parameters:						
#	v	Function	Unit	Step	Min	Max.
d1.01		Analog setpoint (S1.06)	V	0.001	-9.999	+9.999
d1.02		Sum of all post ramp setpoints	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 to Servo valve	---	0.001	-9.999	+9.999
d1.07		Servo current	A	0.001	-1.000	+1.000
d1.09		Normalized servo current	V	0.001	-9.999	+9.999
d1.10		Desired value (w)	V	0.001	-9.999	+9.999
d1.11	3	Actual value, feedback value (x)	V	0.001	-9.999	+9.999
d1.12	3	Lag error (e)	V	0.001	-9.999	+9.999
d1.13	3	Controller output (y)	V	0.001	-9.999	+9.999

d2.01	2	Analog setpoint (S1.05)	V	0.001	-9.999	+9.999
d2.02	2	Sum of all post ramp setpoints	V	0.001	-9.999	+9.999
d2.03	2	Set values after linearization	V	0.001	-9.999	+9.999
d2.04	2	Value after gain adjustment.	V	0.001	-9.999	+9.999
d2.10	2	Desired value (w)	V	0.001	-9.999	+9.999

Set value parameters: Digital setpoints						
#	v	Function	Unit	Step	Min	Max.
S1.01		Internal setpoint 1	V	0.001	-9.999	+9.999
		Internal setpoint 2 3	V	0.001	-9.999	+9.999
S1.03	1	Internal setpoint 3	V	0.001	-9.999	+9.999
S1.04	1	Internal setpoint 4	V	0.001	-9.999	+9.999

Ramp parameters for setpoints						
#	v	Function	Unit	Step	Min	Max.
r1.01		Ramp from 0 ⇒ -	S	0.01	0.000	39.50
r1.02		Ramp from – ⇒ 0	S	0.01	0.000	39.50
r1.03		Ramp from 0 ⇒ +	S	0.01	0.000	39.50
r1.04		Ramp from + ⇒ 0	S	0.01	0.000	39.50

Set value parameters: Digital setpoints						
#	v	Function	Unit	Step	Min	Max.
S2.01	2	Internal setpoint 1	V	0.001	-9.999	+9.999

Ramp parameters for setpoints						
#	v	Function	Unit	Step	Min	Max.
r1.03	2	Ramp from 0 ⇒ +	S	0.01	0.000	39.50
r1.04	2	Ramp from + ⇒ 0	S	0.01	0.000	39.50

Controller parameters:							
#	v	Function	Unit	Step	Min	Max.	Code
C1.00	3	Controller selection	---	1	0	4	0 = off 1 = P-PT$_1$-I-DT$_1$ 2 =Remote 3 =dff 4 =Remote + dff
C1.01	3	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	0.01	0.00	2.00	---
C1.04		Gain B	V/V	0.01	0.00	2.00	---
C1.05		Set value sign and factor	---	0.01	-4.00	4.00	---
C1.06		Set value offset	V	0.001	-9.999	+9.999	---
		Spool overlap compensation negative	V	0.001	0.000	+9.999	9.999 V = max. current depending on current selection E03
C1.08	3	Spool overlap compensation positive	V	0.001	0.000	+9.999	
C1.09	3	Sensor type *1 *1, Attention: No negative controller output possible when 10, 11,12, 23, or 26 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, only pos. 11= 4 ... 20 mA, only pos. 12 = 0 ... 10 V, only pos. 14 = 5V ± 3.0 V 21 = Bipolar voltage 22 = Unipolar voltage 23 = Unipolar voltage, only pos. 24 = Bipolar current 25 = Unipolar current 26 = Unipolar current, only pos 28 = 5 V ± 2.6 V
C1.10	3	Actual value gain	V/V	0.01	0.00	4.00	---
C1.11	3	Actual value offset	V	0.001	-9.999	+9.999	---
C1.12	3	Actual value sign	---	---	- 1	+ 1	- 1 = negative, off = off, + 1 = positive
C1.13	3	P-Portion K_{P1}	V/V	0.01	0.00	4.00	---
C1.14	3	T-Portion for PT1 (to C1.16)	S	0.001	0.000	10.00	---
C1.15	3	Threshold (C1.13, C1.16)	V	0.001	0.000	+9.999	---
C1.16	3	P-Portion K_{P2}	V/V	0.001	0.000	4.00	---
C1.17	3	I-Portion	V/s	0.001	0.000	4.00	---
C1.18	3	D-Portion	Vs	0.001	0.000	4.00	---
C1.19	3	T-Portion for DT1	S	0.001	0.000	10.00	---
C1.20	3	Gain (C1.13 and C1.16)	V/V	1	1	32	---
C1.21	3	Comparator upper level	V	0.001	-9.999	+9.999	---
C1.22	3	Comparator lower level	V	0.001	-9.999	+9.999	---
C1.23	3	Comparator delay into window	S	0.001	0.000	+99.99	---
C1.24	3	Comparator delay out of window	S	0.001	0.000	+99.99	---
C1.25	3	Comparator selection	---	1	0	3	off = off, 1 = Set value 2 = Actual value, 3 = Lag error
C1.26	3	Cable fracture detection feedback	---	---	off	1	off = off; 1 = active
C1.27		Command signal hysteresis	V	0.001	-9.999	+9.999	---
C1.33	3	I-Portion output value limitation	V	0.001	0.000	+9.999	---
C1.36	3	Sensor signal correction factor for values < 0 (related to C1.10)	V/V	0.01	-1.00	+1.00	

Controller parameters:							
C1.37	3	Additional spool overlap compensation negative	V	0.001	0.000	+9.999	
C1.38	3	Additional spool overlap compensation positive	V	0.001	0.000	+9.999	
C1.39	3	Sensor semi automatic calibration	---	---	---	---	Start the calibration
C1.40	3	Last calibration sensor	---	---	---	---	Last stored sensor
L1		Table for linearization	---	---	---	---	Adjustment of 8 individual points

Extended-Parameters: Basic adjustments							
#		Function	Unit	Step	Min	Max.	Code
E00	1	Operation mode	---	---	1	1	1 = Mode 1 → open-loop
E00	3	Operation mode	---	---	3	4	3 = Mode 3 → valve spool position feedback 4 = Mode 4 → process position feedback
E00	3	Operation mode	---	---	4	5	4 = Mode 4 → process position feedback 5 = Mode 5 → HPR valve spool position feedback
E01	4	Analog Output	---	1	Off	11	Off = off Mode1: 1..11 = d1.01..d1.11 Mode3,4: 1..13 = d1.01..d1.13
E02		Push-Pull function	---	---	Off	5	off = Push-Pull function off 1 = Push-Pull function active 4 = Push-Pull function off with detection 5 = Push-Pull function active, w. detect.
E03			---	---	0.80	3.500	1 = 0.8 A 2 = 1.1 A 3 = 1.3 A 4 = 1.6 A 5 = 2.4 A 6 = 2.7 A 7 = 3.5 A
E1.03 E2.03	2	Servo valve selection SW Version V71.xx*, V72.xx*, V74.xx*	---	---	0.80	3.500	1 = 0.8 A 2 = 1.1 A 3 = 1.3 A 4 = 1.6 A 5 = 2.4 A 6 = 2.7 A 7 = 3.5 A
E04		P-Portion current contr. energization	---	1	0000	9999	---
E1.04 E2.04	2	P-Portion current contr. energization	---	1	0000	9999	---
E05		I-Portion current contr. Energization	---	1	0000	9999	---
E1.05 E2.05	2	I-Portion current contr. Energization	---	1	0000	9999	---
E06		P-Portion current controller de-energization	---	1	0000	9999	---
E1.06 E2.06	2	P-Portion current controller de-energization	---	1	0000	9999	---
E07		I-Portion current contr. de- energization	---	1	0000	9999	---
E1.07 E2.07	2	I-Portion current contr. de- energization	---	1	0000	9999	---
E08		Ramp selection	---	1	0	2	0 = digital setpoints (time constant) 1 = all setpoints (rise constant.) 2 = selectable ramp function
E09		Time delay enable signal	s	0.001	0.000	+9.999	---
E10		Solenoid current adaptation	---	0.001	0.050	01.10	Variable adjustment of max. current
E1.10 E2.10	2	Solenoid current adaptation	---	0.001	0.050	01.10	Variable adjustment of max. current
E11		Initial current A solenoid	V	0.001	0.000	+9.999	3.000 V = 30 % of max. rated current
E12		Initial current B solenoid	V	0.001	0.000	+9.999	3.000 V = 30 % of max. rated current
E13		Dither Amplitude	V	0.001	0.000	+3.000	3.000 V = 30 % of max. rated current

Extended-Parameters: Basic adjustments							
E1.13 E2.13	2	Dither Amplitude	V	0.001	0.000	+3.000	3.000 V = 30 % of max. rated current
E14		Dither Frequency	Hz	1	1	300	---
E1.14 E2.14	2	Dither Frequency	Hz	1	1	300	---
E15		Selection setpoint 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 ± 4.5V with signal observation 6 = 0 ... 20 mA w/o cable fracture detection 7 = 10 ± 10 mA w/o cable fracture detection 8 = 4 ... 20 mA w/o cable fracture detection 9 = 4 ... 20 mA with cable fracture detection 10 = 12 ± 8 mA w/o cable fracture detection 11 = 12 ± 8 mA with cable fracture detection
E16	2	Selection setpoint input S1.05	---	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 ± 4.5V with signal observation 6 = 0 ... 20 mA w/o cable fracture detection 7 = 10 ± 10 mA w/o cable fracture detection 8 = 4 ... 20 mA w/o cable fracture detection 9 = 4 ... 20 mA with cable fracture detection 10 = 12 ± 8 mA w/o cable fracture detection 11 = 12 ± 8 mA with cable fracture detection
E17		Set value activation mode	---	1	off, 1	3	off = 2 digital, 1 Analog active 2 = only 2 digitals active
E18	2	Error / Comparator output selection	---	1	off, 1	2	off = only “error” signal relevant 1 = comparator positive logic 2 = comparator negative logic
E19	4	Output factor for the analog voltage output	---	0.01	-2.00	+2.00	---
E22	5	BUS slave address	---	1	Off	12	For more information see the separate documentation
E23	5	BUS timeout	s	0.001	0.000f	9.999	
E26	5	BUS timeout error handling	---	1	Off	1	
E33	4	Offset for analog voltage output	V	0.001	-9.999	+9.999	---

Table 30: Parameter list

13 Declaration of Conformity

This declaration is issued under the sole responsibility of the manufacturer.

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 below complies with the relevant requirements of the above-mentioned Directive, both in its design and in the version placed on the market by us.
This declaration shall become void if the product is modified without our prior written consent.

Product:	Digital Amplifier and Controller Module
Intended use	Automation systems (industrial applications)
Model:	**DMA-22(A)-x**
Rated voltage:	24 V DC (SELV / PELV
Rated power:	max. 100 VA
Protection class:	III
Protection degree:	IP00 (IP20 on request)
Relevant EU Directive:	EMC Directive 2014/30/EU

Applicable Harmonized Standards:

Emissions:	EN 61000-6-4:2007 + A1: 2011; EN 61000-6-3:2007 + A1: 2011
Immunity:	EN 61000-6-2: 2019

Date/manufacturers signature

01.01.2026
Details of signatory: Dipl.-Ing. (FH) Peter Deuschle (General Manager)

Figure 26 : Declaration of conformity

- End -