Manual for
DAC-4x(A)

DIGITAL AMPLIFIER AND CONTROLLER CARD FOR ALL KIND OF PROPORTIONAL VALVES

	Model Code	SW Version	Remarks
Applicable for SW Versions:	DAC-4x(A)-xx-x-Sxx Operation Mode: 01, 02, 03, 04, 06, 08, 10, 11	**V 01.xx**	xx = 01 or higher * = a, b, …. x = additional options
	DAC-4x(A)-01-x-SXLT Operation Mode: 01	**V 04.xx**	

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Revision History

Revision	Date	Author	Description
00	31.03.2023	Deu	First finalized release,
00	10.10.2023	Bm	Format of heading 3 changed, technical data updated
00	06.11.2023	Bm	Description errors corrected
00	22.11.2023	Bm	Minor corrections
1.0	15.01.2024	Bm	Model code update
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1.1	16.08.2024	Bm	The document has been reorganized in certain sections.
1.1	03.12.2024	Bm	Doppelten Punkt entfernt
1.2	29.07.2025	Deu	Error correction chapter 6.7.14
1.3	01.03.2026	Deu	Thoroughly revised and edited

Table of Contents

1 Abbreviations

Abbreviation	Description
DAC	**D**igital **A**mplifier and **C**ontroller
EMC	**E**lectro **M**agnetic **C**ompatibility; properties of the unit in order to comply with the EMC directive
USB	**U**niversal **S**erial **B**us; interface for communication between a PC and the DAC-4x(A)
PC	**P**ersonal **C**omputer
µC	**Mi**cro **C**ontroller; CPU used inside the unit 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 Card	Amplifier for 19" rack system in Eurocard format
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 DAC-4x(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 "DAC-4x(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 amplifier and controller cards "DAC-4x(A)-x" with software for proportional valve control, excluding bus versions. The DAC-4x(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 DAC-4x(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!

Identifiers 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
«ER»	LEDs of the amplifier (for example, «ER»
< >	parameter name
[xx]	Pin number of the rear connector
"…"	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 “8d”) 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 [14d]) 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 cards “DAC-4x(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 DAC-4x(A)-x are ensured.

3.6 Non-intended product use

The digital amplifier modules “DAC-4x(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 17

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)

https://www.h-c-s-gmbh.de/en/sales-partners

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 card 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 card DAC-4x(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 DAC-4x(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 card DAC-4x(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/Q control
  - Pump control
  - Pressure control
  - Control of pilot and main stages
- Cascade control of system components.

4 Product overview and description

4.1 Technical features

The DAC-4x(A) system features include:

- One differential command input (setpoint), selectable as voltage (±10 V) or current (0/4 … 20 mA), resolution 16-bit
- Two single-ended command inputs, selectable as voltage (±10 V) or current (0/4 … 20 mA), resolution 16-bit
- Two single-ended feedback inputs for voltage and current signals, with wide adjustment range, resolution 16-bit
- Optional LVDT inputs (1 or 2 channels) via extension board; details available on request
- Optional SSI input for sensors and encoders; details available on request
- Integrated reference voltage supply of ±10 V (max. 10 mA) for setpoint potentiometers or feedback transducers
- Four (optionally five) selectable digital setpoints
- Direction control via external “+” and “−” inputs
- Enable input for activation of the output stages
- Reset ramp input for fast ramp function reset
- Status outputs for “Error” and “Comparator”
- All digital inputs and outputs are optically isolated for enhanced functional safety
- Front panel with four-digit 7-segment display and six operating keys for parameterization and operation
- Status indication via front panel LEDs
- Additional switching output (24 V, max. 1 A) for direct control of safety valves
- Analog outputs (±10 V, 12-bit resolution) for control, monitoring, or interfacing with downstream devices; optionally configurable as current output (4 … 20 mA)
- Front panel test jacks (2 mm) for commissioning and diagnostics:
  setpoint (SET), feedback 1 (FB1), solenoid currents (A, B), and monitor output (MON) for internal signals
  (±10 V, 12-bit resolution)
- USB interface with USB-C connector
- Optional RS232 interface (alternative to USB-C)
- Optional fieldbus interfaces: PROFIBUS, PROFINET, EtherNet/IP, CANopen

4.2 *Technical data*

4.2.1 General technical data

Feature	Range, characteristics
Supply voltage and Control voltage for digital inputs	12 V DC - 10 % … 24 V DC + 20 %; residual ripple < 10 % (max. 50 VA power draw)
Solenoid system selection	0.8 A; 1.1 A; 1.3 A; 1.6 A; 2.4 A; 2.7 A and 3.5 A (intermediate values adjustable) For Servo valves: 8 mA up to 550 mA in various increments
Ambiant operating temperature	- 40 °C to + 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 when installed in 19" rack system
Connector	In accordance with DIN 41612, 48 pol form F gold plated
EMC	In accordance with the applicable industrial standards (CE - conformity) *3
Dimensions front panel / PCB	50,5 x 128,4 mm; 10TE / 3 HE; 100 x 160 mm euro format
Analogue set values inputs	3 inputs with 16 Bit resolution (1 x differential; 2 x single ended; 0 … +-10 V, 0/4 … 20 mA)
Analogue feedback U/I	2 inputs with 16 Bit resolution (current and voltage with wide range of adjustability)
Analogue feedback LVDT *2	1 or 2 inputs with optional extension board; detailled information on request
Digital inputs	8 inputs (S1.01 … S1.04, ENABLE, RAMP 0, DIRECTION +, DIRECTION -)
Solenoid current (output)	2 PWM output stages, each for up to 3,5 A (with over-energ. and quick de-energization)
Analogue output	1 output with 12 Bit resolution, 0 … +-10 V or 4 ... 20 mA (selectable)
Monitor output	1 output with 12 Bit resolution, 0 … +-10 V
Digital outputs	2 outputs, voltage level 0 V / 24 V, 10 mA (ERROR, COMPARATOR)
Test jacks at front *2	Current A and B, sensor 1 (Fb1) set value (S1.06), Monitor and GND
Auxiliary reference voltage	+- 10 V, max. output 10 mA
Optional digital I/O signals	3 for variable usage, voltage level 24 V or 5 V
Interface 1	USB-C or (optional) RS232, 9-pol SUB-D-conncetor at face plate
Optional interface 2 *2	PROFIBUS DP; PROFINET; EtherNet/IP, other bus interfaces on request
Optional sensor interface *2	SSI encoder interface RS422. 16 .. 30 data bits, cable length 1 .. 400 m. auto baud rate
Display and keypad *2	4-digit 7-segment display, 6 keys, status LED's
PWM frequency	22.2 kHz - independant from dither frequency (customer specific frequencies available)
Cycle times	Closed loop 1 and 2: 0.1 msec

*1: on request *2: limited to some versions *3: details on request

Table 4: General Technical Data

Detailed electrical information:

See □ Chapter "9 Detailed electrical data“, page 81

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

4.2.3 Block diagram hardware

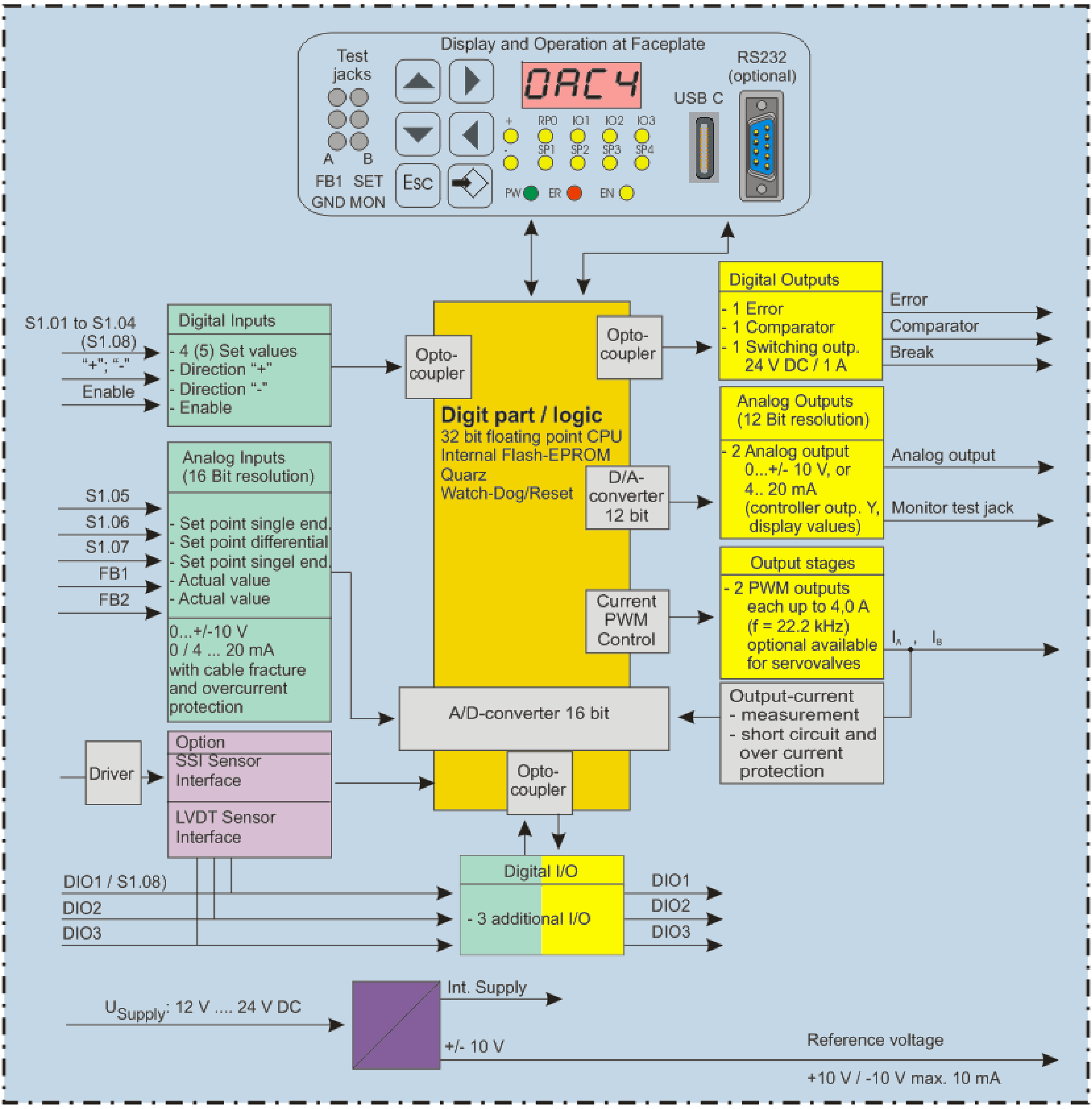


Figure 1 : Block Diagram Hardware

4.3 Model code

D A C - 4 4(A) - 0 1 - 2 7 0 - PN - S 0

Digital
Amplifier
Controller

Version
42 = version w/o keypad and display *1
44 = version with keypad and display
(A) = new advance version

Operation Mode / Version
01 = 1 valve, open loop, 2 solenoids
02 = 2 valves, open loop, 1 solenoid each
03 = 1 valve, spool pos. feedback, 2 solenoids
04 = 1 valve, process value feedback, 2 solenoids
06 = 1 valve, 1 spool + 1 process value, feedback, 2 solen.
07= 2 valves, spool pos. feedback each, 1 solenoid each
08 = 2 valves, 1 process value feedback each, 1 solen. each
10 = 1 process value feedback w/o valve
11 = 2 cascaded process feedbacks w/o valve
05 / 09 = reserved

Solenoid Systems Standand High Current Versions
080 = 800 mA; 110 = 1100 mA; 130 = 1300 mA;
160 = 1600 mA; 240 = 2400 mA; 270 = 2700 mA;
350 = 3500 mA
Solenoid Systems Special Low Current Servo Valve Versions
1) S7110: 0030 = 30; 0040 = 40; 0060 = 60; 0080 = 80; 0100 = 100;
0160 = 160; 0200 = 200 mA
2) S7216: 0120 = 120; 0150 = 150; 0200 = 200; 0300 = 300;
0400 = 400; 0500 = 500; 0550 = 550 mA
3) S7310: 0040 = 40; 0050 = 50; 0080 = 80; 0150 = 150 mA
4) S7410: 0008 = 8; 0010 = 10; 0015 = 15; 0020 = 20; 0030 = 30;
0040 = 40 mA

(Optional) Bus Interfaces *2
PBDP = PROFIBUS DP; PN = PROFINET
EIP = ETHERNET/IP; CO = CANopen

Special Options
_XLT = version for open loop applications only
S0 = no special options (does not have to be specified)
SRS232 = RS232 interface instead of USB-C
USB-C currently not available on DAC-42-x
SCC = Conformal Coating applied as protection against humidity
S7116 = servo valve version: 120 mA up to 550 mA
S7216 = servo valve version: 30 mA up to 200 mA
S7310 = servo valve version: 40 mA up to max 150 mA
S7410 = servo valve version: 8 mA up to max 40 mA
SLVDT-1X-3W = One feedback system with 3 wire-LVDT sensor (direct AC signal)
SLVDT-1X-4W = One feedback system with 4 wire-LVDT sensor (direct AC signal)
SLVDT-2X-3W = Two feedback systems with 3 wire-LVDT sensors (direct AC signal)
SLVDT-2X-4W = Two feedback systems with 4 wire-LVDT sensors (direct AC signal)
SSSI = SSI sensor interface

Combinations possible! Other on request
*1: --> only available with RS232 interface!
*2: --> only available without faceplate and keypad and no XLT versions

Figure 2 : Model code

Remark: Servo valve versions are covered in a separate manual

5 Installation

5.1 Mounting

- Compare the card type (refer to the label on the rear connector) with the parts list and wiring diagram.
- The amplifier card can generally be mounted in any orientation. However, a vertical mounting position is recommended to ensure optimal convection cooling. This orientation also facilitates parameter adjustment and monitoring via the keypad and display (applicable to DAC-44(A) versions only).
- The amplifier card should be installed in a shielded environment (e.g. a control cabinet).
- The amplifier card must be mounted in a 19" rack system in accordance with applicable standards (EIA 310-D, IEC 60297, DIN 41494 SC48D).
- Alternatively, the card can be installed in a suitable card holder.
-

Card holder (HCS article number: 5 741 010 00)

Figure 3 : Card holder and universal rack (not to scale!)

Dimensions Eurocard for 19” rack mounting:

For 3 HE: 100 mm × 160 mm, connector on small side
Faceplate dimensions DAC-4x(A): 3 HE x 10 TE (= 128,4 x 50,5 mm)

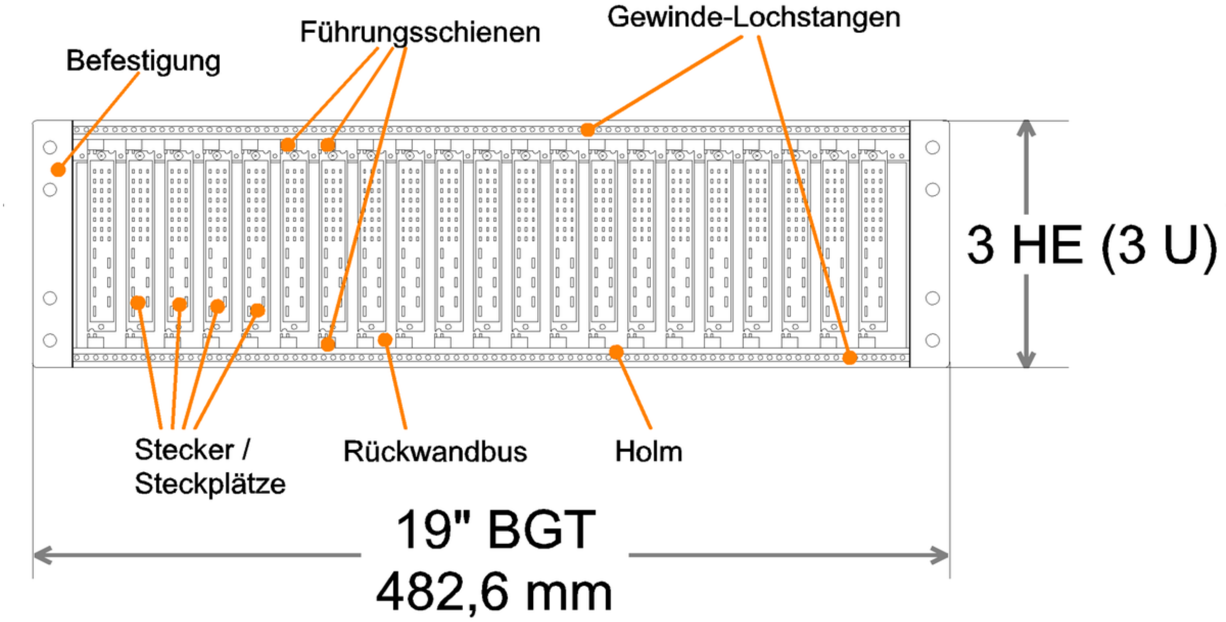


Figure 4 : General example for 19” Rack systems 3 HE

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 card should be protected by a fast-acting fuse.

Terminal	Specification
[32bd]	+UB is 12 V DC - 10 % … 24 V DC + 20 %; residual ripple < 10 %. (at supply voltage down to 12 V DC some limitations may be applicable).
[26bd]	0 V

Table 6: External supply

The solenoids are connected to terminals [22bdz] and [28bdz] for solenoid A, and to terminals [24bdz] and [30bdz] for solenoid B.

The terminals [bdz] are internally bridged on the amplifier card. For optimal load distribution, it is recommended to use all available terminals.

If electrical isolation of the logic inputs and outputs is not required, terminal [26bd] may be bridged to terminal [2d], and terminal [32z] to terminal [32bd].

Terminal [18d] serves as the ground (GND) for digital signals.

5.2.2 The DAC-4x(A) is powered via the USB connection.

⚠ WARNING

The DAC USB port is not electrically isolated.
For protection, the use of an isolation adapter is strongly recommended.
For more information: See □ Chapter "10.2 Importance of Galvanic Isolation", page 82

This is only possible if a USB connector is available on the hardware side.

- The green power LED lights up.
- Complete parameterization can be performed using HCSTool. Parameter sets can be uploaded to the amplifier card.
- The sensor inputs FB1 and FB2 can be configured and tested when a voltage signal is selected. For current input signals, the enable signal must be active to activate the internal shunt resistor.
- The DAC-4x(A) cannot be enabled without an external power supply.
- The solenoid current outputs remain inactive.
- The “Error”, “Comparator”, and “Break” outputs are not powered.
- The reference voltage output (±10 V) is active.

When replacing amplifier cards of type VRD350 or VRD355, note that the protective earth (PE) connection was previously assigned to terminal [18bd].

If PE is still connected to this terminal, it must be disconnected.

5.2.3 Wires and preparation

Connection wires must comply with the following specifications::

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

Table 7: Wires recommendation

⚠ 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).

5.2.4 EMC

Devices of the DAC-4x(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

5.2.5 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:

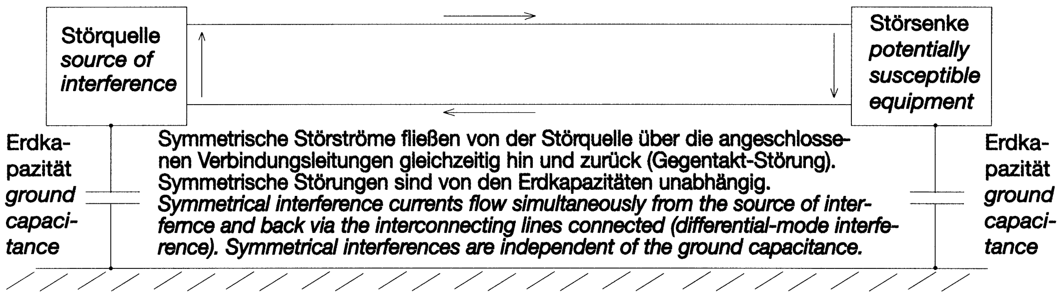
- The most important types of interference and their mitigation
- Design of EMC-compliant control cabinets and systems

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

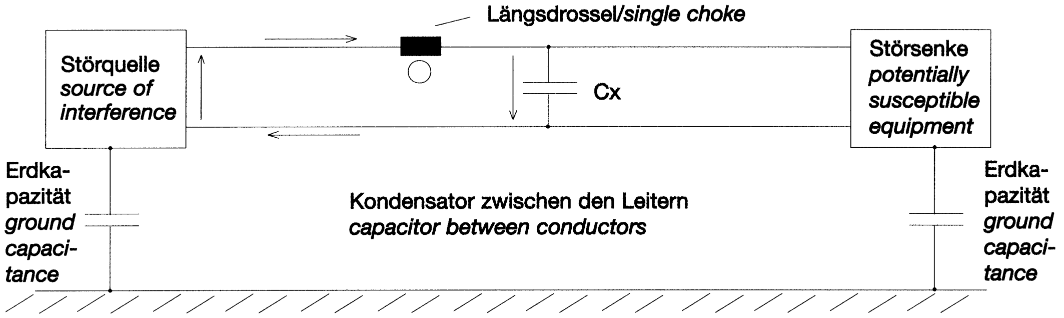
Die wichtigsten Arten von Störungen und Abhilfen:
The most important types of interference and remedies:

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 5 : EMC – interferences and remedies

EMC adequate design of switchgear cabinets and facilities

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

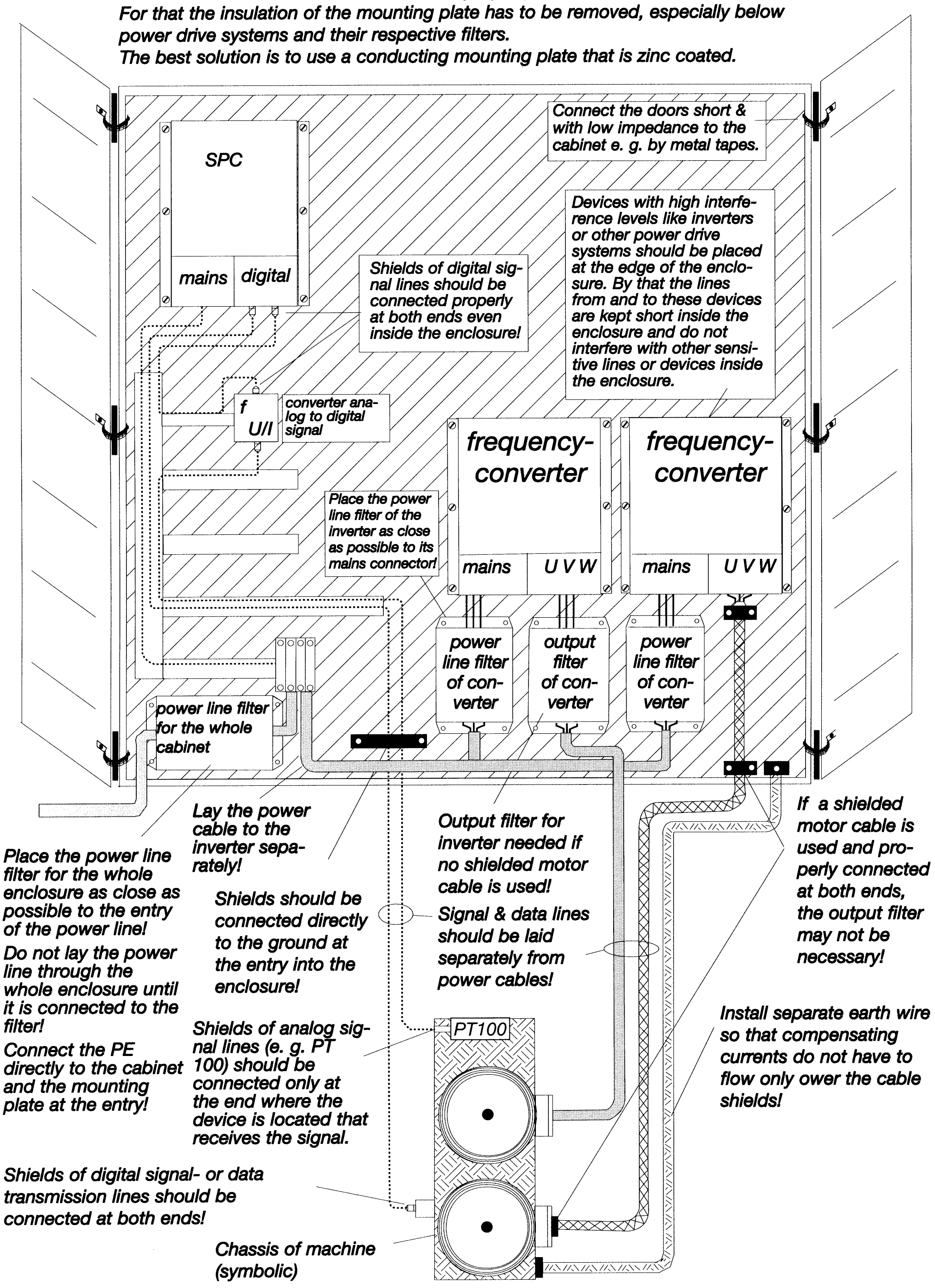


Figure 6 : EMC – adequate design of switchgear cabinets and facilities

5.3 Terminal assignment X13 (back connector)

Pin	d	b	z
2	0 V (External)	DIO 1 or S1.08	- Sign (direction) digital setpoints
4	Digital setpoint 2 (S1.02)	DIO 2	+ Sign (direction) digital setpoints
6	Digital setpoint 3 (S1.03)	DIO 3	Digital setpoint 4 (S1.04)
8	ENABLE (DI 1)	Analog input 1 (Option)	Digital setpoint 1 (S1.01)
10	Sensor 1 (FB 1) U_E, I_E	Analog output	n/c
12	Analog setpoint 6 U_{E+} (S1.06)	n/c	Analog setpoint 5 U_{E+} (S1.05)
14	ERROR (DO 1)	COMPARATOR (DO 2)	Sensor 2 (FB 2) U_E
16	Analog setpoint 6 U_{E-} (S1.06)	Analog input 2 (Option)	Analog setpoint 7 I_E (S1.07)
18	Digital GND	PE	Reset Ramp (DI 2)
20	Reference output - 10.0 V	Break output 24 V / 1 A	Reference output + 10.0V
22	Solenoid output A -	Solenoid output A -	Solenoid output A -
24	Solenoid output B -	Solenoid output B -	Solenoid output B -
26	0 V (Power)	0 V (Power)	Analog GND
28	Solenoid output A +	Solenoid output A +	Solenoid output A +
30	Solenoid output B +	Solenoid output B +	Solenoid output B +
32	+ 24 V (Power)	+ 24 V (Power)	24 V (External)

Table 8: Terminal assignment

5.4 Picture of rear connector

Connector: IEC 60603-2 form F 48 pins

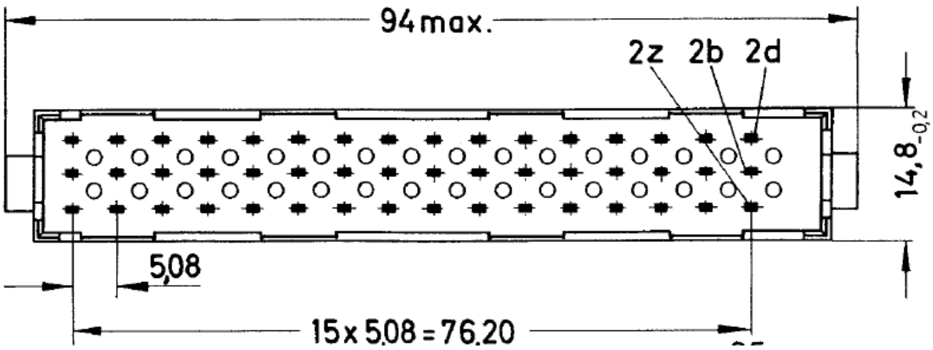


Figure 7 : Connector F48

5.5 *Wiring diagrams for all operation modes*

5.5.1 Operation mode 01

1 valve with 2 solenoids, open loop

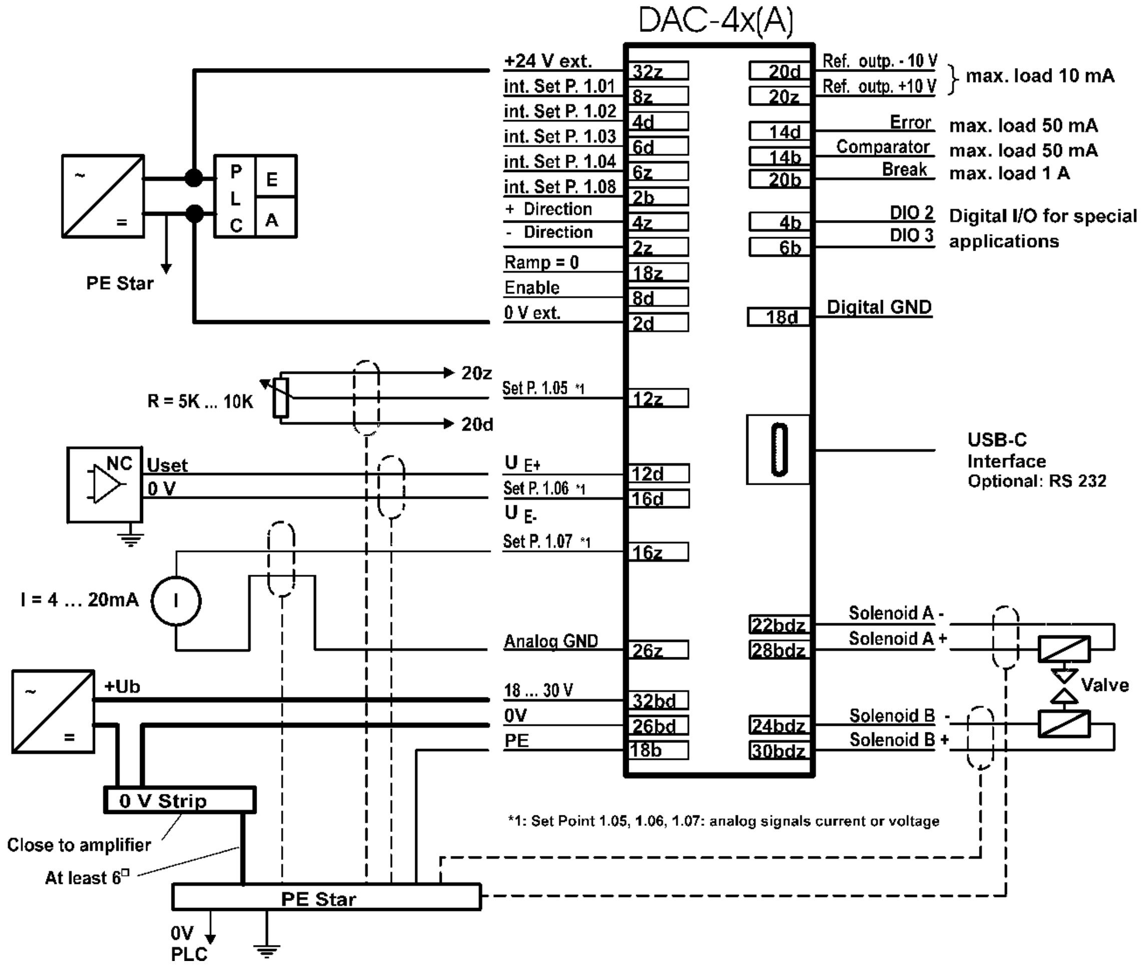


Figure 8 : Wiring diagram Mode 01

5.5.2 Operation mode 02

2 valves with 1 solenoid each, open loop

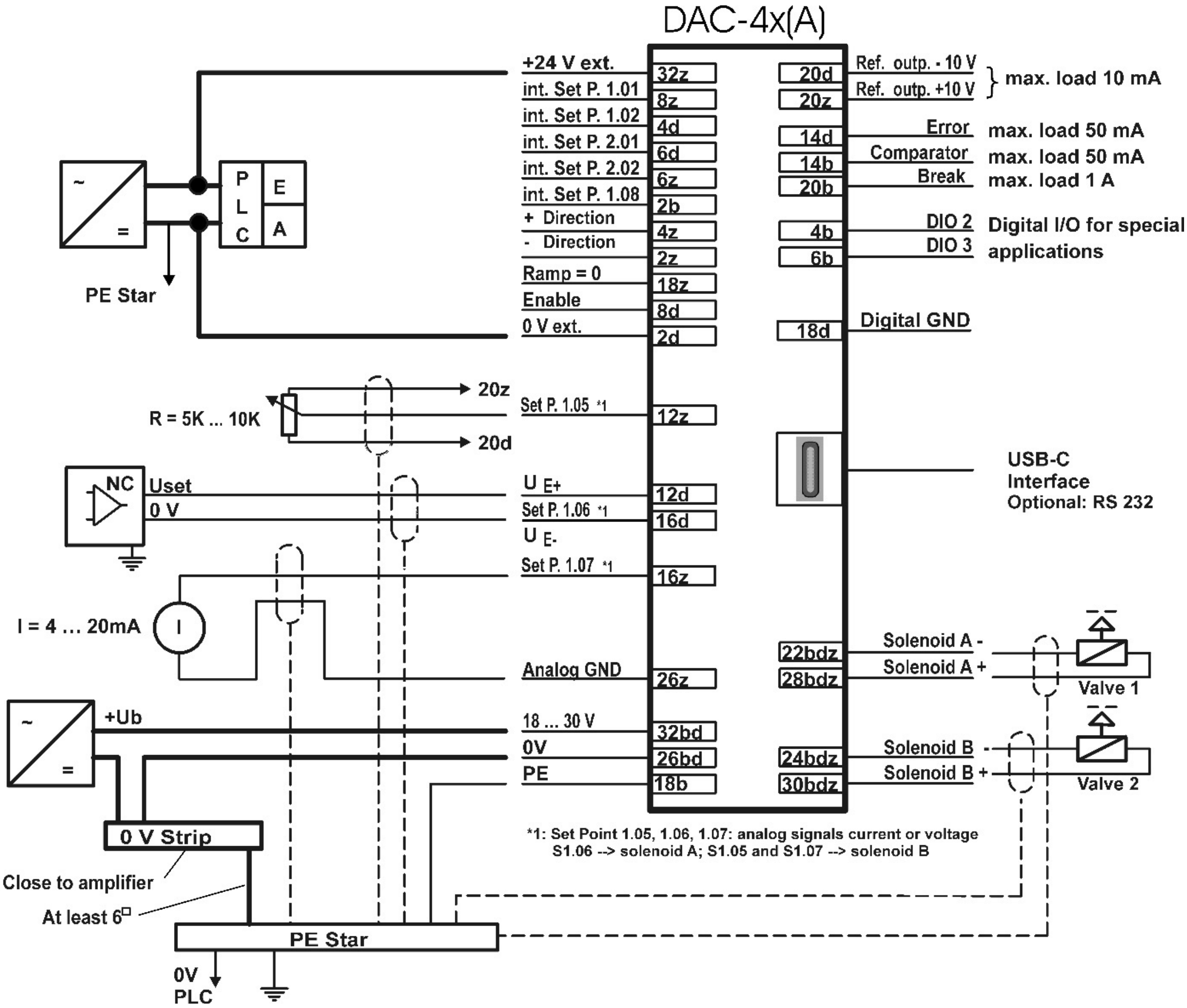


Figure 9 : Wiring diagram Mode 02

5.5.3 Operation mode 03

1 valve with 2 solenoids and spool position feedback

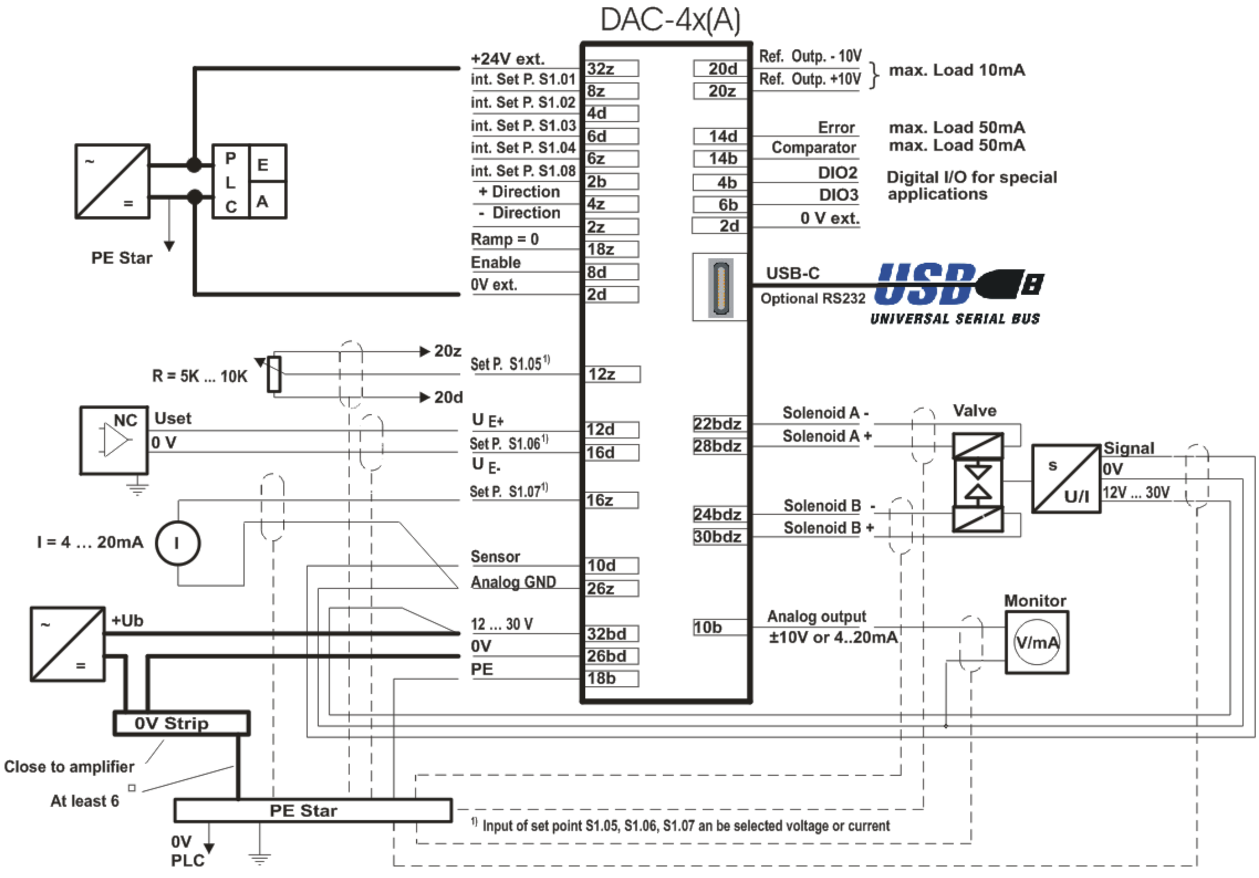


Figure 10 : Wiring diagram Mode 03

5.5.4 Operation mode 04

1 valve with 2 solenoids and process value feedback

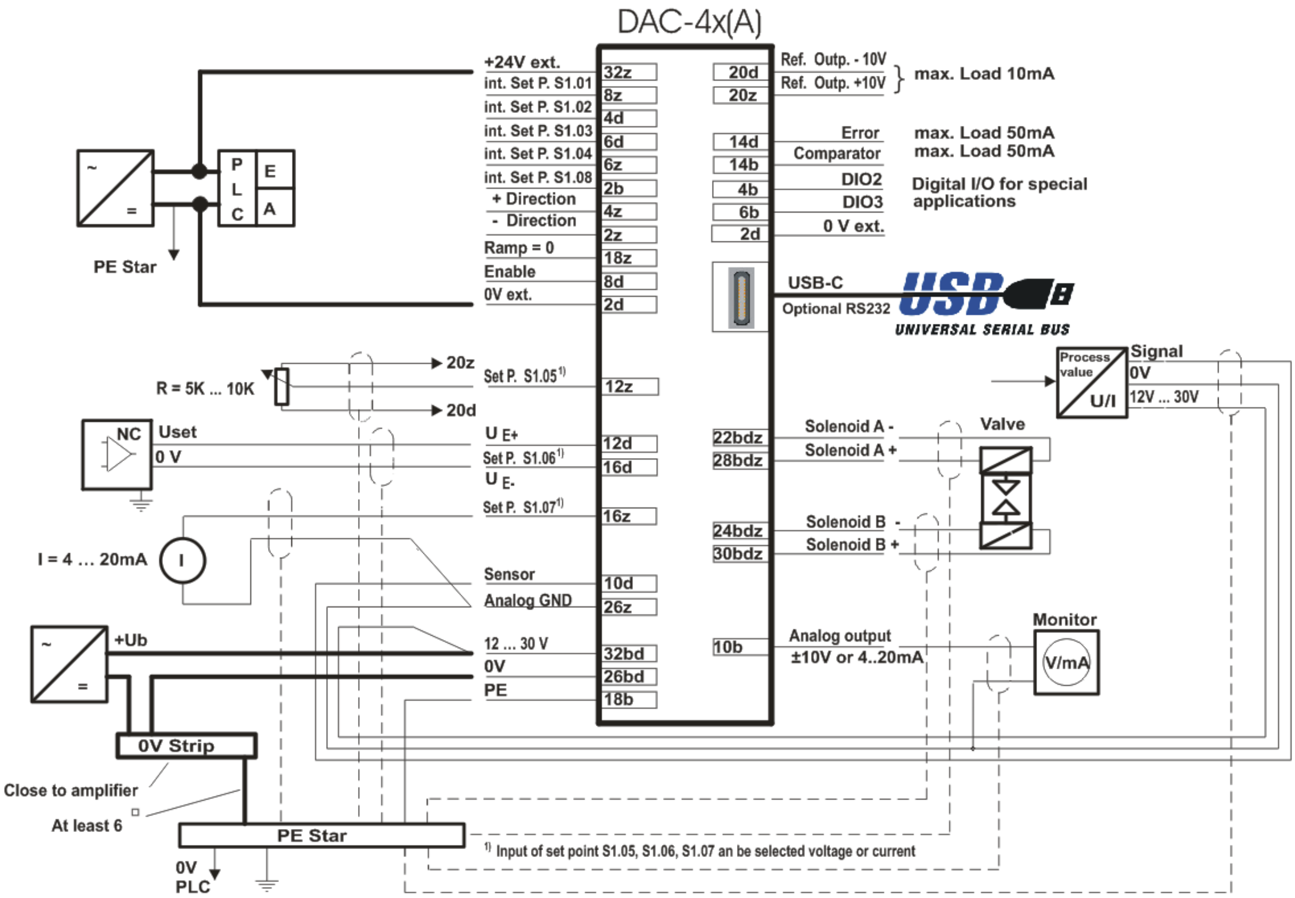


Figure 11 : Wiring diagram Mode 04

5.5.5 Operation mode 06

1 valve with 2 solenoids spool position feedback and process value feedback

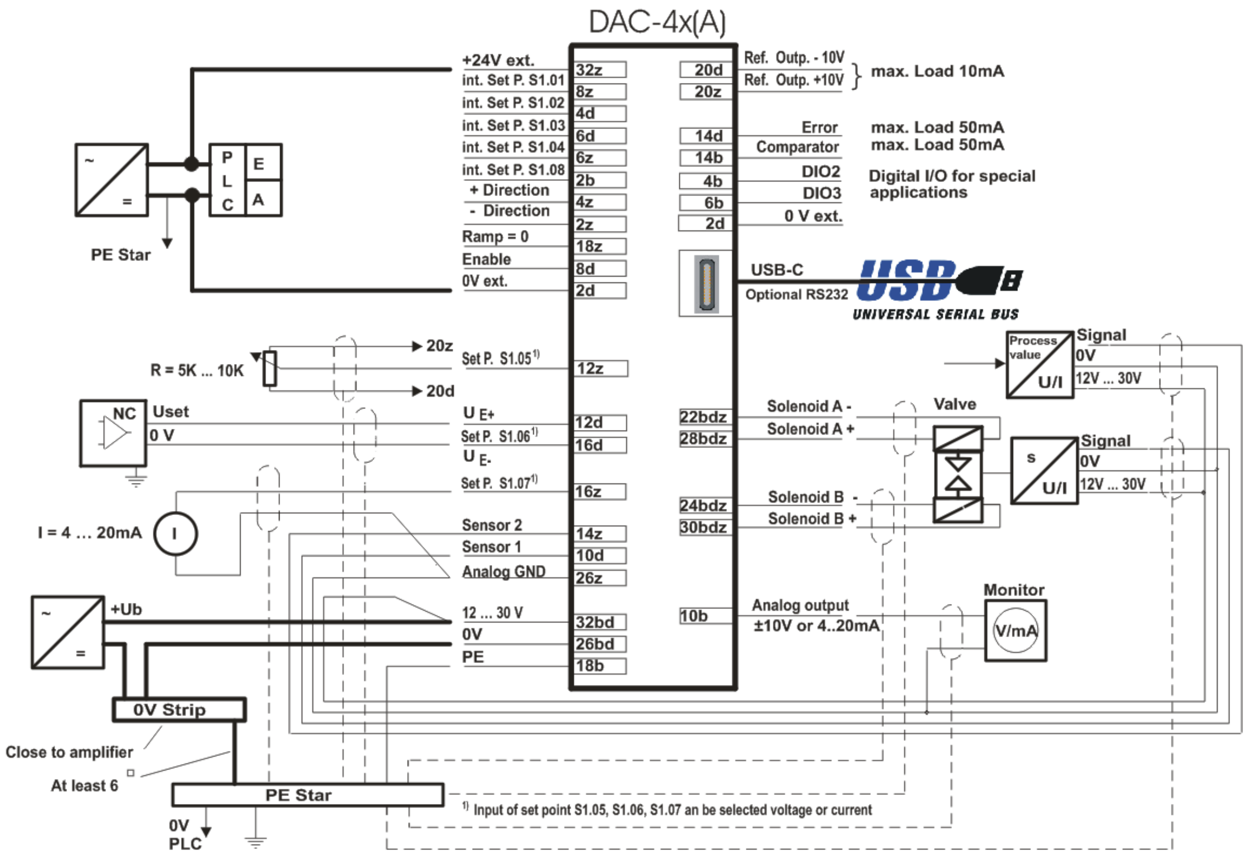


Figure 12 : Wiring diagram Mode 06

5.5.6 Operation mode 08

2 valves with 1 solenoid and process value feedback

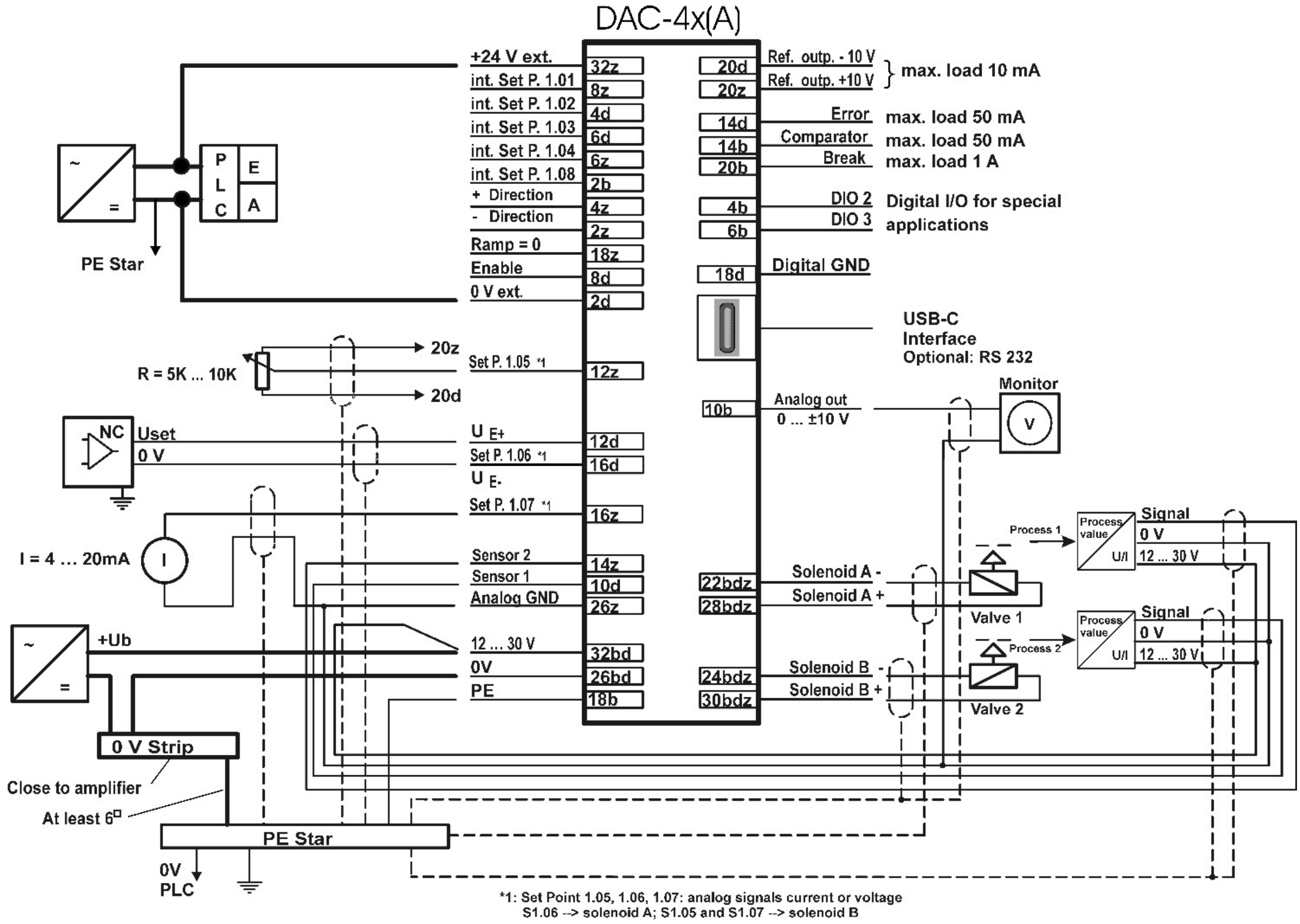


Figure 13 : Wiring diagram Mode 08

5.5.7 Operation mode 10

stand-alone controller with two process feedbacks

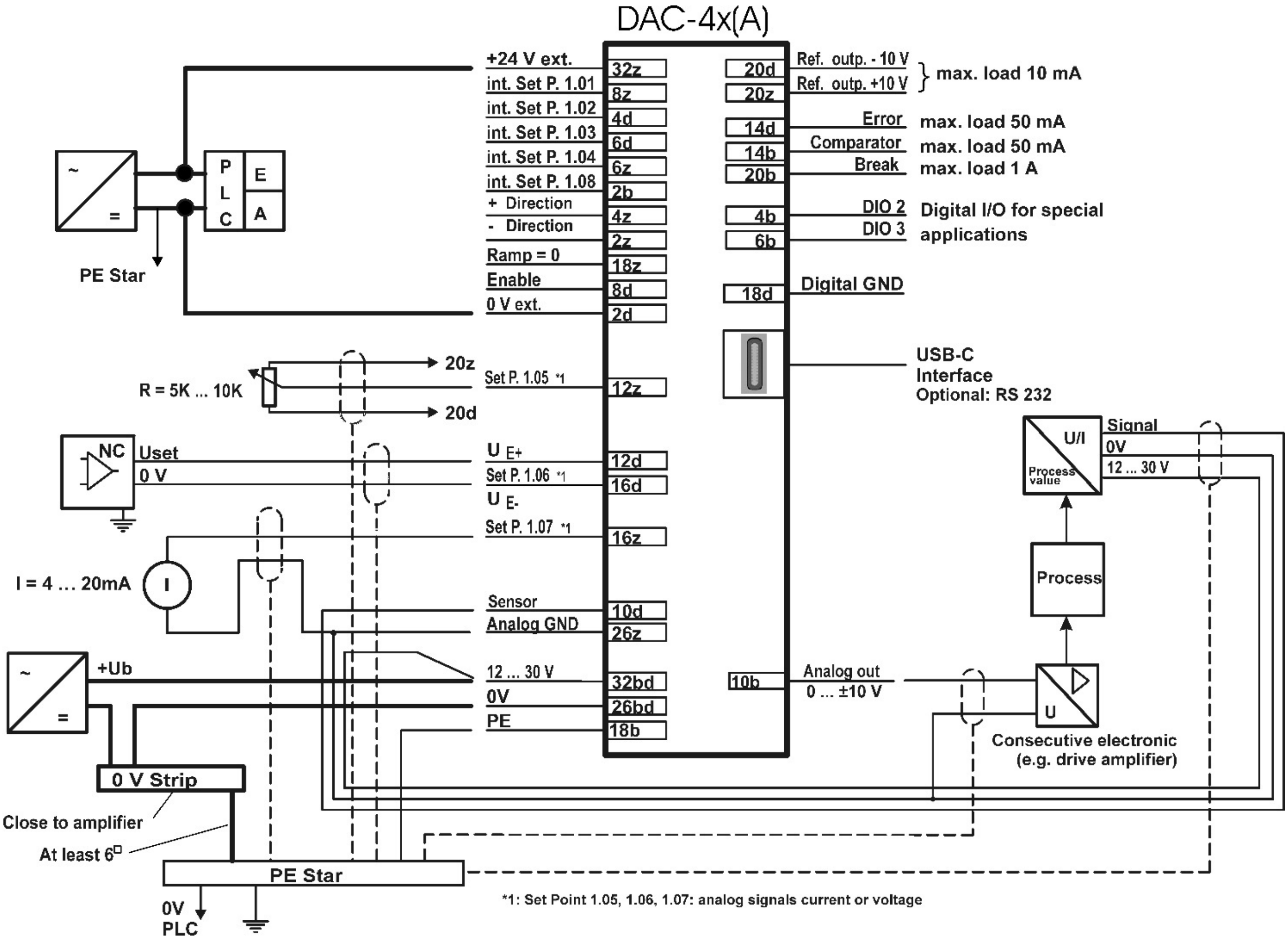


Figure 14 : Wiring diagram Mode 10

5.5.8 Operation mode 11

Closed loop double (cascaded controller) without valve, controller only

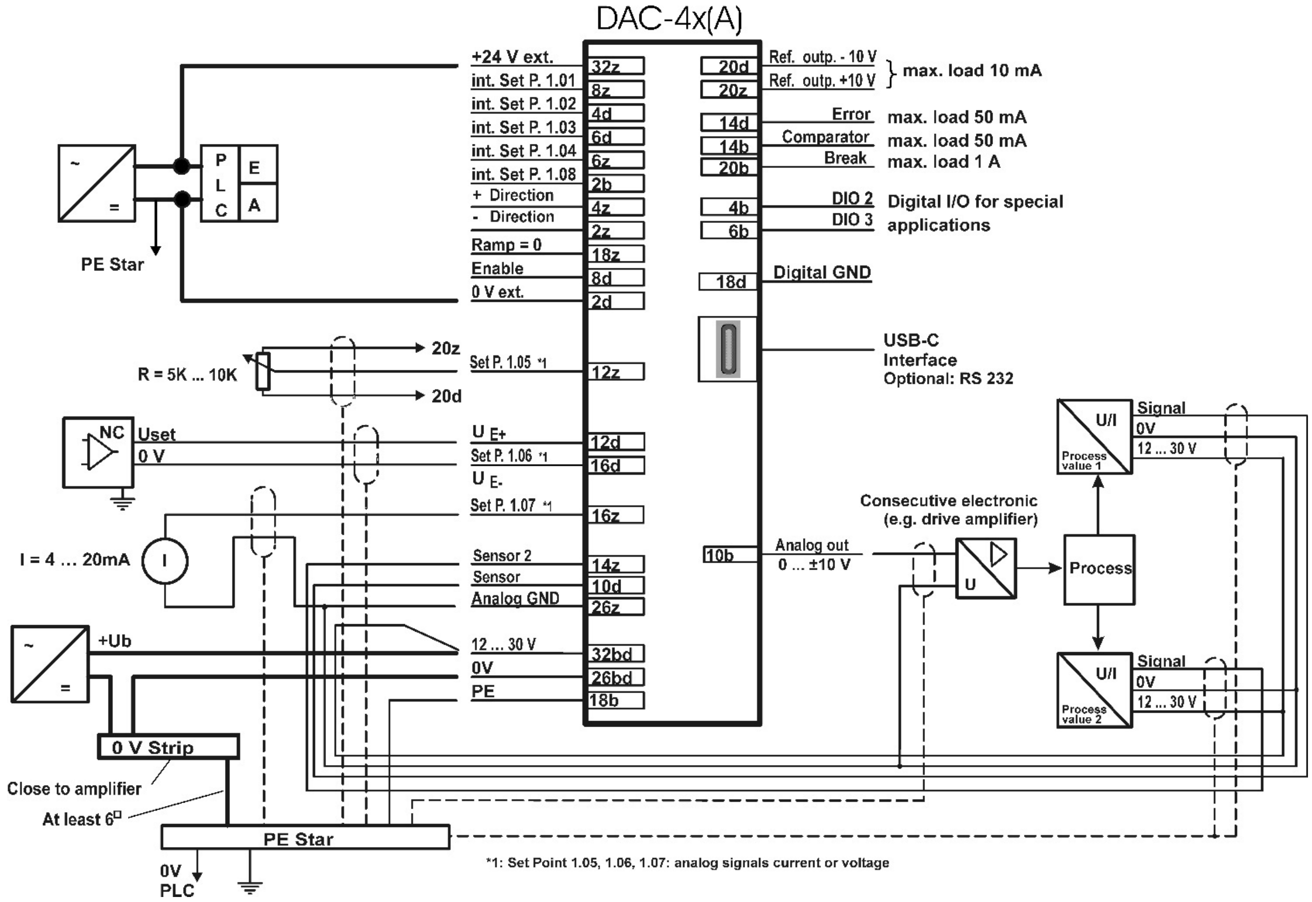


Figure 15 : Wiring diagram Mode 11

6 Commissioning

6.1 *Front elements*

⚠ WARNING

The electrical wiring must be checked before switching on the supply voltage.
Limit switches and safety devices must be active to prevent uncontrolled movements.
All relevant safety regulations must be observed.
Suitable emergency stop measures must be implemented.

6.1.1 DAC-44

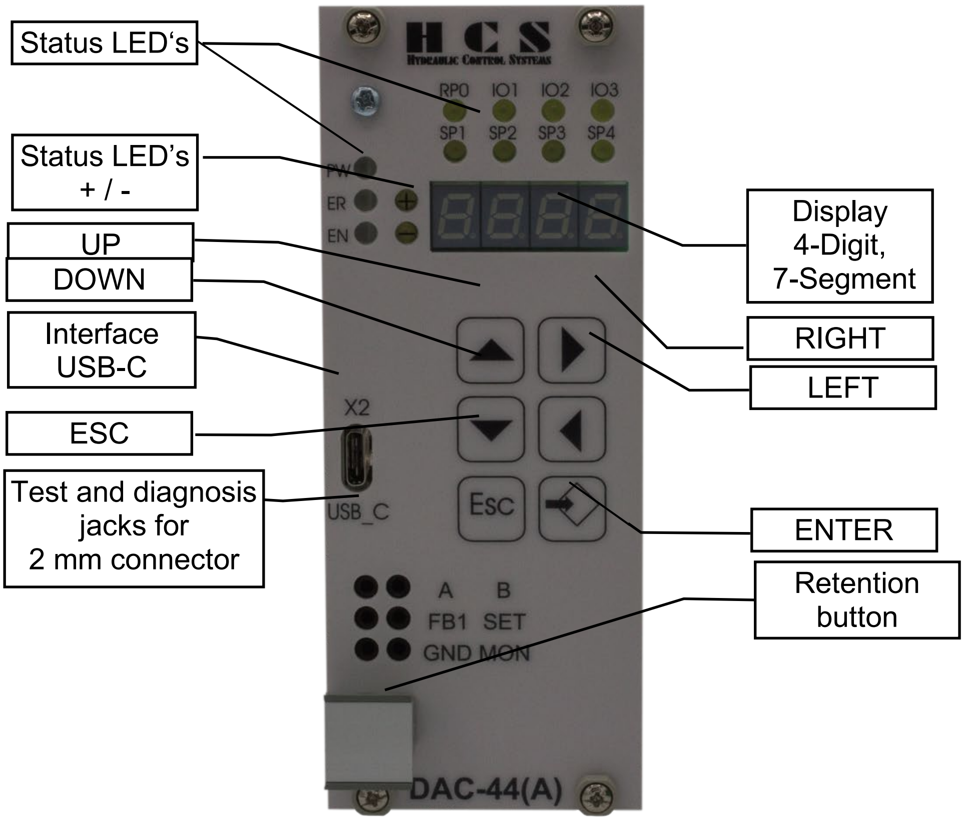


Figure 16 : DAC-44 Front elements DAC-44(A)

Element	Function
Status LED's	Displays the status of digital inputs and outputs
± LED's	Displays the setpoint direction using polarity indicators for parameters and measured values
Display	4-digit display for parameters and measured values
Buttons UP, DOWN, LEFT, RIGHT, ESC and ENTER	All operating, programming, and saving functions are performed using the UP, DOWN, LEFT, RIGHT, ESC, and ENTER buttons
USB-C interface	Interface for programming and parameter access via PC using HCSTool (RS232 optional)
Measuring and test jacks	Direct measurement of setpoint, feedback (actual value), solenoid currents, and internal signals via the monitor output. Use 2 mm test sockets (S1.06, FB1, A, B, d1.01 … d2.13).

Table 9: Front elements DAC-44 explanation

6.1.2 DAC-42

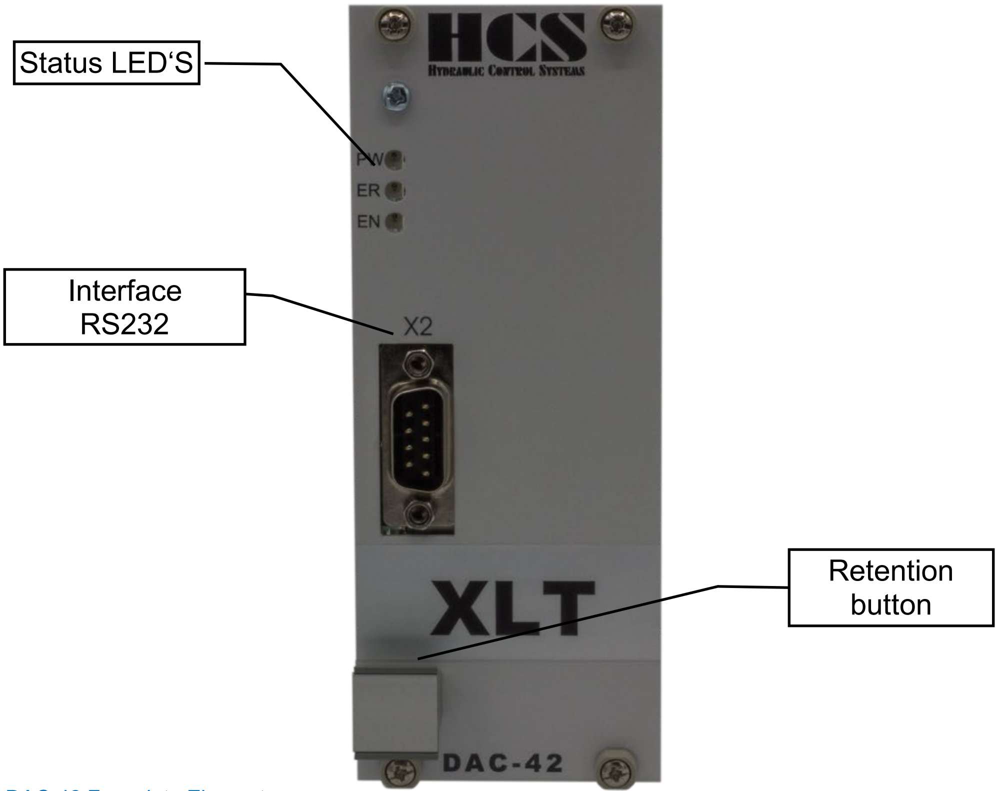


Figure 17 : DAC-42 Faceplate Elements

Element	Function
Status LED's	Displays the status of digital inputs and outputs
RS232 interface	Interface for programming and parameter access via PC using HCSTool (USB-C optional)

Table 10: Front elements DAC-42 explanation

6.2 Operation modes

Parameter <E00> determines the active operation mode. This parameter is factory preset.
Only parameters relevant to the selected operation mode are available.

Available operation modes:

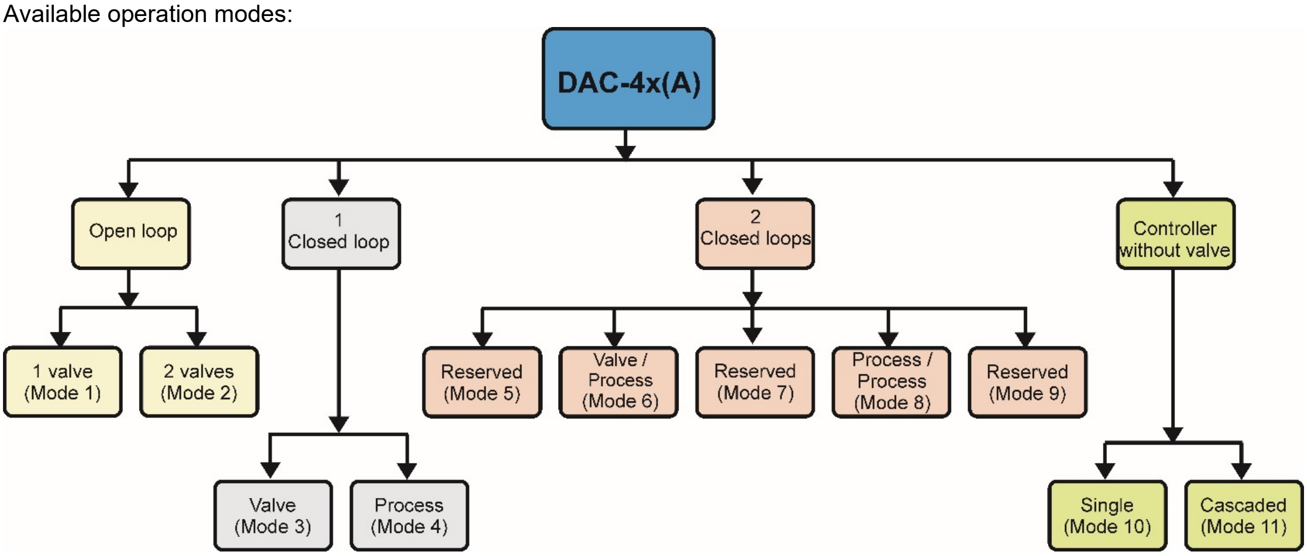


Figure 18 : Available Operation Modes

Parameter <E00> is used to select the desired operation mode.
Any change of the operation mode becomes effective immediately.
The parameters of the newly selected mode are loaded within a few seconds. During this process, the display flashes.
Only parameters relevant to the selected operation mode are available.

<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
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	Reserved
6	Closed loop valve and process, double, 1 proportional valve with 2 solenoids and feedback of spool position and additional feedback of process value (cascaded controller)
7	Reserved
8	Closed loop processes, double, 2 independent proportional valves with 1 solenoid each and feedback of two independent process values (e.g. two pressure control systems)
9	Reserved
10	Controller function without valve, control of 1 process value; provide setpoint to follow up electronics (e.g. valve with integrated electronics, frequency converter for AC motor etc.)
11	Controller function without valve, control of 2 process values (cascaded controller, e.g. position and velocity controller); provide setpoint to follow up electronics (e.g. valve with integrated electronics, frequency converter for AC motor etc.)

Table 11: Operation modes

6.3 Parameter setting

		Mode available
1	Parameters only available for	01, 03, 04, 06, 10, 11
2	Parameters only available for	03, 04, 06, 08, 10, 11
3	Parameters only available for	02, 08
4, 5	Reserved	
6	Parameters only available for PROFINET/PROFIBUS versions; SW V10.xx and V11.xx.	01, 02, 03, 04, 06, 08, 10, 11
Remark:	Parameters “d2.x, S2.x, r2.x and C.2x” only available for (not shown in table 11)	02, 06, 08, 11

display		Set point / ramps		Controller		Extended	
d1.01		S1.01		C1.00		E00	
d1.02		S1.02		C1.01	2	E01	
d1.03		S1.03	1	C1.02		E02	
d1.04		S1.04	1	C1.03		E03	
d1.05		S1.08		C1.04		E04	
d1.06		r1.01		C1.05		E05	
d1.07		r1.02		C1.06		E06	
d1.08		r1.03		C1.07		E07	
d1.09		r1.04		C1.08		E08	
d1.10				C1.09	2	E09	
d1.11	2			C1.10	2	E10	
d1.12	2			C1.11	2	E11	
d1.13	2			C1.12	2	E12	
				C1.13	2	E13	
				C1.14	2	E14	
				C1.15	2	E15	
				C1.16	2	E16	
				C1.17	2	E17	
				C1.18	2	E18	
				C1.19	2	E19	5
				C1.20	2	-	
				C1.21	2	-	
				C1.22	2	E22	6
				C1.23	2	E23	6
				C1.24	2	E26	6
				C1.25	2	-	
				C1.26	2	E31	5
				C1.27		E32	
				C1.33	2	E33	5
				C1.36	2	E34	5
				-		E35	5
				C1.39	2		
				C1.40	2		
				L1			

Table 12: Parameter overview

A complete list of parameters is available. Refer to:

See □ Chapter "11 Complete parameter list", page 85

Also refer to “HCSTool”!

6.4 *Setting of default parameters values:*

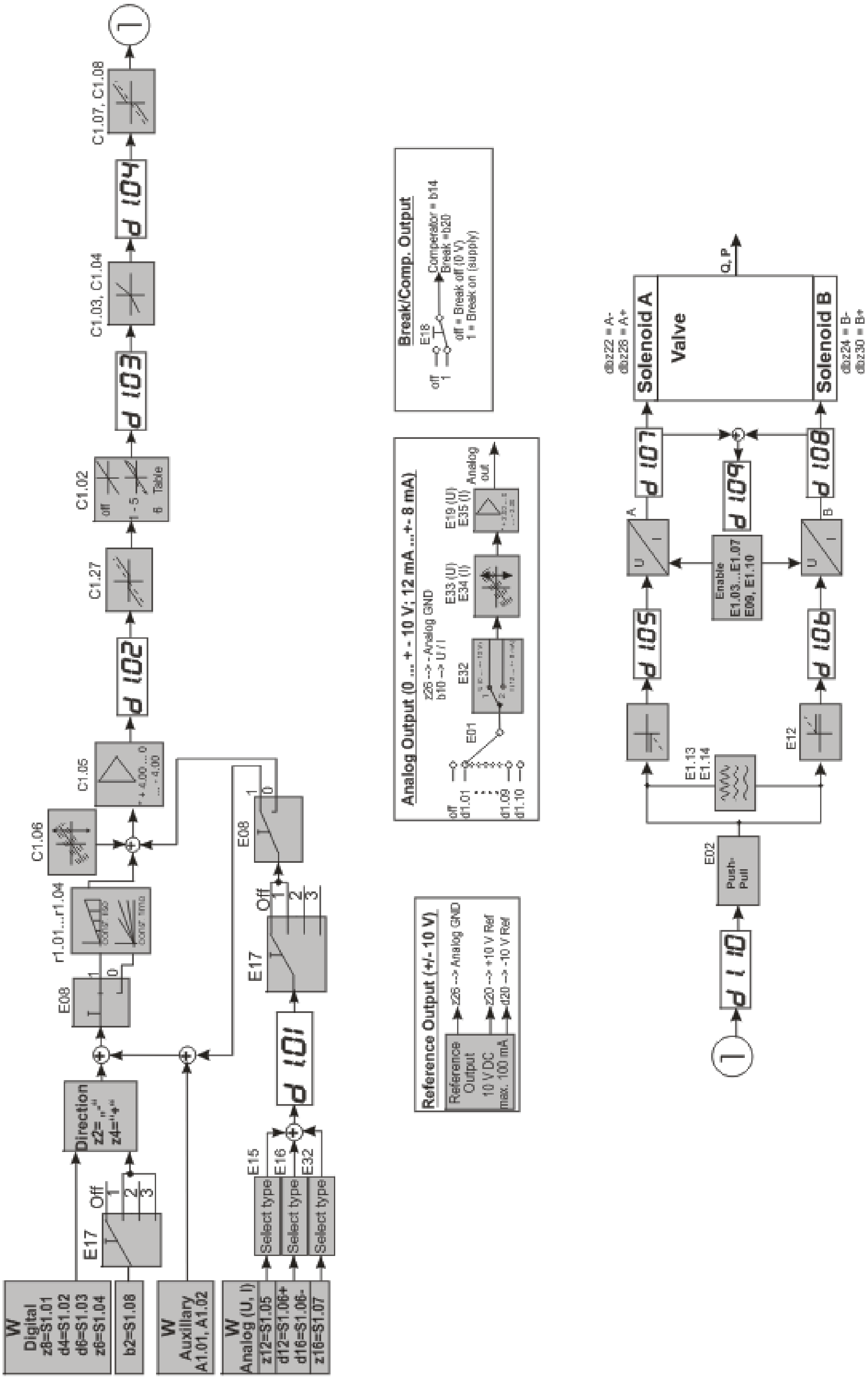
Default values can be saved either as individual parameters or as parameter sets.
HCSTool is used to configure these default values according to application requirements.
For specific configurations or requests, please contact your supplier.

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

6.5 *Software block diagrams*

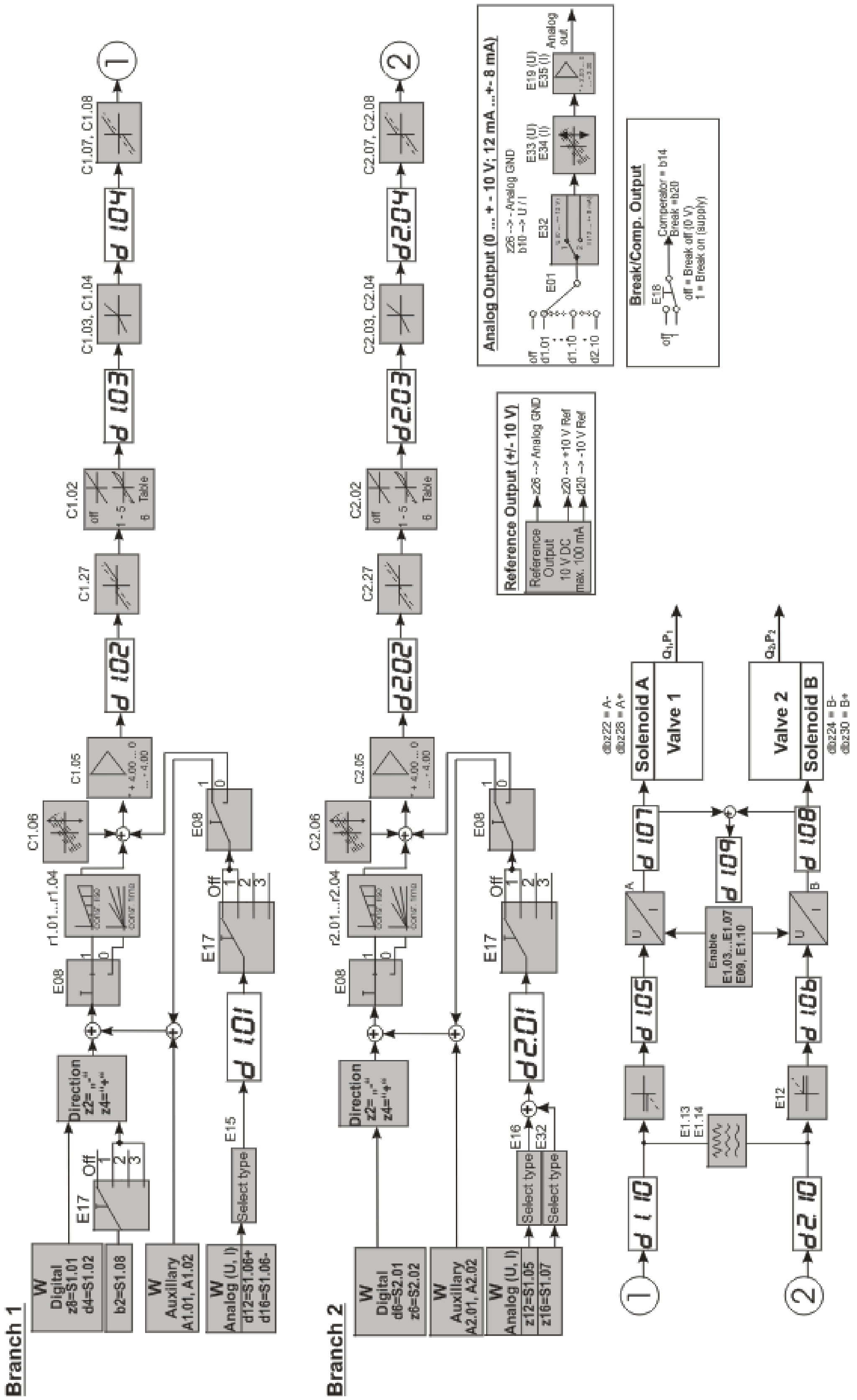
6.5.1 Operation Mode 01

1 valve with 2 solenoids, open loop



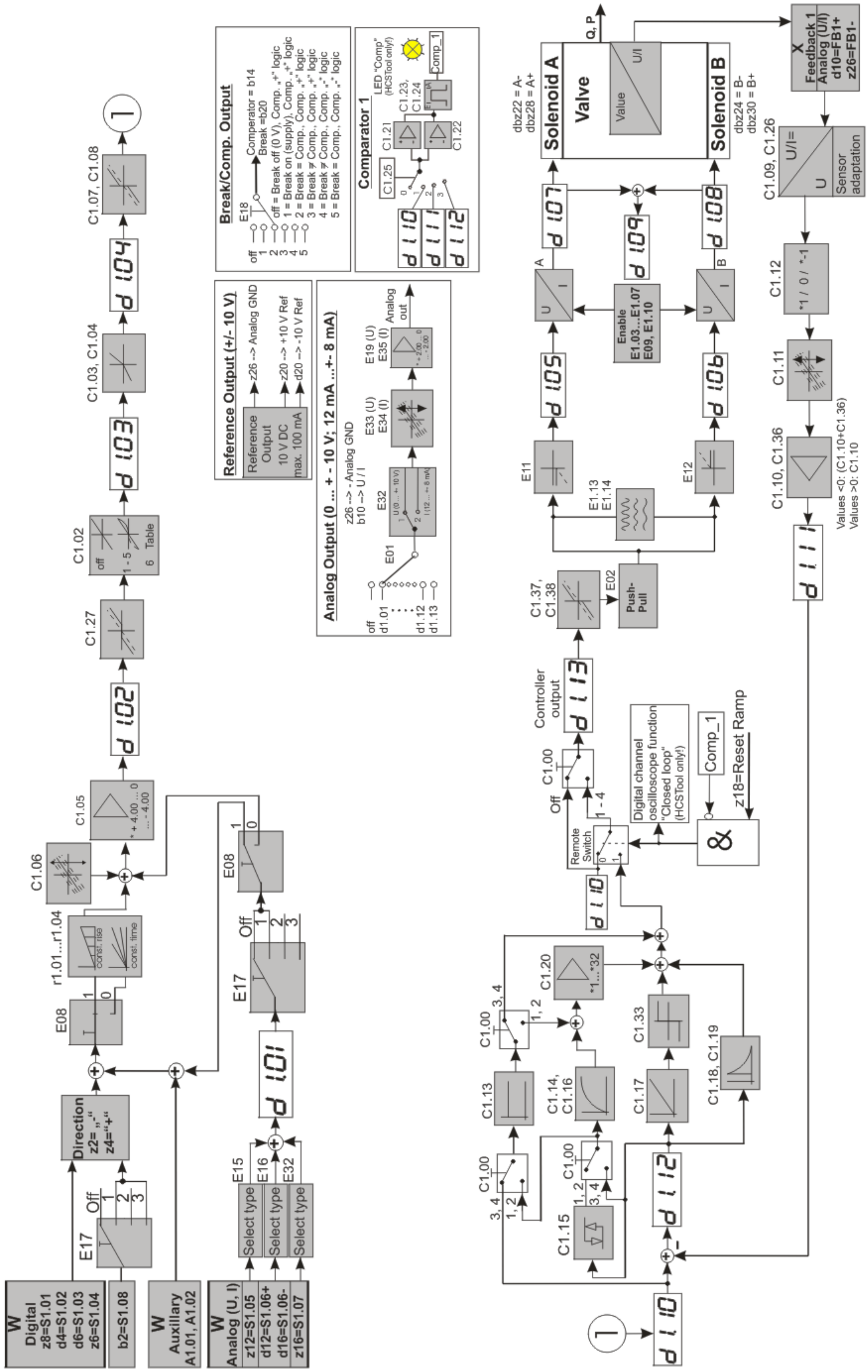
6.5.2 Operation Mode 02

2 valves with 1 solenoid each, open loop



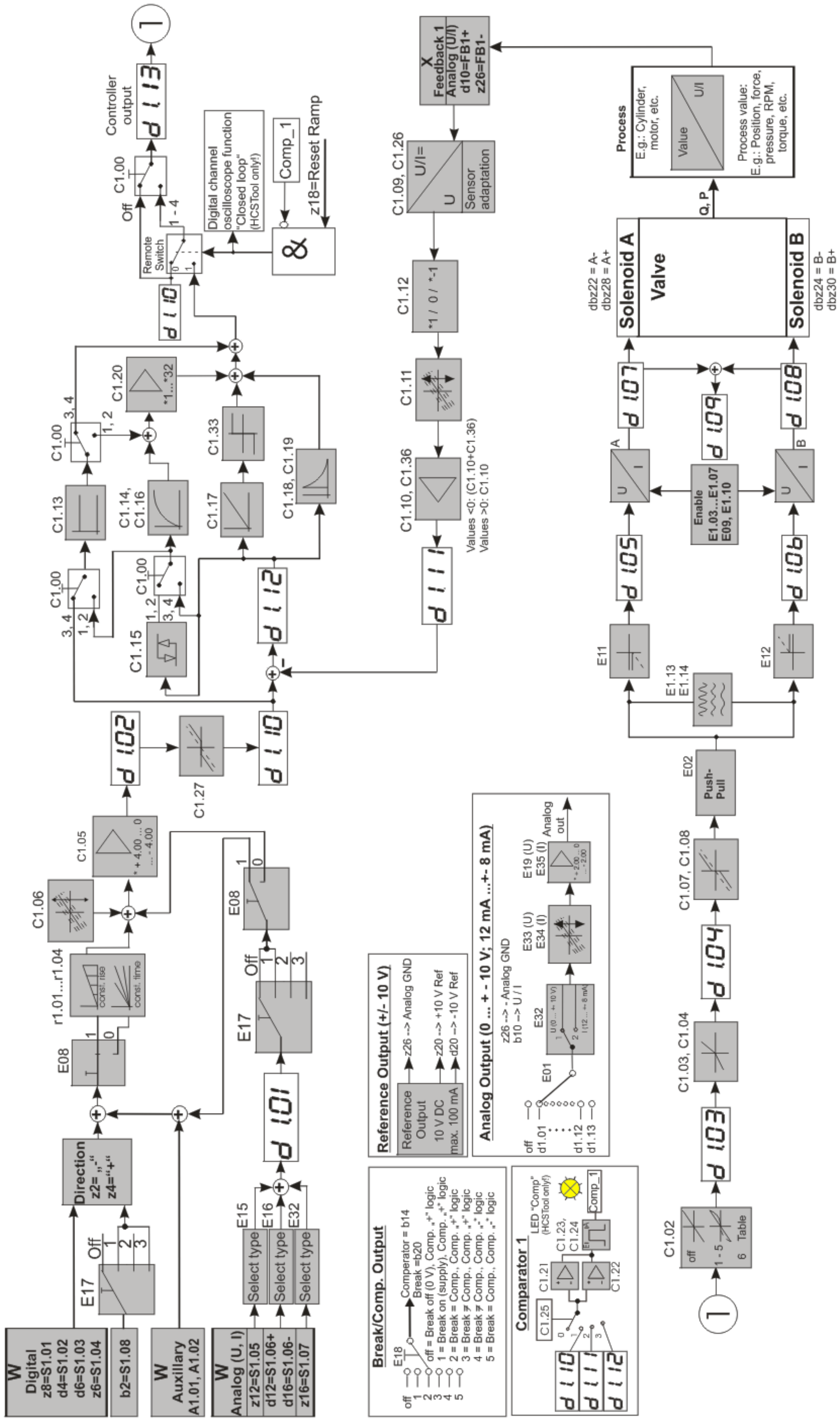
6.5.3 Operation Mode 03

1 valve with 2 solenoids and spool position feedback



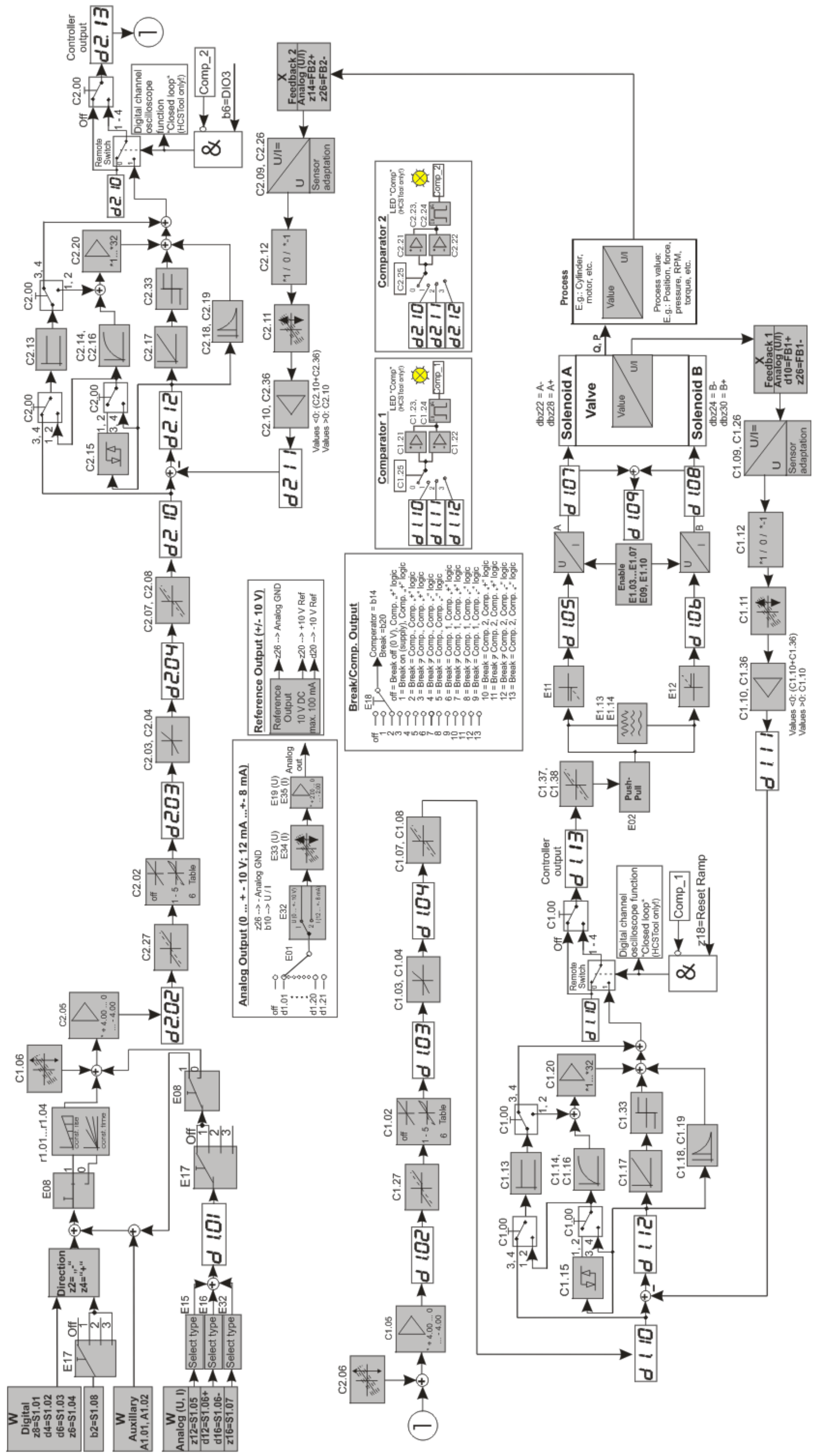
6.5.4 Operation Mode 04

1 valve with 2 solenoids and process value feedback



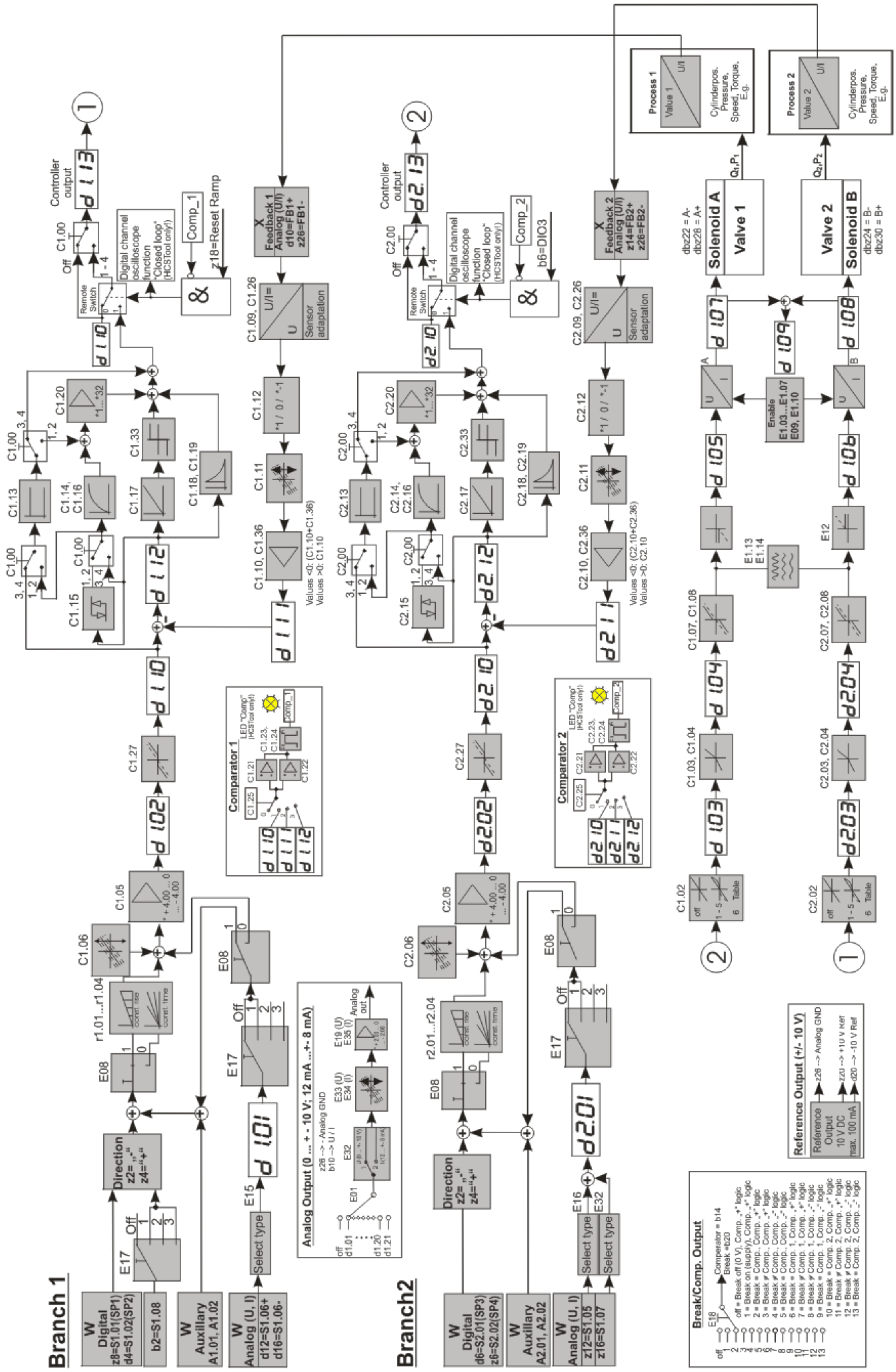
6.5.5 Operation Mode 06

1 valve with 2 solenoids spool position feedback and process value feedback



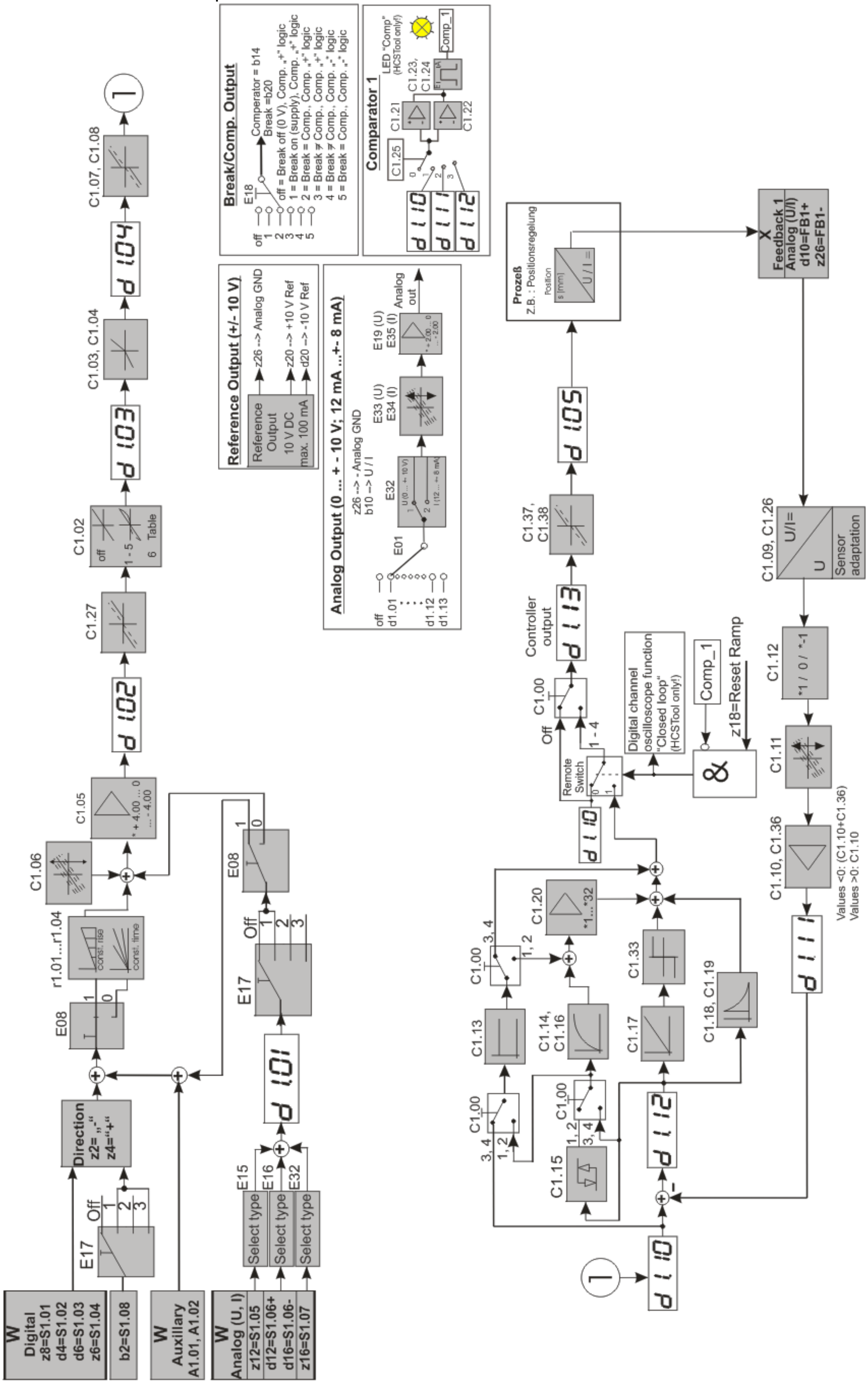
6.5.6 Operation Mode 08

2 valves with 1 solenoid and process value feedback



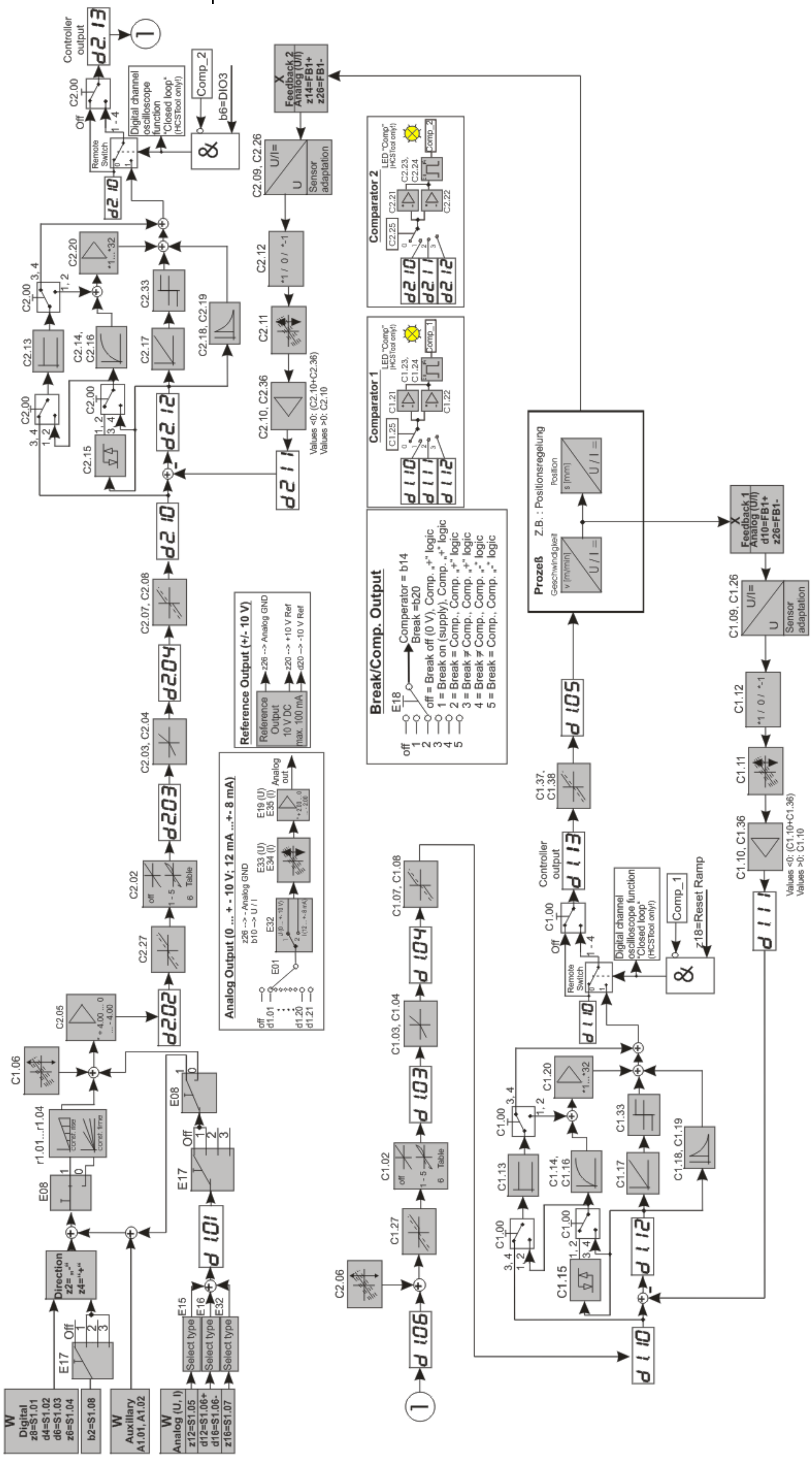
6.5.7 Operation Mode 10

stand-alone controller with process feedback



6.5.8 Operation Mode 11

stand-alone controller with two process feedbacks

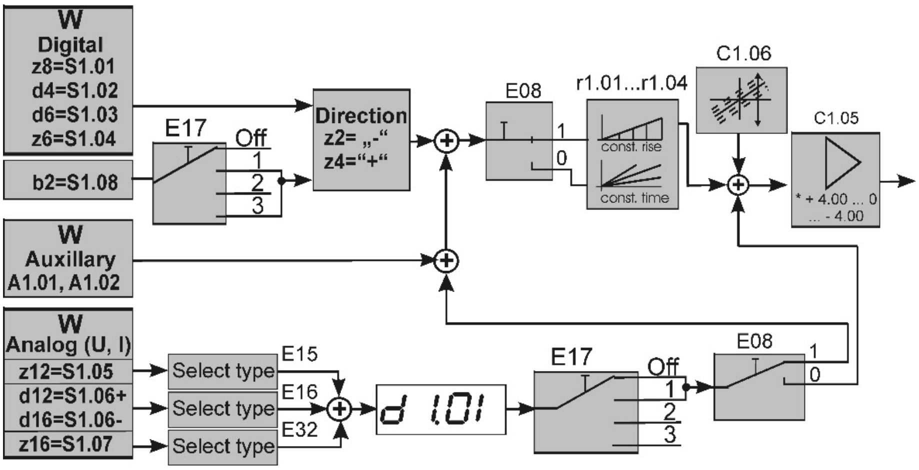


6.6 *Block structures*

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

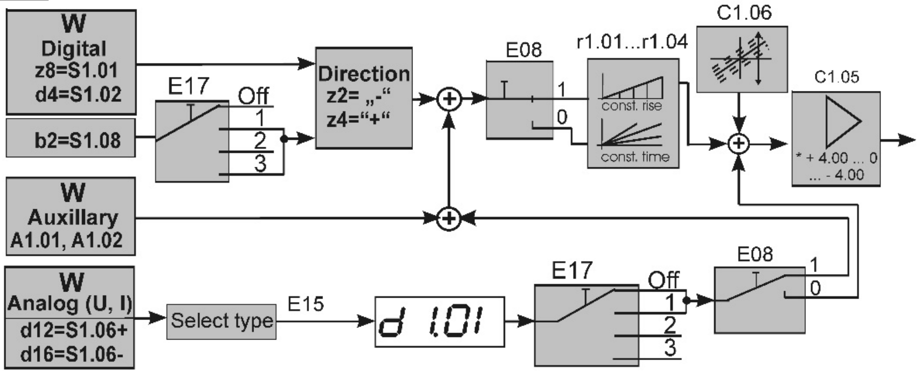
6.6.1 Setpoints

	Mode
Only available for	01, 03, 04, 06, 10, 11

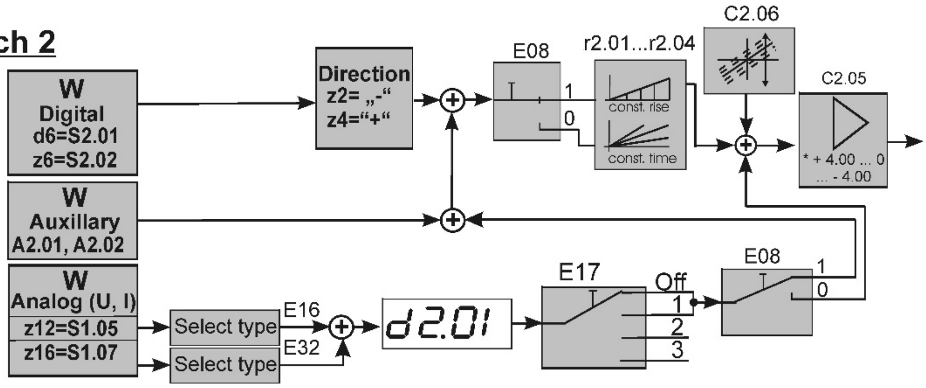


	Mode
Only available for	02, 08

Branch 1

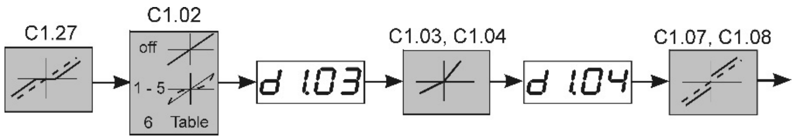


Branch 2

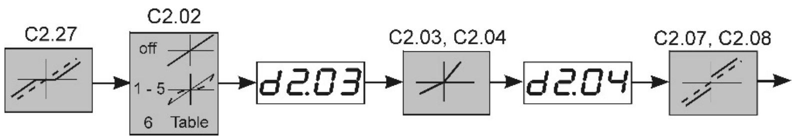


6.6.2 Processing of setpoints

	Mode
Available for	01, 02, 03, 04, 06, 08, 10, 11

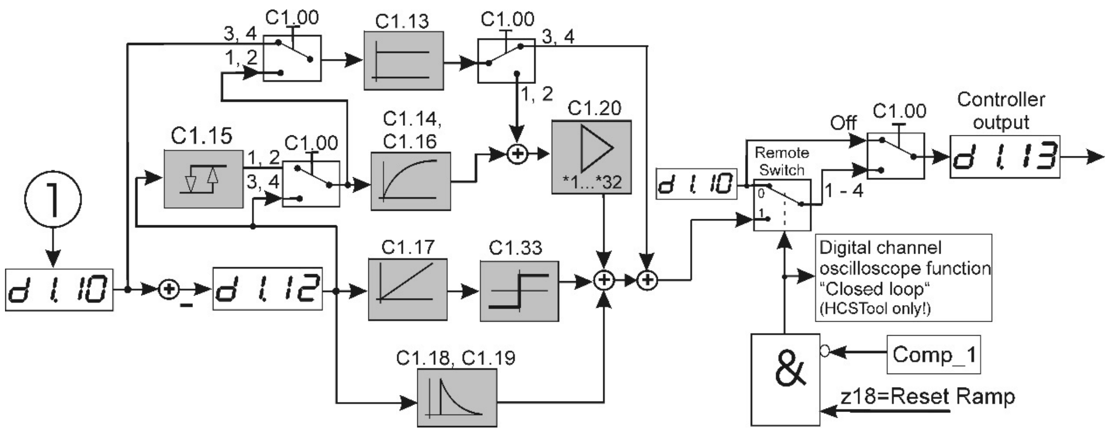


	Mode
Only available for	02, 08

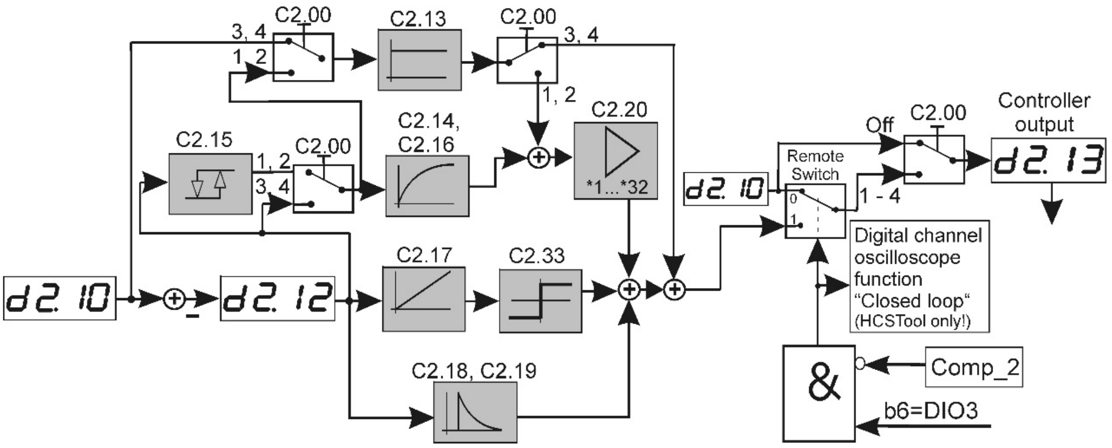


6.6.3 Controller structure

	Mode
Available for	03, 04, 06, 08, 10, 11

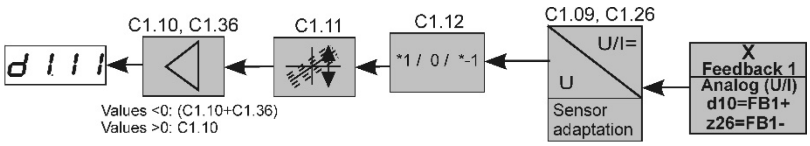


	Mode
Only available for	06, 08, 11

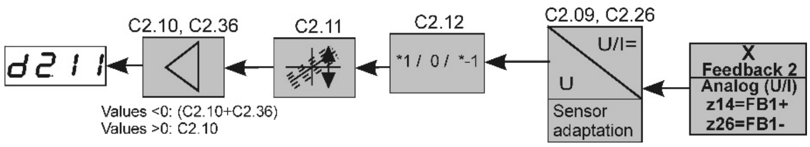


6.6.4 Processing of the actual value

	Mode
Available for	03, 04, 06, 08, 10, 11

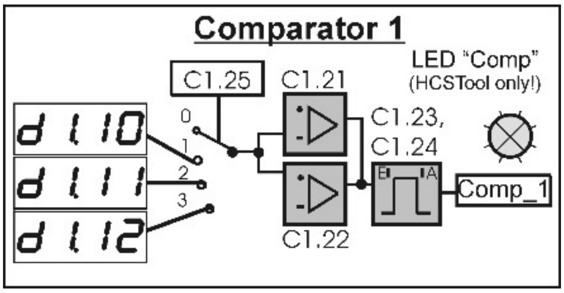


	Mode
Only available for	06, 08, 11

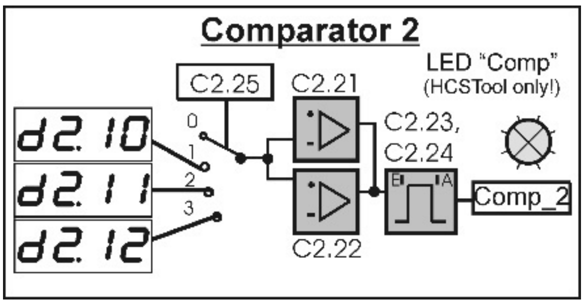


6.6.5 Comparator Function

	Mode
Available for	03, 04, 06, 08, 10, 11

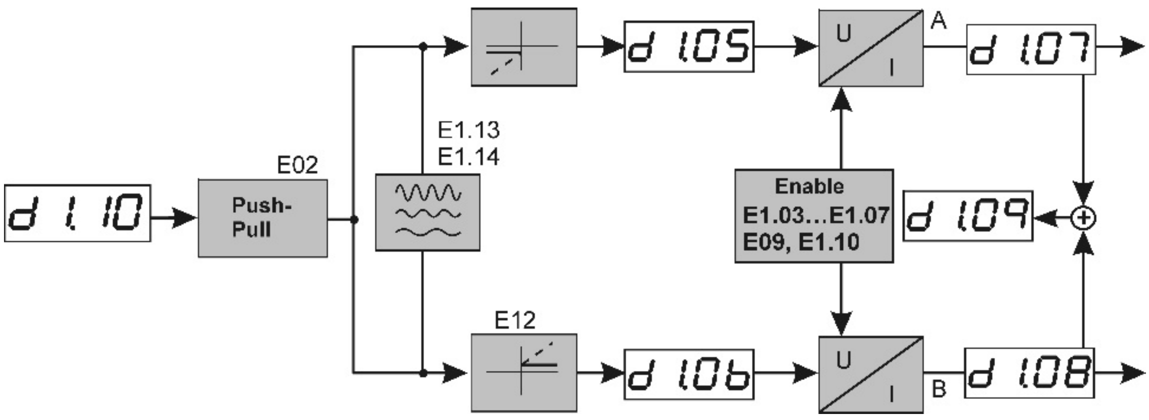


	Mode
Only available for	06, 08, 11

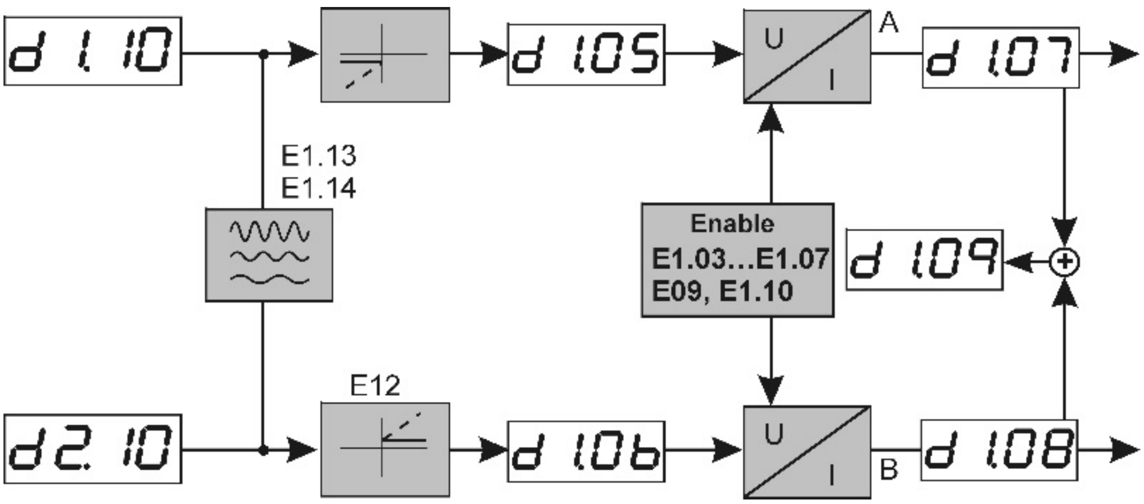


6.6.6 Current processing and output stages

	Mode
Available for	01, 03, 04, 06



	Mode
Only available for	02, 08



6.7 *Description of software program*

6.7.1 General availability and assignment of parameters

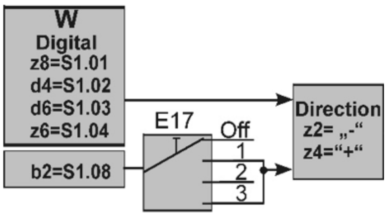
⚠ WARNING
Only trained personnel must make parameter changes. During parameter adjustment, the drive should be switched off. Each parameter change takes effect immediately.

6.7.2 Programmable setpoints

Digital setpoints are internally programmable setpoints activated via digital inputs.
All programmable setpoints can be selected using the corresponding inputs. Setpoint <S1.08> is only available if parameter <E17> is set to a value greater than zero.
The direction of the setpoint is defined by selecting either the “+” or “–” input.

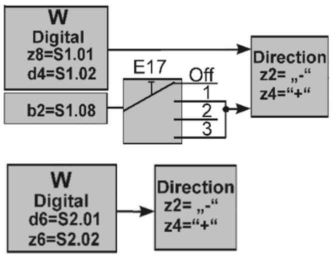
- The inputs can be controlled directly by a PLC.
- If electrical isolation between the PLC and the amplifier card is required, external isolation must be provided.
- All digital setpoints are processed by the ramp function generator.
- All setpoints are additive and include their direction information.
- If multiple setpoints are selected simultaneously, their values are summed and processed accordingly.
- Using binary combinations, up to 4 (16) setpoint values can be selected.

	Mode
Only available for	01, 03, 04, 06, 10, 11



In these modes, only one functional branch is controlled.
All setpoint parameters <S1.02> to <S1.04> and <S1.08> are assigned to this branch.

	Mode
Only available for	02, 08



The available setpoint inputs are divided into two functional branches.
Branch 1: <S1.01>, <S1.02>, <S1.08>
Branch 2: <S2.01>, <S2.02>

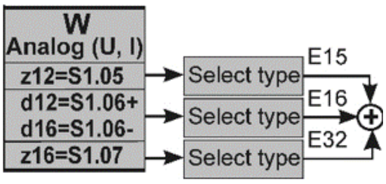
See □ Chapter "6.7.31 Activation of setpoints <E17>”, page 65

See □ Chapter "8.2 Digital inputs", page 77

6.7.3 Analog setpoints <S1.05>, <S1 06>, <S1.07>

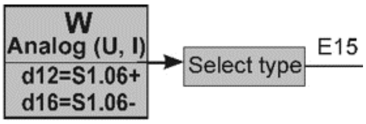
The analog setpoints are designed for voltage or current signals.
S1.06 = differential input
S1.05, S1.07 = single-ended (ground-referenced) inputs
The resolution of all inputs is 16-bit.
Different predefined input ranges can be selected via software parameters. Cable break detection and setpoint type are configured using parameters <E15>, <E16>, and <E32>.
If a current input range is selected, a measuring resistor of 255 Ω is automatically activated.

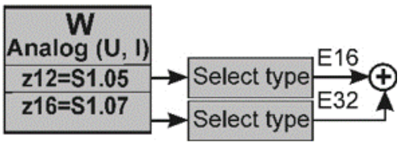
	Mode
Only available for	01, 03, 04, 06, 10, 11



In these modes, only one functional branch is controlled. All analog setpoints are available for this branch.

	Mode
Only available for	02, 08





The available analog setpoint inputs are divided into two functional branches.
Branch 1: S1.06
Branch 2: S1.05, S1.07.

To suppress interference, unused analog setpoints must be deactivated using parameters <E15>, <E16>, and <E32>.
Analog setpoints are not actual parameters; they represent external setpoint signals.

Explanation of the possible ranges and types of analog setpoints:

See □ Chapter "6.7.29 Selection of setpoint S1.06 <E15>", page 64

See □ Chapter "6.7.30 Selection of setpoint S1.05 <E16>", page 64

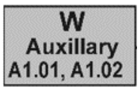
See □ Chapter "6.7.31 Activation of setpoints <E17>", page 65

See also □ Chapter "8.5 Analog inputs", page 79

For clarity, only parameters <r1.xx>, <S1.xx>, and <C1.xx> are shown in the following chapters.

The descriptions also apply to parameters <r2.xx>, <S2.xx>, and <C2.xx>.

6.7.4 Auxiliary setpoints <A1.01>, <A1.02>



Auxiliary setpoints are used for simple testing during commissioning. They allow setpoints to be generated without requiring external input signals and are independent of external setpoints and direction commands.

Only the “enable” signal must be active to energize the output stages. Any change of a setpoint takes effect immediately.

The polarity corresponds to the associated solenoid in the active control state.

Auxiliary setpoints are additive. This means that externally applied analog or digital setpoints are also taken into account.

If <A1.01> is switched to <A1.02> and vice versa, different values can be activated, even with different polarity signs.

As soon as parameter selection is activated, the auxiliary setpoints become active. This is indicated by a flashing last digit of the displayed parameter value.

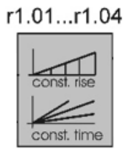
Press ESC to discard the value and exit parameter adjustment; the auxiliary setpoint is then deactivated.

Press ENTER to save the value; the auxiliary setpoint is then deactivated. The saved value becomes active again when parameter adjustment is reactivated.

WARNING

When exiting parameter adjustment for an auxiliary setpoint using ENTER or ESC, the auxiliary setpoint is automatically deactivated.
The value is saved and can be reactivated using the ENTER key.

6.7.5 Ramp function <r1.01> to <r1.04>



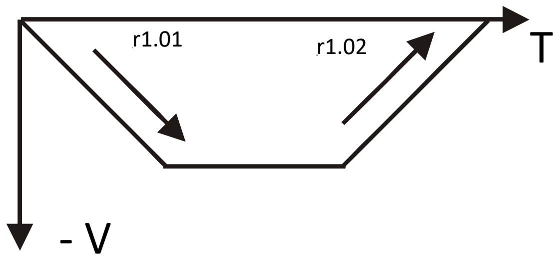
Setpoints are processed by the ramp function generator.

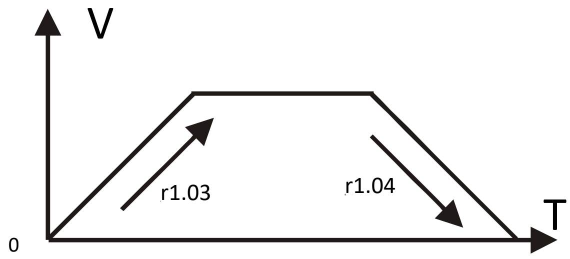
For each change of direction, the ramp time can be set independently. Adjustable ramp times range from 0 to 39.5 s with a resolution of 0.01 s.

The ramp characteristic is defined as follows::

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

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





<E08> = 0: Affects only digital setpoints; constant time base, linear
<E08> = 1: Affects all setpoints; constant rise rate, linear
<E08> = 2: Selectable ramp times; ramp function can be switched

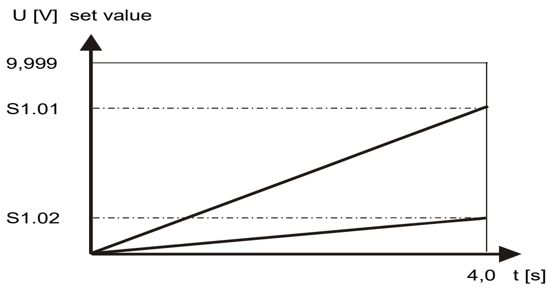
S1.01 [8z]	S1.02 [4d]	Active ramp
-	-	no ramp
active	-	<r1.01> and <r1.02>
-	active	<r1.03> and <r1.04>.
active	active	<r1.01> and <r1.02>

Table 13: Ramp selection by digital input

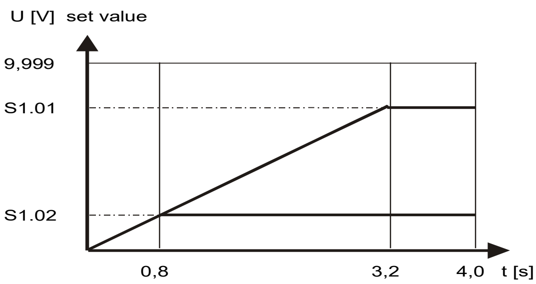
The parameters <S1.01> and <S1.02> remain active and must be set to 0 if they are not used.

6.7.6 Examples for ramps

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

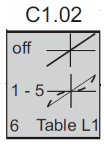


Example 2:
<E08> = 1, ramp with <u>constant rise rate</u>
<S1.01> = 8.00 V; <S1.02> = 2.00 V
<r1.03> = 4.00 sec



The analog setpoints <S1.05>, <S1.06>, and <S1.07> are not processed by the ramp function.	**The ramp function affects both digital and analog setpoints.**

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



Five characteristic curves are available for valve linearization.:

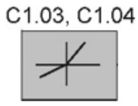
<Cx.02>	Description
off	No linearization active
1	General linearization for NC characteristic curve
2	Linearization for proportional directional valves with flow rate > 10 l/min (NG6)
3	Linearization for proportional directional valves with flow rate < 10 l/min (NG6)
4	Linearization for proportional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

Table 14: <C1.02> selection

Definition of a user-defined characteristic curve:

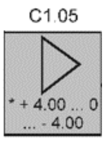
See □ Chapter "6.7.22 Custom specific curve <L1>", page 61

6.7.8 Direction-dependent gain <C1.04>, <C2.04>



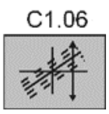
The gain can be adjusted using parameters <C1.03> and <C1.04> for both directions (“+” and “−”).
These parameters are used to adjust the gain.

6.7.9 Setpoint sign / factor <C1.05>



The setpoint sign and scaling function is used to invert the polarity of the setpoint signal, adjust the signal level, or completely disable the signal.
This allows the direction of the valve to be reversed and the setpoint signal to be scaled.
The scaling factor for the setpoint can be set in the range of 0.00 to ±4.00.

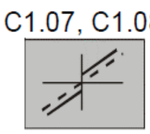
6.7.10 Offset for setpoint <C1.06>



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

The offset setpoint acts as an additional setpoint, enabling very precise positioning of the system, for example when used on an NC axis.

6.7.11 Spool-overlap compensation <C1.07>, >C1.08>

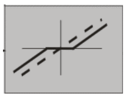


The compensation acts as an additional setpoint that is activated as soon as the polarity of the setpoint changes.

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.

6.7.12 Setpoint dead-band <C1.27>

C1.27



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, 06, 08, 10, 11

6.7.13 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.

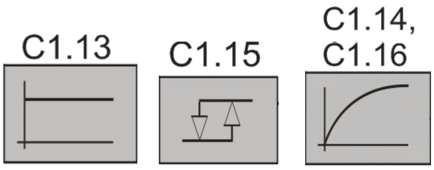
Parameter <C1.00> is used to select and activate the controller configuration. Four different controller configurations are available:

<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 15: Controller selection

6.7.14 P-PT$_1$-I-DT$_1$ controller <C1.00> = 1 or 2

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:

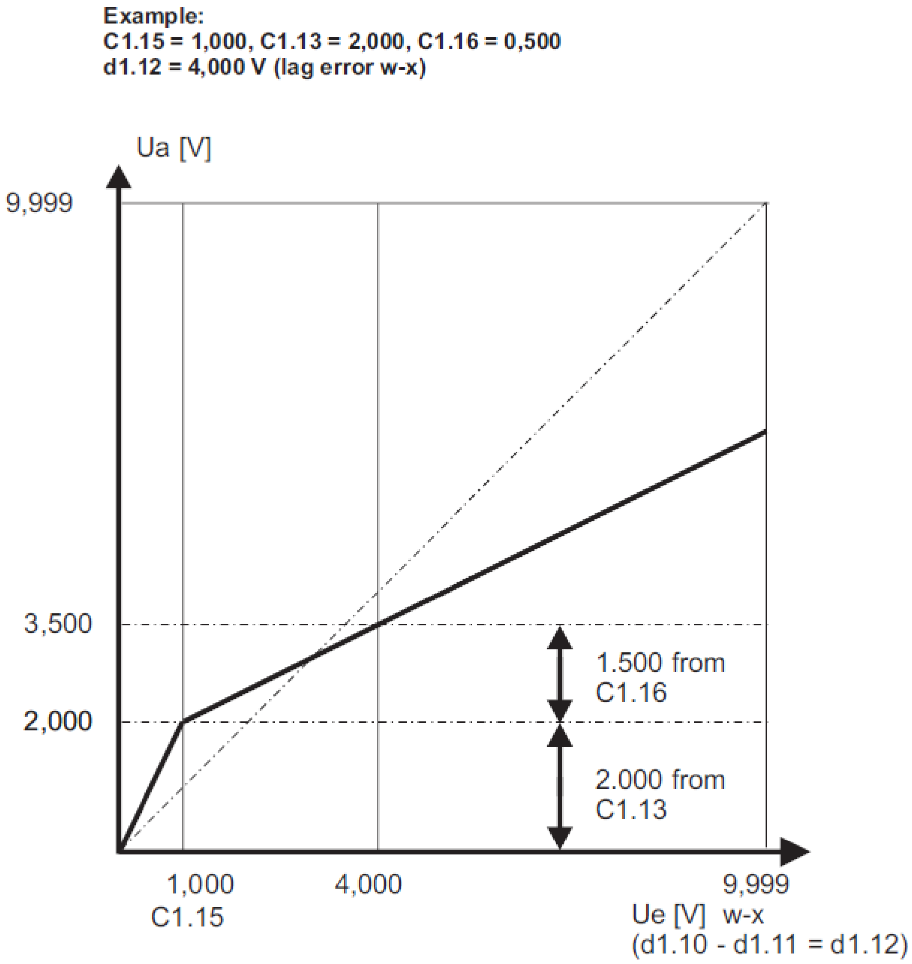


Figure 19 : Diagram function <C1.13> / <C1.15> / <C1.16>

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

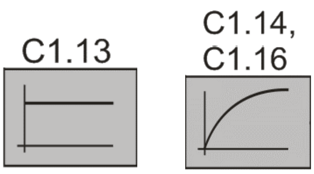
DFF stands for direct feedforward controller.

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

6.7.14.2 Remote loop control <C1.00> = 2 or 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.

For more information about the comparator functionality,
see □ Chapter " 7.2.2 Comparator for remote-loop controllers <C1.00> = 2 or 4", page 69

6.7.15 Safety function <C1.01>

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.

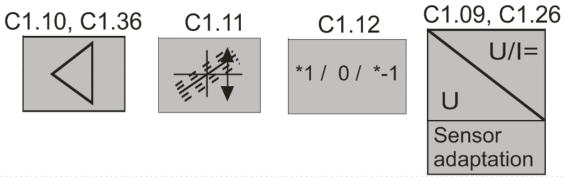
⚠ CAUTION

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 "7.3 Process control loops and safety function", page 70**Fehler! Textmarke nicht definiert.**

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

To choose the appropriate type of sensor for the feedbacks, use parameter <C1.09>.



The following types of sensors are available:

<C1.09>	Input signal range	Wire monitor	Comment
1	0 ... 20 mA	-	---
2	4 ... 20 mA	Yes	---
3	12 mA ± 8 mA	Yes	---
4	0 ... 10 V	-	---
5	0 ... ± 10 V	-	---
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	-	With selection 10, 11 and 12: Only positive controller output possible!
11	4 ... 20 mA	Yes	
12	0 ... 10 V	-	

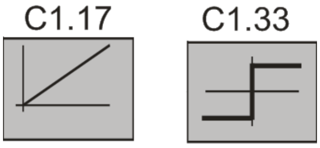
Table 16: Feedback sensor selection

Parameters <C1.11> (offset) and <C1.10> (gain) allow additional fine adjustment. Due to the high resolution and fast cycle time, this function is particularly suitable for valve control applications.

- Selections 10 to 12 are intended for control loops with only positive values; therefore, no negative controller output is possible (e.g. pressure control loops).
- If the sensor signal exhibits different gains or asymmetrical behavior, compensation can be applied using parameter <C1.36>. The gain for positive and negative signals can be adjusted independently.
- Cable break detection for current inputs can be configured using parameter <C1.26>.

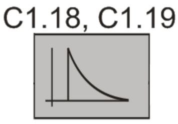
For analog input specifications, see:: See □ Chapter "8.5 Analog inputs", page 79

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



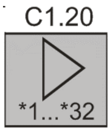
- <C1.17> defines the I-component of the controller (integral controller). The value of <C1.17> is limited to prevent overdrive or saturation. Small values indicate a slow response, while large values indicate a fast response.
- <C1.33> defines the limiting level for the I-component of the controller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

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



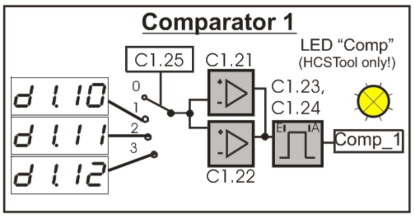
- <C1.18> defines the D-component of the controller and, together with <C1.19>, forms a DT1 element (differential controller).
- <C1.19> defines the time constant for <C1.18> to form a DT1 element.

6.7.19 Additional (P) gain <C1.20>



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

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



- 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 17: The available values for <C1.25>

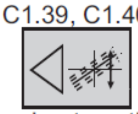
- Parameters <C1.21> and <C1.22> define the comparator window. Both can be set within a range of 0 … ±9.999 V. It is also possible to define a positive, negative, or asymmetrical window. Parameter <E18>, together with <C1.21> and <C1.22>, defines the logic of the comparator output. Note the following 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 "7.2 Comparator“, page 69

6.7.21 Sensor semi-automatic calibration for Fb1 <C1.39>, <C1.40>

C1.39, C1.40



Semi-automatic
calibration
(w. HCSTool only!)

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.

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 18: Semi-automatic feedback calibration procedure

6.7.22 Custom specific curve <L1>

When the corresponding parameter.

L1 table of linearization for C1.02 = 6

is selected in HCSTool, the "Linearization Editor" appears.

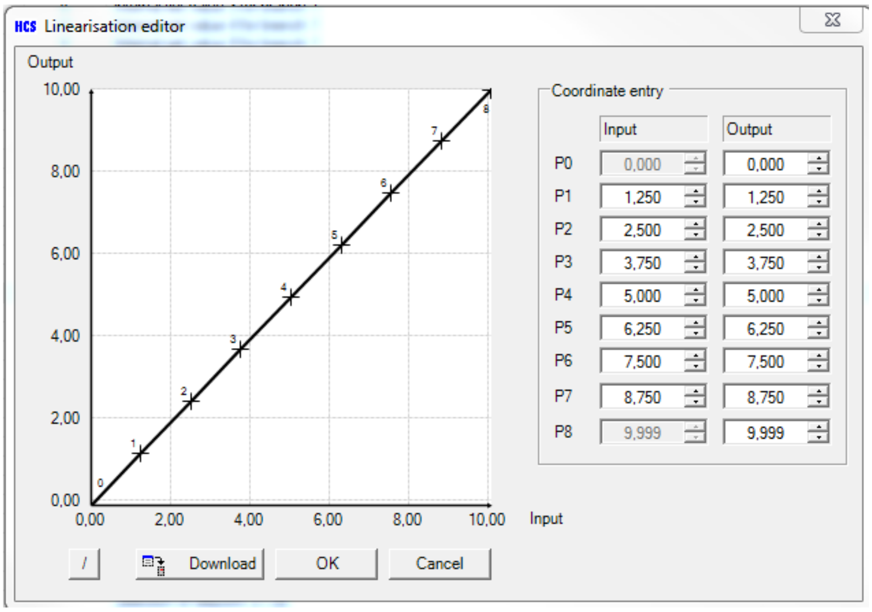


Figure 20 : Start Custom linearization curve by HCSTool

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:

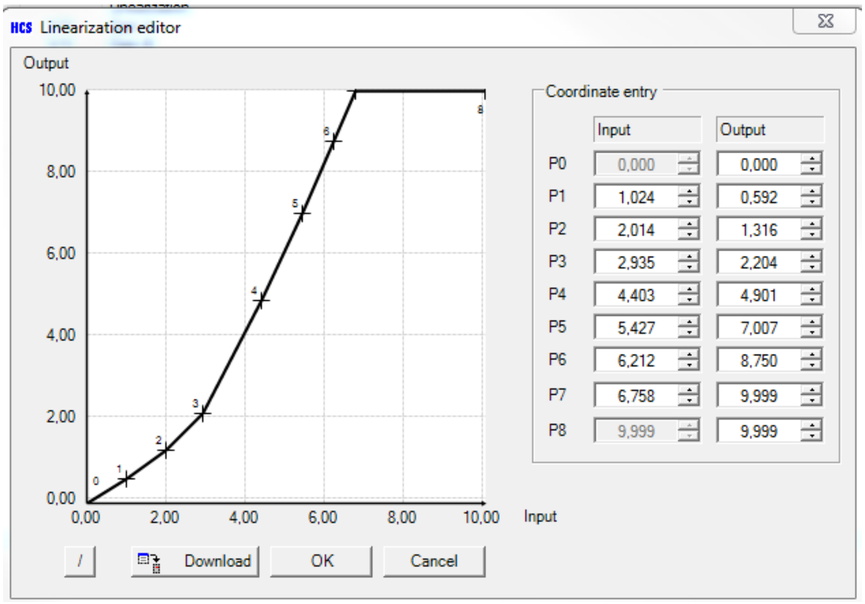
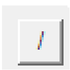


Figure 21 : Definition Custom linearization curve by HCSTool

The button  resets the curve to the linear version.

6.7.23 Operation mode <E00>

At the beginning of commissioning, the application type must be defined, which determines the operating mode of the amplifier card.
The operating mode is set using parameter <E00>.
This parameter is typically predefined by the selected card version. For example, for card version DAC-4x(A)-01-x-Sxxx, <E00> = 1, and for card version DAC-4x(A)-03-x-Sxxx, <E00> = 3.

See □ Chapter "6.2 Operation modes", page 35

6.7.24 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 19: <E02> selection

Short-circuit and overload protection between the outputs is always active, regardless of the setting of <E02>.
If the push-pull function is activated (<E02> = 1 or 5), the solenoid current is distributed between both solenoids at a setpoint of 0.
As the setpoint increases, the current in one solenoid increases accordingly, while the current in the other solenoid decreases.
The push-pull function provides an initial current to the solenoids, thereby improving the dynamic response.

⚠ WARNING

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

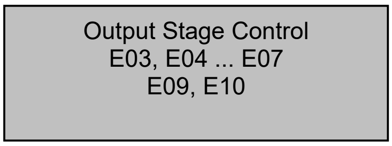
⚠ CAUTION

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".

6.7.25 Output stage parameters <E03>, <E04> to <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.

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.

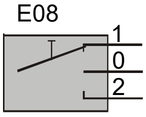
In addition, the controller parameterization has a significant influence on dynamic and static performance. Parameters <Ex.04> and <Ex.05> define the controller behavior for energization, while <Ex.06> and <Ex.07> define it for de-energization.

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.

6.7.26 Type of ramp <E08>

E08



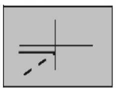
This parameter defines the type of ramp that should be used

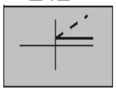
<E08>	Description
0	constant time base (affects only digital setpoints)
1	constant rise rate (effects all setpoints, digital and analog)
2	The ramp function can be enabled or disabled (note: this is not shown in the block diagrams of the operating modes).

Table 20: <E08> selection

6.7.27 Initial current <E11>, <E12>

E11 E12

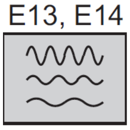




This parameter specifies the initial current of up to 30% of the nominal output current.
The offset current is used to adjust the center position of the proportional valve or the system, if required.

6.7.28 Dither signal <E13>, <E14>

E13, E14



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).

6.7.29 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 21: <E15> selection

See □ Chapter "8.5 Analog inputs", page 79

6.7.30 Selection of setpoint S1.05 <E16>

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 22: <E16> selection

See □ Chapter "8.5 Analog inputs", page 79

6.7.31 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	4 digital setpoints are activated
1	All analog setpoints are activated	5 digital setpoints are activated
2	All analog setpoints are deactivated	4 digital setpoints are activated
3	All analog setpoints are deactivated	5 digital setpoints are activated

Table 23: <E17> selection

6.7.32 Selection of digital output signal; Break and Comparator <E18>

This parameter is used to define the logic for the comparator and break output signals.

Parameter <E18> determines which signal is used to control the comparator and/or break output.

- Comp1: Output of comparator 1 (defined by parameters <C1.21> to <C1.25>)
- Comp2: Output of comparator 2 (defined by parameters <C2.21> to <C2.25>)
- Comp: Logical OR combination of Comp1 and Comp2

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

The following selection for the output is possible with parameter <E18>:

<E18>	Comparator output	Break output
off	Comp. positive logic	Off, 0V
1	Comp. positive logic	On, (Supply voltage output)
2	Comp. positive logic	Follows Comp. logic
3	Comp. positive logic	Inverted Comp. logic
4	Comp. negative logic	Inverted Comp. logic
5	Comp. negative logic	Follows Comp. logic
6	Comp. positive logic	Follows Comp1. logic
7	Comp. positive logic	Inverted Comp1. logic
8	Comp. negative logic	Inverted Comp1. logic
9	Comp. negative logic	Follows Comp1. logic
10	Comp. positive logic	Follows Comp2. logic
11	Comp. positive logic	Inverted Comp2. logic
12	Comp. negative logic	Inverted Comp2. logic
13	Comp. negative logic	Follows Comp2. logic

Table 24: <E18> selection

6.7.33 Analog output <E01>, <E 31>

Any internally measured value can be output as an analog signal at terminal [10b] using parameter <E01>.
This signal is available as either a voltage or current signal with a resolution of 12 bit. The signal type (voltage or current) is selected using parameter <E31>.

<E31>	Description
1	Voltage output ± 10 V is selected
2	Current output 12 mA ± 8 mA is selected

Table 25: <E31> selection

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.

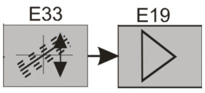
Parameter <E01> selects the display parameter. It can be used to output all internal voltage values <dx.xx> available in the corresponding operating mode.

The output value can be adjusted using an offset and/or an additional scaling factor, see □ the following page.

Also:

See □ Chapter "8.6 Analog outputs", page 80

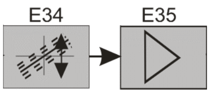
6.7.34 Voltage analog output, offset and factor <E19>, <E33>



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

The voltage output is linked to the enable input on the hardware side.
A valid signal must be present at the enable input for the voltage output to be active.

6.7.35 Current analog output, offset and factor <E34>, <E35>



An additional offset of 12 mA ± 8 mA can be applied to the output signal using parameter <E34>.
Parameter <E35> allows scaling of the output signal with a factor from 0.00 to 2.00.

6.7.36 Selection of setpoint S1.07 <E32>

This parameter is used to select the type of analog setpoint <S1.07>.
If a current input is selected, the measuring resistor is automatically activated.

<E32>	S1.07 Input signal range	Wire break 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 26: <E32> selection

See □ Chapter "8.5 Analog inputs", page 79

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

$T_{ab} = 80µs$

7 Functions

7.1 *Display parameters d1.01> to <d1.13>, <d2.01> to <d2.13>*

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

d 1.01

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.

All internally calculated values can also be output to one of the two analog outputs.

See □ Chapter “6.7.33 Analog output <E01>, <E 31>”, page 66

⚠ 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 analogous setpoints
d1.02	Sum setpoints after ramp function
d1.03	Setpoints after linearization
d1.04	Setpoints after gain adjustment
d1.05	Signal to solenoid A
d1.07	Signal to solenoid B
d1.08	Actual current A
d1.09	Actual current B
d1.10	Total current

	Mode
Only available for	03, 04, 06, 08, 10, 11
d1.11	Actual value, feedback input (x)
d1.12	Lag error, deviation between command and feedback (e)
d1.13	Controller output (y)

	Mode
Only available for	02, 06, 08
d2.01	Sum analog setpoints
d2.02	Sum setpoints after ramp function
d2.03	Setpoints after linearization
d2.04	Setpoints after gain adjustment

	Mode
Only available for	06, 08
d2.10	setpoint, reference input (w)
d2.11	Actual value, feedback input (x)
d2.12	Lag error, deviation between command and feedback (e)
d2.13	Controller output (y)

Table 27: Display parameters

7.2 Comparator

For the comparator explanation, see □ Chapter "6.7.20 Comparator <C1.21> to <C1.25>", page 59

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

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

The monitoring function is used with control circuits (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.

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

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 «RP0»

Reset Ramp (DI 2)	actual value > or < switching threshold	Function	LED «RP0»
Low	inconsequential	open loop	off
High	<	open loop	on
High	>	closed loop	flashes

Table 28: Switching controller status

Unfortunately, the LED **«RP0»** displayed in the HCSTool cannot display the flashing status.

7.2.3 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

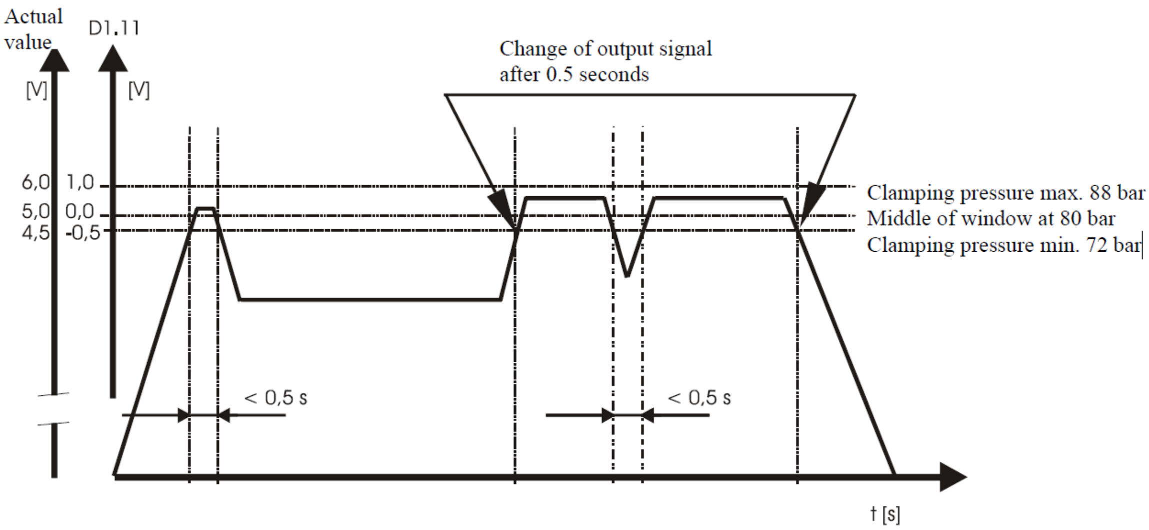


Figure 22 : Clamping pressure monitoring

7.3 Process control loops and safety function

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

CAUTION

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

The internal setpoint used after the emergency stop defines the machine end position, preferably the 'home position'.
The drive velocity 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	Terminal	Signal
1	emergency-stop activated power off	Usupply	32bd	0 V
		Enable	8d	0 V
2	supply on enable activated setpoint inputs at 0 V setpoint direction	Usupply	32bd	high
		Enable	8d	high
		S1.01 to S1.04, S1.08	8z, 4d, 6d, 6z, 2b	0 V
		+ , -	4z, 2z	-
3	The setpoint for the controller becomes independent of the actual setpoint. set to the actual feedback value. The control deviation is therefore 0 V			
4	The controller now holds the position and any drift is compensated for by the controller.			
5	Activate the normal mode of operation; all setpoints are processed once again	Usupply	32bd	high
		Enable	8d	high
		S1.01 to S1.04, S1.08	8z, 4d, 6d, 6z, 2b	At least one high
		+ , -	4z, 2z	One high
6	Drive goes to start position. The start position corresponds to the active setpoints. The selected digital setpoint and the analog setpoint are used.			

Table 29: Safety function logic table

7.4 Output stages

- PWM output stages are used to reduce power losses at higher current output and designed for constant currents of 3.5 A.
- Linear output stages are used for lower current output and designed for constant currents of 0,1 A. each. Current Output up to 0,2 A for < 30 s is possible.
- The pulse frequency is up to 50 kHz
- The output stages are equipped with over drive and high-speed breaking to increase dynamic response
- Parameter <E03> sets the nominal solenoid current. There are different standard settings available Further, there is an infinitely variable reduction possible with the parameter <E10>.

See □ Chapter "6.7.25 Output stage parameters <E03>, <E04> to <E07>, <E09>, <E10>", page 63

7.4.1 Adjustment of the actual value signal Fb1

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

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.

Detailed step by step adjustment description:

⚠ 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 30: Feedback signal adjustment

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

7.4.2 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>).

7.4.3 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..

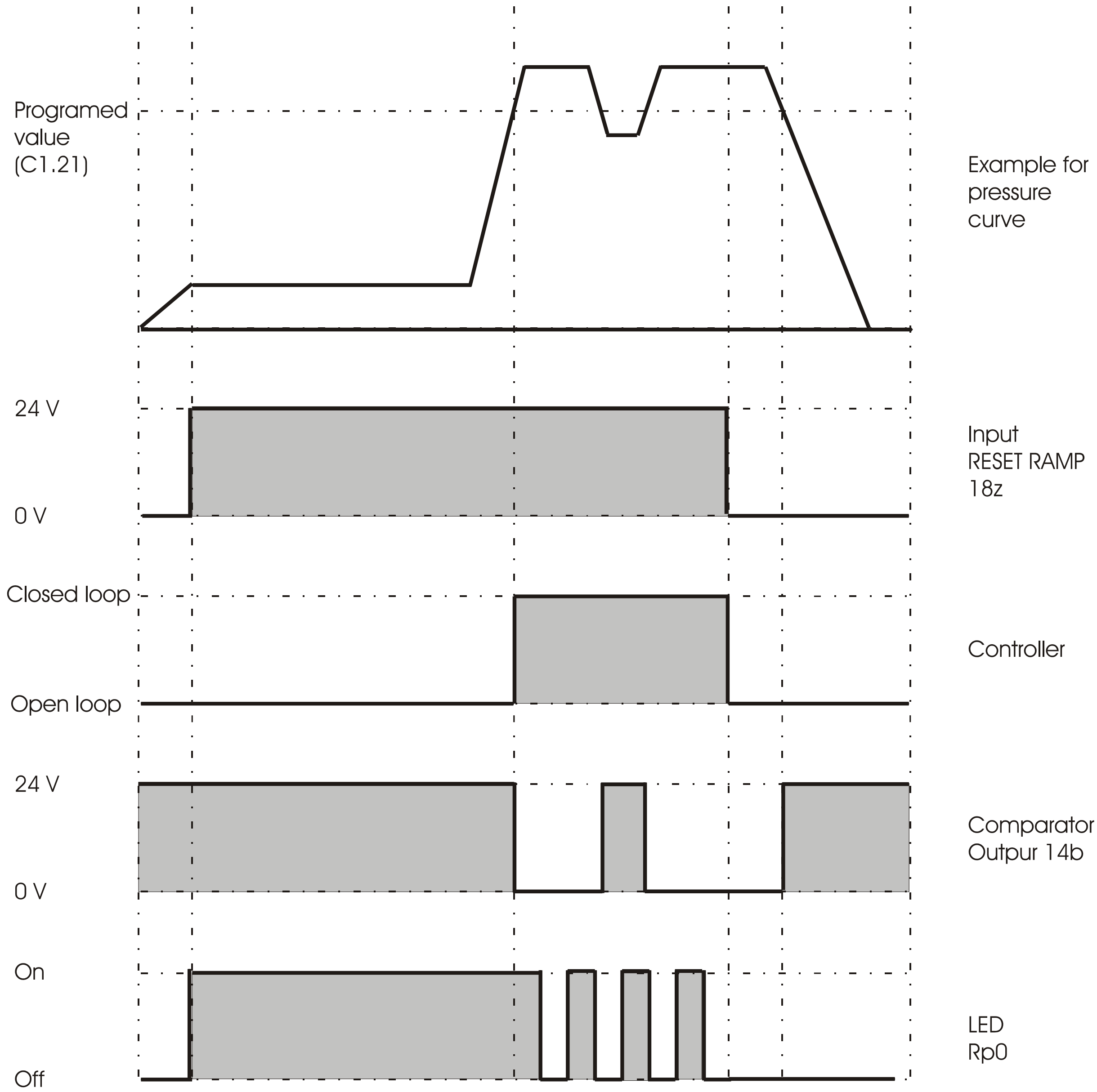
**<C1.23> has no function when the “remote loop controller” is active.
<C1.24> can be used to delay controller activation.**

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

7.4.4 Functional diagram for remote loop control

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



7.5 Control circuits with two control loops (mode 6, 7, 8, 11)

7.5.1 Adjustment FB2

The adjustment procedure is identical to that described for FB1.

Depending on the setting of <E20>, only a limited selection of sensor signals is available.

7.5.2 Control systems with two control loops (general)

Both control loops operate with the same cycle time of 100 µs.

In cascade control applications (modes 6 and 11), the first control loop is typically used as the inner loop, while the second control loop is used as the outer loop.

In mode 4, the first control loop is used for the inner loop of valve position control.

In mode 11, the first control loop regulates velocity, while the second regulates cylinder position.

When using cascade control, the inner loop must be activated first.

In the standard configuration, FB1 (feedback signal 1 at terminal 10d) is assigned to control loop 1, and FB2 (feedback signal 2 at terminal 14z) is assigned to control loop 2.

If a different assignment is required, parameter <E20> can be used.

7.5.3 Control systems with two control loops, safety function, and remote loop control

In cascade controllers, both the safety function and the remote loop controller are applied to the process value.

Therefore, it is generally recommended to assign each function to a separate control loop.

For further information or application-specific recommendations, please contact the manufacturer..

8 Inputs, outputs and messages

8.1 *Status LED´s*

Power LED: ON → Device is supplied with power (via external supply or USB interface).

Error LED: ON → An error has occurred

Enable LED: ON → Signal at terminal [8d] is applied

8.2 *Digital inputs*

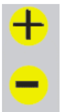
All inputs are electrically isolated via opto-couplers.
If electrical isolation is not required, the following terminals must be bridged:

- [2d] → [26d]
- [32z] → [32bd]

Bridging these terminals disables the electrical isolation of the inputs.

The following LEDs indicate the status of specific digital input signals:

RP0: ON →Signal at terminal **[18z]** is applied.
IO1, IO2, IO3: ON → ON: Signal at the corresponding terminal is applied
IO1 → [2b]; IO2 → [4b]; IO3 → [6b] (
SP1, SP2, SP3, SP4: ON → Digital setpoint signal at the corresponding terminal is applied
SP1 → [8z]; SP2 → [4d]; SP3 → [6d]; SP4 → [6z]



"+" direction: Indicates a positive digital setpoint direction
"-" direction: Indicates a negative digital setpoint direction

See □ Chapter "6.7.2 Programmable setpoints", page 50

8.2.1 Enable Signal and Output Stage Activation

After the enable signal is applied to terminal [18z], the LED "EN" lights up in yellow.
If a time delay has been configured via parameter E9, the LED "EN" will flash yellow for the duration of the delay period.
Once the delay has elapsed, the flashing changes to a continuous signal, indicating that the output stages are enabled.

Behavior Without Enable Signal:

If no enable signal is applied:

- The output stages remain hardware-disabled
- All setpoint inputs are ignored

The enable signal is a mandatory condition for activating the output stages and processing setpoint inputs.

8.2.2 Reset ramp (ramp = 0)

A high signal at the reset ramp input ([18z]) immediately deactivates the ramp function generator. As a result, all setpoints become ineffective.
This condition is indicated by the LED “RP0”.

Once the reset signal is removed:

- The ramp function generator restarts from zero
- The predefined time constants are applied

The following parameters define the ramp behavior:

- r1.01 to r1.04
- r2.01 to r2.04

The ramp always restarts from zero after a reset, regardless of the previous operating state.

State	Condition	Behavior	LED Ind ication
Disabled	Enable = OFF	Outputs locked, no setpoint processing	EN OFF
Enable Delay	Enable = ON, delay active (<E9>)	Waiting phase	EN flashing
Active Control	Enable = ON, delay finished	Normal control with ramp	EN ON
Ramp Reset	Reset = HIGH	Ramp stopped, setpoints ignored	RP0 ON
Ramp Restart	Reset = LOW	Ramp starts from zero	RP0 OFF

8.2.3 Programmable setpoints, directions and polarity signs

Four LEDs indicate the currently selected setpoints:

- SP1 → Parameter S1.01
- SP2 → Parameter S1.02
- SP3 → Parameter S2.01
- SP4 → Parameter S2.02

Additionally:

- DIO1 indicates the input status for parameter S1.08

Two LEDs indicate the selected direction:

- “+” → Positive direction
- “–” → Negative direction

These LEDs are also used to display the polarity of:

- Measured values
- Parameter values

The “+” and “–” LEDs provide a general indication of signal polarity throughout the system.

8.3 Digital Outputs and Electrical Isolation

The outputs error [14d], comparator [14b], and break [20b] are electrically isolated via optocouplers.
All outputs are short-circuit protected, except for the break output [20b], which is not protected.
If electrical isolation is not required, the following terminals must be bridged:

- [2d] → [26d]
- [32z] → [32bd]

Bridging these terminals disables the electrical isolation of the outputs.
All fault messages, as well as the status of the comparator, can be monitored using the HCSTool software

8.3.1 Comparator output

The output is short-circuit protected and can drive non-inductive loads up to 50 mA.
For the special function of the output as a comparator output, please refer to the corresponding section:

See □ Chapter "6.7.20 Comparator <C1.21> to <C1.25>", page 59

8.3.2 Fault (error)

The output is short-circuit protected and can drive non-inductive loads up to 50 mA.
If an internal error is detected (e.g. overcurrent or wire break), the signal at the "Error" output terminal [14d] is set to 0 V. At the same time, the "ER" LED lights up red.
This condition remains active until the cause of the error has been resolved and the error is reset by disabling and re-enabling the card.
For a list of possible errors, please refer to the corresponding section:

See □ Chapter "8.8 Display and error messages", 80

8.3.3 Break output

The break output is electrically isolated from the main supply.
It is designed to directly switch inductive loads up to 1 A / 24 V, allowing, for example, direct control of a valve.
The break output is implemented as an open-drain output and is available at terminal [20b]. The corresponding ground connection is provided at terminal [2d].
Ensure that the supply voltage provided at terminal [32z] is capable of supplying the connected load.
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The output itself is not short circuit protected!

8.4 Test jacks

The sockets "A" and "B" can be used to measure the solenoid currents independently. The measurement voltage is approximately 1 V per 1 A.
The analog setpoint S1.06 can be measured at the socket "SET". The signal is proportional to the internal value, with a scaling of 1:1 (corresponding to half the setpoint voltage).
At the socket "FB1", the analog actual value of the feedback (d1.11) can be measured. The output signal is proportional to the actual value and follows a 1:1 relationship.
At the monitor socket "MON", all display parameters are available as an analog voltage signal in the range of ±10 V.

8.5 Analog inputs

All analog inputs S1.05, S1.06, S1.07, FB1, and FB2 can be configured as either voltage or current inputs.
When an input is configured as a current input, an internal measuring resistor of 255 Ω is automatically activated.
If cable break monitoring is enabled, the system also monitors for undercurrent conditions. An error is triggered if the input current falls below approximately 2 mA.
The inputs are protected against overload. If the signal current exceeds approximately 23 mA, the input is automatically shut down to protect the hardware. In this case, an error is triggered and the corresponding error message is generated. After an overload condition, the input remains disabled until the fault condition is cleared.

8.6 Analog outputs

Two analog outputs are available:

- “AOUT” at terminal [10b]
- “MON” at the test socket

The analog output at [10b] can be configured as either a voltage or a current output via the corresponding parameter.
The monitor output “MON” provides access to internal signals as an analog voltage.

See □ Chapter “8.6 Analog outputs“, 80

8.7 Reference output “±10V”

An integrated reference voltage supply is available:

- +10 V at terminal [20z]
- –10 V at terminal [20d]

The maximum output current is 10 mA. This supply can be used to power a setpoint potentiometer or an actual value transducer.
The reference voltage output is independent of the enable signal of the card.

8.8 Display and error messages

If an error occurs, it is indicated on the 7-segment display and within the HCSTool software.
Defined error and status messages are available for diagnostic purposes:

Error number	Description of error/message
1	General operation error
2	Wire break at sensor 1 (**FB1**)
3	Excess current or short circuit at the output stages
4	Wire break sensor 2 (FB2)
5	Wire break or over voltage at setpoint input S1.05
6	Wire break or over voltage at setpoint input S1.06
7	Wire break or over voltage at setpoint input S1.07
8	Wire break at the output stages
10	PROFIBUS timeout (<E23>) occurred
11	Negative current or overload>22mA sensor 1 (FB1)
12	Negative current or overload>22mA sensor 2 (FB2)
15	Negative current or overload>22mA at input S1.05
16	Negative current or overload>22mA at input S1.06
17	Negative current or overload>22mA at input S1.07
23	Calibration error (unsuccessful semi-automatic calibration)
26	Communication error with the LVDT daughter card.
27	Communication error with the LVDT daughter card.
28	Wire break detected at the LVDT sensor (FB1)
29	Wire break detected at the LVDT sensor (FB2)

Table 31: List of error messages

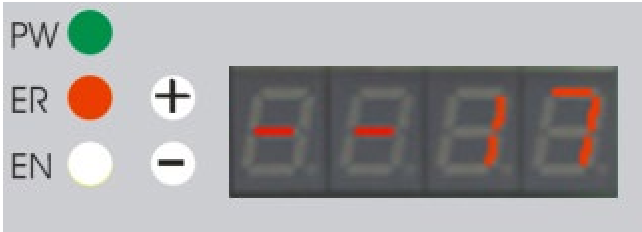

Figure 23 : Example of Error message at the 7-segment display

9 Detailed electrical data

(For applications outside these specified parameters, please consult us!)

Supply voltage nom. 24V=	Min 12 V= -10 % Max 24V= +20 % Residual ripple < 10 %
Power consumption. VA VA VA	4, solenoid not energized 43, one solenoid energized with 3.5 A 82, both solenoids energized with 3.5 A
Solenoid output Iout PWM frequency Cycle time current controller	Rectangular, pulse-modulated voltage with over-energization and quick de-energization Output stages are hardware disabled. 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} = -15V Typ. R_{in} = 200 kΩ Differential input S6 Typ. R_{in} = 333 kΩ Input S5, S7 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} = 0.8 mA Typ. I_{in} = 2.2 mA U_{in} < 3 V U_{in} > 6 V
Digital Output Error, Comparator Supply 24 V Supply 12 V Break 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 I_{outmax} typ. 20 mA Typ. U_{out} > 8 V @I_{out} 2 mA Typ. U_{out} > 5 V @I_{out} 10 mA, I_{outmax} < 1 A I_{outmax} < 1 A
Analog output Voltage is selected Current is selected	-10 V … + 10V, tol. ±0.020 V The voltage output is hardware disabled 4 mA … +20 mA, tol. ±0.020 mA
Reference Output	+ 10 V, tol. ±0.1 V - 10 V, tol. ±0.1 V max. load 10 mA
Control loop Cycle time	100 µs For all PIDT1 or Dff controllers

Table 32: List of error messages

10 USB-C interface

10.1 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.
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⚠ WARNING
The DAC's USB port is not galvanically isolated. For protection, the use of a USB isolator (adapter) is strongly recommended.

10.2 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

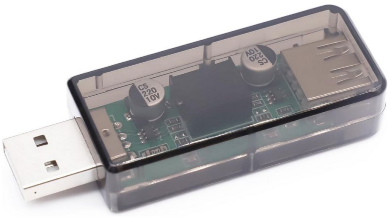

Figure 24 : Galvanically Isolated USB Adapter

10.3 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.

10.4 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)

10.5 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

10.5.1.1 Using HCSTool

Figure 25 : 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 the **HCSTool** main screen (DAC-4x(A)-03 with software version V1.12).

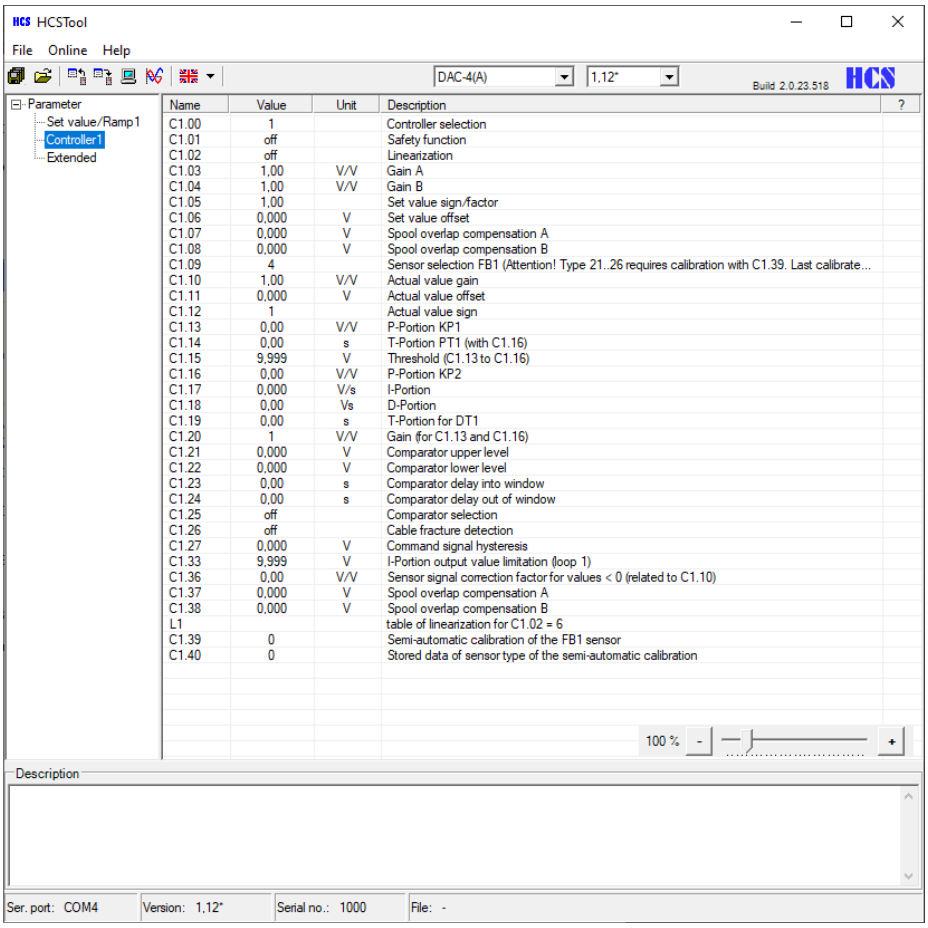

Figure 26 : HCSTool working area screen

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 of editing parameter <C1.05>

:

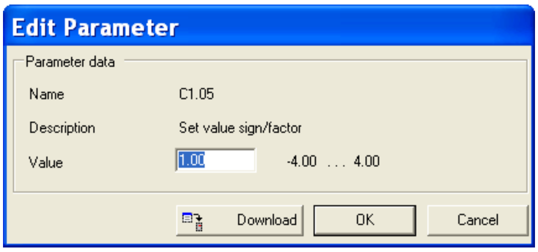

Figure 27 : HCSTool Parameter editing

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.

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11 Complete parameter list

		Mode
1	Parameters only available for **mode**	01, 03, 04, 06, 10, 11
2	Parameters only available for **mode**	03, 04, 06, 08, 10, 11
3	Parameters only available for **mode**	02, 08
4, 5	Reserved	
6	Parameters only available for PROFINET/PROFIBUS versions; SW V10.xx and V11.xx. , **for mode**	01, 02, 03, 04, 06, 08, 10, 11
Remark:	Parameters “d2.x, S2.x, r2.x and C.2x” only available for (not shown in table 11), **for mode**	02, 06, 08, 11

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		Setpoints 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 output stage A	---	0.001	-9.999	+9.999
d1.06		Signal to output stage B	---	0.001	-9.999	+9.999
d1.07		Current output A	A	0.001	-1.000	+1.000
d1.08		Current output B	A	0.001	-1.000	+1.000
d1.09		Normalized current A+B	V	0.001	-9.999	+9.999
d1.10		Desired value (w)	V	0.001	-9.999	+9.999
d1.11	2	Actual value, feedback value (x)	V	0.001	-9.999	+9.999
d1.12	2	Lag error (e)	V	0.001	-9.999	+9.999
d1.13	2	Controller output (y)	V	0.001	-9.999	+9.999
Setpoint parameters: Digital setpoints						
S1.01		Internal setpoint 1	V	0.001	-9.999	+9.999
S1.02		Internal setpoint 2	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
S2.01	3	Internal setpoint 1 branch 2	V	0.001	-9.999	+9.999
S2.02	3	Internal setpoint 2 branch 2	V	0.001	-9.999	+9.999
S1.08		Internal setpoint 8	V	0.001	-9.999	+9.999
Auxiliary parameters: Helper setpoints						
A1.01		Helper setpoint 1	V	0.001	-9.999	+9.999
A1.02		Helper setpoint 2	V	0.001	-9.999	+9.999
A2.01	3	Internal setpoint 1 branch 2	V	0.001	-9.999	+9.999
A2.02	3	Internal setpoint 2 branch 2	V	0.001	-9.999	+9.999
Ramp parameters for setpoints						
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
r2.01		Ramp from 0 □ - (branch 2)	S	0.01	0.000	39.50
r2.02		Ramp from – □ 0 (branch 2)	S	0.01	0.000	39.50
r2.03		Ramp from 0 □ + (branch 2)	S	0.01	0.000	39.50

Controller parameters:							
#	v	Function	Unit	Step	Min	Max.	Code
C1.00	2	Controller selection	---	1	0	4	0 = off 1 = P-PT1-I-DT1 2 =Remote 3 =dff 4 =Remote + dff
C1.01	2	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		Setvalue sign and factor	---	0.01	-4.00	4.00	---
C1.06		Setvalue offset	V	0.001	-9.999	+9.999	---
C1.07		Spool-overlap compensation negative	V	0.001	0.000	+9.999	9.999 V = max. current depending on
C1.08		Spool-overlap compensation positive	V	0.001	0.000	+9.999	current selection E03
C1.09	2	Sensor type *1 *1, Attention: No negative controller output possible when 10, 11 or 12 is selected!	---	1	1	12	1 = 0 ... 20 mA 2 = 4 ... 20 mA 3 = 12 mA ± 8 mA 4 = 0 ... 10 V 5 = 0 ... ± 10 V 6 = 6 V ± 2,5 V 7 = 7,5 V ± 2,5 V 8 = 6 V ± 4 V 9 = 7,5 V ± 2,5 V 10 = 0 ... 20 mA 11= 4 ... 20 mA 12 = 0 ... 10 V
C1.10	2	Actual value gain	V/V	0.01	0.00	4.00	---
C1.11	2	Actual value offset	V	0.001	-9.999	+9.999	---
C1.12	2	Actual value sign	---	---	- 1	+ 1	- 1 = negative off = off + 1 = positive
C1.13	2	P-Portion KP1	V/V	0.01	0.00	4.00	---
C1.14	2	T-Portion for PT1 (to <C1.16>)	S	0.001	0.000	10.00	---
C1.15	2	Threshold (<C1.13>, <C1.16>)	V	0.001	0.000	+9.999	---
C1.16	2	P-Portion KP2	V/V	0.001	0.000	4.00	---
C1.17	2	I-Portion	V/s	0.001	0.000	4.00	---
C1.18	2	D-Portion	Vs	0.001	0.000	4.00	---
C1.19	2	T-Portion for DT1	S	0.001	0.000	10.00	---
C1.20	2	Gain (<C1.13> and <C1.16>)	V/V	1	1	32	---
C1.21	2	Comparator upper level	V	0.001	-9.999	+9.999	---
C1.22	2	Comparator lower level	V	0.001	-9.999	+9.999	---
C1.23	2	Comparator delay into window	S	0.001	0.000	+99.99	---
C1.24	2	Comparator delay out of window	S	0.001	0.000	+99.99	---
C1.25	2	**Comparator selection**	---	1	0	3	off = off 1 = Setpoint 2 = Actual value 3 =Lag error
C1.26	2	Cable fracture detection feedback	---	---	off	1	off = off; 1 = active
C1.27		Command signal hysteresis	V	0.001	-9.999	+9.999	---
C1.33	2	I-Portion output value limitation	V	0.001	0.000	+9.999	---
C1.36	2	Sensor signal correction factor for values < 0 (related to C1.10)	V/V	0.01	-1.00	+1.00	
L1		Table for linearization	---	---	---	---	Adjustment of 8 individual points

Same for C2.xx parameters!

Extended-Parameters: Basic adjustments							
#		Function	Unit	Step	Min	Max.	Code
E00		Operation mode	---	---	1	11	1 = Open loop one valve 2 = Open loop two valves 3 = Closed loop one valve 4 = Closed loop on application 5 = reserved 6 = Closed loop valve/application 7 = reserved 8 = Closed loop application/ application 9 = reserved 10 = Closed loop no valve one feedback 11 = Closed loop no valve two feedback
E01	5	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		Solenoid selection	---	---	0.800	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	---
E05		I-Portion current contr. Energization	---	1	0000	9999	---
E07		P-Portion current contr. de-energization	---	1	0000	9999	---
E08		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
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
E14		Dither Frequency	Hz	1	1	300	---
E15		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 observat. 5 = 5 V ± 4.5V with signal observat. 6 = 0 ... 20 mA w/o cable fract. detect. 7 = 10 ± 10 mA w/o fract. detect. 8 = 4 ... 20 mA w/o fract. detect. 9 = 4 ... 20 mA with fract. detect. 10 = 12 ± 8 mA w/o fract. detect. 11 = 12 ± 8 mA with fract. detect.

Extended-Parameters: Basic adjustments							
#		Function	Unit	Step	Min	Max.	Code
E16		Selection setpoint input S1.06	---	1	Off	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 observat. 5 = 5 V ± 4.5V with signal observat. 6 = 0 ... 20 mA w/o cable fract. detect. 7 = 10 ± 10 mA w/o fract. detect. 8 = 4 ... 20 mA w/o fract. detect. 9 = 4 ... 20 mA with fract. detect. 10 = 12 ± 8 mA w/o fract. detect. 11 = 12 ± 8 mA with fract. detect.
E17		Setpoint activation mode	---	1	off	3	off = 4 digital, 3 analog active 1 = 5 digital SP, 3 analog active 2 = only 4 digital active 3 = only 5 digital active
E18		Error / Comparator output selection Modus 1,2	---	1	off	1	off = break off 1 = break on
		Modus 3,4,10,11	---	1	off	5	off = break off, comp. positive logic 1 = break on, comp. positive logic 2 = break follows comp. positive logic 3 = break not and comp. positive logic 4 = break and comp. negative logic 5 = break not and comp neg. logic
		Modus 6,8	---	1	off	13	off = break off, comp. positive logic 1 = break on (supply) comp. pos. log 2 = break follows comp., comp. pos. log 3 = break log. not comp., comp. pos. log 4 = break log. not comp., comp. neg. log 5 = break a. comp. same, comp. neg. l. 6 = break follow Comp1, comp. pos. log 7 = break log. not Comp1, comp. pos. l. 8 = break log. not Comp1, comp. neg. l. 9 = break a. Comp1 same, comp. neg. l. 10 = break follow Comp2; comp. pos. l. 11 = break log. not Comp2, comp. pos. l. 12 = break log. not Comp2; comp. neg. l. 13 = break a. Comp2 same, comp. neg. l
E19	5	Output factor for analog voltage output	---	0.01	-2.00	+2.00	---
E22	6	BUS slave address	---	1	Off	12	For more information see the separate documentation for Products with bus interfaces
E23	6	BUS timeout	s	0.001	0.000f	9.999	
E26	6	BUS timeout error handling	---	1	Off	1	
E31	5	Mode of the analog output	---	1	1	2	1 = Voltage mode 0 V ± 10 V 2 = Current mode 12 mA ± 8 mA
E32		Selection setpoint input S1.07	---	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 observat. 5 = 5 V ± 4.5V with signal observat. 6 = 0 ... 20 mA w/o cable fract. detect. 7 = 10 ± 10 mA w/o fract. detect. 8 = 4 ... 20 mA w/o fract. detect. 9 = 4 ... 20 mA with fract. detect. 10 = 12 ± 8 mA w/o fract. detect. 11 = 12 ± 8 mA with fract. detect.
E33	5	Offset for analog voltage output	V	0.001	-9.999	+9.999	---
E34	5	Offset for analog current output	mA	0.001	-9.999	+9.999	---
E35	5	Output factor for analog current output	---	0.01	-2.00	+2.00	---

Table 33: Parameter list

12 Declaration of Conformity

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 Card
Intended use	Automation systems (industrial applications)
Model:	**DAC-4x(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 EU 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 28 : Declaration of conformity

- End -