Manual for

DAC-4x(A)-08-PpQ

DIGITAL AMPLIFIER AND CONTROLLER CARD FOR ALL KIND OF PROPORTIONAL VALVES

	Model Code	SW Version	Remarks
Applicable for SW Versions	DAC-4x(A)-08-x-PpQ with power limitation parameters	V67.xx	xx = 01 or higher * = a, b, …. x = additional options All SW versions are working in the control mode 14
	DAC-42A)-08-x-EIP-SPpQ with power limitation parameters and EtherNet-IP interface [1)]	V68.xx	
	DAC-42A)-08-x-PN-SPpQ with power limitation parameters and PROFINET interface [1)]	V69.xx	

[1)] **For the Bus Version, please refer also the related BUS documentation**

*) picture versions with PROFINET and without bus interface

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Revision History

Revision	Date	Author	Description
1.0	27.08.2024	Bm	First edition
1.0	06.09.2024	Bm	Parameter ID (171..174) hex address corrected
1.0	10.10.2024	Bm	Page 41 where the typo and addition explanation

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	**M**icro **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
PpQ	The unit controls displacement or flow (Q), pressure(p) and power or torque(P)
pQ	The unit controls only displacement or flow (Q) and pressure (p)

Table 1: Abbreviations

2 Terms and Definitions

Term	Description
Amplifier Card	Amplifier for 19” rack system in Eurocard format
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
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 and controller card “DAC-4x(A)-x-PpQ”.

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

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

3.2 Scope

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

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

3.2.1 Copyright

3.2.2 Documents place of storage

This manual and all other associated documentation for hardware and software must always be kept in a location where they will be readily accessible and close to the digital amplifier and controller card DAC-4x(A) or the equipment in which it is installed.

3.2.3 Warning signs, symbols and notes

⚠ DANGER
Identifies safety instructions that are intended to warn of an immediate and impending danger to life and limb. Failure to observe these safety instructions will – with a very high probability - lead to death, serious personal injury (disablement)!

⚠ WARNING
Identifies safety instructions that are intended to warn of potential danger to life and limb. Failure to observe these safety instructions might lead to death, serious personal injury (disablement)!

⚠ CAUTION
Identifies safety instructions that are intended to warn of slight personal injury. Failure to observe these safety instructions might lead to slight personal injury.

NOTICE
Failure to observe this safety notice can result in property damage!

ⓘ 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
'STATE'	States of a state machine
«ES»	LEDs of the amplifier (for example, «ES»)
< >	parameter name
"…"	Used for references

Table 3: Identifiers

3.2.4 Safety and liability

NOTICE

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

This operating manual represents the knowledge of HCS and during the drafting of this operating manual the greatest possible care was taken. Nevertheless, HCS disclaims any responsibility and liability claims for individual applications of the user. This is particularly true in cases of non-compliance, omissions, faults, misinterpretations and misunderstandings.

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

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

HCS GmbH refuses any liability in case of omission to comply with these requirements.

⚠ **WARNING**

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

To switch off the enable signal (0 V at terminal 8d) is insufficient. In these cases, hydraulic and/or mechanical safety measures to stop the drive must be provided (e.g. through switching valves with position monitoring).

⚠ **WARNING**

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

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

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

NOTICE

Liability for any content of this document is rejected!

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

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

3.2.5 General information

⚠ WARNING

ESD (electrostatic discharge) may damage components on the card. To prevent any damage please always follow the recommendations below!

Discharge static voltage from your body by using best practice.
Work in safe environment and do not use any devices in the working surrounding which could generate or hold static charge. Avoid using the product in areas where floors or surfaces are composed of materials that could generate static charges.

Handle all equipment very carefully and do not touch exposed pins or components.

Store and transport the units only in its original packaging.

⚠ WARNING

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

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

Monitoring the fault signal (terminal 14d) is recommended.

Malfunctions can occur with the following:

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

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

3.5 Correct product use

The digital amplifier and controller cards “DAC-4x(A)-x-PpQ” are used for the following applications:

- Controlling of proportional valves (namely directional control valves); with or without feedback (depending on operation mode).
- Controls the delivery volume of a pump with a proportional or servo valve in terms of pressure and performance, without the need for hydraulic-mechanical control parts.
- For industrial applications only.

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

If used correctly, the safety of the user as well as the safe and proper function of the amplifier DAC-4x(A) is given.

3.6 Non-intended product use

The digital amplifier and controller cards “DAC-4x(A)-x-PpQ” should not be used in the following cases:

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

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

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

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

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

Malfunctions can occur when:

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

3.7 Selection and qualification of personnel

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

3.7.1 Inquiries and ordering

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

See □ Chapter "3.7.1 Inquiries and ordering", page 10

Please pay attention to our general terms and conditions (available on request) and forward orders and enquiries to the companies as listed on our web page:

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 will be available for any necessary technical support.

Germany and other countries without 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 - under any circumstances - to repair the product yourself

After repair, certain adjustments and test procedures must be performed; this can only be made by qualified and authorized personnel. Products that need repair can be sent to the addresses:

See □ Chapter "3.7.1 Inquiries and ordering", page 10

Please enclose a detailed description of the error, malfunction or failure with the sent item and state the serial number and the purchase date. This will speed up the process and guarantees a fast and reliable repair.

See □ Chapter "3.7.1 Inquiries and ordering", page 10

In the case of a fault or a malfunction, your distributor can give you instructions on the phone or in writing before accepting a repair order. For service and repair, we offer experienced and qualified personnel. In case you need our assistance, please contact the address:

See □ Chapter "3.7.1 Inquiries and ordering", page 10

3.7.3 Cleaning, storage, transport

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

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

See □ Chapter "3.7.1 Inquiries and ordering", page 10

CAUTION

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

3.7.4 Delivery state (default setting)

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

3.8 Introduction

The digital amplifier and controller card “DAC-4x(A)-x” features leading edge technology. This electronic device meets the industrial standards for EMC. This ensures a high interference security and low interference emission.

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

The following features distinguish the “DAC-4x(A)-x” series:

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

3.9 General Applications

The amplifier card “DAC-4x(A)-x-PpQ-x” is generally used for

- Controlling of hydraulic motors, - installations and – systems, e.g.:
  - position
  - speed
  - pressure
  - revolutions per minute
  - torque
  - power etc.

- Volume flow control and pressure limiting function of pumps (pQ)
- Additional power/torque limitation function (PpQ)
- Master / slave operation of such pumps

- Controlling of different process values:
  - P/Q controlling
  - pump controlling
  - controlling of pressures
  - controlling of pilot- and main stage
  - cascade controlling of components etc.

This manual especially applies to the PpQ control of pumps with swash plate angel control (flow control), pressure limiting function and power limiting function.

4 Product overview and description

The DAC-4x(A)-x-PpQ is a fully digital PpQ controller unit for high pressure pump which enables users for different industries to achieve better control, faster response time, higher reliability, and cost savings through a reduced overall component count. The DAC-4x(A)-x-PpQ electronically controls displacement (flow), pressure and power on the pump and additional operational costs and environmental impact may be reduced through energy recovery as the control unit allows the pump to be used 100 percent over center, functioning as a motor for counter moving applications like, for example, lifting and lowering.
The DAC-4x(A)-x-PpQ can control a proportional or servo valve, which controls the pump for pressure, power and displacement, without hydraulic-mechanical control parts. It also adds intelligent mooring control and master/slave functions.
Flow control measures the actual swash-plate position from sensor data, comparing the swash-plate angle with the set value and driving the servo or proportional valve accordingly.

Pressure cut-off control measures pressure in both input and output lines with pressure sensors, reducing output levels if actual pressure exceeds the command signal. This adjusts the pump exactly to the application needs. Power cut-off control calculates actual power by measuring pressures and swash plate angle, which is directly proportional to flow.

A master to slave function allows several pumps to be used to facilitate large-scale applications with high flow demand. In this mode the master pump can be used over its full operational and flow span, while the slave pumps follow the master pump settings. A through drive allows multiple pumps from a single shaft.

4.1 Technical features

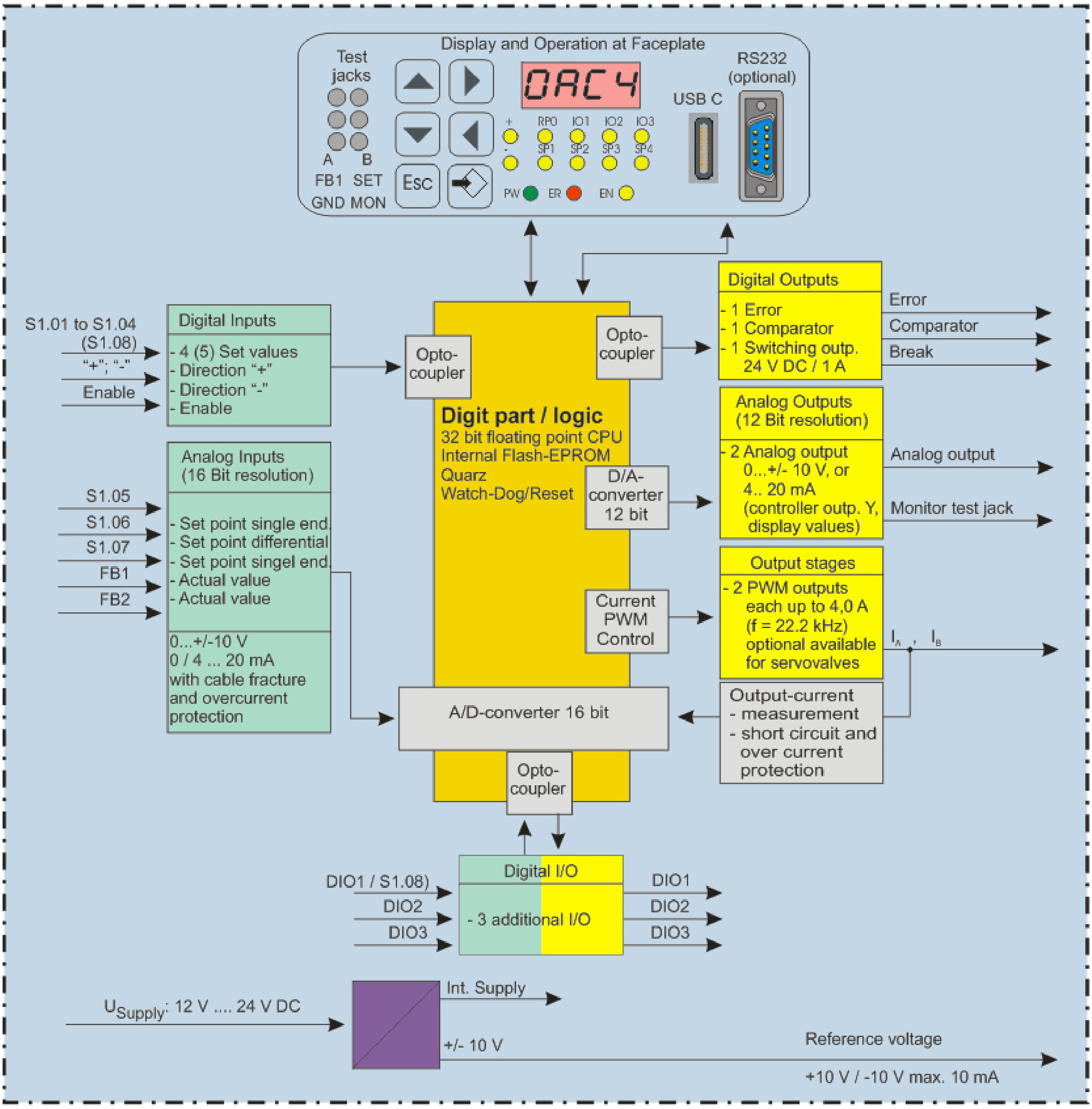
The system features of the DAC-4x(A) are the following:

- Differential amplifier input for set points in the range of 0 ± 10V, resolution 16 bit (flow).
- Single ended set point input in the range of 0 + 10 V, resolution 16 bit (pressure limit)
- Two single ended set point inputs in the range of 0 + 10 V, resolution 16 bit (power / torque limit)
- Integrated reference voltage supply of ± 10 V (10 mA max.), to supply set point potentiometer or actual value transducer.
- 4 recallable digital adjustable set points (2 x flow, 2 x pressure limit).
- Analog feedback input with 16-bit resolution and a high adjustment range. Input signal is selectable by software parameter individual for all feedback signals. All common voltage or current sensors are useable.
  - One analog feedback input for the flow or cylinder position
  - Two independent analog feedback inputs for pressure sensor A / B
- Direction externally set through “+“ and „-“ inputs for the Q-control.
- Enable signal for output stages.
- Reset-Ramp for fast ramp function (zeroing).
- Status outputs "$\overline{\text{error}}$“ and "comparator“.
- All digital inputs and outputs are optically isolated for functional security.
- Four 7-Segment displays and six buttons for easy handling and display.
- Function indication through front panel by LEDs.
- Two PWM output stages for either proportional valve solenoid systems with 0.8 A up to 3.5 A or for servo valves with torque motors and low current ratings from 30 mA to 550 mA (please ask for details regarding servo valve versions)
- Additional switching output (24 V, max 1 A); e.g. to directly disable safety valve.
- Two analog outputs to perform controller functions and / or enable subsequent electronic devices and monitoring (± 10 V, 12-bit resolution) . One is also selectable as current output 4..20 mA.
- Additional front panel test jacks for easy commissioning. Test jacks for set point (SET)[*1], for feedback X1 (FB1; swash plate), for output currents (A) and (B) and monitor (MON) display for analog display of all parameters (± 10 V, 12-bit resolution).
- USB interface with USB-C connector
- Optional available: PROFIBUS, PROFINET, ETherNet/IP and CANopen interfaces available.

4.2 Technical data

Parameters	Range, characteristics
Supply voltage and Control voltage for digital inputs	12 V DC -10 % … 24 V DC + 20 %... 32 V, residual ripple < 10 % (max. 50 VA power draw)
Nominal current selection (solenoid system selection)	0.8 A / 1.1A / 1.3 A / 1.6 A / 2.4 A / 2.7 A / 3.5 A (intermediate values adjustable) (others and special current for servo valves possible, on request)
Applicable fuse (quick reacting)	Max. 3.15 A
Ambient temperature range	0 °C ... +70 °C (other range on request)
Storage temperature range	- 20 °C ...+ 85° C
Plug connection	In accordance with DIN 41 612, 48 pole form F gold plated
EMC in accordance with	In accordance with the applicable industrial standard (CE- conformity)
Dimensions	
Front panel / PCB	50,5 x 128,4 mm; 10 TE / 3 HE / 100 x 160 mm Euro format
Front panel version with Profibus / PCB	71,1 x 128,4 mm; 14 TE / 3 HE / 100 x 160 mm Euro format
Input signals	
Analog set values: S1.06, S1.05, S1.09, S1.10 (shunt for current input = 250 Ohm)	1 input, (flow / swash plate angle) differential 16 Bit resolution voltage/current input. Signal range selectable by parameter E15
	1 input, (pressure limit) single ended 16 Bit resolution voltage/current input. Signal range selectable by parameter E16
	2 inputs, (power/torque limit positive, negative) single ended 16 Bit resolution, 0...+ 10 V
Analog feedback signals (sensor input): X1, $X2_A$, $X2_B$ (shunt for current input = 250 Ohm)	1 input, (flow / swash plate angle) 16 Bit resolution voltage/current input, signal range selectable by parameter C1.09
	2 inputs, (pressure A, pressure B) 16 Bit resolution, resolution voltage/current input, signal range selectable by parameter C2.09
Digital inputs: S1.01, S1.02, S2.01, S2.02; ENABLE, RAMP 0, SIGN +, SIGN -, DIO1, DIO2, DIO3	11 inputs, U_{in} > 8 V = high (1), U_{in} < 3V = low (0), U_{in} = 3 V …. 8 V = not defined, I_{in} @ 24 V < 2,2 mA; I_{in} @ 12 V < 0,8 mA; Rin = approx. 10 kOhm
Output signals	
Solenoid current	2 output stages for proportional valve solenoids rang 0.8 A to 3.5 A; Adaptation with factor parameter E10 = x 0,5 ... 1.10 (other values and standard solenoid currents for up to max. 3.5 A on request); with over-energization and quick de-energization Optional on request: for servo valve torque motors; 30 mA up to 550 mA
Auxiliary voltage	± 10 V, max. load 10 mA.
Analog output	1 output, 12 Bit resolution, selectable by parameter E 31 0 .. ± 10 V or 4 .. 20 mA for controlling of subsequent electronic
Monitor output	1 output, 12 Bit resolution, 0 ... ± 10 V; command signal for slave pump(s) or monitoring of internal values
Digital outputs: "$\overline{\text{Error}}$", Comparator	2 outputs, voltage level 0 V / U_{Supply}, U_{out} @ 10 mA load = U_{Supply} – 6 V
Digital output: "Break"	1 output, voltage level 0 V / 24 V, I_{out} max. = 1 A
Test jacks	Solenoid current, sensor 1, set value, Monitor and GND
Auxiliary voltage	± 10 V, max. load 10 mA
Interface	USB-C connector at front panel
Display and operation	4-digit display, 6 buttons (up, down, left, right, enter and Esc) Status-LED's: PW (Power), ER (Error), EN (Enable), S1.01 …. S1.04, RP0 (Ramp = 0), IO1 ...IO3
Frequencies and cycle times	
PWM Frequency	22 kHz
Cycle times	Current controller, approx. 45 µsec inner closed loop controller 1, approx. 100 µsec (for swash plate angle feedback) pressure loop controller 2, approx. 100 µsec power/torque limiter loop controller 3, approx. 100 µsec

4.3 Hardware Block Diagram (without bus interface)



4.4 Order code

DAC - **42(A)** - **8** - **010** - ***PN*** - ***PpQ***

Digital
Amplifier
Controller

Board Version
44 = version with keypad and display
42 = version without keypad and display
((A) = new advanced version

Operation mode
No selection possible with this software version.
8: PpQ pump in mode 8

Output current for torque motors
080 = 800 mA systems
110 = 1100 mA systems
130 = 1300 mA systems
160 = 1600 mA systems
240 = 2400 mA systems
276 = 2700 mA systems
350 = 3500 mA systems

Other on request!

Interface Options
PBDP = PROFIBUS DP Interface
PN = PROFINET interface
EIP = EtherNet/IP interface

Specific options
PpQ = Board for pump flow control
with pressure and power limiting function
Single operation and master or slave operation possible
pQ = Board for pump flow control
with pressure limiting function
Single operation

5 Installation

5.1 Mounting

- Compare card type (refer to label on rear connector) with part list / diagram.
- The card generally could be mounted in any direction. However, it is recommended to choose a vertical orientation for better convection cooling. Also, this orientation will be obviously better suited for adjusting parameters or monitoring display values via the keypad and display (applicable for DAC-4**4**(A) versions only).
- The amplifier card should be mounted in a shielded environment (e.g. control cabinet).
- The amplifier card module must be mounted either in a rack according to the 19” rack standards (EIA 310-D, IEC 60297 und DIN 41494 SC48D).
  it is also possible to install the card either in a appropriate card holder or HCS own universal rack:

Card holder (HCS article number: 5 741 010 00)	Universal rack (HCS article number: 5 741 000 00)
	

Figure 1 : 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)

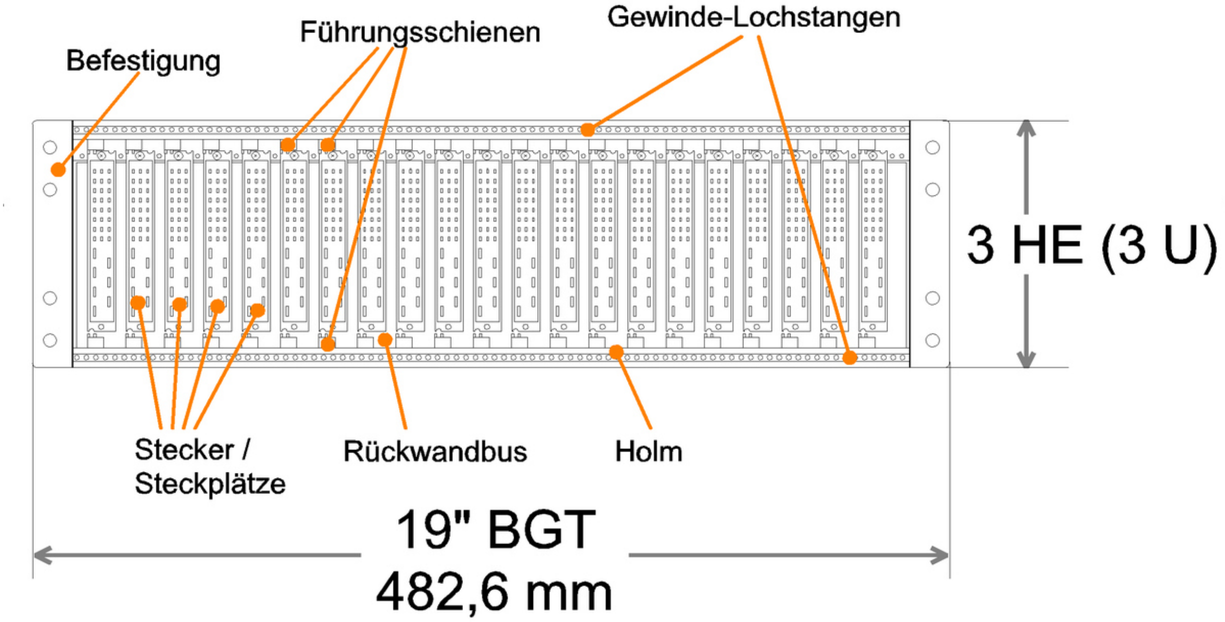


Figure 2 : General example for 19” Rack systems 3 HE

5.2 Connection

5.2.1 General recommendations

The general supply voltage for the unit is at the terminals:
[26bd] = 0 V and [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).

Output stages are electronically protected against short circuit and overload. The amplifiers should be protected with a quick-acting fuse.

The solenoids are connected at terminals [22bdz] and [28bdz] for solenoid A; terminals [24bdz] and [30bdz] for solenoid B. The terminals “bdz” are bridged on the amplifier. We recommend using all three terminals for better load distribution.

If no electrical isolation of logic inputs or outputs is required, terminal [26bd] may be bridged to terminal [2d] and terminal [32z] to terminal [32bd].

Terminal [18d] is the GND for the digital signals.

5.2.2 Wires and preparation

Connection wires must comply to the following specifications:

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

Table 4: Wires recommendation

⚠ WARNING

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

⚠ WARNING

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

5.2.3 EMC

Devices DAC-4x(A) series are class “A” equipment and therefore only suitable for industrial surroundings.

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

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

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

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

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

5.2.4 Specific recommendations for wiring and control cabinets

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

- Use shielded and twisted-pair cables for the solenoid connections. The shield must be grounded (PE Protective Earth) at both ends. The capacity should be ca. 120 pF/m. If the cables are up 100 m long, their cross-section must be 1.5 mm² and 2.5 mm² for cables longer than 100 m.
- Shields of digital signal lines are to be connected at both ends to a PE, a good conductivity of the connection should be provided.
- Set point and actual value connections should have shielded and twisted-pair cables. The analog signal line shields are to be connected, with low impedance, at both ends to PE
- In environments with high interference, use double shielded cables for set point and actual value connections. The inner shield is only grounded at one end, the outer at both ends.
- In the event of low-frequency interference on the analog signal lines (measured value fluctuations), the shield should be connected at one end. Preferably, use a corresponding compensation of potential (see also the following point).
- Use only cables with a Cu shielding grid and a covering of > 85 %. Avoid screening films. Metal foils must be avoided.
- The shield should not be interrupted along the entire length of the cable. If contactors, safety switches, chokes, etc. must be used in the wiring, the installation of a metallic housing with a high HF shield may be necessary.
- Shield terminals are to be connected over a large area to the shield rail to function well.
- The shield rail must be installed close to the cable duct in the control cabinet.
- The metallic parts of the electrical cabinet are to be connected with low impedance on large areas. Make the desired connection with mechanical aids such as scratch plates if necessary. Connect the doors of the cabinet with the shortest possible homogeneous tapes (multiple).
- Solenoid valves, contactors, relays, brakes, etc. must be suppressed directly at the interference source. Suitable suppression devices are, for example, RC networks, diodes or varistors.
- Analog and digital signal lines should preferably enter the control cabinet from only one side.
- Non-shielded lines of an electric circuit must be twisted.
- Auxiliary wires are to be grounded at both ends.
- Avoid unnecessarily long lines. This keeps the coupling impedance low.
- Wiring should preferably not be freely hanging in the cabinet. Lay cables, including auxiliary cables, as close as possible to mounting plates and cabinet housing.

- In the case of a potential difference between the shield connections, a compensation conductor of 〈10 mm² should be laid parallel to the shield to reduce the transient current. A multiple connection of the shield to the cabinet casing and thus PE is generally possible. Also, a multiple connection of the shield outside the cabinet is possible.
- If filters are installed, place them close to the source of interference and keep a good surface contact to the cabinet or mounting plate.
- If converters are used, converter filters must be provided. Variable speed motors may have to be connected using shielded lines. All further instructions of the converter manufacturer have to be observed.

The following two pages show illustrations of:

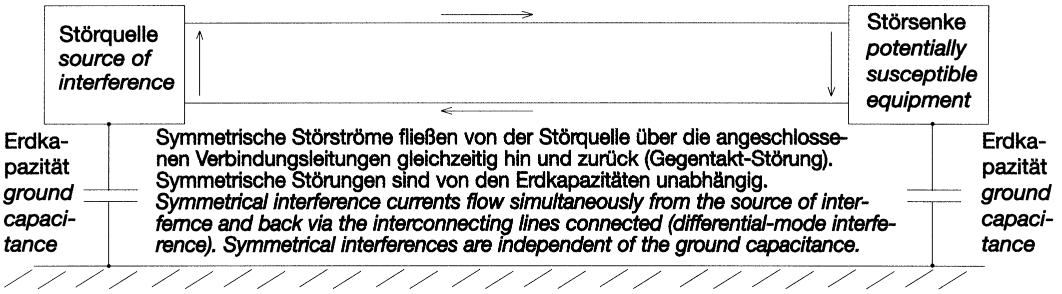
- The most important types of interference and their remedies
- Construction of EMC suitable electric cabinets and systems

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

NKL GmbH
Birckichstr. 15
D-74549 Wolpertshausen

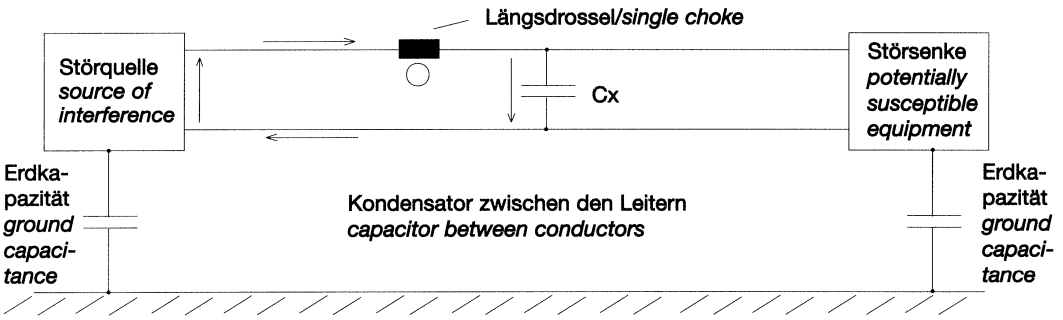
Die wichtigsten Arten von Störungen und Abhilfen:
The most important types of interference and remedies:

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 3 : 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.

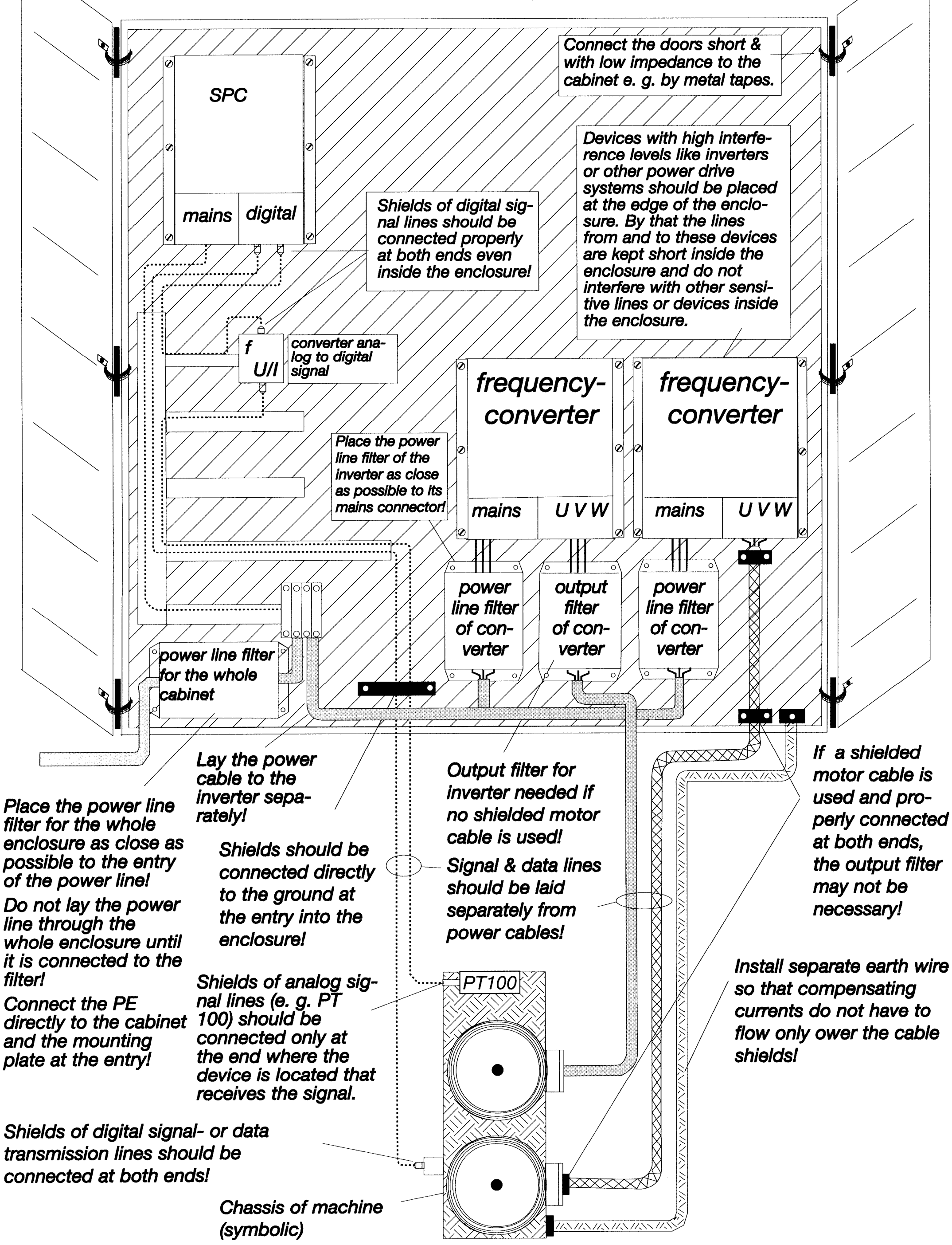


Figure 4 : EMC – adequate design of switchgear cabinets and facilities

5.3 Terminal assignment

Pin	d	b	z
2	0 V (External)	Pressure limiter activation (DIO 1)	n/c
4	Digital set value 2 (S1.02); Flow	Power limiter activation (DIO 2)	n/c
6	Digital set value 3 (S2.01); Pressure	n/c	Digital set value 4 (S2.02), Pressure
8	ENABLE (DI 1)	Analog set value 9 U_{E+} (S1.09) **Power Limit A**	Digital set value 1 (S1.01); Flow
10	**Sensor 1 (FB 1) swash plate**	Analog output	n/c
12	Analog set value 6 (S1.06) **Flow**	n/c	Analog set value 5 (S1.05) **Pressure limit**
14	$\overline{\text{ERROR}}$	COMPARATOR	**Sensor 2 (FB2) Pressure**
16	Analog set value 6 (S1.06) **Flow**	n/c	Analog set value 10 U_{E+} (S1.07) **Power Limit**
18	Digital GND	PE	Ramp = 0 / Slave mode selection
20	Reference output - 10.0 V	Break output 24 V / 1 A	Reference output + 10.0 V
22	Output A -	Output A -	Output A -
24	Output B -	Output B -	Output B -
26	0 V (Power)	0 V (Power)	Analog GND
28	Output A +	Output A +	Output A +
30	Output B +	Output B +	Output B +
32	+ 24 V (Power)	+ 24 V (Power)	24 V (External)

Table 5: Terminal assignment

5.4 Picture of rear connector

Connector: IEC 60603-2 form F 48 pins

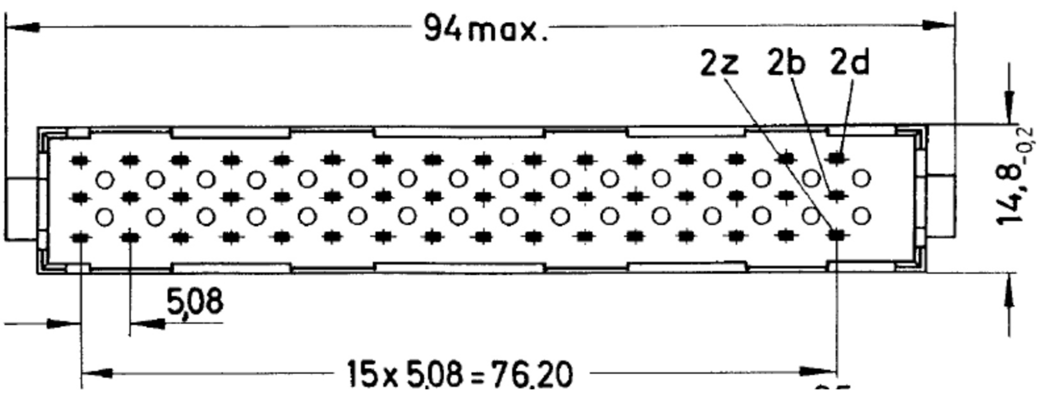


Figure 5 : Connector F48

5.5 Wiring Diagram

5.5.1 Wiring Diagram for PpQ-application M08

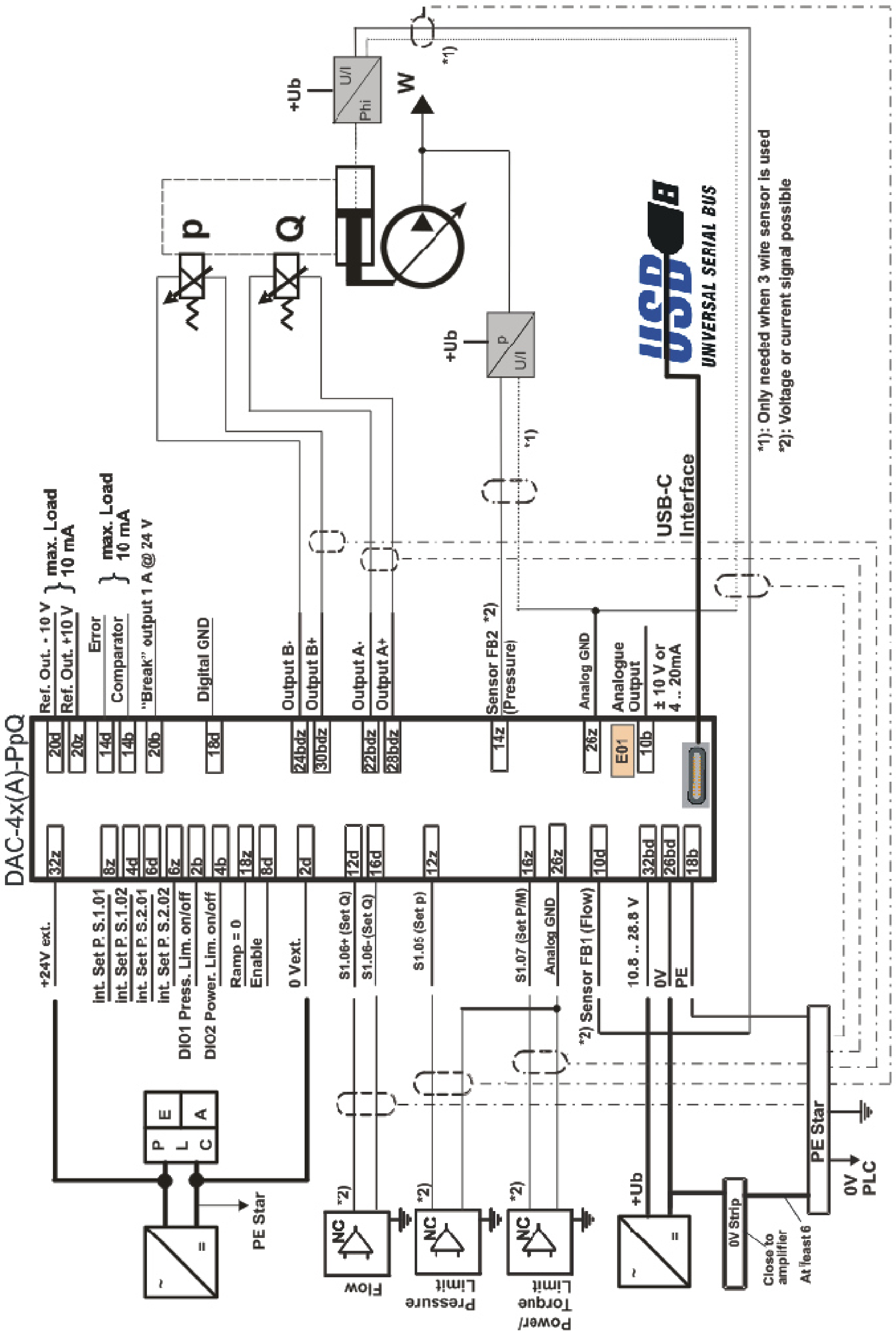


Figure 6 : Wring diagram PpQ in Mode 08

5.5.2 Wiring Diagram for PpQ-application M08 with PN/EIP bus interface

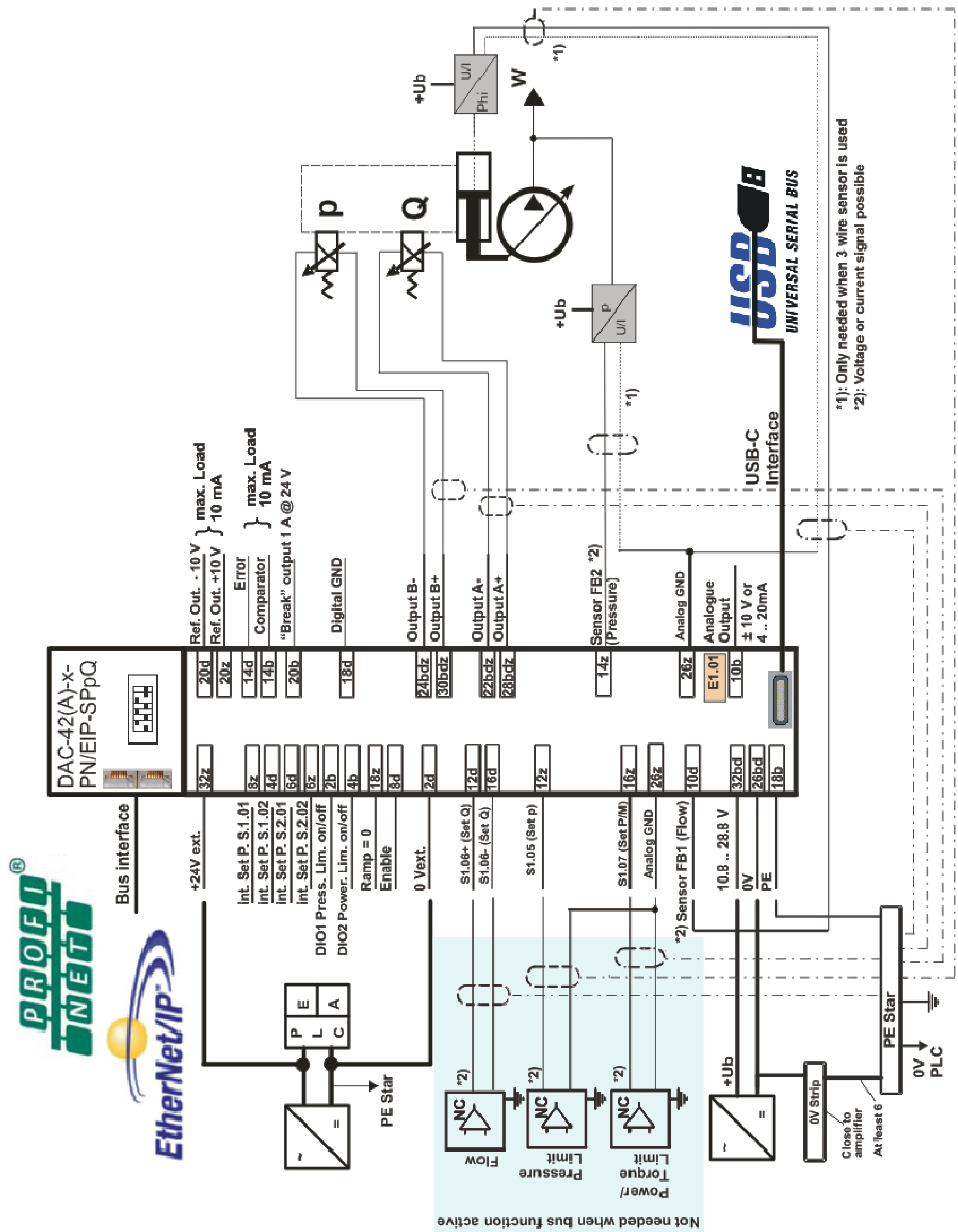


Figure 7 : Wring diagram PpQ in Mode 08 with bus interface

6 Commissioning

6.1 Front elements

DAC-42(A)-x-PpQ has no controls for parameter entry and display

⚠ WARNING
The electrical wiring must be checked before switching on the supply voltage. Limit switches and safety devices must be activated to avoid uncontrolled movements. Carefully follow relevant safety regulations. Suitable emergency stop measures must be taken.

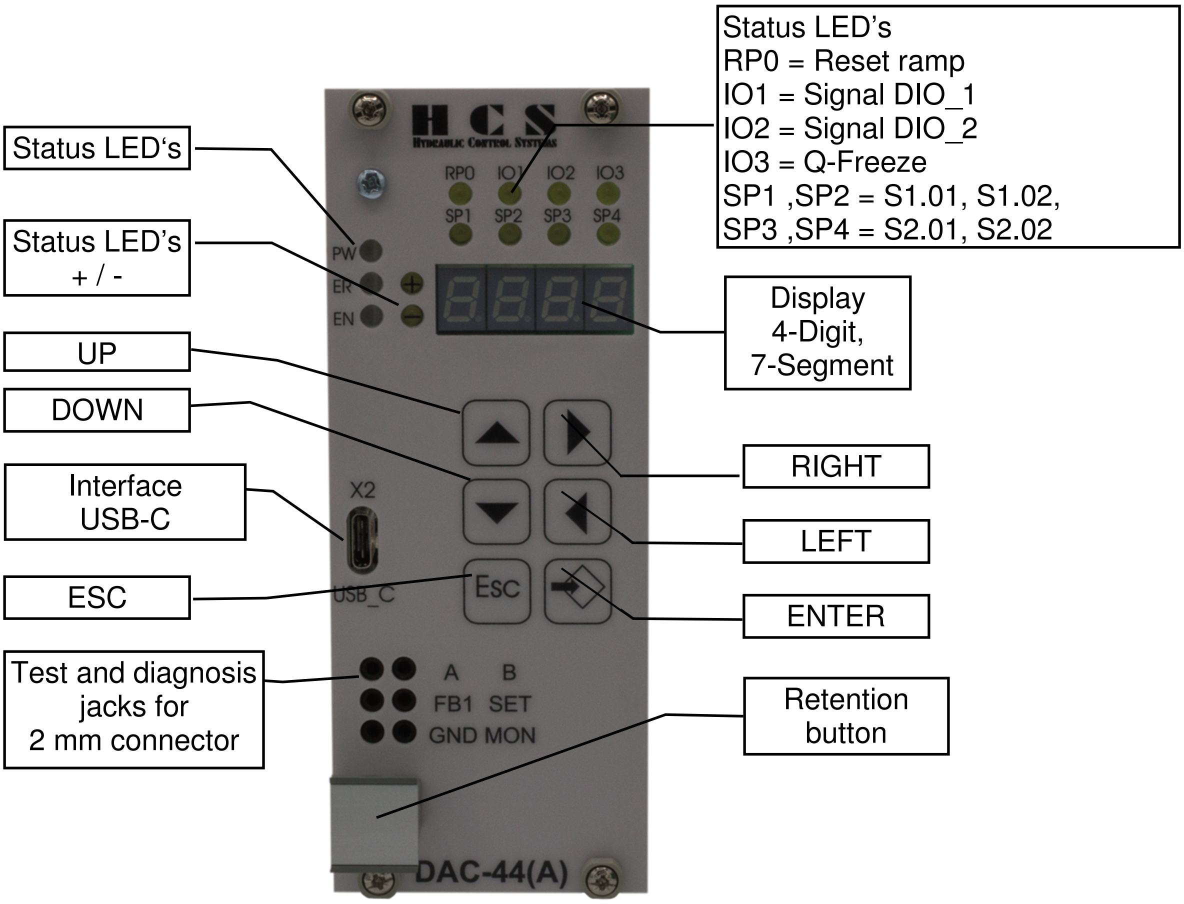


Figure 8 : Front elements DAC-4x(A)

Element	Function
Status LED's	Display of status and signals at the digital inputs and outputs
± LED's	Display of set point direction through polarity signs for parameters and measured values
Display	4-digit display of parameters and measured values
Buttons UP, DOWN, LEFT, RIGHT, ESC and ENTER	All operating, programming and saving may be performed with the buttons UP, DOWN, LEFT, RIGHT, ESC and ENTER
Serial interface	Trough which programing and accessing parameters via PC and HCSTool is executed. RS232 (optional)
Measuring and test jacks	Direct measurement of set point, actual value, solenoid currents and internal values via the monitor output. Use 2 mm sockets (S1.06, FB1, A, B, d1.01 ... d2.13)

Table 6: Front elements DAC-4x(A) explanation

6.2 Parameter setting

		SW version
	Standard version with front plate and keypad	V67.xx
2	Parameters only available for all bus versions	V68.xx, V69.xx
3	Parameters only available for PROFIBUS versions	
4	Parameters only available for EtherNet-IP versions	V68.xx

display		Set point / ramps		Q-flow Controller		p-limit Controller		P-limit Controller		Extended	
d1.01		S1.01		C1.00		C2.00		C6.00		E00	
d1.02		S1.02		C1.01		C2.01		C6.03		E01/E1.01	
d1.03		r1.03		C1.02		C2.02		C6.04		E2.01	2
d1.04		r1.04						C6.05		E02	
d1.05		S2.01		C1.04		C2.04		C6.06		E1.03	
d1.06		S2.02		C1.06		C2.05		C6.07		E2.03	
d1.07		r2.03				C2.06		C6.08		E1.04	
d1.08		r2.04		C1.08		C2.07		C6.09		E2.04	
d1.10				C1.09		C2.08				E1.05	
d1.11				C1.10		C2.09				E2.05	
d1.12				C1.11		C2.10				E1.06	
d1.13				C1.12		C2.11				E2.06	
d2.01				C1.13		C2.12				E1.07	
d2.02				C1.14		C2.13				E2.07	
d2.03				C1.15		C2.14				E09	
d2.04				C1.16		C2.15				E1.10	
d2.10				C1.17		C2.16				E2.10	
d2.11				C1.18		C2.17				E11	
d2.12				C1.19		C2.18				E12	
d2.13				C1.20		C2.19				E1.13	
d2.14				C1.21		C2.20				E2.13	
d2.15				C1.22		C2.21				E1.14	
d2.16	3			C1.23		C2.22				E2.14	
d6.01				C1.24		C2.23				E15	
d6.03				C1.25		C2.24				E16	
d6.04				C1.26		C2.25				E1.17	
				C1.33		C2.26				E2.17	
				C1.34		C2.27				E18	
				C1.35		C2.28				E19	
				L1		C2.29				E22	2
				C1.39		C2.30				E23	2
				C1.40		C2.33				E 26	3
						L2				E33	
										E34	
										E35	
										E37	4
										E38	4
										E39	4
										E40	4
										E41	4
										E42	4

Table 7: Parameter overview

A complete list of parameters is available. Refer to:

See □ Chapter "13 List of parameters", page 59

Also refer to “HCSTool”!

6.3 Setting of default parameters values:

It is possible to save default values as single parameters or a combination of parameters. The program HCS***Tool*** is used to adapt the default values to a combination of parameters, according to the client's needs. If you have any 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

6.4 Software block diagrams

6.4.1 V67.xx, PpQ function (with power or torque limit)

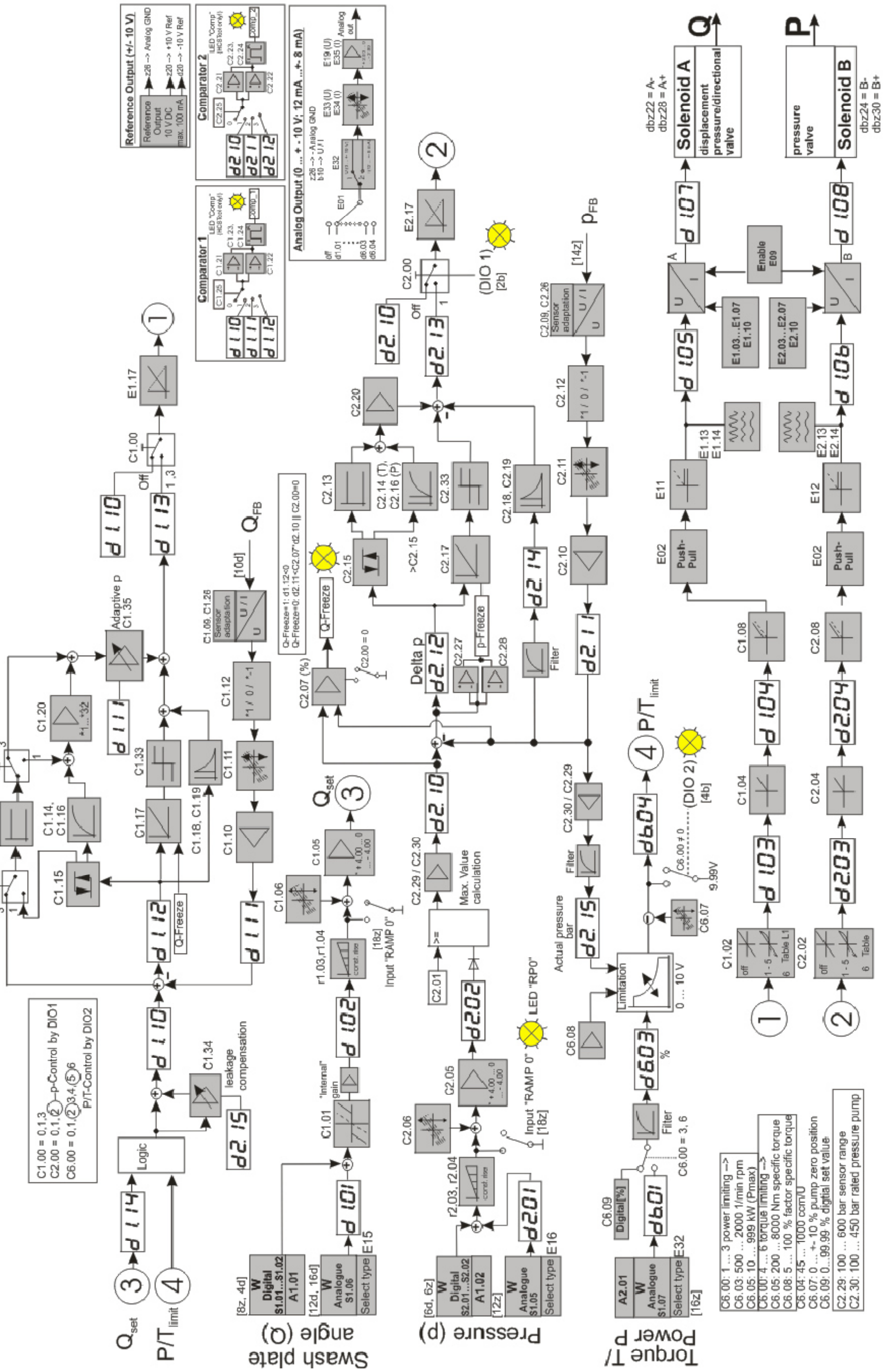


Figure 9 : Software block diagram PpQ power/torque limit

6.4.2 V68.xx, PpQ function (with power or torque limit) with bus function

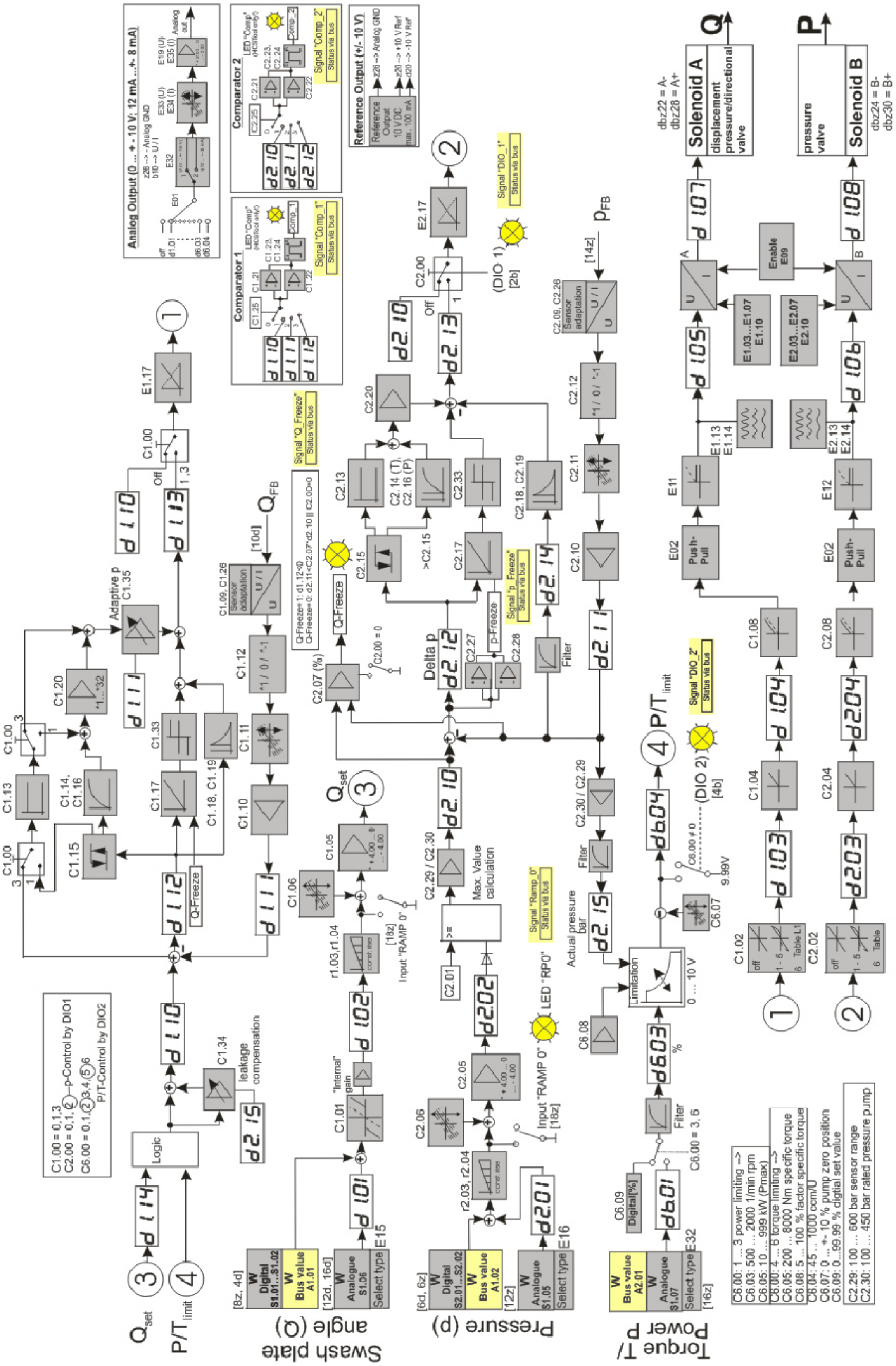


Figure 10 : Software block diagram PpQ power/torque limit and bus function

7 Operation modes

No selection possible with this software version. The fixed set-up is for PpQ pump in closed circuit operation with 1 pressure sensors connected.

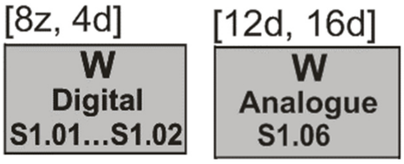
8 Parameter description

WARNING

Only trained staff should make changes of the parameters. During changes the drive must be switched off. Every parameter change is immediately effective!

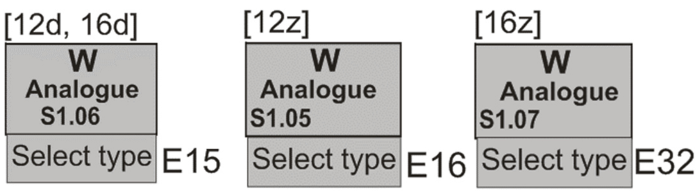
Due to an eventual lack of clearness, not all parameters are shown in the software block diagram

8.1 Programmable set points <S1.01> and <S1.02>, <S2.01> and <S2.02>



- Digital set points are internal programmable set points, activated by digital inputs
- The inputs are opto-decoupled and can be controlled directly from the PLC.
- If an electrical isolation between the PLC and the amplifier is not required, the customer must bridge terminal 2d to terminal [26bd] and terminal [32z] to terminal [32bd].
- Two of the programmable set points can be selected with the respective input <S1.01> and <S1.02> for the flow)
- Two of the programmable set points can be selected with the respective input <S2.01> and <S2.02> for the pressure limiter setting)
- All digital set points are passed through the ramp function generator.
- All set points are additive and include no direction information themselves
- If several set points are selected at the same time, the sum of these set points is subsequently processed

8.2 Analog set points <S1.05>, <S1 06>, <S1.07>



- The analog set points are designed for voltage or current signals
- S1.06 = differential input.
- S1.05, S1.07 = ground-based inputs.
- Resolution of all inputs is 16-bit. Different predefined input ranges can be selected by software parameter. Selection of cable fracture detection and selection of set point type by means of parameter <E15>, <E16>, <E32>.
- If the current range is selected than a measuring resistance of 255 Ω is automatically activated.

8.3 Ramp function <r1.03> to <r1.04>; <r2.03> to <r2.04>

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

r1.03,r1.04

r2.03, r2.04

For flow set points:
<r1.03> ramp from 0 to positive values
<r1.04> ramp from positive values to 0

For pressure set points:
<r2.03> ramp from 0 to positive values
<r2.04> ramp from positive values to 0

The ramp function is always constant time base and linear.

9 Parameters for stroke volume <C1.xx> pressure <C2.xx> control

9.1.1 Selection stroke volume control <C1.00>

This parameter activates the required controller function (Structure).

The controller can be activated or deactivated independently of the selected operation mode. The parameter <C1.00> deactivates closed loop operation. Thus, the card works in open loop mode. There are four different types of controller configurations:

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

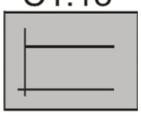
<C1.00>	Controller function	Description
off	--	No controller active, the DAC-4x(A) is working in open loop.
1	P-PT1-I-DT1 – controller	Standard controller with various options
3	direct feed forward controller (dff controller)	This is a controller where a portion of the set point (depending on) <C1.13>) is switched directly on the output stage. The remaining portion is a standard P-PT1-I-DT1 controller; further referred to as a dff controller (direct feed forward).

Table 8: Controller selection

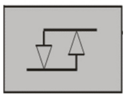
9.1.2 P-PT1-I-DT1 controller <C1.00> = 1

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

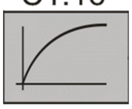
C1.13



C1.15



C1.14, C1.16



When programming the parameters <C1.13> and <C1.16> then also the setting of parameter <C1.00> (controller setting) is of importance. If <C1.00> = 3 or <C1.00> = 4 (dff controller), then <C1.13> is the amplification of the dff controller and <C1.16> is the P-amplification of the remaining PT_1-I-DT_1 controllers. <C1.15> will be without effect in these cases.

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

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

- Case 1, the control deviation is smaller than the threshold (|w-x|< <C1.15>): only the P-portion KP_1 is activated (w-x* KP_1).
- Case 2, the control deviation is larger than the threshold (|w-x|> <C1.15>): from the threshold <C1.15> on, the P-portion KP_1 is activated with the value (w-x* KP_1). The other P-portion KP_2 only functions with the value ([[w-x] - <C1.15>] * KP_2). The complete portion of both controllers is an addition of these values.

The division into two individually adjustable amplifications allows a more stable adjusting of the controller in non-linear systems (which is often the case for hydraulic applications), even if the control deviations are large. The possibility to suppress (attenuate) <C1.16> (KP_2) with a time relay supports this effect and results in adjustable moderate(smooth) PT1-characteristics.

See the following graph for an explanation:

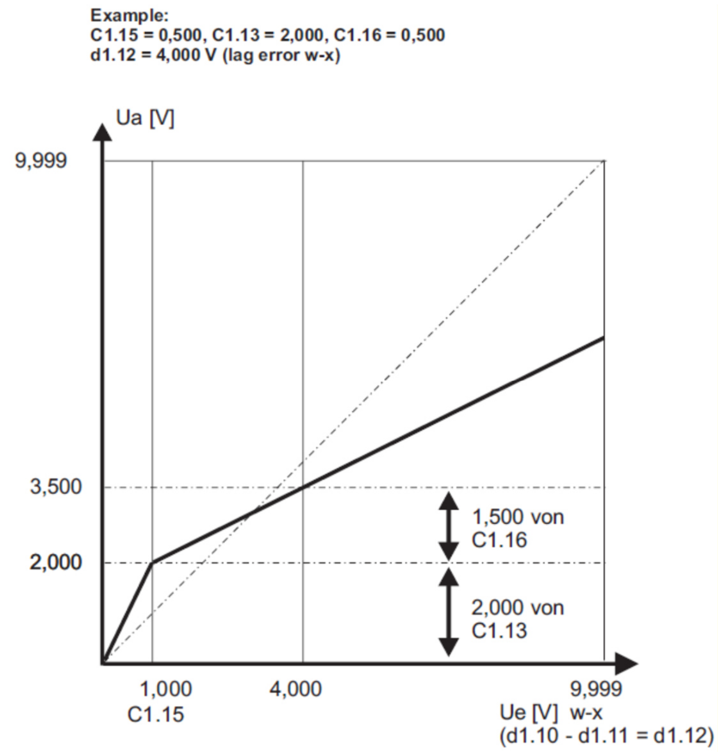
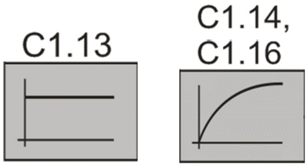


Figure 11 : Diagram function <C1.13> / <C1.15> / <C1.16>

9.1.3 Dff controller <C1.00> = 3

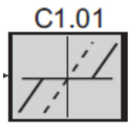
Dff means direct feed forward controller.
Fundamentally the dff controller can always be used instead of a standard controller (P-PT1-I-DT1), simply set <C1.00> = 3 or <C1.00> = 4. The dff controller is designed as a parallel circuit of a P term with a PT1-I-DT1 controller. The processed set point of d1.10 is hereby used directly as an input to the P-amplifier. Following an addition with the dff branch P-factor, the signal is added to the adjusting signal of the PT1-I-DT1 controller. The result can be verified with d1.13. The PT1-I-DT1 controller is supplied with the control deviation d1.12.
This operating mode enables enhanced dynamic performance with simplified parameter setting. Following a general formula, 80 % of the output signal should be supplied by the dff controller, the remaining 20 % should come from the PT1-I-DT1 controller.

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



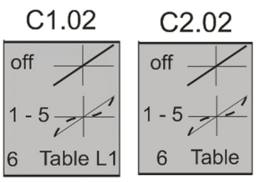
- <C1.13>is the P-amplification with direct feed forward (proportional controller)
- <C1.14> cooperates with <C1.16> and therefore forms a PT_1 term
- <C1.15> is not taken into consideration
- <C1.16> is the P-amplification of the remaining PT_1-I-DT_1 controller

9.1.4 Hysteresis for command signal (flow) <C1.01>



This parameter allows setting of a “dead band” around zero for the flow command signal. This will ensure that with zero command the pump remains in center position without delivering flow.

9.1.5 Characteristic curve <Cx.02>

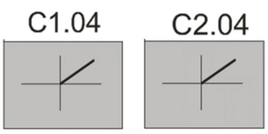


There are five characteristic curves available for the linearization of the valve characteristics + one :

<C1.02>	Description
off	No linearization active
1	general linearization for NC curve
2	linearization for proportional directional valves with flow characteristic > 10 l/min (NG6)
3	linearization for proportional directional valves with flow characteristic 10 l/min (NG6)
4	linearization for proportional directional valves with flow characteristic >50 l/min (NG10)
5	linearization for proportional pressure valves
6	custom specific curve table L1

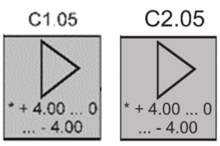
Table 9: <C1.02> selection

9.1.6 Direction independent amplification <Cx.04>



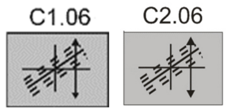
The amplification can be programmed with the parameters <C1.04> and <C2.04>, for both valves. These parameters are used for amplification adjustment.

9.1.7 Set value sign / factor <Cx.05>



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

9.1.8 Offset for set point <Cx.06>



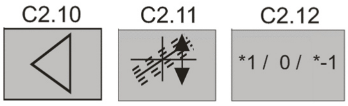
A drift of the drive or the hydraulic system can be corrected with the offset parameter.
The offset-set point can be regarded as an additional set point. This allows a very fine positioning of the system e.g., if it is used on a NC axis.

The offset-set point <C1.06> can be regarded as an additional swash angle set point,
<C2.06> as an additional pressure set point.

9.1.9 Manipulation the actual value <Cx.10>; <Cx.11>, <Cx.12

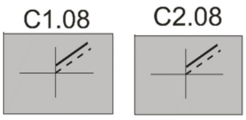
A drift of the drive or the hydraulic system can be corrected with these parameters.
The feedback manipulation for the swash plate:

The feedback manipulation for the pressure sensor:



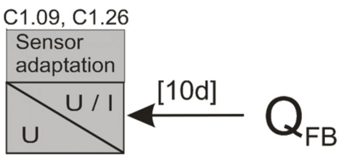
The offset-for feedback signals <Cx.11> mainly compensate the offset of the feedback branch.
Parameters <Cx.11> (for the offset) and <Cx.10> (for the amplifying) allow an even finer, additional adjustment.

9.1.10 Spool overlap compensation <Cx.08>



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

9.1.11 Sensor selection <Cx.09>, <Cx.26>



The following types of sensors are available:

<C1.09>	Input signal range	Wire monitor <C1.26>	Comment
7	**3.4 V … 1.5 V**	**Yes**	**Only positive controller output possible!**
10	**0 ... 20 mA**	**No**	
11	**4 ... 20 mA**	**Yes**	
12	**0 ... 10 V**	**No**	
23	**Unipolar voltage**	**Yes**	
26	**Unipolar current**	**Yes**	

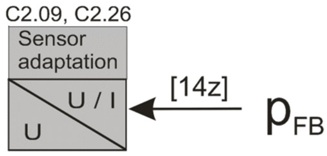
Table 10: Feedback sensor <C1.09> selection

The wire break monitor is activated automatically (if it is in the selection). To activate or deactivate manually, choose parameters <C1.26> and <C2.26>.

All selections are for control loops where no negative value appears, so no negative controller output is possible!
To set the sensor for the first control loop, use parameter <C1.09>. The adjustment of the sensor signal will be supported by the system hardware; the hardware also automatically sets the signal range and therefore guarantees the optimal resolution. Parameters <C1.11> (for the offset) and <C1.10> (for the amplifying) allow an even finer, additional adjustment. This loop takes care of the swash plate angle control.

The feedback input can optionally process current signals in the range of 0 ... 20 mA or 4 ... 20 mA. When these sensor signals are chosen, the required resistance of 100 Ω is automatically activated.

The selection 21 … 26 requires a semi calibration process. This calibration can be carried out using the parameter <C1.39>. This allows the sensor range to be adjusted automatically.
See □ Chapter "9.1.18 Sensor semi calibration <C1.39>, <C1.40>", page 38



The following types of sensors are available:

<C2.09>	Input signal range	Wire monitor <C2.26>	Comment
10	**0 ... 20 mA**	**No**	**Only positive controller output possible!**
11	**4 ... 20 mA**	**Yes**	
12	**0 ... 10 V**	**No**	

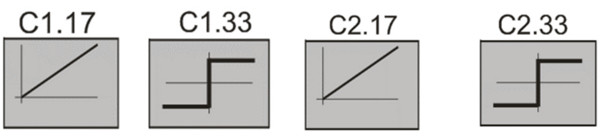
Table 11: Feedback sensor <C2.09> selection

<C2.09> is used to adjust the sensor of the pressure limiter control circuit. Parameter <C2.11> is used to adjust the offset and parameter <C2.10> for the amplifying.
In case of usage of current input signals, the inputs are protected for overload. An error will be triggered at currents above approx. 25 mA. Cable fracture detection if activated will trigger an error for currents below approx. 2 mA. For information about error codes refer to:
See □ Chapter "11.7.3 Display and error message", page 54

⚠ WARNING

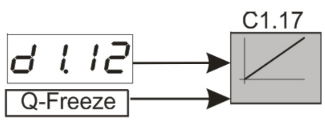
For safety purposes it is preferable to use sensors with a 4 ... 20 mA interface which makes cable fracture detection possible. Also, this current signal is less prone to EMC disturbances.

9.1.12 I-portion <Cx.17>; <Cx.33>)



- <Cx.17> is the I-portion of the controller (integrating controller). <Cx.17> is limited to the maximum value to avoid an overdrive or saturation. Small values do indicate a slow reaction. Large values do indicate a fast reaction!
- <Cx.33> is the limiting level for the I-portion of the controller in order to prevent saturation of the integral part. The integrator limit should be set as low as possible, as the integrator only compensates for the nonlinearities of the system.

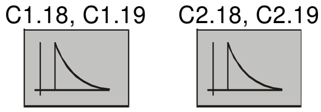
Especially for the <C1.17> of the Q control loop:



When the “Q-Freeze” signal is active, the integrator is locked at its current value, effectively pausing its operation. This means the integrator stops updating or adjusting its output, maintaining the last value it held before the “Q-Freeze” signal was activated. The integrator will remain in this state, with its value unchanged, until the “Q-Freeze” signal is deactivated, at which point it resumes normal operation and can once again adjust its output based on the system's conditions.

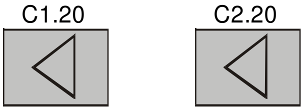
9.1.13 D-portion, DT1-portion <C1.18>, <C1.19>; < C2.18>, <C2.19>

- <Cx.18> is a D-portion and together with Cx.19 forms a PT_1 term (differential controller).



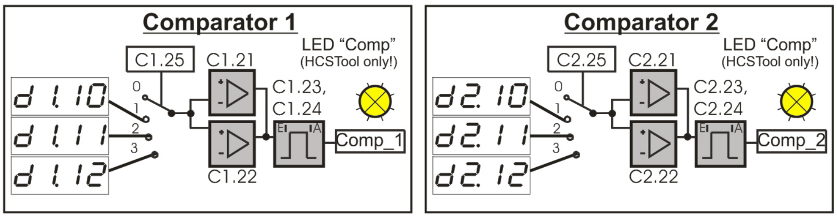
- <Cx.19> is a T-portion for Cx.18 to form a DT_1 term.

9.1.14 Additional (P-) multiplier <C1.20>; <C2.20>



<Cx.20> is an additional proportional factor to increase the effect of <Cx.13> and <Cx.16>, especially for process control.

9.1.15 Comparator <Cx.21> to <Cx.25>



- Parameter <Cx.25> is a switch that defines, which one of the signals will be compared with the comparator values.

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

Table 12: The available values for <Cx.25>

- Parameter <Cx.21> and <Cx.22> define the comparator window. They both can be set to a value of 0 ... ± 9.999 V. It is also possible, to define a positive, negative or asymmetrical window. Parameter <E18> as well as <Cx.21> and <Cx.22> define the logic of the comparator output. Note the following dependencies:
  If <Cx.21> < <Cx.22>, the logic of the output is negated.
  Comparing the comparator value to the control deviation, the window center is defined by:
  Actual value = set point or (actual value - set point) = 0.
  Therefore, the window is "floating" and set point dependent. Depending on the set point, the window will be centered on it.
- A on/off switching delay determined by the parameters <Cx.23> and <Cx.24> can be adjusted to maximum of 9.99s with a 10 ms resolution. The optically-decoupled comparator output signal is available at terminal [14b]. Otherwise, parameter <E18> is enabled:
  <E18> = off: positive comparator logic, meaning that if the comparative value lies within the defined borders, the comparator output will be "high".

In general, the comparator is always linked by a logical "AND" with the "enable" signal, thus, if the enable" signal is "low", the comparator output will also be "low".

9.1.16 Leakage compensation <C1.34>


C1.34

Since the leakage oil loss of the pump is pressure-dependent, the leakage oil loss per 100 bar is entered here. This parameter is used to compensate the Q-set value over the full pressure range.

9.1.17 Adaptive adaption of the P-Part <C1.35>

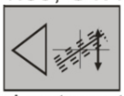
Adaptive p
C1.35

The gain in the pump circuit depends on the current position of the swivel angle Due to this non-linear gain in the pump control loop, this parameter can be used to compensate for this non-linearity.

9.1.18 Sensor semi calibration <C1.39>, <C1.40>

The semi-automatic feedback calibration function supports the user in correctly scaling the feedback signal for offset and gain and such allows the closed loop work as intended. The procedure is performed by means of HCSTool.

C1.39, C1.40



Semi-automatic
calibration
(w. HCSTool only!)

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

9.1.19 custom specific curve <L1>, <L2>

When the parameter

L1			table of linearization for C1.02 = 6
L2			table of linearization for C2.02 = 6

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

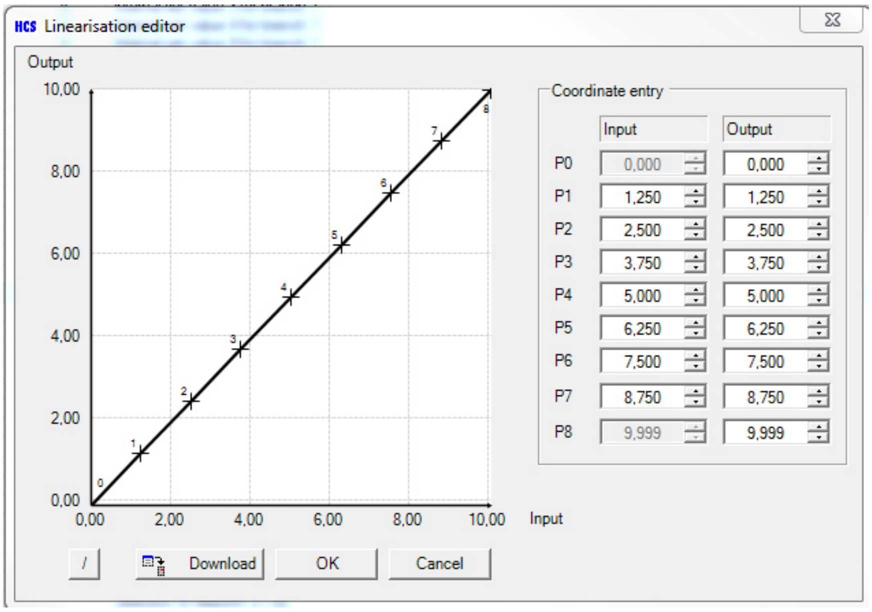


Figure 12 : Start Custom linearization curve by HCSTool

Here an own table can be created depending on the given requirements. One of the 8 points in the coordinates can be moved within the window or corresponding points can be inserted directly into the table.

Example of a customized curve:

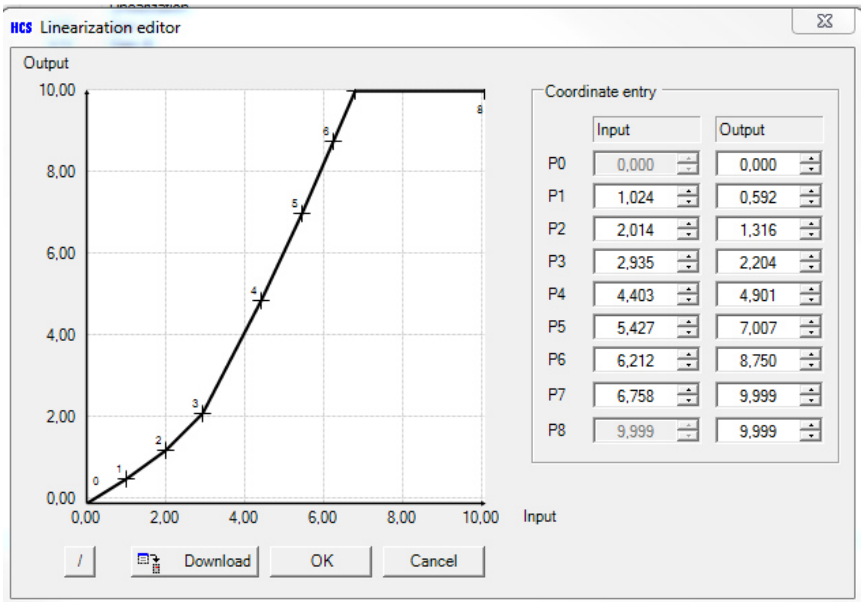


Figure 13 : Definition Custom linearization curve by HCSTool

The button  resets the curve to the linear version.

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 13: Semi-automatic feedback calibration procedure

9.2 Parameters only for pressure limit control <C2.xx>

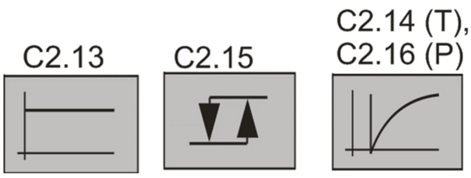
9.2.1 Selection of pressure limit control <C2.00>

These parameters activate or deactivate the related controller function.
The controller and its general functions are activated using parameter <C2.00> There are two different types of controller configurations:

<C2.00>	Controller function	Description
off	--	the pressure limiter is deactivated.
1	P-PT1-I-DT1 – controller	Pressure limiting is active
2	P-PT1-I-DT1 – controller	the pressure limiter function can be activated by means of the digital input "DIO 1" at terminal 2b

Table 14: Controller selection

<u>P-portion, PT1-portion <C2.13>, <C2.14>, <C2.15>, <C2.16></u>

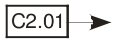


- <C2.13>is the P-amplification (KP_1) for minor control deviations (proportional controller)
- <C2.14>cooperates with <C2.16> and forms therefore a PT_1 term
- <C2.15>is the threshold to control the operation of <C2.13> (KP_1) or <C2.16> (KP_2)
- <C2.16>is the P-amplification (KP_2) for major control deviations, results with <C2.14> as a PT_1 part

Description of the threshold function <C2.15> and the resulting effect of <C2.13> and <C2.16>:

- <u>Case 1, the control deviation is smaller than the threshold (|w-x| < <C2.15>):</u> only the P-portion KP_1 is activated (w-x* KP_1).
- <u>Case 2, the control deviation is larger than the threshold (|w-x| > <C2.15>):</u> from the threshold <C2.15> on, the P-portion KP_1 is activated with the value (w-x* KP_1). The other P-portion KP_2 only functions with the value ([[w-x] - <C2.15>] * KP_2). The complete portion of both controllers is an addition of these values.

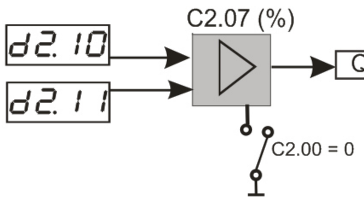
9.2.2 Pressure command signal minimum <C2.01>



<C2.01> defines a minimum pressure even when the pressure command signal should drop to "0". This allows a trouble-free operation even in case of a minimum pressure level present at the pump (e.g. due to the feeding pressure from a pilot pump).

Also allows setting of a pressure limit even when no analog <S1.05>or digital pressure <S2.01>, <S2.02> limit command signal is present.

9.2.3 Factor for generating the 'Q-Freeze' signal <C2.07>

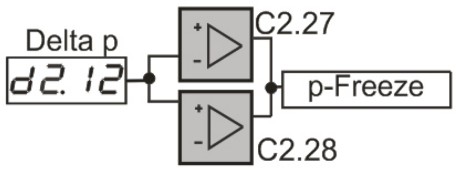


The parameter functions as a threshold for activating the integrator in the stroke volume controller. If the actual pressure exceeds the set pressure, the integrator in the stroke volume controller is frozen by the signal "Q-Freeze". Once the actual pressure falls below the programmed threshold relative to the set pressure, or when it falls below the threshold again, the integrator of the stroke volume controller is reactivated (see signal flow diagram).

Q-Freeze=1: d1.12<0 Q-Freeze=0: d2.11<C2.07*d2.10 || C2.00=0

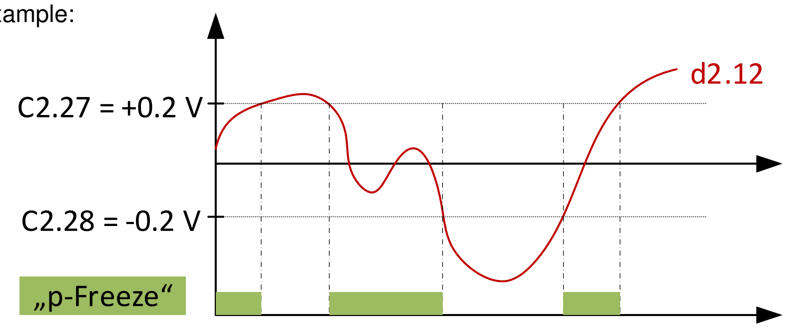
Typical setting:
<C2.07> = 90%

9.2.4 Threshold for the 'p-Freeze' signal <C2.27>, <C2.28>



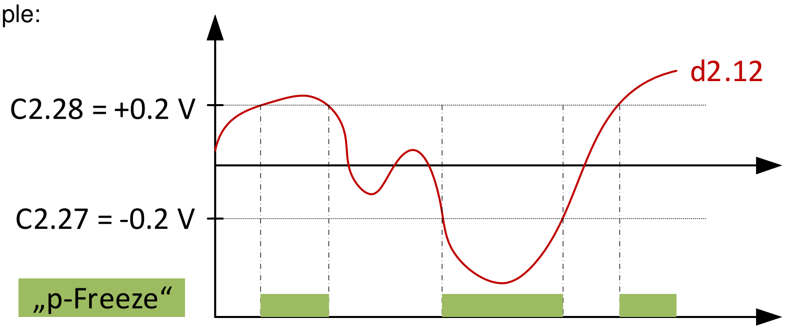
The settings of parameters <C2.27> and <C2.28> can be used to reduce two different effects:

- The "p-Freeze" signal is generated when <d2.12> is <u>within</u> the window (<C2.27> > <C2.28>):
  A high integration component can cause the controller to overcompensate for slowly increasing deviations. Since the integrator accumulates the sum of deviations over time, excessive integration can lead to delayed and amplified responses, making the system unstable and causing oscillations. To prevent this, a window can be defined using parameters <C2.27> and <C2.28>, within which the integrator is deactivated or frozen.
  Example:



This setting is useful for applications like cylinder positioning, where it's common practice to activate the integral (I) component only within a narrow range. This approach is particularly effective when using a traditional proportional directional valve, as the cylinder itself exhibits integral behavior.

- The “p-Freeze” signal is generated when <d2.12> is <u>outside</u> the window (<C2.28> > <C2.27>)::
  The integrator is activated within the set limits, which reduces the overshoot of the actual value during setpoint changes. When the control deviation <d2.12> is within the limits defined by <C2.27> and <C2.28>, the integrator is active, and the "p-Freeze" signal is deactivated. The deactivation of the integrator can be turned off by setting <C2.27> and <C2.28> to 0. In this case, the integrator remains active at all times.
  Example:

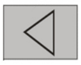


In a quasi-pressure control scenario for positioning the pump’s actuator system, this setting can help maintain stable pressure limitation. By fine-tuning the control parameters, the system can effectively manage pressure fluctuations, ensuring that the pressure remains within the desired limits, even under varying load conditions. This is particularly important for achieving precise and consistent control of the actuator’s position while avoiding overshoots or instability in the pressure regulation.

The deactivation of the integrator can be turned off by setting <C2.27> and <C2.28> to 0. In this case, the integrator remains active at all times.

9.2.5 Pressure sensor range <C2.29> and rated pressure pump <C2.30>

C2.30 / C2.29



This parameter is used to adjust the pressure sensor range as given by the sensor installed. This will give the right scaling for the display parameter for the pressure at <d2.15> and works only properly together with the adjustment of <C2.30>.

Defines the rated pressure of the pump used.

The parameters <C2.29> and <C2.30> work together. The ration between both sets the scaling for the pressure limiter command signal and also for the scaling of the display parameter for the pressure value in “bar” at <d2.15>. The pressure range of the sensor (set by <C2.29>) must be higher than the maximum regular working pressure (rated pressure) of the system or pump otherwise pressure overshoots cannot be measured accurately and such limit the performance of the pressure limiter function. This mechanism also ensures that the command signal for the pressure limiter is “proportional” to the range of the actual pressure.

Example:

Pressure sensor range = 400 bar → <C2.29> = 0400
Rated pressure = 250 bar → <C2.30> = 0250
At 400 bar, then <d1.11> = 9.999 and <d2.15> = 0400
If now the pressure limiter should kick in at 125 bar the command signal would be 5.000 V (125 bar = 50 % of rated pressure). Even so at <d1.10> the signal will then only be 3.125 V. This would match an actual pressure of 125 bar at the sensor which also would give 3.125 V at <d1.11>.

9.3 Parameters for power limit control <C6.xx>

9.3.1 Selection of power limit control <C6.00>

These parameters activate or deactivate the related controller function.
The controller and its general functions are activated using parameter <C6.00> There are six different types of controller configurations:

<C6.00>	Description
off	The **power/torque** limiter function is deactivated
1	**power** limiting is active, by using the analog input for the power set value
2	The **power** limiter function can be activated by means of the digital input “DIO 2” at terminal 4b
3	The **power** limiter function is automatically set to the value of C6.09 (as defined by <C6.05>). In this case, no analog command signal is required.
4	**torque** limiting is active, by using the analog input for the **torque** set value
5	The **torque** limiter function can be activated by means of the digital input “DIO 2” at terminal 4b
6	The **torque** limiter function is automatically set to the value of C6.09 (as defined by <C6.05>). In this case, no analog command signal is required.

Table 15: Controller selection

9.3.2 Power limiter, Drive rpm <C6.03>

This parameter is used to adjust the drive rpm. A proper set-up is important for correct calculation of the power draw of the pump for the power limiting function.
Power calculation is based on rpm, actual flow and actual pressure at pump outlet.
*) In mode Torque limiting, this parameter is not shown, not needed.

9.3.3 Maximum pump displacement <C6.04>

Flow range of the pump. Nominal value for 100 % stroke of the pump (nominal flow). The parameter value is entered in ccm/rpm.

9.3.4 Power limiter: Maximum drive power (kW) <C6.05>

Maximum possible power draw which can be handled by the drive. Pump delivery (Q x P) will be limited to this value for a 10 V command signal at the power limit inputs or when <C6.00> = 3. The parameter value is entered in kW.

9.3.5 Actual value filter for power/torque limiter <C6.06>

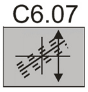
C6.06

Filter

<C6.06> is used to filter the calculated actual power value. It may help to reduce oscillations under certain circumstances.

9.3.6 Pump zero position for power/torque limiter <C6.07>

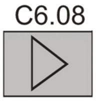
C6.07



<C6.07> is used to compensate an offset of the power/torque limiter.

9.3.7 Torque limiter: factor of corner torque<C6.08>

C6.08



The factor is in the range of 5 … 99.99 %. The percentage value from parameter <C6.08> is the partial value of the maximum possible torque. Maximum torque is calculated from the values “max pump displacement” (parameter C6.04) and “rated pump pressure” (parameter <C2.30>).

9.3.8 Digital set value <C6.09>

C6.09
Digital[%]

This parameter allows a target value to be set even when no analog reference value is available. The input is in percentages of 10.0 V.

9.4 Extended parameters <E xx>

9.4.1 Analog, Monitor output in standard systems <E 01>, <E1.01>, <E2.01>

Every internal measured value can be directed as an analog signal to the “Analog output” at [10b]. This signal is available as a voltage of 0 ... ± 10 V with a 12 Bit resolution.

For DAC-44(A) with front panel:

- Parameter <E 01> selects the display parameter <dx.xx> which is directed to this output at Analog output” [10b]. The selection ranges from 1 to 27 activates the according display parameter.
- The Monitor output which is directed to this output at the face plate. Always outputs the last selected display parameter <dx.xx> on the front panel (Jack MON) as an analog value

For DAC-42(A) without front panel:

- Parameter <E1.01> selects the display parameter <dx.xx> which is directed to this at Analog output” [10b]. The selection ranges from 1 to 27 activates the according display parameter.
- Parameter <E2.01> selects the display parameter <dx.xx> which is directed to this output (MON) at the faceplate. The selection ranges from 1 to 27 activates the according display parameter.

<E 01> <E1.01> <E2.01>	Description
off	Analogue/Monitor output off
1	Analogue/Monitor output = d1.01
2	Analogue/Monitor output = d1.02
3	Analogue/Monitor output = d1.03
4	Analogue/Monitor output = d1.04
5	Analogue/Monitor output = d1.05
6	Analogue/Monitor output = d1.06
7	Analogue/Monitor output = d1.07
8	Analogue/Monitor output = d1.08
9	--
10	Analogue/Monitor output = d1.10
11	Analogue/Monitor output = d1.11
12	Analogue/Monitor output = d1.12
13	Analogue/Monitor output = d1.13
14	Analogue/Monitor output = d1.14
15	Analogue/Monitor output = d2.01
16	Analogue/Monitor output = d2.02
17	Analogue/Monitor output = d2.03
18	Analogue/Monitor output = d2.04
19	Analogue/Monitor output = d2.10
20	Analogue/Monitor output = d2.11
21	Analogue/Monitor output = d2.12
22	Analogue/Monitor output = d2.13
23	Analogue/Monitor output = d2.14
24	Analogue/Monitor output = d2.15
25	Analogue/Monitor output = d6.01
26	Analogue/Monitor output = d6.03
27	Analogue/Monitor output = d6.04

Table 16: Analog output selection

This function is used during commissioning or trouble shooting in order to monitor internal values and to analyze the system.

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

E02

Push-Pull

<E02>	Description
off	**Push-Pull function off. Normal operation mode.**
4	**Push-Pull function off. Wire break detection to the solenoid is activated.**

Table 17: <E02> selection

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

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

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

Solenoid A:
<E1.03> defines the value which set the nominal current through the valve at maximum set value.
<E1.04> defines the energization P-Portion value for the solenoid A.
<E1.05> defines the energization I-Portion value for the solenoid A.
<E1.06> defines the de-energization P-Portion value for the solenoid A.
<E1.07> defines the de-energization I-Portion value for the solenoid A.
<E1.10> variable adjustment of the solenoid current A
Solenoid B:
<E2.03> defines the value which set the nominal current through the valve at maximum set value.
<E2.04> defines the energization P-Portion value for the solenoid B.
<E2.05> defines the energization I-Portion value for the solenoid B.
<E2.06> defines the de-energization P-Portion value for the solenoid B.
<E2.07> defines the de-energization I-Portion value for the solenoid B.
<E2.10> variable adjustment of the solenoid current B

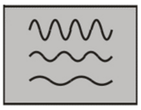
Each current output is activated by a PWM output stage that has over-energization and high-speed de-energization. The solenoid current is measured, compared with the set point (activation value for the output stages) and controlled by a PI controller. This helps to avoid deviations of the solenoid current, e.g. through warming of the coil. Additionally, the programming of the controller has an important influence on the dynamic and static performance. Parameters <Ex.04> and <Ex.05> set the controller for energization and <Ex.06> and <Ex.07> for de-energization.

Parameter <Ex.10> allows a fine and variable adjustment of the solenoid current and this allows adjusting the already set maximum current. Independently of all the settings, the minimum current is limited to *0.5 of the nominal output current (defined by <Ex.03>) in any case.

Parameter E09 sets the time delay of the enable signal. The activation of the output stages will be delayed even though the enable signal is active.

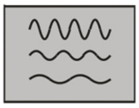
9.4.4 Dither signal <Ex.13>, <Ex.14>

Solenoid A



E1.13
E1.14

Solenoid B



E2.13
E2.14

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

The dither function can be matched to the valve or to the process with the parameters <Ex.13> (for the amplitude) and <Ex.14> (for the frequency). The frequency of the signal is adjusted stepwise. The dither signal reduces the hysteresis of the valve or drive movement and improves the reaction of the system. This has positive effects on the precision and repeatability.
In general, low frequency signals are more effective, but they can result in noticeable disturbances (noise, oscillations). Values less than 100 Hz are for systems with a low characteristic frequency, higher values are used for systems with a high characteristic frequency. Dither amplitudes are set for a range of 2% to 12% (related to current or set point).

Dither signals have an influence on the characteristic curve of the current caused by a physical dynamic correlation. In some cases, this has an effect on the linearity from U to I.

9.4.5 Selection of set point S1.06 <E15>

This parameter is used in order to select the type of Analog set point S1.06. If the current input is selected than the measuring resistance is automatically activated. The following selection for the input is possible with parameter <E15>:

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

Table 18: <E15> selection

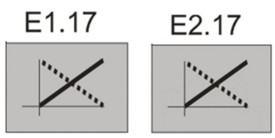
9.4.6 Selection of the pressure set point S1.05 <E16>

This parameter is used in order to select the type of analog set point S1.05. If the current input is selected than the measuring resistance is automatically activated.

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

Table 19: <E16> selection

9.4.7 Signal inversion <Ex.17>



This parameter can be used to adjust the controller output signal to match the valve design. For example, it can be used to set the maximum current to correspond to the maximum flow/pressure, or vice versa.

<E17>	Signal inversion
off	Signal is not inverted: 0 V input == 0V output 10V input == 10V output
1	Signal inverted: 0 V input == 10V output 10V input == 0V output

9.4.8 Selection of the pressure set point S1.07 <E32>

This parameter is used in order to select the type of analog set point S1.07. If the current input is selected than the measuring resistance is automatically activated.

<E32>	S1.07 Input signal range	Cable fraction detection
off	Input is deactivated	-
2	Voltage input 0 V … +10 V.	-
6	Current 0 … 20 mA	-
8	Current 4 … 20 mA	-
9	Current 4 … 20 mA	Yes

Table 20: <E16> selection

9.4.9 Analog output <E 31>, <E 19>, E 33>, <E 34>, <E 35>

The signal defined with parameter <E01> is automatically linked to as an analog signal to the “Analog output” at terminal 10b. This signal is available as a voltage with the range of 0 ... ± 10 V or as a current signal 4 … 20mA with 12 Bit resolution.
The type of signal, voltage or current, can be specified with parameter <E31>.

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

Table 21: <E31> selection

If the amplifier card is used as a controller without a valve, this signal is used to control the subsequent electronics.

- <E31>, with this parameter voltage or current output at pin [10b] is selected
- <E19>, <E35> can assign a factor to the output signal
- <E33>, <E34> an offset to the output signal can be defined.

10 Bus-Relevant parameters

This section is only applicable when using a bus interface.

10.1 EtherNet-IP parameters

Parameter setting example with HCSTool:

E 22	on		BUS activation
E 23	0,000	s	BUS timeout, at 0s the function is deactivated
E 37	192		IP-address "aaa" from "aaa.bbb.ccc.ddd"
E 38	168		IP-address "bbb" from "aaa.bbb.ccc.ddd"
E 39	1		IP-address "ccc" from "aaa.bbb.ccc.ddd"
E 40	0		IP-address of low-byte DIP switch "ddd" (read only)
E 41	12		Input buffer length in byte
E 42	12		Output buffer length in byte

Figure 14 : EIP parameter

Communication with the DAC-42(A) via the EtherNet/IP interface is explained in detail in the document DAC-42(A) EtherNet/IP Manual E Rx_x YYYYMMTT.pdf

10.2 Display parameters <dx.xx>

Example: d 1.01

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

10.3 Evaluation of the controller parameters

10.3.1 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}

$T_{ab} = 45\ \mu s$

10.3.2 Loop Q and Pressure Limiter

$U_p(t) = kp * e(t)$
$U_D(t) = kd * de(t)/dt$
$U_I(t) = ki * e(t)*t$
$U_{dff}(t) = k_{dff} * s(t)$

PT1: $u_a = Kp * \ - (T1p * du_a / dt)$
DT1: $u_a = Kd * du_e / dt - (T1d * du_a / dt)$

Kp = Cx.13 (evaluation of threshold Cx.15 refer to the chapter above)
Kp = Cx.16 (evaluation of threshold Cx.15 refer to the chapter above)
Kd = Cx.18 * T_{ab}
Ki = Cx.17 / T_{ab}
k_{dff}= Cx.13
T1p = Cx.14 * T_{ab}
T1d = Cx.19 * T_{ab}
$T_{ab} = 100\ \mu s$
e(t) = lag error
s(t) = set point
ue = input voltage
ua = output voltage

10.4 General functional description

10.4.1 Flow control

Assumption: The pump operates exclusively in flow control mode, and the pressure limiting function is either not active or disabled.
The command for the desired flow is provided either by an analog command signal at <S1.06> or by the digital command signals <S1.01> and <S1.02>.
The ramp function allows the adjustment of the setpoint’s rate of change to match the system's responsiveness.
The card measures the actual position of the swash plate using an appropriate sensor. This actual value is then compared with the command value, corresponding to <d1.10> versus <d1.12>. The resulting lag error (at <d1.12>) is used to control the swash plate angle and thus regulate the flow. The swash plate angle and flow can be considered proportional to each other without accounting for the pump's efficiency.
The output signal of the swash plate angle controller—defined by the input from <d1.12> and the controller parameter settings—is used to drive a proportional valve or pressure valve. The flow or pressure reduction within the valve itself drives the pump actuator. This system continuously monitors the swash plate angle and compensates by varying the flow/pressure at the valve’s connections to keep the actuator and thus the swash plate in the desired position.
When there are changes in the command signal, the controller responds and adjusts the actuator via the signal to the valve. Compensation continues until the lag error is reduced to “0”.
The swash plate angle controller is a specialized PID controller designed to enhance the performance (accuracy and dynamic behavior) of swash plate angle positioning.

10.4.2 Pressure limiting function

The DAC-4x(A) card measures the actual pressures using a pressure sensor. The pressure limiting function is activated as soon as the measured pressure reaches the limit set by the command signal. This limit can be specified either by an analog command signal at <S1.05> or by the digital command signals <S2.01> and <S2.02>.
The ramp function allows for the adjustment of the setpoint's rate of change to match the system's responsiveness.
The setpoint signal is normalized to the internal signal range of 0 V to 10 V through calculations in <C2.29> and <C2.30>.
When the pressure measured by the sensor reaches the setpoint pressure reduced by parameter <C2.07>, the integrator of the swash plate angle controller is frozen by the “Q-Freeze” signal. The “Q-Freeze” signal remains active until the actual pressure drops below the setpoint value. The controller output from branch 2 will increase in response to the pressure overshoot and control the connected pressure valve. This will reduce the pressure until the setpoint is reached.

The pressure limiting function is maintained by a specialized PID controller. The maximum input signal of 10 V (or 20 mA) corresponds to the real pressure specified in parameter <C2.30>.

10.4.3 Power/Torque limiting function

The DAC-4 card measures the actual pressures by means of a pressure sensor.
<u>If power limiting is selected:</u>
The flow is determined by the swash plate angle, the pump size (nominal flow value) and the drive rpm (value is automatically recalculated in each cycle). Both values than itself are used to calculate the actual power draw of the pump.

Generally speaking, will the power limiter function become active as soon as the actual power reaches the limit set by the command signal provided either by an analog command signal at <S1.09> or directly by the parameter <C6.05> if <C6.00> = 3.

<u>If torque limitation is selected</u>
The flow is determined by the swash plate angle, the pump size (nominal flow value) and the actual pressure (value is automatically recalculated in each cycle). Both values than itself are used to calculate the actual torque draw of the pump.

Generally speaking, the torque limiter function will become active as soon as the actual torque reaches the limit set by the command signal provided either by an analog command signal at <S1.09> or directly by the parameter <C6.05> if <C6.00> = 6.

10.4.4 Test and Monitoring

10.4.4.1 Test jacks

The sockets “A” and “B” can be used to measure the solenoid currents independently. The voltage is approximately 1 V at 1 A. The analog set point <S1.06> can be measured at the socket “SET”. The representation is 1:2 proportional to the measured value (half the set point voltage). At the socket “FB1” the analog actual value of the feedback at terminal [10d] can be measured. The reading is proportional to the actual value signal and has the relation of 1:2.

At the monitor socket “MON”, all display parameters are accessible in the form of an analog voltage being between -10V – +10 V.

In special cases, the signal of the “MON” socket can be directed at the connector X1 on the backside of the card at termina [6b].
For further information, please ask the manufacturer.

10.4.4.2 Display parameter

Internally calculated values can be displayed on the 4-digit display during normal operation and are especially helpful during commissioning and troubleshooting.
The values should be interpreted as voltage or current with a standardized display resolution of 1 mV to 9.999 V for currents between 0,001 A to 4,000 A. The relevant position in the software functions can be taken from the block diagrams. The polarity signs are represented through the LEDs “+” and “-“.

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

Display-Parameter Swash Plate Angle Controller (flow Q)	Function	Display-Parameter Pressure Limiter (pressure P)	Function
<d1.01>	Sum analog set values	<d2.01>	Sum analog set values
<d1.02>	Sum set values after ramp function	<d2.02>	Sum set values after ramp function
<d1.03>	Set points after linearization	<d2.03>	N/A
<d1.04>	Set values after gain adjustment	<d2.04>	N/A
<d1.05>	Signal to solenoid A	N/A	N/A
<d1.06>	Signal to solenoid B	N/A	N/A
<d1.07>	Current solenoid A	N/A	N/A
<d1.08>	Current solenoid B	N/A	N/A
<d1.09<	N/A	N/A	N/A

<d1.10>	Set point, reference input	<d2.10>	Set point, reference input
<d1.11>	Feedback value, controlled value	<d2.11>	Feedback value, controlled parameter
<d1.12>	Lag error, control difference	<d2.12<	Lag error, control difference
<d1.13>	Controller output, controlling variable	<d2.13>	Controller output, controlling variable
<d1.14>	Internal Q set value	<d2.14>	Actual value pressure (filtered)
N/A	N/A	<d2.15>	Actual value pressure [bar]
N/A	N/A	<d2.16>	Profibus address (in PROFIBUS is used
<d6.01>	Analog power/torque limiting	N/A	N/A
<d6.03>	Power limiting command in %	N/A	N/A
<d6.04>	Power limiting command in V	N/A	N/A

10.4.5 Output stages

- PWM output stages are used to reduce power losses.
- The pulse frequency is 22 kHz
- The output stages are equipped with over drive and high-speed breaking to increase dynamic response.
- The output stages are designed for constant currents of up to 3.5 A. each.
- Parameter <E1.03>, <E2.03> sets the nominal output current. There are different standard settings available further; there is an infinitely variable reduction possible with the parameter <E1.10>, <E2.10>.
- The settings can be made separately for both output stages. They operate completely independently of each other.

10.4.6 Analog output

The analog output is defined by <E01> or <E1.03> depending on the hardware used. The signal can be displayed as either an analog voltage or current on contact [10b]. This signal has a 12-bit resolution and can be used, for example, to control subsequent electronics. Various parameters are available to adjust the output to the required current or voltage values.

See □ Chapter "9.4.9 Analog output <E 31>", page 47

⚠ CAUTION
Please note, that changes of other parameters can have an effect on the voltage of this output. The final setting of parameter E19 should therefore only be done after the adjustment of all the other parameters has been performed.

10.4.7 Monitor output

For DAC-44(A) <u>with</u> front panel:

- The Monitor output which is directed to this output at the face plate. Always outputs the last selected display parameter <dx.xx> on the front panel (Jack MON) as an analog value.
- The parameter <E2.01> is not available.

For DAC-42(A) <u>without</u> front panel:
Using parameter <E2.01> (analog monitor output), each of the display values <d1.01> to <d1.13> can be displayed as an analog voltage on jack “MON”. This signal has a voltage of -10V to 10 V and 12 bit resolution.

⚠ CAUTION
Due to the nature of the analog output, a voltage of - 10.0 V will be present after applying supply voltage. If this should negatively affect your system, compensating measures must be taken.

10.5 Control circuit feedback signal adjustment (flow)

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

10.5.1 Adjustment of the actual value signal Fb1 (swash plate angle; flow)

The actual value for the flow control circuit is to be connected at terminal [10d]. Signal range can be:

- 0 ... 10 V
- for wide range asymmetrical signals and LVDT systems between 1,5 V and 13 V (range for middle voltage and voltage variation)
- 0 ... 20 mA or 4 ... 20 mA. The measuring resistance for current signals is 100 Ω.

To ensure utmost safety and best possible reproduction in a user-friendly way, all settings and adjustments are done digitally, supported by the hardware. All adjustments can be completed using the keyboard and controlling the display parameters. Through the 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 obvious.

If <C1.09> = 7, 10, 11, 12, 23 or 26, d1.11 will not show any values < 0.000

Step	Adjustment
Zero point adjustment / general case	
1	Put the output signal of the sensor in its zero position
2	Set amplifier to monitor <d1.11>
3	Save inverted <d1.11> value in <C1.11>
4	Check <d1.11> again, repeat step 2 and 3 if necessary
Amplifier adjustment	
1	Set the system to achieve a maximum actual value
2	Check <d1.11> display
3	Adjust amplifying with <C1.10>
4	Check <d1.11> result
5	Repeat steps 7 and 8 if necessary

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

The actual value signal is also available at the test jack “FB1”.

For DAC-44(A) with front panel:

- If <d1.11> is shown in the display, the actual value signal is available in the form of analog voltage at the test jack “MON”.

For DAC-42(A) without front panel:

- By using parameter <E2.01> (Monitor output), each of the displays <d1.01> to <d6.04> can be given in the form of analog voltage at terminal “MON”.

10.6 Pressure limiting control

Pressure sensors are either designed using two or three-wire technology. The transducers signal is current or Voltage (range from 0 ... 20 mA, 4 ... 20 mA or 0 … 10 V).

When connecting the pressure transducer great care is recommended. The zero-volt wiring, screening and PE connection are critical points. A fault in the signal can lead to a triggering of the wire break monitor or cause instabilities in the control system.

The scaling of the actual value signal is very important for a high-quality pressure control and also guarantees maximum resolution exploitation. The maximum pressure to be controlled is a key factor. The measuring range of the sensor must be as near as possible to the maximum control pressure. The measuring range of the sensor must be adapted to the pressure range of the process. Furthermore, special attention must be given to actual value amplification adjustment. At the controlled maximum pressure, the monitor <d1.11> should read 9.900.

<C2.09> is used in order to select the sensor type. This parameter must be set before other adjustments are made.

When setting the zero point, pumps - due to their design - often do not permit a setting of 0 bar or close 0 bar.

The pressure limiting function and the dynamic behavior are essentially determined by the system properties (pump size, valve design, flow rate, etc.), therefore a production pre-setting is not possible. Should amplification calculations not be possible, the adjustment of the controller must be determined by try and error.

⚠ CAUTION

Avoid control loop instability during adjustment since it may cause damage to the pump or machine.

10.7 Power / torque limiting control

Actual power or torque is automatically calculated by measuring actual pressure and flow (swash plate angle = flow). This calculated value is compared with the command value, defined either by the analog inputs or by <C6.09>.

If the calculated power is exceeding the command signal, then the flow will be reduced until it is meeting the defined max. power. A special filter (parameter <C6.06>) can be utilized in order to adapt to the dynamics of the system.

⚠ CAUTION

The correct power calculation and such power limiting function is depending on a proper setup of drive rpm, pump size and pressure sensors!

10.8 Control circuits with PPQ (flow, pressure and power/torque limiter)

The regulation of all three control loops is performed with a cycle speed of 100 µs. The first control loop is used for the flow control (swash plate angle control), the second loop is used for a pressure limiting function and the third loop takes care of the power limiting function.

Flow control is the basic function and the pressure as well the power limiter will override the flow control and may limit the pump output at any given moment if any of the defined limits is reached.

When using all three control loops, activate flow control loop first.

⚠ CAUTION

Due to their design, some pumps may not remain at center position when the flow control loop is not closed. This can cause significant flow from the pumps outlet port(s).

10.9 Comparator Functions <C1.21> to <C1.25>, <C2.21>

Parameter <C1.25> activates the comparator function and also defines which values are compared. The available values are the set point <d1.10>, the actual value <d1.11> and the deviation or lag error <d1.12>. The comparator is only applicable to the flow control.

See □ Chapter "9.1.15 Comparator <Cx.21> to <Cx.25>", page 37

In general, the comparator is always linked by a logical "AND" with the “enable” signal, thus, if the enable” signal is “low”, the comparator output will also be “low”.

The comparator can be used to generate a “set point reached” (“in position” for swash plate angle control) signal. Simple feedback value checks can thus be performed. The control deviation <d1.12> is the most useful comparative value <C1.25> = 3), the comparator output signal is dependent of the comparison result.

When the value is within the defined window (using parameters <C1.21> and <C1.22>), the “reset Ramp” is slowly flashing.

11 Inputs, outputs and messages

11.1 General

- All inputs and outputs are electrically isolated through opto-coupler.
- Outputs are short circuit protected (except the Break output).
- If no electrical isolation is required the following terminals must be bridged:
  [2d] to [26d], [32z] to [32bd]

11.2 Supply

The LED ”24V” lights up when the supply voltage is present.

11.3 Enable

- After the enable signal has been applied to terminal [8d], the LED ”EN” lights on. If a time delay had been set in parameter <E 09>, LED ”EN” flashes for the period of the delay.
- Once the time delay elapses, the flashing signal becomes a continuous signal and the output stages are enabled

11.4 Reset ramp (ramp = 0)

A 24 V signal at the reset ramp input = 0 (terminal [18z]) deactivates the ramp function generator immediately and the set points are ineffective. This is shown with the LED ”RPO”. Once the signal is switched off, the ramp function generator starts again from zero.

11.5 Fault (error)

- The current in the output stages is monitored in the amplifier. If the total current exceeds a specific threshold value, the output stages are switched off automatically. At the same time, the signal at the output ”Fault” (terminal [14d]) is set to 0 V. The LED ”ER” will flash red and the display will show the fault message ”---3”. LED ”EN” then stops flashing. By using any of the keys, the fault message disappears and new operations are possible. The fault message is displayed again after about 10 seconds. Until the fault is corrected, the LED ”ER” will stay activated and the LED ”EN” will be deactivated.

Malfunction signals should not be corrected by switching off the supply voltage but by taking off the enable signal (after correcting the cause of the malfunction), otherwise a diagnosis is no longer possible.

It is possible to continue the setting of the card even though the malfunction signal flashes. This allows to find the cause of the error and to correct it. Afterwards, the enable has to be reset (deactivated and activated).

11.6 Comparator output

The output is short circuit protected and can drive noninductive loads until 50 mA.
For special function of the output as comparator output refer to

See □ 10.9 Comparator Functions <C1.21> to <C1.25> page 52

11.7 Programmable set points, directions and polarity signs

- 4 LEDs indicate the selected set points (SP1 for <S1.01>; SP2 for <S1.02>; SP3 for <S2.01>; SP4 for <S2.02>)
- The LED's "+" and "-" are also used to show the polarity signs of all measured values and parameters.

11.7.1 LED function "IO3" at the HCSTool "p-Freeze"

The LED "IO3", "p-Freeze" indicates the value of the "P-Freeze" signal.
When "p-Freeze" == 1 → LED "on"
When "p-Freeze" == 0 → LED "off"
When the signal "p-Freeze" is active, the Integrator of the p-Control loop is deactivated.

11.7.2 HCSTool "Q-Freeze"

The LED "Q-Freeze" is used to indicate the value of the "Q-Freeze" signal.
When "Q-Freeze" == 1 → LED "on"
When "Q-Freeze" == 0 → LED "off"
When the signal "Q-Freeze" is active, the Integrator of the Q-Control loop is deactivated.

11.7.3 Display and error message

If an error occurs, it is displayed in the 7-segment display and in the HCSTool.
Defined error and other messages:

Error number	Description of error/message
1	Error of operation
2	Wire break sensor 1 (Fb1)
3	Excess current or short circuit at the output stages
4	Wire break sensor 2 (FB2)
5	Wire break or over voltage at set value input S1.05
6	Wire break or over voltage at set value input S1.06
7	Wire break or over voltage at set value input S1.07
8	Wire break at the output stages
10	Profibus timeout (E23) occurred
11	Negative or overload current >22mA sensor 1 (Fb1)
12	Negative or overload current >22mA sensor 2 (Fb2)
15	Negative or overload current >22mA at input S1.05
16	Negative or overload current >22mA at input S1.06
17	Negative or overload current >22mA at input S1.07

Table 22: List of error messages

Figure 15 : Example of Error message at the 7-segment display

⚠ CAUTION
The general and safety instructions of this manual must be observed in any case!

12 USB-C interface

12.1 Introduction

In industrial settings, the need for reliable and safe data and power transmission is paramount. USB-C, a versatile connector standard, has been widely adopted due to its high data transfer rates and power delivery capabilities. However, in harsh industrial environments, electronic systems are often exposed to noise, voltage surges, and grounding issues, which can cause damage or malfunction. Galvanic isolation is a crucial technology to mitigate these risks by electrically separating different sections of a system to prevent unwanted current flow, ensuring safety and protecting sensitive electronics.

⚠ WARNING
Drivers USB port is not isolated! **For protection, the use of isolator adapter is highly recommended**

12.2 Importance of Galvanic Isolation

Galvanic isolation is a method used to prevent electrical current from flowing directly between different parts of a system. It helps protect equipment and personnel from electrical shocks, reduces the risk of equipment damage due to electrical surges, and minimizes the interference caused by ground loops and noise. In industrial environments, where power lines and machinery can introduce significant electrical noise, galvanic isolation ensures reliable and accurate data transmission.

Applications in Industrial Environments
In industrial environments, USB-C ports can be used for connecting various devices, including sensors, controllers, and computers. By integrating galvanic isolation, these systems can achieve:

- **Protection Against Surges:** Industrial settings often face power surges, which can damage sensitive electronics. Galvanic isolation helps to protect USB-C connected devices from these surges.

Noise Reduction: Industrial machinery and long cable runs can introduce electrical noise. Isolated USB-C connections prevent noise from affecting data integrity.

- **Safety Enhancements:** Galvanic isolation can protect users from potential electric shocks by preventing direct electrical contact between high-voltage and low-voltage systems.

The HCS GmbH Galvanically Isolated USB Adapter is designed for industrial applications requiring secure and reliable data transfer between devices with differing ground potentials. This adapter provides isolation up to 1,500 volts, protecting both the host and connected devices from potential electrical surges, ground loops, and noise interference.

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

Key Features:

- Isolation Voltage: 1,500 V RMS
- Data Transfer Rate: Supports USB 2.0 with data rates up to 480 Mbps
- 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: Durable, industrial-grade casing for enhanced protection
- Application: Industrial control systems

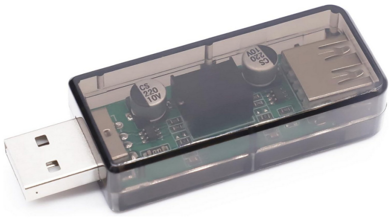


Figure 16 : Galvanically Isolated USB Adapter

12.3 General

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

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

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

12.4 Physical interface data

The connection cable must the following conditions:

- USB-C connector on the DAC-4x(A) side
- Depending on the PC the other side of the cable has to be selected (USB-A; USB-B or USB-C)

12.5 Downloading HCSTool

Please follow this link to download the most recent version of HCSTool free of charge:

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

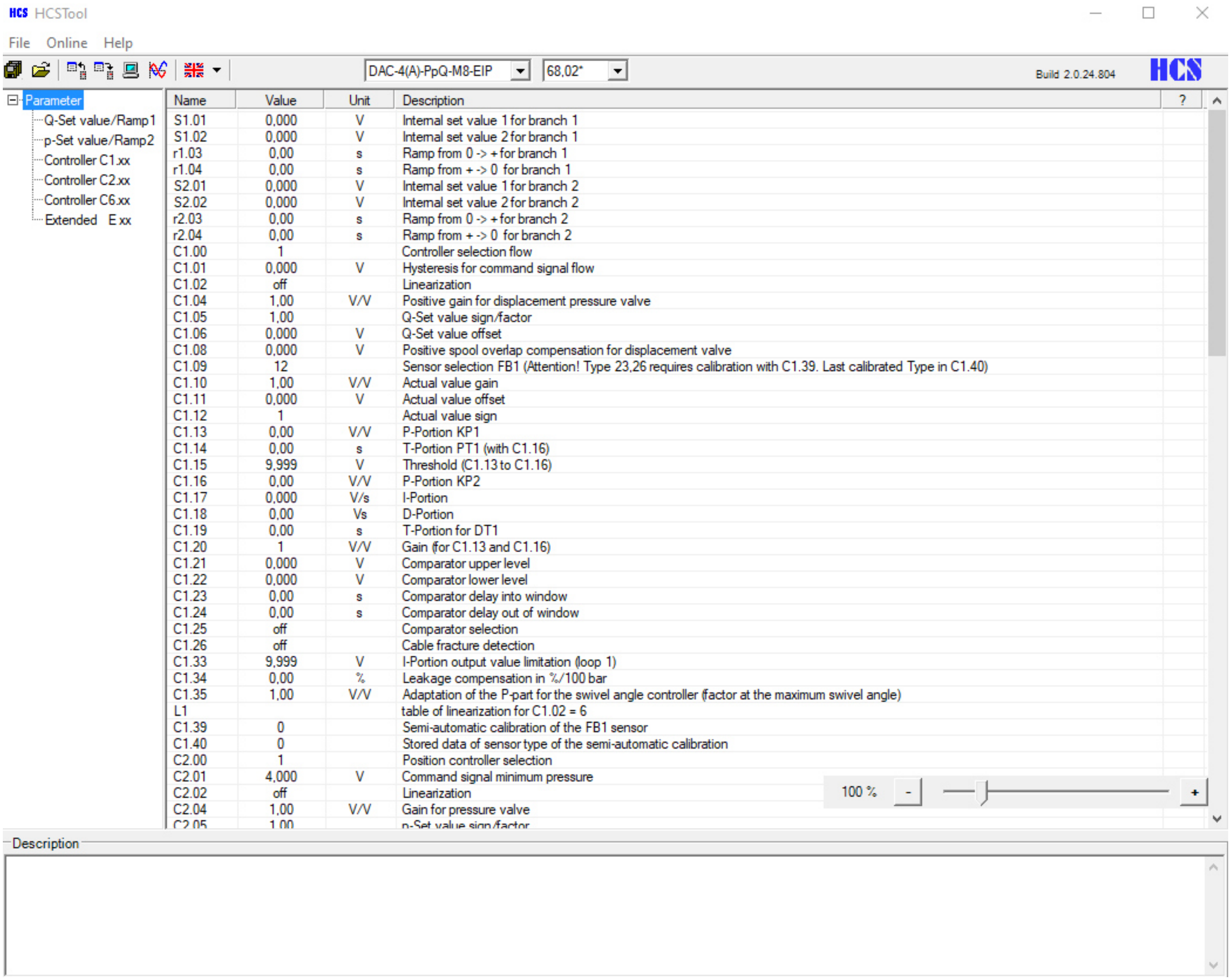
12.6 Using HCSTool

Figure 17 : HCSTool start screen

After starting HCSTool the program can either be used “offline” (without having a unit connected) or “online” in direct operation with a card.

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

Example of HCSTool main screen (DAC-4x(A)-xPpQ with software version V63.02).



Name	Value	Unit	Description
S1.01	0,000	V	Internal set value 1 for branch 1
S1.02	0,000	V	Internal set value 2 for branch 1
r1.03	0,00	s	Ramp from 0 -> + for branch 1
r1.04	0,00	s	Ramp from + -> 0 for branch 1
S2.01	0,000	V	Internal set value 1 for branch 2
S2.02	0,000	V	Internal set value 2 for branch 2
r2.03	0,00	s	Ramp from 0 -> + for branch 2
r2.04	0,00	s	Ramp from + -> 0 for branch 2
C1.00	1		Controller selection flow
C1.01	0,000	V	Hysteresis for command signal flow
C1.02	off		Linearization
C1.04	1,00	V/V	Positive gain for displacement pressure valve
C1.05	1,00		Q-Set value sign/factor
C1.06	0,000	V	Q-Set value offset
C1.08	0,000	V	Positive spool overlap compensation for displacement valve
C1.09	12		Sensor selection FB1 (Attention! Type 23,26 requires calibration with C1.39. Last calibrated Type in C1.40)
C1.10	1,00	V/V	Actual value gain
C1.11	0,000	V	Actual value offset
C1.12	1		Actual value sign
C1.13	0,00	V/V	P-Portion KP1
C1.14	0,00	s	T-Portion PT1 (with C1.16)
C1.15	9,999	V	Threshold (C1.13 to C1.16)
C1.16	0,00	V/V	P-Portion KP2
C1.17	0,000	V/s	I-Portion
C1.18	0,00	Vs	D-Portion
C1.19	0,00	s	T-Portion for DT1
C1.20	1	V/V	Gain (for C1.13 and C1.16)
C1.21	0,000	V	Comparator upper level
C1.22	0,000	V	Comparator lower level
C1.23	0,00	s	Comparator delay into window
C1.24	0,00	s	Comparator delay out of window
C1.25	off		Comparator selection
C1.26	off		Cable fracture detection
C1.33	9,999	V	I-Portion output value limitation (loop 1)
C1.34	0,00	%	Leakage compensation in %/100 bar
C1.35	1,00	V/V	Adaptation of the P-part for the swivel angle controller (factor at the maximum swivel angle)
L1			table of linearization for C1.02 = 6
C1.39	0		Semi-automatic calibration of the FB1 sensor
C1.40	0		Stored data of sensor type of the semi-automatic calibration
C2.00	1		Position controller selection
C2.01	4,000	V	Command signal minimum pressure
C2.02	off		Linearization
C2.04	1,00	V/V	Gain for pressure valve
C2.05	1,00		p-Set value sign/factor

Figure 18 : HCSTool working area screen

Each parameter can be edited individually and either directly changed in the card (selecting download) or only in the PC list (OK). In the latter case the parameter will be highlighted. Finally, all changed parameters can be downloaded.

Example for editing of parameter <C1.01>:

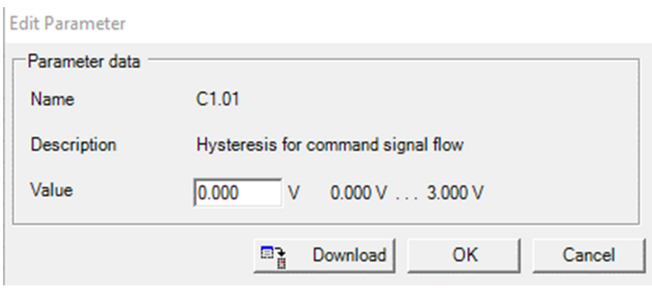


Figure 19 : HCSTool Parameter editing

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

Remark: The monitor also will display error codes and status of digital inputs.

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

13 List of parameters

		SW version
	Standard version with front plate and keypad	V67.xx
2	Parameters only available for bus versions	V68.xx,V69.xx
3	Parameters only available for PROFIBUS versions	
4	Parameters only available for EtherNet/IP versions	V68.xx

All values in decimal, for usage as data values they must be converted into Hex
R = read only parameter.
X = implemented, but not active (no access)
W/R = writing and reading possible.

13.1 Parameter for set values

ID_{Hex}	ID_{dec}	W/R	Name	Function	Unit	Min	Max	Def	Description
0x1F	31	R/W	A1.01	Bus set value (Flow)	V	0	9999	-	0 == -0.000 V; 1000 == 1.000 V This value is, when written, always active. Cleared by reset, or writing “0”. For switching off of the analog set-value, set E24 = “0”
0x20	32	R/W	A1.02	Bus set value (Pressure)	V	0	9999	-	0 == 0.000 V; 1000 == 1.000 V This value is, when written, always active. Cleared by reset, or writing “0”. For switching off of the analog set-value, set E25 = “0”
0x27	39	R/W	A2.01	Bus set value power	V	0	9999	-	0 == 0.000 V; 1000 == 1.000 V This value is, when written, always active. Cleared by reset, or writing “0”. For switching off of the analog set-value, set E26 = “0”

13.2 Complete list

ID_{Hex}	ID_{dec}	W/R	Name	Function	Unit	Min	Max	Def	Description
0x00	0	R	Vers	Software version	---	xx.xx	xx.xx	xx.xx	Depends on HW and SW version
0x01	1	R	d1.01	Sum of analog set value	V	-9999	9999	-	-1000 == -1.000 V; 1000 == 1.000 V
0x02	2	R	d1.02	Sum of all post ramp set values	V	-9999	9999	-	
0x03	3	R	d1.03	Set values after linearization	V	-9999	9999	-	
0x04	4	R	d1.04	Value after gain adjustment.	V	-9999	9999	-	
0x05	5	R	d1.05	Signal A	V	-9999	9999	-	
0x06	6	R	d1.06	Signal B	V	-9999	9999	-	
0x07	7	R	d1.07	Current A	A	0	5000	-	1000 == 1.000 A
0x08	8	R	d1.08	Current B	A	0	5000	-	
0x09	9	-	-	Reserved	-	-	-	-	
0x0A	10	R	d1.10	Desired value	V	-9999	9999	-	-1000 == -1.000 V; 1000 == 1.000 V
0x0B	11	R	d1.11	Actual value, feedback value	V	-9999	9999	-	
0x0C	12	R	d1.12	Lag error	V	-9999	9999	-	
0x0D	13	R	d1.13	Controller output	V	-9999	9999	-	
0xA6	166	R	d1.14	Internal Q-Set value	V	-9999	9999	-	
0x0E	14	R	d2.01	Sum of analog set value	V	-9999	9999	-	
0x0F	15	R	d2.02	Sum of all post ramp set values	V	-9999	9999	-	
0x10	16	R	d2.03	Set values after linearization	V	-9999	9999	-	
0x11	17	R	d2.04	Value after gain adjustment.	V	-9999	9999	-	
0x12	18	R	d2.10	Desired value	V	-9999	9999	-	
0x13	19	R	d2.11	Actual value, feedback value	V	-9999	9999	-	
0x14	20	R	d2.12	Lag error	V	-9999	9999	-	
0x15	21	R	d2.13	Controller output	V	-9999	9999	-	
0xA7	167	R	d2.14	Actual pressure (after filter)	V	-9999	9999	---	---
0xA8	168	R	d2.15	Regulated pressure	bar	0	600	---	1 == 1 bar
0xB5	181	R	d2.16	Profibus Address	-	0	127	-	
0xA9	169	R	d6.01	Command signal power/torque	V	-9999	9999	---	1000 == 1.000 V
0xAA	170	R	d6.03	Power/torque limit command [%]	%	-9999	9999	---	9999 == 99.99%
0xAF	175	R	d6.04	Nominal Power/torque [V]	V	-9999	9999	---	1000 == 1.000 V
0x16	22	R/W	S1.01	Set Value1 (Flow)	V	-9999	9999	0	1000 == -1.000 V; 1000 == 1.000 V
0x17	23	R/W	S1.02	Set Value2 (Flow)	V	-9999	9999	0	
0x18	24	-	S1.03	Reserved	-	-	-	-	
0x19	25	-	S1.04	Reserved	-	-	-	-	
0x1A	26	-	S1.08	Reserved	-	-	-	-	---
0x1B	27	-	r1.01	Reserved	-	-	-	-	1 == 10ms
0x1C	28	-	r1.02	Reserved	-	-	-	-	0 == Ramp function off

ID_{Hex}	ID_{dec}	W/R	Name	Function	Unit	Min	Max	Def	Description
0x1D	29	R/W	r1.03	Ramp from 0 -> + (Flow)	s	0	3950	0	
0x1E	30	R/W	r1.04	Ramp from + -> 0 (Flow)	s	0	3950	0	
0x1F	31	R/W	A1.01	Bus set value (Flow)	V	-9999	9999	0	-1000 == -1.000 V; 1000 == 1.000 V This value is, when written, always active. Cleared by reset, or writing "0". For switching off of the analog set-value, set E24 = "0"
0x20	32	R/W	A1.02	Bus set value (Pressure)	V	-9999	9999	0	0 == 0.000 V; 1000 == 1.000 V This value is, when written, always active. Cleared by reset, or writing "0". For switching off of the analog set-value, set E25 = "0"
0x21	33	R/W	S2.01	Set Value1 (Pressure)	V	-9999	9999	0	-1000 == -1.000 V; 1000 == 1.000 V
0x22	34	R/W	S2.02	Set Value2 (Pressure)	V	-9999	9999	0	
0x23	35	-	r2.01	Reserved	-	-	-	-	1 == 10ms 0 == Ramp function off
0x24	36	-	r2.02	Reserved	-	-	-	-	
0x25	37	R/W	r2.03	Ramp from 0 -> + (Pressure)	S	0	3950	0	
0x26	38	R/W	r2.04	Ramp from + -> 0 (Pressure)	S	0	3950	0	
0x27	39	R/W	A2.01	Profibus set value power	V	-9999	9999	0	0 == 0.000 V; 1000 == 1.000 V This value is, when written, always active. Cleared by reset, or writing "0".
0x28	40	-	-	Reserved	-	-	-	-	-
0x29	41	R/W	C1.00	Controller selection	---	0	3	1	0 = off 1 = P-PT_1-I-DT_1 2 = not applicable 3 = dff
0x2A	42	R/W	C1.01	Hysteresis for command signal Flow	---	-9999	9999	0	-1000 == -1.000 V; 1000 == 1.000 V
0x2B	43	R/W	C1.02	Linearization	---	0	6	0	0 = linear 1 ... 5 = standard curves 6 = customized curve
0x2C	44	-	-	Reserved	-	-	-	-	-
0x2D	45	R/W	C1.04	Positive gain for displacement pressure valve	V/V	0	200	100	100 == Factor 1.00
0x2E	46	R/W	C1.05	Q-Set value sign/factor	-	-400	+400	100	-100 == Factor 1.00
0x2F	47	R/W	C1.06	Q-Set value offset	V	-9999	9999	0	-1000 == -1.000 V; 1000 == 1.000 V
0x30	48	-	-	Reserved	-	-	-	-	1000 == 1.000 V
0x31	49	R/W	C1.08	Positive spool overlap compensation for displacement valve	V	0	9999	0	9.999 V = max. current depending on solenoid selection
0x32	50	R/W	C1.09	Sensor type swash angle Attention: No negative controller output possible when 7, 10, 11, 12, 23 and 26 is selected!	---	7	16	12	7 = 3.4 V … 1.5 V (positive contr. outp. only) 10 = 0…20 mA (positive contr. outp. only) 11 = 4…20 mA (positive contr. outp. only) 12 = 0...10 V (positive contr. outp. only) 23 = unipol. voltage (positive contr. outp. only) 26 = unipol. current (positive contr. outp. only)
0x33	51	R/W	C1.10	Actual value gain	V/V	0	400	100	100 == Factor 1.00
0x34	52	R/W	C1.11	Actual value offset	V	-9999	9999	0	-1000 == -1.000 V; 1000 == 1.000 V
0x35	53	R/W	C1.12	Actual value sign	---	- 1	+ 1	1	- 1 = negative 0 = off + 1 = positive
0x36	54	R/W	C1.13	P-Portion K_{P1}	V/V	0	400	0	100 == Factor 1.00
0x37	55	R/W	C1.14	T-Portion for PT1 (to C1.16)	S	0	1000	0	100 == 1.00
0x38	56	R/W	C1.15	Threshold <C1.13, C1.16)	V	0	9999	9999	1000 == 1.000 V
0x39	57	R/W	C1.16	P-Portion K_{P2}	V/V	0	400	0	100 == Factor 1.00
0x3A	58	R/W	C1.17	I-Portion	V/s	0	4000	0	1000 == 1.000
0x3B	59	R/W	C1.18	D-Portion	Vs	0	400	0	100 == 1.00
0x3C	60	R/W	C1.19	T-Portion for DT1	S	0	1000	0	100 == 1.00
0x3D	61	R/W	C1.20	Gain (C1.13 and C1.16)	V/V	1	32	1	2 = Factor 2.00
0x3E	62	R/W	C1.21	Comparator upper level	V	-9999	9999	0	-1000 == -1.000 V; 1000 == 1.000 V
0x3F	63	R/W	C1.22	Comparator lower level	V	-9999	9999	0	
0x40	64	R/W	C1.23	Comparator delay into window	S	0	9999	0	1 == 10 ms 0 == no delay
0x41	65	R/W	C1.24	Comparator delay out of window	S	0	9999	0	
0x42	66	R/W	C1.25	Comparator selection COMP_1	---	0	3	0	0 = off 1 = Set value 2 = Actual value 3 = Lag error
0x43	67	R/W	C1.26	Cable fracture detection feedback	---	0	1	0	0 = off; 1 = active
0xb3	179	R/W	C1.33	I-portion output value limitation	V	0	9999	9999	1000 == 1.000 V

ID_{Hex}	ID_{dec}	W/R	Name	Function	Unit	Min	Max	Def	Description
0xC9	201	R/W	C1.34	Leakage compensation	%/100 bar	1	500	0	1 == 0.01
0xCA	202	R/W	C1.35	Adaptation of P-part for swivel angle controller (factor at maximum swivel angle)	V/V	100	500	100	100 == 1.00
0xb7	183	--	C1.39	Reserved	-	-	-	-	-
0xE3	227	--	C1.40	Reserved	-	-	-	-	-

ID_{Hex}	ID_{dec}	W/R	Name	Function	Unit	Min	Max	Def	Description
0x44	68	R/W	C2.00	Controller selection	---	0	2	1	0 = off 1 = Pressure limiter active 2 = Pressure limiter selected by DIO1
0x45	69	R/W	C2.01	Pressure command signal minimum	V	0	9999	0	1000 == 1.000 V
0x46	70	R/W	C2.02	Linearization	---	0	6	0	0 = linear 1 ... 5 = standard curves 6 = customized curve
0x47	71	R/W	C2.03	Reserved	-	-	-	-	-
0x48	72	R/W	C2.04	Gain for pressure valve	V/V	0	200	100	100 == Factor 1.00
0x49	73	R/W	C2.05	p-Set value sign/factor	-	-400	+400	100	-100 == Factor 1.00
0x4A	74	R/W	C2.06	p-Set value offset	V	-9999	9999	0	-1000 == -1.000 V; 1000 == 1.000 V
0x4B	75	R/W	C2.07	Factor for generating the 'Q-Freeze' signal (percentage difference from actual pressure)	%	0	9999	9000	9999 == 99.99 %
0x4C	76	R/W	C2.08	Spool overlap compensation for pressure valve	V	0	9999	0	1000 == 1.000 V
0x4D	77	R/W	C2.09	Sensor type pressure Attention: No negative controller output possible when 10, 11 or 12 is selected!	---	10	12	12	10 = 0..20 mA (positive contr. outp. only) 11 = 4..20 mA (positive contr. outp. only) 12 = 0..10 V (positive contr. outp. only)
0x4E	78	R/W	C2.10	Actual value gain	V/V	0	400	100	100 == Factor 1.00
0x4F	79	R/W	C2.11	Actual value offset	V	-9999	9999	0	-1000 == -1.000 V; 1000 == 1.000 V
0x50	80	R/W	C2.12	Actual value sign	---	- 1	+ 1	1	- 1 = negative 0 = off + 1 = positive
0x51	81	R/W	C2.13	P-Portion K_{P1}	V/V	0	400	0	100 == Factor 1.00
0x52	82	R/W	C2.14	T-Portion for PT1 (to C1.16)	S	0	1000	0	100 == 1.00
0x53	83	R/W	C2.15	Threshold <C1.13, C1.16)	V	0	9999	9999	1000 == 1.000 V
0x54	84	R/W	C2.16	P-Portion K_{P2}	V/V	0	400	0	100 == Factor 1.00
0x55	85	R/W	C2.17	I-Portion	V/s	0	4000	0	1000 == 1.000
0x56	86	R/W	C2.18	D-Portion	Vs	0	400	0	100 == 1.00
0x57	87	R/W	C2.19	T-Portion for DT1	S	0	1000	0	100 == 1.00
0x58	88	R/W	C2.20	Gain <C1.13 and C1.16)	V/V	1	32	1	2 = Factor 2.00
0x59	89	R/W	C2.21	Comparator upper level	V	-9999	9999	0	-1000 == -1.000 V; 1000 == 1.000 V
0x5A	90	R/W	C2.22	Comparator lower level	V	-9999	9999	0	
0x5B	91	R/W	C2.23	Comparator delay into window	S	0	9999	0	1 == 10 ms
0x5C	92	R/W	C2.24	Comparator delay out of window	S	0	9999	0	0 == no delay
0x5D	93	R/W	C2.25	Comparator selection COMP_2	---	0	3	0	0 = off 1 = Set value 2 = Actual value 3 =Lag error
0x5E	94	R/W	C2.26	Cable fracture detection feedback	---	0	1	0	0 = off; 1 = active
0xAB	171	R/W	C2.27	Upper threshold for the "p-Freeze" signal	V	-9999	9999	200	-1000 == -1.000 V; 1000 == 1.000 V
0xAC	172	R/W	C2.28	Lower threshold for the "p-Freeze" signal	V	-9999	9999	-200	-1000 == -1.000 V; 1000 == 1.000 V
0xAD	173	R/W	C2.29	Pressure sensor range	bar	100	600	600	
0xAE	174	R/W	C2.30	Rated pressure pump	bar	100	450	300	
0xB4	180	R/W	C2.33	I-portion output value limitation	V	0	9999	9999	1000 == 1.000 V

ID_{Hex}	ID_{dec}	W/R	Name	Function	Unit	Min	Max	Def	Description
0xC2	194	R/W	C6.00	Mode of operation power/torque limiter	---	0	6	0	0 = limiter off 1 = Power limiter with analog and digital input active 2 = Power limiter active by input DIO2 3 = Power limiter active 100%, analog inputs de-activated 4 = Torque limiter with analog input active 5 = Torque limiter active by input DIO2 6 = Torque limiter active 100%, analog inputs de-activated
0xC3	195	R/W	C6.03	Drive rpm	1/min	500	2000	1500	
0xC4	196	R/W	C6.04	Maximum pump displacement	ccm/ rmp	45	1000	45	45 == 45 ccm/rmp
0xC5	197	R/W	C6.05	Maximum drive power nominal corner torque of the drive	kW Nm	10 200	999 8000	125 500	200 == 200 Kw 200 == 200 Nm
0xC6	198	R/W	C6.06	Actual value filter for power limiter Actual value filter for torque limiter	---	0	8	4	Filter factor 0 == no Filter, 8 == maximal filter
0xC7	199	R/W	C6.07	Pump zero position for power and torque limitation	---	-1000	1000	100	100 == 10.00 %
0xC8	200	R/W	C6.08	Factor of corner torque	---	0	9999	9999	9999 == 99.99 %
0xD6	214	R/W	C6.09	Digital power/torque setpoint at C6.00 = 3,6	V	0	9999	9999	1000 == 1.000 V

ID_{Hex}	ID_{dec}	W/R	Name	Function	Unit	Min	Max	Def	Description
0x5F	95	R	E00	Operation mode	---	8	8	8	PpQ control
0x60	96	R/W	E01 E1.01	Analog output	---	0	13 and 27	27	1 = d1.01 to 13 = d1.13 and 15 = d2.01 to 27 = d6.04
0xD8	216	R/W	E2.01	Monitor output	---	0	13 and 27	27	1 = d1.01 to 13 = d1.13 and 15 = d2.01 to 27 = d6.04
0x61	97	R/W	E02	Push-Pull function (depends on HW + SW version)	---	0	1	0	0 = off (no push pull) 4 = off + detection low current to solenoid
0x62	98	R/W	E1.03	Solenoid selection Solenoid selection A (depends on HW + SW version)	---	1	7	6	Standard solenoid definition 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
0x9B	155	R/W	E2.03	Solenoid selection Solenoid selection B (depends on HW + SW version)	---	1	7	6	Standard solenoid definition 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
0x63	99	R	E1.04	P-Portion current contr. Energization A	---	500	9999	500	Default for 2,700 A solenoid
0x9C	156	R	E2.04	P-Portion current contr. Energization B	---	500	9999	500	
0x64	100	R	E1.05	I-Portion current contr. Energization A	---	500	9999	500	
0x9D	157	R	E2.05	I-Portion current contr. Energization B	---	500	9999	500	
0x65	101	R	E1.06	P-Portion cur. contr. de- energization A	---	1300	9999	1300	
0x9E	158	R	E2.06	P-Portion cur. contr. de- energization B	---	1300	9999	1300	
0x66	102	R	E1.07	I-Portion cur. contr. De- energization A	---	500	9999	500	
0x9F	159	R	E2.07	I-Portion cur. contr. De- energization B	---	500	9999	500	
0x67	103	--	E08	Reserved	-	-	-	-	-
0x68	104	R/W	E09	Time delay enable signal	s	0	9999	0	1000 = 1.00 s
0x69	105	R/W	E1.10	Solenoid current adaptation A	---	50	110	100	Variable adjustment of max. current 100 == Factor 1.00
0xA0	160	R/W	E2.10	Solenoid current adaptation B	---	50	110	100	Variable adjustment of max. current 100 == Factor 1.00
0x6A	106	R/W	E11	Initial current solenoid A	V	0	9999	0	3.000 V = 30 % of max. rated current
0x6B	107	R/W	E12	Initial current solenoid B	V	0	9999	0	
0x6C	108	R/W	E1.13	Dither Amplitude A	V	0	3000	0	
0xA1	161	R/W	E2.13	Dither Amplitude B	V	0	3000	0	
0x6D	109	R/W	E1.14	Dither Frequency A	Hz	1	300	0	---
0xA2	162	R/W	E2.14	Dither Frequency B	Hz	1	300	0	---

IDHex	IDdec	W/R	Name	Function	Unit	Min	Max	Def	Description
0x6E	110	R/W	E15	Selection of Q-setpoint S1.06	---	0	9	2	off = Deactivated 1 = not applicable 2 = Voltage 0...10 V 3 ... 5 = not applicable 6 = 0...20 mA w/o cable fract. det. 7 = not applicable 8 = 4..20 mA w/o cable fract. det. 9 = 4..20 mA with cable fract. det.
0x6F	111	R/W	E16	Selection of Pressure setpoint S1.05	---	0	9	2	off = Deactivated 1 = not applicable 2 = Voltage 0...10 V 3 ... 5 = not applicable 6 = 0...20 mA w/o cable fract. det. 7 = not applicable 8 = 4..20 mA w/o cable fract. det. 9 = 4..20 mA with cable fract. det.
0x70	112	R/W	E1.17	Signal inversion for branch 1, displacement valve	---	0	1	0	0 = off 1 = on
0x9A	154	R/W	E2.17	Signal inversion for branch 2, pressure valve	---	0	1	0	0 = off 1 = on
0x71	113	R/W	E18	Break and comparator output	---	0	13	0	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
0x72	114	R/W	E19	Factor for analog voltage output	V/V	-200	200	100	100 == Factor 1.00 Sign and gain!
0xA3	163	R	E 22	Activate/Deactivate bus function	---	0	1	0	0 = No bus function 1 = Standard bus function
0xB1	177	R/W	E23	BUS timeout	s	0	9999	0	1000 == 1 s, 0 = function off
0xB2	178	R/W	E26	BUS timeout error handling	---	0	1	0	0 = Bus timeout causes only error LED to flash (no internal error) 1 = bus timeout causes error
0xD2	210	R/W	E31	Mode of the analog output	---	1	2	1	1 = Voltage mode 0 V ± 10 V active 2 = Current mode 12 mA ± 8 mA active
0xD3	211	R/W	E32	Selection of setpoint S1.07	---	0	9	2	off = Deactivated 1 = not applicable 2 = Voltage 0...10 V 3 ... 5 = not applicable 6 = 0...20 mA w/o cable fract. det. 7 = not applicable 8 = 4..20 mA w/o cable fract. det. 9 = 4..20 mA with cable fract. det.
0xD4	212	R/W	E33	Offset for analog voltage output	V	-9999	9999	0	-1000 == -1.000 V; 1000 == 1.000 V
0xD5	213	R/W	E34	Offset for analog current output 4..20mA	V	-9999	9999	0	-1000 == -1.000 V; 1000 == 1.000 V
0xB6	182	R/W	E35	Factor for analog current output	V/V	-200	200	100	100 == Factor 1.00 Sign and gain!
0xCB	203	-	-	reserved	---	---	---	---	
0xCC	204	R/W	E37	IP-address "aaa" from "aaa.bbb.ccc.ddd"	---	0	255	192	
0xCD	205	R/W	E38	IP-address "bbb" from "aaa.bbb.ccc.ddd"	---	0	255	168	
0xCE	206	R/W	E39	IP-address "ccc" from "aaa.bbb.ccc.ddd"	---	0	255	1	
0xCF	207	R	E40	IP-address of low-byte DIP switch "ddd" (read only)	---	0	255	85	
0xD0	208	R/W	E41	Input buffer length in byte	---	0	32	12	
0xD1	209	R/W	E42	Output buffer length in byte	---	0	32	12	

ID_{Hex}	ID_{dec}	W/R	Name	Function	Unit	Min	Max	Def	Description
0xB0	176	R/W	E Int	Internal Digital Switches (Read/Set)	---	0	0xFFFF		0x0001 = Input **DIO1** active (Read/Write) 0x0002 = Input **DIO2** active (Read/Write) 0x0004 = Comp_1 (Read) 0x0008 = Comp_2 (Read) 0x0010 = Input **Dir+** active (Read/Write) 0x0020 = Input **Dir-** active (Read/Write) 0x0040 = Input **Ramp_0** active (Read/Write) 0x0100 = Input SP1 active (Read/Write) 0x0200 = Input SP2 active (Read/Write) 0x0400 = Enable active (Read only) 0x0800 = Error active (Read only) 0x1000 = Input SP3 active (Read/Write) 0x2000 = Input SP4 active (Read/Write) 0x4000 = General enabled (Read only) 0x8000 = Bus Disable Card (Read/Write)
0xE5	229	R	E sta	Internal status	---	0	0xFFFF		0x0400 = General enabled active 0x08xx = Error is detected. xx is the error number 0x1000 = Q-Freeze is active 0x2000 = p-Freeze limitation is active 0x4000 = P (power) M (torque) limitation is active Detailed explanation of xx error/warning number: 01 = General failure 02 = Wire break at yoke angle Sensor FB1 03 = Overvoltage or short circuit at solenoid connections 04 = Wire break at pressure sensor FB2 05 = Wire break or overload at pressure set value S1.05 06 = Wire break or overload at Q-set value S1.06 07 = Wire break or overload at P/M-set value input S1.07 08 = Wire break at solenoid connections 09 = PROFIBUS/PROFINET timeout (E23) occurred 11 = Overload of current >22mA swash plate sensor FB1 12 = Overload of current >22mA pressure sensor FB2 15 = Overload of current >22mA at pressure set value input S1.05 16 = Overload of current >22mA at Q-set value input S1.06 17 = Overload of current >22mA P/M-set value input S1.07

ID_{Hex}	ID_{dec}	W/R	Name	Function	Unit	Min	Max	Def	Description
0xE6	230	R/W	L1.x0	Linearization curve branch 1 [0,0]	V	0	0	0	1000 == 1.000 V
0xE7	232	R/W	L1.y0	Linearization curve [0,0]	V	0	9999	0	
0xE8	232	R/W	L1.x1	Linearization curve [1,1]	V	0	9999	1250	
0xE9	233	R/W	L1.y1	Linearization curve [1,1]	V	0	9999	1250	
0xEA	234	R/W	L1.x2	Linearization curve [2,2]	V	0	9999	2500	
0xEB	235	R/W	L1.y2	Linearization curve [2,2]	V	0	9999	2500	
0xEC	236	R/W	L1.x3	Linearization curve [3,3]	V	0	9999	3750	
0xED	237	R/W	L1.y3	Linearization curve [3,3]	V	0	9999	3750	
0xEE	238	R/W	L1.x4	Linearization curve [4,4]	V	0	9999	5000	
0xEF	239	R/W	L1.y4	Linearization curve [4,4]	V	0	9999	5000	
0xF0	240	R/W	L1.x5	Linearization curve [5,5]	V	0	9999	6250	
0xF1	241	R/W	L1.y5	Linearization curve [5,5]	V	0	9999	6250	
0xF2	242	R/W	L1.x6	Linearization curve [6,6]	V	0	9999	7500	
0xF3	243	R/W	L1.y6	Linearization curve [6,6]	V	0	9999	7500	
0xF4	244	R/W	L1.x7	Linearization curve [7,7]	V	0	9999	8750	
0xF5	245	R/W	L1.y7	Linearization curve [7,7]	V	0	9999	8750	
0xF6	246	R/W	L1.x8	Linearization curve [8,8]	V	0	9999	9999	
0xF7	247	R/W	L1.y8	Linearization curve [8,8]	V	9999	9999	9999	
0xF8	248	R/W	L2.x0	Linearization curve branch 2 [0,0]	V	0	0	0	1000 == 1.000 V
0xF9	249	R/W	L2.y0	Linearization curve [0,0]	V	0	9999	0	
0xFA	250	R/W	L2.x1	Linearization curve [1,1]	V	0	9999	1250	
0xFB	251	R/W	L2.y1	Linearization curve [1,1]	V	0	9999	1250	
0xFC	252	R/W	L2.x2	Linearization curve [2,2]	V	0	9999	2500	
0xFD	253	R/W	L2.y2	Linearization curve [2,2]	V	0	9999	2500	

ID$_{Hex}$	ID$_{dec}$	W/R	Name	Function	Unit	Min	Max	Def	Description
0xFE	254	R/W	L2.x3	Linearization curve [3,3]	V	0	9999	3750	
0xFF	255	R/W	L2.y3	Linearization curve [3,3]	V	0	9999	3750	
0x100	256	R/W	L2.x4	Linearization curve [4,4]	V	0	9999	5000	
0x101	257	R/W	L2.y4	Linearization curve [4,4]	V	0	9999	5000	
0x102	258	R/W	L2.x5	Linearization curve [5,5]	V	0	9999	6250	
0x103	259	R/W	L2.y5	Linearization curve [5,5]	V	0	9999	6250	
0x104	260	R/W	L2.x6	Linearization curve [6,6]	V	0	9999	7500	
0x105	261	R/W	L2.y6	Linearization curve [6,6]	V	0	9999	7500	
0x106	262	R/W	L2.x7	Linearization curve [7,7]	V	0	9999	8750	
0x107	263	R/W	L2.y7	Linearization curve [7,7]	V	0	9999	8750	
0x108	264	R/W	L2.x8	Linearization curve [8,8]	V	0	9999	9999	
0x109	265	R/W	L2.y8	Linearization curve [8,8]	V	9999	9999	9999	
..	..								

Table 23: Parameter list

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

Product:	Digital Amplifier and Controller 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

01.01.2024
Details of signatory: Dipl.-Ing. (FH) Peter Deuschle (General Manager)

Figure 20 : Declaration of conformity

- End -